PROGRAMME LIMITING AMPLIFIER AM6/7

Introduction

The AM6/7 is intended for use as a protective limiter at transmitters or studios, or as a compressor at unattended studios or for popular music programmes. It has a linear input/output characteristic up to a selected input level, and a constant output for inputs above that level up to the maximum range.

The unit is contained in a chassis CH1/26B, which may be plugged into a nesting box PN3/23. It has two 15-way in-line connectors, and coding pins in positions 23 and 39 to the left of the left-hand connector as viewed from the rear. To instal the AM6/7, the upper bracing bar of the PN3/23 must be removed.

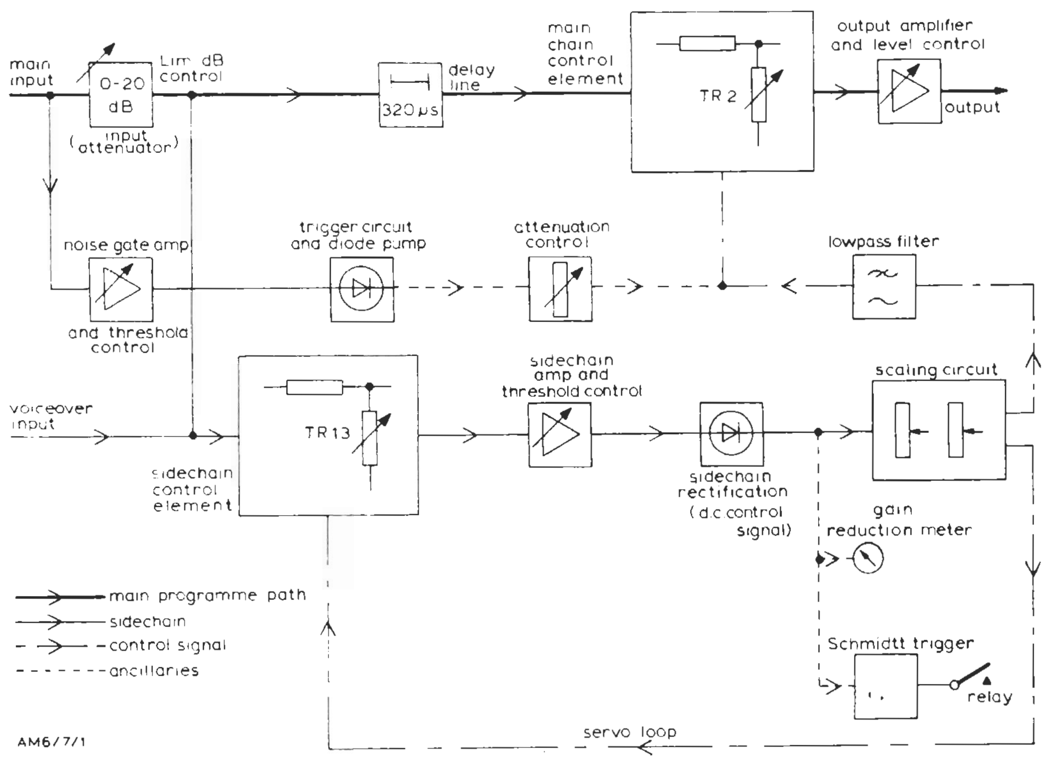

Fig. 1. Simplified Block Diagram of the AM6/7

Facilities (Fig. 1)

Input Attenuator or 'Lim. dB' Control

This control has a range of 20 dB in 2-dB steps and enables the level at which limiting begins to be varied. When the control is set to 0, the limiting threshold is +8 dB referred to 0·775 volt. (See also 'Use at F.M. Transmitters' under Installation Notes.)

Variable 'Gain-recovery Time' Switch

This control allows any of seven fixed recovery times to be chosen, from 160 ms to 3 seconds, according to the type and content of the programme. In addition to the seven fixed-time settings, there is an *Auto* position in which the recovery rate is automatically controlled by the programme content. If the gaps in the programme are shorter than 1 second, the recovery rate is 10 seconds, but if the gap is longer the recovery rate changes to 0·7 second; this changeover takes place at 15 dB below peak signal. Common to all the switch positions is a 30-ms recovery rate.

The effects of the three *Auto* gain-recovery rates are as follows:

1. The long time-constant of 10 seconds permits faithful reproduction of programmes with long reverberation times, and allows for the possibility that two or more limiters may be used in tandem.
2. The intermediate time-constant of 700 ms ensures that the limiter gain is fully recovered within the intervals between different speakers in an interview or discussion, although it is held at any reduced value so long as a speaker continues to speak, by 1 above.
3. The short time-constant of 30 ms avoids prolonged gain depression after a brief isolated excess signal.

The third effect mentioned also applies at all seven fixed or 'manual' settings. The use of short recovery times on speech or music should be avoided. On speech, for example, a rise in gain between words or syllables can exaggerate breath noises.

