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TERMINATING AND JOINTING ELECTRIC WIRES AND CABLES

CHAPTER 122

RECTANGULAR CONNECTORS

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FIGURES

INTRODUCTION

1. Electronic equipments may be made up of a number of sub-units which can be in chassis or printed circuit board form. The sub-units are joined together by some form of connector providing the facility of quick disconnection for testing, repair or replacement on breakdown. To cover the many and varied requirements, numerous types of multi-way plugs and sockets are in use and because of their nature can introduce unreliable operation.

2. The choice of a connector in the first instance depends upon numerous factors including function, environment and electrical characteristics. The mechanical strength of a connector is often more important that it appears at first sight. On portable and semi-portable equipments the connectors of the unit are often used as carrying handles, subjecting them to unusual and unnecessary strains. This practice is to be deplored and should be discouraged.

Connector breakdown

3. A considerable percentage of faults in electronic equipments have been attributed to connectors and although this may be justified to some extent, bad soldering and mishandling have contributed their share to this situation. Connectors are made up from delicate component parts which may be supplied dismantled for conductor attachment and build up by operatives. They may be liable to various types of abuse during assembly and subject to rough handling during fitting into and removal from the main equipment. Damage is also caused by the rough use of test probes during circuit testing.

Connector trends

4. Because of constant research into materials and design, connectors can now be operated over a fairly wide temperature range and reliability has improved. Contact retention within the di-electric has been revised and alternative methods of connecting the conductor to the contacts are now in use, eg crimping, welding and wire wrapping.

5. With the introduction of semi-conductors using low voltages and currents and the general trend towards miniaturisation, high density connectors have been developed. These connectors contain more contacts within a smaller volume than was possible in the past. However they are still relatively rugged by using recently developed materials.

Connector types

6. There are many and varied types of connectors in use and plugs and sockets of the same types are not always interchangeable or intermateable between different manufacturers. More than one manufacturer may be given approval to produce the same style of connector to a Military Specification or a Defence Standard. Each size and style of plug and socket is then identified by its own part number and style reference and is intermateable between manufacturers but it is inadvisable to interchange the individual component parts.

Connector groups

7. Connectors can be divided into three main groups.

a. Audio frequency, covering plugs and sockets for use at audio frequencies and are considered in Chap 123.

b. Radio frequency, including mainly single pole co-axial plugs and sockets for use with high frequency signals and pulses. These items are normally used for the termination of co-axial cables and are dealt with in Chap 125.

c. DC and low frequency. This is possibly the largest group of connectors and may be sub-divided into:

(1) Rectangular connectors

(2) Printed circuit connectors

(3) Circular connectors which are dealt with in Chap 123.

STRUCTURE OF CHAPTER

8. The purpose of this chapter is to provide information relevant to the use of Ractangular and Printed Circuit board connectors. As further information becomes available, new techniques are established and improved materials are developed, amendments to this chapter will be issued which may be in the form of paragraphs, tables and illustrations.

DEFINITIONS

9. a. Style reference

The style references used, are abbreviations to identify families of plugs and sockets, electrical. They are correlated to the NATO Stock Numbers and NATO Type Designation where appropriate. Typical examples of the style reference used are given in the appropriate Detail Specification.

b. Nomenclature

(1) Contact — A single current carrying element in an electrical plus or socket incorporating half the breakable joint face.

(2)	Plug, electrical	An interconnecting device carrying a majority of male contacts for connection with a corresponding electrical socket.
(3)	Socket, electrical	An interconnecting device carrying a majority of female contacts for connection with a corresponding electrical plug.
(4)	Fixed item	A fixed electrical plug or socket is one designed for attachment to a chassis or piece of apparatus.
(5)	Free item	A free electrical plug or socker is one designed for attachment to the end of a cable.
(6)	Plug/Socket coupler	That Plug/Socket type which replaces a Plug/Socket, Fixed, in a cable to cable coupling application.
(7)	Mating set of plugs and sockets, electrical	The combination of an electrical plug or socket and its mating part.
(8)	Shield, electrical, plug-socket	An item specifically designed to enclose that portion of an electrical plug or socket which contains the facilities for attaching wires or cables. It is used for chielding against electrical interference and/ or mechanical damage. This item may have a locking device fitted.
(9)	Maintenance standards	Component which have been superseded for Joint Services use by new standards, but are not completely interchangeable with them, and which are still required for maintenance purposes.
(10)	Connector, butting	An interconnecting device having contacts designed for end face contact only, in which electrical continuity is achieved and maintained by axial force.

RECTANGULAR CONNECTORS

Mating

10. Rack and panel and internal connectors require a force in the direction of the axis of the comtacts for engaging and dis-engaging the two halves of the plug and socket assembly. Where severe vibration conditions are likely to exist some form of locking in the shape of a latch - or some other method - is fitted to maintain the plug and socket in the mating condition - see Fig 1.

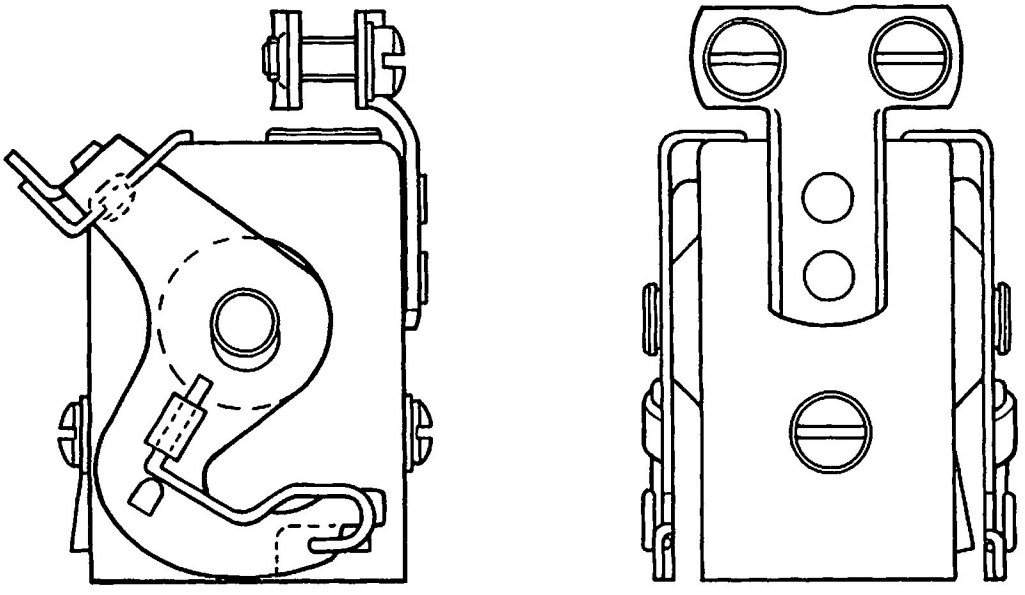


Fig 1 - Vibration lock

Polarisation

11. All connectors with more than one contact are polarised so that the plug and socket can only be mated when the contacts are correctly aligned. This is normally effected by using dis-similar guide pins or irreversible shells with mating keyways in the plug and socket. In some cases a contact is omitted in both halves of the connector and a polarizing pin substituted in place - see Fig 2. When guide pins are fitted they should not be used for carrying signals or power currents or used for earth connections.

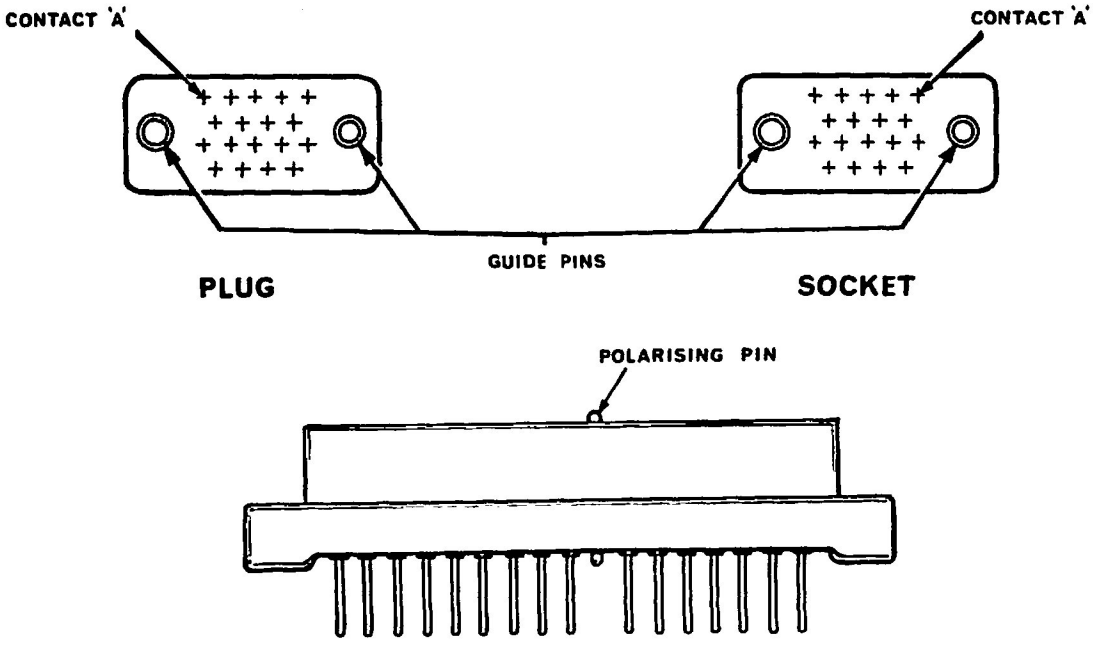


Fig 2 - Polarising methods

Insert materials

12. The di-electric inserts used in plugs and sockets provide the following four functions.

a. Hold the contacts in position.

b. Insulate the contacts from each other.

c. Provide sealing between the individual contacts.

d. Provide a pressure-differential barrier between the two items of the connector and prevent ingress of moisture.

