



Type BA-7-A Audiomatic Limiting Amplifier

APPLICATION

The General Electric BA-7-A Audiomatic Limiting Amplifier is a peak-limiting device designed to permit a substantial increase in the average program level without danger of any audio peaks exceeding a predetermined level.

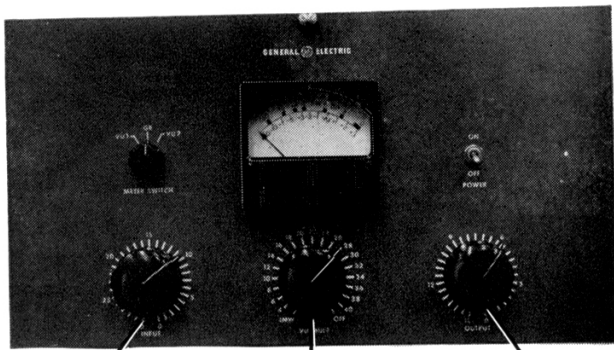
The output of the BA-7-A Audiomatic Limiting Amplifier is sufficient to drive any RETMA AM, FM, or TV audio transmitter to 100% modulation. It is readily adaptable for use in recording systems in the tape, disc, and motion picture sound recording industries. As such, it may be used either before or after pre-emphasis.

FEATURES

1. "Thumping" virtually eliminated. New design uses a new method for eliminating the "thump" component common to limiter actions.
2. Greater limiting range. The new Audiomatic Limiter incorporates a limiting range of 20 db, an increase of 8 db in limiting range over the popular G-E BA-5-A Limiter.

3. Higher output level. The new Audiomatic Limiter has an output level of +27 dbm, an increase of 15 dbm in output level as compared to the G-E BA-5-A Limiter.
4. New program controlled recovery circuit utilized. This circuit permits large amounts of gain reduction with a negligible pumping effect.
5. Two different types of recovery circuits offered. The conventional dual RC type may be used, or the new program controlled recovery circuit may be used.
6. Attack time effectively zero. 70 microsecond attack time is obtained by means of a high speed bias generator.
7. Extremely low transient waveform distortion.
8. Very high compression above threshold of gain reduction action.
9. "Motor-boating" can not occur since automatic control voltage is not a function of the output voltage of the controlled amplifier.
10. Very low steady state distortion and noise level due to inverse feedback circuits.

11. **Instant accessibility.** Vertical rack mounting chassis utilizes single hinged front-cover panel.
12. **Compact.** Entire unit measures only 10½" high by 9" deep, by 19" wide.
13. **Single unit.** All amplifiers and power supply are mounted on the one small chassis.
14. **One VU meter supplies all required readings.** Single VU meter is used to read input level to control amplifiers, gain reduction, output level of limiter, and for balancing of modulator.
15. **No matched tubes required.** The BA-7-A Audiomatic Limiting Amplifier uses only 18 tubes—none of which require matching.
16. **Plug-in connections.** All external connections are made on plugs. It is not necessary to solder or unsolder connections when installing or removing amplifier.
17. **Thoroughly shielded.** All transformers, oscillator, and R.F. power amplifier sections, plus tubes in R.F. section, are thoroughly shielded to prevent radiation and interaction.
18. **Excellent frequency response with low distortion** up to practical limit of gain reduction. (See Electrical Specifications.)



Input Level Control VU Meter Attenuator Output Level Control

Front panel of BA-7-A Amplifier

DESCRIPTION

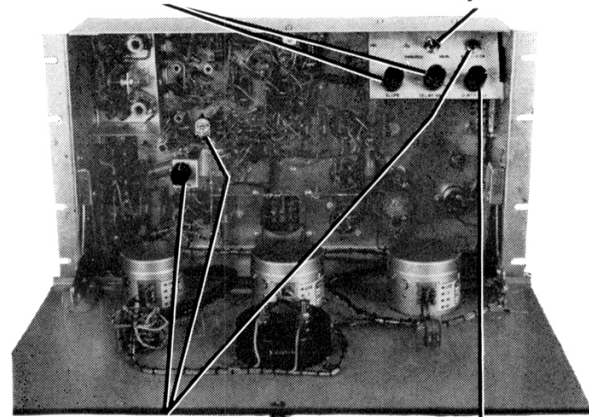
The General Electric Type BA-7-A Audiomatic Limiting Amplifier is designed as a fast-acting, thumpless, peak-limiting audio amplifier. As such it incorporates, among others, two new outstanding features, the first being a new and effective method of eliminating the "thump" component common to all limiter actions. The second outstanding feature is the incorporation of the new program controlled recovery circuit which permits the use of larger amounts of gain reduction with negligible pumping effect. These features are made possible by the use of a new method of limiting, namely the audio modulation of an RF carrier, the imposition of limiting action on this signal, and the demodulation of the RF to render a virtually thumpfree, peak-limited audio signal.

The use of this new design permits an 8 db increase in limiting range, a 15 db increase in output level, and a reduction in physical size as compared to the popular General Electric BA-5-A Limiting Amplifier. Attack

time is effectively zero—being limited to approximately 70 microseconds by means of a high speed generator. A switch is provided which will allow the amplifier to operate either on the new program controlled recovery circuit where large amounts of gain reduction are expected, or on the conventional dual RC recovery circuit. Should conditions require it, this amplifier may be used in a backward acting mode of operation.

Mechanically, the Audiomatic Limiting Amplifier is complete with power supply on one chassis. As such it requires only 10½" of vertical rack space, and 9" of rack depth. This vertical rack-mounted unit is equipped with a hinged front panel allowing instant accessibility to the internal controls and components. Only 110 watts of 110-125 volts AC power are required for its operation.

Adjustments for Proper Compression Characteristics Selects Dual R.C. or Program Control Recovery Circuit



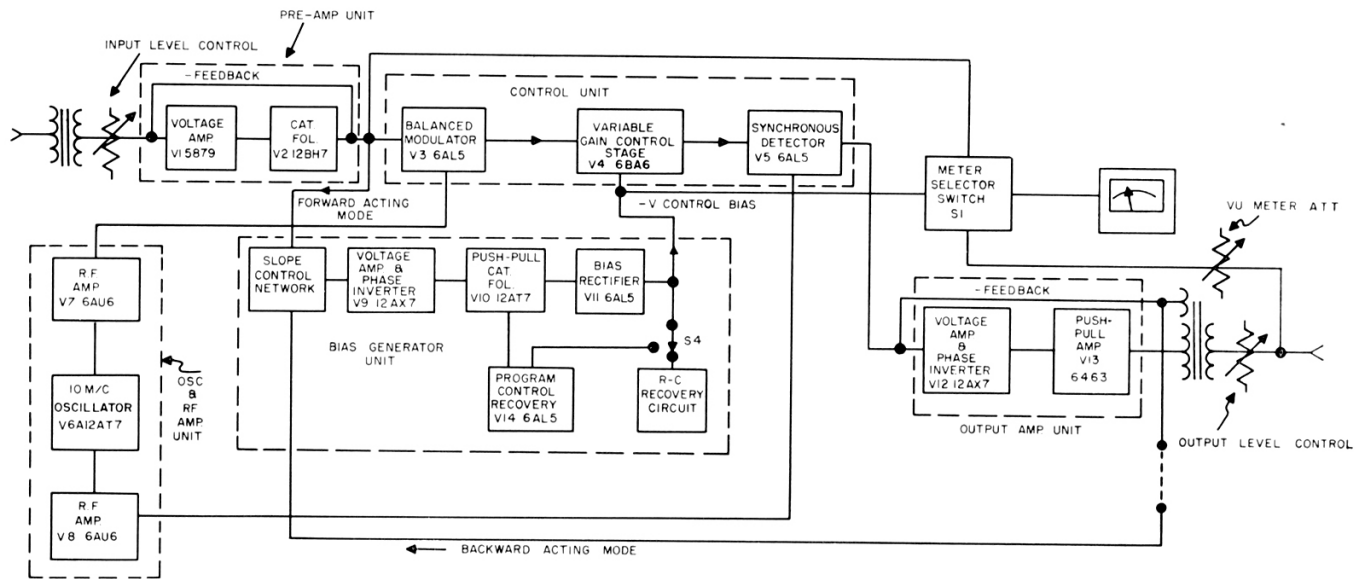
Controls for Adjusting Balance of Modulator Meter Zero Set for Gain Reduction Position

Front view of BA-7-A Amplifier with front panel open to show interior controls

All connections are made by means of a single 10-pin Cinch-Jones plug and a standard AC plug and receptacles, located on the rear of the amplifier chassis. A VU meter is used to measure signal levels and gain reduction.

Electrically, the Audiomatic Limiting Amplifier consists of an amplifier and power supply mounted on one chassis. The amplifier incorporates five sections: a preamplifier, an oscillator and RF section, a bias generator, a control section and an output stage.

The operation of the limiting amplifier on the audio signal is as follows: The incoming audio signal is fed into the loaded input of the preamp stage. From here the signal is split in two paths, the first going to the balanced modulator in the control section, and the second to the bias generator. The balanced modulator receives, in addition to the audio signal, a constant amplitude 10-megacycle carrier from the oscillator and RF amplifier section. This carrier is then amplitude modulated by the audio signal, the main carrier is suppressed, and the resulting output signal, consisting of modulated sidebands only, is fed to the variable gain RF stage in the control section. Simultaneously the audio fed to the bias generator section is first passed through a voltage correction network, through a slope control, then to a



Simplified block diagram of BA-7-A Amplifier

voltage amplifier, a phase splitter and then a push-pull cathode follower. The output of the cathode follower is split in two parts, the first being fed to the program control recovery circuit, the second being fed to a full wave rectifier diode. The variable DC voltage resulting from this latter diode's action is then applied to the grid of the variable gain RF stage in the control section. This variable DC voltage has the effect of controlling the amplitude of the audio modulated sidebands. Since there is no carrier present at the grid of this control stage, the low frequency or thump component, created by varying the control voltage, is not passed through the RF circuit and thus is not detected later. These controlled sidebands are then passed to a synchronous detector which also receives a 10-megacycle constant amplitude carrier from the oscillator and RF section. The carrier and controlled sidebands are recombined and the resultant audio is detected. The audio signal is then fed to a voltage amplifier, a phase splitter and then the push-pull output stage of the limiting amplifier. From a tertiary winding on the output transformer, voltage is fed back around the output unit. The secondary of the output transformer feeds the line through an output attenuator which is bridged by a VU multiplier attenuator. The VU meter is switched to read the output level, the amount of gain reduction, the input level to the balanced modulator, and can be used to check modulator balance.

