LAYOUT, CABLING AND TEST ACCESS FOR LINE TRANSMISSION EQUIPMENT

(PREVIOUSLY MS 034)

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1. INTRODUCTION.

1.1 The layout, cabling and test access arrangements for line transmission equipment differ widely in various Departmental buildings. To give the details for an individual station it would be necessary to trace the historical development of that station. It is not intended in this paper to trace the changes in manufacturing design or installation techniques that have led to the presently accepted standards, but to describe the principles involved and give details for modern installations.

1.2 The layout of line transmission equipment is influenced to a large extent by the design of the buildings housing the equipment. In general, modern buildings cater for the location of line transmission equipment in the one room. In some smaller installations, however, this equipment may be combined with C.B. exchange and trunk signalling equipment.

1.3 Cabling at a line transmission equipment station is kept to the minimum possible and, for this reason, station cabling should be considered in conjunction with station layout. The types of interconnecting cables used in practice will not be dealt with in detail in this paper and, if additional information is required, reference should be made to other papers in the Course of Technical Instruction and E.I.s.

1.4 Various methods are used to obtain "Test Access" for line transmission equipment. Most of these methods, in addition to providing access for testing, provide access for "patching" and the term "Test and Patch Access" can then be applied. In some cases "Test and Monitor Access" is provided. Generally the term "Test Access" will be used throughout this paper although at times this could refer to test, patch and monitor access.

2. LAYOUT OF LINE TRANSMISSION EQUIPMENT.

2.1 General Principles. The layout of line transmission equipment differs in various buildings because of building design and also the types and quantities of equipment to be installed. In any layout a number of common factors are considered. They are:-

(i) All interconnecting apparatus (I.D.F.s. etc.) should be located to allow a minimum of cabling, and also ease of cabling running.

(ii) The Trunk Test Boards and test equipment should be positioned to give an adequate staff working area, known as the Trunk Test Area.

(iii) All aisles should be sufficiently wide to allow easy access and egress of portable test equipment and also new or redundant equipment racks.

(iv) The floor area should be sub-divided into sections. Any one section should contain similar types of equipment.

(v) In the planning sufficient space should be allowed for ultimate development.

2.2 Equipment Layout Categories. In a modern installation the equipment is sub-divided into four categories (A, B, C and D) and the floor area is sub-divided accordingly. The equipment for each category is broadly as follows:-

(i) Category A. Trunk test facilities, special purpose four-wire patching racks, four-wire terminal racks, I.D.F., transformers, V.F. amplifiers, V.F. telegraph equipment, auto patching relay sets for V.F. telegraph equipment, programme equipment, alarm equipment racks, and, at small stations, rural carrier terminals.

(ii) Category B. Voice frequency and programme channel modem equipment, channel carrier supply equipment, through group filters, group distribution frames and group auto gain control racks.

(iii) Category C. Trunk entrance and carrier cable terminal racks, line filter racks, open wire carrier equipment and cable carrier equipment.

(iv) Category D. Coaxial cable terminations, line filter, power feed and amplifier equipment for coaxial cables and broadband radio systems, broadband group and supergroup modem and carrier supply equipment, supergroup auto gain control racks and through supergroup filters.

2.3 Miscellaneous Items. In addition to the equipment listed it is necessary to provide space for the Supervising Technicians' office, an equipment store and in special cases separate rooms for programme, video and radio telephone terminal equipment. If possible power equipment should be in a room separate from the line transmission equipment. When power conversion equipment is installed in the equipment room, adequate separation from line transmission equipment is essential to guard against false operation of, or damage to, power board switches and to ensure safety of personnel.

2.4 Typical Floor Plan. The floor layout of a typical country station is shown in Fig. 1. The line transmission equipment occupies one room and is located to simplify interconnection with power and other communication equipment.

Layout categories A, B, C and D are shown, and power equipment is included with the line transmission equipment.

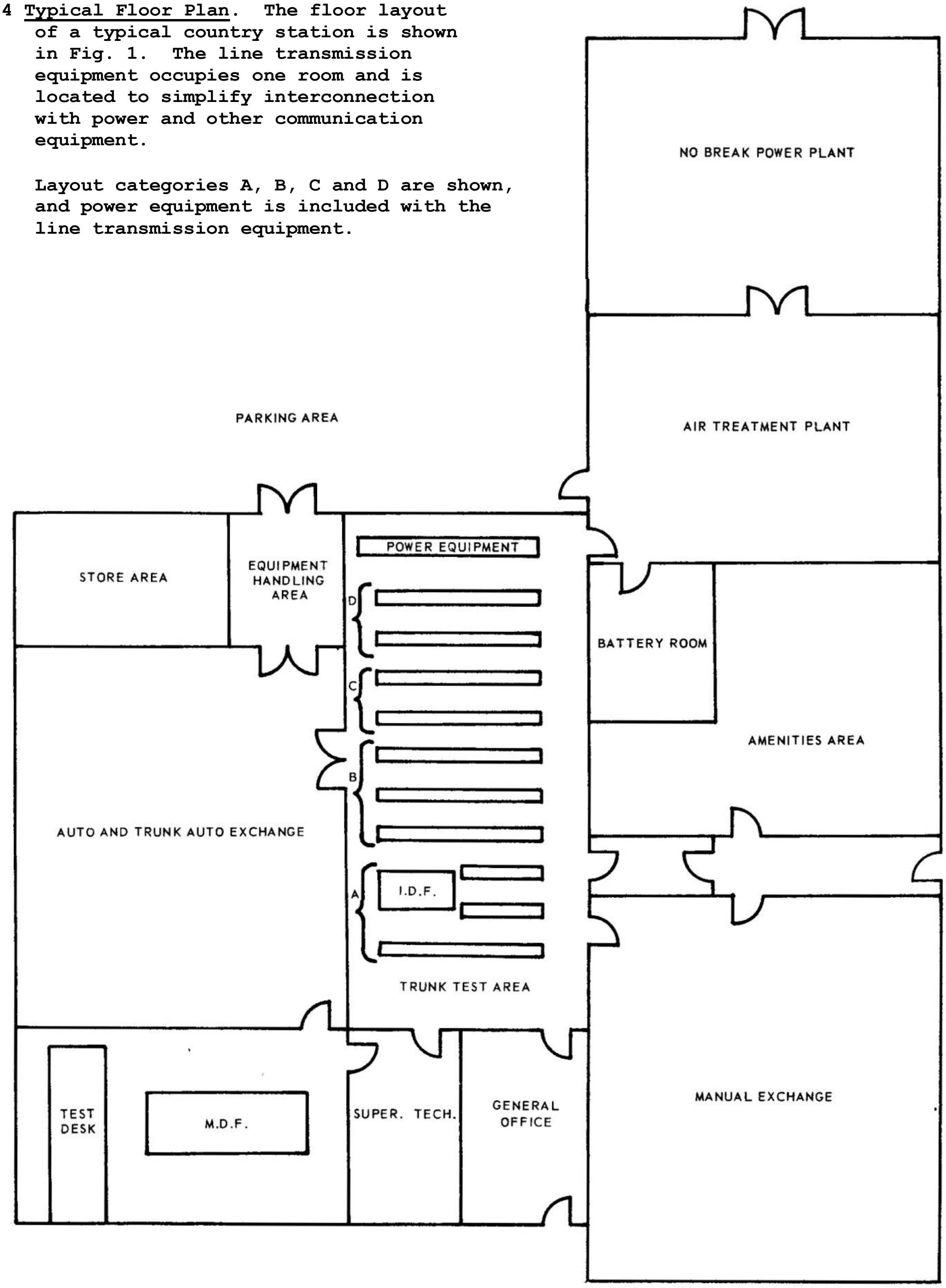


FIG. 1. TYPICAL FLOOR PLAN OF COUNTRY STATION.

2.5 Location of Equipment Rows. Line transmission equipment is installed in suites which may consist of a single row of racks with equipment mounted on both sides, or two rows of racks installed back to back with equipment mounted on the exposed sides.

The major working area for maintenance staff, the trunk test area, is generally at one end of the room and is the starting point for room numbering. Fig. 2 shows a typical floor layout for two stations. Only category A equipment is shown in any detail, and suite numbering and rack lettering are indicated. All rows are designated numerically starting from the front left hand side of the installation viewed from the front. When a centre aisle is provided each half row is given a separate number, and is in effect treated as a separate row. This is indicated in Fig. 2 (b).

The racks are designated alphabetically from left to right viewed from the front. When a centre aisle is provided, the racks for each side are designated separately.

2.6 Spacing of Suites. In older installations a suite spacing of 4′ was generally considered adequate but in modern installations the suite spacing is as shown in Table 1.

Equipment Classification	Centre to Centre Suite Spacing
Broadband line amplifiers and power separation filters	5′ 6″
I.D.F. (Single sided)	4′ 6″
I.D.F. (Double sided)	6′ 9″
Normal equipment suites (approx. Depth 1′ 6″)	4′ 6″
Equipment suites with a depth greater than 1′ 6″	4′ 6″ plus an allowance for additional depth.

TABLE 1. NOMINAL SUITE SPACING.

2.7 Trunk Test Area and Aisle Widths. A minimum space of 8′ is allowed between the Trunk Test Boards and an end wall. This allows for the location of a table in the trunk test area.

A minimum width of 4′ is required for the main aisle. In general the width of a side aisle is 3′ although this can be decreased to a minimum of 1′ if access is not required.

2.8 Length of Equipment Rows (Suites). Row lengths for equipment rooms are based on a rack width of 1′ 8½′ and ideally the number of racks in a row should not exceed 12. This gives a row length of 20′ 6″. A centre aisle is used if the building width is such that a row length greater than 20′ 6″ would result.

Some racks with a width greater than 1′ 8½″ are in use. Equipment of the German type 52 construction has a rack width of 1′ 11⅝″ and is designed for installation in group frames. The maximum length of group frame available provides for 10 racks in a row (20 single sided racks back to back in a suite) and has an overall length of 20′ 7¼′.

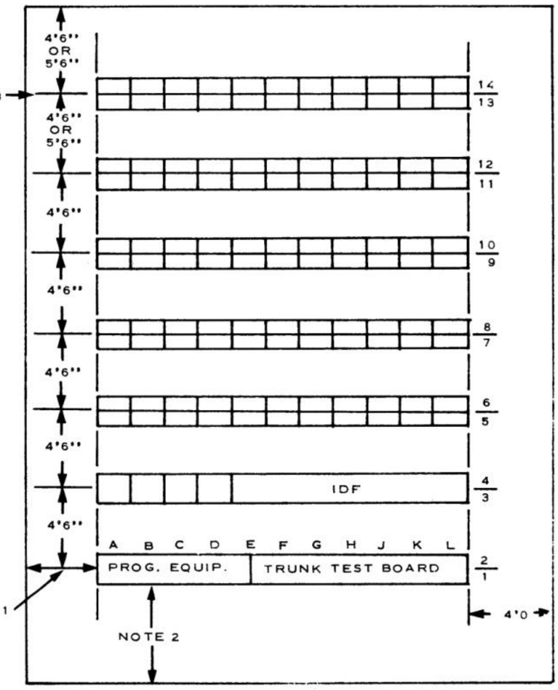
2.9 Power Suites in Line Transmission Equipment Rooms. Power switchboards and rectifiers, if installed in the line transmission equipment room, should be adjacent to the battery room. A clear space of 2′ 6″ should be provided behind the largest size floor mounted rectifier unit and a clear space of 3′ to 4′ should be reserved between the front of the power suite and any line transmission equipment.

