Specification for

3.8/6.6 kV, 300 A bolted flameproof cable couplers and adaptors, for use in coal mines

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British Standards

Committees responsible for this British Standard

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Association of British Mining Equipment Companies
Association of Mining Electrical and Mechanical Engineers
BEAMA Transmission and Distribution Association
Electric Cable Makers' Confederation
Health and Safety Executive
Institution of Mining Engineers
National Coal Board
National Union of Mineworkers
Rotating Electrical Machines Association (BEAMA)

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Contents

Foreword

This British Standard has been prepared by Technical Committee MRE/14. It supersedes BS 3905 : 1984, which is withdrawn. Previously the flameproof enclosures were required to conform to BS 4683 : Part 2 : 1971; in this revision the opportunity has been taken to update the standard to the requirements of BS 5501 : Part 5 : 1977, which is identical with the European Standard EN 50018 : 1977. The 1984 edition of this standard allowed an arrangement with a centre pilot contact tube but did not specify requirements. As a result two British manufacturers each developed their own design of pilot contact tubes. This revision allows these to be accommodated.

This is a companion standard to BS 3454 : 1994, which covers 1.9/3.3 kV couplers and adaptors.

Compliance with a British Standard does not of itself confer immunity from legal obligations. Attention is drawn to the Health and Safety at Work etc. Act 1974 [1], the Mines and Quarries Act 1954 [2], the Regulations made under these Acts, and also any other appropriate statutory requirements or byelaws. These place responsibility for complying with certain specific safety requirements on the manufacturer and the user.

The addresses of the recognised certification authorities in the UK for Group I (mines susceptible to firedamp) apparatus for flameproof purposes are as follows.

Health and Safety Executive
Mining Equipment Certification Service
Harpur Hill
Buxton
Derbyshire SK17 9JN

SIRA Certification Service
Saighton Lane
Saighton
Chester CH3 6EG

Specification

1 Scope

This British Standard specifies requirements for 300 A bolted flameproof cable couplers and adaptors of semi-screened three-phase, or unscreened three-phase with centre pilot tube type, with a voltage rating of 3.8/6.6 kV. The couplers are designed to enable two cables to be coupled together or to enable a cable to be coupled to apparatus by use of adaptors, in both cases the electrical connections being made by separate connecting pins. Provision is also made for insulated end covers.

The use of other forms of intermediate box, with coupling arrangements as specified in this standard, are not precluded provided that all other relevant requirements of this standard are met.

The semi-screened cable couplers are primarily intended for use with three- or four-core wire armoured cables where the fourth conductor is earthed. The cable couplers incorporating a centre pilot are primarily intended for use with three-core wire armoured cables having an additional pilot core(s).

Couplers and adaptors conforming to this standard are not intended to be coupled or uncoupled when the circuit is energized. The dimensions necessary to provide for the connection of enclosures of different manufacture and some electrical and mechanical requirements are specified. This standard does not however, purport to specify a fully detailed design.

NOTE. The figures in this standard show only those essential features and dimensions for function and interchangeability. Dimensions are in millimetres.

2 References

2.1 Normative references

This standard incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on page 30. Subsequent amendments to, or revisions of, any of these publications apply to this standard only when incorporated in it by updating or revision.

2.2 Informative references

This standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the following definitions apply.

3.1 cable half coupler

A detachable cable sealing box utilizing contact tubes and pins to facilitate ready connection to, or disconnection from, a similar unit or other apparatus.

3.2 bolted flameproof cable coupler

Two cable half couplers together with contact pins and a sealing ring, that, when bolted together to form a straight-through connecting box, conforms to the relevant requirements of BS 5501 : Part 5 : 1977.

3.3 cable gland

A device designed to secure the end of the cable to the cable sealing box, by means appropriate to the type of cable, including provision for making electrical connection to the armouring and lead sheath of the cable, where applicable.

3.4 cable sealing box

A device designed to receive and protect the end of the cable, with provision for sealing the conductors and the insulating material of the cable with filling medium and having a cable gland for attaching the cable to the box, together with any terminals provided for connection to the conductors of the cable within the box.

3.5 adaptor

A device used to connect a cable half coupler to apparatus, which can either be separate from or be integral with the enclosure of the apparatus and which can include live-line indication.

3.6 intermediate box

A box that can be inserted between two cable half couplers or between a cable half coupler and an adaptor, to perform a specific function, e.g. live-line indication or metering.

3.7 insulated end cover

A metal cover, suitably insulated, that, when bolted to the coupling face of a cable half coupler or adaptor (with a sealing ring interposed), completes the flameproof enclosure of the cable half coupler or adaptor and enables full working voltage to be applied.

3.8 filling medium

A bituminous-based compound conforming to BS 1858 : 1986 or resin-based compound conforming to BS 7383 : 1990 that is suitable for the electrical stresses imposed in service.

CAUTION. Because of the increased fire risk, bituminous-based compounds are not accepted by the Health and Safety Executive as a filling medium in new cable couplers certified for use in British coal mines.

4 Information to be documented

The following information to be supplied by the purchaser shall be fully documented. Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

a) *General*

1) The number and date of this British Standard, i.e. BS 3905 : 1995.

2) The working voltage of the system on which the equipment is to be used.

3) The group number, or group numbers, of the gases or vapours in which the cable half couplers or adaptors are to be used.

b) *Cable half couplers*

1) The nominal size of conductors (in square millimetres), also the under armour diameter and the overall diameter of cable.

2) The type of cable to be used.

NOTE 1. The number of an appropriate British Standard or other recognized specification should be quoted. For non-standard cables, complete details of the cable's construction and dimensions should be given.

3) The number of contact pins and/or tubes (phase and pilot) required.

4) The type of contact tube cable termination required (compression or clamping).

5) The number of sealing rings required.

6) Whether filling medium and jointing tapes are required.

7) The type of gland required.

NOTE 2. Certain types of cable core insulation, notably polyethylene, are liable to exhibit cracking when subjected to prolonged contact with some bituminous filling compounds. The advice of the cable manufacturer should be sought as to the recommended grade of filling medium.

c) *Adaptors*

1) The nominal size (in square millimetres) of conductor in the connecting leads.

2) Whether leads are stranded or flexible.

3) The number of contact tubes and/or adaptor pins (phase and pilot) required.

4) The type of contact tubes and/or adaptor pins (compression or clamping) required.

5) The number of sealing rings required.

6) Where appropriate, whether a filling medium and jointing tapes are required (see note 2).

5 Design and construction

5.1 General

The general arrangement (except for the front face for insulators) and essential dimensions of both semi-screened and unscreened cable half couplers shall be as shown in figure 1. The front face for insulators shall be as shown in either figure 1 or figure 2.

5.2 Temperature rise

The temperature rise of the cable half couplers shall conform to **8.2.1**.

5.3 Flameproof enclosure

All enclosures and insulated end covers used with couplers and adaptors, shall be of a type that has been manufactured in accordance with BS 5501 : Part 5 : 1977 for Group I electrical apparatus. Only corrosion resistant ferrous alloys or non-ferrous metals permitted by BS 5501 : Part 1 : 1977, shall be used in the construction of the flameproof joint and the cable gland. The cable sealing box shall either be constructed from the same metals, or be an encapsulated assembly conforming to BS 5501 : Part 8 : 1988.

5.4 Cables

Cable half couplers shall be capable of receiving cables with phase conductors up to the following maximum sizes:

a) copper (stranded)	185 mm^2;
b) aluminium (stranded)	185 mm^2;
c) copper (flexible stranded)	150 mm^2.

5.5 Insulation

5.5.1 *Materials*

Properties of materials for insulating components shall conform to the values given in table 1.

5.5.2 *Insulators*

Insulators shall be free from voids and defects and each shall conform to **8.1**.

5.5.3 *Earthed metallic screen*

Insulators used in semi-screened cable half couplers or adaptors shall have fitted to their front face an earthed metallic screen. The radial fins of the screen shall be located midway between the three contact spouts to provide earthed segregation.

The fins of the earthed metallic screen and its earth connections shall withstand a current of 300 A for 500 ms and the temperature rise shall not exceed 50 K.

Table 1. Properties of electrical insulating materials

Property	Value	Test method
Electric strength (90 °C)	8 kV/mm (min.)	BS 2782 : Method 220 and 221 : 1983[1)]
Volume resistivity	1×10^{13} Ω ·cm (min.)	BS 2782 : Method 230A : 1982[2)]
Tensile strength	34.5 N/mm^2 (min.)	BS 2782 : Method 320D : 1976
Flexural strength	60 N/mm^2 (min.)	BS 2782 : Method 335A : 1993
Impact strength	10 kJ/m^2 (min.)	BS 2782 : Method 359 : 1993
Water absorption[3)]	50 mg (max.)	BS 2782 : Method 430A : 1983
Comparative tracking index[3)]	CTI 400 (min.)	BS 5901 : 1980
Oxygen index	28 % (min.)	BS 2782 : Method 141 : 1986

[1)] Also numbered BS 903 : Part C4 : 1983.

[2)] Also numbered BS 903 : Part C2 : 1982.

[3)] Preparatory to any testing for these properties, remove not less than 0.5 mm by machining from all the surfaces of the test specimen and then smoothly finish.

NOTE. 1 N/mm^2 = 1 MPa.

5.6 External body features

5.6.1 *Enclosure*

Assembled cable half couplers, intermediate boxes and insulated end covers, when joined together in any combination, shall have a minimum degree of protection of IP 54 conforming to BS EN 60529 : 1992.

Adaptors shall also have a minimum degree of protection of IP 54 conforming to BS EN 60529 : 1992 at the interface with a cable half coupler, intermediate box or insulated end cover. Metal castings shall conform to **9.2**

5.6.2 *External earthing*

Provision shall be made on the cable gland assemblies for the fixing of a copper earth bond.

5.6.3 *Internal earthing*

5.6.3.1 *General*

Provision shall be made within the cable sealing box for bonding to earth the earth core and/or any screens that may be incorporated in the cable in accordance with **5.6.3.2** to **5.6.3.4**.

Any support pillar or component used for bonding shall be capable of withstanding the short circuit requirements specified in **8.3**.

5.6.3.2 *Earth core*

The earth core shall be terminated in either a brass or copper terminal (bored to accept the relevant core) with provision for attachment to either any support pillar or the box.

5.6.3.3 *Braided wire core screens*

The braided wire core screens shall be terminated in one or more brass or copper terminals (bored to accept the tails formed by unpicking the braid screens) with provision for attachment to either any support pillar or the box body.

5.6.3.4 *Copper tape core screens*

The copper tape core screens shall be terminated on the face of the glandset or box body by use of a stud terminal.

5.7 Separate contact pins

5.7.1 Separate phase contact pins shall be provided to afford electrical connection between the phase contact tubes of two mating cable half couplers or a cable half coupler and adaptor.

The contact pin shall be as shown in figure 3. It shall be solid and manufactured from medium-hard copper of grade C101 or C102 conforming to BS 1433 : 1970 or grade C111 conforming to BS 2874 : 1986, having a hardness of not less than 70 HB when tested in accordance with BS 240 : 1986 and a volume resistivity of not more than 1.7241 Ω·cm at a temperature of 20 °C.

5.7.2 A separate pilot contact pin shall be provided to afford electrical connection between the pilot contact tubes of two mating unscreened cable half couplers or an unscreened cable half coupler and adaptor.

The pilot contact pin shall be one of the three types shown in figure 4[1)] . Type A pins shall be used to connect two type A contact tubes. Type B pins shall be used to connect two type B contact tubes. Type C pins shall be used to connect a type A contact tube to a type B contact tube.

The pilot contact pins shall be manufactured from hard drawn copper of grade C101 or C102 conforming to BS 1433 : 1970, having a volume resistivity of not more than 1.7241 Ω·cm at a temperature of 20 °C. The spring clips shall be silver plated in accordance with classification Cu/Ag25 of BS 2816 : 1989.

[1)] The reason for specifying three types of pilot pin is explained in the foreword.

5.8 Fixed contact tubes for phase conductors

5.8.1 *General*

Fixed contact tubes for cable half couplers and adaptors shall be designed to receive the separate contact pins at the coupling end in accordance with **5.8.2** or **5.8.3**, as appropriate, and shall conform to **9.1**.

Fixed contact tubes for cable half couplers shall either be designed to receive at the termination end copper cable conductors in accordance with **5.8.2.3** or **5.8.2.4**, or aluminium cable conductors in accordance with **5.8.3.3**.

Fixed contact tubes for adaptors shall provide terminations suitable for connecting leads to other apparatus, either directly or via an adaptor pin (see **5.11**). (See figures 12a and 12b respectively.)

5.8.2 *Contact tube for copper cable conductors*

5.8.2.1 *Design and construction*

The contact tube shall be as shown in figure 1.

