INSTRUCTION MANUAL

FOR

THE

OS·A

RANGE OF METALCLAD

FAULT MAKING

OIL SWITCHES

EQUIPMENT RATED VOLTAGE UP TO 15kV

The successful operation of all switchgear depends largely upon careful erection, systematic inspection at regular intervals and the maintenance of all parts in a satisfactory condition. If the equipment described in this manual receives the recommended attention it will give many years of reliable and trouble-free service.

Since all designs in the Yorkshire Switchgear range are the subject of continuous research and development work the equipment supplied may differ in minor details from that described. However, we will be happy to supply on request any additional information which may be required. Please quote the serial number(s) of the unit(s) concerned, the date and reference number of this manual, the part number where applicable, and the contract number if known, with any enquiry.

NOVEMBER 1985
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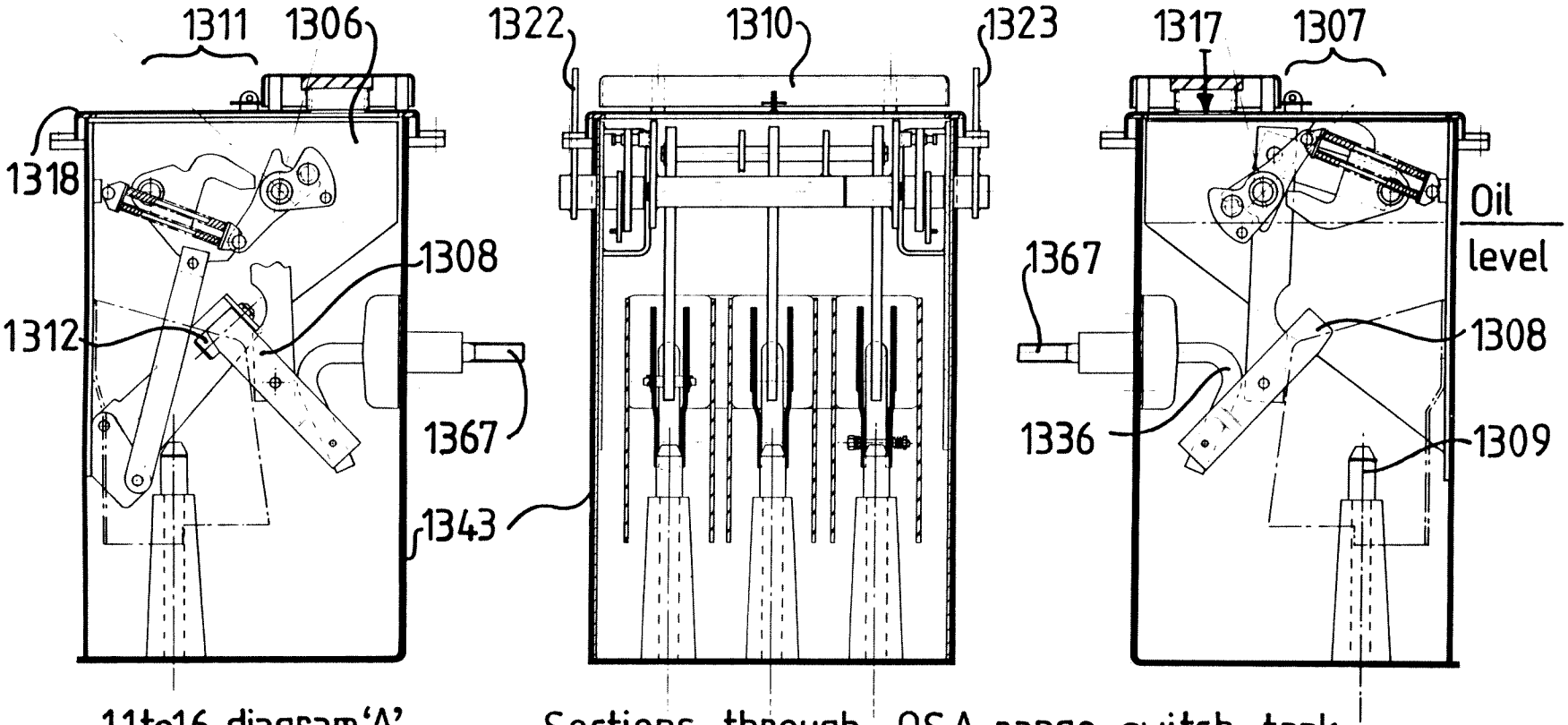


1.1 to 1.6 diagram 'A'

Sections through OSA range switch tank

1 THE "OS-A" RANGE OF OIL SWITCHES - GENERAL DESCRIPTION

1.1 Basic Design Concept

1.11 The "OS-A", "OS-AO" and "OS-AT" are three versions of the same oil switch for three different applications. The basic OS-A is an indoor extensible unit, OS-AO is an outdoor extensible unit, and OS-AT is an outdoor non-extensible unit available as a free-standing or transformer-mounted equipment.

1.12 All versions of the switch comply with the requirements of British Standard Specification BS 5463:1977, "AC Switches of Rated Voltage above 1kV", as applicable to general purpose oil switches. They are suitable for making a circuit under normal and abnormal conditions (e.g. short circuits) and for breaking a circuit under normal conditions only, at system voltages up to 15kV, rated normal currents up to 500A, and fault levels up to 21.9kA. No switch should be employed on a system having a higher voltage or fault level than those indicated on its data plate without prior approval from Yorkshire Switchgear & Engineering Co. Ltd.

1.13 The switch tank (1343) houses a mainframe (1306) on which are mounted two independent manual spring mechanisms, which operate the main (1307) and earth (1311) switches respectively. Separate operating handle stubs (1322, 1323) give independent control of the two switches, which are mechanically interlocked to prevent incompatible switching operations.

1.2 Main Switch

1.21 A fault making, load breaking oil switch (1307/1308) provides ON/OFF control of the main circuit between the rear bushings and the busbars or front cable box. The independent manual spring mechanism ensures consistently reliable operation irrespective of the operator's efforts.

1.22 The main switch is operated by a removable handle (1126) which is fitted to the handle stub (1322) at the left hand side of the unit. The mechanism (1307) drives three double switch blades (1308), which are pivoted on connections to the rear bushings (1367), either into or out of contact with fixed contacts (1309) which are connected through a moulding to the busbars or front cable box.

1.23 Positive ON/OFF indication is given by an indicator (1331) visible through a window in the front of the tank.

1.24 For further details, see Section 2, "DETAILED DESCRIPTION OF MAIN SWITCH".

1.3 Test Unit

1.31 The curved connections (1336), mounted on the switch end of the rear bushings (1367), can be engaged by a plug-in, three phase test device (1319) to permit high voltage, continuity and injected current testing of the rear-connected cable or transformer.

1.32 The test device is inserted through test access orifices (1317) in the main cover (1318). These orifices are normally covered and sealed by a supplementary test access cover (1310). For further details, see paragraphs 1.73 through 1.77, and sub-section 8.5, "Cable Testing Through the Oil Switch".

1.4 Earth Switch

1.41 A second fault making oil switch (1311/1312) controls the earthing of the rear bushings (1367) and thus of the rear-connected cable or transformer. As in the case of the main switch, an independent manual spring mechanism ensures consistently reliable operation.

1.42 The earth switch is operated by the fitting of the removable handle (1126) to the handle stub (1323) at the right hand side of the unit. The mechanism (1311) drives three star-connected earthing contacts (1312) into the open ends of the ring circuit main switch blades (1308) when the latter are in the OFF position.

1.43 Positive EARTH ON/OFF indication is given through the same indicator window (1331) as for ON/OFF indication.

1.44 The earth switch has the same full rated making capacity as the main switch, so that the unit can safely be used to control either incoming or outgoing circuits.

1.45 For further details, see Section 3, "DETAILED DESCRIPTION OF EARTH SWITCH".

1.5 Circuit Connections

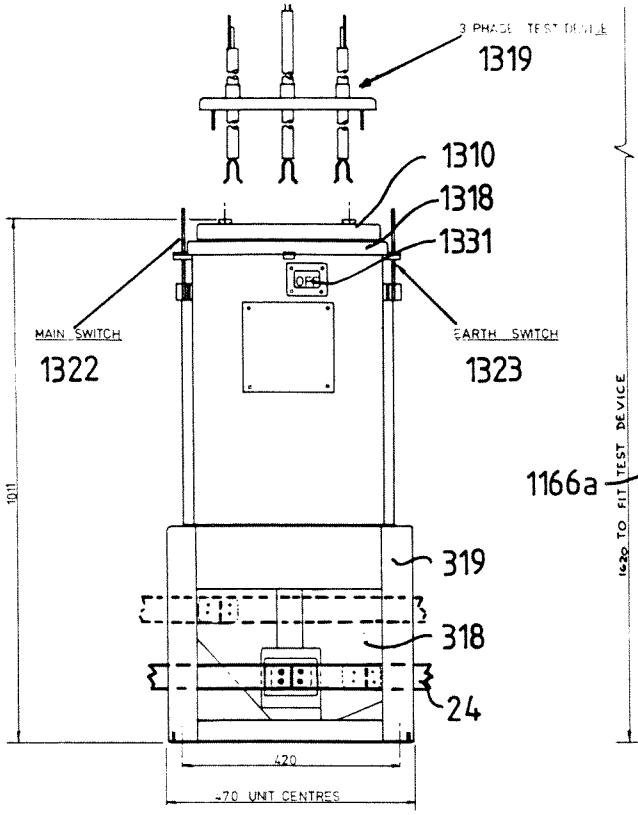
1.51 As will be evident from the foregoing, the rear-connected circuit enters or leaves the switch tank (1343) through bushings (1367) at the upper rear of the unit. Usually, a cable box (1166), will be mounted on studs around these bushings, and cable sockets (1177) will be mounted at the bushing ends. In the case of a transformer-mounted OS-AT unit, the bushings will be connected directly to the transformer HV links or terminations.