NOTES:-

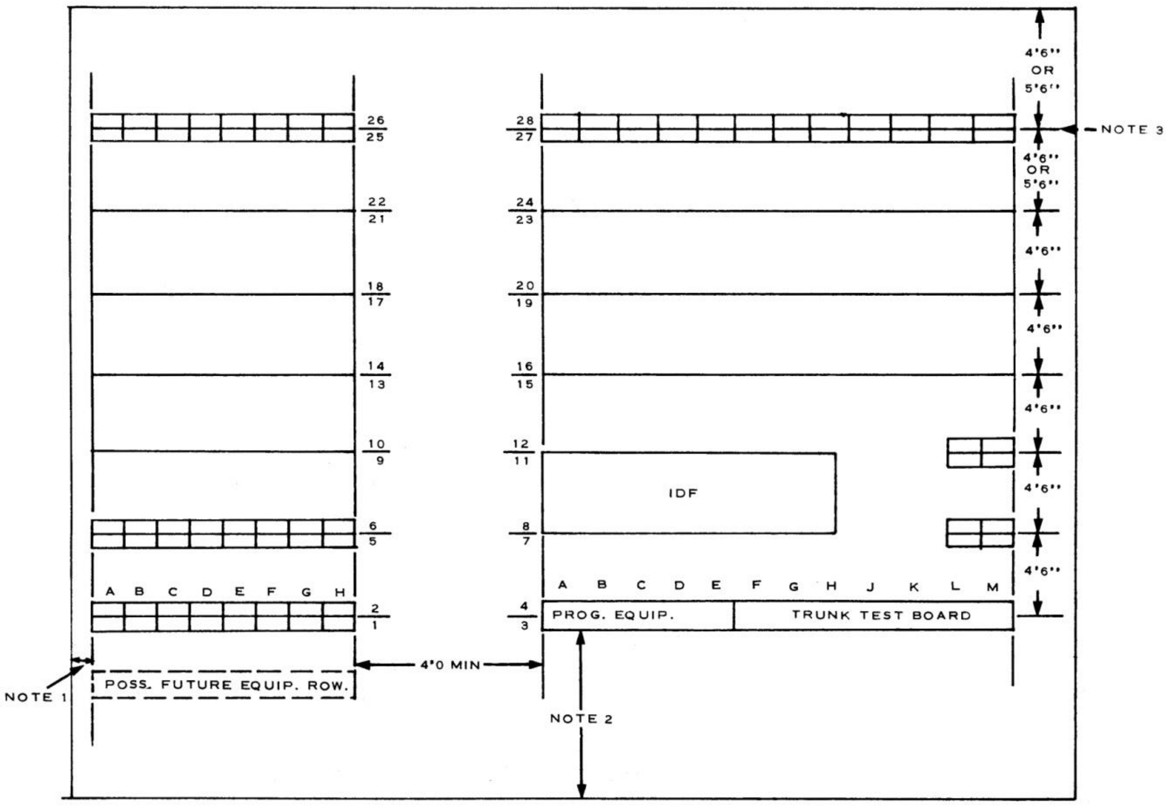
1. GENERALLY THIS SHOULD NOT BE LESS THAN 1' UNLESS GERMAN TYPE 52 EQUIPMENT IN GROUP FRAMES IS USED WHEN A MINIMUM SPACE OF 2'6" IS REQUIRED.

2. THIS DIMENSION TO BE ADJUSTED TO GIVE MAXIMUM NUMBER OF ROWS. IF A TABLE IS TO BE LOCATED BETWEEN T.T.B S. AND THE END WALL A MINIMUM OF 8' IS REQUIRED.

3. 5'6" SPACING IS REQUIRED IF BROADBAND LINE AMPLIFIERS AND POWER SEPARATION FILTERS IN THE LAST ROW.



(a) Layout With Side Aisles Only.



(b) Layout With Centre Aisle.

FIG. 2. LAYOUTS FOR LINE TRANSMISSION EQUIPMENT.

2.10 Typical Layout. Fig. 3 shows the layout of a station with a side aisle. Some equipment is shown for each category although the quantities in a number of cases are not practical. Dimensions are shown for rack spacing, aisle widths and the trunk test area.

2.11 Category A. The trunk test boards and special four-wire patch racks are situated in the first suite (Row 1/2). It is expected that test access facilities for future ARM trunk exchanges will be installed in the auto exchange test area and then secondary trunk test boards will not be required. If space permits, audio programme transmission equipment should be installed in the first suite unless a separate programme room is provided. Alarm equipment should be accessible from the T.T.B. and, if possible, is installed in the first suite.

The I.D.F. is normally located in the second suite, (Rows 3/4) but island type I.D.F.'s, as shown in Fig. 3, occupy the space of two equipment suites (Rows 3/4 and 5/6). Equipment, such as transformers, V.F. amplifiers, four wire terminating sets, hybrids, V.F. ringers, V.F. telegraph systems and auto patching sets for V.F.T.'s, is situated adjacent to the I.D.F. in such a manner as to reduce and simplify cabling but not restrict I.D.F. expansion.

At smaller installations, where their bearers are brought in via the I.D.F., rural carrier systems are situated in layout category A. At larger stations these are located in layout category C.

2.12 Category B. The channel modem equipment for balanced pair cable and open wire twelve channel, and broadband carrier systems is situated in the category B equipment area. Older type twelve channel systems had associated channel modem, group and line equipment mounted on the same rack. Modern channel modem equipment is supplied on racks which accommodate 120 channel ends and, for other than very small installations, group and line equipment is installed separately in category C. Because of the heavy V.F. cabling to the I.D.F. the channel modems are situated in the next suite to the miscellaneous V.F. equipment. Channel carrier supply racks can be installed in this section, although, at some stations, the channel modem racks will incorporate local carrier supply. Alternatively the channel carrier supplies can be obtained from the group carrier supply rack situated in category D.

The group distribution frame (G.D.F.) is the interconnecting point for basic groups (60-108kc/s). Connection between selected channel modems and group modems is made through this frame. If necessary, group automatic gain regulation equipment is added by connection at the G.D.F. Connection to basic groups of other systems is made via through group filters and the G.D.F.

2.13 Category C. In the category C equipment area, a division is made between cable and open wire equipment. The terminal racks for trunk entrance cable and all line filter racks should be located in the same row or, at large installations, in adjacent rows. All open wire carrier repeaters and terminals should be installed in the row adjacent to the cable terminal and filter racks. Group carrier supply racks should be associated with the group terminals. When the bearers for rural carrier systems terminate in the open wire carrier area, the systems should be located in that area.

Cable terminal and balancing racks should be grouped together and associated in the same row, or at larger stations, in adjacent rows with group and line equipment for pair cable systems. Group carrier supplies may be located with the group equipment or obtained from carrier generation equipment installed in the channel modem or broadband area.

2.14 Category d. All equipment for the translation of 12 channel basic groups from the 60-108kc/s range to frequency groupings suitable for transmission on coaxial cable or broadband radio bearers, together with line amplifiers, supervisory and power feed equipment, is included in layout category D. (More information is given on Page 8.)

NOTES:-

1. Row End Frame used for Carrier Supply Distribution.
2. Row End Frame used for Alarm Display and Power Distribution.
3. Location of Rural Carrier Systems dependant on Trunk Entrance Details (See Para. 2.11).

LEGEND:-

RPF - Remote Power Feeding Rack.
PSF - Power Separation Filter Rack.
LAR - Receiving Line Amplifier Rack.
LAT - Transmitting Line Amplifier Rack.
LARAD - Send and Receive Amps. for Radio Links.
SUP - Remote Supervision and Order Wire Equipment.
SGCS - Supergroup Carrier Supply Rack.
SGM - Supergroup Modem Rack.
MGM - Mastergroup Modem Rack.
SGAGC - Supergroup Auto Gain Control Rack.
SGDF - Supergroup Distribution Frame
TSGF - Through Supergroup Filter Rack.
GM - Group Modem Rack.
GCS - Group Carrier Supply Rack.
CTR - Cable Terminal Rack.
LF-H - Line Filter Rack - High Frequency
LF-L - Line Filter Rack - Low Frequency.
GAGC - Group Auto Gain Control Rack.
TGF - Through Group Filter Rack.
GDF - Group Distribution Frame.
CM - Channel Modem Rack.
PROG. - Programme Modem Rack.
CCS - Channel Carrier Supply Rack.
APR - Auto Patching Equipment (V.F.Ts.).
VFT - Voice Frequency Telegraph Equipment Racks.
2W/4W - Four Wire Terminal Rack.
VFR - V.F. Repeater Rack.
TRANS - Transformer Rack.
AER - Alarm Equipment Rack.
AP - Audio Programme Equipment Rack.
4W - Special Four Wire Patching Rack.
S - Secondary Trunk Test Board.
P - Primary Trunk Test Board.

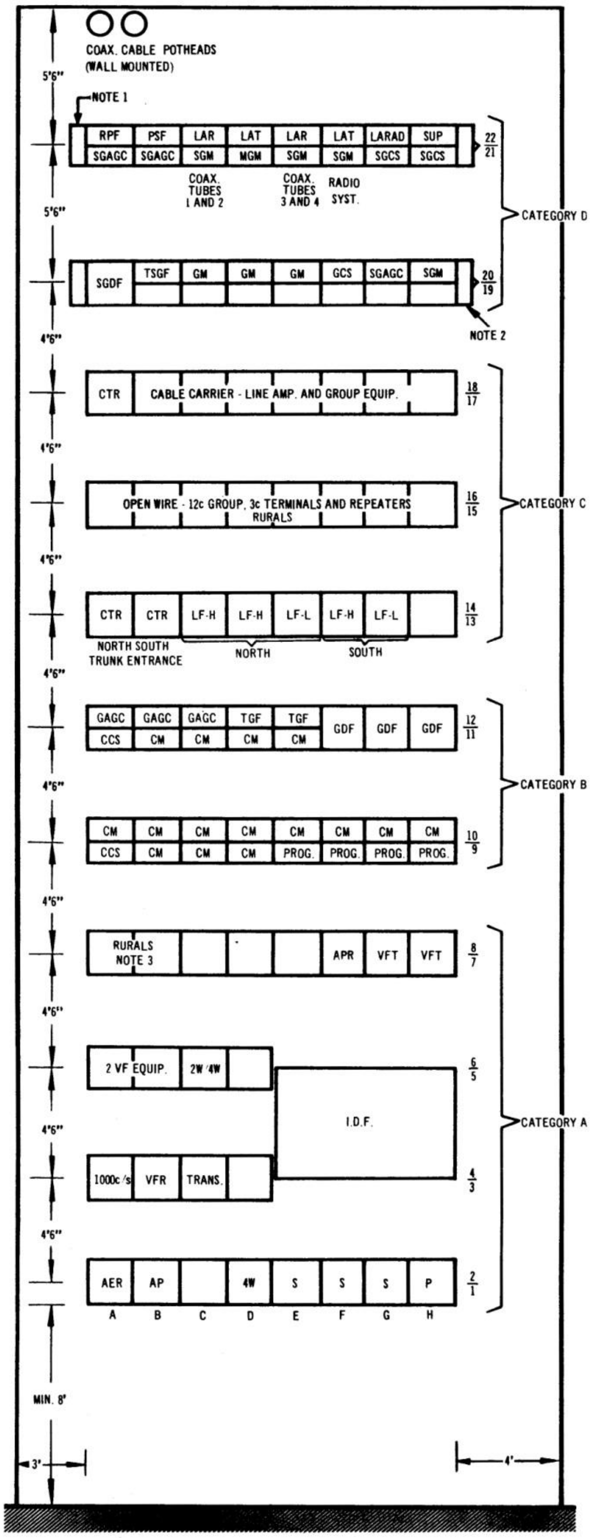


FIG. 3. TYPICAL LINE TRANSMISSION EQUIPMENT LAYOUT.

The group modems are situated in the suite nearest to the channel modems. In the same suite the supergroup distribution frame (S.G.D.F.) is used for interconnection of basic supergroups to the supergroup modems. Selected supergroups can be connected via the supergroup automatic gain control racks which are located as close as possible to the S.G.D.F. but can be situated in any suite in layout category D. The supergroups of different systems can be interconnected via through supergroup filters. The group carrier supply rack should be located with the group modems and in some cases this rack provides carrier frequencies for the channel modems.

The supergroup modems and associated carrier supply rack should be located with the line amplifiers, power and supervisory equipment, as shown in Rows 21/22 of Fig. 3. The coaxial cable potheads should be as close as possible to the power separation filters and line amplifier racks.

2.15 Video Equipment. Where large quantities of video transmission equipment are used it is normal to use a separate room. No provision is shown in Fig. 3 for this equipment, but if used it would be located as close as possible to the coaxial cable or microwave radio bearers.

3. CABLING OF LINE TRANSMISSION EQUIPMENT.

3.1 General Principles. The wiring of line transmission equipment can be divided into two main categories. These are:-

(i) Intra-rack Wiring. In general, the details of intra-rack wiring are arranged between the Department and the manufacturer and details are not given in this paper. The techniques and the types of wiring used are largely dependent on the frequency ranges, transmission levels and functions for which the equipment is designed. For most older types and some modern equipment, rack terminal blocks, at the top of the rack, are used as connecting points for external cabling. For some modern equipment the external cables are wired directly to the rack units.

(ii) Inter-rack Wiring. The following general principles apply:-

(a) Inter-rack wiring should take the most practicable route.

(b) Cabling is enclosed in overhead duct or supported on runway and is separated into lanes, if necessary, to minimise crosstalk.

