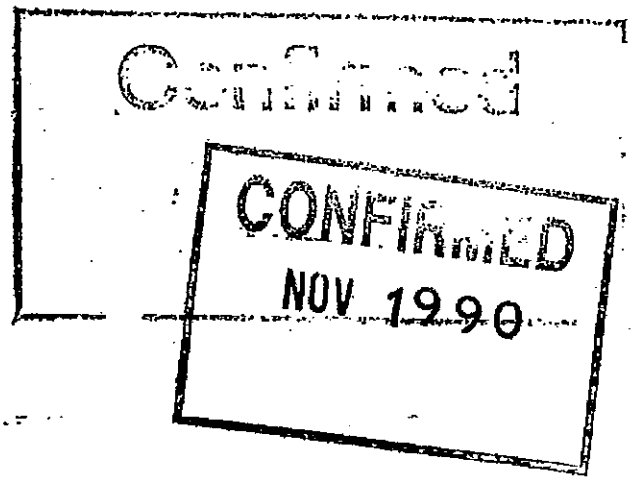
BRITISH STANDARD SPECIFICATION

CARTRIDGE FUSE-LINKS

(RATED AT UP TO 5 AMPERES)

FOR A.C. AND D.C. SERVICE

B.S. 646 : 1958



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THIS BRITISH STANDARD, having been approved by the Electrical Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 31st January, 1958.

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provision of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 4000, indexed and cross-indexed for reference, together with an abstract of each standard, will be found in the Institution's Yearbook.

This standard makes reference to the following British Standards:

B.S. 88.	Electric fuses for circuits of voltage-ratings up to 660 volts.
B.S. 481.	Woven wire and perforated plate sieves and screens for industrial purposes.
B.S. 546.	Two-pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors for circuits up to 250 volts.
B.S. 1362.	Cartridge fuse-links for use in plugs.
B.S. 1363.	Two-pole and earthing-pin fused-plugs and shuttered socket-outlets for a.c. circuits up to 250 volts.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard:—
Committee reference ELE/4, ELE/4/3
Draft for comment CX (ELE) 2569.

CONTENTS

CO-OPERATING ORGANIZATIONS

The Electrical Industry Standards Committee under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

*Admiralty
*Air Ministry
Associated Offices' Technical Committee
*Association of Consulting Engineers (Incorporated)
*Association of Supervising Electrical Engineers
*British Electrical and Allied Industries Research Association
*British Electrical and Allied Manufacturers' Association
British Electrical Development Association
British Railways, The British Transport Commission
*Cable Makers' Association
*Central Electricity Authority and Area Boards
*Crown Agents for Oversea Governments and Administrations
Electric Lamp Industry Council
*Electric Light Fittings Association
*Electrical Contractors' Association (Incorporated)
Electrical Contractors' Association of Scotland
*Engineering Equipment Users' Association
Independent Cable Makers' Association
*Institution of Electrical Engineers
*Ministry of Labour and National Service (Factory Inspectorate)
Ministry of Power
*Ministry of Supply
*Ministry of Works
National Inspection Council for Electrical Installation Contracting
*National Physical Laboratory (D.S.I.R.)
*Oil Companies Materials Committee
*Post Office
Public Transport Association (Incorporated)
Radio Industry Council
South of Scotland Electricity Board
War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the Committee entrusted with the preparation of the standard.

Electrical Association for Women
Fire Offices Committee
Lloyds Register of Shipping
Radio and Electronic Component Manufacturers' Federation.

BRITISH STANDARD SPECIFICATION FOR

CARTRIDGE FUSE-LINKS

(RATED AT UP TO 5 AMPERES)

FOR A.C. AND D.C. SERVICE

FOREWORD

The previous (1935) edition of this specification included two types of fuse-link, namely Type A and Type B, but it was decided that when a new edition was issued, it should apply to the Type A fuse-link only. The current edition, therefore, applies to the former Type A fuse-links, and the Type B fuse-links are the subject of a new British Standard, B.S. 2950 ' Cartridge fuse-links for use with telecommunications and light electrical apparatus '. The designations Type A and Type B have been discarded and each type of fuse-link should be referred to in terms of its relevant British Standard (i.e., B.S. 646 or B.S. 2950).

