BRITISH STANDARD

BS 1858:2002

Electric cables — Accessories — Bitumen-based filling compounds

ICS 29.035.99; 75.140

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee GEL/20, Electric cables, to Subcommittee GEL/20/7, Cable joints and terminations, upon which the following bodies were represented:

BEAMA Ltd — BECCAMA — Electrical
BEAMA Ltd — EIEMA — Electrical
British Approvals Service for Cables
British Cables Association
Electricity Association
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This British Standard, having been prepared under the direction of the Electrotechnical Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 14 February 2002

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BS 688 first published December 1936
BS 803 first published May 1938
First revision combining both standards June 1952
Second revision April 1957
Third revision October 1973
Fourth revision February 2002

The following BSI references relate to the work on this British Standard:
Committee reference GEL/20/7
Draft for comment 99/244647 DC

ISBN 0 580 37296 0

Amendments issued since publication

Amd. No.	Date	Comments

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Foreword

This revision of BS 1858 has been prepared by Subcommittee GEL/20/7[1]. It supersedes BS 1858:1973 (1998), which is withdrawn.

This new edition of BS 1858 incorporates technical changes only. It does not represent a full review or revision of the standard, which will be undertaken in due course.

This new edition is now specific to bitumen for use in accessories of electric cables.

In this new edition of BS 1858, the methods of test continue to be based as far as possible on the standard methods for testing petroleum and its products, published by the Institute of Petroleum. These methods are published as British Standards, which are revised with the minimum of delay when the Institute's methods are revised.

By comparison with the previous edition, this new edition of BS 1858 does not contain the Class VI compound, for which there is very limited and declining demand.

The technical requirements for compounds of Class I to V are substantially the same as those in the previous edition, but some changes have been made to cater for up-to-date techniques.

Annex A, Annex B, Annex C, Annex D and Annex E are normative.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

WARNING. This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

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[1] Subcommittee GEL/20/7 has been redesignated as Subcommittee GEL/20/11 following the reorganization of Technical Committee GEL/20.

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1 Scope

This British Standard specifies requirements for bitumen-based compounds that are subjected to electrical stress in service and are suitable for use as filling compounds in the accessories for electric cables. It is not applicable to oils and oil-resisting compounds, cold pouring compounds and those designed for special purposes.

NOTE Conformity of a filling compound to the provisions of this standard does not necessarily indicate that it is suitable for a particular cable accessory purpose intended by the purchaser. When there is any doubt as to the type of compound to be used for any such purpose, the supplier of the compound should be consulted.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 358, *Method for the measurement of voltage with sphere-gaps (one sphere earthed).*

BS 871, *Abrasive papers and cloths for general purposes.*

BS 2000-35, *Methods for test for petroleum and its products — Part 35: Flash point (open) and fire point of petroleum products by the Pensky-Martens apparatus.*

BS 2000-47, *Methods for test for petroleum and its products — Part 47: Solubility of bituminous binders.*

BS 2000-49, *Methods for test for petroleum and its products — Part 49: Penetration of bituminous materials.*

BS 2000-72, *Methods for test for petroleum and its products — Part 72: Viscosity of cutback bitumen and road oil.*

BS 2000-213, *Methods for test for petroleum and its products — Part 213: Acidity of bitumen (neutralization value).*

BS 4450, *Method for determination of ash from petroleum products.*

BS EN 22592, *Methods of test for petroleum and its products — Petroleum products — Determination of flash and fire points — Cleveland Open Cup method.*

3 Classification

The classes of compounds, classified on the basis of their softening points, covered by this British Standard are listed in Table 1.

Table 1 — Classification of compounds, and their properties

Class	Softening point[a]			Penetration value[b]	Contraction, max.	Electric strength (proof) test	
	Min. °C	Max. °C	Tolerance on agreed value °C		%	Test temperature °C	Test voltage kV
I	[c]	40	±5[d]	[c]	8	60 ± 1	15
II	>40	70	±3	20	8	60 ± 1	20
III	>70	90	±3	20	8	60 ± 1	20
IV	>90	120	±5	10	[e]	90 ± 1	20
V	>120	[c]	±5	7	[e]	90 ± 1	20

[a] See clause **6**.

[b] The penetration value is defined in BS 2000-49 as "the distance in tenths of a millimetre that a standard needle penetrates vertically into a specimen of the material under specified conditions of temperature, load and duration of loading". BS 2000-49 gives "specified conditions".

[c] There is no specified requirement. Any requirement shall be the subject of a purchase contract.

[d] Except when too fluid to test for softening point.

[e] Value subject to agreement between purchaser and supplier.

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4 General requirements

The compound shall be stable and shall neither froth nor emit excessive fumes when heated to a temperature of 85 °C above the softening point (see clause **6**).

Under normal conditions of use there shall be no formation of gas pockets, cavities or cracks in the compound on cooling.

At the temperature reached during installation and under the conditions of service, the compound shall have no injurious effect on metallic or non-metallic components of cables or cable accessories with which the compound comes into contact.

The compound shall be capable of being re-melted repeatedly, without significant separation of the constituents, provided that a temperature of 20 °C above the pouring temperature is not exceeded and that local overheating is avoided. Compounds, especially those of high softening point, shall not be maintained at these temperatures for longer than is necessary.

NOTE References to removal of water in various test methods are applicable only when samples of compound have been contaminated.

5 Solubility

The solubility of all compounds shall be determined by the method given in BS 2000-47. The insoluble content, including the proportion of mineral matter permitted by clause **12**, shall not exceed 0.5 %.