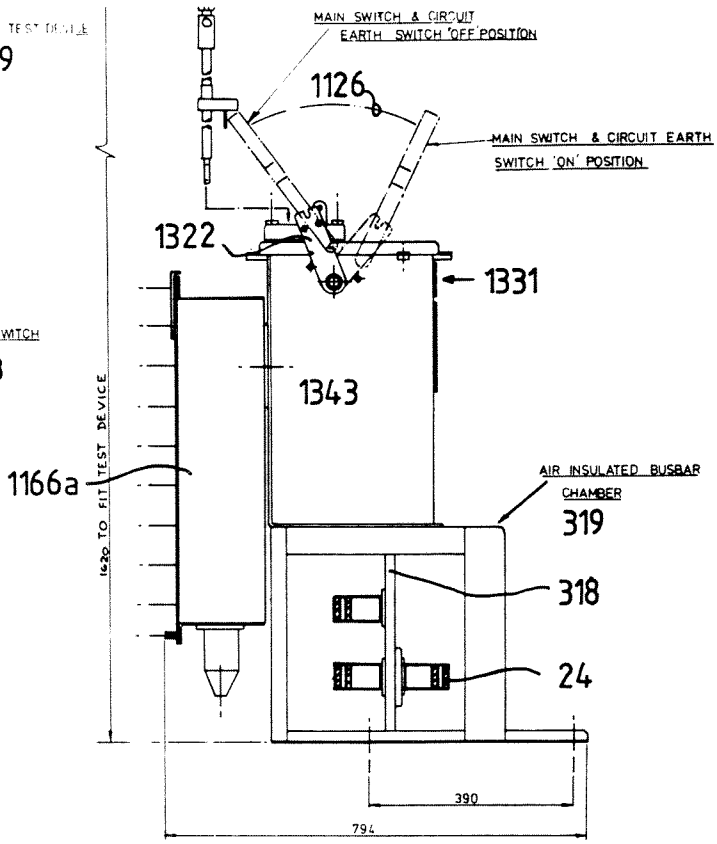
1.52 A rear cable box to accept a 3 core cable up to 630 sq mm (1 sq in) cross section approaching from below, will normally be provided. Where the cable is to approach from above, an additional spacer or "throat" to step the cable box out clear of the tank cover (1318) will be provided.

1.53 An OS-AT unit will have, in addition, a low-level front cable box of similar design. A cable box designed to be compound filled once the cable is installed is provided as standard. However, other methods of insulation and cable termination can be catered for in special circumstances.

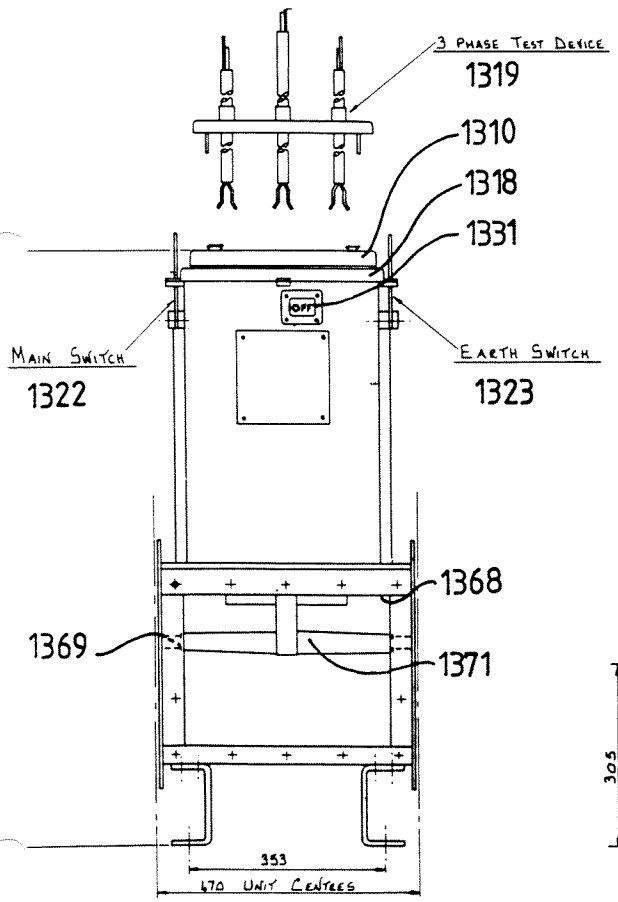
1.6 Busbars

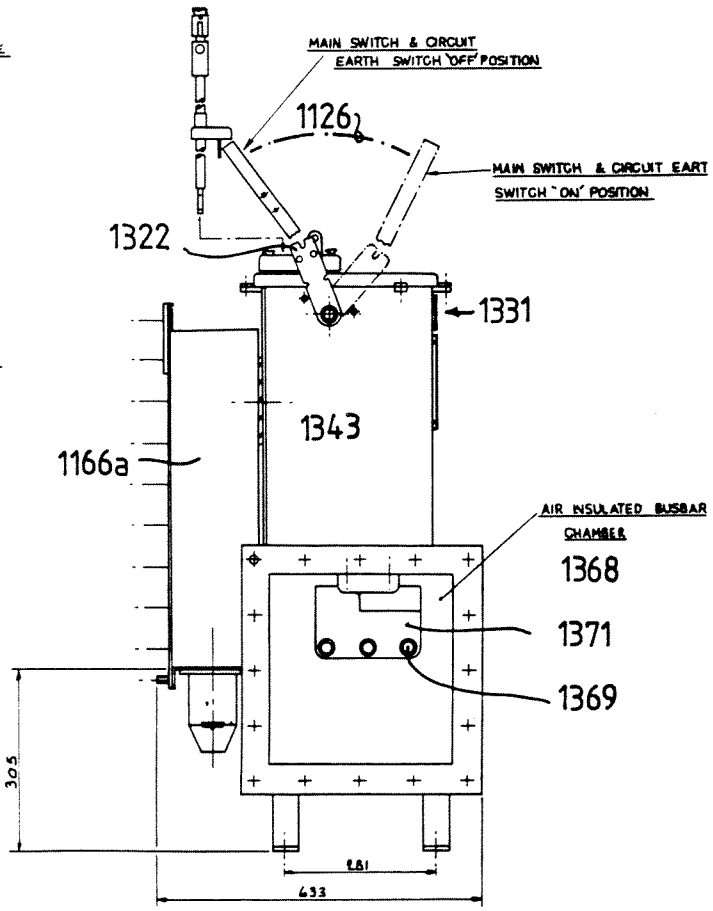
1.61 The indoor extensible OS-A and outdoor extensible OS-AO employ different busbar systems.



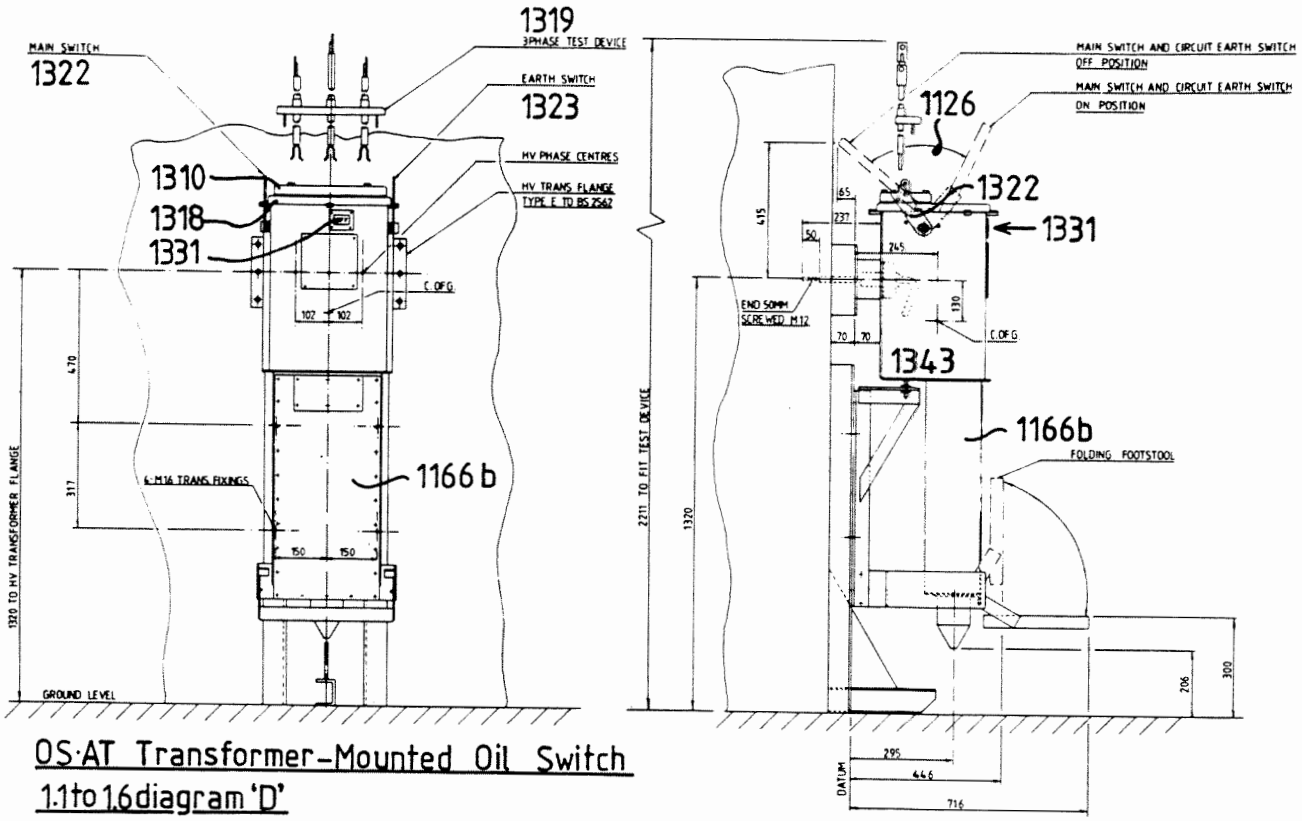


OS·A Indoor Extensible Oil Switch
1.1 to 1.6 diagram 'B'