Side-chain or Voiceover Input

This input enables the main chain output to be controlled by a second programme source. For example, continuity announcements may be used to hold down music, which if a short time-constant is selected will be quickly restored at the end of each interruption.

Noise Gate

This device, operating from the input signal, reduces the gain by a preset amount when the input signal falls below a fixed threshold. The threshold is 30 dB below a peak of +8 dB, i.e., −22 dB, and the reduction in level is set to 12 dB. The gate may produce undesirable effects if used on music or with short recovery rates. It is intended for use in the *Auto* position of the gain-recovery time switch and with 10 to 20 dB of compression applied.

Gain-reduction Meter

This meter gives an indication of the extent of limiting. It is intended as a dynamic indicator, and should not be used for static line-up tests. Provision is made for the use of an external meter.

Relay Circuit

Relay contacts, which close when limiting begins, are available for such uses as muting automatic monitors.

Pre-emphasis

A strap on the back connector SKB pins 7 and 8 connects a pre-emphasis network into the side-chain circuit. This reduces the limiting threshold at high frequencies. The time-constant of the pre-emphasis network is 50 μs, and it can be used at f.m. transmitters to offset the effect of a subsequent pre-emphasis network, e.g., an NE1/12.

Principles of Operation (Figs. 1, 2 and 5)

Control Elements (Fig. 2)

Field-effect transistors are used as variable-resistance elements in the main and side chain control circuits. The output characteristics (Fig. 2) of these devices are roughly linear for low positive and negative values of drain-source voltage, and in the AM6/7 the peak-to-peak voltage across the drain-source of the main control f.e.t. is kept to about 50 mV. Even with this low value of signal voltage, certain f.e.t.s can produce considerable even-harmonic distortion, and to keep distortion down to acceptable levels it is necessary to feed back a portion of the signal voltage to the gate of the f.e.t. in the correct phase.

The correct functioning of the limiter depends entirely on careful adjustment of the components associated with TR2 and TR13. Under no circumstances should the replacement of TR2 or TR13 or adjustment of R23, R66, R106 or R107 be attempted. If failure or misalignment is suspected, the unit should be returned to Equipment Department for rectification.

Limiter Operation

The main programme path is via the input attenuator and delay line to the main control element

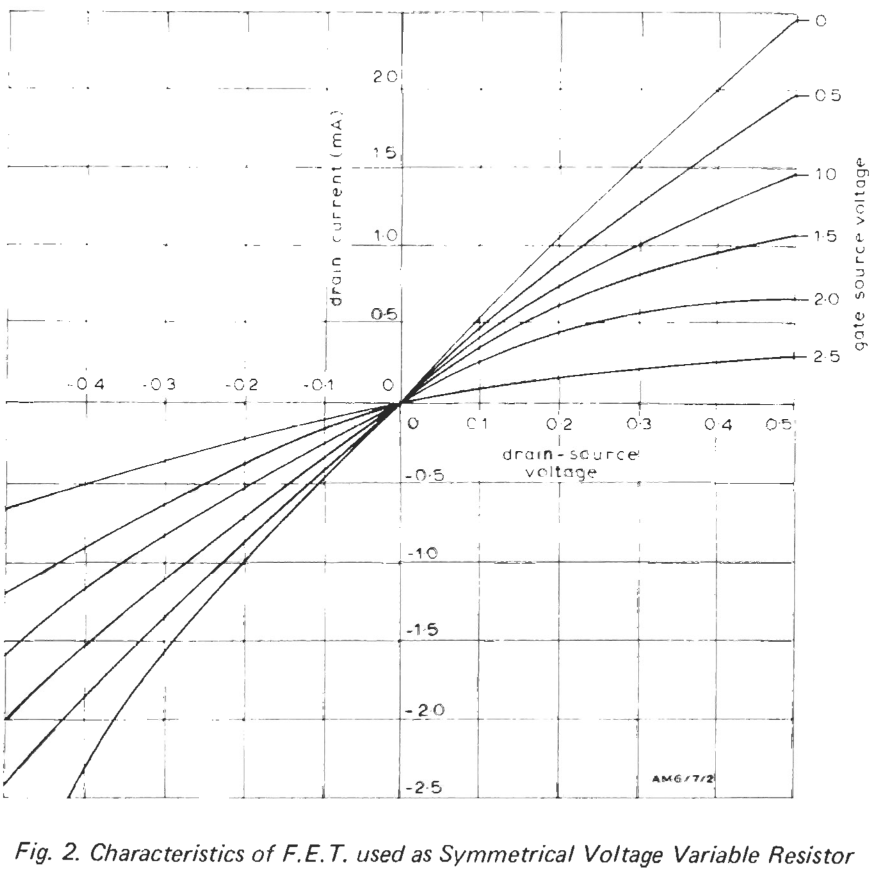

Fig. 2. Characteristics of F.E.T. used as Symmetrical Voltage Variable Resistor

TR2 and output amplifier. The input signal is also fed to the noise gate which converts it to d.c. via a threshold control, trigger circuit and diode pump. The d.c. voltage controls the gate-source bias of f.e.t. TR27. When this transistor is on, the bias to the main control element TR2 may be varied by a preset control R20, hence varying the gain of the main amplifier chain.