6 Softening point

The value of the softening point of a compound in any class shall lie within the range specified for that class in Table 1. If a specific softening point within any class of compound has been agreed between the supplier and the purchaser, the softening point shall not vary from the agreed value by more than the tolerance specified in Table 1. The softening point of Class I compound shall not exceed 40 °C.

7 Penetration

The penetration value of compounds of Classes II, III, IV and V shall be not less[2] than the appropriate value given in Table 1, and the tolerance on penetration shall be in accordance with that given in Table 2. The test for penetration of the compound shall be carried out as described in BS 2000-49.

Table 2 — Tolerance on penetration

Penetration value[a]	Tolerance
Up to 10	±2
11 to 80	±4
81 and above	±10

[a] The penetration value is defined in BS 2000-49 as "the distance in tenths of a millimetre that a standard needle penetrates vertically into a specimen of the material under specified conditions of temperature, load and duration of loading". BS 2000-49 gives "specified conditions".

8 Viscosity of Class I compounds

The viscosity of Class I compounds shall be determined in accordance with BS 2000-72 and shall not vary from the agreed value[3] by more than 25 % of that value.

9 Pouring point of compounds of Classes II to V

The pouring point of compounds of Classes II, III, IV and V[3] shall be determined in accordance with Annex A. The tolerance on the pouring point shall be ±5 °C.

NOTE The pouring point may be regarded as approximating to the temperature to which the compound should be heated for pouring in actual practice and should not be exceeded by more than 20 °C. When the pouring point is not known, the pouring temperature may be taken as being approximately 85 °C above the softening point of the compound (see clause **6**) for all classes of bitumen-based compounds.

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[2] Absolute values are not specified in this standard and should be the subject of a purchase contract.

[3] The value of the property is not specified in this standard. This should be the subject of a purchase contract.

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10 Electric strength (proof) test

Two samples of the compound shall be tested in accordance with Annex B. If one sample fails to withstand for 1 min without puncture the appropriate voltage given in Table 1, at the stated temperature, a third sample shall be tested. The compound shall be deemed to have passed the test if the results for two out of the three samples are satisfactory.

11 Flash point (open)

The flash point of a compound of any class, when determined by one of the methods described in BS 2000-35 or BS EN 22592, shall be not less than 200 °C.

In cases of dispute, the method given in BS 2000-35 shall be used.

12 Mineral matter (ash)

The amount of mineral matter in a compound of any class shall be determined by the method of ashing described in BS 4450. The amount of mineral matter shall not exceed 0.5 %.

13 Acidity: neutralization value

If it is necessary to specify in the purchase contract the neutralization value for any class of compound, this shall not exceed 10 mg KOH/g and shall be determined in accordance with the indicator method described in BS 2000-213.

NOTE In the absence of any requirement to the contrary in the purchase contract, it is preferable that the neutralization value should not exceed 4 mg KOH/g.

14 Freedom from injurious sulfur

The compound shall be tested in accordance with Annex C and there shall be no more than a slight discoloration of the copper.

15 Adhesive properties

If specified by the purchaser, the compound, other than a compound of Class I, shall be tested for adhesive properties in accordance with Annex D. The compound shall be deemed to have passed the test if adhesion occurs over an area of the plate not less than 90 % of that which had been exposed to the molten compound.

16 Contraction and depth of pipe

16.1 Contraction

The compound shall be tested for contraction in accordance with Annex E. The contraction shall not exceed the appropriate value given in Table 1.

NOTE The coefficient of expansion of compounds of all classes is of the order of 0.0006/K on the volume at 20 °C.

16.2 Depth of pipe

The compound shall be tested for depth of pipe in accordance with Annex E. The depth of pipe for compounds of Classes I, II and III shall not exceed 25 mm. The depth of pipe shall be the subject of agreement between the purchaser and the supplier for compounds of Classes IV and V.

NOTE 1 This test is of value in comparing the behaviour, on cooling, of compounds with similar softening points and eliminates those which, by virtue of their composition, have a sharper softening point and a tendency to excessive pipe formation.

NOTE 2 In the practical use of compounds the extent of pipe or depression formation is chiefly governed by the pouring temperature and conditions of cooling. Pipe formation can be reduced by taking care to select a compound having the lowest softening point and pouring temperature consistent with the purpose for which the compound is required, and by encouraging cooling from below upwards by shielding the top portion of the apparatus during the cooling process.

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Annex A (normative)
Pouring point of compounds of Classes II to V

A.1 General

The pouring point is the temperature at which 50 ml of compound flows out of the defined apparatus in 25 s.

NOTE This is equivalent, for all practical purposes, to a viscosity of 1 000 cSt[4] (see note to clause **9**).

A.2 Apparatus

A.2.1 The apparatus for the determination of the pouring point of the compound shall be as shown in Figure A.1, Figure A.2, Figure A.3, Figure A.4 and Figure A.5. The jet, the valve and the container for holding the compound shall have the dimensions shown in Figure A.2 and Figure A.3. Details of the apparatus, arranged for electrical heating, shall be as shown in Figure A.3 and Figure A.4. If gas heating is to be used, the container shown in Figure A.3 shall be fitted into a thick-walled copper vessel into which two copper lugs are screwed and brazed (see Figure A.5). With either form of apparatus the container shall be a close fit in the outer vessel. The construction of the apparatus shall be as described in **A.2.2**, **A.2.3** and **A.2.4**.

A.2.2 The container in which the compound is placed shall consist of a brass tube having a wall thickness of approximately 3 mm, silver-soldered into a brass block 22.2 mm thick, as shown in Figure A.3. The jet shall be of case-hardened steel and shall be as shown in Figure A.3.