The part of the contact tube receiving the connecting contact pin shall facilitate good electrical connection by the provision of radial slits forming not fewer than four separate spring-leaf elements constrained by a circular spring arrangement and further diametrically constrained to a maximum clearance between the constraining device and the contact tube of 0.5 mm to prevent undue distortion of the tube when the mating pin is inserted.

The contact tube shall be provided with the following:

a) a seal to prevent migration of the filling medium from one side of the insulating block to the other side;

b) a locking ring that effectively retains the contact tube in its correct location in the insulator block; and

c) a device that locates and prevents rotation of the contact tube in the insulator block.

5.8.2.2 *Material*

The contact tubes shall be manufactured from copper of grade C101 or C102 conforming to BS 1433 : 1970, having a hardness of not less than 70 HB when tested in accordance with BS 240 : 1986 and a volume resistivity of not more than 1.7241 $\Omega \cdot$cm at a temperature of 20 °C.

5.8.2.3 *Compression termination of conductor*

The part of the contact tube providing the termination for the cable conductor shall be so manufactured as to permit compression jointing of the copper cable conductor to the contact tube. The dimensions and tolerances of the tube shall be in accordance with the compression tool manufacturer's recommendations. Markings shall be provided to assist in the location of the compression dies. These markings shall not remove or displace materials such as could affect the efficacy of the completed compression joint.

5.8.2.4 *Clamped termination of conductor*

The part of the contact providing the conductor termination shall be integral with the contact tube and provide for a clamped connection.

Where screws are used as the clamping device, not fewer than four shall be provided and they shall be cup pointed hexagon socket screws conforming to BS 4168 : Part 5 : 1981. Each contact tube terminal shall provide for the entry of the conductor to a depth of at least 25 mm.

5.8.3 *Contact tube for aluminium cable conductors*

5.8.3.1 *Design and construction*

The contact tube shall be as shown in figure 1. The contact tubes shall be formed by welding a copper billet onto an aluminium billet. The weld shall conform to **9.3**.

NOTE. The accepted method of producing the bimetallic junction is by friction welding.

The part of the contact tube receiving the connecting contact pin shall facilitate good electrical connection by the provision of radial slits forming not fewer than four separate spring-leaf elements constrained by a circular spring arrangement and further diametrically constrained to a maximum clearance between the constraining device and the contact tube of 0.5 mm to prevent undue distortion of the tube when the mating pin is inserted.

The contact tube shall be provided with the following:

a) a seal to prevent migration of the filling medium from one side of the insulating block to the other side;

b) a locking ring that effectively retains the contact tube in its correct location in the insulator block;

c) a device that locates and prevents rotation of the contact tube in the insulator block; and

d) the internal bore of the aluminium sector free from any surface irregularities.

5.8.3.2 *Material*

The copper section shall be manufactured from copper of grade C101 or C102 conforming to BS 1433 : 1970, having a hardness of not less than 70 HB when tested in accordance with BS 240 : 1986. The aluminium section shall be manufactured from aluminium of grade 1050A conforming to BS 1474 : 1987.

5.8.3.3 *Compression termination of conductor*

The part of the contact tube providing the termination for the cable conductor shall be so manufactured as to permit compression jointing of the cable conductor to the contact tube. The dimensions and tolerances of the tube shall be in accordance with the compression tool manufacturer's recommendations. Markings shall be provided to assist in the location of the compression dies. These markings shall not remove or displace material such as could affect the efficacy of the completed compression joint.

5.9 Contact tubes for pilot conductors

5.9.1 *General*

A fixed pilot contact tube shall be fitted in place of the earthed metallic interphase screen in order to provide a termination for the cable pilot conductor and also as a mating contact for the separate pilot contact pin.

5.9.2 *Pilot contact tube for copper cable conductors*

5.9.2.1 *Design*

The pilot contact tube shall be one of the following two types[2)].

a) **Type A**. The part of the fixed tube receiving the pin shall have a bore between 6.96 mm and 6.91 mm diameter, with a depth between 18.0 mm and 17.5 mm.

b) **Type B**. The part of the fixed tube receiving the pin shall have a bore between 6.91 mm and 6.86 mm diameter, with a depth between 19.3 mm and 18.8 mm.

The pilot contact tube shall be provided with the following:

1) a seal to prevent migration of the filling medium from one side of the insulating block to the other side;

2) a locking ring that effectively retains the contact tube in its correct location in the insulator block;

3) a device that locates and prevents rotation of the contact tube in the insulator block.

5.9.2.2 *Material*

The contact tube shall be manufactured from copper of grade C101 or C102 conforming to BS 1433 : 1970, having a hardness of not less than 70 HB when tested in accordance with BS 240 : 1986 and a volume resistivity of not more than 1.7241 $\Omega \cdot$cm at 20 °C.

5.9.3 *Compression termination of conductor*

The part of the contact tube providing the termination for the cable pilot conductor shall be so manufactured as to permit compression jointing of the pilot conductor to the contact tube. The dimensions and tolerances of the tube shall be in accordance with the compression tool manufacturer's recommendations.

5.10 Sealing ring

When any two cable half couplers are bolted together, the coupling faces of the material forming the respective contact tube housings, or contact tube housing and insulated end cover, shall be sealed by the interposition of a ring of resilient insulating material that shall conform to the dimensions shown in figure 5. The properties of the material of the sealing ring shall conform to the values given in table 2.

5.11 Adaptors

5.11.1 *General*

Dimensions of adaptors shall be as shown in figures 6, 7 and 8. If plug-in cable adaptor connections are required, the dimensions of the adaptor pin shall be as shown in figure 9. The insulating shroud shall be arranged to remain in position during normal handling and service.

5.11.2 *Adaptor pin for compression termination of conductor*

The part of the adaptor pin receiving the cable conductor shall be so manufactured as to permit compression jointing of the copper cable conductor onto the adaptor pin. The dimensions and tolerances of the pin shall be in accordance with the compression tool manufacturer's recommendations. Markings shall be provided to assist in the location of the compression dies. These markings shall not remove or displace material such as could affect the efficacy of the completed compression joint.

5.11.3 *Adaptor pin for clamped termination of conductor*

The conductor termination shall be integral with the adaptor pin and provide for a clamped connection. Where screws are used as the clamping device not fewer than four shall be provided and they shall be cup pointed hexagon socket screws conforming to BS 4168 : Part 5 : 1981. Each terminal shall provide for the entry of the conductor to a depth of at least 25 mm.

[2)] The reason for specifying two types of contact tube is explained in the foreword.

Table 2. Properties of sealing ring

Property	Value	Test method
Electric strength	100 kV/mm (min.)	BS 2918 : 1957
Volume resistivity	1×10^{13} Ω·cm (min.)	BS 2782 : Method 230A : 1982[1)]
Relative permittivity	5.0 (max.)	BS 2782 : Methods 240A and 240B : 1982[2)]
Comparative tracking index	CTI 400 (min.)	BS 5901 : 1980
Water absorption (after 14 days at (23 ± 2) °C)	1% (max.)	BS 2782 : Method 430A : 1983
Resistance to liquids (after immersion for 7 days at (23 ± 2) °C in transformer oil complying with BS 148 : 1992)		BS 903 : Part A16 : 1987
Tensile strength	7.5 N/mm^2 (min.)	
Ultimate elongation	250 % (min.)	
Accelerated ageing (168 h at 120 °C)		BS 903 : Part A19 : 1986
Tensile strength	10 N/mm^2 (min.)	
Ultimate elongation	300 % (min.)	
Compression set (70 °C for 24 h)	15 % (max.)	BS 903 : Part A6 : 1992
Hardness	55 to 65 IRHD	BS 903 : Part A26 : 1969

[1)] Also numbered BS 903 : Part C4 : 1983.

[2)] Also numbered BS 903 : Part C3 : 1982.

NOTE. 1 N/mm^2 = 1 MPa.

5.12 Filling holes

Metallic cable sealing boxes that are to be filled with a filling medium shall have a minimum of two orifices of not less than 30 mm diameter sited in the same plane and provided with suitable covers, or threaded to receive screwed plugs.

Where angled adaptors are designed to be filled in situ, they shall be provided with at least two filling orifices of not less than 30 mm diameter and provided with suitable covers, or threaded to receive screwed plugs (see figure 1).

Non-metallic cable sealing boxes shall be provided with either one aperture or two equal sized apertures, having a minimum total cross-sectional area of 2500 mm^2. The aperture or apertures shall be arranged (and augmented if necessary, by other means of venting) so as to facilitate the complete filling with a compound conforming to BS 5501 : Part 8 : 1988.

5.13 Insulated end covers

Insulated end covers shall be as shown in figure 10 and shall conform to **9.4**.

6 Dimensions

6.1 Components

The dimensions of the components of cable half couplers, adaptors and insulated end covers shall be as shown in figures 1 to 10. The relative positions of the contact tubes and of the flange bolt holes shall be as shown in figure 1.

6.2 Electrical clearances

The clearance and creepage distances shown in figures 11, 12 and 13 shall be not less than those given in table 3.

6.3 Fasteners

All bolts, screws and studs used for attaching parts of the enclosure shall have a strength grade designation of 8.8, as specified for bolts and screws in BS 3692 : 1967 and for studs in BS 4439 : 1969, with grade 8 nuts as specified in BS 3692 : 1967. Coupling screws shall be size M10 of length 45 mm. If bolts are used, threaded length shall be not less than 25 mm.

Table 3. Minimum creepage distances and clearances				
Description	**In air**		**In filling medium**	
	Reference letter (see figures 11 and/or 12)	**Dimension** mm	**Reference letter** (see figures 11 and/or 12)	**Dimension** mm
Clearance phase to phase direct	A	89	E	25
Clearance phase to earth direct	B	64	F	19
Creepage phase to phase over insulation	C	146	G	64
Creepage phase to earth over insulation	D	89	H	32
Creepage phase to earth over cable surface	—	—	J	48

7 Cable glands and cable sealing boxes

7.1 General

The design of the gland and sealing box shall be such as to minimize the transfer to the conductor connections stresses induced by bending of the cable.

NOTE. The problem is particularly acute for pliable wire armoured cables.

The gland shall include a clamp for securing and ensuring electrical contact with the armour of the cable. The cable gland shall be so designed that it does not impose on the armour wires of the cable a bending radius less than the diameter of the wire.

Where a coned draw-gland is used for double wire armoured cable, an inter-armour cone shall be interposed between the inner and outer layers of wire armour to facilitate uniform clamping of armour wires.

Provision shall be made on the cable gland for the fixing of an earth bond.

Coupler gland sets shall conform to table 4.

The glands shall conform to **8.4**, **8.5** and **8.6**.

7.2 Cable glands for non-metallic bodied cable sealing boxes

The minimum dimension between the start of the filling medium encapsulation and the termination of the cable outer sheath shall be 24 mm, as shown in figure 16.

8 Type tests

8.1 Insulators heat resistance

8.1.1 *Requirement*

When tested in accordance with **8.1.2**, the dimensions of each insulator shall not depart from the original dimensions by more than 0.2 % and there shall be no form of surface cracking or scaling on the insulator.

8.1.2 *Method*

Heat the insulator in an oven at (120 ± 5) °C for a period of 24 h and then allow to cool to ambient temperature. Examine the insulator for surface cracking or scaling.

8.2 Temperature rise

8.2.1 *Requirement*

When tested in accordance with **8.2.2**, the temperature rise of the components within the cable half coupler shall not exceed 45 °C in a maximum ambient temperature of 25 °C as measured in **8.2.2.1**d. The temperature deviation of the components within the cable half coupler shall be equal to, or less than, that of the average temperature of the cable conductor.

NOTE. Because of the nature of this test, if a bad reading occurs, the parties concerned may need to reach agreement, for example, on whether to continue the test.

The tests shall be conducted, under draught-free conditions, on two filled cable half couplers, bolted together, and complete with three contact pins and a sealing ring that all conform to this standard.

Table 4. Details of coupler glandsets			
Type of armour	**Cable sheath**	**Minimum dimensions** (see figures 14 and 15)	
		Support length *A* mm	**Penetration** *B*
Pliable wire armour (PWA)	Polychloroprene (PCP)	30	1.25 times the outside diameter of the cable (90 mm minimum)
Single wire armour (SWA) and double wire armour (DWA)	Polyvinylchloride (PVC)	20	0.67 times the outside diameter of the cable (30 mm minimum)

8.2.2 *Method*

8.2.2.1 *General*

Attach each cable half coupler to a 2 m length of three-core 185 mm^2 stranded copper, or three-core 185 mm^2 solid or stranded aluminium single or wire-armoured cable conforming to BS 6346 : 1989 for 6.6 kV working.

