TECHNICAL INSTRUCTION

S6

AUTOMATIC MONITORS

December 1950

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SECTION A : AUTOMATIC MONITOR MINOR

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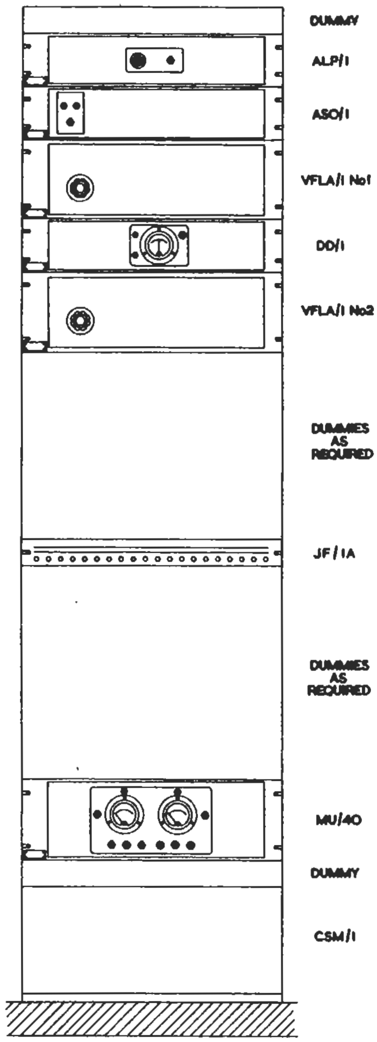

Fig. A2. Automatic Monitor Minor: Bay Lay-out

S E C T I O N A

A U T O M A T I C M O N I T O R M I N O R

INTRODUCTION

The present-day broadcasting system involves a complex distribution network, whereby a programme originating from a Studio centre is fed via land-lines through programme-switching centres to the transmitters. The programme chain is thus composed of many links, each of which is susceptible to complete breakdown, or to faults which will introduce distortion or extraneous noise. To enable the faults to be located and cleared in the shortest possible time, it has been the practice up to the present to employ engineers to monitor aurally the programme at each centre through which it passes.

Automatic monitors have been designed to reduce the number of engineers engaged on this work, and yet preserve the same quality standards. These monitors will compare a signal under observation with a reference signal, and will operate an alarm system when the two signals differ by a pre-set amount. The signal under observation (referred to as the 'compared signal') may be taken from any point in the transmission chain subsequent to the point from which the reference signal is obtained. In addition, a comparison can be made between the output of a check receiver and a reference signal. The reference signal is assumed to be within acceptable tolerances, and must therefore have been checked aurally, or by an automatic monitor earlier in the transmission chain.

The differences between the two signals may arise from a breakdown of equipment or lines, noise, variation of frequency response, variation of transmission equivalent or non-linearity. The magnitude of the difference which will operate the alarm system varies with input level and with the frequencies present in the input signal. The monitor has characteristics similar to those of the human ear, that is, it is more sensitive to faults and noise at middle frequencies than at high or low frequencies.

A fault in the compared signal will not in general produce continuous operation of the alarm system, and the duration and frequency of operation of the alarm system is a rough indication of the seriousness of the fault. For example, noise will operate the alarm system mainly in gaps in the programme, or at low programme volume; non-linearity produced by overloading will operate the alarm system when the programme is at high volume.

The frequency components of the programme serve as the test frequencies to check the circuit frequency response. Thus a variation in frequency response will be indicated only when the programme contains a component within the affected frequency band, and when this component is of sufficient magnitude.

Additionally, the monitor incorporates a unit which suppresses the operation of the alarm system during the inevitable occasions when the transmitter is overmodulated, and the output from a check receiver is reduced in comparison with the reference signal. If however, the periods of such overmodulation are too frequent or too long, (when appreciable distortion would result) the alarm system is operated.

Two models of the automatic monitor have been developed; the Automatic Monitor Minor, for use where the programme signal under observation and the reference programme signal can be brought together (geographically) for comparison, and the Automatic Monitor Major for use where conditions do not permit this being done, in which case the essential information about the signal under observation is fed to the comparison point by a special carrier system.

This Instruction deals with the former equipment, the Automatic Monitor Minor.

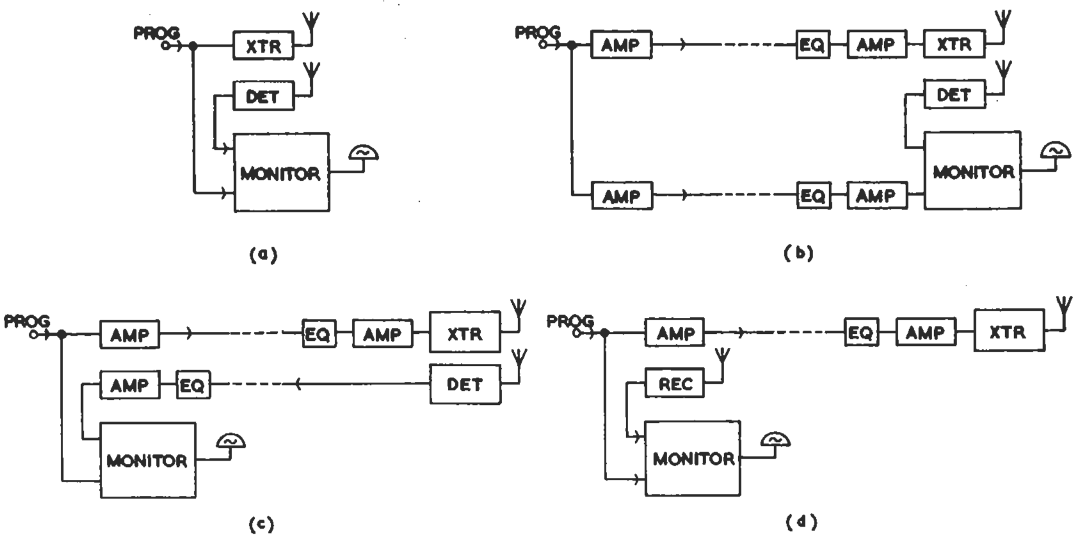

Fig. A2. Typical Monitor Installations

The necessity of bringing the two signals together for comparison does not preclude the automatic monitor Minor from monitoring a programme signal at a point remote from where the monitor is situated and where the reference signal is available. The compared signal may be returned by land-line or obtained from a check receiver adjacent to the monitor, or from a check receiver at the transmitter station, the output of the receiver being fed back by land-line. Examples of installations for which the automatic monitor Minor is suitable are shown in Fig. A2.

In each of these installations a transmitter is included in the circuit monitored, but it will be appreciated that the installations of the type shown in (b) and (c) could be used to monitor any link in a transmission chain. Both these installatations require an additional line for their operation; in (b) the additional line is used to carry the reference signal, in (c) to carry the compared signal. With an unattended remotely controlled transmitter, an installation similar to that shown in example (c) would be used, and the compared signal may be fed back over the transmitter control line. Where the additional line is also the programme reserve line, not only is the programme circuit monitored, but the reserve line also.

Where the compared signal path includes a land-line link, whilst the reference signal path does not include a comparable link, (as in Fig. A2 (c) and (d)), the additional length of land-line is limited in the majority of cases to about 100 miles by considerations arising from the delay distortion introduced in the compared signal.

The monitor has been designed to require the minimum of maintenance, and the alarm system will be operated if the monitor itself develops a fault.

ELECTRICAL DESIGN CONSIDERATIONS

The automatic monitor is required to accept two signals, the reference signal and the compared signal, compare them, and operate an alarm system when the two differ by a pre-set amount. Before discussing the method of comparison, it is necessary first to consider the relationship between the two signals.

Consider then the installation shown in Fig. A2(c). The compared signal path includes land-line links and amplifiers, to which there are not corresponding units in the path of the reference signal.

In traversing the additional land-line links the compared signal will suffer (a) attenuation distortion, (b) delay, this latter due to the fact that the velocity of propagation of signals over land lines is relatively slow. The velocity of propagation also varies with frequency, so that in a signal with components of several frequencies, each component will in general, be attenuated and delayed by amounts differing from those of the components of other frequencies. The attenuation distortion can be corrected by means of an equaliser, which will restore the components of the signal to their correct relative amplitudes. The normal types of equaliser (EV/2, EV/3,) do not however, equalise the delay times, so that the equalised signal waveform will, in general, be distorted, due to the unequal rate of transmission of its components.

Although this delay, and its variation with frequency, is tolerable from the viewpoint of programme quality, it precludes direct balancing of the reference and compared signals as a method of monitoring.

The method of comparison adopted is akin to taking a P.P.M. check on the programme. The signals are rectified in a circuit with a short charge time constant and a relatively long discharge time constant. In this way the amplitude of certain peaks of the programme are examined, and the amplitude of the peaks 'memorised' after the peaks have passed. These rectified outputs are then compared in a circuit which observes the difference between the two, and operates the alarm system when the difference exceeds the pre-set amount. The slow decay of the rectified outputs allows the operation of the alarm system to be delayed, so that, provided the difference between the amplitudes of the rectified outputs produced by corresponding peaks in the two signals is within the tolerance limit, the alarm system is not operated. The maximum delay which the comparator will tolerate is the limiting factor in determining the maximum length of additional land-line allowable in the compared signal path, which in the majority of cases is about 100 miles.

The variation of delay time with frequency, producing distortion of the signal waveform, is, within this limit, insufficient to require correction.

However, it is not sufficient to rectify the signals, and observe the difference between voltages in the rectified outputs. If this were done, and the signals differed by 1 db (a ratio of amplitude of approximately 1.1 : 1), the rectified outputs might be 1.1 volts and 1.0 volts, for a low volume signal, and 110 volts and 100 volts for a higher volume signal. If the comparator were to operate the alarm system when the difference was 0.1 volt, at the higher volume the alarm system would be operated when the signals differed by a fraction of a decibel, and the monitor would be over sensitive. Conversely, if the alarm system were set to operate when the difference were 10 volts, the monitor would be insensitive at the lower volume. This point is of considerable importance, as the monitor must be sensitive at both very low volumes, to detect the presence of noise, and at high volumes, to detect non-linear distortion due to overload.

This requirement could be met by amplifying the signals prior to rectification by amplifiers having logarithmic input/output characteristics, such that the amplitude of the signal output would be proportional to the volume of the input signal. Under these conditions, a difference of N db between the input signals would produce the same voltage difference between the amplitudes of the output signals, and thus also the magnitudes of the rectified outputs, irrespective of the actual volumes of the input signals. Thus the sensitivity of the monitor, defined as the difference in decibels between the input signals necessary to produce operation of the alarm, would be constant, and independent of the actual volume of the input signals.

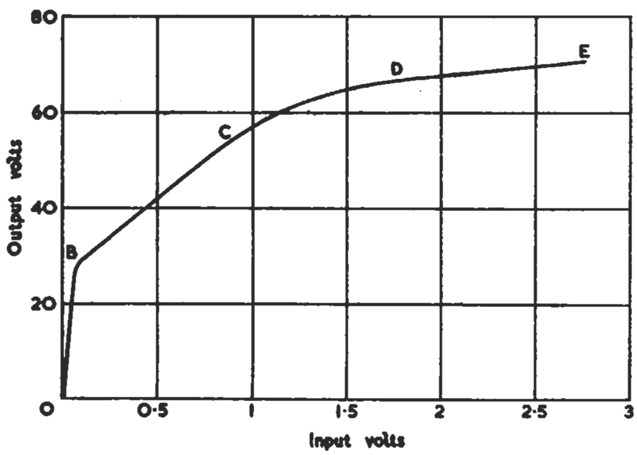

Fig. A3. Limiting Amplifier Input/Output Characteristic

In practice the amplifiers have been designed with the type of input/output characteristic shown in Fig. A3 where a portion of the characteristic (CD), approximates to a logarithmic law. This characteristic has been re-drawn to a logarithmic base in Fig. A9 where the output signal peak amplitude has been plotted against input volume for an input signal at 1 kc/s. It will be seen that for a given difference between the volumes of the input signals, there is maximum difference between the peak amplitudes of the output signals, and thus maximum sensitivity, in two regions corresponding to high and low volume respectively.

The region at high volume will disclose the presence of non-linear distortion arising from overload, and the region at low volume will disclose the presence of noise which will only produce significent change of compared-signal amplitude when this signal is at low volume. Further, noise will produce an output from the compared signal amplifier during gaps in programme when the reference signal amplifier output is zero. Thus the minimum volume of noise which the monitor will detect is that which will produce an amplitude of rectified output equal to the difference to which the comparator is set to operate the alarm system. Changes in transmission equivalent and frequency response are indicated in both regions.

It is further necessary to distort the applied signals with respect to frequency. The reasons for this are,

(1) The human ear is more sensitive at middle frequencies than at high or low frequencies, as shown by aural sensitivity curves. The monitor is required to simulate the sensitivity of the ear to noise, and to achieve this, attenuation must be introduced at high and low frequencies, so that a greater volume of noise is required at these frequencies to operate the alarm.

(2) The distribution of power with respect to frequency in a normal programme signal is, in general, such that the low-frequency components have much larger amplitudes than the high-frequency components. The periods when the high-frequency components predominate are thus rare. A change in the frequency response at high frequencies in the compared signal path will therefore only occasionally produce sufficient signal amplitude change to operate the alarm. To increase the number of alarms when such a fault occurs, it is necessary to 'weight' the two signals, by attenuating the low-frequency components, so that a change in amplitude of the high-frequency components will more often produce sufficient signal amplitude change to operate the alarm.

(3) Because of the difficulties of equalisation at the extremes of the audio-frequency range, the frequency response characteristics of land-line links commence to fall off at very high and very low frequencies. This is an 'acceptable' fault, and the monitor sensitivity must therefore be lower at these frequencies.

Requirement (3) is met by the post-distortion unit, which follows the non-linear amplifier. This unit has a frequency response characteristic which falls off above 1 kc/s (slowly at first, falling more rapidly above 5 kc/s to 10 db at 10 kc/s) and below 200 c/s (to 2 db at 60 c/s).. This unit produces the desired reduction in sensitivity at very high and very low frequencies.

Part of requirement (1) is met by the post-distortion unit, by attenuating the high frequencies; the attenuation at low frequencies is, however, insufficient to simulate the aural sensitivity curve at noise level, and the additional attenuation is introduced by the pre-distortion unit, which precedes the non-linear amplifier. The frequency response characteristic of this unit falls off below 1 kc/s (to 18 db at 60 c/s), and this provides the required degree of low-frequency attentuation. It is important to note that the pre-distortion unit does not affect the sensitivity of the monitor at low frequencies, and in this, it is fundamentally different from the post-distortion unit. This point is discussed fully in the circuit description.

The pre-distortion unit, in attenuating frequencies below 1 kc/s, also meets requirement (2). It might appear at first sight that the attenuation introduced at high frequencies by the post-distortion unit would nullify this, but this is not so, as the degree of attenuation introduced by the pre-distortion unit is much greater than that introduced by the post-distortion unit, and thus the required relative attenuation is obtained

Further, the human ear is not very conscious of slow changes of overall volume. To simulate this property of the ear, the monitor must therefore have a lower sensitivity to slow changes in transmission equivalent. This is achieved by the 'self-centre' circuit in the rectified outputs comparator. This comprises a capacitor connected in series with the two rectified outputs and the comparator. When a slow change in transmission equivalent occurs and one signal is consistently greater than the other, this capacitor charges to the mean value of the difference between the rectified outputs. The deviation from the mean value is thus less than the difference between the signal amplitudes and a greater difference between the inputs is thus required to produce the deviation necessary to operate the alarm system.
If a rapid change in transmission equivalent occurs, the capacitor has not time to charge appreciably, and the sensitivity is thus unaltered.

MECHANICAL DESIGN CONSIDERATIONS

The units of the Automatic Monitor (Minor) have been designed for mounting on 22½ inch racks. Where the equipment is to be mounted on a separate rack, the layout is as shown in Fig.A1. It is envisaged, however, that at certain stations where there is insufficient space available to instal a new rack, the panels will be distributed over the existing racks, as and where space permits.

GENERAL DESCRIPTION

The equipment comprises the following units:
3- Volume-folding and Limiting Amplifiers, VFLA/1 (one spare)
1- Differential Detector DD/1
1- Alarm Panel, ALP/1
1- Alarm Suppressor Overmodulation, ASO/1
1- Mains Unit, MU/40
Additionally, if it is desired to extend the alarm system locally, an Alarm Panel, ALP/2, is fitted at the point selected.

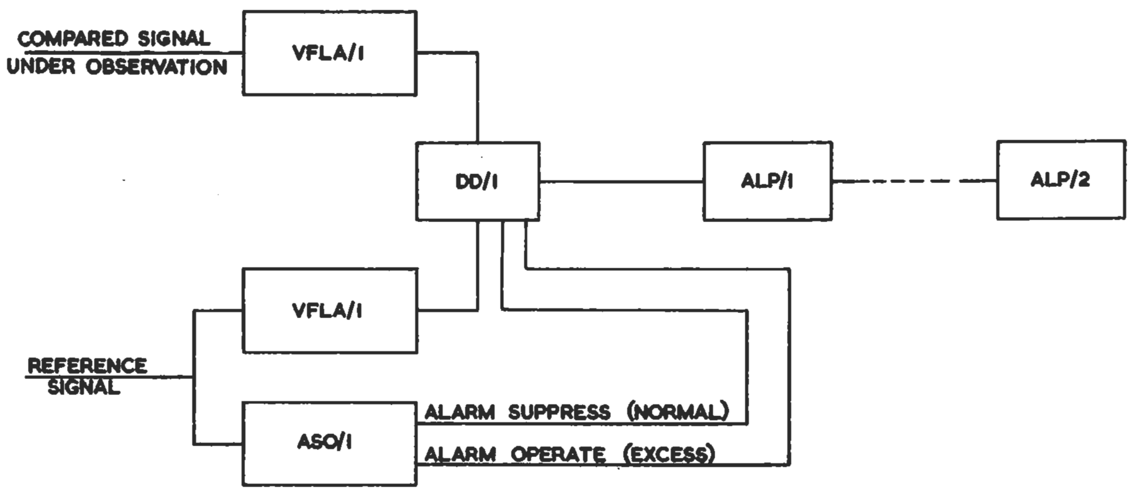

Fig.A4. Monitor Block-Schematic Diagram

The block schematic diagram of the monitor is shown in Fig.A4. From this it will be seen that there are two identical a.f.units, the volume-folding and limiting amplifiers which feed into the differential detector (DD/1), one of which is fed from the reference signal and one from the compared signal. The alarm suppressor over-modulation (ASO/1) is fed from the reference signal. All three units have been designed to accept inputs at zero volume, and all have high input impedances, thus obviating the need for separate trap-valve feeds

The contents and functions of each unit are summarised below.