The specification prescribes new requirements and tests, and the breaking capacity rating has been raised to values corresponding to B.S. 88 Categories of Duty AC1 and DC1. Both a.c. and d.c. are prescribed for all tests for duty which include tests at prospective currents simulating the most severe operating conditions.

This British Standard is one of a series including the following:

B.S. 88.	Electric fuses for circuits of voltage-ratings up to 660 volts.
B.S. 714.	Cartridge-fuse links for use in railway signalling circuits.
B.S. 1361.	Cartridge-fuses for domestic consumers' units.
B.S. 1362.	Cartridge fuse-links for use in plugs.
B.S. 1454.	Consumers' electricity control units.
B.S. 2510.	Composite units of switches and fuses in industrial systems and domestic circuits.
B.S. 2692.	Fuses for alternating-current circuits above 660 volts.
B.S. 2950.	Cartridge fuse-links for telecommunication and light electrical apparatus.
B.S. 3036.	Semi-enclosed electric fuses of ratings up to 200 amps and 250 volts to earth.

'Fuses within the scope of this standard are not sensitive to normal electromagnetic disturbances, and therefore no immunity tests are required.

Significant electromagnetic disturbance generated by a fuse is limited to the instant of its operation. Provided that the maximum arc voltages during operation in the type test comply with the requirements of the clause in this standard specifying maximum arc voltage, the requirements for electromagnetic compatibility are deemed to be satisfied.'

SPECIFICATION

SECTION ONE : GENERAL

SCOPE

1. This British Standard relates to cartridge fuse-links of current-ratings up to 5 amperes (hitherto known as Type A fuse-links) intended for use in plugs, and socket-outlet adaptors to B.S. 546† for two-wire circuits of

† B.S. 546. ' Two-pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors for circuits up to 250 volts '.

which the declared voltage does not exceed 250 volts a.c. at 50 cycles per second, or 250 volts d.c.

Fuse-links for use in plugs specified in B.S. 1363 are separately provided for in B.S. 1362.

DEFINITIONS

2. The following definitions have been adopted for the purpose of this standard.

a. Fuse. A device for the purpose of protecting a circuit against damage from an excessive current flowing in it by opening the circuit on the melting of a fuse-element by such excessive current. The fuse comprises all the parts that form the complete device.

b. Fuse-element. That part of the fuse which is designed to melt and thus open a circuit.

c. Cartridge. A totally-enclosing fuse-element container consisting of insulating material; generally tubular in form, and having its ends enclosed by metallic caps.

d. Cartridge fuse-link (hereinafter called a fuse-link). A cartridge containing a fuse-element.

e. Voltage-rating. A voltage stated by the manufacturer as the highest declared voltage that may be associated with the fuse-link.

f. Recovery-voltage. The r.m.s. value of the normal-frequency a.c. voltage, or the d.c. voltage, that exists across the terminals of a fuse after the opening of the circuit.

g. Current-rating. A current less than the minimum fusing-current, stated by the manufacturer as the current that the fuse-link will carry continuously in the testing-enclosure without deterioration (see Figure 2).

h. Minimum fusing-current. The minimum current at which a fuse-element in a fuse-link will melt in the testing-enclosure.

i. Fusing-factor. The ratio, greater than unity, of the minimum fusing-current to the current-rating, namely :

$$\text{Fusing factor} = \frac{\text{Minimum fusing-current}}{\text{Current-rating}}$$

j. Prospective current (of a circuit). The direct current, or the r.m.s. value of the alternating current, that would flow on the making of the circuit when the circuit is equipped for the insertion of a fuse-link, but the fuse-link is replaced by a link of negligible impedance.

k. Breaking-capacity rating (of a fuse). A prospective current stated by the manufacturer as the greatest prospective current that may be associated with the fuse under prescribed conditions of voltage and of power-factor or time-constant.

l. Duty (of a fuse). The satisfactory opening, at declared voltages not higher than its voltage rating, of the circuit or circuits protected by it under conditions that produce for the requisite length of time any prospective current greater than its minimum fusing-current up to its breaking-capacity rating.

m. Type-test. A test of a sample or an article intended to show that all other articles made to the same design would, or would not, pass an identical test.

SECTION TWO : REQUIREMENTS

VOLTAGE-RATINGS

3. The standard voltage-ratings are 250 volts alternating at 50 c/s, and 250 volts d.c.

CURRENT-RATINGS

4. The standard current-ratings are as follows:

1 ampere
2 amperes
3 amperes
5 amperes

Intermediate or lower current-ratings are permissible provided that the fuse-links comply with this specification in all other respects.