Recovery of the amplifier is controlled by two different types of circuits, both located in the bias generator section. The first circuit is the conventional dual RC circuit. The second circuit is the new program controlled recovery circuit. This latter recovery control is obtained

by placing a diode in the discharge path of a capacitor in the recovery circuit. The diode is biased to an equivalent voltage of 15 db of gain reduction. The amplitude of the audio trigger voltage from the cathode-follower (bias generator) output is adjusted to produce an artificial verge of 3 db. Thus, below 3 db of gain reduction the diode will not conduct, resulting in a very slow discharge rate and consequent slow recovery time of the amplifier. Between 3 db and 20 db of gain reduction the audio trigger voltage will cause the diode to conduct. This results in a voltage discharge of the capacitor which produces a normal amplifier recovery rate. However, during the absence of program material the diode will cease to conduct and recovery of the amplifier will be appreciably slowed down. Hence, the audio gain recovery is controlled by the variances in peak audio amplitudes, with the resulting advantage that large amounts of gain reduction may be used with negligible pumping effect. Where only small amounts of gain reduction from threshold to 6 db are required, the dual RC circuit should be used.

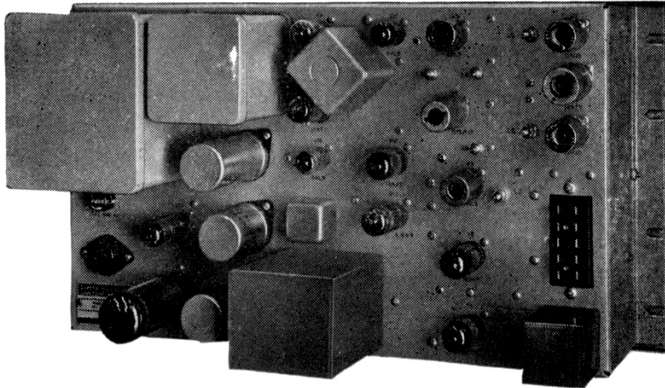
The recommended compression ratio for this amplifier operation is 20:1 when used in either the dual RC or program controlled recovery operational mode. If used as a backward acting amplifier, the recommended compression ratio is 2:1.

Balanced tubes are not required in this unit. Only a simple adjustment of the modulator balance controls is necessary to balance the modulator. A push-button balance check switch provides an easy, rapid and convenient means of checking the modulator balance.

Performance, distortion ratings, etc., may be found in the *Electrical Specifications* section.

MECHANICAL SPECIFICATIONS

Units:	1—BA-7-A Audiomatic Limiting Amplifier.
Dimensions:	Height: 10½" (6 Rack Units) Width: 19" Depth: 9" Weight: 42 lbs.
Mounting:	Standard RETMA 19" rack mounting with hinged front panel.
Operating Conditions:	Maximum ambient temperature: 113° F (45 °C). Maximum relative humidity: 95%
Electrical Connections:	Input and output audio signals made through a 10-pin Cinch-Jones plug and receptacle. AC power made through standard AC plug and receptacle.
Safety Provisions:	Power supply primary fused. All exposed wiring normally covered by hinged front panel.
Ventilation:	Normal rack ventilation. No blowers required.



Rear view of BA-7-A Amplifier

ELECTRICAL SPECIFICATIONS

Type of Circuit: (See block diagram of circuitry.) Audio signal is fed into preamplifier through an input transformer with terminated secondary into a 5879 voltage amplifier and 12BH7 cathode-follower output. The preamplifier incorporates inverse voltage feedback. The audio signal is then split into two paths, one into the balanced modulator using a 6AL5, the other into the bias generator circuit. A 10 M/C constant amplitude carrier is generated by an oscillator consisting of one-half of a 12AT7 and amplified by a 6AU6 power amplifier. This carrier signal is fed to the balanced modulator and is modulated by the audio signal. The output of the modulator consists of sidebands only with the carrier suppressed. The sidebands are then fed to a variable gain RF stage using a 6BA6. The audio signal which is fed to the bias generator is passed through a voltage correction network; it is then fed into a 12AX7 voltage amplifier and phase splitter, which drives a 12AT7 push-pull cathode-follower. Full wave rectification is then achieved by using a 6AL5 dual diode. This variable DC voltage is then applied to the grid of the variable gain RF stage (6BA6) to control the amplitude of the

sidebands. The controlled sidebands are passed to a synchronous demodulator using a 6AL5. The demodulator receives a 10 M/C constant amplitude carrier from the same source as the balanced modulator for the detection process. The audio signal is then fed into a 12AX7 voltage amplifier and phase splitter which drives the push-pull 6463 amplifier output stage. Two different types of recovery circuits can be used, the conventional dual RC type or the new program recovery circuit.

Performance:

Output Level:	Variation of ± 0.5 db from verge to 20 db of limiting
Frequency Response:	± 1 db from 50 to 15,000 cycles (from verge to 20 db of limiting)
Distortion:	From verge to 12 db of gain reduction: 1% or less, 50 to 15,000 cycles From 12 db to 20 db of gain reduction: 1.5% or less, 100 to 15,000 cycles 2.5% or less, 50 to 100 cycles
Attack Time:	Approximately 70 microseconds
Compression Ratio:	Forward acting: 20:1 Backward acting: 2:1

Recovery Time:

Dual RC:

Approximately 0.5 seconds for short peaks for 63% gain recovery. For sustained or rapidly recurring peaks, the recovery time is approximately the same for 50% recovery and increases to 10 seconds for 90% gain recovery.

Program controlled recovery:

Determined by type of program material

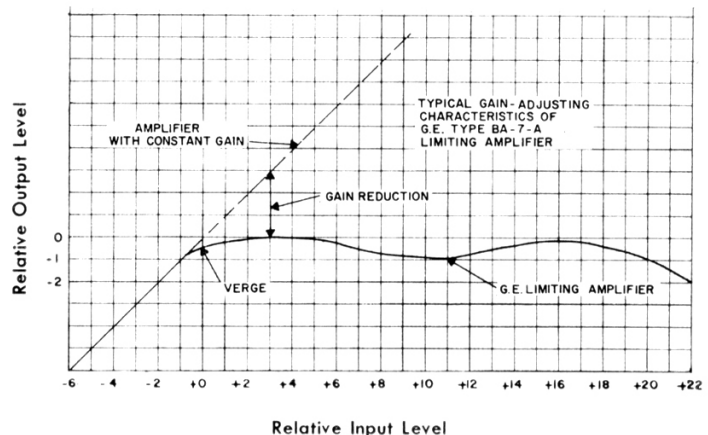
Signal to

Noise ratio: 65 dbm below ± 27 dbm output at threshold or below

Signal to

Thump Ratio: -45 db or better

Total Gain (amplifier set at verge of limiting: 57 dbm, ± 2 db.



INSTRUCTIONS

LIMITING AMPLIFIER
MODEL 4BA7A3, REVISION A

EBI-2178

INDUSTRIAL ELECTRONICS DIVISION

GENERAL  ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.



Type BA-7-A Audiomatic Limiting Amplifier

INTRODUCTION

The General Electric Limiting Amplifier, Model 4BA7A3, is a peak limiting amplifier designed to permit a substantial increase in the average program level without danger of any audio peaks exceeding a pre-determined level. The design incorporates an improved thump reduction circuit, extended limiting range and output level, plus a unique

program-controlled recovery circuit. The output of the Limiting Amplifier is sufficient to drive any EIA transmitter to 100% modulation, and the unit is readily adaptable for use in recording systems as it can be easily converted to a backward-acting limiter. It can be used before or after pre-emphasis.

TECHNICAL SUMMARY

POWER INPUT

105/117/125 volts, 50/60 cycles, 120 watts.

SIGNAL INPUT LEVEL

-30 dbm minimum at verge of gain reduction;

0 dbm maximum at verge of gain reduction;

+20 dbm maximum with 20 db of gain reduction (0 dbm equals 1 mw, sine wave, 600 ns).

Levels adjustable in 1 db steps between above limits at front panel 30-step, input-level control.

SOURCE IMPEDANCE

600/150 ohms, balanced or unbalanced.

LOAD IMPEDANCE

600 ohms, balanced or unbalanced. (Cannot be a center-tapped grounded balanced line, but can be balanced in the respect that neither side of the line is grounded.)

OUTPUT LEVEL

+27 dbm, maximum level at the start of gain reduction with output level control at zero attenuation.

+12 dbm, minimum output level. Output level control adjustable in 30 steps, 0.5 db/step.

FREQUENCY RESPONSE

± 1.0 db, 50 to 15,000 cycles throughout the limiting range.

GAIN

57 dbm, with maximum settings of input and output level controls.

NOISE LEVEL

-65 dbm or less, signal-to-noise ratio at verge of gain reduction.

STEADY STATE DISTORTION

1.0% or less (total rms harmonic distortion), 50 to 15,000 cycles, from verge to 12 db gain reduction.

1.5% or less, 100 to 15,000 cycles; or 2.5% 50 to 100 cycles, from 12 db to 20 db gain reduction.

ATTACK TIME

70 microseconds (approximately).

RECOVERY TIME

With dual RC recovery circuit; 0.5 sec-

ond (approximately) for single short peaks, for 63% recovery after signal drops below verge.

0.5 second (approximately) for sustained or rapidly recurring peaks up to about 40% of gain recovery, increasing to about 7 seconds for 90% gain recovery.

With program-controlled recovery circuit; 0.5 second to 1.5 minutes, depending on the nature and level of the program material.

TUBE COMPLEMENT

1 Type 5879 (V1)
 1 Type 12BH7 (V2)
 4 Type 6AL5 (V3, V5, V11, V14)
 1 Type 5749/7165492-1 (V4)
 2 Type 12AT7 (V6, V10)
 2 Type 6AU6 (V7, V8)
 1 Type 12AX7 (V12)
 1 Type 6463 (V13)
 1 Type 5U4GA (V15)
 1 Type 12AU7 (V17)

FUSE COMPLEMENT

F1; 2 amp in the a-c line.

