

Compulsory Specification for

## **Earth leakage protection units**

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**VC 8035**

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**DEPARTMENT OF TRADE AND  
INDUSTRY**

**No. 2286**

**16 October 1987**

**STANDARDS ACT, 1982**

**COMPULSORY SPECIFICATION FOR EARTH  
LEAKAGE PROTECTION UNITS**

On the recommendation of the Council of the South African Bureau of Standards and under the powers vested in me by section 16 (1) of the Standards Act, 1982 (Act 30 of 1982), I, Daniël Wynand Steyn, Minister of Economic Affairs and Technology, hereby declare the specification contained in the Schedule to be a compulsory specification for earth leakage protection units.

The compulsory specification shall become operative on a date two months after the date of publication of this notice.

**D. W. STEYN,  
Minister of Economic Affairs and Technology.**

## DEPARTMENT OF TRADE AND INDUSTRY

No. R. 1369

22 June 1990

### STANDARDS ACT, 1982

#### AMENDMENT OF THE COMPULSORY SPECIFICATION FOR EARTH LEAKAGE PROTECTION UNITS

I, Theodorus Gerhardus Alant, Deputy Minister of Trade and Industry, acting on behalf of and assignment by the Minister of Trade and Industry and Tourism, hereby under section 16 of the Standards Act, 1982 (Act No. 30 of 1982), and on the recommendation of the Council of the South African Bureau of Standards, amend the compulsory specification for earth leakage protection units published by Government Notice No. 2286 of 16 October 1987, with effect from the date two months after publication of this notice. Particulars of the amendment are contained in the Schedule.

T. G. ALANT,  
Deputy Minister of Trade and Industry.

### SCHEDULE

#### AMENDMENT OF THE COMPULSORY SPECIFICATION FOR EARTH LEAKAGE PROTECTION UNITS

**Subsection 4.13:** Delete the fourth sentence and substitute the following:

The test facility shall be so designed that the ampère turns required to operate the test circuit at rated voltage do not exceed 2,5 times the ampère turns utilized to operate the sensing circuit.

The protective conductor shall not become live when the test facility is operated.

It shall not be possible to energize the protected circuit by operating the test facility when the earth leakage circuit-breaker is in the open position. The test facility shall not be the sole means of performing the opening operation and is not intended to be used for this function.

*Note:* The test facility is intended to check the tripping function only, and not the value at which the function is effective with respect to the rated earth leakage tripping current and to the break times.

## SCHEDULE

### COMPULSORY SPECIFICATION FOR EARTH LEAKAGE PROTECTION UNITS

#### 1. SCOPE.

1.1 This specification covers earth leakage protection units (circuit-breakers) for use in domestic and industrial or similar electrical installations and connected to a source of alternating current supply operating at a frequency of 50 Hz, the neutral conductor of which is connected to the general mass of earth on the supply side, and subject to the following limitations:

(a) Maximum rated voltage .....	500 V.
(b) Maximum rated current .....	100 A.
(c) Maximum rated earth leakage tripping current.....	30 mA.
(d) Ambient temperature .....	-5 °C to +40 °C.

1.2 The earth leakage protection units covered by this specification are intended to reduce fire and electrocution hazards caused by current leaking from line and neutral conductors to earth.

1.3 This specification does not cover earth leakage protection units intended for service under extreme operating conditions such as continuous high atmospheric humidity, atmospheric pollution, mechanical vibration, mechanical shock, and excessively high or low temperatures.

#### 2. DEFINITIONS.

2.1 For the purposes of this specification the following definitions shall apply:

*Acceptable:* Acceptable to the authority administering the specification.

*a-contact:* A control contact or auxiliary contact that is closed when the main contacts of the mechanical switching device are closed and open when they are open.

*b-contact:* A control contact or auxiliary contact that is open when the main contacts of the mechanical switching device are closed and closed when they are open.

*Breaking capacity:* The highest prospective current that, according to the manufacturer, the earth leakage circuit-breaker will break and make-and-break successfully at the rated voltage under prescribed conditions of use and behaviour.

*Circuit-breaker (breaker):* A mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions such as those of short-circuit or earth fault.

*Note:* A circuit-breaker is usually intended to operate infrequently although some types are suitable for frequent operation.

*Double-pole circuit-breaker:* A circuit-breaker having two poles for connection in the two conductors of a supply, each pole being fitted with one or more different releases, the poles being so coupled (mechanically) with each other that they operate together and if a fault on *any one* pole occurs, the supply will be isolated.

*Single-pole and neutral circuit-breaker:* A circuit-breaker having two poles that are coupled mechanically in such a manner as to operate together, and only one of which is fitted with one or more different releases.

*Single-pole and switched-neutral circuit-breaker:* A single-pole circuit-breaker fitted with a switched neutral that is arranged to operate with the pole of the circuit-breaker, and to close before and open after the pole contacts, for the purpose of isolating the neutral conductor.

*Single-pole circuit-breaker:* A circuit-breaker having one pole, the pole being fitted with one or more different releases.

*Triple-pole and neutral circuit-breaker:* A circuit-breaker having four poles, three of which are fitted with one or more different releases, all the poles being so coupled (mechanically) that they operate together, a fault on one or more phases resulting in isolation of the supply.

*Note:* The three poles fitted with releases are intended for connection in the phase conductors, and the fourth pole in the neutral conductor, of a three-phase four-wire supply.

*Triple-pole and switched-neutral circuit-breaker:* A triple-pole circuit-breaker fitted with a switched neutral that is arranged to operate with the main poles of the circuit-breaker, and to close before and open after the pole contacts, for the purpose of isolating the neutral conductor in a three-phase four-wire supply.

*Triple-pole circuit-breaker:* A circuit-breaker having three poles each being fitted with one or more different releases, and so coupled (mechanically) that they operate together.

**Note:** This arrangement is intended for use on a three-phase supply where control of the three phases is required to be simultaneous and where a fault on one or more phases will result in isolation of the supply.

**Clearance:** The shortest distance, measured through air, between two conductive parts.

**Creepage distance:** The shortest path, measured between two conductive parts along the surface of an insulating material.

**Note:** A joint between two pieces of insulating material is considered part of the surface.

**Current:** When applied to an alternating current circuit, the root-mean-square value of the current.

**Earth fault current:** The current flowing to earth owing to an insulation fault.

**Earth leakage current:** The current flowing from live parts of the installation to earth in the absence of any insulation fault.

**Earth leakage protection circuit-breaker (EL circuit-breaker):** An EL circuit-breaker capable of sensing the sum of an earth leakage and earth fault current in a circuit and of interrupting the circuit when this current exceeds a predetermined value.

**Earth leakage tripping current:** The value of leakage current to earth that will cause an EL circuit-breaker to operate.

**Inherent resetting time:** The time interval between a breaking operation during specified abnormal conditions and the successful reclosing of the breaker under normal conditions.

**Pole:** A conducting path in an EL circuit-breaker equipped with a set of contacts for carrying, making and breaking the main current through the EL circuit-breaker.

**Power-frequency recovery voltage:** The recovery voltage after the transient voltage phenomena have subsided.

**Prospective current:** The current that would flow on the making of a circuit where the circuit is equipped for the insertion of an EL circuit-breaker when a link of negligible impedance is inserted instead of the EL circuit-breaker. (In some circuits the link may replace the EL circuit-breaker and the connecting leads from the supply.)

**Rated load current:** The highest load current, assigned by the manufacturer, that an EL circuit-breaker is capable of carrying continuously at the rated voltage under specified conditions, without exceeding the temperature limits specified.

**Rated short-time withstand current:** The current, assigned by the manufacturer, that an EL circuit-breaker can carry in the closed position during a specified short time under prescribed conditions of use and behaviour.

**Rated value:** The numerical value of a quantity (such as voltage, current) included in the rating and indicated in the marking.

**Rated voltage:** The highest voltage, assigned by the manufacturer, at which the EL circuit-breaker may be used.

**Recovery voltage:** The voltage that appears across the terminals of a pole of an EL circuit-breaker after breaking of the current.

**Note:** This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which power-frequency voltage alone exists.

**Release:**

**Non-time-delay (overcurrent) release:** A tripping device without any purposely delayed action.

**Overcurrent release:** A release that permits a circuit-breaker to open with or without delay when the current in the release exceeds a predetermined value.

**Shunt release:** A trip coil energized from the main circuit or from a separate auxiliary supply through a relay, a switch or other means.

**Time-delay (overcurrent) release:** A trip device with a purposely delayed action.

**Undervoltage release:** A release that permits an EL circuit-breaker to open with or without delay, when the voltage across the terminals of the release falls below a predetermined value and that permits the circuit-breaker to be closed when the voltage across the terminals is above a predetermined value.

**Solid neutral:** In an EL circuit-breaker, a conducting path which is not equipped with a set of contacts and to which the neutral paths, both incoming and outgoing, are connected one at each end.

**Switched neutral:** A pair of contacts in a conducting path normally at or about earth potential, capable of carrying the rated current of the EL circuit-breaker, and also capable of carrying, for a specified time, currents under specified abnormal circuit conditions (such as those of short-circuit), but not designed to make or break currents through the circuit.

**Transient recovery voltage (TRV):** The recovery voltage during the time in which it has a significant transient character.

**Note:**

(a) The transient recovery voltage may be oscillatory or non-oscillatory or a combination of these, depending on the characteristics of the circuit and the circuit-breaker. It includes the voltage shift of the neutral of a polyphase circuit.

(b) The transient recovery voltage in three-phase circuits is, unless otherwise stated, the voltage across the first pole to clear because this voltage is generally higher than that which appears across each of the other two poles.

**Trip-free EL circuit-breaker:** An EL circuit-breaker in which the automatic release mechanism will, under fault conditions, open the contacts of the EL circuit-breaker independently of the means used to close the contacts, and will ensure that the contacts are not held closed against a condition where tripping should occur.

**Tripping:** The opening of an EL circuit-breaker either manually or automatically.

**Tripping time:** The interval of time between the application of a steady overcurrent or earth leakage current and the interruption of the circuit.

**Voltage:** When applied to an alternating current circuit, the root-mean-square value of the voltage.

**3. DESIGN AND CONSTRUCTION.**

**3.1 STANDARD OF WORKMANSHIP AND FINISH:** All work shall be properly executed and finished and shall be so arranged as not to constitute a hazard.

**3.2 MOULDED CASE:** The operating mechanism of an EL circuit-breaker shall be contained in a moulded case made of a non-combustible insulating material that will not allow the escape of flame or molten metal through the openings surrounding the operating toggle.

**3.3 PROTECTION.**

**3.3.1** Live parts of an EL circuit-breaker intended for open surface mounting shall be protected against inadvertent contact by means of acceptably strong covers of insulating material.

**3.3.2** Live parts on the underside of an EL circuit-breaker designed for mounting on a surface shall—

- (a) be covered by a shield or barrier of insulating material; or
- (b) be countersunk at least 3 mm below the surface of its base and covered with a waterproof insulating sealing compound that will not flow during any of the tests specified in Section 6; or
- (c) have a minimum clearance of 6 mm from the mounting surface and be riveted, upset or otherwise acceptably prevented from loosening.

**3.4 CLEARANCES AND CREEPAGE DISTANCES:** All clearances and creepage distances shall be as large as is practicable and, in order to break the continuity of conducting deposits that may form, creepages shall, wherever practicable, incorporate ridges.

**3.5 MOUNTING:** Each EL circuit-breaker shall have at least two holes for mounting purposes or an alternative method of mounting that will ensure acceptable stability.