Volume-folding and Limiting Amplifier (VFLA/1)

The two input signals are 'processed' and rectified in these units. Each of these amplifiers comprises the following four stages in cascade.

(1) Pre-distortion unit. This is the amplifier-input stage, and has a frequency response falling below 1 kc/s. The effect of this falling bass response is to 'weight' the signal applied to it so that, for a normal programme signal, the output from the stage has a more uniform distribution of power with frequency than the input signal. The attenuation of low frequencies also means that noise of a low frequency must be of a higher volume than noise of a middle frequency to produce the amplitude of rectified output necessary to operate the alarm.

(2) Limiting Amplifier. This amplifier distorts the signal applied to it, to give the maximum change in peak output voltage for a given change in input power in two regions, corresponding to low and high volume respectively.

(3) Post-distortion unit. The frequency response of this stage falls off at frequencies above 1 kc/s and below 200 c/s. The unit has two functions. Firstly, the falling high-frequency response ensures that noise of a high frequency must be of a higher volume than noise of a middle frequency, to produce the amplitude of rectified output necessary to operate the alarm. (The attenuation of low frequencies is very much less than the attenuation of low frequencies introduced by the pre-distortion unit, and thus the post-distortion unit has little effect on the volume of noise of low frequencies necessary to operate the alarm). Secondly, the falling response at high and low frequencies ensures that the monitor maximum sensitivity is lower at these frequencies than it is at middle frequencies.

(4) Rectifier Unit. This is a full-wave rectifier with a short charge-time constant and a relatively long discharge-time constant which rectifies the 'processed' signal so that the amplitude of the rectified output conveys the essential information about the amplitude of the input signal. The long discharge-time constant of the circuit enables comparison

of the rectified outputs of the two amplifiers to be delayed and so allow for delay which may exist between the signals.

Differential Detector (DD/1)

This unit incorporates the d.c. comparator circuit to which is applied the rectified outputs from the two volume-folding and limiting amplifiers. When the two outputs differ by a pre-set amount, the comparator closes a relay to trigger the alarm system in the panel ALP/1 (and ALP/2 if fitted) A delay in comparing the two rectified outputs is effected by shunting the alarm-triggering relay by a capacitor. This delays the operation of the relay and ensures that if the two rectified outputs are of equal amplitudes but separated by a short time interval, the relay does not close during this interval.

The comparator also incorporates the 'self-centre' circuit which reduces the sensitivity of the monitor to slow changes in transmission equivalent, guard circuits which operate the alarm system if the h.t. or l.t. supplies fall below specified limits, and a meter giving a visual indication of the balance between the amplitudes of the two rectified outputs.

Alarm Suppressor Overmodulation (ASO/1)

This unit is fed by the reference signal, and operates a relay to suppress the alarm system when the reference signal is at high volume. The volume at which this relay operates varies between -4 and 0 db (between '5' and '6' on a P.P.M.), depending on the particular installation. Its purpose is to suppress the operation of the alarm during periods when a transmitter is over-modulated or non-linear due to the high level of modulation, during which time the output from a check receiver will be low or distorted compared with the reference signal. Such occurences are inevitable, and it is not desired that the monitor should alarm on these.

The operation of the alarm-suppression relay brings into action an integrating stage, which if held operated for a period of about two minutes will operate the alarm system. This provides a safeguard against persistent high volume, which might arise from a change of transmission equivalent prior to the monitor, and would otherwise not be indicated.

Alarm Panels ALP/1 and ALP/2

The alarm panel ALP/1 contains the alarm release relay and the alarm system. This latter consists of an alarm bell and warning lamp fed from separate supplies, so that in the event of the failure of either supply, the other alarm will still operate. In addition to the alarm-release relay and alarm system, the alarm panel ALP/2 contains fault-indicator lamps in parallel with lamps on the various units, and a meter connected in series with the balance meter on the Differential Detector.

CIRCUIT DESCRIPTION

Volume-folding and Limiting Amplifier

A complete circuit diagram of this amplifier is shown in Fig.1. The amplifier will be considered in three sections (a) Pre-distortion unit, (b) Limiting amplifier (c) Post-distortion unit and rectifier unit.

Pre-distortion Unit

A simplified circuit diagram of this unit is shown in Fig.A5. The input transformer TI has an impedance ratio of 1:10, and is

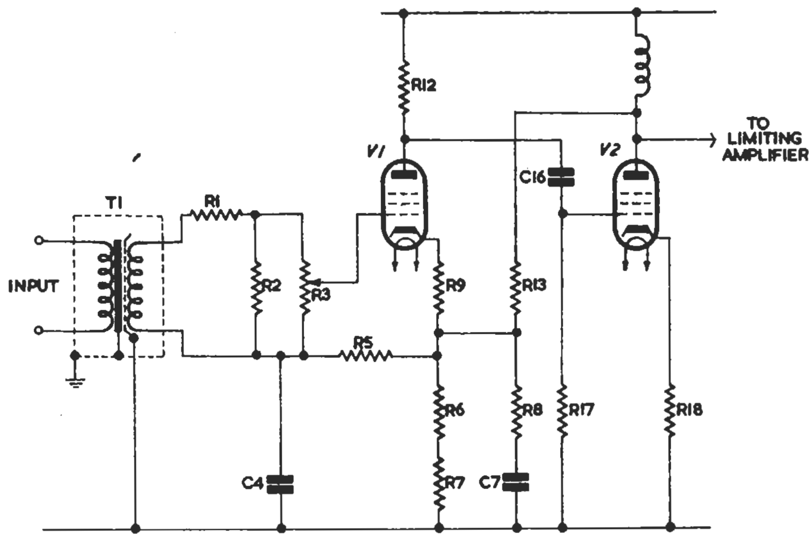

Fig.A5. Pre-distortion Unit, Simplified Circuit terminated by R1 and R2, R3 in parallel, presenting an input impedance of 10,000 ohms. The input gain control R3 is calibrated in 0.5 db steps from +5 db to -5 db, to allow initial adjustment of balance. The unit has the frequency-response characteristic shown in Fig.A6. The falling bass response is achieved by using a negative-feedback chain which is frequency selective. A large amount of negative feedback is applied at low frequencies to the cathode of V1 from the chain R13, R6, R7. At these frequencies the impedance of C7 is high, and R6, R7 are not shunted appreciably by C7 and R8. At high frequencies the impedance of C7 is low, and the feedback ratio is affectively determined by R13 and R8.

With the gain control set at '0' (that is, with the 5-db attenuation from the gain control) the voltage gain from the input terminals to the anode of V2 is about 33 db at frequencies above 1 kc/s. There is approximately 20-db rise in gain from 50 c/s to high frequencies due to the action of C7.

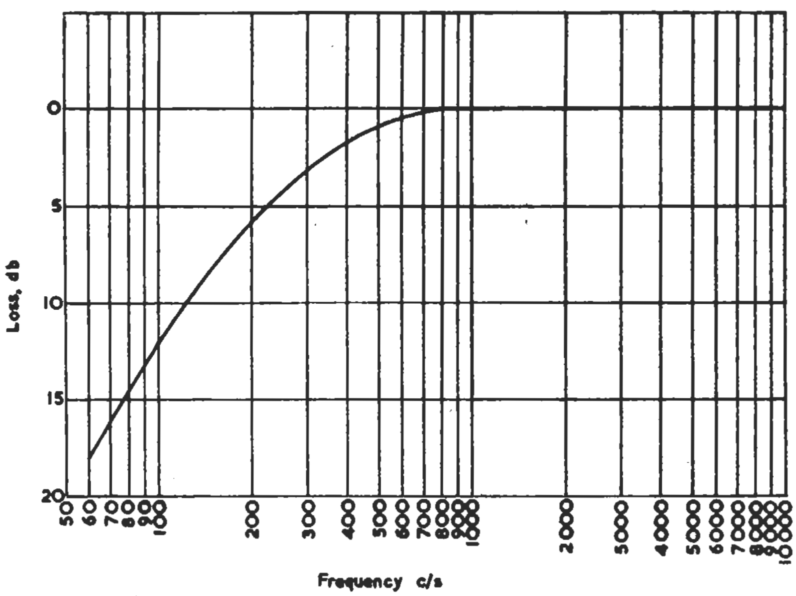

Fig.A6. Pre-distortion Unit. Frequency-response Characteristic

Limiting Amplifier

A simplified circuit of this amplifier is shown in Fig.A7. This amplifier incorporates three stages of peak limiting, controlled by V7 and V8, W1 and W2, and V5 and V6. V7 and V8 operate at low volume W1 and W2 at intermediate colume, and V5 and V6 at high volume. For convenience of description, the amplifier will be considered in two sections, the input circuit to V3, and the circuit associated with V3 and V4.

Input Circuit V3

The output from the pre-distortion unit is applied to the grid of V3 by C17, R20, R21, C18 and R24. R20 and R21, R24 (in parallel from the grid of V3 to earth) form a potentiometer. R21 and R24 are shunted by pairs of metal rectifiers (W1 and W2, in series with R52) and diodes (V5 and V6), biased to different degrees by the bleeder chain from h.t. This bleeder chain is decoupled to earth at the centre point by C13, so that R21 is returned to earth and the bias resistors of W1 and W2 (R39 R22) and V5 and V6 (R51, R39 and R50, R22) are arranged symmetrically about earth. The bias applied to W1 and W2 is about 15.5 volts, and the bias applied to V5 and V6 is about 24 volts. When the peak amplitude of the signal at the grid of V3 is less than 15.5 volts therefore, the metal rectifiers and diodes do not conduct, and the proportion of the amplitude of the signal at the anode of V2 applied to the grid of V3 is determined by the values of R20 (100 kilohms), R21 (180 kilohms) and R24 (560 kilohms).

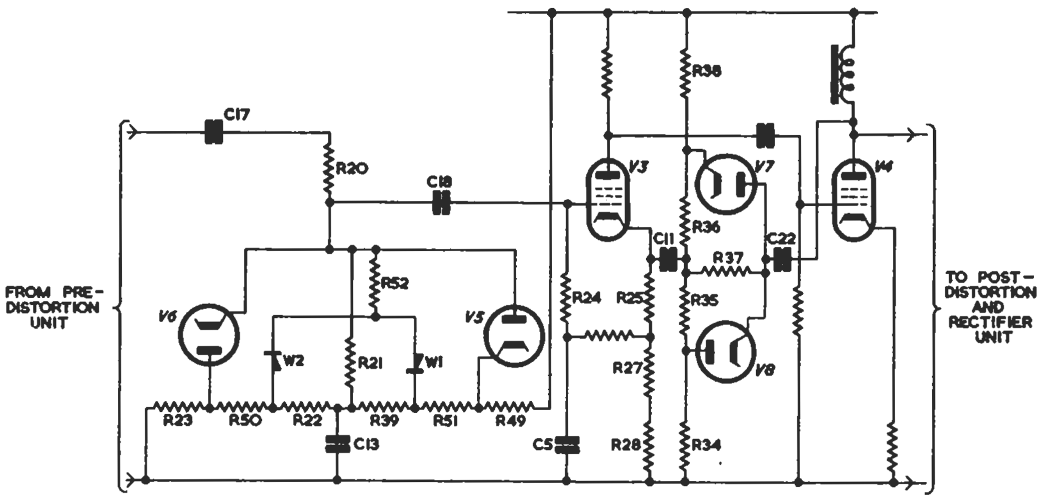

Fig. A7. Limiting Amplifier, Simplified Circuit

Consider now an input signal to the VFLA of frequency 1 kc/s or above, i.e. a signal not attenuated by the pre-distortion unit. When the signal volume is less than -10 approximately (i.e. 10 db below the volume producing a reading of '6' on a P.P.M.), W1, W2 and V5, V6 are not conducting, and the signal is applied undistorted to the grid of V3.

When the signal volume exceeds -10 db, W1 and W2 conduct on the peaks of alternate half cycles, introducing additional resistance in parallel with R21 and R24. This additional resistance comprises R52 in series with the forward resistance of W1 or W2 and R39 or R22. This reduces the proportion of the signal at the anode of V2 applied to the grid of V3, and thus 'clips' the signal peaks. The variation of the forward resistance of W1 and W2 is such that if the input signal volume is increased in uniform steps the signal peak voltage amplitude at the grid of V3 will increase by a constant amount for each step. There is thus compression of the signal peak amplitude introduced; whilst the input signal volume increases by 6 db, the signal peak amplitude at the grid of V3 rises by approximately 2.5 db.

From this it follows that the peak of a signal will not only be reduced in amplitude, but also distorted. This does not upset the operation of the monitor, since both reference signal and compared signal are affected similarly.

When the input signal volume exceeds -4 db, V5 and V6 conduct on the peaks of alternate half cycles, introducing a low resistance (equal to the forward resistance of V5 or V6 and R51, R39 or R50, R22) in parallel with R21 and R24. This has the effect of reducing still further the proportion of the signal peak applied to the grid of V3, so that the amplifier limits the signal peak amplitude sharply. A rise of 8 db in input signal volume produces approximately 1.5 db rise in the amplitude of the signal at the grid of V3.

The effect of W1, W2 and V5, V6 on the input/output characteristic of the amplifier can be seen from Figs. A3 and A9., where C and D correspond to the points at which W1, W2 and V5, V6 commence to conduct.

Circuit V3,V4

The output from V3 is applied to the grid of V4 by C6, R40 and C8, R42 (See Fig.1). These two networks are used in cascade to minimise the possibility of d.c. appearing at the grid of V4 due to leakage across C6 and C8 which are paper capacitors.

Negative feedback is applied from the anode of V4 to the cathode of V3. The feedback path contains two diodes V7, V8 which are biased by the bleeder chain across the h.t. supply (the bias being about 37 volts) so that they do not conduct when the input signal is at low volume. In this condition feedback is applied by R37. When the input signal volume exceeds -35 db the signal peak amplitude across R37 exceeds 37 volts, and V7 and V8 will conduct on alternate peaks. When V7 or V8 is conducting, the degree of negative feedback is considerably increased, and the gain is sharply reduced. Signals thus distorted as shown in Fig. A8, where the full curve shows the signal at the anode of V4 for a low value input signal at 1 kc/s of volume -29 db approximately. V is the amplitude of the signal at the anode of V4, when V7 and V8 commence to conduct, and is about 38 volts. The dotted portion of the curve shows the waveform of the output signal obtained if V7 and V8 are not in circuit. In practice, as the signal volume increases, the waveform may be further distorted and become asymmetrical due to phase distortion within the amplifier.

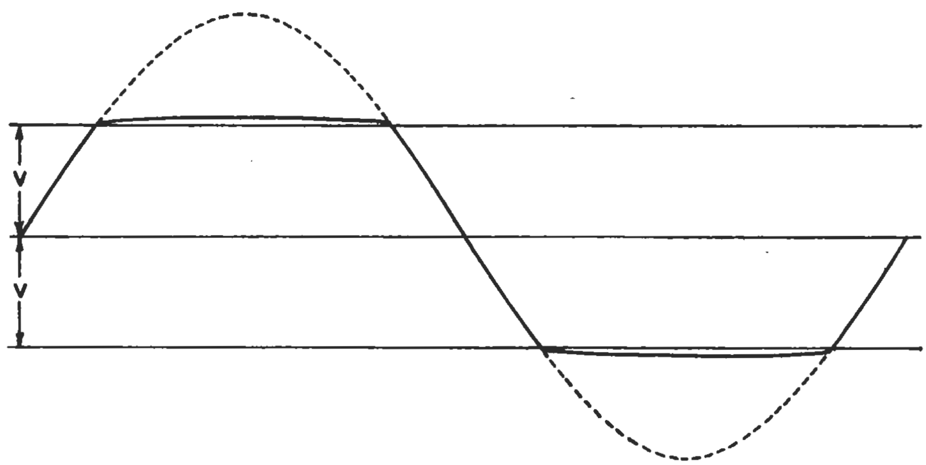

Fig. A8. Waveform at Anode of V4 with Input Signal at 1 kc/s. Volume -29 db (approx.)

Circuit Operation

The table gives the sequence of operation of the limiting stages. The input volumes quoted refer to signals not attenuated by the pre-distortion unit, i.e. signals of frequency greater than 1 kc/s. For input signals of frequency below 1 kc/s, these input volumes must be increased by the number of decibels of attenuation introduced by the pre-distortion unit.

Input volume	Amplifier condition
Less than -35 db	Amplifier linear; no limiting.
Greater than -35 db) Less than -10 db)	V7 and V8 conducting on signal peaks; peak amplitude reduced.
Greater than -10 db) Less than -4 db)	V7 and V8 conducting over most of signal cycle; W1 and W2 conducting on signal peaks; Amplifier approximates to logarithmic characteristic.
Greater than -4 db	V7 and V8 conducting over most of signal cycle; W1 and W2 conducting over large proportion of signal cycle; V5 and V6 conducting on signal peaks; peak output sharply limited.

Consider now a steady sinusoidal input at a frequency not attenuated by the pre-distortion unit, say 1 kc/s.

It will be assumed that the effect of the post-distortion unit can be neglected (for input signals of frequency 1 kc/s or less this is approximately true). The input-power/peak-output volts characteristic for the VFLA/1 for a 1 kc/s input signal is shown in Fig. A9. For low-volume input signals (less than -35 db) the amplifier input-volts/output-volts characteristic is linear, so that the input-volume/output-volts characteristic is exponential, as shown. When the input volume reaches -35 db approximately, V7 and V8 commence to conduct, and there is a marked reduction in the slope of the characteristic (point B). When the input volume reaches -10 db, W1 and W2 commence to conduct (point C) and between -10 db and -4 db the peak output increases linearly with increase in input volume. When the input volume exceeds -4 db V5 and V6 commence to conduct, (point D), and the output is sharply limited for input volumes greater than this (portion DE).

