TECHNICAL INSTRUCTION
T.10

Band II Transmitters: Programme Input, Programme Control and Monitoring

PART 1: BASIC METHODS AND EQUIPMENT

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PART 1

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BAND II TRANSMITTERS: PROGRAMME INPUT, PROGRAMME CONTROL AND MONITORING

PART 1. BASIC METHODS AND EQUIPMENT

SECTION 1

INTRODUCTION

All Band II v.h.f./f.m. installations conform with principles of a single design but there is some diversity in matters of practice especially with regard to programme control and monitoring. In that connection the usual methods and common types of apparatus are described in Part 1 of this Instruction, and more specific details of particular arrangements at individual stations are given in Part 2. As a background to this information the following survey deals with various features which characterise the Band II installations.

The scheme to provide national coverage by f.m. transmission has been largely fulfilled through groups of transmitters placed at existing t.v. transmitting sites, and also incorporated in new stations employed to give supplementary coverage for both sound and vision services in certain areas. In this pairing the Band II extension constitutes a completely separate entity including a power-distribution system covering the needs of the transmitters and all auxiliaries. Sharing of major facilities is limited to drawing two power feeds from the station supply system and using the main mast for mounting a slot-aerial system beneath the Band I aerial for television transmission.

Band II equipments are designed for fully-automatic operation, which allows semi-attended working during hours when staff is present but engaged primarily in duties concerning television transmission, and unattended working for the overnight periods when the station is vacated. Continuous radio-check on the transmissions from a site is not generally undertaken locally, monitoring being done either with automatic monitors or aurally at other centres staffed on a 24-hour basis. The external monitoring, and provision for remote programme-switching from these centres, is referred to later. Powering of the transmitters is controlled through time-switches, which are adjusted for a seven-day cycle of make and break operations at times appropriate to the programme-service schedules of the transmitters with which they are associated. Remote warning of serious faults requiring corrective action is given at an alarm panel on the t.v. transmitter control desk. Signal lamps on the panel give information of a summated nature, sufficient to provide preliminary guidance in a rapid localisation of faults made possible by the extensive indication facilities in the Band II transmitter hall.

The typical installation has a complement of six transmitters engaged two each in the Light, Third and Home programme services. Exceptionally the number may vary to suit requirements in certain areas, notably at sites capable of substantial coverage in two adjoining programme regions. By adding another pair of transmitters, making a total of eight, the Basic Home programme can be transmitted in two channels with different regional-programme contributions in the separate transmissions. At each site the Light, Third and Home services are carried by transmitters working on carrier frequencies in ascending order for the stated sequence. The usual one-site spacing of adjacent channels is 2.2 Mc/s, although there are a few instances where slightly different spacing has been adopted to avoid interference.

The pairing of transmitters follows a general practice of duplicating equipment with the object of reducing the chance of complete interruption in the several programme services. The duplicate equipments are utilised so as to divide the whole installation into two halves working independently of one another. The essentials of this method are indicated in the block-schematic diagram of Fig. 1.1, showing a related pair of transmitters powered from separate distribution systems and feeding their outputs into separate halves of the common aerial system. The transmitters working into each half-aerial are connected through an output-combining filter which is not shown because the sequence in successive combination of the several outputs is not the same at all sites. The diagram illustrates the code for identifying apparatus, numbers 1, 2 and 3 being applied to items concerned with Light, Third and Home services respectively, whilst the halves of the installation are distinguished from one another by letters A and B.

With a formation as in Fig. 1.1 the services can be maintained even when transmitters in one half of the installation become immobilised by a power failure or are incapable of radiating because of a fault affecting one half of the aerial. Under the one-transmitter condition the reduction from normal strength is 6 dB, of which 3 dB is attributable to the fall in effective aerial gain. As further provision for emergency working the source ends of the aerial feeders are generally fitted with switches to enable a rapid cross-over connection to be made if maintaining the service necessitates feeding the outputs of either the A or B groups of transmitters into the alternative halves of the aerial.

phasing control giving compensatory adjustment. The phasing control works in conjunction with two phasing amplifiers through which the paired transmitters are individually fed from one of two r.f. drives; see below. Phasing equipments are provided by transmitter manufacturers, for which reason the manner of applying phase correction shows some variation according to the particular make used. Some later stations have phasing equipments omitting the automatic-control feature, any corrective adjustments being made by hand control when an alarm signals an error outside a predetermined tolerance value.

On transmitter manufacture also depends

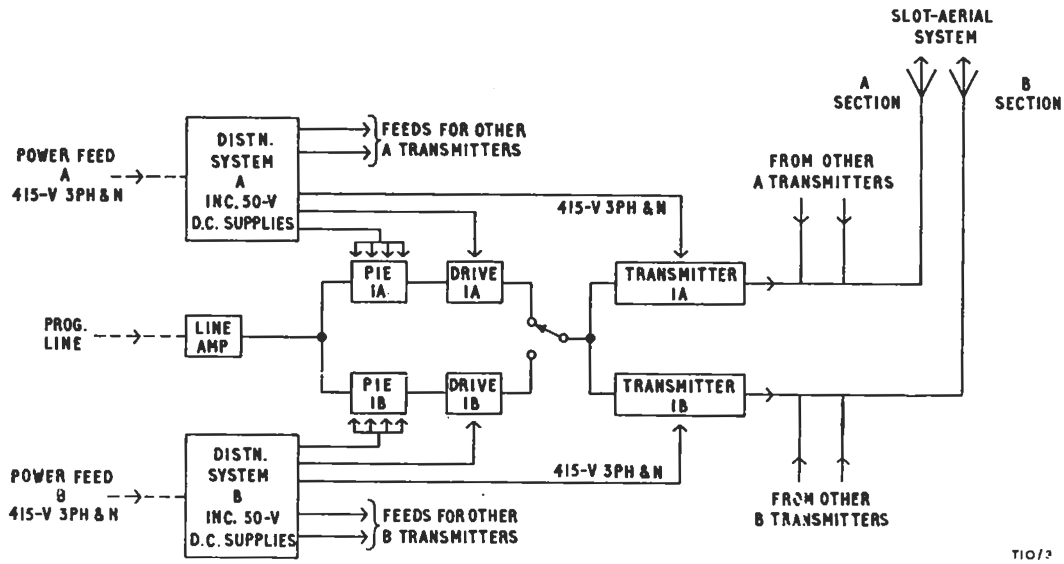


Fig. 1.1 Simplified Schematic showing Disposition of Duplicate Equipments for Single-programme Transmission

Independent transmission in the single channels makes it essential for the outputs of each pair of transmitters to be kept in correct phase relationship at the aerial feed points. The electrical lengths of the main aerial feeders are made identical, by folding the feeder to the lower half of the aerial, and therefore the condition is met by ensuring that the outputs of two transmitters are in phase at points on feeders which connect them individually to the A and B combining units. Automatic phasing equipment is largely used for correcting phase differences as detected with a phase comparator to which inputs are taken from probes in the two transmitter-output feeders. For an out-of-tolerance discrepancy the error signal produced in the comparator causes operation of a motor-driven

arrangements for applying drive to the paired transmitters. Drives are fed with separate programme inputs, as in Fig. 1.1, for a modulation process occurring in an osciallator stage working at a fraction of the required carrier frequency, obtained through a succession of frequency multipliers. Associated with the drives is a changeover switching panel arranged to transfer automatically to the reserve source on failure of the drive in service. With M.W.T. transmitters the general practice is to use the switch for selecting carrier-frequency feed from the drive outputs, this being passed to the above-mentioned phasing amplifiers. For S.T.C. transmitters, however, the switching is done intermediately, in advance of two phasing amplifiers with their outputs severally connected to two final-tripler stages. Although forming part of the drive installations these triplers have operating supplies drawn from the internal power-distribution of the transmitters, A to A and B to B, instead of employing locally-derived supplies as used with the preceding stages.

Provision for switching to standby programme feed is directed towards maintaining the Home and Light services during the Unguarded Hour, that is the overnight period mentioned earlier. The usual plan for this emergency feeding is to make reserve Home feed available on the otherwise idle Third Programme circuit, and to use a 200-kc/s rebroadcast receiver as the alternative source of Light programme. When a transmitting site is about to be vacated the operation of a single switch sets up conditions for operating programme-switching relays by remote control from the staffed centre at which monitoring is carried out. To enable the reserve-line feed to be switched to the Home transmitters the relays in Home and Third Programme chains are interconnected and arranged for co-ordinated operation through the remote-control system. In addition to providing for programme-feed and drive change-over these relay systems are designed to permit programme to be cut from the transmitters by suitable action at the remote-control position. For the local control operative during staffed hours at transmitting stations the transfer to emergency programme-feeding is usually done manually.

Phantom circuits are employed for remote-control purposes and for passing d.c. signals from automatic monitors to transmitting sites. These circuits are normally derived from programme lines, although control and reserve lines are sometimes utilised especially on long links. Simple earth phantoms are generally used except where the number of circuits available is inadequate for switching and signalling requirements. In this circumstance the extra facilities are provided with the aid of special phantom systems making separate use of the A and B legs of lines in conjunction with earth returns.

External monitoring of programmes by an aural radio-check is common only in respect of Home Service. It is convenient to do this as in many instances monitoring of a medium-wave transmission of the same programme takes place at some centre within the service area of the v.h.f. station, whose transmission is therefore included on a sequential basis. Otherwise the monitoring is mainly done by various methods entailing use of several types of automatic monitor, each having the function of comparing programme at some point on the transmission system with that at another point on the system. Arrangements for three-programme monitoring differ from station to station, one major factor governing the choice of methods being the line routes serving a transmitting site and other centres in the surrounding area.

While most Band II sites are served by the S.B. system there are some relying either partly or entirely on v.h.f. receivers instead of lines for normal programme inputs to transmitters. This permanent, as distinct from emergency, use of v.h.f. channels for rebroadcasting is a practice which is being extended both in the v.h.f. network and to medium-wave sites, especially at stations not manned. Stations chosen for parent duty with respect to one or more dependent sites are equipped with oscillators for modulating their transmissions with 20-kc/s tone. It is applied after the programme-input chains for any transmitters involved in the rebroadcasting facilities. With the aid of this so-called monitoring tone the equipment at a dependent station can distinguish between a programme break prior to the point of tone injection at the parent station and one due, say, to a faulty receiver. Two receivers are provided for each programme service taken by radio, one a standby which is automatically switched into use on failure of the working receiver. Tone is not filtered from received signals and thus it is possible to employ tandem working, that is with dependent stations in chain sequence. All further details of the rebroadcasting technique are given, with information on the equipments at parent and dependent stations, in Section 5. The separation of this from other descriptions relating to practice when working with lines is done for clarity of exposition only, as both methods of taking programme may be used in complementary association to cover the several programme services radiated by individual sites.

Band I/Band II stations generally are provided with means for occasional monitoring at three points in the building. One is a general-purposes position in the Band II hall where rack-mounted equipments include a loudspeaker unit, fed as desired by flying-lead connector. The other two, in the quality room and at the t.v. transmitter control desk, are similarly arranged to feed a loudspeaker unit via a selector switch. The 12-way switch usually fitted has, apart from settings for t.v. sound monitoring, three positions for connecting feeds associated with each programme service. They comprise two from r.f. monitors in the A and B transmitters for a particular service and one from the related programme chain, the switch-setting for the latter being intermediate to those for the monitors.

Voltage-stabilised supplies are provided for programme amplifiers, drives and all other low-power equipments. At some installations, where the transmitters incorporate three-phase regulators in connection with their power inputs, a single-phase regulator is fitted into each half-system to stabilise a feed covering general 240-volt distribution. At others the transmitters are not equipped with regulators and bulk regulation is carried out with high-power, three-phase regulators operating on main 415-volt feeds to A and B halves of the supply system. Both A and B 240-volt supplies are distributed to sockets in each of the p.i.e. bays, to allow individual equipments to be connected to the appropriate sources. 50-volt d.c. supplies for relay operation are derived through rectifier units, and are positive-earthed. They are initially distributed as separately-fused feeds, most of which are taken to a control and indication bay (CIB). Two of the latter are 1A and 1B supplies for control and indication equipments associated with Light Programme, and similarly paired 2A/2B and 3A/3B supplies are for equipments engaged in the Third Programme and Home services respectively. Another two feeds are identified as 5A and 5B supplies, for general-purpose use with apparatus not specially related with a particular programme. The subsidiary distribution of 50-volt supplies is sometimes done through U-link panels, but this is practised to a limited extent only.

SECTION 2

PROGRAMME INPUT INSTALLATIONS

2.1 General

Programme input installations show differences from one another but mainly in details only. The programme chains differ in arrangements for switching from normal to emergency programme feeds and in ways by which reserve feeds are derived. Variations occur also in layouts of apparatus forming programme chains, later practice being to segregate the initial sections associated with lines from the equipments more directly involved in providing transmitter inputs. The greatest diversity is found in control and monitoring equipments, chosen on the basis of widely varying requirements at individual sites. In view of the impossibility of referring to a standard arrangement the following description deals with general features of the installations and the commoner types of equipment, including those added where necessary to provide automatic monitoring facilities. The treatment applies specifically to stations taking programme feeds via lines, supplementary and amending information relevant to parent and dependent stations concerned with the alternative use of receivers for that purpose being given in Section 5, dealing exclusively with the subject of permanent-rebroadcasting arrangements.

2.2 P.I.E. Layouts

A minimum complement of equipment is normally carried in four bays in the Band II transmitter hall, and these have a left-right sequence as follows:

Bay 1 Transmitter Bay, TL/55 (Modified)
Bay 2 Limiter Bay, LIMB/2
Bay 3 Receiver Bay, RCB/1
Bay 4 Control and Indication Bay, CIB/1

There are some stations where a Type-BA13/1 bay (Transmitter Input and Limiter) is employed instead of the above No. 1 and No. 2 bays, and further reference is made to this after dealing with the bays listed. Other bays covering automatic monitoring are added when necessary, and they comprise:

Bay 5 Automatic Monitor Bay, AMTB/1
Bay 6 Line Monitor Bay (Receive), LMBR/1

In a few instances the incoming lines are taken to equalisers and line amplifiers on bay No. 1, but usually this apparatus is mounted on a bay placed either with the t.v. sound bays in the Band I transmitter hall, or in the line termination room.

There are a number of variants for many of the basic units employed in these bays, each being distinguished from the parent type by a letter added to the code reference. To avoid confusing detail in the following descriptions of bay equipments the parent-type code is quoted in most instances, but it is to be understood that any one of a series may be used in a particular installation.

(a) Bay 1 TL/55 (Modified)

This bay is primarily a routing and switching position for normal and reserve programme sources for the three programme services, and from it are fed the modulating signals for r.f. drives. In some installations the bay contains line-terminating equipments, but more often these are placed elsewhere as previously mentioned. For each programme service the switching functions are carried out in a U-link and Relay Panel, ULR/1, the number of relays varying with the switching facilities required. These panels serve as distribution units for programme feed to limiters and automatic monitors. In addition the outputs of check monitors in the drives and transmitters are fed to them. Further, each provides for extending a phantom control circuit to external equipment.

At installations where line terminating equipments are incorporated in the bay, the incoming lines are connected to repeating coils in the several ULR panels. The output of each repeating coil is fed to an equaliser and line amplifier (GPA/4A), both mounted in the upper part of the bay. The line-amplifier output is taken to the ULR panel for connection with a hybrid transformer providing separate outputs for use in the main programme chain and for occasional-monitoring purposes. The line amplifiers are grouped on an Amplifier Panel (AP/2) and operated with supplies taken from a Supply Distribution Panel (SDP/1) used in conjunction with a Mains Unit (MU/51). The duplicate equipments of the mains unit are connected one each to 240-volt A and B supplies to allow distribution arangements which obviate loss of programme should either half of the power-supply system fail.

The method takes into account the powering of equipments providing reserve programme feeds and is usually, although not necessarily always, as indicated in the following table.

Programme Service	*Line Amplifier Supply*	*Rebroadcast Receiver Supply*
Light	A	B
Third	B	A
Home	A	B

The amplifier normally associated with Third Programme is operated with a B feed to cover its use as the reserve source of Home programme during the Unguarded Hour.

Where line-terminating equipment is placed in a separate bay the circuit and supply arrangements are essentially as already described. Each of the segregated sets of equipment comprises a repeating coil, equaliser, lines amplifier and hybrid transformer, the first and last items being omitted from the associated ULR panel on bay No. 1. A jackfield is added to this remote equipment for the purpose of providing monitoring and test facilities in the several programme circuits. For each programme chain the interconnection with bay No. 1 is effected through three circuits, two from the main-programme and monitoring outputs of the hybrid transformer and one, a single-wire circuit, between the centre-point of the repeating coil and a phantom-circuit U-link position at the ULR panel.

The No. 1 bay is also equipped with an amplifier-mounting panel holding apparatus for general-purpose visual and aural monitoring of programmes. The panel may be either an AP/3 type fitted with a Monitoring Amplifier (MNA/3) and a Remote Programme Meter (PRM/2), or an AMS/1 panel carrying similar units plus a box-type mains supply unit. The latter panel is employed where the line-terminating gear is in a separate bay, in which event bay No. 1 is not provided with an MU/51 mains unit.

The bay has three terminal blocks bearing identification letters A, B and C, which are associated with bay interconnection relevant to the Light, Third and Home programmes respectively.

(b) Bay 2 Limiter Bay, LIMB/2

Six limiters in this bay have number-letter references indicating their use in A and B branches of the three programme chains, the inputs and outputs of related pairs being tied to U-link sockets on the appropriate ULR panels in bay 1. The type of limiter is either a LIM/6 or a LIM/6A, which have identical circuits but are designed for mounting in 22-in. and 19-in. bays respectively. On the bay also is a Limiter Indicator Panel (IP/1) comprised of three similar sections, each of which is interconnected with the A and B limiters for a single transmission. Details of the limiters and means for signalling their operation are given in sections 3.2.2 and 3.2.3.

The bay equipment is completed with a Mains Unit (MU/51) and Supply Distribution Panel (SDP/1) covering the distribution of A and B supplies to the two groups of letter-related limiters.

(c) Bay 3 Receiver Bay, RCB/1

This bay is equipped with receivers on the basis of one for each programme service for which a rebroadcast facility is required. Each receiver output is tied to a U-link position on the appropriate ULR panel at bay No. 1. If that bay is not fitted with line-terminating equipment, a feed is taken to a monitoring jack at the l.t. bay, by connection from the bay No. 1 terminal position. These receivers are operated with supplies provided by mains units (MU/16H), each using a mains feed taken from that half of the power-supply system alternative to the one through which the line amplifier for the particular programme service is supplied; see table under heading (*a*).

The receivers are selected from an RBR/2 series of fixed-tuned types, choice being governed by the suitability of various channels for the purpose of rebroadcasting from a given site. The complete series comprises twelve receivers, of which one is a long-wave (200 kc/s) version identified by the parent code. The others are all designed for use on one of the BBC medium-frequency channels, and identified with different letter suffixes to the reference code. Information on this range of receivers is obtainable from Instruction RS.1, Section 1.

Other equipments fitted as standard items on this bay are a loudspeaker monitoring assembly (LSU/4) and a telephone panel (TP/13).

(d) Bay 4 Control and Indication Bay, CIB/1

The above functional title refers to facilities provided in general for the complete Band II installation. Although only a proportion of the units are directly associated with programme operations the various types of apparatus normally comprising a full complement of equipments are briefly described below. All the units mentioned are available in at least one version which is a modified form of the parent type.

The Phantom Relay Receiving Panel (PRR/2) is a combined control and metering unit for incoming phantom circuits except those used in line automatic monitoring. For the latter purpose there is direct connection from the ULR panel in bay No. 1 to the bay containing the Line Automatic Monitor equipment. Otherwise the phantom circuits extended through ULR panels are taken to the PRR/2 panel to allow current in the individual circuits to be measured and enable circuits to be switched when required for a local-control condition whilst the station is manned, and a remote-control condition during the Unguarded Hour. For unswitched phantoms the circuits are simply extended so that fault signals from distant automatic monitors are fed to Integrating Alarm Panels (IAP) referred to below. Change-over switching is provided for phantoms required to carry fault signals for an IAP during station-manned periods, and be used as means for remote control when the transmitter building is vacated. A ganged switching arrangement provides for simultaneous transfer from one condition to the other, and remote control is obtained by connection with relays giving executive action. A number of other circuit rearrangements occur as the single control is set for either local or remote control, these being concerned with indication and alarm facilities. Details of these are given with a description of the equipment under heading 4.2.1.

Next in a top-to-bottom sequence is a Feeder Indicator Panel (FIP/1) using lamps to illuminate portions of a caption frame showing output-switching conditions for the A and B groups of transmitters and operation of auxiliaries, such as dehydrators, employed with the r.f. output feeder system.

Below the FIP unit are three Control and Indicator Panels (CIP/1), one associated with each programme service. The panel provides a comprehensive display by illumination of captions which are largely relevant to operation of a pair of A and B transmitters and to conditions in their drive and phasing equipments. Additionally there is provision for indicating the state of any monitoring equipments, normally AMT/2 automatic monitors (transmitter), when employed with the programme chain. The three panels in a bay are generally the same versions of the equipment type, but do not necessarily give similar indications. This is because for each version of the equipment there is a set of display-frame labels from which choice is made to suit the indication facilities needed for the specific application of the individual equipment. All versions of the panel have a drive-selector switch providing four alternative conditions for operation of the A and B drives.

Use of the above-mentioned Integrating Alarm Panels (IAP/1) is not obligatory. These are added to bay equipments when required by the programme control and monitoring scheme for the site of installation. The equipment is for integrating the fault signals emanating from an automatic monitor, this usually being an Automatic Monitor Minor (AMM) situated at a distant centre. Ordinarily the unit is employed to initiate an alarm for faults which are persistent or continuous, but one version of the panel is available for use where additionally it is intended that executive action (programme-feed switching) takes place concurrently with the issuing of an alarm. The equipment has an indication panel, is mains-operated, and contains duplicate integrating circuits working independently of one another to obtain enhanced reliability of operation.

Near the foot of the bay is a panel carrying a mains-fed Transformer Unit (TU/5) providing two l.v. outputs at different voltages for general-purpose use with equipments needing external supplies for indication lamps. Also mounted on the bay are two boxes, each containing three time-switches. These are A and B sets used in control circuits for automatically powering the transmitters. Two switches, one in each box, are used in conjunction with two relays in the CIP, the circuit arrangement ensuring that control over the powering of a related pair of A and B transmitters will not be lost if one of the time-switches fails.

The bay termination is a subsidiary distribution point for 50-volt, positive-earthed, supplies used in relay operation. The supplies are taken from the power-distribution cubicle through a number of circuits, comprised of three pairs of A and B feeders serving equipments associated with the several programme-transmission chains, and another pair carrying ' common ' A and B supplies for miscellaneous purposes. Their distribution is largely internal, but supplies are fed to other bays containing units needing direct 50-volt supplies.

(e) Bay 5 Automatic Monitor Bay, AMTB/1

This bay can accommodate six AMT/2 Automatic Monitors (Transmitter), which are used in pairs for monitoring over A and B sections of programme chains. A normal complement, however, is either four or two units, because in general the Home transmission at least is monitored without their aid.

The monitor is a self-contained, mains-operated equipment in which two a.f. inputs are compared. For their use at f.m. transmitting stations one input is derived from a drive output for comparison with another taken from a limiter input. Comparison is made after both inputs have undergone a special process of conversion to obtain d.c. signals applied to a differential detector. The monitor is designed to take account of undue disparity of noise level at the two inputs, the resultant action being as for a programme-comparison fault condition. Monitors may be used either to give an alarm only or to initiate a drive change-over when a fault occurs. In referring to equipments with these alternative functions a distinction is made by use of the qualifying terms ' non-executive ' and ' executive ' respectively.

(f) Bay 6 Line Monitor Bay (Receive), LMBR/2

A Line Automatic Monitor, LAM/1, consists of this bay and a Line Monitor Bay (Send), LMBS/2. The sending bay is installed at a centre on the programme-feed route as determined by particular circumstances, often but not necessarily the one nearest the transmitting site. The sets of equipments are linked by an earthed phantom circuit, normally derived from the programme line being monitored by the LAM/1.

The method in monitoring is essentially similar to that outlined for AMT/2 monitors, but using a more elaborate arrangement of separate units at both ends of the monitored line. The receiving-bay equipment includes a Quadrature Splitting Panel (QSP/1) and two Volume Folding and Limiting Amplifiers (VFLA/4) with which processed signals giving information on programme and noise are obtained. Additionally there is a Phantom Receiving Unit (PUR/1) in which the VFLA/4 outputs are combined into a ' compared ' input signal for a Differential Detector (DD/2). Similar processing is done at the sending bay, but a Phantom Sending Unit (PUS/1) provides for combining of the VFLA/4 outputs and ' backing off ' for the resultant ' reference ' signal applied to the phantom circuit. This signal is passed to the second input of the Differential Detector on the receiving bay, so that fault signals will occur when the two inputs differ by more than predetermined tolerance values. Provision is made for obtaining an alarm under excessive-fault conditions, by feeding fault signals to an IAP/1 unit; see reference under (*d*).

The receiving bay is fitted with a mains unit (MU/51A) providing supplies for the three signal-processing equipments only, as the PUS/1 and DD/2 units have internal mains-operated power supplies. One of duplicated sections in the mains unit is used in feeding dependent equipments through a Supply Distribution Panel (SDP/2). The output connector of the other section is ' parked ' on the distribution panel to enable a quick substitution to be made if the working section fails.

(g) Transmitter Input and Limiter Bay, BA13/1

This bay is an alternative to the No. 1 and No. 2 bays described earlier, as it provides facilities equivalent to those otherwise obtained by joint use of a modified TL/55 bay, that is without line-terminating equipments, and a limiter bay, LIMB/2.

The bay carries six limiters (LIM/6A) for service in A and B branches of the several programme chains, and these are number-letter identified as stated under heading (*b*). Two mains units (MU/51) and a supply distribution panel are used in feeding the limiters with either A or B supplies following the general practice in distribution.

A special feature is the fitting of only two U-link and relay panels on the bay. One panel (ULR/1A) is designed as a control and distribution unit in connection with programme feeds for both the Light and Third transmissions. The other panel (ULR/1B) makes generally similar provision for Home programme-feeding, and has a miscellaneous section mainly concerned with tie-line and occasional-monitoring arrangements. Also in the bay is an Amplifier Panel (AP/3) carrying a group of box-type units providing programme-metering and occasional-monitoring facilities.

(h) Additional Equipments

Various other equipment types are sometimes used in meeting special requirements at particular stations, especially in connection with programme-control arrangements. In view of their limited employment these are referred to as necessary in descriptions for individual stations, given in Part 2 of this Instruction.

One standard extra item is a remote supervisory position for the Band II installation. This is usually an alarm panel (ALP/7) suitable for mounting on the transmitter control desk in the Band I hall, although an alternative type may be used in some instances. The panel has a block formation of signal lamps, an internal alarm-buzzer and terminals for an extension circuit to a remote alarm, if desired. Associated with each programme service are four lamps showing (*a*) when the time switches for automatic transmitter-powering are operated, (*b*) when the transmitters are radiating, (*c*) existence of a System Normal condition, and (*d*) that a Monitoring Normal condition exists. The last two indications together give collective information regarding virtually all the apparatus engaged for single-programme transmission.

SECTION 3

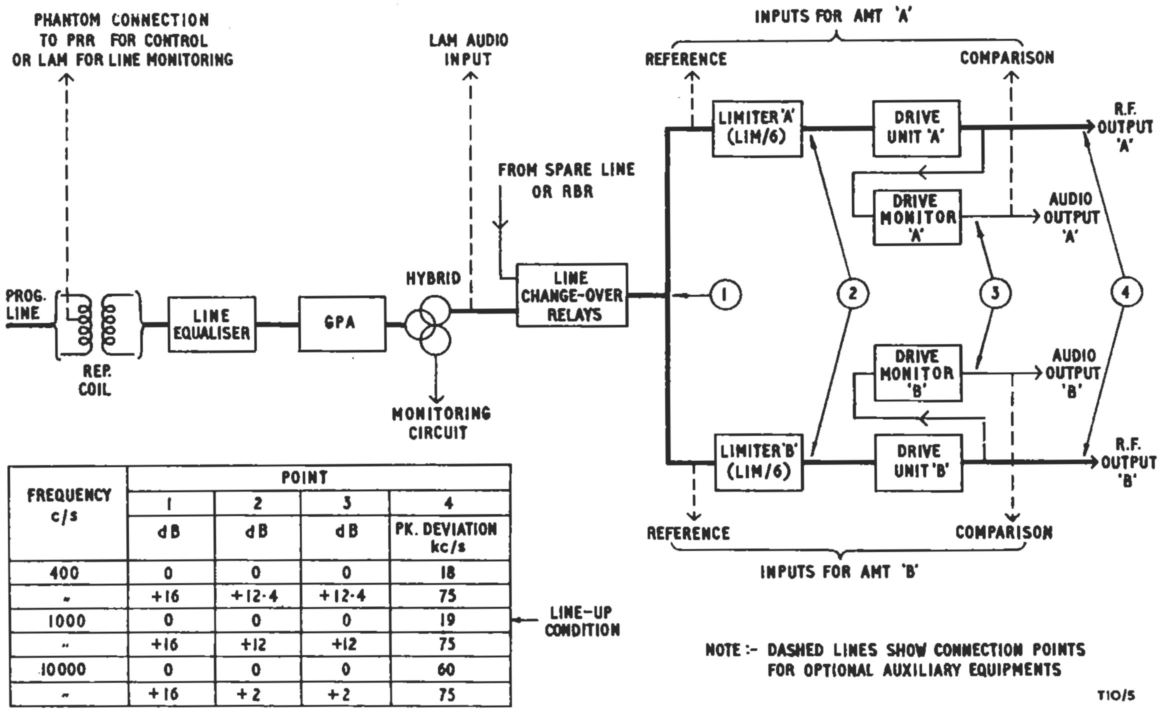
SINGLE-PROGRAMME TRANSMISSION AND MONITORING

Information in this Section refers to practices at stations using programme feeds taken by line, and details regarding the alternative use of receivers for taking programme are given in Section 5.

3.1 Programme Chain

Fig. 3.1 is a schematic showing the sequence of equipment in a typical programme chain. The diagram is largely simplified by omitting U-links fitted on a ULR/1 panel containing the line-switching relays. Links immediately precede the relay contacts in normal and reserve programme the reference-input terminals of automatic monitors (transmitter). Additionally the limiter outputs and comparison inputs for the automatic monitors (transmitter) are routed through links on the ULR/1 panel.

Reference was made in Section 2 to the use of a hybrid transformer for isolating a comprehensive checking circuit from the programme chain, and to the method in powering equipments from A and B sources to minimise the risk of complete loss of programme if the supply system is affected by partial failure.



FREQUENCY c/s	POINT 1	2	3	4
	dB	dB	dB	PK. DEVIATION kc/s
400	0	0	0	18
„	+16	+12·4	+12·4	75
1000	0	0	0	19
„	+16	+12	+12	75
10000	0	0	0	60
„	+16	+2	+2	75

Fig. 3.1 Simplified Block Schematic of Programme Chain

circuits, and others are intended for use in providing comparison and reference inputs, the latter from a phantom, to a line automatic monitor when employed. Alternatively where means of remote programme-switching are required the phantom is linked with a PRR/2 panel. The switched feed from the line relays passes to a pair of ' master ' links serving a buswire-distribution arrangement of other links for feeding limiters and, where required,

The required pre-emphasis of the a.f. signals takes place in the drive units, through circuits with an effective time-constant of 50 μsec in stages preceding the modulators. The process has to be taken into account to obtain suitable controlling action by the limiters, and is done by applying the same degree of pre-emphasis in their side chains. The limiters are used to restrict carrier-frequency swing to a maximum of 75 kc/s. As shown in the table with Fig. 3.1 the 1,000-c/s tone for line-up is at zero level, 12 dB below that for maximum permissible modulation, and corresponds to a swing of approximately 19 kc/s. The figures for other frequencies are intended to illustrate the effect of pre-emphasis on carrier-frequency swing.

Note that the swing values for point 4 in the diagram refer to drive equipments in which all cascaded multipliers for deriving carrier frequency are in advance of an automatic change-over panel which selects one drive for both transmitters. With the alternative arrangement in which switching precedes two final tripler stages, one in each drive, separately feeding the transmitters the swing values at the point mentioned are one-third of the given values. In this instance the carrier-frequency swing may be measured by feeding measuring equipment through a monitoring tripler. This is connected at the input side of the change-over switching, as also is the drive monitor in either of the two drive systems. Each monitor incorporates a de-emphasis network, and thus when an automatic monitor (transmitter) is used it is effectively supervising a section of programme circuit having a substantially level overall frequency-response.

3.2 Apparatus

The initial part of the chain is comprised of equipment types which are in general use and do not need special comment. The line amplifier is normally a Type-GPA/4A, details of this item being given in an Instruction dealing with Type-B studio equipment; refer to page 21.6 of Instruction S.3 (Studios, Volume 1). The accompanying circuit diagram shows the amplifier as usually produced, together with amending details of some slight modifications in the equipment when intended specifically for use at v.h.f. transmitting stations.

3.2.1 U-link and Relay Panel, ULR/1, ULR/1A and ULR/1B Figs. 1 and 2

The ULR/1 version of this panel is used singly with individual programme chains, so that three of these equipments are the normal complement for stations employing that type. An alternative arrangement for three-programme working is to use one each of the other two versions. The ULR/1A panel is designed with joint facilities for both Light and Third programme chains, and the ULR/1B panel provides those needed for a Home programme chain. The ULR/1B panel is utilised also for miscellaneous purposes in connection with tie lines and occasional-monitoring circuits, these facilities being severally provided at the Light and Home panels respectively where ULR/1 equipments are installed.

All three versions are constructed on a 19 in. by 7 in. hinged-mounting panel which is partly equipped to constitute a basic assembly. The assembly has a front cover which is suitably cut away to give direct access to that part of the U-link panel fitted with four horizontal rows of 28 sockets. To their right is a group of three lamp jacks, for use as required in signalling the operation of relays. A frame drilled to accommodate three relays is fixed opposite a cut-out section on the concealed lower edge of the U-link panel. Other internal fittings include a 40-way main terminal block.

The ULR/1 panels have no standard circuit arrangement. Each unit is equipped and wired for use with a particular programme chain at a given site, and for each station there is a set of P.I.D. drawings showing the arrangements for the three panels. A repeating coil and hybrid transformer are incorporated in each panel if it is on a bay at which incoming lines are terminated. In most instances, however, these items are placed with line terminating gear in a separate bay, as explained in Section 2. The differences between panels are chiefly in the provision for programme-source switching. Variations occur in the number of relays fitted for that purpose, and in the way the relay contacts are connected to give the desired form of control. The panels engaged with Light, Third and Home programme services at any one site have dissimilar operational features, and additionally the units employed with the same programme services at different stations are not necessarily identical in their means for control. The diversity prevents reference to typical arrangements, but the examples provided below in describing the ULR/1A and ULR/1B versions are illustrative of the general principles on which programme-source switching are based.

In a ULR/1 panel the selected programme feed is distributed on buswires to several pairs of sockets connected through U-links to A and B limiters and any other equipments as required. Each panel has a single U-link position which is used when necessary for extending an incoming phantom circuit either to a phantom relay receiving panel, as done when the phantom is used for remote control or to pass fault signals from a remote automatic monitor, or to a line automatic monitor. Circuits incoming to each panel include two carrying a.f. outputs of monitors in the associated

A and B drives, and two similarly employed in connection with monitors in the A and B transmitters. The drive-monitor feeds are intended for A and B automatic monitors (transmitter), where the programme chain is provided with these AMT/2 equipments, and the transmitter-monitor outputs are for quality-checking and test purposes.

Distribution and monitor-feed arrangements for individual services are essentially as described above where the ULR/1A and ULR/1B panels are in use as a complementary pair. Circuit diagrams of these panels are shown in Figs. 1 and 2, together with schematic diagrams giving supplementary details relevant to their use in a BA13/1 bay. The bay was described in section 2.2 (*g*). The diagrams show that U-link positions in the left-hand and right-hand halves of the ULR/1A panel (Fig. 1) are connected in circuits associated with Light and Third programme services, and corresponding halves of the ULR/1B panel (Fig. 2) are associated with Home service and the miscellaneous facilities respectively. There is no general rule regarding which programme chains shall be provided with automatic monitors (transmitter), their inclusion in the schematic diagrams being to show how these equipments are fed when employed.

Each relay in these panels has two windings which are separately terminated so that they can be severally energised with 50-volt A and B supplies switched concurrently through pairs of relay contacts in other units. In this way operation of a relay is ensured despite loss of either energising supply or a fault affecting one of the coil circuits. All four relays are normally energised, and thus their contacts are disposed as shown in Figs. 1 and 2.

An inter-panel connection of programme-switching contacts on relays A (Third) and B (Home) enables the Third Programme line to be used, when available, as a standby circuit for the purpose of maintaining Home programme feed. This applies particularly during unattended working in the Unguarded Hour, preparation for which involves selection of a remote-control condition under which the A and B relays become capable of operation. Selection is made with a switch on a phantom relay receiving panel, and results in an incoming phantom circuit being connected to two relays within that unit. These relays act as intermediaries by which the ULR relays may be operated from the distant control centre. They are arranged for alternative operation as determined by the polarity of a 50-volt supply applied to the phantom at the remote-control position. Their contacts are interconnected so that operation of one relay causes energising of relay B only, and operation of the other is attended by energising of relays A and B. The first state gives a programme-cut condition, and the second results in substitution of standby Home programme-feed present on the Third programme line and change-over of drives. Further details are obtainable from section 4.2.1(*b*) and Fig. 4.1 which, although referring to A relays in two ULR/1 panels, exemplifies the general arrangement for remote control.

Other contacts of relays A and B are used in signalling the alternative states available by remote control. Referring to Fig. 2 showing the ULR/1B panel, it is usual to (*a*) apply a 4·7-volt supply to one terminal of the lamp circuit, and earth the other terminal, and (*b*) connect contact B6 in a 50-volt supply for a System Normal relay in the control and indicator panel (CIP) associated with Home service. The programme-cut condition (relay B operated) is signalled by lighting of LP1 on the ULR/1B panel, whilst de-energising of the System Normal relay causes loss of a System Normal indication at the Home CIP. Referring to Fig. 1 showing the ULR/1A panel, it is usual to (*a*) apply a 4·7-volt supply to terminal 10, (*b*) connect contact A6 in series with the System Normal relay in the Third Programme CIP, and (*c*) connect contacts A5 and D4 in a supply for the Remote lamp on the phantom relay receiving panel. With reserve programme-feed in use (relay A also operated) lighting of LP1 on the ULR/1A panel gives supplementary indication denoting the particular condition, in addition to which there is loss of System Normal indication at the Third Programme CIP and extinguishing of the Remote lamp at the phantom relay receiving panel.

Relays C and D provide Light programme-switching facilities as for Home service, but the alternative states are obtained by operation differing from that of relays A and B. With relay-contact interconnection as shown by the schematic in Fig. 1 a transfer to reserve feed from a rebroadcast receiver involves operation of one relay (C) only, whereas programme cut-off is effected with both relays operated. For remote control, where required, the supplies of these relays are controlled in an RLP/31 unit by two relays to which an incoming phantom circuit is extended with the switch on the phantom relay receiving panel at Remote. The control system is similar to that in the above-mentioned Fig. 4.1, an E relay operating for phantom-positive voltages so as to make supplies for relay C, and an F relay operating for phantom-negative voltages to cause energising of relays C and D. Contacts C5 and D5 switch supplies to LP2 and LP3 signalling operation of the associated relays, contact C4 is used in series with the System Normal relay in the Light CIP, whilst contact D4 ensures interruption of the supply for the Remote lamp at the phantom relay receiving panel when the standby programme source is in service.

Although remote control is extensively used the relays in ULR panels are sometimes arranged for operation by local control, especially where Light programme chains are concerned. For instance the control may be exercised by use of the executive version (IAP/1A) of an integrating alarm panel; see section 4.2.2. With this equipment a transfer to reserve feed occurs automatically if fault signals fed to it from a line automatic monitor (LAM) become excessive. Whilst the foregoing description deals with the essentials of switching in ULR panels, more specific information on particular control arrangements at individual stations are provided in Part 2 of this Instruction.

3.2.2 Limiters, LIM/6 and LIM/6A Fig. 3

These equipments have identical circuits, the LIM/6 being mounted on a 22-in. panel and the LIM/6A on a 19-in. panel. They were produced specifically for use at v.h.f. transmitters and the electrical design is a modified form of that for limiters LIM/5 and LIM/5A. The 22-in. version has been largely superseded by the smaller unit, and in the title for the circuit diagram in Fig. 3 reference is made to the LIM/6A only so as to ensure that the component table is regarded as applying to the single type. Differences in some component types for the LIM/6 have no special significance.

A detailed description of the LIM/5 is given in Section 19 of Instruction S.3 (Studios, Vol. 1). The circuit differences for the later types can be summarised as follows:

(*a*) Higher input impedance to allow several limiters to be paralleled across a 600-ohm circuit.

(*b*) Provision of a fixed timing circuit associated with the detector stage in the side chain. This gives a timing condition corresponding with that at setting 1 of the timing switch on the LIM/5.

(*c*) The side chain is effectively given a response rising with frequency by taking the input through a pre-emphasis network. The purpose has been explained under heading 3.1.

(*d*) The side chain is fed from the output stage, instead of the first stage. This compensates attenuation due to change (*c*), but incidentally results in the limiting level being effected by the Output Level control setting. It involves a setting-up procedure in which (i) the Output Level control is used for gain adjustment *under the non-limiting condition*, produced at the fully-clockwise position of the Limiting Level control and (ii) the latter is turned to the desired setting. See Appendix A.

(*e*) An electrically-biased moving-coil relay is added to the cathode circuit of the first stage in the main chain. It operates when limiting occurs and is engaged in signalling through the indication panel described below.

3.2.3 Limiter Indicator Panel, IP/1 Fig. 4

This panel has three relay-and-lamp combinations employed separately to indicate limiting action by A and B limiters in one of the programme chains.

All three sections make use of common supplies, 50 volt d.c. for relay operation and 4·7 volt a.c. for lamps. The lamps are grouped behind a translucent window at the panel front, one to each of six sub-divisions marked with the number-letter references of individual limiters. At the right of the window is a test key whose opposite directions of throw provide for simultaneous testing of the indication circuits for the three A and three B limiters. The panel is interconnected with other panels giving remote-indication facilities. Fig. 4 gives complete circuit detail for the No. 1 (Light) section of the panel, and with this is tabulated information and notes concerning terminations for the identically-arranged No. 2 and No. 3 sections.

Fig. 3.2 is a simplified diagram for the purpose of explaining the operation. It depicts the interconnection of an A limiter on the Light programme with an A relay in the No. 1 section of the IP/1 panel, and also the means for remote indication. The B relay is included merely to show that its function with respect to a B limiter is identical with that for which details are given.

In setting up a limiter for use the Bias control is adjusted to give a total V1 and V2 cathode current of 16 mA. Internal relay A has coils which are opposed, and a current of about 15 mA is required through the biasing-winding circuit for a working condition. This is obtained by turning the Rel. Bias control until the moving contact of the relay is just touching an unwired fixed contact. Thus for the fall in cathode current occurring during limiting the moving contact travels away from the biased position to make an earth connection for limiter-terminal 8. Relay sensitivity is considered adequate if the contact closes consistently when tone input level is raised by 1 db above the value at which limiting is just starting, but this applies for an equal coil-current condition referred to in Appendix A.

Closing of contact A at the limiter causes energising of relay A in the IP/1 unit, and this the lamp circuits. The first-named contact makes lamp 1A dependent on a supply via D2, and because of cycling the lamp is extinguished at regular intervals instead of being continuously lit as in normal circumstances. The transfer by contact A4 provides for supplying the lamp at the ALP/7 panel either through D3, from the IP/1 lamp feed, or through E1, from the supply made available through the Monitoring Normal contact at the CIP/1 panel. (Note that the latter supply is usually connected to the remote lamp via unoperated contacts A4 and B4.) Consequently the remote lamp becomes extinguished only when both contacts are open, that is for the relatively short

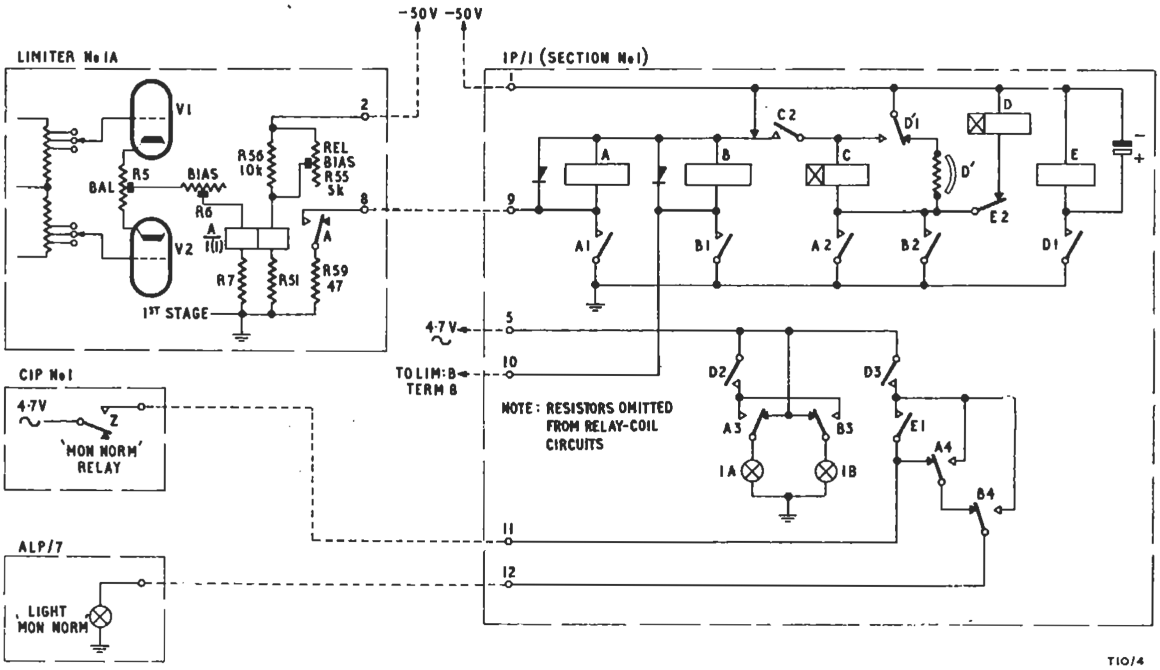


Fig. 3.2 Simplified Diagram showing Circuit for Signalling Limiter Operation

relay seals itself via A1. Contact A2 closes in the supply for a slow-operating relay D, which causes D1 to complete a supply for relay E. This relay also is slow-operating, due in this instance to voltage build-up in the large-value capacitor shunting the coil, and after a delay E2 interrupts the coil circuit of relay D. This marks the start of cycling action by relays D and E, each in turn being responsible for de-energising the other. The results consequent on this form of operation are illustrated in Fig. 3.3.

The operation of relay A is attended by transfer of contacts A3 and A4 to alternative positions in period of overlap when both D and E relays are de-energised, as shown in Fig. 3.3.

The warning flashes continue for about one minute, as determined by thermally-operated contact D'1 which, with a bimetallic element and heater, is attached to the body of relay D. The heater supply is made when relay A operates, and following a nominal delay of 30 seconds the contact is transferred so as to break the heater supply and cause energising of relay C. The composite contact C2 then operates to re-route the relay-A supply through D'1. That condition is maintained until the heated element cools sufficiently for D'1 to open in the relay-A supply. Then the indication equipment relapses to normal, assuming that the relay contact in the limiter is open.

3.3 Methods for Monitoring

The essentials of four methods for monitoring transmissions are represented in Fig. 3.4 Any combination of these methods may be in use for the programme services from one site, and in general more than one remote centre is concerned in the monitoring arrangements for a particular station. The latter is an outcome of consideration given to both programme routing and monitoring in evolving schemes for individual stations.

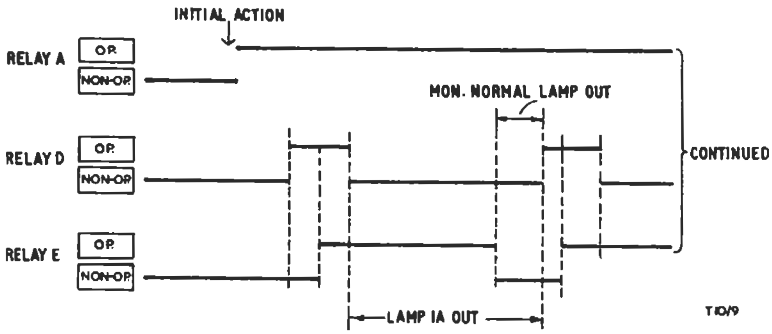


Fig. 3.3 Cycling Operation of Relays D and E in Limiter Indication Panel (IP/1)

Method (*a*) is one used largely in respect of Home Service, and it is usual to choose an attended medium-wave station as the radio-check point. Aural monitoring at this position may be done on a sequential basis, faults on transmission being reported to the v.h.f. station by telephone for most of the programme hours. A remote-control condition is selected at the v.h.f. station before staff leave for the overnight period (Unguarded Hour), to enable line and drive change-overs to be executed from the monitoring centre when necessary.

This overall checking by listening watch has an alternative in the arrangement shown by Fig. 3.4(*b*). An automatic monitor minor displaces the human monitor, to detect discrepancies between a reference input, from the input of the C amplifier feeding the v.h.f. site and a comparison input provided by a receiver incorporating de-emphasis and tuned to the appropriate transmission. Fault warnings originated by the monitor consist of interruptions to a 50-volt d.c. supply carried via the phantom on the associated programme circuit to alarm equipment at the transmitting station. Because the monitor is unable to appraise the line-derived reference input there is still a need for subjective checking. Thus the most convenient application is where aural monitoring is taking place in any event at some centre beyond the monitoring position so far as programme routing is concerned. To provide for an Unguarded Hour Condition some monitors are arranged to automatically effect remote change-overs as for method (*a*), when faults occur. Others are used simply to give local warnings during this period, and the changeovers are made by manual operation of switches at the monitoring centre.

Figs. 3.4(*c*) and (*d*) illustrate arrangements adopted if it is necessary to choose a monitoring station outside the service area of the v.h.f transmitter. Lack of radio checking is not of extreme importance in view of the extensive protection and alarm facilities employed with the transmitters and other plant excluded from these monitoring systems. Fig. 3.4(*c*) can be supplemented by referring to Fig. 3.1, in which connection points for the two monitoring equipments at the transmitter are indicated. The end product of processing in each set of LAM equipment is a d.c. output whose variations constitute information on programme volume and noise level at the take-off point. The apparatus at the transmitter includes a detector unit in which the local LAM output is compared with the remote LAM (reference) output. Any departure from coincidence, subject to a predetermined tolerance, is communicated to an integrating alarm panel which operates an alarm if fault signals occur sufficiently rapidly or are maintained. Reference has been made to using automatic monitors (transmitter) either executively or non-executively, and details of these functions are given with a later description of the equipment.

Method (*c*) is suitable when programme is

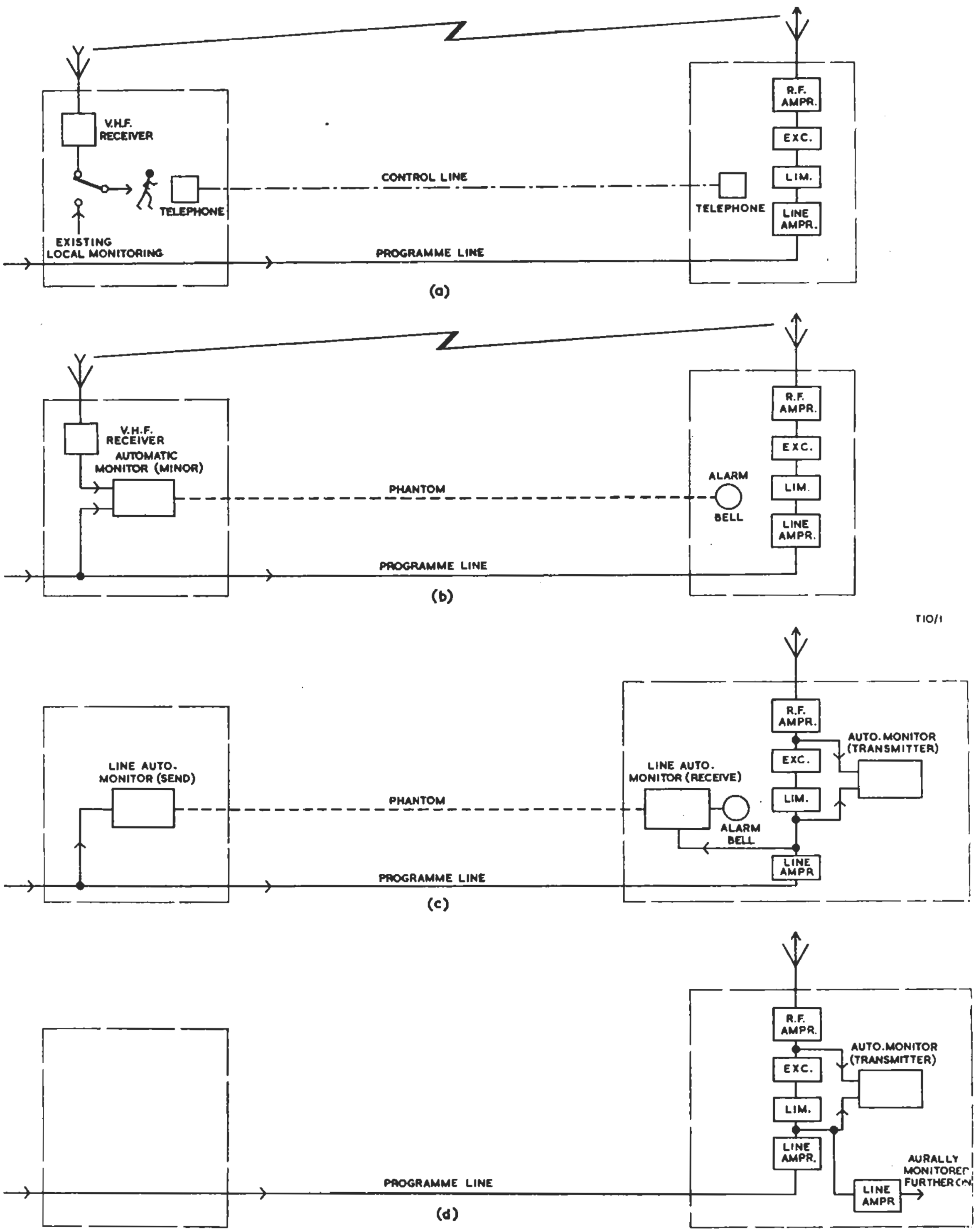


Fig. 3.4 Methods for Continuously Monitoring Transmissions

aurally monitored at a centre being fed through the monitoring station, except where the v.h.f. transmitter is intermediate to the aural-monitoring point. In this instance there is no need for line automatic monitoring, and the result is a simple arrangement as depicted in Fig. 3.4(*d*).

3.4 Apparatus

Of the several equipments mentioned in the preceding sub-section the Automatic Monitor Minor, AMM, is the subject of Section A, Instruction S.6. The following descriptions relate to the Automatic Monitor (Transmitter), AMT/2, and the various units which in slightly differing combination are the sending and receiving equipments of a Line Automatic Monitor, LAM. Operating instructions for this apparatus are given as appendices to this Instruction.

3.4.1 Automatic Monitor (Transmitter), AMT/2 Fig. 5

The monitor contains two comparators working over different volume ranges for the purpose of detecting amplitude inequalities between signals applied to reference and comparison input terminals. The unit is a development from the AMT/1 equipment for which a full description is given in Section B, Instruction T.8. The description includes an introduction dealing with the principles governing the design of this form of monitor, and therefore it is not intended to refer to such matters except as necessary to explain features of the particular equipment type.

A low-level comparator is used primarily to disclose undue differences in noise level at the two inputs, although to a limited extent it is also responsive to changes in compared signal amplitude over the low-level range. A high-level comparator is employed to detect non-linearity and reduction in compared-signal amplitude caused either by gain changes and/or variations in frequency response. The chief differences with respect to the AMT/1 equipment are (*a*) deletion of a rectifier for demodulating an r.f. feed to the comparison input terminals, and (*b*) addition of an integration circuit. Change (*a*) makes the unit generally suitable for feeding with two a.f. inputs which, in the application under consideration, are taken one from the limiter input and the other from the associated drive; see Fig. 3.1 and related description. In the drive monitor providing the comparison input is a de-emphasis network to offset the pre-emphasis present in the a.f. feed derived from the drive take-off point. The integration section receives fault signals from the comparators and has a discriminatory action such that an alarm condition occurs only for faults which are rapidly successive or continuous.

The unit is designed for mounting in 19-in. bays and has a panel depth of 10½ in. All controls, signal lamps, listening jacks for the two a.f. inputs and a metering socket for the comparators are centralised on a sub-panel cleared by a hole in the front cover. Inside the cover, to the left of the sub-panel, access is gained to sockets for metering valve anode-currents with a portable test meter; each socket is beside the valve with which it is associated. The unit contains seven relays, six in a vertical row at the centre front on the main panel and one, coded F, placed near the valve (V1) in whose cathode circuit the relay coil is connected. A 12-way plugging connector makes external connections, excepting the mains supply taken through a 3-pin plug and socket. Various d.c. supplies are all obtained through rectifiers in mains-conversion equipment producing valve-operating supplies, a.c. supplies for signal lamps and low-voltage d.c. supplies for the high-level comparator and miscellaneous purposes.

Circuit Description

The complete circuit diagram given in Fig. 5 shows pentodes V1 and V2 in amplifying stages for the reference and comparison inputs respectively. These basically similar stages differ in (*a*) provision for adjusting the input voltage for V2 only, and (*b*) purpose served by negative feedback circuits used with both valves. The V2 input controls comprise a switched Test Sens. potentiometer which is normally left at the 0 dB setting and an Adj. Comp. Prog. resistor, R1, in series with the potential divider. The first-named control is used only during testing of the unit, as means for readily ascertaining the degree of sensitivity by operation to reduced-input settings calibrated in decibels as marked in the diagram. The second control is for use in making the V2 input equal to that for V1.

In both stages the negative feedback is applied from the anode circuit to a resistor in series with the input-transformer secondary. V1 is given a constant feedback factor with C2, R9 and R10 to obtain a gain-frequency characteristic as level as possible. On the other hand the V2 feedback is aimed at promoting an output which rises from a middle-frequency minimum as both ends of the a.f. range are approached. The rise at low frequencies is imparted by C1 whose relatively small value ensures a feedback factor decreasing with falling frequency. The rise towards the high-frequency end of the range also is by progressive reduction of feedback, in this instance through the series combination of C9 and R13 shunting feedback resistor R12.