DIMENSIONS

Width: 19 inches
 Depth: 9½ inches
 Height: 10½ inches

WEIGHT

40 pounds (nominal).

DESCRIPTION

The Limiting Amplifier consists of a single unit containing all components, including a power supply, necessary to perform its functions (see Fig. 1). The unit is constructed on a deep tray-type chassis equipped with a hinged front cover, allowing maximum accessibility to components and wiring. The

front panel mounts a meter and the controls used in normal operation. Adjustment controls are mounted on two sub-panels inside the chassis. All connections to the Amplifier are made through a 10-pin Jones connector and a standard a-c receptacle. The Amplifier is shipped with a full complement of tubes.

INSTALLATION**Mounting**

Mount the unit in a standard 19-inch rack

by opening the front panel and bolting the slotted mounting flanges to the rack with the 12-24 mounting screws provided.

Connections

AUDIO INPUT

The unit as shipped is wired to match a 600-ohm source impedance. Connect the input to P2-11 and -12. For operation from a 150-ohm source impedance, remove the wires from T1-1 and -4 and reconnect them to T1-9 and -10, respectively.

AUDIO OUTPUT

The unit as shipped is wired for operation into a 600-ohm load. Connection is to P2-3 and -4.

POWER CONNECTION

The a-c power plug (female), to which a power cord may be attached, plugs into a flush-mounted receptacle (male) on the rear of the chassis.

REMOTE GAIN REDUCTION METER

A remote gain reduction meter may be connected across pins 9 and 10 of P2.

WIRING

When wiring input and output connections, it is recommended that a covered #22 shielded twisted pair audio cable be used (similar to G-E Types FA-19-K or -L) with the shield grounded on P2-7.

OPERATION

Operating Checks and Adjustments

TUBES

Check all tubes to see that they are properly seated in the sockets.

POWER

Apply power by throwing the POWER switch on the front panel to ON. The VU Meter lights indicate that power is applied to the unit. Allow at least 30 minutes for the Amplifier to warm up and stabilize before beginning adjustments.

BALANCE ADJUSTMENT

Do not apply a signal. Two balance controls are used: C3, a trimmer capacitor located on the chassis just above the MOD BAL bracket, for coarse adjustment; and R12, marked MOD BAL on the bracket, for fine adjustment. Balance adjustment is checked at the factory, but should be rechecked prior to putting the Amplifier in service. Make the adjustment as follows:

1. Set the OUTPUT gain control to the maximum clockwise position.

2. Set the VU Meter multiplier (VUMULT) at the 22 MW position, then try steps 3, 4, and below. If there is no deflection of the meter

needle, set the multiplier in the 1 MW position and repeat steps 3, 4, and 5. (Initial setting at the 22 MW position will prevent "pegging the needle" and consequent possible meter damage should the modulator be out of balance.)

3. Place the METER SWITCH in VU 2 position. This connects the VU Meter to the output of the Amplifier through the VU Meter multiplier.

4. Set the recovery selector switch (sub-panel) to the DUAL position.

5. Press the push button marked BAL CHECK (sub-panel). There should be a negligible deflection of the VU Meter indicator (less than -10 on the VU scale, 1 MW position). If there is needle deflection, read this step all the way through, then proceed as follows: Set MOD BAL at mid-range (12 o'clock) and carefully adjust C3 for a null (minimum needle deflection). Note that C3 may be adjusted for a null in two places, only one of which is correct. This location will be found when the manufacturer's type numbers on C3 are in the upper half of the circle, near the mounting screws. At this point C3 should be turned slowly clockwise. Generally the null will be found in about one sixth of a turn in this direction. After locating the null, set MOD BAL for fine balance of the null. Actuate the push button at 15-second intervals in order to give the

limiter time to recover. When adjusting C3 for a null, it may be necessary to decrease the VU Meter sensitivity to prevent the meter from going off scale (adjust in a clockwise direction from 1 MW).

VU METER ADJUSTMENT FOR GAIN REDUCTION

Set the METER SWITCH in the GR position. Adjust 0-MTR ADJ so that the meter reads full scale. The meter will measure the approximate amount of gain reduction when the remaining adjustments on the Amplifier have been made.

AUTOMATIC GAIN ADJUSTING CHARACTERISTICS

To adjust the automatic gain adjusting characteristic, proceed as follows:

1. Connect a 600-ohm 1-watt resistor across terminals 3 and 4 of P2.
2. Set the METER SWITCH in the VU 1 position. This places the VU Meter across the output of the pre-amplifier stage.
3. Place the INPUT gain control at the 20 db position.
4. From an audio signal generator, feed a 1 kc signal in at P2-11 and -12. Adjust the signal generator input so that the VU Meter reads -10 VU. This level corresponds to a -10 dbm input signal at the input terminals.
5. Turn the VU Meter multiplier (VU MULT) to the +28 position.
6. Turn the METER SWITCH to the VU 2 position. The meter now reads the output level of the Amplifier.
7. Set the OUTPUT gain control at the 0 db position.
8. Turn the SLOPE and DELAY BIAS controls to the full counterclockwise position. The recovery selector switch should be in the DUAL position. The VU Meter should now read an output level of +27 dbm \pm 2 db. If this reading is low, a check on the tuning of the unit should be made as described under Tuning Adjustments below.
9. Adjust the OUTPUT gain and VU MULT so that the meter indicates approximately 0 VU on the VU scale.

10. Set the SLOPE control at approximately 11 o'clock. Advance the DELAY BIAS control clockwise until the meter reading decreases $\frac{1}{2}$ VU division (this corresponds to 0.5 db gain reduction or what may be referred to as the verge of gain reduction). Note this point for future verge reference.

11. Advance the INPUT gain control slowly 20 steps (1 db per step) and note the variation in output level as the input is increased. This variation should be not more than \pm 0.5 db from 0 to +18 db of input gain, and should respond approximately according to the gain reduction curve in Fig. 2. For example, when the INPUT level control is advanced 4 to 5 steps, the output level should increase $-\frac{1}{2}$ VU to a zero maximum. If the output level variation does not agree with the gain reduction curve, make adjustments according to paragraphs 12 and 13, below.

12. If the level increases more than 0.5 db, adjust the SLOPE control clockwise so that the maximum increase in output level does not exceed 0.5 db throughout the 20 db gain reduction range. Set the INPUT level control back to 20 and allow the Amplifier to recover full gain. Reset the verge by adjusting the DELAY BIAS control to the verge reference point noted in step 10. It may be necessary to repeat the procedure several times to obtain the correct settings of the SLOPE and DELAY BIAS controls.

13. Conversely, if the output level decreases more than 0.5 db, adjust the SLOPE control counterclockwise as required. Return the INPUT level control to 20 and reset the verge adjustment to the verge reference point noted in step 10. Repeat the procedure, making fine adjustments of the SLOPE and DELAY BIAS controls until the output level variation is within the $\pm \frac{1}{2}$ db tolerance.

14. After the correct gain reduction curve has been obtained, the meter switch can be placed in the GR position and the input gain control advanced 20 positions from its initial setting at verge. The meter should then indicate approximately 20 db gain reduction on the GR scale. Likewise, if the INPUT control is advanced only 10 positions, the meter should indicate approximately 10 db of gain reduction.

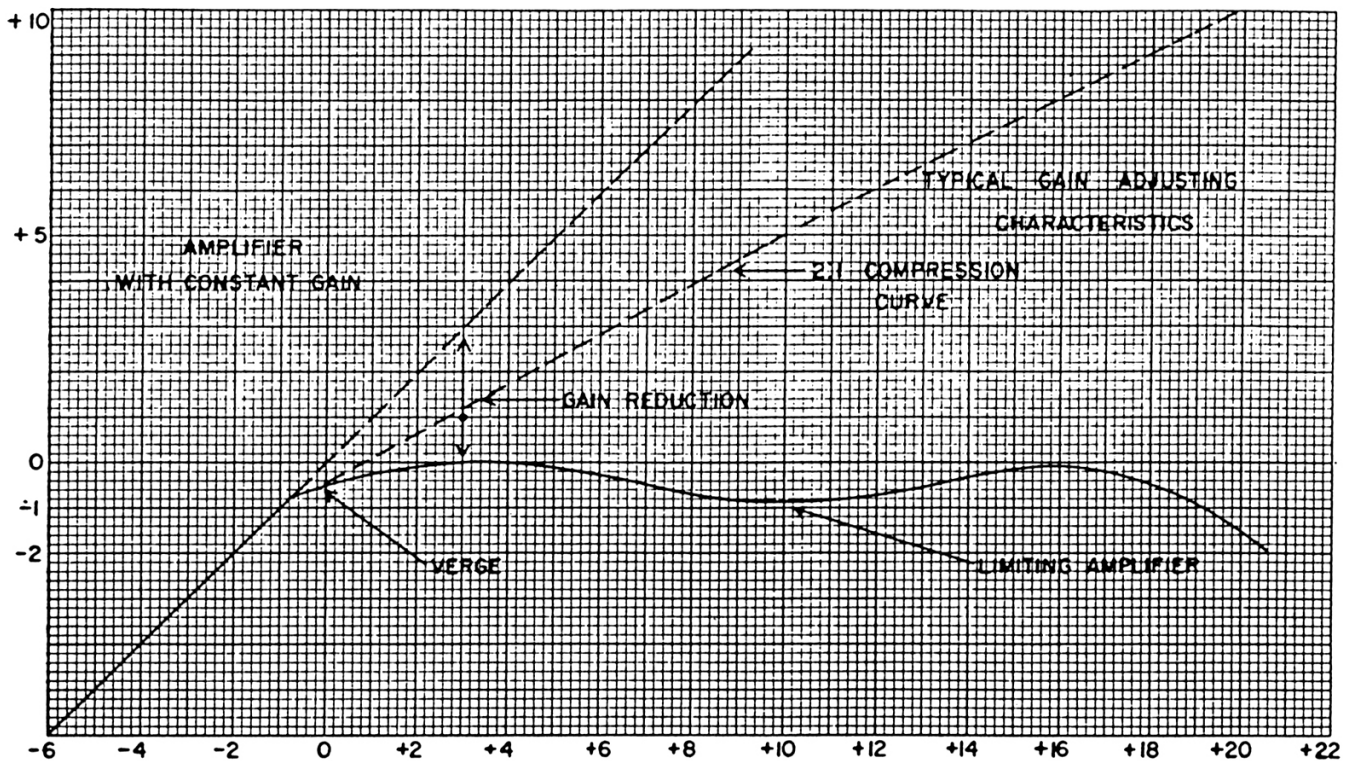


Fig. 2 Typical Gain-Adjusting Characteristics

Tuning Adjustments

The Limiting Amplifier has been tuned and tested at the factory, and should perform satisfactorily after the operational checks as outlined above have been made. However, if the performance does not check with the specifications outlined above, it will be necessary to retune the coils. It is possible that the locking nuts on the coil assemblies have become loose in transit or while uncrating, causing the coils to become detuned, resulting in low gain. Proceed as follows to retune the coils:

1. Turn the 0-MTR ADJ, DELAY BIAS, and SLOPE controls to the maximum counter-clockwise position and set the meter switch to VU 2.-
2. Check the oscillator (V6) frequency, using an accurately calibrated grid dip meter in the CW position at L7 to show a dip between 10 and 10.5 mc. If necessary, adjust the oscillator frequency at L7 to produce a dip between 10 and 10.5 mc.
3. Loosen all locking nuts on coils L2, L3, L4, L5, L8, and L9.
4. Tune L8 for a maximum -d-c voltage

at J3 and tighten the locking nut.

5. Tune L9 for a maximum -d-c voltage (at least -40 volts) at J4 and tighten the locking nut. (If -40 volts cannot be obtained, check V6 and V8).

6. Feed a 1-kc signal of approximately -10 dbm into the unit. Back out L2 its entire length, then tune L5, L4, and L3, in order, for maximum output reading on the VU meter. Then turn in L2 past the first peak to the second peak. Readjust L5, L4, L3, and L2 until no further gain can be obtained. This may require three or four tuning cycles. Tighten all locking nuts.

7. When the above operational checks and adjustments have been completed, remove the 600-ohm termination from pins 3 and 4 of P2.

On-Air Operational Adjustments

The following paragraphs cover input and output level adjustments for on-air operation in AM systems.

The maximum output level of the Limiting Amplifier is +27 dbm \pm 2 dbm. This level is sufficient to meet the input level requirements

of broadcast transmitters which have been set at $+10 \text{ dbm} \pm 2 \text{ dbm}$ for 100% modulation by EIA standards. This output level can be controlled in 0.5 db steps, 15 db over-all which means that the minimum level would be $+12 \text{ dbm}$. If a lower level is required, a 6-db fixed pad can be inserted according to information on the Elementary Diagram, Fig. 5.

With the pad inserted, the output level can be controlled from $+6 \text{ dbm}$ to $+21 \text{ dbm}$. The Limiting Amplifier output is designed to feed a 600-ohm resistive transmitter input.

Note that the output should work into a 600-ohm load which is essentially resistive over the entire frequency range to assure constant gain reduction characteristics at all frequencies. To adjust the Amplifier output level proceed as follows:

1. Set the INPUT gain control at the -30 db position and place the METER SWITCH on VU 2.

2. Feed a 1 kc signal into the unit, adjusting the input level until the VU Meter indicates a maximum output (zero relative level as shown on Fig. 2).

3. Place the METER SWITCH on GR. The meter should now indicate approximately 4 to 5 db of gain reduction.

4. Reset the METER SWITCH on VU 2 and increase the OUTPUT gain to give the required level for 100% modulation. It is characteristic of the Type BA-7-A Limiting Amplifier that there is substantially no change in output within the 20-db limiting range. Consequently, the output level may be set at the 100% modulation point of the associated transmitter without danger of sacrificing performance.

5. Feed a normal program signal to the input terminals. With the METER SWITCH on GR, advance the INPUT gain control until the meter indicates 1 to 2 db of gain reduction. This means that program peaks are just above the verge or threshold point. Now the INPUT gain control can be advanced to give the desired amount of gain reduction. The increase in input level may be as much as 17 db. Although the automatic gain reduction characteristic curve shows a limiting range of 20 db, it must be remembered that the meter will not indicate the peak value of short program peaks. Consequently, when the GR meter indicates 17 db of gain reduc-

tion, the actual limiting point may be as much as 20 db. Therefore, in order to remain within the distortion specifications of the Limiting Amplifier, it is recommended that the maximum increase in input level be held to 17 db above the verge of gain reduction.

When large amounts of gain reduction are employed with a limiter using the conventional R-C time constant type of recovery circuit, a certain type of program distortion is introduced which in broadcasting is called pumping. This is a periodic rise of background noise or low-level material at a rate determined by the R-C time constant. The Type BA-7-A Limiting Amplifier incorporates a type of recovery circuit which is dependent upon the rate and intensity of the program material. This may be called a program-controlled recovery circuit (see the THEORY AND CIRCUIT ANALYSIS section). It is recommended that this circuit be used when the amount of gain reduction exceeds 6 to 7 db, in order to minimize pumping action. To put the program-controlled recovery circuit into operation, throw the recovery selector switch on the sub-panel to the PGM REC position.

Use of Limiting Amplifier in FM Systems

When using a limiting amplifier in a pre-emphasized system, such as FM, special operating conditions prevail. These conditions necessitate a consideration of whether the primary function of the limiting amplifier is to be (a) prevention of over-modulation, or (b) increase in average modulation. (In flat AM systems the advantage of (a) and (b) are obtained simultaneously.)

OVER-MODULATION GUARD

In FM systems receiver distortion may become objectionable if the transmitter swing is appreciably greater than $\pm 75 \text{ kc}$ at any time. This is due to the relatively narrow flat portions of receiver detector characteristics and the fact that a reasonably high quality audio system following the detector will not only pass distortion directly to the listener but will also tend to bring it more forcibly to the listener's attention.

In order to prevent overswing, the Limiting Amplifier would have to be located after the pre-emphasis network. In this way program material containing high signal voltages at the higher frequencies (which frequently result when certain types of program material rich in highs are passed through the pre-emphasis network) will be effectively reduced in gain by the limiting amplifier. Thus, overswing is prevented.

However, when the limiter follows the pre-emphasis network, it is not feasible to employ a large amount of limiting in an effort to increase the average modulation level to gain increased coverage. If this is done the program will suffer changes in loudness without apparent good reason. This is the result of the pre-emphasis increasing the intensity of high-frequency components of the program material to such an extent that they initiate gain reduction even when the middle, loudness-controlling frequencies do not require it.

When the limiter follows pre-emphasis in an FM system, level control is inherently dependent upon frequency and amplitude of the program material, whereas in a flat system such as conventional AM, level control depends on amplitude alone.

The idea has been advanced that a limiting amplifier following pre-emphasis will defeat or minimize the pre-emphasis. There is no justification for this either in theory or practice since when a peak of any frequency is incident upon the Type BA-7-A Limiting Amplifier, it causes virtually instantaneous gain-reduction at all frequencies. Also, this gain reduction once initiated, lasts from 0.5 to 7 seconds depending on the nature of the peaks in the program. Therefore, there is no change in frequency response whether considered on a short or long time basis.

If there were peak clipping there might be some basis for a change in the pre-emphasis characteristic due to limiting. In this case the high-frequency peaks would be eliminated without a corresponding reduction in gain at other frequencies. Such clipping might take place in the first few cycles of a slow-attack limiting amplifier, or it might take place in equipment overload following such a limiter. The Type BA-7-A Limiting Amplifier, with its extremely short attack time,

does not subject any signal, whether pre-emphasized or not, to clipping action. Therefore, this form of distortion of the pre-emphasis characteristic does not exist with this Amplifier.

Also, listening tests with the limiter following pre-emphasis have not disclosed any evidence of a change in frequency response. The conclusion may, therefore, be drawn that pre-emphasis is substantially unaltered when passed through a modern limiting amplifier such as the General Electric Type BA-7-A.

INCREASE OF AVERAGE MODULATION LEVEL

If the limiter is to be used primarily to increase the average modulation level of the FM transmitter, it should be located ahead of the pre-emphasis network; that is, it should work in the flat portion of the audio system where gain-reduction is initiated by any peak above threshold. In practice, this means that gain-reduction will generally be initiated by the middle, loudness-controlling frequencies.

It should be understood that such use seriously impairs the prevention of over-modulation function of the limiter. This is because the controlled output of the limiting amplifier, which does not vary with frequency, is passed through pre-emphasis which causes the level fed to the transmitter to vary with frequency.

Thus, in effect, the limited level at the transmitter varies with the frequency content of the program, making establishment of any ceiling on peaks a practical impossibility. When the limiting amplifier is located ahead of pre-emphasis the transmitter operator must monitor the modulation level and try to see that peaks are kept within acceptable limits.

Limiter Following Pre-Emphasis

When the limiter is used as an over-modulation guard in FM systems, make the following adjustments:

1. The output level should be adjusted as explained above.
2. The input level control should be adjusted so that only occasional 2 to 3 db gain-reduction kicks would be obtained with normal

program levels as observed on the station VU Meters. This slight amount of gain reduction should occur on program material rich in high frequencies.

Limiters Ahead of Pre-Emphasis

When the Limiter is used to increase the average modulation level in FM systems, make the following adjustments:

1. **Input Level (First Adjustment).** With the limiter ahead of pre-emphasis the adjustment of its input level is similar to that in flat AM broadcasting systems. The input control is merely advanced until the desired gain reduction peaks are observed on the Gain-Reduction meter.

2. **Output Level.** The output level (or input level to the transmitter) should be adjusted under program conditions at the point where the pre-emphasized transmitter is operated at an acceptable average modulation level when the gain-reduction meter indicates the desired amount of gain-reduction.

This adjustment will vary between different types of programs. Occasional readjustment of the transmitter input level will be necessary if it is desired to maintain the same modulation level. Such readjustments will, of course, affect the loudness of the signal as heard in the receiver.

