

**INSTRUCTION MANUAL  
No. 55/ 3016****OPERATION AND MAINTENANCE INSTRUCTIONS**

FOR TYPES

VSI, SINGLE BUSBAR AND

VTD, DUPLICATE BUSBAR

AIR INSULATED, VERTICAL ISOLATION

INDOOR SWITCHGEAR

Given correct and normal routine maintenance this switchgear will give the purchaser satisfactory service.

Communication with the Works should quote the contract and serial numbers of the units to facilitate prompt attention to any enquiries.

Designs are constantly being improved and consequently there may be small differences in detail between the gear supplied and that described in this Manual.

'Instructions in this manual are given for information and guidance for qualified installation engineers, and where applicable must be considered in relation to the requirements of H.M. Government's Health & Safety at Work Act 1974 and subsequent amendments.

Should the user have any doubt regarding the interpretation of the information contained therein, our Engineering Department will be pleased to advise accordingly.'

January 1981.

**BRUSH SWITCHGEAR LIMITED**

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HIGH VOLTAGE ELECTRICAL EQUIPMENT SHOULD ALWAYS  
BE CONSIDERED TO BE DANGEROUS

BEING UNTRAINED, CARELESS OR BEING SKILLED  
WITHOUT COMPLETE CONCENTRATION CAN HAVE  
FATAL RESULTS

THIS MANUAL SHOULD BE CAREFULLY READ BEFORE  
UNPACKING THE EQUIPMENT

## SECTION 1

### WARNING - SAFETY PRECAUTIONS

SHOULD THE USER HAVE ANY DOUBT REGARDING THE INTERPRETATION OF THE INFORMATION CONTAINED WITHIN THIS PUBLICATION, OUR CONTRACT ENGINEERING DEPARTMENT SHOULD BE CONTACTED FOR THE REQUIRED INFORMATION

When carrying out work in accordance with the instructions contained within this manual, tools and substances will be used and operations performed which will require positive safety precautions to avoid health and injury hazards to the operators and others within the vicinity.

Attention is therefore drawn to the following hazards and necessary safety precautions recommended in accordance with H.M.Government's Health and Safety At Work Act 1974 and British Standard 5405 1976 Code Of Practice for the Maintenance of Electrical Switchgear

Lifting Gear Inadequately rated lifting gear or tackle or such correctly rated equipment used beyond its authorised Safe Working Load constitutes a serious danger.

Use the correct lifting equipment, having first checked the security of lifting stirrups. All lifting operations should be attended by an experienced 'slinger'.

Lifting or any movement of switchboards prior to installation should be carried out, either by ensuring that the Circuit Breaker is raised a few inches above the Isolated position, this will prevent the carriage moving in the housing during lifting, or by removing the Circuit Breaker from the housing. When lifting without the Breaker in position, the structure is unequal in its weight distribution, having the greater weight within the top half of the panel.

The lifting or movement of the switchgear requires extreme care and crane lifting straps should remain connected with the unit and in a taut position until the unit is ready for bolting down. Do not use fork lift trucks for moving units of switchgear.

Equipment is supplied with gross weights clearly marked on the packing cases, or on the back of the unit, and reference to this must be made before lifting commences.

Tools Hand tools used in a worn condition can result in injury, ensure the correct type of hand tool is used and that it is in good condition.

Switchgear Insulating Oil to B.S. 148 or equivalent is inflammable. Prolonged or frequent oil contact with the skin and oil vapour inhalation can all be considered to be a health hazard.

Avoid the Use of Naked Flames and excessive heat in the vicinity of oil - use approved protective clothing which is impervious to oil - allow for adequate natural or forced ventilation. Wash any areas of the skin contaminated by oil with water containing an approved detergent.

Compound Compound used for insulating and cable boxed should not be allowed to be in contact with the skin, and therefore protective gloves and clothing should be worn by personnel using compound. Melting points mentioned within the manual should not be exceeded.

Solder The application of heated solder can be dangerous and if carelessly applied can result in burns. Do not exceed the working temperature of any grade of solder and ensure that moisture is not present within the area of soldering.

General Guidance It is strongly recommended that before commencing any work, even basic cleaning, some review of the practices of good housekeeping should be considered. Hazards and injury are often the result of carelessness and untidyness.

Everyone involved with this equipment, including those working in close proximity to the equipment, should consider the necessity of wearing safety helmets, reinforced and approved safety footwear, protective clothing, the use of correct tools and - equally important - a clean, uncluttered area.

WARNING - DO NOT USE COMPRESSED AIR 'BLOWERS' TO REMOVE DIRT, SWarf, DUST ETC. ONLY A VACUUM APPLICATION SHOULD BE USED

An extremely dangerous situation can arise if fluid cleaning agent used is of an inflammable nature, or if it is not recognised to be a fluid for the exclusive use of cleaning. Particular attention should be applied to the manufacturers instructions. Cleaning agents should only be used in a controlled, well ventilated area.

Fluid splashed or spilled onto the skin should be immediately washed off with soap and water.

THIS EQUIPMENT IS DESIGNED TO A HIGH DEGREE OF SAFETY AND MANUFACTURED TO RIGID STANDARDS - QUALITY CONTROL DURING MANUFACTURE ENSURES THAT THE PRODUCT MEETS WITH THE STRICT REQUIREMENTS NECESSARY FOR EFFICIENT OPERATION.

SKILLED AND CAREFUL OPERATORS ARE ESSENTIAL FOR THE SAFE INSTALLATION, OPERATION AND MAINTENANCE OF THIS EQUIPMENT

GENERAL DESCRIPTION

Type VSI and VTD switchgear is of the flush fronted metalclad type with air insulated busbars, and oilbreak circuit breakers. VSI has a single set of three phase busbars and VTD a duplicate set, Figures 2.1 and 2.2 illustrate typical panels.

Both types of switchgear have Instrument Chambers with hinged doors as an integral part of the housing. Relay Chambers and Voltage Transformers can be mounted on top of the housing if required on contract.

The circuit breakers are vertically isolated and horizontally withdrawn on fully interlocked carriages.

In the VSI, busbar and cable earthing facilities are integral, with selection by transfer of the circuit breaker to the appropriate position. Cable and busbar earthing is effected by removing the circuit breaker and using a separate carriage complete with earthing switch. For Operation Instructions, see Publication No. 55/4034.

Independently operated safety shutters cover the fixed isolating contact bushing apertures and are positively operated by raising or lowering the circuit breaker. In any of the positions the appropriate shutters only are operated and the others may be padlocked closed. Independent catches are fitted enabling the shutters to be held open for maintenance or testing purposes. Re-insertion of the circuit breaker into the housing automatically cancels the catches.

A voltage transformer, either circuit connected or busbar connected, can be mounted on top of the Current Transformer or Busbar chamber. There are two types:- oil-insulated and dry type epoxy resin insulated. Either can be fitted to both VSI and VTD. The oil insulated voltage transformer is horizontally isolatable and runs on rails. The dry type has spring controlled hinged vertical isolation. Both are held securely in the service position by a catch, if required they can be padlocked 'in' or 'out' of service, (padlocks not supplied). Safety shutters screen live parts when the transformers are isolated.

Unless customers specify an alternative colour, the switchgear is finished in dark grey paint to B.S.381 shade number 532.