**3.6 MODE OF OPERATION**

**3.6.1** An EL circuit-breaker shall be arranged for manual closing and opening and for automatic stripping. The mechanism shall be trip-free.

**3.6.2** The actuating mechanism shall be such that when an EL circuit-breaker is mounted in the normal manner, the contacts cannot close by themselves as a result of failure of the mechanism.

**Note:** The mounting of an EL circuit-breaker on a vertical plane with its major axis vertical or horizontal shall be considered as mounted in the normal manner.

**3.6.3** The tripping of an EL circuit-breaker under any conditions within its ratings shall not cause the contacts that break the circuit to bounce or show any tendency to reclose.

**3.7 ARCH SHIELDS:** Means shall be provided to ensure that when a multi pole EL circuit-breaker operates, there is no arcing between the poles.

**3.8 TRIP INDICATION:** An EL circuit-breaker shall be so designed that when it has been tripped, a clear indication to that effect is visible to the user.

3.9 TERMINALS.

3.9.1 An EL circuit-breaker shall be provided with suitable terminals for the connection of copper conductors of the size given in column 2 of Table 1, appropriate to the current rating of the EL circuit-breaker. The terminals of an EL circuit-breaker with an intermediate rating shall accommodate conductors of the nominal cross-sectional area specified for the next higher current rating.

TABLE 1—WIRING TERMINALS (COPPER CONDUCTORS)

	1	2
	Rated current of circuit-breaker, A	PVC-covered copper conductor, quantity and nominal cross-sectional area, mm <sup>2</sup> , min.
Not exceeding	10 .....	2 x 1,5
	16 .....	2 x 4,0
	20 .....	2 x 4,0
	25 .....	2 x 4,0
	32,5 .....	2 x 6,0
	40 .....	2 x 10,0
	50 .....	16,0
	63 .....	25,0
	80 .....	35,0
	100 .....	50,0

3.9.2 Terminals shall be so designed that they do not allow the conductors to be displaced and are not themselves displaced in a manner detrimental to the operation of the EL circuit-breaker or the effectiveness of the insulation [i.e. the minimum prescribed values for clearances and creepage distances specified in 3.3.2 (b) and (c) shall be maintained under all conditions of normal operation of the EL circuit-breaker].

3.9.3 Each terminal for the connection of an external conductor shall be so arranged that it is readily accessible under the intended conditions of use, and an earth terminal (when provided) shall, in addition, be—

- (a) suitably protected against corrosion,
- (b) permanently and indelibly marked with the symbol , and
- (c) of such a size as to accommodate a conductor that complies with the provisions for earth continuity conductors of SABS 0142 'The wiring of premises'.

3.9.4 A wiring terminal need not be such as to accept a conductor directly, i.e. without some suitable termination being applied to the conductor, but where a terminal is intended to accommodate a stranded conductor, means shall be provided to prevent the conductor wires from spreading.

3.9.5 Each wiring terminal screw shall thread into metal and shall have a smooth clean-cut thread that is free from burrs. The end of the screw shall be so shaped that it will not damage the conductor. Except as allowed below, iron and steel, unless present as a constituent of an alloy that is inherently corrosion resistant, shall not be used for terminals.

3.9.6 Terminals of the type in which the external connecting conductors make direct electrical contact with the pole of an EL circuit-breaker and that are not dependant upon to carry the main current of the EL circuit-breaker, may be of iron or steel that has been plated in an acceptable manner with copper, nickel, cadmium, silver or zinc.

3.10 EARTHING: Provision shall be made for the earthing of any exposed metal parts of an EL circuit-breaker that may become live if the insulation of any part of the EL circuit-breaker becomes defective (see also 3.9.3).

TABLE 2—CONDUCTOR SIZES FOR TEMPERATURE RISE AND OVERCURRENT RELEASE TESTS (COPPER)

	1	2
	Rated current of circuit-breaker, A	Conductor nominal cross-sectional area, mm <sup>2</sup>
Not exceeding	10 .....	1,5
	16 .....	2,5
	20 .....	2,5
	25 .....	4
	31,5 .....	6
	40 .....	10
	50 .....	10
	63 .....	16
	80 .....	25
	100 .....	35

4. ELECTRICAL AND PHYSICAL REQUIREMENTS.

4.1 RATINGS: Each EL circuit-breaker shall be rated in terms of voltage, current, breaking capacity or short-time withstand current, and number of poles.

(a) The rated voltage shall not exceed 500 V and the rated load current shall not exceed 100 A.

(b) The breaking capacity shall be 2,5 kA or 20 times the value of the rated current, whichever is the greater.

(c) The rated earth leakage tripping current of an EL circuit breaker shall, subject to a tolerance of  $^{+0}_{-50}\%$ , be

5, 10 or 30 mA, as applicable.

*Note:* The values for the rated earth leakage tripping current are recommended by the International Electrotechnical Commission.

4.2 INSULATION RESISTANCE: When determined in accordance with 6.3, the insulation resistance of an EL circuit-breaker shall be at least  $10\text{ M}\Omega$ .

4.3 UNDERVOLTAGE RELEASE.

4.3.1 When so required, an EL circuit-breaker shall be provided with an undervoltage release.

4.3.2 An EL circuit-breaker having an undervoltage release shall, when tested in accordance with 6.4, open even on a slowly falling voltage (1 % per second) at a value of between 70 % and 35 % of the rated voltage of the undervoltage release.

The undervoltage release shall prevent closing of the circuit-breaker at a voltage below 35 % and shall not prevent closing at and above 85 % of the rated voltage of the undervoltage release.

4.4 SHUNT RELEASE.

4.4.1 When so required, an EL circuit-breaker shall be provided with a voltage-operated shunt release having a specific voltage rating or range of voltage ratings.

4.4.2 An EL circuit-breaker provided with a voltage-operated shunt release shall, when tested in accordance with 6.5, operate on both 70 % and 120 % of the rated voltage of the shunt release.

4.5 OVERCURRENT RELEASE.

4.5.1 *General:*

4.5.1.1 When so required, an EL circuit-breaker shall be fitted with an overcurrent release.

4.5.1.2 The overcurrent release shall be of an adjustable or non-adjustable time-delay type or a non-time-delay type.

4.5.1.3 The current-time characteristic of an EL circuit-breaker shall be that assigned by the manufacturer and marked on the EL circuit-breaker [see 5.1 (k)].

4.5.2 *Time-delay type:*

4.5.2.1 An EL circuit-breaker having a non-adjustable time-delay release shall carry its rated current continuously without tripping but, when tested in accordance with 6.6, shall release automatically within the periods given in Table 3, appropriate to the rated current of the EL circuit-breaker.

4.5.2.2 An adjustable time-delay release shall be such that, when it is adjusted to its maximum setting, the EL circuit-breaker will comply with the requirements of 4.5.2.1

4.5.3 *Non-time-delay-type.* An EL circuit-breaker having a non-time-delay release shall carry its rated current continuously without tripping and, when 135 % of rated current is applied, shall release instantaneously and the arc shall be extinguished within 0,1 second.

TABLE 3—OPERATION OF OVERCURRENT RELEASE

1	2	3	4	5	6	7
Rated current (I), A		Tripping time, max.				
		Percentage of rated current				
	135	200	400	600	1 000	2 000
$I \leq 40$ .....	50 min	3 min	25 s	10,0 s	3,5 s	1,0 s
$40 < I \leq 80$ .....	100 min	4 min				
$80 < I \leq 100$ .....	100 min	6 min	As stated by the manufacturer.			

4.6 OVERLOAD: When tested in accordance with 6.7 or 6.8, as applicable, an EL circuit-breaker shall show no sign of electrical or mechanical failure and no welding, undue burning, or pitting shall occur at the contacts.

4.7 TEMPERATURE RISE: When determined in accordance with 6.9, the temperature rise of the insulating materials and of each of the parts of an EL circuit-breaker shall not exceed the relevant value given in Table 4.

TABLE 4—TEMPERATURE RISE

1	2
Parts and types of material*	Temperature rise, °C, max.
(a) Wiring terminals .....	70
(b) Contacts:	
copper or copper alloys.....	45
silver.....	†
silver-tungsten and other sintered metals .....	‡
(c) Cotton, silk, paper and similar materials, non-impregnated .....	65
(d) Cotton, silk, paper and similar materials impregnated with a resin, and enamel when it is used with such materials.....	80
(e) Wire covered with formaldehyde-, polyvinyl-, or epoxy resin or polyurethane, when these are not used with fibrous materials .....	95
(f) Phenolic composition employed as electrical insulation.....	§80
(g) Mica, glass fibre or asbestos, with binder and impregnation.....	105
(h) Bare coils.....	90
(i) Operating toggles (hand-operated) .....	25

\* Other materials not included in this table shall be deemed acceptable if it has been proved that such materials can operate, without adverse effects, at the temperatures attained in service.

† Limited solely by the necessity of not causing any damage to adjacent parts.

‡ To be specified according to the properties of the metals used and limited by the necessity of not causing any damage to adjacent parts.

§ Unless it has been established that the material is acceptable for use at higher temperatures.

4.8 MECHANICAL STRENGTH: When tested in accordance with 6.10, an EL circuit-breaker shall show no sign of cracks or permanent deformation.

4.9 PERFORMANCE OF AN EL CIRCUIT-BREAKER UNDER EARTH FAULT CONDITIONS: When an EL circuit-breaker is tested in accordance with 6.11, the unit shall trip, the butter muslin shall not be ignited, and the fuse shall not rupture.

The EL circuit-breaker shall, within 24 hours after the test, be capable of operating successfully at the rated earth leakage tripping current.

4.10 BREAKING CAPACITY (FOR AN EL CIRCUIT-BREAKER FITTED WITH AN OVERCURRENT RELEASE).

4.10.1 (a) An EL circuit-breaker shall be capable of once breaking and once making-and-breaking a circuit adjusted for the prospective current with the relevant power factor given in Table 7, appropriate to the breaking capacity of the EL circuit-breaker.

(b) The inherent resetting time of an EL circuit-breaker shall not exceed 15 minutes.

4.10.2 When an EL circuit-breaker is tested in accordance with 6.12—

(a) it shall show no sign of electrical or mechanical failure;

(b) the butter muslin placed over the operating toggles shall not be ignited;

(c) the average value of the power-frequency recovery voltage shall be equal to a value corresponding to 110 % of the rated operational voltage [see 6.12.1 (b)] occurring across the terminals of a pole of the EL circuit-breaker immediately before the flow of the test current, and this voltage shall be maintained for a period of at least 0,1 second after extinction of the arc;

*Note:* This may require that the applied voltage be increased but the tolerance on the prospective peak-making current shall not be exceeded without the consent of the manufacturer.

(d) there shall be no damage to insulation of conductors used to connect the EL circuit-breaker in the circuit;

(e) the fuse connecting metal parts to the neutral of the a.c. power supply shall not rupture;

(f) The EL circuit-breaker shall still comply with the requirements of 4.5.2 for 200 % of the rated current, or 4.5.3, as applicable; and

(g) the EL circuit-breaker shall still be capable of withstanding, for one minute without breakdown, a test voltage of magnitude as given in Table 7, appropriate to the rated voltage of the EL circuit-breaker.

4.11 SHORT-TIME WITHSTAND CURRENT (FOR AN EL CIRCUIT-BREAKER NOT FITTED WITH AN OVERCURRENT RELEASE): When tested in accordance with 6.13, an EL circuit-breaker that is not fitted with an overcurrent release shall be capable of once making and carrying for a period not exceeding 40 ms the prospective current appropriate to the specified rated short-time withstand current (not less than 2,5 kA) [see 5.1 (j)], the power factor being that applicable for the breaking capacity class of the same prospective current (see Table 6).