Separate output connections are taken from the anode circuit of each valve to both comparators. The ' weighting ' in the V2 response is required in the input to the high-level comparator only. This is done in consideration of aural-sensitivity effects making it possible for the compared signal to suffer greater reduction at the extreme frequencies than at middle frequencies; see Instruction mentioned earlier. The margin of tolerance for the high-frequency content of signals applied to the high-level comparator is effectively made greater than by V2 feedback alone, by the inclusion of L3 in the connection from the reference stage V1. A sensibly level frequency-response characteristic is needed in feeding the low-level comparator from V2. This is achieved by choosing a value for coupling capacitor C11 so that bass frequencies are suitably attenuated, whilst R20 in conjunction with the stray primary capacitance of transformer TR4 offsets the rise at high frequencies.

Inputs for the low-level comparator are applied from V1 and V2 through similar voltage step-up transformers, and appear on the grids of a double triode, V3A and V3B, as d.c. signals. These are obtained following limiting and rectification through components associated with the transformers. The V2 input, for example, is limited by two metal rectifiers, MR7 and MR8 across the primary of TR4, and R20 in series with the primary. At low signal levels the resistor has little effect on primary voltage, because of the high forward and backward resistances of the rectifiers. With increasing signal level the proportion of input voltage absorbed by the resistor gradually increases as the result of the fall in forward resistances of the rectifiers, and so limiting occurs. For the high signal-level condition the voltage developed on the primary is about 20 per cent only of the applied voltage. The d.c. signal is produced by metal rectifiers MR9 and MR10 connected in a full-wave arrangement to the secondary of TR4, and is negative-going at V3B grid. With the component values in this rectifier circuit the charge and discharge time-constants are approximately 10 mS and 50 mS respectively. A reference d.c. signal for V3A is derived as described above.

The V3A and V3B grids are biased slightly negative through R36 in a commoned-cathode return. Grid-signal excursions for these valves are restricted by the limiting on the input-transformer primaries to maximum values little greater than necessary for anode current cut-off. This obviates unduly prolonged periods of cut-off following bursts of high programme volume, an effect which would occur if the rectifier circuits, having relatively long discharge periods, were allowed to deal with input voltages much greater than required. A fault-signalling relay B/1 has two windings connected one in each anode circuit, the magnetically-opposed sensing of the coils providing for operation of a change-over contact from normal in the presence of anode-feed unbalance. Further reference to the relay is made later. Individual anode feeds are measurable at sockets associated with shunts R34 and R35, making use of the two-pin connector from a 0/100-μA meter in the portable test meter PTM/6. Static balancing of the comparator is carried out with the four-pin connector of that instrument in a Bal. Meter socket for connecting two 100/0/100-μA meters at corresponding bridging points in both comparators. The meter for the low-level comparator is placed between junctions formed by two resistors in each anode circuit, as shown by the Noise Ind. titling in Fig. 5. The resistors comprise R29 and R31 which assist in development voltage swings suitable for meter operation, and R32 a variable type used with R33 in providing for balance adjustment. The value of R33 in the V3B circuit is practically half that of the variable R32 in the V3A circuit, and thus the single V3 Bal. control is given equal ranges of compensating adjustment to either side of the nominally correct midpoint setting.

The high-level comparator uses a high-speed relay A/1 with two windings arranged for separate energising by d.c. obtained through rectifying the inputs from V1 and V2. Limits are imposed on the volume range over which comparison is made by the use of two mains-derived supplies for ' backing off ' purposes. They are provided from full-wave bridge rectifiers, MR13 giving a 14-volt supply as measured across a loading resistor R45, and MR14 an output at 50 volts. Note: Mean values are quoted for these voltages, the 14-volt circuit including a resistor for voltage adjustment and the 50-volt rectifier has a permissible output-voltage tolerance of $\pm$ 5 volts. These two sources are connected in series, with the 50-volt positive terminal earthed, and a three-point connection is made with the symmetrically-disposed components forming the two halves of the comparator.

Taking the reference section as an example, V1 provides an input for a full-wave rectifier MR5 biased in the non-conductive direction by the 50-volt supply applied via the relay winding and earth. Thus, with conduction prevented until the input-signal amplitude exceeds the bias voltage, a lower limit for the range of comparison is established. The rectifier circuit has charge and discharge time-constants of approximately 5 mS and 50 mS respectively. An upper limit for the operating range is determined by the effective voltage from the 14-volt rectifier, as developed across R45 and applied in series with half-wave rectifier CL1 to the ends of the relay winding. The polarities for this supply also are in the reverse sense making the rectifier non-conductive until the relay-coil voltage due to the applied signal rises above that on R45. At the onset of conduction the relay winding becomes paralleled by the relatively low forward-resistance of CL1, ignoring the small bias-source impedance, and then the inverse voltage/resistance characteristic of the rectifier provides limiting ensuring virtually no increase of coil current for higher values of sigi al-derived voltage. Relay A/1 is designed to operate a change-over contact when current predominates in a particular winding, that being the one connected in the reference section of the comparator.

The comparator has two pre-setting controls, one a variable resistor R46 (Raise Lim. Point) for adjusting the voltage on R45 and so determining the upper-limit voltages for both reference and comparison sections. The other is variable resistor R26 (Increase Sens.) in series with R27 between the non-common ends of the two relay windings. These components constitute a bridging circuit through which current flows during unbalanced states only, the control providing for adjustment of the shunting effect the degree of which is reflected in the apparent sensitivity of the relay. In parallel with this circuit is a socket position (High Mod. Ind.) for attaching an external meter, as described earlier, when making balance measurements.

The means for integrating fault signals are dealt with below as part of a sequential description of relay operation following the switching-on of the equipment. First to operate is high-speed relay F, when the cathode current of V1 has achieved a substantially normal value. This results in change-over contact F1 transferring an earth from the anode circuit of V5, a cold-cathode diode stabiliser, to a lamp LP1 (V1 Cathode Current) and so causes it to light. Removal of the earth from the V5 anode circuit allows C17 to start charging via R41 from a potentiometer junction, R37 and R38, across the h.t. supply. When the voltage across the capacitor rises to the value at which V5 strikes, high-speed relay C is operated to seal itself on the h.t. supply through contact C1. The C1 contact is also responsible for completing the supply to relay G, thus causing contact G1 to close and earth R42 by which the anode voltage of V5 is reduced to a very small value, to terminate the discharge in that valve. Contact G2 makes a supply for lamp LP5 (Delay), whilst G3 makes in a 50-volt supply taken from an external source for relay D. If this supply is present, as normally will be so, relay D operates and causes D1 to transfer an earth from R49, in the grid circuit of cold-cathode thyratron V4, to lamp LP3 which lights to signal the establishment of a working condition. Concurrently D3 makes a supply for operating the thyratron, whilst D4 and D2 close in circuits marked System Normal and Monitoring Normal in Fig. 5. These titles are added to the diagram for ease of reference to the similar relay-contact arrangements whose function, and the external control of relay D, is dealt with under heading 3.4.2. The delay between the lighting of LP1 (V1 Cathode Current) and lamps LP3 and LP5 should be 80 seconds ± 40 seconds.

An h.t. supply for V4 is obtained by connection with the centre point of an h.t. winding feeding a bridge rectifier providing the anode supply for all other valves. In this separated arrangement the MR12 section of the bridge rectifier gives full-wave rectification of the V4 supply. Fault signals from both comparators are integrated by using the A and B relay contacts to switch the thyratron h.t. supply to a CR timing combination in the grid circuit of V4. Operation of either the A or B relay causes the appropriate contact first to break a short-circuit on LP2, lighting to signal a Fault condition, and then switch the h.t. via R48 to C22 in the grid-cathode circuit of V4. With an initially uncharged capacitor the period required to charge C22 to grid striking-voltage is from 1·5 to 2 seconds. Provision is made for a relatively slow cancellation of partial charging due to infrequent faults of shorter duration by paralleling C22 with a high-value resistor R50. If V4 strikes, relay E in the anode circuit becomes operated to seal itself independently on the h.t. supply via contact E4, and an Alarm indication is given due to E2 making a supply for LP4. Contacts E1 and E3 open in the

50-volt control circuits mentioned earlier, their action being explained below. The locked condition of relay E can be cancelled by pressing Reset switch (SWB), opening of which causes de-energising of relay D. This, through contact D3, breaks the thyratron supply and allows relay E to relapse to normal, whilst at the same time contact D1 is responsible for rapid discharge of C22 through R49.

3.4.2 AMT/2 Control and Signalling Facilities

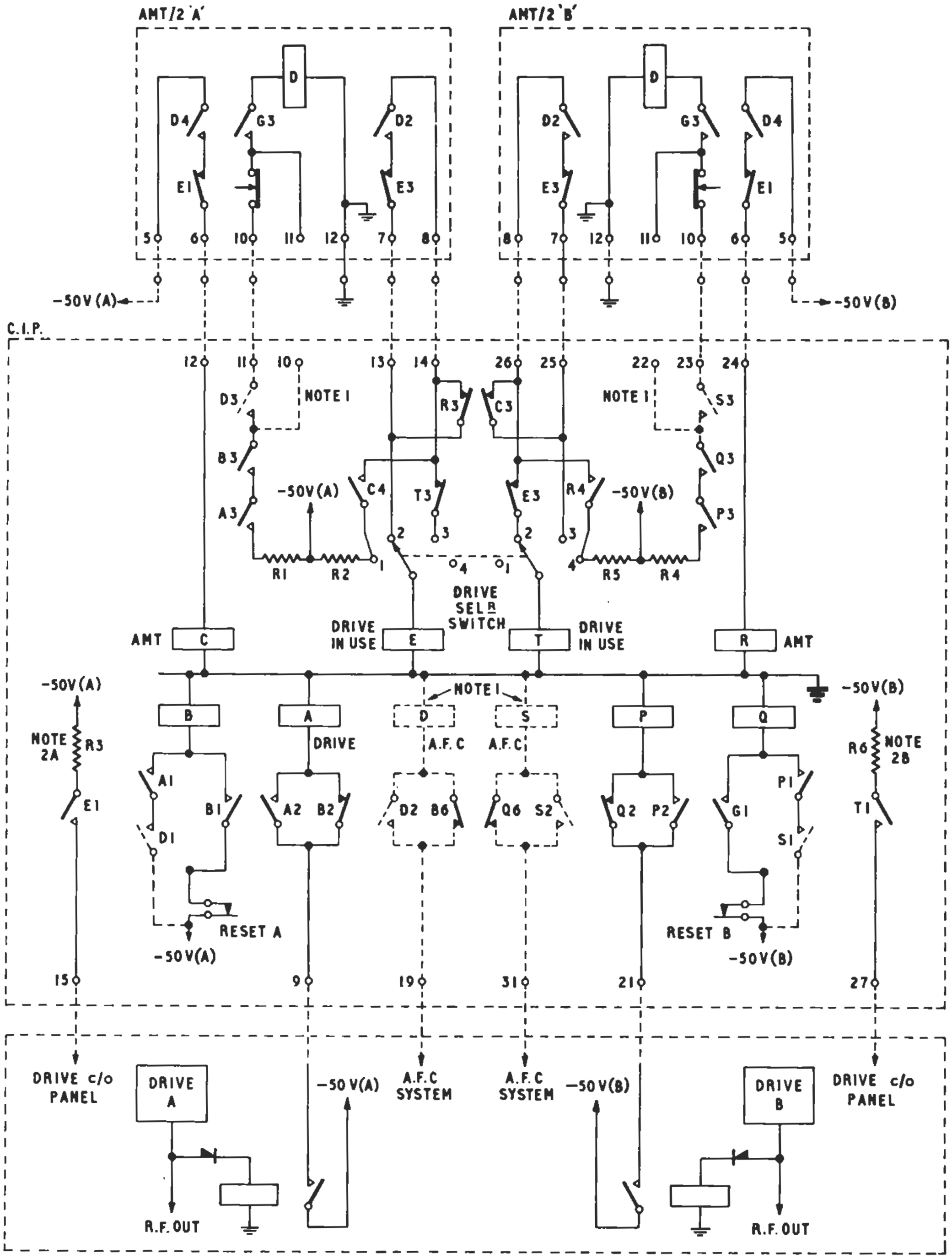
(a) Executive A.M.T. Arrangement

When used to initiate drive change-overs under fault conditions the A and B monitors of a programme chain are connected to the associated control and indicator panel as shown in Fig. 3.5. The details for the control panel in this diagram are given compositely to illustrate alternative circuit arrangements for the two types in general use. One is the CIP/1 panel used largely with M.W.T. drive installations, and the other is the CIP/1C panel normally employed with S.T.C. drive equipments, in which provision is made for automatic frequency-control. With respect to the first type the only differences in the second are (*a*) deletion of limiting resistors (R3 and R6) from drive change-over relay circuits, and (*b*) addition of two relays (D and S) working with the a.f.c. systems. To draw attention to these differences the components used in one type only are indicated by dashed lines in Fig. 3.5, and explanatory notes are given with the diagram. There follows an operational description concerning the CIP/1C panel, and from this it should easily be possible to appreciate the control exercised through the alternative type.

Each drive equipment includes an output-monitoring relay fed through a rectifier, and this switches a 50-volt supply to the CIP provided output is adequate. With drive A, for example, the initial connection of this supply causes energising of relay A, first via B2 and then through A2 also in preparation for the latter acting as a sealing contact. A1 makes in the relay-B circuit and A3 closes in the extension to the relay in automatic monitor A. Relay D is energised through a limit switch fitted on the a.f.c. capacitor in the drive, and its operation results in D1 making the supply for relay B. Then B1 closes as the subsequent means for sealing relay B, whilst B2 and B6 open to leave relays A and D dependent on their sealing contacts. Meanwhile, closing of D3 and B3 completes a 50-volt supply for relay D in monitor A. This relay operates and establishes a normal working condition, one of the several D contacts switching an h.t. supply to the thyratron used in fault signalling; details of relay operation in the monitor are given in the preceding sub-section. Subsequent loss of drive output produces a lock-out condition, relay A being tripped without disturbing the operated state of relay B, maintained through B1. At that time the automatic monitor is made ineffective as a consequence of A3 opening. To de-energise relay B requires momentary operation of a key on the CIP to a Reset A position, which enables a relay-operating sequence to occur as described, when drive A is restored.

As relay D in the monitor operates, D4 makes a supply for relay C, and D2 closes in a circuit extending to a Drive Selector switch on the CIP. Positions 1 and 4 of the switch are for selecting individual drives, each setting giving direct connection of a 50-volt supply to one of the two Drive in Use relays (E and T). Through contacts E1 and T1 these relays are responsible for switching 50-volt supplies to co-axial relays at the drive change-over panel for the purpose of connecting either drive to the two transmitters. For executive working, however, the switch must be placed to either position 2, making drive A the primary source, or position 3, with drive B as the primary source, to obtain co-ordinated control required for automatic change-overs.

At position 2, as shown in Fig. 3.5, a supply for CIP relay E is made via C4 and contacts D2 and E3 in the monitor. In the CIP the closing of E1 causes drive A to be switched to the in-service condition, whilst opening of C3 prevents operation of relay T. If integration of fault signals by monitor A is sufficient to operate the internal relay E, that relay locks itself through a sealing contact, and E1 and E3 open to de-energise CIP relays C and E respectively. This results in a drive change-over taking place as CIP relay E relapses to normal, contact E1 opening to initiate disconnection of drive A, whilst in monitor B an E3 contact makes to energise relay T causing T1 to effect connection of drive B. The transfer can take place only if monitor B indicates the drive is prepared for duty. If this is not so neither drive can be switched to the transmitters, and other contacts of relays C and R in the CIP are arranged to break the transmitter remote-start circuits, incorporating the time-switches, so that the transmitters are shut down. When the drive fault is cleared the resetting of the monitor is done by using its push-button switch to unseal monitor relay E, as explained under 3.4.1.



NOTES: 1 D & S RELAYS IN CIP/IC UNITS ONLY
D3 AND S3 SHORT-CIRCUITED IN
SOME EQUIPMENTS

2A } USED IN CIP/I UNITS ONLY
2B } R3 = 300 Ω R6 = 680 Ω

DRIVE SELECTOR SWITCH

POSITION		
POSITION	1	A
"	2	A OR B
"	3	B OR A
"	4	B

T10/10

Fig. 3.5 Circuit Arrangement for Drive Change-over Control through Automatic Monitors (Transmitter)

Titles beside a number of relays in Fig. 3.5 are the legends marked on the indication panel of the CIP. Behind each legend is a lamp to which a supply is switched by a contact of the associated relay when operated. Additionally the relays E and T have change-over contacts in a System Normal signalling circuit, referred to under heading (*b*), and they are interconnected to provide a path when either relay is operated. Note: Some CIP/1C units have the contacts D3 and S3 effectively deleted by strappings between terminals 10–11 and 22–23. terminal 10 of the unit and therefore controlled internally only; refer to Fig. 3.5.

For signalling purposes the corresponding D and E contacts in both monitors are linked to form two similar series circuits controlling relays M (System Normal) and Z (Monitoring Normal) at the CIP. The separate operating supplies may be connected as in Fig. 3.6, but are more usually routed via signalling contacts in associated equipments of other types. The diversity in practical arrangement precludes giving details at this stage, but reference is made to other signalling contacts in later

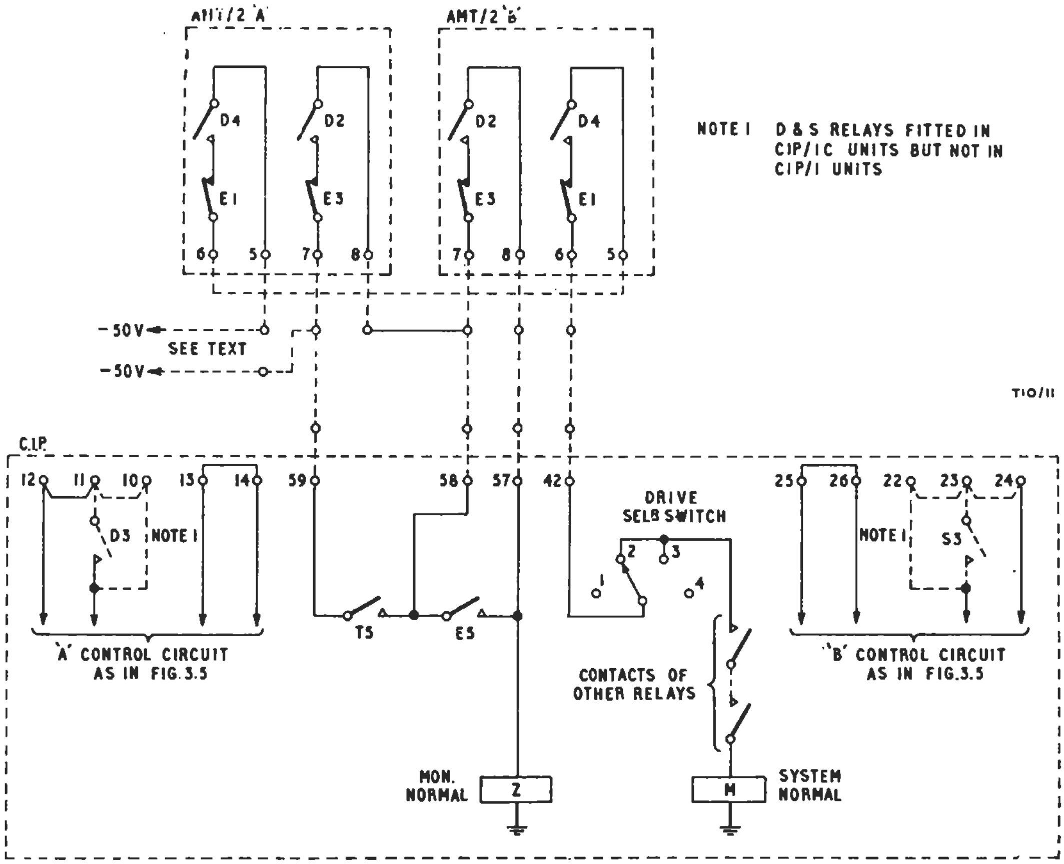


Fig. 3.6 External Connection of Automatic Monitors (Transmitter) when used Non-executively

(b) Non-executive A.M.T. Arrangement

Fig. 3.6 is patterned on the preceding diagram to emphasise circuit differences in connecting a pair of AMT/2 monitors as non-executive equipments to a control and indicator panel, CIP. The coil circuits of D relays in the monitors are not shown as a 50-volt supply (5A) for each is fed directly to descriptions of the various equipments. Energising of the System Normal relay depends on both monitors being fully operative, assuming the Drive Selector switch is at one of two settings providing for automatic drive change-over; the switch is part of a ganged combination including the sections depicted in Fig. 3.5. A Monitoring Normal indication simply requires a normal condition in the monitor associated with the working drive, contacts E5 and T5 of the Drive in Use relays being alternatively responsible for short-circuiting the contact in the standby monitor.

Taking into account the minor circuit differences as explained under 3.4.2(*a*) the CIP/1 and CIP/1C equipments have terminals strapped as in Fig. 3.6 when non-executive monitors are used and there is no provision for remote switching of drive outputs; see special note below. From Fig. 3.5 it can be seen that this results in relay C being controlled by A3 and B3 contacts, and also if required by contact D3 in CIP/1C equipments, relay R being similarly controlled through equivalent contacts associated with drive B. This, and the terminal strapping 13–14 and 25–26, alters their primary purpose to that of causing drive change-over by action of to the bay terminal connected with CIP terminal 42. External switching contacts are introduced between terminals 13–14 and 25–26 when provision is made for remote control of drive change-over.

3.4.3 Line Automatic Monitor, LAM Figs. 6 to 11

The Line Automatic Monitor constitutes a development from the Automatic Monitor Minor described in Instruction S.6. It consists of two sets of rack-mounting equipment separated by the circuit for which monitoring is desired. One is a Line Monitor Bay (Send), LMBS/2, and the other is a Line Monitor Bay (Receive), LMBR/2, at the source and destination ends respectively of the monitored circuit. The essential arrangement of the system is given by the block schematic in Fig. 3.7.

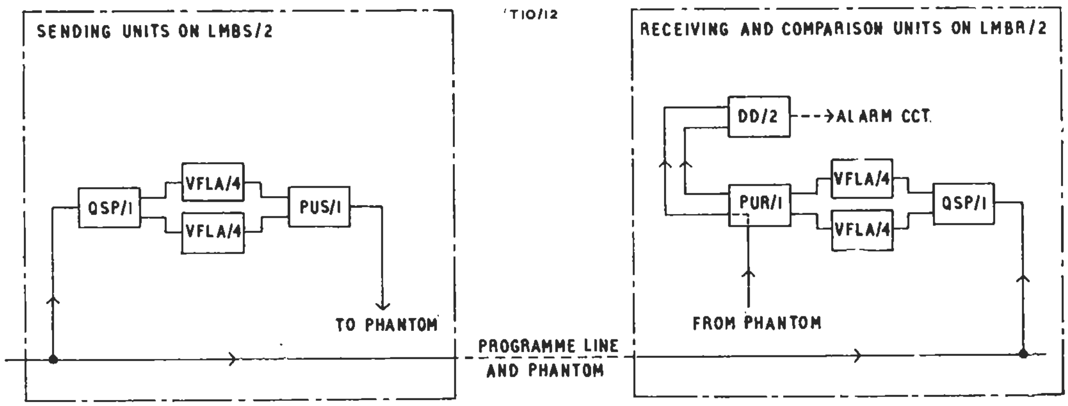


Fig. 3.7 Schematic of Line Automatic Monitor, LAM

relays E and T, when the working drive fails. This operational change is covered by marking the indication-lamp positions for relays C and R with the title Drive, instead of AMT, and Drive indications as given through relays A and P in panels used with executive monitors are deleted.

Special Note: The information on the CIP applies also if AMT/2 units are not included in the single-programme apparatus. In this event the CIP terminals 57 and 59 are linked by strapping the corresponding bay terminals, and a 50-volt supply is passed through contacts in any other units requiring a Monitoring Normal indication. Usually this is done for at least an Integrating Alarm Panel, IAP/1, but there are a few instances where even this equipment is not used and so relay Z is unconnected. For the System Normal circuit a 50-volt supply is taken either directly or indirectly

The method is to derive processed signals relating to programme at both points, for continuous comparison with one another in a unit from which an alarm is issued for disparities exceeding predetermined limits. The comparison takes place at the receiving end, the signal from the remote equipment being transmitted through a phantom circuit and regarded as the reference to which the signal is compared. In the application under consideration the sending equipment is connected across the input to the line amplifier feeding the transmitter site, and the receiving equipment shunts the circuit between the incoming amplifier and the A and B limiters. An earth phantom is employed, with the programme circuit acting as one leg through centre-point connection with the line repeating coils. At the sending end the reference signal is taken via a Phantom Relay Sending

Panel, PRS/2, to line, and at the receiving end a direct connection from the repeating coil is taken to the LMBR/2 bay. The PRS/2 panel does not form part of the LAM; references to various versions used at monitoring centres are given in Part 2.

To obtain the processed signal the programme feed is applied first to a Quadrature Splitting Panel, QSP/1, which provides separate inputs differing in phase by 90 degrees for two Volume Folding and Limiting Amplifiers, VFLA/4. The purpose in this split feeding of two amplifiers is to counter the effect on the programme envelope of any phase distortion which may occur in the line.* Each amplifier is a multi-stage unit with a non-linear input/output characteristic and a weighted frequency response, the output being a positive-going d.c. voltage fluctuating in sympathy with programme volume up to a maximum of 100 volts. At the sending position the two outputs are combined with each other and a stabilised 50-volt d.c. supply in a Phantom Sending Unit, PUS/1. The d.c. supply is added to give backing-off whereby the phantom-transmitted signal has an intermediate datum for voltage excursions ranging between −50 volts and +50 volts. As a further precaution against unduly stressing the line the PUS/1 unit contains an overload trip acting for excessive positive voltages with respect to earth. Because line feeding is not involved such measures are unnecessary in the Phantom Receiving Unit, PUR/1, but the equipment includes an artificial phantom whose electrical length can be adjusted to simulate the condition to which the remote-point signal is subject. Thus virtual symmetry of arrangement is obtained in the feeding of processed reference and compared signals to constituent halves of a Differential Detector, DD/2, which is adjusted to operate an alarm for a difference of 10 volts between the two inputs.

The discontinuous characteristic of the VFLA/4 equipment is achieved by limiting so that high gain is provided for low-amplitude inputs and low gain for high-amplitude inputs. With the added effect of weighting, the output of this amplifier-detector is made dependent on both the magnitude and frequency of an applied signal. Additional weighting is incorporated in the QSP/1 unit, to give a falling low-frequency response. These are the means of providing the monitor with a predetermined variation in sensitivity to differences in programme-feed content at the monitoring points. Attention is directed particularly to detecting changes in transmission equivalent, and of undue differences in noise level at the low-volume end of the range, suitable allowances being made for the degree of objectionableness of frequency-components in the noise spectrum. This brief reference can be augmented from Instruction S.6, the introductory pages of which deal at length with the several factors requiring consideration in designing a basically similar type of monitor.

Each group of equipments is completed with a Mains Unit, MU/51A, used in conjunction with a Supply Distribution Panel, SDP/2. All units are assembled on 19-in. panels, hinged for the operational equipments excepting the QSP/1 which, like the mains unit, has a fixed panel with a shallow back-cover. These mechanical-design features are to enable the apparatus to be placed on either front or rear of a 19-in. double-sided mounting rack.

The inter-connection of units is done entirely with plug-and-socket connectors, including the provision of h.t. and l.t. supplies, via the distribution panel, for the QSP/1 and two VFLA/4 equipments. The PUS/1, PUR/1 and DD/2 units have internal mains-operated power supplies, the first two items being equipped also with switched metering facilities. Metering for the other operational units is provided through sockets connected with shunts suited to the use of a portable test meter, PTM/6.

Fig. 6 shows the inter-unit connection and wiring to bay terminals for the sending and receiving equipments, and also indicates the relative positions of individual units. The use of the words Upper and Lower is the approved means for distinguishing between two VFLA/4 equipments.

Line Automatic Monitor Units

(*a*) *Quadrature Splitting Panel, QSP/1 Fig. 7*

This panel carries a single-stage amplifier using an EF50 pentode in producing two output voltages with a 90-degree phase difference. With the circuit as given in Fig. 7 the requirement is met substantially for a range of frequencies from 40 c/s to 2 kc/s, above which the maintenance of quadrature is not essential.

The amplifier has a high input impedance (10 k), the input being balanced for connection across a programme circuit and incorporating U-links readily accessible when the front cover of the unit

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* A detailed account of this phenomenon is given in Proceedings of the Institution of Electrical Engineers, Vol. 98, Part III, No. 55.

is removed. The input-transformer secondary is loaded with a variable potentiometer, R1, in series with which is C1 with a value causing progressive loss at low frequencies, from about 500 c/s downwards. This Input Volume control is normally left at a setting marked 0, intermediate to −5 dB and +5 dB limits of a range covered in 0·5 dB steps. The control is fitted for testing purposes only and must not be used to compensate a departure from normal input at zero volume. The 1,000-c/s voltage gain at the correct setting is 0 dB from the input to either output. Negative feed-back is provided by applying the output of V1 to a fixed potentiometer, the R3 portion of which developes a voltage in series with the grid-input voltage. Phase shift for unbalanced high-impedance outputs is obtained with CR networks interposed between two output-transformer secondaries and terminals for separately feeding the upper and lower VFLA equipments.

Operating supplies for V1 are drawn from the mains unit on the bay, and a socket on the exposed panel at the front of the unit carries a socket for measuring anode current.

(*b*) *Volume Folding and Limiting Amplifier, VFLA/4 Fig. 8*

This amplifier makes alternate use of CV138 and EF55 pentodes in four cascaded stages, the last feeding a full-wave rectifier circuit employing a CV140 double-diode for deriving a d.c. output. The same type of diode is used in three limiters, and at the centre of the amplifying chain is a CR network giving the required frequency-response shaping. The h.t. supply is utilised to provide bias for use with the limiters, this being stabilised by a 150B2 gas-filled voltage stabiliser connected to the h.t. circuit through a dropping resistor. The circuit diagram of the equipment is shown in Fig. 8.

An input from the quadrature splitting panel is applied through a 1 : 1 transformer to V1, in a conventional circuit arrangement but with R9 in the cathode circuit for the purpose of injecting feedback. The feedback voltage is obtained from the anode of the following valve V3, through a potential-dividing circuit with an upper arm represented by R15. This resistor is paralleled with a limiter valve V2, connected also to a series of resistors loading the stabilised bias supply so that the anode of each diode is negative with respect to the associated cathode. The individual diodes have equal bias voltages developed one across R12 and the other across R13, to prevent conduction until the a.c. voltage on R15 exceeds the d.c. value. With R15 having a much larger value than R9 the feedback factor remains comparatively small until the V3 output voltage attains a certain value, marked by a sudden large increase in feedback due to the diodes conducting. The effect of this transition is to level-off the peaks of signals from V3, one diode being responsible for clipping positive half-cycles and the other acting similarly on negative half-cycles.

The coupling between V3 and the following stage, V5, includes a parallel-T network with a cross-over point near the lower limit of the audio range, and also C13 whose small value introduces some attenuation at low frequencies. In view of the use of a frequency-shaping network the placing of a limiter in a feedback circuit is not practicable and the second limiter using V4 is shunted across the V5 input. This limiter circuit resembles that in the feedback circuit apart from the use of a resistor, R31, in series with the diodes for the purpose of moderating the limiting action. The third limiter containing V6 works as a feedback control with V5 and V7, the entire circuit arrangement being closely similar to that for the initial amplifying stages. The V7 output is coupled by choke and capacitor to a 1 : 1 transformer with the secondary feeding double-diode V8 in a full-wave rectifier balanced to earth. Rectifier loading is provided in the next equipment, either a PUS/1 or PUR/1, where the outputs of two VFLA's are combined as described under heading (*c*). For the loaded condition the amplifier delivers a maximum d.c. output at 100 volts.

One sub-panel inside the unit carries the input and output U-links, and another is fitted with the two jacks for making test measurements at the outputs of V5 and V7. In the line with the latter are four anode-current metering sockets, whilst near the U-link panel is a socket for measuring the stabilised-bias voltage. The power supplies are obtained from the MU/51A unit as indicated in Fig. 6.

(*c*) *Phantom Unit* (*Sending*), *PUS/1 Fig. 9*

This unit employs two parallel-connected EF55 valves in a cathode follower, serving as a transforming device to obtain the relatively low impedance needed for working into the phantom circuit. The method in combining two processed inputs, and measures for minimising voltage stress on the line, necessitates use of an unearthed h.t.

supply, provided from internal power-supply gear and limited to 250 volts for safety reasons. Additionally a 50-volt stablised d.c. supply, positive earthed, is required and this is obtained from an external source. The complete circuit is given in Fig. 9 but reference will be made first to the simplified diagram in Fig. 3.8. showing the main features of the unit.

The two processed-signal sources are joined in a series-aiding connection making use of four equal resistors as shown, with the result that half the output voltage of each VFLA is employed usefully as a contribution to the cathode-follower input. This applies for normal working but provision is made for feeding from either VFLA, in which event the necessary switching transfers the 'idle' resistor, R_B or R_C, into the grid–cathode circuit. In this way the whole output of the single VFLA is utilised and the input-signal excursion has the same maximum as with combined-source operation.

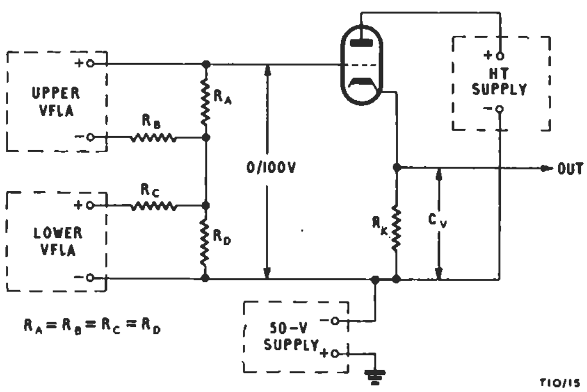


Fig. 3.8 Simplified Circuit Diagram for Cathode Follower in Phantom Unit (Send), PUS/1

The symbol C_v in the diagram represents the voltage across R_k for the static (no-signal) condition. Thus with a positive-going input up to the stated maximum and the 50-volt d.c. supply introduced as shown the voltage on the phantom ranges $(-50 + C_v)$ volts and $+50$ volts. Since C_v is nominally 18 volts the no-signal phantom voltage is about -32 volts. The unit includes a tripping circuit operating for excessive positive voltages; see below.

Figure 9 shows the U-links by which either or both VFLA outputs can be connected to the cathode follower. The links are mounted on an internal panel, and with them is a single link for connecting the cathode–follower output to the phantom circuit. Preceding this link is a low-pass filter, comprising L2, L3 and C5, for the purpose of restricting the effective response of the unit to the band from d.c. up to 50 c/s. Also in series with the output is a relay contact (B1) for breaking the connection to line in the event of an over-voltage condition.

The tripping circuit makes use of a thyratron, V3, with relay RLD in the anode circuit and relay RLA in series with a connection from the h.t. circuit to the grid. When supplies are initially switched on the small flow of current from the striker (grid) of V3 to the earth line causes RLA to operate, contact A1 closing and completing a 50-volt supply for relay RLB. Then B1 makes to switch the cathode–follower output to line, B2 makes to connect the output via coil RLD to V3 anode, B3 makes to energise RLC which operates to seal itself through C1, and B4 opens in a supply for the Phantom Trip lamp LP1. Although C2 opens, RLB is kept energised through the late-make sealing contact B5, and the protective circuit is then set up for normal working with RLD only unoperated.

Action by RLD arises from excessive positive voltage on the phantom, a value of approximately 70 volts being sufficient to cause anode-cathode discharge in V3. Then D1 opens to de-energise RLB and a Phantom Trip indication is given as the relay relapses to disconnect the cathode-follower from both line and the V3 anode circuit. D1 re-closes as soon as this happens but in the short open period RLB becomes locked out due to B5 opening. Cancellation of the indication and reversion to normal requires operation of Reset switch to energise RLB until it seals itself through B5.

The front panel is equipped with two meters and multi-position switches providing comprehensive measurem'nt. The joint facilities comprise measurement of *(a)* supply voltages, *(b)* individual V1 and V2 anode feeds, *(c)* balance of cathode-follower stage, *(d)* grid current in thyatron V3, *(e)* individual VFLA outputs, *(f)* balance of VFLA outputs and *(g)* phantom current. The metering circuits shown in Fig. 9 have straightforward arrangement apart from means for preventing readings under heading *(e)* being obtainable if the equipment also happens to be set for purpose *(f)*. This is to avoid a shunting effect and involves a series connection of banks SWAc and SWBc on switches associated with M1 and M2 respectively. It necessitates placing

SWA, on the left, to any position except that marked VFLA Bal. to be able to use M2 and SWB, on the right, at settings marked VFLA Upper and Lower. The latter markings are in red as a reminder of this special operational requirement. One setting of SWB makes connection between M2 and an Ext. Feed socket, for which an extension lead is provided, to allow measurements to be made at the test points on the QSP/1 and VFLA equipments.

(*d*) *Phantom Unit* (*Receive*), *PUR/1 Fig. 10*

The circuit details for this equipm nt, Fig. 10, show an arrangement similar in all comparable respects with those for the PUS/1 unit.

The over-voltage protection circuit is deleted because line transmission is not required, and for the same reason an artificial phantom network is placed after the cathode follower. This enables the condition applying to the sending-equipment signals to be approximately simulated, by using a suitable number of the iterative sections formed by series resistors, R37 to R49 ,and shunt capacitors, C1 and C14. During installation an adjustment is made on the basis of connecting one capacitor in circuit for each 180 ohms of true-phantom resistance, the first in any required number being C8, electrically next to the output terminal, and continuing backwards towards the cathode follower.

On the internal sub-panel holding the VFLA Selector U-links is a Phantom Tap U-link through which the sending-end signal is passed on to the following unit (Differential Detector, DD/2). In series with the link is R51 providing for measurement of the incoming-phantom current. This is the sole addition to switched-metering facilities which, apart from the omission of an unwanted V3 grid-current position, are like those described for the PUS/1 equipment. Reference should be made to section (*c*) for details on the conditional use of Upper and Lower VFLA settings for meter switch SWB used in conjunction with M2.

(*e*) *Differential Detector, DD/2 Fig. 11*

In this unit is a comparator employing two valves and a high-speed relay to originate an alarm for a minimum difference of 10 volts between the reference signal from the sending-end equipment and the compared signal derived locally. The diagram in Fig. 11 depicts a circuit closely resembling that for the DD/1 equipment in the Automatic Monitor Minor covered by Instruction S.6. One salient difference is that operation with unbalanced, instead of balanced, input-feeding necessitates using a non-earthed h.t. supply. This is taken from internal power equipment using metal rectifiers to provide a 250-volt h.t. supply, with the positive line connected to earth through a high-value resistor R19. The alarm circuit is given the secondary duty of signalling loss of internal supplies, for which purpose the h.t. is utilised to operate two relays in a circuit arranged to cause their de-energising and so initiate an alarm if a heater supply failure occurs.

The two signal sources are in series, with opposed polarities and their junction earthed, between the grids of V1 and V2. These EF50 pentodes are strapped as triodes, and in the anode circuit of each is one of two windings on a high-speed relay A/1. With flux opposed sensing of these coils the single relay contact remains in a normally-closed position in the alarm circuit for equal anode current in the two valves. The tractive effort of these coils differs slightly, due to some electro-mechanical asymmetry in the relay construction, such that one coil has less leakage flux than the other and would require the smaller current for relay operation. This characteristic is overcome by shunting the more sensitive winding, connected in the V2 anode circuit, with series-connected R15 and R16 to allow the sensitivity to be reduced to parity with that of the coil used with V1. The variable element of the shunt path is R16 (Equalise Relay) which is adjusted for the desired condition. This control and two others referred to below are screwdriver-adjusting types inside the unit.

Delayed operation of relay A is obtained through capacitance connected directly between the two anodes, to give a retarding effect because of charging taking place when inequality of input voltages causes anode-current unbalance. The purpose is to mask any slight time-displacement between the local and remote signals, and the nominal value of capacitance is represented by C4 in Fig. 11. C5 and C6 are available for adding in parallel with C4 if increased delay is required, the working value being chosen during installation in consideration of the particular circuit for which monitoring is provided.

An indication of the degree of unbalance under working conditions is given by M1, a centre-zero meter in series with R8 as a bridging connection between the two anode circuits. This meter is used in setting up the comparator for static balance, during which process a push-button switch (Test Det. Bal.) on the front panel is used to short-circuit the inputs and earth the grids via

R1 and R20 whilst a zero reading is obtained with the internal Adj. Bal. resistor R14. This control is connected with cathode circuits d.c. coupled to one another by R9 and R10 (Adj. Sensitivity) joining the junctions formed by a series-connected resistor and lamp in each circuit. By cathode-following action any input-signal difference causes the cathode potential of one valve to rise as that of the other falls to a similar extent, and so current flows through the bridging circuit. For a given difference at the grids the change in cathode voltages can be made progressively smaller by increasing the bridging current, and this is accompanied by a reduction of current feedback in each valve. Thus the sensitivity of the comparator is dependent on the R10 setting, the smaller the effective value the greater the change in anode currents with a specific unbalance at the grids. Feedback gives the comparator a substantial immunity from changes in valve parameters and supply voltages, but the inclusion of lamps LPR1 and LPR2 in the cathode circuits is a further precaution against variations in sensitivity. The change of resistance produced by an upward or downward change of anode current is responsible for an adjustment of the degree of feedback in a direction tending to oppose the change.

The relay-A contact works in an alarm circuit using relays B and C, the former a high-speed type, with a gas-filled triode V3 used as a two-electrode device, and a double-diode V4 with anodes and cathodes strapped. Relay B has two windings, one connected across R24 being energised first in a setting-up sequence when power is applied to the unit. This causes relay B to operate, and B1 closes to complete a supply, taken via A1 from the junction of V3 and R21 across the h.t. supply, for relay C and the second winding of relay B. Concurrent energising of both relay-B coils lasts for a short period until C1, an early-break contact, opens as relay C begins operating after the delay imposed by capacitor C9 in parallel with its winding. Then C2 breaks a supply for fault-warning lamp LP1 on the front panel, whilst C3 performs a change-over operation. The last-named contact offers the alternatives of obtaining an external alarm by either a make or break condition.

In signalling faults the sole function of relay A is to start a train of events during which control passes to relays B and C. When A1 opens even momentarily, de-energising of both relays is immediately followed by relay B relapsing to normal. Opening of B1 provides an additional coil-circuit break which temporarily deprives contact A1 of the ability to control relay C. On the delayed release of this relay, due to C9 discharging through the coil, C2 and C3 are responsible for LP1 lighting and operation of the remote-alarm equipment, respectively, as C1 makes the supply for the relay-B winding across R24. Relay B operates and so B1 closes to restore control to A1. If this contact is already closed the alarm ceases after an interval needed for relay C to become fully operated, and during which relay B reverts to the normal-working state as previously detailed. By the operations described the two relays ensure a definite minimum duration for fault-alarm signalling however short the period for which contact A1 is closed.

Warning of heater supply failure is conveyed by continuous operation of the external alarm without lighting of LP1, consequent on V4 becoming non-conductive in the common holding supply for the auxiliary relays. The use of gas discharge tube V3 in providing this particular supply is contributory to a circuit arrangement by which changes in h.t. voltage result in greater variation proportionally in the relay-operating voltage. This effectively enhances the sensitivity of the relays to h.t. voltage variations, such that an alarm is given for a much smaller reduction in h.t. voltage than would be possible with a conventional circuit with voltage-dropping resistors only. For information on this type of h.t. guard circuit reference should be made to Appendix 1 of Instruction S.6, giving a detailed account for the generally similar circuit in the DD/1 unit.

(*f*) *Mains Unit, MU/51A, and Supply Distribution Panel, SDP/2*

These two items are employed in powering one QSP/1 unit and two VFLA/4 units as indicated schematically in Fig. 6. The MU/51A equipment comprises two identical power supplies with a circuit as in Fig. 3.9, one in use and one in reserve. Each set of l.t. winding has a phased-out termination to permit their parallel connection, a desirable condition in view of the disparate needs of the dependent equipments and the only distinguishing feature with respect to the MU/51 mains unit. Paralleling is done at the distribution panel which, as shown by the semi-pictorial rear view in Fig. 3.10, has an unwired ' parking ' position for the connector from the reserve section in the mains unit in addition to those for distributing the output of the working section.

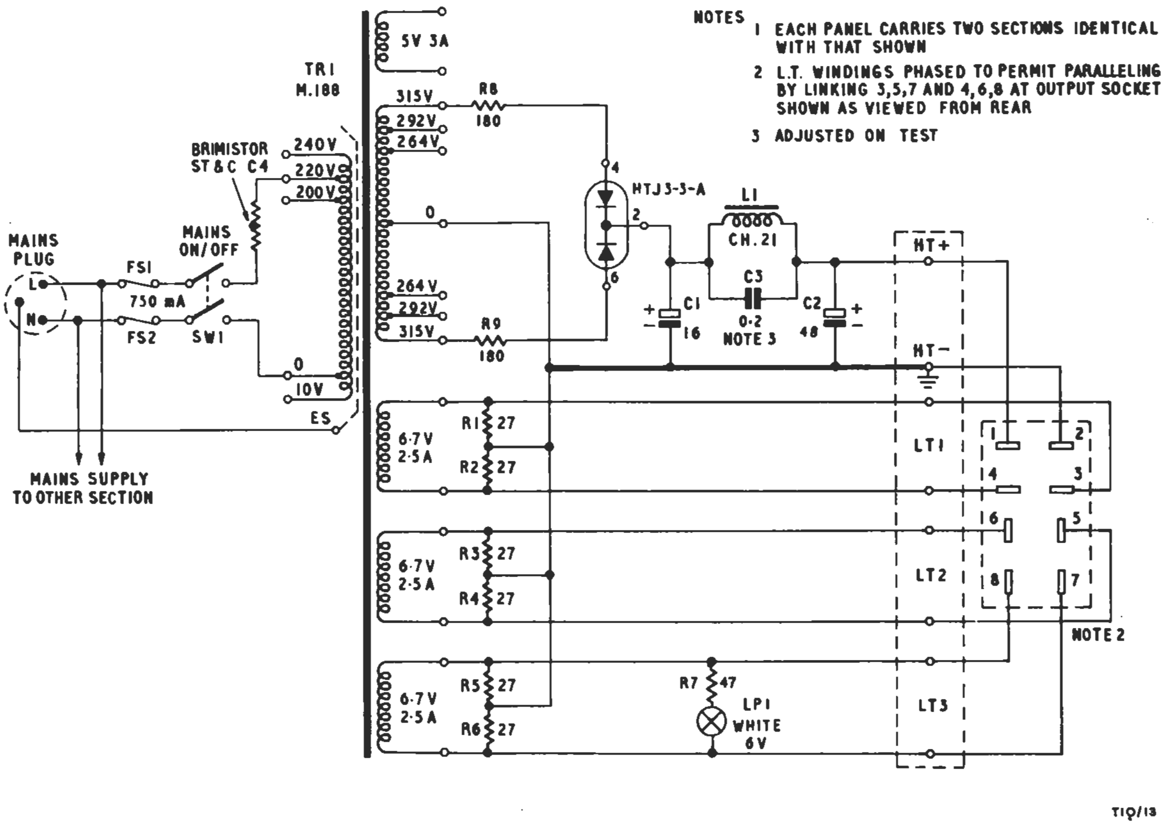


Fig. 3.9 Circuit Diagrams for Individual Section of MU/51A

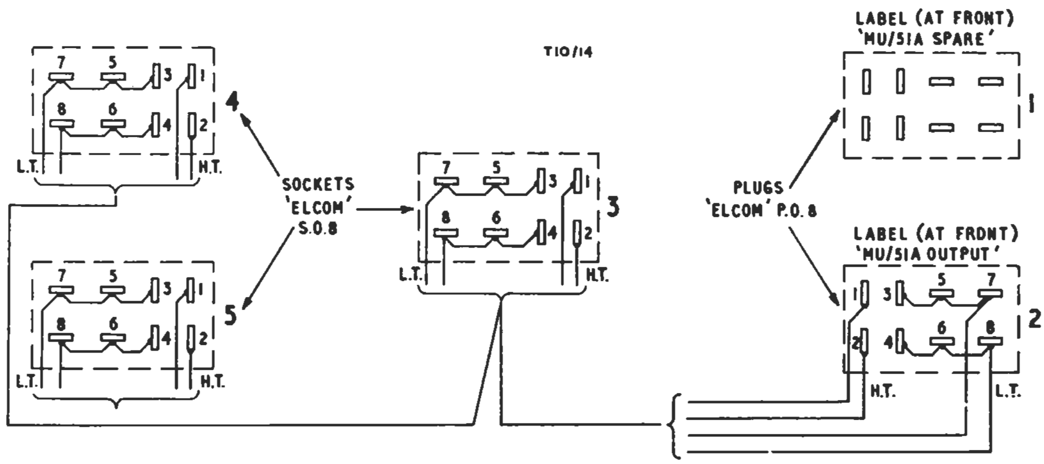


Fig. 3.10 Rear View of Points on Supply Distribution Panel, SDP/2, used with MU/51A

SECTION 4

AUXILIARY EQUIPMENT

4.1 General

The several types of equipment dealt with in this Section are either wholly or partially engaged in providing control, indication and alarm facilities relevant to programme switching and monitoring. The types described are limited to items ordinarily represented in a v.h.f. transmitter installation and one equipment which, although not necessarily included, is used in many instances. Information of apparatus used relatively infrequently for special purposes will be given where necessary in subsequent details of arrangements at particular stations. The restricted list of auxiliaries comprises:

(*a*) Phantom Relay Receiving Panel, PRR/2
(*b*) Integrating Alarm Panel, IAP/1
(*c*) Control and Indicator Panel, CIP/1
(*d*) Alarm Panel, ALP/7
(*e*) Transformer Unit, TU/5

Reference codes for the first three items in this list apply to one of a series of equipments which are also available in various modified forms. The variants are denoted by a letter suffix to the common reference as quoted above.

The Phantom Relay Receiving Panel is employed to obtain centralised control of incoming phantom circuits used in automatic monitoring, except where an LAM is concerned, and for remote-control purposes. Basically there are two types. One is used in systems where phantoms are normally unenergised, as done where switching for a particular service is effected through a line other than that carrying programme for the service. The other serves where there is standing current on phantoms, as practiced where the line carrying switching current is also the main route for programme feed in the associated service.

The main feature of the panel is a single change-over switch for selecting either local or remote control. The switch performs a multiplicity of operations including simultaneous transferred connection of the individual phantoms to equipment appropriate to the selected condition of working, where such an alteration is necessary. Indication lamps show the alternative operating states, and in addition the panel is equipped for measurement of phantom currents and has an alarm-buzzer circuit with provision for extension to an external alarm. The parent type, PRR/2, has accommodation for three phantom circuits in conjunction with Light, Third and Home services, but this is not necessarily fully utilised in the control scheme for a given site. With the widely differing nature of requirements it has been necessary to evolve several modified forms of this panel. In all there are six of the variant types with code references PRR/2A to PRR/2E, which include two designated PRR/2B and PRR/2B (Mod.).

The Integrating Alarm Panel forms part of the apparatus used in single-programme work when integration of fault signals from an automatic monitor is desired. This unit has a discriminatory purpose of determining, from the duration and rapidity of succession of fault signals, when a serious-fault condition is in evidence and then promoting a continuous alarm at other signalling positions. One common application is with a Line Automatic Monitor, taking fault signals from the local section of that equipment. Another is with an Automatic Monitor Minor (AMM) passing fault signals from a distant centre to the transmitting site via a phantom circuit. The series of IAP/1 units includes two versions with reference codes IAP/1A and IAP/1B.

The Control and Indicator Panel is an essential single-programme auxiliary with a general-purpose duty respecting the plant concerned in one transmission, including two transmitters. Various uses of the panel in relation with r.f. drives and automatic monitor (transmitter) units have been given in operational descriptions under heading 3.4.2. References in these descriptions were confined to the parent unit, CIP/1, and a modified type, CIP/1C, which as alternatives to one another are used at the majority of stations. The only important difference between these two panels is the inclusion in the CIP/1C unit of means for signalling operation of an a.f.c. control system for the drives. Such systems are a feature of transmitter equipments made by S.T. and C., but are not incorporated in those made by M.W.T., and the choice of panel depends on the manufacture of drives at a particular station. Other modified versions, used to a limited extent, have code references CIP/1A, CIP/1B and CIP/1D.

The Alarm Panel, ALP/7, is an indication-and-alarm equipment by which operation of a Band II installation can be supervised remotely, usually at the control desk in the Band I transmitter hall. The alarm is common to three sets of lamps, the four in each set showing the state of apparatus engaged in one programme transmission. Information conveyed by these is adequate to indicating, when the alarm sounds, the general position of a fault in addition to the programme affected by it. More exact means of locating the fault are available from the appropriate control and indicator panel (CIP) in the Band II hall. For the few stations from which four programme services are transmitted the need for extra indication is met by the alternative use of an ALP/7A version of the panel.

The Transformer Unit, TU/5, is a mains-operated source of l.v. supplies, a.c. one-side earthed, for indication lamps and alarm devices. The greatest demand on its services is by the equipments in the control and indication bay (CIB) where it is installed, but distribution is general to other bays containing equipments requiring supplies.

Note:—A Phantom Relay Sending Panel, PRS/2, is employed at centres associated with v.h.f. stations for remote-control purposes. It is equipped to provide d.c. supplies, normally 50 volts, from mains feeds and with switching arrangements for connecting these to phantom circuits. The panel is available in several versions. Further references are made to these, and other equipment types used externally in phantom-circuit links with particular transmitting sites, in Part 2 of this Instruction.

4.2 Equipment Details

4.2.1 Phantom Relay Receiving Panel, PRR/2 Figs. 12 to 17

Fig. 12 is a circuit diagram for the parent PRR/2 panel. Figs. 13 to 17 give equivalent details for the several modified versions of the unit, their application in some instances being limited to use at a single station. They have been included both to show variations in circuit arrangements and for reference purposes in later descriptions dealing with programme-control schemes for individual transmitting sites. The differences in these panels are in details only, and therefore the following description consists of an itemised survey, based on Fig. 12, regarding various common features of the panels.

(*a*) *Construction*

The equipment is assembled on a 19-in. hinged panel with a shallow back, panel height being 5¼ in. At the left-hand front is the main terminal block, and at the right-hand front is a group of relays, four in the PRR/2 panel but up to six in other versions. At the centre-front is an exposed sub-panel carrying the Local/Remote switch (SWA) consisting of a ganged assembly of wafer-type sections. On this panel also are indication lamps switched metering equipment (M1 and SWB), a plugging connector (External Metering) for attaching an extension lead to the metering equipment, and a Reset push-button switch (SWC). The last item is used with a relay in an alarm circuit, which includes a buzzer fixed to the back of the main panel.

(*b*) *Phantom-circuit Facilities*

Figure 12 shows provision for dealing with three phantom circuits, one for each programme, although this accommodation is not necessarily fully used. When a programme circuit is utilised in single earth phantom working the connection with the panel is made from the line repeating coil via a U-link on the ULR panel associated with the programme line. This is done for signals to be passed to an I.A.P. during periods of local control, and/or where the phantom is used for remote control during the Unguarded Hour. It does not apply if the signals emanate from the remote portion of an LAM equipment, a connection in this event being taken from the U-link to the bay containing the local LAM equipment; see Fig. 6.

At the PRR/2 panel each phantom signal is passed to the appropriate IAP unit through a resistor and rectifier. The resistor is a shunt for measuring phantom current with M1, using selector switch SWB at one of the positions 1 (Light), 2 (Third) or 3 (Home) under a Line I bracketing. The switch has settings for measuring two 50-volt supplies (3A and 3B) fed to the panel for use with Home programme-switching relays, and another setting for making connection with the external-metering point. The rectifier prevents the possibility of a relay in the IAP being energised by current with opposite polarity from the negative-to-line signals transmitted by a remote monitor.

When a circuit is employed as the means for remote control the rectifier is switched out of circuit as that condition is selected, and the phantom is connected to relays in the phantom receiving panel. The single example in Fig. 12

applies to use of a Third Programme circuit as a switching control-circuit for Home Programme. Details from this diagram are given in simplified form in Fig. 4.1, showing a commonly-used arrangement for obtaining remote-control facilities. Note that the relay in each ULR panel has two windings, sep rately energised with 50-volt 3A and 3B supplies switched individually by the pairs of C and D contacts in the phantom relay receiving panel.

Home ULR panel, which results in programme being cut from the Home transmitters. At the Line C/O setting relay C is operated, and thus the A relays in both ULR panels are energised with their contacts disposed so as to switch standby Home programme-feed from the Third Programme circuit to the Home transmitters. At the same time, opening of C1 and C2 causes a drive change-over for these transmitters assuming that, as normally done, the condition for obtaining automatic

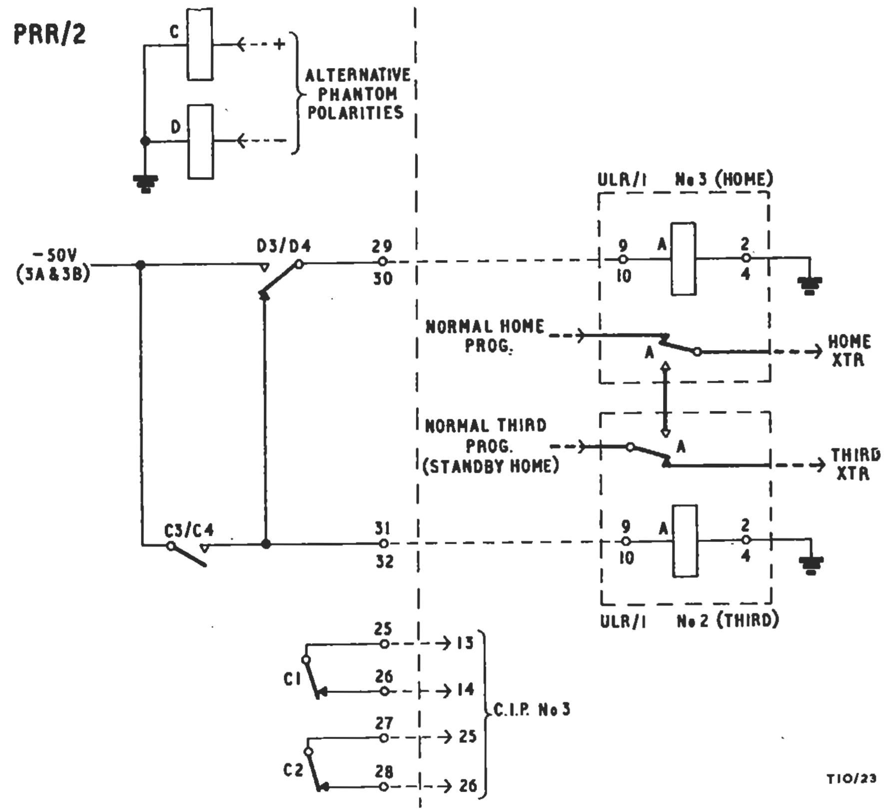


Fig. 4.1 Relay System for Remote Control of Programme and Drive Switching through Phantom Circuit

At the remote-control point is a switch, normally left open but with alternative settings for connecting 50 volts to the phantom. One setting (Line C/O) makes the positive side of the supply to line, and the other (Transmitter Off) switches the negative to line. Polarity-sensed working of the two relays in the PRR/2 panel is achieved through rectifiers in series with their windings, relays C and D being operated for phantom-positive and phantom negative states respectively.