(c) All V.F. wiring is run in plastic insulated sheathed multi-wire cable.

(d) Carrier frequency cabling, up to about 200kc/s, is run in screened pair.

(e) For higher frequencies solid dielectric coaxial cable is used.

(f) Cabling quantities are stated per unit of equipment rather than per rack, due to the increasing number of units which can be accommodated in a rack.

(g) The majority of V.F. cabling is to the I.D.F. and interconnection is made with jumpers at this point. Screened jumpers are required for audio programme circuits.

(h) The majority of carrier frequency cabling (up to 200kc/s) is to the G.D.F. and interconnection is made with screened jumpers at this point.

(i) Cabling for broadband terminal equipment (supergroups) is to the S.G.D.F. and interconnection is made with coaxial jumpers at this point.

3.2 V.F. Cabling. Fig. 4 shows typical V.F. cabling. The number of wires required per circuit are indicated and these can be made up by the use of pair, triple or quad cable. The cable sizes preferred for modern installation are, 21 wire (pair) 42 wire (pair) 63 wire (triple) 80 wire (quad) 101 wire (pair).

To simplify cabling from the I.D.F. to some equipment racks, Runway Row Blocks are installed. These terminal blocks (20 x 4) are adjusted on the various runways and are cabled to the I.D.F. with 80 wire quad cable. The number of blocks distributed over any row is dependent on the ultimate cable requirements to the I.D.F. for that row. Cabling from the equipment rack to the I.D.F. is made from the rack terminal block to the runway row block, and thence via the 80 wire cable to the I.D.F. Generally these blocks are necessary only in rows allocated to carrier telephone systems of up to 5 channels and in voice frequency telegraph rows.

A convenient point for the connection of any active equipment rack to the station alarm cabling, V.F. tone distribution and similar common services is provided by Common Services Blocks. The blocks are usually provided on the basis of one to every two racks of active equipment. They are not required for transformer racks, filter racks, I.D.Fs. etc.

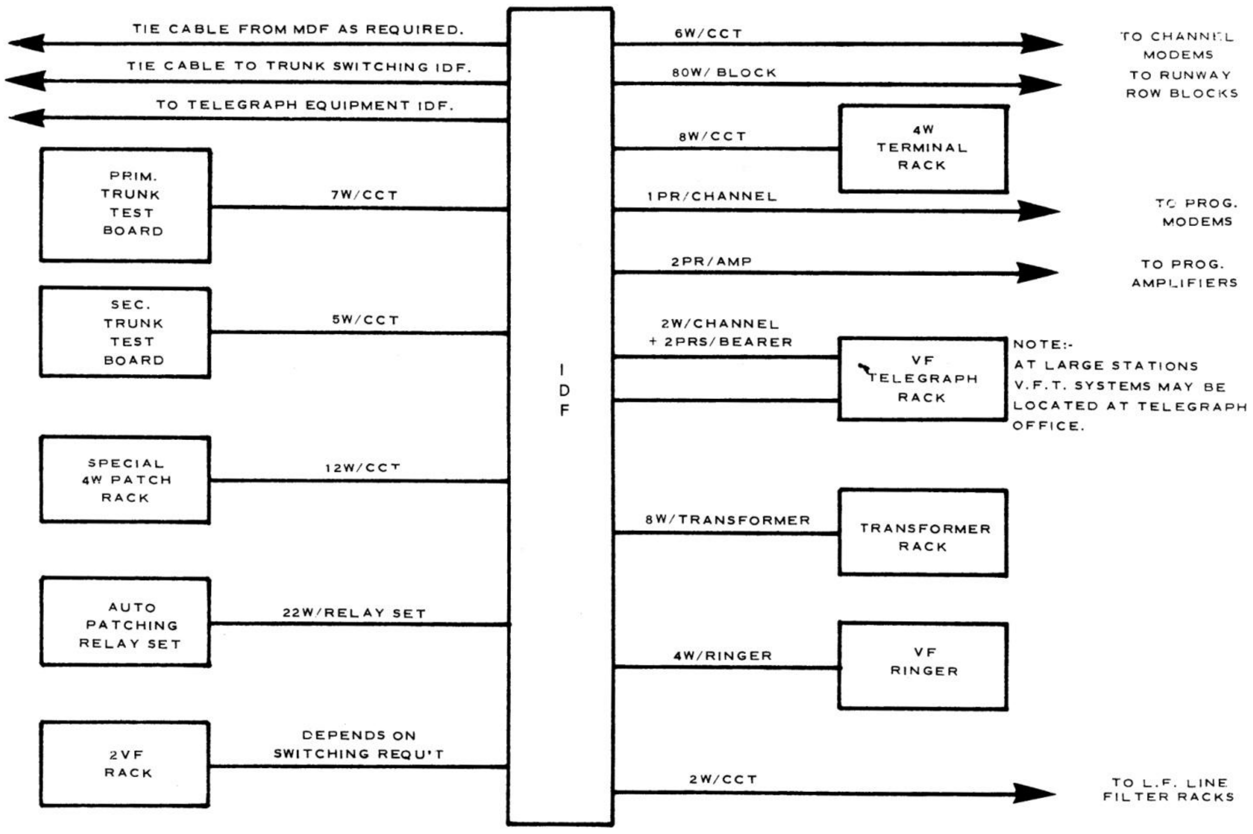


FIG. 4. V.F. CABLING.

3.3 Carrier Frequency Cabling (up to 200kc/s). A typical cabling arrangement for carrier frequencies is shown in Fig. 5. The majority of equipment interconnection is made with screened jumpers at the G.D.F. The channel carrier supplies are wired direct to the appropriate modems.

The trunk entrance detail for the bearers for open wire carrier systems is via a cable terminal rack to the appropriate line filter rack. Form this rack a screened pair completes the circuit to the open wire terminal. The bearers for pair cable carrier systems terminate on the cable terminal rack and the circuit to the line equipment is completed with screened pairs.

When a programme system is used in place of three telephone channels, the programme channel and the nine telephone channels are combined at the programme modem rack, and connection to the G.D.F. is made from this rack.

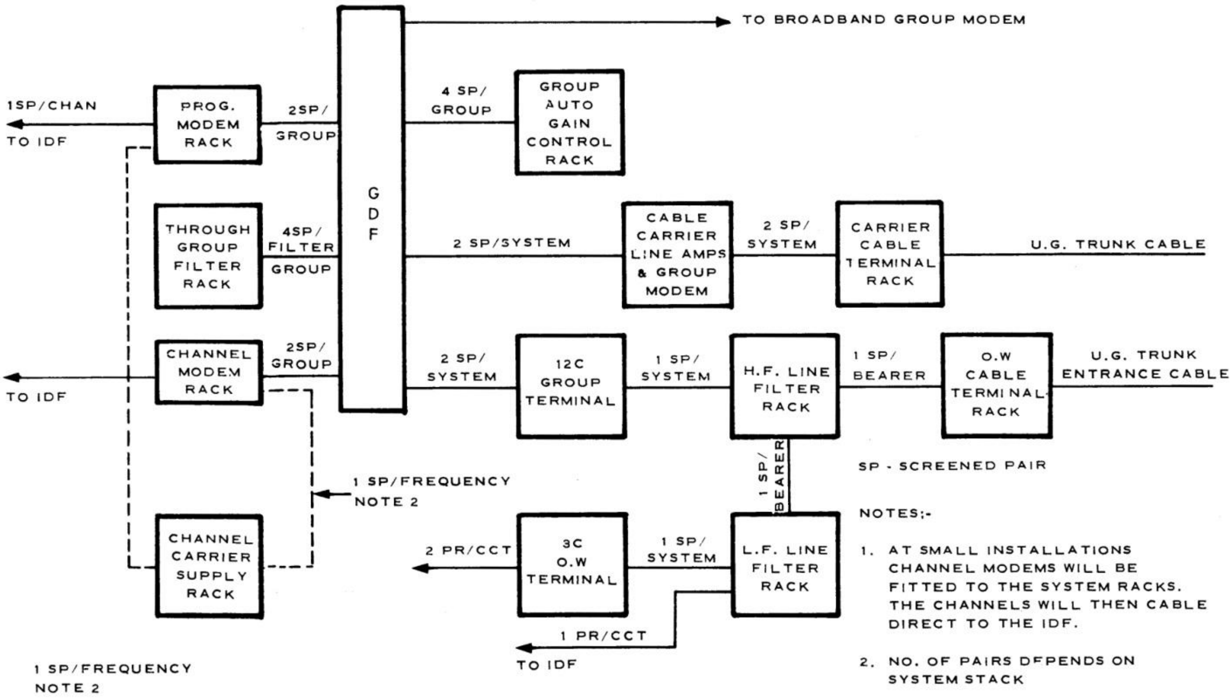


FIG. 5. CARRIER FREQUENCY CABLING (UP TO 200kc/s).

3.4 Coaxial Cabling (Broadband Terminal). The majority of interconnection is made via the S.G.D.F. and with the exception of the input circuit to the group modems, all connecting is with solid dielectric coaxial cable.

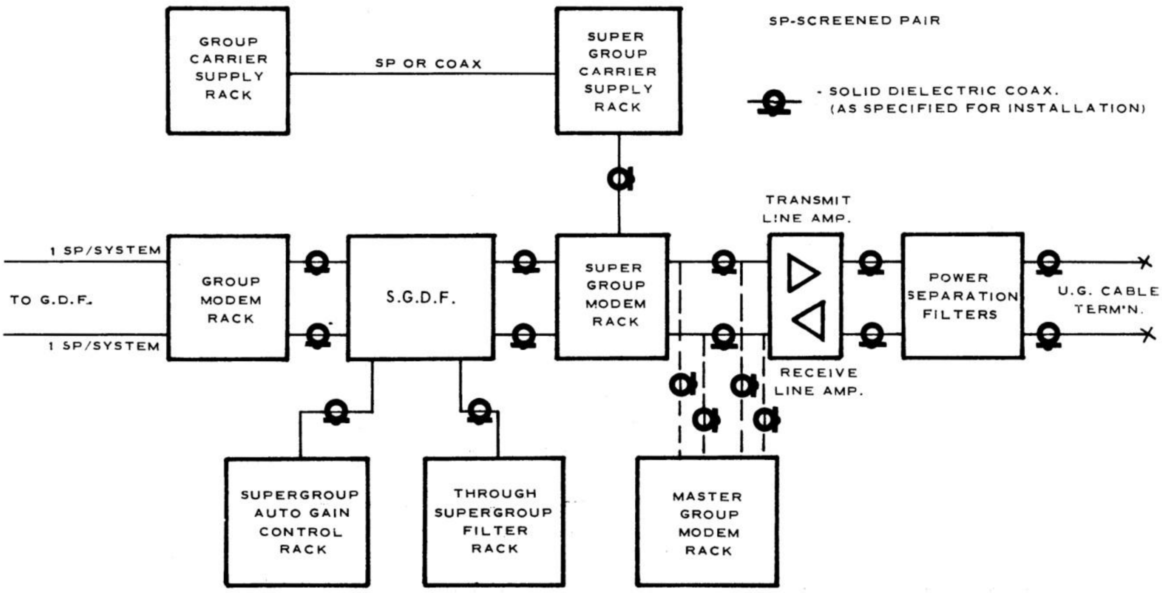


FIG. 6. TYPICAL COAXIAL CABLING (BROADBAND TERMINAL).

3.5 Cabling Ducts. In early line transmission equipment installations, internal plant cabling has been placed on runways mounted on the overhead ironwork in the installations. For large multiple pair cables, working at voice frequencies, this method is satisfactory. Where a number of pairs involved carry higher frequency circuits at various power levels, the risk of crosstalk between circuits has been found to necessitate the separation and shielding of the various groups or levels of conductors. The simplest way of overcoming this problem is to use a number of metal ducts. A general view of such a system is shown in Fig. 7.