A signal is taken from the output of the input attenuator to the side chain control element TR13 and side chain amplifier. Providing the signal at the input of the limiter is below the limiting threshold (+8 dB with input attenuator at 0), it passes to the output unaltered except for a 320-μs delay. If the input exceeds this threshold, the output from the side chain when rectified is sufficient to drive the scaling circuit. The signal is fed back to the side chain control element and makes a closed servo loop. This loop settles down to a steady state in about 50 microseconds, the 'attack time', and the gain of the loop is such that a full range of control, 20 dB, is achieved with a change of less than 1 dB at its output.

There is a second output from the scaling circuit and this is taken to the main control element. The adjustment of the scaler is such as to match the control-signal/attenuation characteristic of the two control elements. The control signal to TR2 is then passed via a half-section lowpass filter, which effectively slows it up and eliminates any fast changes which cause distortion effects. The delay is such that TR2 takes on its new value of channel resistance, and hence attenuation, in about 315 μs. Since the main programme signal is delayed by 320 μs, the gain of the amplifier thus settles down a few microseconds before the programme signal reaches the main control element. The output is therefore devoid of overshoot and also of the unpleasant effects present in fast-acting output-controlled limiters.

In normal use, the unit has zero gain. With the input attenuator set at 0, a signal at a level of +8 dB or less appears at the output at the same level. If the input is greater, the output is held to +8 dB within the range of the unit, i.e., 20 dB.

The input attenuator is termed the 'Lim. dB' control. As it is turned from 0 to 20, the attenuation is decreased in 2-dB steps, raising the input to the side chain and introducing a corresponding degree of limitation in a signal peaking to a level of +8 dB (i.e., of zero programme volume) at the input. The rectified signal from the side chain also drives the meter circuit indicating the amount of limiting or gain reduction and it operates a relay whose contacts close when limiting begins.

There is a separate input to the side chain. This is buffered off from the main programme chain but it allows a second programme source ('voiceover') to control the main chain gain.

Circuit Description (Figs. 1, 3 and 5)

General

The limiter has a high-impedance balanced input. The input attenuator or *Lim. dB* control, which follows the input transformer T1, has a maximum attenuation of 20 dB. The attenuator, whose total resistance is about 2·5 kilohms, and the transformer impedance-ratio, which is 4:1, together produce an input impedance to the limiter of 10 kilohms. The attenuator output is taken to an emitter-follower TR1, which effectively buffers off the main programme chain from the side chain or voiceover input. There is a similar emitter-follower TR12 at the input to the side chain.

Delay Network L1 to L20 and C3 to C22

The delay network comprises 10 second-order allpass sections, and the input to the network is via a 13-dB pad, R15, R17 and R16. This pad provides the network with its correct source impedance of 600 ohms and also attenuates reflections caused by imperfections in the delay network which may enter the side chain. The delay network has a flat frequency response from 30 Hz to 16 kHz and the group delay of about 320 μs is constant over this frequency range. Its output is terminated by R18 (620 ohms).

Main Chain Amplifier and Output Stage TR4 to TR6

The main chain amplifier comprises two transistors TR4 and TR5. It has d.c. feedback from TR5 emitter via R28 to TR4 base, and a.c. feedback from TR5 collector to TR4 emitter via R27. The gain of this two-stage amplifier is about 36 dB. A small-value capacitor C27 is added across R27 to ensure stability of the feedback loop.

The signal appearing at TR5 emitter is fed via R131 and R133 to the primary of transformer T5. The secondary of T5 is connected in series with the gate of control f.e.t. TR2 The purpose of this circuit is to cancel even-harmonic distortion produced by TR2 when limiting takes place. R133 is adjusted to produce a second-harmonic minimum when 1-kHz tone is applied to the input with the *Lim. dB* control set to 14. C56 corrects the feedback phase at higher frequencies around 5 kHz where distortion would rise if it were not fitted.

The output from TR5 is taken to the main level control R32. This control has a range of about 16 dB. Finally the signal proceeds to the output amplifier, comprising TR6 and T2. The output stage has a gain of about 16 dB, controlled by a tertiary winding on T2 in series with TR6 emitter. The voltage feedback also produces a low output impedance, which is less than 75 ohms. R123 and C53 correct the output impedance at high frequencies.