13. Some plugs and sockets are manufactured with resilient inserts of neoprene or silicone rubbers. Silicone rubbers can be used at a higher temperature without any appreciable drop in insulation resistance but the material should not be heavily compressed at high temperatures as the insert may not restore to the original shape. At temperatures in excess of 200°C ceramics have superior electrical properties but they are mechanically weak.

14. A hard di-electric material using silicone-resin based compounds can be used up to a temperature of 300°C before exhibiting mechanical weakness. Silicone rubbers are also resistant to ozone and ultra-violet light but have the disadvantage in that they are adversely affected by kerosene and certain hydraulic oils.

METHODS OF CONTACT RETENTION

15. The contacts are held in position in the inserts in a number of different ways. In the past, rigid phenolic inserts with recesses to hold the contacts have been used with ancillary rubber washers or glands to seal the plug and socket and prevent the ingress of moisture. As environmental conditions are becoming increasingly severe this type of plug and socket is no longer suitable for high temperature and high pressure differential applications.

Soldered contacts

16. To overcome this problem a resilient insert is used made from a single piece of rubber. The insert is moulded into the shell. Shaped channels are provided in the insert to accommodate the contacts which are bonded in position.

17. In some cases the insert is made from a hard insulating material, usually about 1/4 in thick. The contacts are moulded into the material during manufacture and are not replaceable (Fig 3.a). Should one or more contacts become damaged the entire insert must be replaced. In full hermetic seal applications the contact is amalgamated within a glass bead which has been fused into the shell insert - see Fig 3.b.

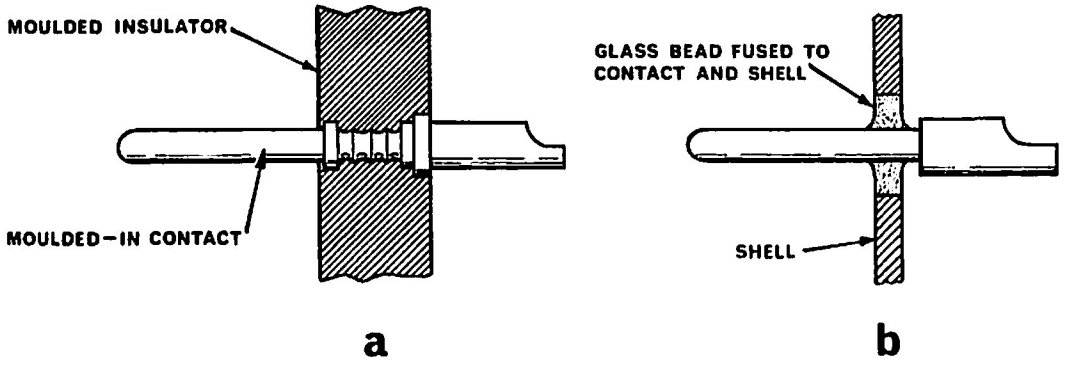


Fig 3 - Retention of soldered contacts

Crimped contacts

18. Crimped contacts being removable, require a more complex method of contact retention, sometimes provided by the multi-layer insert construction. In an alternative design the contacts are held in position by metal clips or "tines" moulded into a hard thermosetting insulating material. Special tools are required to fit an remove the contacts as and when required. See Chapter 121.

CONTACT DESIGN

19. The contact is required to provide a low resistance connection which is reliable over a wide range of environmental conditions. The forces required to insert and withdraw the plug and socket must remain low, particularly when a large number of contacts are present.

Contact types

20. There are three basic types of contacts as follows:

a. Round or circular

b. Flat or rectangular

c. Printed circuit

and are shown in Fig 4.

21. a. The round type can be either stamped and formed for normal use or machined producing closer tolerances. (Fig 4.a).

b. The flat contact for a given cross sectional area, has a larger surface area than the round contact. This gives a lower contact resistance and for this reason they are used on low force plugs and sockets. (Fig 4.b)

c. The contacts on the edge connectors used with a printed circuit board consists of two spring halves which make connections with the plug contacts of the printed circuit board. The spring tension

provides the force required to retain the board in the edge connector (Fig 4.c). A means of locking the two halves of the connector together is also normally provided. In both the round and flat contacts, the force required to make good contact and retain the pin in the socket, is usually provided by a tapered, phosphor bronze or beryllium copper spring mounted inside the socket moulding.

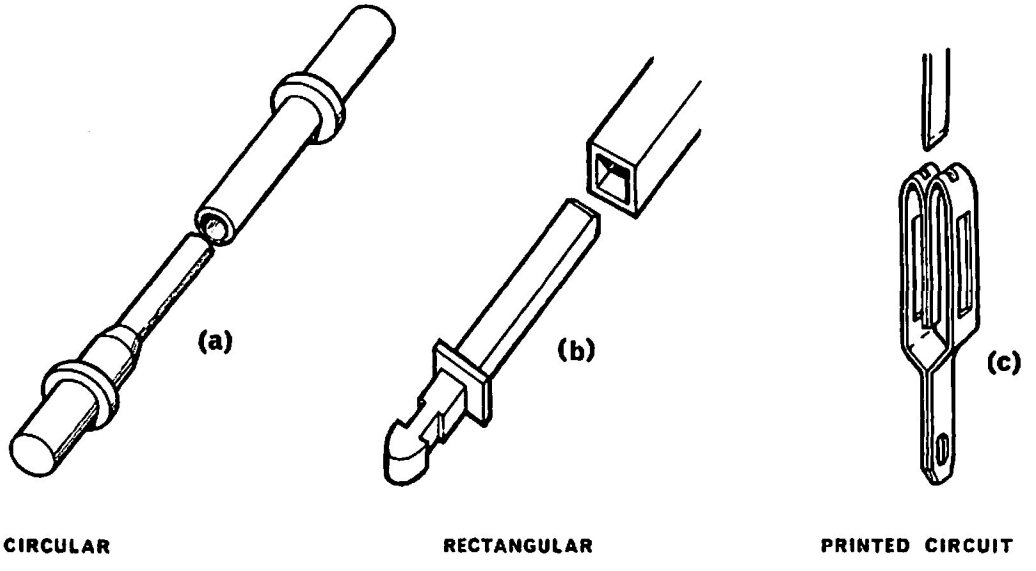


Fig 4 - Contact types

Connector failure

22. A common cause of connector failure, particularly at low voltages, is the effect of contamination at the surface of the contact. This contamination may consist of dust, grease, or films produced by absorption or corrosion and has the effect of producing an open circuit condition at low voltages.

23. To prevent corrosion taking place at the contact surface, particularly when the connector is used in an impure atmosphere, it is now general practice to gold plate the contact over a thin coating of nickel or copper. Another advantage of using gold plated contacts is that there is less force required to maintain good contact resistance. It is therefore possible to design connectors with relatively large numbers of contacts and requiring low insertion and withdrawal forces.

24. However this does not prevent dust or grease from being deposited on the surface of the contacts. An endeavour must be made to ensure that plugs and sockets used in low voltage circuits are installed in an atmosphere free from dust and grit or they should be sealed to prevent the ingress of foreign matter.

NUMBER OF CONTACTS

25. When a large number of connections has to be made between two units, it may be advisable to use more than one connector to keep the number of contacts per plug and socket to a minimum. This will require smaller forces for mating and separating the connector pair. It is good practice to provide some spare contacts in the connector pair, then any design changes and modifications can be accommodated without installing additional connectors.

Methods of connection

26. Up until recent years the normal method of jointing the wires to the contacts have been by soldering. Another method that has been developed and is now almost as common is crimping. Both methods produce connections with similar electrical characteristics. Two other methods are also in use and under review, ie welding and wire wrapping.

Soldered connections

27. Soldering is normally carried out with the contacts permanently fitted in position in the plug or socket. One advantage with soldering is the fact that, should it be found necessary to change or repair a connection the only tools needed are a soldering iron and a pair of pliers.

28. However if one contact becomes damaged the whole connector must be replaced involving unsoldering and resoldering each connection. It should be remembered that poor workmanship in soldering contacts is often the cause of unreliability in plugs and sockets.

Crimped connections

29. It is now common practice to use crimped connections instead of soldering. With this type of connection the conductor insulation is removed, the bare end of the conductor is inserted into the contact barrel which is compressed completing the joint. The pressure and depth of the crimp is controlled by the tool ensuring a uniform connection regardless of the skill and ability of the operator. (See Chap 121).

30. Because of the size and shape of the crimping tool it is not possible to make the connections to contacts that are permanently fixed in the insert. The contacts are provided as loose items and after crimping are lodged individually into the insert with the aid of special tools. Dummy contacts are inserted into the holes that are not occupied by a wired contact.

Wrapped connections

31. Another method of connection which is used with removable contacts and when soldering or crimping is undesirable is the wrapped joint. In this type of connection the conductor end of the contact is of square or rectangular cross section and single strand wire is wrapped around it with a wrapping tool to form the joint. Six turns of wire are generally agreed to be the minimum necessary to produce a sound joint. This method of connection is particularly suitable if more then one conductor is required to be connected to each contact.

Shields

32. These items are provided to protect the wire connections at the rear of the plug or socket. They are termed Hoods in some cases and usually have some form of vibration lock fitted. They provide support and strain relief to the cable and facilitate the dis-engagement of the mated connectors. The wires should be threaded through the cable clamp entry prior to soldering into the contacts as shown in Fig 5.