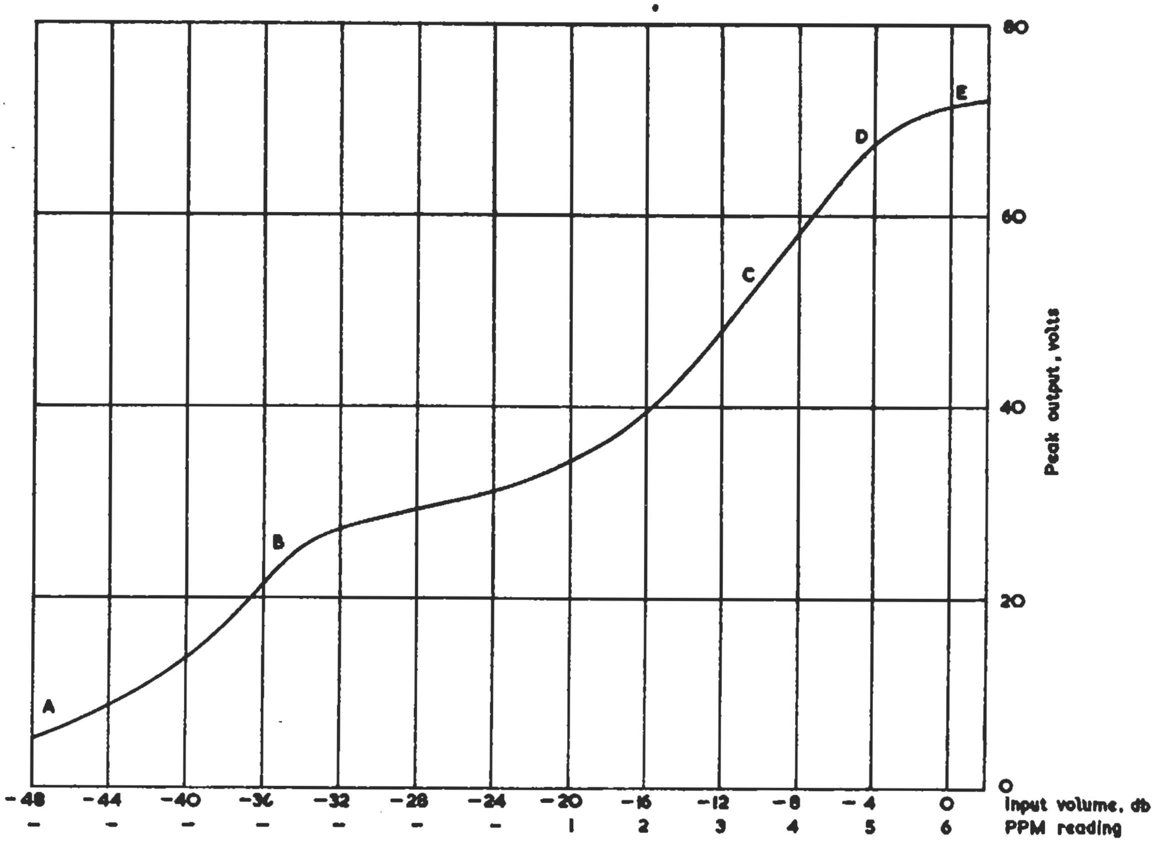

Fig. A9. VFLA/1 Input-volume/peak-output Characteristic, 1 kc/s Input

Bearing in mind that the monitor has two identical VFLAs feeding into the d.c. comparator, it is now possible from Fig. A9 to estimate the sensitivity of the monitor at 1 kc/s, i.e. the difference between the volumes of the two input signals at 1 kc/s necessary to operate the alarm. Under the steady state conditions assumed, the magnitude of the rectified output will be very nearly equal to the peak output amplitude, and the alarm system is normally operated when the difference between the rectified outputs is about 7.5 volts. It will be seen from Fig. A9 that the difference between the input signals to produce this difference between the rectified outputs varies with the volume of the input signals, and is least when the volumes of the inputs lie in the range about and just below B, and in the range C-D and just below C. In these regious a difference of 3 db between the input signals will produce of 7.5 volts between the rectified outputs.

Thus the sensitivity of the Monitor is at a maximum in these regions.

Expressed differently, it may be said that the sensitivity of the Monitor is proportional to the average slope of the characteristic. Where the slope is steepest, the minimum difference between the volumes of the input signals is required to produce the difference between the rectified outputs from the two amplifiers necessary to operate the alarm.

The d.c. comparator operates on the magnitude of the difference between the outputs, and does not distinguish which signal has the greater volume. To avoid ambiguity, therefore, the sensitivity of the Monitor is quoted as referring to the higher volume input signal. For example, the sensitivity is 3 db with an input signal at 1 kc/s of volume -34 db, that is, the alarm is operated when one signal is of volume -34 db and the other -37 db. This does not specify which signal, the reference signal or the compared signal, is of the higher volume.

Where the input-signal frequency is less than 1 kc/s, and has been attenuated by the pre-distortion unit, the characteristic must be modified accordingly. If the signal has been attenuated by N db (relative to a 1 kc/s signal) then the signal applied to the limiting amplifier will be N db less than an equal-volume input signal at 1 kc/s. Thus for the same peak output the input signal must be N db greater than a 1 kc/s signal, the characteristic will be displaced bodily as shown in Fig. A10. Curve (a) is the reference 1 kc/s curve; curve (b) the characteristic with an input signal at 100 c/s.

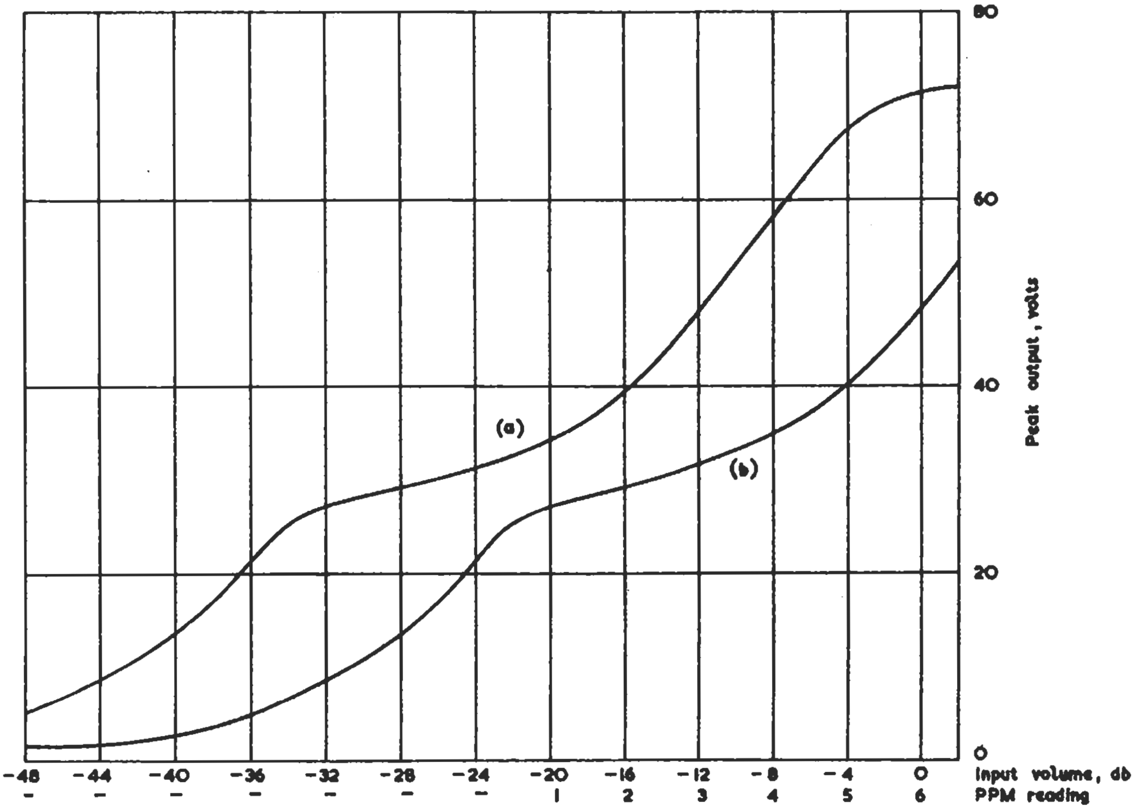

Fig. A10. VFLA/1 Input/volume/peak-output Characteristic
Curve (a) 1 kc/s input
Curve (b) 100 kc/s input

From Fig.A6. it will be seen that a signal of this latter frequency is attenuated by about 12 db, and as can be seen from Fig.A10., curve (b) is displaced by this amount from the reference curve.

Curve (b) also shows that the maximum sensitivity of the monitor is unchanged by the action of the pre-distortion unit; the regions of maximum sensitivity however, now occur at higher input volumes.

The displacement of the curve means also that the sensitivity to noise has been altered. With a noise signal at 1 kc/s, an input volume of -42 db will produce a rectified output of 7.5 volts, and with no output from the other VFLA, the alarm will be operated. With a noise signal at 100 c/s, an input volume of -30 db is required to produce 7.5 volts rectified output, and thus the sensitivity to noise is 12 db lower at 100 c/s than at 1 kc/s.

Post-distortion and Rectifier Unit

The circuit diagram of this unit is shown in Fig.A11. Transformer T2 has a turns ratio of 1:1 to each half of the

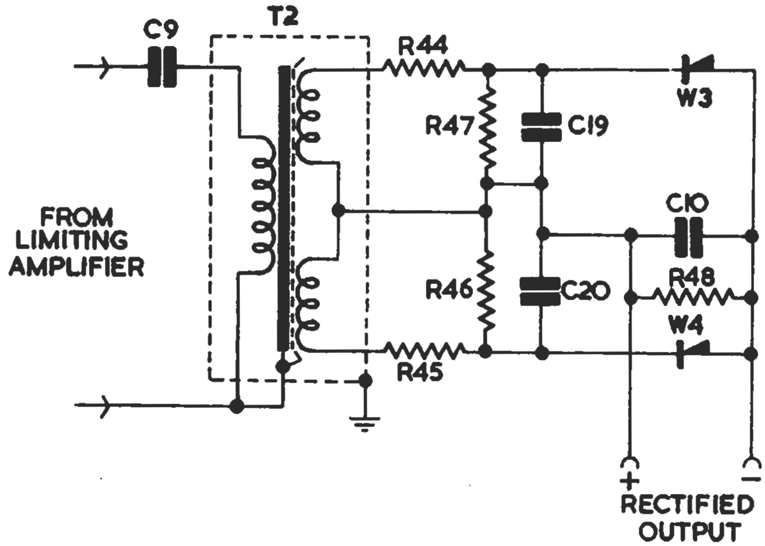

Fig. A11. Circuit Diagram, Post-distortion and Rectifier Unit

secondary winding. There is a loss at all frequencies due to the potential dividers across each half of the secondary. This loss is greater than is immediately apparent since R47 and R46 are shunted by the input impedance of the rectifier unit.

Additional low-frequency attenuation is introduced by the relatively high impedance of C9 at low frequencies, and high-frequency attenuation by C19 and C20, shunting R46 and R47. The loss introduced by these components is shown by the frequency response characteristic in Fig.A12.

The rectifier unit comprises W3 and W4 in a full-wave rectifier circuit. The charge-time constant of this circuit is determined by C10, (0.5 uF) R44 or R45 (10 K) and the output impedance of the amplifier. At low volumes, when the output impedance referred to the secondary of T 2 is about 6 kilohms, the charge-time constant is about 8 milli-seconds.

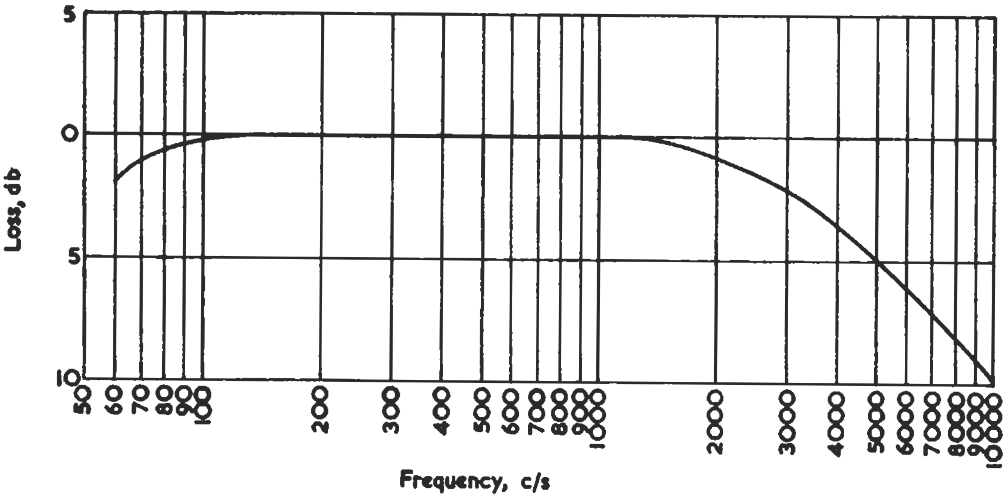

Fig. A12. Post-distortion Unit Frequency-response Characteristic

At high input volumes, when V7 and V8 are conducting and increasing the feedback applied to the amplifier, the output impedance of the amplifier is negligible, and the time constant is about 5 milli-seconds. The discharge-time constant, determined by R48 (200 kilohms) and C10 is about 100 milli-seconds. Thus, on programme signals the charge-time constant of the rectifier is sufficiently short to enable C10 to charge up to peak amplitude on important short-duration sounds, for example speech sibilants. The effect of the long discharge-time constant is to ensure that these amplitudes decay slowly, so that comparison of the rectified outputs may be delayed.

The effect of the post-distortion unit in combination with the limiting amplifier, is markedly different from that of the pre-distortion unit in combination with the limiting amplifier.

Assume initially that the output from the limiting amplifier is sinusoidal, for a sinusoidal input to the VFLA/1, for all input volumes. Consider an input signal not attenuated by the pre-distortion unit, and attenuated N db (relative to a 1 kc/s signal) by the post-distortion unit. Then the peak output would be everywhere N db less than the corresponding peak output for a 1 kc/s signal, as shown by the characteristics in Fig.A13, where where curve (a) is the reference curve (1 kc/s) and curve (c) is the theoretical curve for an input signal at 7 kc/s, (attenuated approximately 8 db by the post-distortion unit).

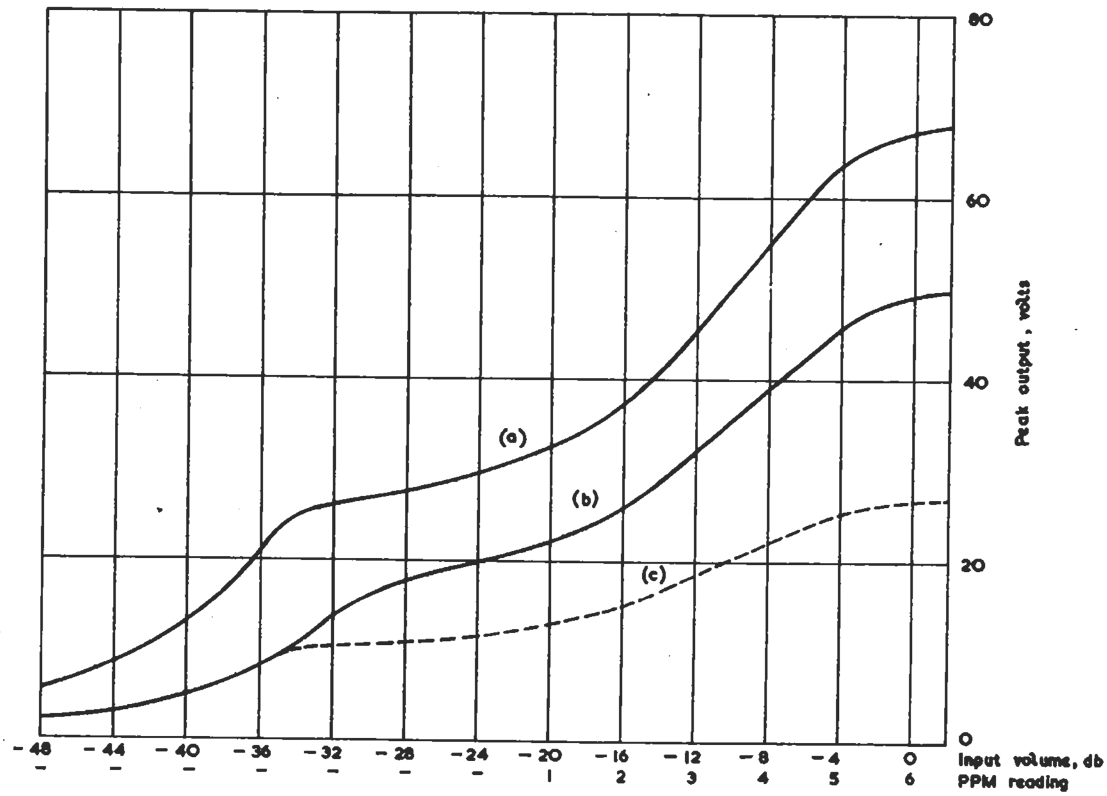

Fig. A13. VFLA/1 Input-volume/peak-output Characteristics
Curve a 1 kc/s input
Curve b 7 kc/s input

From this it will be seen that whilst the regions of maximum sensitivity occur at the same input volumes, the actual values of the maximum sentitivities are different, and is lower for the 7 kc/s signal. This marks the major difference between pre- and post-distortion, since the pre-distortion varies the position of the regions of maximum sensitivity with respect to input volume, but does not alter the actual value of the maximum sensitivity.

In practice, the action of the limiting amplifier in distorting all but very low-volume applied signals (as shown in the example in Fig. A8) modifies the characteristic considerably. The characteristic actually obtained for a 7-kc/s input signal is as shown in curve b in Fig. A13. It will be observed that curve b and curve c coincide for very low volume inputs, where the signal is not distorted by the limiting amplifier. Analysis of the output signal from the limiting amplifier when the signal has been distorted, will show that the signal contains a component at the fundamental frequency of the signal (i.e. at 7 kc/s), of amplitude greater than the actual peak amplitude of the output signal, and components at harmonic frequencies of the fundamental. The attenuation introduced by the post-distortion unit increases with frequency so that the harmonics of the signal are attenuated more than the fundamental. Consequently, for high frequency input signals, all harmonics are attenuated much more severely than the fundamental. The output signal thus approximates to a sine wave at the fundamental frequency with a peak amplitude greater than that obtained with a sinusoidal input, having the same peak amplitude as the distorted signal, applied to the post-distortion unit.