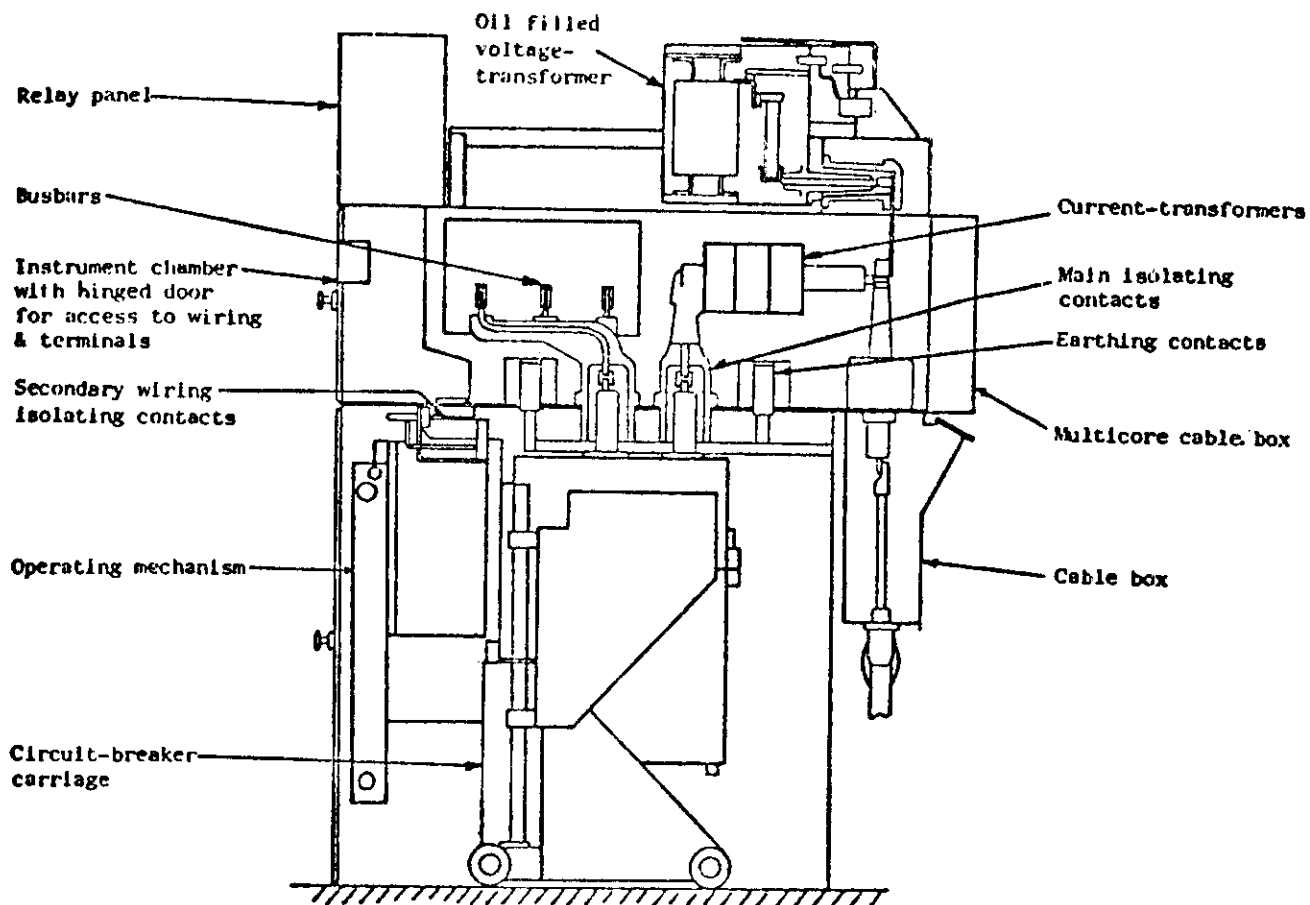


Fig. 2.1. Typical VSI Panel.

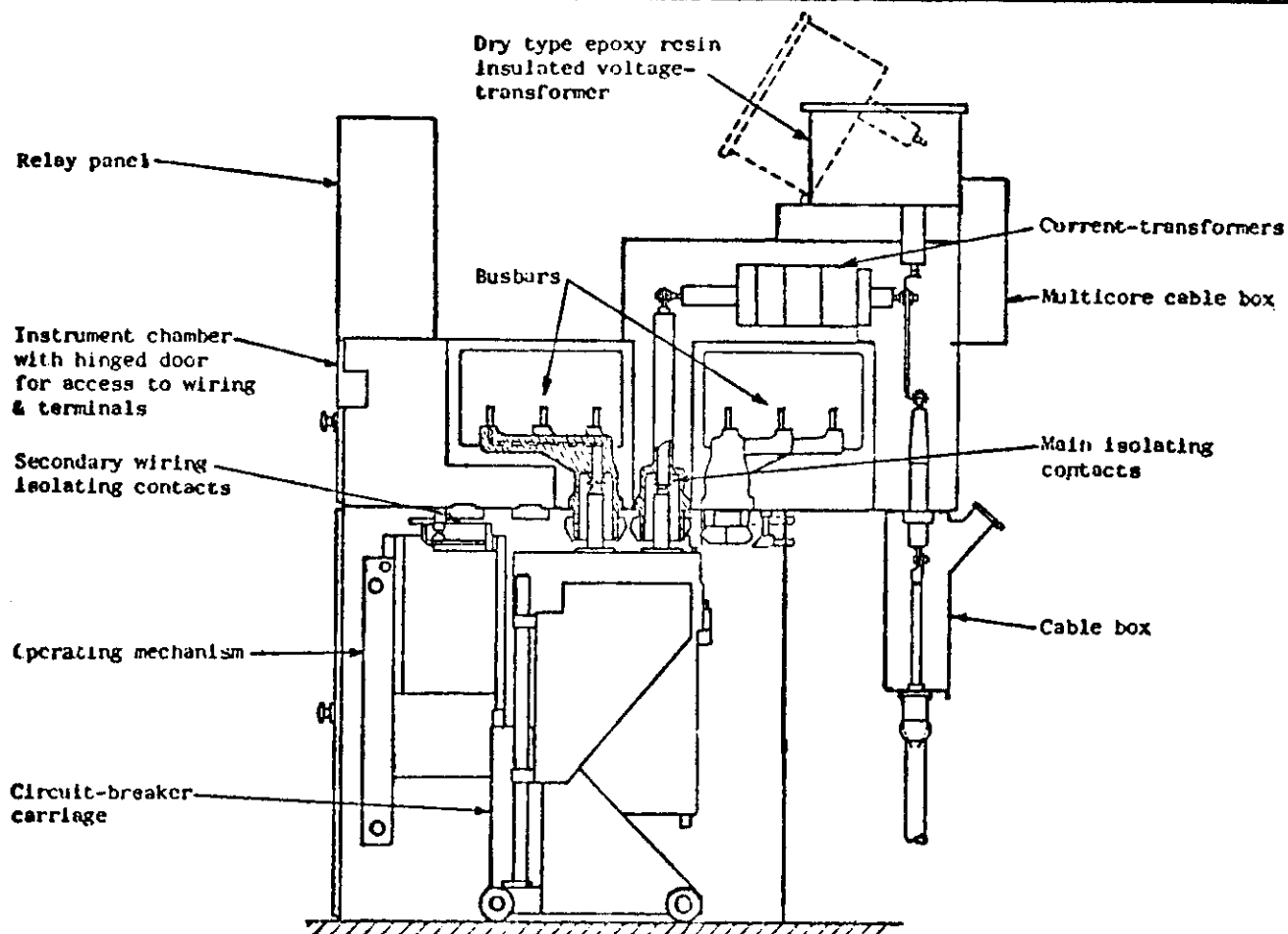


Fig. 2.2. Typical VTD Panel.

DESPATCH AND CHECKING UPON RECEIPT

Switchboards are despatched as units or sections, with all interconnecting busbars supplied as loose items. Panels are despatched with the circuit breaker carriage in the normal SERVICE position and the circuit breaker raised slightly above the ISOLATED position. Transported in this manner, the carriage cannot roll out of the housing and damage to the isolating contacts is avoided.

In accordance with the manufacturer's recommendations relay movements are tied and induction discs are wedged. Indicating instrument movements are not secured.

Each switchboard is supplied complete with:

- (i) Foundation bolts for each unit.
- (ii) Plumb Bob.
- (iii) Circuit breaker raising and lowering handle.
- (iv) Maintenance operating handle (also for use as emergency charging handle for motor wound spring operated mechanism).
- (v) Charging handle (for manual charge spring operated power close mechanisms only).
- (vi) Safety rod (for spring operated power close mechanisms only).

Test spikes, earthing equipment and tool kits are supplied when specified.

Oil complying with B.S. 148 is despatched separately to site in sealed containers by oil manufacturer or supplier.

Should the equipment remain in store, further checks should be undertaken before commissioning, see Section 5.

On arrival at site, each part of the consignment should be checked against relevant despatch notes and examined to ensure that no damage or contamination has occurred in transit. Any shortage or damage should be reported within three days of receipt to the carriers and either to Brush Switchgear Limited or the agent who supplied the equipment. As well as quoting the contract number, a full description of the parts concerned and any damage involved should be given.

SITE PREPARATION AND ERECTIONA. SITE PREPARATION

The switchgear is accurately made and will function satisfactorily if properly erected on site. The switchboard is jig assembled on level foundation rails in the Works and to obtain satisfactory operation these conditions must be reproduced on site.

The area of the substation floor in front of the switchboard must be flat and level to ensure that the carriage is standing in a vertical position at the point of entry into the housing. If carriage rails are provided, these must not be fixed until after the switchboard housings have been erected.

Where packing shims are found to be necessary, these should be at least 100 x 50 mm and should be positioned at the edges of the unit bottom plate. Care should be taken when tightening down the foundation bolts, see Figure 4.2, since excessive tightening will distort the bottom plate. It is usual, when cementing in the grouting bolts, to flood a 300 mm diameter pad of concrete, thus supporting the bottom plate.

Vacuum clean area and remove all items not necessary. Check suitability of lifting equipment to be used for positioning the equipment (See Section 1).

Before lifting operations are started, ensure that the circuit breaker is raised a few inches above the ISOLATED position. This prevents the carriage moving in the housing during lifting. The circuit breaker should not be raised to the ENGAGED position, otherwise damage to the isolating contacts may occur.