Side-chain Amplifier and Limiting Threshold Circuit TR14 to TR17

The input to the side-chain amplifier is taken from TR1 via R55 and R61. A capacitor C39 may be paralleled with R55 via an external strap; this gives the pre-emphasis time-constant of 50 μs when the limiter is used at an f.m. transmitter and increases the input to the side-chain amplifier and threshold circuit at high frequencies.

via C42. A tantalum capacitor is fitted in this position because leakage into the drain of the control element TR13 can produce l.f. instability of the servo loop. The two-stage amplifier TR14 and TR15 is similar to the one used in the main chain. It has a.c. and d.c. feedback, the a.c. feedback capable of being varied by R71. This control sets the limiting threshold of the control loop, and its range of control is some 30 dB. The loop has also an extended frequency response, the 3-dB points being at about 7 Hz and 100 kHz; this wide response is needed to provide the short attack-time of the side chain. The side-chain signal is fed into an emitter-follower TR16 which provides a low source impedance to feed transformer T4 and bridge rectifier D2 to D5. The full-wave rectified signal is passed to the base of TR17.

TR17 has a zener diode in its emitter circuit and does not pass current until the voltage at its base exceeds the zener voltage plus the base-emitter drop. When the signal into the side chain exceeds a predetermined level set by R71, the rectified signal causes TR17 to conduct on its positive peaks.

R95-R101 is replaced by a single resistor R_a. Before limiting begins, the point A is at +14 volts and TR17 is cut off. The point B is also at +14 volts, having been charged up through R_a.

Suppose now that limiting begins and that the excess signal at the input causing this is maintained. TR17 then conducts and point A drops toward the negative rail. Diode D11 is now forward-biased and C52 discharges through TR17. Point B therefore attains a new voltage.

This voltage is applied to the gate of the scaling f.e.t. TR20, which tends to conduct less. The source follows the gate and this change is detected, via R106 and R107, at the gates of the control elements TR2 and TR13, which then assume a lower value of channel resistance.

The gain of the amplifier is therefore reduced and remains at its new value until the excess signal at the input is removed or falls below the threshold of limiting. When this happens, the input to TR17 is below that required to turn it on and its collector, point A, rises to +14 volts. D11 becomes reverse-biased, and because C52 cannot change its

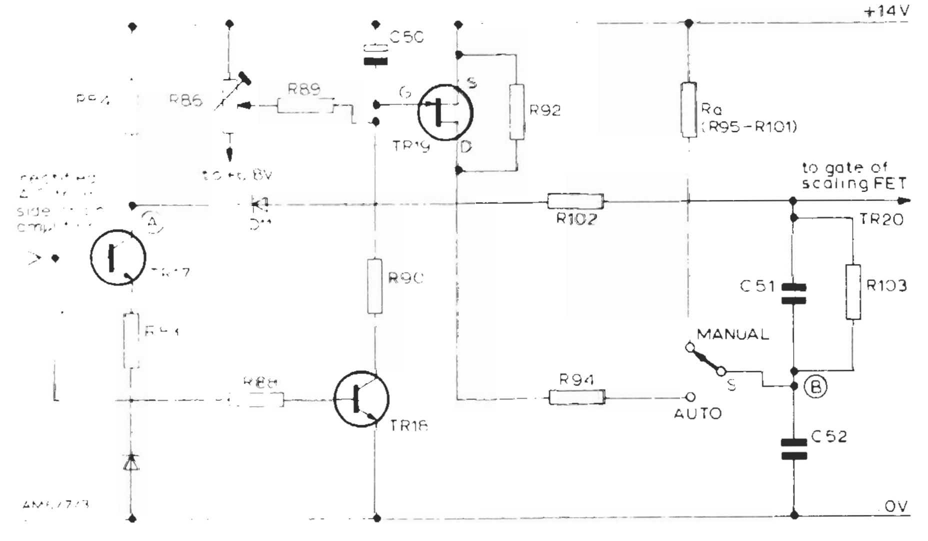

Fig. 3. Gain Recovery Circuit

Gain-recovery Circuit TR18 to TR20 (Fig. 3)

There are two modes in which the limiter can be set for gain recovery, *Manual* and *Auto*.

(a) Manual Mode

In this mode there are eight distinct rates at which the gain of the circuit can recover. Seven of these rates, from 160 ms to 3 seconds, may be selected manually and are determined by a chain of resistors R95-R101 and capacitor C52. The other recovery rate, determined by C51 and R103, operates only for excess signals of short duration and is not affected by the position of the time-constant switch. This rate is about 30 ms.

To understand the operation of the recovery circuit, refer to Fig. 3. In this the chain of resistors time-constant of (C52 × R_a). The gate and source of TR20 follow this change and hence the gates of control elements TR2 and TR13.

In the *Manual* mode, therefore, the gain recovery, except for brief excess signals, is determined by C52 and R95 to R101.

(b) Auto Mode

In this mode, the chain of resistors R95-R101 is replaced by R92, R94 and TR19. The recovery can be at three rates:

1. (R94 × C52),
2. [(R92 + R94) × C52],
3. (R103 × C51).

As in the *Manual* mode, this last recovery rate operates only for brief excess signals.