FUSING-FACTOR

5. The fusing-factor shall be between 1·6 and 1·9.

BREAKING-CAPACITY RATING

6. The breaking-capacity rating shall be 1000 amperes at a lagging power-factor not greater than 0·6 for alternating current, and a time-constant not less than 0·003 second for direct current.

PERFORMANCE

7. Fuse-links shall open circuits adjusted for any prospective current greater than their minimum fusing-currents up to their breaking-capacity rating, and shall be tested for duty in accordance with Clauses 12 to 15.

SECTION THREE : CONSTRUCTION

DIMENSIONS

8. The dimensions of the fuse-links shall be as shown in Fig. 1.

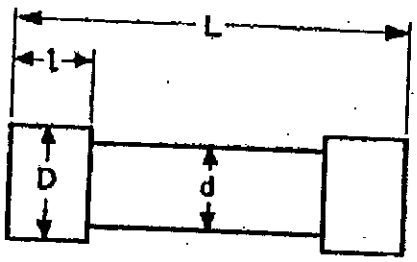

Fig. 1

DIMENSIONS OF FUSE-LINKS

	Length (L)	Length of each end-cap (l)	Diameter of end-cap (D)
inches	$\frac{3}{4}$ $+\frac{1}{32}$ $-\frac{1}{64}$	$\frac{5}{32}$ $+\frac{1}{32}$ $-\frac{1}{32}$	0·210 + 0·005 − 0·005
millimetres	max. 19·84 min. 18·65	4·76 3·18	5·46 5·21

The maximum diameter (d) of the cartridge between the end-caps shall be less than the diameter of the end-caps.

END-CAPS

9. Fuse links shall have, at each end, a metallic cap with a cylindrical surface, and the outer ends shall be substantially flat and at right-angles to the axis of the cylinder. The end-caps shall be either of non-corroding metal or of a metal suitably protected against corrosion. The cylindrical surface shall be the effective contact.

SECTION FOUR : TESTS

TYPE TESTS

10. All tests of fuse-links specified in the following clauses are type-tests, and the fuse-links used for the type-tests shall be identical in all details likely to affect performance with those to be used in service. The purchaser shall accept certificates of type-tests as evidence of the compliance of fuse-links with the requirements of the relevant clauses of this specification, and the manufacturer shall hold available such certificates together with detail drawings of the fuse-links and a record of any alterations that have been made in the fuse-links subsequent to the type-tests. The manufacturer shall, if required by the purchaser, certify that the fuse-links are identical in material and performance with those covered by a certificate of stated date. Type-tests may be made by the manufacturer, provided that he shall arrange for a recognized authority to make any type-tests for which he himself is not equipped.

Fuse-links shall be deemed to comply with this specification only if all that are tested pass the tests.

PREPARATION AND TESTS FOR MINIMUM FUSING-CURRENT AND WATTS LOSS

11. Fuse-links shall be mounted for tests for minimum fusing-current and watts loss in the metal testing-enclosure shown in Fig. 2, in surroundings free from external draughts, and at the commencement of each test the

fuse-links and testing enclosures and conductors connected to them shall be approximately at the ambient temperature, which shall be between 15°C and 25°C. The conductors shall be 3/·029 vulcanized-rubber-insulated or polyvinyl-chloride-insulated cable at least 2 ft in length, and shall be connected to the terminal studs by means of electric cable soldering tags of appropriate size.

The fuse-links shall be mounted vertically for test and any adjustment to the test-circuit shall be made prior to the insertion of the fuse-link to be tested. All fuse-links shall be in a clean and new condition.

The fuse-elements of the fuse-links shall not melt within 30 minutes at a current equal to 1·6 times their current-rating, and shall melt within 30 minutes at a current equal to 1·9 times their current-rating. The source of energy for the tests may be alternating or direct current.

For each current-rating, 12 fuse-links shall be tested; 6 at the high current and 6 at the low current.

A test shall be made to verify that at rated current the watts loss in the fuse-links, measured between the end-caps, does not exceed the following values:

Current-rating	Watts loss
1 amp	0·5 watts
2 amp	0·6 watts
3 amp	0·7 watts
5 amp	0·8 watts

The watts loss for any non-standard rating shall not exceed that specified for the next higher standard rating.