When lifting the equipment ensure that:

- (i) The S.W.L. of the lifting gear is suitable for the operation.
- (ii) All transit stirrups are securely bolted to the equipment - see Figure 4.1.
- (iii) Approved and tested slings are used.
- (iv) When multiple units are to be lifted the units are securely bolted together.

When the units require to be rolled into their final positions after being lifted from the lorry, they must be lowered very carefully onto three solid steel rollers of 25mm approx. diameter, positioned so as to avoid flexing of the unit structure.



## B. REQUIREMENTS FOR CORRECT ERECTION

The basic requirements are as follows:

Correct site preparation carried out in accordance with Section A.

The bottom plate of the unit must be flat and level.

The 'toe' of the unit bottom plate must be within 1.5 to 3mm of the substation floor.

WARNING - IF FEEDER CONNECTED V.Ts ARE FITTED WE RECOMMEND THAT THE MOVING PORTION BE REMOVED BEFORE ERECTION PROCEDURE COMMENCES.

Position unit/s on the prepared area and couple each section in the following manner:

- (i) Withdraw the carriage from the housing. See Page 11
- (ii) Remove lifting hooks and rubber plugs in interpanel fixing holes in bottom housing and instrument chamber sides and busbar/C.T. chamber.
- (iii) Bring units together over floor grouting holes, lining up front edges of units and busbar apertures.

(As an alternative to foundation bolts, unistrut fixings may be used, ensure that these are set to pick up the fixing holes in the base of the units as shown on the foundation plan supplied).

The longitudinal alignment and height of the units should be referred to the front of the basic housing and instrument panels.

The sides of the basic housing must be vertical and particular attention should be paid to the front of the unit.

Fit the plumb-bob (supplied with the switchboard) to each of the screws ringed in red in the top plate of the bottom housing. One screw is located at the front and one at the rear.

If necessary, the housing should be packed so that the point of the plumb is coincident with the 'centre pop' within the red circle on the bottom plate of the housing.

When the plumb-bob point is ON the 'centre-pop', the housing will be level and vertical.

It is preferable to start assembly at the centre of a switchboard consisting of more than five panels.

- (iv) Bolt units together, using holes in bottom housing and instrument chamber.
- (v) Grout in foundation bolts, filling holes completely with cement (see Fig.4.2).
- (vi) Remove covers from busbar chambers.
- (vii) Install busbars, ensuring that joint faces are clean and smeared with a thin film of vaseline (see Fig.4.3).
- (viii) Add inter-panel bolts above busbar apertures. Clean out all chambers thoroughly.
- (ix) Replace covers over busbar chambers.
- (x) Connect earth bars.
- (xi) Complete the panel wiring if necessary, and inter-panel bus wiring in accordance with the wiring and key diagrams.

Panel wiring is identified by numbered ferrules, and is completed as far as possible before despatch.

#### EXTENSION OF EXISTING SWITCHBOARDS

At each end of a switchboard the end of the busbar chamber is blanked off with a steel cover. This cover is fitted from the inside of the chamber, the exterior of the chamber being free of all protuberances. Thus, when an existing switchboard is being extended, the new panels can be grouted in position and the cables made off whilst the existing busbars are still alive. Finally, the busbars are made dead, and proved to be so, the internal end cover removed and the new busbars fitted between the existing and the new panels. In this way interruption of supply on the switchboard is kept to an absolute minimum.

Insulation of busbar joints, when specified, is done on site and the materials are supplied separately with the new switchboard.

All joints must be clean and securely bolted before the insulation is applied. The operator must have clean hands and must ensure that dust or moisture does not contaminate the insulation materials.

Refer to Manual No. 55/4024 "Instructions for Shrouding of Busbar Joints on VSI or VTD Type Switchgear".

Earth bars are fitted along the backs of the units. Ensure that all joints between earth bar sections are securely bolted together. The connection to the station earth should have a cross-section not less than that of the earth bar on the switchboard.

#### CABLE BOXES

CABLE JOINTING CONTRACTORS SHOULD BE ENGAGED FOR JOINTING AND TERMINATION OF MAIN CABLES INTO CABLE BOXES AND MULTI-CORE CONTROL CABLING IF FITTED.

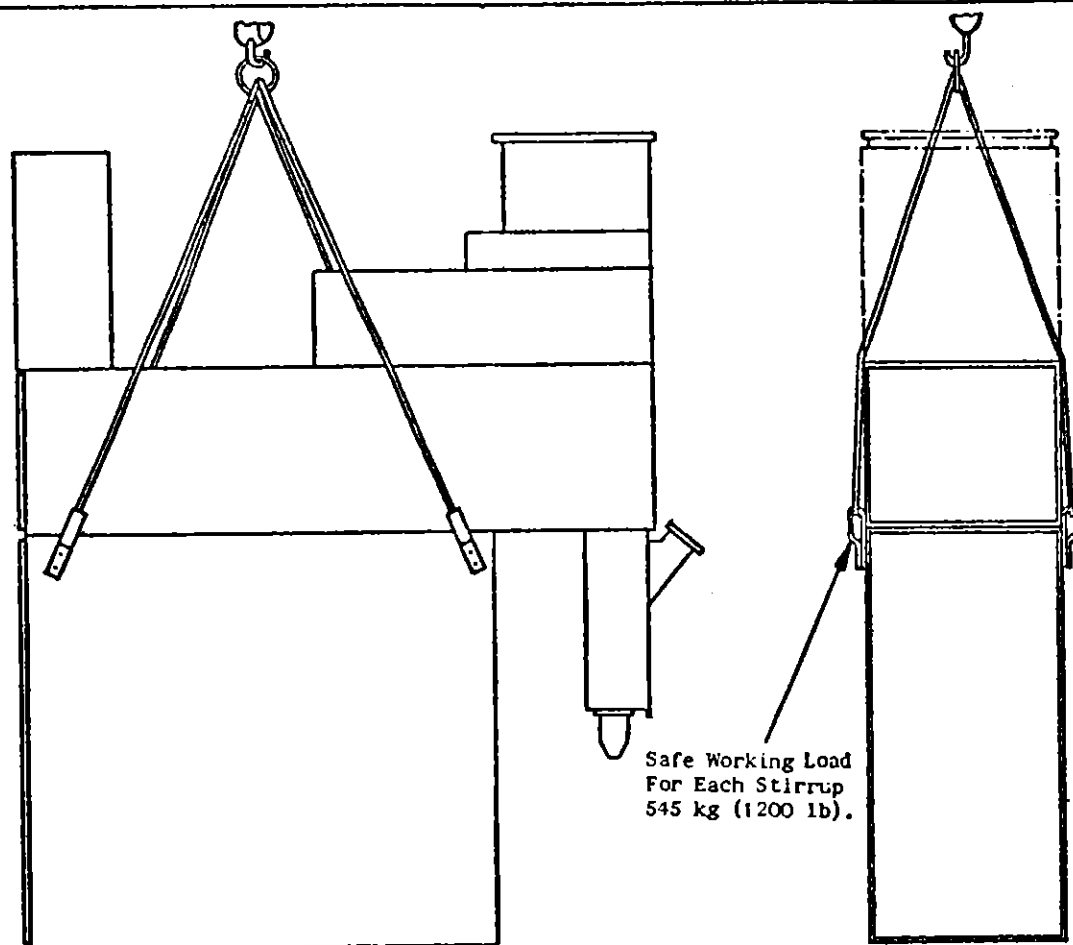


Fig. 4.1. Method of Lifting Unit.

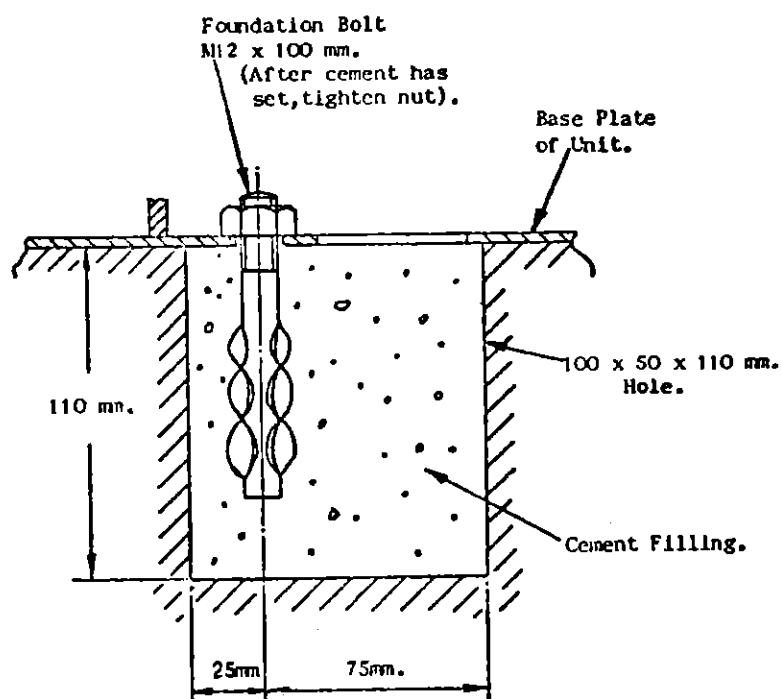


Fig. 4.2. Foundation Bolt Detail.