Consider an excess signal at the input which is maintained. The side-chain input to TR17 is also applied to TR18 via R88 and this transistor passes collector current which flows through R90, R89 and R86 to the +14-volt rail. This current flow tends to make the gate of TR19 negative with respect to its source due to the voltage drop across R86 and R89. The f.e.t. is turned off and effectively becomes an open-circuit as far as R92 (40 megohms) is concerned.

In this condition, the recovery rate is determined by (R92 + R94) and C52, and is about 10 seconds.

If the side-chain input falls below a certain value, TR18 turns off. Its collector tends to rise, but due to the presence of C50 and R89 it can only change at a rate determined by their *CR* value and the setting of the control R86. This control is preset so that if the pause in the input signal is greater than 1 second TR19 turns on and short-circuits R92.

The gain recovery then depends on R94 and C52 and its rate is about 700 ms. The change from 10 seconds to 700 ms occurs about 15 dB below limiting threshold.

Meter Circuit, TR22, TR23

The input to the scaling f.e.t. TR20 from the recovery circuit is also connected through R108 to source-follower TR21. The source of this f.e.t. behaves in the same way as TR20 and adjusts itself according to the degree of limiting. A tap is taken off between R109 and R110 in the source circuit and fed to emitter-follower TR22. The meter and associated components are connected between the emitters of TR22 and TR23.

The control R122 in the base circuit of TR23 enables the voltage across the meter to be varied. It is adjusted to make the meter read 2 dB when 2 dB of limitation is applied to a signal which has a level of +8 dB (corresponding to a programme volume of 0 dB) at the input to the limiter. When the input is increased to produce more than 2 dB of limiting, the voltage at the source of TR21 falls; therefore more current flows through the meter. R113, R114, D12 and D13 are present to shape the meter scale. Because, however, of the characteristic of the f.e.t.s feeding the meter circuit, the scale is only correct at 2 and 20 dB of limiting. In between these points the error may be up to ±3 dB. The meter, therefore, only serves as a dynamic indicator and cannot be used for static line-up.

Relay Circuit TR24 to TR26

Connected to the resistor chain in the source of TR21 is R111, a variable resistor. The d.c. voltage is fed to TR24 and TR25, which when R111 is adjusted correctly are normally held on when the limiter is not limiting.

TR24 to TR26 form a Schmidtt trigger circuit, and when TR24 and TR25 are on TR26 is off, due to the voltage drop across R118 which removes the base bias. When limiting begins, the voltage at the source of TR21 falls, and TR24 and TR25 turn off. TR25 collector voltage rises and, due to the chain of resistors R118, R119 and R121, TR26 conducts causing relay RLA to operate and its contact RLA1 to close. RLA1 is connected between PLA8 and PLA4.

Noise Gate TR7 to TR11, TR27 and IC1

The input to the noise gate is taken from the secondary of input transformer T1 via switch SB. TR7 acts as a buffer for the main input. R40 from TR7 emitter prevents TR8 and TR9 from producing distortion in the main amplifier on high input signals. TR8 and TR9 form a two-stage amplifier with a gain of about 42 dB. R45 and R43 define the gain and R43 may be adjusted to alter the sensitivity of the noise gate.

The signal is fed via R44 to TR10. In the absence of a signal, TR10 is cut off due to the presence of D1 in its emitter circuit. When the signal from TR9 is about 8 volts p-p, TR10 conducts on the positive peaks, and 12-volt negative pulses from its collector are fed via C35 to IC1, which is a monostable integrated circuit. The monostable circuit produces at its output (pin 6) positive pulses of 35 ms duration and about 4 volts amplitude.

The pulses are inverted by TR11 and passed to the diode pump circuit C37, D19, D14 and C38. C38 charges up to −4 volts within the duration of the 35-ms pulse and this negative voltage is sufficient to keep TR27 pinched off. TR27 drain is connected via R20 to the gate of the main chain control f.e.t. TR2.

When the input level to the limiter falls below −22 dB (i.e., 30 dB below +8 dB) the signal from TR9 is insufficient to turn TR10 on. IC1 therefore produces no pulses at its output and C38, which was previously charged to −4 volts, begins to discharge through R127. After about half a second TR27 is turned on; this has the effect of modifying the bias to TR2, which attenuated the signal through the main programme path. The amount by which the gain is reduced is determined by the setting of R20, the maximum reduction being about 21 dB. R126, C54 and C55 following the diode pump ensure that no switching spikes are present in the main programme path.

Installation Notes (Fig. 5)

Gain

The gain of the amplifier is normally set to be 0 dB when the limiter is working into a high-impedance load, e.g., using the ATM/1 high-impedance input. If the unit is to be loaded with a lower impedance, the gain must be reset. To do this, apply zero-level 1-kHz tone to the input, set the *Lim. dB* control to 0, and adjust R32 to give zero-level output across the desired load impedance.

Voiceover Facility

The input to the side chain, PLB5 and PLB6, is set to have a threshold of either +8 dB or −12 dB by strapping PLB14 to PLB15 or to PLB13. If voiceover is not required, PLB14 must be strapped to PLB15 and not left unconnected.