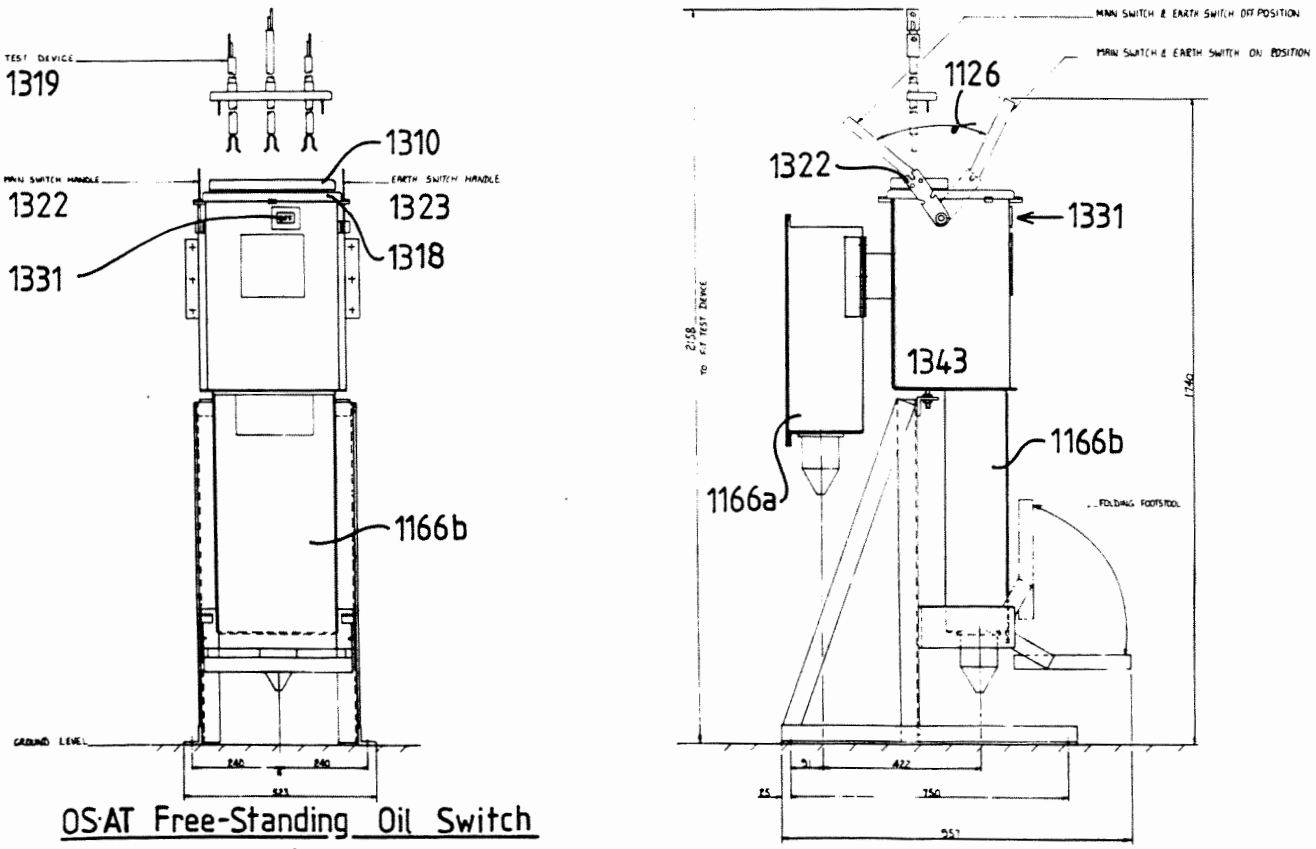




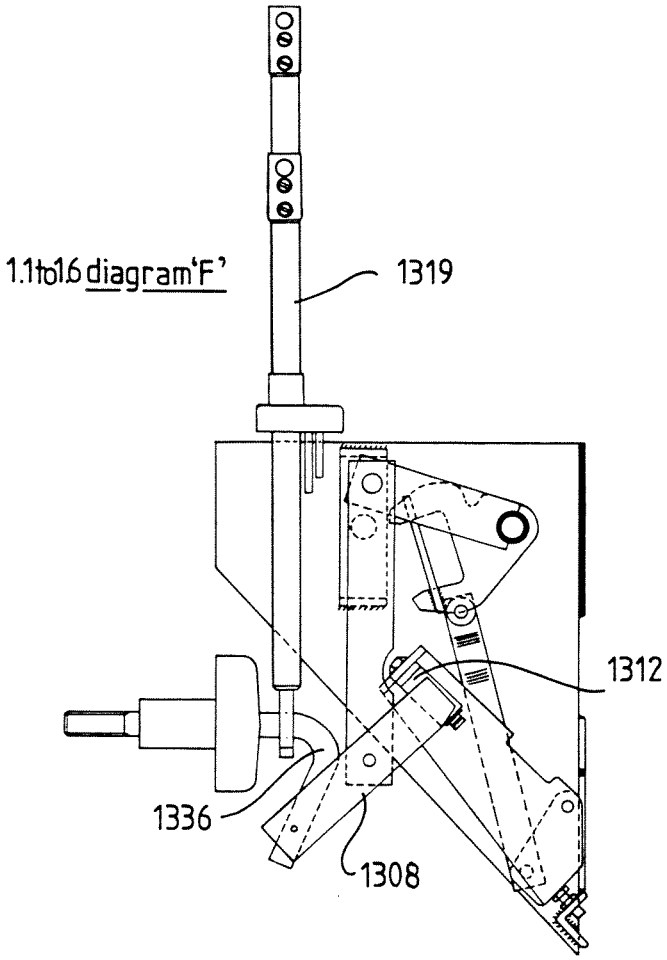
OS·AO Outdoor Extensible Oil Switch
1.1 to 1.6 diagram 'C'



OS·AT Transformer-Mounted Oil Switch
1.1 to 1.6 diagram 'D'



OS·AT Free-Standing Oil Switch
1.1 to 1.6 diagram 'E'



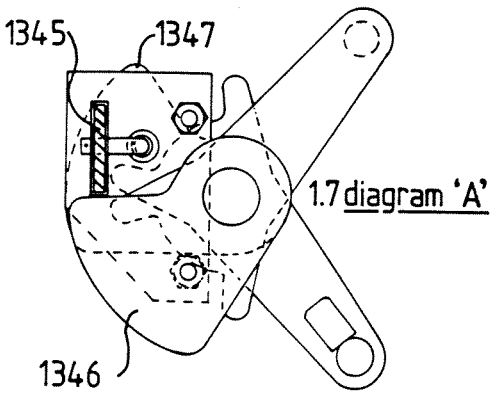
1.62 The busbar chamber (319) and fittings of the indoor OS-A are fully compatible with those of the complementary indoor circuit breaker and oil fuse switch to permit the construction of composite indoor switchboards. The panel width of all standard units is the same, and only a brief busbar outage is necessary to permit the replacement of one type of unit by another. The resin moulding (318) which supports the rectangular section busbars and incorporates the tee-off connections passes from the busbar chamber (319), through into the oil tank (1343), where the three conductors are connected to the main switch fixed contacts (1309).

1.63 The busbar chamber (1368) and fittings of the outdoor extensible OS-AO are fully compatible with those of the complementary outdoor extensible fuse switch and ring main unit, to permit the construction of composite outdoor switchboards. A single resin moulding (1371) incorporates the circular section busbars (1369) and their tee-off connections to the main switch fixed contacts (1309) in the oil tank (1343). The unit-to-unit busbar connections are insulated by heat-shrinkable sleeves (1370) during erection.

1.7 Interlocks and Padlocking

1.71 Positive mechanical interlocks incorporated in the design of the switches prevent dangerous switching practices.

1.72 The main and earth switches cannot be ON together. The switch blades (1308) must be raised in the OFF position before the earthing contacts (1312) can engage them. Also, a sliding interlock bar (1345) is so located that when it clears the main switch drive cam (1346) to permit the main switch to be operated to ON, it obstructs the earth switch drive cam (1347) and holds it in the EARTH OFF position. Conversely, when the main switch is OFF and the earth switch is operated to EARTH ON, the interlock bar is pushed across to obstruct the main switch interlock cam and prevent the main switch being operated to ON.



1.73 The test access cover (1310) can only be opened to give access to the test orifices (1317) when the related earth switch is set to EARTH ON and the related main switch is set to OFF. This is because a pivoted hook (1348), mounted on the mainframe (1306), is driven by a rod from the earth switch contacts operating shaft (1360) to engage a hole in an interlock bar on the bottom of the test access cover when the earth switch is set to OFF. This also prevents removal of the main cover (1318).

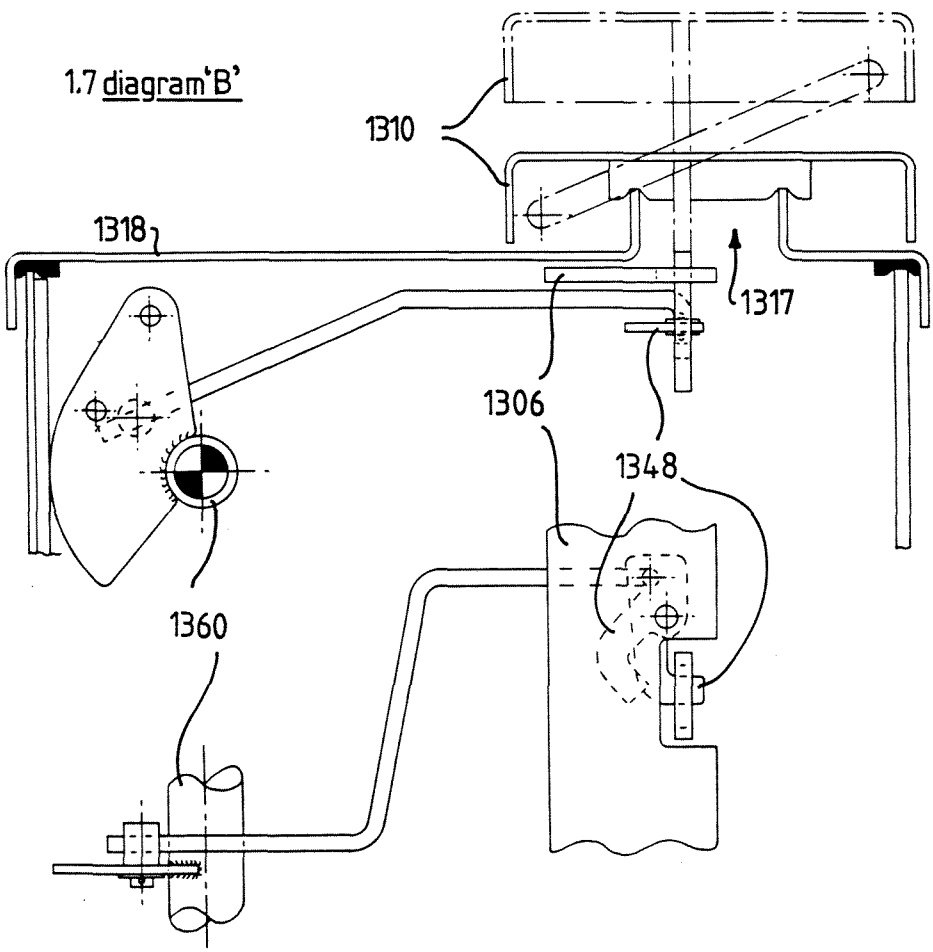
1.74 When the test access cover (1310) is opened, the related earth switch cannot be moved to OFF, nor the main switch to ON. This is because two interlock catches (1349, 1350) on the switch mechanisms are spring loaded to lock the earth switch mechanism at EARTH ON and the main switch mechanism at OFF, respectively. When the cover is in position, two "prongs" on its underside hold these catches clear of the mechanisms.