Wiring the plug or socket

33. The cable outer (if fitted) should be stripped for a distance such that there is sufficient length of inner conductor to be joined to the contacts without any strain on the joints when the outer is clamped to the hood entry. The individual conductors should have identification sleeves fitted and the insulation removed from the ends for about 1/8 in as shown in Fig 5.

34. The ends of stranded wire (if used) should be given a slight twist in the direction of the lay before tinning. Tin the wires at the extreme ends only far enough to take full advantage of the depth of the solder bucket if the joints are to be soldered. If the conductors are tinned beyond this distance the conductor flexibility will be reduced.

35. Thread the conductors through the clamp and aperture on the hood either at the top or side entry as required. Join the bared conductor ends to the contacts and slide the identification sleeves over the joints. The hood should now be fitted to the connector moulding and the cable outer adjusted to suit in the aperture and the clamp fitted so that the cable is firmly held.

PATTERN 102 PLUGS AND SOCKETS

General

36. This is a range of multi contact, non-sealed rectangular plugs and sockets, with soldered terminations, suitable for inter-chassis connections.

Style references

37. The style references used in this specification are abbreviations to identify individual plug and socket styles. A typical reference is

FUNCTION	PATTERN	No OF CONTACTS	VARIANT LETTER
P	02	25	A

where

Function letter - P = plug: S = socket

Pattern number - 02 = pattern 102

Number of contacts - 25 indicates number of contacts as appropriate

Variant letters - A or B - A denotes 2 large pine

B denotes 4 large pins - See Fig 6

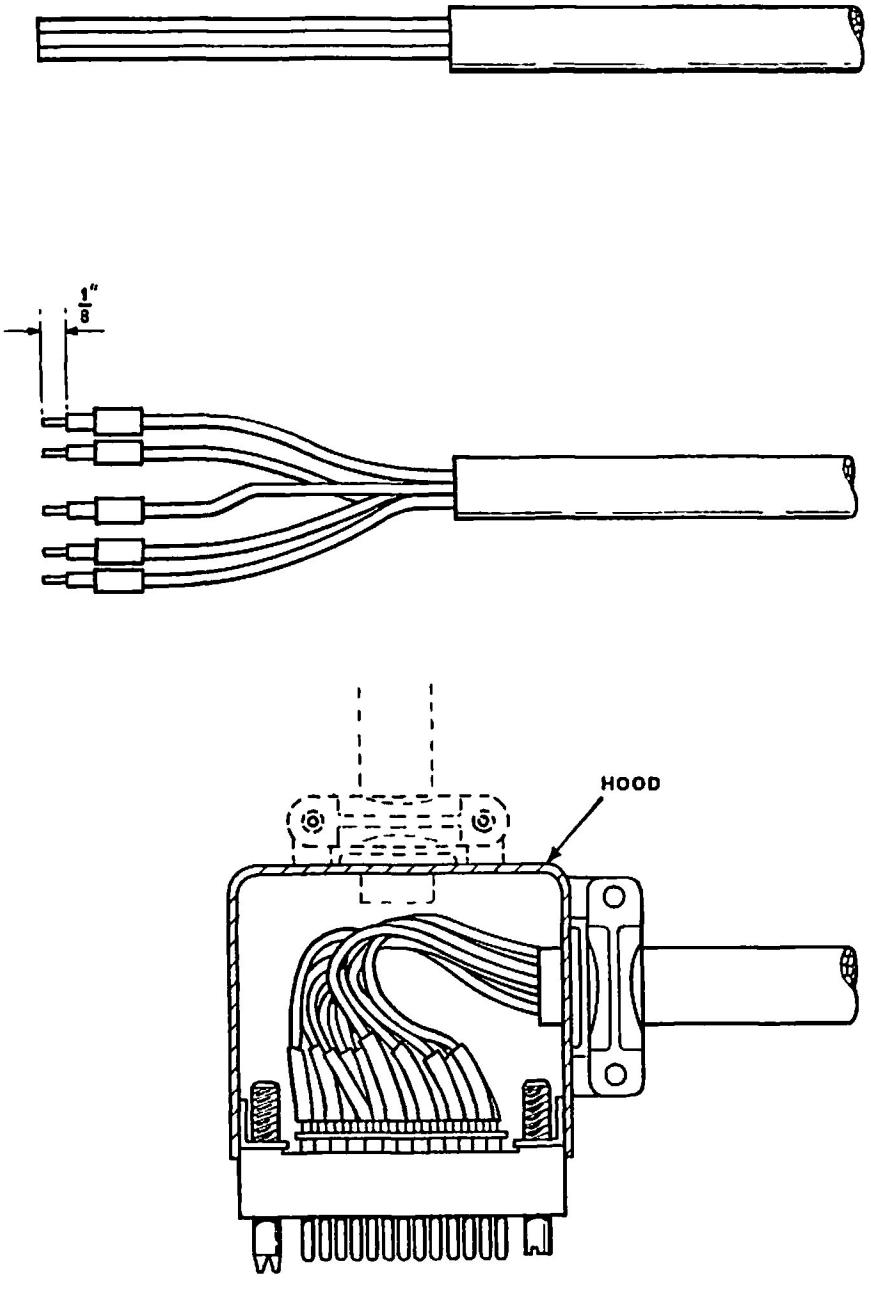


Fig 5 - Cabling the connector

ITEMS PERMITTED ONLY FOR MAINTENANCE PURPOSES

PLUGS AND SOCKETS, ELECTRICAL, PATTERN 102

NATO Stock Number	Item Name	Style Reference
5935-99-056-2501	Plug, electrical	P-02-4-A
-2502		P-02-8-A
-2503		P-02-12-A
-2504		P-02-18-A
-2505		P-02-25-A
-2007		P-02-25-B
-2506	Socket, electrical	S-02-4-A
-2507		S-02-8-A
-2508		S-02-12-A
-2509		S-02-18-A
-2510		S-02-25-A
-2008		S-02-25-B

Table 1 - Pattern 102 plugs and sockets

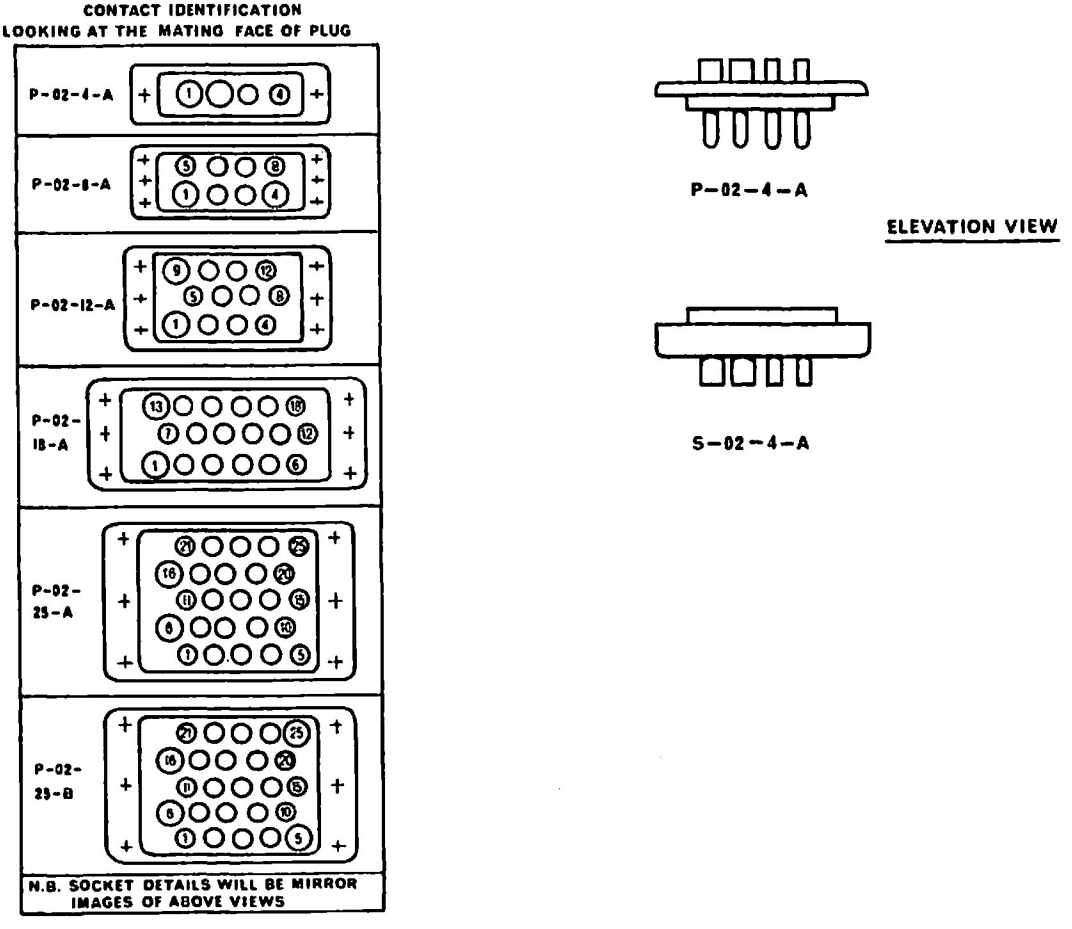


Fig 6 - Pattern 102 plug and socket comtact arrangements

PATTERN 103 PLUGS AND SOCKETS

General

38. This is a range of multi contact unsealed rectangular plugs and sockets with soldered terminations, suitable for inter-chassis terminations.