Throwing the switch to Transmitter Off causes relay D to operate and so energise relay A in the change-over has been selected at the CIP. Further details on the operation of drive-control apparatus in CIP units is available from section 3.4.2. This specifically refers to control when AMT/2 monitors are in use, but should be sufficient to understanding the action promoted through contacts connected to a CIP as in Fig. 4.1.

In respect of programme switching by remote control the foregoing example illustrates a basic method liable to some minor variation in practical application. The source change-overs may, for instance, be performed by A and B relays in

ULR/1A (Light and Third) and ULR/1B (Home and Miscellaneous) panels respectively, or even by A and B relays in the second-named unit, where Home programme feeding is involved. Further it is fairly common practice to rely on pre-tuned rebroadcast receivers instead of lines as sources of standby programme, more especially in maintaining Light Programme service with programme obtained from the 200-kc/s transmission. If as usual the C and D relays at a PRR/2 panel are engaged on Home programme duty, a need for similar control of Light Programme during the Unguarded Hour is normally met by providing an RLP/31 relay panel. This is equipped with two relays, polarity-sensed by rectifiers for the purposes of permitting programme cut-off or change-over to be executed from a remote centre as previously described. The phantom circuit is taken to the PRR/2 panel, for extension to the additional relay panel when remote control is selected. Appropriate 50-volt supplies, 1A and 1B, for the programme-switching relays are fed directly to the RLP/31 unit. A drive-switching facility through relay contacts is not included, because in general the control of drives is undertaken by executive AMT/2 monitors; see reference in preceding paragraph.

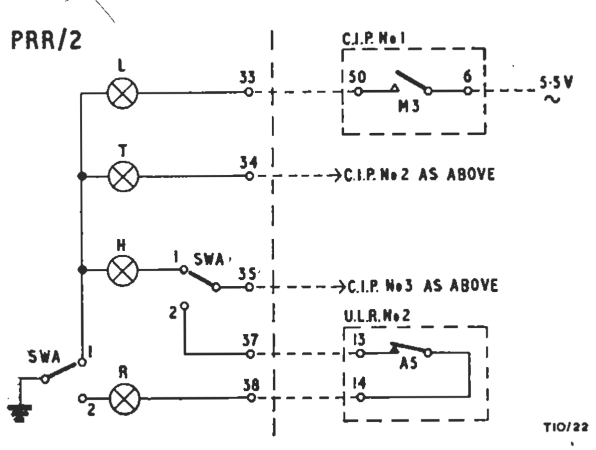


Fig. 4.2 Connection of Supplies for Indication Lamps at PRR/2 Panel

Provision for remote control of Home drives is retained as a standard feature in modified PRR/2 panels, Figs. 13 to 17, the relay contacts used for this purpose being short-circuited by sections of switch SWA until remote control is selected. Otherwise the diagrams illustrate a variety of special remote-control arrangements in panels which were designed to meet the individual needs at relatively few transmitting sites. Further reference will be made to these panels in later descriptions of control schemes for the stations at which they are installed.

(*c*) *Indication-lamp Circuits*

The PRR/2 panel, Fig. 12, is equipped with three green lamps which are operative during local control, and associated one each with the separate programme equipments, and a red lamp which shows when remote control is in use. Their supplies are taken from the 5.5-volt outlet, one-side earthed, of a transformer unit TU/5 (see section 4.5.2), and fed to the PRR/2 panel as shown in Fig. 4.2.

Whilst local control is in use the green lamps, L, T and H, remain lit for a satisfactory state of the related equipments, the contact in each CIP being part of relay M with the function of signalling a System Normal condition. Other contacts of relay M are connected in an alarm circuit common to the three CIP units, as described under heading (*d*), and therefore extinguishing of a lamp due to relapse of an M relay is accompanied by operation of an alarm buzzer in the PRR/2 panel.

On transferring to remote control, the red Remote lamp acts as a system-normal indicator for the Home equipments, the supply being controlled by contacts in the Home CIP and the ULR panel associated with the Third Programme. As explained under (*d*), a continuous alarm is not given for de-energising of relay M during remote control, and thus a fault signalled at the CIP causes extinguishing of the Remote lamp only. Breaking of this lamp supply in the ULR is indicative of relay A being energised to switch standby programme from the Third Programme circuit to the Home transmitters. Any doubt as to the cause of the Remote lamp being out can be dispelled by referring to the indication lamps at the CIP and ULR.

Variations from the circuit arrangement in Fig. 4.2 are of a minor nature, such as connection with a ULR/1A panel (Light and Third) instead of a ULR/1 panel. In either panel the lamp supply may be routed via se-ies-connected contacts of two relays where an additional signalling facility is required. Further, in some instances a PRR/2 panel is adapted to provide a Remote Light indication, the Remote lamp as shown in Fig. 4.2 being titled Remote Home. An extra section of change-over switch SWA is employed to transfer the supply at PRR terminal 33 from the Light lamp to the

Remote Light lamp, the return circuit from which is connected to position 2 of the earthed switch shown in Fig. 4.2.

(*d*) *Alarm Circuits*

The PRR/2 alarm equipment provides warning of faults signalled at the three CIP units and at a feeder indication panel (FIP) which shows switching conditions in feeders carrying the transmitter outputs. In dealing with this apparatus it is convenient to refer also to means for muting, during periods of remote control, the alarm systems of any integrating alarm panels (IAP) included in single-programme equipments. The essentials of circuits on the right-hand side of Fig. 12 are given in Fig. 4.3, showing their interconnection with other equipments.

A 50-volt supply (CIB Common) for alarm-buzzer relay A is normally made via a chain of relay contacts in the FIP and three CIP's. Initially the relay needs setting up in the energised state by closing B2, using a Reset push-button switch at either the PRR/2 panel or the ALP/7 panel to energise relay B. This causes A1 to transfer, breaking the internal buzzer supply and sealing relay A, as A2 makes another 50-volt supply from the PRR/2 panel to the alarm relay A in the ALP/7, to silence the remote alarm buzzer.

The circuit through each CIP is represented by a complex series-parallel formation of normal-operating and quick-break, early-make contacts; see buzzer relay circuit in Fig. 19 for example. The combination has the ability to maintain continuity whether the associated relays are energised or not. A momentary break occurs when a relay is in the act of relapsing to the unoperated state due to a fault condition, and this is sufficient to trip relay A and cause operation of the internal and remote buzzers. The alarm can be cancelled immediately by using one of the Reset buttons, after which the

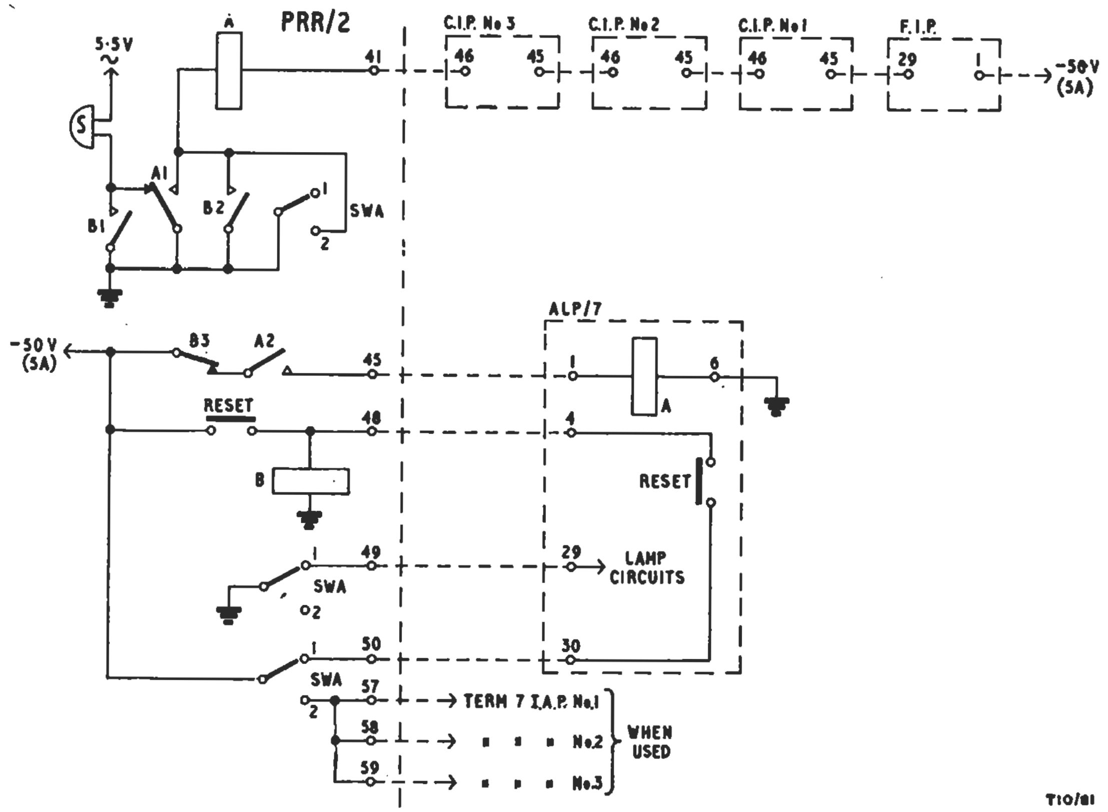


Fig. 4.3 External Connection of Alarm and Muting Equipment in PRR/2 Panel

fault remains indicated at the appropriate CIP. After a fault has been cleared the relay responsible for its being signalled reverts to normal, and in so doing the quick-break co tact ensure a momentary interruption in the relay-A energising circuit. Thus there is further buzzer operation requiring cancellation by one of the Reset buttons.

Early cancellation of an alarm is not possible for fault signals originating from the FIP. This unit has a series-parallel arrangement of normal-operating contacts ensuring continued interruption of the 50-volt supply when feeders are incorrectly switched or their dry-air supply fails. An unsuccessful attempt to cancel an alarm is therefore indicative of a fault being signalled from the FIP, but note that in any event the action of contact B1 keeps the PRR/2 buzzer operating until the Reset button is released.

Selecting remote control puts the resetting feature out of action, one section of SWA short-circuiting contact B2 as another transfers the 50-volt supply from the Reset switch at the ALP/7. Then relay A is able to alternate between energised and de-energised states as determined by faults signalled from the four indication panels. From earlier explanation it is clear that during unattended working in the Unguarded Hour a prolonged sounding of the alarm buzzers can occur only from loss of feeder dry-air supply, that is excepting an unindicated alarm possible due to loss of certain 50-volt supplies. Where IAP/1 units are used the transfer of the 50-volt supply to terminals connected with these panels, as shown, causes muting of their alarm-operating circuits. This results from energising of one coil of a double-winding relay in each IAP; refer to the following sub-section. The IAP/1A panels could be similarly connected for muting, but in practice this facility is almost invariably not required with that version.

Under remote control another section of SWA is open in an earth-return circuit for most of the indication lamps at the ALP/7 panel, details of which are given in section 4.2.4.

4.2.2 Integrating Alarm Panel, IAP/1   Fig. 18

The panel is equipped with two similarly arranged sets of components which independently integrate fault signals taken from an automatic monitor, the object in duplication being to enhance the reliability of the equipment. It also contains a mains-operated power supply providing h.t. for the integrating circuits and l.t. for indication lamps. The parent IAP/1 panel is used where an alarm only is required to draw attention to serious-fault conditions, done by breaking the supply for the Monitoring Normal relay in the associated CIP and so causing operation of alarm equipment in the PRR/2 panel. Alternatively an IAP/1A version is used when additionally there is need for executive action, that is programme source changeover. This extra feature is provided by utilising spare contacts of relays as fitted in the parent type, a minor difference enabling the details to be shown with a complete circuit diagram of the IAP/1 panel in Fig. 18. Circuit modifications incorporated in an IAP/1B version of the equipment are also given with the diagram, but will not be described as the panel was produced for Wrotham and is not in general use.

(a) Construction and Supplies

The unit is assembled on a 19-in. hinged, shallow-back panel with a height of 5¼ in. The left-hand front is occupied by power-supply components, including a mains terminal block connected through fuses only to the power transformer, and a main 20-way terminal block. Behind the hinged panel at the front are two controls, R6 (Decrease Time V1) and R16 (Decrease Time V2), beside a group of five relays letter-identified on their armatures. On the right are V1 and V2, cold-cathode gas-filled triodes, and capacitors associated with them as timing elements. Mounted off the main panel is an exposed sub-panel carrying an indication display frame, two push-button switches (SWA and SWB), a Test key-switch (K1), and a socket connector, marked 185 v., for use in making external measurement of h.t. voltage. Four indication lamps in the display frame are used to illuminate captions as given in Fig. 18.

The panel requires a 50-volt supply at terminal 1, and if it is an IAP/1 type this is usually taken from the CIB Common (5A) distribution. For an IAP/1A panel the equivalent terminal is connected to an A supply appropriate to the programme source, an association applying also to the additional 50-volt A and B supplies required at terminals 3 and 4.

(b) Operation of IAP/1

Fault signalling from an automatic monitor consists of interruptions to a 50-volt supply, the negative side of which is otherwise continuously applied to terminal 5 to keep relay A energised. For explanatory purposes it is convenient to ignore that relay for the present and assume the mains supply has just been switched on. This involves no alteration of relay-contact dispositions as shown in

Fig. 18, and a resetting operation is necessary to establish a working condition.

Closing Reset switch B connects a local 50-volt supply to relay B. Then B2 and B5 make the h.t. supply to windings e–d of relays C and D respectively, as B1 and B4 open to ensure that h.t. is not applied to V1 and V2 anodes during the resetting sequence. Contacts B3 and B6 change over, the first to break a supply for the Demute lamp (LP2) and provide a grid-earth path, additional to that through C2, for V1, whilst the second removes an earth for relays E and F and transfers it to the grid of V2, also earthed through D2.

The B3 and B6 contacts maintain the grid-earthed conditions when, with operation of relays C and D, C2 and D2 open. Concurrently, C4 and D4 close in preparation for duty as sealing contacts, series-connected C1 and D1 close to make the local 50-volt supply to terminal 9 (Mon. Norm. Relay), and series-connected C3 and D3 close in the common coil circuit of relays E and F. Also, contacts C7 and D7 individually make supplies to Mon. A. Norm. and Mon. B. Norm. lamps (LP3 and LP4), lighting of which shows that the Reset switch should be released.

On doing this the setting-up sequence continues as, with relay B de-energised, contacts B1 and B4 switch the h.t. supply to the anodes of V1 and V2 respectively. Relays C and D become dependent on their sealing contacts C4, and D4, due to B2 and B5 opening. Simultaneously, contacts B3 and B6 relapse to remove the earths from the V1 and V2 grids, the first transferring to complete a supply for the Demute lamp (LP2) as the second makes an earth connection for the coil circuit of relays E and F. Provided relay A is operated, as indicated by a Mon. Sig. lamp supplied via A2, the A1 contact will be closed and so the transfer of B6 is responsible for energising of relays E and F from the local 50-volt supply. Then the normal working condition is attained as three contacts of relays E and F open in the grid circuits of V1 and V2 respectively.

Completion of these operations enables the capacitors between grid and cathode of each valve to start acquiring charges from the h.t. supply, in a manner to be illustrated by referring to V1 circuits. Slow charging of C2 begins immediately, because that capacitor is left connected through a high-value resistor R10 to the tapping point of R6, a potentiometer control providing for variation of the effective source voltage. The other capacitor, C3, remains isolated until an incoming fault signal is indicated by extinguishing of the Mon. Sig. lamp and causes de-energising of relay E. Consequently, E4 closes and allows C2 to start discharging rapidly through R11 into C3, as E2 makes connection with the V1 grid. Simultaneously, E3 operates to switch R9 in parallel with R10 which considerably reduces the resistance through which charging current taken from the h.t. supply. When the relay-E contacts open, after a fault signal assumed to be of short duration, C2 reverts to charging through R10, and C3 discharges through R13. This resistor has an extremely high value, such that loss of charge by C3 is inappreciable unless several minutes elapse before the next fault signal arrives. Otherwise a burst of short-duration signals, or a prolonged one, cause the voltage applied from C3 to the V1 grid to rise to a critical value at which anode-cathode discharge occurs through the thyratron. This results in release of relay C, due to the anode-current flow through winding a–b producing flux opposing that provided from winding d–e. Consequently individual contacts of relay C act to (*a*) extinguish the Mon. Norm. A lamp, (*b*) earth V1 grid, (*c*) interrupt the energising supplies for relays E and F, and (*d*) break the 50-volt supply to terminal 9, for the Mon. Normal relay at the associated CIP.

Suitable and virtually coincident action in both integrating circuits can be obtained through test operations and adjustments involving use of the Rel. A switch and Test key-switch; information on this subject is given in a following sub-section. In any event when one of these circuits initiates an alarm the process of integration is halted, see item (*c*) above, and cancellation occurs in the use of the Reset switch for restoration to an operative state as already described.

Provision for muting the equipment involves making relay B continuously energised under certain conditions, and thereby provide a state corresponding with that for an incomplete resetting operation with the Reset switch kept closed. The essentials of this circuit arrangement are given in Fig. 4.4, which also show the connection with the Monitoring Normal relay in the CIP. During local control one winding of relay B is energised by a 50-volt supply extended through contacts of K and Y relays in the CIP, during periods when neither of the two transmitters is powered. The K and Y relays are associated with the A and B transmitters respectively, each performing a number of duties which include switching a supply to the lamp in the Radiate portion of the indication panel at the CIP. The above feature is over-ridden when remote control is selected at the PRR/2 panel, a 50-volt supply being switched from that unit to the other relay-B winding to ensure that muting continues when the transmitters are powered. Note: The PRR/2 unit has commoned terminals (57, 58 and 59) for making connection with Light, Third and Home IAP's respectively; refer to Fig. 4.3.

At stations whose transmissions are received by other sites for rebroadcasting on a permanent basis the Monitoring Normal relays may have an additional use. That is to give warning of loss of the 20-kc/s monitoring tone applied locally with programme inputs to transmitters providing such facilities. For this purpose contacts of relays in the

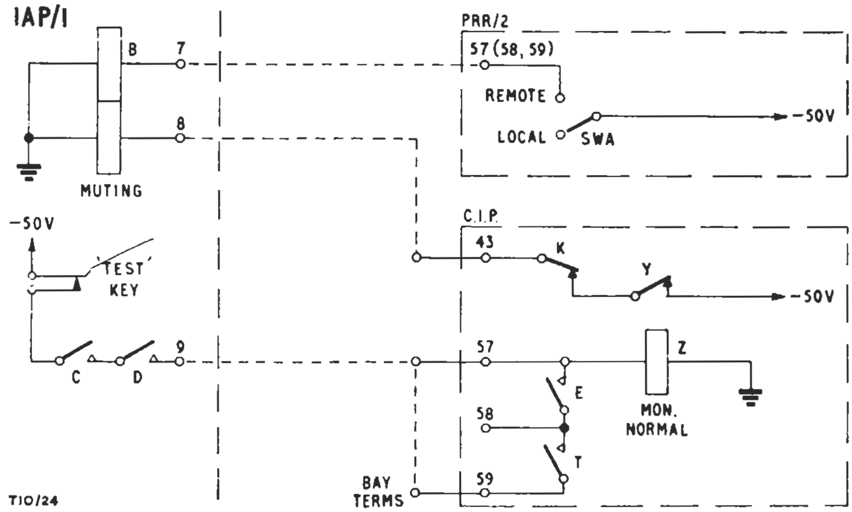


Fig. 4.4 Muting Circuits for Integrating Alarm Panel, IAP/1, and Connection with Monitoring Normal Relay

The Monitoring Normal relay circuit of Fig. 4.4 applies where relay Z is required to provide external signalling for an IAP only. When a pair of non-executive AMT/2 monitors are used with the programme chain the relay is also employed to signal their operation. If monitors alone are used, that is without an IAP, the supply for relay Z is applied to an interconnected arrangement of relay contacts (D2 and E3) in the two monitors and contacts of relays E and T in the CIP, as described under 3.4.2(*b*) and illustrated in Fig. 3.6. Should both equipment types be provided, terminal 9 at the IAP is connected to these contacts instead of directly to the CIP. Operation of relay Z then depends on a satisfactory state in the IAP and working AMT/2 monitor, the relay contacts of the standby monitor being short-circuited by contacts of relays in the CIP. One contact of relay Z switches a supply for the Monitoring Normal lamp at the CIP, and another two operate in a circuit extending to the alarm-buzzer equipment in the PRR/2 panel. The use of two alarm contacts is to obtain a momentary-break condition which, as a special feature of the alarm operation, is referred to in section 4.2.1(*d*).

monitoring-tone equipment are included in the coil circuits of Monitoring Normal relays in the appropriate CIP's; see Section 5 for details.

(*c*) *Integrating Alarm Panel, IAP/1A Fig. 18*

This version is designed to meet an occasional requirement that programme source change-over shall occur when an alarm signal issues from the panel. The executive facility is obtained by using spare contacts on relays and the Test switch, as fitted in the IAP/1 panel, to control the energising supplies for a programme change-over relay in a ULR panel. Details of these additional circuits are given at the top right-hand corner of Fig. 18. According to usual practice for such purposes the circuits are duplicated so that two windings of the ULR relay can be separately energised with 50-volt A and B supplies. The pairs of contacts are open for a normal working condition. As mentioned earlier, the means of muting in connection with a PRR/2 panel is not usually employed with this executive equipment.

(*d*) *Notes on Testing and Adjustment*

The h.t. meter-feeding circuit is suited to use of a 0/100-μA meter, with the resistance built out to

10 k ± 2 per cent, connected to a two-pin socket (185v.) on the front panel. The portable test meter PTM/6 can be used for measurements, or alternatively the meter in the PRR/2 panel can be connected with the meter switch at the panel set to Ext. Feed and a flying lead with plug and socket at opposite ends as the inter-panel link. A reading of 55 ± 5 μA is to be expected, with a slight fall to 50 ± 5 μA on pressing the Reset button to operate relays C and D.

Periods needed for alarm operation under simulated fault conditions are determined with the key-switch K1 set to Test, so that relay A is energised by the local 50-volt supply taken through the Rel. A switch. For a prolonged-fault test it is first necessary to operate the Reset switch and keep it so until the Rel. A switch has also been operated and maintained open by continued pressure on the push-button. Then the Reset switch can be allowed to open, noting the period from that instant to the moment when relays C and D release, as shown by extinguishing of the Mon. A Norm. and Mon. B Norm. lamps. This should occur within 9 sec ± 1 sec, failing which the controls R6, for relay C, and R16, for relay D, should be re-adjusted until operation within the given limits is obtained.

For an intermittent-fault test, press and release the Reset button only. Then, after a five-minute delay, momentarily operate the Rel. A button and check that this has not caused release of relays C and D. Continue with the momentary interruptions by Rel. A switch until the relays do release, which should occur within three to five repetitions.

As a further test, operate and release the Reset button, following this immediately by pressing the Rel. A button for six seconds. Then wait for 45 seconds before again pressing the Rel. A button until relays C and D release. An acceptable condition is where this happens within from three to six seconds.

4.2.3 Control and Indicator Panel, CIP/1 Figs. 19 to 22

Circuit diagrams for the four versions of this relay-and-lamp panel are given in Figs. 19 to 22. Details of the CIP/1A and CIP/1B equipments are given for the sake of completeness, as they were provided for Wrotham but have been superseded by the other versions in subsequent installations. Reference was made under heading 4.2.1 to transmitter manufacture being a factor in choosing between CIP/1 and CIP/1C equipments, Figs. 19 and 22, which have more comprehensive facilities than the earlier versions and in this respect they differ slightly from one another. Relays with similar functions in all four panels are identified similarly, by letters marked on the relay armatures. The following description refers to the CIP/1 and CIP/1C equipments in particular, although some of the information applies to the other equipments.

(a) Construction and Operating Supplies

The unit is built on a 19-in. hinged, shallow-back, panel with a height of 5¼ in. Four rows of relays are mounted on the front of the panel, an A set in the two upper rows, the corresponding B set below them, and to their left a column of three relays (L, M and Z) with common associations. To the left of the relays is a main terminal block and behind the panel are resistors and rectifiers. Supported off the main panel is a sub-panel carrying the indication display frame, a four-position Drive Selector switch (SWA), and a key-switch (K1) with Reset A and Reset B positions for use in operating drive-latching relays B and Q respectively.

The panel requires three direct feeds from the 50-volt distribution system. Two obtained through branches appropriate to the programme service, for example 1A and 1B feeds for a Light CIP, are applied at terminals 1 and 3, and similarly used with a proportion of the circuits in separate relay systems associated with the A and B drives respectively. The third 50-volt supply is a CIB Common (5A) feed to terminal 7, this being used for miscellaneous purposes including connection with a circuit for IAP muting, and also supplying lamps showing the operation of duplicate time-switches controlling the transmitter powering. All other lamps in the indication frame are operated with a 4·7-volt a.c. supply applied between terminal 5 and earth. This feed and a 5·5-volt a.c. supply, between terminal 6 and earth, are used with a number of circuits providing external-signalling facilities. The two supplies are obtained from a transformer unit TU/5; see 4.2.5.

(b) Operation

The relay circuits whose operation is described elsewhere, as a matter of convenience in showing their relation with particular equipment types, are as follows:

Drive Relays
- Section 3.4.2 and Figs. 3.5 and 3.6

Buzzer Relay Circuit
- Section 4.2.1 and Fig. 4.3

IAP Muting Circuit and Monitoring Normal Relay (Z)
Section 4.2.2 and Fig. 4.4
Lamp-circuit extensions to ALP/7
Section 4.2 4 and Fig. 4.6

The CIP/1 and CIP/1C panels have similar System Normal relay circuits apart from the use in that de-energising of relay M occurs for any fault condition, except Monitoring Normal, signalled by extinguishing of a lamp in the indication frame. Externally the operation of relay M is, in any event, controlled by relay contacts at the Feeder Indication Panel (FIP), to which a 50-volt supply is taken for use in common with the System Normal

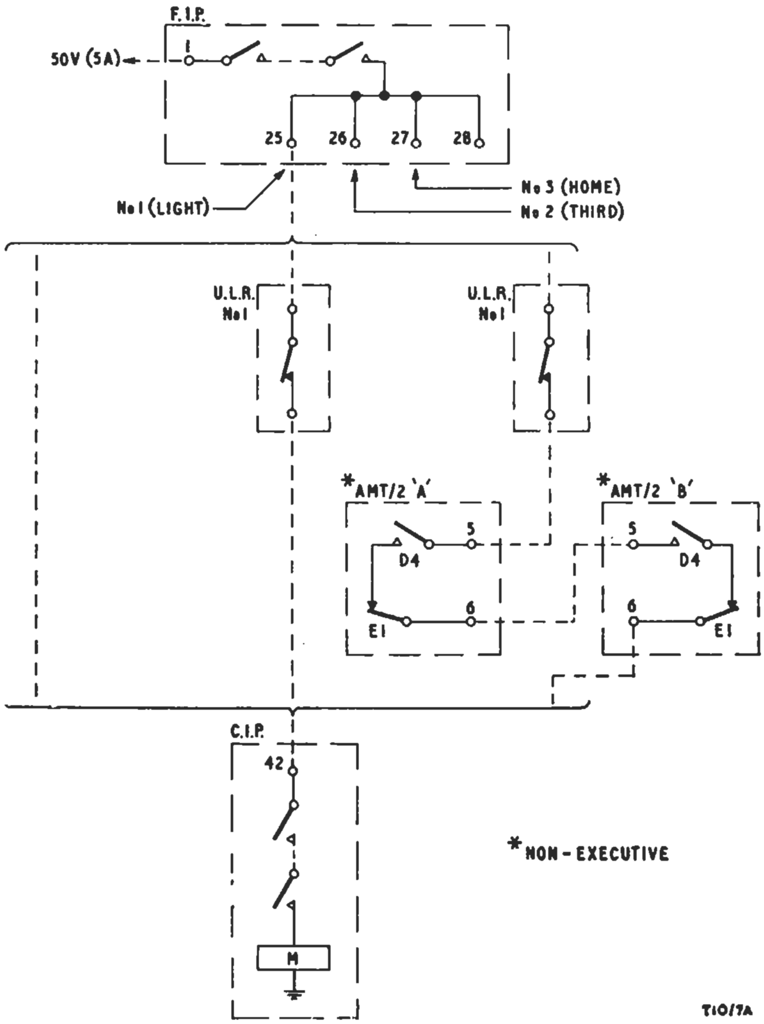


Fig. 4.5 Schematic showing 50-volt Distribution to System Normal Circuits and Alternative Connections to CIP

the latter unit of additional contacts (D7 and S7) of AFC relays fitted in that equipment only. Internally a supply for relay M is controlled by a chain of relay contacts with which connection is made provided the Drive Selector switch is at either of two positions titled A or B and B or A. Not all relays in the unit are represented by contacts in this chain, but the arrangement is such circuits to individual CIP's associated with each of the three programme services. Essentials of this arrangement are given in Fig. 4.5, showing within brackets the three alternative methods by which an FIP may be linked with, for example, a Light CIP. Direct connection is not practised to any great extent, the usual routing being through a ULR only in most circumstances, and additionally through the signalling contacts of relays D and E in non-executive AMT/2 monitors when employed. Specific references have been omitted from Fig. 4.5 where there is liability to circuit variation. For instance in the FIP the number of series-connected contacts is not always the same, but in any equipment they serve to provide a through path when the main r.f. feeder switches are correctly disposed. For the ULR also, the terminal and contact references are absent from the diagram because control may be applied through either a single contact or alternatively by two contacts connected in series or parallel, of a relay or relays engaged in programme-source switching. With any combination, however, the aim is to provide continuity whilst a normal programme-feeding condition exists, and an interruption when a transfer to reserve-source feeding takes place. Operation of relay M is signalled by lamps on the PRR/2 and ALP/7 panels, lamp supplies being switched through contacts M3 and M1 respectively as shown in Fig. 4.6. De-energising of the relay is accompanied by operation of the alarms in both panels, this being initiated through contacts Mx5 and M7 in the buzzer-relay circuit extending to the alarm relay at the PRR/2 panel; see reference to alarm circuit in foregoing summary.

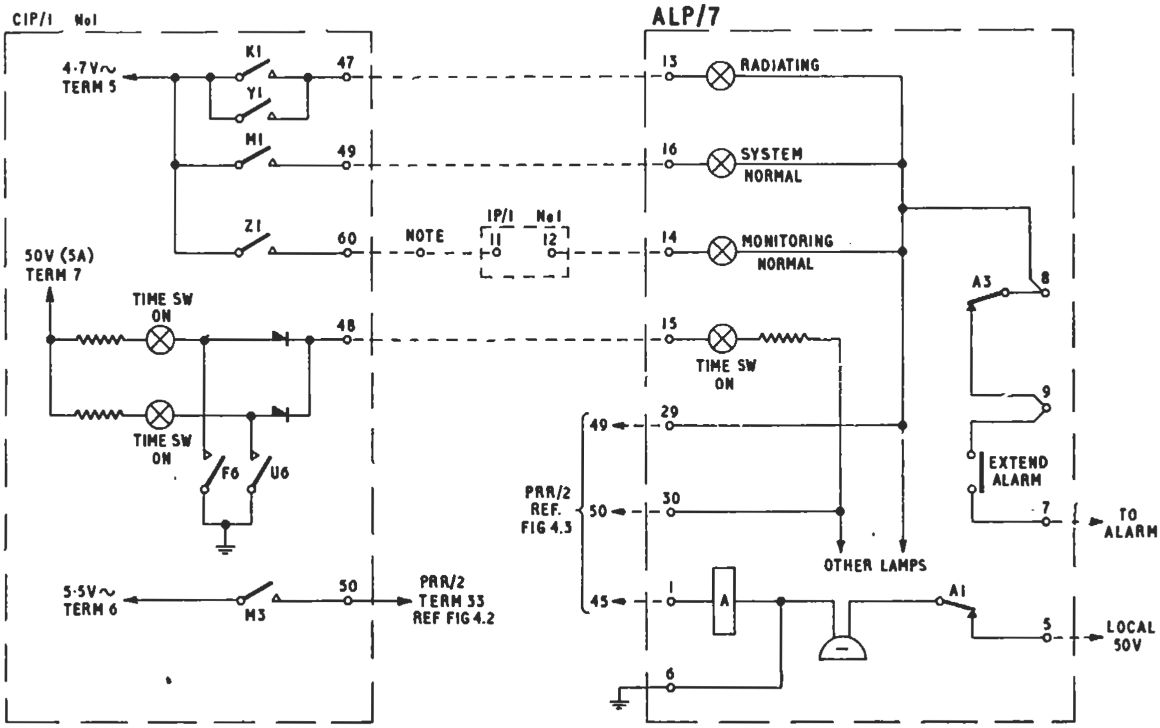
For completeness there follows an account of the functions of relays other than those concerned with programme operations. Two Time Switch On relays, F and U, are energised with 50-volt A and B supplies appropriate to the programme service, for periods determined by pre-setting of duplicate time-switches associated one with each relay. The time-switches have 48-hour clockwork movements and electrical winding attachments making use of mains supplies. This equipment provides for automatic powering of the transmitters, and to ensure that this will not be affected by failure of either time-switch there is parallel connection of contacts on both relays in the control circuits to the A and B transmitters. These pairs of contacts, F1 and U1 and F2 and U2, are in series with similarly paralleled contacts of C and R relays, an arrangement making powering conditional on the presence of an output from at least one of the r.f. drives. Other contacts of these relays are connected in the System Normal relay circuit (F4 and U4) and buzzer-relay circuit (Fx3, F5, Ux3 and U5). Additionally, contacts F6 and U6 switch a 50-volt supply for two lamps at the CIP and one at the ALP/7, a special circuit arrangement including rectifiers for which an explanation is given in section 4.2.4 dealing with the ALP/7 panel.

Automatic control, as an alternative to hand control, is selected at the individual A and B transmitters. Then, subject to the closed state of several series-connected auxiliary contacts on switches in the transmitters, relays J and X (Xtr. Sw. to Auto.) become operated. At some installations the 50-volt supplies for these relays are taken from A and B transmitter-indication services common to all transmitters. In others use is made of the two CIB feeds associated with the particular programme service. Contacts J8 and X8 operate in supplies for indication lamps, whilst J7 and X7 are connected in the System Normal relay circuit.

The A and B supplies for relays J and X are shared with two more pairs of relays, G and V (Xtr. R.F. Out) and H and W (Output to Comb. Unit). Feeds for relays G and V are controlled by contacts of carrier-operated relays in the A and B transmitters respectively. The carrier relays are arranged to operate and close their contacts as, during starting operations, the transmitters output-powers approach normal values, interruption occurring if subsequently the outputs fall to somewhat lower values at which these relays release. In series with each of the relays H and W is an auxiliary contact on the test-load switch for the associated transmitter, A and B respectively, the contact completing the relay supply when the switch is set to connect the transmitter to the appropriate A or B combining unit. All four relays have contacts in the System Normal circuit and switching lamp supplies.

Contacts of these four relays are also used for controlling the two Radiate relays, the arrangement consisting of G1 and H1 in series with relay K, and V1 and W1 in series with relay Y. Both relays are operated with a 50-volt CIB Common supply, usually 5A, taken to the FIP for a number of purposes. Relay contacts in the FIP are closed so as to extend the supply to CIP terminal 36 (relay K) when the A combining unit output is switched to the main aerial feeder. Connection with terminal 40 (relay Y) is similarly established when the B combining unit output is switched to the main aerial. Thus if the transmitters are switched to feed into the combining units, so that H1 and W1 are closed, the supplies for relays K and Y are ultimately completed through H1 and W1 closing as the transmitters are powered and start delivering normal outputs. Contacts of these relays are connected in the buzzer-relay circuit and an IAP muting circuit; see previous summary referring to information given elsewhere. Contacts on the K and Y relays are used conventionally in providing local Radiate indications, and also in switching a supply to the Radiate lamp at the ALP/7. These remote-signalling contacts, K1 and Y1, are parallel-connected and therefore a Radiate signal is still obtained for a one-transmitter condition. The Station Logger contacts K3 and Y3, for operating transmission-hour summating devices, are not yet employed.

Relay L (Phase) is used in conjunction with a phasing (variable capacitor) control operated automatically through a system for detecting and correcting and phase differences in the outputs of a pair of transmitters. It is arranged that the relay shall remain energised unless the phasing control is driven to either extreme of travel in attempting correction beyond its range. Practice differs with transmitter manufacture, but in any event the control of relay L is obtained with limiting switches on the phasing control. For this the relay may be connected either directly in series with the switches or in series with contacts of other relays which are operated through the limit switches. A CIB Common (5B) supply is normally used with the relay, contacts of which operate in the System Normal relay circuit and in a supply for the Phase lamp. Note: The relay may be operated by other means for a similar purpose where automatic phasing equipment is not provided.



NOTE:- 4·7V~ CONNECTED AT BAY TERMINAL IF No IAP OR AMT'S

EQUIVALENT TERMINALS

PROG	CIP No	PRR/2	IP/1	ALP/7
LIGHT	1	33	11-12	13-16-14-15
THIRD	2	34	19-20	17-20-18-19
HOME	3	35	27-28	21-24-22-23

T10/178

Fig. 4.6 External Connection of Alarm-buzzer Circuits and One Set of Indication Lamps at ALP/7 Panel

4.2.4 Alarm Panel, ALP/7 Fig. 23

The circuit diagram for this equipment, Fig. 23, shows a lamp panel connected to a separate alarm-buzzer panel which is fitted inside a control desk and to which all external connections are taken.

Circuits for operating alarm relay A and cancelling alarms through the Reset switch have been described by reference to Fig. 4.3 in section 4.2.1 (*d*). Fig. 4.6 shows complementary details of the local alarm circuit, provision for an extended-alarm facility and the typical circuit arrangement for feeding indication lamps associated with a single programme service (Light). A table below the diagram relates terminals in the circuits illustrated with corresponding terminals in Home and Third Programme indication circuits.

A source other than those for the v.h.f. installation is used in alarm-buzzer operation, a supply usually being obtained from the Station 50-volt system covering general requirements. If the alarm extension is needed the live circuit from the external alarm is taken to either terminal 7 or terminal 9, dependent on whether the Extend Alarm switch is to be included, and terminal 8 has to be connected to terminal 29, through which return is provided in the PRR/2 panel during local control.

In the Time Sw. On circuit are rectifiers which ensure that operation of the time-switches is signalled independently by the CIP lamps despite their common connection with the ALP/7 lamp. Thus if only one time-switch operates, the closed relay contact provides an earth for the appropriate CIP lamp and also, via the forward resistance of one rectifier, for the ALP/7 lamp, but the other CIP lamp cannot light because it is earthed through the backward resistance of the second rectifier. Where the supply for the Monitoring Normal lamp is connected alternatively as noted in Fig. 4.6, the indication applies to operation of the two limiters connected to the IP/1 panel. The action of contacts in this panel is described in section 3.2.3.

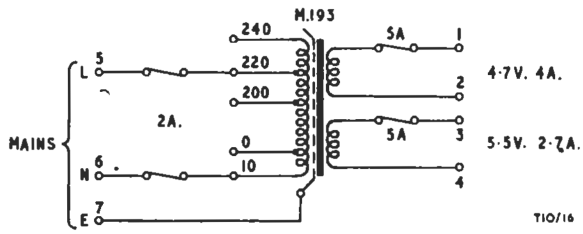


Fig. 4.7 Circuit Diagram for Transformer Unit, TU/5

4.2.5 Transformer Unit, TU/5

Fig. 4.7 gives circuit details for this panel-mounted item. The l.v. feeds are internally and externally distributed from the CIB bay termination, at which position the non-fused sides of the two windings are earthed.

SECTION 5

V.H.F. LINK SERVICES FOR RELAY STATIONS

5.1 General

This Section is mainly concerned with operation of a 20-kc/s tone monitoring system in conjunction with radio links providing programme feed through v.h.f. transmission. Parent roles in such links are usually assigned to high-power Band II transmitters, and dependent transmitters are generally in the m.p. and l.p. categories. Link services are used to a considerable extent for relay stations in the m.f. band, but further description is directed particularly to practice at those working in Band II.

The tone monitoring system was evolved for application with wide-band programme channels to enable an automatic check to be kept on the continuity and, to some degree, the transmission equivalents of individual links. The tone is originated at parent stations, for introduction at a specified level into programme chains of those transmitters on which link services are centred.

At relay stations the tone is monitored in outputs of receivers which supplant the amplifiers ordinarily associated with line-fed programme. Limiters are not needed owing to the limiting undertaken at parent stations and so, subject to interposition of switching for programme control, the receivers normally feed directly to transmitter drives. Note that this refers to Band II relay stations only, as those engaged in a.m. transmission use limiters to reduce the dynamic range of programme obtainable generally in Band II. The receivers have de-emphasised outputs suitable for re-radiation by the m.f. installations, and at Band II sites the pre-emphasis of modulating signals occurs in drives as with line-derived programme feed.

One type of unit is generally employed for the purpose of monitoring the 20-kc/s tone. Its function at parent stations is to switch a standby oscillator into use on failure of the working oscillator, in common service with the various programme chains, and cause an alarm to operate. Monitors at relay stations are used to promote executive action when the level of tone falls by more than a relatively small margin from a predetermined working value.

Executive action differs with requirements, but normally at Band II relay stations it is a sequential switching to several receivers in attempts to restore programme; this control is detailed later. Additionally it is possible to arrange for receiving site transmitters to become powered when 20-kc/s tone appears, and to close down on its cessation. This control application is favoured for unattended installations, but is not described here as it is outside the scope of this Instruction.

Band II relay stations usually have three receivers for each programme service taken by radio link. Two are v.h.f. types for the most suitable Band II channel, one an RC5/1A and the other an RC5/1B. These are identical except that their oscillators work below (A) and above (B) the wanted signal frequency; see Instruction RS.2, Section 3. Apart from a primary purpose with indication and alarm facilities, the carrier-failure relay of each receiver is connected to short-circuit the receiver output when released. This feature is to prevent tone monitors from being sustained in the operated state by the increased hiss from receivers as parent stations close. In reserve to both v.h.f. receivers is one for receiving an a.m. transmission, chosen from such as the RBR/3 series for 200 kc/s and principal BBC m.f. channels; refer to Instruction RS.1, Section 3. Ordinarily no difficulty arises with Light Programme, but for the other domestic sound services the installation of a.m. receivers is conditional on acceptability of signals at a given site.

The v.h.f. receivers have individual tone monitors jointly controlling relays giving fixed-order selection of receiver outputs. Alteration for the various possible conditions is obtained by change-over switching, partly of a.f. feeds and partly of drive outputs. One v.h.f. receiver is preferred while its tone output remains unaffected, transfer to the second occurs if its tone output persists after that from the first has failed, otherwise programme feed is taken from the a.m. receiver. This control system is self-restoring in its ability to revert to the normal working condition when tone reappears after, say, parent-transmitter shutdown.

The next sub-section covers the general overall arrangement for 20-kc/s tone monitoring and states the nominal tone levels adopted for satisfactory working of the system.

5.2 20-kc/s Tone Monitoring System

Parent stations are equipped with two fixed-frequency oscillators (OS2/5), two tuned amplifier-detectors (AM3/1) and auxiliaries for controlling and distributing tone. Their arrangement is shown by Fig. 5.1, in which nominal tone levels at various points are encircled.

merely includes lettered a.c. symbols to denote dependence on the alternative supplies.

Oscillator-output switching shows preference to oscillator A, with relay RLA normally energised via one contact of a relay in the detector unit associated with it. This gives a fail-to-safe feature respecting faulty A units and loss of their supplies. The detector-B relay is used only for signalling the state of the B equipments.

The OS2/5 oscillator will deliver tone at approximately +20 dB across a load of 600 ohms. Directly shunting each oscillator output is a variable resistor, suitably range-limited, for making

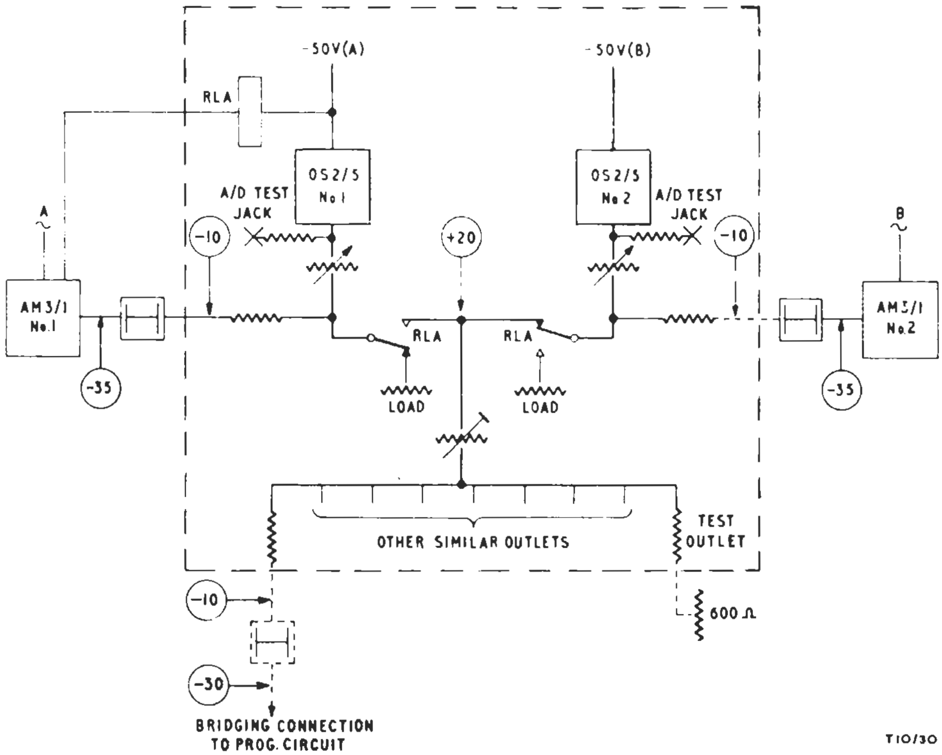


Fig. 5.1 20-kc/s Tone Monitoring System: Basic Arrangement of Parent-station Equipment

As customary with duplicate equipments the related pairs of units take operating supplies from A and B halves of the Band II power-supply system. The oscillators are pnp-transistor equipments designed for use with reasonably stable 50-volt supplies, readily obtainable from the voltage-regulated, positive-earthed, sources generally associated with control and indication facilities. The amplifier-detectors need conventional valve-operating supplies from external sources. Means of providing these differ to some extent, and Fig. 5.1

adjustments to the correct working level. This is carried out with the oscillator also working into a fixed resistor (Load in Fig. 5.1) while using a test amplifier-detector plugged into a test jack fed through series resistors. These resistors, in conjunction with the 600-ohm input of the test instrument, introduce a 30-dB loss.

Similarly all other feeds taken externally are attenuated initially to −10 dB in the vicinity of the oscillators. Detector inputs are applied through series resistors and a 600-ohm termination presented by a loss pad near each detector unit. The additional loss in this pad is 25 dB to make the detector input nominally —35 dB. For the distribution to programme chains each feed is further attenuated to —30 dB by a loss pad of which one element is the effective impedance of the programme circuit at 20 kc/s.

Part of the loading for the in-service oscillator is provided by one or more fixed resistors collectively represented as a single pre-setting component in Fig. 5.1 They are for compensatory adjustment taking account of the number of tone outlets in use. One outlet is terminated with 600-ohms primarily to prevent the possibility of tone at +20 dB appearing on distribution wiring. Addition of a jack provides a test-measurement facility.

Tone is injected by bridging connection into programme chains at points of zero level line-up, which must be subsequent to limiters. Thus a typical chain having the branched formation of Fig. 3.1 requires two feeds, effectively applied to the drive inputs. With two-stage attenuation as already mentioned the tone can be distributed at a suitable level (—10 dB) and yet, by placing loss pads as close as practicable to programme circuits, the tendency to cross-talk between programme chains is inhibited. Programme-circuit loss owing to the bridging connection is inappreciable.

The amplifier-detector has a sensitivity control to determine the applied tone level for operation of the internal relay. At parent stations the setting used is one which keeps the relay operated, a barely-holding state, while tone level at the programme-circuit injection points remains at a nominal —30 dB; release occurs for a fall of about 2 dB. As this condition is marginal there is a switch for short-circuiting one series limb of the loss pad preceding each unit, and that is used temporarily if a relay fails to operate as tone levels are restored to normal.

Detectors at relay stations are bridged directly across circuits at points of zero level line-up; see next paragraph. Their sensitivity controls are usually set for relay operation at —36 dB, with release at approximately —38 dB. The relatively lower values are intended to ensure that oscillator failure will be remedied at parent stations before relay stations initiate needless executive operations. The stated levels do not apply rigorously because individual links show some variation in overall 20-kc/s loss, from differing small contributory losses in drives and receivers. Consequently the levels may be altered slightly as a compensatory measure.

Detectors at receiving sites must be in advance of limiters, but the omission of these in Band II relay stations removes that restriction and tone monitoring is not necessarily effected directly at the receiver outputs. Conventionally one v.h.f. receiver feeding drive A and the other associated with drive B are treated as the main and reserve combinations respectively. In some instances control is obtained with one detector virtually tied to the drive-A output by its connection with the drive-A monitor, and the other detector across the circuit between the B receiver and drive. The A detector has control of drive changeover, such that drive A is preferred in normal circumstances, while detector B determines whether the reserve v.h.f. receiver (preferred) or the a.m. receiver is switched to drive B. In this way the control system provides an ordered selection of receiver outputs.

Tone monitoring at main-drive outputs is not always possible, in which event the detectors are fed in advance of the drives, which are monitored with AMT/2 equipments used executively for drive change-over; see Section 3.4.2. A detailed description given later refers to an example using this arrangement, the reason for which is an introduction of newly-originated tone at a relay station with parent duty towards another relay station.

The above sufficiently indicates that generally similar control features are achieved by different methods. To summarise, the existing variants for monitoring comprise:—

(a) AM3/1 units alone, fed from drive monitors.
(b) AM3/1 units fed by drive monitors, and AMT/2 monitors used with drives.
(c) AM3/1 units at receiver outputs, and AMT/2 monitors used with drives.

5.3 Parent-station Tone Installation

5.3.1 Equipment and Supplies Fig. 24

The usual aggregation of equipment is described below. Installations tend to differ in minor respects, such as the method of mounting the detector units and providing their supplies.

The oscillators and detector units are carried by three 19-in. rack-mounting panels, generally accommodated on the transmitter input bay as the most convenient position for making connection with programme circuits. The total panel height is 17½ in., made up of 3½ in. for an Oscillator Mounting and Distribution Panel, PA1/10, and the remainder shared between two Amplifier Mounting and Supply Panels, AMS/1. One extra item, a key-switch for the resetting of detector units, is fitted on a 1¾-in. panel placed near the AMS/1 panels.

The circuit diagram of the PA1/10 panel, Fig. 24, includes the OS2/5 oscillators which are added to make up the complete apparatus within broken lines in Fig. 5.1. The oscillator, described later, is constructed in box form as a plug-in assembly, secured to the panel by a single Dzus-type fastener with a head to be seen on removing a cover from the unit.

with slotted shaft-ends concealed by domed screw-on caps. Above these, cleared by a cut-away in the panel cover, are the signal lamps and test jacks connected to the oscillator outputs. Towards the left are the two oscillators and a 40-way terminal position.

Most equipments commonly related with several programme services draw any 50-volt supplies they need from C1B Common (5A and 5B) outlets of the 50-volt systems. The oscillator panel differs in taking P.I.E. Executive feeds, from 4A and 4B outlets at stations radiating three programme services. At four-programme stations the equivalents are 6A and 6B feeds.

The AMS/1 panel has mountings for three plug-in units and incorporates a mains unit to

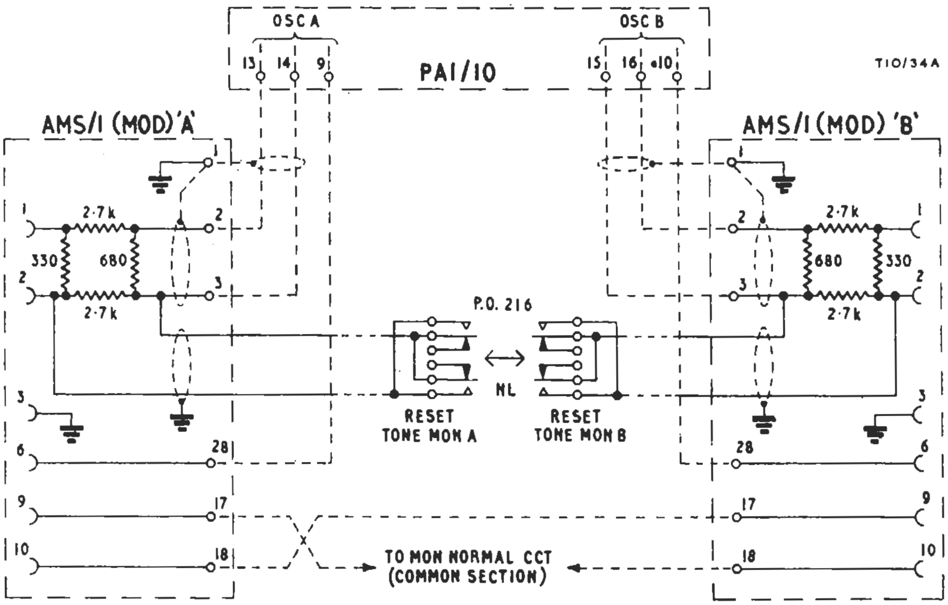


Fig. 5.2 20-kc/s Tone Monitoring System: Panel Interconnection at Parent Station

The panel has a front cover which encloses the oscillator units and components as in Fig. 24. At the right is relay RLA and tag boards carrying all fixed resistors used with the oscillator outputs. On the upper board of a two-tier layout are separate groups of resistors connected with the individual oscillators, and also the three resistors (R7, R35 and R36) for compensative loading of the in-service oscillator. The lower board carries two groups, R17 to R25 and R26 to R34, in outlets to programme circuits. On the lower part of the central sub-panel are controls RV1 and RV2,

provide their supplies. This panel was first produced as part of the Type-B studio equipment, and its description with a circuit diagram is in Section 21 of Instruction S.3. For tone monitoring at parent stations each panel is fitted with an AM3/1 detector, so that A and B mains supplies can be used one with each. The detector occupies the No. 1 mounting, furthest from the mains unit, and the loss pad in its tone feed is placed behind the panel at that position. The mains unit is set for the light-load condition appropriate to the demand of a single unit, by transformer-tapping adjustment as noted on the above-mentioned circuit diagram.

AMS/1 panels are referred to subsequently although, as an instance of variation, both detectors may be placed on an AP/3 panel. This has four plug-in mountings, but no mains unit. Like the AMS/1 panel it is adapted with loss pads in leads from the terminal block to occupied positions. For operating supplies, A and B, it is usual to rely on mains units employed with other apparatus on the bay.

Fig. 5.2 gives the interconnection of the three-panel assembly. The normal state of each associated pair of units is signalled on the PA1/10 panel, by a lamp lit while an earth path exists through a normally-open contact of the relay in the AM3/1 and the AMS/1 plugging connectors 3 and 6. The A-lamp circuit incorporates relay RLA (Fig. 24) by which preference is given to the oscillator-A output.

The relay in each detector unit has another normally-open relay contact providing signalling by the series arrangement of connectors 9 and 10 at both AMS/1 panels. These two relay contacts operate on a 50-volt supply, usually 5A, for use in common with monitoring-normal systems of the several programme chains. For example, by inter-bay wiring the contacts would be placed in advance of the Test Key in Fig. 4.4, as well as preceding equivalent circuits associated with the other CIP's. Consequently a failure of 20-kc/s equipment is marked by general loss of monitoring-normal indications, as distinct from individual signalling relevant to the monitoring employed with particular programme chains. Descriptions which accompany Figs. 4.4 and 4.6 contain information about remote-indication and alarm facilities for drawing attention to monitoring abnormalities. Fig. 5.2 shows how one series element of a loss pad is temporarily short-circuited to increase the input of an AM3/1 and so restore its relay to the operated state. A key-switch is usually employed for hand-resetting, although it is possible to substitute relay contacts to make the process automatic.

5.3.2 Tone Distribution Arrangements

Injection of tone into programme circuits is normally undertaken in ULR panels, where spare U-link positions are utilised to make connection as for the single tone feed in Fig. 5.3.

The given values for the resistor network are suited to bridging connection on a circuit with source and destination impedances of 600 ohms, giving a side-chain termination of effectively 300 ohms. These main-circuit impedances must apply at 20 kc/s, otherwise the network series-arms need adjusting to secure the requisite loss at the injection point. Similar alteration is carried out where, in any event, main-circuit impedances differ from the stated value. The setting-up procedure during installation includes measurements to check that injection-point levels are within 0·5 dB of —30 dB. The tone outlet for test measurement at the —10 dB level is wired to some convenient position such as a pair of U-link sockets, with the 600-ohm resistor between them. at one of the ULR panels.

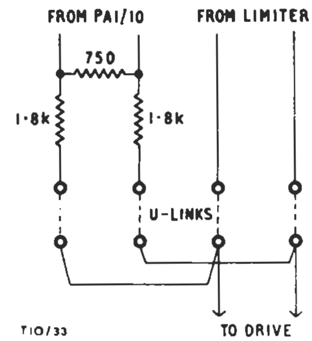


Fig. 5.3 20-kc/s Tone Monitoring System: Connection of Tone Feed in ULR Panel

Fig. 24 shows the oscillators have dummy loads with values of 1,000 ohms. Substantially the same value is presented for the in-service condition owing to pre-adjustment of fixed resistors for adding loading consistent with the number of tone outlets in use. One resistor, R7, is permanently in circuit, and one of another two is paralleled with it. Where six feeds are taken the additional resistor is R35, and with three feeds it is R36. These alternative pairings are adequate for keeping within a permissible tolerance of 10 per cent when using any number of outlets up to the maximum available.