External Meter

When an external meter is used it is connected to the tags on the nesting box corresponding to PLA3 and 7, and the straps between PLA3 and 5 and PLA6 and 7 are removed. The meter should be of 1 mA sensitivity and should have a resistance of 600 ohms. A suitable type is the P.P.M. meter to Equipment Department Specification ED 1478. The scale should be in accordance with Drawing No. DSK 11378 Fig. 1.

Pre-emphasis

Pre-emphasis can be introduced by shorting together the pins corresponding to PLB7 and 8 in the nesting box. There is no provision for adjustment.

Muting Relay

The relay circuit threshold is set by adjustment of R111. To set the threshold, apply tone at +9 dB to the limiter input, set the *Lim. dB* control to 0 and adjust R111 until the contacts just close. When the input level is reduced, the contacts should open before it reaches +8 dB. The relay contacts are brought out at PLA8 and PLA4.

Noise Gate

The reduction in gain when the input level falls below −22 dB is adjusted by varying R20.

To make the adjustment, switch the noise gate to *In* and feed −30 dB at 1 kHz to the main input. Observe the output level on the ATM/1 and set R20 to give the required reduction in level.

Use of Limiter at F.M. Transmitters

At f.m. transmitters it is often desirable to operate with the output limiting level at +12 dB, giving a 4-dB margin over the normal maximum level of programme peaks of +8 dB. The change is effected by the insertion of 4 dB of attenuation into the input circuit and a corresponding 4-dB increase in the gain of the final amplifier, as follows:

1. Replace the wire strap between tags 12 and 13 on the delay-line printed board with a 1·5-kilohm Mullard MR25 resistor.
2. Apply 1-kHz tone at +4 dB to the input and adjust R32 to give a level of +4 dB at the output with the *Lim. dB* control set at 0.

Performance Tests (Figs. 4 and 5)

Apparatus Required

Low distortion oscillator
or TS/10 with lowpass filter
Amplifier Testmeter ATM/1
Avometer Model 8
Waveform analyser or FHP/3
D.C. supply of 250 mA at 24 volts
Oscilloscope

1. Test Conditions

The test conditions, except where otherwise stated, are as follows:

(a) Source and load impedances 600 ohms.
(b) Noise gate switched out.
(c) PLB14 strapped to PLB15.
(d) PLA3 strapped to PLA5.
(e) PLA6 strapped to PLA7.
(f) Gain recovery switch on *Auto*.

2. Limiting Characteristic

Feed 0-dB 1-kHz tone to the main input, set the *Lim. dB* control to 0 and adjust R32 to give 0 dB at the output. Increase the input level to +8 dB and adjust R71 to depress the output by about 0·1 dB, i.e., to 7·9 dB. Rotate the *Lim. dB* control from 0 to 20 and observe the output on the ATM/1. The variation from minimum to maximum should not exceed 1 dB; in addition the output should not fall below +7·3 dB or rise above +8·5 dB. On no account should the scaling components R23, R66, R106 and R107 be adjusted, if the output falls outside the above limits.

3. Frequency Characteristic

With the *Lim. dB* control set to 0, and a constant input level of 0 dB, the output level should fall within the following limits with respect to 1 kHz:

60 Hz to 15 kHz	0 ±0·3 dB
30 Hz to 60 Hz	0 ±0·5 dB

4. Harmonic Distortion

(a) Measured with Waveform Analyser

Using the TS/10 with a lowpass filter, or a low-distortion oscillator, the following results should be obtained with 1-kHz tone at an input level of 0 dB:

Lim. dB Setting	*Percentage Harmonics 2nd*	*3rd*	*Others*
0	0·1	0·1	negligible
14	0·2	0·1	negligible

With the *Lim. dB* control set at 14, adjust R133 to give a minimum of second harmonic.

(b) Measured with FHP/3

If a waveform analyser is not available, an FHP/3 should be used and the results should be as follows:

Lim. dB Setting	*Total Harmonics*
0	0·15%
14	0·2%

Without a waveform analyser, the adjustment of R133 is not practicable.

5. Noise Volume

With the input terminated in 600 ohms and the *Lim. dB* control at 0, the total unweighted noise measured on an ATM/1 peaking to 6 should be better than −65 dB.

6. Input and Output Impedances

The input and output impedances, measured by resistance substitution at 1 kHz, should be as follows:

Input impedance	10 Kilohms ±500 ohms
Output impedance	not more than 75 ohms

7. Noise Gate

With the noise gate off, apply 1-kHz tone at −30 dB to the main input and use the ATM/1 to measure the output level, which should be −30 dB. Switch on the noise gate and again measure the output, which should now have fallen about 12 dB to −42 dB. Adjust this value if necessary by varying R20. Increase the input and note the input level at which the noise gate opens; this level should be −22 ±2 dB.