It is recommended that when the limiter is used in FM systems, the dual R-C recovery circuit be used, as the program-controlled circuit is intended for use only when large amounts of gain reduction are used to minimize pumping effect.

Use of VU Meter Under Program Conditions (AM)

When the METER SWITCH (S1) is in the VU 1 position, the VU Meter is connected to the output of the pre-amplifier through a fixed resistor (R20) in series. When a -10 dbm level is applied to the input of the Amplifier, the VU Meter will read a -10 VU with the input attenuator set at the 20 db position. Thus input levels between -20 dbm to +3 dbm may be checked by direct reading on the VU Meter. Studio level checks may be made by

this method.

The VU 2 position connects the VU Meter across the output of the Limiting Amplifier. This position can be used for routine monitoring in connection with the station Percent Modulation Meter.

Use of VU Meter Under Program Conditions (FM)

When the limiter follows pre-emphasis, that is, the VU Meter is subjected to pre-emphasis, the VU Meter gives different peak indications (which may be 2 to 6 db high) than in a flat system, depending on the high-frequency content of the program material. Therefore, use of the VU Meter in either position is not recommended under these conditions. A standard VU Meter such as the General Electric Type FA-1-A should be used for checking studio levels in the flat portion of the system.

With the Limiting Amplifier ahead of pre-emphasis, the VU Meter may be used as described above for AM systems.

Backward-Acting Operation

When the Limiter Amplifier is employed for recording purposes, it may be desired to use it in a backward-acting mode of operation. As shown in Fig. 3, audio voltage is taken from the Amplifier output to generate control bias. A 2:1 compression ratio is recommended (see Fig. 2). The following wiring changes are required:

1. Disconnect the wire from J2-6 and reconnect it to E19-1.
2. Connect a 27,000-ohm resistor from T3-5 to E19-1.

When using the Limiting Amplifier in a backward-acting mode, the maximum input levels will be 10 dbm lower than for the forward-acting mode, since with a 2:1 compression ratio the output level will increase 10 dbm for a signal input increase of 20 db. With a -20 dbm 1-kc input signal, and the INPUT gain control set at 20, adjust the DELAY BIAS and SLOPE controls for threshold (0.5 db gain reduction). Advance the INPUT gain control 20 steps and note the

output level change. For each 1-db increase in input the output level should increase 0.5 db (see Fig. 2). It may be necessary to re-

adjust the SLOPE and DELAY BIAS controls to produce the proper 2:1 compression curve as shown on Fig. 2.

THEORY AND CIRCUIT ANALYSIS

General

The Limiting Amplifier is composed of five sections (refer to the Block Diagram, Fig. 3 and the Elementary Diagram, Fig. 5). The five sections are:

1. The pre-amplifier stage, consisting of V1, V2 and associated components.
2. The oscillator stage, V6, together with its associated amplifiers, V7 and V8.
3. The thump-reducing and variable control section consisting of V3 (balanced modulator), V4 (variable gain control stage), and V5 (synchronous detector).
4. The bias generator section and associated gain recovery circuits consisting of V17, V10, V11, and V14.
5. The output amplifier section consisting of V12 and V13.

The incoming audio signal is fed through P2-11 and -12 to the primary of the input transformer (T1), where it is stepped up, then amplified by the pre-amplifier stage (V1, V2). From the output of the pre-ampli-

fier the signal follows two paths, the first going to the balanced modulator (V3) in the control section, and the second to the bias generator section.

The balanced modulator receives, in addition to the audio signal, a constant-amplitude 10-megacycle carrier from the oscillator and RF amplifier section. The carrier is amplitude-modulated by the audio signal (V3), the main carrier is suppressed, and the output signal, consisting of modulated sidebands only, is fed to the variable gain RF stage in the control section. Simultaneously the audio fed to the bias generator section is first passed through the SLOPE control (R33), to a voltage amplifier and phase splitter (V17), then to a push-pull cathode follower (V10). The output of the cathode follower is split in two parts, the first going to the program control recovery circuit (V14), and the second to a full-wave rectifier diode (V11). The variable d-c voltage from the diode (V11) is applied to the grid of the variable gain RF stage (V4) in the control section.

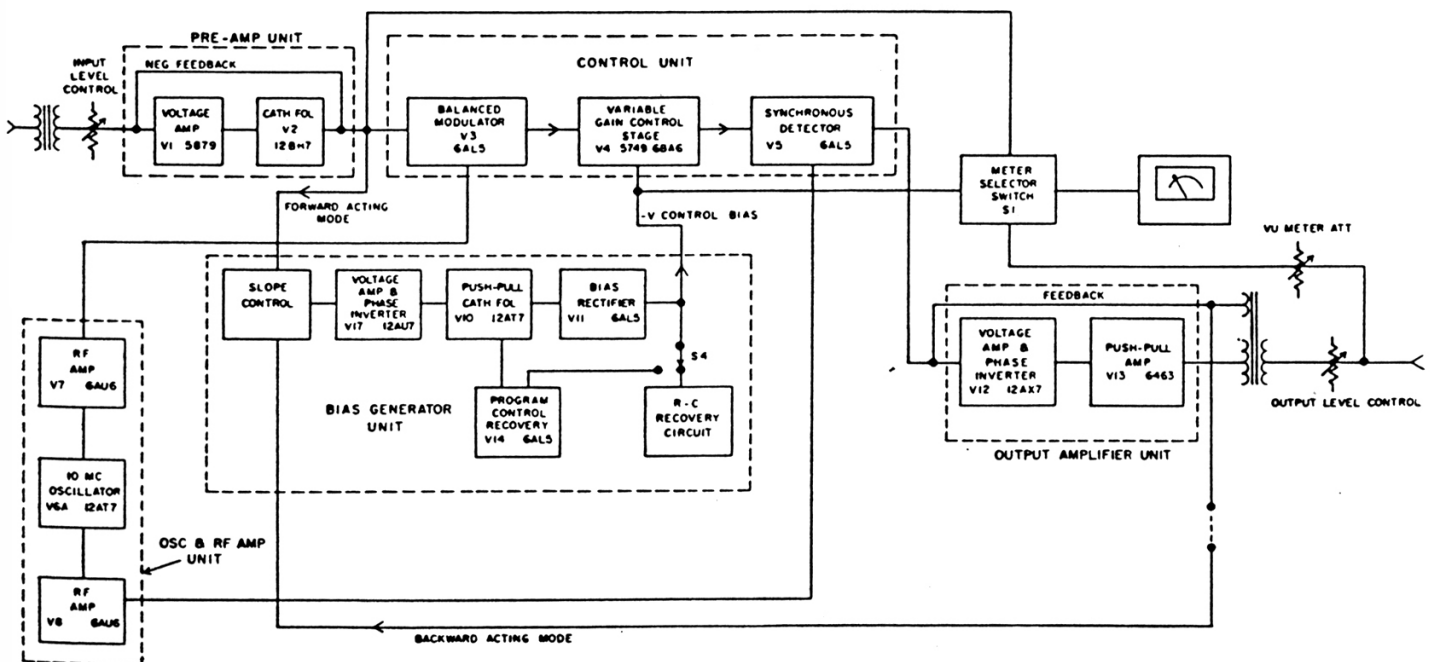


Fig. 3 Block Diagram (C-7776695, Rev. 1)

This variable d-c voltage has the effect of controlling the amplitude of the audio modulated sidebands. Since there is no carrier present at the grid of the control stage (V4), the low frequency or thump component, created by varying the control voltage, is not passed through the RF circuit, and, thus, is not detected later. The controlled sidebands are then passed to a synchronous detector (V5) which receives a 10-mega-cycle constant amplitude carrier from the oscillator and RF section. The carrier and controlled sidebands are recombined and the resultant audio is detected. The audio signal is then fed to a voltage amplifier and phase splitter (V12) and then to the push-pull output stage (V13) of the Limiting Amplifier.

From a tertiary winding on the output transformer (T3), voltage is fed back around the output unit. The secondary of the output transformer feeds the line through an output attenuator which is bridged by a VU multiplier attenuator. The VU Meter is switched (S1) to read the output level, the amount of gain reduction, the input level to the balanced modulator, and can be used to check modulator balance.

The recovery time characteristics of the Limiting Amplifier are discussed under Recovery Time Circuits further along in this section.

Performance Analysis

GENERAL

The Limiting Amplifier will permit a high degree of limiting without any audible evidence of limiting action and with essentially no over-modulation. This performance is obtained through the use of a very high compression ratio, a very short attack time and an automatic variation of recovery time.

The ideal limiting amplifier is one in which the output increases directly as the input level is increased, up to a specified point known as the threshold, and does not increase with further increase in input. This ideal limiter would accept signals whose peak intensity just equalled the threshold level, without change in the normal gain relation-

ship. Input signals above the threshold value would instantaneously cause a reduction in db gain exactly equal to the db increase in input level, thus holding output constant.

Limiting amplifiers previously available (except for the General Electric Limiting Amplifier, Type BA-5-A) have departed from the ideal by allowing an appreciable increase in output signal with inputs beyond threshold, and by not having gain reducing actions rapid enough to catch fast peaks.

HIGH COMPRESSION RATIOS

A measure of the limiting action is the "compression rate." This is the ratio of the change in input level (in db) to the change in output level (in db) for a stated increase in input level above threshold. Thus the compression ratio of a limiting amplifier tells how effectively it holds the output constant when the peak input signal exceeds the threshold value. Fig. 2 shows that the Type BA-7-A Limiting Amplifier, over a 20 db gain reduction range, has a compression ratio of better than 20:1. The variation of the output level is less than 1 db over this range. This high compression ratio is due to the use of control voltage obtained from the pre-amplifier. Constant output is thus obtained above the threshold point because, as the input signal increases, the d-c control bias also increases the same amount to hold the output constant. The use of the DELAY BIAS control (R67), the SLOPE control, and its associated logarithmic voltage correction network, maintain close control of this relationship.

ATTACK TIME

Although an adequate compression ratio, or gain-reduction characteristic, is essential it is also necessary that the compression characteristic be effective for rapidly changing waveforms as well as for those changing slowly. If the limiter is to catch fast program peaks, voltages rising in a matter of microseconds must be controlled in accordance with the curve. Otherwise, severe instantaneous overmodulation would result. Thus, a good limiting amplifier must be very fast-acting; that is, it must have a short attack time.