Style references

39. The style references used in this specification are abbreviations to identify individual plugs and sockets. A typical reference is:

Control Drawing No	No of contacts	Contact
CC/C1514/1	7	P

where

CC/C indicates the Control drawing number

Number of contacts - 7 indicates number of contacts as appropriate

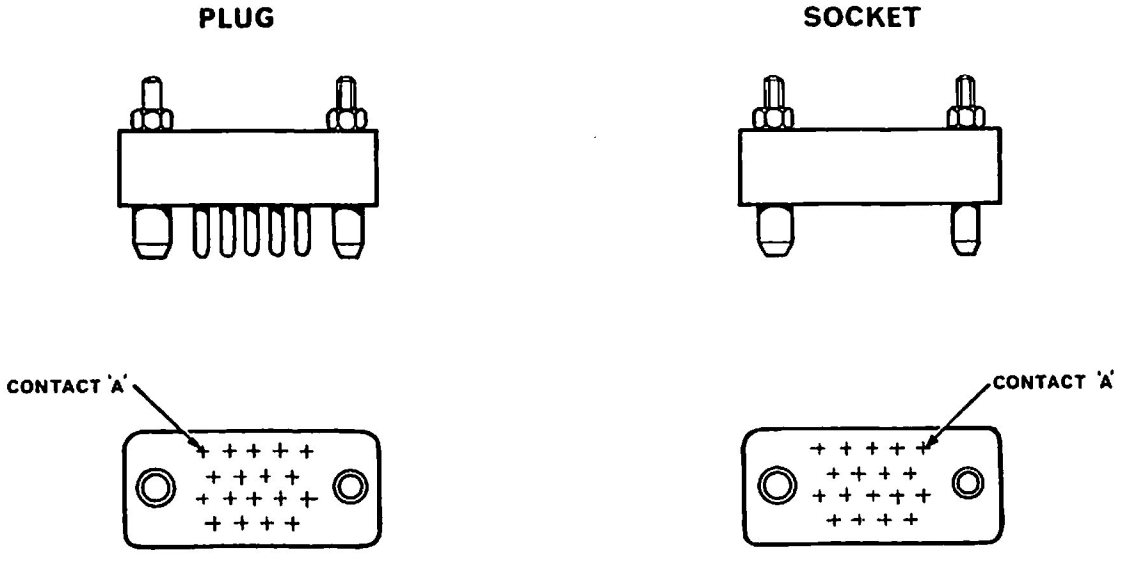
Contact - P = plug S = socket

STANDARD RANGE

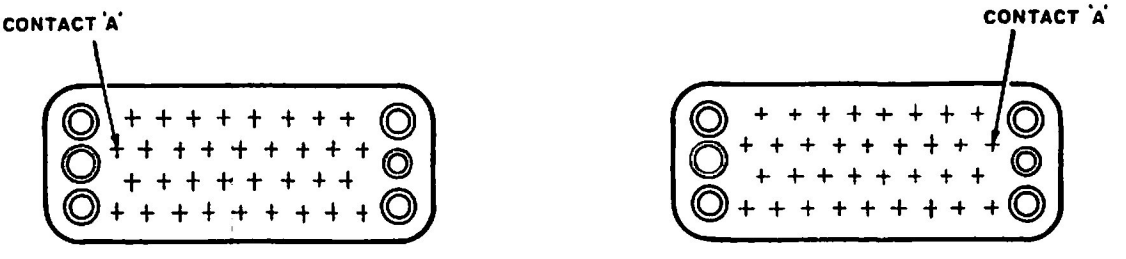
PLUGS AND SOCKETS, ELECTRICAL, PATTERN 103

Style Reference	NATO Stock Number	Item Name
CC 1514-7P	5935-99-013-0277	Plug electrical
CC 1514-7S	-0278	Socket electrical
CC 1515-14P	-0279	Plug electrical
CC 1515-14S	-0280	Socket electrical
CC 1516-18P	-0281	Plug electrical
CC 1516-18S	-0282	Socket electrical
CC 1517-26P	-0283	Plug electrical
CC 1517-26S	-0284	Socket electrical
CC 1518-34P	-0285	Plug electrical
CC 1518-34S	-0286	Socket electrical
CC 1519-50P	-0287	Plug electrical
CC 1519-50S	-0288	Socket electrical

Table 2 - Pattern 103 plugs and sockets



7, 14, 18 and 26 contacts (18 contact plug and socket shown)



Plugs **Sockets**

34 and 50 contacts (34 contact plug and socket shown)

VIEWED LOOKING AT THE MATING FACES

Fig 7 - Pattern 103 plug and socket comtact arrangements

PATTERN 109 PLUGS AND SOCKETS

See Chap 208 Ref

General

40. These plugs and sockets require low engagement and dis-engagement forces. They are intended for rack and panel and inter-chassis connection application. They are available with either gold or silver plated contacts and can be supplied with solder or wire wrapping termination (see Style references and Tables 3, 4 and 5.)

Style references

41. The style references are abbreviations to identify individual plug and socket variants. A typical style reference is CC/C1663-G-35MS.

Control Drawing No	Contact finish	No of Contacts	Contact type	Termination type
CC/C 1663	G	35	M	S

where

CC/C - indicated the Control drawing number

Contact finish - G = Gold S = Silver

No of contacts - 35 indicates number of contacts as appropriate

Contact type - M = Male F = Female

Termination type - S = Solder W = Wire wrapped

STANDARD RANGE

PLUGS AND SOCKETS, ELECTRICAL, PATTERN 109

Style Reference	NATO Stock Number	Item Name
CC 1663-G-35MS	5935-99-012-8451	Plug, electrical
CC 1663-G-35FS	-8452	Socket, electrical
CC 1664-G-50MS	-014-9772	Plug, electrical
CC 1664-G-50FS	-9773	Socket, electrical
CC 1665-G-70MS	-012-8453	Plug, electrical
CC 1665-G-70FS	-8454	Socket, electrical
CC 1666-G-91MS	-8455	Plug, electrical
CC 1666-G-91FS	-8456	Socket, electrical

Table 3 - Pattern 109 plugs and sockets
(gold plated contacts soldered terminations)

STANDARD RANGE

PLUGS AND SOCKETS, ELECTRICAL, PATTERN 109

Style Reference	NATO Stock Number	Item Name
CC 1667-S-35MS	5935-99-012-8457	Plug, electrical
CC 1667-S-35FS	-8458	Socket, elctrical
CC 1668-S-50MS	-014-9774	Plug, electrical
CC 1668-S-50FS	-9775	Socket, electrical
CC 1669-S-70MS	-012-8459	Plug, electrical
CC 1669-S-70FS	-8460	Socket, electrical
CC 1670-S-91MS	-8461	Plug, electrical
CC 1670-S-91FS	-8462	Socket, electrical

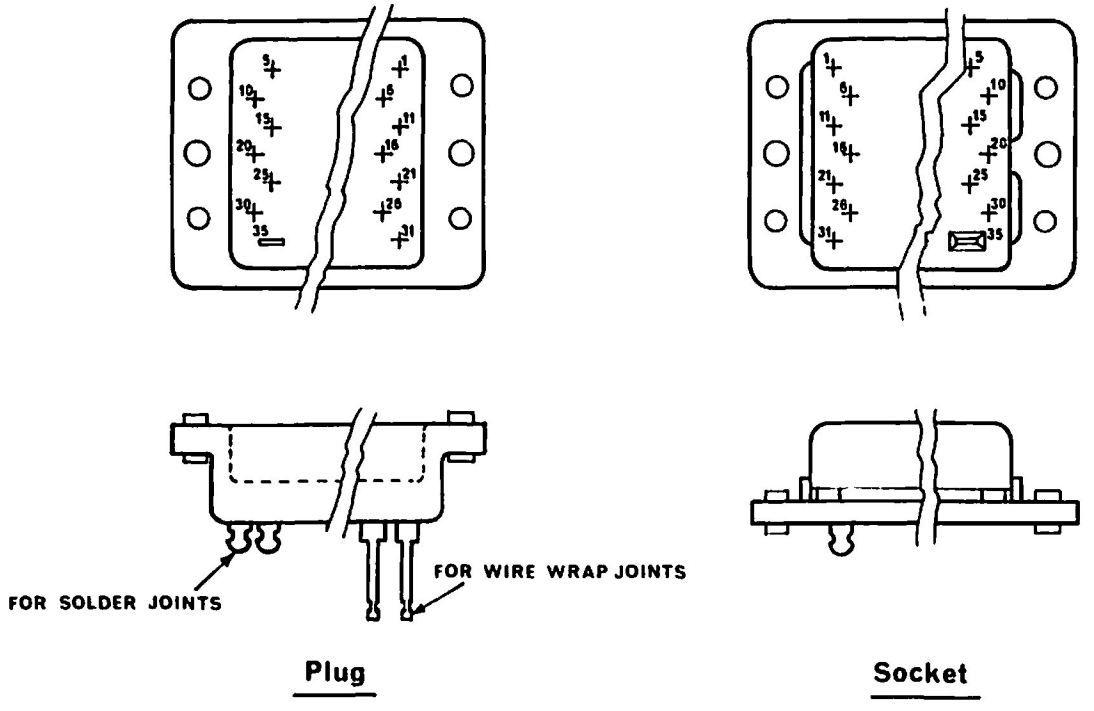
Table 4 - Pattern 109 plugs and sockets
(silver plated contacts, soldered terminations)

STANDARD RANGE

PLUGS, ELECTRICAL

Style Reference	NATO Stock Number	Item Name
CC 1663-G-35MW	5935-99-014-1453	Plug, electrical
CC 1665-G-70MW	-1454	Plug, electrical
CC 1666-G-91MW	-1452	Plug, electrical

Table 5 - Pattern 109 plugs
(gold plated contacts, wire wrap termination)



VIEWED LOOKING AT THE MATING FACE

Fig 8 - Pattern 109 plug and socket contact arrangements
(35 contact type shown)

NOTES With the 70 contact type for contact 5 read 10 and for contact 35 read 70

With the 91 contact type for contact 5 read 13 and for contact 35 read 91.