This apparent reduction in attenuation varies with frequency; for input signals of 1 kc/s or less, the effect is not very marked as sufficient harmonic components of the distorted signal are passed without serious attenuation for the waveform of the output signal to approximate closely to the waveform of the applied signal.

The post-distortion unit has the same effect on the sensitivity to noise as the pre-distortion unit; thus for an input noise signal at 7 kc/s, the signal volume must be 8 db higher than the volume of noise of 1 kc/s to produce the amplitude of rectified output necessary to operate the alarm. As was observed in discussing the effect of the pre-distortion unit, the sensitivity to noise at low frequencies is not much affected by the attenuation introduced by the post-distortion unit, as this latter is very much less than the attenuation introduced at low frequencies by the pre-distortion unit.

Where, however, the input signal is at a frequency affected by both pre-distortion and post-distortion, i.e. 200 c/s and less, the regions of maximum sensitivity are shifted, and the maximum sensitivity is reduced.

The combined effect of the pre-distortion and post-distortion units is shown most clearly by Fig. A14. The contours are of constant sensitivity; that is, the contours give the difference between the volume of the input signals in decibels necessary to operate the alarm, referred to the volume of the greater signal.

For example, if the greater input signal is of volume -4 db and of frequency 1 kc/s, it will be seen that the corresponding point on Fig. A14 is enclosed by the 3-db contour.

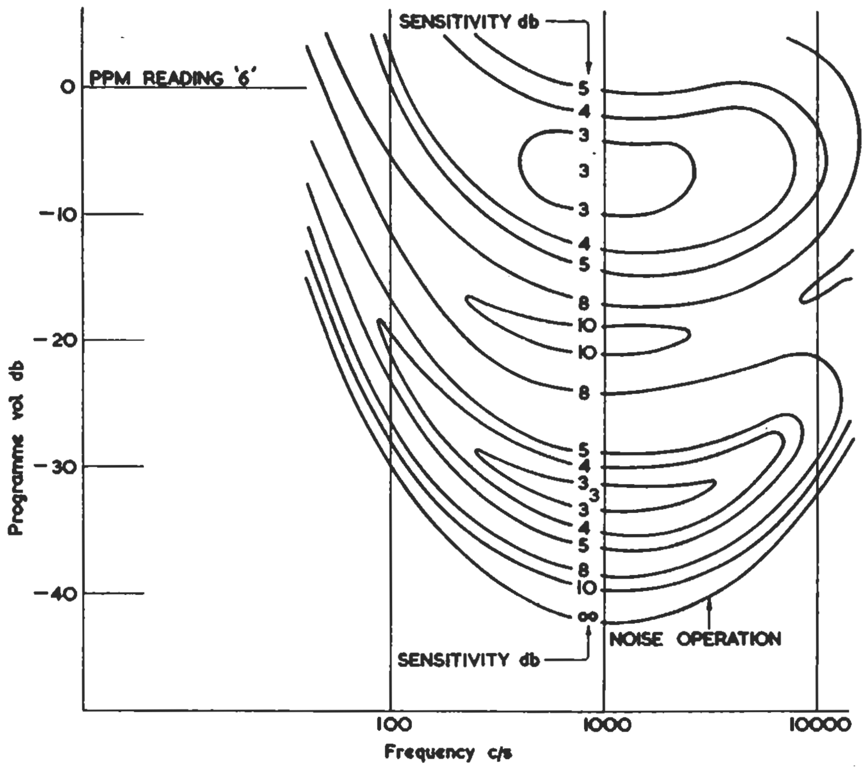

Fig. A14. Overall Sensitivity of Automatic Monitor Minor

The sensitivity in this region is slightly better than 3 db, so that the volume of the smaller input signal must be in the region of -7 db to produce operation of the alarm. If, however, the signal frequency is 10 kc/s, where the corresponding point in Fig. A14. is on the 5-db contour, then the smaller input signal must be of volume -9 to produce operation of the alarm.

These contours have been plotted using steady-tone inputs, whereas actual programme signals are composed of components of many frequencies of different volumes and different durations. It is thus not possible to discuss in detail the behaviour of the monitor in terms of the contours of Fig. A14.

The contours do, however, show that when the volume of the input signal is between -12 db and 0 db, corresponding to programme peaking between '3' and '6' on a P.P.M. (the normal conditions encountered), the sensitivity of the monitor is high; and that there is a second region of high sensitivity at low volume to disclose the presence of noise when the programme is at low volume.

The pre-distortion unit is responsible for the rise of the contours in the region below 1 kc/s, and the post-distortion unit for the rise in the contours at frequencies above 1 kc/s. Thus both units combine to determine the shape of the noise-operation contour, which gives the minimum volume of noise at any given frequency which will operate that alarm during a gap in programme. It will be seen that this volume increases as the frequency of the noise departs from 1 kc/s and the contour closely resembles the low-volume sensitivity curve of the ear, as is desired.

The closing of the contours is due entirely to the action of the post-distortion unit. If the attenuation of the high frequencies were accomplished by the pre-distortion unit, and there were no post-distortion unit, then the contours would be equally spaced. The fact that high frequencies are attenuated more than low frequencies by the post-distortion unit is shown by the much more rapid reduction in sensitivity at high frequencies. Thus, at low input volumes, the maximum sensitivity at 10 kc/s is worse than 5 db; at 100 c/s it is better than 4 db.

It will be observed that, for any given input frequency, corresponding to each value of sensitivity (less than the maximum at that frequency) there are four values of input volume. This is the counterpart to the fact that on the characteristic shown in Fig. A9 there are four points on the curve having the same slope. The points at which the contours close, where maximum sensitivity occurs, correspond to the portions of the curve in Fig. A9 (B, and C-D) where the slope is a maximum.

Test Points

The VFLA/1 has test points included for monitoring the signal waveform and checking valve feeds (see Fig.1). The cathode circuits of V1, V2, V3 and V4 include resistors brought out to tags for checking the total valve feeds, and a table of the correct readings across these resistors is given in the General Data section. Additionally, A, B and C are test points from which a signal can be taken for examination on a C.R.O., or for feeding to an Amp.Det. These test points have a high series internal impedance, and the VLFA circuits are not appreciably loaded by the monitoring equipment.

Differential Detector

A circuit diagram of this unit is given in Fig. 2.

D.C. Comparator Circuit

A simplified circuit of the comparator is given in Fig. A15.

Valves V1 and V2 comprise the d.c. comparator, to which the rectified outputs from the VFLAs are applied for comparison.

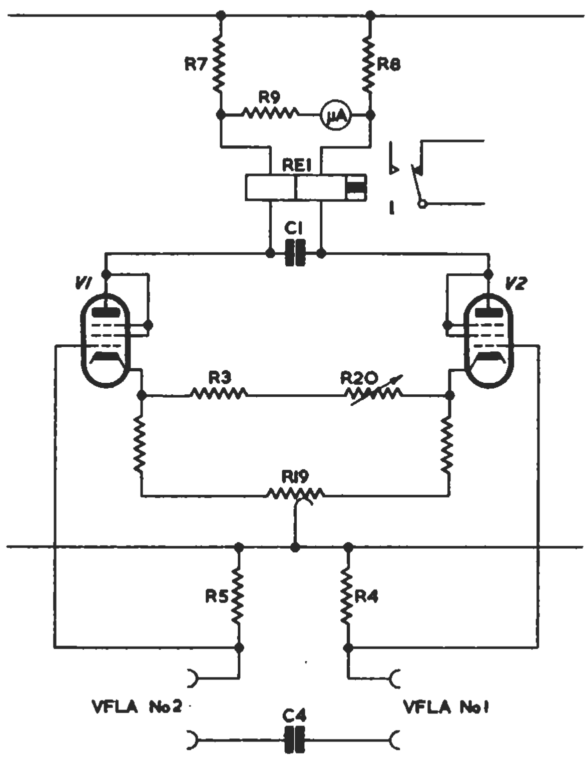

Fig. A15. D.C. Comparator Simplified Circuit

The two rectified outputs are connected in opposition in the common grid circuit which is completed by C4. It may be assumed initially that the rectified outputs vary sufficiently rapidly for C4 to be regarded as a low impedance. Any difference in amplitude between the two outputs produces equal voltages of opposite polarity at the grids of V1 and V2, so that the current through one valve will rise and the current through the other fall. In the anode circuits of these valves is a high-speed differential relay, Re 1, connected so that when the valve anode currents are equal there is no flux in the relay armature. The relay closes when there is a difference of about 7.5 volts between the grids of V1 and V2. When such a difference in the VFLA output occurs, the capacitor C1 delays the operation of the relay, whilst it charges. The outputs decrease in amplitude relatively slowly, due to the long discharge-time constant of the VFLA rectifier circuit. If the difference is caused by the delay introduced by additional land-line links in the path of the compared signal, then provided the delay is less than the charging time of C1, and the delayed signal is of the correct amplitude, Re 1 does not close. This is shown diagrammatically in Fig. A16.

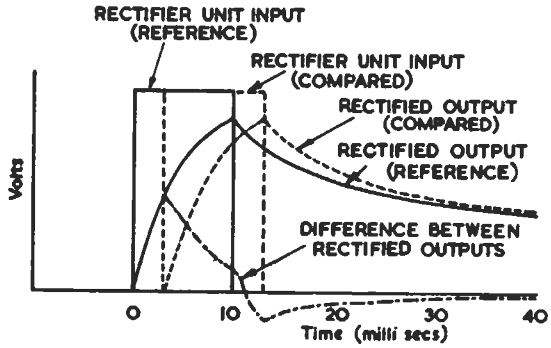

Fig. A16. Illustrating action of Comparator Delay Circuit

If, however, there is sufficient difference in amplitude due to a fault, say, a drop in frequency response, C1 will charge sufficiently, and the relay close. It will be appreciated that the long discharge-time constant of the VFLA rectifier circuit is thus essential for the successful operation of the circuit.

It will be seen that the delay introduced by C1 sets a limit to the delay that can be tolerated in the compared signal, and this limit is about 2 milli-seconds.

The relay Re 1 has two windings mounted on a common U-shaped core, the armature being permanently in contact with one end of the core. In general the winding nearer the gap has less stray flux losses from its field than the other winding, and consequently produces a greater flux in the air gap than the other winding, when they are carrying equal currents. The relay is thus biased in favour of operation by the winding nearer the air gap. To equalise the sensitivity of the two windings, R6 and R21 ('Equalise Relay') (see Fig.2) are shunted across the winding nearer the air gap, reducing the current in this winding and thus the flux produced by it.

A 100-0-100 microammeter is connected between the anodes in series with R9. This meter serves to give a visual indication of the balance of the standing current in the two valves when adjusting the comparator, and on programme indicates the extent of the unbalance between the input signals.

The cathode circuits of V1 and V2 are coupled in a delta network. R19 adjusts the d.c. balance of the anode currents (checked by the anode-current balance meter), and the sensitivity of the comparator is adjusted by R20. If the VFLA outputs are not equal, the full voltage difference appears from grid to grid, producing equal and opposite voltages at each with respect to earth, and the cathode potentials of V1 and V2, following their respective grids, move in opposite senses to each other. This produces a current through R3 and R20, tending to equalise the cathode potentials. The lower the value of R20, the less the changes in cathode potentials that occur, the less negative current feedback applied to each valve, and consequently, the greater the change in anode currents for a given difference in VFLA outputs.

Thus the difference in VFLA outputs necessary to close Re 1 varies with the setting of R20. R20 is normally adjusted so that the maximum sensitivity of the monitor with a 1 kc/s input is 3 db. This is equivalent to about 7.5 volts between the rectified outputs.

With this setting of R20 the valves are subject to a considerable degree of negative feedback; the behaviour of the comparator is thus largely independent of valve parameters. The high cathode loads also ensure that the anode currents are virtually independent of variations in h.t. and l.t. supply voltages, and such variations of sensitivity that may occur with variations of anode current are reduced by the use of metal filament lamps P1 and P2 (see Fig.2). The resistance of these lamps varies with the current flowing through them, hence if the anode currents fall the resistances also fall, the amount of negative feedback decreases and the sensitivity tends to rise, and vice versa.

Self-Centre Circuit

The rectified outputs of the VFLAs are applied to the grid circuit of V1 and V2 in opposition and in series with C4. If these outputs are equal in amplitude, there will be no voltage acting around the circuit C4, R4, R5, and consequently no voltage will appear at either grid As soon as inequality occurs, current will flow round the circuit, (charging C4) producing equal and opposite voltages at the grids of V1 and V2. If the sum of the voltages at the grids exceeds 7.5 volts, Re 1 will be operated. The time constant for the grid circuits (C4, R4, R5) is about 9 seconds, so that C4 will not charge appreciably when the rectified outputs differ only occasionally.

When one signal is persistently greater than the other, there will be a uni-directional, although pulsating, current around the grid circuit and C4 will charge to the average value of the voltage difference, with a polarity such as to oppose the voltage producing it. For a 3-db difference between the input signals, the voltage difference will vary between 0 and 8 volts (approximately), and C4 will be charged to a value in the neighbourhood of 4 volts, the actual value depending on the average programme volume and frequency content. When the voltage difference between the two outputs is equal to the voltage across the capacitor, the anode-current balance-meter will read zero, as the sum of the voltages acting around the grid circuit will be zero. In the gaps in programme the capacitor will commence to discharge, and the voltage acting around the grid circuit will be about 4 volts, and the anode-current balance-meter will deflect to one side. When the voltage difference between the two outputs is about 8 volts, the voltage acting around the grid circuit will be of the order of 4 volts, and the anode-current balance-meter will deflect to the other side.

Under these circumstances, therefore, the sum of the voltages between the grids will never equal 7.5 volts, and Re 1 will not close.

To operate the alarm under these conditions, (corresponding to a change in transmission equivalent) the difference in volume between the input signals must be of the order of 5 db, so that C4 charges to about 7.5 volts, and Re 1 is closed during gaps in programme.

It has been noted that the time constant of the grid circuit is about 9 seconds, so that C4 will be charged very slowly. If a sudden difference of transmission equivalent of 3 db occurs, Re 1 will probably close before C4 charges sufficiently to lower the sensitivity. If the change occurs slowly, then C4 will have time to charge, and suppress the operation of Re 1 until the difference is in the order of 5 db. In this way the detector simulates the behaviour of the human ear, and is less sensitive to slow changes in overall volume than rapid changes in overall volume.

If the output of one VFLA exceeds the other spasmodically, C4 will not charge appreciably, and Re 1 will close if the difference between the signals is great enough. In this way the unit differentiates between a change in transmission equivalent and variation of frequency response.

If noise is present and of sufficient volume, Re 1 will close during a gap in the programme. C4 will charge, and if the gap is long enough Re 1 will open and the anode-current balance-meter re-centre. On recommencement of programme, when the programme signal swamps the noise and the rectified outputs are again equal, the anode-current balance-meter will be displaced in the opposite direction as C4 discharges, and Re 1 will again close, until C4 has discharged sufficiently.

Resistors R15 and R16 (See Fig.2) apply positive bias to the grids of V1 and V2 to offset the large negative bias developed in the cathode circuits, and guard against the possibility of either of the VFLA outputs becoming disconnected. If this occurs, one grid is at earth potential, with the valve cut off, whilst the current in the other will be increased. The resultant difference in anode currents is sufficient to close Re 1.

Two keys are provided, 'Self-centre off' and 'Test det. balance'. The former short-circuits C4, and the latter short-circuits the VFLA outputs so that the inherent balance of the comparator may be checked.

C2 and C3 (see Fig. 2) are included in parallel with the grid resistors to reduce the amplitude of sharp peaks at the grids of V1 and V2 which might otherwise cause grid current to flow and upset the balance of the comparator.

Relay Circuits (Fig. A17.)

A circuit diagram of the relays with all supplies off is shown in Fig. A17. When h.t. is applied, current flows through one half winding of Re 2 and Re 3/1. Re 2 closes, and completes the circuit from V4 to earth, energising Re 3, and the other half winding of Re 2 (the two half windings are connected so that they are mutually aiding). The operation of Re 3 is delayed whilst capacitor C5 charges; when Re 3 does close, Re 3/1 breaks the supply to its half winding of Re 2, so that Re 2 is held closed by the supply taken through Re 2/1. When the required difference in VFLA outputs occurs, relay Re 1 closes, removing the supply holding Re 3 and the half winding Re 2. Re 2 opens and a short while later (due to the action of C5) Re 3 opens. Contact Re 3/1 (early break) provides an earth for the other half winding of Re 2, which closes, making Re 2/1, preparing the path for the restoration of Re 3. It will be noted that during the period after Re 2 has opened, and before Re 3/1 has completed the circuit for Re 2, Re 1 has no control over the setting of Re 3. This sets the minimum time of operation of the alarm system.

Relay Re 3 in opening lights the white panel lamp (via Re 3/2) indicating the presence of a fault condition at the detector. Contact Re 3/3 interupts the 24V supply, to open the relay in the Alarm Panel and operate the main alarm to indicate this unbalance. If high modulation has occurred, a relay contact in the Alarm Suppressor Overmodulation, in parallel with Re 3/3 makes, and the operation of the main alarm is suppressed. A full account of the alarm system and the conditions of its operation are given on Page 35.