A.2.3 A pin-type valve of silver-steel rod of 6.4 mm diameter (see Figure A.2), with a fitting to hold the thermometer, shall close the orifice of the jet. The valve shall be fitted with a short pin so that it can be supported in the ring-holder above the orifice during a test. The stirrer shall consist of a spiral of 1.600 mm diameter spring steel wire (see Figure A.2). The receiver shall be a transparent silica flask graduated at 50 ml intervals (see Figure A.1).

NOTE A silica or borosilicate glass test-tube, 22 mm to 25 mm in diameter, can be used.

A.2.4 The container shall have a mark cut on the inside all round the tube at a distance of (95.0 ± 0.2) mm from the upper surface of the brass block. When electrical heating is to be used, the container shall fit closely into an outer vessel of brass mounted on a brass block (see Figure A.4). The external surface of the outer vessel shall be insulated with a suitable thermal and electrical insulating material on which is wound nickel-chromium wire kept in place with refractory cement[5] (see Figure A.4). A suitable thermal insulation shall be wound over the heater and covered with a copper foil sheath. For temperature control, a suitable variable resistor shall be connected in series with the heater. For testing the compounds covered by this British Standard, the heater shall be suitable for dissipating not less than 200 W.

NOTE The size and number of turns of wire depend on the voltage of the circuit to which the heater is to be connected. For a supply of between 200 V and 230 V, 100 turns of 0.315 mm diameter nickel-chromium wire is suitable for testing the compounds covered by this standard.

A.2.5 When gas heating is to be used, the outer vessel shall be turned out of solid copper and fitted with two copper rods (heater lugs) screwed and brazed into the vessel (see Figure A.5). In other respects the apparatus shall be similar to that described in **A.2.1**, **A.2.2**, **A.2.3** and **A.2.4**. The brass container for holding the compound shall be a close fit in the outer vessel.

A.3 Procedure

A.3.1 Heat the compound to a temperature 90 °C to 100 °C above the softening point (see clause **6**) and pour into the container which was previously placed in the outer vessel and raised to the same temperature, up to the “filling mark”. When the temperature of the compound (with continuous stirring) has been steady for about 2 min, raise the pin-valve and support in the holder clear of the jet, and the compound flows out into the graduated receiver (see Figure A.1). Use a stop-watch, reading to one-fifth of a second, for determination of the time required for 50 ml of compound to flow out. Wind up the stop-watch fully before each test.

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[4] 1 000 cSt = 1 mm^2/s.

[5] Alundum is known to be suitable.

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A.3.2 To ascertain the pouring point of a compound, make not less than four tests on four portions at different temperatures and determine the time of outflow of 50 ml of compound in each case. Make the tests at four temperatures covering the range of temperature at which the time of efflux is not less than 10 s or more than 50 s. To avoid decomposition, take care not to overheat the compound.

NOTE Overheating can be recognized by dense or coloured fumes or by the formation of a skin on the surface of the compound.

A.3.3 To determine the pouring point, plot the results of the tests with the temperatures in degrees centigrade (°C) against the $\log_{10}$ of the times of outflow in seconds (s). Obtain the pouring point by interpolation from this curve.