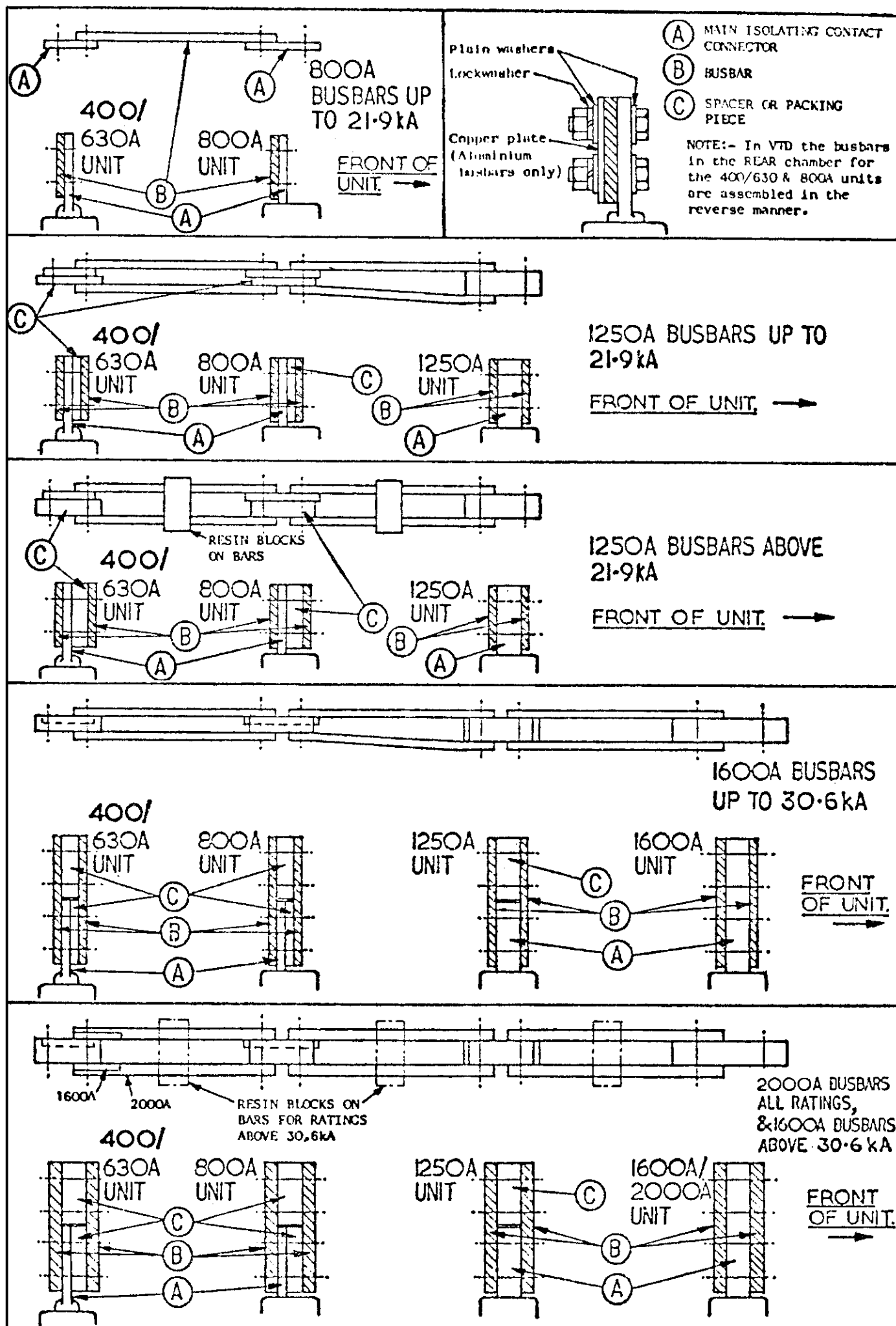


Fig. 4.3. Typical Busbar Joints.

## CIRCUIT BREAKERS - REMOVAL OF TANKS

Remove circuit breaker from housing as follows:

Ensure that the circuit breaker is OPEN by pressing the red trip button and noting that the green 'OFF' indicator flag can be observed through the perspex window.

Move the interlock lever marked 'Isolating Mechanism' to the 'FREE' position, see Fig.6.1.

Insert cranking handle into winding gear aperture located R/H side of breaker and rotate anti-clockwise, lowering the circuit breaker to the isolated position. Remove handle.

Move the carriage interlock located on R/H side of breaker to the 'FREE' position.

Withdraw the carriage using both hands by the fixed handle located on top front of breaker.

**WARNING - DUE TO THE WEIGHT INVOLVED THE UTMOST CARE MUST BE TAKEN WHEN WITHDRAWING OR REPLACING THE CIRCUIT BREAKER**

Remove the circuit breaker tank as follows:

Move carriage interlock to the "Locked" position.

Insert cranked handle into winding gear aperture located on R/H side of breaker and rotate anti-clockwise, lowering the circuit breaker to its lowest position.

Release tank securing bolts and allow tank to rest on ground having a level surface.

With the tank securing bolts 'FREE' raise the circuit breaker to its fullest extent beyond the 'ENGAGED' position. Slow close the circuit breaker with the maintenance operating handle. Wheel the carriage away from the tank. Open the circuit breaker slowly, using the hexagonal maintenance operating handle.

**WARNING - IT IS DANGEROUS TO CLOSE THE CIRCUIT BREAKER WITH THE NORMAL OPERATING HANDLE, OR TO OPEN THE CIRCUIT BREAKER BY PRESSING THE RED TRIP BUTTON WHILST THE HEXAGONAL MAINTENANCE OPERATING HANDLE IS FITTED.**

Ensure that the interior of the tank is clean and dry, using a non-fibrous cloth. Fill the tank to the indicated level with clean moisture-free oil complying with B.S.148. Note health warning in Section 1. Recommendations for drying out and testing oil are given in Section 7.

Raise circuit breaker to its fullest extent and then close, using the maintenance operating handle. Wheel the carriage up to the tank which must contain the specified quantity of clean, moisture-free oil complying with B.S. 148 (See Section 3). The travel limit pad on the tank should face towards the jack-screw on the lift mechanism.

Open the circuit breaker slowly using the maintenance operating handle.  
When open remove handle.

Move the interlock lever on the ISOLATING MECHANISM to the 'FREE' position and the carriage interlock to the 'LOCKED' position.

ENSURE THAT THE TANK GASKET IS INTACT AND UNDAMAGED.

Insert the cranked raising and lowering handle and rotate anti-clockwise to lower the circuit breaker to the 'ISOLATED' position - remove handle.

Secure the tank fixing screws evenly until the tank touches the stops on the top plate.

#### OPERATING MECHANISM

Check that the mechanism is clean and operates freely (refer to appropriate mechanism manual). Ensure that auxiliary switch contacts and operating links are clean and operate freely and that the electrical connections are secure.

It should be noted that power closing of solenoid and electrical spring release mechanisms can only be carried out after electrical control system has been energised, also electrical tripping.

#### BOTTOM HOUSING

Remove any dirt and dust from the bottom housing, paying particular attention to the main isolating contact bushings.

Ensure that the shutter operating mechanism including the maintenance operating mechanism and the position selector mechanism operate freely and smoothly.

The circuit breaker should be tried in all positions to check correct operation of shutters and racking switches, if fitted, by visually checking the correct location of operating arms.

Check that the main contacts, the secondary contacts, the earthing contacts and the top plate earthing contacts are clean. Apply a thin film of silicon grease MS4, preferably, or petroleum jelly.

## REPLACEMENT OF CIRCUIT BREAKER CARRIAGE INTO HOUSING

Ensure that the circuit breaker is wound down, and that it is in the isolated position and the carriage interlock is set to the 'Free' position. See Fig.6.1.

Set the selector device to the required position and padlock if required. (See section 6 page 27).

Using both hands on the fixed handle located on the top of the breaker, wheel carriage into the housing and position it so that the vertical arrow on the circuit breaker is aligned to the previously selected position marked on the housing base plate.

Insert cranked handle into the winding gear aperture located on the R/H side of the circuit breaker and rotate the handle clockwise raising the circuit breaker to the fully engaged position - remove cranked handle.

Move the interlock lever on the isolating mechanism to the 'LOCKED' position.

The circuit breaker may now be operated only if the above sequence has been carried out correctly.