PREPARATION OF FUSE-LINKS FOR TESTS FOR DUTY

12. Fuse-links shall be mounted for tests for duty in the metal testing-enclosure shown in Fig. 2. The cover of the enclosure shall not be rigidly attached to the box. For these tests only, the enclosure may be of 16-mesh woven-wire cloth as specified in B.S. 481, 'Woven-wire and perforated sieves and screens'.

All fuse-links shall be in clean new condition and shall be mounted vertically for the tests.

The arrangement of the fuse-link and of the testing apparatus shall be as indicated in Fig. 3.

During the tests the metal testing-enclosure shall be connected as shown in Fig. 3 to one terminal of the supply through a fine-wire fuse wired with copper wire not greater than 0·0048 in. diameter (No. 40 S.W.G.) with a break not less than 3 in.

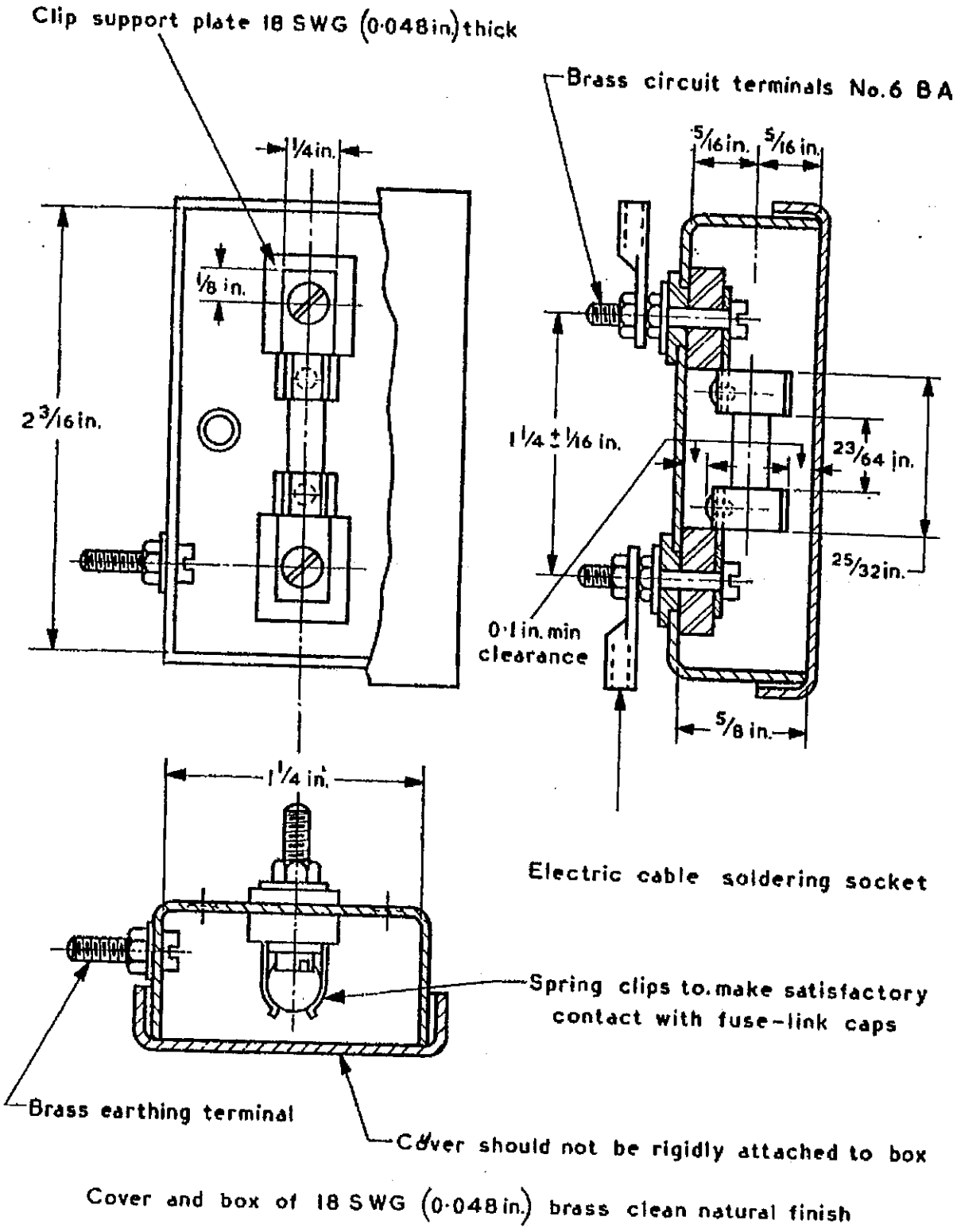

Fig. 2. Testing enclosure

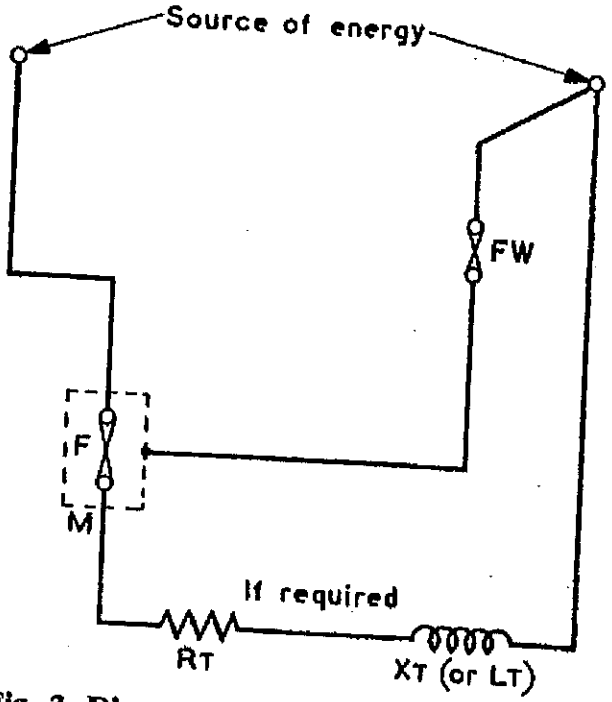

Fig. 3. Diagram of connections for tests for duty

F Fuse-link on test.
M Testing enclosure.
FW Fine-wire fuse.
RT Resistor (for all tests) if required.
XT Reactor (for a.c. tests) if required.
LT Inductor (for d.c. tests) if required.

TESTS FOR DUTY

13. Fuse-links shall be tested for duty, in accordance with Clause 14, in a single-phase* a.c. circuit at not less than 250 volts and in a d.c. circuit at not less than 250 volts.

In test *a.* of the a.c. tests of Clause 14 the circuit shall be 'made' at a rising voltage of 50 per cent of the peak value, with a tolerance of plus or minus 15 per cent of the peak value.

The frequency of the source of supply for a.c. tests shall be 50 c/s with a tolerance of plus or minus 25 per cent.