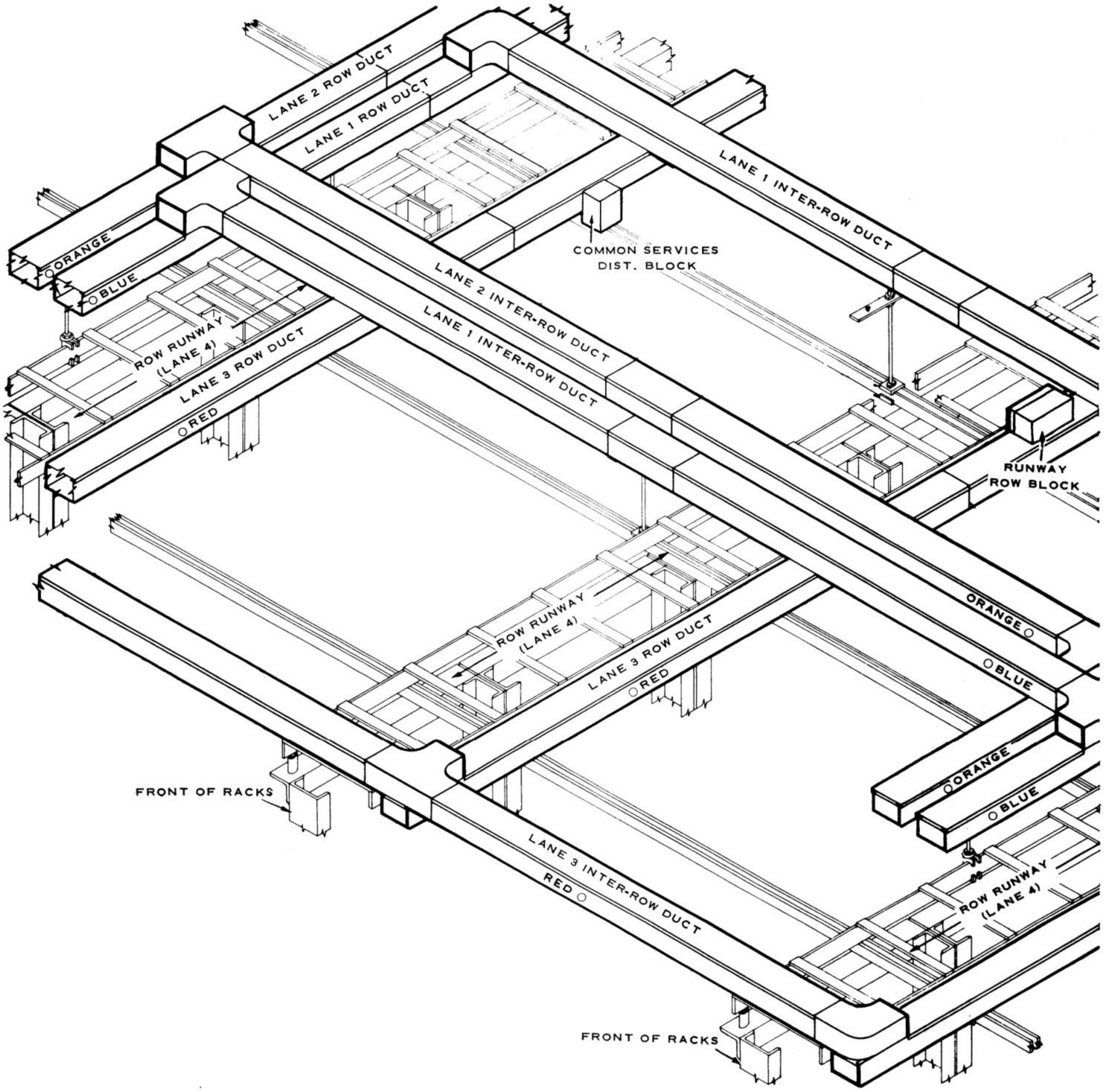


FIG. 6. TYPICAL DUCTING PLAN.

3.6 Duct Allocations. The duct system gives the necessary cable separation to obtain the required crosstalk figures for line transmission equipment using frequencies up to 150kc/s. The ducts are divided into four lanes and given distinguishing colours as follows:-

(i) Lane 1 Duct (blue).

(ii) Lane 2 Duct (orange).

(iii) Lane 3 Duct (red).

(iv) Lane 4 Runway (brown).

Lane 1 duct and lane 2 duct are allocated for one pair screened cable within predetermined frequency ranges and transmission levels. Fig. 8 and Table 2 indicate the use of these two ducts. Lane 3 duct and lane 4 runway are used for other than screened one pair and details of their use are given in Table 2.

Lane 1 Duct (Blue). Any screened pair used for the transmission of a signal, any part of whose frequency and level falls in Zone 1 of the chart, Fig. 8, is classified as Lane 1 Wiring and is placed, at random, in Lane 1 duct throughout its run.

Lane 2 Duct (Orange). Any screened pair which is used for the transmission of a signal, any part of whose frequency and level falls into Zone 2, Fig, 8, is classified as Lane 2 wiring and is placed, at random, in Lane 2 duct throughout its run.

Circuits having signal levels which fall only in Zone 3 use special screened cable and are placed by considering the availability of either Lane 1 or Lane 2 duct and the space available in the duct. As an example, cabling between Channel Modem and Group Modem rack at -5dbm is in Zone 3. As this cabling is associated with a complementary run at -42dbm which falls in Zone 2, both should be placed in Lane 2 duct.

If the signal frequencies and level on any circuit exceed the upper level limit for Zone 1 or falls below the lower limit for Zone 2 Fig. 8, a special screened cable is required, having superior crosstalk characteristics to that normally used. The screened pair is located in the more appropriate duct.

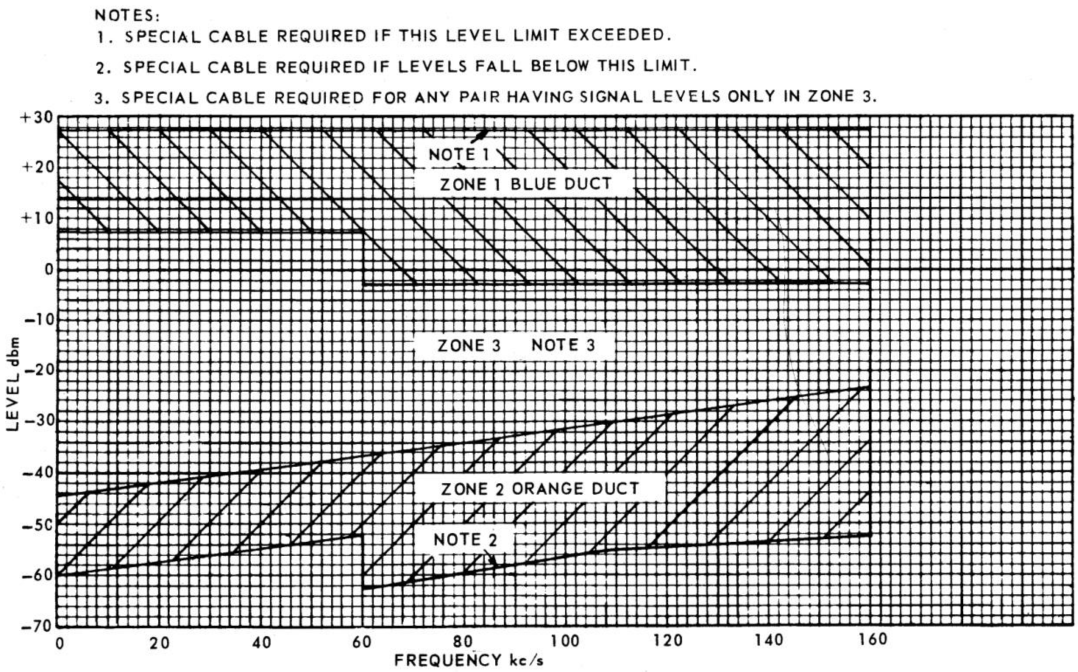


FIG. 8. USE OF CABLE DUCTS LINE TRANSMISSION EQUIPMENT.

Lane 3 Duct (Red). This lane carries all miscellaneous common services distribution such as, alarm wires, test tone distribution, 2 VF tone distribution, 17c/s ringing feeds, telegraph test reversals, etc. Generally these will be small cables or single wires which are not easily accommodated on runway.

Lane 4 Runway (Brown). All voice frequency cables including voice frequency telegraph signal tones.

As a guide, Table 2 lists some of the more general type of line transmission equipment cabling and the wiring lane in which they will be run.

LANE 1 DUCT - BLUE
Line side of all open wire systems.
Line side of cable systems transmitting 60-108kc/s. (Single Pair).
All carrier supply distribution.
Line side of cable systems transmitting 60-108kc/s. (Two pairs).
Physical programme circuits.
LANE 2 DUCT - ORANGE
Line side of cable systems transmitting 6-54kc/s. (Single pair).
All cabling between Group Modems and Channel Modems.
Line side of cable systems receiving 12-60kc/s (Two pairs).
Line side of cable systems receiving 60-108kc/s (Two pairs).
LANE 3 DUCT – RED
All alarm wires.
Distribution leads for signal and testing tones.
Ringing supply 17c/ and 1000/17c/s.
LANE 4 RUNWAY – BROWN
Channel modems to I.D.F. (MOD.IN, DEMOD.OUT, Signalling E & M Leads) I.D.F. to Four Wire Terminal racks.
Transformers to I.D.F.
Trunk Test Boards to I.D.F.

TABLE 2. WIRING LANE ALLOCATIONS – TYPICAL EXAMPLES OF INTER-RACK CABLING.

3.7 Power Distribution. Generally power distribution at a line transmission equipment station is made by means of busbars. Details of power equipment and distribution is given in Telephony 5, Papers 1 and 2.

Details of A.C. power distribution is given in the A.P.O. E.I. INTERNAL PLANT INSTALLTION Practice P 3520.

4. TEST ACCESS FOR LINE TRANSMISSION EQUIPMENT.

4.1 General Principles. Test access and test and patch access facilities are provided with various types of line transmission equipment for two main reasons. They are:-

(i) To give ready access to all lines and major items of equipment for testing purposes.

(ii) To gain flexibility in the event of line or equipment failure.

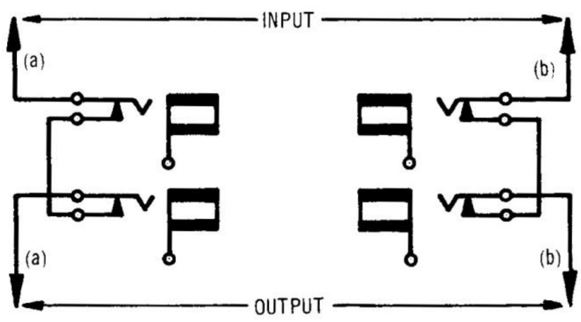
It is important that the test access facilities provided be such that no undue interference to working circuits can occur. For this reason, the modern trend is to reduce the number of test access points to a minimum and to use only test access equipment designed to give maximum reliability.

In general, the test access facility is associated with a point of circuit interconnection. In this way provision is made for test and patch access and, in some cases, an additional feature of monitor access is provided.

Test access can be obtained by the use of plugs and jacks or plugs and sockets.

4.2 Plugs and Jacks. Fig. 9 shows a typical circuit connection through jacks. Four magneto type jacks are used and the group of jacks can be referred to as a "4 jack circuit". The 'a' and 'b' sides of the incoming circuit are wired to the tips of one pair of jacks and the 'a' and 'b' sides of the outgoing circuit are wired to the tips of the other pair of jacks. Interconnection is made by strapping the inner springs as shown. The jacks can be arranged with the pairs of jacks either horizontal or vertical with respect to each other. It is normal for the 'a' side of jacks when arranged horizontally to be on the left as viewed from the front, and when arranged vertically to be on the top. A pair of jacks are called "twin" jacks.

For single wire circuits two magneto jacks can be used to give test access to input and output circuits. The circuit arrangement is then similar to that shown for either the 'a' or 'b' side of Fig. 9.



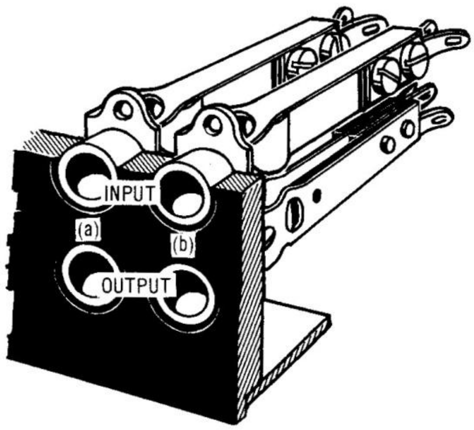


FIG. 9. TYPICAL TWIN JACK ARRANGEMENT USING MAGNETO TYPE JACKS.

Test and patch access is obtained by means of plugs and cords and typical plugs and cords are illustrated in Fig. 10. The 'a' side of the twin plug is marked with serrations to allow easy identification.

Connections from a circuit to a test jack can be made with a cord and plug or with a "patch cord" which is a cord terminated with a plug at both ends.

Patch cords are available in various length and either screened or unscreened pairs can be used.