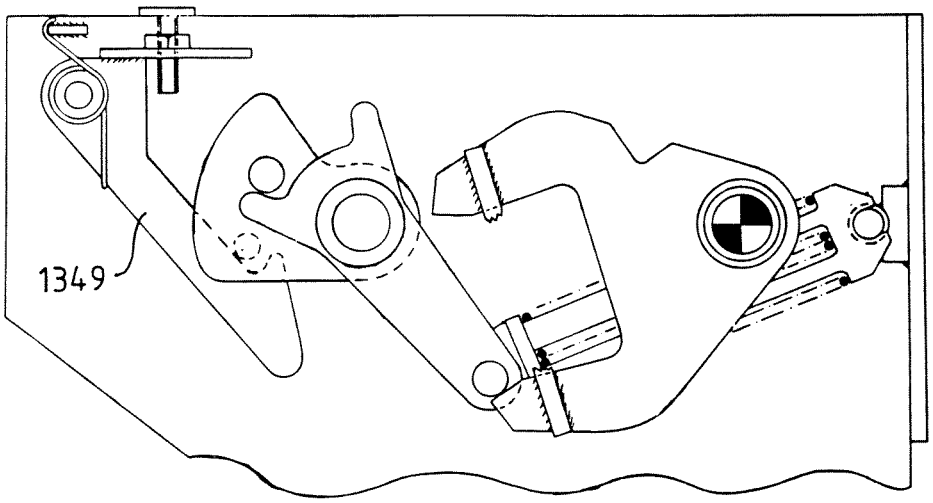
1.75 When the test device (1319) is inserted, the earth switch can be moved to EARTH OFF to permit testing of the cable. This is because a single prong on the underside of the device holds off the earth switch ON interlock catch (1349).

1.76 Once the earth switch has been switched to EARTH OFF with the test device (1319) in position, the test device cannot be removed until the switch is set to EARTH ON again. This is because the pivoted interlock hook (1348), mentioned above, engages a hole in an interlock bar on the bottom of the test device when the earth switch is set to OFF.

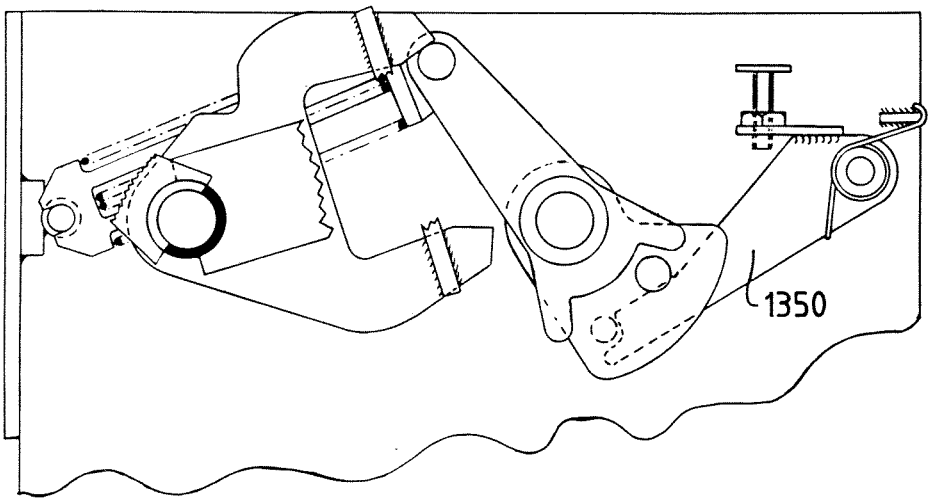
1.77 The test access cover can be padlocked in the closed position, to prevent its being opened or the main cover (1318) being removed.

1.78 A captive padlockable cover (1320) can be locked so as to prevent access to the earth switch handle stub (1323). Both the main (1322) and earth (1323) switch handle stubs can be padlocked independently in their ON or OFF positions.





1.7 diagrams 'C & D'



1.8 Technical Specification

1.81 The OS-A range fault making oil switch is constructed to specification ESI 41-5, and in addition is tested to B.S.5463 and IEC 265 Standards. It conforms to the requirements for a General Purpose switch.

1.82

Service Voltage:	15.0kV
Frequency:	50-60Hz
Highest System Voltage:	15.0kV
Impulse Voltage Withstand Level:	95kV
Normal Current:	500 A
3 Second Short Time Current:	21.9kA
Peak Making Current:	56.0kA
Earth Switch 3 Second Short Time Current:	21.9kA
Earth Switch Peak Making Current:	56.0kA
Busbar Current Rating:	630/800 A

2 DETAILED DESCRIPTION OF MAIN SWITCH

2.1 Principal Features

2.11 The basic operating mechanism (1307) is a well-tried over-toggle spring design, which has been successfully employed in other Yorkshire Switchgear units for a number of years.

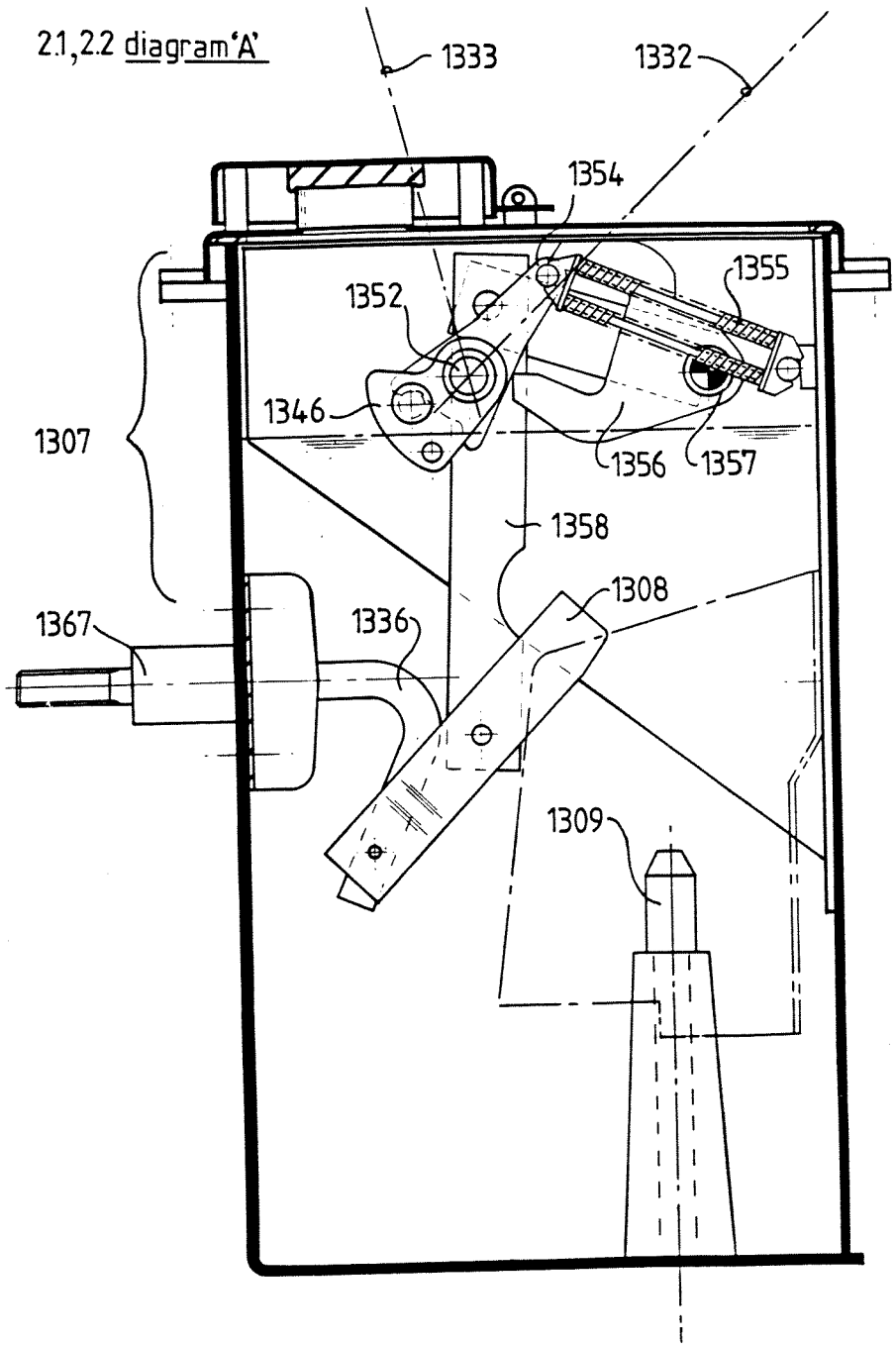
2.12 The mechanism (1307) drives three sets of twin switch blades (1308), which are pivoted on connections (1336) to the rear bushing assembly (1367). These blades engage fixed contacts (1309) in series with the busbars or front cable box when in the ON position.

2.13 Bakelised wood sections (1358) link the mechanism to the blades.

2.2 Operating Sequence

2.21 As the operating handle (1126, 1322) is moved forwards from the OFF position (1333) it rotates the drive shaft (1352).

2.22 A cam (1346) which is mounted on the shaft (1352) also rotates, and a pin on the cam engages a lug on the spring compression lever (1354). The spring compression lever pivots and compresses a battery of operating springs (1355).



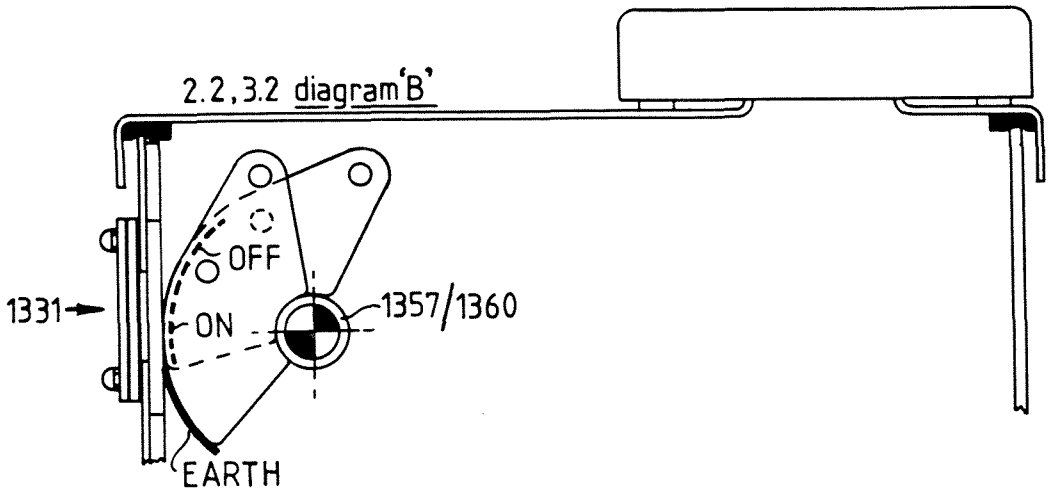
2.23 Shortly before the pivoting spring compression lever (1354) reaches its mid-point, an extension on its side engages one arm of a large operating claw (1356) which is fastened to the main switch blades operating shaft (1357).