The impedance of an a.c. test circuit, including, if required, a resistor RT and a reactor XT, shall be appropriate to the required prospective current at a power-factor not greater than 0·6 in all tests for duty.

The resistance of a d.c. test-circuit, including, if required, a resistor RT, shall be appropriate to the required prospective current, and the resistance and the inductance of the circuit, including, if required, an inductor LT, shall be such that the circuit has a suitable time-constant not less than 0·0030 second in all tests for duty.

The source of energy for the tests shall be capable of giving the required prospective currents and shall produce initially a recovery-voltage equal to the rated voltage of the fuse-link with a tolerance of plus or minus 5 per cent.

* See Appendix A for a note on single-phase testing.

To prove that the fuse-link will withstand indefinitely continued application of its voltage-rating the recovery-voltage shall be maintained within the limits of tolerance for not less than 30 seconds immediately after the opening of the circuit by the fuse-link.

The insulation-resistance between the end-caps of the fuse-link shall be measured at approximately 500 volts d.c. within three minutes of the conclusion of the above test.

NUMBER OF TESTS FOR DUTY

14. Tests for duty shall be as follows (see also Appendix B):

a. Six fuse-links shall be tested in a circuit having a prospective current not less than 100 per cent and not greater than 115 per cent of the breaking-capacity rating of the fuse-link.

b. Three fuse-links shall be tested in a circuit having a prospective current equal to 2·5 times the current-rating of the fuse-link.

c. Six fuse-links shall be tested, one at each of the following values of current: five, ten, fifteen, twenty, twenty-five and thirty times the rated current.