Determine the temperature rise of the components within the cable half coupler and the temperature deviation of the same components from that of the cable core using thermocouples placed as follows:

a) Attach one thermocouple to the conductor socket of each contact tube, adjacent to the conductor.

b) Attach one thermocouple to the end of each contact tube, adjacent to the contact pin.

c) Attach one thermocouple to each of the cable conductors in a separate 2 m length of uncut cable at a distance of 1 m from the end of the cable. Insert the thermocouples through holes in the cable sheath and insulation. Connect this cable in series with the cable half coupler.

d) To measure the ambient temperature, attach one thermocouple to the body of one of two cable half couplers, bolted together, and not included in the test loop.

8.2.2.2 *Continuous loading sequence*

Conduct this test on two cable half couplers as initially assembled. Pass a three-phase current of 300 A, 40 Hz to 62 Hz through the cables and cable half couplers for a period of 30 days. Record the temperature of the selected components at intervals not greater than 24 h.

8.2.2.3 *Intermittent loading sequence*

On completion of the continuous loading sequence (see **8.2.2.2**), switch off the test current for a period of 24 h and then switch on for a further period of 24 h. Repeat this on/off sequence so that 10 such sequences are completed. Record the temperature of the selected components just prior to the end of each on-load period.

8.2.2.4 *Load cycling sequence*

On completion of the intermittent loading sequence (see **8.2.2.3**), carry out the following load cycling sequence:

a) 390 A for 40 min;

b) 130 A for 10 min;

c) 195 A for 10 min;

d) 130 A for 10 min.

Repeat this sequence 33 times without interruption followed by a continuous load of 300 A for a minimum period of 10 h. Record the temperature of the selected components just prior to the end of the test period. Repeat the test sequence a), b), c), d) and the 10 h continuous loading period a further 30 times making a total cycling sequence of 990 (nominally 1000) cycles.

8.3 Through fault current

8.3.1 *Requirement*

When tested in accordance with **8.3.2**, cable half couplers and adaptors shall show no visible signs of physical disturbance.

8.3.2 *Method*

Apply a current of 13.1 kA, r.m.s. symmetrical, for 1 s, with an asymmetrical peak value of not less than 33.4 kA to a correctly assembled cable half coupler with any compatible design of adaptor or coupler at any suitable voltage up to the rated voltage. If a tendency toward light welding of the contacts occurs, check that they can be separated by normal means. If any burning is visible, repeat the temperature rise test described in **8.2** without reconditioning.

NOTE. The tests on live-line indicators may be applied with the indicating devices removed.

8.4 Tensile load on gland

8.4.1 *Requirement*

When tested in accordance with **8.4.2**, there shall be no visible slip of the armour wires. Tests shall be conducted for the smallest size of each design of cable gland and for both steel wire and pliable wire armoured cables using two new clean samples for each test.

8.4.2 *Method*

For each test assemble two samples onto the ends of a length of cable, so that they are at least 300 mm apart, and in accordance with the manufacturer's instructions.

Wire armoured cables shall have armour wires of 2.0 mm diameter. Pliable wire armoured cables shall have armour wires of 7 × 0.90 mm diameter.

Glands intended for a metallic bodied cable sealing box shall be fitted to the sealing box or to a suitable jig. The gland assembly shall not contain any filling medium.

Where a gland is intended for a non-metallic bodied cable sealing box, fit the gland to the cable sealing box and ensure the assembly contains sufficient filling medium to completely cover the gland.

Cable cores shall not be terminated.

Attach the glands to the drawbars of a tensile test machine. Apply the test load given in table 5 and maintain it for 2 min.

Table 5. Tensile load

Size of armour mm	Tensile load kN
2.0	7
7/0.90	10

8.5 Cable gland distortion in metallic bodied cable sealing boxes

8.5.1 *Requirement*

When tested in accordance with **8.5.2**, the distortion of the gland mounting flange when measured against the coupler mounting flange shall not exceed 0.5 mm; the bow in the armour clamp shall not exceed 2 mm and no damage shall occur to the gland components or the threads of the adjusting studs or bolts.

8.5.2 *Method*

Assemble a cable coupler and glandset. Clamp the armour wires of the cable applying a maximum torque of 95 N·m to each adjusting stud or bolt.

8.6 Cable gland distortion in non-metallic bodied cable sealing boxes

8.6.1 *Requirement*

When tested in accordance with **8.6.2**, the bow in either the armour clamp or the gland mounting shall not exceed 2 mm and no damage shall occur to the gland components or the threads of the adjusting studs or bolts.

8.6.2 *Method*

Assemble a cable and coupler glandset. Clamp the armour wires of the cable apply a maximum torque of 20 N·m to each adjusting stud or bolt.

8.7 Additional tests for cable half couplers having non-metallic cable sealing boxes

8.7.1 *Torsion*

8.7.1.1 *Requirement*

When tested in accordance with **8.7.1.2**, close examination using normal or corrected vision shall reveal no evidence of relative movement of the interfaces between the metal casting, the moulded insulator and the encapsulating compound. There shall be no evidence of movement or damage to the cable or encapsulating compound.

8.7.1.2 *Method*

Fit the cable half coupler to one end of a 3 m length of three-core 185 mm^2 stranded copper wire armoured cable conforming to BS 6622 : 1991 for 6.6 kV working. Fit a flanged glandset to the other end of the cable. Bolt the flameproof flange of the cable half coupler to a fixed location. Attach a lever to the flange of the distant glandset to enable a torque to be applied to the cable.

Use the lever to rotate the glandset through 180° in a direction untwisting the lay of the cable. Return the lever to its original position. Use the lever to rotate the glandset through 180° in the opposite direction, tightening the lay of the cable. Release the load. Longitudinally section the cable half coupler along its centre line.

8.7.2 *Drop*

8.7.2.1 *Requirement*

When tested in accordance with **8.7.2.2**, close examination using normal or corrected vision shall reveal no evidence of damage or relative movement at the interface of the metal casting, the insulator and encapsulating compound.

8.7.2.2 *Method*

Fit the cable half coupler to one end of a 3.5 m length of three-core 185 mm^2 stranded copper wire armoured cable conforming to BS 6622 : 1991 for 6.6 kV working. Using two cable cleats, anchor the other end of the cable horizontally to a fixed structure positioned 2 m above a concrete surface. The length of free cable between the cable half coupler and the nearest cleat shall be 3 m. Support the cable half coupler at the height of the structure with the cable horizontal, then allow it to drop onto the concrete, so that it falls in an arc of 3 m radius through a vertical height of 2 m. Slacken the cleats, rotate the cable through 90° and retighten the cleats. Repeat the test, carrying out four in total, rotating the cable through 90° in the same direction for each repeat test as described. Release the assembly. Longitudinally section the cable half coupler along its centre line and through all points of impact.

9 Routine tests

9.1 Contact tube dimensions

9.1.1 *Requirement*

At the contact pin receiving end, each contact tube shall admit a pin gauge of 15.443 mm diameter under its own weight, but shall not admit a pin gauge of 15.646 mm diameter of minimum mass of 200 g under its own weight.

9.1.2 *Method*

Each contact tube shall be measured using a pin gauge at the manufacturer's premises.

9.2 General pressure test for cable half coupler and adaptor

9.2.1 *Requirement*

When the specified sample of metallic body casting half couplers or adaptors is tested in accordance with either **9.2.3** or **9.2.4**, no air or water shall be observed to escape from any part of the metallic body casting under test.

NOTE. Marking is required to indicate that the metallic body casting conforms to this requirement, see item f) of clause **10**.

9.2.2 *Sampling*

Twenty per cent of each of the first five batches shall be tested. If any of the 20 % of each of the first five batches being tested fail to conform to **9.2.1**, all of the relevant batch shall be tested.

If the rejection rate of the 20 % of each of the first five batches being tested is zero, then it shall be permissible to reduce the percentage being tested to 2 % of each batch and for it to remain at that level.

If any of the 2 % of a batch being tested fail to conform to **9.2.1**, all of the relevant batch shall be tested and the 20 % test percentage shall be reinstated. When a rejection rate of zero for five batches has been achieved, then it shall be permitted to reinstate the reduced test percentage of 2 %.

9.2.3 ***Pneumatic method***

Immerse the body with suitable gaskets, blanking devices and pneumatic connections in a suitably guarded water tank. Pressurize the body casting internally using compressed air, slowly building up the pneumatic pressure to a test pressure of 10.3 bar[3)]. Maintain the test pressure for 1 min.

9.2.4 ***Hydraulic method***

Place the body with suitable gaskets, blanking devices and hydraulic connections in a test rig that allows full visual inspection of the casting. Check that the external faces of the prepared casting are clean and dry. Pressurize the body casting internally using water, slowly building up to a test pressure of 10.3 bar. Maintain the test pressure for 1 min.

9.2.5 ***Vacuum impregnation***

9.2.5.1 If castings showing porosity in the area of the body other than flameproof faces are recovered by vacuum impregnation, they shall all be pressure tested in accordance with either **9.2.3** or **9.2.4** and marked accordingly.

9.2.5.2 Castings that are vacuum impregnated as a normal production routine prior to machining shall be sampled in accordance with **9.2.2** and shall be tested in accordance with either **9.2.3** or **9.2.4**. In the event of failure due to porosity these castings shall not be recovered by further impregnation as specified in **9.2.5.1**.

9.3 Bend test for bimetallic fusion welded connectors

9.3.1 ***Requirements***

When tested in accordance with **9.3.2**, all fusion welded, bimetallic terminal/contact tubes shall reveal no signs of cracks at the weld line visible to the naked eye. All connectors that are not straight within 0.5 mm diameter or concentric within 1.5 mm shall be either rectified or rejected.

When tested in accordance with **9.3.3**, if the weld line of one or more connections shows evidence of failure, a further set of samples shall be selected at random and tested. Failure of any of the second set of connectors shall result in the entire batch being rejected.

9.3.2 ***Proof test method***

Remove the welding flash at the weld interface. Locate the connector in a suitable device so that diametrically opposed mandrels acting, in turn, at right angles to the main axis of the connector can be caused to impose a bending and shearing force on the welded joint. The mandrels shall be so designed that small indentations are created on the connector to indicate that the test has been carried out.

Impose the force given in table 6 at a point on the aluminium portion of the connector, 25 mm from the interface of the two materials forming the connector.

After this test, measure all connectors for straightness and concentricity.

Table 6. Bending forces

Connectors for cable size mm^2	Force N
70	2220
95	2890
150	3110
185	3550

9.3.3 ***Batch test method***

A batch shall be a quantity not greater than 1000 connectors of any one size produced at any one time.

From every batch so produced, select at random 1 % of the batch or three connectors, whichever is the greater, and test these to destruction, by bending the aluminium section through 90° at the weld line. Examine the weld line for any cracks that can be seen using normal or corrected vision. Discard the tested batch.

9.4 High voltage

9.4.1 ***Requirement***

When each assembly of insulator and contact tubes is tested in accordance with **9.4.2**, no breakdown shall occur. The tests shall be routine tests applied on the manufacturer's premises.

For live-line indicators a test shall be applied, at line voltage, to each completed assembly to ensure correct indication.

[3)] 1 bar = 10^5 N/m^2 = 100 kPa.

9.4.2 *Method*

Apply an alternating test voltage of 14.2 kV of any frequency between 40 Hz and 62 Hz and of approximately sine-wave form:

a) between each contact tube and each of the other contact tubes, unless screens are provided; and

b) between each contact tube and the body of an associated enclosure.

NOTE 1. For item b) a simulated enclosure may be used.

NOTE 2. Where live-line indicators are fitted, these should be removed before commencing the test.

Commence the tests at a voltage of about one-third of the test voltage and increase to the test voltage in a period not exceeding 10 s. Maintain the full test voltage for 1 min. During the test to earth, connect one pole of the testing transformer to earth and to the body of the cable half coupler or adaptor.

10 Marking

All enclosures and insulated end covers shall be legibly and permanently marked with the following:

a) the registered trade mark or trade name of the manufacturer, or his agent, on all principal components forming the complete cable half coupler;

NOTE 1. Other items, such as fasteners and tie rods, need not be so marked.

b) the designation by which the type is identified;

c) voltage and current rating;

d) a warning prominently shown on the casing:

'DO NOT SEPARATE WHEN ENERGIZED';

e) the number and year of this British Standard, i.e. BS 3905 : 1995[4)];

f) the pressure test mark denoted by the letters 'PP' stamped on the metallic body casting to indicate that the casting conforms to **9.2**.

NOTE 2. When a certificate has been obtained, any additional marking requirements should be requested by the testing authority concerned.