5.3.3 20-kc/s Fixed Frequency Oscillator OS2/5 Fig. 25

This equipment employs pnp transistors in delivering tone with a virtually sinusoidal waveform at a level of +20 dB into a 600-ohm load. It is designed to work with a 50-volt d.c. supply, has only a single control for limited alteration of frequency, and is issued with the output level predetermined by a fixed adjustment.

The unit is built as a plug-in assembly with approximate overall dimensions of 2½ in. width, 3½ in. height, and 6 in. from front to back. The chassis, fitted with a slide-on cover, is a U-section as seen from the side, with a partition between the front and rear walls. At the rear is a tongue serving as a catch when attached to the PA1/10 panel mounting, and extending in a sleeve through the unit is a Dzus-type fastener with which it is secured in position. Components dispersed about the interior include two transistors fixed by clips to the front wall, and four more similarly attached near the rear end of the partition. For external connection the chassis is fitted with the plug portion of an eight-way key-formation connector.

Fig. 25 shows oscillator and driver stages using OC71 and OC202 transistors respectively, and a push-pull output stage with two OC72 transistors parallel-connected in each half. All are employed in the common-emitter configuration, and their effective operating supply is about 25 volts owing to the total-current loss with R10 interposed between the external supply and negative rail.

TR1 is used in an oscillator circuit which is the subject of a BBC patent application[1], and the general principles of its operation are described in Appendix D. This oscillator is characterised by a small negative drift in frequency, of the order of 100 c/s in three hours, after the supply is switched on. Most of this change occurs within the first 30 minutes, which should be regarded as the minimum period before an adjustment of frequency is attempted. Adjustment is carried out in the TR1 emitter circuit, using RV1 which provides for a 2 to 1 range of resistance values. The control is a screwdriver-adjusting type, with a locking collar for the shaft extending through the front of the unit. The acceptable limit for frequency adjustment is ±50 c/s.

The oscillator stage provides a signal input for the driver stage by direct connection from its emitter circuit, with R8 introduced to reduce the loading otherwise imposed from TR2. This transistor works in Class A with the output applied to the push-pull stage through a transformer with the centre-tapped secondary shunted by R13. The individual equipment has that resistor fitted after a test to ascertain the particular value needed for the output stage to deliver the +20 dB level across a 600 ohm load. Change in output level from supply-voltage variation is about ±0·5 dB for ±5 volts alteration. The final stage uses TR3 to TR6 conventionally with an output transformer with two secondaries that become paralleled when the unit is mounted on the PA1/10 panel; see Fig. 24.

[1]No. 5455/58

The following table gives typical voltages and currents measured with a Model 8 Avometer set to the 10-V, 100-V and 10-mA ranges as appropriate.

Transistor	*Volts*			*Collector Current (mA)*
	Collector	*Base*	*Emitter*	
TR1 ..	3·6	0·8	0·7	0·85
TR2 ..	6·5	0·85	0·3	4.5
TR3 (4,5,6)	24·5	4·6	4·5	4·9

In lieu of the usual harmonic distortion test it will suffice to view the output waveform on an oscilloscope, with the equipment terminated in 600 ohms. The display should show a reasonably sinusoidal shape without clipping of either peak.

5.3.4 Amplifier Detector (20 kc/s) AM3/1 Fig. 26

The amplifier detector is designed to monitor 20-kc/s tone at any level between −50 dB and −20 dB in a source impedance of 300 ohms, as presented to the input bridging a circuit with the usual 600-ohm terminal impedances. The equipment has high input impedance, such that programme-circuit loss from its connection is not more than 0·1 dB. It has a single control, operating on the input as a sensitivity adjustment determining the applied level necessary to operate a relay. External supplies are required, comprising 300-volt h.t. with a nominal maximum current drain of 15 mA, and a 6·3-volt heater supply at 0·6 amperes. The circuit diagram is given in Fig. 26.

Constructionally the unit follows the general pattern for panel-mounting plug-in units. Components are assembled on a tray chassis, secured to a panel mounting by a Dzus fastener through the centre of the main surface. Fixed to an open edge of the chassis is a 10-way plugging connector with the standard in-line arrangement. The unit is complete with a louvred cover which slides on corner posts, and its approximate overall dimensions are 4 in. by 6 in. by 6½ in., the last being the front-back dimension.

The chassis is mounted with the main face vertical, and removal of the cover exposes most of the major components to view. They include a screwdriver-adjusting input control, an input transformer, two Ferroxcube pot-core inductors, and the relay with its own cover. Other items include a polarity-sensed socket for connecting a PTM/6 instrument to measure relay-coil current, and a miniature screw-in h.t. fuse. The two valves are in the special-quality category, one a CV4014 which is the superior version of an equivalent-type class including EF91 and 6AM6 pentodes. The other, a CV4024, is similarly related to the 12AT7 double-triode and corresponding types.

The circuit diagram in Fig. 26 shows the pentode V1 and triode V2A in a two-stage tuned amplifier followed by a half-wave rectifier feeding triode V2B. The rectifier, MR1, is connected to apply signal-derived d.c. with positive polarity to the grid of V2B, which is biased into anode current cut-off. Therefore, the relay in its anode circuit is unoperated for the no-signal condition.

Fixed-tuning of individual equipments is undertaken during production testing, when basic capacitance values are augmented to the exact values needed. The input circuit is made selective with a basic C1 increased sufficiently to give maximum wanted-signal voltage, measuring with a valve voltmeter across cathode resistor R3. Final values for C2 and C5 in the V1 and V2A tuned-anode circuits are similarly determined with maximum voltages across R5 and R10 respectively. The second-amplifier tuning must also satisfy a condition, as revealed by testing of the relay-operating stage, that frequencies for 3-dB down points of the response curve are found within specified, and comparatively narrow, bands spaced equally from 20 kc/s.

The large bias for V2B is obtained mainly by utilising V2A anode current and bleed current from h.t. positive through R17. With the commoned-cathode arrangement in Fig. 26, the V2A self-bias adds to the voltage developed on R6, as standing bias for V2B. Consequently there is an appreciable increase in both bias voltages when V2B is driven into conduction sufficiently to operate the relay in its anode circuit.

The d.c. developed on diode load R10 is applied to V2B grid through a filter, R11 and C9. In V2B anode circuit is C7 shunting the relay coil to offer a low-impedance path for a.c. components, in addition to by-passing provided by C11 between anode and earth. C11 has a value great enough to give a slight delay in release of the relay. Under the no-signal condition the relay coil is paralleled also by C10, a high-value capacitor which imparts a slugging action to contact-make operation that results in its disconnection and discharge through R22. This is a safeguard against false relay operation that could otherwise occur from the impulsive effect of transients at the input, especially owing to atmospheric static discharges, and therefore it is of particular importance in equipments at the receiving sites.

On an equipment with no signal input the voltages measured with a 20-kilohm/volt instrument, such as the Avometer Model 8, should be substantially as tabled below.

Valve	*Volts*		
	Anode	*Screen*	*Cathode*
V1	270	110	1·3 ± 0·3
V2A	180	—	22·0* (V2A and V2B)
V2B	270	—	

*Effective V2A bias of approximately 1·25 volts.

5.3.5 Operational Details

During the commissioning of a 20-kc/s tone installation the adjustments include:

(a) Connection of fixed resistors (in the PA1/10 panel) appropriate to the number of tone outlets in use, to make the load switched to the working oscillator have a value of 1,000 ohms ±10 per cent. This can be checked simply by feeding a test amplifier-detector from one of the test jacks, JKA and JKB, while operating and releasing the change-over relay RLA. A satisfactory state is shown if the reading remains approximately the same under both conditions.

(b) Choice of suitable values for the series resistors in programme-circuit isolating networks; see Fig. 5.3 and related description. Tone injected at a point of zero level line-up is adjusted to —30 dB ±0·5 dB.

Subsequently the setting-up operations given below should be carried out at reasonably frequent intervals to ensure that correct working conditions are being maintained. N.B.—After line-up the gain of a modulator-drive unit should not be altered to compensate a programme-circuit change occurring in advance of the 20-kc/s tone injection point.

(i) Connect a test amplifier-detector (600-ohm input) to No. 2 jack on the PA1/10 panel. Adjust RV2, below the jack, to obtain a reading of −12 dB.

(ii) Turn the input control of No. 2 (B) AM3/1 slowly from maximum until the internal relay *just releases*, as shown by extinguishing of the associated lamp on the PA1/10 panel.

(iii) Readjust RV2 to the setting where the amplifier-detector indicates −10 dB.

(iv) Repeat the (i) to (iii) procedure with reference to No. 1 jack, RV1 and the No. 1 (A) AM3/1 input control.

The prescribed order should be followed so that release of change-over relay RLA (PA1/10 panel) switches the distribution networks to an oscillator (No. 2) already set for the correct output level.

(v) Use the high-impedance input of the test amplifier-detector in checking that the level at the external test jack, connected to one of the PA1/10 outlets, is still substantially −10 dB ±0·5 dB.

5.4 Relay-Station Programme Control System

The following description concerns arrangements using 20-kc/s tone in automatic programme-feed selection as outlined under 5.1, the usual control application at Band II relay stations. Control through 20-kc/s tone can also extend to transmitter powering, but that facility is not dealt with in this Instruction.

Band II sites do not necessarily work as satellites for all three domestic sound services, and in many instances the Home programme is taken by line. Thus the installations using v.h.f. links differ both in their equipment complements and in detail matters for overall programme control. The underlying method is to be illustrated by reference to the Light Programme arrangement at a station where Third Programme also is taken by v.h.f. link, but the Home transmitters have line-fed programme. This was chosen because it embodies the means of tandem working, with the particular relay station acting as parent to another relay station.

5.4.1 Equipment

The installation taken as an example is made up largely of rack-mounting bays to be found at line-fed sites, namely a Transmitter Input Bay (BA13/1), Rebroadcast Receiver Bay (RCB/1), Control and Indication Bay (CIB) and an Automatic Monitor Bay (AMTB/1). A limiter bay is not provided, the two limiters needed for Home Service being accommodated on the transmitter input bay. The AMTB/1 is equipped with two pairs of AMT/2 monitors used with the Light and Third Programme transmission chains.

Completing a five-bay assembly is a V.H.F. Receiver Bay holding two receivers (RC5/1A and RC5/1B) for each of the two services employing wireless link. Associated with these are a lamp panel providing indication from receivers and tone monitors, a U-link panel for connection from receivers and for feeding the tone monitors, and a filter panel FL4/5.

The filter panel is an extra item in connection with the tandem working previously mentioned. It is used to remove the received 20-kc/s tone so that locally-generated tone can be injected as at true parent stations. This practice ensures that the intermediate station is capable of radiating 20-kc/s tone at the requisite level relative to programme line-up, and it also provides for the presence of monitoring tone if the a.m. receiver is brought into use. Accordingly the v.h.f. receiver bay also contains a PA1/10 panel and two AM3/1 units to monitor its oscillator outputs, in an arrangement like that at the parent sites. All AM3/1 units, including four used in conjunction with the receivers, are carried by an AP/2 panel designed to hold a maximum of 12 plug-in type amplifiers.

The tone monitors used with the receivers apply control through an RLP/31 panel containing groups of relays suitably arranged for the switching facilities needed in the two link-fed transmission chains. They, and the two equipments for oscillator-output monitoring, draw operating supplies from an MU/51A unit used with an SDP/2 distribution panel. One of each pair of monitors uses A-derived supplies and the other B-derived supplies, on the usual safeguarding basis. Similarly the pairs of v.h.f. receivers, incorporating power-conversion equipment, take a.c. feeds from the A and B halves of the power-supply system. The a.m. receivers at the RBR bay have supplies appropriate to their duty as second-reserve sources of programme feed. For instance for Light the typical allocation of supplies is:—

A mains: RC5/1A, AM3/1 No. 1A and l.w. receiver
B mains: RC5/1B, AM3/1 No. 1B

Relays in the v.h.f. receiver bay are operated with programme-related 50-volt feeds, 1A/1B (Light) and 2A/2B (Third). These, and a 5·5-volt supply for signal lamps, are obtained through the distribution from the control and indication bay. The 20-kc/s oscillators use special individual feeds from the P.I.E. Common (5A and 5B) branches of the 50-volt system.

of attenuation at 20 kc/s. This may have to be compensated in the adjustment of tone monitors.

Normally the A receiver is in service, while its tone monitor remains operated to keep an external B relay energised so that the drive-A output is switched to the transmitters. Tone failure causes drive change-over whereby the B branch is switched into service. Failure confined to the A branch

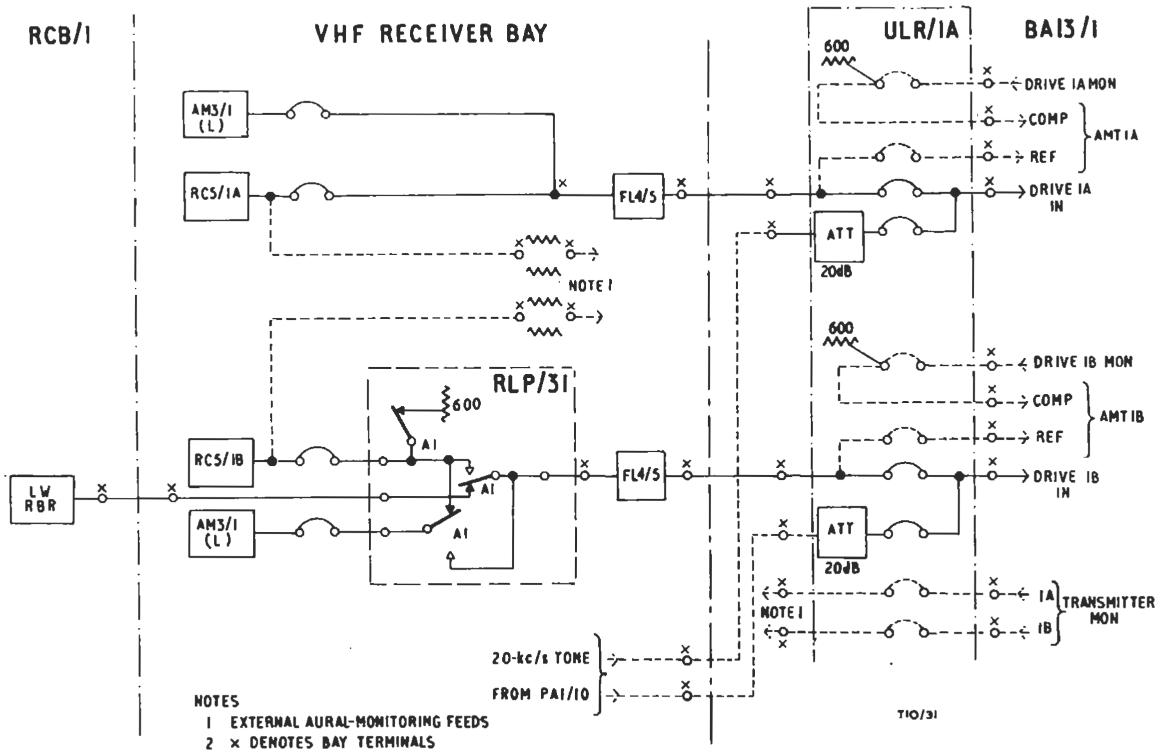


Fig. 5.4 Schematic of Receivers and Tone Monitors for Single Programme Service at Station providing Link Service to Another Relay Station

5.4.2 Programme-feed Selection

The three-stage selection is undertaken partly by receiver-output switching, as given in Fig. 5.4, and partly through drive change-over. The diagram indicates by broken lines the provision for using AMT/2 monitors in connection with the A and B drives, and other features relevant to the particular installation. Reference is made later to the simplification resulting from omitting the means of tandem working.

The v.h.f. receiver outputs are adjusted to 0 dB and, therefore, the level of 20-kc/s tone at the monitoring points should be —30 dB. The last value is nominal for, as explained under 5.2, individual links are liable to small differing amounts

results in use of the reserve v.h.f. receiver, connected through operated A1 contacts under control of tone monitor B. When that monitor also is affected by-tone failure, the A1 contacts are released to positions as in Fig. 5.4, and so the l.w. receiver feeds the reserve drive.

Through the same relay action the B receiver is switched to a resistor simulating the in-circuit loading, as the B tone monitor is transferred from the programme circuit to its output. This is a standby condition which enables the v.h.f. receiver to be substituted automatically for the l.w. receiver as soon as tone reappears. Where such restoration follows common failure, however, the A tone monitor exercises over-riding control through a drive change-over to establish a normal working condition with branch A in service.

In this instance the tone monitors are necessarily tied to receiver outputs owing to the use of a low-pass filter (FL4/5) in each branch to remove incoming 20-kc/s tone. Additionally AMT/2 units, fed as in Fig. 5.4, are needed for a complementary monitoring of the drives. These monitors work executively, for drive output change-over when drive faults occur, in control which is independent of the system being described.

The filters are omitted at relay stations not engaged as intermediaries for tandem working, and consequently 20-kc/s tone is present in their drive outputs. In that circumstance the A tone monitor is fed at the stipulated level from the drive-A monitor (part of the basic drive equipment and providing for aural programme-checking) and the AMT/2 equipments are not used. For this arrangement the control is as already described, with tone monitor A in sole charge of transfers between the two drives.

Fig. 5.4 shows take-off arrangements in connection with aural monitoring facilities at the particular installation; others may differ in minor respects. Note that at combined Band I/Band II stations, as in this instance, the monitoring is usually centralised on the t.v. control desk, where a multi-way switch can be used to select from sound-services and television-sound feeds.

5.4.3 Control and Signalling Circuits

Details of circuit arrangements to provide operational features described under 5.4.2 are given in Fig. 5.5. The particular RLP/31 panel contains C1, C2 and D relays in addition to those in the diagram, and for Third Programme control their functions are equivalent to those referred to in following description. Information about the FIP/1, CIP/1 and ULR/1A panels is in previous Sections of this Instruction.

The AM3/1 units jointly control three relays, A1 for programme-feed switching in branch B (Fig. 5.4), B primarily for indirect programme-

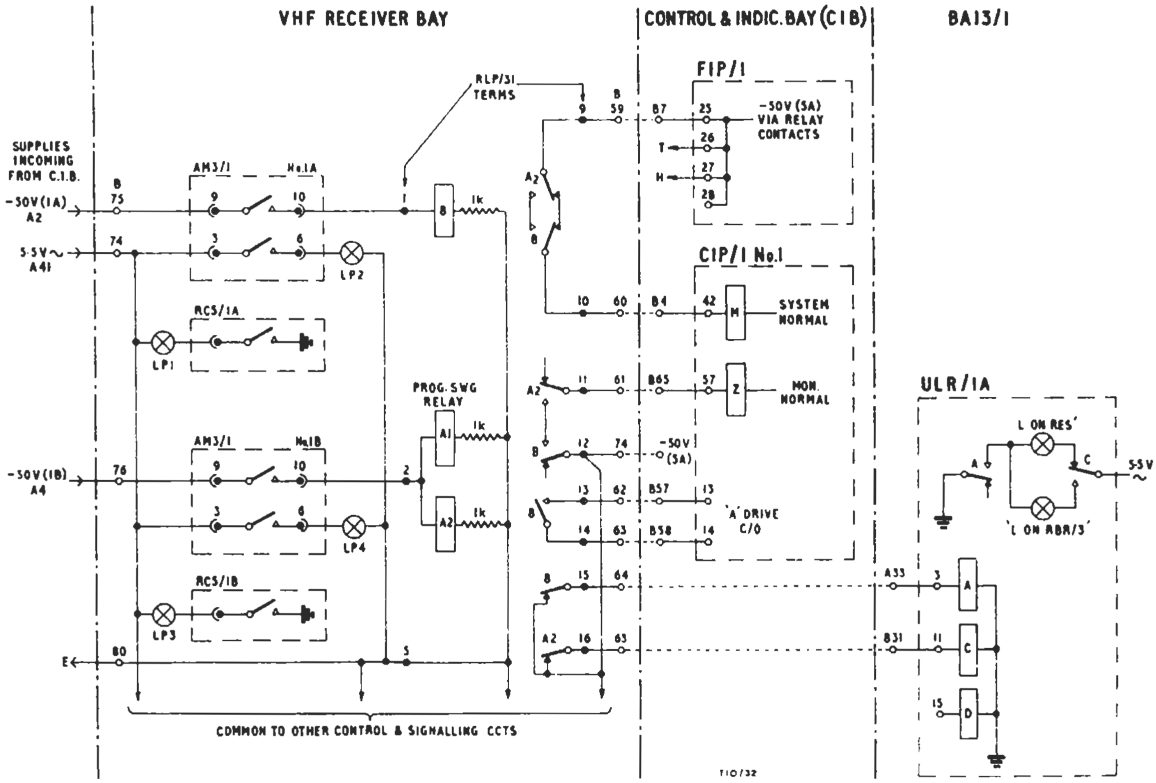


Fig. 5.5 Control and Signalling Circuits for Single Programme Service

feed alteration through drive change-over, and A2 which is used solely for signalling. Normally they are all energised when, with adequate tone levels at the v.h.f. receiver outputs, the relays in tone monitors are operated. That state is indicated by lighting of LP2 and LP4 on the lamp panel, where LP1 and LP3 also are lit while carrier-failure relays in the v.h.f. receivers are operated.

The use of A1 contacts to connect either of the reserve receivers to drive B has been mentioned. For drive change-over control the A and B drives are treated as master and slave respectively, by setting the selector switch on the CIP/1 at position 2 (A or B). The CIP/1 terminals 13 and 14 are associated with drive A, which remains in service so long as the terminals are bridged by the B-relay contact between them. Where AMT/2 monitors are employed, as at the example installation, independent drive control is effected with their relay contacts normally bridging terminals 11, 12 (A monitor) and 25, 26 (B monitor) of the CIP/1. With the simpler arrangement of equipment referred to earlier, no AMT/2 monitors and one AM3/1 tied to the drive-A output, these pairs of terminals are strapped. See Section 3.4 for supplementary explanations.

The condition of the switching system is signalled remotely by using A2 and B relay contacts on principles applying at line-fed installations. For instance, the FIP/1 connection with the System Normal relay is only a variant from the several examples in Fig. 4.5. Note that this relay is energised provided the tone monitors are either both operated or both unoperated, whereas the Monitoring Normal relay is energised only while the first-mentioned condition exists. The ULR/1A indication facilities are restricted to showing whether either of the reserve receivers is in use; the panel has another lamp which is used with relay D for signalling relevant to Third Programme control.

5.4.4 Low-pass Filter FLA/5 Fig. 27

This filter, designed to work between 600-ohm impedances, is for rejecting monitoring tone from link-derived programme feed. Ordinarily it is used at relay stations which have parent responsibility to other transmitting sites, as explained under 5.4.2.

As issued the filters are fitted on a 3½-in. rack-mounting panel capable of accommodating four separate units, sufficient for two programme chains arranged as in Fig. 5.4. The filter circuit is shown in Fig. 27, which includes a table giving tag-block terminal references for the individual units.

J.R. 0961

APPENDIX A

OPERATING INSTRUCTIONS: LIMITERS LIM/6 AND LIM/6A

For their intended application at v.h.f. transmitting stations these equipments are normally set to limit at + 12 dB. Information below includes their adjustment for that condition and illustrates method if limiting at some other level is required. In this event the only change is substitution of the appropriate value for 12 in the itemised account of procedure.

(a) Supplies

These are connected to the unit through a 12-way miniature plug wired as follows:

Pins 10 (+) and 7 (− and earth) to 300-volt h.t. supply.

Pins 9 and 12 to 6·3-volt a.c. supply at 1·5 amperes (Centre-tap of this supply *must* be connected to earth).

Pins 2 (−) and 5 (+ and earth) to 50-volt d.c. supply.

(b) Alignment

(*i*) *Bias Controls*

With no audio input to limiter and switch SWB at setting marked V1 and V2 ÷ 2, adjust the Bias control so that meter reads 16 mA. Turn SWB to Rel. Bias position and note meter reading after Rel. Bias control has been adjusted so as to make the travelling contact of the moving-coil relay just touch the *unconnected* fixed contact. The indicated current should be 15 mA approximately. Note: This setting has been found preferable to one giving 16 mA through the relay-bias coil also, as it provides a greater margin against an effect of mains-voltage variation. With equal coil currents the operative contact should close for a tone input-level increase of less than 1 dB from the value at which limiting starts. An even smaller increase of input can result in limiting indication if subsequent to a setting-up operation a mains-voltage change causes the travelling contact to shift towards the connected fixed contact. Using unequal coil currents as above slightly reduces the high sensitivity of the system but also avoids a too-frequent signalling of limiting as the result of the effect described.

(*ii*) *Balance Controls*

Terminate the input and output circuits with 600 ohms, set Output Level control for maximum gain, and connect a Test Programme Meter to measure the audio output. Then adjust the Hum Bal. control for minimum deflection of the meter. N.B. This control will not operate correctly unless the heater supply centre-tap is earthed as noted above.

Leave test conditions as in previous paragraph, but also turn the Limiting Level control fully anti-clockwise, and measure output with a high-impedance amplifier-detector instead of the programme meter. Press the Set Bal. push-button repeatedly at intervals of not less than one second whilst adjusting the Balance control for minimum deflection on the amplifier-detector.

Set switch SWB to V1 and V2 ÷ 2 setting and, if necessary, readjust the Bias control so that meter reads 16 mA.

(c) Level Controls

Retaining the 600-ohm input and output terminations as above, and the high-impedance amplifier-detector for measurement, apply 1,000-c/s tone at zero level to the input. With the Limiting Level control fully anti-clockwise and the Limiting dB control at 0, adjust the Output Level control to give zero-level output.

Set switch SWB to V1 and V2 ÷ 2 position and check that meter M1 still reads 16 mA. Turn Limiting dB control to 12 dB, and check that output-level reading on the amplifier-detector is + 12 dB. Slowly rotate the Limiting Level control clockwise until meter M1 shows a slight reduction of current, marking the onset of limiting. For this threshold condition the output-level reduction by limiting should not be apparent from the amplifier-detector reading. Leave the Limiting Level control at the position obtained, and the Limiting dB control at 12 dB.

Check that relay A in the limiter is not operated with the input at 0 dB but operates consistently for the particular input-level increase as determined by the Rel. Bias adjustment; see note under Bias Controls heading. Restore the Limiting dB control to 0.

(d) Maintenance Instructions

(i) Voltage and Current Measurements

Voltages measured with a Model 40 Avometer across various resistors should be:

Resistor	*Voltage*		*Meter Range*
R11 (V3A cathode)	0·85 v.	± 20%	12 v.
R44 (V3B cathode)	1·70 v.	± 20%	12 v.
R27 (V5 cathode)	30·0 v.	± 20%	120 v.
R31 (V6 anode)	50·0 v.	± 20%	120 v.

The V4A and V4B cathode currents, as read with internal meter M1, should be 6·8 mA ± 20 per cent and not differ from one another by more than 0·3 mA.

(ii) Test Conditions

Input of limiter terminated with 600 ohms.
Output level measured into 600 ohms.
Limiter gain of 0 dB.
Limiting Level control set so that limiting starts at + 12 dB.

(iii) Limiting Characteristics

Using 1,000-c/s tone and measuring with the amplifier-detector, the following output levels should be obtained:

Tone Input Level (dB)	*Limiting dB Control Setting*	*Output Level (dB)*
+ 4	0	+ 4
+ 8	0	+ 8
+ 12	0	+ 12
+ 12	2	+ 12 { − 0 / + 1
+ 12	8	+ 12 { − 0 / + 1·5
+ 12	16	+ 12 { − 0 / + 2

(iv) Frequency Characteristic

With Limiting dB control at 0, check that the unit has a gain of 0 dB, and that limiting starts at + 12 dB. Alter tone input-level to − 10 dB for various frequencies and measure output levels which, relative to that at 1,000-c/s, should be within the following limits.

Frequency (c/s)	*Output Level (dB relative to level at 1,000 c/s)*
40	− 1·0 ± 1·0
60	− 0·4 ± 0·4
10,000	− 0·5 ± 0·5
15,000	− 1·0 ± 1·0

Increase input level to 12 dB and set Limiting dB control at 4 for a further check which should give values within the following limits.

Frequency (c/s)	*Output Level (dB relative to level at 1,000 c/s)*
40	− 1·0 ± 1·0
60	+ 1·0 ± 1·0
5,000	− 5·0 ± 1·0
10,000	− 10·0 ± 1·5
15,000	− 13·0 ± 2.0

(v) Harmonic Distortion

Check that the limiter is still balanced, that the gain is 0 dB, and that limiting starts at + 12 dB when the Limiting dB control is at 0.

Measurements of total harmonic distortion for various conditions should give figures better than those tabulated below.

Input Level (dB)	*Limiting dB Control Setting*	*Harmonic Distortion at: 90 c/s*	*1,000 c/s*
0	0	− 40 dB	− 55 dB
+ 12	0	− 40 dB	− 50 dB
+ 12	12	− 40 dB	− 50 dB
+ 12	16	− 35 dB	− 45 dB

(vi) Noise

Set Limiting dB control at 0 and inject 1,000-c/s tone at zero level. Measure audio ouput across 600 ohms, using a Test Programme Meter with the controls set at 0; a reading of 4 should be obtained. Disconnect tone input and adjust controls of TPM until meter peaks 6, also checking that the Hum Bal. control is correctly adjusted. Signal-noise ratio as read from the TPM controls should be better than 55 dB. Restore the 1,000-c/s tone input at zero level.

(*vii*) *Relay Operation*

Under the non-limiting condition check that M1 reads 16 mA at the V1 and V2 ÷ 2 setting of SWB, and that the appropriate current is indicated at the Rel. Bias setting of the meter switch; see explanation under heading (*b*). Increase input level until limiting just occurs. Then check relay A for consistency of operation by further increase of input level as described under heading (*c*).

(*viii*) *Listening Test*

Conduct this test with programme applied at zero volume to the input, and with the Limiting dB control at 12. Absence of spurious noises due to limiting action is indicative of satisfactory operation.

APPENDIX B

OPERATING INSTRUCTIONS: AUTOMATIC MONITOR, AMT/2

The procedure detailed below deals specifically with operations when the monitor is in use with an f.m. transmitter, as described in Section 3. An essential preliminary to these operations is the correct setting-up of audio gain for the transmitter, such that a 1,000-c/s input at zero level produces a carrier-frequency swing of ± 19·2 kc/s. Apparatus needed for making measurements comprises:

Portable Test Meter, PTM/6
High-impedance Amplifier Detector
Avometer (Model 1, 7, 8 or 40)

Before completing the mains supply for the monitor:

(*a*) Ensure that the 12-way socket is correctly wired and connected to the equipment.
(*b*) Set mains-transformer primary connections on tappings suitable for measured mains voltage.
(*c*) Remove V4 (G240/D) from unit.
(*d*) Ascertain that neither the transmitter nor monitor have a.f. inputs.
(*e*) Select the desired transmitter drive, A or B, and make certain that the Test Key on the IAP, if employed, is not operated.

Then power the monitor and transmitter.

After a warming-up delay the lamp LP1 (V1. Cath. Current) should light first, to be followed after a further interval of 80 seconds ± 40 seconds by lighting of LP3 (Demute) and LP5 (Delay). During this period check that the Mon. Normal indication is given at the CIP coincidentally with lighting of LP3 at the monitor.

Connect the feed plug of the PTM/6 in turn to the internal feed sockets of the monitor, to check that each feed-meter reading is mid-scale ± 15 μA. Place the four-pin plug from the PTM/6 in the Bal. Meter socket on the monitor front-panel, and adjust the V3 Bal. control to obtain a mid-scale reading on the left-hand meter. Verify that the control works in the correct sense, to give a meter-pointer movement in a direction corresponding with that in which the knob is being turned. With some valves it is not possible to obtain an exact balance, but a reading within 20 μA of mid-scale is acceptable as a working condition. Failing this the valve should be rejected for use in other equipment types with less stringent requirements. Check that a mid-scale indication is given by the right-hand meter of the PTM/6, which should be left connected to the monitor.

Use the Avometer to measure the operating voltages, which should be inside the following limits:

Voltage across C19a	310 v. ± 25 v.
Voltage across C21	– 50 v. ± 5 v.
Voltage across C20	– 14 v. ± 6 v.

(a) High-level Sensitivity

(i) Place Test Sens. switch at 0 dB setting, and apply 1,000 c/s tone at + 5 dB to a.f. input for transmitter. Take measurements with amplifier detector to ensure that the level at the Ref. Prog. List jack on monitor is + 5 dB, and that at the Comp. Prog. List. jack is the same within ± 0·5 dB.

(ii) Turn Adj. Comp. Prog. control to the position giving a reading of zero on the right-hand meter of PTM/6.

(iii) Increase tone level by 8 dB, and then reduce it gradually to zero level whilst watching that the right-hand meter maintains a balance indication within ± 10 μA.

(iv) Set the Test Sens. switch to a loss of 2 dB and *slowly* increase the input level until a maximum negative deflection is shown on the right-hand meter of PTM/6. This should occur at an input level of + 7·5 dB, otherwise the Increase Lim. Point control should be adjusted until that condition is obtained.

(v) With the input level still at + 7·5 dB, reset the Test Sens. switch to 0 dB position, and then rotate it slowly until the Fault lamp (LP2) lights. This should occur at, but not before, the 2-dB marking. If not, alter the Increase Sens. control until the condition is secured, the *re-testing after each adjustment of the control beginning with the Test Sens. switch at 0.* With the alarm just operating the right-hand meter of the PTM/6 should show a deflection of 46 μA ± 11·5 μA to *left* of mid-scale.

(vi) Turn Test Sens. switch to 0 dB and reduce input level to + 6 dB.

(vii) Slowly increase the tone frequency, during which the right-hand meter of the PTM/6 should show an increasing deflection to the right while the left-hand meter remains at mid-scale ± 10 μA. Revert to 1,000-c/s tone, and then start slowly reducing frequency to 60 c/s, during which the right-hand meter should deflect increasingly to the right as the left-hand meter remains balanced within ± 10 μA.

(b) Noise Sensitivity

(viii) Set Test Sens. control at 0 dB and disconnect the input from the Ref. Prog. Input position. Adjust the input tone to zero level at 1,000 c/s, for which the left-hand meter of PTM/6 should have a large deflection and relay RLB should be operated.

(ix) Reduce the input level to a value, about − 40 dB, at which the relay opens, and then slowly increase the level until the relay re-operates. This gives the sensitivity to noise at 1,000 c/s. Values at this and other frequencies, to be obtained by repetitions of the method described, should lie within the following limits:

Frequency (*c/s*)	*Noise Sensitivity* (*dB*)	
60	− 22.5	± 5 dB
110	− 26·5	
250	− 26	
1,000	− 24	
5,000	− 16·5	
10,000	− 12	

Check that the left-hand meter of the PTM/6 shows a reading of + 60 μA ± 15 μA for the just-operated condition of relay RLB.

(c) Alarm Delay Time

(x) Reset the frequency to 1,000 c/s and reduce input to − 40 dB.

(xi) Insert V4 and increase the tone input until Fault lamp (LP2) lights. Note the interval between operation of relay RLB, as shown by the Fault indication, and operation of relay RLE, marked by lighting of Alarm lamp (LP4); this should be between 0·5 seconds and 2 seconds. Also check that the Mon. Norm. lamp on the CIP is extinguished as the Alarm lamp lights.

(d) Programme Balance

(xii) Restore the feed to Ref. Prog. Input of monitor and disconnect tone to substitute programme at zero level, peaking well up to 6 on PPM scale.

(xiii) Press Reset switch on monitor and keep it operated until Alarm lamp (LP5) is extinguished.

With programme applied and the Test Sens. switch at 0 dB, the right-hand meter of PTM/6 should show varying deflections to the right, but should not deflect to the left of mid-scale by more than 10 μA. Under these conditions the left-hand meter may show deflections to right or left of centre scale, not exceeding 25 μA. Having observed the balance to be satisfactory:

(xiv) Turn Test Sens. switch to 2½ dB marking.

Then the Fault lamp should light fairly frequently and the right-hand meter of the PTM/6 should swing fairly often to the left of mid-scale to the extent of 25 μA or more. Check that the monitor gives an alarm after three or four successive operations of the Fault lamp.

(xv) Restore the Test Sens. control to the normal 0 setting, reset the monitor and re-check that it shows a satisfactory balance on programme.

APPENDIX C

OPERATING INSTRUCTIONS: LINE AUTOMATIC MONITOR, LAM

In this Appendix the information given first is based on production test schedules for individual equipment types, and followed by details relevant to the aggregated units at the sending and receiving positions.

A. Quadrature Splitting Panel, QSP/1

The test apparatus required comprises:

- Avometer (Model 7, 8 or 40).
- Portable Test Meter, PTM/6.
- High-impedance Amplifier Detector.
- Test Programme Meter, TMP/3.
- Tone source covering the range 40 c/s to 10 kc/s and capable of providing an output up to + 20 dB.
- A Phase-measuring Circuit.

(a) Preliminary

It is assumed that the circuit has been checked, and that the valve and U-links are fitted. Make use of an 18-way miniature socket with the QSP/1, wired to connect:

- Pins 3 (+) and 4 (– and chassis) to h.t. supply at 300 volts,
- Pins 5 and 6 to 6·3-volt a.c. supply,
- Pin 18, or 4, to earth.

After warming-up period, attach the feed plug of the PTM/6 to V1 Feed socket at front of QSP/1. The feed meter should register 50 μA ± 10 μA.

(b) Gain

(i) Place Input Volume control at 0 dB setting.

(ii) Terminate the tone source in 600 ohms, and feed 1,000 c/s input at zero level to QSP/1 by connection with pins 1 and 2 of the 18-way socket.

(iii) Check with amplifier detector that Upper output level, pins 7 and 8 of socket, is 0 dB ± 1 dB. Repeat measurement to check Lower output level, pins 9 and 10, is within similar limits.

(iv) Rotate the Input Volume control clockwise from 0, to check that the input required to produce zero level output corresponds with calibration within 0·2 dB. Starting again at 0, repeat calibration check in counter-clockwise direction. Then reset control to 0.

(c) Overload

(v) Increase input level to + 12 dB and check that output level has increased by 12 dB ± 0·25 dB. Then reduce the input to zero level.

(d) Frequency Response

(vi) Use the amplifier detector in an arrangement of apparatus as depicted schematically in Fig. C.1, to measure both the Upper and Lower outputs with a constant input at zero level for the frequencies listed below.

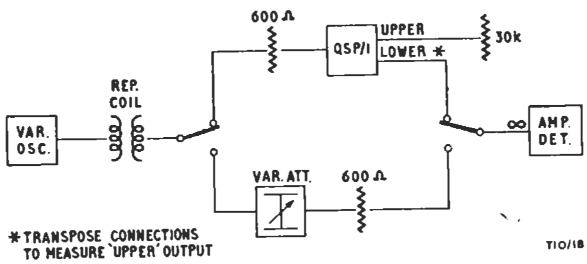


Fig. C.1 Test Apparatus for Measuring Frequency Response of QSP/1

The output-level figures, with tolerance values, are those which should be obtained in successive tests at the Upper output (pins 7 and 8) and Lower output (pins 9 and 10) positions.

Frequency (c/s)	*Output Level (dB)*	
40	– 12	± 1 dB
60	– 9	
150	– 2·5	
250	– 2	
500	0	
1,000	0	
2,000	0	
3,000	+ 1	
4,000	+ 1	
5,000	+ 1	
6,000	+ 1	
7,000	+ 1	
8,000	+ 1	
9,000	+ 1	± 2 dB
10,000	+ 1	

(e) Noise

(vii) Terminate the QSP/1 input with a 600-ohm resistor, and use amplifier detector to check that noise at each output does not exceed − 50 db.

(f) Output Phase Difference

(viii) Use test apparatus in connection with QSP/1 as indicated in Fig. C.2.

Note: The LG/124 transformers are connected so that the QSP/1 is loaded with a high impedance and the Phase-measuring Circuit is working from an input impedance of 600 ohms. Details of the Phase-measuring Circuit are available from Design Department Test Room.

Using expressions:

$$\varphi \text{ (degrees)} = 2 \cos^{-1} \text{antilog}_{10} \frac{\text{Voltage Sum in dB}}{20}$$

also

$$\varphi \text{ (degrees)} = 2 \sin^{-1} \text{antilog}_{10} \frac{\text{Voltage Difference in dB}}{20}$$

the following figures can be obtained:

Frequency (c/s)	*Phase Angle (degrees)*
40	90 ± 10
60	
150	
250	
500	
1,000	
2,000	70 ± 10
3,000	60 ± 10

An alternative, but less accurate, method is to use a Cossor Type-1049 double-beam oscilloscope for visually estimating phase angle. For this purpose, connect pins 8 and 10 of QSP/1 to earth terminal of the test instrument, pin 7 to the input of one Y-amplifier and pin 9 to the other input.

With an input of 1,000 c/s at zero level to the QSP/1 the two wave-traces should be seen 90 degrees out-of-phase. As frequency is gradually lowered to 40 c/s the phase difference should at no point be less than 60 degrees or more than 120 degrees, see Fig. C.3.

Reset the frequency to 1 kc/s and increase the input by 12 dB to check that the two output waveforms remain sinusoidal. Alter the frequency to 110 c/s and again check that the outputs are sinusoidal.

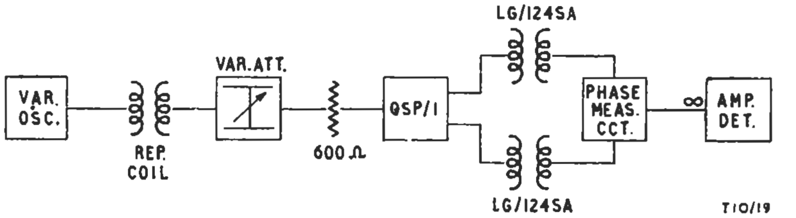


Fig. C.2 Test Apparatus for Measuring Output Phase-difference of QSP/1

B. Volume Folding and Limiting Amplifier, VFLA/4

The test apparatus required comprises:

A d.c. precision micro-ammeter to B.S. 89, having full-scale deflection of 100 or 120 μA and resistance built out to 1 MΩ ± 1 per cent.
High-impedance Amplifier Detector.
Tone source with range from 40 c/s to 10 kc/s, 600-ohm output impedance and variable output level from − 50 dB to + 10 dB.
600-ohm resistor.
Portable Test Meter, PTM/6.
Avometer (Model 7, 8 or 40)

(a) Preliminary

It is assumed that the circuit has been checked, and that valves and U-links are fitted. Makc use of an 18-way miniature socket with VFLA/4, wired to connect:

Pins 3 (+) and 4 (− and chassis) to h.t. supply at 300 volts,
Pins 5 and 6 to 6·3-volt a.c. supply,
Pin 10, or 4, to earth.

Allow one minute for unit to warm up, and then use Avometer to check that voltage across each valve-feed test point is less than 1 volt. Also check, using 100-volt range of this meter, that the voltage across the Stab. Bias test point does not exceed 60 volts.

Attach the feed plug of the PTM/6 to each test socket in turn, checking that a reading of 50 μA ± 10 μA is obtained at points associated with valves, and that a reading of 50 μA ± 2 μA is produced at the Stab. Bias point.

(*b*) *Gain*

(i) Feed 1,000 c/s tone at zero level across pins 1 and 2 of 18-way socket, and use amplifier detector to measure levels at the Test Amp. 1 and Test Amp. 2 jacks. These should be − 20 dB ± 1 dB and − 20 dB ± 0·5 dB respectively.

Tolerance value of ± 2 μA for all figures above the line, and of ± 3 μA for figures below line.

(iii) Remove tone from pins 1 and 2, to check that a standing current of 3 μA ± 2 μA is registered by the micro-ammeter.

Note: Departures from the correct 'law' as given in the table may be caused by poor heater-cathode insulation in one of the thermionic diodes.

C. Phantom Sending Unit, PUS/1

The test apparatus required comprises:

Avometer (Model 7, 8 or 40).

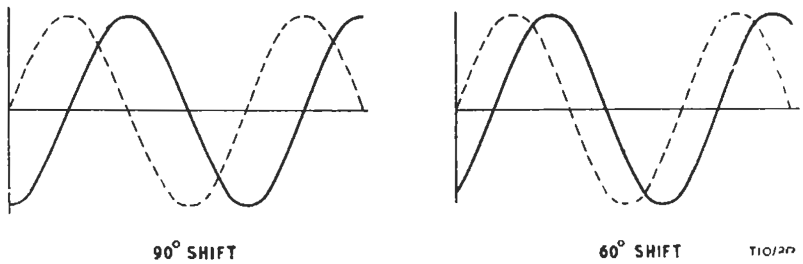


Fig. C.3 Phase Shift as shown by Oscilloscope Trace

(*c*) *Input/Output Characteristic*

(ii) Connect the built-out d.c. micro-ammeter (see list of test gear) between pins 7 (+) and 8 (−) of the 18-way socket. Apply tone at pins 1 and 2 for the purpose of making a series of output-current measurements, which should be within the limits indicated for various frequencies and input levels listed in the following table.

Input Level (dB)	*Output Current (μA)* *F (c/s)* 40	60	110	1,000	5,000	10,000
− 45	3	3	3	5	4	3
− 40	3	3	4	9	5	4
− 35	3	3	6	15	9	5
− 30	3	4	10	26	14	8
− 25	3	6	18	43	24	13
− 20	3	11	31	46	37	23
− 15	4	19	44	49	42	29
− 10	7	33	46	55	47	33
− 5	12	44	50	65	55	39
0	20	47	57	82	69	48
+ 5	47	53	65	95	80	55
+ 10	51	56	77	95	85	59

A d.c. power supply continuously variable from 0 to 100 volts, suitable for a maximum load current of 40 mA, and *isolated from earth.*

100-volt h.t. battery.

(*a*) *Preliminary*

It is assumed that the circuits of the unit have been checked, especially those associated with meters M1 and M2, and that all valves, lamps (P.O. No. 2), and U-links have been inserted.

(i) Place mains-transformer primary connections on tappings appropriate to mains voltage.

(ii) Ensure that U-links are set to Normal. Attach an 18-way miniature socket to unit, wired to connect:

Pin 13 (live) and 14 (neutral) to mains supply.

Pin 15 to *mains earth.*

Pins 10 (−) and 18 (earthed) to 50-volt d.c. supply.

Pins 8 and 12 to a resistor whose value, plus that of R21, gives a total resistance of 5,600 ohms.

After making the mains supply, allow one minute before carrying out measurement of V1 and

V2 heater voltages; to be 6·3 v. ± 0·3 v. Use selector switch SWB and meter M2 for the following checks:

Setting Title	*Required Reading*
50 v.	50 μA ± 2·5 μA
H.T. Volts	50 μA ± 10 μA
V3 Ig	50 μA ± 10 μA

Then use selector switch A and meter M1 for checking that a reading of − 32 μA ± 2 μA is obtained at the Ph. Current setting. Leaving the meter switch at this setting, break the mains supply to check that current through M1 falls to zero. Then restore the mains to check that the current through M1 returns to the value stated above.

(iii) Remove valve V3 and check that the current through meter M1 again drops to zero, and that Phantom Trip lamp (LP1) lights. Restore V3 and check that the Phantom Trip lamp is not extinguished. Press the Reset button (SWC), which should cause extinguishing of LP1. Break the 50-volt supply for a few seconds, and check that this causes LP1 to light and remain so following the re-connection of the 50-volt supply. Again operate the Reset switch.

(*b*) *Phantom Trip*

(iv) Connect the 100-volt battery between pins 4 (+) and 6 (−) on 18-way socket, and transfer VFLA Selector U-links to the Lower position.

(v) Set the d.c. power supply so that it delivers about 50 volts, and operate selector switch SWA to Ph. Current setting.

(vi) Connect the Avometer between the R7–R8 junction and earth, and the meter should indicate about + 50 volts. Then connect the d.c. power supply in parallel with the Avometer and gradually increase the applied voltage until the phantom trip operates. This is indicated by lighting of the Phantom Trip lamp (LP1) and should occur with a d.c. power-supply voltage at 70 volts ± 10 volts.

(vii) Whilst the trip is still operated check that M1 is registering zero phantom current. After disconnecting the d.c. power supply, press the Reset button, which should extinguish LP1 and result in a reading of 55 μA ± 5 μA on meter M1. Disconnect the Avometer and 100-volt battery.

(*c*) *Cathode Follower Performance*

(viii) Transfer the VFLA Selector U-links to the Upper position and connect the d.c. power supply between pins 1 (+) and 3 (−) on the 18-way socket. Adjust the d.c. input voltage to values as listed below in a table showing readings to be expected on M1, with SWA at Ph. Current, and M2, with SWB at settings indicated.

D.C. Input Volts	*Meter M1 With SWA at: Ph. Current*	*Meter M2 With SWB at:* VFLA Upper Out		
		VFLA Upper Out	*V1 Feed*	*V2 Feed*
0	− 32 ± 2	0	0	0
25	− 17 ± 2	24 ± 2	11 ± 3	11 ± 3
50	+ 5 ± 2	48 ± 2	28 ± 3	28 ± 3
75	+ 29 ± 2	72 ± 2	45 ± 2	45 ± 2
100	+ 51 ± 2	96 ± 2	61 ± 2	61 ± 2

N.B. Readings at the VFLA Upper Out and VFLA Lower Out settings of switch SWB can be given by M2 only if switch SWA, for M1, is *not* at the position marked VFLA Bal; see switch position marked in red instead of white.

(ix) Adjust the d.c. input voltage to 100 volts and set switch SWA at C.F. Bal. to check that the meter M1 reads 0 ± 10. Remove valve V1 and check that M1 now reads + 75 or higher. Replace V1 in its holder and turn switch SWA to VFLA Bal. to check that M1 reads + 35 ± 10. Operate switch SWA to the Ph. Current setting and reduce the d.c. input to zero.

(x) Transfer the variable d.c. source connectors from pins 1 and 3 to pins 4 (+) and 6 (−), and the VFLA Selector U-links from the Upper to the Lower position. Then repeat the d.c. input-voltage adjustments, as under (viii), to check that M1 and M2 readings are within specified limits shown by the above table. Switch SWB is, of course, used at the VFLA Lower Out position, instead of VFLA Upper Out, for these tests.

(xi) With a d.c. input voltage of 100 volts, set switch SWA at C.F. Bal. to check that the meter M1 reads 0 ± 10. On removing V1 a reading of + 75 or higher should be indicated by meter M1, whilst on restoring it and removing V2 the reading should change to − 75 or higher. Replace V2 and set switch SWA to VFLA Bal. as a check that M1 now reads − 35 ± 10. Disconnect the variable d.c. source.

D. Phantom Receiving Unit, PUR/1

The test apparatus required comprises:

Avometer (Model 7, 8 or 40)

A d.c. power supply, continuously variable from 0 to 100 volts, capable of a maximum load current of 40 mA, and *isolated from earth.*

(a) Preliminary

It is assumed that the circuits of the unit have been checked, especially those associated with meters M1 and M2, and that the valves and U-links have been fitted

(i) Place mains-transformer primary connections on tappings appropriate to mains voltage.

(ii) Attach an 18-way miniature socket to equipment, wired to connect:

Pins 13 (live) and 14 (neutral) to mains supply.

Pins 15 to *mains earth.*

Pins 10 (−) and 18 (+) to 50-volt d.c. supply.

Pin 7 to pin 8.

Pins 9 and 12 to a resistor, value 3·3 k ± 2 per cent.

Also short-circuit R21.

Allow one minute for warming-up after making mains supply and then measure V1 and V2 heater voltages, which should be 6·3 volt ± 0·3 volt. Use selector switch SWB and meter M2 for the following checks:

Setting Title	*Required Reading*
50 v.	50 μA ± 2·5 μA
HT. Volts	50 μA ± 5 μA

Then use selector switch SWA at Rec. Ph. Current setting to check that meter M1 indicates a current of − 32 μA ± 2 μA. Turn SWA to Loc. Ph. Current position to check that current through M1 is still − 32 μA ± 2 μA.

(b) Cathode Follower Performance

(iii) Place VFLA Selector U-links in Upper position and connect the variable d.c. source between pins 1 (+) and 3 (−) on 18-way socket. Adjust the d.c. input voltage to values as listed below in two tables, one showing readings to be expected on M2 using SWB at several settings, and the other for M1 at various settings of SWA.

D.C. Input Volts	*Meter M2 With SWB at:* VFLA Upper Out	*V1 Feed*	*V2 Feed*
0	0	0	0
25	24 ± 2	11 ± 3	11 ± 3
50	48 ± 2	28 ± 3	28 ± 3
75	72 ± 2	45 ± 2	45 ± 2
100	96 ± 2	61 ± 2	61 ± 2

N.B. Readings at the VFLA Upper Out and VFLA Lower Out settings of switch SWB can be given by M2 only if switch SWA, for M1, is *not* at the position marked VFLA Bal.; see switch positions marked in red, instead of white.

D.C. Input Volts	*Meter M1 With SWA at:* Rec. Ph. Current	*Loc. Ph. Current*	*C.F. Bal.*	*VFLA Bal.*
0	− 32 ± 2	− 32 ± 2	0	0
25	− 16 ± 2	− 16 ± 2	0 ± 20	+ 8 ± 2
50	+ 5 ± 2	+ 5 ± 2	0 ± 20	+ 16 ± 2
75	+ 27 ± 2	+ 27 ± 2	0 ± 20	+ 25 ± 2
100	+ 48 ± 2	+ 48 ± 2	0 ± 20	+ 33 ± 2

(iv) Leaving d.c. input voltage at 100 volts, turn switch SWA to C.F. Bal. and then, with valve V1 removed, check that meter M1 reads + 75 or greater. Replace V1 and set SWA at VFLA Bal. to check that meter M1 reads + 32 ± 2. Return switch to C.F. Bal. and with valve V2 removed the meter M1 should indicate − 75 or greater. Replace V2.

(v) Transfer the variable d.c. source connectors from pins 1 and 3 to pins 4 (+) and 6 (−), and the VFLA Selector U-links from the Upper to the Lower position. Then repeat the d.c. input-voltage adjustments as under (iii) to obtain two sets of readings at various settings of switches SWA and SWB. Figures taken with M2 in this test should be within the limits specified in the previous tabulation, but using switch SWB at the VFLA Lower Out setting instead of VFLA Upper Out. For this test all values in the preceding table for

M1 apply but with negative, instead of positive, signs qualifying the figures in the VLFA Bal. Column.

(vi) Leaving the d.c. input at 100 volts and with SWA at C.F. Bal., remove V1 and check that M1 reads + 75 or greater. Then restore V1 and remove V2, which should cause M1 to indicate − 75 or greater. Restore V2, disconnect the variable d.c. supply, transfer the VLFA U-links to Normal, and remove the short-circuit from R21.

E. Differential Detector, DD/2

Test apparatus required comprises:

Avometer (Model 1, 7, 8 or 40)

A Variac.

A d.c. supply with provision for continuous variation from 0 to 20 volts and capable of giving a maximum current of 5 milliamperes.

Portable Test Meter, PTM/6.

(*a*) *Preliminary*

It is assumed that the circuit of the unit have been checked and that the relays are correctly adjusted.

(i) Place mains-transformer primary connections on tappings suited to mains voltage.

(ii) Attach an 18-way miniature socket to the unit, wired to connect:

Pins 13 (live) and 14 (neutral) to mains supply.

Pin 15 to *mains earth.*

Pin 18 to *programme earth.*

After a one-minute warming up period, during which lamp LP1 should become extinguished, check at the valve-heater pins for voltages of 6·3 v. ± 0·3 v. Also check with the Avometer that the voltage across each of the three test sockets does not exceed 1 volt.

Press the Test Det. Bal. switch and set the Adj. Bal. control for a reading of mid-scale ± 2 μA on M1. On releasing the switch the reading should remain at the stated value. Connect the feed plug of the PTM/6 to each feed socket; those marked V1 Feed and V2 Feed should give a meter current of 50 μA ± 15 μA, and the H.T. Volt point a reading of 50 μA ± 5 μA.

(*b*) *Detector Sensitivity*

(iii) Connect the variable d.c. source to pins 1 (+) and 2 (−) on 18-way socket. Gradually increase the applied voltage from 0 until the detector alarm circuit operates and causes red lamp LP1 to light. The meter M1 should show a deflection to the left. Set the Adj. Sens. control to produce operation of the alarm with an input voltage of between 9 and 11 volts, and *note the precise voltage (Y volts) at which the alarm occurs.*

(vi) Reduce to zero the voltage of the d.c. source prior to reversing its polarity so that the connection is pin 1 (−) and pin 2 (+) at 18-way socket. Gradually increase the applied voltage from 0 until the detector alarm circuit again operates. This time meter M1 should be deflected to the right, and the voltage necessary to cause an alarm should be Y ± 0·5 volts. If the voltage required is greater than this, the Equalise Relay control should be adjusted counter-clockwise, but if less the adjustment should be in the clockwise direction.

(v) Repeat the above tests until symmetry of sensitivity is obtained to within 0·5 volt, and then set the Adj. Sens. control so that the alarm circuit operates at 10 volts ± 0·5 volts. It may be necessary to check the balance circuit of the DD/2 when obtaining a setting for the Adj. Sens. control. When the alarm circuit is just operating the meter M1 should indicate ± 75 μA ± 10 μA.

(vi) During operation of the alarm, check at the 18-way socket that pin 8 has become internally connected to pin 7, but not to pin 9. For the unoperated condition there should be an internal path from pin 8 to pin 9, but not to pin 7.

(vii) Disconnect the variable d.c. supply from pins 1 and 2, and then check that removal of either V1 or V2 causes alarm operation.

(*c*) *Low Mains-voltage Alarm*

(viii) Connect the mains supply through a Variac, or other means of continuous voltage adjustment, to pins 13 and 14. Gradually reduce voltage until the alarm operates, which should happen with a value between 20 and 30 per cent below normal.

F. Sending-end Equipment

(*a*) *Preliminary*

When an equipment is installed the value of R21 in the PUS/1 is chosen to provide build-out which, added to the d.c. resistance of the phantom circuit (including the earth return) gives a standard total value of 2,400 ohms ± 100 ohms. In addition it is necessary to:

(i) Set VFLA Selector U-links in PUS/1 to Normal.

(ii) Adjust primary tappings of mains transformer in PUS/1 and those in both halves of the MU/51A.

(iii) Check l.t. voltages at heater pins of valves in all operational units, to be 6·3 v. ± 0·3 v.

(iv) Adjust h.t. tappings on both mains transformers in MU/51A, one at a time whilst loaded to provide a supply at 300 volts ± 5 per cent at the QSP/1 and VFLA/4 units.

(v) Adjust h.t. tappings of transformer in PUS/1, using the right-hand meter switch at H.T. Volts in checking for the required reading of 50 ± 5 on the associated meter.
Note: The reading fluctuates under working conditions, when high-level signals cause the voltage to fall by 20 to 30 volts, represented by 4 to 6 divisions on the meter.