2.24 Once the spring compression lever (1354) has passed its mid-point, pressure on the operating springs (1355) is released, and as the assembly has passed its over-toggle position the springs are free to expand once more. They now drive the spring compression lever which in turn carries the operating claw (1356) with it.

2.25 The claw (1356) drives round the operating shaft (1357), and cranks extending from the shaft operate the switch blades (1308) through the medium of bakelised wood insulated links (1358).

2.26 The opening operation is the reverse of the above.

2.27 The ON/OFF indicator (1331) is mounted on the operating shaft (1357) to indicate directly the actual position of the mechanism and blades, rather than merely that of the operating handle.



3 DETAILED DESCRIPTION OF EARTH SWITCH

3.1 Principal Features

3.11 The earth switch operating mechanism (1311) is very similar to that employed on the main switch.

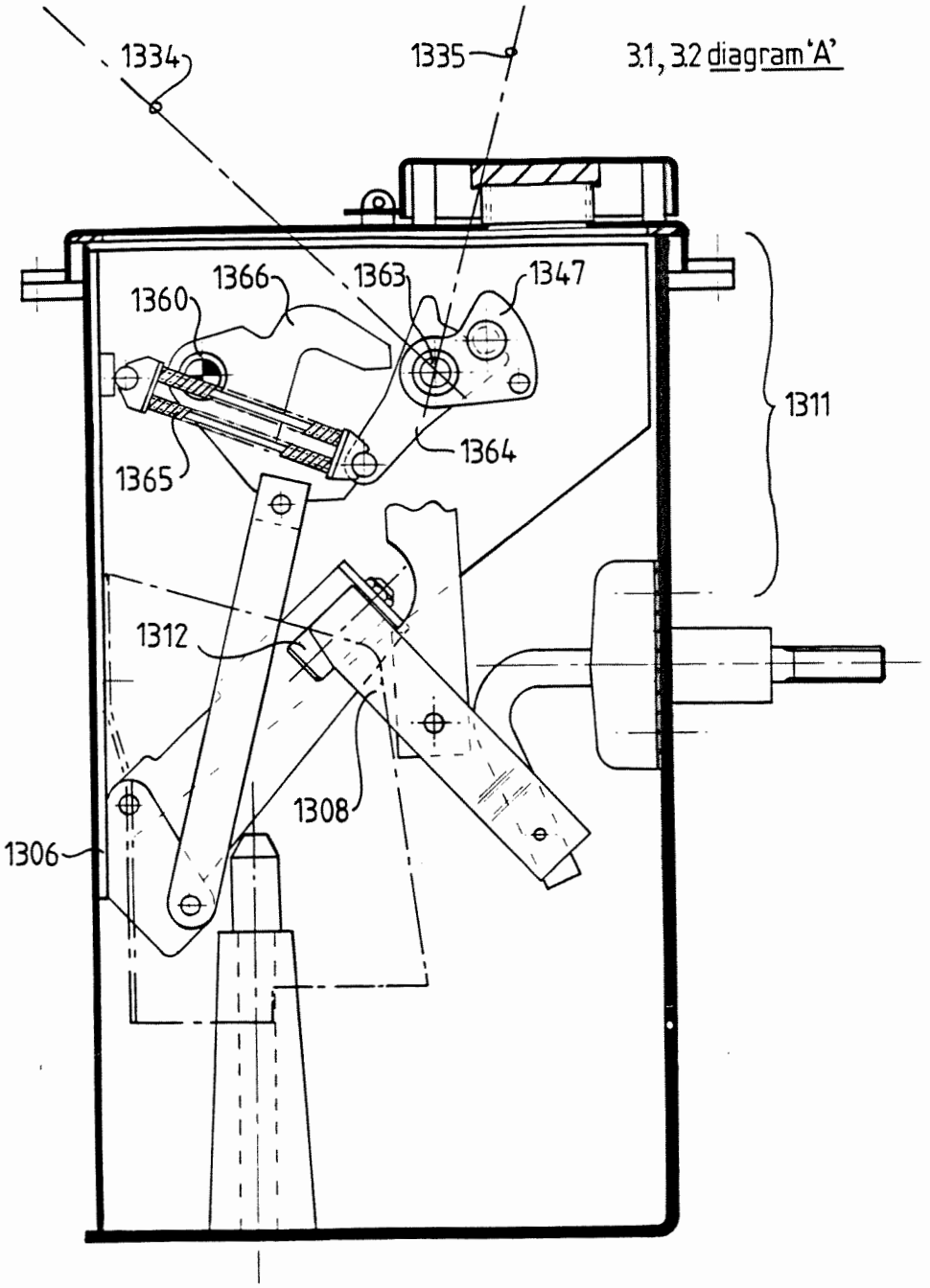
3.12 The earth switch contacts (1312) comprise three cylindrical copper contacts mounted on a star connecting metal blade. Operation to EARTH ON of the mechanism drives the contacts into the open ends of the main switch blades (1308) when the latter are in the OFF position. A wiper contact at the end of the earth switch star point blade connects the earth contacts to earthed metalwork.

3.13 The contacts (1312)/blade assembly is pivoted from the bottom of the ring switch mainframe (1306).

3.2 Operating Sequence

3.21 This is virtually identical (though opposite-handed) to that of the ring circuit main switches.

3.22 An EARTH ON indicator which is mounted on the earth switch contacts operating shaft (1360) obscures the OFF indication of the main switch in the tank window (1331) when the earth switch is operated to EARTH ON.



4 DELIVERY & ERECTION

4.1 Loading, Delivery and Unloading

4.11 "SO-HI" units may be carried on open trucks if adequately secured and tarpaulined against the weather.

4.12 For speed and safety the use of a small crane, forklift or other handling device to unload switchgear is recommended. The safe working load (SWL) should be at least twice the total weight of any load to be lifted; in the case of a crane, this should be the SWL at the maximum radius required by the site layout.

4.13 A 6 m (20 ft) circumference endless sling, SWL at least twice the total weight of any load to be lifted, looped under main structural components, should be used for crane unloading. WARNING: Do not loop the sling under the front of an OCB lid (2) without first ensuring that all four securing screws (87) are tightened fully home.

4.14 Do not attempt to operate any item of switchgear until the appropriate erection, preparation and commissioning procedures have been completed.

4.2 Delivery Weights, Oil & Compound Volumes

4.21 These are approximate minimum values only and may be significantly exceeded where numerous auxiliaries (e.g. relays) are employed.

Equipment	Ref.	Delivery Weight		Volume of Oil or Compound Required		Equivalent Compound Weights						Equivalent Oil Weight	
						BICC G83 for XLPE cables		BICC G21		BICC G101 Trinidite A58			
		kg	lb	litres	galls	kg	lb	kg	lb	kg	lb	kg	lb
4.22 Moving portion without oil or mechanism/arc traps assembly	1 etc.	132	291	91	20	-	-	-	-	-	-	78	172
4.23 Mechanism/arc traps assembly	6, 3	34	75	-	-	-	-	-	-	-	-	-	-
4.24 Fixed portion complete but without cable box fluid, relays or voltage transformer	16,17, 19,49, 50	260	575	36.5 (cable box)	8	50	110.5	46	100	38	82	32	70
4.25 Bus section fixed portion add to 4.24	-	98	215	-	-	-	-	-	-	-	-	-	-
4.26 Voltage transformer without oil	15	86	190	91	20	-	-	-	-	-	-	78	172
4.27 Oil Fuse Switch without fuses or compound but with cable box	323 etc.	135	298	66 (switch tank)	15	-	-	-	-	-	-	56.5	125
				29 (cable box)	6.4	39.5	87	36.5	80.5	30	65	25	55
4.28 Oil switch without oil or compound but with cable box	415 etc.	135	298	43.5 (switch tank)	10	-	-	-	-	-	-	38	84
				29 (cable box)	6.4	39.5	87	36.5	80.5	30	65	25	55

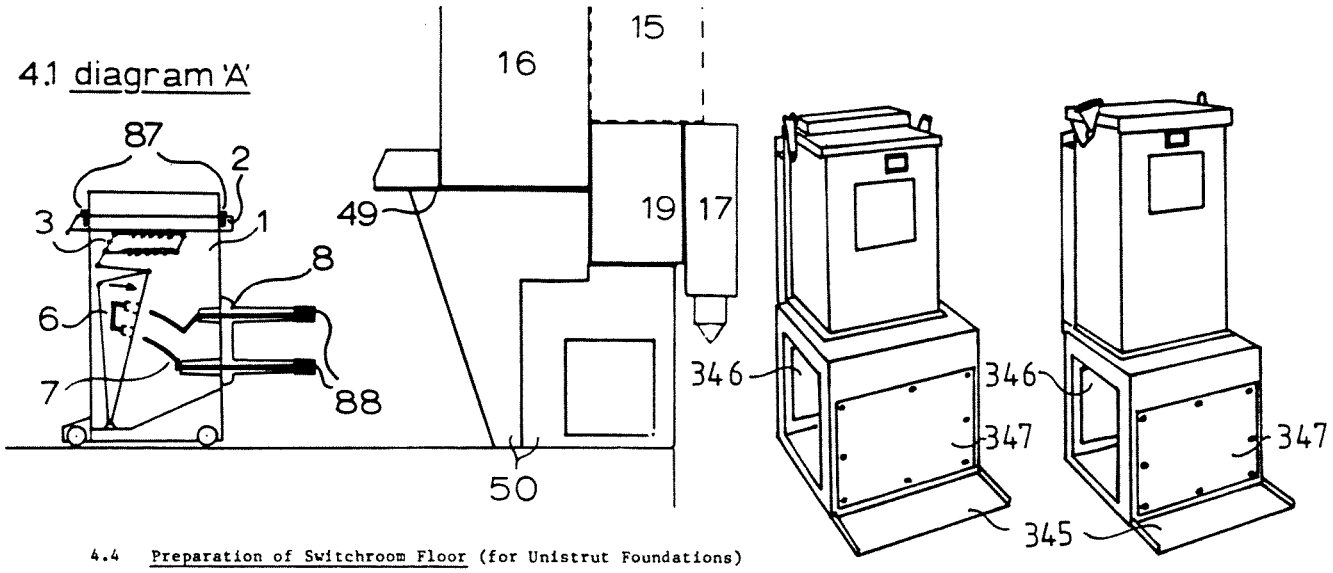
N.B. Cable box compounds with a pouring temperature above 130°C must not be used.