[4)] Marking BS 3905 : 1995 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

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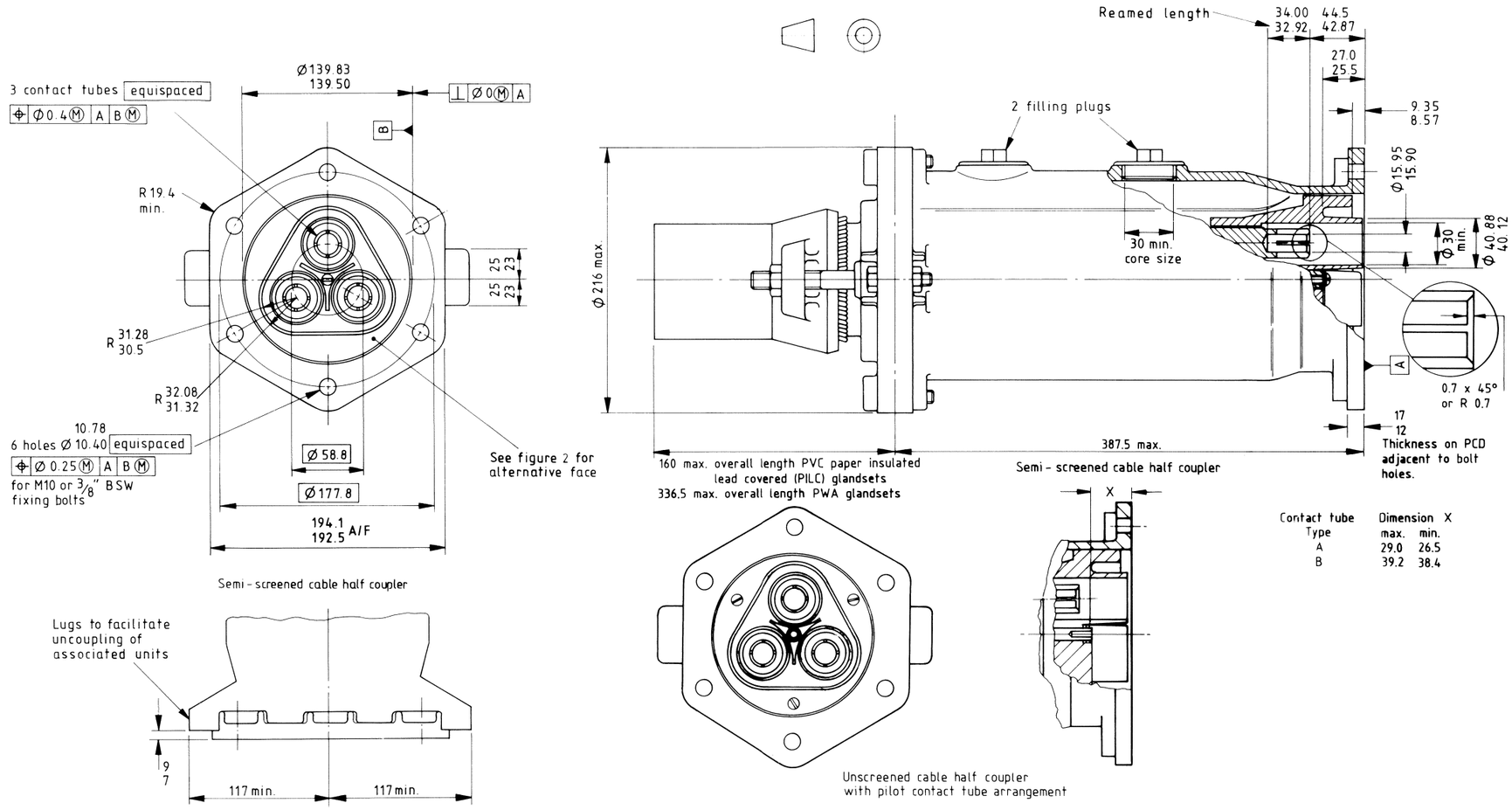

Contact tube Type	Dimension X max.	min.
A	29.0	26.5
B	39.2	38.4

See note to clause **1**.

Figure 1. 6.6 kV, 300 A cable half coupler

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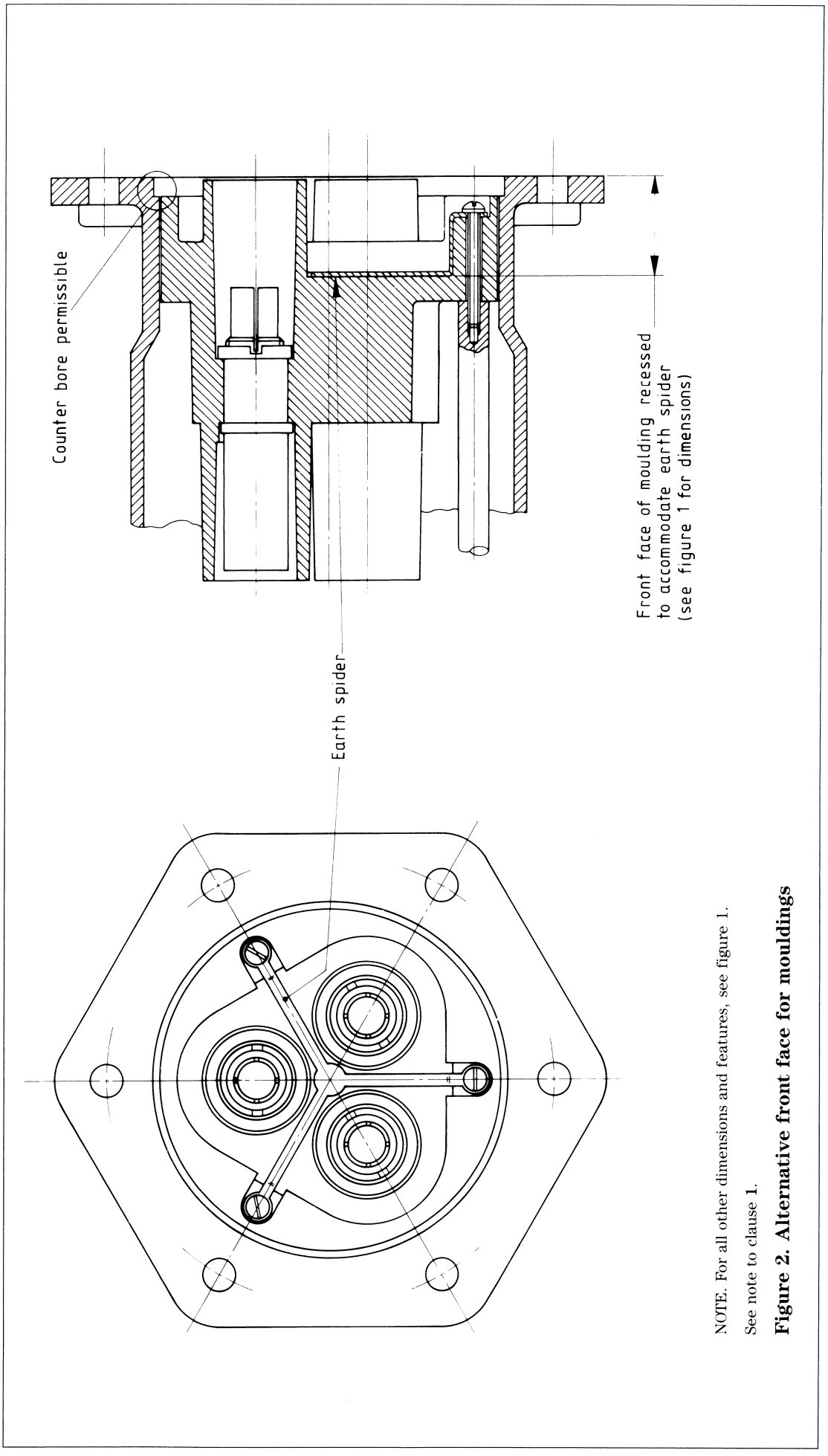
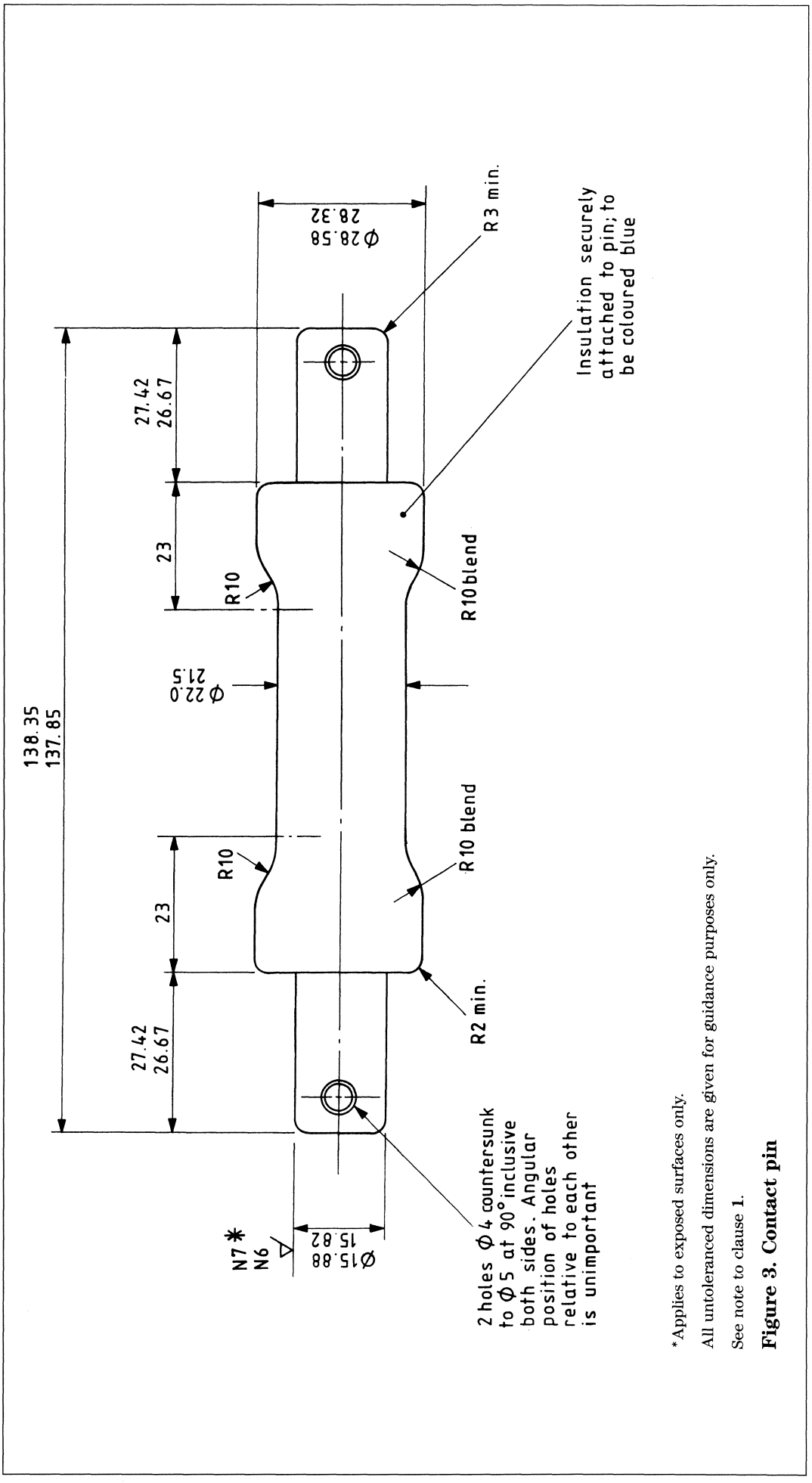


NOTE. For all other dimensions and features, see figure 1.

See note to clause 1.

Figure 2. Alternative front face for mouldings

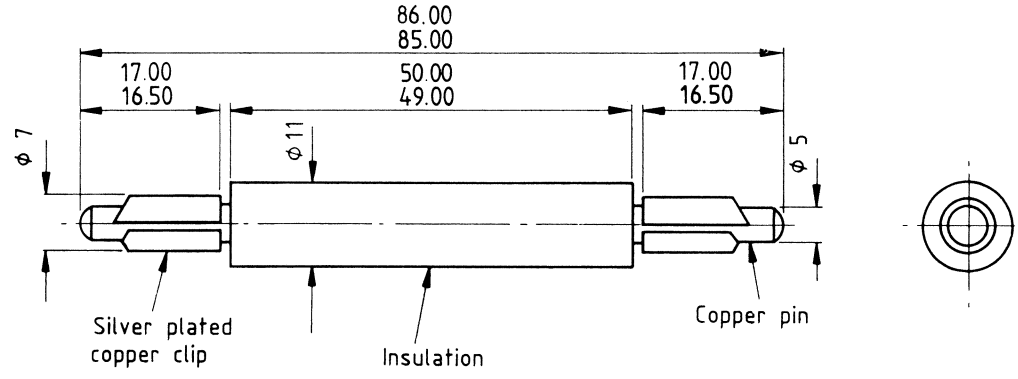


*Applies to exposed surfaces only.