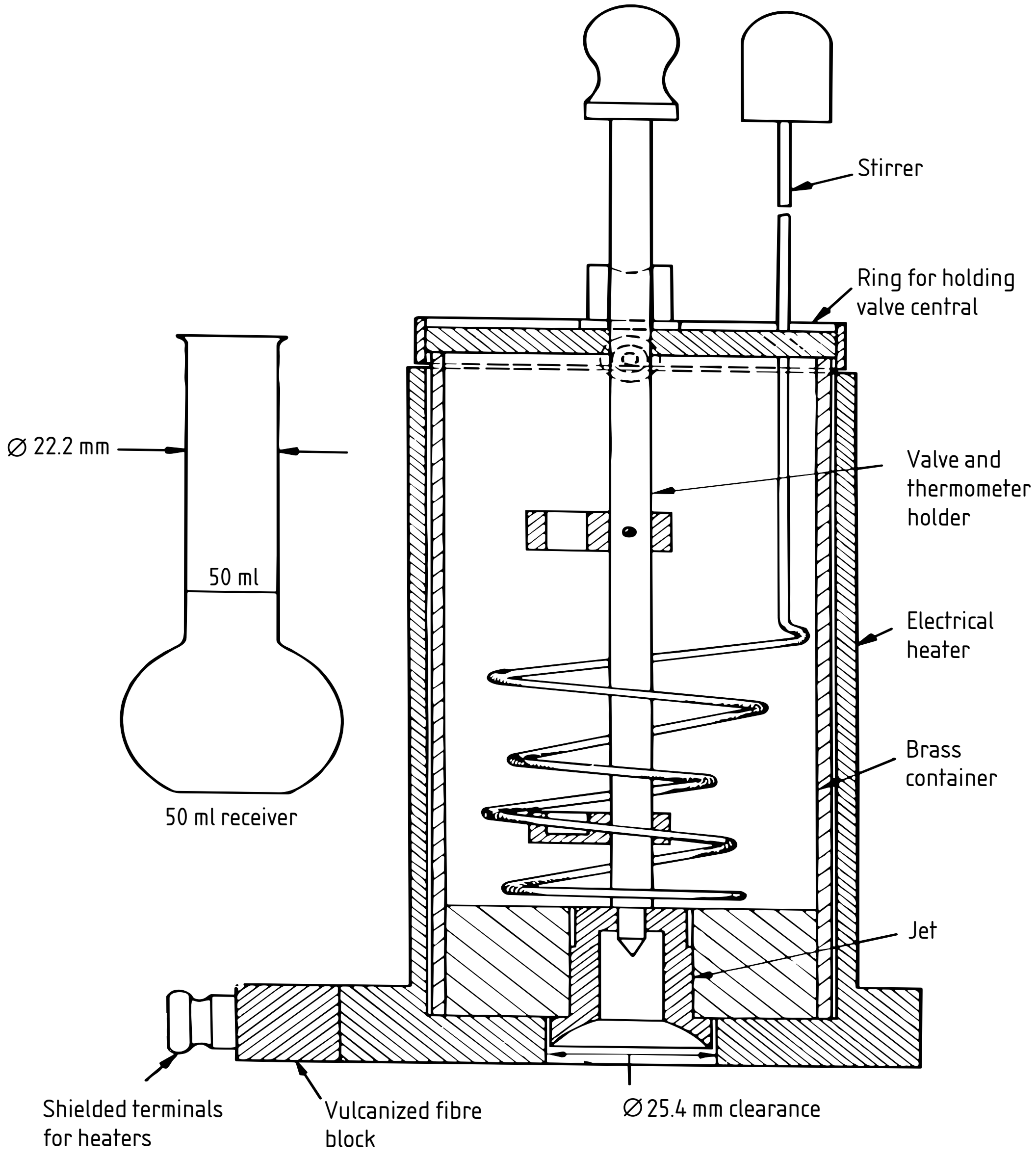

Figure A.1 — Apparatus for determination of pouring point arranged for electrical heating