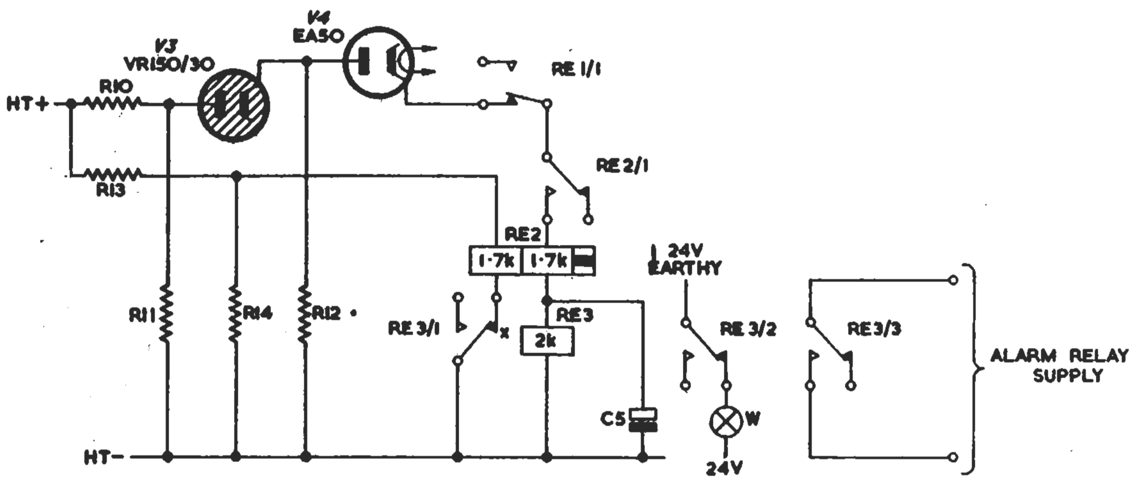

Fig. A17. DD/1 Relay Circuits

Re 3 and one half of Re 2 are held by current taken from the h.t. supply via a gas-discharge tube V3 and a diode V4. If failure of the l.t. supply occurs, V4 will cease to conduct, and Re 3 will open to operate the alarm. The circuit associated with V3 is such that if a variation occurs in the h.t.-supply voltage, a much greater variation occurs in the voltage applied to the relays. The circuit is therefore very sensitive to changes in h.t. voltage, and the alarm will be operated if the h.t. supply voltage falls by about 30 volts. The action of the circuit associated with V3 is discussed in detail in Appendix 1.

Alarm Suppressor Overmodulation

The circuit diagram of this unit is shown in Fig.3. The unit has a conventional two-stage input amplifier, having a large degree of negative feedback, and a gain control ('sensitivity').

A simplified circuit of the succeeding stages is given in Fig. A18. The output from the input amplifier is rectified by the full-wave rectifier unit W1 and W2, which charges C6.

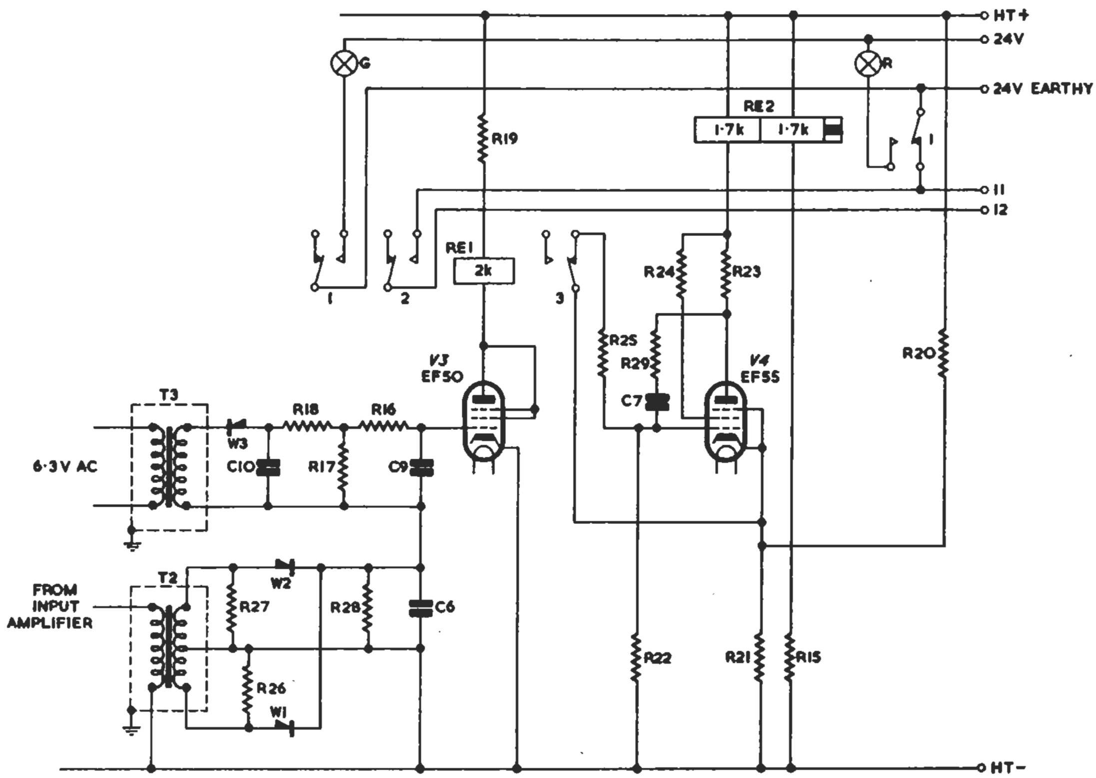

Fig. A18. ASO/1 Simplified Circuit Final Stages

The charging-time constant of the rectifier unit is short, whilst the discharge time constant is about 1 second. This value is lower than is apparent, due to the fact that R28 is shunted by the backward resistance of the rectifiers. The voltage developed across C6 is thus similar to that developed in a P.P.M. unit. It is applied in series with a d.c. bias (from T3, rectified by W3 and smoothed by C9, C10, R16, R17, R18) to the grid of V3. This d.c. bias is sufficient to bias the valve to well beyond cut-off when no signal is present. The voltage across C6 opposes this standing bias, and if the input signal amplitude is large enough, V3 will conduct and Re 1 will close. The gain control is set so that this happens when the signal amplitude reaches a value corresponding to between '5' and '6' on the P.P.M., the actual value depending on the particular installation.

When Re 1 closes, Re 1/1 makes to light the overmodulation (normal) green pilot lamp; Re 1/2 makes to complete the circuit between tags 11 and 12. This contact is in parallel with contact Re 3/3 in the differential detector, and thus the breaking of the latter contact does not operate the alarm system if the former has made.

It will be noted that when Re 1 is open, Re 1/3 completes the circuit from the cathode of V4 to its grid via R25, the latter forming a potentiometer with R22, thus applying a portion of the voltage developed across R21 to the grid of V4. When Re 1 closes, Re 1/3 breaks, and the full voltage developed across R 21 is applied to the grid of V4. The circuit is an adaption of the Blumlein-Miller Integrator circuit, so that when the bias applied to V4 suddenly changes, the anode current does not change instantaneously, due to the action of C7, which feeds back to the grid a voltage opposing the applied bias. The anode current thus falls very slowly. After a period of approximately two minutes the current falls sufficiently for the differential relay Re 2 to be closed by the current taken by the other half winding.

It will be appreciated that not only will the anode current fall slowly when Re 1/3 breaks, but it will also rise very slowly when Re 1/3 makes again. Thus it is not necessary for Re 1/3 to break for two minutes continuously for Re 2 to be closed. If Re 1/3 breaks for long periods with short intermittent periods when it makes (as will happen during programme when the mean volume is too high, Re 1/3 breaking in quiet passages and gaps in programme), Re 2 will eventually close, although the total time taken from the first occasion that Re 1/3 breaks till Re 2 closes will be greater than two minutes. Similarly, once Re 2 has closed, it will be held closed for some time after Re 1/3 has made again, whilst the anode current of V4 attains the value necessary to open Re 2.

When Re 2 closes the red pilot lamp (Overmodulation Excess) lights, and the circuit from the 24 V supply to the alarm relay in the alarm panel (ALP/1 and ALP/2) is interrupted. When this latter relay opens, the main alarm is operated.

The failure of V4 is guarded against by using the double-winding relay Re 2, arranged so that under no fault conditions, there is no flux in the relay armature. If then V4 fails, Re 2 is closed by the current taken via R15, operating the main alarm system.

Alarm Panels ALP/1 and ALP/2

The circuit diagrams of these two units are shown in Figs A19. and A20.

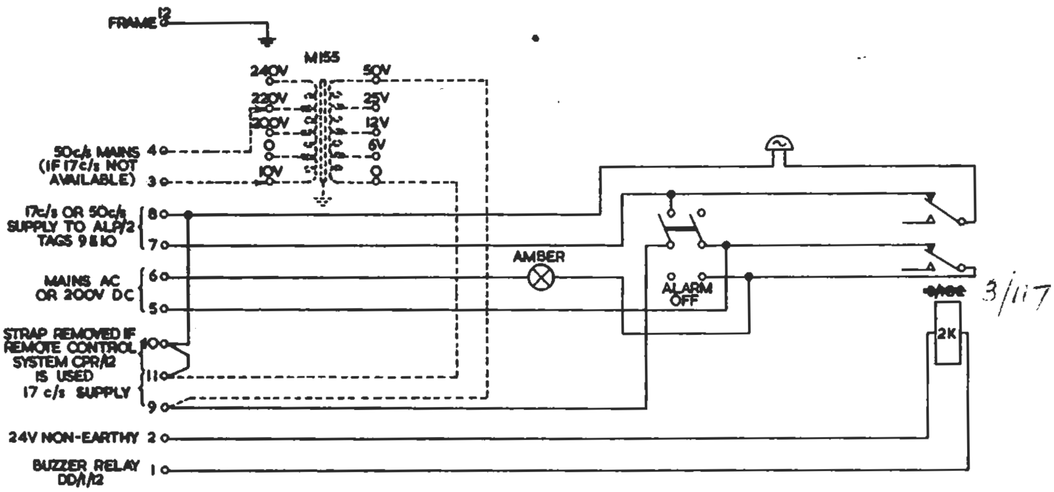

Fig. A19. Alarm Panel, ALP/1 Circuit

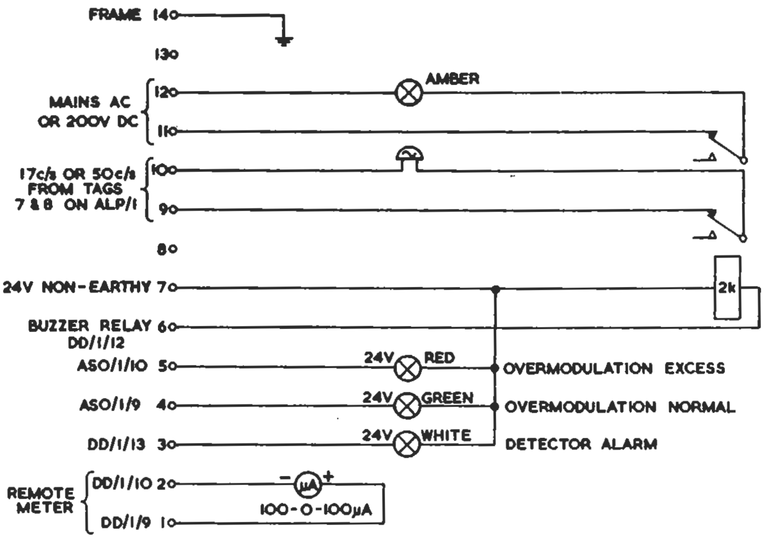

Fig. A20. Alarm Panel, ALP/2 Circuit

The relay operating the main alarm system is normally (in the no fault condition) held closed. Thus in the event of the failure of the 24 V supply, the alarms are operated. The conditions of operation of the alarm system are discussed below.

Alarm System

The alarm system may be considered in two parts, the main alarm system indicating the presence of faults requiring attention, and the fault-indication system.

On the monitor rack, the two are separate. The main alarm system is mounted on the Alarm Panel ALP/1, whilst the fault indicators are on the individual panels. At the remote point, both are mounted on the Alarm Panel ALP/2.

Main Alarm System

Bell operated by 17 c/s ringing tone or 50 c/s mains.

Amber lamp operated from the mains supply (if bell operated by 17 c/s supply) or 200 V d.c. local supply (if bell is mains-operated).

Thus, in the event of failure of either supply, the other alarm will still operate.

Fault-indicator Alarms

Unbalance meter indicating extent of unbalance at the Differential Detector.

White (Detector Alarm) pilot lamp on Differential Detector panel indicating fault condition.

Green (Overmodulation normal) pilot lamp on Alarm Suppressor panel indicating high modulation. (Main alarm suppressed).

Red (Overmodulation excess) pilot lamp on Alarm Suppressor Panel indicating persistently high modulation. (Main Alarm operated).

The above pilot lamps are operated from the 24V supply.

White pilot lamp on the mains unit (l.t. Supply) and h.t. current meter.

Interconnection of Alarm Circuits

Fig. A21. shows schematically the alarm interconnections. The main alarm circuits are shown in heavy lines. It will be

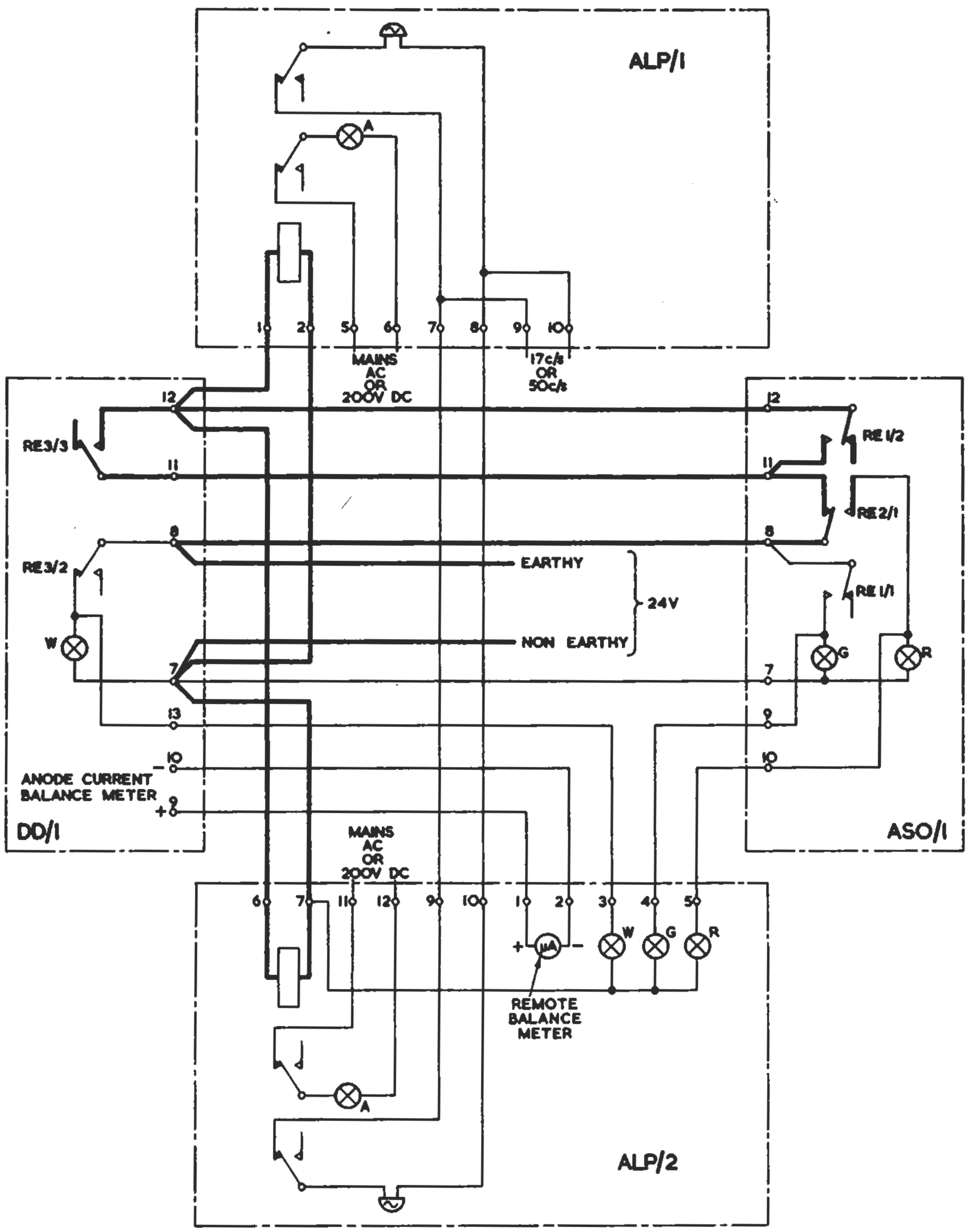

Fig. A21. Alarm Circuits, Schematic Diagram seen that the relays in the panels ALP/1 and ALP/2 are in parallel.

If a break is introduced into this circuit by the operation of a relay, the relays in the panels ALP/1 and ALP/2 will open and the main alarms operate. Such a break may be introduced by

(1) Re 2 (ASO) closing. This will happen if persistently-high modulation occurs.
(2) Re 3 (DD) opening. This will happen when the input signals differ sufficiently (and when the h.t. or l.t. supply fails).

The operation of the main alarm by the openings of Re 3 (DD) is conditional upon the setting of Re 1 (ASO). If this relay has closed, the main alarm will not operate. Re 1 (ASO) closes when the reference-signal volume exceeds the pre-set volume (between '5' and '6' on a P.P.M. generally).

The operation of the pilot lamp will be obvious on inspection of the circuit.

Mains Unit MU/40

The mains unit MU/40 supplies h.t. and l.t. to all the Monitor units. It comprises two identical units, one in use,

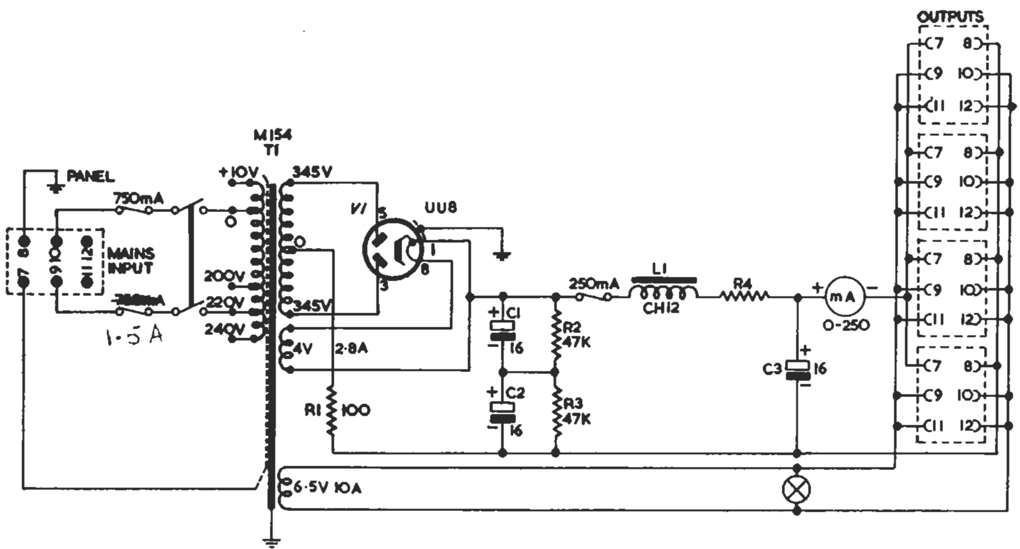

Fig. A22. Mains Unit, MU/40, Circuit

and one as standby, and the circuit diagram of one of these is shown in Fig. A22. As can be seen, its design is conventional, except for the arrangement of capacitors C1 and C2. These together are equivalent to a capacitor of 8 microfarads capacitance. They are connected in series to reduce the voltage appearing across each, and thus decrease the chance of breakdown. R2 and R3 ensure that the voltages across the capacitors are equal. R4 is variable and is adjusted on installation to give the correct h.t. voltage.