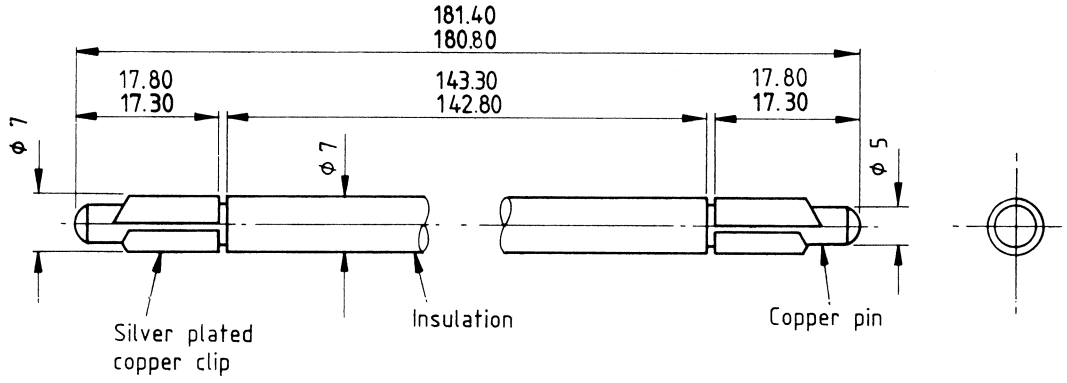
All untoleranced dimensions are given for guidance purposes only.

See note to clause 1.

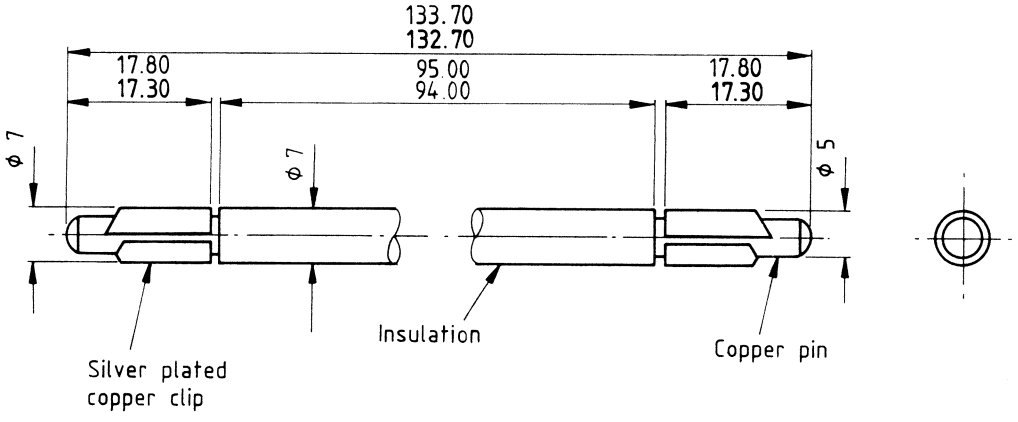
Figure 3. Contact pin



Type A



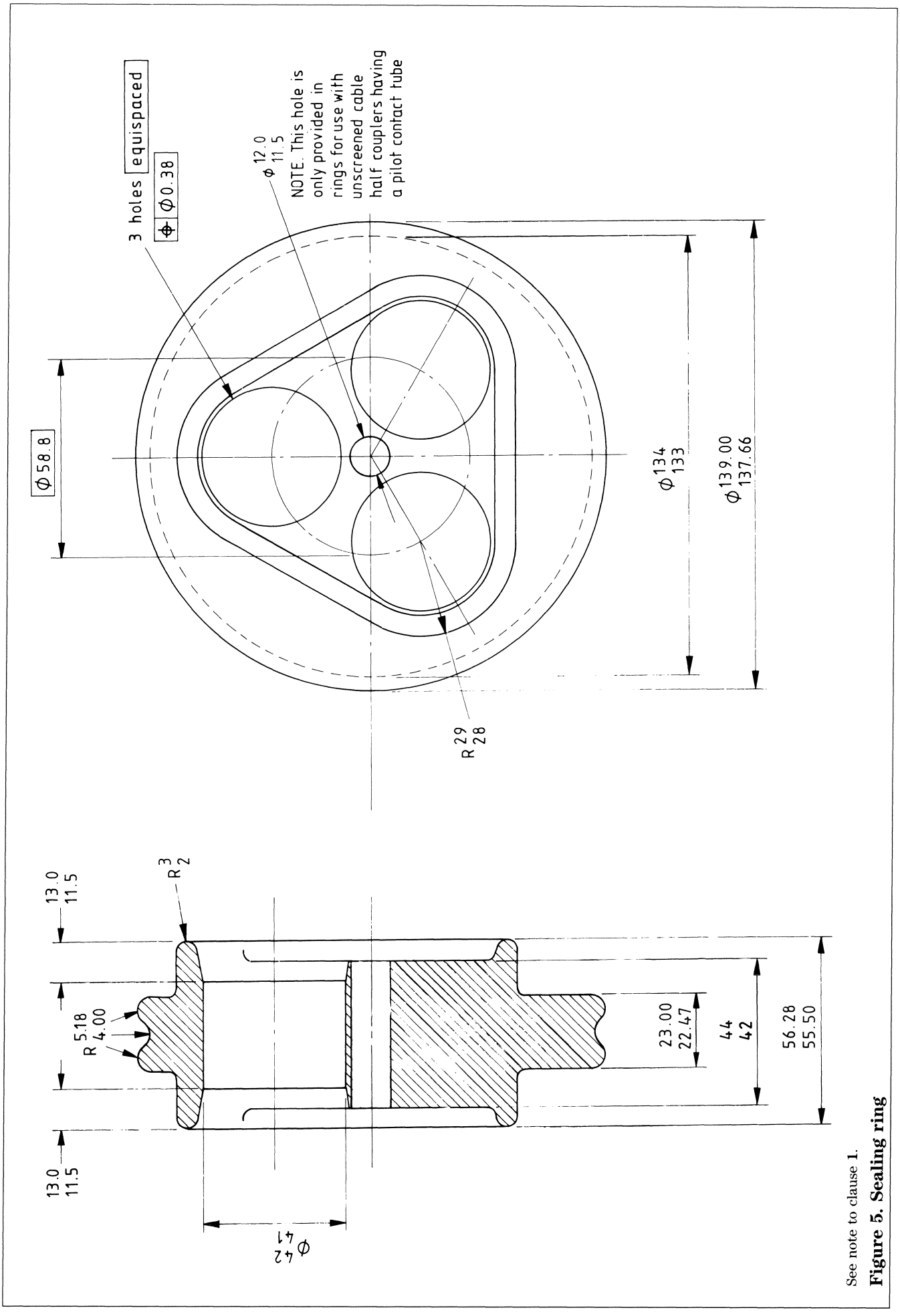
Type B



Type C

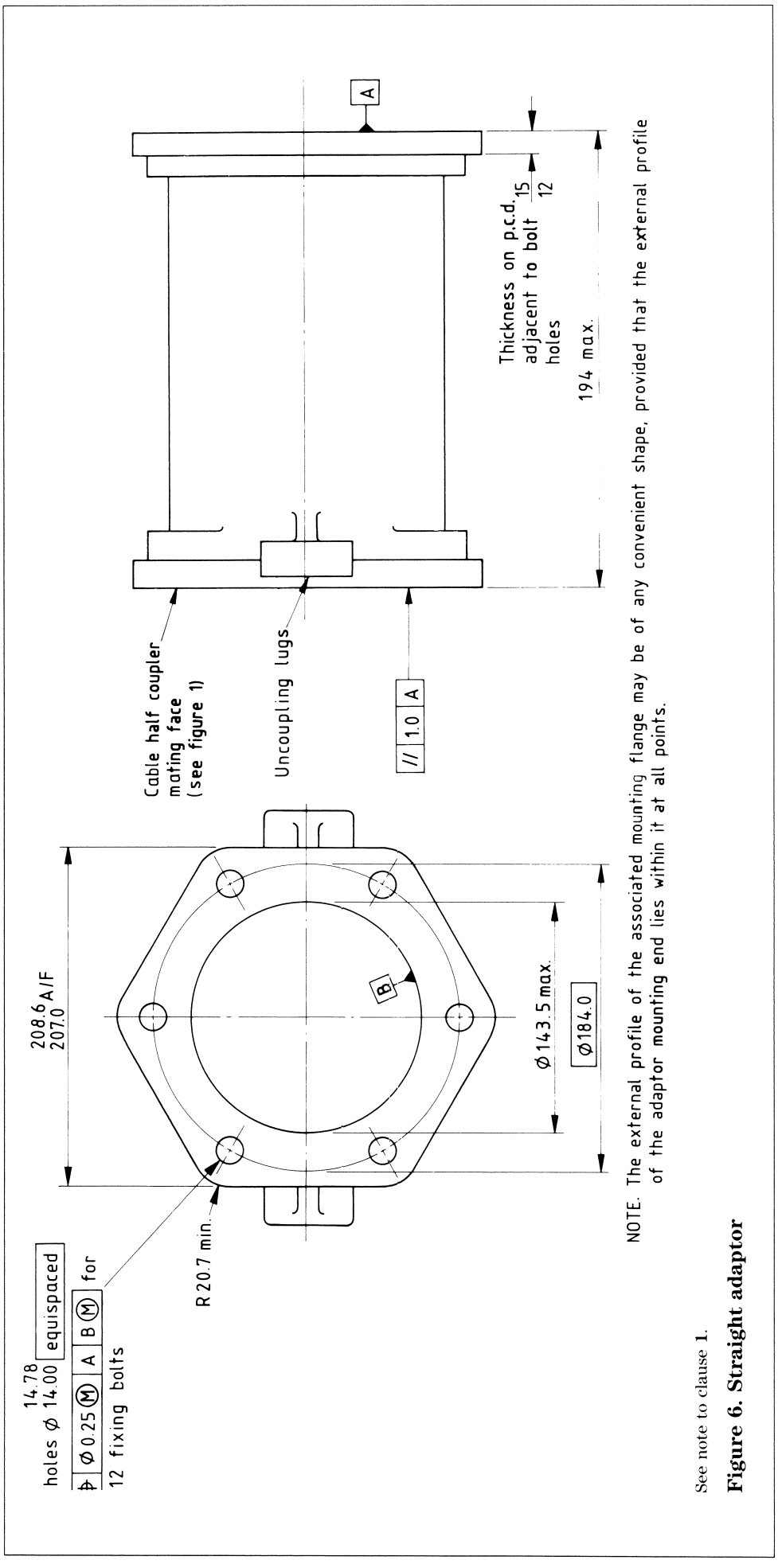
See note to clause **1**.

Figure 4. Pilot contact pins



See note to clause 1.