(vi) Set the right-hand meter switch on PUS/1 to Ext. Feed and attach the extension lead provided for connecting with the similarly titled socket. Attach the extension in turn to each of the test points in the QSP/1 and both VFLA/4 units. The readings shown by the right-hand meter should be 50 ± 10 for all points excepting the VFLA/4 Stab. Bias points for which the required reading is 50 ± 2.

Using the PUS/1 metering equipment for internal measurements, *without programme input to the system*, the following readings should be obtained:

Left-hand		*Right-hand*	
Switch at:	*Meter Reading*	*Switch at:*	*Meter Reading*
Ph. Current	– 32 ± 2	V1 Feed	2 ± 2
C.F. Bal.	0 ± 2	V2 Feed	2 ± 2
*VFLA Bal.	0 ± 1	V3 Ig.	50 ± 10
		H.T. Volts	50 ± 5
		50 V.	50 ± 2
		*VFLA Out Upper	1 ± 1
		*VFLA Out Lower	1 ± 1

Notes: 1. VFLA Out readings can be obtained only if the left-hand switch is *not* at VFLA Bal. setting.

2. Multiplying factor of 0·16 approximately gives current in mA at Ph. Current setting; thus the normal phantom current is about – 5·2 mA.

G. Receiving-end Equipment

During installation the setting-up of the artificial phantom network in the PUR/1 involves connection in circuit of a suitable proportion of 2-μF capacitors (C1 to C14) available as shunt arms for individual sections. Dividing the true-phantom d.c. resistance by 180, to the nearest integer, gives the number required and selection should always start C8, C9, C10 etc., that is working away from terminal 8. On the PUR/1 a short-circuit should be connected initially across R21. Other preliminary operations are similar to those detailed under F, with the exception that PUR/1 should be read for PUS/1. Readings obtained with the metering equipment at the PUR/1 should be:

Left-hand		*Right-hand*	
Switch at:	*Meter Reading*	*Switch at:*	*Meter Reading*
Ph. Current Rec.	– 32 ± 2	V1 Feed	2 ± 2
Ph. Current Loc.	– 32 ± 2	V2 Feed	2 ± 2
C.F. Bal.	0 ± 2	H.T. Volts	50 ± 5
*VFLA Bal.	0 ± 1	50 Volts.	50 ± 2
		*VFLA Out Upper	1 ± 1
		*VFLA Out Lower	1 ± 1

N.B. Both switches must not be used simultaneously at any VFLA positions.

H. Sending-end Line-up Check

Programme at zero volume is normally fed to the system (input impedance 10 k), and the QSP/1 Input Vol. control should be at the 0 setting apart from occasions when used for test purposes.

(i) Feed 1,000-c/s tone at zero level into the equipment by, say, removing the QSP/1 input U-links and making connection with the App. sockets.

(ii) Employ the high-impedance amplifier-detector to check that the level as measured across the input-listen sockets for each VFLA/4 is 0 ± 1 dB, and that the level at the two test jacks on each of these units is – 20 dB ± 1 dB.

(iii) At the PUS/1, check with the right-hand switch and meter that a reading of 82 ± 2 is obtained for each VFLA/4 output; see note below table in previous sub-section. These readings are included with others which should be obtained for the line-up condition:

Left-hand		*Right-hand*	
Switch at:	*Meter Reading*	*Switch at:*	*Meter Reading*
Ph. Current	32 ±2	V1 Feed	48 ± 5
C.F. Bal.	0 ± 5	V2 Feed	48 ± 5
VFLA Bal.	0 ± 3	V3 Ig.	50 ± 10
		H.T Volts	45 ± 5
		50 V.	50 ± 2
		VFLA Out Upper	82 ± 2
		VFLA Out Lower	82 ± 2

Note: Ph. Current reading corresponds with a phantom current of about 4·8 mA, applying the approximate conversion factor (0·16) previously mentioned.

(iv) Remove tone from the system and substitute programme at normal volume. For this condition the V1 and V2 Feed readings should fluctuate between 0 and 50, with both VFLA Out readings varying between 0 and 100, and the Ph. Current reading ranging from − 32 to + 50.

Also with programme applied, the C.F. Bal. measurement should be made to check for expected fluctuations, which are acceptable if within the limits of ± 20 from mid-scale. Larger variation is indicative of serious unbalance, in which event tests should be made by measuring individual feeds with tone applied as described earlier. Similarly the VFLA Bal. setting should be used to check for equality of output from the two VFLA's. With other than a pure sine-wave input to the system there is likely to be some unbalance due to quadrature effects, but the deviation should not normally exceed ± 30.

J. Receiving-end Line-up Check

The procedure is as described in the preceding sub-section, including the reference to the QSP/1 input control. Local tone can be used but it is essential that any settings be confirmed in an overall line-up originating from the sending centre, with 1,000-c/s tone at zero level applied to the normal programme circuits.

Readings obtainable at the PUR/1 should be as tabled for the PUS/1, having regard to variations in metering facilities. Thus the Ph. Current Loc. setting is the counterpart of the Ph. Current setting at the PUS/1. It enables quick comparison to be made between the artificial-phantom and true-phantom currents, the latter measurable at an adjacent Ph. Current Rec. setting. For the overall line-up, with the sending-end participating, the two readings should be identical within ± 1 μA despite quoted limits of 32 ± 2 for readings at the individual phantom units. Other tests should be made during the overall line-up as follows:

(i) Press the Test Det. Bal. switch on the DD/2 to check that the associated meter reads zero ± 1. If not, alter the Adj. Bal. control as necessary to obtain this reading. On releasing the switch the meter should continue to indicate balance within ± 10.

(ii) Set the Input Vol. control on the *local* QSP/1 to the + 4½ dB position, which should cause the meter on the DD/2 to deflect to 65 ± 10 without operation of the alarm. Advance the control to the + 5 dB setting to confirm that the alarm circuit operates, as indicated by lighting of the red lamp, with the balance meter registering 75 ± 10.

(iii) Restore the QSP Input Vol. control to 0. Then, with no input at either end of the system, the balance meter on the DD/2 should show 0 ± 10.

Under working conditions the balance meter at the DD/2 may show deflections to either side of zero, but these should not exceed ± 35. In monitoring certain lines it may be desirable to " slow up ' the operating speed of the differential detector, by connecting C5 or C6, or both, in parallel with C4.

K. Monitor Sensitivity Tests

Co-ordinated operations at both ends of the monitored circuit are necessary to obtain comprehensive data on the sensitivity of the complete Line Automatic Monitor. With this equipment set up as previously explained the first of two tests is carried out as follows:

(i) Connect a variable-frequency tone source through a repeater coil and variable attenuator to the amplifier (trap valve or C) feeding the monitored link. Load the amplifier input with 600 ohms where required.

(ii) Connect a high-impedance amplifier-detector across the input to the QSP/1 in the sending bay. Set the Input Vol. control of the QSP/1 to + 2½-dB marking.

(iii) Set the Input Vol. control of the QSP/1 at the receiving bay to the – 2½-dB position.

(iv) Using tone at 1,000 c/s, adjust the level as measured by the amplifier-detector to approximately – 2 dB, and then employ the variable attenuator for fine adjustment to obtain maximum deflection on the meter of the DD/2. Adjust the sensitivity of the DD/2 so that 5 dB-sensitivity causes an alarm but a 4·5 dB difference will not. It is convenient to move the Input Vol. control of the receiving-bay QSP/1 temporarily from – 2·5 to – 2 to provide the latter difference.

(v) Without altering tone level as measured by the amplifier-detector, reset the QSP/1 Input Vol. controls at the sending and receiving bays to settings marked – 2·5 dB and + 2·5 dB, repectively. Again the 5-dB differencc should just cause alarm at the DD/2, the meter on which should show a deflection in the opposite direction from that obtained under (iv).

(vi) If operation (v) shows that the monitor has not a ± 5-dB sensitivity, first alter the Equalise Relay control setting in the DD/2 and then repeat the procedure under headings (iv) and (v). This successive adjustment and testing should continue until the desired symmetry is obtained.

After this setting-up of the DD/2 it is possible to make sensitivity measurements at various frequencies, the results of which should be as tabled below.

Upper Sensitive Point

Frequency c/s	*Sensitivity ± dB*	*Level Measured at Amp. Det.*	*Volume + 8 dB = 0 level*
40	5½	+ 10·0 dB	+ 2·0 dB
110	7	+ 12·5 dB	+ 4·5 dB
250	5	+ 2·5 dB	– 5·5 dB
1,000	5	– 2·0 dB	– 10·0 dB
3,000	5½	– 2·0 dB	– 10·0 dB
5,000	6½	– 2·0 dB	– 10·0 dB
7,000	8½	– 3·0 dB	– 11·0 dB
10,000	10 +	– 3·5 dB	– 11·5 dB
15,000	10 +	– 3·0 dB	– 11·0 dB

Lower Sensitive Point

Frequency c/s	*Sensitivity ± dB*	*Level Measured at Amp. Det.*	*Volume + 8 dB = 0 level*
60	6½	– 2·0 dB	– 10·0 dB
110	6	– 16·5 dB	– 24·5 dB
250	6	– 26·0 dB	– 34·0 dB
1,000	6	– 29·5 dB	– 37·5 dB
3,000	7	– 28·0 dB	– 36·0 dB
5,000	8½	– 25·0 dB	– 33·0 dB
7,000	10 +	– 22·0 dB	– 30·0 dB
10,000	10 +	– 23·5 dB	– 31·5 dB
15,000	10 +	– 22·5 dB	– 30·0 dB

Noise-sensitivity tests are carried out with the DD/2 adjusted as for previous sensitivity tests. Tone is originated from the sending centre as under (i), and prior operations are:

(i) At the sending bay. Remove U-links from the QSP/1 and connect a 600-ohm resistor between the App. sockets to terminate the input of the unit.

(ii) At the receiving bay. Connect a high-impedance amplifier-detector across the input to the QSP/1.

If (ii) is not possible, a high-impedance amplifier-detector can be used at the sending end, for measuring across the output of the amplifier feeding the monitored line, in which event allowance must be made for line-up levels.

(iii) With the Input Vol. control of the QSP/1 at the receiving end at the 0-dB setting, adjust the level sent to the monitored line until a threshold condition is reached, that is one just sufficient to cause operation of the DD/2 alarm. The following table gives figures which can be regarded as typical.

Frequency c/s	*Level Measured with Amp. Det. at Receiving end*	*Volume + 8 dB = 0 level*
40	+ 7·0 dB	– 1·0 dB
60	– 9·5 dB	– 17·5 dB
110	– 17·9 dB	– 25·9 dB
250	– 27·8 dB	– 35·8 dB
1,000	– 31·1 dB	– 39·1 dB
3,000	– 28·9 dB	– 36·9 dB
5,000	– 26·0 dB	– 34·0 dB
7,000	– 23·7 dB	– 31·7 dB
10,000	– 20·2 dB	– 28·2 dB
15,000	– 14·0 dB	– 22·0 dB

APPENDIX D

THEORY OF TRANSISTOR OSCILLATOR

This Appendix, based on part of Designs Department Test Report No. 2.79 (58), refers to the type of oscillator embodied in the OS2/5 equipment.

A passive network as in Fig. D.1(a) forms an anti-resonant circuit between points A and B at resonance where, with a loss-free circuit, I_C and I_L are equal but displaced in phase by 180 degrees with respect to each other.

Fig. D.1(d), an augmented version of Fig. D.1(b), shows a circuit with the same current flowing through the two inductors. This current

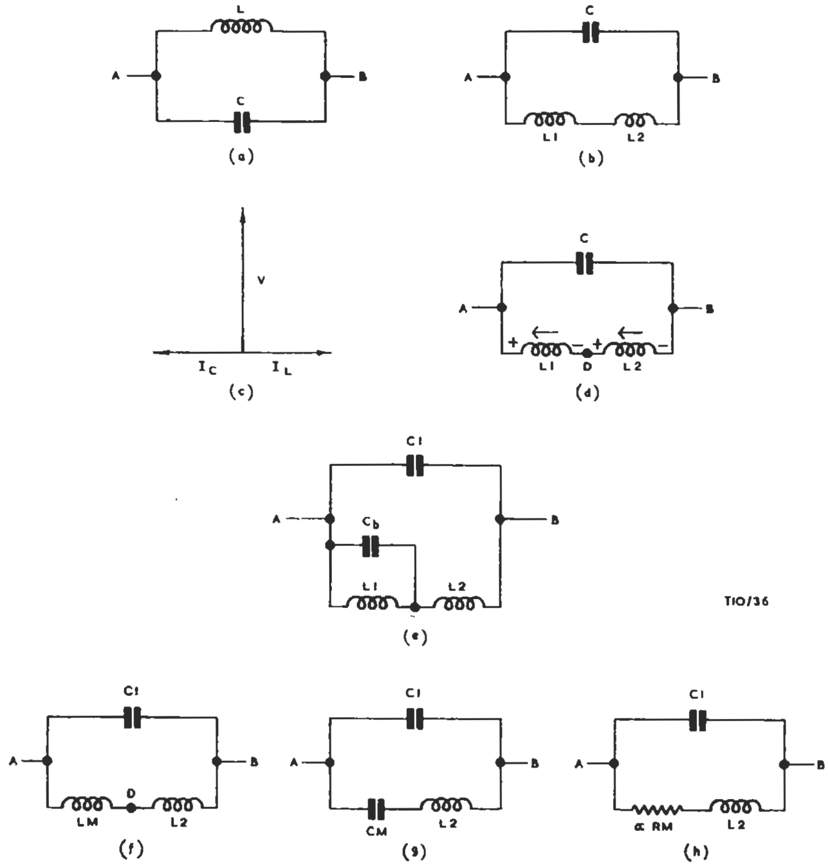


Fig. D.1 Derivation of LC Arrangement, and Equivalent Circuit for Various Frequencies

the frequency for which $X_L = X_C$. The same applies if the inductive arm comprises two inductors, with or without mutual coupling, as in Fig. D.1(b). Absence of mutual coupling gives a frequency of resonance where $X_{(L1+L2)} = X_C$.

With an alternating e.m.f., V, applied across points A and B the voltage/current relationship is as shown by Fig. D.1(c) at the frequency of

produces instantaneous voltages, for A to D and B to D, which are 180 degrees out of phase with respect to each other. Thus voltages at point A, with respect to point D, are displaced 180 degrees from voltages at point B, also with respect to point D.

Paralleling L1 with the capacitor C_b provides the arrangement of Fig. D.1(e). With this the apparent inductance of L1 is increased for frequencies below the one at which L1 and C_b resonate, while above that particular frequency the reactance of L1 shunted by C_b is capacitive. Illustrating these two conditions are Figs. D.1(f) and (g), with LM and CM representing effective values of L1 in parallel with C_b. Fig. D.1(h) gives the equivalent circuit when L1 resonates with C_b.

The above is confirmed by Foster's theorem, stating that a two-terminal network containing N reactive terms, expressed in their simplest form and without duplication of combinations, will exhibit

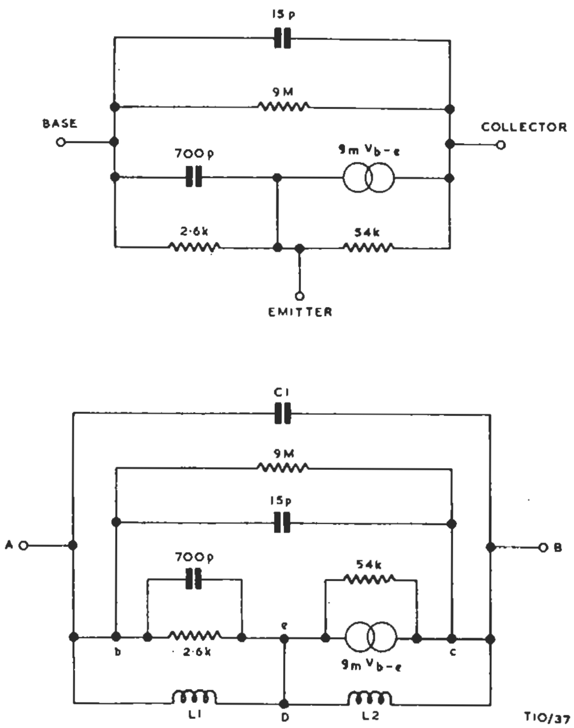


Fig. D.2 Equivalent Circuit for a Transistor, and the Combination with Tuning Elements

(N-1) resonances and anti-resonances. Thus the circuit of Fig. D.1(e) has three frequencies of resonance owing to the introduction of C_b, but only with the condition indicated by Fig. D.1(e) gives the 180-degree phase relationship between voltages developed across the AD and BD portions of the inductive arm.

To obtain oscillation in a transistor circuit a phase relationship of 180 degrees displacement is needed between the collector-emitter and base-emitter voltages. This displacement is available with the circuit of Fig. D.1(d). Thus by connecting the transistor with collector to point B, emitter to point D, and base to point A, the necessary

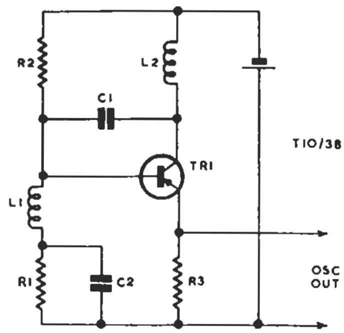


Fig. D.3 Circuit Diagram of Oscillator

phase relationship for oscillation exists. The only further requirement is adequate gain to restore losses in the inductive and capacitive arms.

The equivalent circuit for a combination as described is shown in Fig. D.2 giving separate details for a GT.13 transistor which is the subject of this example. Fig. D.3 is a conventional diagram of the practical circuit, using R1 and R2 with values appropriate to TR1 biasing, and with R3 providing negative feedback for d.c. and a.c. stabilisation. R1 is shunted by C2, which is

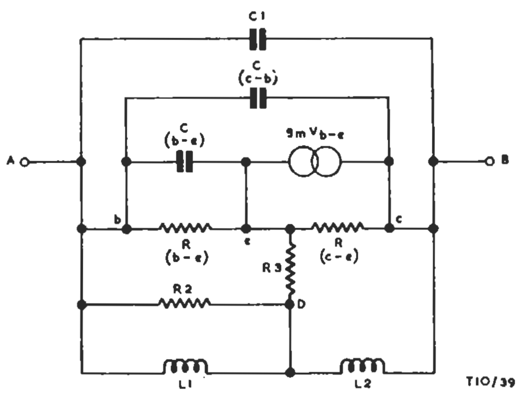


Fig. D.4 Equivalent Circuit for Oscillator

given a value offering very small impedance at the frequency of oscillation. Therefore it is possible to ignore these components in the equivalent circuit depicted by Fig. D.4.

That diagram can be further simplified because the collector-base capacitance of TR1 is in parallel with C1, and can be termed C_x. Also R2 has little effect, and the collector-emitter resistance of TR1 is very high, 54 kilohms in the example. With such omissions the equivalent circuit has the form

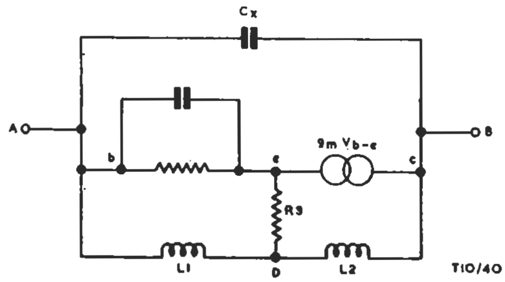


Fig. D.5 Simplified Equivalent Circuit

of Fig. D.5. This is similar to the arrangement in Fig. D.1(e), and consequently the circuit oscillates at one frequency only, as determined by the values of inductance and capacitance together with the parameters of the transistor.

58/JR/121/DJE
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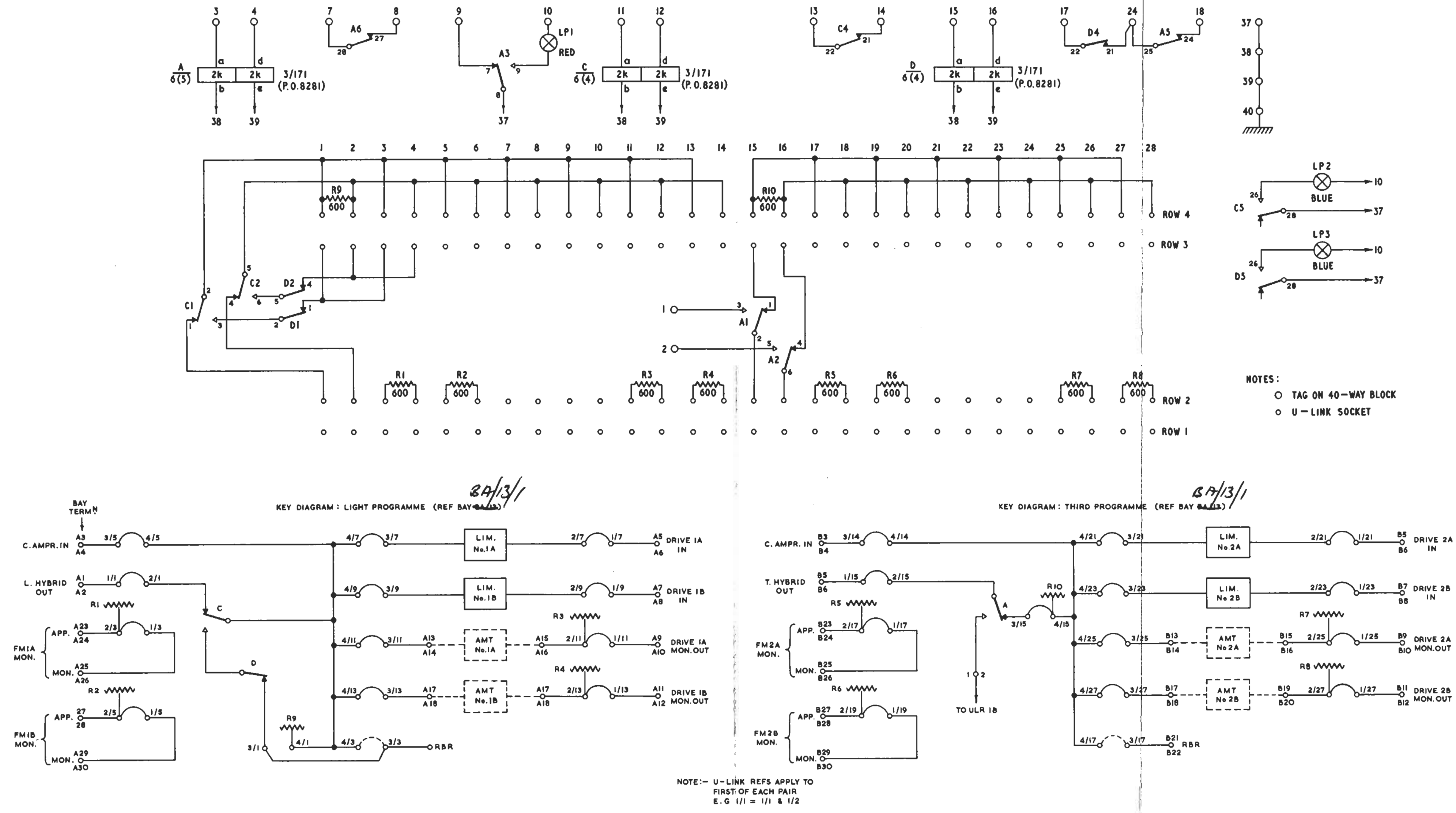
P1D.3985.9IC.ISS.2

FIG. 1



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U-LINK & RELAY PANEL ULR/1A. (LIGHT & THIRD)

58/JR/122/AP
PID. 4025.3.1B ISS2.
PID. 3985.9.1C ISS2.

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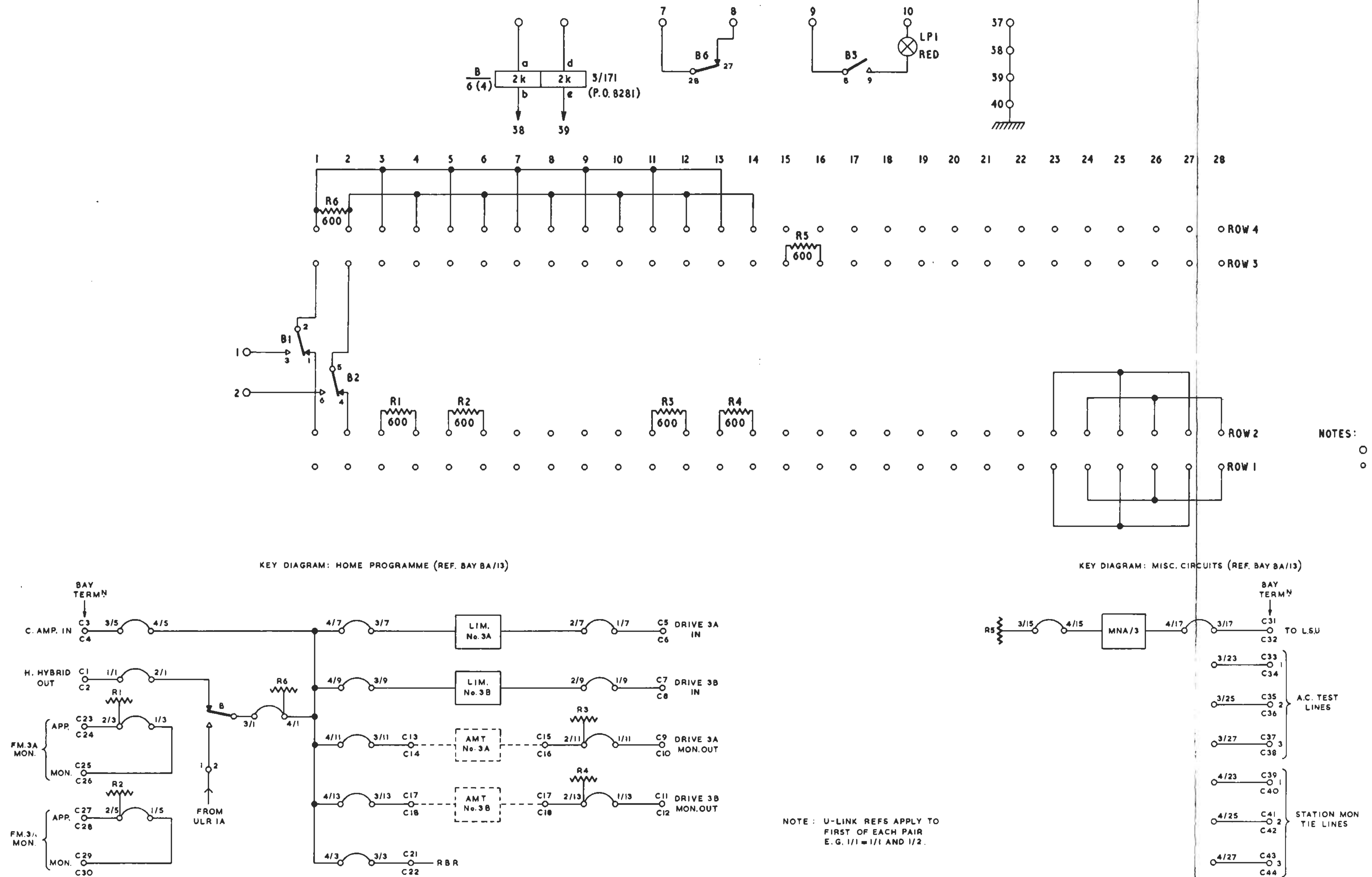
FIG. 2



NOTES:
○ TAG ON 40-WAY BLOCK
○ U-LINK SOCKET

NOTE: U-LINK REFS APPLY TO FIRST OF EACH PAIR E.G. 1/1 = 1/1 AND 1/2.

U-LINK & RELAY PANEL ULR/IB (HOME & MISC.)

COMPONENT TABLE: FIG. 3

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
AT1	D5	BBC PNN/4M2 Spec.		R23	B11	Erie 8 0·5W	± 10
		ED/PNN/4M2		R24	E14	Erie 9 0·25W	± 10
				R25	F11	Erie 9 0·25W	± 10
C1	K4	T.C.C. SCE 76PE/PVC		R26	G11	Erie 9 0·25W	± 10
C2	K7	T.C.C. SCE 76PE/PVC		R27	F14	Erie 9 0·25W	± 10
C3	O4	T.C.C. CP35N/PVC	± 20	R28	J13	Erie 9 0·25W	± 10
C4	P7	T.C.C. CM20N	± 20	R29	J10	Erie 9 0·25W	± 10
C5	R7	T.C.C. CE25AAR/PVC		R30	K11	Erie 9 0·25W	± 10
		(Reversible)		R31	L11	Painton P306 3W	± 5
C6	T7	T.C.C. CP35N/PVC	± 20	R32	L10	Painton P306 3W	± 5
C7	C12	T.C.C. SCE 77L/PVC		R33	L15	Erie 9 0·25W	± 10
C8	M14	T.C.C. CP32N/PVC	± 25	R34	M14	Erie 9 0·25W	± 10
C9	P12	Hunts B501K		R35	O14	Erie 9 0·25W	± 10
C11	N9	T.C.C. SM3N	± 5	R36	P12	Erie 9 0·25W	± 10
C13	O3	Plessey CE809/1		R41	U12	Colvern CLR 1132/15S	± 10
C14	G12	Hunts B822		R42	M4	Erie 9 0·25W	± 10
C15	M8	Erie P100/L	± 10	R43	A12	Morganite LHNAR/	
C16	Q3	T.C.C. CP32N/PVC	± 25			10450/32000	± 20
C17	H2	Hunts B503K		R44	B14	Erie 9 0·25W	± 10
C18	B11	T.C.C. CSM20N	± 5	R45	G10	Erie 9 0·25W	± 10
C19	C14	Hunts B608		R46	J8	Erie 9 0·25W	± 10
				R47	N8	Erie 9 0·25W	± 10
LP1	T13	P.O. No. 2 (6V.)		R48	P1	Erie 8 0·5W	± 10
				R49	N5	Erie 9 0·25W	± 10
M1	V6	Turner, Model 909 F.S.D.		R50	M6	Erie 9 0·25W	± 10
		1mA Scaled 0/20mA		R51	A11	Erie 108 0·5W	± 2
				R52	A14	Erie 9 0·25W	± 10
MR1	E12	Westinghouse W.6		R53	M6	Erie 9 0·25W	± 10
MR2	E14	Westinghouse W.6		R54	D2	Erie 8 0·5W	± 10
				R55	E3	Morganite HNAR/	
R5	F5	Colvern CLR1132/15S	± 10			50250/32000	± 20
R6	F4	Colvern CLR1132/15S	± 10	R56	E2	Erie 8 0·5W	± 10
R7	H5	Painton P406 3W	± 1	R57	H2	Painton P406 3W	± 1
R8	J4	Erie 100 1W	± 2	R58	G2	Erie 9 0·25W	± 10
R9	J6	Erie 100 1W	± 2	R59	H1	Erie 9 0·25W	± 10
R10	M6	Morganite LHNAR/		R60	M5	Erie 9 0·25W	± 10
		104500/32000	± 20	R61	T13	Painton MV1 1·5W	± 5
R11	N8	Erie 109 0·25W	± 2				
R12	O3	Erie 9 0·25W	± 10	RLA	F3	Elliott R100B (Moving	
R13	O7	Erie 109 0·25W	± 2			Coil)	
R14	Q5	Erie 9 0·25W	± 10				
R15	R8	Erie 100 1W	± 1	SWB	V6	N.S.F. DM 2P.4W Ref.	
R16	R6	Erie 109 0·25W	± 1			EPA 8001	
R17	Q8	Erie 100 1W	± 1	SWC	F11	Painton No. 200100	
R18	Q6	Erie 109 0·25W	± 1				
R19	Q8	Painton P406 3W	± 1	TR1	B5	BBC LL/64SA	
R20	R9	Painton P406 3W	± 1	TR2	K5	BBC AGG/5SA	
R21	T2	Erie 109 0·25W	± 2	TR3	R2	BBC AAL/19-2P	
R22	S5	Erie 9 0·25W	± 10	TR4	D13	BBC AGG/5SA	

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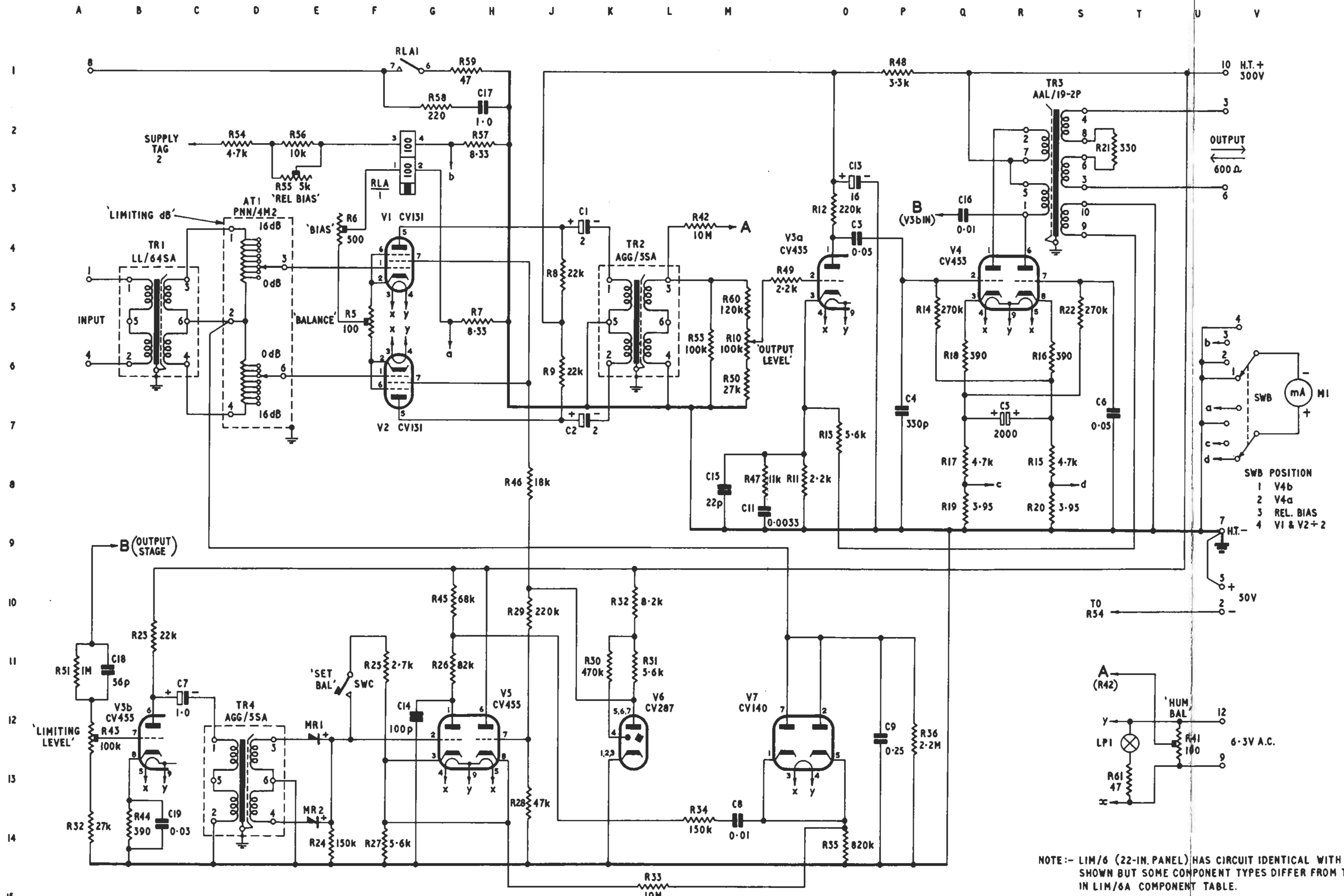
FIG. 3

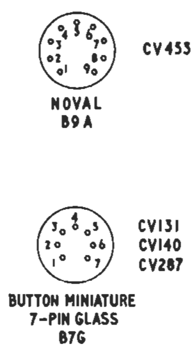


LIMITER LIM/6A

TRANSFORMER RATIOS (TURNS)

TR1	4·08 : 1
TR2	1 : 2·83
TR3	P-S 5·5 : 1 P-T 30 : 1
TR4	AS TR2

VALVE BASES



NOTE:– LIM/6 (22-IN. PANEL) HAS CIRCUIT IDENTICAL WITH THAT SHOWN BUT SOME COMPONENT TYPES DIFFER FROM THOSE IN LIM/6A COMPONENT TABLE.

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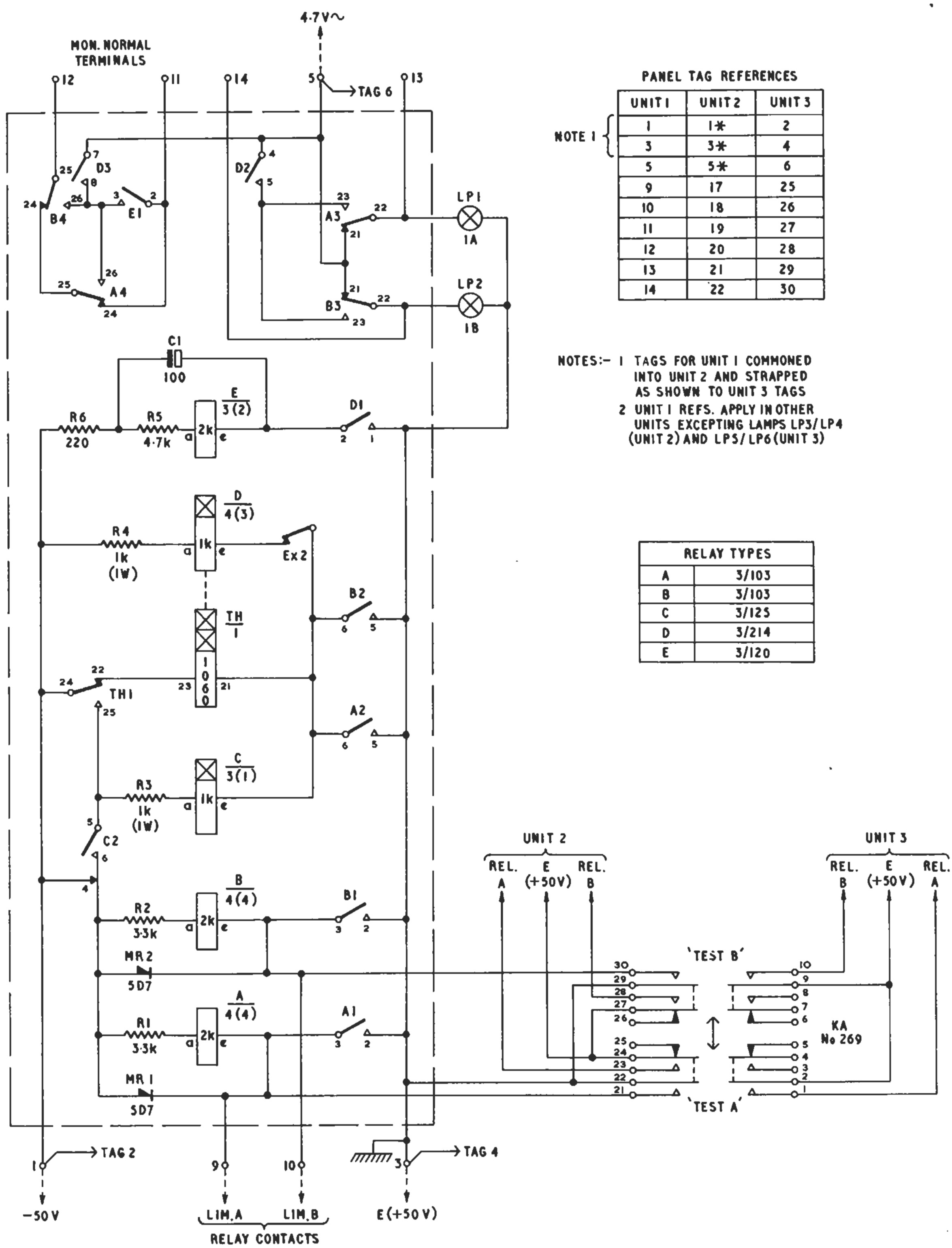
FIG. 4



PANEL TAG REFERENCES

UNIT 1	UNIT 2	UNIT 3
1	1*	2
3	3*	4
5	5*	6
9	17	25
10	18	26
11	19	27
12	20	28
13	21	29
14	22	30

NOTE 1 (applies to the first three rows)

NOTES:-
1 TAGS FOR UNIT 1 COMMONED INTO UNIT 2 AND STRAPPED AS SHOWN TO UNIT 3 TAGS
2 UNIT 1 REFS. APPLY IN OTHER UNITS EXCEPTING LAMPS LP3/LP4 (UNIT 2) AND LP5/LP6 (UNIT 3)

RELAY TYPES

A	3/103
B	3/103
C	3/125
D	3/214
E	3/120

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LIMITER INDICATION PANEL IP/1

COMPONENT TABLE: FIG. 5

Comp.	Loc.	Type	Tolerance Per cent
C1	F13	T.C.C. SM3N	± 5
C2	F6	T.C.C. CP35N/PVC	± 20
C3	H5	Muirhead 234/AT/1M	± 1
C4	F7	T.C.C. CP37N/PVC	± 20
C5	F8	T.C.C. SCE79C	± 25
C6	H12	Muirhead 234/AT/1M	± 1
C7	F14	T.C.C. CP37N/PVC	± 20
C8	G16	T.C.C. CE24B/PVC	
C9	F16	T.C.C. M2N	± 20
C10	H6	T.C.C. CP35N/PVC	± 20
C11	H13	T.C.C. SM3N	± 5
C12	K5	Dubilier B213	± 20
C13	J7	T.C.C. CP37N/PVC	± 20
C14	K12	Dubilier B213	± 20
C15	K15	T.C.C. CP37N/PVC	± 20
C16	M12	Dubilier B213	± 20
C17	Q15	Dubilier B213	± 20
C18A	R5	Plessey CE820/1	
C18B	V5		
C19A	T4	Plessey CE911/1	
C19B			
C20	S6	T.C.C. CE24B/PVC	
C21	T8	Plessey CE170 69/1	
C22	T15	Dubilier B213	± 20
CL1	N5	G.E.C. GEX45/1	
CL2	N8	G.E.C. GEX45/1	
FS1	Y6	Belling Lee L562	
FS2	Y5		
JK1	B6	S.T.C. 4112B	
JK2	B13		
L1	G5	Partridge to BBC Ref. C25/60	
L2	G12	Partridge to BBC Ref. C25/60	
L3	I5	Partridge to BBC Ref. LD/10	
L4	T3	Partridge to BBC Ref. CH24	
LP1	R11	P.O. No. 2(6V.)	
LP2	V11		
LP3	V16		
LP4	W15		
LP5	T1		

Comp.	Loc.	Type	Tolerance Per cent
MR1	H7	Westinghouse 16K16	
MR2			
MR3	J6	Westinghouse 16K2	
MR4	J8	Westinghouse 16K2	
MR5	J5	Westinghouse 5D42	
MR6	J12	Westinghouse 5D42	
MR7	H14	Westinghouse 16K16	
MR8			
MR9	J14	Westinghouse 16K2	
MR10	J15	Westinghouse 16K2	
MR11	U4	S.T.C. DA40–18–1W	
MR12			
MR13	U6	Westinghouse 5B1019	
MR14	U8	Westinghouse 5D34	
R1	C13	Morganite HNAR/ 25350/32000	
R2	E15	Erie 109 0·25W	± 2
R3	D15	Erie 109 0·25W	± 2
R4	D15	Erie 109 0·25W	± 2
R5	D14	Erie 109 0·25W	± 2
R6	D14	Erie 109 0·25W	± 2
R7	D14	Erie 109 0·25W	± 2
R8	E7	Erie 9 0·25W	± 10
R9	E7	Erie 108 0·5W	± 2
R10	E8	Erie 108 0·5W	± 2
R11	E14	Erie 108 0·5W	± 2
R12	E16	Erie 108 0·5W	± 2
R13	F15	Erie 108 0·5W	± 2
R14	F16	Erie 9 0.25W	± 10
R15	G10	Erie 109 0·25W	± 2
R16	F12	Erie 9 0·25W	± 10
R17	G4	Erie 109 0·25W	± 2
R18	F5	Erie 9	± 10
R19	H6	Erie 109 0·25W	± 2
R20	H13	Erie 109 0·25W	± 2
R21	K14	Erie 9 0·25W	± 10
R22	K7	Erie 9 0·25W	± 10
R23	L5	Erie 100 1W	± 2
R24	L8	Erie 100 1W	± 2
R25	M7	Erie 108 0·5W	± 2
R26	M6	Morganite HNAR/10490	
R27	M7	Erie 109 0·25W	± 2
R28	M9	Painton P301 4·5W	± 5
R29	L11	Erie 8 0·5W	± 10
R30	M11	Erie 109 0·25W	± 2
R31	N11	Erie 8 0·5W	± 10
R32	L12	Morganite LHAP/50250/ 20000	

COMPONENT TABLE: FIG. 5 (continued)

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
R33	N12	Erie 9 0·25	± 10	R56	G5	Erie 100 1W	± 2
R34	M13	Erie 109 0·25	± 2	R57	G13	Erie 100 1W	± 2
R35	N13	Erie 109 0·25	± 2	R58	F7	Erie 109 0·25W	± 2
R36	L16	Erie 9 0·25	± 10	R59	F14	Erie 109 0·25W	± 2
R37	O12	Erie 108 0·5W	± 2				
R38	O13	Erie 108 0·5W	± 2	Relays			
R39	P10	Painton P302 6W	± 5	A	N7	T.M.C. 6U31	
R40	R10	Erie 8 0·5W	± 10	B	M10	Siemens RD7322	
R41	R13	Erie 9 0·25W	± 20	C	P15	Siemens 89L	
R42	R15	Erie 9 0·25W	± 10	D	Y15	BBC Ref. 3/139	
R43	R13	Erie 100 1W	± 2	E	S11	BBC Ref. 3/139	
R44	R5	Erie 9 0·25W	± 10	F	G8	Siemens 89Y	
R45	R5	Painton P306 3W	± 5	G	P11	BBC Ref. 3/139	
R46	T6	Reliance TW/1/85/W					
R47	S8	Painton P301 4·5W	± 5	SWA	E14	N.S.F. DM 1P 6W	
R48	U14	Erie 109 0·25W	± 2			shorting	
R49	U15	Erie 109 0·25W	± 2				
R50	T16	Erie 9 0·25W	± 20	TR1	B7	BBC LG/75A	
R51	S1	Erie 8 0·5W	± 10	TR2	B14	BBC LG/75A	
R52	U10	Erie 100 1W	± 2	TR3	I6	BBC AGG/1SA	
R53	V15	Erie 8 0·5W	± 10	TR4	I14	BBC AGG/1SA	
R54	W14	Erie 8 0·5W	± 10	TR5	W5	BBC M199	

58/JR/101/AP
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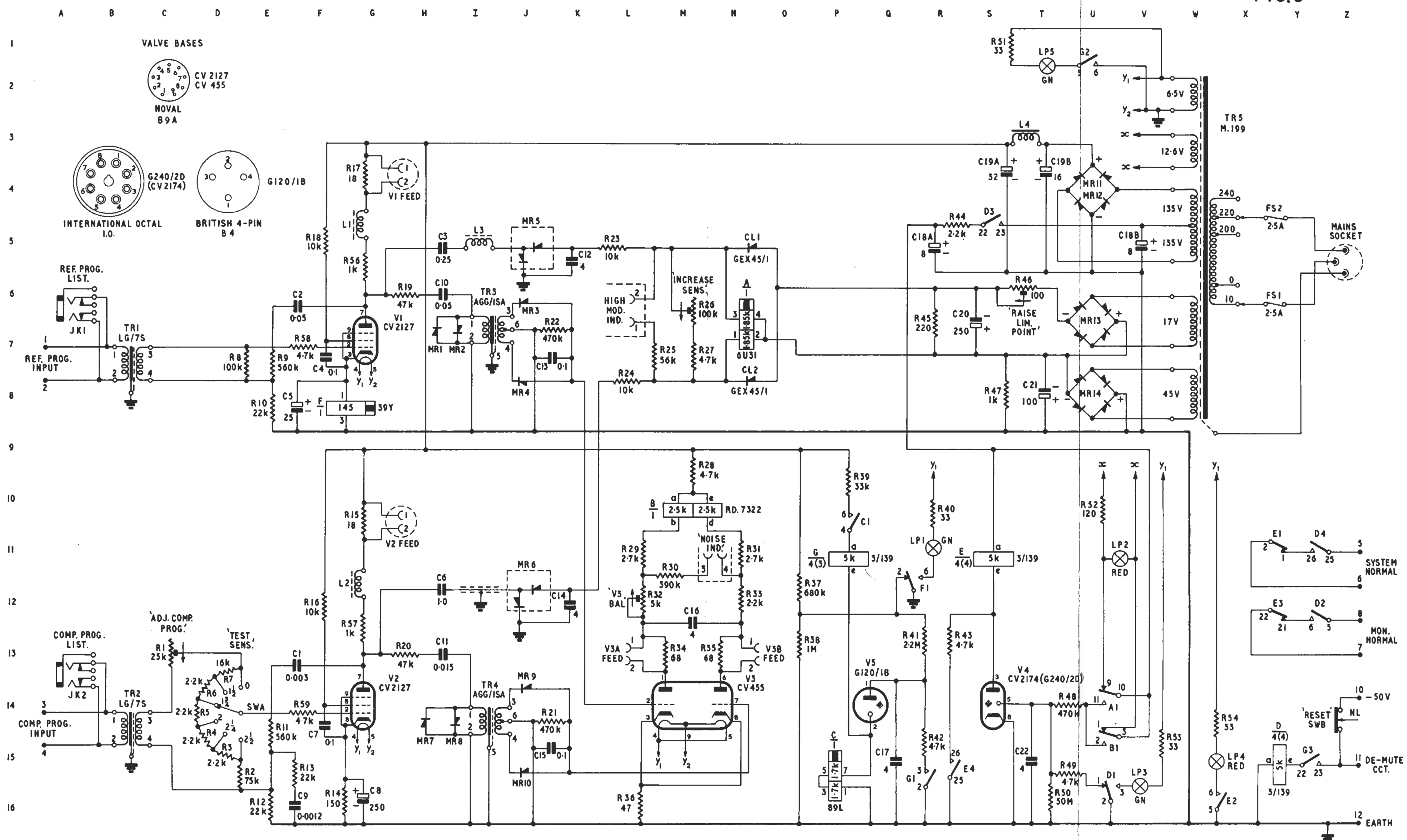
T10

FIG. 5

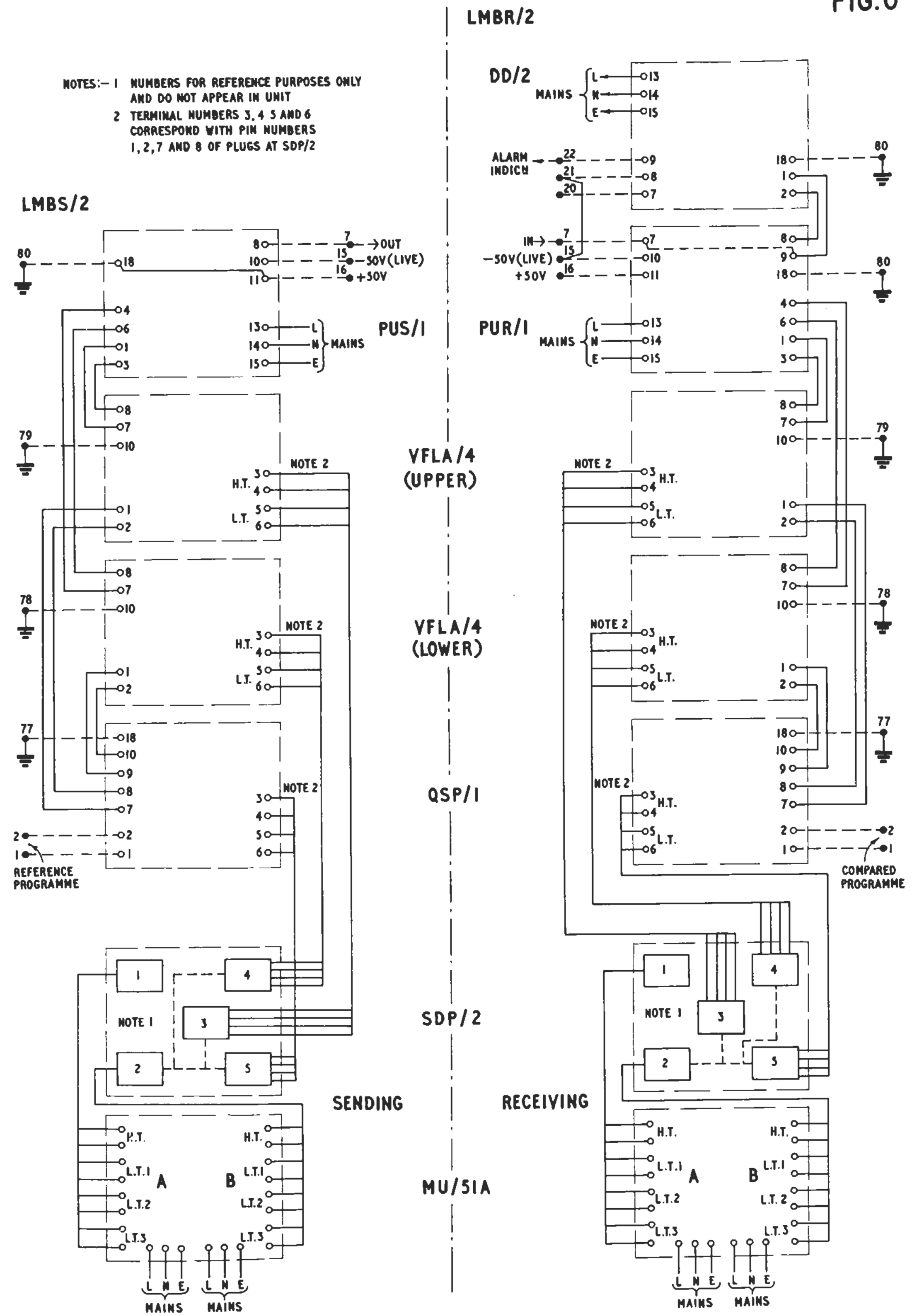


LAMPS
LP1 V1 CATHODE CURRENT
LP2 FAULT
LP3 DE-MUTE
LP4 ALARM
LP5 DELAY

TRANSFORMER RATIOS (TURNS)
TR1 & TR2 1: 3.16
TR3 & TR4 1: 2

AUTOMATIC MONITOR (TRANSMITTER) AMT/2

FIG.6



L.A.M. EQUIPMENT: SCHEMATIC AND BAY WIRING

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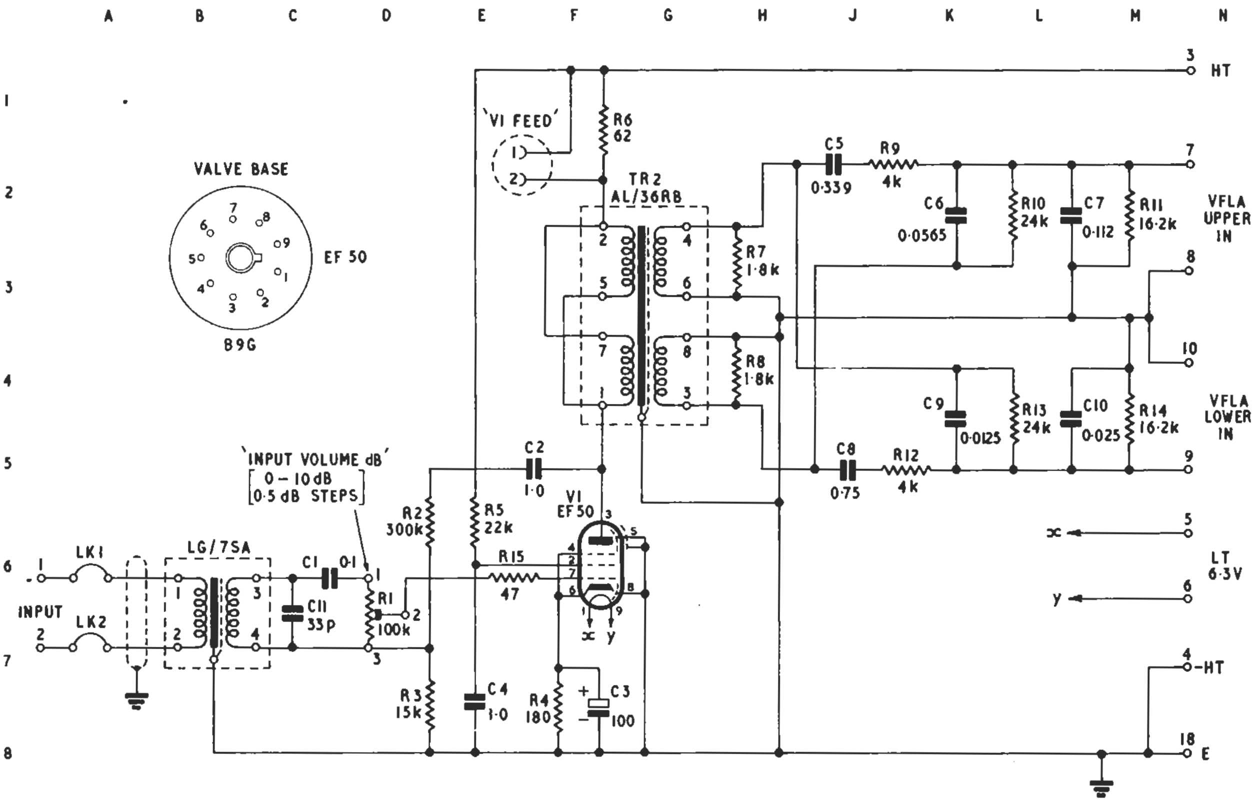
FIG.7



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COMPONENT TABLE

COMP	LOC	TYPE	TOLERANCE PER CENT	COMP	LOC	TYPE	TOLERANCE PER CENT
C1	C6	T.C.C SM3N	±5	R3	D8	ERIE 108 0·5W	±1
C2	F5	MUIRHEAD 39AT	±10	R4	F8	" 9 0·25W	±10
C3	F8	T.C.C CE18B/PVC	−20 +50	R5	E6	" 8 0·5W	±10
C4	E8	MUIRHEAD 39AT	±10	R6	F2	" 108 0·5W	±1
C5	J2	IN TYPE 33AT CASES	±1	R7	H3	" " "	"
C6	K2	"	"	R8	H4	" " "	"
C7	L2	"	"	R9	J2	" " "	"
C8	J5	"	"	R10	L2	" " "	"
C9	K5	"	"	R11	M2	" " "	"
C10	L5	"	"	R12	K5	" " "	"
C11	C7	T.C.C CSM20N	±5	R13	L4	" " "	"
R1	D7	PAINTON J (TO PAINTON SPEC. 170078)		R14	M4	" " "	"
R2	D6	ERIE 108 0·5W	±1	R15	E6		