**Note:** The test shall be conducted with a preceding circuit-breaker or fuse in the circuit, when so requested. Such protection shall be supplied.

4.12 PERFORMANCE OF AN EL CIRCUIT-BREAKER UNDER EARTH LEAKAGE CONDITIONS. When an EL circuit-breaker is tested in accordance with 6.14, 6.15 and 6.16—

- (a) the EL circuit-breaker shall on each occasion trip positively;
- (b) under no conditions shall the EL circuit-breaker trip when the value of earth leakage current is less than 50 % of the rated value;
- (c) no value of the operating time for a suddenly applied earth leakage current shall exceed the applicable value given in Table 5;
- (d) all five values of earth leakage current in each test for a gradually applied earth leakage current shall be between  $0,5 I_{\Delta_n}$  and  $I_{\Delta_n}$ , when  $I_{\Delta_n}$  is the rated earth leakage tripping current; and
- (e) no value of the operating time recorded while the EL circuit-breaker is closed on the rated earth leakage current shall exceed the applicable value given in column 2 of Table 5.

TABLE 5—MAXIMUM OPERATING TIMES FOR VALUES OF EARTH LEAKAGE CURRENT

1 Rated earth leakage tripping current ( $I_{\Delta_n}$ ), A	2 Operating time, s, max.		
	$I_{\Delta_n}$	$2I_{\Delta_n}$	4 0,25 A
$I_{\Delta_n} = 0,005$ .....	5	1	0,04
$I_{\Delta_n} = 0,01$ .....	5	0,5	0,04
$I_{\Delta_n} = 0,03$ .....	0,5	0,2	0,04

4.13 TEST AND RESET BUTTONS: Every EL circuit-breaker shall have a test button that is easily accessible when the EL circuit-breaker is mounted in its normal position, and by means of which the correct functioning of the EL circuit-breaker may be tested. The test button shall preferably be of a light colour (red or green shall not be used). The test facility shall be so connected in the circuit as to ensure that the sensing device, the amplifier, and the circuit-breaker mechanism are all tested for failure or deterioration. The test facility shall be so designed that a current equivalent to 125–175 % of the rated earth leakage tripping current flows through the sensing device when the test button is operated with the EL circuit-breaker energized at its rated voltage. Where necessary, a reset button shall be provided but this shall not inhibit the functioning of the EL circuit-breaker. The test and the reset buttons shall be identified in accordance with 5.1 (d).

When tested in accordance with 6.17, the test button shall show no signs of mechanical failure and the EL circuit-breaker shall still trip when the test button is operated.

4.14 DESENSITIZATION CAUSED BY LOOP RESISTANCE OF A NEUTRAL TO EARTH FAULT: When tested in accordance with 6.18, and EL circuit-breaker shall trip before the earth leakage exceeds twice the rated value.

4.15 TRIPPING CAUSED BY CAPACITIVE CURRENTS: When tested in accordance with 6.19, an EL circuit-breaker shall not trip more than five times.

4.16 NON-COMBUSTIBILITY: When tested in accordance with 6.20, materials that are required to be non-combustible shall be incapable of giving off flammable vapours.

## 5. MARKING.

5.1 EL CIRCUIT-BREAKERS: The following information shall appear in legible and indelible markings in (unless otherwise required) either or both of the official languages of the Republic of South Africa, either on the body of the EL circuit-breaker or on a label (see 5.3) securely attached to it, as appropriate:

- (a) The rated load current ( $I_n$ );
- (b) the rated earth leakage tripping current ( $I_{\Delta_n}$ );

(c) the "ON" and "OFF" positions of the EL circuit-breaker either on the operating toggle or on the case, in one of the following ways:

- (1) the symbols | and O for the "ON" and "OFF" positions respectively; or
- (2) in both official languages, the words "ON" and "OFF" ("AAN" and "AF");

**Note:**

- (i) The "ON" or | marking shall denote that the switch is in the up position.
- (ii) The symbol | used for the "ON" position shall be an upright straight line, not I or L.

(d) the words "Test" and "Toets" or the letter T on, or adjacent to, the test button and "Reset" and "Herstel" adjacent to the reset button (if fitted);

(e) EL circuit-breakers not fitted with an overcurrent release shall be clearly marked: NO OVERLOAD PROTECTION;

**Note:** The above markings [(a)–(e)] shall be clearly visible to the operator when the EL circuit-breaker is mounted as for normal service. If the markings are on the case or on the cover of the EL circuit-breaker, they shall be adjacent to the operating toggle and visible when the toggle is in the relevant position. Where covers are used for marking, they shall be nonreversible.

(f) the rated voltage;

(g) the name, trade name or registered trade mark of the manufacturer or the supplier;

(h) a catalogue number or type number or other identification marking that will distinguish the EL circuit-breaker from any other type marketed by the manufacturer;

(i) in the case of an EL circuit-breaker equipped with a neutral terminal, the letters L and N to identify the respective terminals;

(j) the rated short-time (40 ms) withstand current or breaking capacity class, in kiloamperes;

(k) the current-time characteristic (this marking may be in code and shall apply only to an EL circuit-breaker fitted with an overcurrent release);

(l) an acceptable identification mark for the line and load terminals, or alternatively, direction arrows indicating the entry and exit directions of the supply leads;

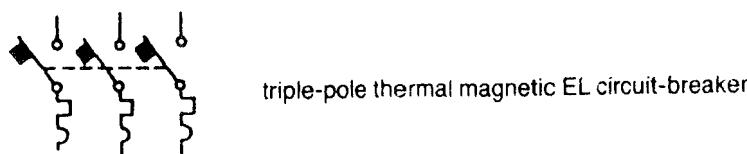
(m) in the case of an EL circuit-breaker not fitted with an overcurrent release and not marked with a rated short-time withstand current value, marking stating that an alternative method of overload protection shall precede the EL circuit-breaker in the circuit.

5.2 The appropriate of the following symbols may also appear in legible and indelible marking on the body of a circuit-breaker:

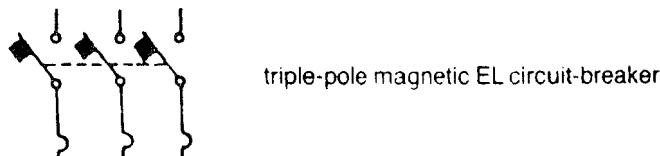
$I_n$  = rated current

$U_n$  = rated voltage

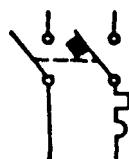
$I_{cn}$  = rated breaking capacity class, e.g. "I<sub>cn</sub> 2,5 kA"



triple-pole thermal magnetic EL circuit-breaker



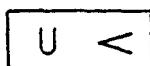
triple-pole magnetic EL circuit-breaker



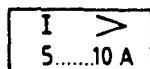
single-pole and neutral EL circuit-breaker



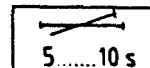
single-pole and switched-neutral EL circuit-breaker



undervoltage relay



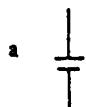
overcurrent relay with a setting range from 5 A to 10 A



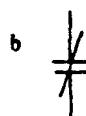
time-lag adjustable from 5 s to 10 s



shunt trip



auxiliary a-contact



auxiliary b-contact

5.3 **LABELS:** Labels (when used) shall be of acceptable material and when they are tested in accordance with 6.21, the marking shall still be legible and, in the case of a stick-on label, it shall not be possible to remove the label in one piece.

5.4 **EARTH TERMINALS.** Any earth terminal shall be permanently and indelibly marked with the symbol

6. **INSPECTION AND METHODS OF TEST.**

6.1 **INSPECTION:** Visually examine and, when relevant, measure each EL circuit-breaker for compliance with the relevant requirements of the specification for which tests to assess compliance are not given in 6.3–6.21 (inclusive) (as given in Section 3, 4 and 5).

6.2.1 Unless otherwise required, carry out the tests on each EL circuit-breaker as a whole and with the ambient temperature maintained at 15–25 °C.

- 6.2.2 Test each single-pole and switched-neutral EL circuit-breaker, and each single-pole and neutral EL circuit-breaker, as a double-pole EL circuit-breaker.
- 6.2.3 With the exception of the air-core reactor in any phase (which shall be shunted by a resistance of a value such that the current through the resistor is 0,6–0,7 % of the current through the air-core reactor), do not connect in parallel the reactance or resistance components of a test circuit load impedance.
- 6.2.4 Except where otherwise specified, use for the test an alternating current supply of practically sinusoidal waveform and that has a frequency of  $50 \pm 2$  Hz. For any test where no tolerances are stated, the following general tolerances shall apply:

Voltage  $\pm 5$  %; Current  $\pm 5$  %; Frequency  $\pm 2$  Hz; Time  $\pm 5$  %.

- 6.3 INSULATION RESISTANCE TEST: Measure at a d.c. voltage of 500 V the insulation resistance in the following positions:

- (a) Between live terminals and any metal parts that would be exposed when the EL circuit-breaker is mounted in its normal position. Do this test (with all exposed metal parts electrically connected together and with all live terminals electrically connected together) with the EL circuit-breaker first in the "ON" position and then in the "OFF" position.
- (b) Between each incoming and each outgoing terminal, with the EL circuit-breaker in the "OFF" position and, in the case of multipole circuit-breakers, with electrical interconnection between—
  - (1) all incoming terminals, and
  - (2) all outgoing terminals.

Check for compliance with 4.2.

- 6.4 UNDERVOLTAGE RELEASE TEST: Connect the undervoltage release to a power supply operating at its rated voltage. Reduce the voltage at a rate of 1 % per second until the EL circuit-breaker trips, and record the voltage at this point. Adjust the voltage to 34 % of the rated voltage and try to close the EL circuit-breaker. Adjust the voltage to 85 % of the rated voltage, close the EL circuit-breaker and determine whether or not it remains closed at this voltage. Check for compliance with 4.3.2.

- 6.5 SHUNT RELEASE TEST: Connect the EL circuit-breaker to the power supply and determine whether the EL circuit-breaker trips when the shunt release is energized at a supply voltage of

- (a) 70 %, and
- (b) 120 %

of the rated voltage. Check for compliance with 4.4.2.

- 6.6 OVERCURRENT RELEASE TEST.

- 6.6.1 *Mounting and connections:* Mount the EL circuit-breaker as for normal service (with all covers in position) and, using conductors of length at least 1 m and of the size given in Table 2, appropriate to the current rating of EL circuit-breaker, connect it to the power supply.

- 6.6.2 *Procedure:*

- (a) Using any convenient voltage, determine the current-time characteristic of the EL circuit-breaker by operating it at an ambient temperature of  $25 \pm 5$  °C at all the following percentages of rated current:

135	1 000
200	2 000
400	

Test each pole fitted with an overcurrent release separately except that for calibration at 135 % of the rated current, all poles shall be tested simultaneously and shall be equally loaded. Test two poles, or one pole and the neutral, to ensure that the currents through the sensing device are balanced. Check for compliance with 4.5.1.3.

*Note:* Where the characteristics of an EL circuit-breaker are such that the above points do not produce a smooth curve, additional intermediate points may be taken as required.

- (b) Finally, verify the current rating by operating the EL circuit-breaker at its rated through all poles simultaneously for at least two hours.

- 6.7 OVERLOAD TEST FOR AN EL CIRCUIT-BREAKERS FITTED WITH AN OVERCURRENT RELEASE.