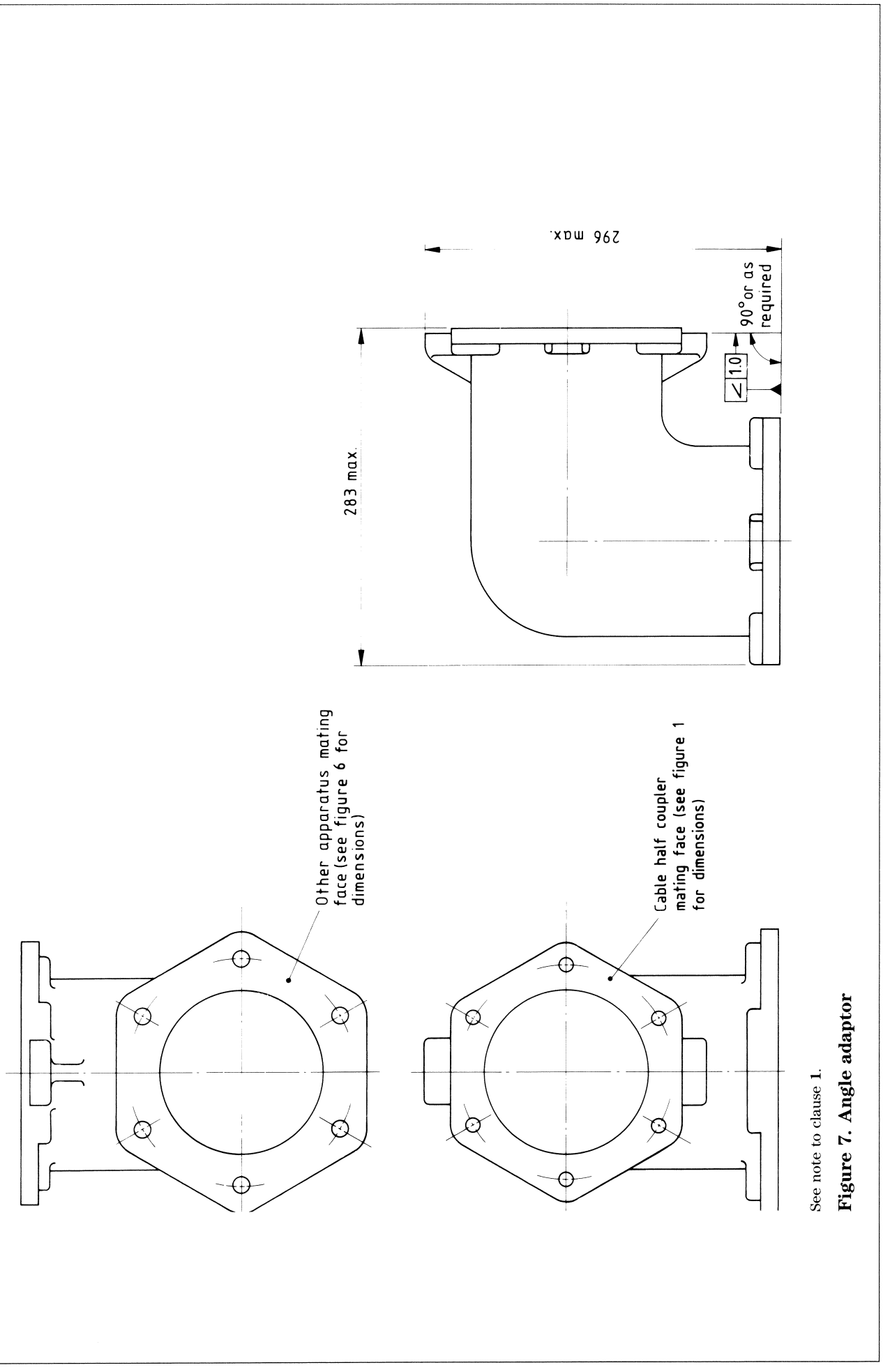
Figure 5. Sealing ring



NOTE. The external profile of the associated mounting flange may be of any convenient shape, provided that the external profile of the adaptor mounting end lies within it at all points.

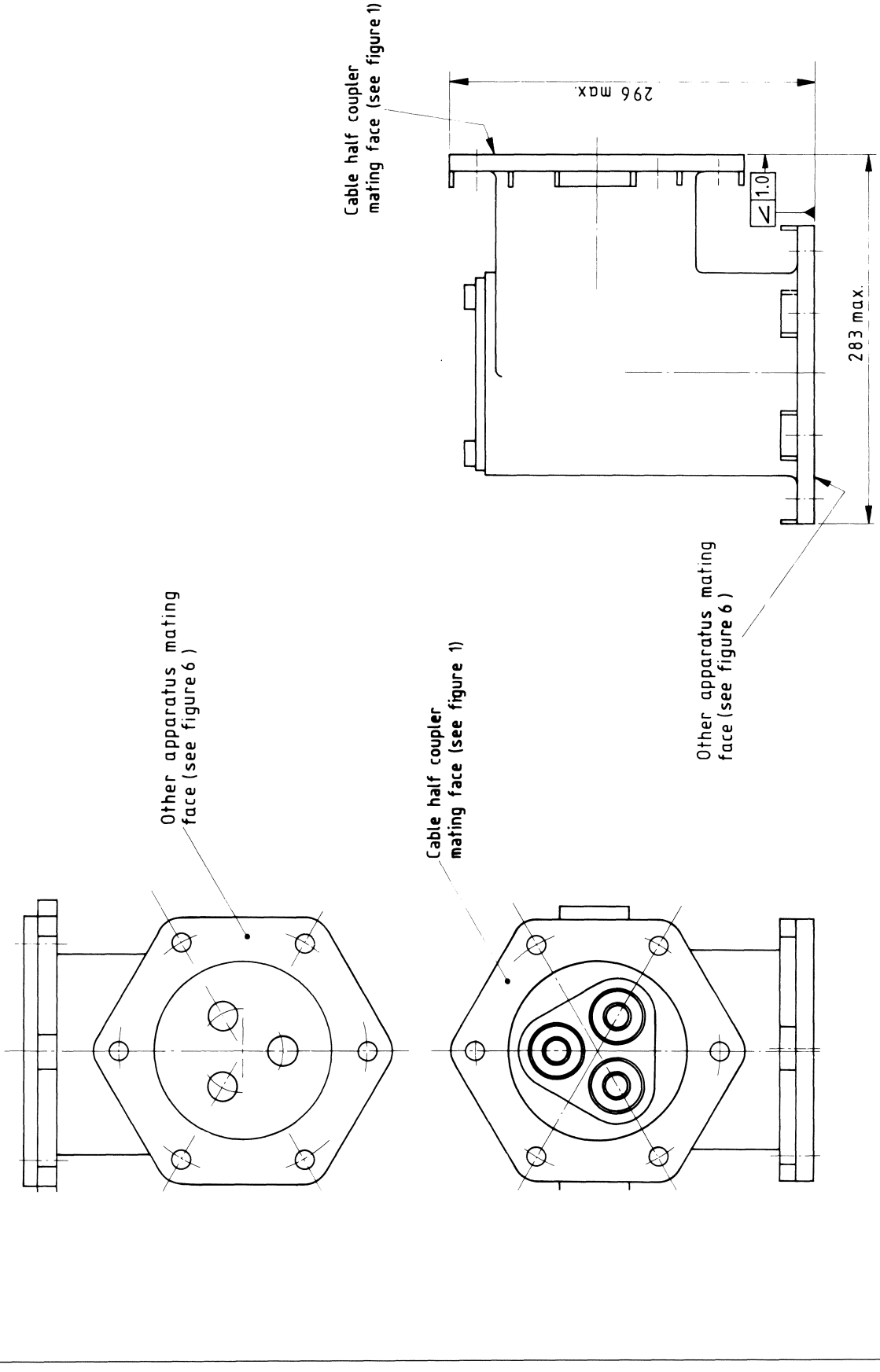
See note to clause 1.

Figure 6. Straight adaptor



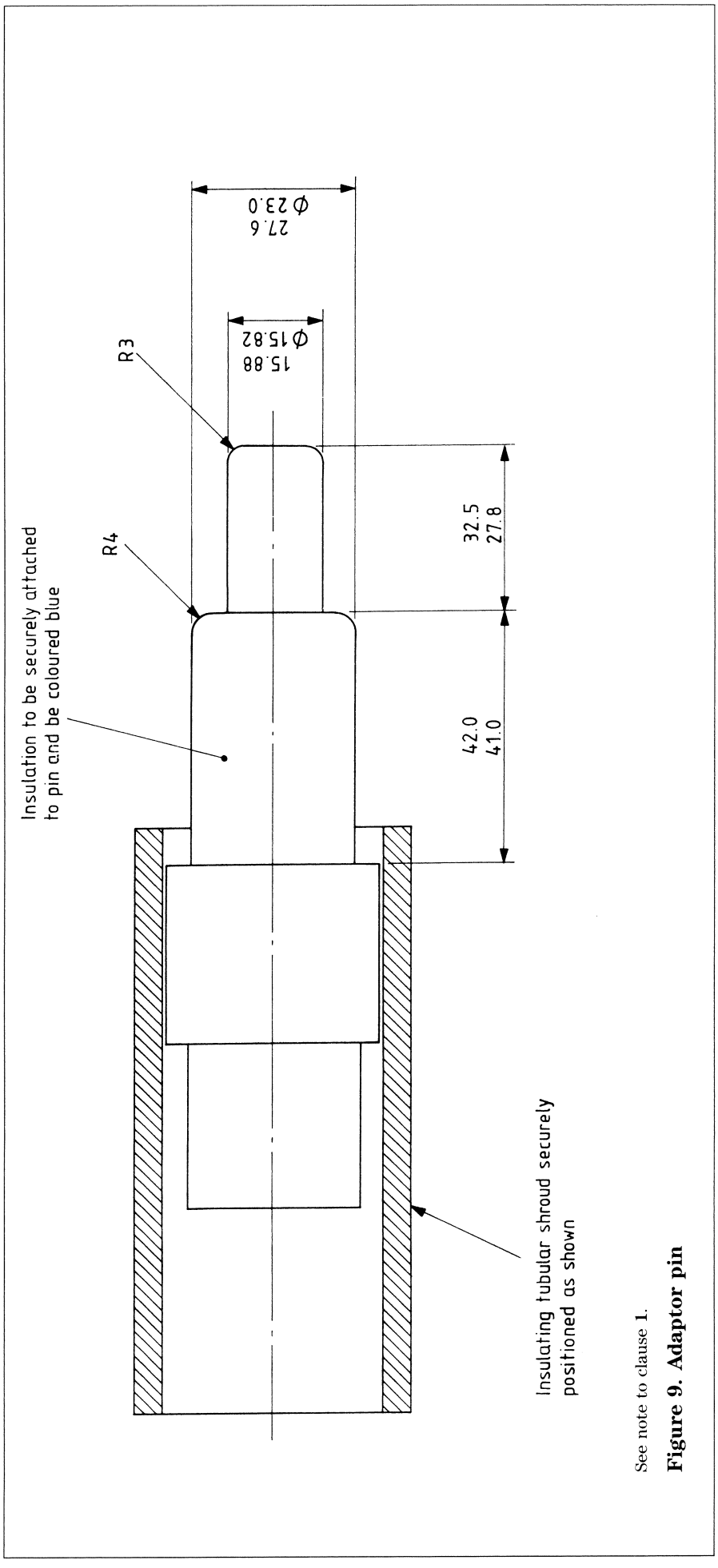
See note to clause 1.

Figure 7. Angle adaptor



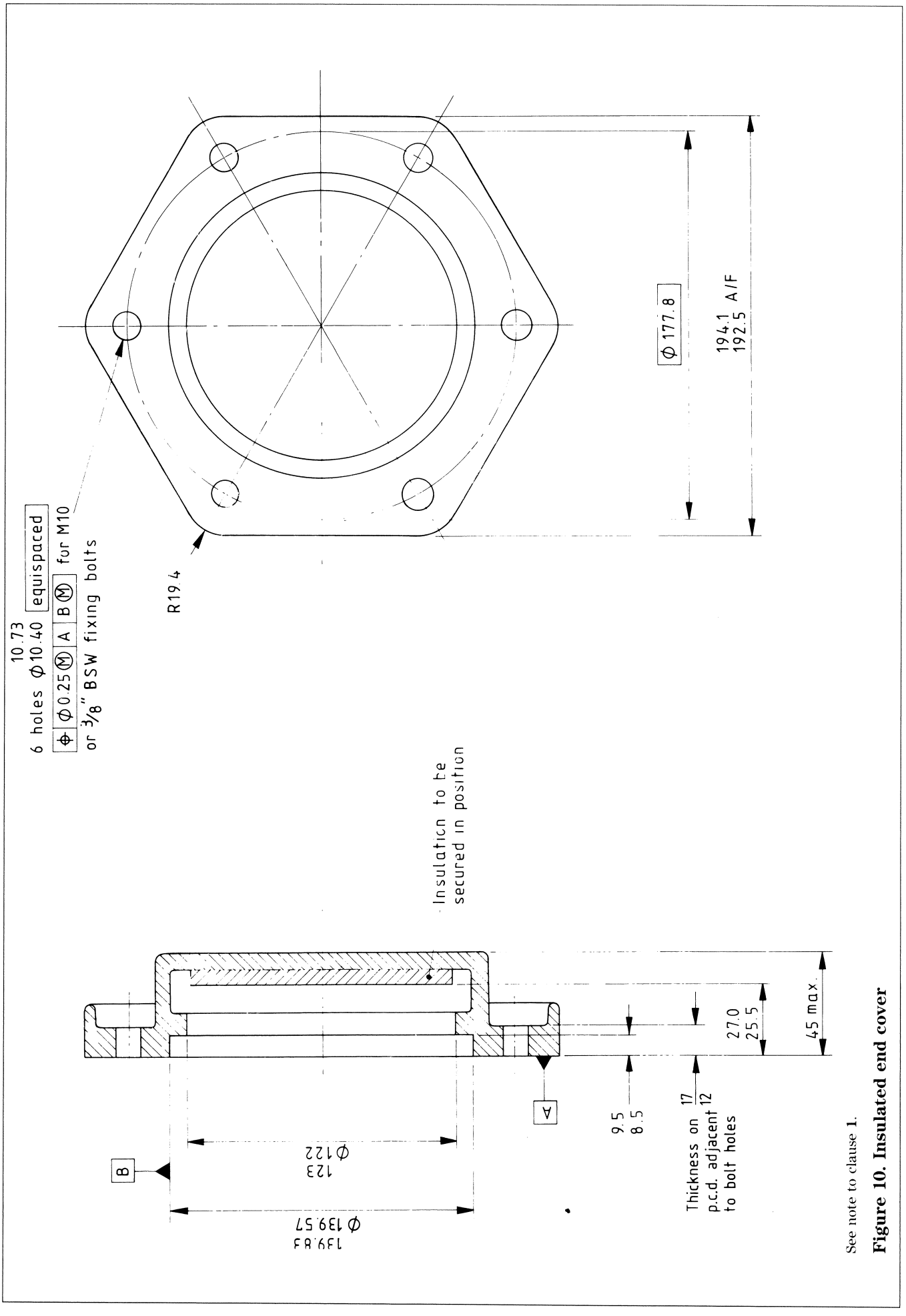
See note to clause 1.