8. Side-chain or Voiceover Input

Apply 120-Hz tone at −30 dB to the main input and, with the ATM/1, measure the output level, which should be −30 dB. With PLB14 strapped to PLB15, apply 1-kHz tone at +8 dB to the input to the side chain: the level at the main output should remain at −30 ±0·5 dB. Increase the side-chain input to +10 dB; the main output should fall by 2 dB.

Remove the strap between PLB14 and PLB15 and strap PLB14 to PLB13. The main output should now remain unaltered when −12 dB is applied to the side chain, but should fall by 2 dB when the side-chain input is increased to −10 dB.

9. Lim. dB Control

Set the *Lim. dB* control to 0 and feed 1-kHz tone at −20 dB to the main input. With the ATM/1, measure the output level, which should be −20 dB. Alter the setting of the *Lim. dB* control one stop at a time. The level at the main output should rise by 2 ±0·2 dB at each change, with a maximum cumulative error of ±0·3 dB.

10. Gain-recovery Times (Fig. 4)

Gain-recovery times are measured by Equipment Department during acceptance testing, but in the event of doubt the following checks should be made.

Select a gain-recovery time of 3 seconds. Feed 1-kHz tone at +8 dB to the main input and connect an oscilloscope to the main output. Set the *Lim. dB* control to 12 and the oscilloscope timebase to a suitable slow speed, say 0·5 cm/s. Suddenly reduce the main input by 20 dB and observe the oscilloscope trace, which should be as shown in Fig. 4.

The recovery time t is the time taken for the recovering signal under the conditions specified to reach the mid-point between its initial amplitude x and its final amplitude y, i.e. $(x + y)/2$ as shown.

A recovery time of 3 seconds ±20 per cent should be obtained. The other recovery times, except on the *Auto* position, should also be within ±20 per cent of nominal.

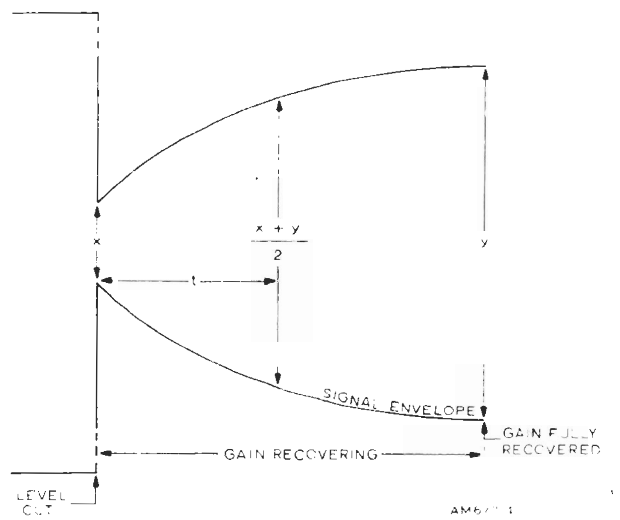

Fig. 4. Gain Recovery Characteristic

11. Meter Circuit

Feed 1-kHz tone at +8 dB to the main input with the *Lim. dB* control at 0. As the *Lim. dB* control is switched round, the meter should be correct at 2 dB and 20 dB, with errors of not more than ±3 dB on the intermediate positions.

12. Relay Circuit

Switch the Avometer to the *Ohms* range and connect it to PLA8 and PLA4. Feed 1-kHz tone at +9 dB to the main input. The relay contacts should close; if they do not adjust R111. Slowly reduce the input level; the contacts should open at or above +8 dB.