## VOLTAGE TRANSFORMER

WARNING - OIL FILLED VOLTAGE TRANSFORMERS ARE DESPATCHED WITHOUT OIL. FOR COMMISSIONING IN THE MAINLAND OF GREAT BRITAIN, UPON RECEIPT ENSURE THAT THE BUSHINGS AND TANK INTERIOR ARE CLEAN AND DRY. FILL THE TANK TO THE INDICATED LEVEL WITH CLEAN, MOISTURE-FREE OIL COMPLYING WITH B.S.148.
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Transformers that have been stored for long periods, or exposed to damp or tropical conditions, should be dried out. The temperature of the winding must not be allowed to exceed 70°C at any time.

On completion of drying out, the hot transformer should be immediately immersed in clean, moisture-free oil.

## COMMISSIONING AND TESTING

Commissioning is the transference of the equipment as assembled and installed on site to being a functioning part of an H.V. distribution and utilisation network. As such, reference to Instruction Manuals of associated equipment e.g. H.V. cables, tripping supplies, inter-connected control and protection schemes, must be made.

IT IS RECOMMENDED THAT THE FOLLOWING PRE-COMMISSIONING CHECKS AND TESTS BE CARRIED OUT BEFORE ANY CONNECTIONS ARE MADE TO THE SWITCHBOARD. ONCE ANY CONNECTIONS HAVE BEEN MADE TO THE SWITCHBOARD, EITHER H.V. OR CONTROL, THESE MUST BE ASSUMED TO BE LIVE, OR BEING CAPABLE OF BEING MADE LIVE, UNTIL PRECAUTIONS ARE TAKEN TO MAKE THEM SAFE.

It should be noted that after cleaning the switchgear in accordance with the instructions, further ingress of dirt may occur due to building or other trade work going on. It is essential that the equipment is clean before any attempt is made to put it into service.

Before applying high voltage tests to the unit, ensure that the high voltage fuses are removed.

Check that all packing material used on meters and relays has been removed. Check zero settings of ammeters and voltmeters.

If a tripping supply is available, operate the relay to check the tripping.

Before 'megger' testing the small wiring disconnect all earth connections as shown on the wiring diagrams from current transformers, voltage transformers etc.

Care should be taken before 'meggering' where static relays or other devices form part of the circuit, and the manufacturer's instructions sought.

## ELECTRICAL TESTING

### (a) Low Voltage Circuits

Test the secondary wiring with a 500 or 1000 volt 'megger' after looping the ends together at some convenient point such as a terminal board.



The value of insulation resistance per unit should be in the region of 2 megohms. When a switchboard consisting of a number of units is being tested, the average value of a unit may be obtained by multiplying the reading by the number of units. It should be remembered, however, that the value of an individual unit may be below the average figure.

After completion of 'megger' tests, replace all earth connections and any division sheets which may have been removed.

Integrity of circuits must be proved as part of the pre-commissioning tests by primary injection of C.T.s and functional tests on closing, tripping and interlock circuits. Secondary injection tests of protective relays and devices should be carried out to prove that no disturbance has taken place during transit. As schemes are specific to user's requirements, no detailed instruction can be given here.

- (b) High Voltage Circuits, including busbars, circuit breakers & feeder connections.

<p>WARNING- WHEN H.V. TESTING IS BEING CARRIED OUT IT IS RECOMMENDED THAT THE AREA CONCERNED SHOULD BE CORDONED OFF AND SAFETY NOTICES CLEARLY POSITIONED.</p> <p>IT IS ESSENTIAL TO EARTH THE EQUIPMENT UNDER TEST AFTER EACH AND EVERY TEST HAS BEEN MADE.</p>
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Before the switchgear is tested with a high voltage supply, ensure that the voltage transformers are isolated and tested separately.  
A test voltage between phases of a voltage transformer would burn out the primary winding.

The unit must be well earthed and isolated from other gear and it must be clean and dry.

Access to test the busbars is achieved via the red shutters in the bottom housing, and using the approved test plugs.

Using a 1000 volt or, if available, a 2500 volt 'megger' measure the insulation resistance to earth of each busbar in turn with the other two earthed. If the insulation resistance readings are appreciably below 100 megohms after careful cleaning and drying of the insulation surfaces, an inspection for insulation fault should be made before proceeding with high voltage tests.

If the 'megger' readings are satisfactory, apply high voltage tests in a similar manner to the 'megger' tests and in accordance with the following tables :-

Note: When testing at the higher voltage it may be found necessary to remove the fronts of the cable boxes and to temporarily shroud the terminals with solid insulation.

Rated System Voltage (kV)	Test Voltage (kV)
3.3	8.6 for 1 minute
6.6	15.2 for 1 minute
11.0	24.0 for 1 minute

Note: The test voltages are given for alternating current with a frequency of 25 to 100 cycles per second.

If it is impracticable to test at the above values then voltages reduced in accordance with the following tables may be used for a longer period:

Duration of Test (minutes)	Percentage of 1 min. Test Voltage
1	100.0
2	83.5
3	75.0
4	70.0
5	66.6
10	60.0
15	57.7

When testing large switchboards consisting of many units, the capacitive current taken may be sufficient to distort the test voltage supply wave form so that the peak voltage will exceed 2 times the r.m.s. voltage as recorded by the voltmeter on the testing transformer. In such cases a sphere spark gap should be connected across the transformer and the gap set at a distance which would cause flashover at a voltage slightly in excess of the test value, the gap setting being based on B.S. 923. The test voltage should then be raised to just below the spark gap flashover value.

It is necessary to test cables with direct current after they have been permanently connected to the switchgear. For such D.C. tests, the circuit breaker should be isolated so that only those parts of the switchgear are tested which cannot readily be disconnected from the cable during the test.

Tests should not be in excess of those laid down by B.S. or I.E.C. standards.

(a) Primary Winding

Connect all secondary terminals together and connect them to the earthed V.T. tank. The test voltage in accordance with B.S. 3941 should then be applied between the primary terminals connected together and the earthed tank.

(b) Secondary Wiring

When applying a 2kV test voltage between the secondary terminals connected together and the earthed tank, ensure that the primary terminals are connected together and earthed.

Take care never to apply a test voltage across the winding of a transformer as this will result in the winding being burnt out.  
In case of a voltage transformer having a high voltage neutral connection earthed, it should be disconnected during tests and replaced afterwards.

REMOVAL OF CIRCUIT BREAKER FROM BOTTOM HOUSING

Follow instructions in Section 4, Page 11.

REMOVAL OF CIRCUIT BREAKER TANK

Follow instructions in Section 4, Page 11

REPLACEMENT OF CIRCUIT BREAKER TANK

Follow instructions in Section 4, Page 12.

SELECTOR DEVICE

Location of the circuit breaker in the housing is by a selector device situated at the right-hand side of the bottom housing. The selector is set to the position required and the carriage is wheeled into the housing to the selected position.

When manually operated, a spring-loaded bolt on the carriage will engage in a hole in the selector plate and in this position the shutter plate covering the bearing hole for the raising and lowering handle on the carriage will uncover the aperture to allow the handle to be inserted and the circuit breaker elevated to the 'ENGAGED' position when the ISOLATING MECHANISM is set to the 'FREE' position.

VSISERVICE position

Indicated by actuator/indicator rod 'A' in position shown.

Only aperture 2 is available to accept the bolt on the carriage.

The selector can now be locked, if required, into the SERVICE position with a padlock, as shown at LOCK INTO SELECTED POSITION.

If required, a padlock can also be fitted to LOCK OUT CIRCUIT EARTH or LOCK OUT BUSBAR EARTH positions.

CIRCUIT EARTH positions

Put actuator/indicator rod 'A' to CIRCUIT EARTH position.

Only aperture 1 is available to accept the bolt on the carriage.

The selector can now be locked if required into the CIRCUIT EARTH position with a padlock as shown at LOCK INTO SELECTED POSITION.

If required a padlock can also be fitted to LOCK OUT BUSBAR EARTH position.

BUSBAR/EARTH position (when provided)

Put actuator/indicator rod 'A' to BUSBAR EARTH position.

Only aperture 3 is available to accept the bolt on the carriage.

The selector can now be locked if required into the BUSBAR EARTH position with a padlock as shown at LOCK INTO SELECTED POSITION.

A padlock can also be fitted to LOCK OUT CIRCUIT EARTH position.

## VTD

Selector device. See Fig. 6.3.

### FRONT BARS SERVICE position

Indicated by actuator/indicator rod 'A' in position shown.

Only aperture 1 is available to accept the bolt on the carriage.

The selector can now be locked if required into the FRONT BARS SERVICE position with a padlock, as shown at LOCK INTO SELECTED POSITION.

A padlock can also be fitted to LOCK OUT EARTH POSITION.

### REAR BARS SERVICE position

Put actuator/indicator rod 'A' to REAR BARS SERVICE position.

Only aperture 2 is available to accept the bolt on the carriage.