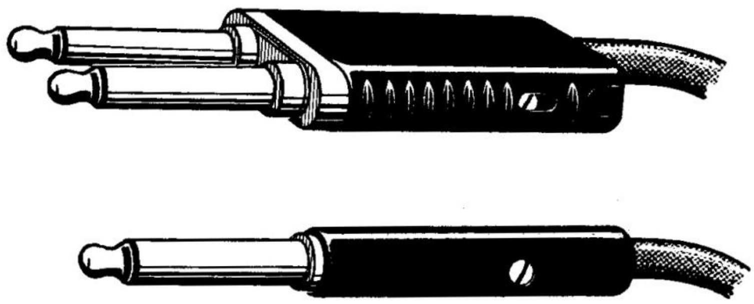


FIG. 10. TYPICAL SINGLE AND TWIN PLUGS AND CORDS.

In order to save space, some line transmission equipment uses C.B. type jacks. Fig. 11 shows a typical example of the jack arrangements, and the test plug and cord. The 'a' and 'b' sides of the incoming circuit are wired to the tip and ring of one jack and extended via inner springs and straps to the outgoing circuit.

Test and patch access can be made to either circuit by means of plugs and cords. A twin plug is sometimes used to give access to both circuits simultaneously. More details are given in Para. 4.15.

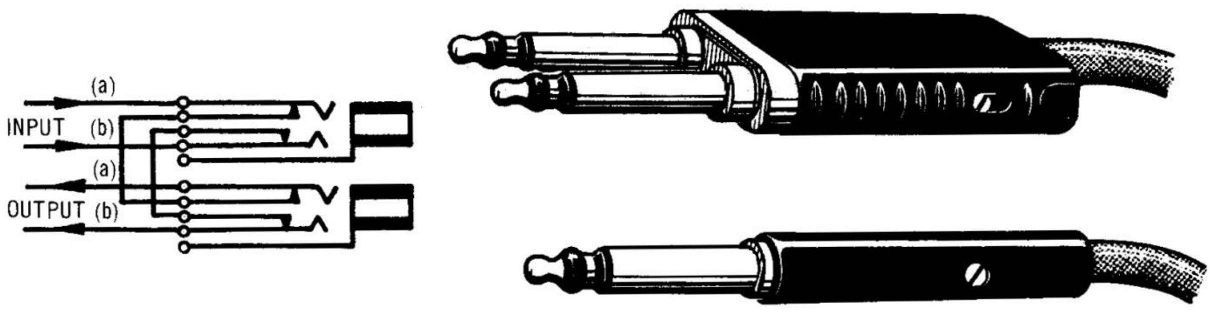


FIG. 11. TYPICAL KACK ARRANGEMENT USING C.B. TYPE JACKS.

4.3 Plugs and Sockets. A simple but effective method of interconnecting circuits is by means of sockets and links (connectors). A typical example is shown in Fig. 12. The incoming and outgoing circuits terminate on sockets and are interconnected by a link. The link shown is of the 6 pin variety but other types, for example, 2 pin and 12 pin, are in common use. Monitoring access is sometimes provided in the link as shown in the diagram.

The spacing of the pins and sockets prevent incorrect positioning of the link.

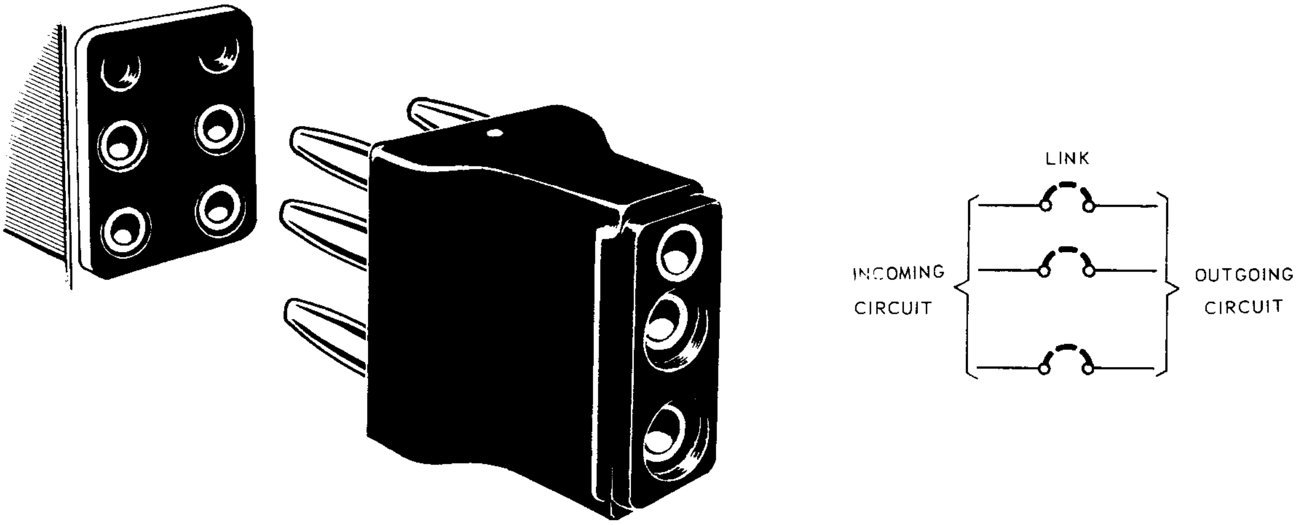


FIG. 12. INTERCONNECTION BY SOCKETS AND LINKS.

Test and patch access is obtained by removing the link and connecting to the required circuit with a plug and cord. (Fig. 13).

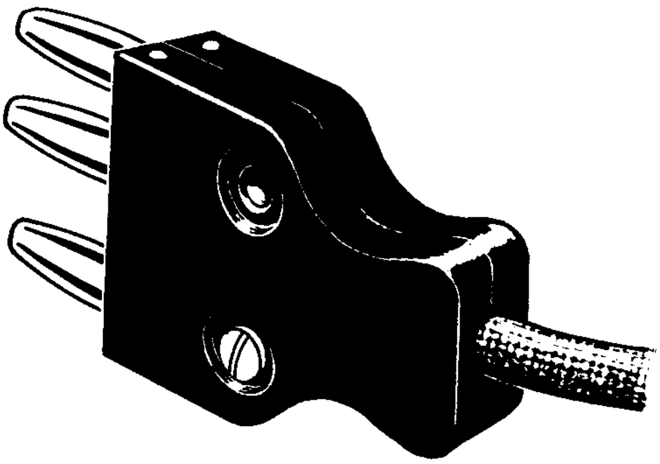


FIG. 13. PLUG AND CORD - 3 PIN TYPE.

4.4 Test Access for High Frequency Broadband Equipment. Special hard dielectric coaxial cable is used for inter-rack and intra-rack cabling of high frequency broadband equipment. Special coaxial type connectors are used with the equipment. Details of coaxial connectors are not given in this paper but the principles stated for test access in the lower frequency ranges apply.

4.5 The test and patch access facilities provided on equipment and systems supplied by various manufacturers generally conform with Departmental specifications. Details of these facilities are given in other equipment papers in the Course of Technical Instruction.

Details of the test access facilities provided by the equipment racks which are common to various types of line transmission equipment will be given. The equipment racks concerned are:-

(i) Cable Terminal Racks (Open wire and pair cable).

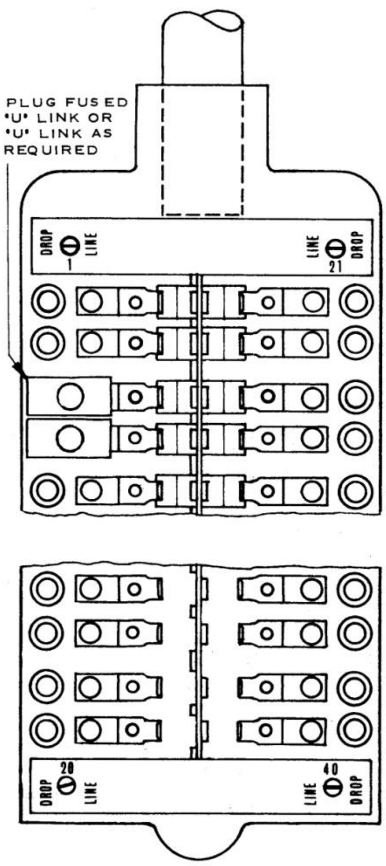
(ii) Filter Racks (Low frequency and high frequency).

(iii) V.F. Test and Monitor Racks.

(iv) Special 4 wire Patch Racks.

(v) Trunk Test Boards (Composite, primary and secondary).

4.6 Cable Terminal Rack. Cable terminal racks are divided into two types. One is a terminal rack for trunk entrance cable connected to open wire pairs and the other is a terminal rack for trunk cable pairs used as bearers for pair cable carrier systems. In both cases the incoming cable terminates on a cable terminating unit on which test access facilities are provided in the form of sockets. Any additional equipment required, for example, protection equipment, load units, capacity balancing equipment, etc, is mounted and wired on these racks. The face layout and cross section of a typical unit are shown in Fig. 14. Test access for 40 pairs is provided although normally 38 pairs are used leaving four spare link positions. A smaller unit with test access for 14 pairs is available.



The 14 or 38 pair units can be used to terminate trunk entrance cable pairs associated with open wire trunk circuits or cable pairs used as bearers for pair cable carrier systems. Protection is provided in the form of carbon arresters and fuses. The fuse is included, if required, in the link which is then known as a "Plug fused 'U' link".

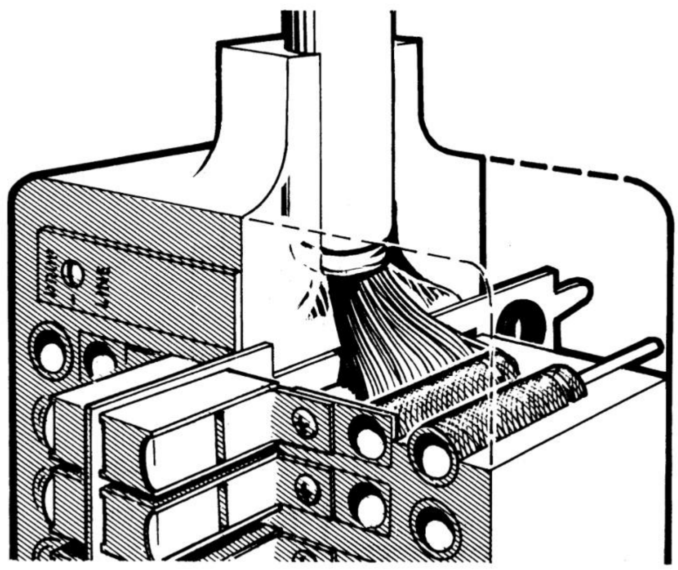
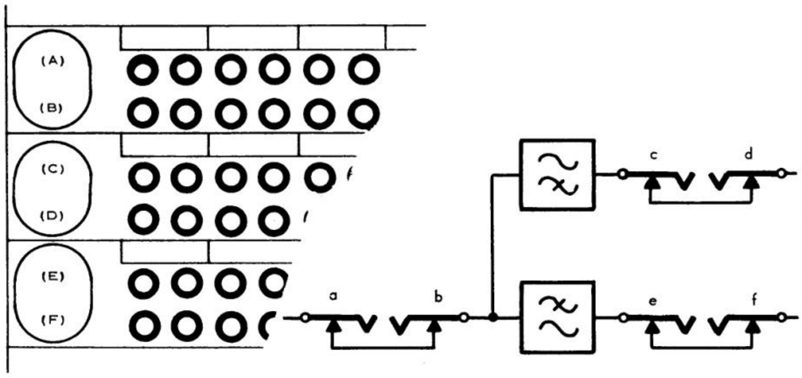


FIG. 14. TYPICAL CABLE TERMINATING UNIT.

4.7 Filter Racks. The two standard types of filter racks in a line transmission equipment station are the low frequency (three channel) filter rack and the high frequency (twelve channel) filter rack. Standard 3kc/s, 4kc/s and 5.6kc/s line filter groups are mounted on the low frequency filter rack and 32kc/s line filter groups on the high frequency filter rack.

Circuit arrangements and jack designations and layout for both rack types are shown in Fig. 15.



	HIGH FREQUENCY FILTER RACK	LOW FREQUENCY FILTER RACK
A	LINE	LINE
B	12 CHAN. FILTER LINE	FILTER LINE
C	12 CHAN. H.P.F. DROP	H.P.F. DROP
D	12 CHAN. EQUIP	3 CHAN. EQUIP.
E	L.P.F. DROP	L.P.F. DROP
F	3 CHAN. EQUIP.	V.F. EQUIP.