Interconnection of Units

The wiring diagram of a monitor rack installation is shown in Fig. 4. The programme input signals and power supplies to the volume folding and limiting amplifiers are made through F. and E. plugs and sockets. The provision of these connectors enables either VFLA to be taken out of circuit when a fault occurs and to be replaced by the spare amplifier in the shortest possible time. The rectified outputs are applied to the inputs of the differential detector by flexible plug-ended connectors. This has been done to isolate these circuits, and thus ensure freedom from steady unwanted potentials which might arise from leakance paths.

OPERATING INSTRUCTIONS

Once the monitor is properly balanced on programme, and its alarm proved, it should remain quiet until a fault develops on the programme chain it is monitoring, or on its own circuits. When the alarm operates, the first action to be taken is to listen to the compared programme, when, if the fault is on the programme circuit, it should be apparent.

If the fault is of a transitory nature, e.g. a switching click, the fault condition will have cleared before the programme is aurally monitored. It is therefore to be expected that occasional apparently spurious short alarms will occur.

Normal Operation

The anode current balance meter at the differential detector will execute small irregular displacements about zero due either to slight unbalance in the signals or slight differences between the volume folding and limiting amplifiers. The overmodulation (normal) green lamp will come on when the reference programme volume exceeds the pre-set volume (generally between '5' and '6' on the P.P.M). Occasionally the red (overmodulation excess) lamp will light and the main alarm will be operated, if the general programme volume is persistently high. This is not necessarily a fault condition, and the programme should be monitored aurally to decide whether a P.P.M. check is necessary.

Dynamic Operational Check

If it is desired to check that the Monitor is operating satisfactorily whilst monitoring programme, the following tests may be made. It is important to realise that these tests are not rigid, and the nature of the programme must be considered when making the tests.

(1) Press 'Self Centre Off' and 'Test Bal.' keys on the Differential Detector, and check that the anode-current balance-meter reads zero ± 2 divisions. A reading outside these limits indicates unbalance in the comparator circuit.

(2) Release keys. Advance the gain control of either VFLA by + 2½ db. Press 'Self Centre Off' key. The anode-current balance-meter should kick persistently to one side, but the alarm system should not be operated. Operation of the alarm indicates that the monitor is too sensitive.

(3) Advance the gain control by 1 db to 3½ db. Press 'Self Centre Off' key. The anode-current balance-meter should deflect persistently to one side, and the alarm system should be operated occasionally. Non-operation of the alarm system indicates that sensitivity is low, or a circuit fault is present.

(4) Release 'Self Centre Off' key. After a few seconds the anode-current balance-meter should re-centre and deflect from side to side about zero. The alarm system should not now be operated except perhaps after a long gap in programme when the self-centre capacitor has discharged.

(5) Advance the gain control by 2 db to + 5 db. The anode-current balance-meter should deflect strongly from side to side about zero, and the alarm system operate occasionally. The frequency with which the alarm system will be operated in these circumstances is dependent on the programme content. With speech fairly frequent alarms may be expected; with music with a small range of variation of volume, alarms may be relatively infrequent.

(6) Press 'Self Centre Off' key. The alarm system should operate frequently.

(7) Restore all controls to normal setting.

(8) Check that the green lamp (Overmodulation normal) on the ASO/1 lights when the P.P.M. peaks over the pre-set volume; and that the alarm system is not operated when the green and white lamps light together.

Fault on Programme Circuit

In general the frequency and duration of operation of the alarm system is a rough indication of the magnitude of the fault. The first action to be taken is to listen to the compared programme, when the fault should be apparent.

The most common faults and the indications to be expected are tabulated below.

(1) Change in Transmission Equivalent, Variation in Frequency Response (The indications for these two types of fault are similar)	Main alarm operated, white lamp flashing. Anode-current balance-meter deflecting to one side during gaps in programme. With a change in T.E. meter will swing to one side on practically all programme pulses; with a change in frequency response meter will only swing to one side if programme pulse has a component in affected frequency band.
(2) Noise	Main alarm operated, white lamp flashing, mainly in gaps in programme or periods of low programme volume. Anode-current balance-meter deflecting to one side in these gaps. If a long pause occurs, the detector will 'Self Centre' on the noise, and the alarm will cease operation, the meter returning to centre. On recommencement of programme, the alarm will operate and meter deflect to other side until 'Self Centre' capacitor discharges.
(3) Overload or non-linearity	Main alarm operated, mainly on peaks of programme; meter swinging mainly to one side on such peaks.

Fault on Monitor

A fault on the monitor will generally be identified by the continuous operation of the alarm system. Once it has been checked that the compared signal is satisfactory, the monitor should be checked, and the following is set out as a rough guide in tracing the source of the trouble.

(1) Observe the red lamp on the ASO/1. If this has lighted, and the programme volume is satisfactory, this will localise the fault to the ASO/1. Valve faults are the most likely cause of trouble.
(2) Observe the anode current balance meter on the DD/1. If this is reading zero, or is not deflecting appreciably from zero, the fault should be suspected in the monitor alarm or relay system. Possible faults are failure of 24-V supply, h.t. or l.t. supply, valves V3 and V4 in the DD/1, or an open circuit fault in the alarm relay circuit.
(3) If the anode current balance meter is deflecting to one side and the white lamp is lighted, the fault may be localised to the rectified outputs comparator or the VFLAs.
(4) Press 'Self Centre Off' and 'Test Bal.' keys. If the meter remains deflected to one side, the comparator circuit should be checked. The most likely source of trouble is with valves V1 and V2, and the valve feeds should be checked.
(5) If, on pressing the 'Self Centre Off' and 'Test Bal.' keys the anode current balance meter returns to zero, a fault on the VFLAs is indicated. Check that the plug-ended connectors have not been removed from their sockets.
(6) The most likely source of trouble with the VFLA/1 is a valve fault, and before further action is taken, the valve feeds should be checked, and the valves changed one by one.
(7) If the fault still persists, substitute the spare for each VFLA/1 in turn, and thus determine which is faulty. This amplifier can then be serviced at leisure.

Faults on a VFLA/1 are most easily detected by a point-by-point comparison with a known-good VFLA/1. This can be done by using the test points A B and C in conjunction with an Amp. Det. or C.R.O. with various levels and frequencies of tone applied to the VFLA inputs connected in parallel. Alternatively, the panels may be tested in accordance with the test specification given in Appendix 2, but it must be emphasised that point-by-point comparison of the VFLAs has been found to be a better method.

LINING-UP PROCEDURE

(a) Adjust Detector Balance

Press 'Test Bal.' key and 'Self Centre Off' key, wait for meter pointer to become stationary and adjust to centre reading (if necessary) by means of 'Adjust Balance' control. Release 'Self Centre Off' key and observe that the pointer is not shifted from its centre reading by more than one division. This unbalance usually indicates lack of equality in bias provided by R15 and R16. (It is an unlikely fault).

(b) Adjust Sensitivity

Send zero-level 1000c/s tone into the input jack of one of the VFLAs. Terminate the input to other VFLA with 600 ohms and double-end the input listen jacks of the two VFLAs. Then with the input volume control of VFLA No.1 set to '0' and that of VFLA No.2 to + 2 db adjust the level of the tone by a few db either way to find the maximum anode-current balance-meter displacement. Increase the volume control setting of VFLA No.2 from + 2 db to + 3 db in $\frac{1}{2}$ db steps. The alarm should operate between + $2\frac{1}{2}$ and + 3 db (not at + $2\frac{1}{2}$ db). Re-set the 'Adjust Sensitivity' control if necessary. Set volume control of VFLA No.2 to '0' and increase the setting of the volume control of VFLA No.1 in $\frac{1}{2}$ db steps to + 3 db. Check that the alarm operates between $2\frac{1}{2}$ db and 3 db (not at $2\frac{1}{2}$ db). If it is necessary to re-set 'Adjust Sensitivity' control to achieve this, re-set the volume control of VFLA No.1 to '0' and repeat process until alarm operates between + $2\frac{1}{2}$ db and 3 db (not at $2\frac{1}{2}$ db) for both VFLAs. If a setting of the 'Adjust Sensitivity' control to meet this requirement cannot be found, it may be necessary to adjust 'Equalise Relay' control on the Differential Detector. This should be avoided if possible.

Press 'Self-centre Off' key during this test.

With volume control of VFLA No.1 set to + 3 db and that of No.2 to 0, decrease common input level and find other point of maximum sensitivity. It should be at approximately - 26 db. If operation of the alarm occurs at this point, check that it does not occur at + $2\frac{1}{2}$ db displacement. If it does not occur, check that it will do so at $3\frac{1}{2}$ db displacement. VFLA No.1 input control should now be restored to '0' and VFLA No.2 input control set to + 3 db and this process repeated. The adjustment is satisfactory if in neither case is the alarm operated at $2\frac{1}{2}$ db displacement but is definitely operated at $3\frac{1}{2}$ db displacement. If these limits are not met it is likely to be due to lack of balance near this level. This should be checked and possibly adjusted as a compromise with the initial balance adjustment at zero level. Alternatively the 'Adjust Sensitivity' control should be so adjusted that at one of the maximum sensitivity levels there is operation at 3 db unbalance, and at the other $3\frac{1}{2}$ db. At neither maximum sensitivity level should the alarm operate at an unbalance of $2\frac{1}{2}$ db.

Remove tone input and double-ended cord connecting VFLA listen jacks. Terminate both inputs with 600 ohms. Apply low-level tone to the input of one VFLA and verify that alarm operates at a level of -33 ± 2 db. Repeat for other VFLA.

Press 'Self-centre Off' key during this test.

(c) Alarm Suppressor Overmodulation

Send 1000 c/s tone to the input at the appropriate level, with the listen jack terminated in 600 ohms and vary 'Sensitivity' control until the suppressor relay operates; green light on panel indicates this operation. Remove input tone for about 2 minutes. Replace input tone to operate suppressor relays. The integrator relay should operate in 1 3/4 $\pm \frac{1}{2}$ minutes. The red light indicates this operation. Remove input, and red light will extinguish in about a minute.

GENERAL DATA

Impedances

VFLA input	Z	=	10 kΩ
ASO/1 input	Z	=	30 kΩ
Normal working input volume			0 db

Valve Data

All tests made with Avo. A 40

VFLA		Cathode current mA	Volts from Test Point to Earth	Avo range V
V1	EF 50	0.8 - 1.2	0.3 - 0.35	0 - 1.2
V2	EF 50	6 - 8	0.6 - 0.7	0 - 1.2
V3	EF 50	1 - 1.4	0.2 - 0.25	0 - 1.2
V4	EF 55	22 - 30	2.7 - 3.0	0 - 12

Differential Detector	Anode Current mA (measured at feed jacks)
V1 EF 50	6
V2 EF 50	6

Alarm Suppressor

		Cathode Current mA	Volts from Test Point to Earth	Avo Range V
V1	EF 50	0.8 - 1.2	0.20 - 0.30	0 - 1.2
V2	EF 55	15 - 22	3 - 4	0 - 12
V3	EF 50	---	---	---
V4	EF 55	15 - 17	29 - 33	0 - 120

APPENDIX A.1

HT GUARD CIRCUIT

In the circuit description of the Differential Detector reference was made to the fact that a variation in the ht. supply voltage produced a greater variation in the voltage across the relays Re 2 and Re 3.

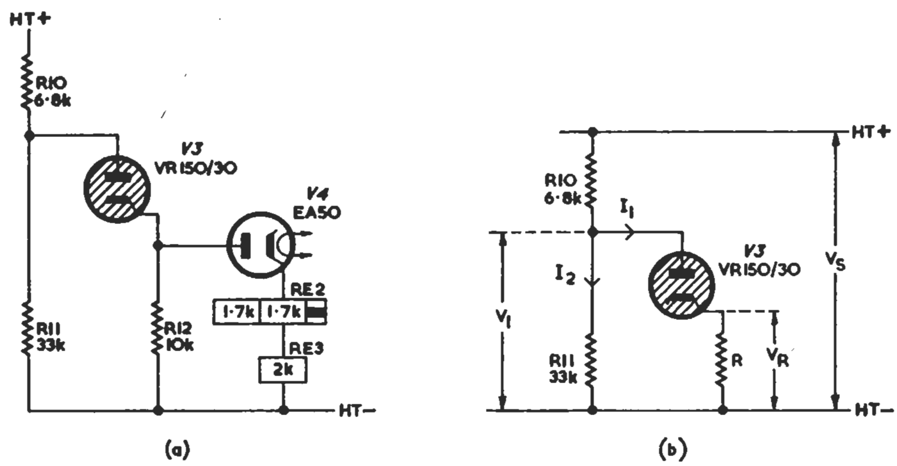

Fig. A1/1 HT Guard Circuit, Simplified Diagrams

For the purposes of explanation of the action of this circuit, a simplified circuit is shown in Fig. A1/1. (a) above, where all relay contacts normally made have been omitted, and an average value (33 kilohms) has been assumed for R11.

This circuit is equivalent to that shown in Fig. 1/1 (b), (the resistance of V4 being assumed negligible) where R (2.7 kilohms) is equivalent to the resistance of R12 and Re 2, Re 3 in parallel. Using the notation of Fig. 1/1 (b).

$$I_1 = \frac{V_r}{2.7} \text{ mA}$$

The voltage drop across the gas-discharge tube V3 is maintained at a value of 150 volts (within 4 volts) over a range of variation of

I_1 of 5 - 40 mA, so that within this range

$$V_1 = 150 + V_r$$

and $$I_2 = \frac{V_1}{R11}$$

$$= \frac{150 + V_r}{33} \text{ mA}$$

therefore $$I_1 + I_2 = \frac{150 + V_r}{33} + \frac{V_r}{2.7} \text{ mA}$$

whence $$V_s = R10\,(I_1 + I_2) + V_1$$

$$= 6.8 \left(\frac{150 + V_r}{33} + \frac{V_r}{2.7}\right) + V_1 \text{ volts}$$

$$= 6.8 \left(\frac{150 + V_r}{33} + \frac{V_r}{2.7}\right) + 150 + V_r$$

and $$V_s = 3.73\,V_r + 181$$

or $$3.73\,V_r = V_s - 181 \quad .. \quad .. \quad .. \quad .. \quad (1)$$

with V_s = 300 volts, V_r = 31.9 volts

Further, if a change of dV_s in V_s produces a change dV_r in V_r,

$$(V_s + dV_s) - 181 = 3.73\,(V_r + dV_r)$$

and therefore $$dV_s = 3.73\,dV_r$$

whence, dividing by (1)

$$\frac{dV_s}{V_s - 181} = \frac{dV_r}{V_r}$$

and

$$\frac{dV_s}{V_s} = \frac{dV_r}{V_r} \frac{(V_s - 181)}{V_s}$$

but V_s = 300 volts

therefore

$$\frac{dV_s}{V_s} = 0.4 \frac{dV_r}{V_r}$$

or

$$\frac{dV_r}{V_r} = 2.5 \frac{dV_s}{V_s} \quad .. \quad .. \quad .. \quad .. \quad (2)$$

If a change of N% occurs in the h.t. supply voltage,

$$\frac{dV_s}{V_s} = \frac{N}{100}$$

and from (2)

$$\frac{dV_r}{V_r} = \frac{2.5\ N}{100}$$

and the change in V_r is 2.5 N%

The range over which this calculation is valid is limited by the characteristics of V3. The current through V3 when V_r = 31.9 volts is 8.6 mA. The voltage across V3 is held approximately constant down to I_1 = 5 mA, corresponding to V_r = 18.9 volts.

This is well below the fall-off voltage of the relays, so that the calculation is valid for the range of working voltages concerned.

In practice, the charge is about 2.9 N%, the calculated value being low due to the simplifying assumption made.

APPENDIX A.2

Test Specifications for VFLA/1, DD/1 and ASO/1

Two test specifications for these units (a) and (b) are given below, and may be used for fault locating, or performance testing after repair.

Specification (a) is the rigid specification and should be used only by engineers having the necessary equipment, and authority to carry out the adjustments detailed.

Specification (b) can be carried out with the equipment normally to hand at a station. It must be noted that owing to meter inaccuracies, results may not be within the limits specified; nevertheless, satisfactory operation of the monitor may be secured with two VFLA/1's having similar performance figures.

Specification (a)

Mains Unit, MU/40

With R4 set to zero, and a load current of 200 mA, the h.t. supply should be 300 volts at least.

With a load current of 150 mA, the ripple should be less than 700 mV peak-to-peak.

With the normal load current (approximately 170 mA), R4 should be adjusted so that the h.t. supply is 300 volts.

With no load connected, the l.t. supply should be 6.7 volts (R.M.S.). With a load current of 10 amps the l.t. supply should be 6.3 volts (R.M.S.).

VFLA/1

A microammeter which will give grade 1 or substandard accuracy of reading over the range 50 - 500 microamps (Resistance 2000 ohms approx.), should be connected in series with the output load resistor R48 (200 k-ohms). No other load should be connected to the output terminals. The supply voltage to the unit must be maintained at 300 volts accurately during these tests.

Send 1 kc/s tone to the input of the VFLA/1 at -27 db voltage level, and measure output by means of the microammeter. Vary the voltage over the limits ± 0.75 db until the output is exactly 110 microamps, then vary the input voltage as in the following table:-

		level	Output, Microamps
	Decrease	3 db	74 ± 3
	Increase	7 db	135 ± 5
	"	21 db	201 ± 5
x	"	27 db	Adjust to 270 ± 2
	"	31 db	312 ± 5
	"	35 db	331 ± 5

x If the limits at this point are not met, but are within the limits ± 8 microamps, R52 should be adjusted. Variations beyond the limits of ± 8 microamps should be treated as a fault condition. (Rectifier W1 or W2 or diodes).