- 6.7.1 *Test circuit:* With the EL circuit-breaker mounted as for normal service, connect it into a circuit in which the current has been adjusted to  $600 \pm 5$  % of the relevant rated value and the applied voltage to  $100 \pm 5$  % of the rated voltage of the EL circuit-breaker. Use an a.c. circuit having a lagging power factor of 0,45–0,5.

- 6.7.2 *Procedure:* Unless otherwise required, close and open the EL circuit-breaker 50 times consecutively at the rate of six operation cycles per minute and ensure that the contacts do not remain closed for more than two seconds in each cycle. In the case of multi-pole EL circuit-breakers, test simultaneously all poles.

intended to interrupt current, each pole carrying the current specified above. In the case of an EL circuit-breaker with no overcurrent release but fitted with a shunt release, carry out the test as described above but so energize the release (by applying a voltage equal to the rated voltage of the release) that the circuit-breaker opens 20–40 ms after closing. Check for compliance with 4.6.

6.8 OVERLOAD TEST FOR AN EL CIRCUIT-BREAKER NOT FITTED WITH AN OVERCURRENT RELEASE.

6.8.1 *Test circuit:* With the EL circuit-breaker mounted as for normal service, connect it into a circuit in which the current has been adjusted to 150 % of the relevant rated value with a power factor of 0,95 and the applied voltage has been adjusted to  $110 \pm 5$  % of the rated voltage of the EL circuit-breaker.

6.8.2 *Procedure:* Close and open the EL circuit-breaker five times consecutively and ensure that the contacts do not remain closed for more than two seconds in each cycle. In the case of multipole EL circuit-breakers, test simultaneously all poles intended to interrupt current, each pole carrying the current specified above. Check for compliance with 4.6.

6.9 TEMPERATURE RISE TEST: Mount the EL circuit-breaker as for normal service (with all covers in position) in a place where there are no draughts and where the ambient air temperature is  $25 \pm 5$  °C.

Using conductors each of length at least 1 m and of the size given in Table 2, appropriate to the current rating of the EL circuit-breaker, connect the EL circuit-breaker to the power supply and pass the rated current through the EL circuit-breaker for a period of two hours or until thermal equilibrium is attained. Then measure the relevant temperatures (see Table 4) by means of thermocouples or any other acceptable method, at the points where the temperatures are judged to be highest. Check for compliance with 4.7.

6.10 MECHANICAL STRENGTH TEST.

6.10.1 *Apparatus:*

(a) A mechanical strength test apparatus as shown in Fig. 1. The metal cylinder A of mass 250 g and of external diameter 25 mm fits loosely over the guide rod B. The guide rod is not rigidly fixed to the frame of the test apparatus and can be easily slid up and down. A hard fibre washer C of diameter 25 mm and of thickness 12,5 mm is fixed to the bottom of the guide rod.

(b) A rectangular hardwood block D that fits on the base of the test apparatus.

6.10.2 *Specimen:* Use one EL circuit-breaker from the sample.

6.10.3 *Procedure:*

(a) Place the hardwood block on the base of the test apparatus and firmly hold or otherwise mount the specimen on the block with its mounting surface down (i.e. toggle uppermost).

(b) Raise the guide rod and so move the block that, when the guide rod is lowered, the fibre washer rests on the surface of the specimen. Lower the guide rod, raise the metal cylinder to a height of 250 mm above the fibre washer, and allow the cylinder to drop onto the fibre washer.

(c) Repeat the drop twice, ensuring that the toggle is subjected to one drop when it is in the OFF position.

(d) So turn the specimen that it lies on its side on the block and proceed as described in (b) above, subjecting the specimen to three drops, two at random (but not on an edge of the specimen) and one approximately in the middle of the terminal guard.

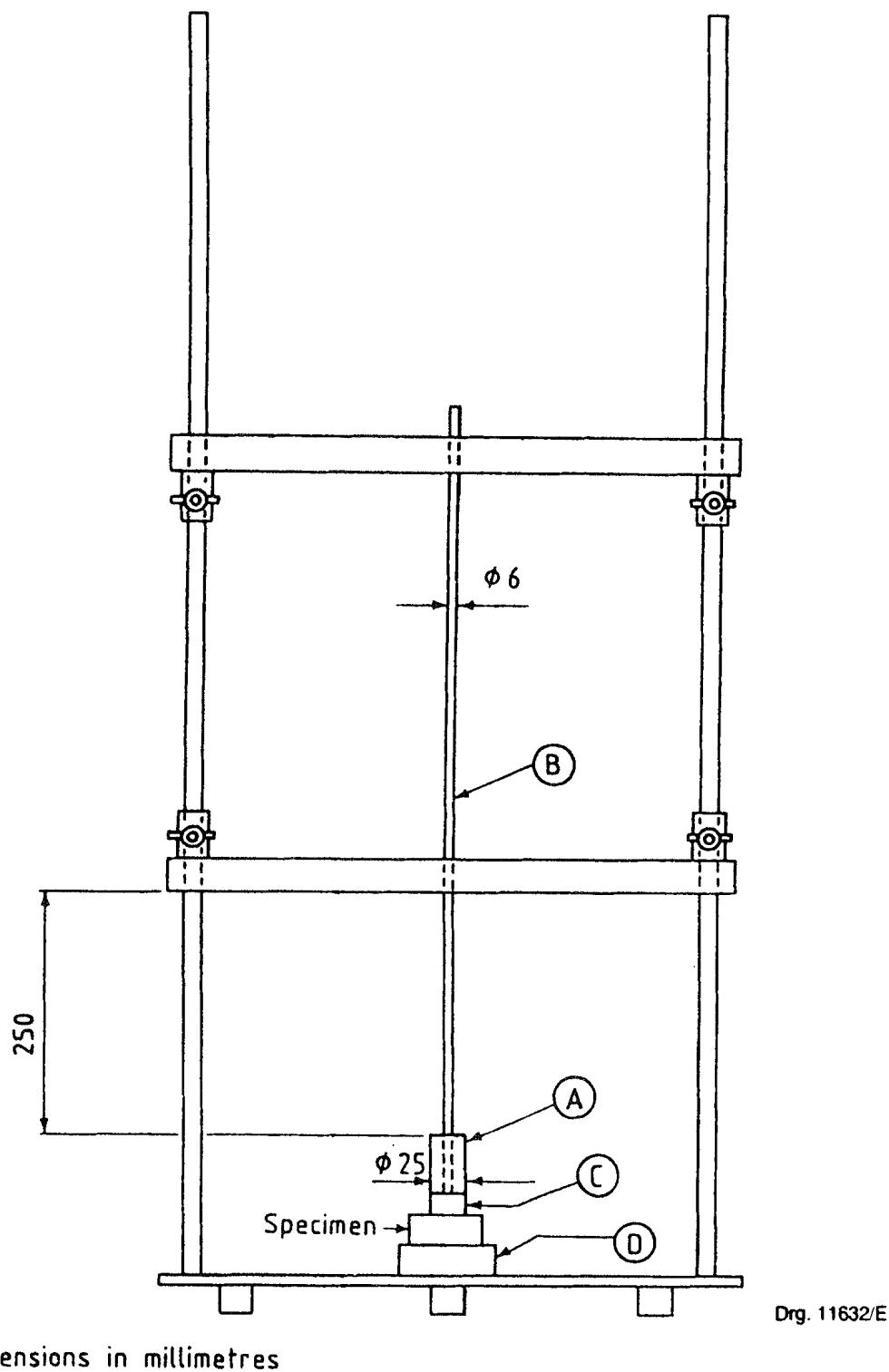
(e) Turn the specimen onto the other side and repeat the procedure given in (d) above.

(f) After the specimen has been subjected to nine drops, examine it for compliance with 4.8.

6.11 TEST FOR PERFORMANCE OF AN EL CIRCUIT-BREAKER UNDER EARTH FAULT CONDITIONS: Connect a 1 A fuse between the earthed conductor of the supply circuit and any metal parts that will be exposed when the EL circuit-breaker is mounted in its normal position. Connect all exposed metal parts together electrically. Connect the EL circuit-breaker to a power supply having an open circuit voltage of  $100 \pm 5$  % of the rated voltage.

Adjust the impedance of the load to provide a prospective earth fault current of 500 A with a power factor of 0,45–0,50. Cover that part of the surface of the EL circuit-breaker in which the toggle is situated with clean dry butter muslin that complies with requirement for Grade 1 butter muslin of SABS 446 'Absorbent gauze (fabric and swabs) and butter muslin'. Ensure that any cut or torn edges of the muslin are not exposed directly to the arc openings where flame may be emitted. Apply the earth fault current once by means of a separate switch in the supply circuit and once by means of the EL circuit-breaker switch, with the separate switch closed (i.e. close the EL circuit-breaker switch onto the fault.) In the case of a three-phase EL circuit-breaker test only one pole. Check for compliance with 4.9.

Immediately after the test, check the EL circuit-breaker for performance under earth leakage conditions at room temperature, the earth leakage current being applied gradually (see 6.14.3). Should the unit fail to comply with the requirement given in 4.12 (d), repeat the earth leakage test (as in 6.14.3) after 24 hours.



Dimensions in millimetres

Fig. 1—Apparatus for Mechanical Strength Test

6.12 BREAKING CAPACITY TEST (FOR AN EL CIRCUIT-BREAKER FITTED WITH AN OVERCURRENT RELEASE)

6.12.1 *Power supply:*

(a) *Alternating current:* A source capable of giving  $100 \pm 5\%$  of the relevant prospective current with the corresponding lagging power factor given, any current-limiting impedances used being placed between the circuit-breaker and the power supply.

(b) *Voltage:* The voltage of the test circuit immediately before the flow of the test current shall be not less than 105 % and not more than 115 % of the rated voltage of the circuit-breaker.

6.12.2 *Mounting:* Mount the EL circuit-breaker as for normal service and connect it into the test circuit with conductors each of length (on both the load and the line sides) 0,5–0,75 m and of the size given in Table 2, appropriate to the current rating of the EL circuit-breaker.

6.12.3 *Earthing of metal parts:* If the EL circuit-breaker contains any exposed metal parts or is intended for mounting on a metal plate or support, connect all such metal parts (through a tinned-copper wire fuse of nominal diameter 0,125 mm and of length 75–100 mm) to the neutral wire.

6.12.4 *Butter muslin:* Cover that part of the surface of the EL circuit-breaker in which the operating toggle is situated with clean dry butter muslin that complies with the requirements for Grade 1 butter muslin of SABS 446 'Absorbent gauze (fabric and swabs) and butter muslin'. Ensure that any cut or torn edges of the muslin are not exposed directly to the arc openings where flame may be emitted.

6.12.5 *Test circuit:*

(a) *Double-pole, single-pole and neutral, and single-pole and switched-neutral circuit-breakers:* Use a circuit as specified in Fig. 4 or Fig. 5.

(b) *Triple-pole or triple-pole and neutral circuit-breakers:* Use a circuit as specified in Fig. 6.

(c) *Resistance of voltage measuring circuit:* The value of the resistance of the voltage measuring circuit connected across the terminals of a pole of an EL circuit-breaker shall be at least  $100 \Omega$  per volt of the power-frequency recovery voltage.