FIG. 15. JACK ARRANGEMENTS FOR FILTER RACKS.

At some line transmission equipment stations the 32kc/s line filter groups are situated at the cable head pole as pole mounted filters or in a filter hut or cabinet. The separation of the high and low frequencies at this point allows the requirements for impedance matching to be met. To enable patching to be performed at the station on the high frequency circuits, the jack points "12 CHAN H.P.F. DROP" and "12 CHAN EQUIP" are repeated on the "High Frequency Patching Rack" at the line transmission equipment station. This is shown in Fig. 29.

4.8 V.F. Test and Monitor Rack. This rack is not used in modern installations but is in use at some existing stations. The four wire V.F. connections of carrier systems are brought out to the V.F. Test and Monitor Rack where jack provision is made, as shown in Fig. 16. Provision is also made, in some cases, for adjustment of channel gain by locating the gain control of the channel amplifier on the V.F. Test and Monitor Rack. This feature is shown on the circuit but is not included with the jack layout.

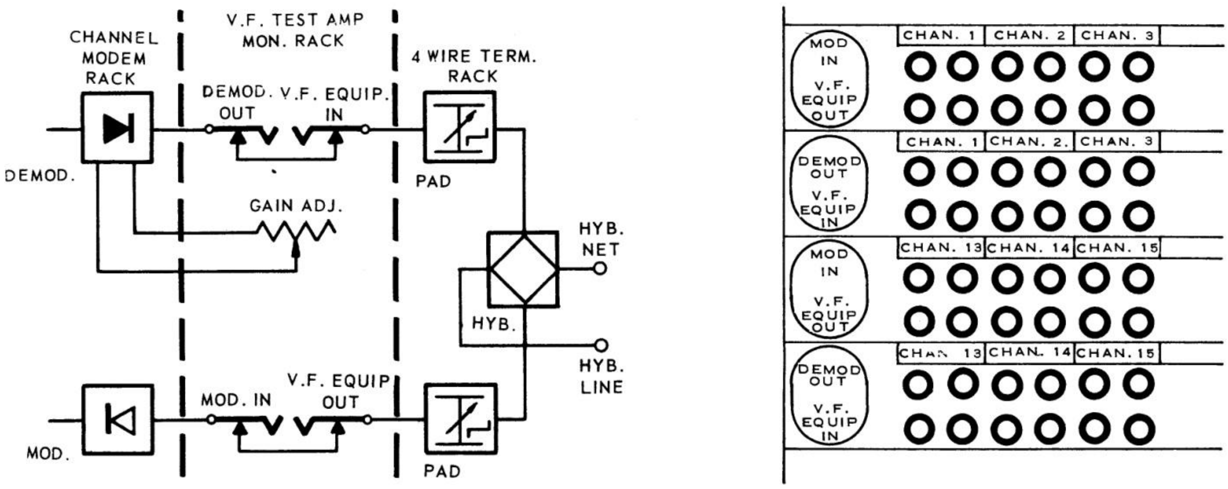


FIG. 16. JACK ARRANGEMENTS - V.F. TEST AND MON. RACK.

4.9 Special 4 Wire Patch Rack. High priority circuits using four wire working are extended through a special 4 wire patch rack. Typical examples are bearers for a V.F. carrier telegraph systems carrying circuits leased to the Department of Civil Aviation or a high speed circuit of the Overseas Telecommunications Commission. In addition to these circuits a number of selected low priority circuits are taken through jacks on this rack. These circuits are used as patch circuits for the high priority circuits.

A typical circuit arrangement is shown in Fig. 17.

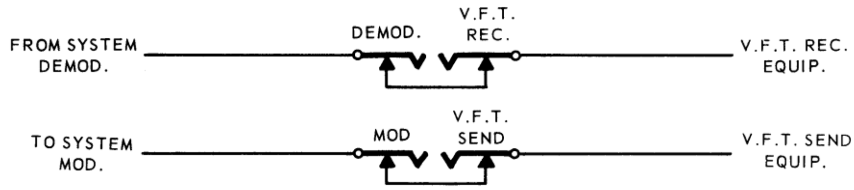


FIG. 17. JACK ARRANGEMENTS - SPECIAL 4 WIRE PATCH RACK.

4.10 Trunk Test Boards (T.T.Bs.). At line transmission equipment stations the standard practice is to install one or more T.T.Bs. through which all telephone and telegraph lines, both physical and derived, are connected. These boards give test access by jacks to equipment and lines associated with trunk circuits and this enables tests, and equipment and line changes, to be made by using plugs and cords in association with the jacks. Standard jack circuits have been developed and are generally named according to the number of jacks which comprise the circuit.

The jack circuits using magneto type jacks are divided into the following types:-

(i) Ten jack circuits.

(ii) Six jack circuits.

(iii) Two jack circuits.

Later type secondary trunk test boards use C.B. type jacks and are described in Para 4.14.

4.11 Types of Trunk Test Boards. There are three basic types of T.T.Bs. in use. They are:-

(i) Composite.

(ii) Primary.

(iii) Secondary.

The type of board or boards installed depends on local considerations. Originally all T.T.Bs. were of the composite type but because of the large increase in the number of derived circuits, these have been replaced in many stations by primary and secondary T.T.Bs.

The composite T.T.B. is so named because it provides test and patch access for both physical and derived circuits. The primary trunk test board provides test and patch access for physical lines and the secondary trunk test board for derived circuits only.

This paper gives details of the test and patch access for the three types of trunk test boards. Other papers in the Course of Technical instruction give information on the testing, speaking, signalling and monitoring facilities provided by these boards.

4.12 Composite Trunk Test Boards. This type of trunk test board has a jack field comprised of 10 jack, 6 jack and 2 jack circuits. Most early installations were equipped with composite T.T.Bs. but modern planning restricts the use of these to small stations.

Fig. 18 illustrates a typical composite T.T.B. jack field. The row of miscellaneous jacks at the top of the board is normally used for the provision of short circuits, grounds, etc., which may be required during line testing. The conditions are applied to the line under test by means of patch cords. All circuits are wired to rack terminal blocks and from this point are cabled to the I.D.F.

A number of 2 jack miscellaneous circuits are used to terminate Interposition Trunks. (I.P.T.S.). These jacks are wired to similar jacks on other trunk test boards and, in some cases, to other equipment racks. They provide a means of extending speech and V.F. test circuits within the station.

Details of lines and equipment are printed on cards and placed in the "designation strips" above the rows of jacks. A combination of background colour and letter colour gives an indication of the type of circuit. For example, designations for all programme circuits are printed in black on a blue background and the designations for all telegraph bearers are printed in black on a red background.

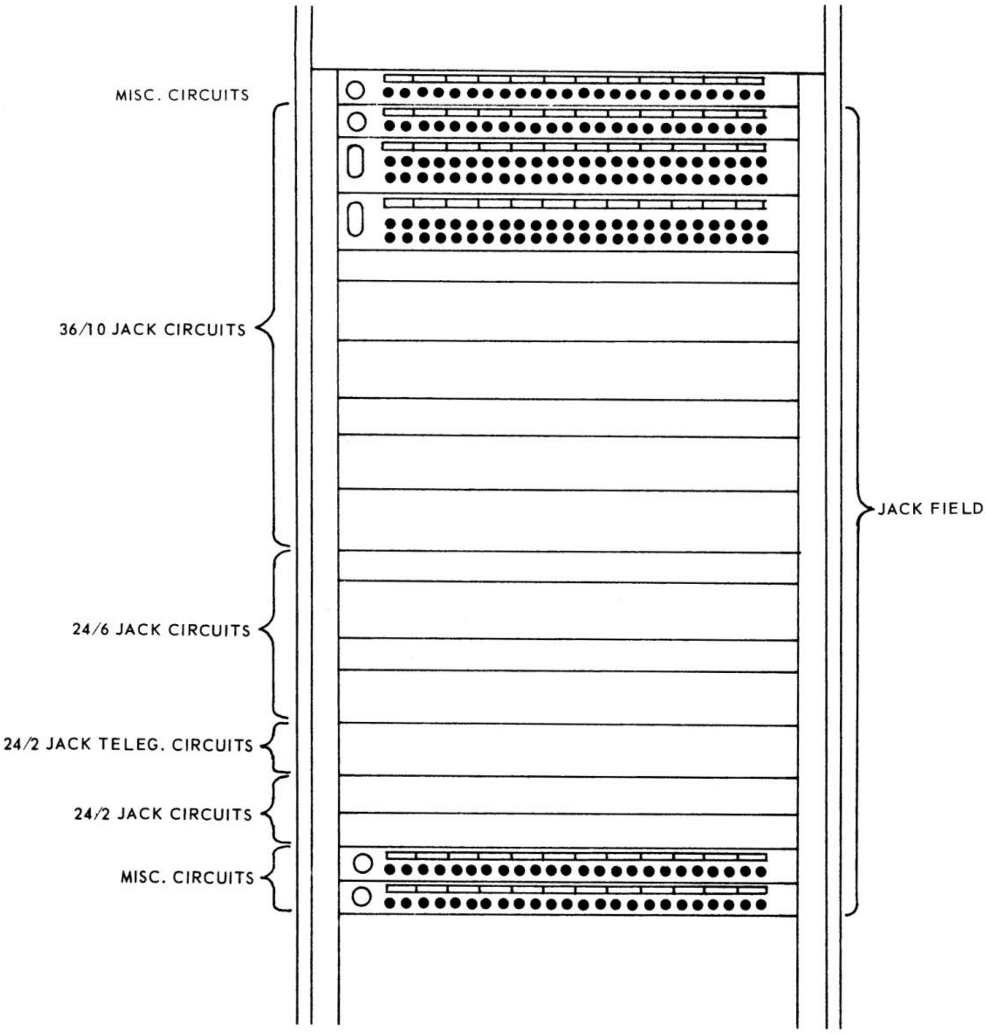


FIG. 18. LAYOUT OF JACK FIELD FOR COMPOSITE TRUNK TEST BOARD.

Ten Jack Circuit. Physical circuits with associated V.F. equipment are provided with 10 jack circuits. Fig. 19 shows the jack layout for one row of 10 jack circuits.

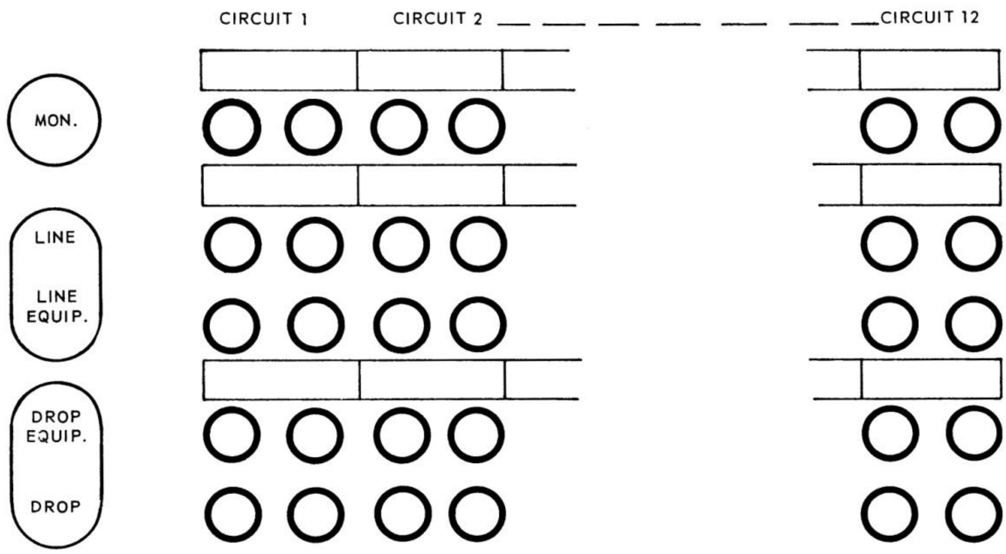


FIG. 19. LAYOUT OF 10 JACK CIRCUITS ON COMPOSITE TRUNK TEST BOARD.

Fig. 20 shows the 10 jack circuit in schematic form. For simplicity the circuit, although two wire, has been shown as a single wire circuit. It will be noted that the jacks provide test and patch access for the line, the V.F. equipment and the switching equipment. A monitor jack (MON) allows the testing officer to listen across the circuit without breaking the through connection.