Figure 8. Angle adaptor with access plate



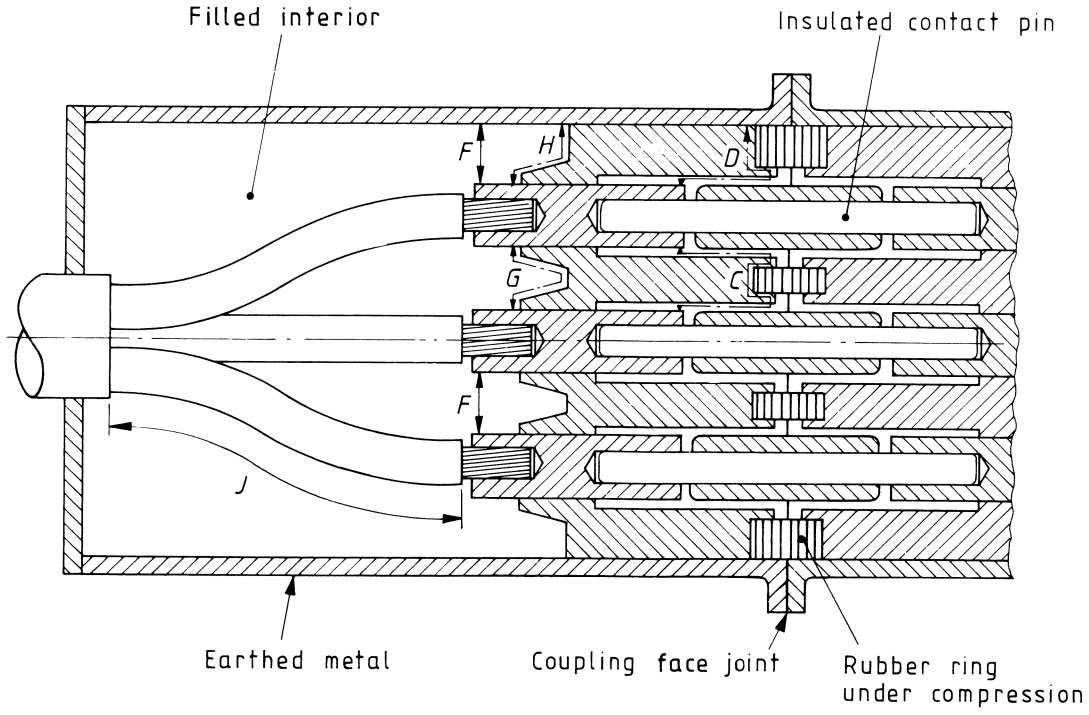
See note to clause 1.

Figure 9. Adaptor pin



See note to clause 1.

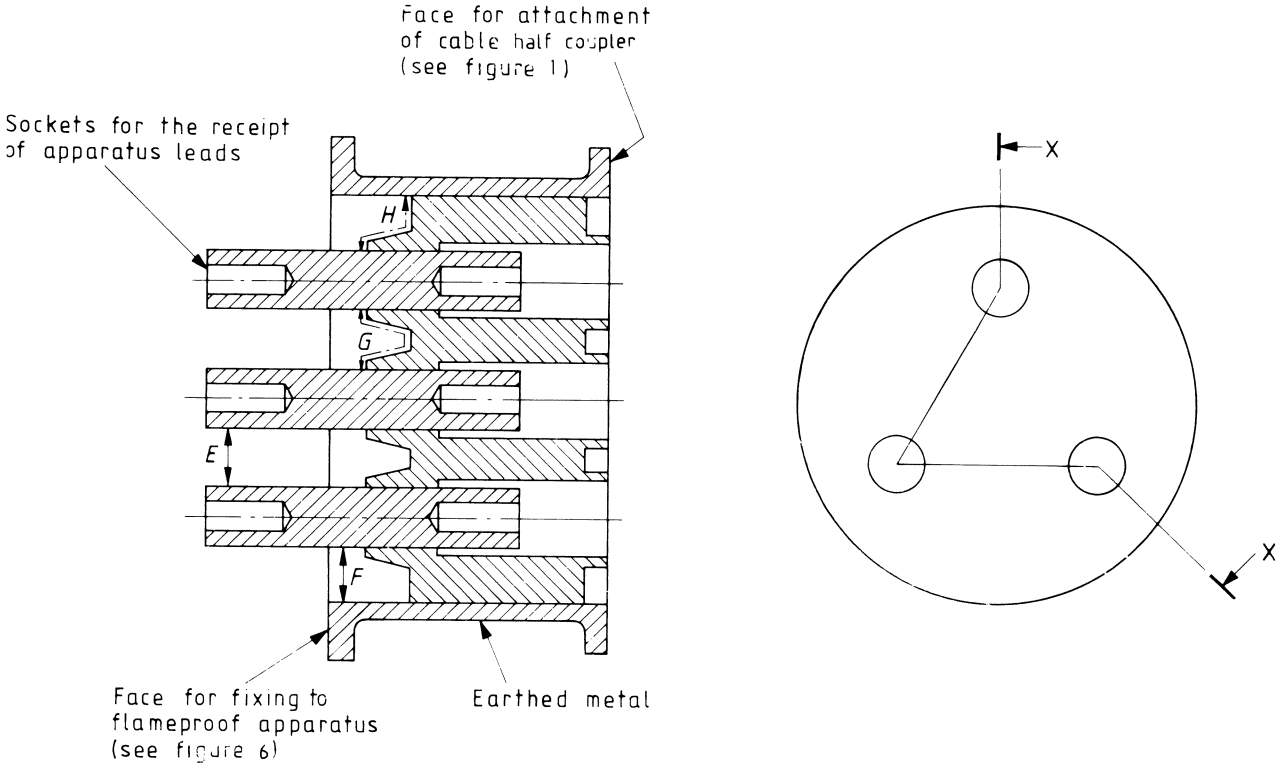
Figure 10. Insulated end cover



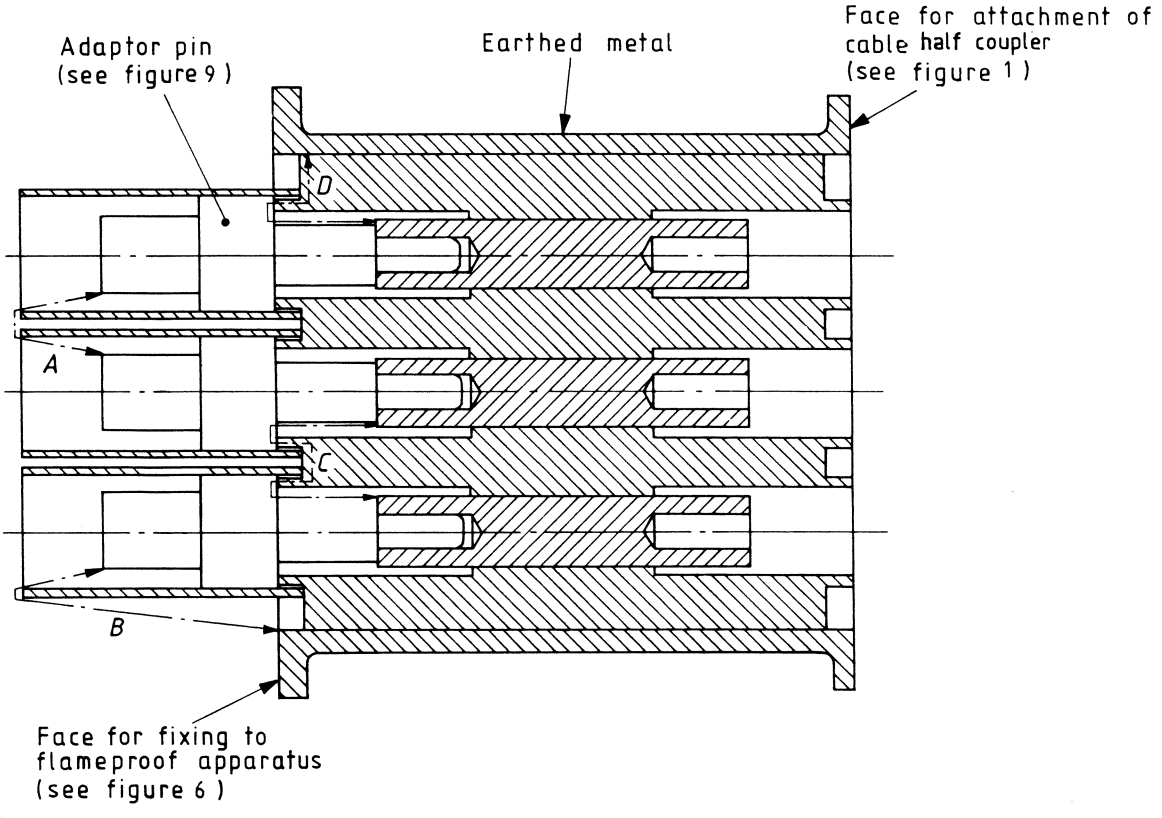
NOTE. For dimensions corresponding to the reference letters, see table 3.

See note to clause **1**.

Figure 11. Electrical creepage distances and clearances for cable coupler



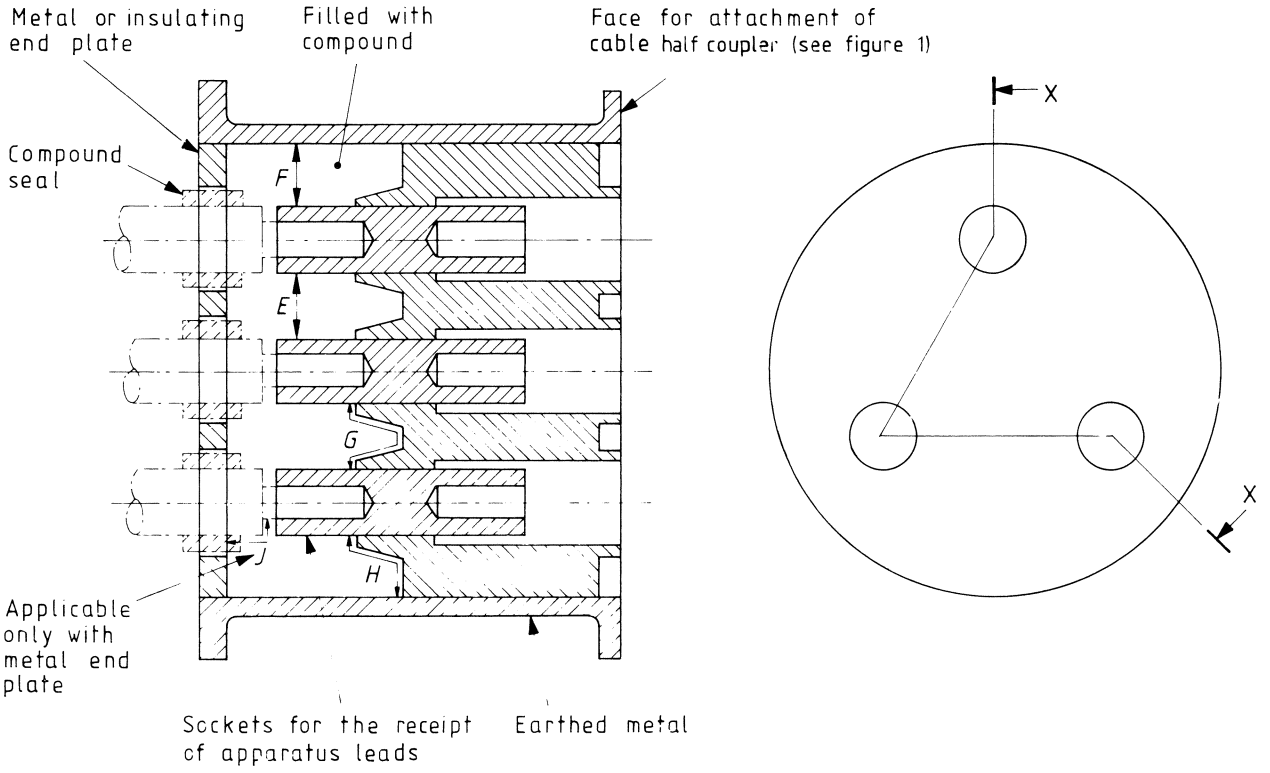
a) Straight adaptor for attachment to compound filled enclosure



b) Straight adaptor for attachment to air-filled enclosure

NOTE. For dimensions corresponding to the reference letters, see table 3.
See note to clause **1**.