Change frequency to 150 c/s (accurate) and send a voltage level corresponding to an increase of 5 db, the output should be 77 ± 5 microamps.

Change frequency to 7 kc/s and send the same voltage level as for 150 c/s, the output should be 74 ± 8 microamps.

DD/1

The relay adjustments should be checked.

Check that when the h.t. voltage is reduced the alarm operates at between 8% and 14% low. If this does not occur, adjust R11 (between the limits 15K - 43K) so that the drop-off occurs as nearly as possible to 10% low.

Check that the anode current balance meter indicates that the unit is balanced. If this is not so, press 'Self Centre Off' key and 'Test Bal.' key and adjust 'Adjust Balance' control.

Connect two 200 K-ohm resistors across U-link sockets 1-2 and 3-4.

Supply U-link sockets 1 and 4 with 7 volts D.C. (from say, a dry battery and low resistance potentiometer).

Press 'Self Centre Off' key and set 'Adjust Sensitivity' control until detector just operates. Check balance and re-adjust if necessary. Re-check sensitivity, etc.

Reverse polarity of the d.c. supply and check that detector again just operates. A limit for the 'just operating' would be 7 ± 0.5 volts.

If the symmetry of sensitivity is outside these limits the 'Equalise Relay' control should be rotated until the same value of either polarity of input voltage gives operation. Repeat the adjustment for sensitivity until all conditions are satisfied.
Note:- A good method of ensuring that this balance is achieved is to make and break the d.c. voltage by operating the 'Test Bal.' key during the adjustments.

Check that operation can still be secured for eith polarity of 6 - 8 volts over the range of the 'Adjust Sensiticity' control.

ASO/1

The relay adjustments should be checked.

Send 1 kc/s tone at +8 db level to the input, and vary 'Sensitivity' control so that suppressor relay operates; green light on the panel indicates this operation. Check that the latitude on adjustment is such that +4 to +8 db will give operation

Remove input tone for about two minutes. Re-apply input tone to operate suppressor relays. The integrator relay should operate in 1 3/4 $\pm \frac{1}{2}$ minutes. The red light on the panel indicates this operation. Remove input, and red light should extinguish in about a minute.

Specification (b)

1. Check as accurately as possible that the h.t. supply is 300 V.

2. DD/1

Check that when the h.t. voltage is reduced the detector drops off at between 8% and 14% low. (If this does not occur adjust R11 (between the limits 15K - 43K) so that the drop off occurs as near as possible to 10% low.

Check that the anode current balance meter indicates that the unit is balanced. If this is not so, press 'Self Centre Off' key and 'Test Bal.' key and adjust 'Adjust Balance' control.

Connect the 200 K-ohm resistors across U-link sockets 1 - 2 and 3 - 4.

Supply U-link sockets 1 and 4 with 7 volts d.c. (from say, a dry battery and low resistance potentiometer).

Press 'Self Centre Off' key and set 'Adjust Sensitivity' control until detector just operates. Check balance and re-adjust if necessary. Re-check sensitivity, etc.

Reverse polarity of the d.c. supply and check that detector again just operates. A limit for the 'just operating' would be 7 ± 0.5 volts.

If the symmetry of sensitivity is outside these limits, the 'Equalise Relay' control should be rotated until the same value of either polarity of input voltage gives operation. Repeat the adjustment for sensitivity until all conditions are satisfied.
Note:- A good method of ensuring that this balance is achieved is to make and break the voltage by operating the 'Test Bal.' key during the adjustments.

Check that operation can still be secured for either polarity of 6 - 8 volts over the range of the 'Adjust Sensitivity' control.

3. VFLA/1

Remove the output of one of the VFLA/1's from the detector (DD/1) and replace it by a variable d.c. supply resistor and voltmeter (Avometer) as in the Fig. A2.1 This supply should be capable of variations from approximately 10 volts to 70 volts. Make sure that the correct polarity is applied to the DD/1 terminals. Short out or keep depressed the 'Self Centre Off' key.

Send 1 kc/s tone to the input of the VFLA/1 under test at - 27 db voltage level. Adjust the voltage so that an accurate voltage of 18.8 volts is supplied to the DD/1 and adjust the level of the tone by means of the fine control on the tone source over the limits ± 0.75 db until the DD/1 is balanced. Adjust Amp Det. to read exactly - 27 db using 'Adjust' control and then change the voltage as detailed in (a) - (j) in the following table (read the levels off the Amp. Det.). At each level the reading on the DD/1 balance-meter should be restored by means of the balancing voltage. Owing to meter inaccuracies (i.e., in the initial setting of 18.8 volts or the h.t. voltage of 300) the results obtained may not be within the limits specified, but two or more VFLA/1s measured in the same way and on the same instruments should give similar results.

Change frequency to 150 c/s (accurately) and leaving everything as set for test above, apply voltage level as detailed in (h) below.

Repeat at 7 kc/s, as detailed in (j) below.

Frequency	Level db Amp./Det. Reading	D.C. Volts to restore Balance	Limits
(a) 1 kc/s	- 27.0	18.8	
(b) "	- 30.0	11.5	± 0.5
(c) "	- 20	23.5	± 1.0
(d) "	- 6	36.5	± 1.0
(e) "	0	50.5	± 0.5
(f) "	+ 4	59.0	± 1.0
(g) "	+ 8	63.0	± 1.0
(h) 150 c/s	- 22	12.0	± 1.0
(j) 7 kc/s	- 22	11.5	± 1.0

Test (b) in the table checks the amplifier in the linear condition.

Test (c) and (d) check that V7 and V8 are operating correctly.

Test (e) checks that W1 and W2 are operating correctly.

Test (f) and (g) check that V5 and V6 are operating correctly.

Test (h) checks the frequency response of the pre-distortion unit with the amplifier in the linear condition.

Test (j) checks the frequency response of the post-distortion unit with the amplifier in the linear condition.

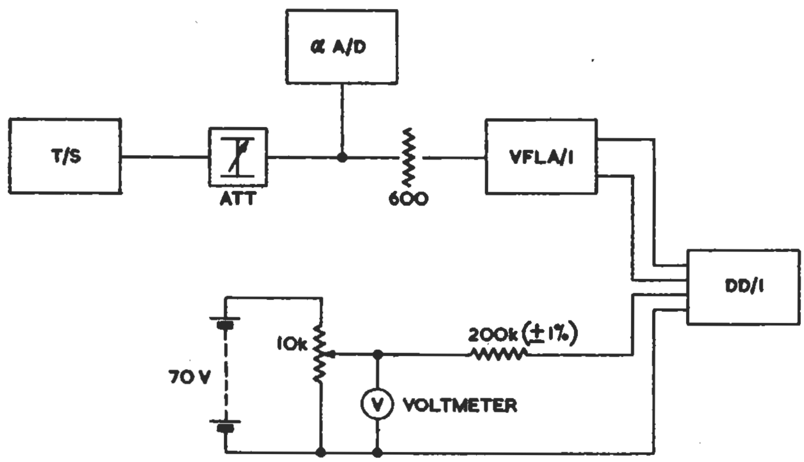

Fig. A2/1. Specification (b) test schematic

4. ASO/1

Send 1 kc/s tone at + 8 db level to the input, and vary 'Sensitivity' control so that suppressor relay operates; green light on the panel indicates this operation. Check that the latitude on adjustment is such that + 4 to + 8 db will give operation.

Remove input tone for about two minutes. Re-apply input tone to operate suppressor relays. The integrator relay should operate in 1 3/4 ± ½ minutes. The red light on the panel indicates this operation. Remove input, and red light should extinguish in about a minute.

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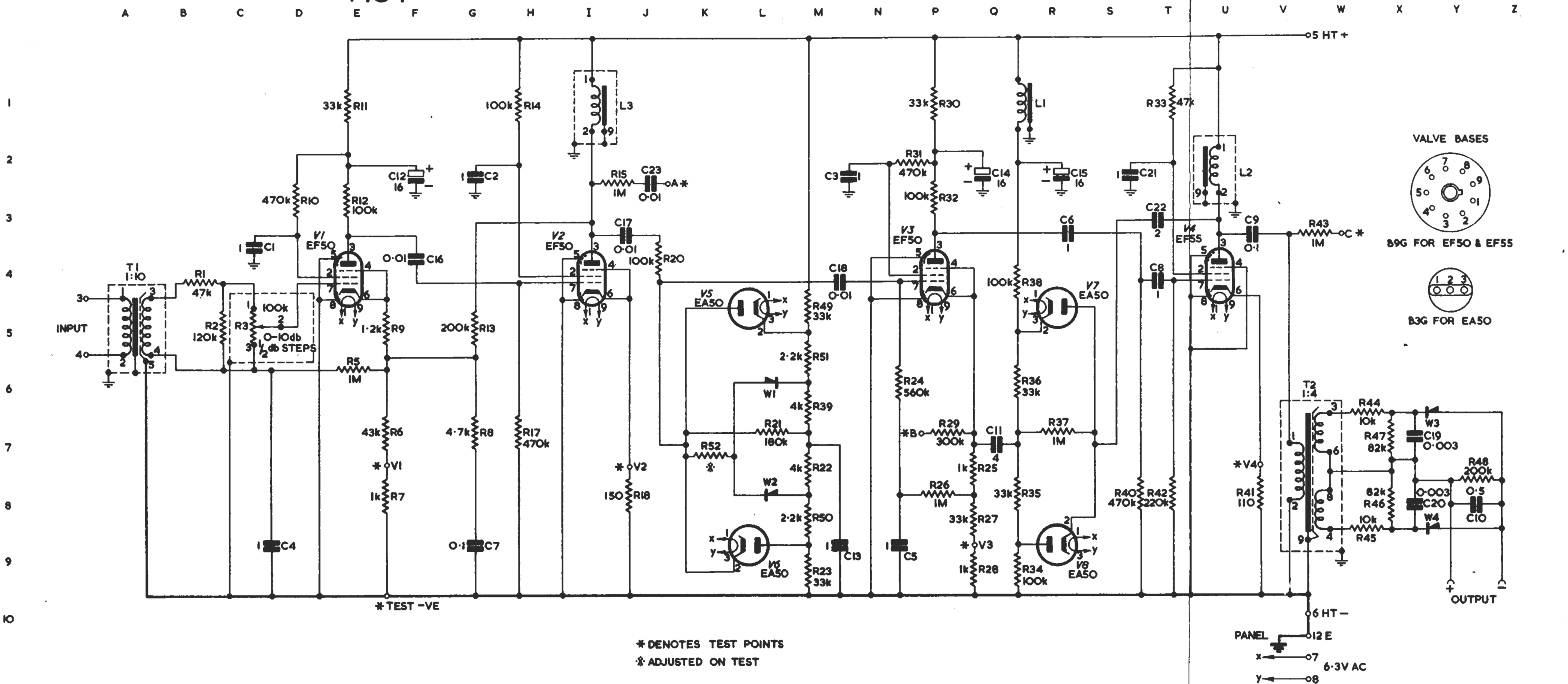
50/GGJ/002/AJDC

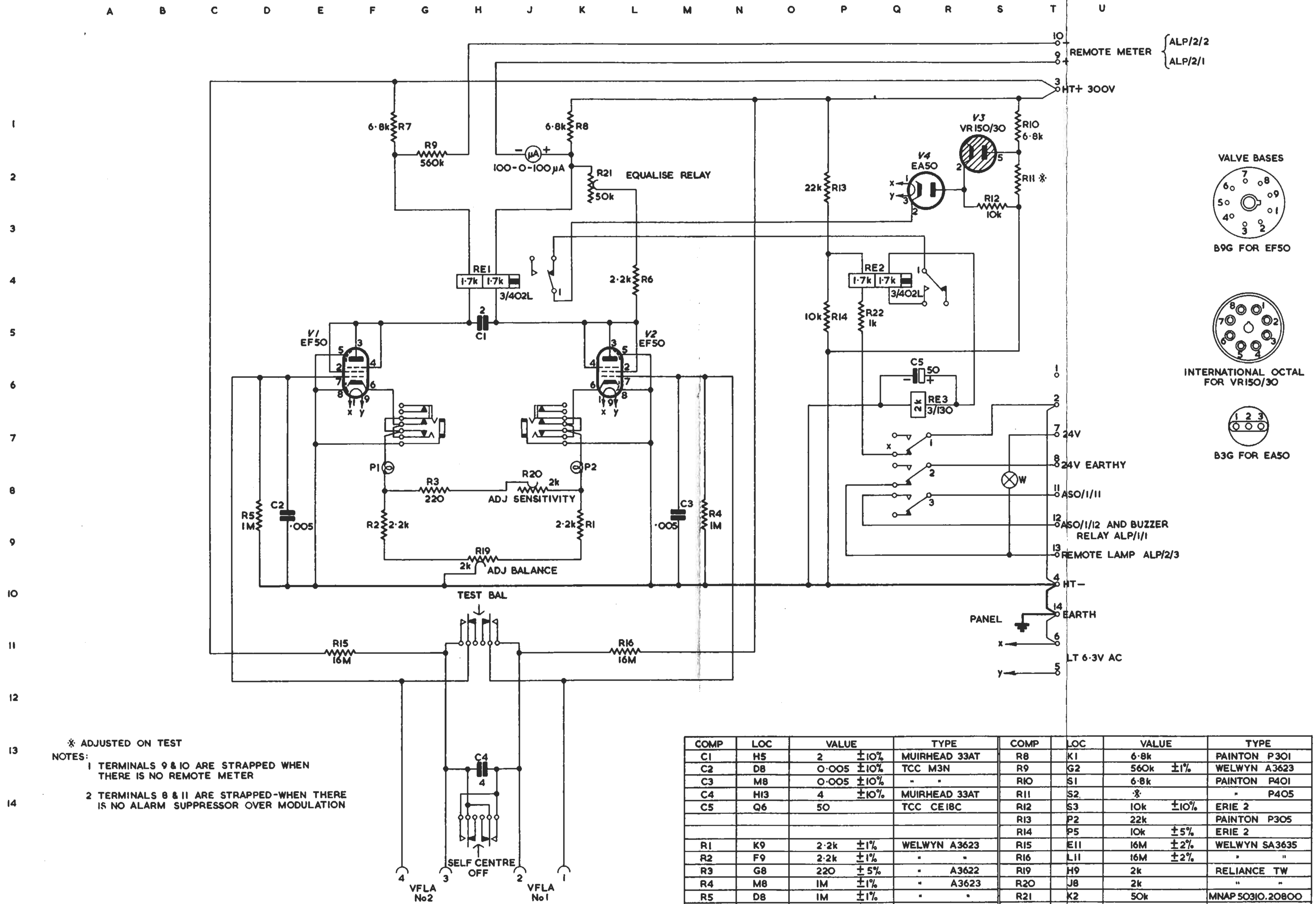
FIG I



COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1	C4	1 ±10%	MUIRHEAD 39AT	C22	T3	2 ±10%	MUIRHEAD 39AT	R14	H1	100k ±10%	ERIE 8	R37	R7	1M ±1%	WELWYN A3634
C2	G2	1 ±10%	" "	C23	J2	0·01 ±5%	TCC M3N	R15	J2	1M ±1%	WELWYN A3634	R38	Q4	100k ±1%	" A3623
C3	N2	1 ±10%	" "					R17	H7	470k ±10%	ERIE 9	R39	M6	4k ±1%	" A3622
C4	D9	1 ±10%	" "					R18	J8	150 ±1%	WELWYN A3622	R40	S8	470k ±10%	ERIE 9
C5	N9	1 ±10%	" "	L1	R1		BULGIN LF/40	R20	J4	100k ±1%	" A3623	R41	V8	110 ±1%	WELWYN A3622
C6	R3	1 ±10%	" "	L2	U2		R/1A	R21	L7	180k ±1%	" "	R42	T8	220k ±10%	ERIE 9
C7	G8	0·1 ±1%	" 33AT	L3	I1		"	R22	M7	4k ±1%	" A3622	R43	W3	1M ±1%	WELWYN A3622
C8	T4	1 ±10%	" 39AT					R23	M9	33k ±1%	" A3634	R44	W6	10k ±1%	" "
C9	U3	0·1 ±1%	" "					R24	N6	560k ±10%	ERIE 9	R45	W8	10k ±1%	" "
C10	Y8	0·5 ±1%	" 33AT	R1	B4	47k ±1%	WELWYN A3622	R25	Q7	1k ±10%	"	R46	X8	82k ±1%	" A3623
C11	Q7	4 ±10%	" 39AT	R2	C5	120k ±1%	" A3623	R26	P8	1M ±10%	"	R47	X7	82k ±1%	" "
C12	F2	16	BEC CE 15129	R3	C5	100k	PAINTON	R27	Q8	33k ±1%	WELWYN A3622	R48	Z8	200k ±1%	" "
C13	M9	1 ±10%	MUIRHEAD 39AT	R5	E6	1M ±10%	ERIE 9	R28	Q9	1k ±1%	" "	R49	M5	33k ±1%	" A3634
C14	Q2	16	BEC CE15129	R6	F7	43k ±1%	WELWYN A3622	R29	P7	300k ±1%	" A3623	R50	M8	2·2k ±1%	" A3622
C15	R2	16	" "	R7	F8	1k ±1%	" "	R30	P1	33k ±10%	ERIE 9	R51	M6	2·2k ±1%	" "
C16	F4	0·01 ±1%	UIC SMP701	R8	G7	4·7k ±1%	" "	R31	P2	470k ±10%	"	R52	K7	⁑	" "
C17	J3	0·01 ±1%	" "	R9	F5	1·2k ±10%	ERIE 9	R32	P3	100k ±1%	WELWYN A3623				
C18	M4	0·01 ±1%	" "	R10	D3	470k ±10%	" "	R33	T1	47k ±10%	ERIE 2				
C19	X7	0·003 ±1%	" "	R11	E1	33k ±10%	" "	R34	Q9	100k ±1%	WELWYN A3623	T1	A5		LG/7SA
C20	X8	0·003 ±1%	" "	R12	E3	100k ±1%	WELWYN A3623	R35	Q8	33k ±1%	" A3622	T2	V7		AGG/7RA
C21	S2	1 ±10%	MUIRHEAD 39AT	R13	G5	200k ±1%	" A3634	R36	Q6	33k ±1%	" "				