An action sufficiently rapid for fast program peaks is obtained in this limiting amplifier through the use of a special low-impedance, high-speed bias generator which is used to control the gain of the controlled amplifier.

THUMP ELIMINATION

Thump may be described as a low-frequency transient caused by rapid changes of control bias in the grid circuits of the control stages. The Type BA-7-A Limiting Amplifier employs a technique which virtually eliminates the thump component. Due to the fact that the carrier frequency is suppressed in the balanced modulator, V3, and because here are only high-pass coupling circuits after the gain control stage (V4) until the signal is demodulated, the thump component is not passed. When the modulator is adjusted correctly, the signal to thump ratio can be as low as 55 db, which is a considerable improvement over previous limiters.

RECOVERY TIME CIRCUITS

The gain recovery time of a limiting amplifier must be properly proportioned and preferably automatically adjusted in accordance with the number and duration of the program peaks if completely satisfactory operation is to be obtained. Most limiting amplifiers have the recovery time adjustable in several steps. A compromise setting is usually sought, in which the recovery time is made short enough so that one sudden peak will not cause the gain to depress for too long a time, thus causing an attendant hole in the program; and is made long enough so that a number of peaks will not cause a rapid shifting of gain, or what is called a pumping effect. The pumping effect is most likely to occur on programs such as athletic events where the background level of crowd noise and applause will rise and fall with the announcer's voice. The Type BA-7-A Limiting Amplifier incorporates two types of gain recovery circuits which tend to eliminate the pumping effect. The dual recovery time circuit used in the General Electric Limiting Amplifier, Type MA-5-A, is also used in the Type BA-7-A Limiting Amplifier. This recovery circuit

consists of two separate R-C time constants, one of short duration (0.5 second) shunted by one of large duration (4 seconds) for 63% of gain recovery. The theory of circuit action is that for sudden peaks the short time constant (R50-C36) controls the gain recovery time, preventing holes from occurring in the program content; and for sustained peaks the longer time constant (R51-C45-R50) is in control, preventing a rapid shift of gain recovery. This type of recovery circuit is adequate for minimizing the pumping effect within a range of gain reduction of 7 to 8 db and dependent upon the type of program material.

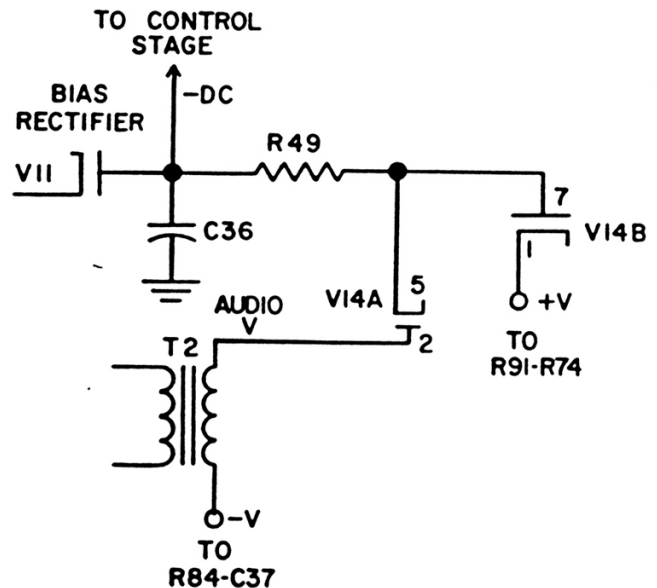


Fig. 4 Simplified Program Gain-Reduction Circuit

For higher limits of gain reduction, the program-controlled gain reduction circuit is used. Refer to Fig. 4 for a simplified circuit diagram, and to the Elementary Diagram, Fig. 5.

A diode (V14A) is placed in the discharge path of a capacitor (C36) in the recovery circuit. (This effectively substitutes a diode for the R in an R-C time constant recovery circuit.) A negative voltage is applied to the plate (pin 2), providing a bias equivalent to 15 db of gain reduction. The amplitude of the audio trigger voltage from the bias generator output, through T2 to V14A, produces an artificial verge or threshold of 6 db. Thus,

below 6 db of gain reduction the diode will not conduct, resulting in a very slow discharge rate and consequent slow recovery time of the amplifier. Between 6 db and 20 db of gain reduction, the audio trigger voltage will cause the diode to conduct. This results in a voltage discharge of C36 which produces a normal amplifier recovery rate. However, during the absence of program material, the diode will cease to conduct

and recovery of the amplifier will be appreciably slowed down. Hence, the audio gain recovery is controlled by the variances in peak audio amplitudes (and the value of R49), with the resulting advantage that large amounts of gain reduction may be used with negligible pumping effect. Diode V14B is shunted across V14A and biased to prevent program audio peaks from causing too rapid a discharge rate of C36.

MAINTENANCE

To assure continuous satisfactory operation of the Limiting Amplifier a regular maintenance schedule should be set up. Check the unit for overheating and discoloration of components. Check the tubes for emission. Check the d-c voltages to ground bus at the tube sockets against the voltages shown in the tabulation below. Use a VTVM for all measurements.

Clean the unit with an air hose or soft brush regularly. Do not disturb the leads or com-

ponent positions.

If a component requires replacement, obtain its description from the Parts List. Do not replace a faulty component without first checking the circuit to determine the cause of the failure. When a part which may affect the frequency response is replaced, check the response, and if necessary readjust the amplifier alignment as described in Tuning Adjustments under OPERATION.

TUBE	PIN								
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
V1	0	0	5.7	fil	fil	0	160	100	5.7
V2	280	70	92	fil	fil	280	70	90	fil
V3	+20 to +30	-20 to -30	fil	fil	0.5		-0.65		
V4	-0.3 (threshold)	3.35	fil	fil	280	130	3.35		
V5	0	-35 to -50	fil	fil	-1.6		-35 to -50		
V6	0	0	0	fil	fil	171	-3		fil
V7	-4.2	0	fil	fil	300	190	0		
V8	-3.8	0	fil	fil	300	190	0		
V10	302	-2.55	4.5	fil	fil	302	2.55 ⁻¹	4.5	fil
V11	4	0	fil	fil	4.5		-0.3 (threshold)		
V12	140	0	1.2	fil	fil	235	27.5	52	fil
V13	285	11.2	0	fil	fil	290	11.2	0	fil
V14	1.83	27.5	fil	fil	0	0	0		
V15								320	
V17	185	0	7	fil	fil	180	26	93	fil
J3	-5 to -10 (with R12 at mid-range)								
J4	-40 to -50								

The following a-c voltages were measured at the threshold point:

<u>Check Point</u>	<u>Volts</u>	<u>Check Point</u>	<u>Volts</u>	<u>Check Point</u>	<u>Volts</u>
E10-1	0.32	T3-9	27.50	V13-3	2.85
E14-3	1.35	V5-E2	4.50	V13-8	2.75
T3-7	27.50	V12-7	2.90		

PARTS LIST

Symbol	Description	G-E Drawing
ATTENUATORS		
AT1	Bridged T; impedance in and out 600 ohms \pm 5%, dissipation 0.6 w, 30 steps, 0.5 db per step. Daven Spec #4936.	M-7479731-P3
AT2	Multiplier; impedance in 7500 ohms, out 3900 ohms, dissipation 0.6 w, 20 steps, 2 db per step. Daven Spec #4426 or Daven Type TA-1000-2.	M-7478642-P3
CAPACITORS (Silver mica, \pm 5%, 500 v d-c w, unless otherwise specified)		
C1	Paper, molded plastic; 0.10 mfd \pm 20%, 400 v d-c w. Sprague Cat. #109P10404.	B-7491096-P33
C2	Electrolytic, tubular, 10 mfd +100% -10%, 150 v d-c w. Mallory Cat. #TC42.	P-7774786-P64
C3	Variable, ceramic, 3 to 12 mmfd, 500 v d-c w. Erie Type TS2A-NPO.	M-7484389-P2
C4 and C5	100 mmfd.	P-3R122-P47
C6	Electrolytic, tubular, 50 mfd +250% -10%, 25 v d-c w. Mallory Cat. #TC29.	P-7774786-P3
C7 and C8	100 mmfd.	P-3R122-P47
C9	56 mmfd.	P-3R122-P41
C10	510 mmfd, 300 v d-c w.	P-3R122-P64
C11	Ceramic, temp compensating, tubular, 5.0 mmfd \pm 5%, 500 v d-c w.	P-7770468-P36
C12	Ceramic high K disk, 0.001 mfd +100% -0%, 500 v d-c w.	C-7774750-P4
C13	Ceramic, temp compensating, tubular, 2.0 mmfd \pm 5%, 500 v d-c w.	P-7770468-P33

Symbol	Description	G-E Drawing
CAPACITORS (CONTINUED) (Silver mica, $\pm 5\%$, 500 v d-c w, unless otherwise specified)		
C14	68 mmfd.	P-3R122-P43
C15	180 mmfd.	P-3R122-P53
C16 and C17	47 mmfd.	P-3R122-P39
C18	Ceramic high K disk, 0.00047 mfd +100% -0%, 500 v d-c w.	C-7774750-P1
C19	Paper, molded plastic; 0.047 mfd $\pm 20\%$, 200 v d-c w. Sprague Cat. #109P47302.	B-7491096-P11
C20	56 mmfd.	P-3R122-P41
C21	Ceramic high K disk, 0.001 mfd +100% -0%, 500 v d-c w.	C-7774750-P4
C22	56 mmfd.	P-3R122-P41
C23	Mica, Class C; 510 mmfd $\pm 5\%$, 500 v d-c w. EIA Type RCM20C511J.	P-3R141-P144
C24 and C25	100 mmfd.	P-3R122-P47
C26	47 mmfd.	P-3R122-P39
C27	Ceramic high K disk, 0.00047 mfd +100% -0%, 500 v d-c w.	C-7774750-P1
C28	100 mmfd.	P-3R122-P47
C29	47 mmfd.	P-3R122-P39
C30	Ceramic high K disk, 0.00047 mfd +100% -0%, 500 v d-c w.	C-7774750-P1
C31	Paper, molded plastic; 0.047 mfd $\pm 20\%$, 200 v d-c w. Sprague Cat. #109P47302.	B-7491096-P11
C32	Electrolytic, tubular, 50 mfd +250% -10%, 25 v Mallory Cat. #TC29.	P-7774786-P3