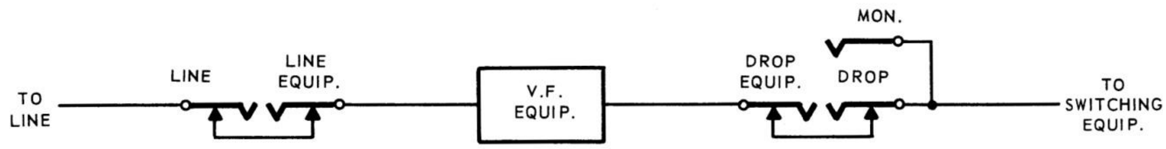


FIG. 20. SIMPLIFIED SCHEMATIC - 10 JACK CIRCUIT.

Six Jack Circuits. Derived circuits (channels of carrier systems, phantom circuits etc.), are provided with six jack circuits. Fig. 21 shows the jack layout for a row of six jack circuits.

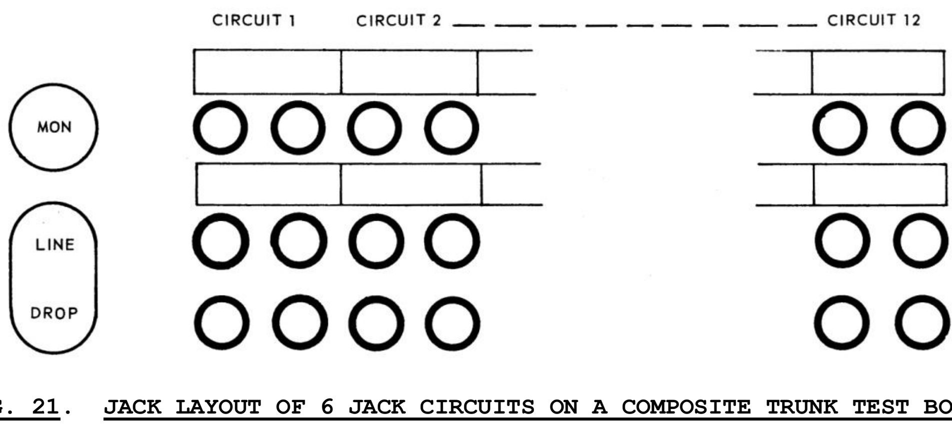


FIG. 21. JACK LAYOUT OF 6 JACK CIRCUITS ON A COMPOSITE TRUNK TEST BOARD.

Fig. 22 shows the schematic arrangements for a 6 jack circuit. Test and patch access is provided for the line (derived circuit) and the switching equipment. The MON jack is provided for monitoring purposes. For simplicity the circuit has been shown single wire, although in practice two wires are used.

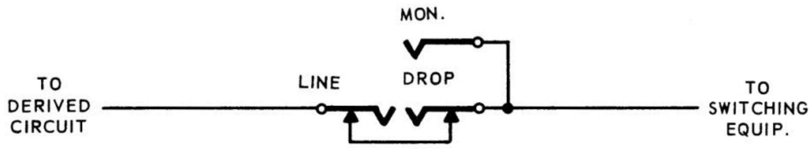


FIG. 22. SIMPLIFIED SCHEMATIC - 6 JACK CIRCUIT.

Two Jack Circuits. Two jack circuits are divided into two types:-

(i) Telegraph Circuits. Fig. 23 shows the jack layout and simplified schematic circuit for telegraph two jack circuits. It must be noted that a single wire circuit only is provided and the two jacks concerned are mounted vertically one above the other. Test and patch access is available for the telegraph line and the telegraph equipment.

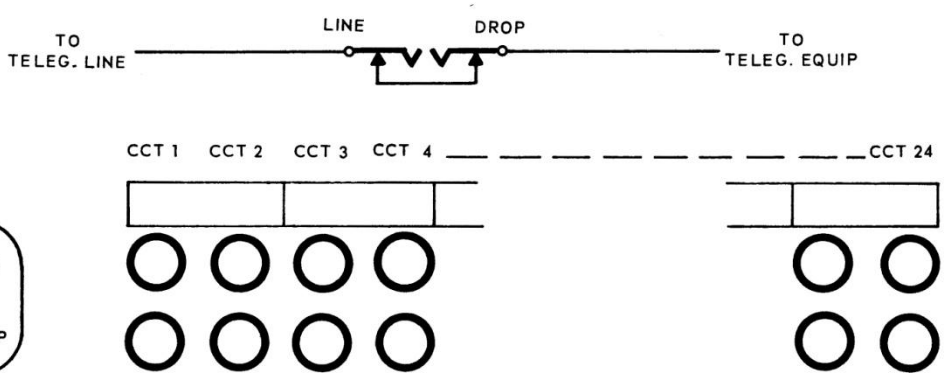


FIG. 23. JACK LAYOUT AND SCHEMATIC FOR TELEGRAPH 2 JACK CIRCUITS.

(ii) Miscellaneous Circuits. The jack layout and schematic circuit for miscellaneous two jack circuits is shown in Fig. 24. Through connection is not made by the inner springsets as these circuits are provided to terminate order wires, I.P.T.'s, etc.

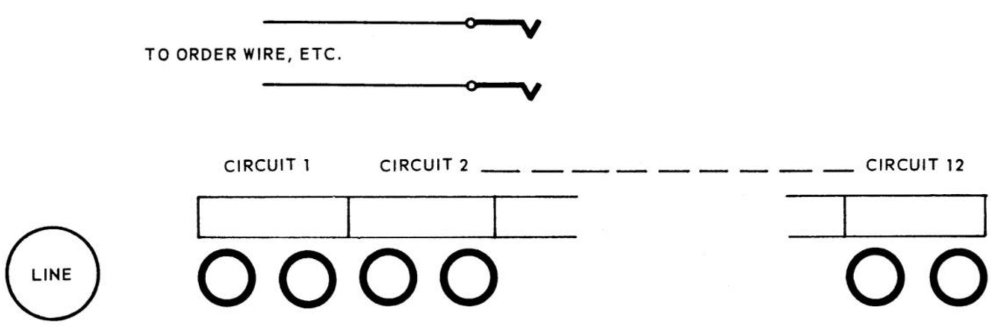


FIG. 24. JACK LAYOUT AND SCHEMATIC FOR MISCELLANEOUS 2 JACK CIRCUITS.

4.13 Use of Primary and Secondary Trunk Test Boards. With the introduction of a large number of multi-channel carrier systems, and in particular broadband carrier systems, it is necessary to use many more 6 jack circuits. The composite T.T.B. does not always meet these requirements and is replaced with Primary and Secondary T.T.B.s.

With regard to the jack field of primary and secondary T.T.B.s the following general statements apply.

(i) Primary T.T.B.

(a) With the exception of miscellaneous circuits, the entire jack field is comprised of 6 jack circuits.

(b) Only physical lines appear on this T.T.B.

(ii) Secondary T.T.B.

(a) With the exception of miscellaneous circuits the entire jack field is comprised of either 6 jack circuits or C.B. type "2 jack circuits" which, in conjunction with the test equipment, provide similar facilities to that of 6 jack circuits.

(b) All speech circuits appear on this T.T.B.

(c) Provision is made for test access on E and M signalling leads.

4.14 Primary Trunk Test Boards. The jack layout for a typical primary truck test board is shown in Fig. 25. The jack field provides test access for 60 circuits by means of 6 jack circuits. In addition provision is made for 24-2 jack telegraph circuits, 24-2 jack miscellaneous circuits and a number of miscellaneous exchange line and test circuits. As supplied by the manufacturer the jack field is not wired except for the miscellaneous circuits. Cabling to the jack field is direct from the I.D.F.

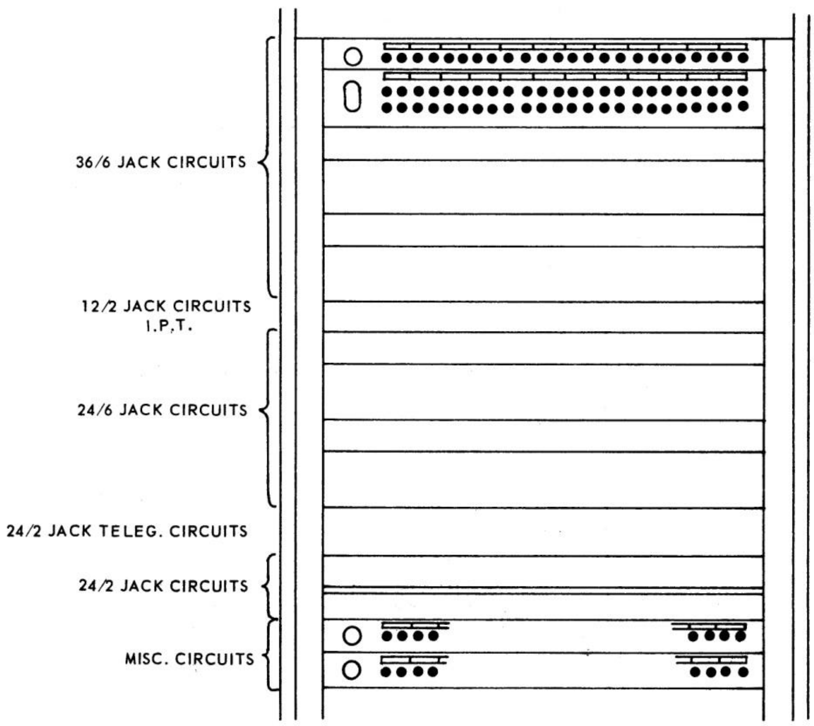


FIG. 25. LAYOUT OF JACK FIELD FOR PRIMARY TRUNK TEST BOARD.

4.15 Secondary Trunk Test Board. The jack fields for the original secondary trunk test boards were composed mainly of 6 jack circuits, but later boards use C.B. type jacks to give similar facilities. The jack layout for a typical secondary trunk test board is shown in Fig. 26. The jack field is composed of 2 jack circuits of the C.B. type described in para. 4.2. Test and patch access is provided for at least 120 circuits. For these circuits, access is given to LINE and DROP, HYBRID NET and NET and E and M signalling leads. Provision can be made for more circuits if only a two wire connection is required, or if signalling leads are not necessary. The jack field designations for the network and signalling circuits are engraved LINE and DROP, on the back, and can be reversed. As supplied by the manufacturer the jack field is not wired except for the miscellaneous circuits and cabling to the jack field is direct to the I.D.F.

Monitor jacks are not provided but monitoring facilities are available when testing with the test cord circuits. Two test cord circuits are fitted with twin plugs which are inserted in the LINE and DROP jacks simultaneously. Keys associated with the cord circuits give monitoring facilities, or "split" the circuit to allow testing of the LINE or DROP circuit as required.

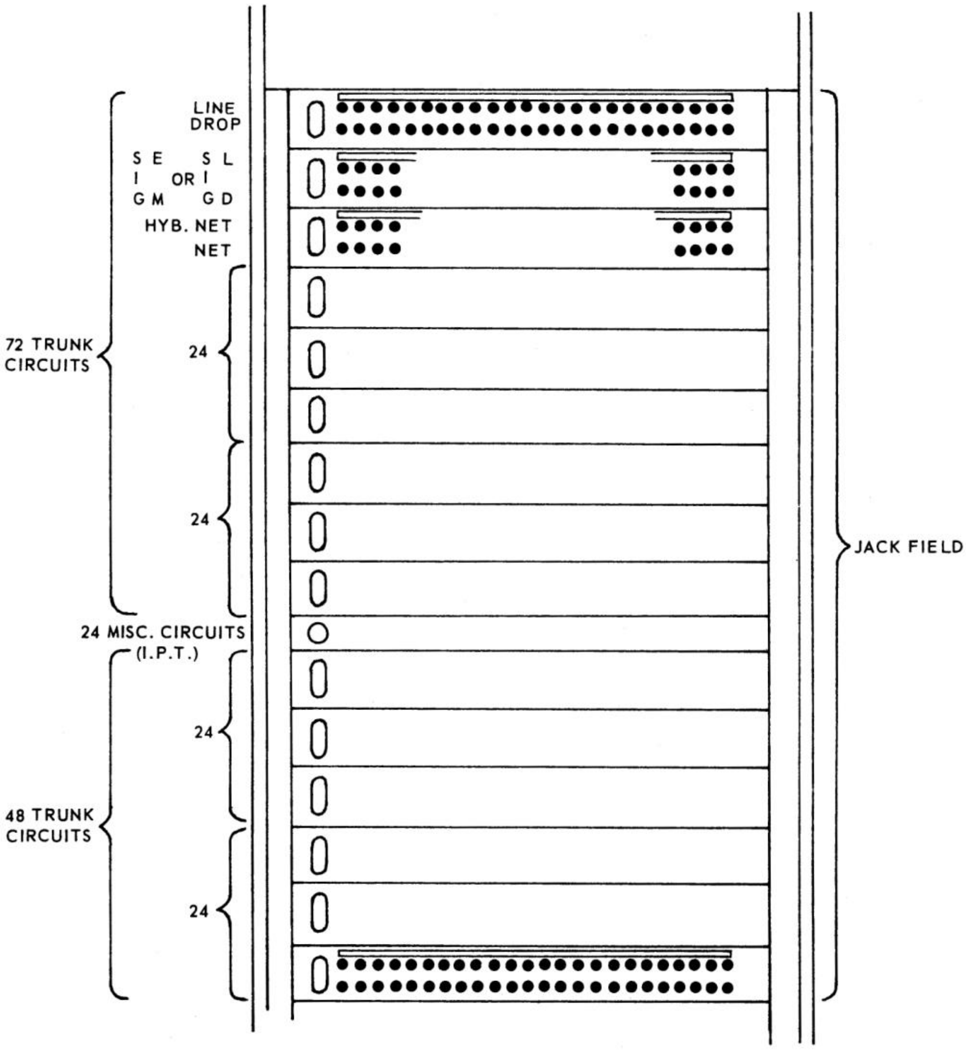


FIG. 26. LAYOUT OF JACK FIELD FOR SECONDARY TRUNK TEST BOARD.