The selector can now be locked, if required, into the REAR BARS SERVICE position with a padlock, as shown at LOCK INTO SELECTED POSITION.

A padlock can also be fitted to LOCK OUT EARTH positions.

## EARTHING

A separate carriage complete with earthing switch is required - see Manual for earth test truck.

### CIRCUIT EARTH position

Put actuator/indicator rod 'A' to CIRCUIT EARTH position.

Only aperture 4 is available to accept the shoot bolt in the carriage.

The selector can now be locked if required into the CIRCUIT EARTH position with a padlock, as shown at LOCK INTO SELECTED POSITION.

If required, a padlock can also be fitted to LOCK OUT SERVICE POSITIONS.

### FRONT BARS EARTH position

Put actuator/indicator rod 'A' to FRONT BARS EARTH position.

Only aperture 3 is available to accept the bolt on the carriage.

The selector can now be locked, if required, into the FRONT BARS EARTH position with a padlock, as shown at LOCKED INTO SELECTED POSITION.

A padlock can also be fitted to LOCK OUT SERVICE POSITIONS.

### REAR BARS EARTH position

Put actuator/indicator rod 'A' to REAR BARS EARTH position.

Only aperture 5 is available to accept the bolt on the carriage.

The selector can now be locked if required into the REAR BARS EARTH position with a padlock, as shown at LOCKED INTO SELECTED POSITION.

If required, a padlock can also be fitted to LOCK OUT SERVICE POSITIONS.

### BUS SECTION and BUS COUPLER panels

Similar mode of operation; only the label readings differ.

### REPLACEMENT OF CIRCUIT BREAKER CARRIAGE INTO HOUSING

Follow instructions on Section 4, Page 13.

### OPERATION OF VOLTAGE TRANSFORMERS

#### (a) OIL INSULATED TRANSFORMER

The voltage transformer and its associated high voltage fuses are accommodated in a welded steel draw-out type tank which runs on rails. The secondary fuses are mounted outside the tank and can be removed in either the service or isolated positions.

Safety shutters automatically seal off live parts when the tank is withdrawn. The shutters can be padlocked closed. For testing and maintenance purposes the shutters can be kept open by means of a manually operated catch which is self-cancelled when the transformer tank is returned to the service position.

IT IS IMPORTANT THAT THE AREA WHERE TESTING, OPERATION OR ROUTINE MAINTENANCE IS BEING CARRIED OUT IS FREE FROM LOOSE HAND TOOLS, OTHER OBJECTS AND DIRT THAT COULD PRESENT A SAFETY HAZARD.
--

To isolate the transformer:

Depress the catch handle and withdraw the tank from the service position.

To re-engage the transformer :

Pull the tank forward fully until the catch engages to hold the transformer in the service position.

To remove the high voltage fuses:

Isolate the transformer and remove 6 screws and the cover from the tank. Remove the fuses. These are mounted vertically and forward of the transformer. When two transformers are fitted the fuses are located between the transformers.

The lower end of the fuses are located in cluster-type contacts and the upper ends are held in contact clips.

b) DRY TYPE TRANSFORMER

The voltage transformer and its associated high voltage fuses are accommodated in a welded steel hinged type housing. The secondary fuses are mounted outside the housing and can be removed in either the service or isolated positions.

To isolate the transformer:

Release the securing catch and lift the housing upwards, the movement is spring assisted. Safety shutters automatically seal off live contacts..

WARNING - WHEN THE HOUSING IS FULLY RAISED, ENSURE THAT THE SUPPORTING STAY IS ENGAGED CORRECTLY IN THE LOCKED POSITION.

To re-engage the transformer, lift to allow the support stay to disengage. Lower the transformer gently to the position. Close securing catch and padlock.

To remove the H.V. fuses:

Isolate the transformer (see above). The fuses are contained in the moulded insulators and are held in this position by the plate carrying the spring-loaded contacts. Removing the three screws releases the fuses.

SPRING OPERATED INDEPENDENT MANUAL CLOSING MECHANISM, TYPE M21XA

See Manual 55/4028

To close the circuit breaker:

Ensure that the ISOLATED MECHANISM is set to the LOCKED position.

Raise the operating handle to its full extent and press downwards to return it to its original position.

To open the circuit breaker:

Press the trip button.

WARNING - IF THE OPERATING HANDLE IS FULLY RAISED FOR A CLOSING STROKE AND IT IS REQUIRED TO LOWER IT WITHOUT OPERATING THE CIRCUIT BREAKER, IT SHOULD NOT BE ATTEMPTED BY PRESSING THE TRIP BUTTON WHILST PUSHING THE HANDLE DOWN. THIS WILL CAUSE A "TRIP-FREE OPERATION" WITH PARTIAL CLOSURE OF THE CIRCUIT BREAKER, AND ALSO POSSIBLY DAMAGE THE MECHANISM.

With the aid of an assistant, lower the handle as follows:

Set the ISOLATING MECHANISM to the 'FREE' position.

Support, or have the assistant hold, the operating handle to prevent it prematurely falling whilst performing the subsequent operations.

Remove the cover from the R/H side of the mechanism.

Whilst pressing the trip button, push upwards on the trip roller bearing so that the trip linkage collapses upward.

Whilst continuing to hold the trip linkage to prevent it from falling back again, pull upwards and forwards on the toggle lever which projects from the bottom of the mechanism until the trip linkage collapses.

The operating handle is then free and can be lowered to the fully down position.

Replace the cover on the R/H side of the mechanism.

Return the ISOLATED MECHANISM to the LOCKED position so that the circuit breaker is ready for closing.

#### SLOW OPERATION FOR MAINTENANCE

Withdraw the circuit breaker (see Section 4, Page 11)

<p>SLOW OPERATION OF THE CIRCUIT BREAKER CANNOT BE PERFORMED UNLESS THE CARRIAGE IS WITHDRAWN FROM THE HOUSING. THE SECONDARY CIRCUIT PLUG BOARD MUST BE DISENGAGED FROM THE MAINTENANCE POSITION.</p>
--

With the circuit breaker in the ENGAGED position, set the ISOLATING MECHANISM to the LOCKED position.

Ensure the circuit breaker is open.

Raise the operating handle to its fullest extent.

Fit the maintenance operating handle to the L/H side of the mechanism. The lever should be fitted so that it lies at the maximum angle below the horizontal, approximately 30°.

Lift the handle to slow close and reverse the motion to slow open the circuit breaker.

To restore the circuit breaker to normal operating condition, remove the maintenance operating handle when the circuit breaker is in the OPEN position. Close the circuit breaker using its own operating handle and open it by pressing the trip button.



WARNING - IT IS DANGEROUS TO CLOSE THE CIRCUIT BREAKER WITH THE NORMAL OPERATING HANDLE OR TO OPEN IT BY PRESSING THE TRIP BUTTON WHILST THE OPERATING HANDLE IS FITTED.

SOLENOID OPERATED POWER CLOSE MECHANISM, TYPES M14EK1, M14ED3 and M14K2K3

See Instruction Manual 55/4012

To close the circuit breaker:

Ensure that the ISOLATING MECHANISM is set to the LOCKED position.

Operate the control switch.

To open the circuit breaker:

Local operation - press the trip button

Remote operation - operate the control switch

SLOW OPERATION FOR MAINTENANCE - Mks 2, 4 & 8

Circuit breakers with M14EK1, M14EK3 mechanisms only.

SLOW OPERATION OF THE CIRCUIT BREAKER CANNOT BE PERFORMED UNLESS THE CARRIAGE IS WITHDRAWN FROM THE HOUSING. THE SECONDARY CIRCUIT PLUG BOARD MUST BE DISENGAGED FROM THE MAINTENANCE/TEST POSITION.

Withdraw the circuit breaker, see Section 4, page 11.

With the circuit breaker in the ENGAGED position set the ISOLATING MECHANISM to the LOCKED position.

Remove the mechanism cover.

Fit the maintenance operating handle onto the hexagonal shaft at the R/H side of the mechanism.

Raise the handle to close the circuit breaker and lower the lever to open it.

Ensure that the handle is removed and the mechanism cover replaced before returning to normal operation.

## SLOW OPERATION FOR MAINTENANCE - Mk 12

Circuit breakers with M14k2EK3 mechanisms only.

SLOW OPERATION OF THE CIRCUIT BREAKER CANNOT BE PERFORMED UNLESS THE CARRIAGE IS WITHDRAWN FROM THE HOUSING. THE SECONDARY CIRCUIT PLUGBOARD MUST BE DISENGAGED FROM THE MAINTENANCE/TEST POSITION.

Withdraw the circuit breaker, see Section 4, Page 11.

With the circuit breaker in the ENGAGED position set the ISOLATOR MECHANISM to the LOCKED position.

Remove the mechanism cover to slow close the circuit breaker.