LIMITING AMPLIFIER

EBI-2178

Symbol	Description	G-E Drawing
CAPACITORS (CONTINUED) (Silver mica, $\pm 5\%$, 500 v d-c w, unless otherwise specified)		
C33 and C34	Paper, molded plastic; 0.047 mfd $\pm 20\%$, 200 v d-c w. Sprague Cat. #109P47302.	B-7491096-P11
C35	Ceramic high K disk, 0.001 mfd $+100\% -0\%$, 500 v d-c w.	C-7774750-P4
C36	Paper, molded plastic; 0.047 mfd $\pm 20\%$, 600 v d-c w. Sprague Cat. #109P47306.	B-7491096-P51
C37	Electrolytic, tubular, 50 mfd $+250\% -10\%$, 25 v d-c w. Mallory Cat. #TC29.	P-7774786-P3
C38	Paper, molded plastic; 0.10 mfd $\pm 20\%$, 200 v d-c w. Sprague Cat. #109P10402.	B-7491096-P13
C39	Paper, molded plastic; 0.10 mfd $\pm 20\%$, 400 v d-c w. Sprague Cat. #109P10404.	B-7491096-P33
C41	Ceramic high K disk, 0.001 mfd $+100\% -10\%$, 500 d-c w.	C-7774750-P4
C42 thru C44	Paper, molded plastic; 0.047 mfd $\pm 20\%$, 200 v d-c w. Sprague Cat. #109P47302.	B-7491096-P11
C45	Paper, molded plastic; 0.10 mfd $\pm 20\%$, 600 v d-c w. Sprague Cat. #109P10406.	B-7491096-P53
C46	Electrolytic, polarized twist prong base, 40-40 mfd $+50\% -10\%$, 450 v d-c w. Mallory Type FP.	P-7770994-P25
C47	Electrolytic, polarized twist prong base, 20/20/50/50 mfd, 450/450/50/50 v d-c w. Mallory Type FP.	P-7770994-P47
C48	82 mmfd.	P-3R122-P45
C49	Electrolytic, polarized twist prong base, 20/20/20/20 mfd $+50\% -10\%$, 450/450/450/450 v d-c w. Mallory Cat. #FP444.	P-7772415-P43
C50 and C51	Paper, molded plastic; 0.001 mfd $\pm 20\%$, 400 v d-c w. Sprague Cat. #109P10204.	B-7491096-P21
C52	68 mmfd.	P-3R122-P43

Symbol	Description	G-E Drawing
CAPACITORS (CONTINUED) (Silver mica, $\pm 5\%$, 500 v d-c w, unless otherwise specified)		
C53	Metallized plastic, hermetically sealed; 1.0 mfd $\pm 20\%$, 200 v d-c w. Sprague Cat. #118P10502S4.	B-7489159-P13
RECTIFIERS		
CR1 and CR2	Germanium diodes. EIA Type 1N90.	A-7164424-P4
FUSE		
F1	Slow blow, Type 3AG, 2 amp at 125 v. Bussman Cat. #MDL2.	B-7487942-P27
JACKS AND RECEPTACLES		
J1	Receptacle; miniature motor base, 10 amp at 250 v, 15 amp at 125 v. G-E Cat. #2711.	M-7478622-P1
J2	Receptacle, 10 pin male. Jones Cat. #P-2410-SB.	P-7771181-P11
J3 and J4	Jacks, tip: yellow head. EF Johnson Type 105-527-25.	A-7142648-P7
INDUCTORS		
L1	RF choke coil: inductance 11.5 uh $\pm 10\%$, resonant freq 37 mc $\pm 10\%$, resistance 0.045 ohm max. Jeffers Elec. Div. #10753-1.	A-7142203-P1
L2	Coil, variable inductance.	B-7488718-P1
L3 thru L5	Coils, variable inductance.	B-7488456-P1
L6	RF choke coil: inductance 1.0 mh $\pm 5\%$, resonant freq 2.0 mc $\pm 10\%$, resistance 14.5 ohms max. Jeffers Elec. Div. #10404-14.	K-7142203-P2
L7	Coil, variable inductance.	B-7488456-P1

Symbol	Description	G-E Drawing
INDUCTORS (CONTINUED)		
L8 and L9	Coils, variable inductance.	B-7488719-P1
L10	Reactor: inductance 6.0 h at 0.240 amp d-c, resistance 114 ohms \pm 15% d-c.	M-7483280-P1
METERS		
M1	VU Meter. Weston Elec. Instrument Model 862 (illuminated) Class 49 front, special scale, calibrated for use on magnetic panel.	C-7775508-P3
PLUGS		
P1	Miniature connector body, brown phenolic, 10 amp-250 v, 15 amp-125 v. G-E Cat. #2716.	M-7478622-P2
P2	10 female contacts. Jones Cat. #S-2410-CCT.	P-7770059-P5
RESISTORS (Composition, \pm 5%, $\frac{1}{2}$ w, unless otherwise specified)		
R1	Attenuator, potentiometer type, impedance 60,000 ohms, max dissipation 0.6 w, 30 steps, 1 db per step. Daven Spec. #1951.	M-7479730-P1
R2	430 ohms.	C-3R77-P431J
R3	2400 ohms.	C-3R77-P242J
R4	0.10 megohm.	C-3R77-P104J
R5	0.20 megohm \pm 10%, 1 w.	C-3R78-P204K
R6	0.22 megohm \pm 10%.	C-3R77-P224K
R7	240 ohms, 1 w.	C-3R78-P241J
R8	Wirewound, 3100 ohms \pm 10%, 10 w. Tru-Ohm SR-10.	A-7164093-P2
R9	4700 ohms.	C-3R77-P472J

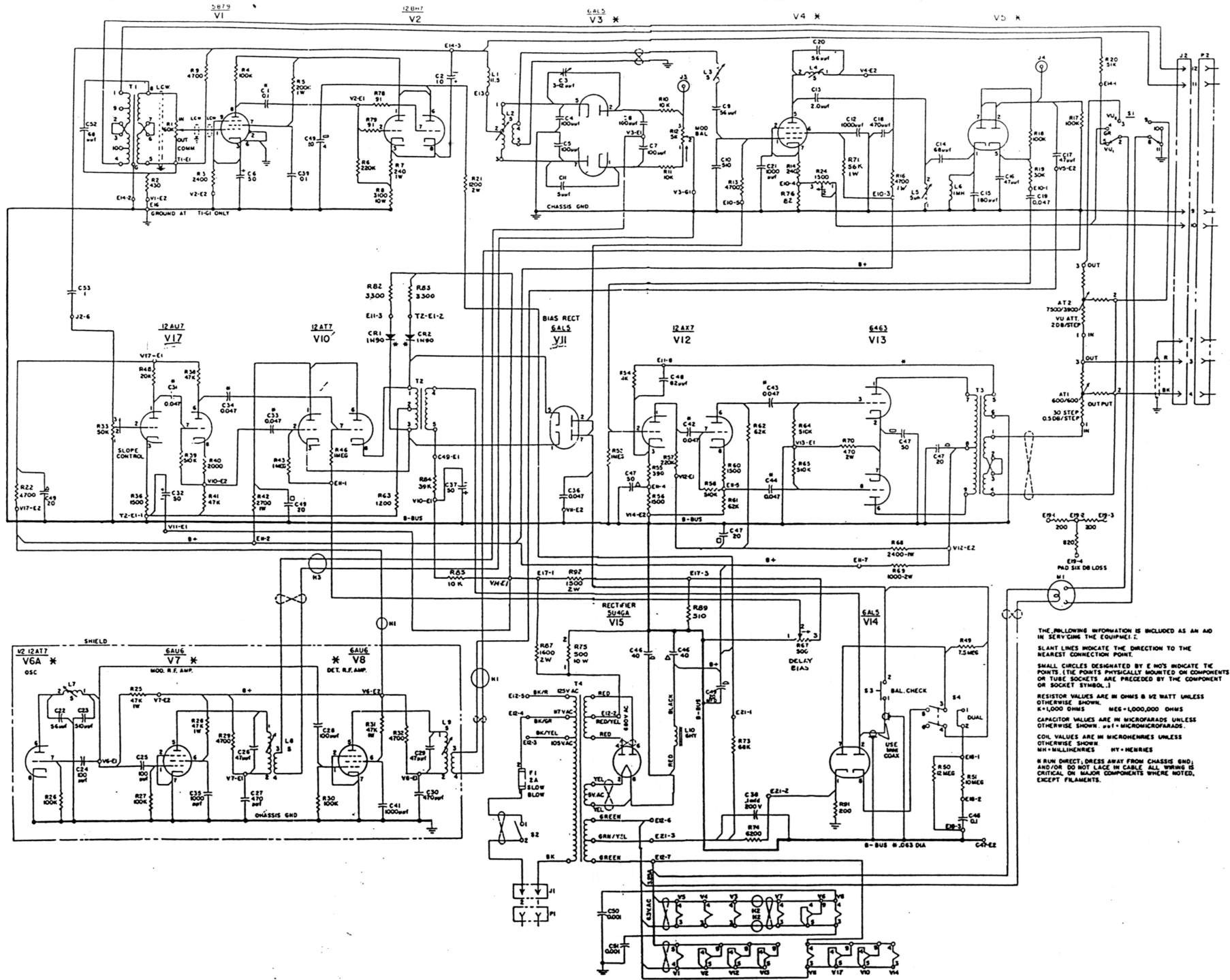
Symbol	Description	G-E Drawing
RESISTORS (CONTINUED) (Composition, $\pm 5\%$, $\frac{1}{2}$ w, unless otherwise specified)		
R10 and R11	10,000 ohms.	C-3R77-P103J
R12	Potentiometer, composition: 5000 ohms $\pm 20\%$, 2.25 w, linear taper. Allen Bradley Type J.	M-2R73-P12
R13	4700 ohms $\pm 10\%$.	C-3R77-P472K
R14	240 ohms.	C-3R77-P241J
R16	4700 ohms.	C-3R77-P472J
R17 and R18	0.10 megohm.	C-3R77-P104J
R19	30,000 ohms.	C-3R77-P303J
R20	51,000 ohms.	C-3R77-P513J
R21	1200 ohms, 2 w.	C-3R79-P122J
R22	4700 ohms.	C-3R77-P472J
R24	Potentiometer, composition: 1500 ohms $\pm 20\%$, 2.25 w, linear taper. Allen Bradley Type J.	M-2R73-P9
R25	47,000 ohms, 1 w.	C-3R78-P473J
R26 and R27	0.10 megohm.	C-3R77-P104J
R28	47,000 ohms, 1 w.	C-3R78-P473J
R29	4700 ohms.	C-3R77-P472J
R30	0.10 megohm.	C-3R77-P104J
R31	47,000 ohms, 1 w.	C-3R78-P473J
R32	4700 ohms.	C-3R77-P472J
R33	Potentiometer, composition: 50,000 ohms $\pm 20\%$, 2.25 w, linear taper. Allen Bradley Type J.	M-2R73-P18
R36	1500 ohms.	C-3R77-P152J