TRANSFORMER RATIOS (TURNS)

LG/7SA	1:3·16
AL/36RB	5:1

QUADRATURE SPLITTING PANEL QSP/1

COMPONENT TABLE: FIG. 8

Comp.	Loc.	Type	Tolerance Per cent
C1	B9	T.C.C. CP37N/PVC	± 20
C2	D3	Plessey CE809/1	+ 50, − 20
C3	D5	T.C.C. CP37N/PVC	± 20
C4	D4	T.C.C. SM3N	± 2
C5	D9	Muirhead 39AT (Inverted Mounting)	± 10
C6	D8	Muirhead 33AT (Inverted Mounting)	± 10
C7	H4	Muirhead 39AT (Inverted Mounting)	± 10
C8	K3	Muirhead 39AT	± 10
C9	J5	Muirhead 39AT (Inverted Mounting)	± 10
C10	M3	Muirhead M81 (In 33AT case—Inverted Mounting)	± 1
C11	L4	Muirhead M81 (In 33AT case—Inverted Mounting)	± 1
C12	M12	Muirhead M81 (In 33AT case—Inverted Mounting)	± 1
C13	N3	T.C.C. 601 SMP	± 1
C15	O5	T.C.C. SM3N	± 2
C16	M9	Muirhead 33AT (Inverted Mounting)	± 10
C17	O9	T.C.C. CP37N/PVC	± 20
C18	Q3	Plessey CE809/1	+ 50, − 20
C19	R4	Muirhead 39AT (Inverted Mounting)	± 10
C20	Q5	T.C.C. CP37N/PVC	± 20
C21	R8	Muirhead 39AT (Inverted Mounting)	± 10
C22	R4	Muirhead 39AT (Inverted Mounting)	± 10
C23	T4	Muirhead 39AT (Inverted Mounting)	± 10
C24	V5	Muirhead 39AT (Inverted Mounting)	± 10
C25	V3	Muirhead 39AT (Inverted Mounting)	± 10
C26	W6	T.C.C. 601 SMP	± 1
C27	Z6	Muirhead 233AT (In 33AT case—Inverted Mounting)	± 1

Comp.	Loc.	Type	Tolerance Per cent
JK1	J7	S.T.C. 4112B	
JK2	Y3	S.T.C. 4112B	
L1	U3	BBC Ref. R/1	
R1	C1	Erie 109 0·25W	± 2
R2	C2	Erie 9 0·25W	± 10
R3	C3	Erie 8 0·5W	± 10
R4	D3	Erie 9 0·25W	± 10
R5	B7	Erie 109 0·25W	± 2
R6	D11	Erie 100 1W	± 2
R7	C7	Erie 9 0·25W	± 10
R8	B8	Erie 9 0·25W	± 10
R9	C9	Erie 108 0·5W	± 1
R10	E10	Erie 108 0·5W	± 1
R11	E9	Erie 108 0·5W	± 1
R12	E8	Erie 108 0·5W	± 1
R13	F8	Erie 108 0·5W	± 1
R14	G9	Erie 108 0·5W	± 1
R15	G8	Erie 100 1W	± 1
R16	J1	Erie 108 0·5W	± 2
R17	J2	Painton P301 4·5W	± 5
R18	K2	Erie 8 0·5W	± 10
R19	H7	Erie 9 0·25W	± 10
R20	H9	Erie 9 0·25W	± 10
R21	L3	Erie 108 0·5W	± 1
R22	M3	Erie 108 0·5W	± 1
R23	M4	Erie 108 0·5W	± 1
R24	K4	Erie 108 0·5W	± 1
R25	L10	Erie 108 0·5W	± 1
R26	L8	Erie 108 0·5W	± 1
R27	N8	Erie 108 0·5W	± 1
R28	N9	Erie 108 0·5W	± 1
R29	N4	Erie 108 0·5W	± 1
R31	M5	Erie 108 0·5W	± 1
R32	N8	Erie 108 0·5W	± 1
R33	O7	Erie 108 0·5W	± 1
R34	P7	Erie 9 0·25W	± 10
R35	O8	Erie 9 0·25W	± 10
R36	P9	Erie 108 0·5W	± 1
R37	O5	Erie 9 0·25W	± 10
R38	P1	Erie 109 0·25W	± 2
R39	P2	Erie 9 0·25W	± 10
R40	P3	Erie 8 0·5W	± 10
R41	Q3	Erie 9 0·25W	± 10
R42	R5	Erie 9 0·25W	± 10

COMPONENT TABLE: FIG. 8 (continued)

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
R43	R10	Erie 108 0·5W	± 1	R53	X4	Erie 108 0·5W	± 1
R44	R8	Erie 108 0·5W	± 1	R54	W5	Erie 108 0·5W	± 1
R45	S8	Erie 108 0·5W	± 1	R55	K7	Erie 108 0·5W	± 1
R46	S9	Erie 108 0·5W	± 1	R56	B5	Erie 109 0·25W	± 2
R47	T8	Erie 100 1W	± 1	R57	W2	Erie 109 0·25W	± 1
R48	T7	Erie 9 0·25W	± 10	R58	X2	Erie 109 0·25W	± 1
R49	U9	Erie 9 0·25W	± 10				
R50	U1	Erie 100 1W	± 2	TR1	A5	BBC Ref. LG40/SA	
R51	V2	Eire 8 0·5W	± 10	TR2	X5	BBC Ref. AGG/7R	
R52	V2	Painton P301 4·5W	± 5				

58/JR/108/DJE
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FIG. 8

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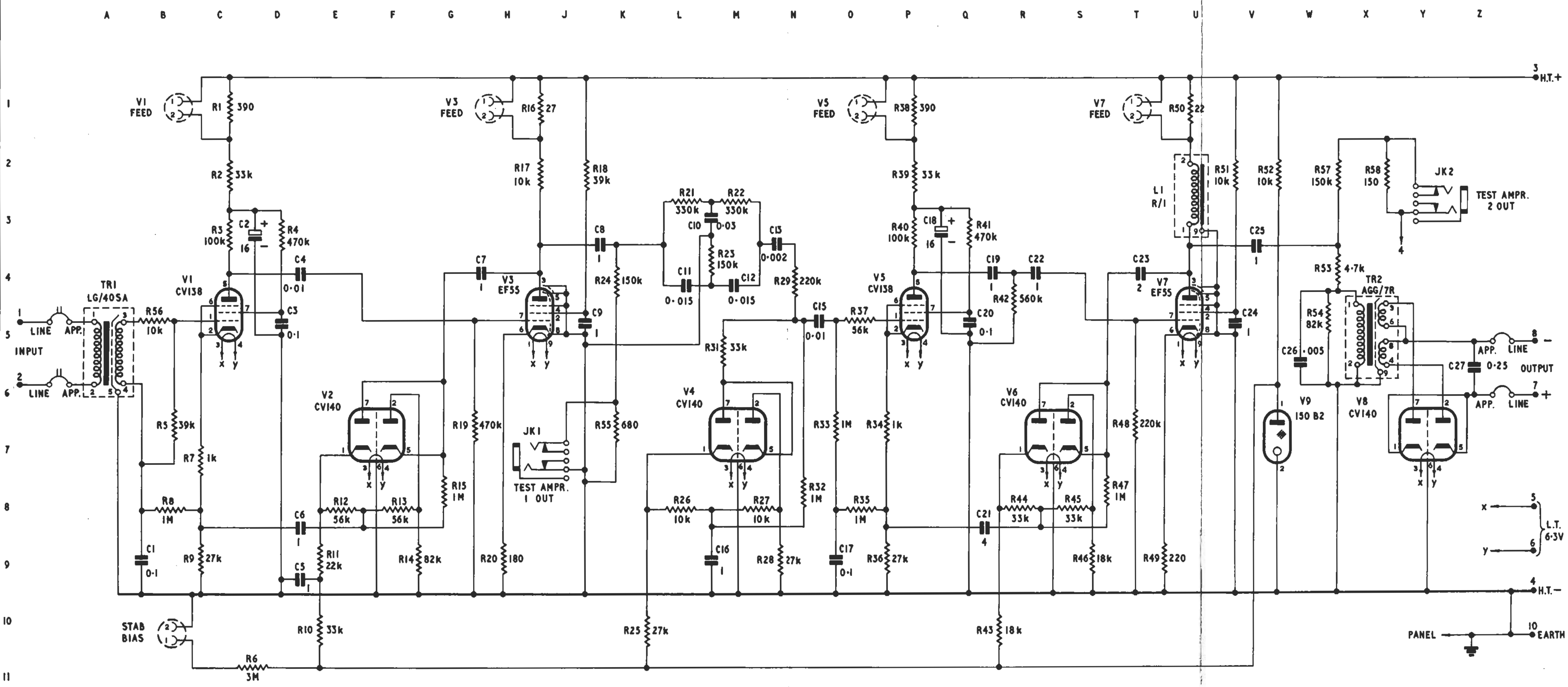
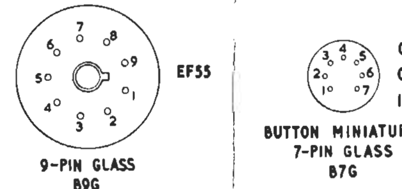


VOLUME FOLDING AND LIMITING AMPLIFIER VFLA/4

TRANSFORMER RATIOS (TURNS)

LG/40SA	1:1
AGG/7R	1:1

VALVE BASES



COMPONENT TABLE: FIG. 9

Comp.	Loc.	Type	Tolerance Per cent
C1	G2	Plessey CE811/1	
C2	F10	Hunts B500K	± 25
C3	J9	Hunts B500K	± 25
C4	L1	Hunts B500K	± 25
C5	K9	Hunts B504/P	± 25
FS1, 2	A2	Belling Lee L562	
FS3	D3	Belling Lee L562	
L1	G1	BBC Ref. CH23	
L2, L3	K8	BBC Ref. D160	
M1	Q5	Turner Model 225	
M2	S5	Turner Model 225	
MR1, 2	D2	Westinghouse 5D73	
R1	B4	Erie 108 0·5W	± 1
R2	B6	Eire 108 0·5W	± 1
R3	B7	Erie 108 0·5W	± 1
R4	B10	Erie 108 0·5W	± 1
R5	G5	Erie 9 0·25	± 10
R6	H5	Erie 9 0·25	± 10
R7	G6	Erie 108 0·5W	± 2
R8	H6	Erie 108 0·5W	± 2
R9	G7	Welwyn AW3115 3W	± 5
R10	J7	Welwyn AW3115 3W	± 5
R11	F4	Erie 9 0·25W	± 10
R12	J4	Erie 9 0·25W	± 10
R13	G3	Erie 108 0·5W	± 2
R14	J3	Erie 108 0·5W	± 2
R15	G2	Erie 108 0·5W	± 2
R16	J1	Dubilier BTB 1W	± 10
R17	K4	Welwyn AW3115 3W	± 5
R18	K6	Welwyn AW3111 4·5W	± 5
R19	M6	Erie 109 0·25W	± 2
R20	L8	Erie 100 1W	± 2
R21	M8	As required; see note 1 on diagram	
R22	M9	Erie 108 0·5W	± 2
R23	Q6	As required; See note 2 on diagram	
R24	T6	As required; See note 3 on diagram	
R25	B11	Erie 8 0·5W	± 10
R26	L1	Erie 9 0·25W	± 10
R27	F10	Erie 9 0·25W	± 10
R28	H9	Erie 9 0·25W	± 10
R29	G3	Welwyn AW3111 4·5W	± 5
R30	T7	As required; See note 4 on diagram	
R31	F2	Erie 109 0·25W	± 2
R32	L12	Erie 108 0·5W	± 1
R33	B5	Erie 109 0·25W	± 1
R34	B6	Erie 109 0·25W	± 1
R35	B8	Erie 109 0·25W	± 1
R36	B9	Erie 109 0·25W	± 1
Relays			
A	L7	Siemens 89L (with cover)	
B	E10	BBC Ref. 3/147 (with cover)	
C	K2	BBC Ref. 3/128 (with cover)	
D	H10	Siemens RD7048 (with cover)	
SWA	P5	DH (3p. 4w. non-shorting) BBC Ref. EPA7963	
SWB	S6	DH (3p. 8w. non-shorting) BBC Ref. DA 2745	
SWC	G9	Walter 1290	
TR1	B2	BBC Ref. M194	

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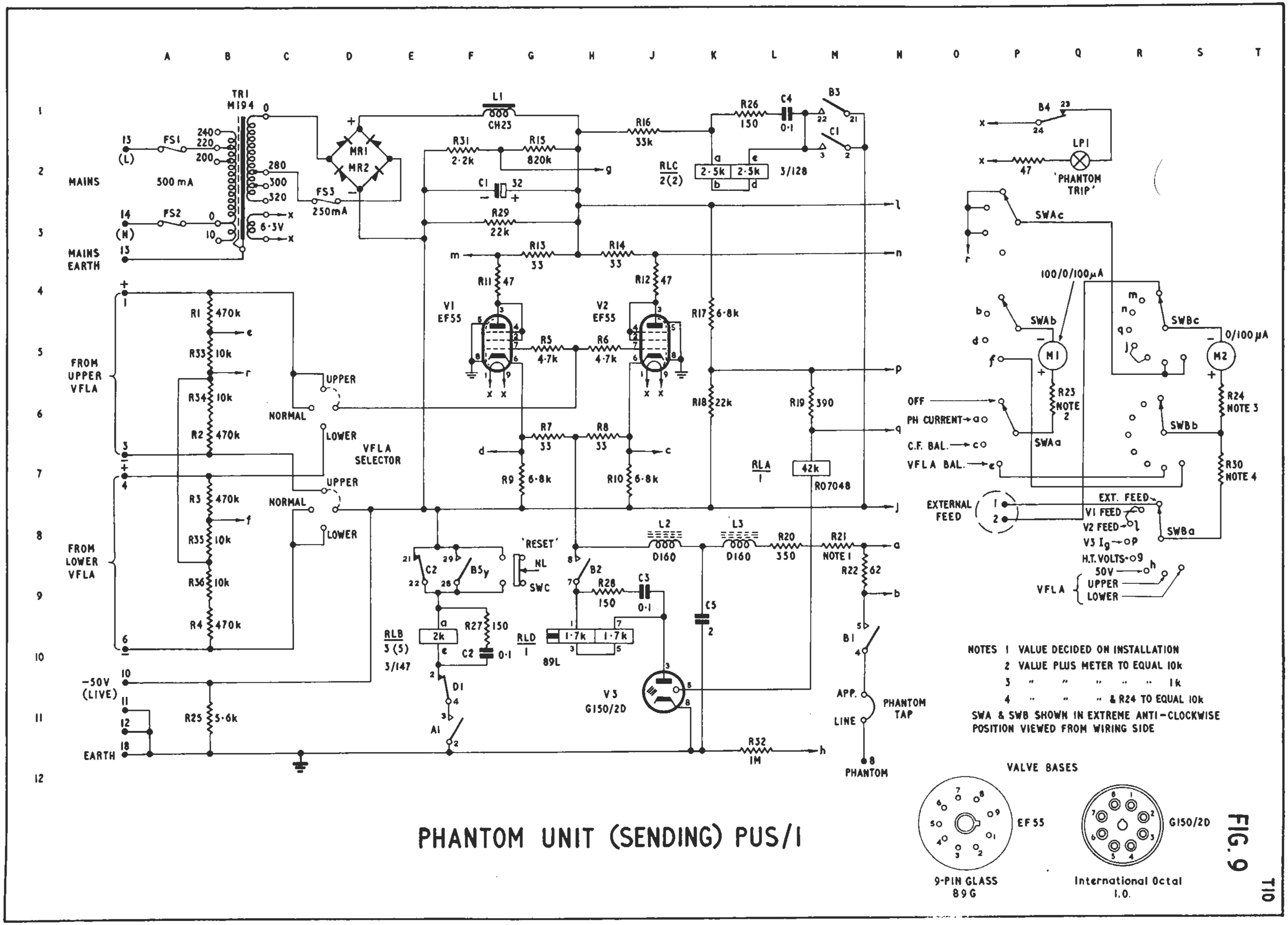

PHANTOM UNIT (SENDING) PUS/1

FIG. 9

T10

COMPONENT TABLE: FIG. 10

Comp.	Loc.	Type	Tolerance Per cent
C1 to C14	N10	Hunts W.48 (150-V wkg) Min Moldseal List No. A304	
C15	G9	Min Moldseal List No. A304	
C16	F2	Plessey CE811/1	
FS1, 2	A2	Belling-Lee L562	
FS3	D2	Belling-Lee L562	
L1	F1	BBC Ref. CH23	
L2	J12	BBC Ref. D160	
M1	N4	Turner Model 225	
M2	Q4	Turner Model 225	
MR1, 2	D2	Westinghouse 5D73	
R1	B4	Erie 108 0·5W	± 1
R2	B6	Erie 108 0·5W	± 1
R3	B7	Erie 108 0·5W	± 1
R4	B9	Erie 108 0·5W	± 1
R5	G5	Erie 9 0·25W	± 10
R6	H5	Erie 9 0·25W	± 10
R7	G6	Erie 108 0·5W	± 2
R8	H6	Erie 108 0·5W	± 2
R9	F7	Welwyn AW 3115 3W	± 5
R10	H7	Welwyn AW 3115 3W	± 5
R11	F4	Erie 9 0·25W	± 10
R12	J4	Erie 9 0·25W	± 10
R13	G3	Erie 108 0·5W	± 2
R14	H3	Erie 108 0·5W	± 2
R15	G2	Erie 108 0·5W	± 2
R20	H9	Erie 100 1W	± 2
R21	H9	As required; See note 1 on diagram	
R22	J9	Erie 108 0·5W	± 2
R23	N4	As required; See note 2 on diagram	
R24	Q4	As required; See note 3 on diagram	
R25	B11	Erie 8 0·5W	± 10
R29	F3	Welwyn AW3111 4·5W	± 5
R30	Q6	As required: See note 4 on diagram	
R31	F2	Erie 109 0·25W	± 2
R32	F10	Erie 108 0·5W	± 1
B33	B5	Erie 109 0·25W	± 1
R34	B6	Erie 109 0·25W	± 1
R35	B8	Erie 109 0·25W	± 1
R36	B9	Erie 109 0·25W	± 1
R37 to R49	N10	Erie 9 0·25W	± 10
R50	H7	Erie 108 0·5W	± 2
R51	J12	Erie 108 0·5W	± 1
R52	K9	Erie 108 0·5W	± 2
SWA	M3	N.S.F. DH (3p. 5w. non-shorting) BBC Ref. DA 2920	
SWB	R5	N.S.F. DH (3p. 7w. non-shorting) BBC Ref. DA 2921	
TR1	B2	BBC Ref. M194	

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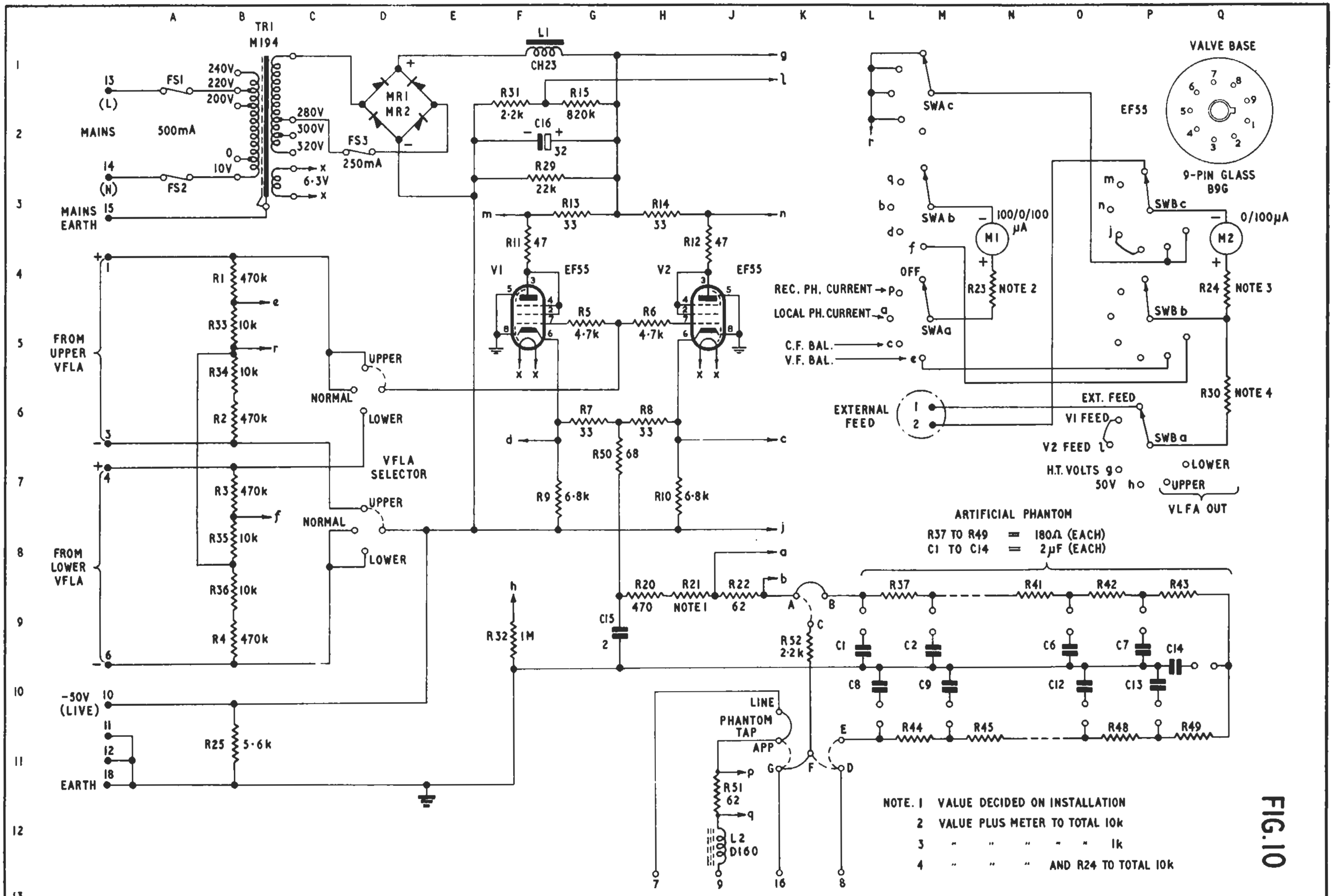


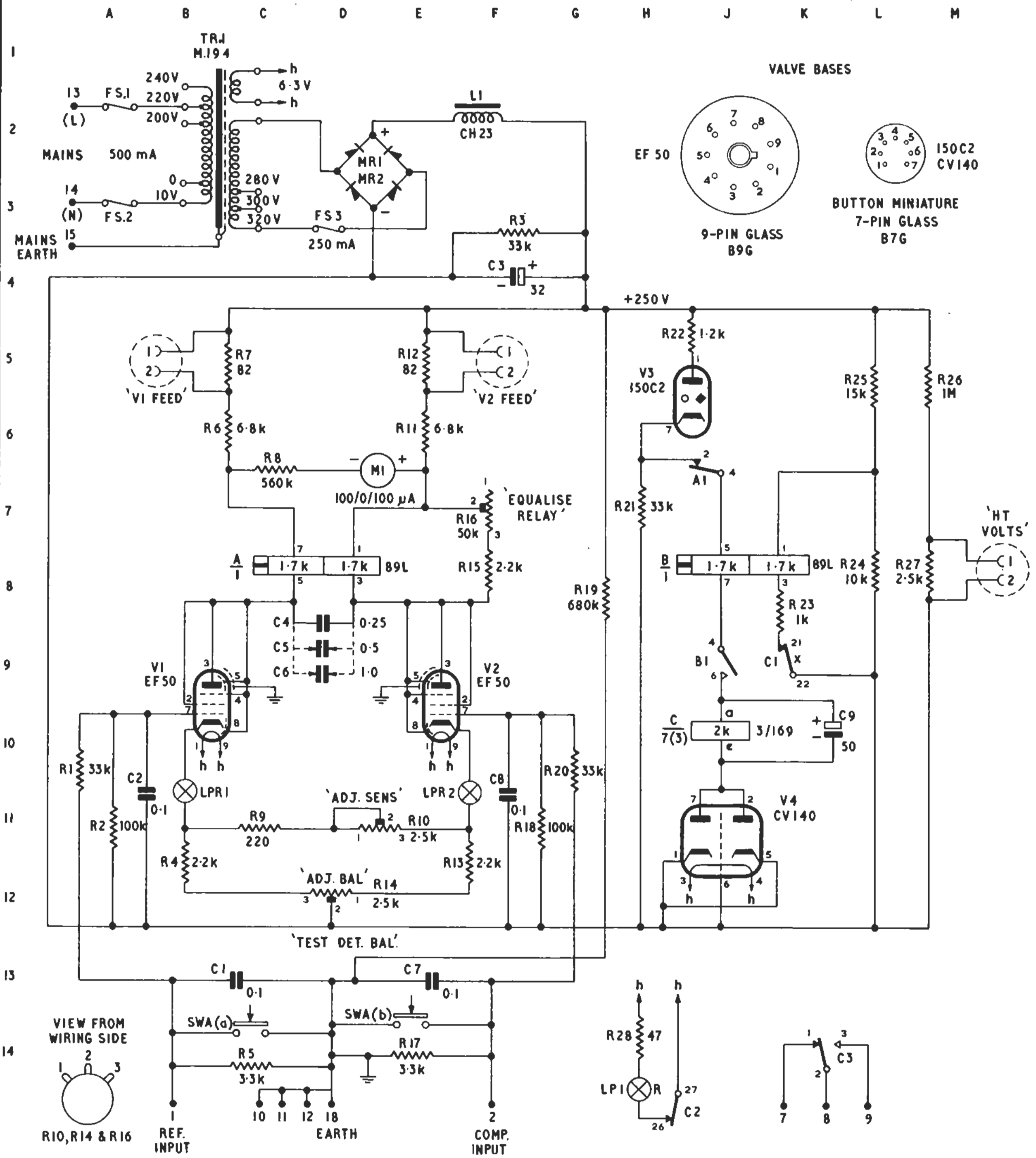
PHANTOM UNIT (RECEIVING) PUR/1

T10

COMPONENT TABLE: FIG. 11

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
C1	C13	T.C.C. CP37N/PVC	± 20	R6	B6	Painton P301 4·5W	± 5
C2	A11	T.C.C. CP37N/PVC	± 20	R7	C5	Erie 108 0·5W	± 2
C3	F4	Plessey CE811/1	− 20 + 50	R8	C7	Erie 108 0·5W	± 2
C4	D8	Muirhead 33AT	± 10	R9	C11	Erie 9 0·25W	± 10
C5	D9	Muirhead 33AT	± 10	R10	D11	Reliance TW/1/8S 5W	± 10
C6	D9	Muirhead 33AT	± 10	R11	E6	Painton P301 4·5W	± 5
C7	E13	T.C.C. CP37N/PVC	± 10	R12	E5	Erie 108 0·5W	± 2
C8	F11	T.C.C. CP37N/PVC	± 20	R13	F12	Erie 108 0·5W	± 2
C9	K10	Plessey CE17078/1	− 20 + 50	R14	D12	Reliance TW/1/8S 5W	± 10
				R15	F8	Erie 8 0·5W	± 10
FS1, 2	A2	Belling Lee L562		R16	F7	Morganite H	± 20
FS3	D3	Belling Lee L562		R17	E14	Erie 100 1W	± 2
				R18	G11	Erie 108 0·5W	± 2
L1	F2	BBC Ref. CH23		R19	G8	Erie 8 0·5W	± 10
				R20	G10	Erie 109 0·25W	± 2
LP1	H14	P.O. No. 2 (6v)		R21	H7	Dubilier BTB 1W	± 10
LPR1	B11	P.O. No. 2 (17v)		R22	J5	Erie 9 0·25W	± 10
LPR2	F11	P.O. No. 2 (17v)		R23	K8	Erie 9 0·25W	± 10
				R24	L8	Painton P306 3W	± 5
M1	E7	Turner Model 325		R25	L5	Painton P306 3W	± 5
				R26	M5	Erie 108 0·5W	± 2
MR1, 2	D2	Westinghouse 5D73		R27	M8	Erie 109 0·25W	± 2
				R28	H14	Painton MV1 1·5W	± 5
R1	A10	Erie 109 0·25W	± 2				
R2	A11	Erie 108 0·5W	± 2	SWA	D14	Walters 1849	
R3	F3	Painton P301 4·5W	± 5				
R4	B12	Erie 108 0·5W	± 2	TR1	B2	BBC Ref. CH23	
R5	C14	Erie 100 1W	± 2				

FIG. 11



DIFFERENTIAL DETECTOR DD/2

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COMPONENT TABLE: FIG. 12

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
C1	R4	Hunts B501/P		R1	B2	Erie 108 0·5W	± 2
				R2	B4	Erie 108 0·5W	± 2
M1	K7	Turner Model 225		R3	B6	Erie 108 0·5W	± 2
				R6	K7	Erie 108 0·5W	± 2
MR1	F6	Westinghouse 16K7		R7	M5	Erie 108 0·5W	± 2
MR2	B3	Westinghouse 16K7		R8	M6	Erie 108 0·5W	± 2
MR3	B5	Westinghouse 16K7		R9	T1	Erie 8 0·5W	± 10
MR4	D6	Westinghouse 16K7		R10	Q2	Painton P301 4·5W	± 5
MR5	B7	Westinghouse 16K7		R11	R3	Erie 9 0·25W	± 10
				R12	Q5	Painton P301 4 5W	± 5
RLA	S1	Siemens 100AE					
RLB	R6	BBC Ref. 3/103					
RLC	D7	BBC Ref. 3/133					
RLD	F7	BBC Ref. 3/133					

58/JR/112/DJE
DC 2571
ISS 3

FIG. 12

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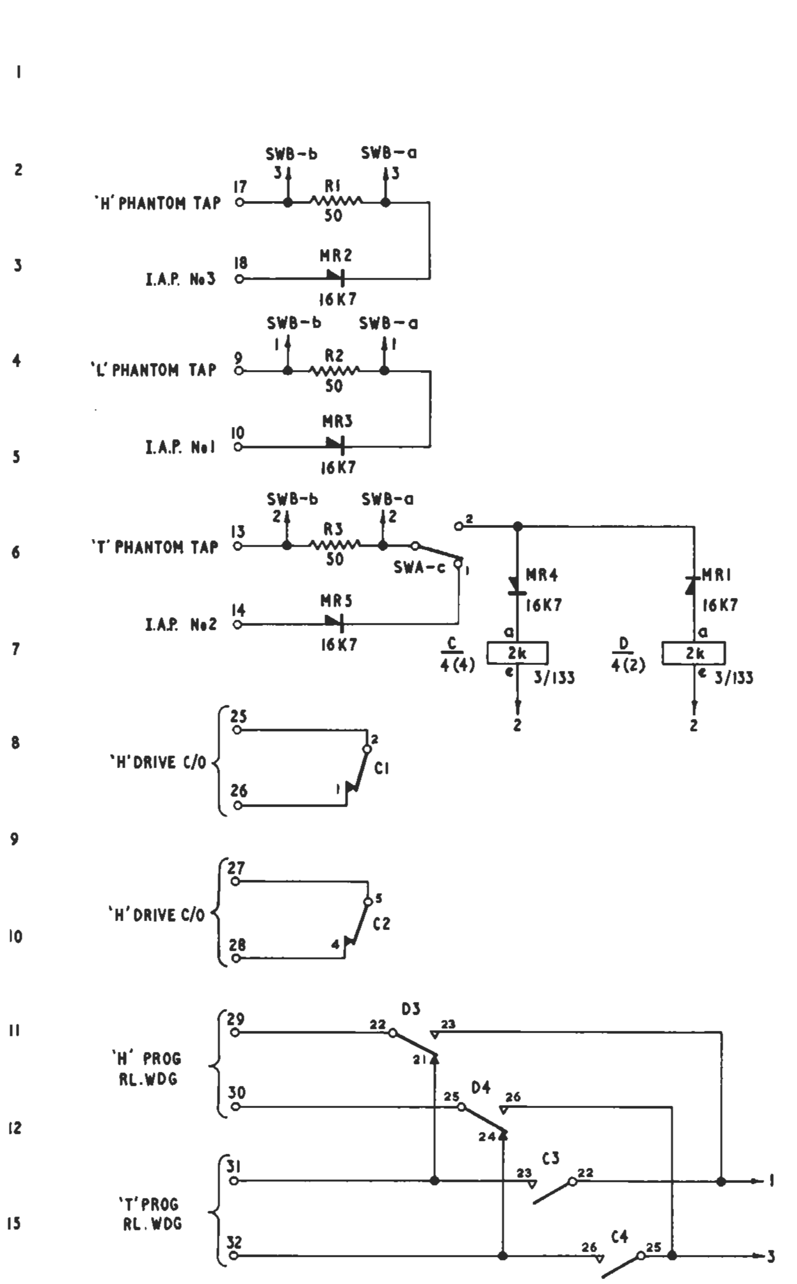
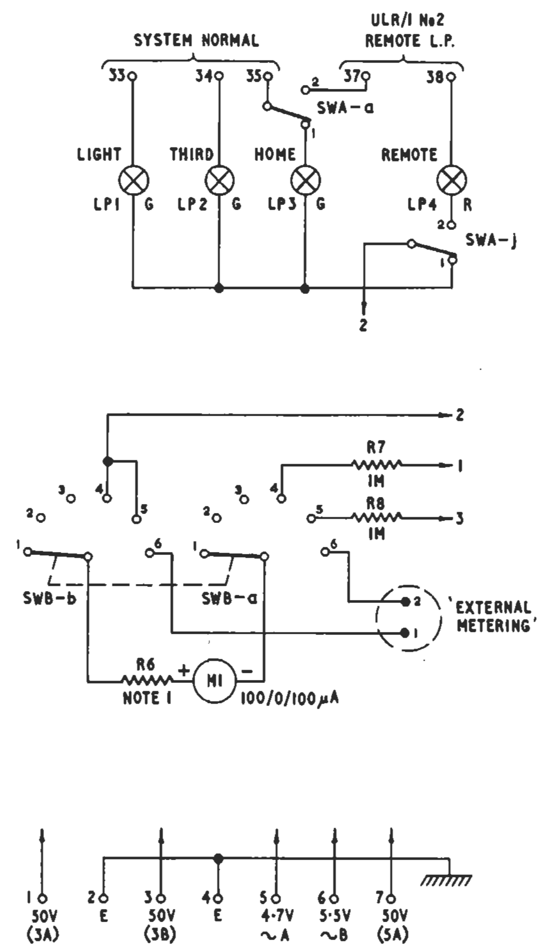
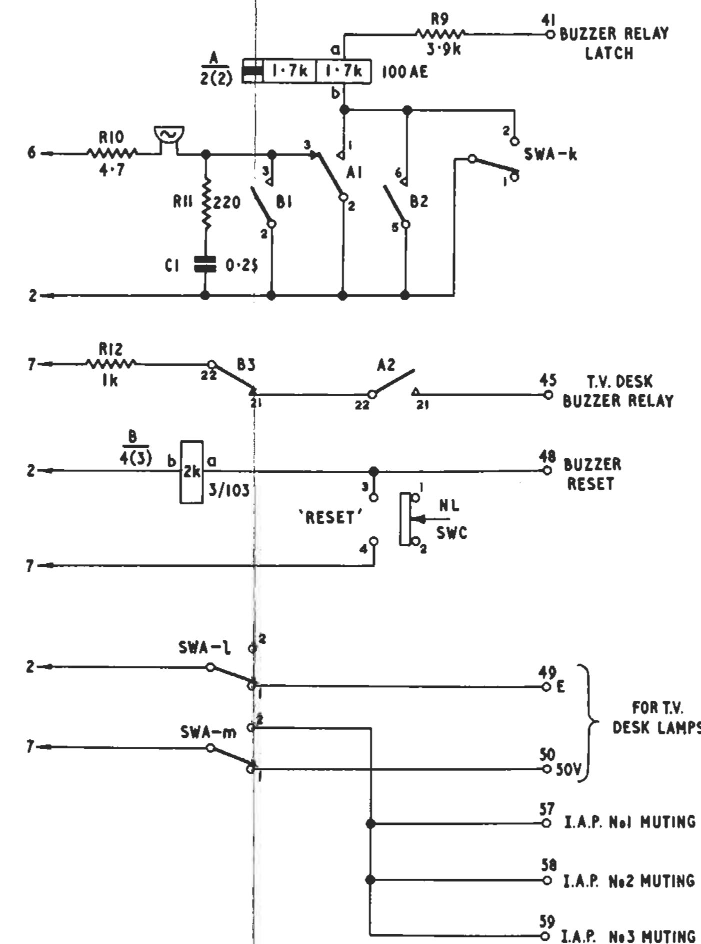






COMP	LOC	TYPE	TOLERANCE
C1	R4	HUNT B501/P	
M1	L8	TURNER MODEL 225	
MR1-5	C7	WESTINGHOUSE 16K7	
RLA	S1	SIEMENS 100AE	
RLB	R6	BBC REF 3/103	
RLC	D7	" " 3/133	
RLD	E7	" " "	
R1-3	—	ERIE 108 0·5W	±2%
R6-8	—	" " "	"
R9	T1	" 8 "	±10%
R10	Q2	PAINTON P301 4·5W	±5%
R11	R3	ERIE 9 0·25W	±10%
R12	Q5	PAINTON P301 4·5W	±5%

NOTES:- 1. ADJUSTED TO GIVE TOTAL RESISTANCE OF 10k ±2% FOR R6 PLUS M1

2. SWITCH SETTINGS

SWA
1 LOCAL
2 REMOTE

SWB
1, 2, 3 LINE I (÷5mA)
4 50V A
5 50V B
6 EXT.

PHANTOM RELAY PANEL (RECEIVING) PRR/2

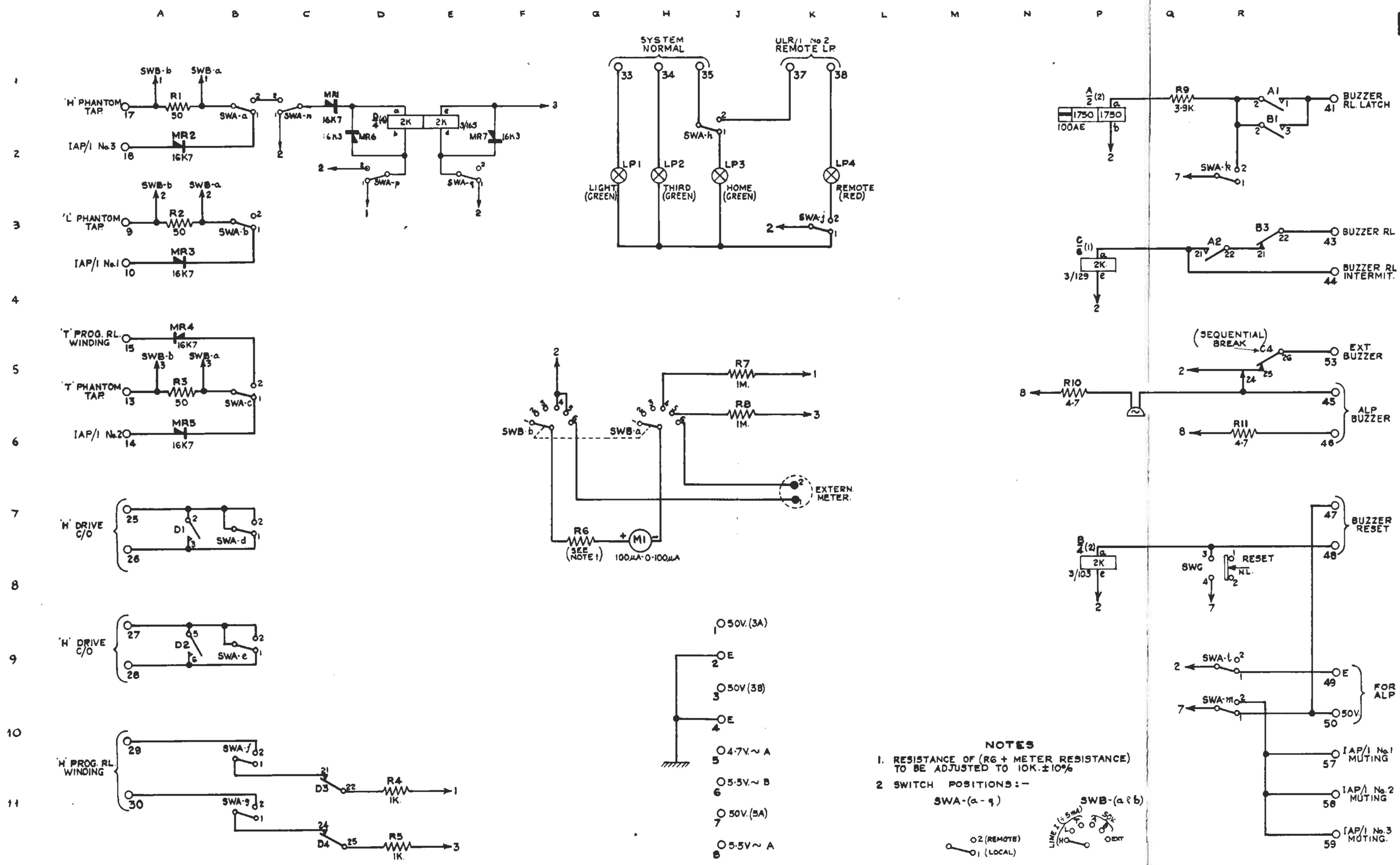
COMPONENT TABLE: FIG. 13

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
M1	G7	Turner Model 225		R1	A1	Erie 108 0·5W	± 2
				R2	A3	Erie 108 0·5W	± 2
MR1	C1	Westinghouse 16K7		R3	A5	Erie 108 0·5W	± 2
MR2	A2	Westinghouse 16K7		R4	D11	Painton P301 4·5W	± 5
MR3	A4	Westinghouse 16K7		R5	D11	Painton P301 4·5W	± 5
MR4	A4	Westinghouse 16K7		R6	G7	Erie 108 0·5W	± 2
MR5	A6	Westinghouse 16K7		R7	J5	Erie 108 0·5W	± 2
MR6	D2	Westinghouse 16K3		R8	J6	Erie 108 0·5W	± 2
MR7	F2	Westinghouse 16K3		R9	Q2	Erie 8 0·5W	± 10
				R10	P5	Painton P301 4·5W	± 5
RLA	P2	Siemens 100AE		R11	R6	Painton P301 4·5W	± 5
RLB	P8	BBC Ref. 3/103					
RLC	P4	BBC Ref. 3/129					
RLD	E2	BBC Ref. 3/165					

58/JR/114
DC2475
ISS.4.

T10

FIG. 13



PHANTOM RELAY PANEL (RECEIVING) PRR/2A

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COMPONENT TABLE: FIG. 14

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
C1	N3	Hunts B501/P		R1	A1	Erie 108 0·5W	± 2
				R2	A3	Erie 108 0·5W	± 2
M1	G7	Turner Model 225		R3	A5	Erie 108 0·5W	± 2
				R6	F7	Erie 108 0·5W	± 2
MR1	C1	Westinghouse 16K7		R7	J5	Erie 108 0·5W	± 2
MR2	C2	Westinghouse 16K7		R8	J6	Erie 108 0·5W	± 2
MR3	A3	Westinghouse 16K7		R9	Q1	Erie 8 0·5W	± 10
MR4	A6	Westinghouse 16K7		R10	M2	Painton P301 4·5W	± 5
				R11	N2	Erie 9 0·25W	± 10
RLA	P1	Siemens 100AE		R12	Q5	Painton P301 4·5W	± 5
RLB	P8	BBC Ref. 3/103					
RLC	D1	BBC Ref. 3/133					
RLD	D2	BBC Ref. 3/133					
* RLE	D3	BBC Ref. 3/133					

* In PRR2/B (MOD) VERSION ONLY.

58/JR/115
DC2942 ISS.2
DC3609 ISS.1

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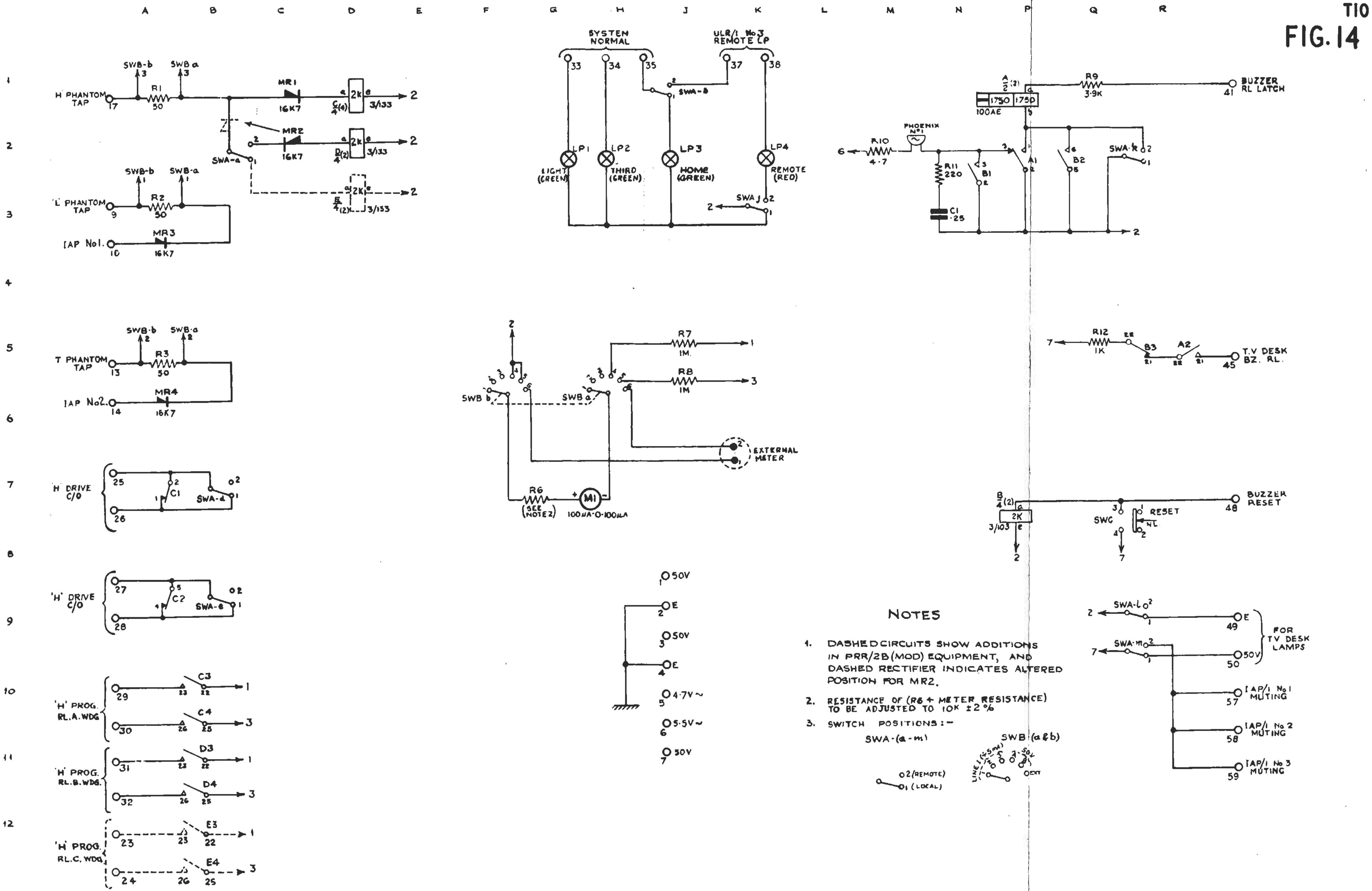
T10
FIG. 14



NOTES

1. DASHED CIRCUITS SHOW ADDITIONS IN PRR/2B (MOD) EQUIPMENT, AND DASHED RECTIFIER INDICATES ALTERED POSITION FOR MR2.
2. RESISTANCE OF (R6 + METER RESISTANCE) TO BE ADJUSTED TO 10K ±2%
3. SWITCH POSITIONS:–

SWA-(a-m): 2 (REMOTE), 1 (LOCAL)

SWB (a & b): LINE 1 (±5mA), 2, 3, 50V, EXT

PHANTOM RELAY PANEL (RECEIVING) PRR/2B & PRR/2B (MOD.)

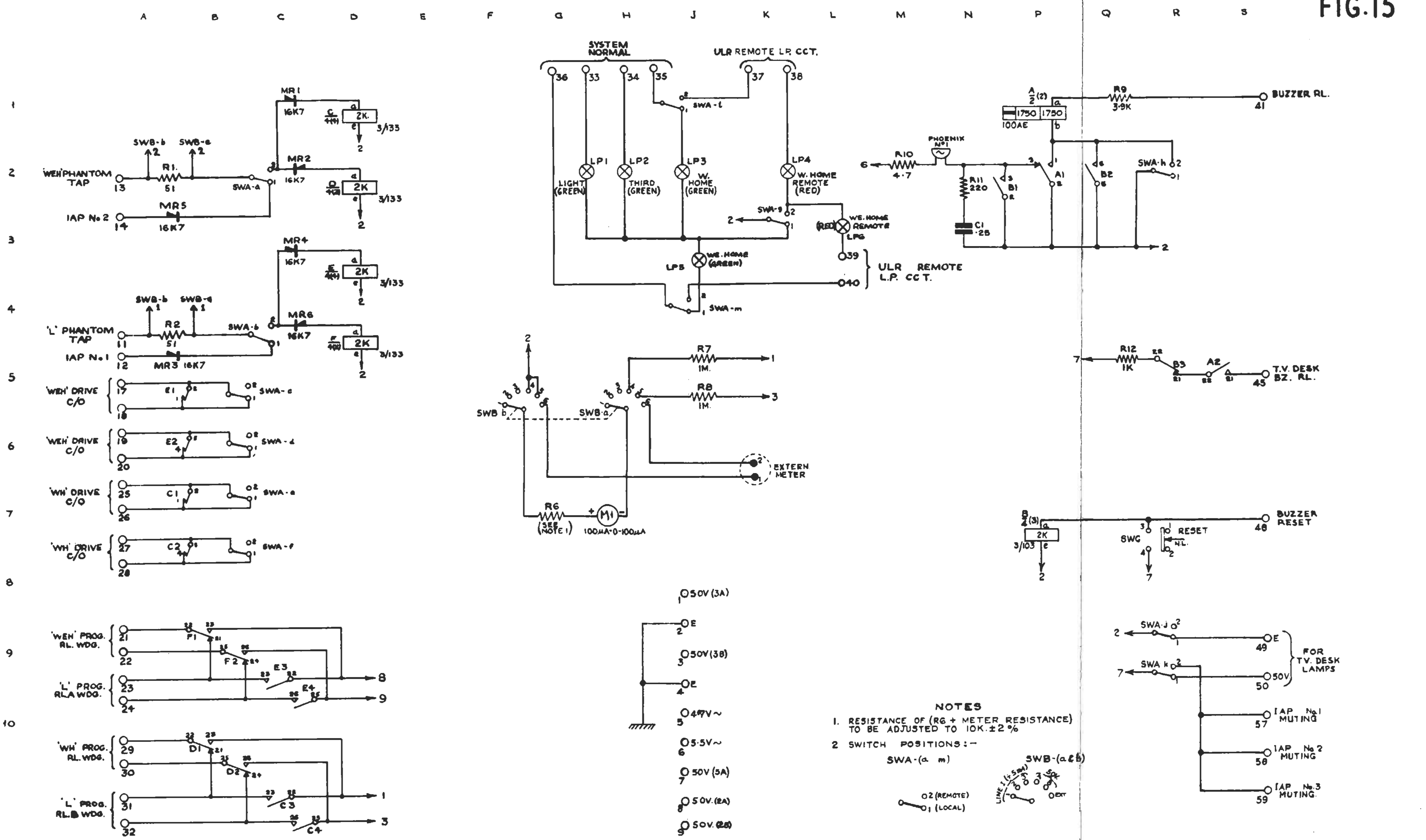
COMPONENT TABLE: FIG. 15

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
C1	N3	Hunts B501/P		RLD	D2	BBC Ref. 3/133	
				RLE	D3	BBC Ref. 3/133	
M1	H7	Turner Model 225		RLF	D5	BBC Ref. 3/133	
MR1	C1	Westinghouse 16K7		R1	A2	Erie 108 0·5W	± 2
MR2	C2	Westinghouse 16K7		R2	A4	Erie 108 0·5W	± 2
MR3	A5	Westinghouse 16K7		R6	G7	Erie 108 0·5W	± 2
MR4	C3	Westinghouse 16K7		R7	J5	Erie 108 0·5W	± 2
MR5	A3	Westinghouse 16K7		R8	J6	Erie 108 0·5W	± 2
MR6	C4	Westinghouse 16K7		R9	Q1	Erie 8 0·5W	± 10
				R10	M2	Painton P301 4·5W	± 5
RLA	P1	Siemens 100AE		R11	N2	Erie 9 0·25W	± 10
RLB	P8	BBC Ref. 3/103		R12	Q5	Painton P301 4·5W	± 5
RLC	D1	BBC Ref. 3/133					

58/JR/116
DC3095
ISS.3

T10

FIG.15



NOTES

1. RESISTANCE OF (R6 + METER RESISTANCE) TO BE ADJUSTED TO 10K ±2%
2. SWITCH POSITIONS:–
   SWA-(a – m) — 2 (REMOTE), 1 (LOCAL)
   SWB-(a & b)

PHANTOM RELAY PANEL (RECEIVING) PRR/2C

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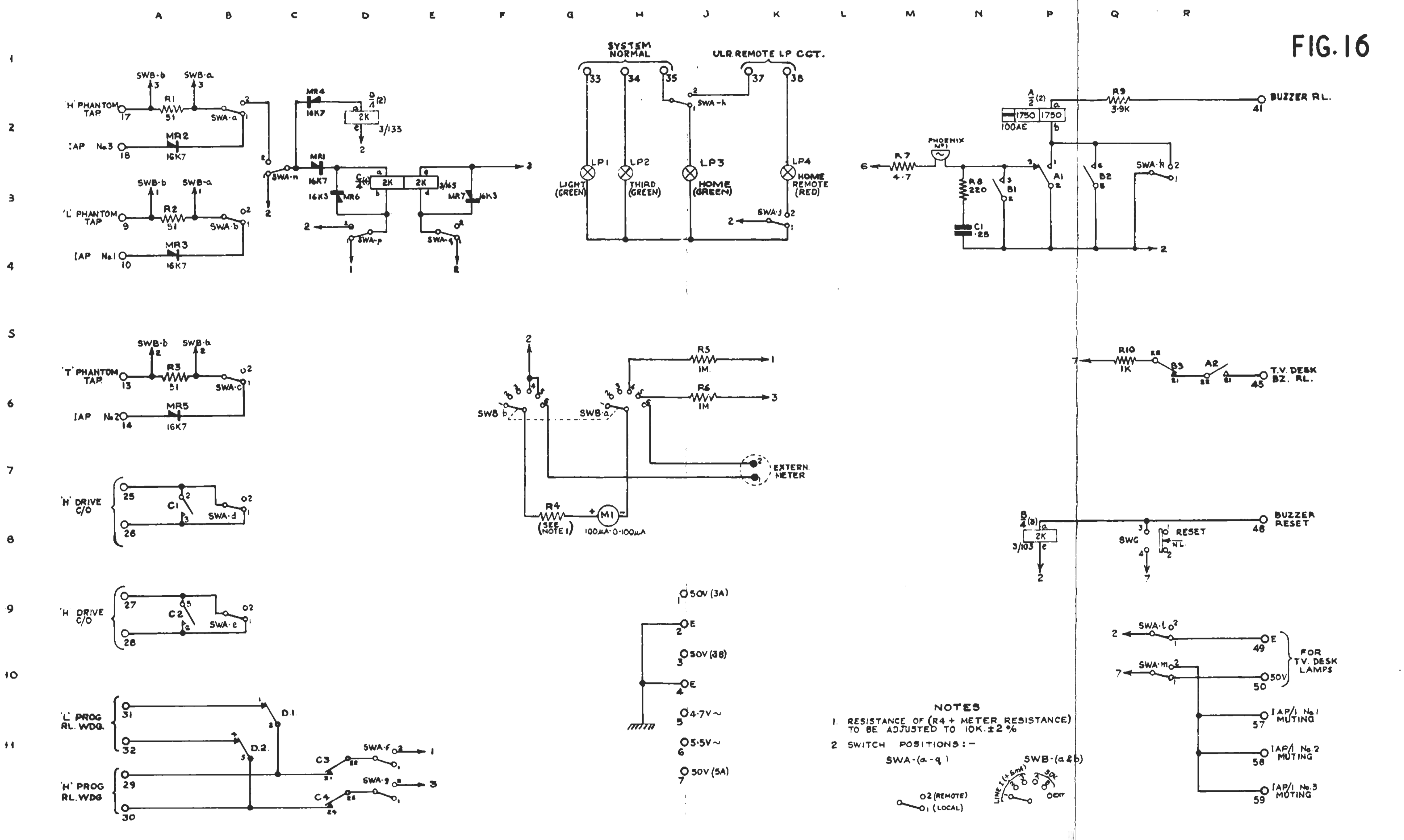
COMPONENT TABLE: FIG. 16

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
C1	N4	Hunts B501/P		RLC	E3	BBC Ref. 3/165	
				RLD	D2	BBC Ref. 3/133	
M1	G8	Turner Model 225					
				R1	A2	Erie 108 0·5W	± 2
MR1	C3	Westinghouse 16K7		R2	A3	Erie 108 0·5W	± 2
MR2	A3	Westinghouse 16K7		R3	A5	Erie 108 0·5W	± 2
MR3	A4	Westinghouse 16K7		R4	G8	Erie 108 0·5W	± 2
MR4	C2	Westinghouse 16K7		R5	J5	Erie 108 0·5W	± 2
MR5	A6	Westinghouse 16K7		R6	J6	Erie 108 0·5W	± 2
MR6	D3	Westinghouse 16K3		R7	M3	Painton P301 4·5W	± 5
MR7	F3	Westinghouse 16K3		R8	N3	Erie 9 0·25W	± 10
				R9	Q2	Erie 8 0·5W	± 10
RLA	P2	Siemens 100AE		R10	Q5	Painton P301 4·5W	± 5
RLB	P8	BBC Ref. 3/103					

58/JR/117
DC3302
ISS.3

T10

FIG. 16



PHANTOM RELAY PANEL (RECEIVING) PRR/2D

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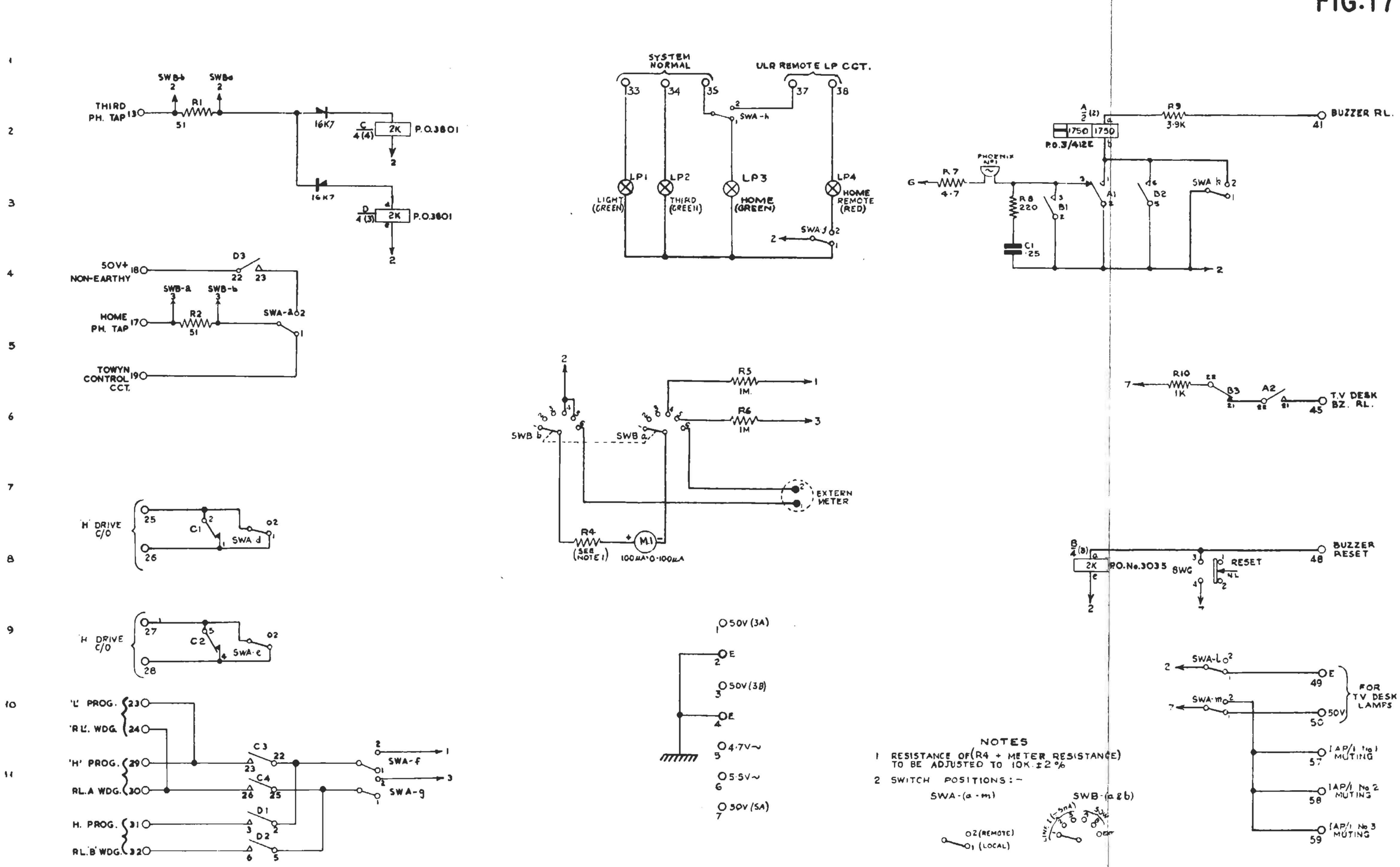
COMPONENT TABLE: FIG. 17

Comp.	Loc.	Type	Tolerance Per cent	Comp.	Loc.	Type	Tolerance Per cent
C1	N4	Hunts B501/P		R1	A2	Erie 108 0·5W	± 2
				R2	A5	Erie 108 0·5W	± 2
M1	H8	Turner Model 225		R4	G8	Erie 108 0·5W	± 2
				R5	J6	Erie 108 0·5W	± 2
MR1	C2	Westinghouse 16K7		R6	J6	Erie 108 0·5W	± 2
MR2	C3	Westinghouse 16K7		R7	M3	Painton P301 4·5W	± 5
				R8	N3	Erie 9 0·25W	± 10
RLA	P2	G.P.O. No. 3/412E		R9	Q2	Erie 8 0·5W	± 10
RLB	P8	G.P.O. No. 3035		R10	Q6	Painton P301 4·5W	± 5
RLC	D2	G.P.O. No. 3801					
RLD	D3	G.P.O. No. 3801					

58/JR/118
DC 4036
ISS.2.