4.3 Storage of Switchgear

4.31 "SO-HI" indoor switchgear must not be left out of doors, even in fine weather, for more than a few minutes unless it is adequately protected by tarpaulins. Even if it is so protected, it must be taken indoors as soon as possible, preferably within 24 hours of delivery.

4.32 If it is to be stored for any length of time before installation it should be kept in a warm, dry room.

4.1 diagram 'A'

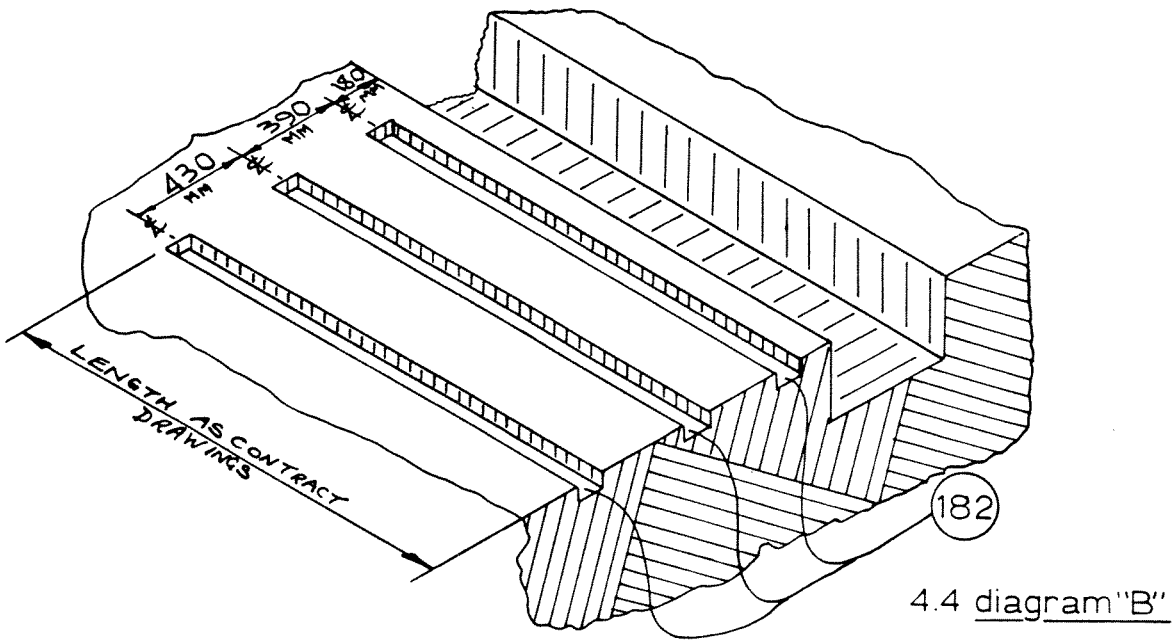


4.4 Preparation of Switchroom Floor (for Unistrut Foundations)

4.41 This section covers the use of fixed portions and busbar chambers with integral baseplates, on "Unistrut" foundation runners (181). All types of unit, OCB, oil switch, fuse switch, busbar cable box and busbar voltage transformer, are covered.

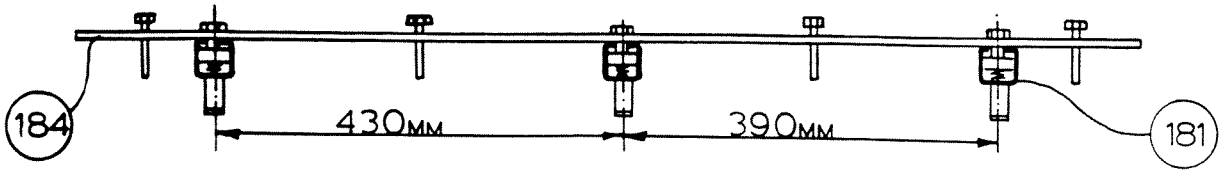
4.42 Foundation details vary from switchboard to switchboard. Reference should always be made to the foundation plan supplied for the individual installation. A cable trench or conduits, of size and layout to suit the cables to be used, will usually be required at the rear of the switchboard. Rear access for cable jointing will also be necessary. Where firewalls are installed they must be extended down into the trench, oversize gaps being left for the installation of cable ducts, busbar trunkings etc. The holes can be filled in to size when all equipment is in position.

4.43 Prepare a sub-floor 40 mm (1.5/8 in) below finished floor level, with chases (182) a further 70 mm (2.1/2 in) deep by 100 mm (4 in) wide as shown in diagram 'B'. Note that for circuit breaker fixed portions three chases (182), at centres of 180 mm + 390 mm + 430 mm from the trench edge will be required. All other units require only the first two chases. The length of the chases must be at least the total ultimate length of the switchboard, including any future extensions which may be under consideration.

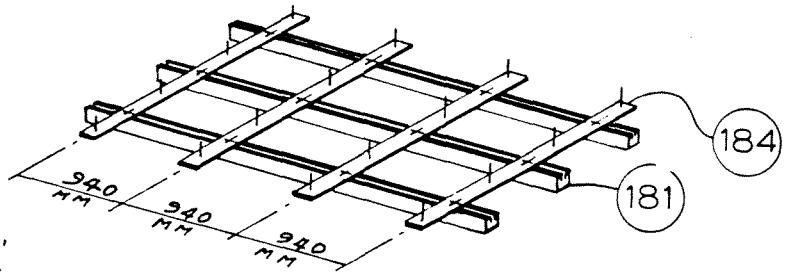


4.4 diagram "B"

4.44 Place the Unistrut runners (181) in their approximate positions in the cases and burn 50 mm (2 in) gaps in the foam plastic filler at approximately 940 mm (37 in) centres, using a blowlamp. Using the M10 spring nuts (183) provided, fix tie bar jigs (184) to the foundation runners (181) at 940 mm (37 in) centres as shown in diagrams 'C' and 'D'.



4.4 diagram "C"

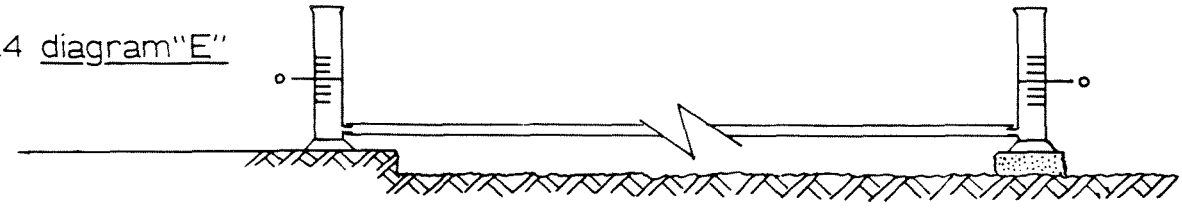


4.4 diagram "D"

4.45 Erect a fixed datum, representing the finished floor level of 40 mm (1.5/8 in) above the prepared sub-floor, half way along the switchboard. Take a water level gauge consisting of two graduated jars connected by a flexible pipe of at least 3/4 of total switchboard length (diagram 'E") and fill with water, taking care to remove all trapped air from the pipe by letting the pipe lie flat on the floor. Place both jars on the datum and note their common reading (on short switchboards a spirit level and long straight edge may be used).

4.46 Check by measuring corresponding diagonals that the Unistrut/tie bar assembly (181/184) is 'square'. Position small pieces of steel plate under the levelling screws, and ensure that the centre of the rear runner is 180 mm from the cable trench edge at both ends. Where two or more lengths of Unistrut are to be butted end to end, they must line up exactly.

4.4 diagram "E"

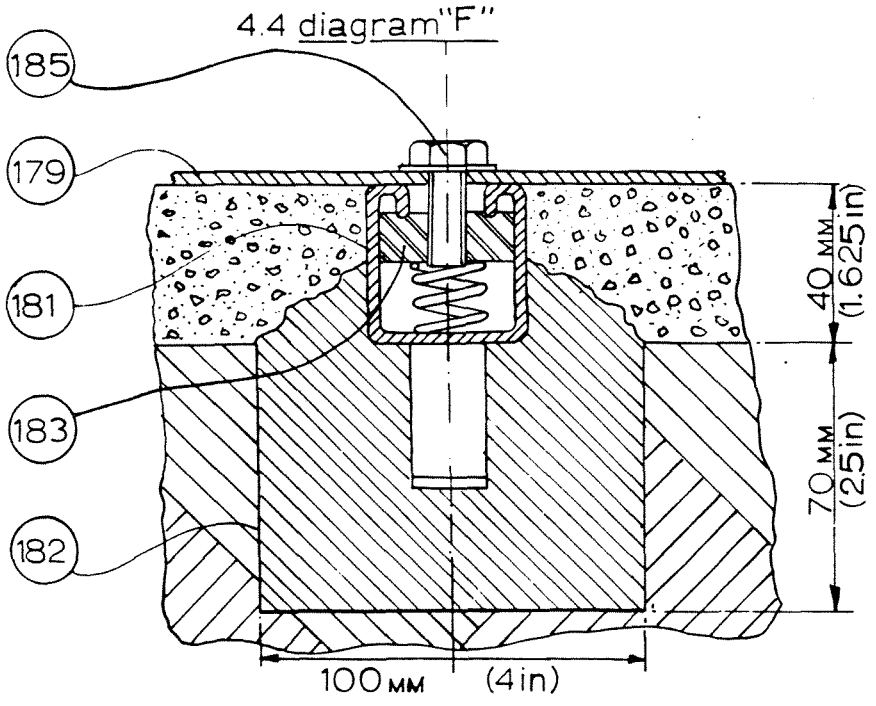


4.47 Leaving one of the water level jars on the datum, place the other on top of each runner (181) in turn along the length of the switchboard, each time adjusting the local jacking screws until the previously noted common water level is attained. This will result in the runners being level over the full length of the switchboard. A tolerance of plus or minus 0.5 mm is acceptable.

4.48 Grout the Unistrut runners (181) in position, the grout filling the chases and reaching approximately half way up the Unistrut sides (diagram 'F'). When the grout is fully set, remove the tie bars (184) and sprung nuts (183) from the runners.

4.49 Float the finished floor between the runners (181), the level coinciding with the tops of the runners. Take care not to get concrete into those parts of the channels from which the foam has been removed. When the switchboard floor area has set, float the rest of the floor using the finished area as datum.