PATTERN 110 PLUGS AND SOCKETS

General

42. These multi-contact rectangular plugs and sockets are fitted with size 20 contacts and are suitable for soldered terminations. They are unsealed and are designed for making inter-chassis connections.

Style references

43. The style references used are abbreviations to idenfity individual plug and socket variants. A typical style reference is CC/C1148-N-9P.

Control Drawing No	Type of Mounting	Number of contacts	Contact
CC/C1148	N	9	P

where

CC/C - indicates the control drawing number

Type of mounting - N = Normal, B = floating bush

Number of contacts - 9 indicates number of contacts as applicable

Contact - P = pin S = socket

STANDARD RANGE

PLUGS AND SOCKETS, ELECTRICAL, PATTERN 110

Style Reference	NATO Stock Number	Item Name
CC 1148-N-9P	5935-99-014-1442	Plug, electrical
CC 1149-N-9S	-9583	Socket, electrical
CC 1150-N-15P	-1443	Plug, electrical
CC 1151-N-15S	-9585	Socket, electrical
CC 1152-N-25P	-1444	Plug, electrical
CC 1153-N-25S	-9587	Socket, electrical
CC 1154-N-37P	-1445	Plug, electrical
CC 1155-N-37S	-9589	Socket, electrical
CC 1156-N-50P	-1446	Plug, electrical
CC 1157-N-50S	-9591	Socket, electrical

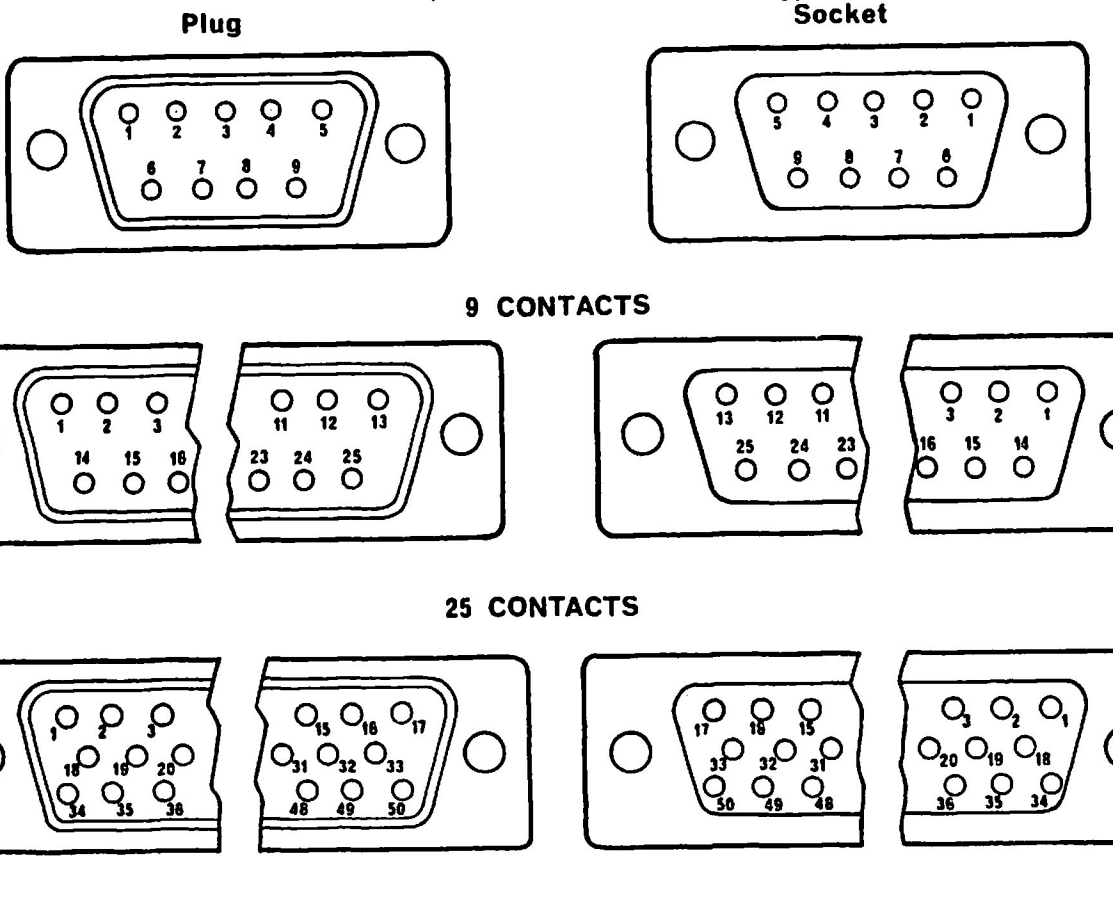
Table 6 - Pattern 110 plugs and sockets
(Normal mountings)

STANDARD RANGE

PLUGS AND SOCKETS, ELECTRICAL, PATTERN 110

Style Reference	NATO Stock Number	Item Name
CC 1148-B-9P	5935-99-014-7491	Plug, electrical
CC 1149-B-9S	-7492	Socket, electrical
CC 1150-B-15P	-7993	Plug, electrical
CC 1151-B-15S	-7494	Socket, electrical
CC 1152-B-25P	-7495	Plug, electrical
CC 1153-B-25S	-7496	Socket, electrical
CC 1154-B-37P	-7497	Plug, electrical
CC 1155-B-37S	-7498	Socket, electrical
CC 1156-B-50P	-7499	Plug, electrical
CC 1157-B-50S	-7500	Socket, electrical

Table 7 - Pattern 110 plugs and sockets
(Floating bush mounting)



VIEWED LOOKING AT THE MATING FACE

Fig 9 - Pattern 110 plug and socket contact arrangements

PRINTED WIRING BOARD PLUGS AND SOCKETS

General

44. The introduction of the printed circuit board as the basis building unit of electronic equipments brought about a wide range and variety of edge connectors. The basic requirements of edge connectors is to retain the printed wiring board securely and to transfer voltages and currents with a minimum of contact loss.

Printed circuit contacts

45. The design of the contacts are the most important factor in the production of a successful printed circuit board system. The board contacts may be printed on one or both sides of the card and these form the male or plug (referred to as pads) part of the connector. The female contacts of the connector are held in the edge connector socket moulding and are either in single sided or double sided form. In addition the cable terminations on the double row edge connector contacts may be joined and located centrally, or off-set (see Fig 10).

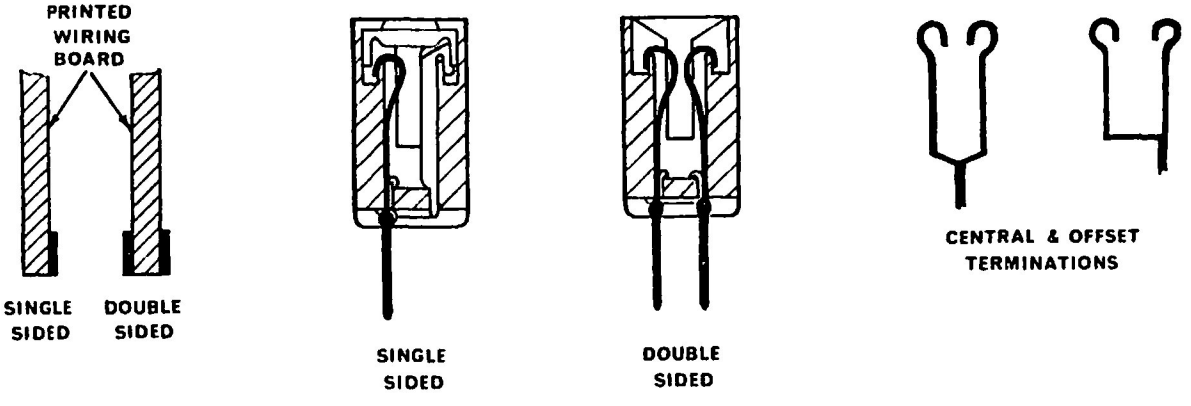


Fig 10 - Board and edge connector contacts

DEFINITIONS

46. a. Base material

Insulating material upon which the pattern may be formed.

b. Board thickness

Thickness of the metal-clad base material or printed board (including conductive layer or layers).

c. Bow (warpage)

Deviation from flatness of a board characterized by a roughly cylindrical or spherical curvature such that if the board is rectangular, its front corners are in the same plane.

d. Conductive foil

Conductive material that covers one or both faces of the base material and is etched or otherwise processed to create a pattern.

e. Conductor

Single conductive path in a conductive pattern.

f. Conductive pattern

Design formed by the conductive material of a printed circuit.

g. Connection

Means by which the components are attached to the conductive pattern.

h. Cross-hatching

Breaking up of large conductive areas.

j. Current-carrying capacity

Maximum current that can be continuously carried under specified conditions without causing objectionable degradation of electrical or mechanical properties of the printed board.

k. Definition

Degree of conformity of the pattern edges with the design.

l. Printed edge board contacts

Series of contacts printed on the board and intended for mating with an edge socket connector.

m. Embossing

Process consisting of indenting a pattern into a base material.

n. Etching

Process consisting of chemical or electrochemical removal of the unwanted portion of the conductive foil.

o. Flush conductor

Conductor the outer surface of which is in the same plane as the surface of the base material.

p. Land

Portion of a conductive pattern for the connection and/or attachment of components.

q. Legend (marking)

Printed lettering or symbols on the printed board indicating part numbers, component locations, etc.

r. Mass soldering

Method of soldering in which many joints are made in the same operation.

s. Master drawing

Scaled drawing of the pattern required for reproduction.