FIG.17



PHANTOM RELAY PANEL (RECEIVING) PRR/2E

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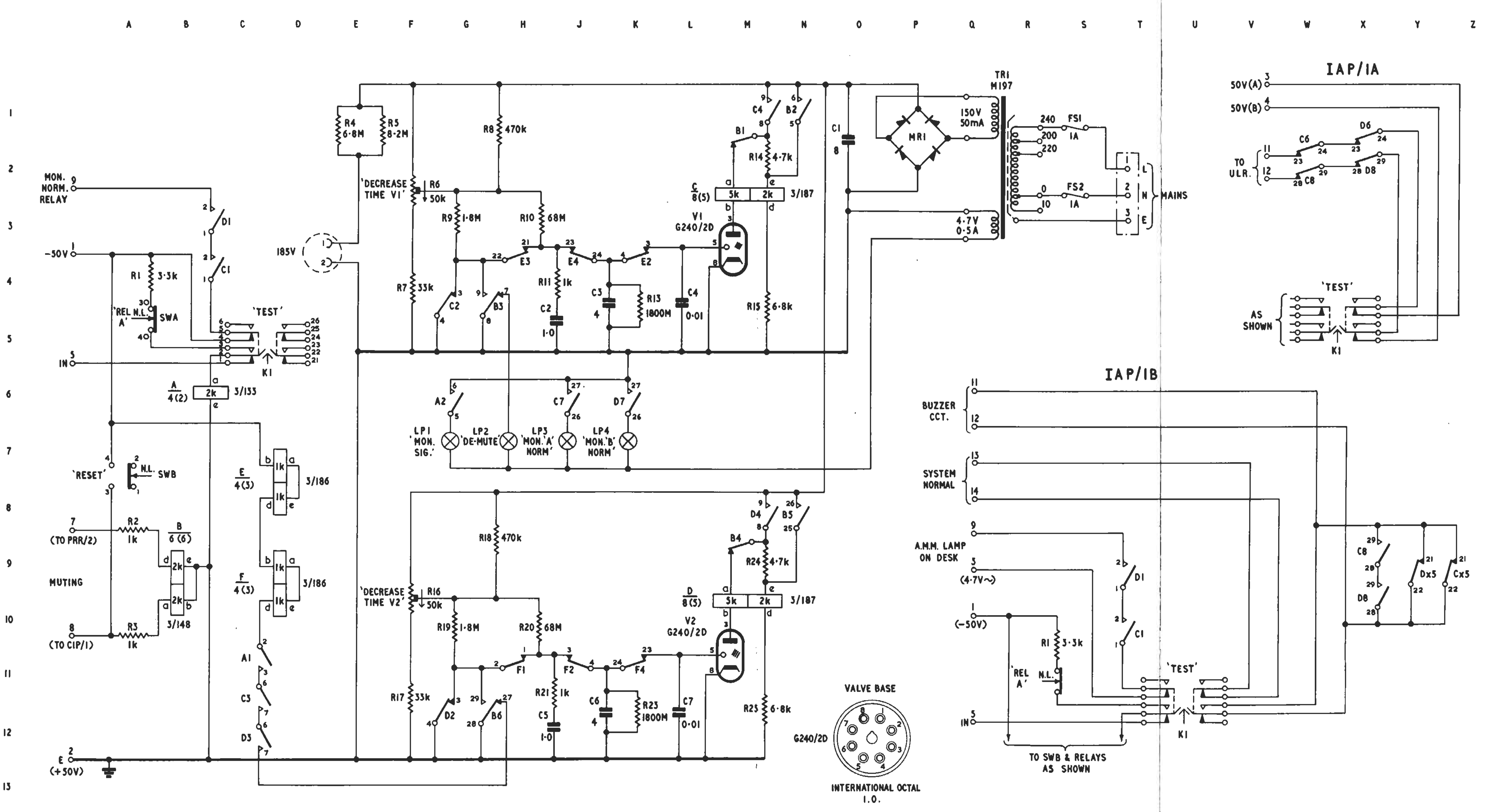
COMPONENT TABLE: FIG. 18

Comp.	Loc.	Type	Tolerance Per cent
C1	O1	T.C.C. CP150T	± 20
C2	J5	T.C.C. CP142T	± 20
C3	K4	T.C.C.147T	± 20
C4	L4	T.C.C. M3N	± 20
C5	J12	T.C.C. CP142T	± 20
C6	K12	T.C.C. CP147T	± 20
C7	L12	T.C.C. M3N	± 20
FS1, 2	S2	Belling Lee L 562	
K1	C5	P.O. No. 73	
LP1–4	H7	P.O. No. 2 (6v)	
MR1	P1	S.T.C. MBA 25—8—1GZ	
R1	A4	Erie 8 0·5W	± 10
R2	A8	Erie 8 0·5W	± 10
R3	A10	Erie 8 0·5W	± 10
R4	E1	Welwyn S3623	± 2
R5	F1	Welwyn S3623	± 2
R6	F2	Morganite H (Linear)	± 20
R7	F4	Erie 8 0·5W	± 10
R8	H1	Erie 9 0·25W	± 10
R9	G3	Welwyn S3623	± 2
R10	H3	Welwyn S3635	+ 5
R11	J4	Erie 8 0·5W	± 10
R13	K4	Welwyn H12	± 10
R14	M2	Painton MV1 1·5W	± 5
R15	M5	Painton P306 3W	± 5
R16	F10	Morganite H (Linear)	± 20
R17	F12	Erie 8 0·5W	± 10
R18	H9	Erie 9 0·25W	± 10
R19	G10	Welwyn S3623	± 2
R20	H10	Welwyn S3635	± 5
R21	J11	Erie 8 0·5W	± 10
R23	K12	Welwyn H12	± 10
R24	M9	Painton MV1 1·5W	± 5
R25	M12	Painton P306 3W	± 5
Relays			
A	B6	BBC Ref. 3/133	
B	B9	BBC Ref. 3/148	
C	M2	BBC Ref. 3/187	
D	M10	BBC Ref. 3/187	
E	D7	BBC Ref. 3/186	
F	D9	BBC Ref. 3/186	
SWA	A5	Painton 501404	
SWB	A7	Painton 501404	
TR1	R2	BBC M197	

58/JR/102/DJE
DC 2459 ISS 4
DC 3765 ISS 1
DC 4220 ISS 1

FIG. 18



INTEGRATING ALARM PANEL IAP/1 (IAP/1A & IAP/1B)

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FIG.19

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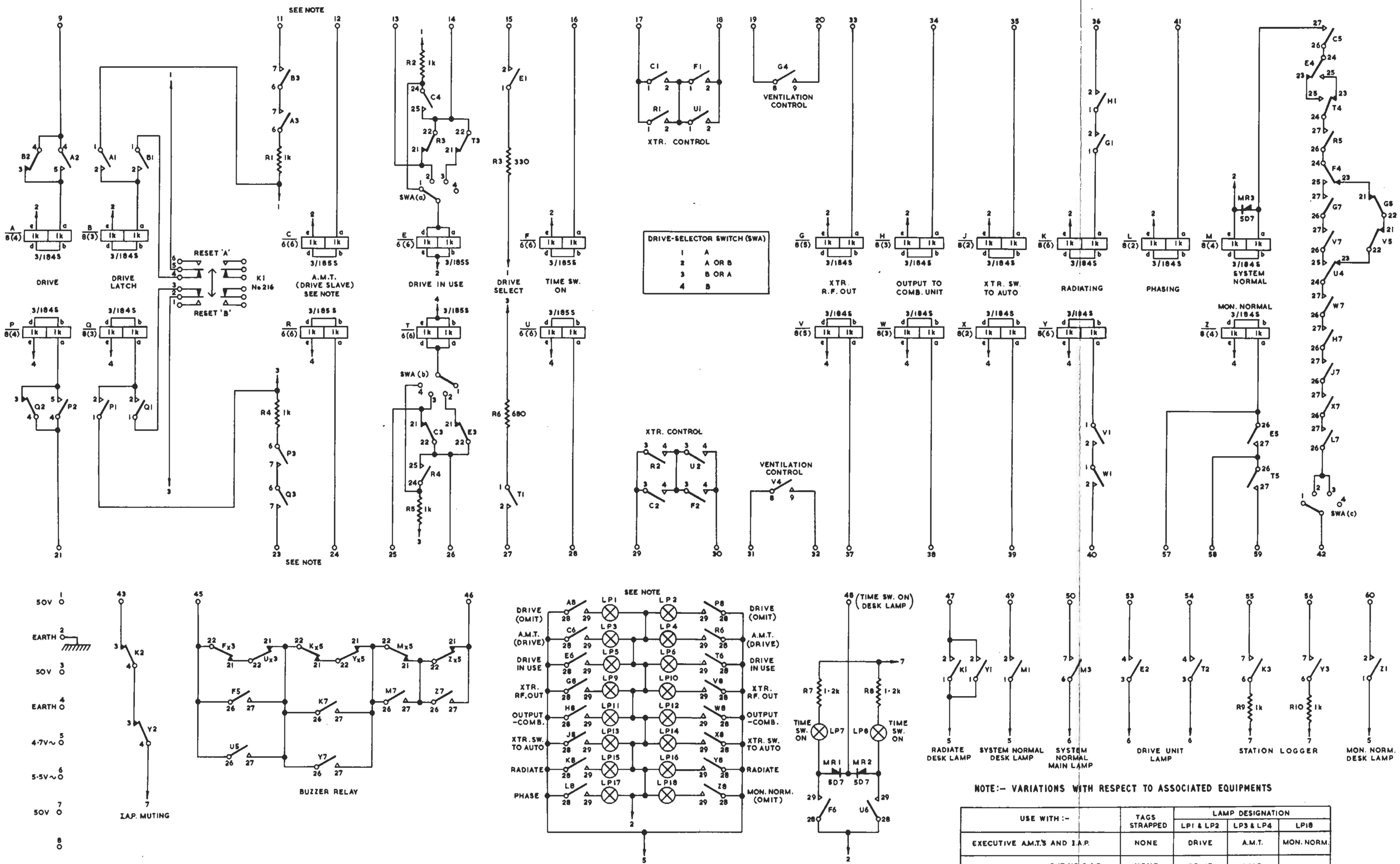


CONTROL & INDICATOR PANEL CIP/1

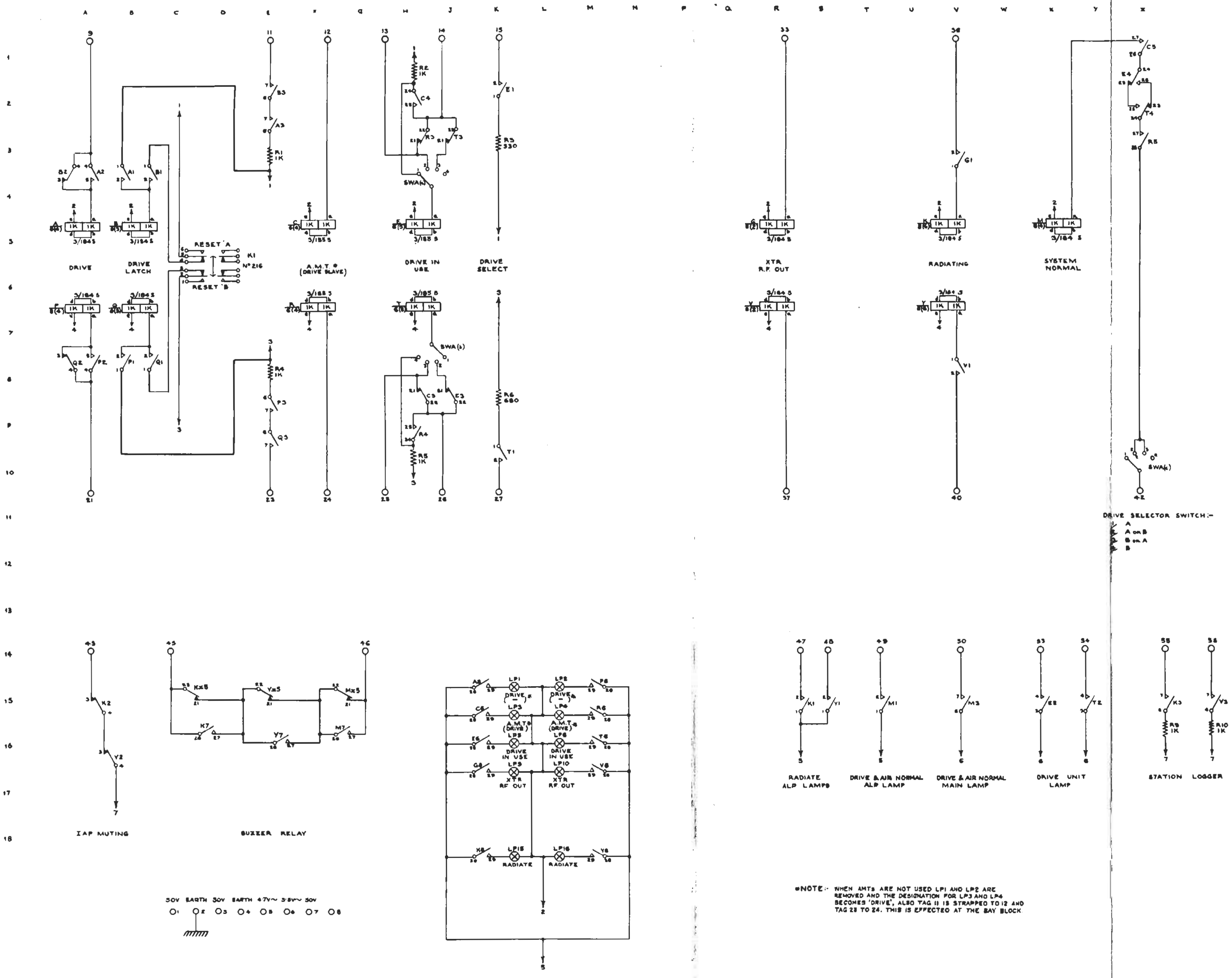
NOTE:- VARIATIONS WITH RESPECT TO ASSOCIATED EQUIPMENTS

USE WITH :-	TAGS STRAPPED	LAMP DESIGNATION LP1 & LP2	LP3 & LP4	LP18
EXECUTIVE A.M.T.'S AND I.A.P.	NONE	DRIVE	A.M.T.	MON. NORM.
" " BUT NO I.A.P.	NONE	DRIVE	A.M.T.	*
NON-EXECUTIVE A.M.T.'S AND/OR I.A.P.	11–12 23–24	*	DRIVE	MON. NORM.
NEITHER A.M.T.'S NOR I.A.P.	11–12 23–24	*	DRIVE	*

* LAMPS OMITTED

58/JR/119
DJ2457
ISS. 2

FIG. 20



CONTROL & INDICATOR PANEL CIP/1A

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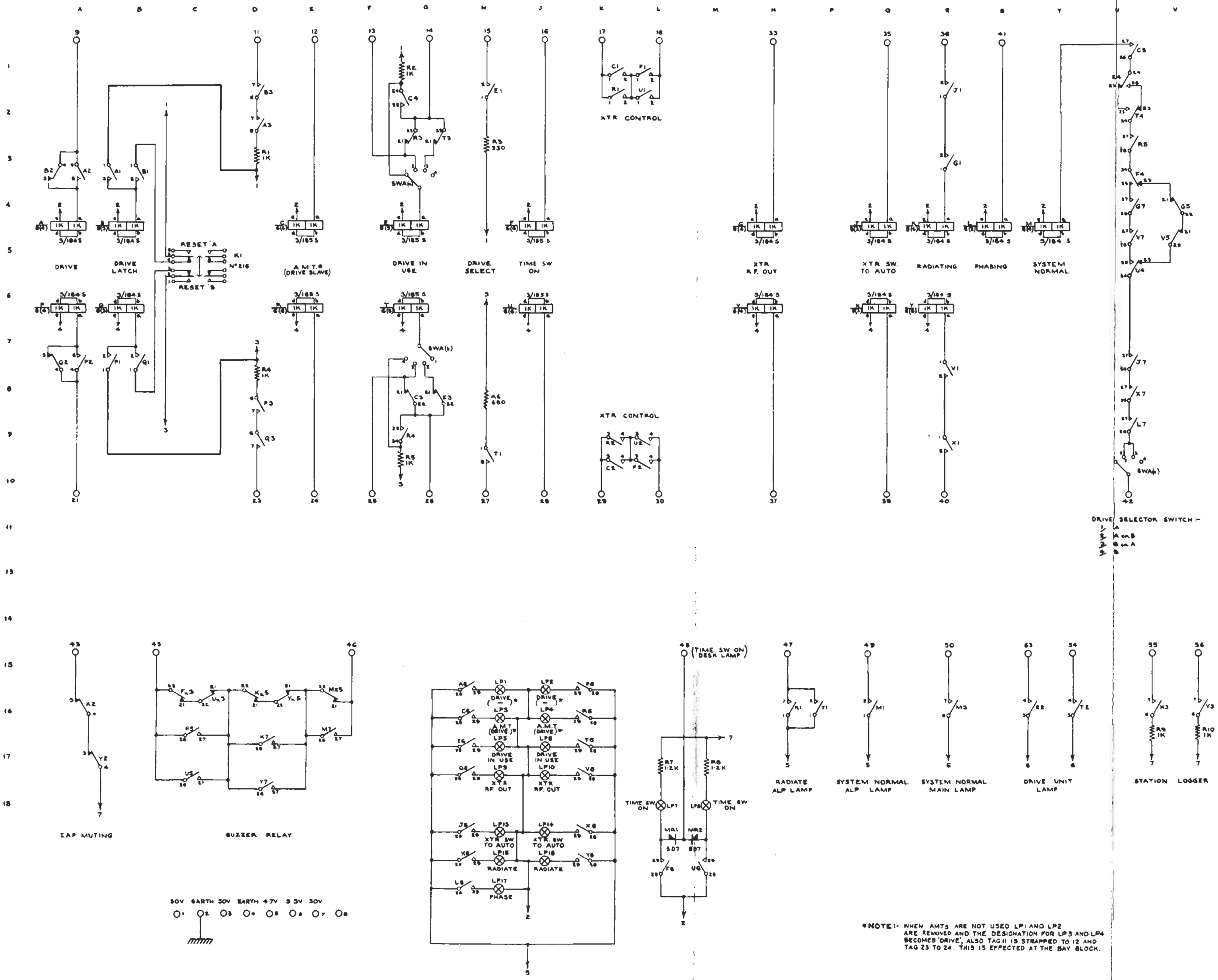
58/JR/120
DJ 2456
ISS.2

T10

FIG. 21



CONTROL & INDICATOR PANEL CIP/IB

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FIG. 22

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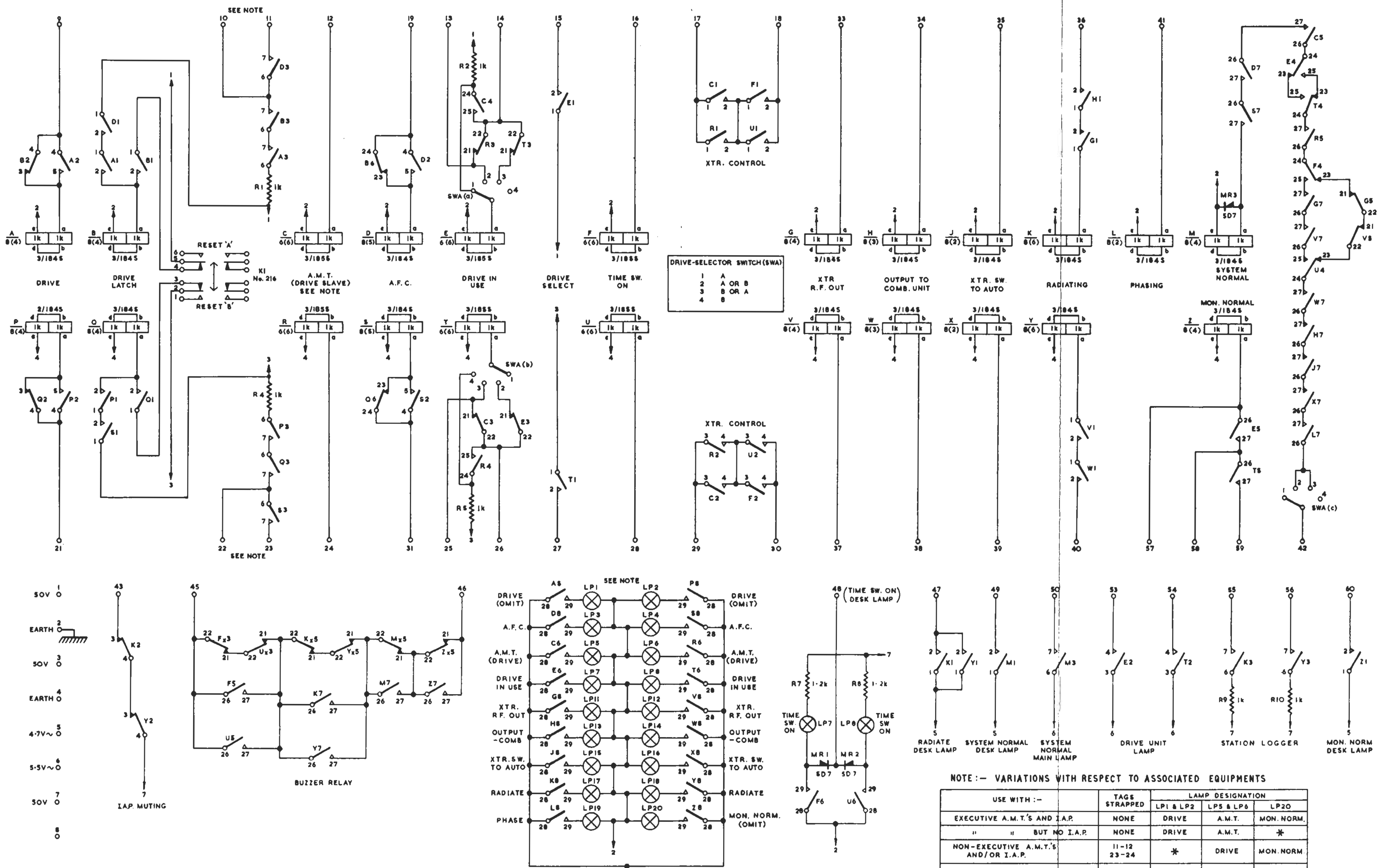

NOTE :— VARIATIONS WITH RESPECT TO ASSOCIATED EQUIPMENTS

USE WITH :—	TAGS STRAPPED	LAMP DESIGNATION		
		LP1 & LP2	LP5 & LP6	LP20
EXECUTIVE A.M.T.'S AND I.A.P.	NONE	DRIVE	A.M.T.	MON. NORM.
" " BUT NO I.A.P.	NONE	DRIVE	A.M.T.	*
NON-EXECUTIVE A.M.T.'S AND/OR I.A.P.	11-12 23-24	*	DRIVE	MON. NORM.
NEITHER A.M.T.'S NOR I.A.P.	11-12 23-24	*	DRIVE	*

FOR ANY OF ABOVE CONDITIONS THE TAGS 10-11 AND 22-23 ARE ALSO STRAPPED WHEN A.F.C. EXECUTIVE ACTION IS NOT REQUIRED

*LAMPS OMITTED

CONTROL & INDICATOR PANEL C1P/1C

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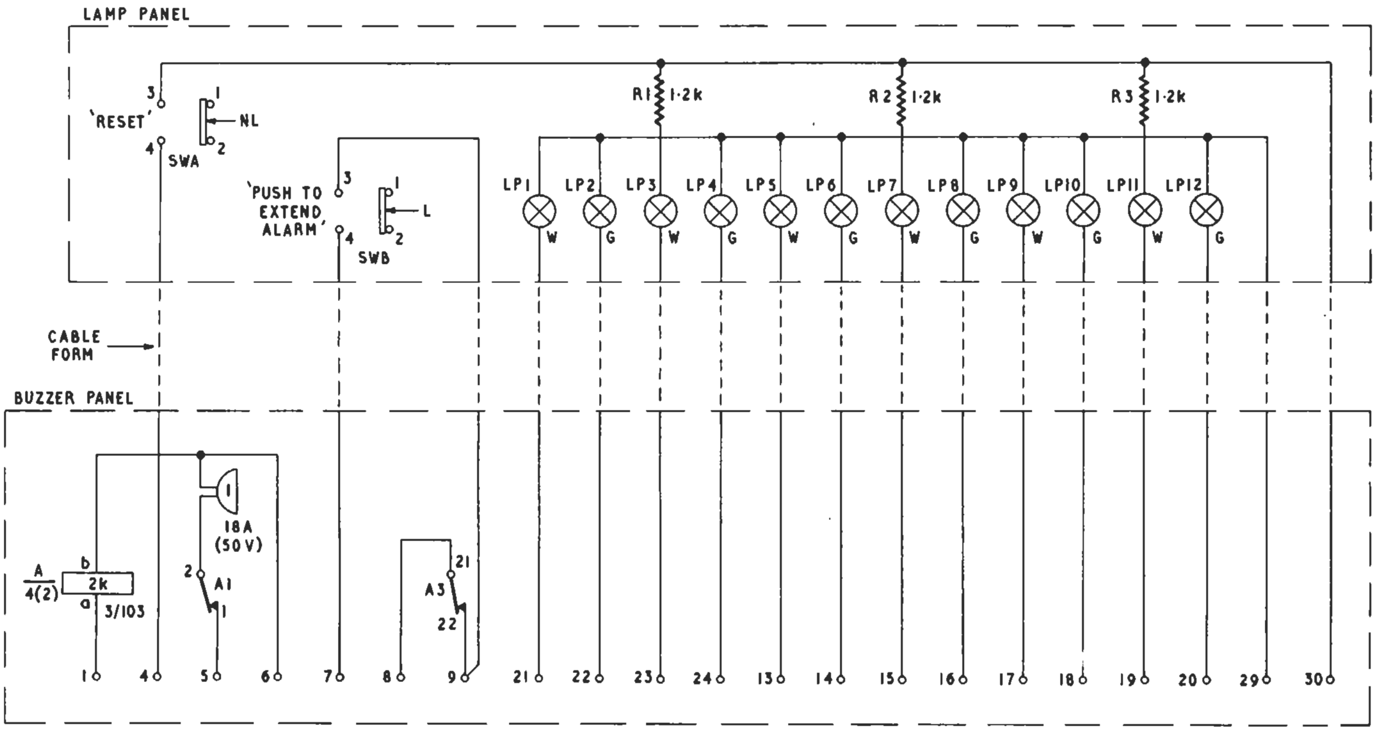
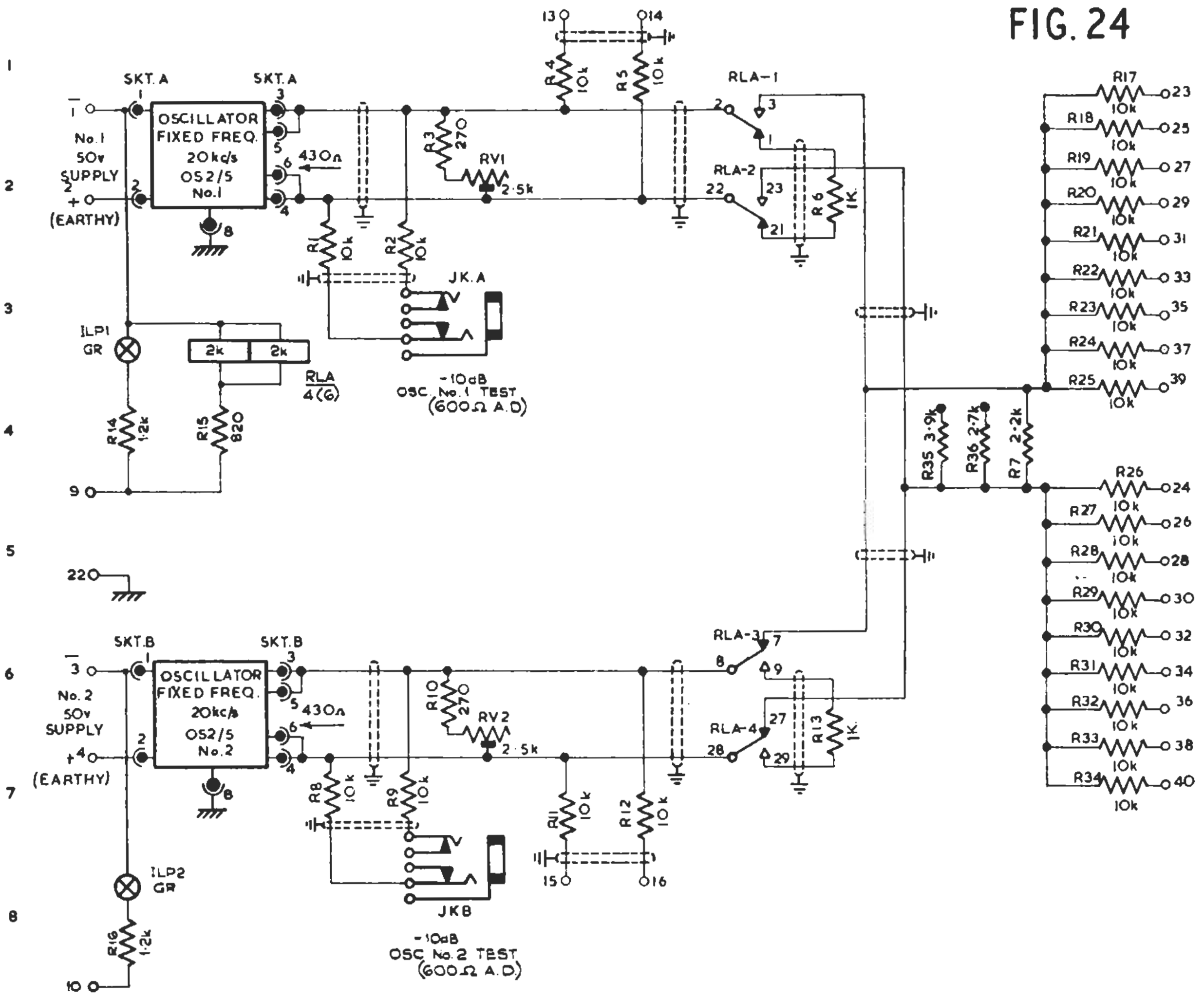


ALARM PANEL: ALP/7

FIG. 23

59/JR/113
DB5892
ISS3

FIG. 24



COMP	LOC	TYPE	TOLERANCE
JKA	D3	P.O. 50086	
JKB	D8	" "	
LP1	A3	P.O. No. 2 (6V)	
LP2	A8	" " "	
R1	C3	ERIE 109 0·25W	±2
R2	C3	" " "	"
R3	D2	" " "	"
R4	E1	" " "	"
R5	E1	" " "	"
R6	G2	" " "	"
R7	H4	" " "	"
R8	C7	" " "	"
R9	C7	" " "	"
R10	D6	" " "	"
R11	E7	" " "	"
R12	E7	" " "	"
R13	G7	" " "	"
R14	A4	PAINTON P. 306A	±5
R15	B4	" MVIA	"
R16	A8	" P. 306A	"
R17	J1	ERIE 109 0·25W	±2
R18	J2	" " "	

COMP	LOC	TYPE	TOLERANCE
R19	J5	ERIE 109 0·25W	±2
R20	J2	" " "	"
R21	J2	" " "	"
R22	J3	" " "	"
R23	J3	" " "	"
R24	J3	" " "	"
R25	J4	" " "	"
R26	J5	" " "	"
R27	J5	" " "	"
R28	J5	" " "	"
R29	J5	" " "	"
R30	J6	" " "	"
R31	J6	" " "	"
R32	J6	" " "	"
R33	J7	" " "	"
R34	J7	" " "	"
R35	H4	" " "	"
R36	H4	" " "	"
			"
RLA	B3	P.O. 8281	"
			"
RV1	D2	MORGANITE LH/WN	±20
RV2	D7	" " "	"

OSCILLATOR MOUNTING PANEL PA1/10: CIRCUIT

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COMPONENT TABLE: Fig. 25

Comp.	Loc.	Type	Tolerance per cent
C1	A1	Plessey CE1025/1	
C2	A2	Plessey CE1261/1	
C3	A5	Plessey CE1261/1	
C4	C3	T.C.C. CSM2ON	5
C5	E5	Plessey CE42/1	
L1	B4	BBC F/93	
L2	C2	BBC F/94	
R1	B5	Painton P406 3W	1
R2	B4	Painton MV1A 1·5W	5
R3	B2	Painton P406 3W	1
R4	B1	Painton P401 4·5W	1
R5	C3	Painton MV1A 1·5W	5
R7	C4	Painton MV1A 1·5W	5
R8	D3	Painton MV1A 1·5W	5
R9	E4	Painton MV1A 1·5W	5
R10	F1	Painton MV1A 1·5W	5
R11	G4	Painton P406 3W	1
R12	G1	Painton P401 4·5W	1
R13	G3	Painton MV1A 1·5W	Adj. on test
R14	H3	Painton P406 3W	1
R15	J3	Painton P406 3W	1
R16	H4	Painton P406 3W	1
R17	J4	Painton P406 3W	1
R18	K1	Painton P406 3W	1
R19	E3	Erie 109	2
RV1	C5	Morganite BJ	20
T1	F3	BBC F/87	
T2	L3	BBC AL/50SN	

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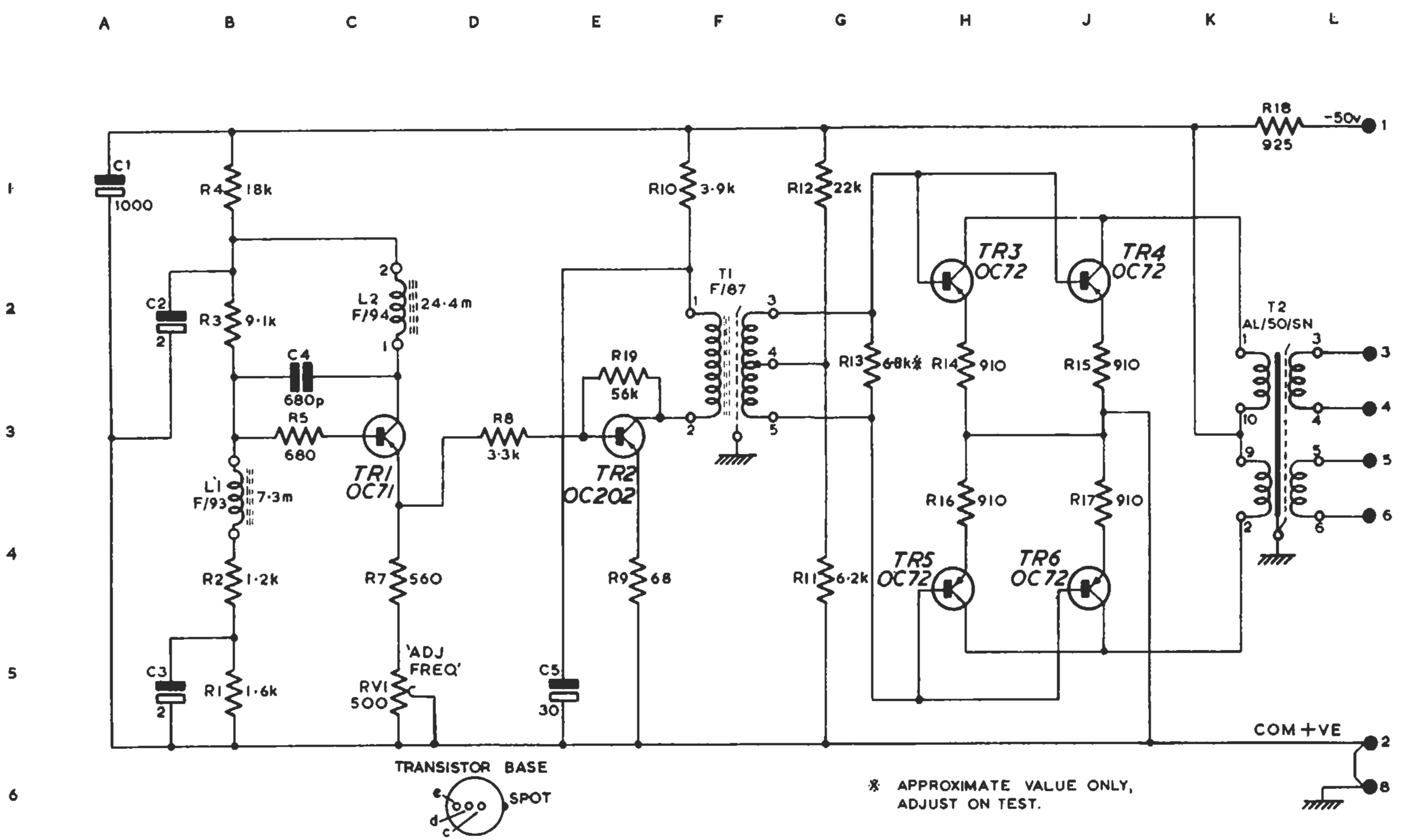
59/JR/111/AP
DA 5896
ISS 5



20-kc/s FIXED OSCILLATOR OS2/5: CIRCUIT

FIG. 25
ISSUE 2 (FEB65)

COMPONENT TABLE: Fig. 26

Comp.	Loc.	Type	Tolerance per cent
C1	A3	T.C.C. CSM2ON	5 (Adj. on test)
C2	D2	T.C.C. SM3N	5 (Adj. on test)
C3	E4	T.C.C. CP32N/PVC	
C4	E3	T.C.C. CP32N/PVC	
C5	G2	T.C.C. SM3N	5 (Adj. on test)
C6	G2	Plessey CE822/1	
C7	K3	Hunts W49 B500K	
C8	G3	T.C.C. CP32N/PVC	
C9	H4	T.C.C. CP32N/PVC	
C10	K3	Plessey CE1246/1	
C11	J4	Dubilier BR0750	
FS1	K1	Belling Lee L562/·050	
L1	D2	BBC F/62A	
L2	F2	BBC F/78A	
MR1	G4	B.T.H. CG44	
R2	C3	Erie 10 0·25W	10
R3	D4	Erie 10 0·25W	10
R4	D3	Erie 16 0·25W	10
R5	F5	Erie 16 0·25W	10
R6	F5	Erie 8 0·5W	10
R7	F5	Erie 16 0·25W	10
R8	F3	Erie 16 0·25W	10
R9	F2	Painton P306A 3W	5
R10	H4	Erie 16 0·25W	10
R11	H3	Erie 16 0·25W	10
R12	J1	Erie 8 0·5W	10
R13	K1	Painton MV1A 1·5W	5
R14	J2	Erie 109 0·25W	2
R15	C2	Erie 109 0·25W	2
R16	C5	Erie 109 0·25W	2
R17	E2	Painton P203A 6W	5
R18	K3	Erie 16 0·25W	10
RLA	J2	P.O. 12205	
RV1	C5	Morganite LH/WN 0·25W	
T1	B4	BBC F/139 A2	

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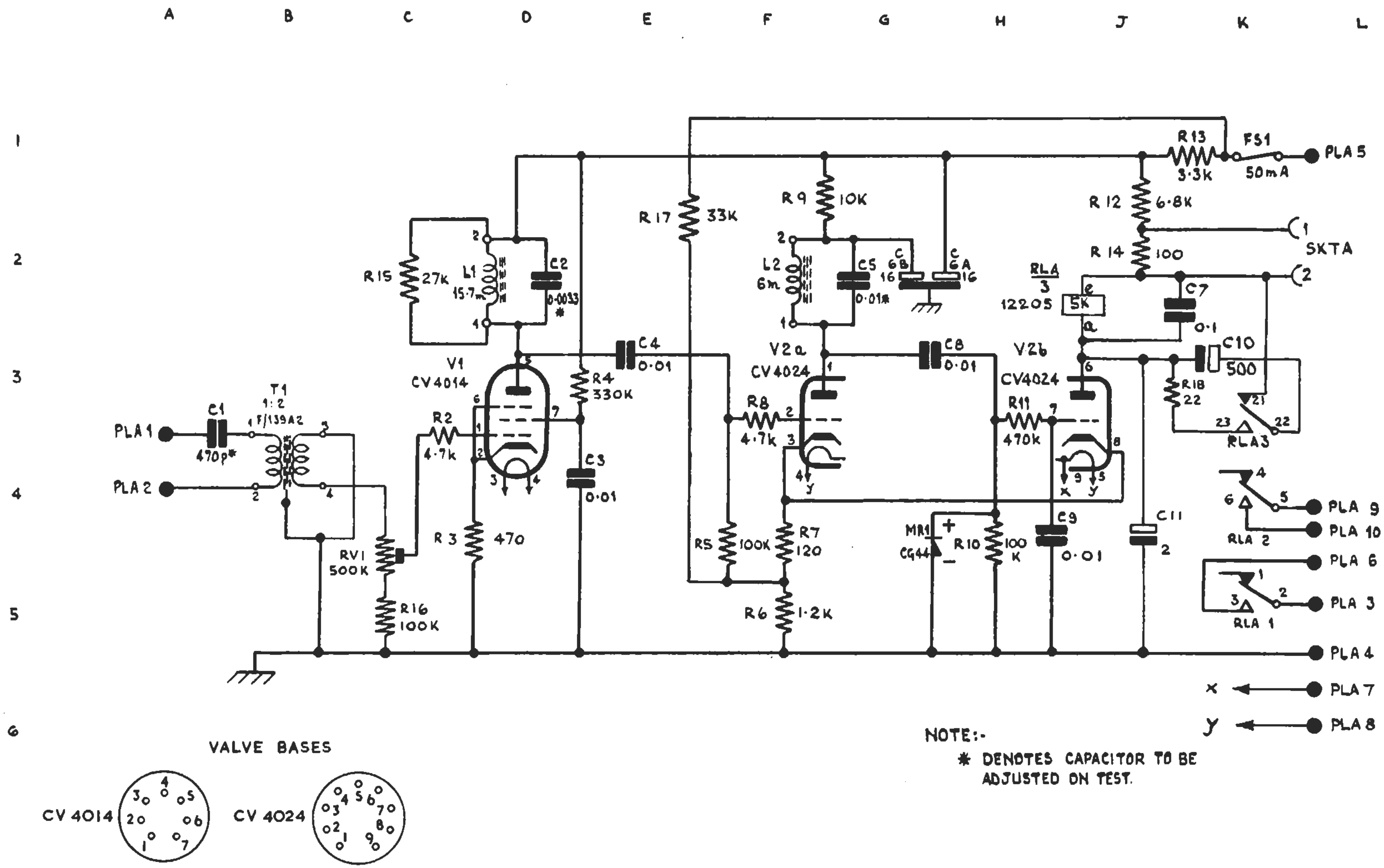


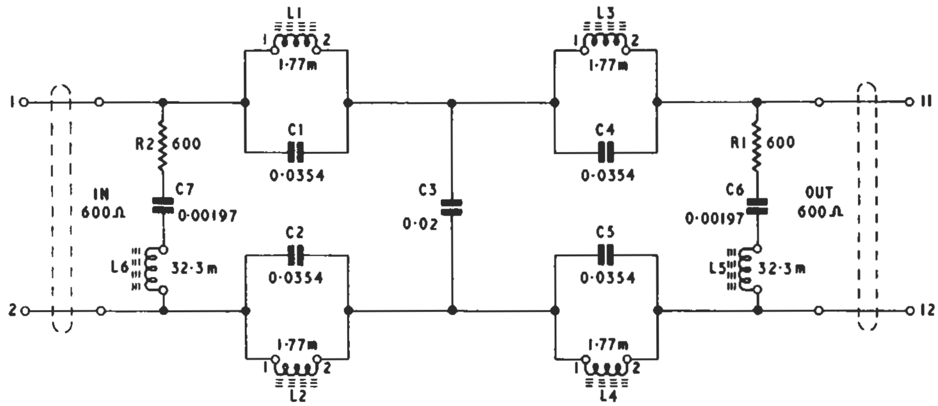
Button Miniature 7-pin Glass B7G

Noval B9A

AMPLIFIER DETECTOR (20 kc/s) AM3/1: CIRCUIT

FIG. 26

FIG. 27



NOTE: PANEL HOLDS FOUR FILTER UNITS AS SHOWN

EQUIVALENT TERMS

IN	1	3	5	7
	2	4	6	8
OUT	11	13	15	17
	12	14	16	18

COMPONENT TABLE

COMP	TYPE	TOLERANCE PER CENT
C1,2,4,5	SALFORD PF	2
C3	SALFORD PF	2
C6,7	T.C.C. CSM20N (1,500p IN PARALLEL WITH 470p)	5
L1,2,3,4	BBC F/161.A.1	
L5,6	BBC F/79.A.1	
R1,2	ERIE 108	2

LOW-PASS FILTER FL4/5: CIRCUIT

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TECHNICAL INSTRUCTION
T.10

Band II Transmitters:
Programme Input, Programme Control and Monitoring

PART 2: INDIVIDUAL STATIONS

First issue September 1960

PART 2

AMENDMENT RECORD

Amendment Sheet No.	*Initials*	*Date*	*Amendment Sheet No.*	*Initials*	*Date*
T10/2–1					
T10/2–2					
T10/2–3					
T10/2–4					
T10/2–5					
T10/2–6					
T10/2–7					
T10/2–8					
T10/2–9					
T10/2–10					
T10/2–11					
T10/2–12					
T10/2–13					
T10/2–14					
T10/2–15					
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T10/2–17					
T10/2–18					
T10/2–19					
T10/2–20					

PART 2: INDIVIDUAL STATIONS

CONTENTS

ILLUSTRATIONS IN TEXT

DIAGRAMS AT END

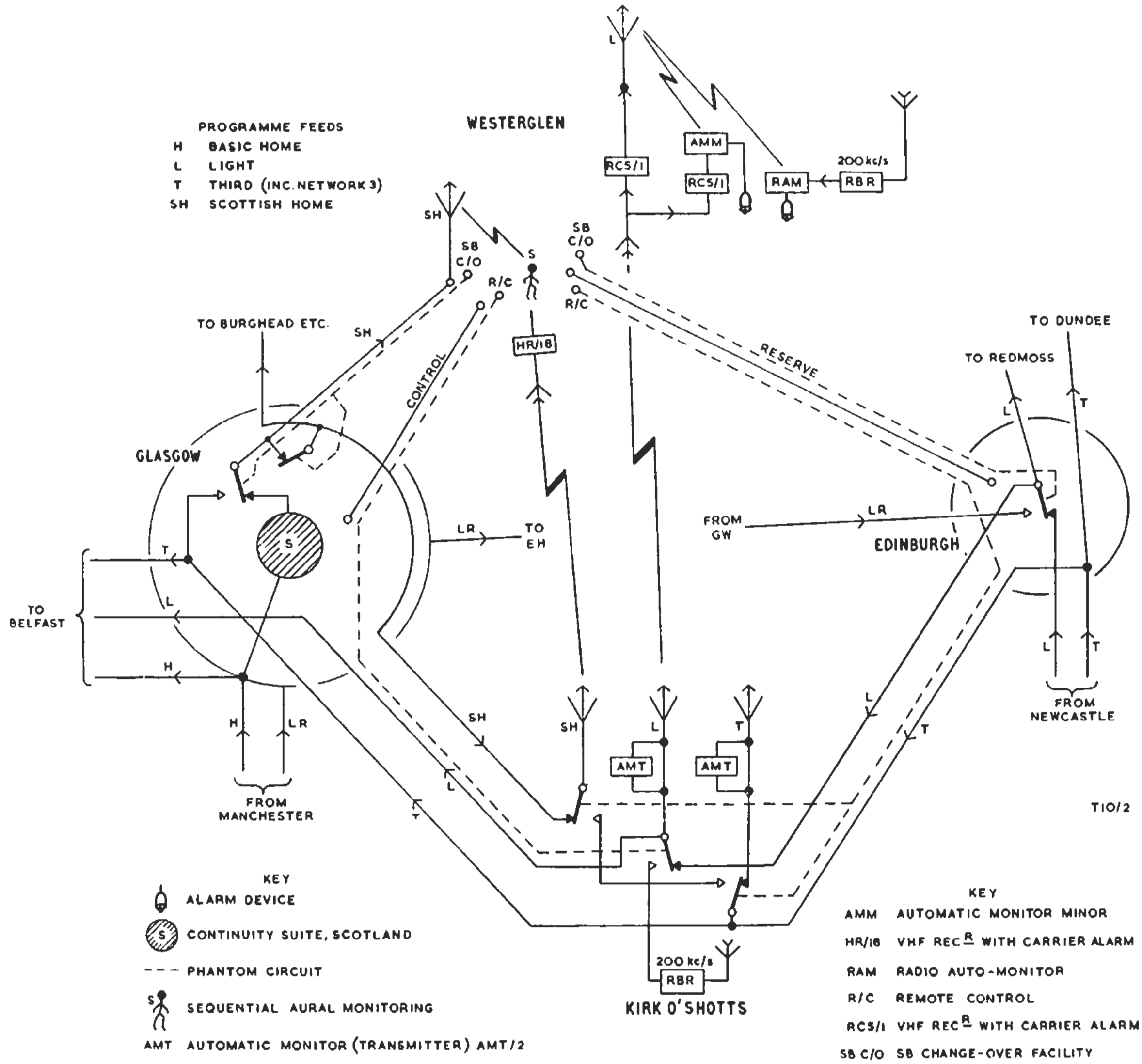


Fig. 6.1. Kirk o' Shotts: Line, Monitoring and Control Arrangements

BAND II TRANSMITTERS: PROGRAMME INPUT, PROGRAMME CONTROL AND MONITORING

PART 2: INDIVIDUAL STATIONS

SECTION 6

KIRK O' SHOTTS

6.1 Line, Monitoring and Control Scheme

6.1.1 General

Fig. 6.1 illustrates essentials of the overall scheme in connection with the three programme services transmitted from Kirk o' Shotts. The diagram includes only those line routings that are necessary for the purpose of the following description. Further information regarding these and other circuits in the area is available from a diagram of the Main S.B. Line System (North), LJ 583, issued by O & M. Section of Lines Department. Supplementary to this is another schematic diagram with the reference LJ 510, which is entitled Normal and Reserve Sound Programme Routing During Unstaffed Periods.

The Light programme chain is monitored at Lisnagarvey, a terminal station fed via Glasgow and Belfast. At Kirk o' Shotts the automatic monitors (transmitter) are used executively, that is to give automatic change-over of drives and limiters in the event of faults.

At Westerglen the Light v.h.f. transmission is picked up by a single aerial connected via an aerial-coupling unit to two receivers; these receivers incorporate a carrier-alarm facility which is not used. One receiver provides a rebroadcast feed as the normal input for the m.f. Light transmitter there. The other is used to obtain from the Kirk o' Shotts transmission a reference programme-signal input for an automatic monitor minor (AMM), and signals applied to the comparison input of the monitor are derived from the local transmission. Thus monitoring is effective from the rebroadcast-receiver input onwards, as faults prior to that point are likely to affect both receivers equally. Further supervision is undertaken at Westerglen with a radio auto-monitor (RAM), which issues an alarm if programme as radiated locally does not correspond with that taken from a receiver tuned to the Light 200-kc/s transmission.

Faults observed on the Light v.h.f. transmission are reported by Westerglen via Glasgow during staffed hours at Kirk o' Shotts. The control system enables Westerglen to transfer the Light v.h.f. transmitters at any time from line feed to the output of a local 200-kc/s rebroadcast receiver. It also provides for the cutting of programme during unstaffed hours. From Fig. 6.1 it is to be seen that this switching is operative also for the input of an amplifier which feeds Light Programme onwards to Glasgow.

Additional to these facilities there is provision for remote S.B. switching by Westerglen during the time that Edinburgh studio is unstaffed. The Light standby feed is taken on a reserve Manchester-Glasgow circuit and passed on a reserve circuit to Edinburgh where provision is made for change-over switching; see lines designated LR in Fig. 6.1. Operation of a relay at Edinburgh causes substitution of this standby feed for that normally taken via the Newcastle-Edinburgh route. The phantom circuit used for this control is derived from a line on which a reserve Light feed is passed from Edinburgh to Westerglen during the Unguarded Hour.

The Third Programme chain is monitored aurally at Belfast throughout each transmission period. At other times it is used in connection with the general distribution of Basic Home programme for standby purposes in the Unguarded Hour. The nominal programme-hour schedule for this service is within staffed hours at Kirk o' Shotts, where the automatic monitors (transmitter) are employed non-executively to give warning of p.i.e. and drive faults.

The Home v.h.f. transmission is aurally monitored at Westerglen, sequentially with monitoring of the same programme as radiated by the local m.f. transmitter. As for Light Programme, a fault-reporting liaison is maintained by telephone with the v.h.f. site during the hours when that is possible. Kirk o' Shotts has an m.f. rebroadcast receiver for emergency use, and this is normally tuned to the Westerglen Home transmission on 809 kc/s. The receiver is available only during staffed hours as its output has to be connected manually, following consultation with Westerglen about the operation. This precaution is necessary to avoid the possibility of sing round the loop, because Westerglen has a facility for re-radiating Home Service programme taken on v.h.f. from Kirk o' Shotts.

For Unguarded Hour working the remote-control facilities made available to Westerglen, with respect to Kirk o' Shotts Home transmission, allow simultaneous line-and-drive change-overs to be made at the v.h.f. site, and provide the alternative of cutting modulation from the Home transmitters. Line transfer gives connection with the Third Programme circuit carrying the above-mentioned Basic Home feed. In this instance the switching, unlike that for Light, operates on a branch feed for the transmitters only, and so the Basic Home feed for centres beyond Kirk o' Shotts remains unaffected.

Additional flexibility in respect of emergency programme-feeding is provided by an arrangement permitting Westerglen to carry out S.B. switching operations at Glasgow. The latter centre is responsible for making this control available, as it has a key-switch for either preparing or disabling the remote-control system.

The remote-control system employs polarity-sensed operation of relays to allow selection of either of two conditions differing from normal. One alteration is achieved with a change-over relay following the Scottish continuity suite. Its operation transfers all stations depending on the suite from normal Basic Home feed on a Manchester-Glasgow circuit to the reserve Basic Home feed on the Third Programme chain routed through Edinburgh.