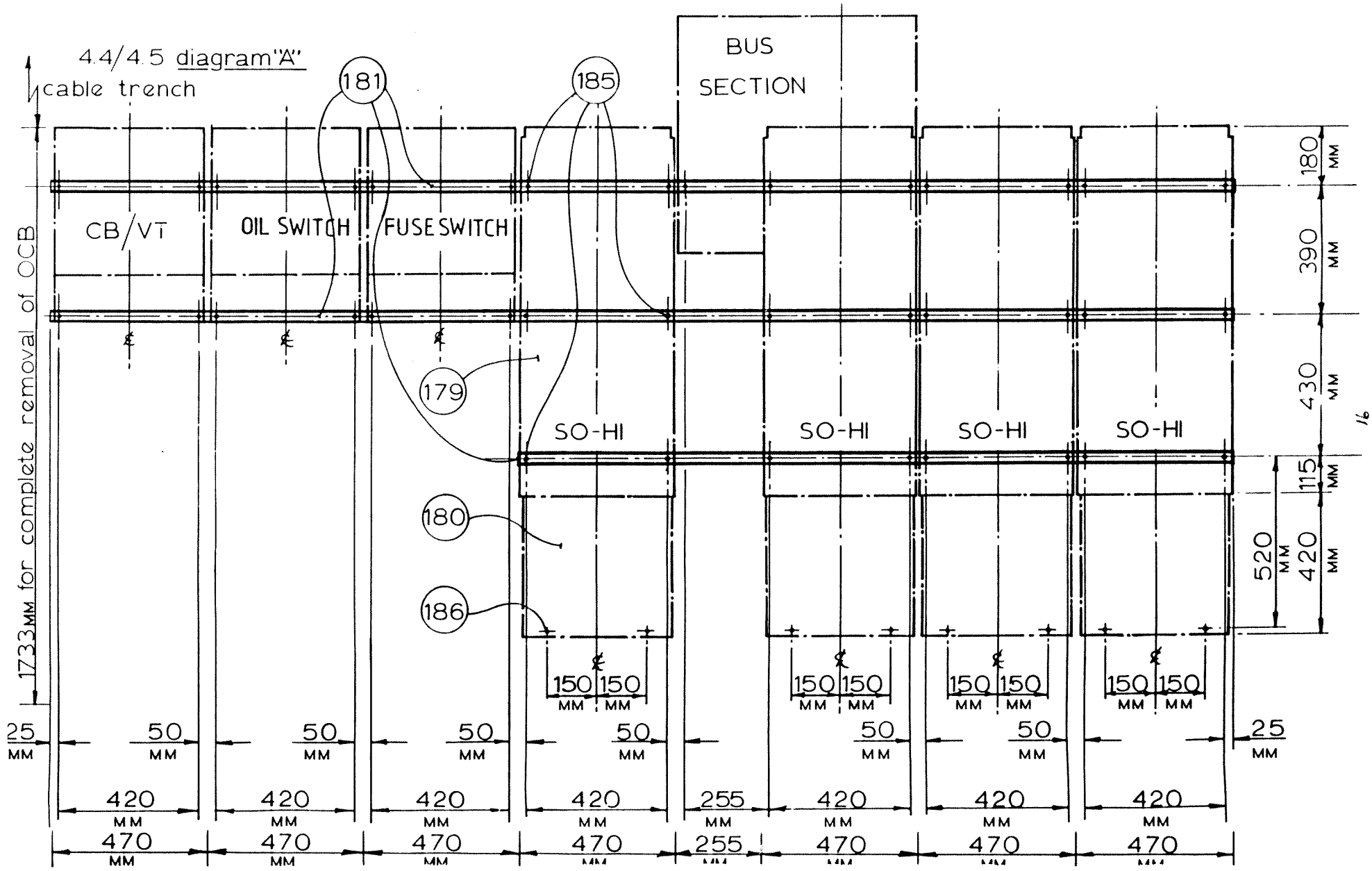
4.4 diagram "F"



4.5 Erection of Fixed Portions and other Units (on Unistrut)

4.51 This section covers the use of fixed portions or busbar chambers, with integral baseplates, on "Unistrut" foundation runners. All types of unit, OCB, oil switch, fuse switch, busbar cable box and busbar voltage transformer, are covered.

4.52 Using the foundation plan for the specific switchboard as a guide, burn 50 mm (2 in) gaps in the Unistrut (181) foam plastic filler at the fixed portion fixing points with a blowlamp. Position the 3/8 in spring nuts (183) in the runners at these points.


4.4/4.5 diagram "A"
cable trench
181
185
BUS
SECTION
CB/VT
OIL SWITCH
FUSE SWITCH
179
180
186
SO-HI
SO-HI
SO-HI
SO-HI
1733 MM for complete removal of OCB
180 MM
390 MM
430 MM
115 MM
520 MM
420 MM
150 MM
150 MM
25 MM
50 MM
420 MM
255 MM
470 MM

4.53 In the case of a CIRCUIT BREAKER fixed portion, unfasten, remove and store the busbar chamber back plate (91), earthing device locating angles (90) and front shutter assemblies mounting plate (92) from each unit. Check that anti-vermin strips (95a, 95b) are fitted at the right hand side of each unit (except the extreme right hand unit on the switchboard). Should the strips not be fitted already (e.g. on an extension at the right of an existing board) appropriate lengths of strip can be supplied for on-site application. The backing material is simply peeled off and the sticky surface applied to the clean painted surface.

4.54 For ANY OTHER type of unit unfasten, remove and store the busbar chamber back plate (346) and front plate (347). Again, check that anti-vermin strips (95) are in position at the top and sides of each right hand busbar aperture except on the extreme right hand unit of a switchboard. See 4.53 above for details of on-site fitting.

4.55 Place all switchgear fixed portions and busbar chambers in position, ensuring by using a long straight edge that their back surfaces at floor level are exactly in line (except for bus sections). Check the unit centres against the contract foundation plan. Bolt all units down using M10 x 30 mm long hexagonal headed screws (185) and washers.

4.56 Adjacent CIRCUIT BREAKER fixed portion shells (49, 50) must then be fastened together. Each sidewall (50) has two 7 mm (9/32 in) fastening holes (164) in the offset front edge, and one 11 mm (7/16 in) hole (165) adjacent to the frong lower corner of the current transformer (position may change from that illustrated). The smaller holes take 12 mm (1/2 in) long 'O'BA screws, washers and self-locking nuts which are tightened up to hold the offset edges of adjacent panels firmly together. The larger hole takes on 8 mm (5/16 in) diameter screw, washers and nut which are used only to pull the units into position and must not be tightened hard as this will distort the sidewalls.

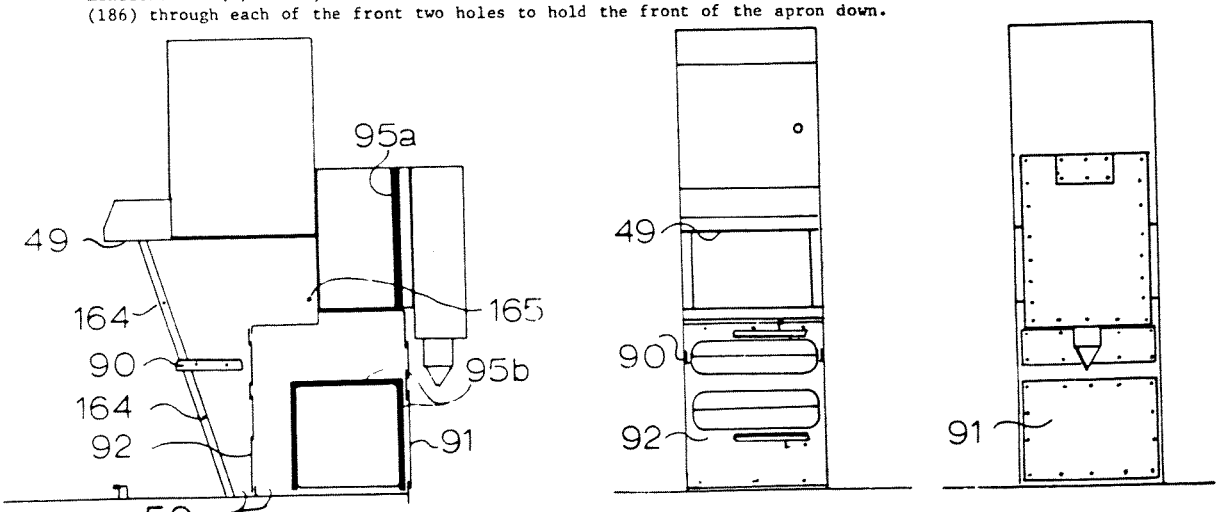
4.57 CIRCUIT BREAKER fixed portions can then have their removable front aprons (180) fitted to the fronts of their baseplates (179) as follows.

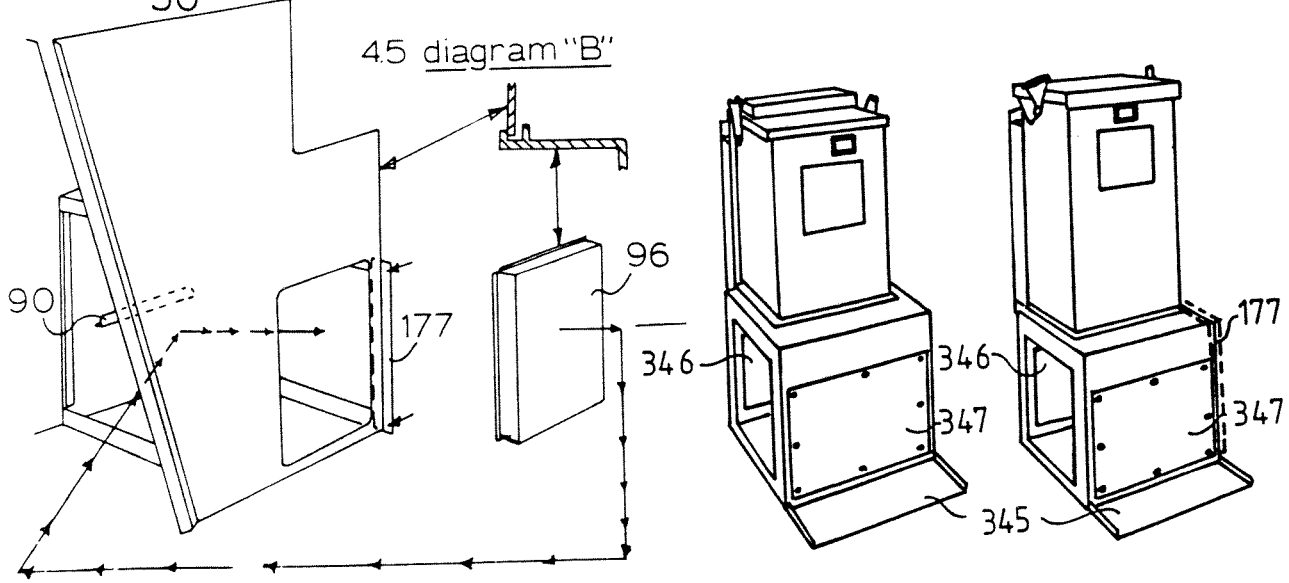
(a) Secure each apron (180) to the front of its baseplate (179) using the three studs and nuts provided.