6.12.6 *Procedure:*

(a) With the test circuit adjusted to the appropriate value of voltage, prospective current and power factor as given in Table 6, subject the EL circuit-breaker to a break test, using point-on-wave switching to obtain the greatest practicable transient current. Maintain the recovery voltage for at least 0,1 second after extinction of the arc. After an interval of not less than two minutes and not more than 15 minutes (the inherent resetting time), subject the EL circuit-breaker to a make-and-break test, maintaining the recovery voltage for at least 0,1 second after extinction of the arc. During both the tests, record by means of an oscillograph or by other acceptable means, the amplitudes and duration of voltage and current.

TABLE 6—VALUES OF PROSPECTIVE CURRENT AND POWER FACTORS FOR BREAKING CAPACITY TEST

1	2	3
Breaking capacity class	Prospective current, symmetrical r.m.s., A	Power factor, lagging
SABS 2,5 kA.....	2 500 AC	0,45–0,5
SABS 5 kA.....	5 000 AC	0,45–0,5
SABS 7,5 kA.....	7 500 AC	0,45–0,5
SABS 10 kA.....	10 000 AC	0,45–0,5
SABS 12,5 kA.....	12 500 AC	0,25–0,3
SABS 15 kA.....	15 000 AC	0,25–0,3
SABS 20 kA.....	20 000 AC	0,25–0,3
SABS 25 kA.....	25 000 AC	0,15–0,2

(b) After the break and make-and-break tests, check the EL circuit-breaker for compliance with 4.10.2 (a), (b), (d) and (e).

(c) Determine from the oscillograms the power-frequency recovery voltage in accordance with 6.12.7 below, and check for compliance with 4.10.2 (c).

(d) Test, in accordance with 6.6.2, the overcurrent release (if fitted) of the EL circuit-breaker at 135 % or 200 % of the rated current, as applicable, and check for compliance with 4.10.2 (f).

(e) Finally, apply between the parts listed in 6.3 'Insulation resistance test', an alternating voltage of approximately sinusoidal waveform and of the relevant value given in Table 7.

Start the test at a voltage not exceeding one-third of the appropriate test voltage and increase it to its full value as rapidly as is consistent with the true value being indicated by the measuring instrument. Maintain the full test voltage for one minute and then decrease it rapidly to not more than one third of this value before switching off. Check for compliance with 4.10.2 (g).

TABLE 7—TEST VOLTAGE

1	2
Rated voltage, V of EL circuit-breaker	Test voltage, V (r.m.s.)
Not exceeding 250 .....	1 500
Exceeding 250 but not exceeding 500 .....	2 000

#### 6.12.7 Interpretation of oscillograms:

(a) *Determination of applied voltage and power-frequency voltage:* From the oscillograms recorded during the calibration of the circuit the break test and the make-and-break test, determine the applied voltage and the power-frequency recovery voltage by estimating these voltages using the examples as shown in Fig. 2. (Fig. 2 applies to the make-and-break test.)

Measure the power-frequency voltage during the first half-cycle (without transients) after extinction of the arc, and during the next five successive peaks. Take the sum of these six peaks divided by  $6\sqrt{2}$  as the r.m.s. power-frequency recovery voltage for each phase as shown in Fig. 2 (b) and (c), and check for compliance with 4.10.2 (c).

*Note:* Attention is drawn to the fact that because of the influence of—

- (1) short time variations in the insulation resistance of a circuit-breaker,
- (2) short time variations in the insulation resistance of arc gaps, or
- (3) the resistance in recovery voltage measuring circuits, or any combination of these, certain types of triple-pole circuit-breaker exhibit a tendency for the power-frequency recovery voltage across each pole of the circuit-breaker to undergo short time variations in amplitude that fall below 105 % and rise above 115 % of the rated voltage of the circuit-breaker. Other types of triple-pole circuit-breaker have been observed to exhibit erratic short time variations in the power-frequency recovery voltage during which the amplitude varies from approximately zero value to full recovery voltage across one pole, while the recovery voltage across the other two poles shows short time variations in amplitude from above to below the specified limits. Where doubt exists regarding compliance of the circuit-breaker with the requirements for power-frequency recovery voltage, take three additional circuit-breakers and subject them to the break and make-and-break tests in accordance with the procedure given in 6.12.6 above, but with the neutral of the source of supply being connected to the common earth connection (Point F in Fig. 6).

(b) *Determination of the prospective breaking current:* Determine the value of the prospective breaking current by comparing the current trace obtained in the calibration of the circuit [see Fig. 2 (a)] with that obtained during the break test the oscillogram of which is not shown in Fig. 2, or that obtained in the make-and-break test [see Fig. 2 (b)]. Take the prospective breaking current in each phase to be the value of the r.m.s. power-frequency component of the calibration current that corresponds to the instant of separation of the arcing contacts [values corresponding to  $A_1$  or  $A_2$  of Fig. 2 (a)]. Ensure that the prospective current in any one phase does not differ from the average value by more than 10 %.

(c) *Determination of the prospective peak-making current:* Determine the peak-making current from the calibration oscillogram and take its value as being equal to  $A_3$  [see Fig. 2 (a)]. In the case of a three-phase test, take the highest of the  $A_3$  values obtained from the oscillogram.

*Note:* For tests on single-pole circuit-breakers, attention is drawn to the fact that the prospective peak-making current determined from the calibration oscillogram may differ from the value of the prospective peak-making current corresponding to the test, depending on the instant of making.

#### 6.13 SHORT-TIME WITHSTAND CURRENT TEST (FOR EL AN CIRCUIT-BREAKER NOT FITTED WITH AN OVERCURRENT RELEASE): Use the breaking capacity test circuit given in 6.12.

6.14 TEST FOR PERFORMANCE OF AN EL CIRCUIT-BREAKER UNDER EARTH LEAKAGE CONDITIONS AT ROOM TEMPERATURE (15–25 °C).

6.14.1 *Conditioning:* Condition the EL circuit-breaker under test for at least 6 hours at the specified ambient temperature (see 6.2.1) and maintain this ambient temperature during the test. Do not energize the EL circuit-breaker during the conditioning.

6.14.2 *Suddenly applied earth leakage current:* With the EL circuit-breaker energized at—

- (a) low voltage (70 % of the rated voltage or 70 % of the lowest voltage of the voltage range, as applicable). and
- (b) high voltage (110 % of the rated voltage or 110 % of the highest voltage of the voltage range, as applicable),

and without passing a load current through the EL circuit-breaker (except that, in order to facilitate the test procedure, the contacts of the EL circuit-breaker may be connected to a circuit incorporating a measuring device such as a cathode ray oscilloscope, an electromagnetic oscilloscope, a digital counter or a recording millivoltmeter, and if such a procedure is adopted, a current not exceeding 50 % of the rated load current of the EL circuit-breaker may be passed through the EL circuit-breaker), suddenly apply, in turn, at each of the energizing voltages, the applicable leakage currents specified in Table 5 and record the time interval between the instant the current starts to flow and the instant at which the contacts of the EL circuit-breaker start to open.

In the case of a three-phase EL circuit-breaker, conduct the test with the leakage current to earth applied to each current path in turn and record the results. Note on which path the highest tripping current is obtained.

Make five measurements of the operating time for each value of the earth leakage current and check for compliance with 4.12 (c).

6.14.3 *Gradually applied earth leakage current:* With the EL circuit-breaker energized as in 6.14.2 (a) and (b), pass a leakage current to earth through the EL circuit-breaker, starting with a current not greater than  $0.2 I_{\Delta_n}$ . Increase the current steadily and try to attain within 30 seconds an earth leakage current equal to  $I_{\Delta_n}$ .

Maintain the current at this value for a period longer than the time specified in column 2 of Table 5, appropriate to the rated earth leakage tripping current. In the case of a three-phase EL circuit-breaker, conduct the test with the leakage current to earth applied to each current path in turn and record the results. Note on which path the highest tripping current is obtained.

Should the EL circuit-breaker trip before the rated value is reached, record the value at which tripping occurs. Make five measurements of the tripping current and check for compliance with 4.12 (d).

6.14.4 *Closing of EL circuit-breaker on rated earth leakage tripping current,  $I_{\Delta_n}$ :* With the EL circuit-breaker energized as in 6.14.2 (a) and (b) but on no-load and with the test circuit calibrated to give rated earth leakage current, close the contacts of the EL circuit-breaker. In the case of a three-phase EL circuit-breaker, conduct the test with the leakage current applied to each current path in turn.

Record the time interval between the instant the current starts to flow and the instant the contacts of the EL circuit-breaker start to open. Measure the operating times for five operations and check for compliance with 4.12 (e).

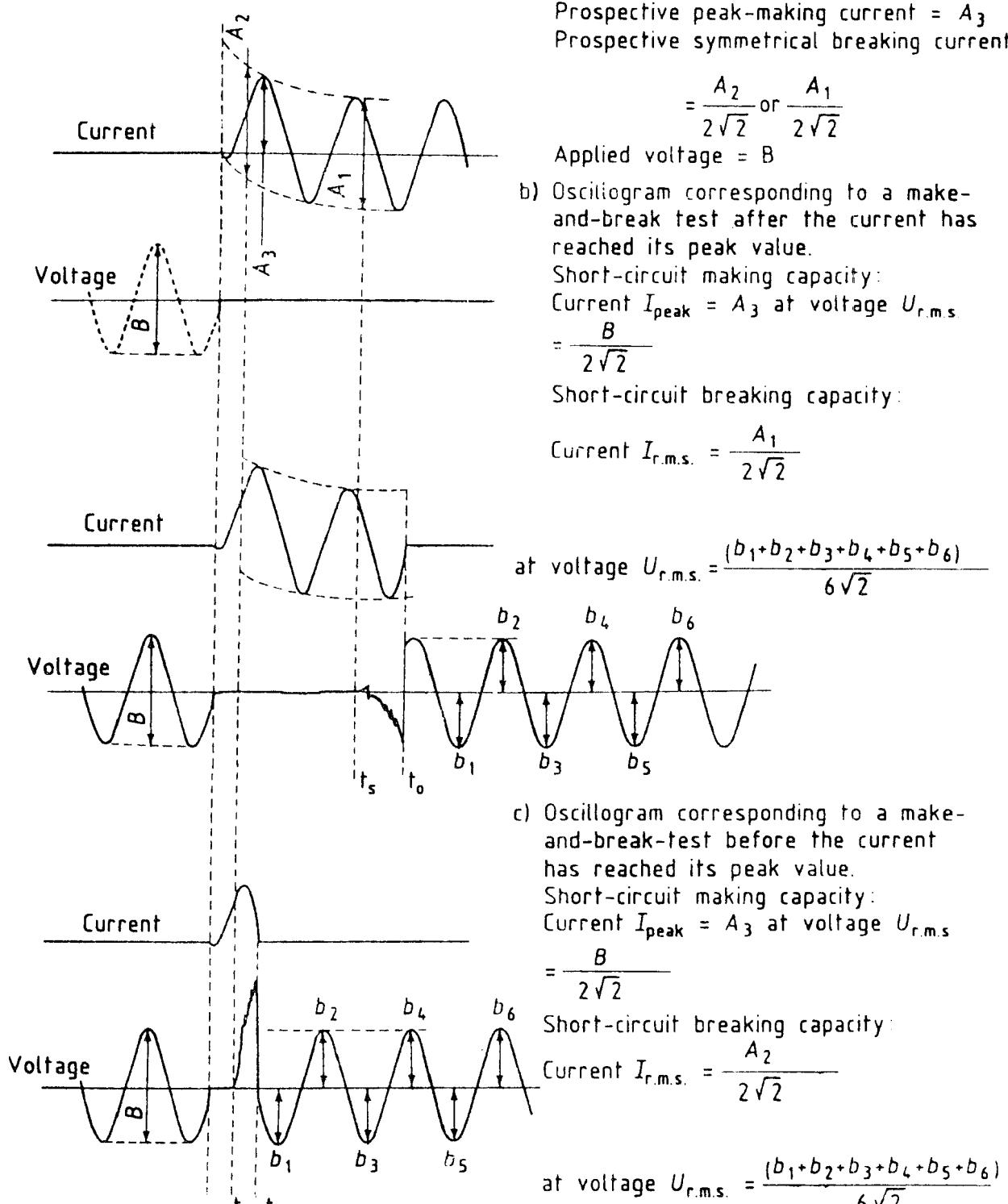
6.14.5 *Tests at rated load current:* With the EL circuit-breaker carrying rated current as for normal service shortly before and during each test, repeat, in turn, the tests given in 6.14.2, 6.14.3 and 6.14.4 and check for compliance with 4.12 (c), (d) and (e), respectively.