Fit jacking frame by sliding the open end onto the mechanism solenoid actuator such that the closed end forms a platform below the solenoid actuator.

Insert hydraulic jack between this platform and the solenoid plunger rod.

Fit the maintenance operating handle onto the hexagonal shaft at the R/H side of the mechanism.

Move this handle as to close the circuit breaker sufficiently to insert the spacing block between the top of the solenoid plunger rod and the mating roller in the mechanism.

Remove operating handle and operate hydraulic jack to close circuit breaker.

When the circuit breaker is fully closed the spacing block must be removed.

Remove the hydraulic jack and jacking frame from the solenoid actuator.

WARNING - DO NOT ATTEMPT TO FULLY CLOSE THE CIRCUIT BREAKER WITH THE SLOW OPEN MAINTENANCE OPERATING HANDLE. DAMAGE TO THE MECHANISM WILL RESULT.

To slow open the circuit breaker:

Fit the maintenance operating handle onto the hexagonal shaft at the R/H side of the mechanism.

Pull lever in a downward direction exerting sufficient force to break the linkage toggle in the mechanism. Movement beyond this point is assisted by the circuit breaker opening springs.

Ensure that the lever is removed and the mechanism cover replaced before returning to normal operation.

SPRING OPERATED POWER-CLOSE MECHANISM - MANUAL CHARGED TYPE M14C-  
MOTOR CHARGED TYPE M14D

See Instruction Manual 55/4011.

Manual release of the springs is provided, but electrical release can also be provided by the addition of a solenoid.

Discharge of the springs is prevented when the circuit breaker is already closed.

The mechanism is prevented from re-setting unless the springs are fully charged.

Ensure that the ISOLATING MECHANISM is set to the LOCKED position.

To charge the spring-box:

Type M14C

Insert the handle into the charging lever of the spring box and "pump" up and down to full extent of travel until resistance is no longer felt on the downward stroke. The indicator will show SPRING CHARGED.

Remove the handle.

Type M14D

The springs are maintained charged by the motor.

For manual charging proceed as follows:

Detach the manual release lever at the L/H side by removing the screw through the boss.

Remove the mechanism cover.

Fit the maintenance handle onto the lower hexagonal shaft on the R/H side of the mechanism and with the handle portion vertical above the shaft.

If the carriage has been withdrawn from the housing, ensure that it is suitably restrained from tipping forward.

Pull the maintenance handle down about 90°.

Remove and refit the maintenance handle, then pull it down again to the fullest extent possible.

Remove the maintenance handle.

To close the circuit breaker:-

Refit the manual release lever.

Depress the manual release lever.

Electrical (if released solenoid is fitted):

Operate the control switch.

To open the circuit breaker:

Local operation - press the trip button

Remote operation - operate the control switch.

#### SLOW OPERATION FOR MAINTENANCE

SLOW OPERATION OF THE CIRCUIT BREAKER CANNOT BE PERFORMED UNLESS THE CARRIAGE IS WITHDRAWN FROM THE HOUSING. THE SECONDARY CIRCUIT PLUG BOARD MUST BE DISENGAGED FROM THE MAINTENANCE/TEST POSITION).

With the circuit breaker in the ENGAGED position set the ISOLATING MECHANISM to the LOCKED position.

Detach the manual release lever by removing the screw through the boss.

Remove the mechanism cover.

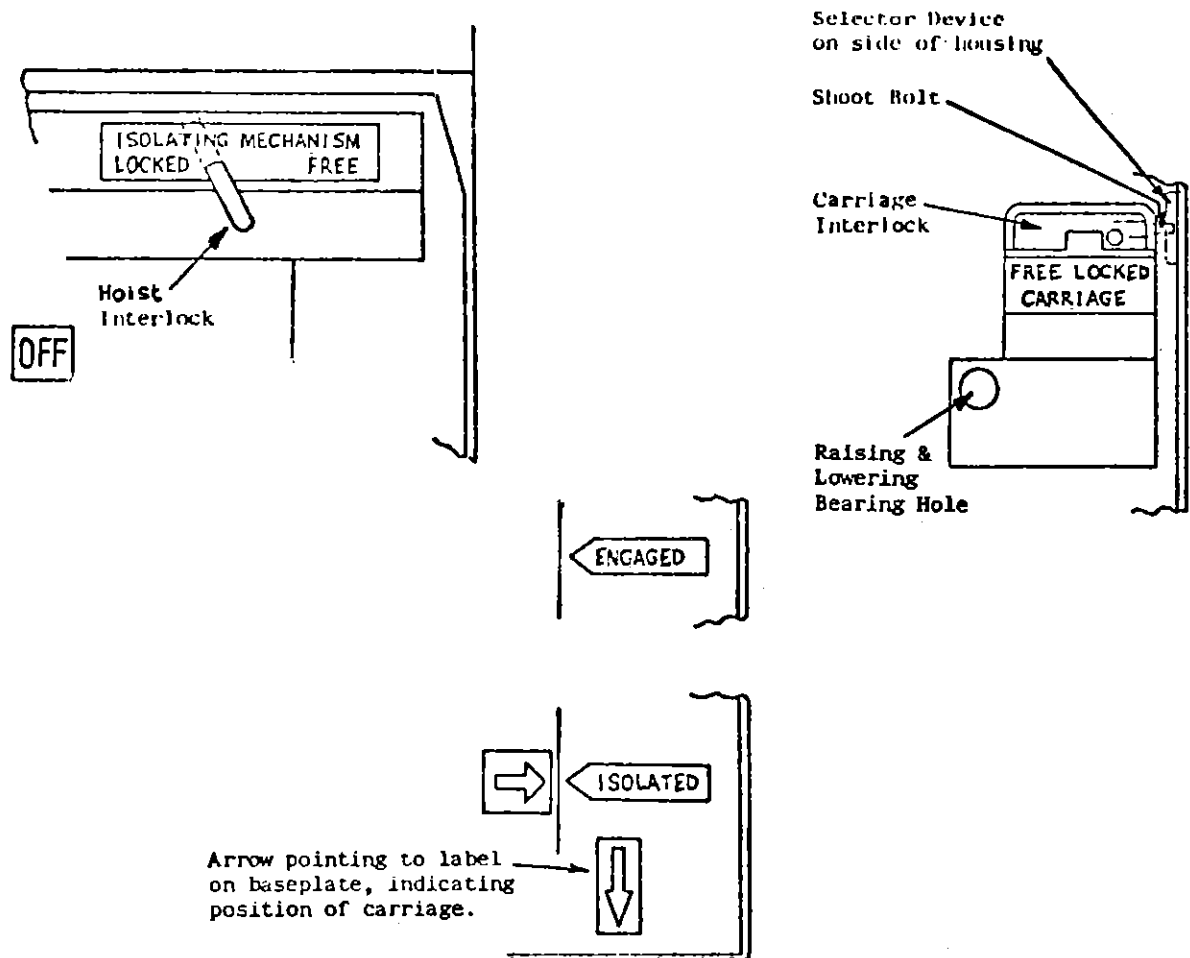


Fig. 6.1. Carriage Interlocks.

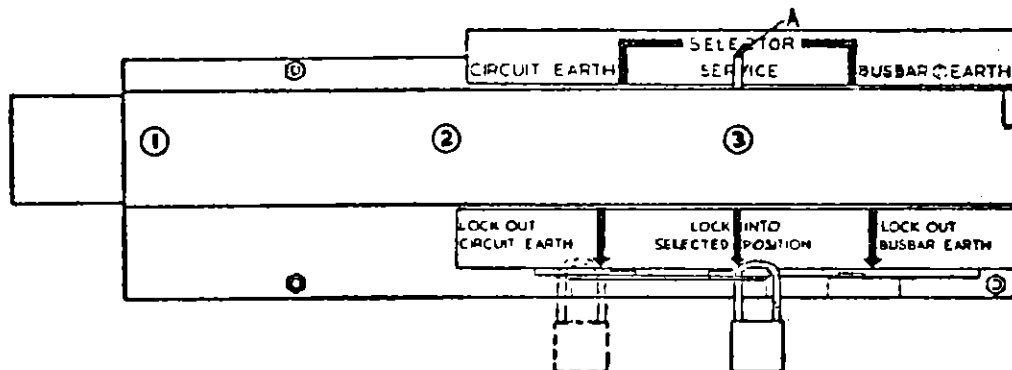


Fig. 6.2. VSI Selector Device.