Symbol	Description	G-E Drawing
RESISTORS (CONTINUED) (Composition, $\pm 5\%$, $\frac{1}{2}$ w, unless otherwise specified)		
R38	47,000 ohms.	C-3R77-P473J
R39	0.51 megohm.	C-3R77-P514J
R40	2000 ohms.	C-3R77-P202J
R41	47,000 ohms.	C-3R77-P473J
R42	2700 ohms, 1 w.	C-3R78-P272J
R43	1.0 megohm.	C-3R77-P105J
R46	1.0 megohm	C-3R77-P105J
R48	20,000 ohms.	C-3R77-P203J
R49	7.5 megohm.	C-3R77-P755J
R50	12.0 megohm.	M-7478624-P12
R51	10.0 megohm.	C-3R77-P106J
R52	1.0 megohm.	C-3R77-P105J
R54	11,000 ohms $\pm 10\%$.	C-3R77-P113K
R55	390 ohms.	C-3R77-P391J
R56	1500 ohms.	C-3R77-P152J
R57	0.22 megohm.	C-3R77-P224J
R58	0.51 megohm.	C-3R77-P514J
R60	1500 ohms.	C-3R77-P152J
R61 and R62	62,000 ohms.	C-3R77-P623J
R63	1200 ohms.	C-3R77-P122J
R64 and R65	0.51 megohm.	C-3R77-P514J
R67	Potentiometer, composition: 500 ohms $\pm 20\%$, 2.25 w, linear taper. Allen Bradley Type J.	M-2R73-P6

Symbol	Description	G-E Drawing
RESISTORS (CONTINUED) (Composition, $\pm 5\%$, $\frac{1}{2}$ w, unless otherwise specified)		
R68	2400 ohms, 1 w.	C-3R78-P242J
R69	1000 ohms, 2 w	C-3R79-P102J
R70	470 ohms, 2 w.	C-3R79-P471J
R71	56,000 ohms.	C-3R78-P563J
R73	68,000 ohms, 1 w.	C-3R78-P683J
R74	6200 ohms.	C-3R77-P622J
R75	Wirewound, 500 ohms $\pm 10\%$, 10 w. Tru-Ohm Type SR-10.	A-7164093-P1
R76	82 ohms.	C-3R77-P820J
R78 and R79	91 ohms.	C-3R77-P910J
R82 and R83	3300 ohms.	C-3R77-P332J
R84	39,000 ohms.	C-3R77-P393J
R85	10,000 ohms.	C-3R77-P103J
R87	Wirewound, 1600 ohms $\pm 5\%$, 5 w. Sprague Type 5KT with pigtail terminals.	M-7478711-P33
R89	510 ohms.	C-3R77-P511J
R91	200 ohms.	C-3R77-P201J
R92	1500 ohms, 2 w.	C-3R79-P152J
SWITCHES		
S1	Rotary style: 1 section, 2 pole, 3 position, non-shorting. Oak Type H.	M-7480247-P1
S2	Toggle style, midget, spst, 3 amp at 250 v. Arrow Hart and Hegeman Type 20994-WJB; Carling Cat. #110-73.	C-7775772-P1

Symbol	Description	G-E Drawing
SWITCHES (CONTINUED)		
S3	Push-button type, momentary contact, red button, sp NO., $\frac{1}{2}$ amp at 115 v a-c. Grayhill Cat. #4001.	M-7481654-P1
S4	Toggle style, midget, dpdt, 1 amp at 250 v, 3 amp at 125 v. Arrow Hart and Hegeman Type 20905-WJB; Carling Cat. #316-73.	C-7775772-P4
TRANSFORMERS		
T1	Audio input. Pri imp: 300/600 ohms; sec imp: 60,000 ohms.	A-7139209-P1
T2	Audio input. Turns ratio: full pri to sec 1:1.	B-7489201-P1
T3	Audio output. Pri imp: 9000 ohms; sec imp: 600/150 ohms; ter: feedback windings.	A-7137659-P1
T4	Filament and plate. Pri: 110/117/125 v, 60 cycles; sec #1: 680/340 v, 0.240 amp; sec #2: 5.0 v, 6.0 amp; sec #3: 6.4/3.2 v, 7.5 amp.	B-7483279-P1
FUSE SOCKET		
XF1	Bussman Type HKP.	K-7115179-P1
TUBE SOCKETS (Mica filled phenolic)		
XV1 and XV2	9 pin miniature, 4 ground lugs.	M-7480532-P8
XV3 thru XV5	7 pin miniature, bottom mount flat top, 4 ground lugs.	P-7768887-P14
XV6	9 pin miniature, 4 ground lugs.	M-7480532-P8

Symbol	Description	G-E Drawing
TUBE SOCKETS (CONTINUED)		
XV7 and XV8	7 pin miniature, bottom mount flat top, 4 ground lugs.	P-7768887-P14
XV10	9 pin miniature, 4 ground lugs.	M-7480532-P8
XV11	7 pin miniature, bottom mount flat top, 4 ground lugs.	P-7768887-P14
XV12 and XV13	9 pin miniature, 4 ground lugs.	M-7480532-P8
XV14	7 pin miniature, bottom mount flat top, 4 ground lugs.	P-7768887-P14
XV15	Octal. Cinch Type 9886.	K-7103053-P1
XV17	9 pin miniature, 4 ground lugs.	M-7480532-P8



THE FOLLOWING INFORMATION IS INCLUDED AS AN AID IN SERVICING THE EQUIPMENT:

SLANT LINES INDICATE THE DIRECTION TO THE NEAREST CONNECTION POINT.

SMALL CIRCLES DESIGNATED BY E-NOTS INDICATE THE POINTS (THE POINTS PHYSICALLY MOUNTED ON THE COMPONENT OR TUBE SOCKETS ARE PRECEDED BY THE COMPONENT OR SOCKET SYMBOL.)

RESISTOR VALUES ARE IN OHMS & VE WATT UNLESS OTHERWISE SHOWN.
 K=1,000 OHMS
 MEG=1,000,000 OHMS

CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN. μ =1-MICROMICROFARADS.

COIL VALUES ARE IN MICRORHENRIES UNLESS OTHERWISE SHOWN.
 MH= MILLIHENRIES
 H= HENRIES

R= RUN DIRECT, DRESS AWAY FROM CHASSIS GND, AND FOR DO NOT LACE IN CABLE. ALL WIRING IS CRITICAL ON MAJOR COMPONENTS WHERE NOTED, EXCEPT FRAGMENTS.

Fig. 5 Elementary Diagram, Limiting Amplifier, Model 4BA7A3 (E-7354582, Rev. 4)

Fig. 5 Elementary

48A7A3
GENERAL ELECTRIC COMPANY
ELECTROBICS DIVISION
TECHNICAL PRODUCTS OPERATION
SYRACUSE, N. Y. U.S.A.

PACKING LIST FOR:

LIMITING AMPLIFIER TYPE BA-7-A PER MODEL 48A7A3

SHEET 1 OF 1 SHEET

BOX #1/48A7A3

- | | | |
|---|--------------------|----------|
| 1 | LIMITING AMPLIFIER | 48A7A3 |
| 2 | INSTRUCTION BOOKS | EG1-2178 |

PACKED BY:
INSPECTED BY:

PLEASE RETURN THIS PACKING LIST WITH ANY COMPLAINTS REGARDING
SHORTAGE OR DAMAGE.
1/12/59BB

WHERE TO OBTAIN SERVICE

Requests for engineering service information or replacement parts not obtainable from a local dealer may be directed to the nearest office listed below or to the General Electric Company, Service Engineering, Technical Products Operation, Communication Products Department, Division Street Plant, Syracuse, N.Y.

ATLANTA	Room 517 1330 W. Peachtree St. N.W.	TRinity 5-6691
CHICAGO	Room 811 Engineering Bldg. 205 W. Wacker Dr.	ANdover 3-7830
CLEVELAND	1013 Williamson Bldg.	SUperior 1-6822
DALLAS	3200 Maple Ave. Room 108	RIverside 7-4296
KANSAS CITY, MO.	3628 West 95th St. Shawnee Mission, Kansas	MItchell 9-7131
LOS ANGELES	Suite 210, North Lake Bldg. 232 North Lake Ave. Pasadena, Calif.	SYcamore 5-1209 MUrray 1-5965
NEW YORK	2801 Graybar Bldg. 420 Lexington Ave.	PLaza 1-1311, Ext. 2663
SAN FRANCISCO	565 Broadway Redwood City, Calif.	EMerson 8-4681
SCHENECTADY	201 S. Brandywine Ave.	EXpress 3-9110
SEATTLE	2 Hanford St.	MUtual 2-8208
SYRACUSE	Service Engineering Technical Products Operation Communication Products Department Division Street Plant	GRanite 6-4411 Ext. 6357
WASHINGTON	927 Wyatt Bldg. 777 14th St. N.W.	EXecutive 3-3600, Ext. 210