**Note:** Rated current may be circulated at any appropriate voltage except where the sensing and operating devices must be supplied at rated voltage.

6.15 TEST FOR PERFORMANCE OF AN EL CIRCUIT-BREAKER UNDER EARTH LEAKAGE CONDITIONS AT LOW TEMPERATURE: Repeat the tests given in 6.14.2 and 6.14.3 but in each case condition the EL circuit-breaker for at least six hours at an ambient temperature of between  $-4^{\circ}\text{C}$  and  $-6^{\circ}\text{C}$ . Maintain this temperature during the test.

Do not energize the EL circuit-breaker during the conditioning period. In the case of a three-phase EL circuit-breaker, conduct the test only on the path for which was recorded the highest value of tripping current during the tests at room temperature.

**Note:** To prevent icing, ensure that the dew point of the air inside the test chamber is not higher than  $-6^{\circ}\text{C}$ .



$t_s$  = Separation of contacts  
 $t_o$  = Arc extinction

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Fig. 2—Verification of Short-circuit Making and Breaking Capacities on AC

6.16 TEST FOR PERFORMANCE OF AN EL CIRCUIT-BREAKER UNDER EARTH LEAKAGE CONDITIONS AT HIGH TEMPERATURE.

6.16.1 Repeat the test given in 6.14.2 and 6.14.3 but in each case condition the EL circuit-breaker for at least six hours at an ambient temperature of between 38 °C and 40 °C. Maintain this temperature during the test. Do not energize the EL circuit-breaker during the conditioning period. In the case of a three phase EL circuit-breaker, conduct the test only on the path for which was recorded the highest value of tripping current during the tests at room temperature.

6.16.2 Repeat the test given in 6.16.1 but with the EL circuit-breaker carrying rated current. Conduct the test only after thermal steady state conditions have been attained.

**Note:** Rated current may be circulated at any appropriate voltage except where the sensing and operating devices must be supplied at rated voltage.

6.17 TEST FOR ENDURANCE OF TEST BUTTON.

6.17.1 *Mounting and supply:* Mount the EL circuit-breaker as for normal service (with all covers in position) and energize it at  $110 \pm 5\%$  of the rated voltage.

6.17.2 *Procedure:*

**Note:** Do not lubricate or otherwise condition the EL circuit-breaker during the test.

Operate the EL circuit-breaker carrying no current for 1 000 cycles (each consisting of one make and one break operation), using the test button. Check for compliance with 4.13.

6.18 TEST FOR DESENSITIZATION: Connect a resistance of  $1,5 \Omega$  between the supply neutral connection and the load neutral connection of the EL circuit-breaker (see Fig. 3).

With the EL circuit-breaker mounted as for normal service and energized at rated voltage, close the EL circuit-breaker contacts. Starting with a current of approximately  $0,2 I_{\Delta n}$ , apply a gradually increasing current between any line terminal on the load side and neutral. Record the value of the current at which the EL circuit-breaker trips. Repeat the test with the EL circuit-breaker energized at—

- high voltage (110 % of the rated voltage or 110 % of the highest voltage of the rated voltage range, as relevant), and
- low voltage (70 % of the rated voltage or 70 % of the lowest voltage of the rated voltage range, as relevant). Check for compliance with 4.14.

6.19 TEST FOR EFFECTS OF CAPACITIVE CURRENT.

(a) Connect via a separate electronic switch (to eliminate contact bounce) a capacitor of the value given in Table 9, appropriate to the rated earth leakage tripping current of the EL circuit-breaker under test, between the load terminal and earth in the case of a single-phase EL circuit-breaker, or between each current path and earth, in turn, in the case of a three-phase EL circuit-breaker.

(b) With the EL circuit-breaker mounted as for normal service and energized at rated voltage, close the EL circuit-breaker contacts.

(c) Operate the switch connecting the capacitor.

(d) Perform the test 50 times and discharge the capacitor after each test.

(e) Check for compliance with 4.15.

TABLE 8—VALUES OF CAPACITORS

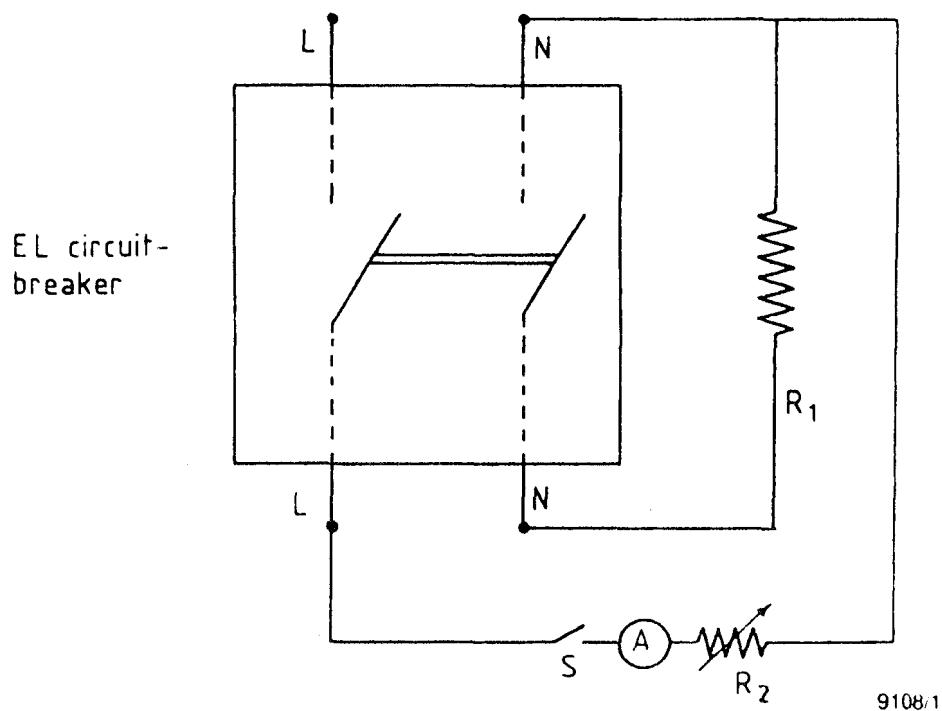
1	2
Rated earth leakage tripping current of EL circuit-breaker, mA	Value of capacitor, $\mu\text{F}$
30	0,1
10	0,033
5	0,016

NOTE: The source impedance  $Z$  shall be greater than  $0,44 \Omega$  ( $R = 0,433 \Omega$ ;  $X_L = 0,0774 \Omega$ ).

6.20 COMBUSTION TEST.

6.20.1 *Test specimens:* From the appropriate parts of the circuit-breaker, prepare at least three test specimens of width approximately 12 mm, of length approximately 50 mm and of thickness approximately 12 mm. (If the thickness of the material is greater than 12 mm, cut the specimens to a thickness of 12 mm.)

6.20.2 *Conditioning:* Condition the specimens for a period of at least 18 hours in an atmosphere having a relative humidity of  $75 \pm 5\%$  and a temperature of  $20 \pm 2^\circ\text{C}$ . Test every specimen within three minutes after removing it from the controlled atmosphere.



9108/1

$R_1$  = 1,5  $\Omega$  resistor  
 $R_2$  = Variable resistor  
A = Milliammeter  
S = Switch

Fig. 3—Wiring Diagram for the Desensitization Test

6.20.3 *Apparatus:* A test oven having a heating chamber as shown in Fig. 7. The area of the opening at the top of the conical cover is approximately 700 mm<sup>2</sup> and the total area of the air intake holes at the bottom of the oven is approximately 70 mm<sup>2</sup>. A light stirrup of wire may be used to support the specimen, the support being so arranged that the specimen is held centrally in the heating chamber, with its longest dimension vertical, and its upper end approximately 70 mm below the pilot flame. The apparatus is heating by passing a suitably regulated electric current through a heating element surrounding the heating chamber.

6.20.4 *Temperature measurement:* Take as the temperature of the heating chamber that shown by a thermocouple situated at the level of the middle of the specimen and equidistant from the inner surface of the chamber and the specimen.

6.20.5 *Procedure:* Suspend the specimen in the heating chamber and, keeping the specimen and pilot flame under observation, raise the temperature of the heating chamber to  $300 \pm 5$  °C and maintain this temperature for a period of five minutes. Report as defective any specimen that burns or gives off flammable vapours that ignite at the pilot flame.

6.21 TEST FOR LEGIBILITY OF LABELS AND ADHERENCE OF STICK-ON LABELS.

6.21.1 *Preparation of specimens:* Condition three EL circuit-breakers in a ventilated oven at  $70 \pm 2$  °C for a period of 168 ± 2 hours. In the case of a stick-on label, within three minutes after removing each EL circuit-breaker from the oven, peel back the label for approximately a quarter of its length (without removing the remainder of the label from its original position). Allow the EL circuit-breaker to cool (for at least four hours) to room temperature before carrying out the test described below.

6.21.2 *Procedure:*

(a) *All labels:* Soak in tap water a piece of butter muslin that complies with the requirements for Grade 1 butter muslin of SABS 446 'Absorbent gaugze (fabric and swabs) and butter muslin' and, applying a pressure of 0,05-0,1 MPa, rub the muslin a total of 30 times in each direction (forward and reverse) over the markings on the label. Repeat the test with butter muslin soaked in petroleum spirit and then examine the markings and check for compliance with 5.3.

(b) *Stick-on labels:* Using a spring balance and a suitable clamp attached to the free end of the label (see 6.21.1), try to remove the label from the EL circuit-breaker by pulling the free end with a force of 0,15-0,18 N/mm width of the label for a period of five seconds in a direction at right angles to the surface of the label. Check for compliance with the relevant requirement of 5.3.