Satisfactory tests for 5-ampere fuse-links shall be deemed to prove that fuse-links of other current-ratings are also satisfactory, provided that they are of the same material and general construction as the 5-ampere fuse-links.

If the material or general construction of fuse-links of current-ratings other than 5 amperes differ from those of the 5-ampere fuse-links tested, separate tests for duty shall be made of fuse-links of the highest current-rating of each construction.

CRITERIA OF FAILURE IN TESTS FOR DUTY

15. Fuse-links shall be deemed not to comply with this British Standard if during the test for duty one or more of the following occur:

a. Melting of fine-wire fuse, indicating arcing to the metal case.

b. External damage of the cartridge tube or end-caps.

c. Reduction of the insulation-resistance between the end-caps of the fuse-link to less than 100 000 ohms when measured in accordance with Clause 13.

SECTION FIVE : MARKING

MARKING

16. Every fuse-link shall be clearly and indelibly marked with its manufacturer's name or identifying mark, with its current rating, and with the number of this specification.

COLOUR CODE

17. The standard current-ratings shall be distinguished by the colours given below:

Current-rating	Colour
1 ampere	Green
2 amperes	Yellow
3 amperes	Black
5 amperes	Red

APPENDIX A

SINGLE-PHASE TESTING

(Appendix C of B.S. 88 : 1952)

The stipulation in Clause 20 of B.S. 88 that fuses shall be tested for duty by testing single fuses in a single-phase a.c. circuit means that each fuse shall be tested independently, but it does not mean that only one fuse need be tested at once, or that the tests need be only on a single-phase supply.

If, for example, in the absence of a special timing-device it is desired to use phase-differences in the making of the circuit of Test *a* of Clause 21 of B.S. 88 at the specified part of the voltage-wave, three similar fuses may be tested at once, one in each of three single-phase a.c. circuits each of which has a voltage as required by Clause 20 of B.S. 88; and the three circuits may be arranged as a three-phase combination in accordance with either Fig. 4 or Fig. 5. Each fuse is then tested in an independent single-phase a.c. circuit, provided that, if the circuit of Fig. 4 is used, the impedance through earth between E1 and E2 is negligible compared with the impedance of the remainder of the test-circuit.

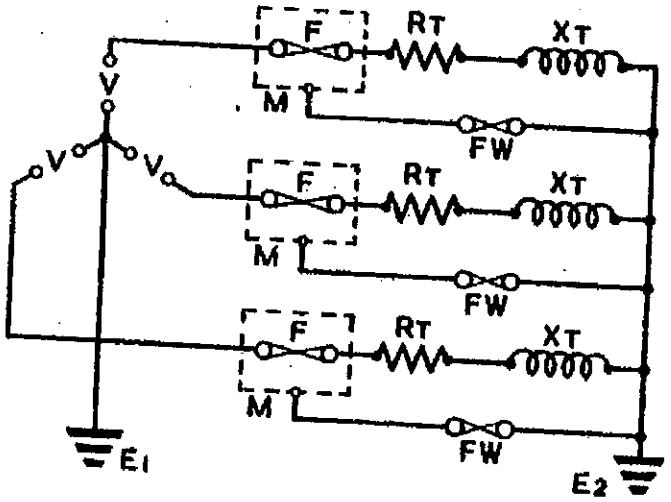

Fig. 4. Diagram of connections for tests for duty, using three fuses

V —Source of energy.
F —Fuse on test.
M —Metal case or woven wire cloth.
FW—Fine-wire fuse.
R_T —Resistor, if required.
X_T —Reactor, if required.