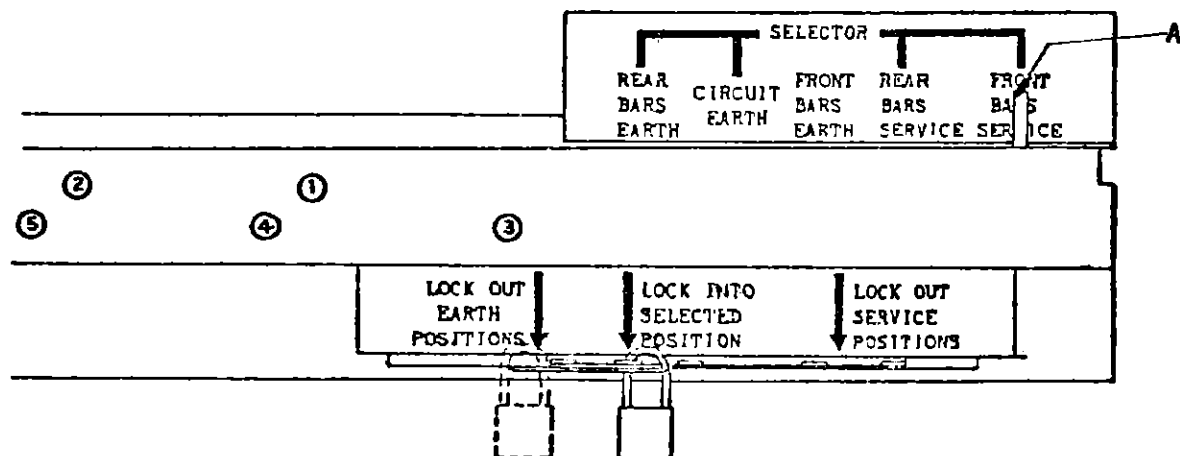


Fig. 6.3. VTD Selector Device.

## MAINTENANCE

### GENERAL

Regular and thorough maintenance is essential if the switchgear is to give reliable and satisfactory service.

Before formulating a routine maintenance programme, reference should be made to recommended procedures outlined in BS 5404 and BS 5730.

In addition inspection should be made as soon as possible after the occurrence of a fault on the circuit.

Existing adjustment settings should not be modified unless recommended in the maintenance programme.

#### WARNING

MAINTENANCE PROGRAMMES SHOULD INCLUDE CHECK SCHEDULES DESIGNED TO ENSURE THAT ALL TOOLS AND REPLACEMENT PARTS/MATERIALS ARE REMOVED FROM THE INTERIOR OF SWITCHGEAR ON COMPLETION OF MAINTENANCE.

### MECHANICAL DETAILS

#### A. Circuit-Breakers

Withdraw the carriage from the housing as detailed under Section 4 Page 11.

Padlock the safety shutters covering the main isolating contact orifices in the housing.

Refer to the appropriate circuit-breaker manual for maintenance of the contacts and internal parts.

#### B. Operating Mechanism

Clean all the moving parts and thoroughly check all fixings for tightness. Lubricate all sliding surfaces with a good quality oil of medium viscosity, wiping off any surplus oil.

Refer to the appropriate manual for details of any adjustments.

#### C. Auxiliary Contacts

Clean the operating linkage and lubricate with a good quality oil of medium viscosity.

Inspect and clean any exposed contacts and apply a thin film of silicon grease MS4, preferably, or petroleum jelly.

D. Main Isolating Contacts

Under normal conditions it should not be necessary to remove the isolating contacts.

Full details of main isolating contacts are given in the appropriate manual for the circuit-breaker.

E. Secondary Isolating Contacts

Clean with a lint free cloth. Carbon tetrachloride or silver-polish may be used. Harsh abrasive materials must be avoided.

Apply a thin film of silicon grease MS4, preferably, or petroleum jelly after cleaning.

F. Circuit-Breaker Carriage

Clean and lubricate the bearings, gears, jackscrew and guide pillars. Also lubricate the carriage wheels, and interlocks.

G. Housing

DANGER

BUSBARS AND CABLES MUST BE DEAD AND EARTHED BEFORE WORKING ON THE BOTTOM HOUSING.

Clean and lubricate the safety shutter mechanisms.

Manually operate the safety shutters as follows:-

Rotate the cancellation lever on the R/H side fully forward. The tension spring will hold the lever in this position.

Open shutters by hand.

Move the slide bar forward until the rear face lodges under the pin on the linkage and holds the shutters open.

Although the shutter hold open linkage is normally automatically cancelled on reinsertion of the carriage into the housing, it should be cancelled manually after cleaning of isolating contacts during maintenance.

Inspect and clean the main isolating contact orifice bushings using a clean dry lint free cloth.

Clean the isolating contact plugs. Carbon tetrachloride or silver-polish should be used. Harsh abrasive materials must be avoided.

Apply a thin film of silicon grease MS4, preferably, or petroleum jelly after cleaning.

Clean the earthing isolating contact plugs and the top plate earthing blades in the same manner as the main isolating contact plugs, and apply a thin film of silicon grease MS4, preferably, or petroleum jelly.

Clean and lubricate all moving surfaces of the selector mechanism.

Ensure all electrical connections are tight.

#### H. Voltage Transformers

The low voltage fuses can be withdrawn and replaced whether the transformer is in service or isolated.

When the oil-insulated transformer is isolated the shutter must be padlocked closed by padlocking the linkage, thereby locking the transformer out of service.

When the dry-type transformer is isolated the shutter automatically locks and the transformer must be padlocked out of service by fitting a padlock through holes in the isolating linkage.

Clean the primary and secondary isolating contacts with a lint free cloth. Carbon tetrachloride may be used, but harsh abrasive materials must be avoided.

Apply a thin film of silicon grease MS4, preferably, or petroleum jelly after cleaning.

Check the spring-loaded contact on the primary bushing for freedom of movement.

Clean and lubricate the shutter operating mechanism and other moving parts and linkages.

### ELECTRICAL DETAILS

#### A. Insulating Oil

Circuit-breaker and oil-filled voltage transformer tanks should be filled to the level marks with oil which complies with BS 148. The insulating oil should be tested and maintained in accordance with the recommendations given in BS 5730.



B. Insulating Surfaces Under Oil

Thoroughly clean the surfaces of all insulators normally under oil. For cleaning purposes it is important not to use what is generally known as 'cotton waste'. Cloths used for this purpose should be clean, dry and free from loose fibres, metallic threads or similar particles.

Pay particular attention to all horizontal surfaces because if sludge has formed it is most likely to have accumulated on these surfaces so diminishing the effective creepage distances.

C. Continuity of Tripping Circuits

Check tripping circuits during routine testing.

Trip Coils

After isolation from source of supply, examine each trip coil to ensure the insulation is sound and that the leads are not broken. Check the plunger and tripping levers for freedom of movement.

D. Continuity of Fuses

Test high-voltage transformer fuses and low-voltage fuses for continuity. Low-voltage and time-limit fuses may be checked with a battery bell set. Good contact at the clips of time-limit fuses is essential for proper operation of protection equipment.

Because high-voltage fuses have a limiting resistance it is not possible to check continuity with a battery bell set. A convenient method is to check continuity of these on the resistance scale of an Avometer or similar instrument.

E. Wiring

Check the continuity of wiring with a battery bell set or similar testing equipment.

Check insulation resistance, as detailed in Section 5 Page 16.

F. Tripping Batteries

See that the tripping batteries are free from faults and well charged.

Test in accordance with the maker's recommendations.

## DRYING OUT

### DRYING OUT SOLID INSULATION

If moisture is present on insulators it should be dried out by the most suitable means available.

#### 1. Methods of Drying Out

- a. Components which are removable may be placed in an oven and heated at  $100^{\circ}\text{C}$  for three hours.
- b. Insulators in oil-filled chambers can be dried out by circulating oil at a temperature of  $70^{\circ}\text{C}$ .
- c. For insulators in air, hair-dryers or lamps may be used at an air temperature of  $50^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ .

#### 2. Testing

When drying out, the insulation resistance should be measured before beginning to dry out, and periodically during drying out, until the values obtained reach a steady value. Always make sure these tests are carried out when the insulation is at atmospheric temperature.

### DRYING OUT OIL

Oil containing moisture may be dried out by one of the following methods, or it may be returned to the suppliers.

- a. The preferred method is to circulate the oil through an oil purifier at about  $70^{\circ}\text{C}$ . The outlet pipe should be about 75mm below the surface of the oil and the inlet pipe about 75mm from the bottom of the tank.
- b. As an alternative, the oil may be dried out by using an immersion heater. Dry out oil by heating it to  $105^{\circ}\text{C}$ ; raise the temperature at not more than  $20^{\circ}\text{C}$  per hour to avoid carbonisation and maintain the final temperature for five hours.

When cool test again for moisture in accordance with BS 148.

### TEST PLUGS

Refer to the instruction supplied with the equipment.

### EARTHING AND TESTING CARRIAGES

Refer to the appropriate manual.

SHOULD THERE BE ANY DOUBT REGARDING THE INTERPRETATION OF THE INFORMATION CONTAINED WITHIN THIS MANUAL, IN THE INTEREST OF SAFETY AND HEALTH, IT IS ESSENTIAL THAT OUR ENGINEERING DEPARTMENT IS CONTACTED.