VOLUME-FOLDING AND LIMITING AMPLIFIER VFLA/1 CIRCUIT

FIG 2



※ ADJUSTED ON TEST

NOTES:

1 TERMINALS 9 & 10 ARE STRAPPED WHEN THERE IS NO REMOTE METER

2 TERMINALS 8 & 11 ARE STRAPPED-WHEN THERE IS NO ALARM SUPPRESSOR OVER MODULATION

COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1	H5	2 ±10%	MUIRHEAD 33AT	R8	K1	6·8k	PAINTON P301
C2	D8	0·005 ±10%	TCC M3N	R9	G2	560k ±1%	WELWYN A3623
C3	M8	0·005 ±10%	" "	R10	S1	6·8k	PAINTON P401
C4	H13	4 ±10%	MUIRHEAD 33AT	R11	S2	※	" P405
C5	Q6	50	TCC CE18C	R12	S3	10k ±10%	ERIE 2
				R13	P2	22k	PAINTON P305
				R14	P5	10k ±5%	ERIE 2
R1	K9	2·2k ±1%	WELWYN A3623	R15	E11	16M ±2%	WELWYN SA3635
R2	F9	2·2k ±1%	" "	R16	L11	16M ±2%	" "
R3	G8	220 ±5%	" A3622	R19	H9	2k	RELIANCE TW
R4	M8	1M ±1%	" A3623	R20	J8	2k	" "
R5	D8	1M ±1%	" "	R21	K2	50k	MNAP 50310.20800
R6	L4	2·2k ±5%	" "	R22	Q5	1k	ERIE 9
R7	F1	6·8k	PAINTON P301				

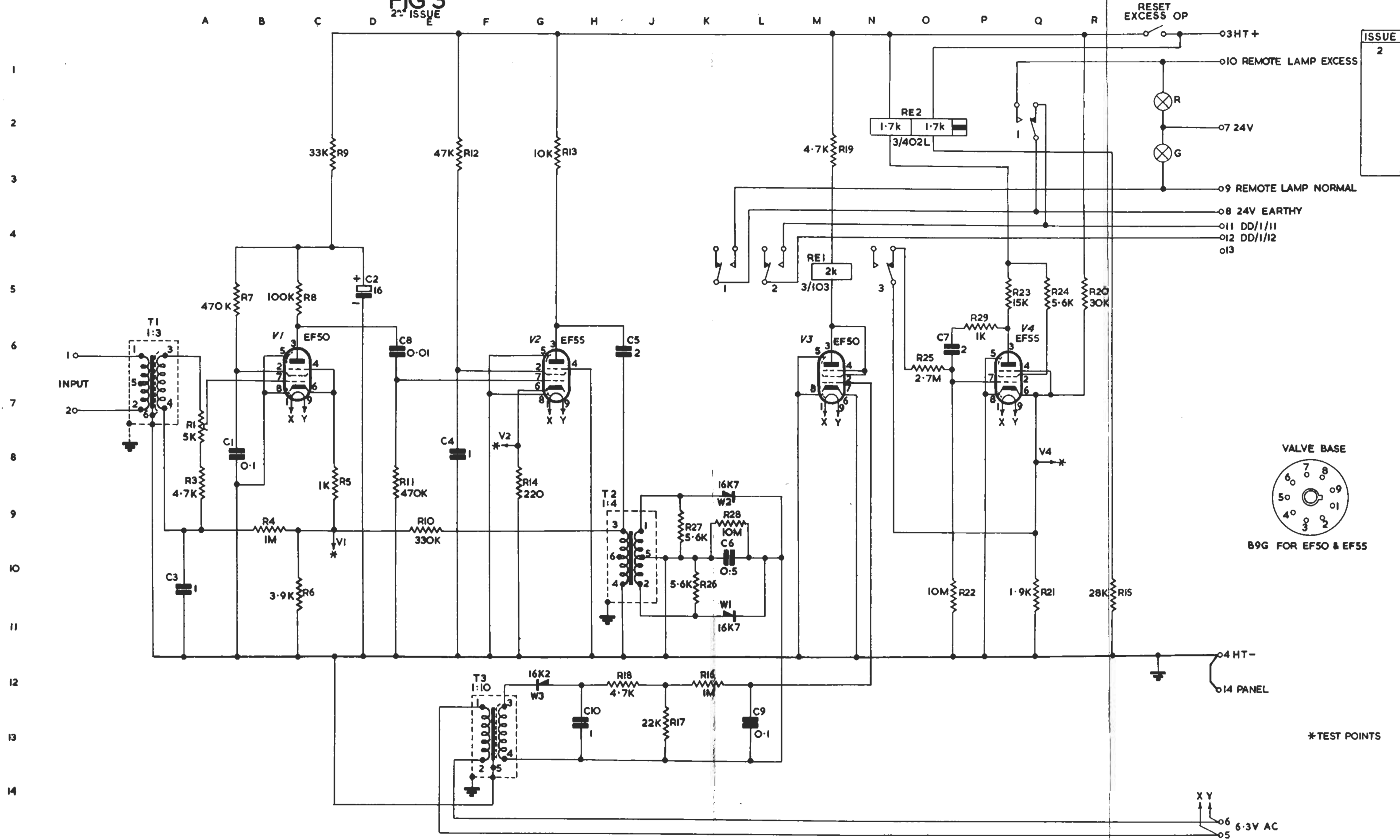
DIFFERENTIAL DETECTOR DD/1 CIRCUIT

50/GGJ/003/AJDC

FIG 3

2nd ISSUE

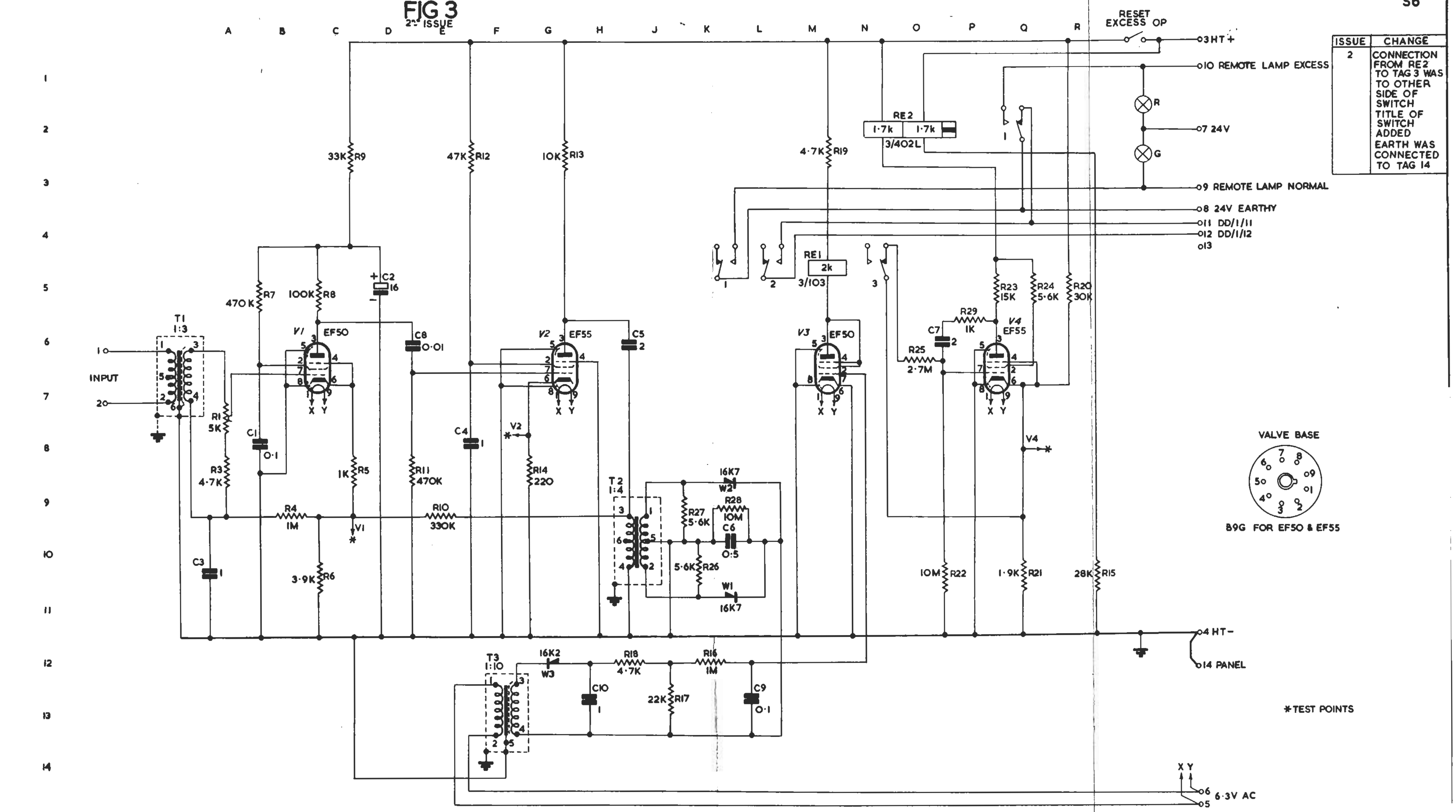
ISSUE	CHANGE
2	CONNECTION FROM RE2 TO TAG 3 WAS TO OTHER SIDE OF SWITCH TITLE OF SWITCH ADDED EARTH WAS CONNECTED TO TAG 14



COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1	B8	0·1 ± 20 %	TCC 346	R1	A7	5K	MNAP 50250,20800	R13	G3	10K ± 5 %	PAINTON P301	R24	Q5	5·6 K ± 10 %	ERIE TYPE 1
C2	D5	16	BEC CE15129	R3	A9	4·7K ± 5 %	WELWYN A3622	R14	G9	220 ± 10 %	ERIE TYPE 9	R25	O6	2·7 M ± 2 %	WELWYN A3634
C3	A10	1 ± 10 %	MUIRHEAD 39AT	R4	B9	1M ± 10 %	ERIE TYPE 9	R15	R11	28 K ± 1 %	PAINTON P405	R26	K10	5·6 K ± 10 %	ERIE TYPE 9
C4	F8	1 ± 10 %	" "	R5	C9	1K ± 10 %	" " "	R16	K12	1 M ± 10 %	ERIE TYPE 9	R27	J9	5·6K ± 10 %	" " "
C5	J6	2 ± 10 %	" "	R6	C11	3·9K ± 1 %	WELWYN A3622	R17	J13	22K ± 5 %	" " 8	R28	K9	10M ± 2 %	WELWYN SA3635
C6	L10	0·5 ± 10 %	" "	R7	B5	470K ± 10 %	ERIE TYPE 9	R18	H12	4·7K ± 5 %	" " 9	R29	P6	1 K ± 10 %	ERIE TYPE 9
C7	P6	2 ± 10 %	" "	R8	C5	100K ± 10 %	" " 8	R19	M3	4·7K ± 10 %	" " 1				
C8	E6	0·01 ± 20 %	TCC M3N	R9	C3	33K ± 10 %	" " "	R20	R5	30K ± 1 %	PAINTON P405				
C9	L13	0·1 ± 20 %	" 346	R10	E9	330K ± 10 %	WELWYN A3623	R21	Q11	1·9 K ± 1 %	P406	T1	A7		LG/23SA
C10	H13	1 ± 20 %	MUIRHEAD 39 AT	R11	E9	470K ± 10 %	ERIE TYPE 9	R22	O11	10M ± 2 %	WELWYN SA 3635	T2	J10		LGG/1SA
				R12	F3	47K ± 10 %	" " 2	R23	P5	15K ± 5 %	PAINTON P306	T3	F13		LG/7SA

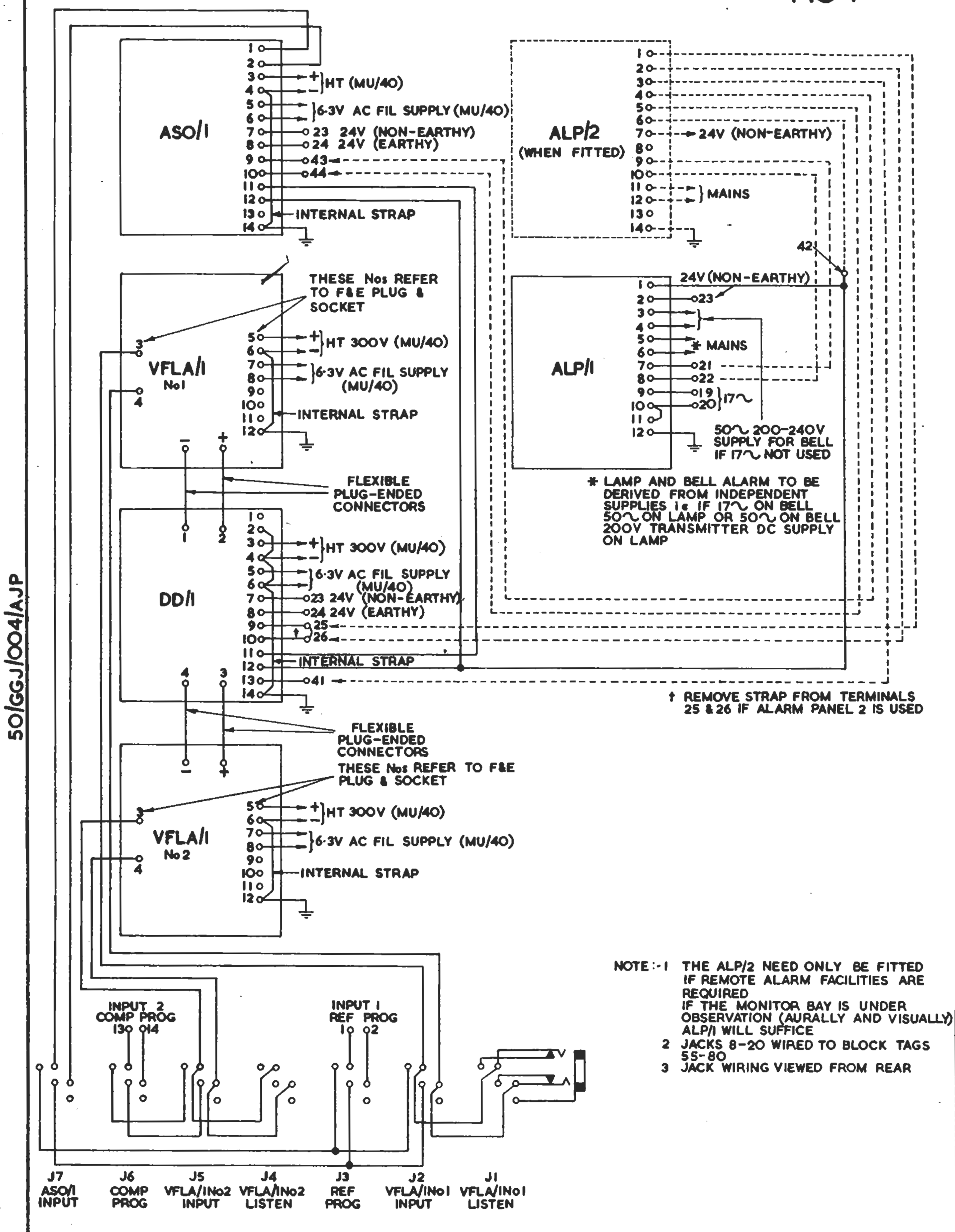
ALARM SUPPRESSOR. OVER-MODULATION ASO/1 CIRCUIT

FIG 3
2nd ISSUE



COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE	COMP	LOC	VALUE	TYPE
C1	B8	0·1 ± 20 %	TCC 346	R1	A7	5K	MNAP 50250,20800	R13	G3	10K ± 5 %	PAINTON P301	R24	Q5	5·6 K ±10 %	ERIE TYPE 1
C2	D5	16	BEC CE15129	R3	A9	4·7K ± 5 %	WELWYN A3622	R14	G9	220 ±10 %	ERIE TYPE 9	R25	O6	2·7M ±.2 %	WELWYN A3634
C3	A10	1 ± 10 %	MUIRHEAD 39AT	R4	B9	1M ±10 %	ERIE TYPE 9	R15	R11	28 K ± 1 %	PAINTON P405	R26	K10	5·6 K ±10 %	ERIE TYPE 9
C4	F8	1 ± 10 %	" "	R5	C9	1K ±10 %	" " "	R16	K12	1 M ±10 %	ERIE TYPE 9	R27	J9	5·6K ± 10 %	" " "
C5	J6	2 ± 10 %	" "	R6	C11	3·9K ± 1 %	WELWYN A3622	R17	J13	22K ± 5 %	" " 8	R28	K9	10M ± 2 %	WELWYN SA3635
C6	L10	0·5 ± 10 %	" "	R7	B5	470K ±10 %	ERIE TYPE 9	R18	H12	4·7K ± 5 %	" " 9	R29	P6	1K ±10 %	ERIE TYPE 9
C7	P6	2 ± 10 %	" "	R8	C5	100K ±10 %	" " 8	R19	M3	4·7K ±10 %	" " 1				
C8	E6	0·01 ±20 %	TCC M3N	R9	C3	33K ±10 %	" " "	R20	R5	30K ± 1 %	PAINTON P405				
C9	L13	0·1 ±20 %	" 346	R10	E9	330K ± 10 %	WELWYN A3623	R21	Q11	1·9K ± 1 %	P406	T1	A7		LG/23SA
C10	H13	1 ±20 %	MUIRHEAD 39 AT	R11	E9	470K ± 10 %	ERIE TYPE 9	R22	O11	10M ± 2 %	WELWYN SA 3635	T2	J10		LGG/1SA
				R12	F3	47K ± 10 %	" " 2	R23	P5	15K ± 5 %	PAINTON P306	T3	F13		LG/7SA

ALARM SUPPRESSOR. OVER - MODULATION ASO/1 CIRCUIT



NOTE:- 1 THE ALP/2 NEED ONLY BE FITTED IF REMOTE ALARM FACILITIES ARE REQUIRED
IF THE MONITOR BAY IS UNDER OBSERVATION (AURALLY AND VISUALLY) ALP/1 WILL SUFFICE
2 JACKS 8-20 WIRED TO BLOCK TAGS 55-80
3 JACK WIRING VIEWED FROM REAR

AUTOMATIC MONITOR MINOR EXTERNAL CONNECTIONS