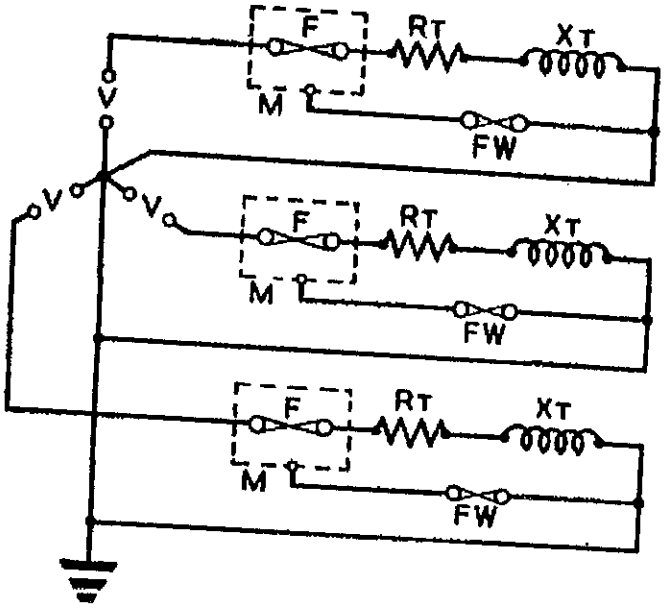

Fig. 5. Alternative diagram of connections for tests for duty, using three fuses

V —Source of energy.
F —Fuse on test.
M —Metal case or woven wire cloth.
FW—Fine-wire fuse.
R_T —Resistor, if required
X_T —Reactor, if required.

APPENDIX B

TESTS FOR DUTY

The value of the prospective current stipulated in Clause 14 *a.* has been formulated on the basis that the fuse protecting the sub-circuit in which the fuse-link to B.S. 646 is used, will have a cut-off current below the test values specified in this test clause.

The prospective current stipulated in Clause 14 *b.* has been formulated to ensure tests at a moderate over-current with values not less than the minimum fusing current and not greater than 1·4 times the maximum fusing current as provided for in B.S. 88 : 1952—Clause 20—Note‡

Fuse links complying with this specification and tested in accordance with Clause 14 *a.* will exhibit cut-off. Clause 14 *c.* has been formulated to ensure that tests are made at smaller prospective values approximating to those specified in Clause 21 *b.* of B.S. 88 : 1952.

APPENDIX C

DEFINITIONS OF TERMS USED IN FUSE-TESTING

The following are definitions of terms in common use in fuse-testing:

Arc-voltage. The voltage that exists across a fuse during the arcing time.

NOTE. The maximum value of arc-voltage may exceed the peak-value of the a.c. recovery-voltage or the d.c. recovery-voltage.

Loop. The part of an alternating wave which extends from one zero to the next.

NOTE. For the purpose of indicating the number of current-zeros during arcing-time, arcing-time may be referred to as including a stated number of loops.

Cut-off. If the melting of a fuse-element prevents the current through the fuse from reaching the otherwise attainable maximum (the peak current of the first major loop on an a.c. circuit, or the steady current in a d.c. circuit), the fuse is said to cut-off, and the instantaneous maximum current attainable is called the cut-off current.

NOTE 1. In an a.c. circuit the numerical value of the cut-off current may be greater than the numerical value of the prospective current.

NOTE 2. A fuse only exhibits cut-off at prospective currents greater than a particular value; the transition point varies with different fuses, and may be at a prospective current greater than the breaking-capacity rating.

Pre-arcing time. The time between the commencement of a current large enough to cause a break in a fuse-element and the instant when an arc is initiated.

Arcing time. The time between the end of the pre-arcing time and the instant when the circuit is broken and the current becomes permanently zero.

Operation (of a fuse). The process in it between the beginning of the pre-arcing time and the end of the arcing-time. Operation is sometimes called 'blowing'.

Total operating time. The sum of the pre-arcing time and the arcing time.

BRITISH STANDARDS INSTITUTION

The British Standards Institution was founded in 1901 and incorporated by Royal Charter in 1929.

The principal objects of the Institution as set out in the charter are to co-ordinate the efforts of producers and users for the improvement, standardization and simplification of engineering and industrial materials; to simplify production and distribution; to eliminate the waste of time and material involved in the production of an unnecessary variety of patterns and sizes of articles for one and the same purpose; to set up standards of quality and dimensions, and to promote the general adoption of British Standards.

In carrying out its work the Institution endeavours to ensure adequate representation of all viewpoints. Before embarking on any project it must be satisfied that there is a strong body of opinion in favour of proceeding and that there is a recognized need to be met.

The Institution is a non-profit-making concern. It is financed by subscriptions from firms, trade associations, professional institutions and other bodies interested in its work, by a Government grant and by the sale of its publications. The demands on the services of the Institution are steadily increasing and can only be met if continuing and increased financial support is provided.

Membership of the Institution is open to British subjects, companies, technical and trade associations, and local and public authorities.