Figure 12. Electrical creepage distances and clearances for adaptors to enclosures

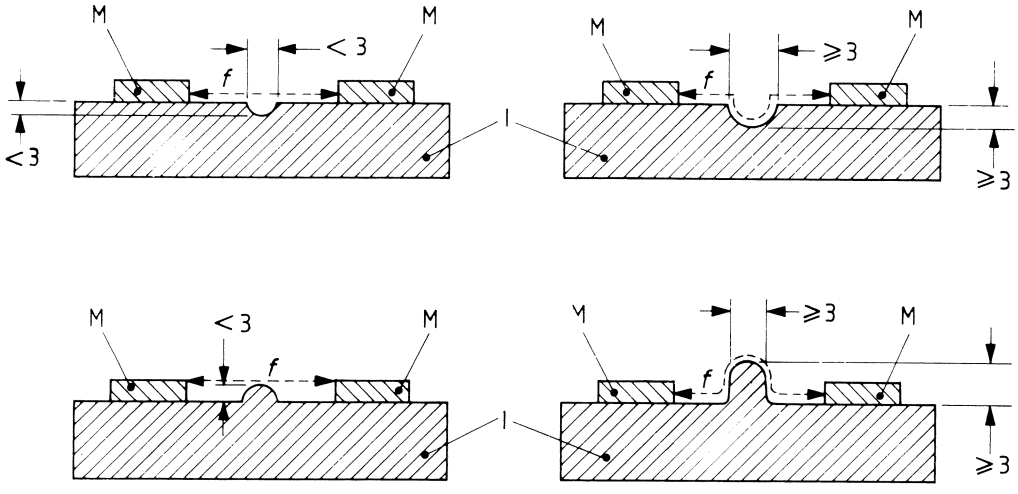


c) Compound-filled straight adaptor for attachment to air or compound-filled enclosure

NOTE. For dimensions corresponding to the reference letters, see table 3.

See note to clause **1**.

Figure 12. Electrical creepage distances and clearances for adaptors to enclosure *(concluded)*



Key

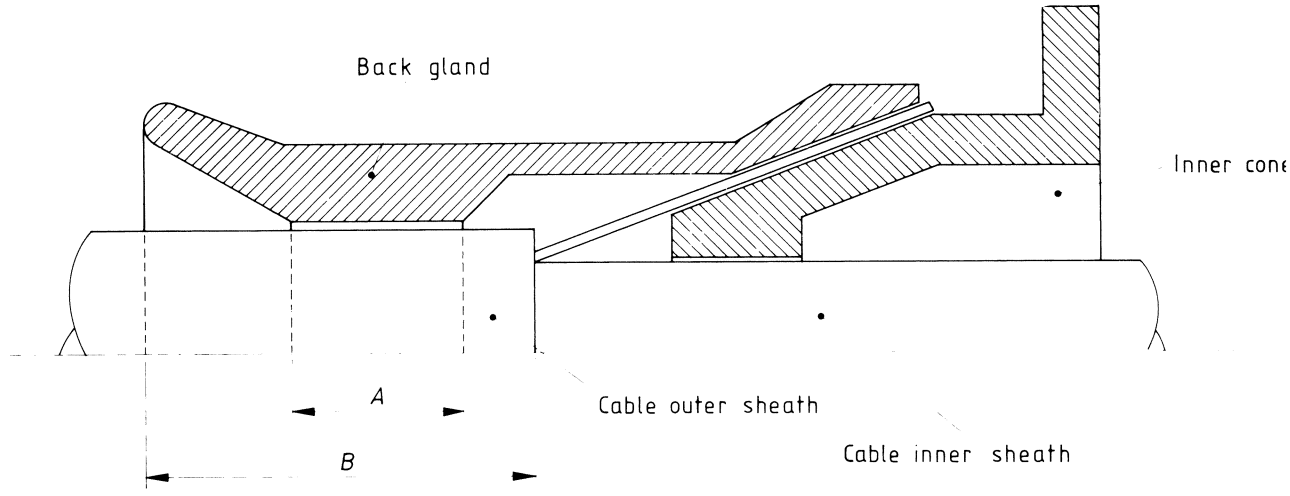
f is the creepage distance or clearance

M is the metal

I is the insulation material

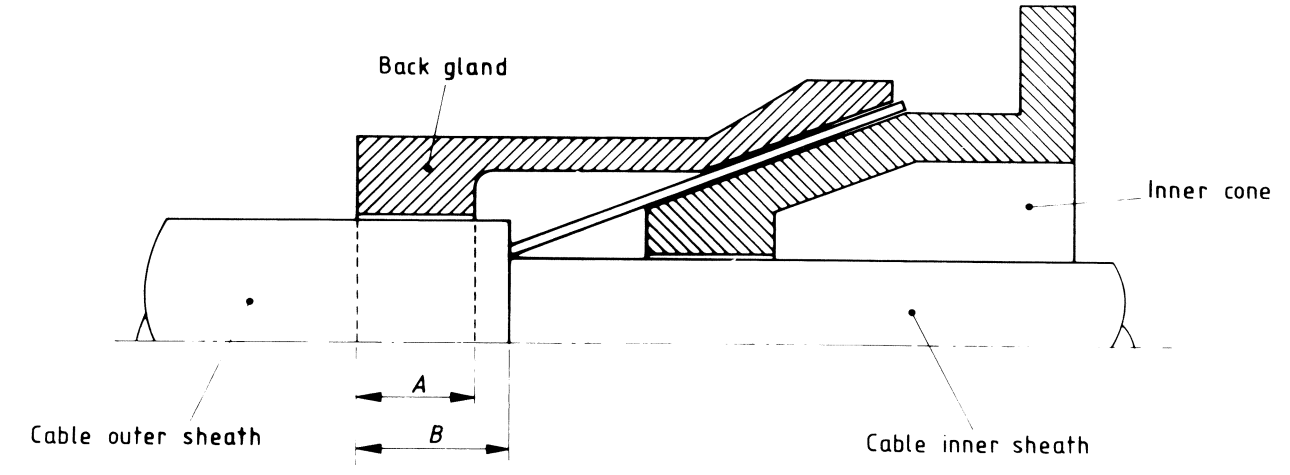
See note to clause **1**.

Figure 13. Creepage distances and clearances



See note to clause **1**.

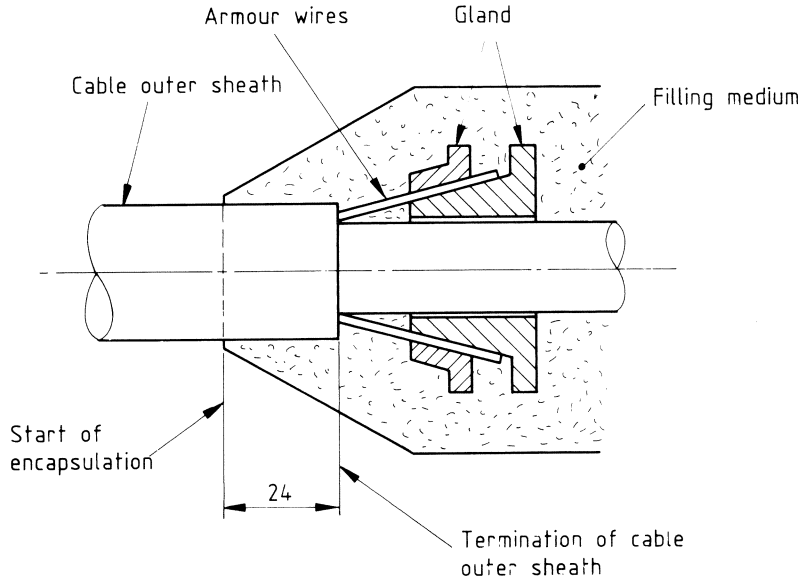
Figure 14. Coupler glandsets for pliable wire armoured cables



NOTE. Only single wire armoured cable is shown

See note to clause **1**.

Figure 15. Coupler glandsets for single and double wire armoured cables



See note to clause **1**.

Figure 16. Gland for single or double wire armoured cable for non-metallic cable sealing box

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List of references

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 148 : 1984	*Specification for unused mineral insulating oils for transformers and switchgear*
BS 240 : 1986	*Method for Brinell hardness test and for verification of Brinell hardness testing machines*
BS 903:	*Physical testing of rubber*
BS 903 : Part A6 : 1992	*Method for determination of compression set at ambient, elevated or low temperatures*
BS 903 : Part A16 : 1987	*Determination of the effect of liquids*
BS 903 : Part A19 : 1986	*Heat resistance and accelerated ageing tests*
BS 903 : Part A26 : 1969	*Determination of hardness*
BS 903 : Part C2 : 1982	*Determination of volume resistivity*
BS 903 : Part C3 : 1982	*Determination of loss tangent and permittivity at power and audio frequencies*
BS 903 : Part C4 : 1983	*Determination of electric strength*
BS 1433 : 1970	*Specification for copper for electrical purposes. Rod and bar*
BS 1474 : 1987	*Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections*
BS 1858 : 1973	*Specification for bitumen-based filling compounds for electrical purposes*
BS 2782:	*Methods of testing plastics*
BS 2782 : Part 1 :	*Thermal properties*
BS 2782 : Method 141 : 1986	*Determination of flammability by oxygen index*
BS 2782 : Part 2 :	*Electrical properties*
BS 2782 : Methods 220 and 221 : 1983	*Determination of electric strength: rapidly applied voltage method. Determination of electric strength: step-by-step method*
BS 2782 : Methods 230A : 1982	*Determination of volume resistivity*
BS 2782 : Method 240A and 240B : 1982	*Determination of loss tangent and permittivity at power and audio frequencies*
BS 2782 : Part 3 :	*Mechanical properties*
BS 2782 : Methods 320A to 320F : 1976	*Tensile strength, elongation and elastic modulus*
BS 2782 : Method 335A : 1993	*Determination of flexural properties*
BS 2782 : Method 359 : 1993	*Determination of Charpy impact strength*
BS 2782 : Part 4 :	*Chemical properties*
BS 2782 : Methods 430A to 430D : 1983	*Determination of water absorption at 23 °C. Determination of water absorption at 23 °C with allowance for water-soluble matter. Determination of boiling water absorption. Determination of boiling water absorption with allowance for water-soluble matter*
BS 2816 : 1989	*Method for specifying electroplated coatings of silver and silver alloys for engineering purposes*
BS 2874 : 1986	*Specification for copper and copper alloy rods and sections (other than forging stock)*
BS 2918 : 1957	*Determination of electric strength of solid insulating materials at power frequencies*
BS 3692 : 1967	*Specification for ISO metric precision hexagon bolts, screws and nuts. Metric units*

BS 4168 :	*Hexagon socket screws and wrench keys: metric series*
BS 4168 : Part 5 : 1981	*Specification for hexagon socket set screws with cup point*
BS 4439 : 1969	*Specification for screwed studs for general purposes. Metric series*
BS 5501:	*Electric apparatus for potentially explosive atmospheres*
BS 5501 : Part 1 : 1977	*General requirements*
BS 5501 : Part 5 : 1977	*Flameproof enclosure 'd'*
BS 5501 : Part 8 : 1988	*Encapsulation 'm'*
BS 5901 : 1980	*Method of test for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*
BS 6346 : 1989	*Specification for PVC-insulated cables for electricity supply*
BS 6622 : 1991	*Specification for cables with extruded cross-linked polyethylene or ethylene propylene rubber insulation for rated voltages from 3800/6600 V up to 19 000/33 000 V*
BS 7383 : 1990	*Specification for cold-pour resin-based compound for use as a filling medium in terminating cables in enclosures for voltages not exceeding 11 kV for use in coal mines*
BS EN 60529 : 1992	*Specification for degrees of protection provided by enclosures (IP code)*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 3454 : 1994[5)]	*Specification for 1.9/3.3 kV, 300 A bolted flameproof cable couplers and adaptors (including 380/660 V and 640/1100 V, 300 A adaptors), for use in mines*
BS 4683 :	*Specification for electrical apparatus for explosive atmospheres*
BS 4683 : Part 2 : 1971[5)]	*The construction and testing of flameproof enclosures of electrical apparatus*

Other references

[1] GREAT BRITAIN. Health and Safety at Work etc. Act 1974. London: HMSO[5)]
[2] GREAT BRITAIN. Mines and Quarries Act 1954. London: HMSO[5)]

[5)] Referred to in the foreword only.

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