The other change results in cessation of feed to all stations tied to the continuity suite, excepting Westerglen where the programme cut-off relay of the transmitter is operated. Westerglen, as the controlling centre, continues to monitor the programme. Cessation of feed is accomplished through a relay whose multiple contacts close to apply short-circuits to individual feeds outgoing to various centres of the Scottish regional group. As the short-circuiting cannot easily be indicated in Fig. 6.1 the essential operational function is suggested with a normally-closed contact in the line representing a feed for Kirk o' Shotts.

The above description of Home control as applied to Kirk o' Shotts can be summarised thus:

(a) On-site programme-feed change, accompanied by drive change-over, and transmitter-input cutting facilities. Control from Westerglen conditional on Kirk o' Shotts setting up the control system for operation.

(b) Programme-control facilities equivalent to (a), but in common with other centres and by switching at Glasgow. Westerglen in control, subject to Glasgow making the control system operative.

6.1.2. Remote Control and Remote S.B. Switching Facilities Fig. 100

Fig. 100 is a schematic giving further information about means which enable Westerglen to carry out remote switching at Kirk o' Shotts and two points on the S.B. system.

The diagram includes programme lines and other circuits which are utilised to obtain phantom circuits linking the controlling centre with relays at Edinburgh, Glasgow and the v.h.f. transmitting site. It also has circuit-diagram references for various units involved in remote control, those for Kirk o' Shotts including diagrams in this Instruction. Note, however, that the ULR/1A panel of Fig. 1 indicates provision for switching an outgoing Third Programme feed, whereas Fig. 100 shows the particular unit has been altered to avoid this control. Also the PRR/2 panel differs from that in the earlier diagram, by having an extra rectifier in series with the *Local* contact of its change-over switch; see Fig. 100. Such minor changes from basic design are common in suiting requirements of individual stations, information for which is shown in P.I.D. diagrams. Information on Kirk o' Shotts programme chains is given later, and supplementary details regarding the Kirk o' Shotts relay-operating circuits shown schematically in Fig. 100 are obtainable from a two-part diagram, PID.3864.3.1K. This includes all control and indication circuits of the particular v.h.f. installation.

Programme-feed changes by use of remote S.B. switching facilities at Glasgow and Edinburgh are described under 6.1.1, and systems for those purposes as shown in Fig. 100 need little explanation.

The Home-programme control at Glasgow is effected through a conventional phantom circuit to which either 50 volts positive or 50 volts negative is made at alternative settings of a key-switch at Westerglen. The system is prepared for use when a key-switch at Glasgow is thrown from a *Disable* position to a *Working* position, to remove short-circuits from coils of relays A and C at that centre. By applying positive to line the relays A and B at Glasgow are operated to select programme feed from the reserve circuit. With negative to line the relays C and D operate to cut Kirk o' Shotts programme feed, a condition commonly imposed on feeds for centres served by the continuity suite excepting Westerglen which has a local programme-cut facility.

Light programme-control at Edinburgh is confined to switching over to a reserve programme feed, and so the control system is a simple one using a single change-over relay. In this instance the phantom is one leg of a reserve Edinburgh-Westerglen line, whose other leg is part of a Home-control phantom system linking Westerglen with Kirk o' Shotts.

The remote-control system associated with the Home transmitters is made ready for operation by turning a switch on the PRR/2 panel from *Local* to *Remote*. With that same action the Light remote-control system undergoes a slight change needed to allow two-condition operation instead of the one condition available at *Local*. For this setting the Light phantom is connected via a rectifier which will permit current flow provided Westerglen applies positive to line, at the *Line C/O* position of the Light key-switch. At *Remote* this rectifier is out-of-circuit, and so either of the two relays in the RLP/31 panel can be operated, one with positive to line as at *Local*, and the other with negative to line when the Light key-switch at Westerglen is at *Xtr. Off*. Apart from this special feature for Light the two systems are operationally similar to those described in Section 4.2.1(b) with reference to an example circuit in Fig. 4.1. Below are tabulated the conditions obtained with the PRS/2A key-switches at Westerglen in their alternative positions.

Light Programme

Switch at:	*Phantom Polarity*	*Relay(s) operated in:* RLP/31	ULR/1A	*Programme Input*
Line C/O	+	E	C	From RBR
Xtr. Off	−	F	C and D	Cut

Home Programme

Switch at:	*Phantom Polarity*	*Relay(s) operated in:* PRR/2	ULR Panels	*Programme Input*
Line C/O	+	C	A and B	From Third Programme chain
Xtr. Off	−	D	B	Cut

Additionally throwing the Home key-switch gives drive change-over, consequent on operation of relay C in the PRR/2 panel. Two normally-closed contacts (C1 and C2) of the relay are connected to control individual supplies for relays E and T in the Home CIP. On opening, these contacts promote drive transfer by action similar to that where the relays mentioned are controlled by executive AMT/2 monitors; see Section 3.4.2 for a detailed account of the operations.

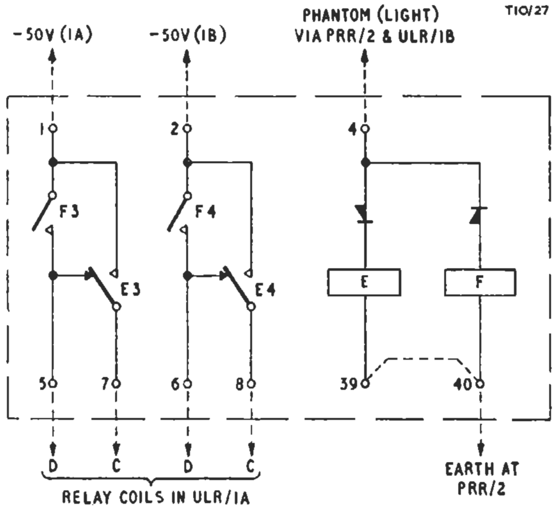


Fig. 6.2. Kirk o' Shotts: Circuit and External Connection of RLP/31 Panel (Light Programme Control.)

Each programme-switching relay has a contact to signal operation by making the supply for a lamp on the front of the appropriate ULR panel. Relay A has another two contacts that signal operation by breaking supplies, one responsible for extinguishing the *Remote* lamp on the PRR/2 panel, the other causing loss of *System Normal* indication at the Third Programme CIP by de-energising relay M in that unit. Refer to the PID diagram mentioned earlier for details of these indication facilities.

Supplementing the basic arrangement indicated in Fig. 100, the diagram in Fig. 6.2 shows the circuit of the RLP/31 panel for Light Programme control at Kirk o' Shotts.

6.2 Programme Input Equipment

6.2.1 Layout and Equipment Types

The complete installation is mounted on five bays, one in the l.t. room and the others in the Band II hall. The l.t. bay (No. 5) is equipped with the usual three-programme complement of apparatus including repeating-coils, line equalisers, GPA amplifiers for incoming programme feeds, and a jackfield giving break and listening facilities. Also on this bay are the hybrid transformers used one in each programme chain to obtain separate transmitter-input and monitoring feeds.

The transmitter-hall section of the installation is a conventional assembly of four bays, to which brief individual references are made below.

Bay 1 Transmitter Input and Limiter Bay, BA13/1

Equipments on this bay are as described under section 2.2(g).

Bay 2 Receiver Bay, RCB/1

To qualify description under 2.2(c), this bay is fitted with two RBR/2 receivers. One is the 200-kc/s version serving as a Light standby source, the other being an m.f. version in similar relation to the Home Programme service.

Bay 3 Control and Indication Bay, CIB/1

Dealing first with equipment types normally found on this bay, but available in several versions, the apparatus includes one PRR/2 panel, one FIP/1A panel and three CIP/1C panels. Also fitted are the RLP/31 panel used for Light remote-control, the IP/1 panel associated with the three pairs of limiters on bay 1, and basic items represented in duplicate time-switch cabinets and a TU/5 lamp-supply panel. For distribution of 50-volt d.c. supplies undertaken at this bay there are two P.O. U-link panels, their use in that connection being a special arrangement which is individual to Kirk o' Shotts. General information about most of the above equipments is given in Sections 2.2(b) and 2.2(d).

Bay 4 Automatic Monitor Bay, AMTB/1

Consistent with requirements, this bay carries four AMT/2 monitors. Two are employed executively with the Light programme chain, and two work non-executively in connection with the Third programme chain.

6.2.2 Programme Chains Fig. 101

The programme chains are closely similar except for their means of programme switching. The arrangement of all three is shown schematically in Fig. 101, to provide information regarding such details as terminal references and sources of operating supplies for amplifiers in non-duplicated sections of the chains. Further information on the Kirk o' Shotts p.i.e. installation may be had from a PID.4465 series of diagrams.

SECTION 7

DIVIS

7.1 Line, Monitoring and Control Schemes

7.1.1 General

The schematic in Fig. 7.1 shows collective information regarding the programme lines serving Divis and means by which transmissions from that site are monitored and controlled. Details of all line routings in the area are obtainable from map diagrams which are issued by O. and M. Section of Lines Department. One diagram which illustrates the Main S.B. Line System (North) has the reference LJ 583, and another giving the Normal and Reserve Sound Programme Routing during Unstaffed Periods is coded LJ 510.

Monitoring of the Light and Home v.h.f. transmissions is undertaken at Lisnagarvey by a similar process for both programme services. The method is to use an automatic monitor minor (AMM) for comparing signals received from Divis with those derived from the corresponding local m.f. transmission, in conjunction with aural sequential monitoring of the m.f. and v.h.f. transmissions for the particular service. One person in the control room is occupied with full monitoring for Light Programme, and another in the transmitter hall carries out the monitoring for Home Programme on a supplementary basis. When an automatic

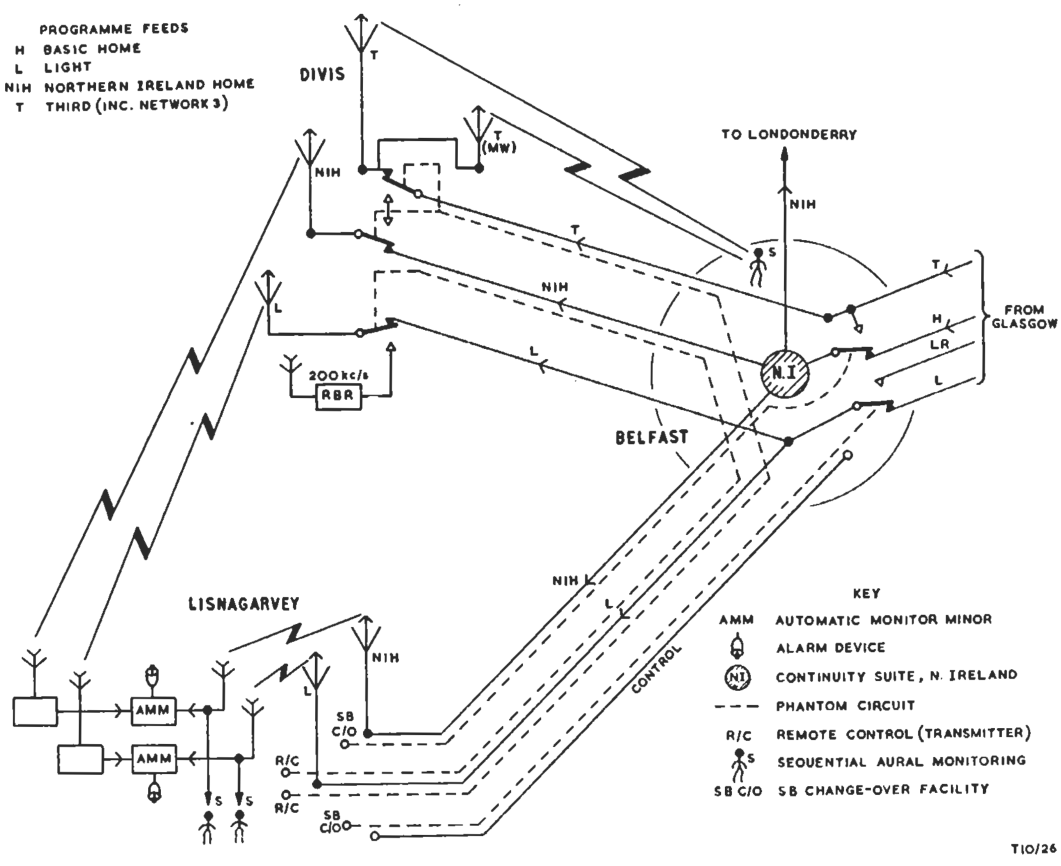


Fig. 7.1. Divis: Line, Monitoring and Control Arrangements

monitor originates a fault-alarm signal the fact is reported to Divis during staffed hours, by using the control line via Belfast.

Monitoring for Home Service is occasionally affected by a special circumstance arising primarily from the synchronised-frequency operation of Home m.f. transmitters at Lisnagarvey and Stagshaw. As a consequence the Northern Ireland regional-programme contributions are sometimes radiated on v.h.f. from Divis but not by the Home transmitter at Lisnagarvey. In that event the v.h.f. transmission is aurally monitored at Belfast until return to common programme material allows resumption of the normal monitoring at Lisnagarvey.

Similar facilities are provided by the remote-control systems which are extended from Divis to Lisnagarvey, continuously for Light and during the Unguarded Hour for Home. Each system offers the alternatives of switching the associated transmitters to standby programme feed, which is automatically accompanied by drive change-over, or of cutting their programme input. A reserve feed for Light is provided from a 200-kc/s receiver at Divis, as shown, and for Home it is present on the Third Programme line which is utilised to carry Basic Home feed for emergency use in the Unguarded Hour.

Fig. 7.1 indicates that Lisnagarvey is also capable of making programme-feed alterations at Belfast, by means of remote-control systems for Light and Home change-overs causing Divis and other stations depending on the S.B. centre to be transferred to reserve programme circuits. A Light standby feed is made available on a reserve line from Glasgow during periods of overnight working, and transfer to it is effected through a control system employing a phantom on the Belfast-Lisnagarvey control line. As it is not essential to this description, and for the sake of clarity, Fig. 7.1 does not show a Light feed outgoing from Belfast to Londonderry.

To maintain Home Service the transfer is made to the Third Programme line carrying the Basic Home feed from Glasgow, by control through a phantom derived from the Belfast-Lisnagarvey Home programme circuit.

The Third Programme is radiated from Divis on v.h.f. and also by a low-power transmitter on an m.f. channel. The service as radiated on both channels is received at Belfast for sequential aural monitoring, and the v.h.f. site is warned by telephone when faults in transmission are heard.

7.1.2. Remote-control Systems Fig. 102

For inter-station links in control systems associated with the Light and Home transmitters, the Light Programme line between Lisnagarvey and Belfast is utilised to provide a pair of split-phantom circuits which individually work in conjunction with separate phantoms on two Belfast-Divis programme circuits. The latter comprise the Home and Third Programme lines which are engaged for Light and Home control respectively. The arrangement of these circuits in connection with apparatus used for remote control is given schematically in Fig. 102.

Over the split-phantom sections of the control systems the signalling is done at low level so as to reduce the effects of d.c. flux in repeating-coils. From Belfast the signals are relayed with the aid of a d.c. repeater panel in which 50-volt supplies are switched to the phantoms terminating at Divis. The supply switching at this intermediate point is effected with two relays in each system, these being arranged to secure their alternative operation as determined by the direction of conduction for rectifiers in series with their coils. This gives a selective-control feature such that the polarities of supplies switched to both sections of a phantom link are similar for either of the possible conditions of operation. At Lisnagarvey the phantom relay sending panel is connected to line through a retard panel which, by slowing the rate of change in line signal-currents, serves as a safeguard against spurious relay operation otherwise likely from coupling between the split-phantom circuits.

The Light control system is permanently ready for operation owing to strapping of contacts on the *Local/Remote* switch in the PRR/2 panel at Divis, and the Home control system becomes operable at the *Remote* setting, as in Fig. 29. Working states alternative to normal result from conventional polarity-sensed operation of relays, already explained under 4.2.1(b). Conditions available by use of key-switches on the PRS/2A panel at Lisnagarvey are:—

Light Programme

Switch at:	*Phantom Polarity*	*Relay(s) operated in: RLP/31*	*URL/1 No. 1*	*Programme Input*
Line C/O	+	E	A and B	From RBR
Xtr. Off	–	F	A	Cut

Home Programme

Switch at:	*Phantom Polarity*	*Relay(s) operated in: PRR/2*	*URL/1's*	*Programme Input*
Line C/O	+	C	A (Nos. 2 and 3)	From Third Programme chain
Xtr. Off	–	D	A (No. 3)	Cut

Simultaneously with line change-over for Light, a drive change-over occurs from operation of relay E in the RLP/31 panel, of which circuit details are given in Fig. 7.2. The contacts responsible are E1 and E2 which open to de-energise relays E'and T respectively in the Light CIP, and consequently a drive transfer takes place as when initiated by executive AMT/2 monitors; refer to Section 3.4.2. With Home line change-over the switching into service of the reserve drive is similarly promoted, in this instance from the PRR/2 panel by C1 and C2 contacts (see Fig. 12) connected to the Home CIP like their counterparts in Fig. 7.2.

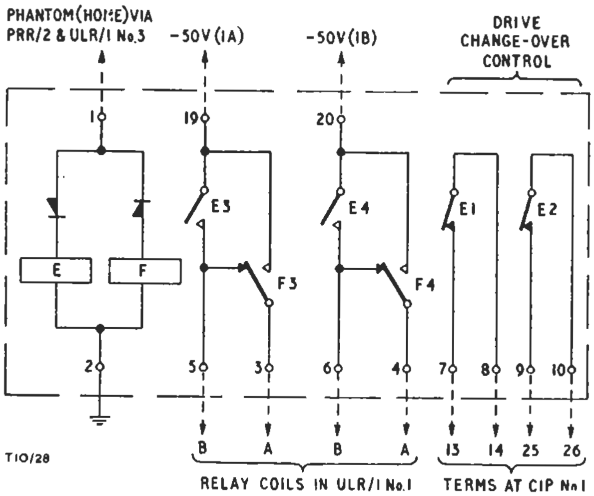


Fig. 7.2. Divis: Circuit of RLP/31 Panel (Light Programme Control.)

Each of the relays in the ULR panels has a contact for locally signalling the operated state by completing a supply to a lamp on the front of the panel. Additionally a break contact on each A relay is placed in series with relay M at the programme-related CIP, to cause loss of *System Normal* indication at the panel while the relay is operated. Additional external signalling is provided by using relay-A break contacts to interrupt the supply for the *Remote* lamp on the PRR/2 panel. The contacts for that purpose are on A relays in the No. 1 (Light) and No .2 (Third) ULR panels, and therefore the lamp is extinguished under any of the tabled switching conditions excepting that where the Home programme is cut.

Details of these signalling arrangements and control-circuit interconnections of the several units at Divis are given in a two-part diagram, PID. 3538.3.1K and 2K, of control and indication circuits at the Divis v.h.f. installation.

7.2 Programme Input Equipment

7.2.1 Layout and Equipment Types

Programme lines are terminated in the Band II transmitter hall at a TL/55 bay occupying the No. 1 position of a four-bay assembly. The other bays in ascending numerical order have references LIMB/2, RCB/1 and CIB/1. For further information refer to section 2.2 which includes descriptions dealing with the complements of equipment on the individual bays. The No. 3 bay at Divis holds four rebroadcast receivers, and on No. 4 bay is the RLP/31 panel for Light remote control, additional to items mentioned in the earlier description. One rebroadcast receiver is the 200-kc/s standby whose output can be switched by remote control to the Light transmitters. The others comprise one tuned to 647 kc/s for reception of Third Programme from Daventry, and two tuned to 692 kc/s and 1151 kc/s for Home Programme from Moorside Edge and Lisnagarvey respectively. These three receivers require hand plugging connection with programme chains under emergency conditions.

7.2.2 Programme Chains Fig. 103

In Fig. 103 are separate schematics giving the arrangement of the three programme chains. These conform with general practice and do not require explanation. However, it may be added that the l.p.m.f. transmitter at Divis is fed from the Third Programme chain by connection with the busbar preceding the limiters used with the v.h.f. transmitters. Note that Fig. 103 has references to circuit diagrams of the ULR panels, and that the parent reference for diagrammatic information on the Divis p.i.e. installation is PID.3482.

SECTION 8

HOLME MOSS

8.1 Line, Monitoring and Control Scheme

8.1.1 General

Fig. 8.1 shows programme lines for Holme Moss and the essentials of arrangements for monitoring and control of transmissions from that site. Information regarding all lines in the area is given in a diagram (LJ 510) of the Main S.B. Line System (North), supplementary to which is a schematic (LJ 583) of the Normal and Reserve Sound Programme Routing during Unstaffed Periods; both are issued by O. and M. Section of Lines Department.

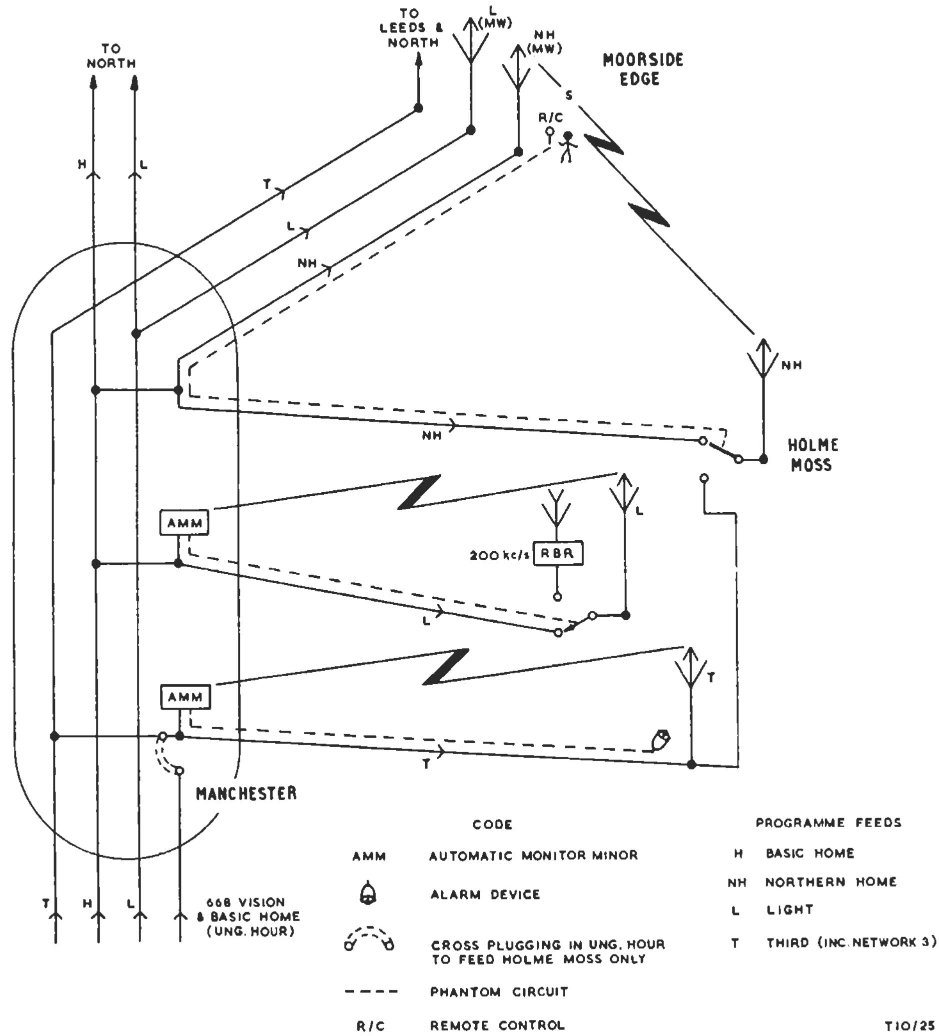


Fig. 8.1. Holme Moss: Line, Monitoring and Control Arrangements

The Light transmission is monitored at Manchester by using an automatic monitor minor (AMM) to compare the received signals with the programme feed outgoing to Holme Moss. Fault signals from the monitor are carried by a phantom on the Light programme line to the v.h.f. site and applied to an integrating alarm panel used for executive duty. In circumstances where fault signals from the monitor become excessive the alarm panel initiates programme-feed transfer from line to a local 200-kc/s receiver, and in consequence of this action a drive change-over also takes place. The system is in use on a continuous basis, with the minor difference that an alarm facility operative during local control is muted when Holme Moss selects the remote-control condition for Unguarded Hour working.

Monitoring of Third Programme transmissions at Manchester is carried out by means identical with those described for Light. In this instance the monitor passes fault signals to an integrating alarm panel with a non-executive function, that is to operate an alarm in the event of serious faults warranting the attention of Holme Moss staff. The phantom circuit is disconnected from the panel, and the alarm facility is muted, on switching to remote control for the Unguarded Hour. During this overnight period the Third Programme line is fed with Basic Home programme, by cross-plugging from a vision sound-circuit at Manchester, for emergency use with the Home transmitter.

At Moorside Edge the Home transmission is aurally monitored in sequence with the local Home m.f. transmission, reports of faults being made by telephone to the v.h.f. station while staffed. The remote control extended to Moorside Edge in the Unguarded Hour provides for the usual alternatives of either line change-over to the above-mentioned Basic Home feed, with drive change-over also, or of cutting the input to the Home transmitter.

8.1.2 Remote-control Systems Fig. 104

The arrangement of phantom circuits and equipments used in remote control is shown schematically in Fig. 104. The circuit-drawing references for various units in the schematic include two figure numbers of diagrams associated with Part 1 of this Instruction.

The control systems have the fail-to-safe feature which is characterised by phantoms that are normally energised. This practice is customary where a single line serves the dual purpose of carrying the programme and providing for control in respect of an individual programme service. For the remote-control operation giving transfer to reserve programme feed the phantom supply has to be interrupted either manually with a switch or, taking the simplest example in that connection, as a prolonged fault signal from the automatic monitor. Thus if line failure causes a phantom-supply break the resultant action at the receiving centre is the remedial one of switching the standby programme source into service. So far as Holme Moss is concerned this safeguard applies continuously to the control system for Light, and in the Unguarded Hour to the control system for Home.

At Holme Moss the phantom relay receiving panel is a PRR/2D version slightly modified to suit control requirements. The change consists of strapping appropriate contacts of the *Local/Remote* switch so that at the alternate settings the Light phantom remains connected to No. 1 integrating alarm panel, an IAP/1A version. The C and D relays in this panel are normally operated, and with relay A in No. 1 ULR panel unoperated the Light transmitter is fed from line.

Serious-fault operation of an IAP/1A equipment depends on the effective duration of fault signals, as explained in Section 4.1. The operation results in its C and D relays releasing to make a supply for relay A in No. 1 ULR panel, to switch from line to the output of a rebroadcast receiver. Relay B in the same panel has a passive function as it is not used for the intended purpose of interrupting the circuit, by becoming energised via a carrier-failure relay contact, in circumstances where the receiver has no input other than noise. Drive change-over is promoted concurrently by operation of relay A, two contacts of which are used to break energising supplies for relays E and T in the Light CIP. These contacts, A4 and A5, serve a similar purpose to E1 and E2 contacts in Fig. 7.2, illustrating a conventional circuit arrangement by which automatic change-over of drives is obtained. Information relevant to operations following the opening of the A-relay contacts is in Section 3.4.2.

The change in working conditions is signalled from the IAP/1A and from No. 1 ULR panel. The first-named unit has local signal-lamp indication in addition to providing remote indication through contacts on the C and D relays. By opening, these contacts de-energise relay Z in the Light CIP, which results in loss of Monitoring Normal indication at that panel and at the ALP/7 panel used for supervision in the control room. During local control this signalling is accompanied by sounding of alarm buzzers in the PRR/2D and ALP/7 panels, but with remote control the alarms are made inoperative by means of muting circuits, Details of the muting arrangements are in Section 4.2.2 (b) but note, with reference to Fig. 4.4, that the IAP/1A in this instance has no external connection from terminal 7 because the equipment must remain operational for the remote-control condition. At No. 1 ULR panel the relays A and B signal their operation locally by contacts making supplies to lamps on the unit. The A relay also has a contact which breaks the supply for relay M in the Light CIP, and so *System Normal* lamps at the PRR/2D and ALP/7 panels are extinguished. Relay M has contacts to operate the above-mentioned alarms, but as they are in a general-alarm circuit including contacts of relay Z the alarm operation in the particular circumstance could be caused by de-operation of either of these relays.

To revert to normal, when the fault condition has been cleared, a *Reset* push-button on the IAP/1A is used for a setting-up operation by which relays C and D in the IAP are once more energised. This de-energises relay A in No. 1 ULR panel, causing change-over to line feed and change-over to the original drive, while with release of the Reset button the condition for control from the remote monitor is re-established. Section 4.2.2 gives operational details for the IAP/1 equipments.

The phantom circuit from the Third Programme automatic monitor is switched through the PRR/2D panel to No. 2 IAP during local control and disconnected while remote control is in use. The integrating alarm panel is an IAP/1 version which, consistent with its purpose of providing for alarm operation without control of switching facilities, functions similarly to the IAP/1A version. Contacts of relays C and D in this unit are in the energising supply for relay Z in the Third Programme CIP. On opening, owing to an excessive-fault condition, they cause relay Z to release and give loss of *Monitoring Normal* indications at the Third Programme CIP and ALP/7. Also, through relay-Z contacts in the above-mentioned general-alarm circuit, operation of alarm buzzers in the PRR/2D and ALP/7 panels occurs as warning to Holme Moss staff of the need to take action. Loss of programme feed is covered by using a rebroadcast receiver tuned to Third Programme on 647 kc/s, the receiver output being tied to No. 2 ULR panel for connection via U-links to the programme chain in such emergencies. Relay A in No. 2 ULR panel is not employed for Third Programme switching, and is operable only during periods of remote control for the purpose of connecting reserve programme feed to the Home transmitters as explained below. No. 2 IAP is reset similarly to the No. 1 equipment, but with regard to muting the description under 4.2.2(b) applies without the reservation made in respect of the latter unit.

The PRR/2D relay circuits for Home Service remote control are shown in Fig. 104 as a considerably simplified form of the practical arrangement. Details which are available from Fig. 16 show circuits devised to ensure smooth transition between the alternative states of local and remote control. The switching provides for relay C being kept operated during local control, for which purpose the a-b and d-e windings are energised with local 50-volt 3A and 3B supplies respectively. In parallel with each relay winding is a half-wave rectifier, connected so that shunting through its forward resistance is avoided under all working conditions. Additionally, in series with the a-b winding of relay C, and also the complete series-aiding windings of relay D, are half-wave rectifiers providing for selective operation.

When the PRR/2D switch is turned from *Local* to *Remote* the local 50-volt supplies are disconnected from relay C. However, from slugging imparted by the rectifier across its windings, this relay remains operated until the a-b winding is connected to the phantom circuit; the other winding is then out-of-use. Thus, if the *Ung. Hr.* key-switch on the control panel at Moorside Edge has already been closed, the C relay remains operated by the 50-volt supply applied positive to the phantom. Relay D is switched to the phantom but, with the supply polarity as stated, is prevented from becoming operated because of the rectifier in series with its windings. One further operation during this switching is connection of the local 50-volt supplies to relay-C contacts which, for the relay-operated condition, are open and so preventing energising of the A relays in No. 2 and No. 3 ULR panels; see Fig. 104. Another is the removal of short-circuits from two relay-C contacts, made because the relay is operated, for duty as the means of obtaining drive change-over.

When the double-throw key-switch at Moorside Edge is operated to *Line C/O* the phantom supply is broken and relay C releases. Then two relay-C contacts, which are associated with a pair of normally-closed relay-D contacts (Fig. 104), close to connect the local 50-volt supplies to the A relays in No. 2 and No. 3 ULR panels. Operation of these relays effects a transfer to reserve programme-feed from the Third Programme line. Simultaneously the relay-C contacts for drive control relapse to their normally-open states, C1 and C2 thereby breaking paths hitherto provided via terminals 13/14 and 25/26 respectively at the Home CIP. This initiates a drive change-over by operations that are described in Section 3.4.2.

Alternatively, when the key-switch at Moorside Edge is thrown to *Xtr. Off*, the polarity of the phantom supply is reversed, with negative to the phantom connection. By this reversal the de-operation of relay C occurs, because of the rectifier in series with the a-b winding, but for the same reason relay D becomes operated. In this way the A relay in No. 3 ULR panel only is made to operate, and cut programme from the Home transmitter.

The signalling of these switching conditions includes indication at No. 2 and No. 3 ULR panels, the A relay in each having a contact to show operation by making a supply to a lamp on the unit. Operation of these relays is signalled externally with the aid of break contacts. The contacts, one on each relay, that are used under local control to de-energise related M relays, and so extinguish *System Normal* indications at the PRR/2D and ALP/7 panels, are not effective during remote control, as already explained for Light. The A relay in No. 2 ULR has another break contact to signal operation by opening in the supply for the *Remote* lamp at the PRR/2D panel, the circuit being similar to that shown in Fig. 4.2.

Circuit details of the remote-switching arrangements at Holme Moss are provided in a two-sheet diagram, PID.3516.3.1K and 2K, showing all control and indication circuits of the v.h.f. installation at that site.

8.2 Programme Input Equipment

8.2.1 Layout and Equipment Types

A separated disposition of equipment is employed, the apparatus associated with incoming programme lines being fitted on a bay (No. 4) in the l.t. room and the remainder in the Band II hall. The l.t. bay is conventionally equipped with line-terminating gear, GPA/4A amplifiers and a jackfield giving break and listening facilities in the programme chains. Also on the bay are the hybrid transformers used one in each chain to obtain a monitoring feed separated from a programme feed to No. 1 bay in the v.h.f. transmitter hall, and an Amplifier Test Panel, ATP/1.

The four bays in the transmitter hall are the usual minimum complement referred to in Section 2.2, under which heading are general descriptions regarding the usual aggregations of equipment of the individual bays. To supplement that information there follows a summary specifying the more important items on the several bays at Holme Moss.

Bay No.	*Type*	*Equipment*
1	TL/55 (Mod.)	Three ULR/1 panels and an Amplifier Mounting, carrying units for programme metering and occasional monitoring. Also a PA1/10 panel and two AM3/1 units, which is parent-station apparatus for 20-kc/s tone monitoring, and three f.m. rebroadcast receivers. Two receivers are RC5/1B equipments, and one is an RC5/1A.
2	LIMB/2	Six LIM/6A limiters, and an Indicator Panel IP/1.
3	RCB/1	Three RBR/2 receivers for standby use, one with each programme service. The comprise a 200-kc/s version, for Light, and two m.f. versions. The loudspeaker unit for occasional monitoring is an LSU/4A.
4	CIB/1	Basic equipment comprises a PRR/2D panel, an FIP/1 panel and three CIP/1 panels. With these two are two Integrating Alarm Panels, one an IAP/1A version (Light) and the other an IAP/1 version (Third Programme).

8.2.2 Programme Chains Fig. 105

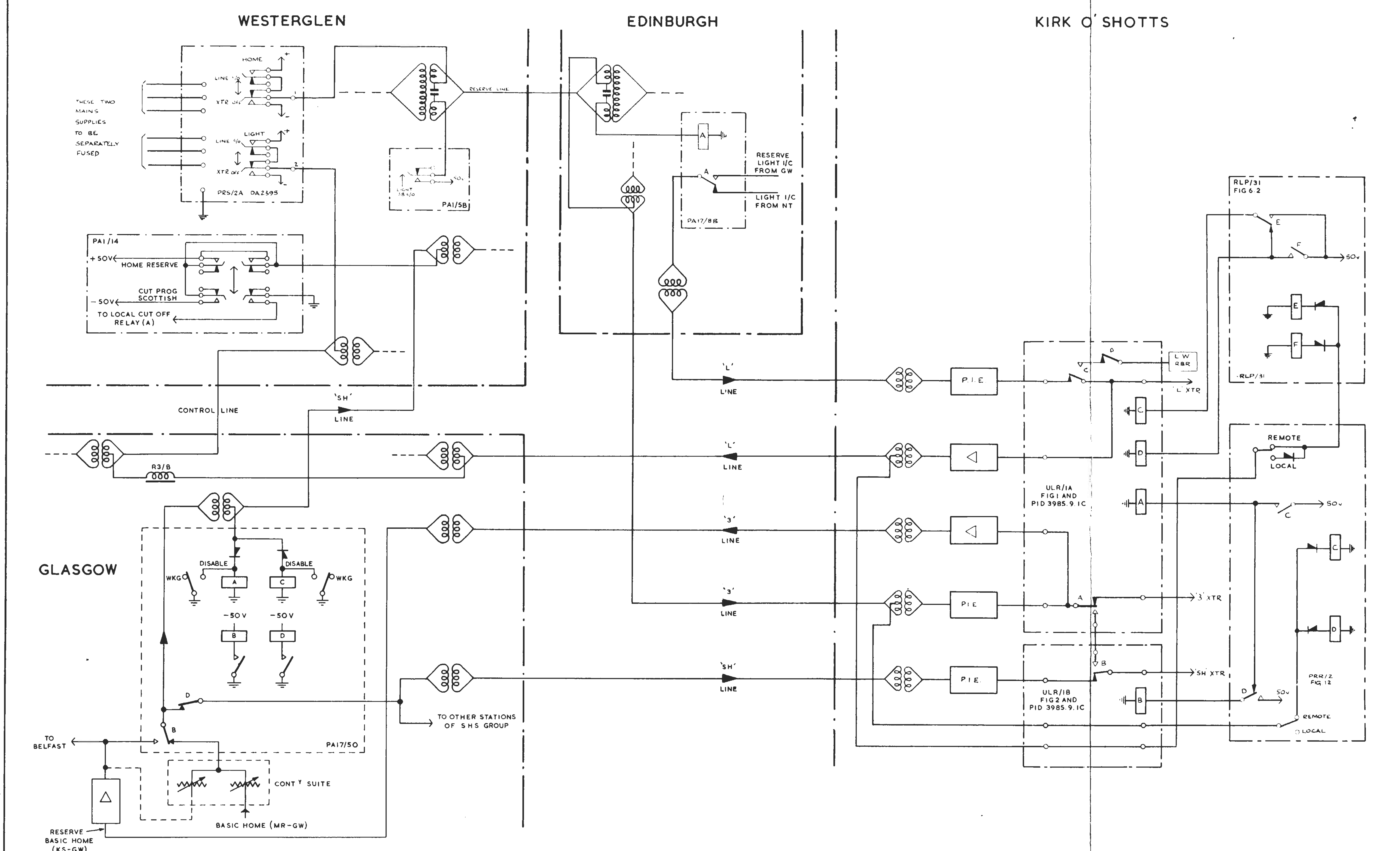
The several programme chains are shown schematically in Fig. 105. All three are generally similar excepting their means for programme switching, already described. Note that the output of the Light rebroadcast receiver is normally linked through at No. 1 ULR panel to allow it to be automatically switched into use, whereas the other receivers are U-linked to the programme chains when necessary. Apart from this there are no features warranting special mention.

J.R. 8/60

58/JR/123
PID 4465.9.8D
ISS. 1

T10

FIG. 100



KIRK O'SHOTTS: LINE ARRANGEMENT FOR REMOTE CONTROL AND S.B. SWITCHING

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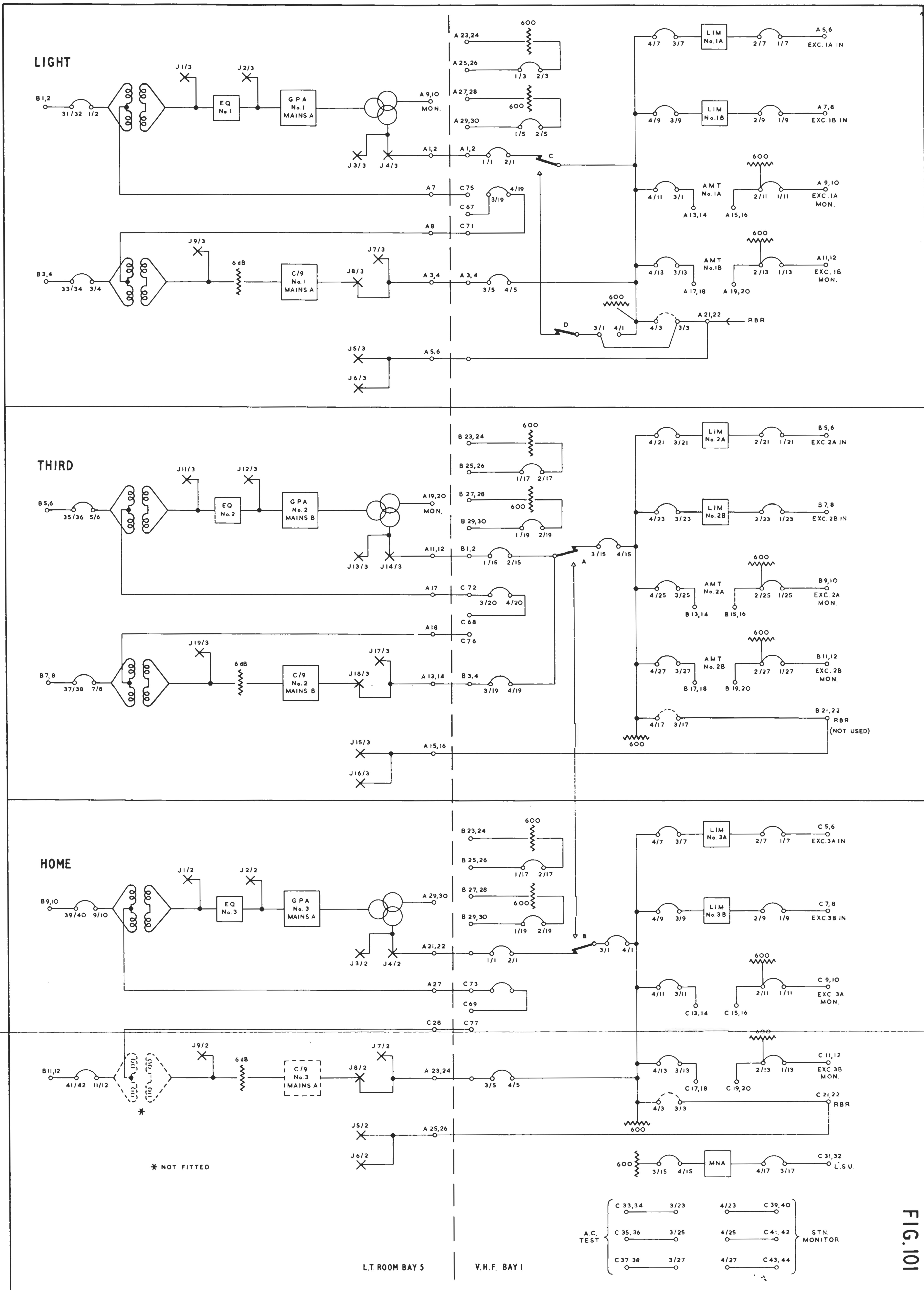
59/JR/108/AP
PID 4465.9.1C
155.2



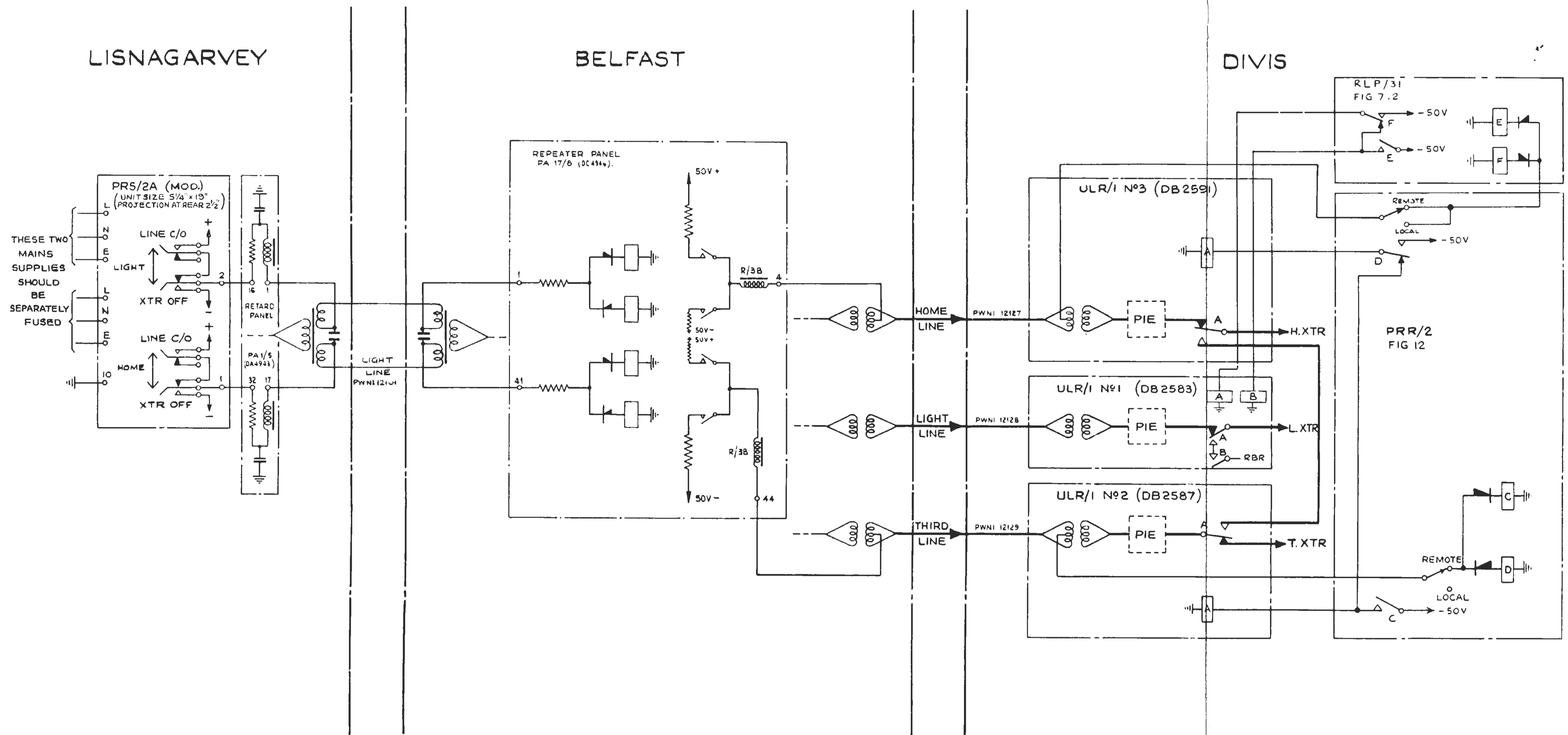
KIRK O'SHOTTS: PROGRAMME SCHEMATIC

FIG. 101

T10

58/JR/124
PID 3482. 9. 2D
ISS 3

FIG. 102



DIVIS: LINE ARRANGEMENT FOR REMOTE CONTROL

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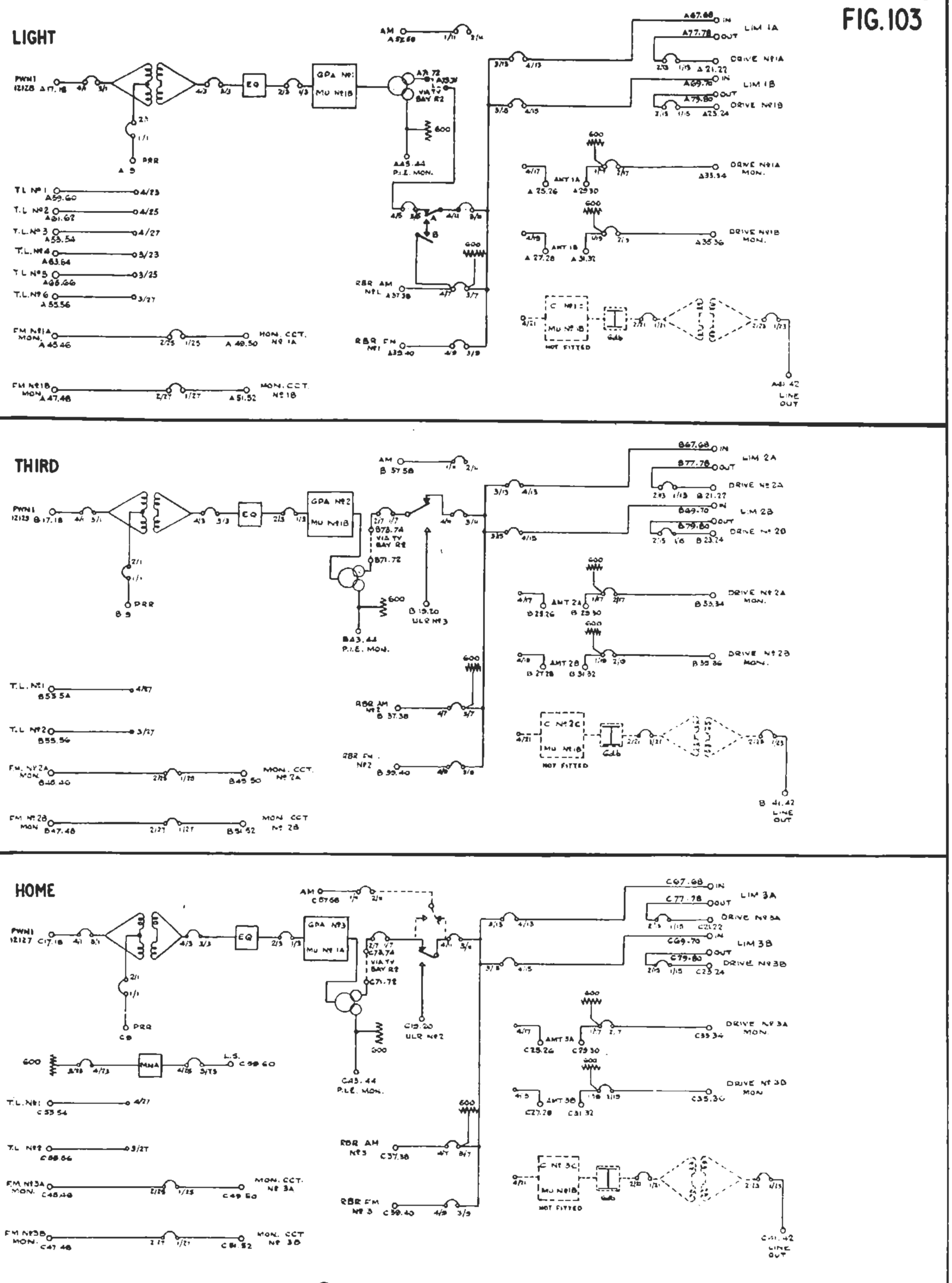
59/JR/102
PID.3482.9.IC.
ISS.3.

T10
FIG.103



NOTES 1. U-LINK SOCKETS

2. 2/7 ROW 2 (NUMBERED UP FROM BOTTOM)
SOCKET 7 (NUMBERED LEFT TO RIGHT, VIEWED FROM FRONT)
3. AMT/2'S ARE NOT FITTED AT THIS STATION

DIVIS : PROGRAMME SCHEMATIC

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59/JR/101/DJE
PID.4456.9.5C
ISS 3 (REV)

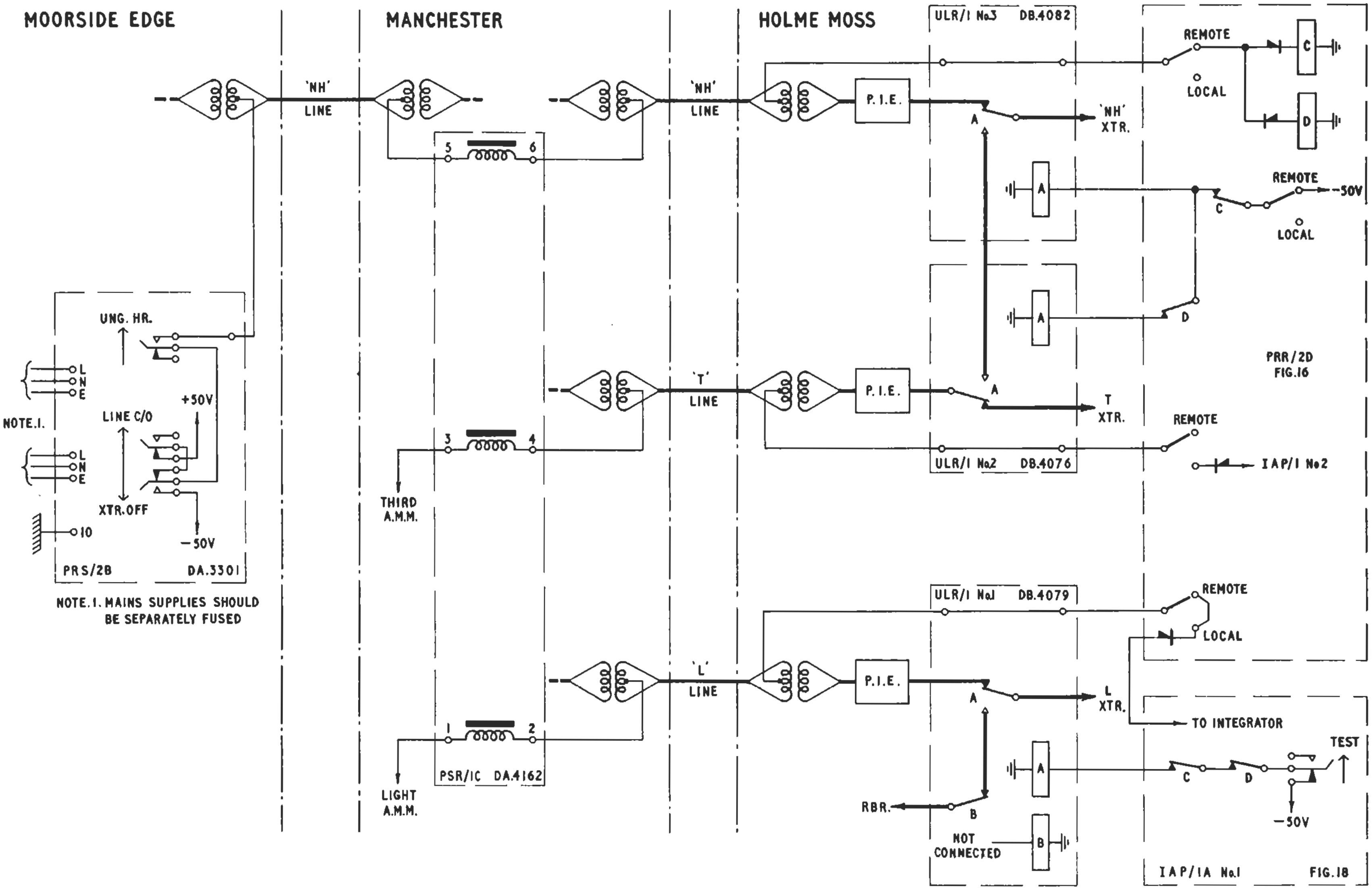

FIG.104

HOLME MOSS: LINE ARRANGEMENT FOR REMOTE CONTROL

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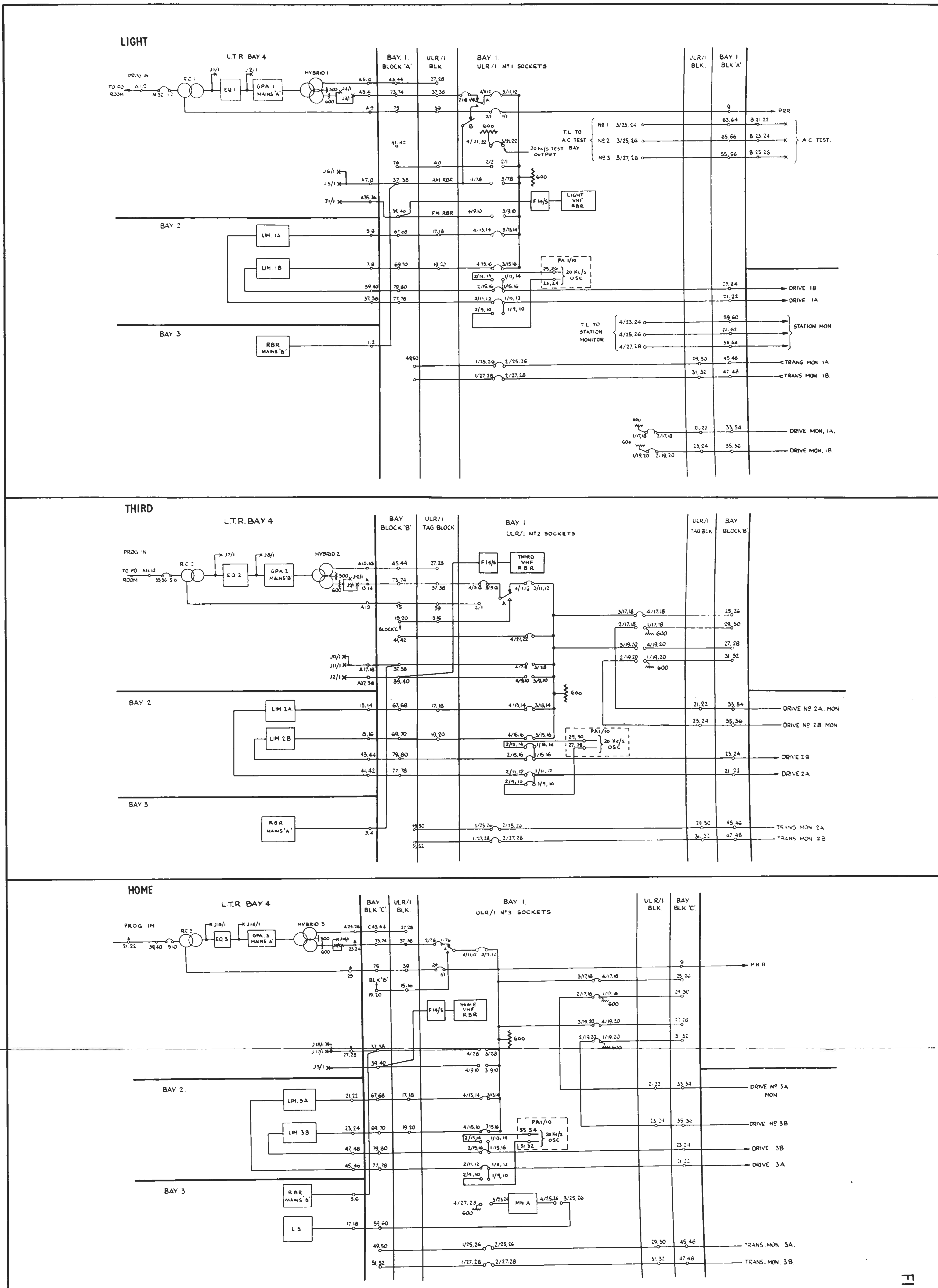
59/JR/103
PID4456.9.1C,
2C & 3C



HOLME MOSS : PROGRAMME SCHEMATIC

FIG. 105

T10