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Dimensions in millimetres

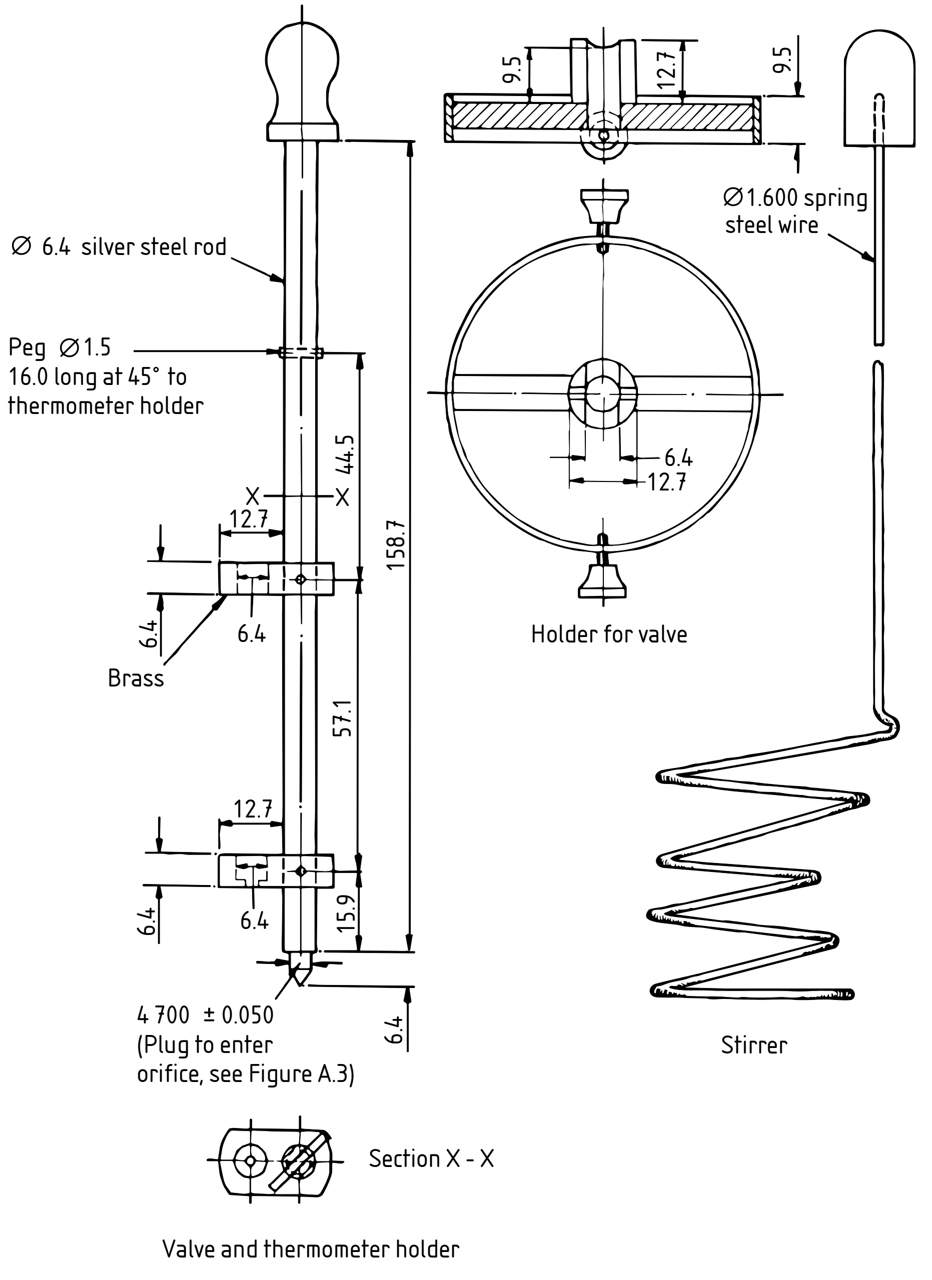

Figure A.2 — Valve, holder and stirrer

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Dimensions in millimetres

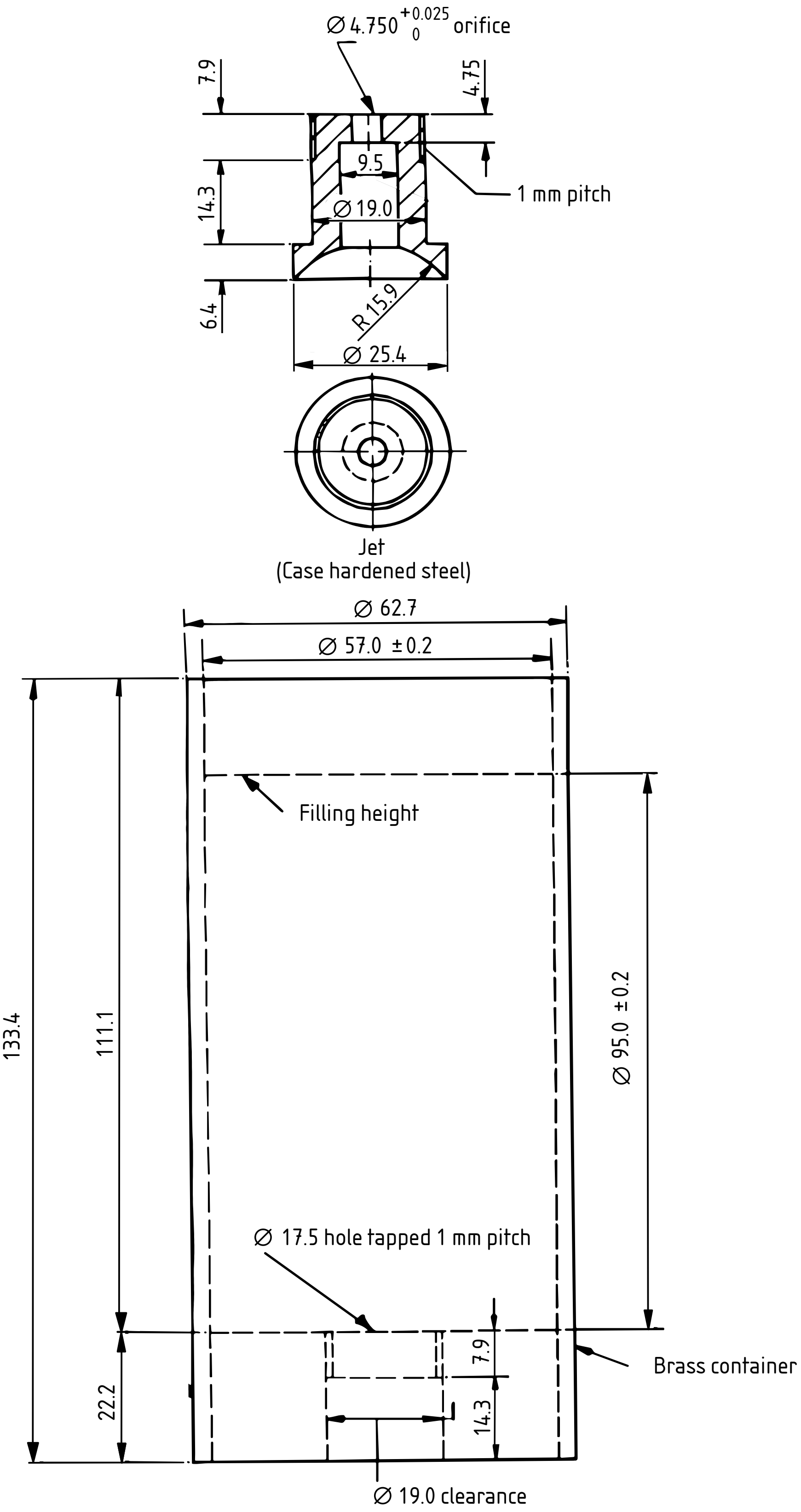

Figure A.3 — Container for compound and jet

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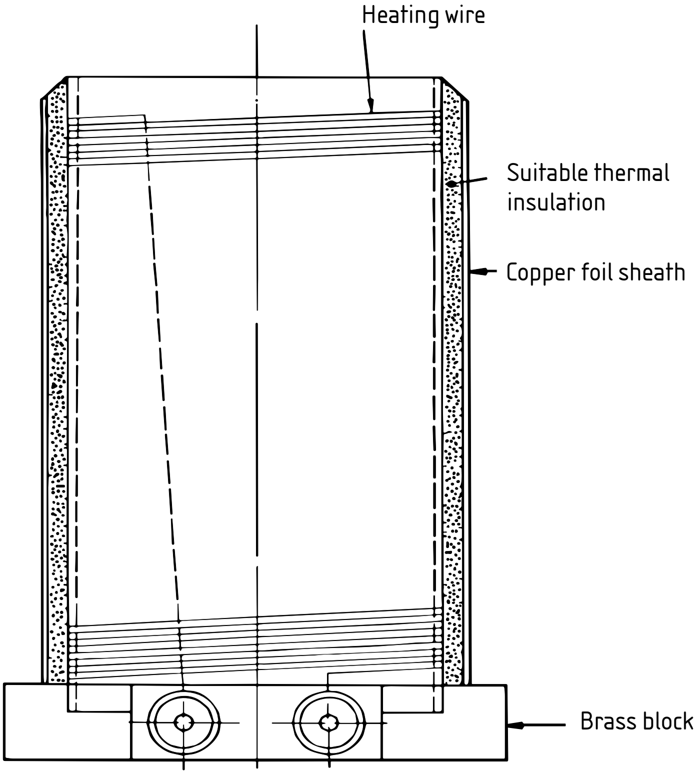