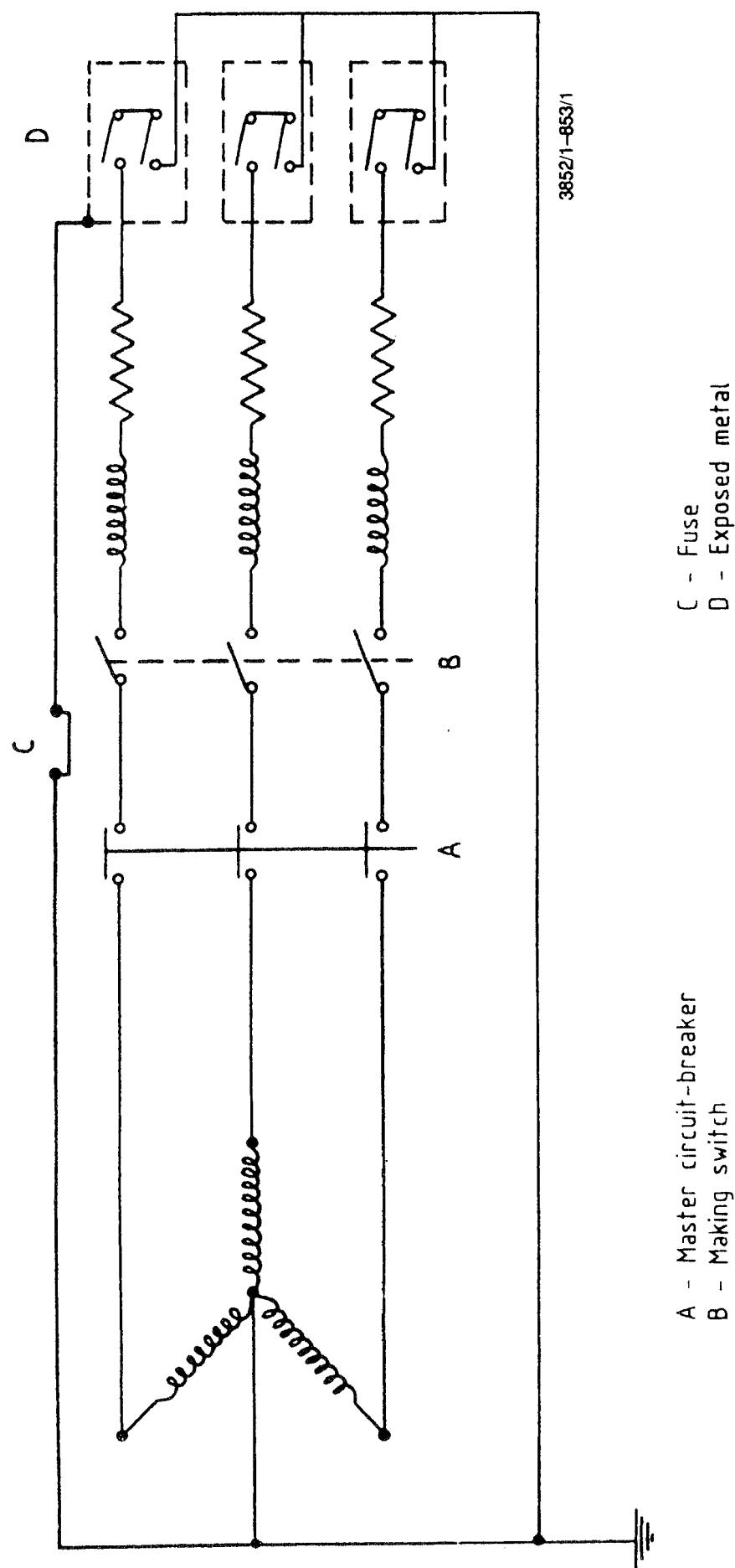
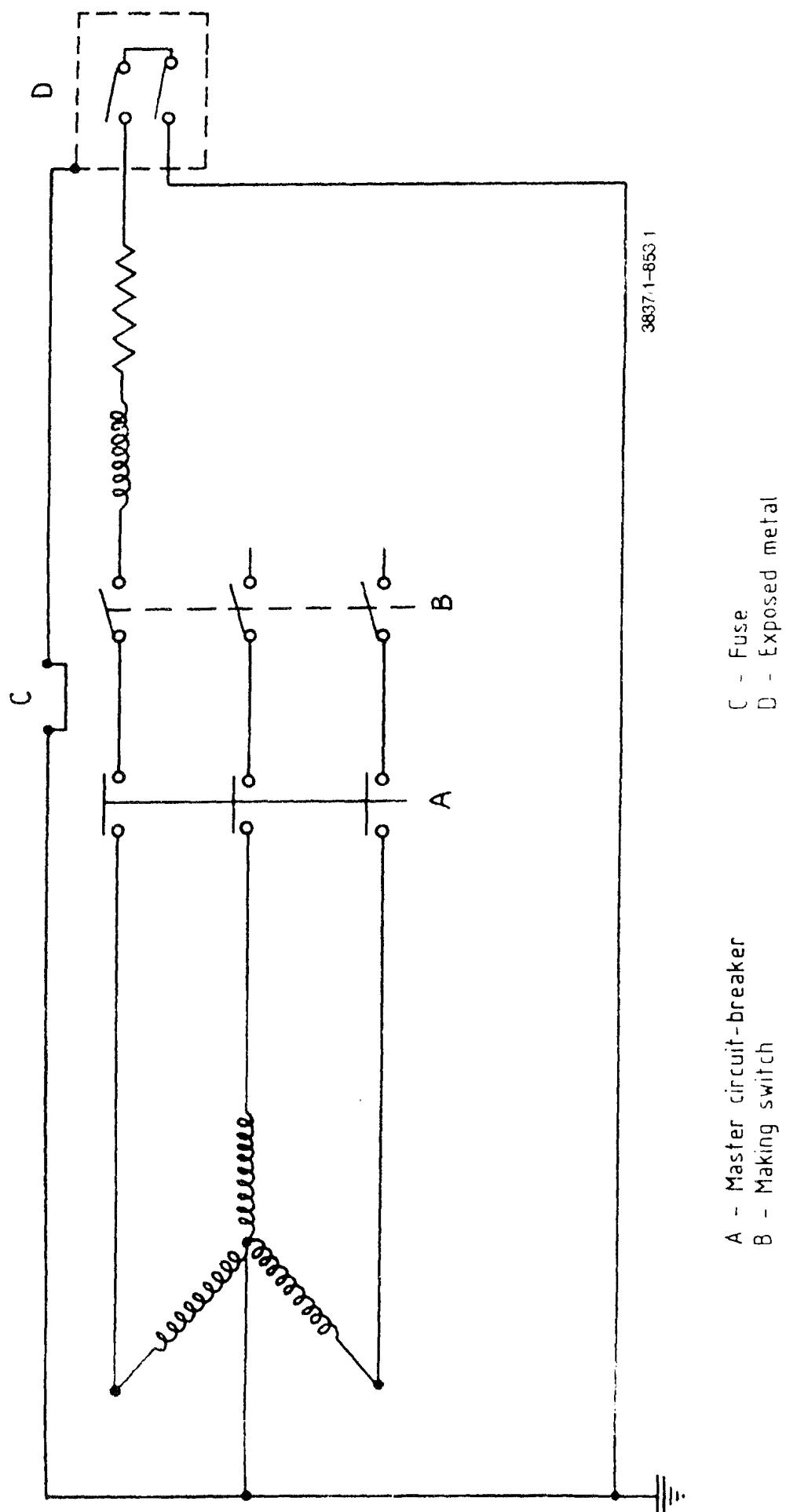


Fig. 4—Circuit Diagram for Breaking Capacity Test on Double-pole Circuit-breakers



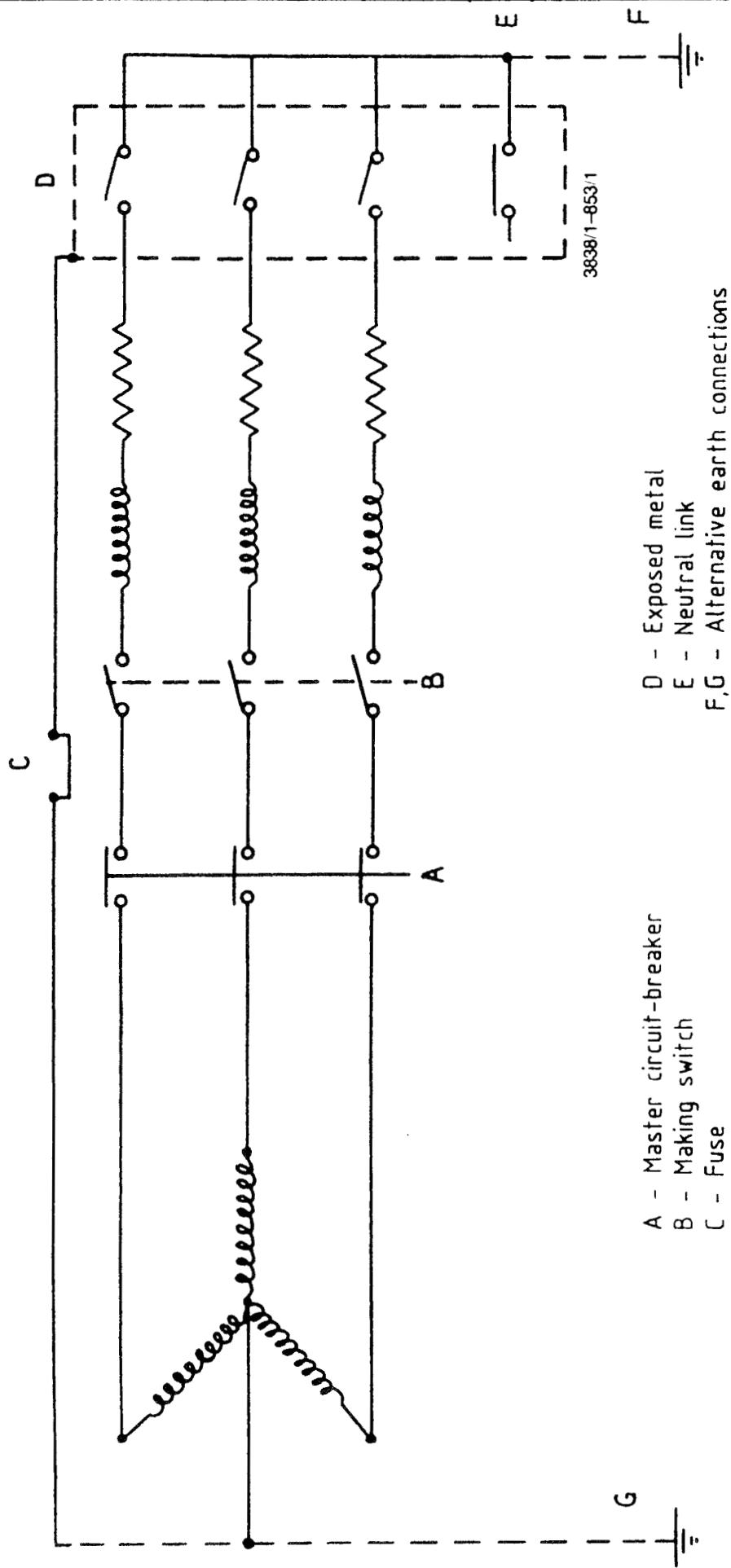
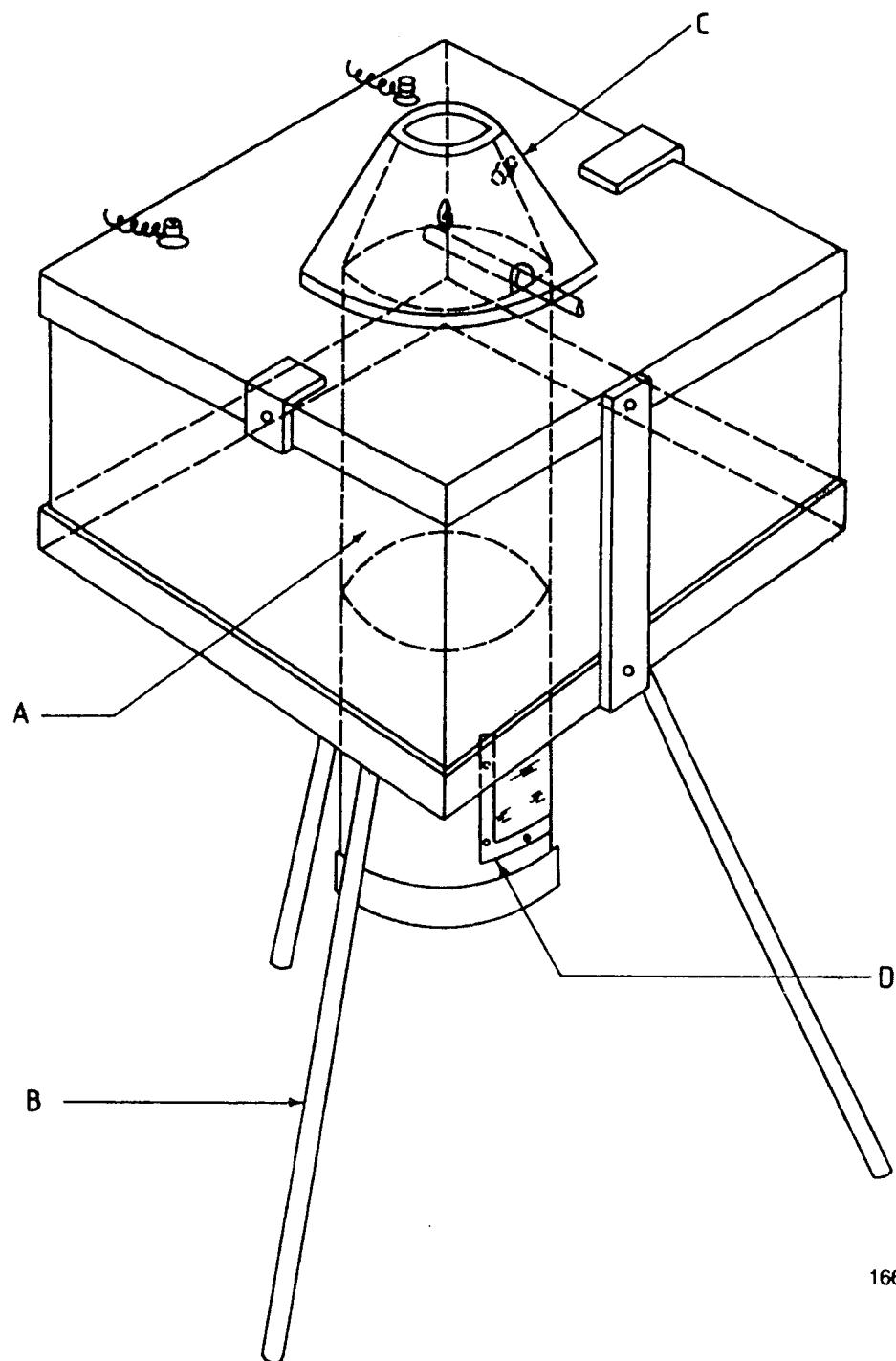