t. Metal-clad base material

Base material covered with metal foil or foils.

u. Mounting hole

Hole used for the mechanical mounting of a printed board to the chassis or for the attachment of components to the board.

v. Non-conductive pattern

Design formed by functional non-conductive material of a printed circuit (eg dielectric).

w. Overhang

Increase in conductor width, caused by plating build-up, over that indicated by the master drawing.

x. Pattern

Design of the material present on the base material after the operations by which a printed board is manufactured.

y. Peel strength

Force per unit width required to peel the conductor from the adjoining base material.

z. Pinhole

Minute imperfection through the conductive foil or conductive pattern.

aa. Plated-through hole

Hole in which metal is deposited on the wall.

ab. Plating

Process consisting of the chemical or electrochemical deposition of metal on all or part of the conductive pattern.

ac. Plating-up

Process consisting of electrochemical deposition of a conductive pattern on the base material or through a hole, the surface of the base material or the walls of the hole having been previously made conductive.

ad. Polarizing slot

Slot, in the edge of a printed board, used to align certain typed of printed circuit connectors to provide a unique connection.

ae. Printed board

Base material cut to size, bearing a pattern and with all designed holes.

af. Printed board assembly

Printed board with electrical and mechanical components attached to it and with all processes of fabrication, soldering, coating etc completed.

ag. Printed circuit

Circuit obtained by printing and comprising printed components, printed wiring or a combination thereof, all formed in predetermined design in, or attached to a surface,or surfaces, of a common base.

ah. Printed component

Component that forms part of the pattern of a printed circuit (eg printed inductor, resistor, capacitor or transmission line).

aj. Printed contact

Portion of a printed circuit serving as a switch contact.

ak. Printed wiring

Wiring technique in which the connections between the components of an electronic device or part of it, including shielding parts, consist of thin conducting strips within or bonded to the surface of a base material and in which all the functional components are separated from the base material.

al. Printing

Act of reproducing a pattern on a surface by any process.

am. Pull-off strength

Force, normal to the printed board, required to separate a land from the base.

an. Reference grid

Orthogonal network consisting of parallel equidistant lines for positioning the holes on a printed board.

ao. Reference hole or notch

Hole or notch placed in the printed board to enable the board to be positioned accurately.

ap. Reference system

Method of positioning the pattern with respect to the reference grid.

aq. Registration

Degree of conformity of the position of a pattern, or a portion thereof, with its intended position or with that of a pattern on the opposite side of a board.

ar. Resist

Coating used to mask or protect material locally during processing or testing.

as. Terminal hole

Hole that lies partly or completely within a conductive pattern.

at. Through connection

Means of connection between patterns on opposite sides of a printed board.

au. Twist

Deviation of a corner of a rectangular sheet from the plane containing the other three corners.

av. Undercut

Reduction of conductor cross-section under the upper surface of the conductor.

Edge connector terminations

47. Numerous types of terminations are in use, the shape varying depending upon the method of wire connection. The conductor may be soldered, crimped, welded or wrapped. Soldered wire connection requires a reasonable degree of skill by the operator. In some cases the solder spill is tubular which may create a dry joint as the solder could be blown away from the inside of the spill by the expanding hot air. A method to prevent this taking place is to scarf the end of the spill at an angle to assist the expansion of the gases. Samples of contact terminations are shown in Fig 11.

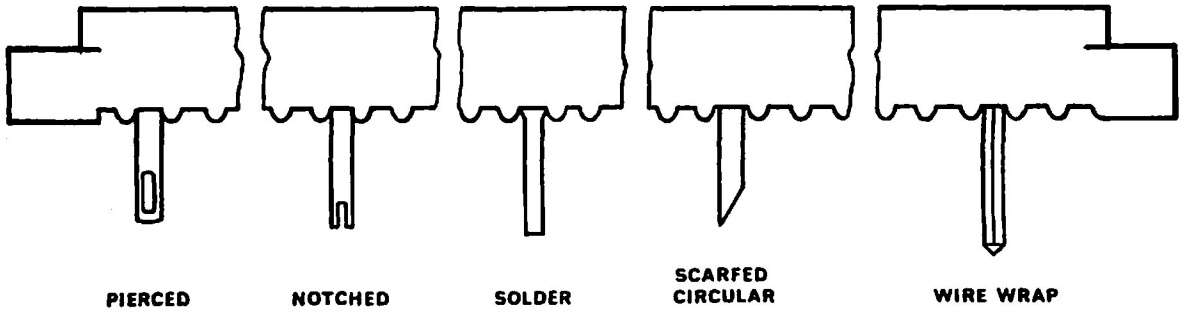


Fig 11 - Types of edge connector terminations

BOARD MATERIALS

48. The printed wiring board material should have a good copper to board bond and have good electrical characteristics. It is usually a copper clad fibre-glass laminate. The quality of the copper is an important factor in selecting board material. Small holes in the copper can produce points of high resistance in the wiring.

BOARD TYPES

49. A typical printed wiring board for direct insertion into a corresponding edge connector is shown in Fig 12. It should be noted that all the contacts may not be used on the edge connector sockets but are usually fitted as the spring fingers assist in the board retention. The important point is that the "pitch", ie the distance between the edge of one contact and the corresponding edge of the next contact are identical in both the board pad and the edge connector socket.

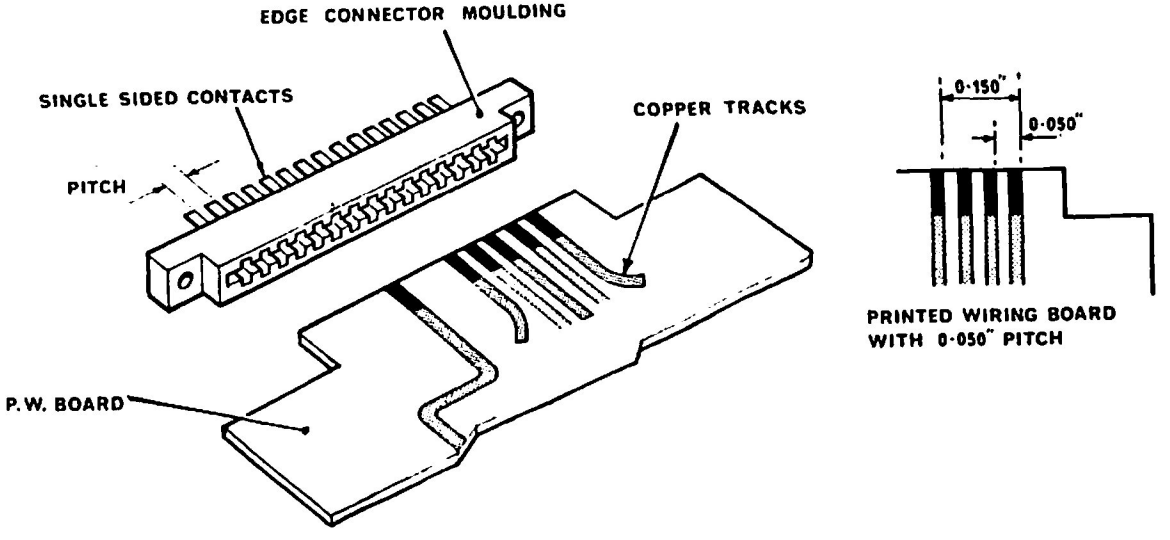


Fig 12 - Typical printed wiring board edge connector

An alternative system in service has a two part connector similar to the standard rectangular plugs and sockets. The socket part of the connector is usually mounted on the equipment and the plug part is bolted to board, see Fig 13.

50. The former type of board is lighter and cheaper as the printed wiring board constitutes part of the connector. The forces required for insertion and withdrawal are lower as the connector plug and socket are in a straight line with the board but with a two part connector the board plug is slightly offset.

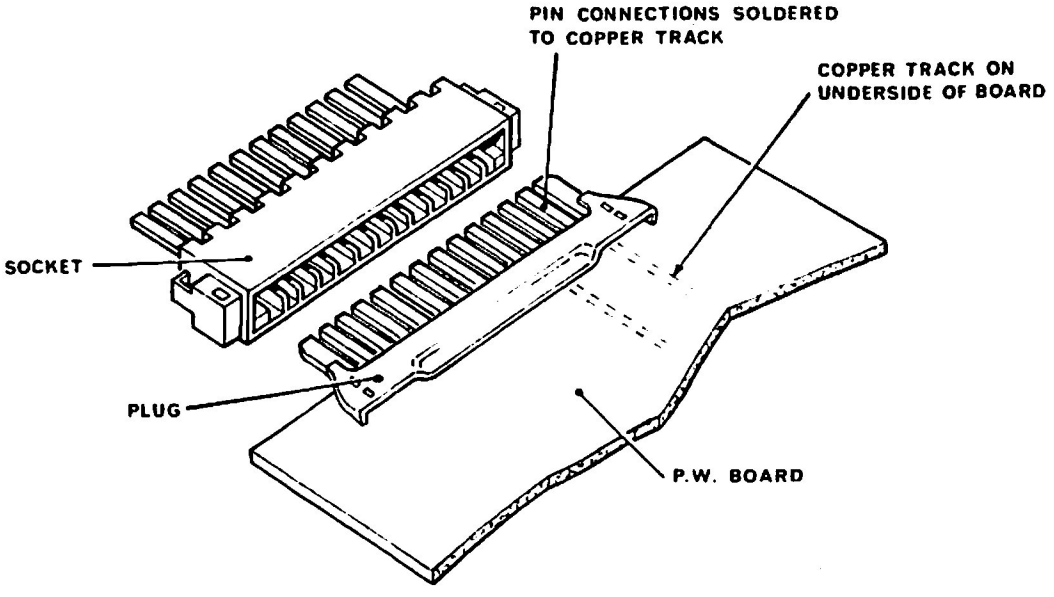


Fig 13 - Printed wiring board with two part connector

51. With a connection fault on the two part connector changing one part of the connector or possibly the faulty contact only may rectify the failure. With a printed wiring board fault if the mating edge is damaged it may be necessary to replace the complete assembly which includes the card and the components attached.