Figure A.4 — Outer vessel for electrical heating

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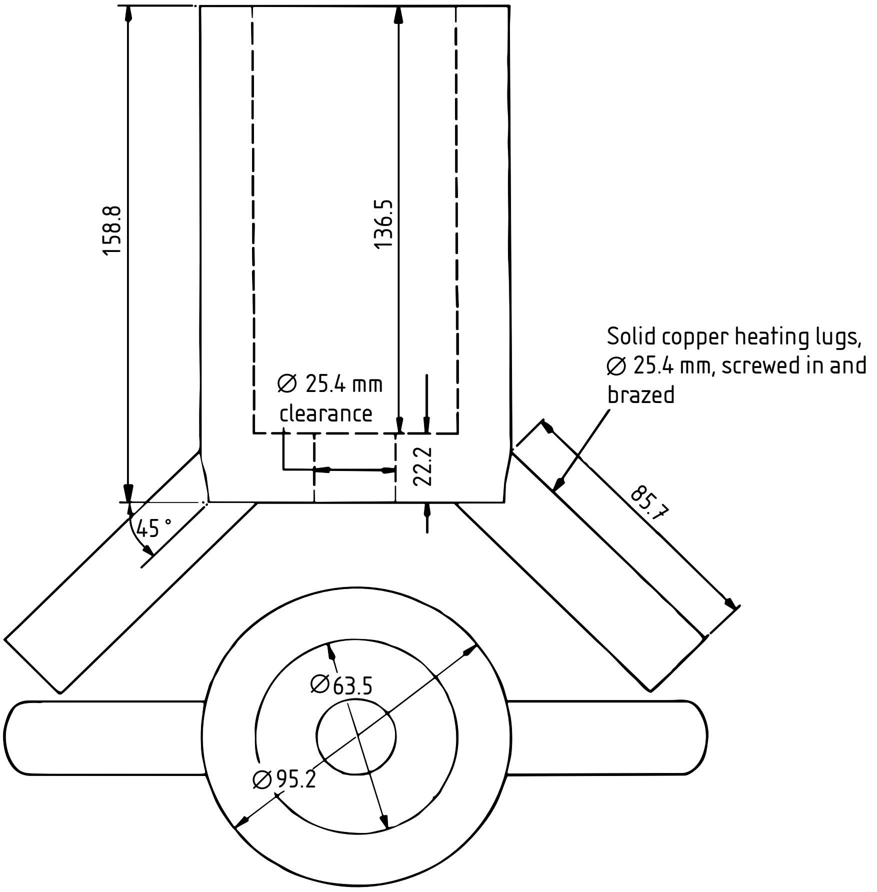

Figure A.5 — Outer vessel for gas heating

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Annex B (normative)
Electric strength (proof) test

NOTE This annex is in accordance with BS EN 60243-1.

B.1 Apparatus

B.1.1 *Two spherical steel or brass electrodes*, of diameter between 12.5 mm and 13.0 mm arranged horizontally 1.25 mm apart, at the test temperature, in a suitable container (**B.1.2**) into which the compound can be poured.

B.1.2 *Glazed porcelain vessel*, or other suitable form of container, having the internal dimensions shown in Figure B.1.

NOTE 1 A satisfactory method of mounting the electrode is shown in Figure B.1.

NOTE 2 If the electrodes are fitted to steel shanks and the gap between the electrodes is set at a temperature of 20 °C, then this gap will be approximately 0.05 mm short at 60 °C and 0.1 mm short at 90 °C. Allowance should be made for the expansion of all shanks when setting the gap or, preferably, the gap should be set at the test temperature.

Dimensions in millimetres

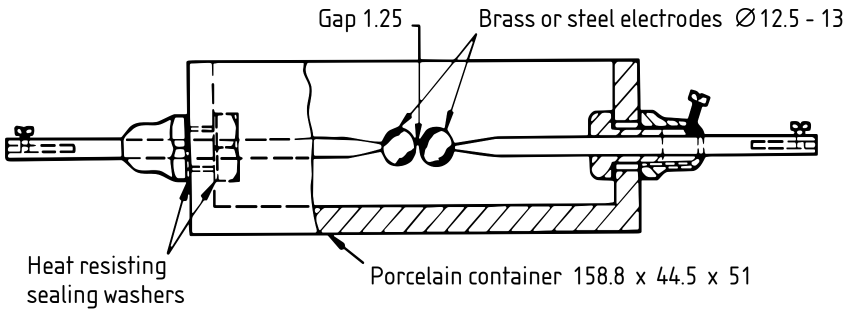

Figure B.1 — Apparatus for electric strength (proof) test

B.2 General

The test voltage shall be provided by a transformer and shall be alternating at any convenient frequency between 25 Hz and 100 Hz. It shall be of approximately sine wave form with a peak factor within the limits of ($\sqrt{2} \pm 7$) % (1.31 to 1.51) at the test voltage.

The test voltage shall be measured in one of the following two ways;

a) *either* the peak value of the test voltage shall be measured by a peak voltmeter, in which case the r.m.s. value for the purposes of this standard shall be considered as the peak value so determined divided by $\sqrt{2}$;

b) *or* the test voltage shall be determined by a voltmeter connected to the input or output side of the testing transformer and calibrated against a sphere gap connected to the output terminals of the transformer (see BS 358).

The impedance of the testing set shall be such that the short-circuit current is not less than 20 mA at all required voltage settings above 15 kV.