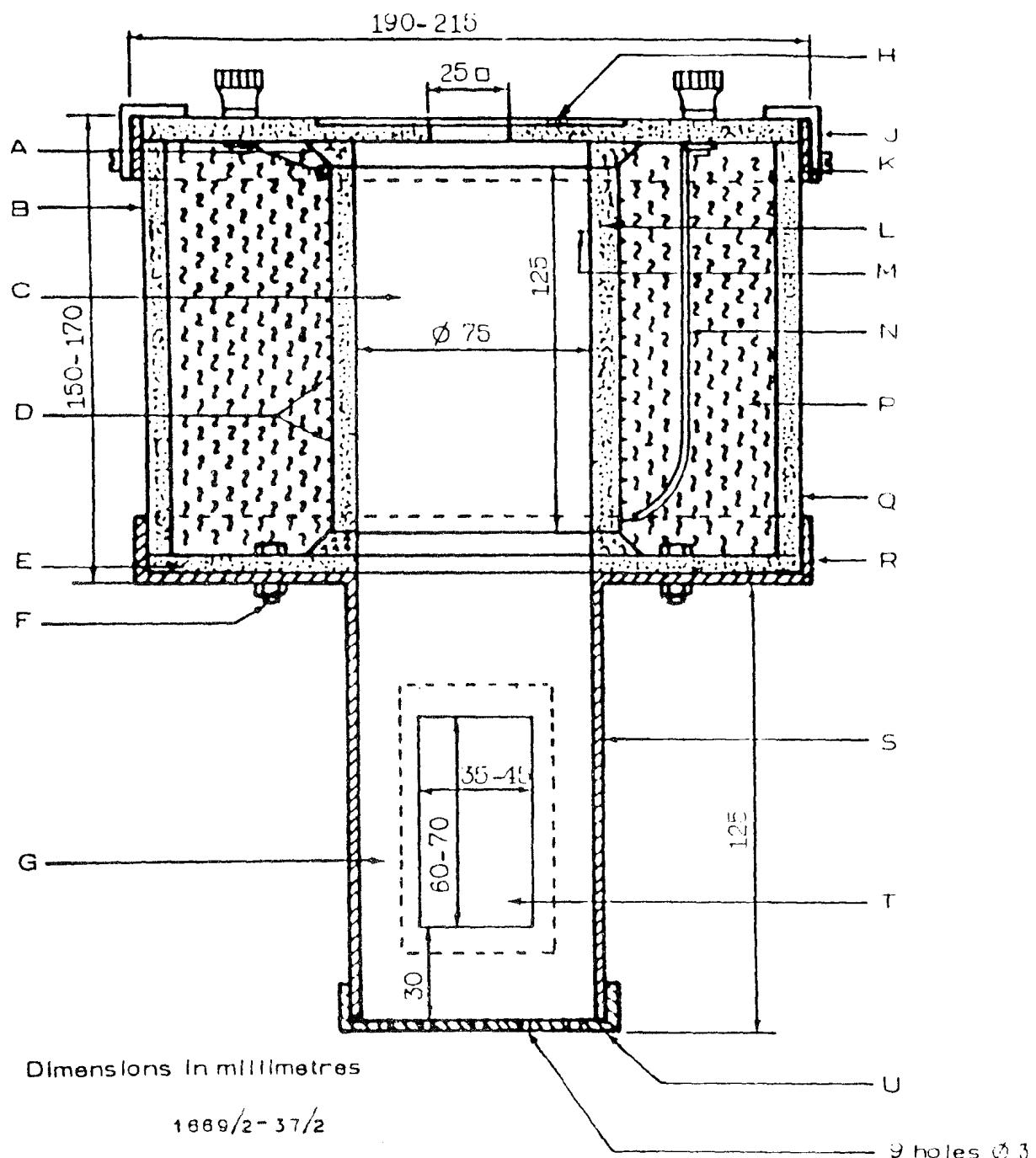
Fig. 6—Circuit Diagram for Breaking Capacity Test on Triple-pole Circuit-breakers



A - Heating chamber  
B - Tripod support

C - Conical cover  
D - Observation chamber

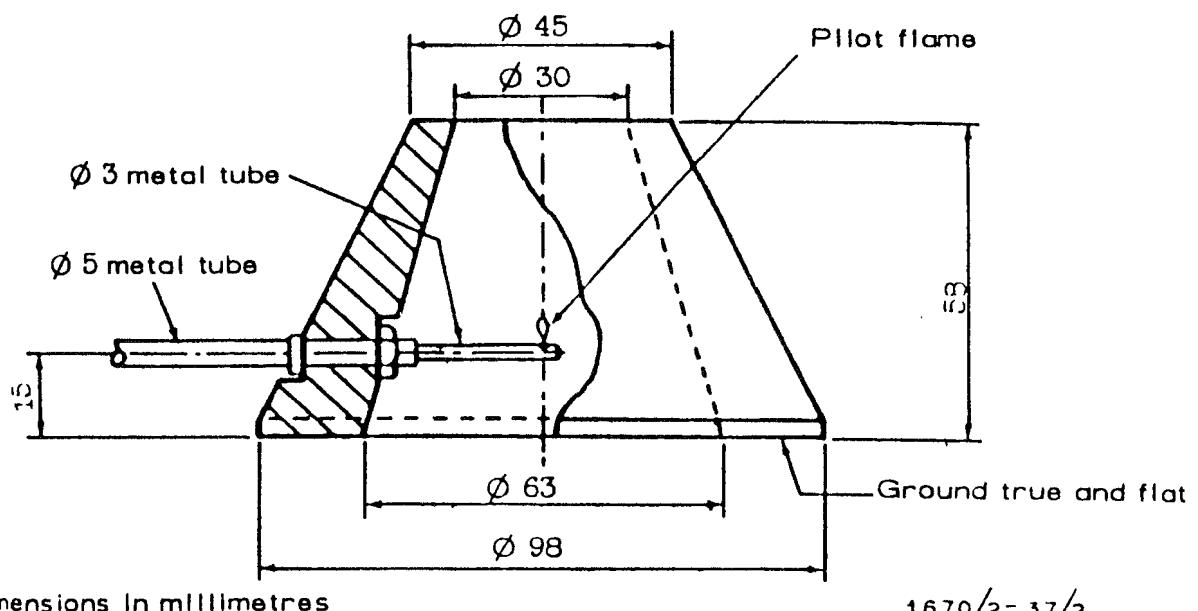
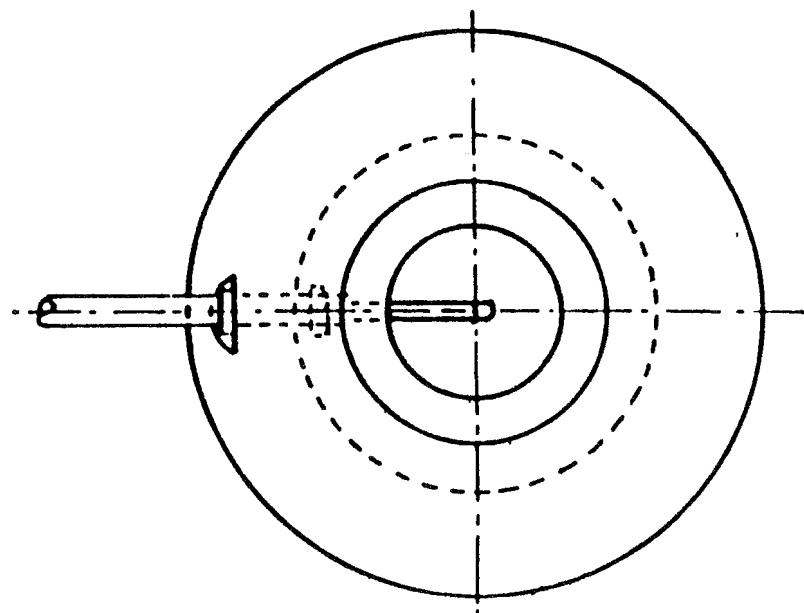
Fig. 7 (a)—Sketch of Assembled Apparatus



A - Refractory cement  
 B - Asbestos cement sheet  
 C - Heating chamber  
 D - Nichrome element  
 E - Asbestos board  
 F - Brass bolt  
 G - Observation chamber  
 H - Recess for placing of conical cover  
 J - Metal clip

K - Metal band  
 L - Fireclay or silica tube  
 M - Thermocouple  
 N - Heat-resisting insulation  
 P - Packing of asbestos wool or magnesia asbestos  
 Q - Asbestos cement sheet  
 R - Angle Iron  
 S - Metal cylinder  
 T - Mica window  
 U - Screw-on or sliding-fit cap

Fig. 7(b) - Details of Oven



Dimensions in millimetres

1670/2-37/2

Fig. 7(c) - Details of Conical Cover