Polarizing and board location

52. With edge connectors a polarizing key (usually plastic) is provided which may be inserted into any one of the contact positions (see Fig 14.a). The printed wiring board is slotted to enable the two items to be mated. Using this method of polarization one contact is forfeited. In an alternative method the polarizing key is fitted into the moulding clear of the contacts and the cut out on the board is between the pads,(see Fig 14.b).

Contact mating reliability

53. When a printed wiring board is fitted into an edge connector it could be that they are incompatible. The edge connector mould and contacts are usually the results of well designed close tolerance mass production practice. The pads which are the plug part of the connector on the printed wiring board are part of the work of an artist sometimes using masking tape for this purpose. The mark to space ratio of the edge pads may not be consistent because of tape widths available to the artist.

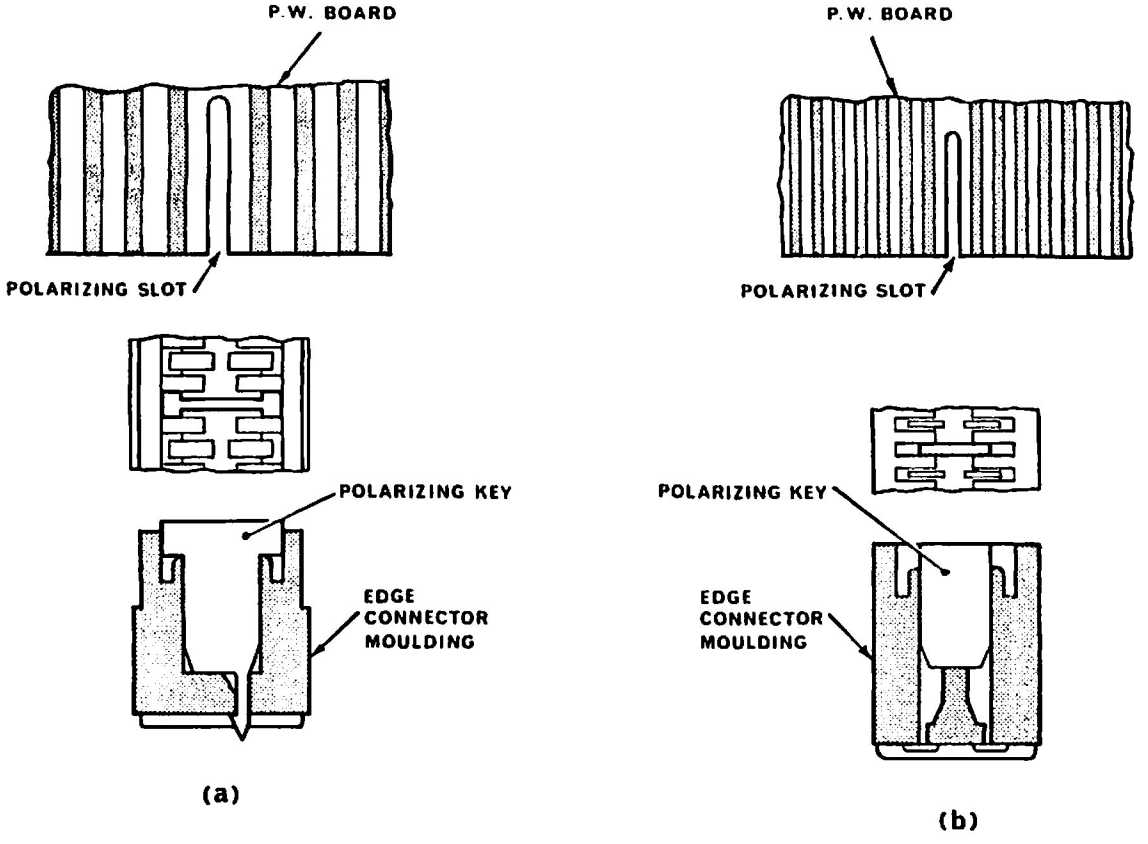


Fig 14 - Polarizing methods

54. The production of a printed wiring board contact system is intricate particularly in the location of the board pads relative to the contact fingers of the socket. If a socket contact face is slightly out of parallel with the board face or slightly concave the force of the spring finger could be exerted against the insulating gap between the pads instead of on the pads.

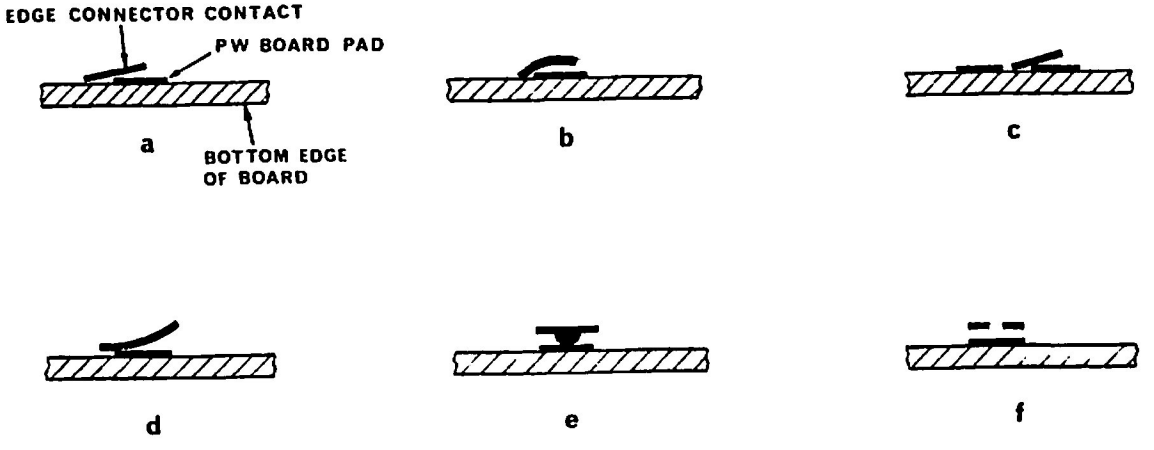


Fig 15 - Risk conditions of contact mating

55. The following conditions are feasible (see Fig 15):

a. Flat contact out of parallel

b. Contact concaved

c. High mark/space ratio - most dangerous with wide socket contact

d. Contact convex shape - risk reduced

e. Pip or central rib - risk reduced

f. Contact divided producing two contact areas - risk reduced.

56. Whichever type of contacts are used the best solution appears to be that of making the socket contact narrow and the board pad only wide enough so that the extreme edges of the socket contacts never overlap the insulation gap of the board.

CONTACT DEVELOPMENT

57. Considerable controversy exists over reliability and efficiency of pin shapes and styles. Efficiency is dependent on the marrying up of the two halves of any connector system and in particular on the intimate mating of the male and female contacts. Normally the greater the contact pressure the lower is the electrical resistance of the junction.

58. However with high contact pressure the mating and separating process requires greater engagement/dis-engagement forces causing excessive and increasing contact wear. A compromise must be found and constant research is being directed to solving these and other problems related to connector design. Details of a number of other contact types designed towards reducing this and other problems follow.

Forked pin contacts

59. A forked pin type of contact is employed in some printed wiring board systems. The forked pin contacts may be staked into the printed wiring boards as in Fig 16 and can be used to connect one printed wiring board to another. The contacts can be staked in such a way that the boards may be parallel to each other, in line with each other, or at right angles to each other.

60. The forked pin contacts are also available carried in a moulding designed as an edge connector for use in an orthodox printed wiring board system. The contact material is phosphor bronze with gold finish over nickel plating.

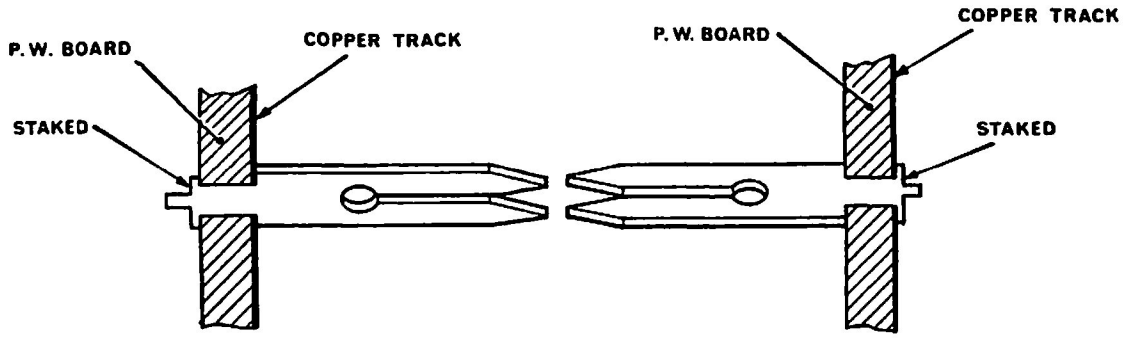


Fig 16 - Forked pin contacts

Filter pin contacts

61. Certain contacts include a filter designed to block radio frequency interference which occur along the circuit paths from entering the units but will pass the lower frequencies. Most filter pin contacts use a π network low pass ferrite filter.

62. The filter is formed by ferrite beads (the inductance), surrounded by a copper alloy pin, which is in turn surrounded by a ceramic sleeve having two separate silvered sections on the inside surface, forming the plates of two capacitors, in conjunction with a single continuous coating on the outer, forming the earth side of both capacitors (see Fig 17).