NOTE To prevent damage to the electrodes the short-circuit current may be limited, if desired, by the addition of external impedance, but should not be reduced below the value stated above.

Either one pole of the testing transformer shall be earthed or both shall be insulated. In the latter case, the voltages to earth from each pole shall be approximately equal.

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B.3 Procedure

Heat the compound, container and electrodes to the pouring point of the compound under test.

Pour the compound into the container until the electrodes are covered to a depth of not less than 6 mm. Maintain the vessel and compound at the pouring point for at least 1 h to ensure that all air bubbles have dispersed. Cool the compound slowly to the test temperature. Measure this temperature by inserting a thermometer in a control cell placed close to the cell under test at a depth approximately at the position of the electrodes. Maintain this temperature for at least 3 h before the test is made, to ensure that the temperature at the electrodes is the correct test temperature.

NOTE To ensure that it is dry when poured, Class 1 compound should be poured at a temperature of not less than 100 °C.

Make the electric strength (proof) test at the appropriate temperature given in Table 1.

Raise the voltage gradually from zero to the appropriate value given in Table 1, in approximately 10 s, and maintain the voltage at that value for 1 min.

Annex C (normative)
Injurious sulfur

WARNING. Solvents deemed suitable for this test may be toxic, and adequate precautions should be taken. They may be flammable or, if non-flammable, may become toxic in the vapour phase. For these reasons the presence of flames or other sources of ignition should be prohibited.

C.1 Separate about 1 g of the compound into pieces as small as practicable and place in a porcelain dish. Add about 50 ml of a suitable solvent (see **C.2**) and then heat the dish gently on a water bath. Clean and polish a piece of freshly polished copper foil approximately 50 mm square with a pad of cotton wool and a fine abrasive powder[6], and rub with successive pads of cotton wool until a fresh pad remains unsoiled after having been rubbed on the foil. Completely immerse the foil in the warm solution for 30 min, the bulk of the liquid being maintained by occasional additions of the solvent as required. On removal of the copper foil from the solution, wash it with the liquid used as the solvent and examine it for discoloration.

C.2 A solvent shall be deemed to be suitable if, when the procedure described in **C.1** is carried out without the compound, there is no discoloration of the copper.

Annex D (normative)
Adhesive properties

D.1 Apparatus

A steel mould “A”, in the form of a cylinder of the dimensions shown in Figure D.1, shall rest on a steel plate “B”. The mould shall contain two dowels (not shown) fitted in one end, which register easily in holes “C” and “D” in the plate. A hole shall be drilled through the wall of the mould and shall be continued into the plate to receive a thermometer.

D.2 Preparation

Prepare the surface of the steel plate either by means of a recognized polishing machine, as used for the preparation of specimens for metallographic examination, or by hand with a fresh, clean sheet of no. 1 emery cloth to BS 871. If the latter method is used, place the emery cloth on a flat surface and lay the steel plate face downward on the emery cloth. Rub the plate to and fro in one direction, avoiding a circular motion, until all marks are in that direction, and then in a direction at right angles until all marks are in the latter direction. Carry out the double rubbing not less than three times and until inspection of the surface of the plate shows that all the scratches are new.

D.3 Procedure

Immediately after cleaning as described above, place the apparatus in an oven until the thermometer registers the appropriate temperature specified in Table D.1. Heat the compound under test to the pouring point[7], and then pour it into the mould until the latter is full.

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[6] 100 µm carborundum is suitable.

[7] When the pouring point is not known, the compound can usually be heated safely to 85 °C above the softening point.

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Table D.1 — Mould temperatures

Softening point of compound		Mould temperature
Above	Up to and including	
—	90 °C	As softening point
90 °C	120 °C	Softening point plus 20 °C
120 °C	—	Softening point plus 40 °C

Cool the apparatus and compound to a temperature of (20 ± 5) °C and maintain at this temperature for not less than 1 h. Screw a ring or other form of handle into the underside of the plate and subject the mould and plate to a slow steady pull until they are separated. Examine the plate and report the percentage area of adhesion.

NOTE A brown stain is not regarded as an indication of adhesion between the compound and the base plate.