A typical circuit arrangement for a carrier system circuit, with line and network extended to the switching equipment, is shown in Fig. 27. The signalling receive and send leads (E and M) may also be taken through jacks on the T.T.B. as shown in Fig. 28.

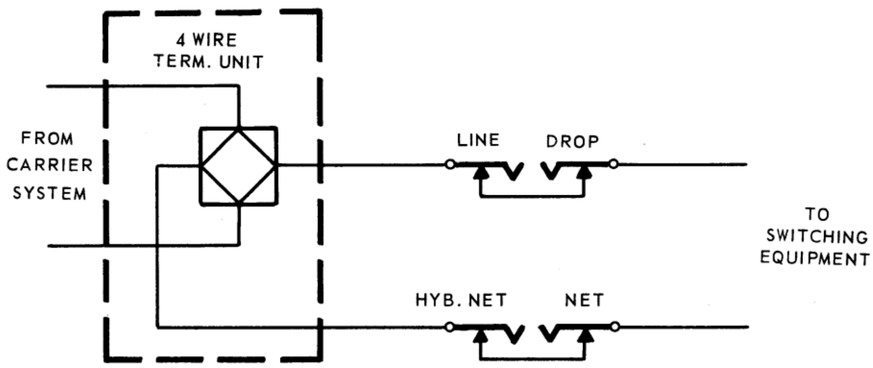


FIG. 27. USE OF LINE AND NETWORK JACKS ON SECONDARY T.T.B.

4.16 With the introduction of ARM trunk exchanges it is anticipated that the test access facilities for trunk telephone circuits will be included with the trunk switching equipment. These test access facilities will be associated with automatic trunk testing equipment and it is possible that test access at the Secondary T.T.B. will not be required.

4.17 Typical Equipment Interconnection. Fig. 28 shows typical interconnection of equipment at a station with a composite trunk test board. A three channel system, a physical voice frequency circuit and an earthed phantom (cailho) circuit are obtained on the one physical pair. For matching purposes the trunk entrance cable pair could be loaded, and a terminal load unit, if required, would be mounted on the Cable Terminal Rack. The carrier screened cable pairs, used for interconnection of the higher frequency circuits, are placed in the appropriate cable ducts. The cable pairs used for voice frequency and telegraph distribution are placed on the runways and interconnection is made at the I.D.F. The two signalling methods shown in this diagram are 1000c/s ringing and 2 VF signalling. In some cases out-of-band signalling is associated with channels of three channel systems. In this example it is assumed that the hybrids and associated pads for each channel are situated with the carrier equipment.

Fig. 29 shows typical interconnection of equipment at a station with primary and secondary trunk test boards. A twelve channel system, a three channel system, a physical voice frequency circuit and an earthed phantom (cailho) circuit are obtained on one physical pair. The H.F. filters (32kc/s) are obtained at the cable head pole and a H.F. Patching Rack is added in the station. A terminal load unit, if required for the carrier loaded pair would be added at the Cable Terminal Rack. The carrier screened cable pairs are distributed in the appropriate cable ducts and the voice frequency and telegraph cables are placed on the runways. In some installations a V.F. Test and Monitor Rack is associated with the carrier channels. At those installations, test access for the channels is given on the V.F. Test and Monitor Rack.

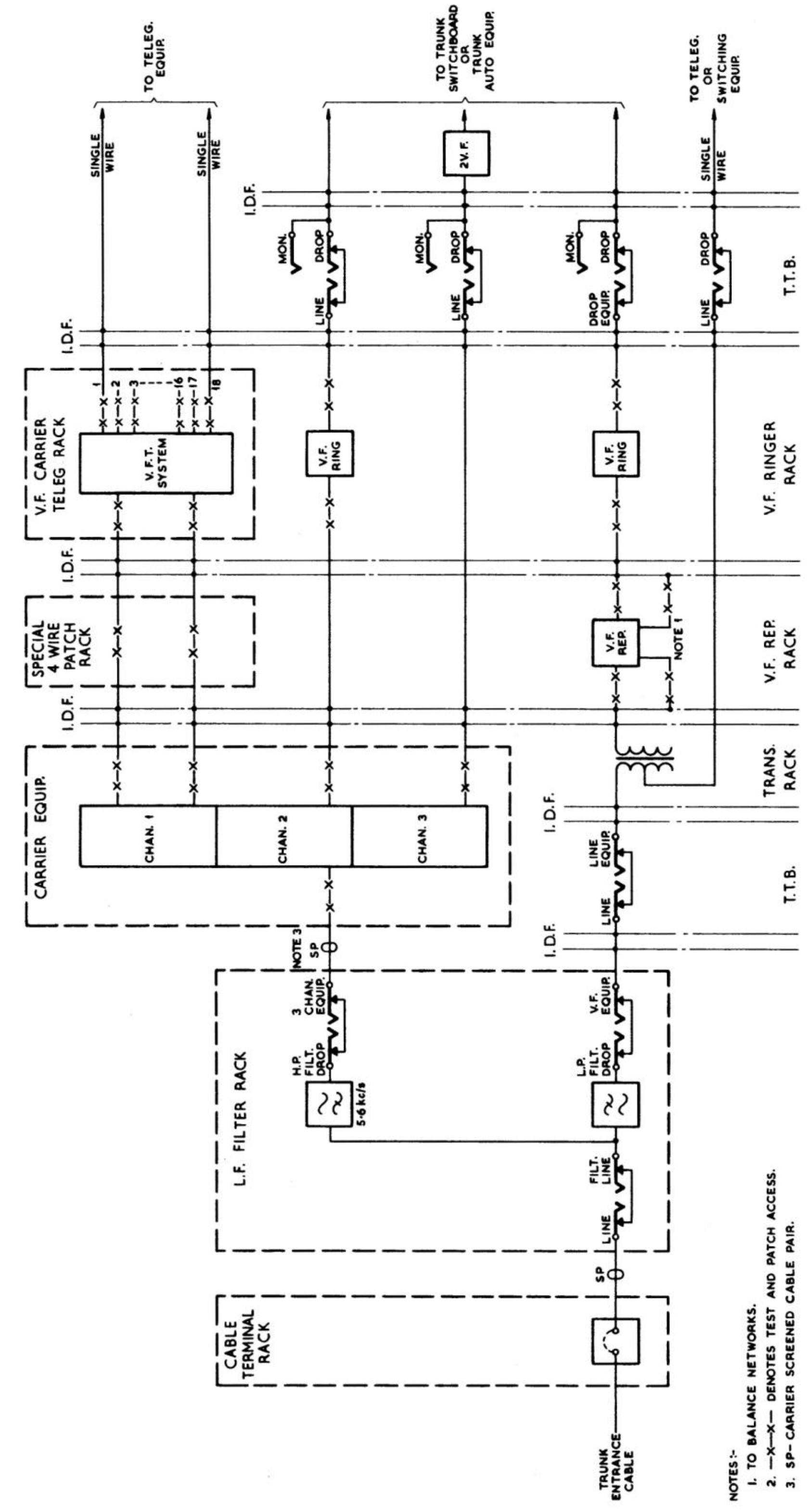


FIG. 28. INTERCONECTION OF EQUIPMENT - COMPOSITE TRUNK TEST BOARDS.

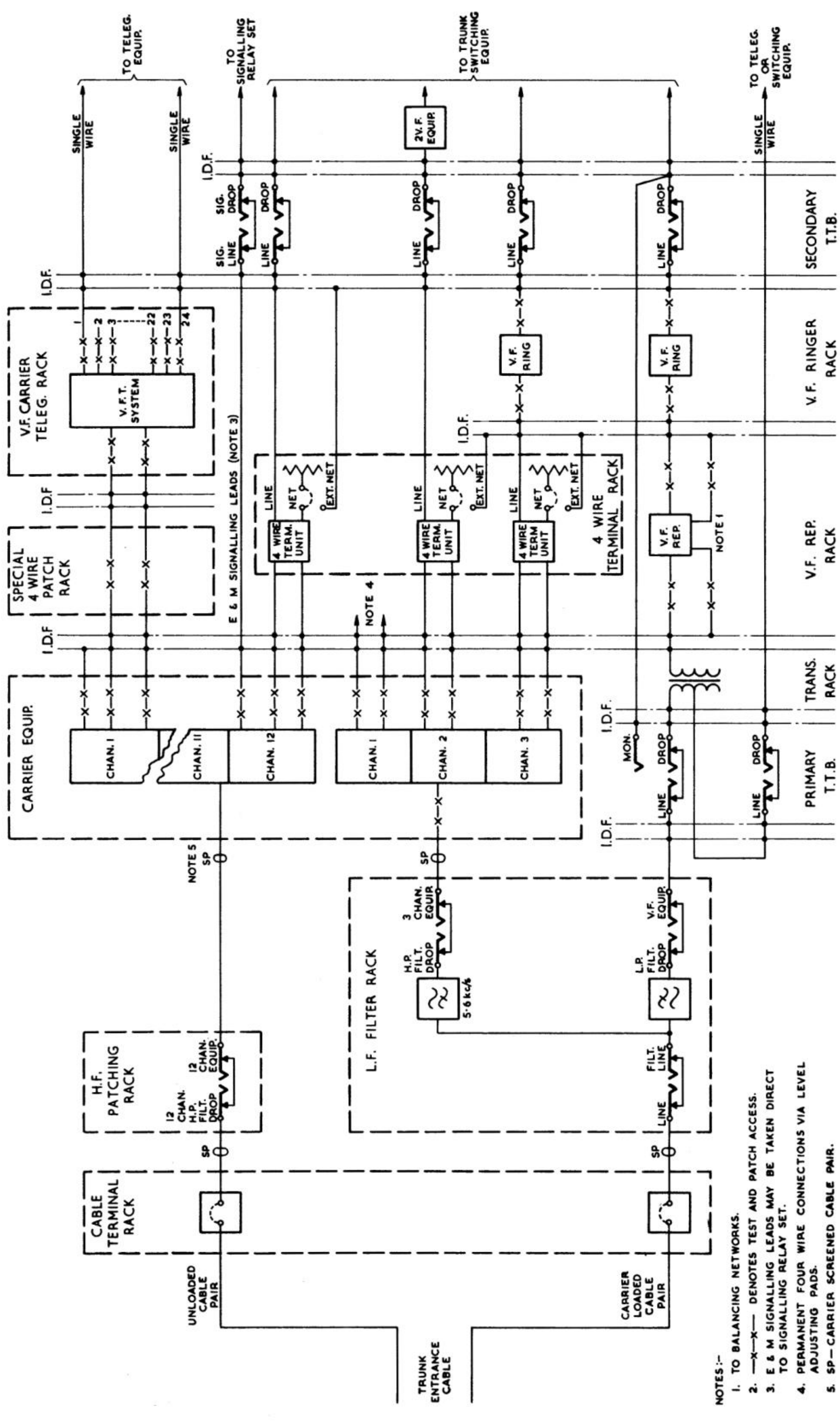


FIG. 29. INTERCONECTION OF EQUIPMENT - PRIMARY AND SECONDARY TEST BOARDS.

NOTES.