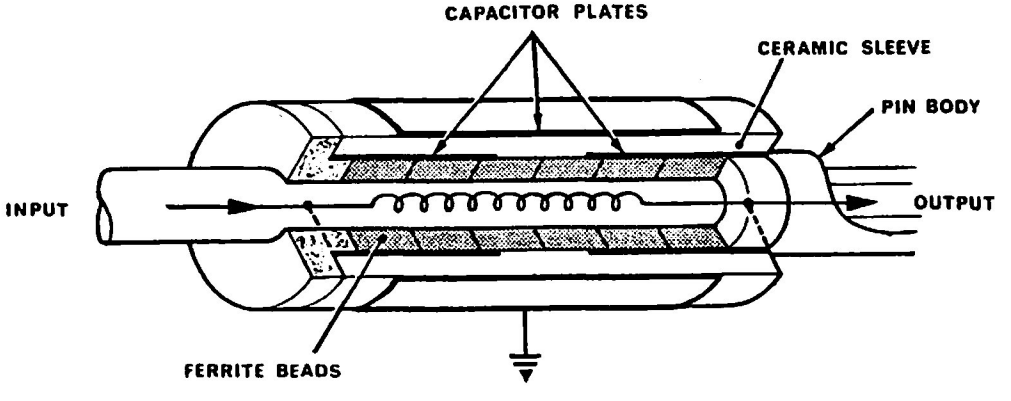


Fig 17 - Filter pin contact

Wire cage type socket

63. Other connection methods are available one of which is the wire-cage socket (Fig 18). A standard pin is inserted into the resilient wire cage which expands and makes even contact along the length of the pin. The current is carried through the socket along the spring wires.

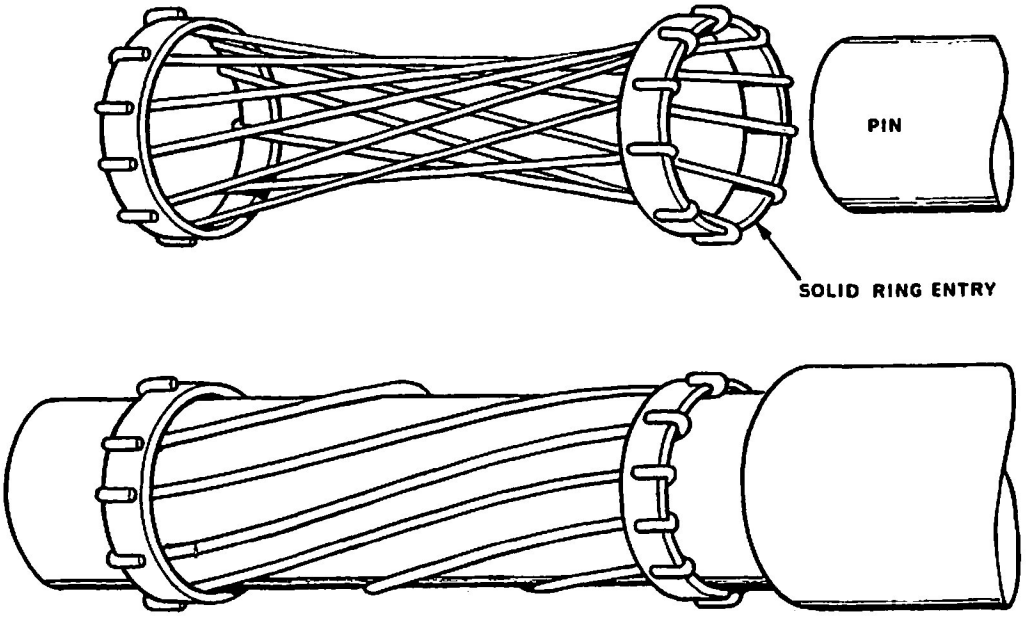


Fig 18 - Wire cage socket

64. On insertion of the pin the wires wind themselves round the circumference of the pin offering many minute areas of contact along the entire length of each wire. The contact resistance ideally should not be greater than the resistance of a piece of wire of the same gauge as the main wiring. The contacts are usually made from a low resistance copper-based alloy such as phosphor bronze or brass but for special applications other materials may be used (eg steel and nickel silver).

65. To prevent the inadvertent entry of an oversize pin or prod, it is now common practice to manufacture the sockets with a solid ring entry (see Fig 18). Thus the danger of causing damage by forcing test prods in and out of the sockets, sometimes at odd angles with considerable force, is eliminated.

Zero force connector

66. Connector designs predominantly utilize pin and socket contacts and variations of the blade and fork principle. Basic mating/engagement technique however involves pushing one contact into the other. The engagement force is on average around 4.5 ozs per contact so on a multi-contact connector the force required is considerable. This leads to high contact wear and shortened life.

67. A connector has been devised with a new contact form and a new method of mating (see Fig 19). The contacts are identical in both the plug and socket members and are removable from the body by depressing a "tine".

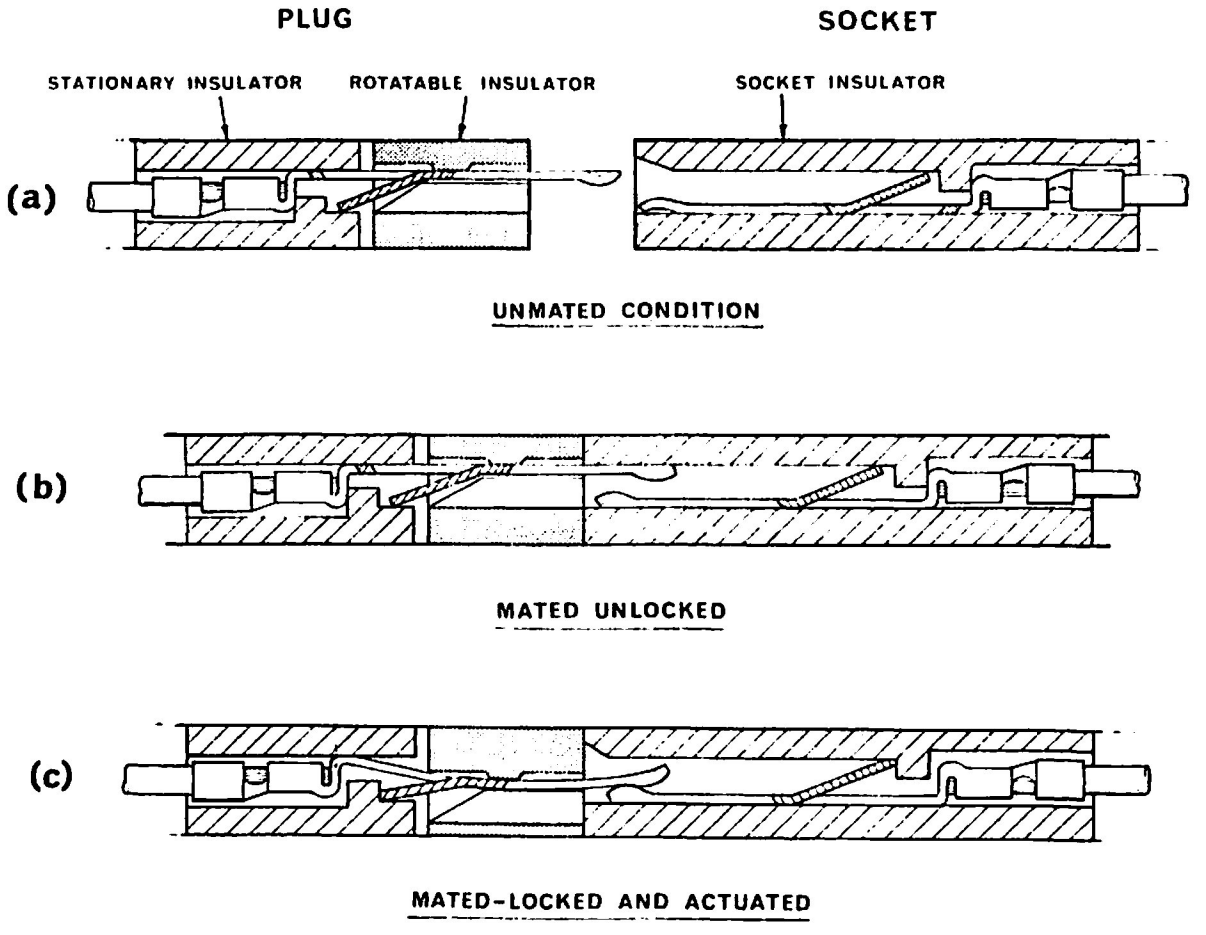


Fig 19 - Zero force connector

Operation

68. a. In Fig 19(a) the plug and socket are unmated and the plug contact is parallel with the body due to the position of the rotatable cam.

b. In Fig 19(b) the plug is mated with the socket and as the rotatable cam has not been moved the plug contact is still parallel.

c. In Fig 19(c) the rotatable cam has been turned thus marrying the plug contact to the socket contact. A contact wiping movement is produced by the mating action.

PRINTED WIRING BOARD REPAIRS

69. Details of a tool kit for this purpose and methods of repair are laid down in EMER Telecommunications A 414 and should be consulted.

Note: This Page 33, Issue 2 supersedes Pages 33-36, Issue 1 dated Apr 73. Para 70 has been revised and the contents of the superseded pages transferred to Chap 100.

CONNECTOR IDENTIFICATION

70. Detailed information on connectors and their components is contained in:-

REGISTER OF CLASS CODE 5935 - PLUGS, SOCKETS ETC
Chap 100 refers.

R/9553

End of Chapter 122