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Dimensions in millimetres

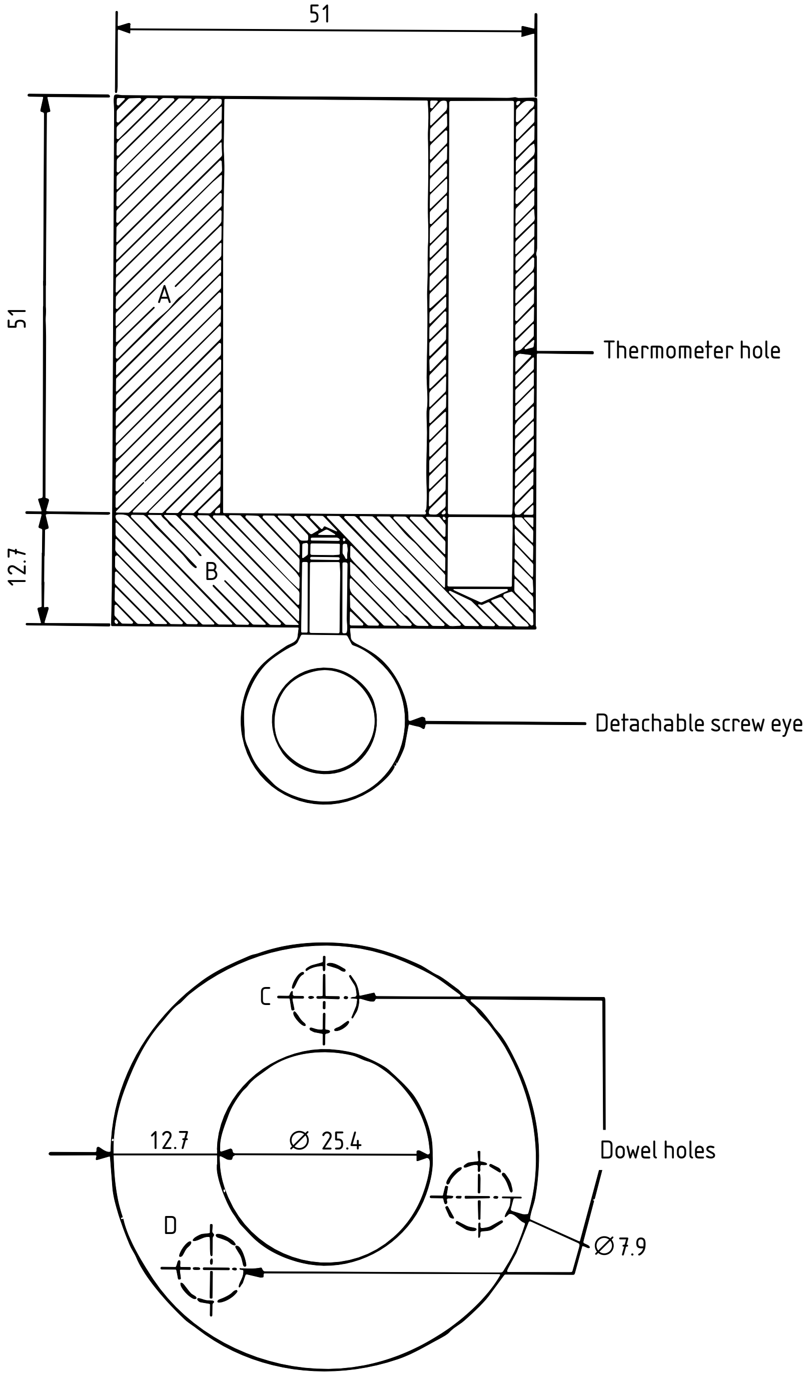

Figure D.1 — Apparatus for determination of adhesive properties

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Annex E (normative)
Contraction and depth of pipe

E.1 Method

Measure the contraction and depth of pipe by using a glass tube of 40 ml nominal capacity and 20 mm internal diameter, having flat, ground edges (see Figure E.1). Heat the tube to 150 °C, slightly overfill with the compound under test, also preheated to this temperature, and maintain at (150 ± 1) °C for 1 h when testing compound of softening point below 120 °C, or for 2 h when testing compound of softening point above 120 °C.

At the end of this period, level the compound to the top of the tube by means of a heated metal spatula. Immediately transfer the compound-filled tube to the laboratory bench and cool to a temperature of (20 ± 1) °C. In order to control the rate of cooling, enclose the tube throughout this period in a draught screen, 225 mm to 250 mm high, with a covered top, which is either a cylinder of 100 mm to 175 mm diameter, or a rectangular screen having 150 mm to 175 mm sides.

If the laboratory temperature exceeds 21 °C, after cooling in air to the laboratory temperature, immerse the tube in a water-bath and cool to a temperature of (20 ± 1) °C. Take the temperature measurements with a thermometer immersed in another similar tube of compound, which is submitted simultaneously to the same heating and cooling cycle as the compound under test.

E.2 Contraction

Ensure that the compound is free from internal cavities after cooling to 20 °C. Fill, with methylated spirit from a burette, the pipe formed in the compound as the result of cooling it in air to 20 °C. Note the volume of spirit required to fill the pipe. From the figure obtained, calculate the percentage contraction.

E.3 Depth of pipe

Measure, by means of a depth gauge or other suitable instrument, the depth between the ground mouth of the tube and the bottom of the pipe in the compound at 20 °C.

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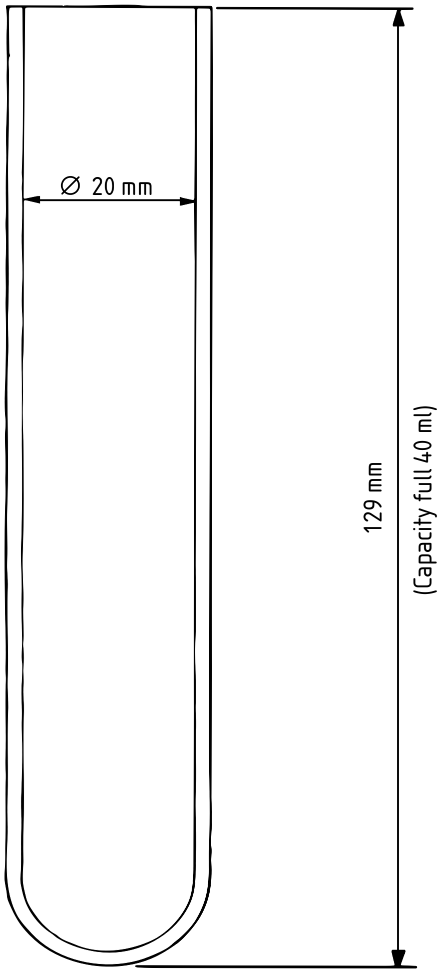

Figure E.1 — Glass tube for contraction and depth of pipe

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Bibliography

BS EN 60243-1, *Methods of test for electric strength of solid insulating materials — Part 1: Tests at power frequencies.*

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