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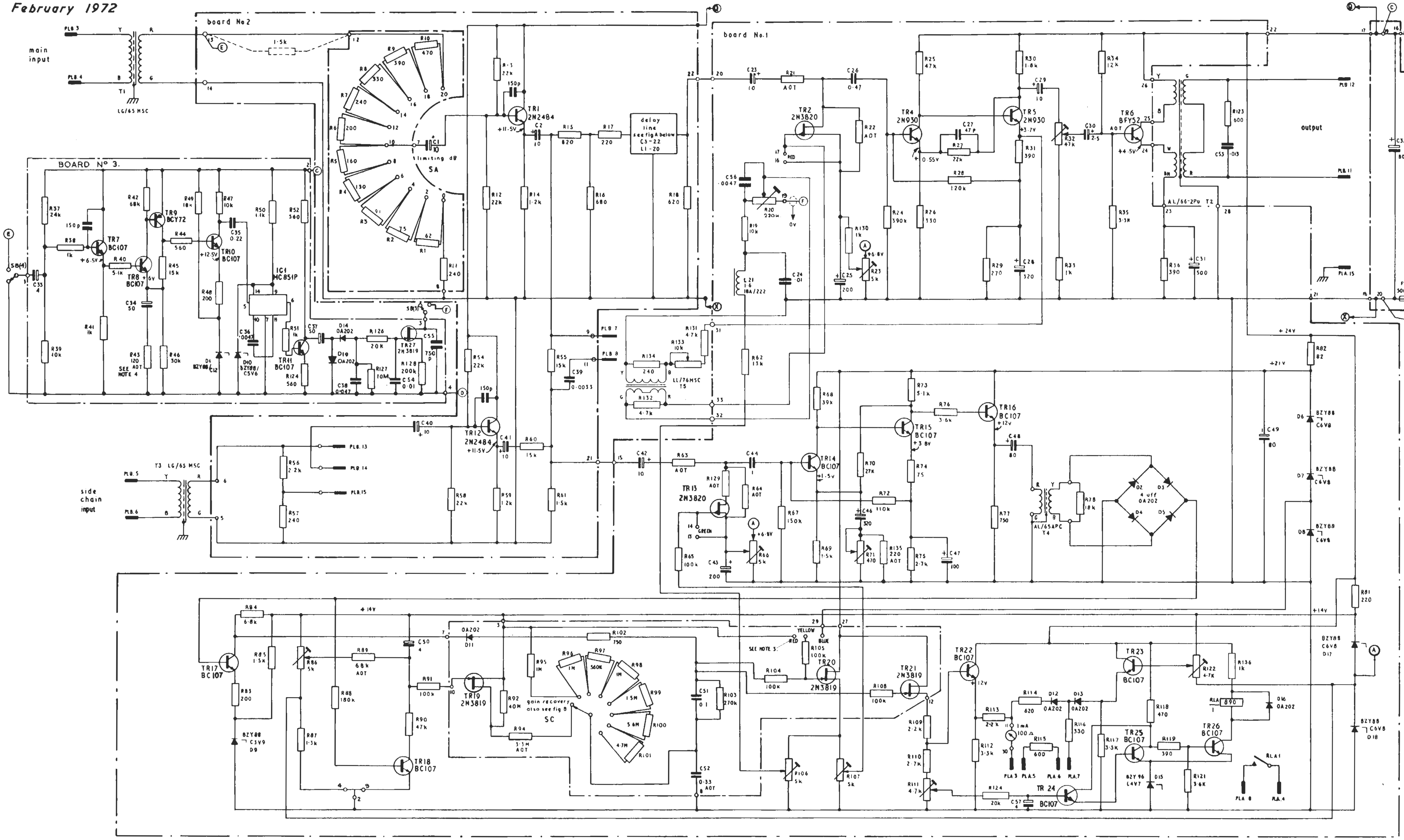
February 1972

AM6/7



from D23051 A1
parts list D23052 A4

AM6/7/5T

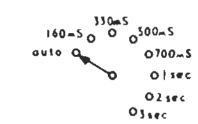


FIG B
gain recovery switch
SC

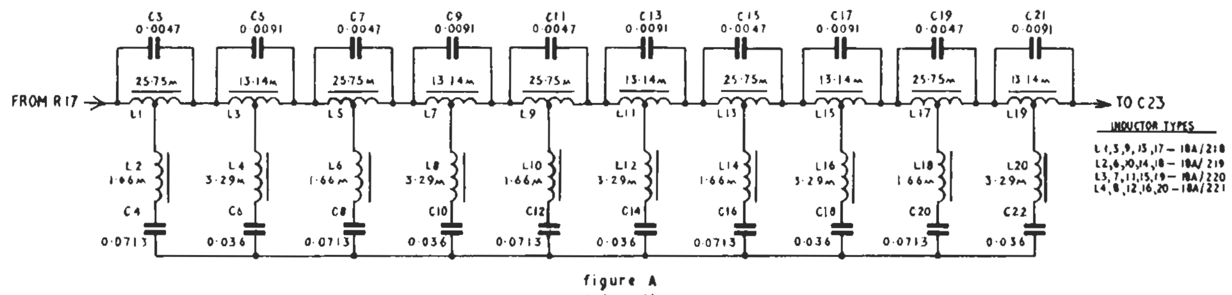
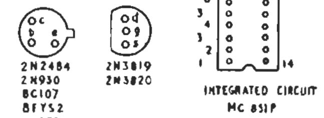


figure A
delay line

Fig. 5. Circuit of AM6/7

transistor terminations



view on leads

NOTES

1. POINTS SHOWN THUS —o— ARE NUMBERED PINS OR PRINTED BOARD.
2. SIMILARLY LETTERED POINTS SHOWN THUS (A) ARE JOINED TOGETHER.
3. THESE POINTS ARE SITUATED ADJACENT TO R103 ON SC.2.
4. NOISE GATE THRESHOLD IS AT 30dB BELOW PEAK SIGNAL (+8) FOR HIGHER THRESHOLDS. R43 MAY BE CHANGED AS FOLLOWS :-

THRESHOLD			R43
25dB	BELOW	PK	220Ω
20dB	"	"	390Ω
15dB	"	"	680Ω

5. VOLTAGES, MEASURED ON AVO 8 w.r.t NEGATIVE RAIL, ARE TYPICAL VALUES.
6. EMITTER VOLTAGES ARE WITH RESPECT TO THE NEGATIVE RAIL