(b) Using the two countersunk holes at the front of the apron as guides, drill two 7 mm (9/32 in) diameter by 50 mm (2 in) deep pilot holes in the floor.

(c) Unfasten and remove the apron and open out the holes in the floor to 9 mm (3/8 in) diameter.

(d) Fit a 'UNI-FIX' plug type P5 in each hole, replace the apron and secure it by the nuts and studs mentioned in (a) above, then drive a No. 14 x 1.1/2 in long countersunk Phillips-headed wood screw (186) through each of the front two holes to hold the front of the apron down.





4.58 Fit pieces of clip-on plastic cover to any exposed lengths of Unistrut runner, e.g. where provision has been made for future extensions or adjacent to bus section fixed portions.

4.6 Fitting the Busbars

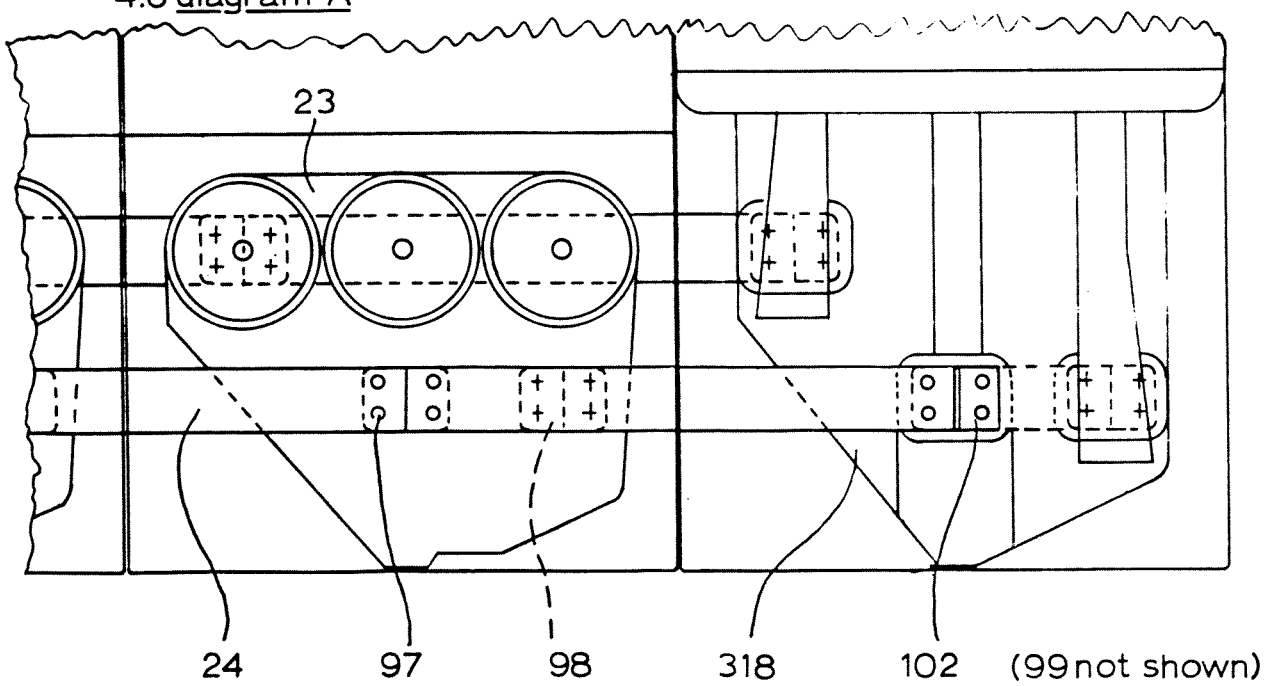
4.61 The busbars (24) can now be fitted between adjacent units.

Do not start to fit them until you have read the whole of this section (4.6).

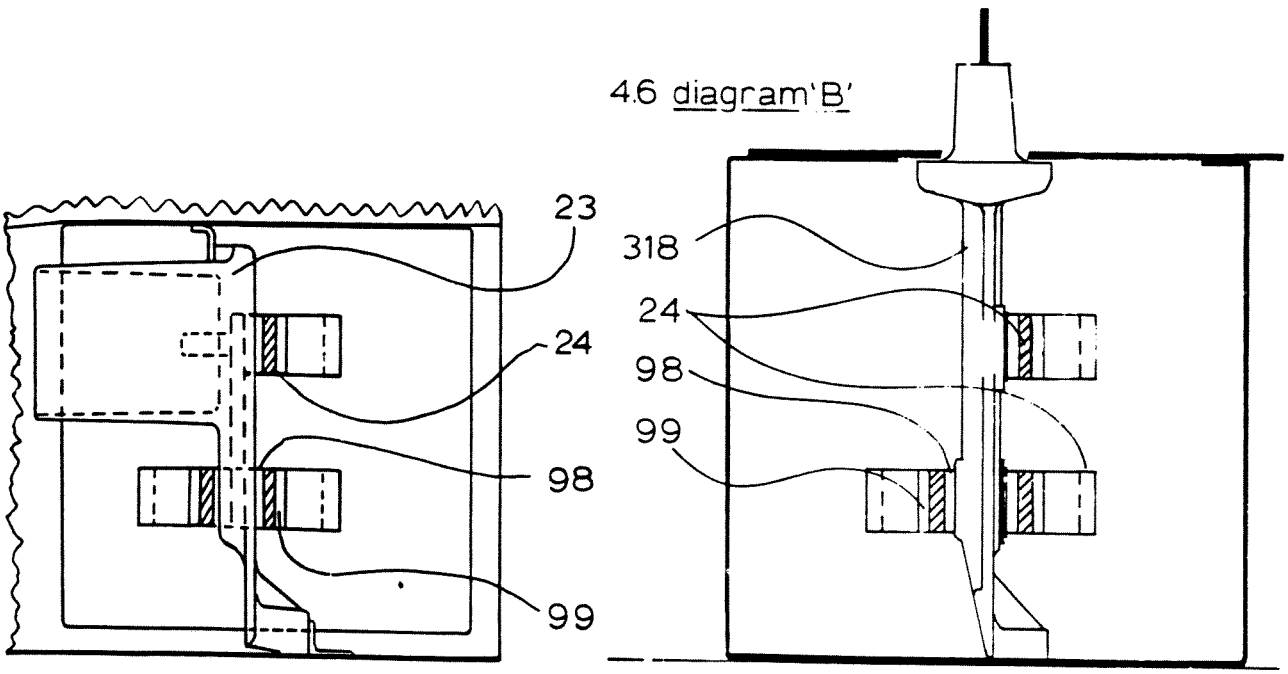
4.62 Unit length, resin coated busbars are employed in the following arrangements:

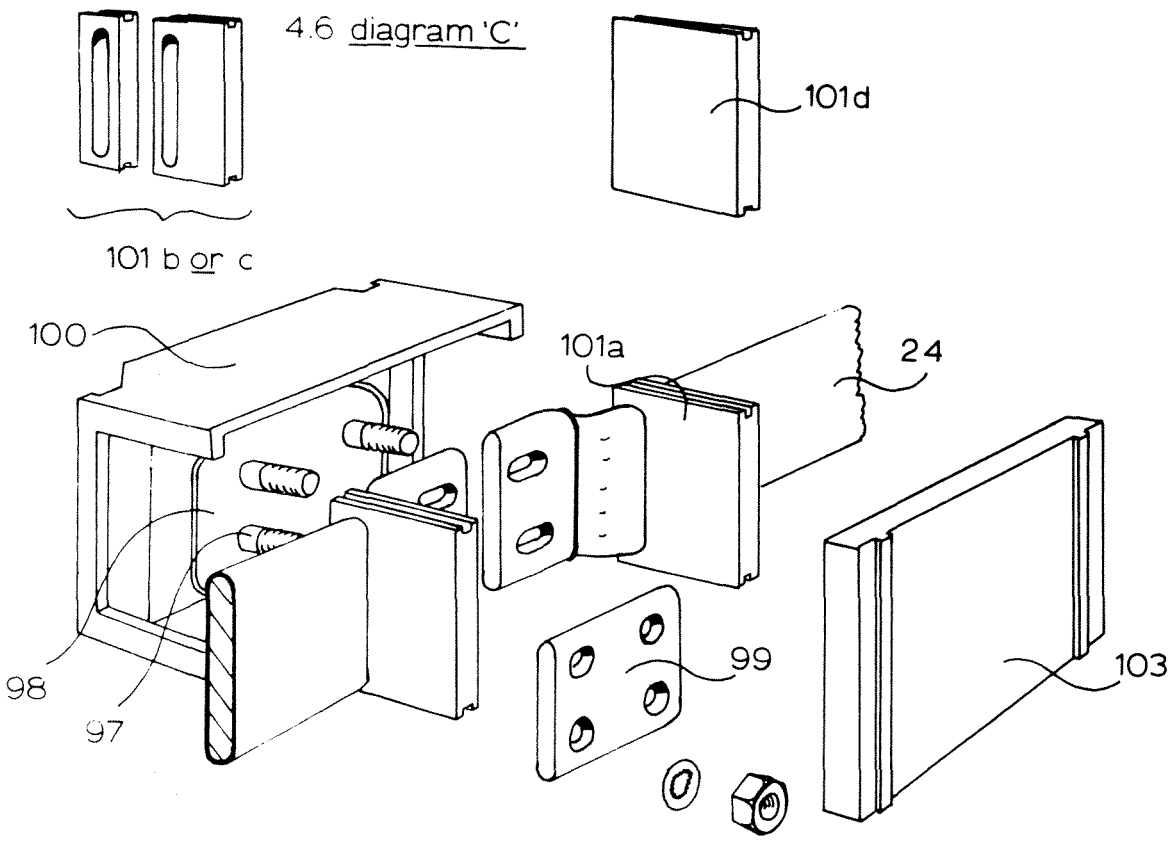
Current Rating	No. Laminations per phase	Size of each laminations
800 A	1	51 mm x 6 mm (2 in x 1/4 in)
1250 A	2	51 mm x 6 mm (2 in x 1/4 in)
2000 A	2	51 mm x 10 mm (2 in x 3/8 in)

4.6 diagram 'A'



4.6 diagram 'B'





4.63 Each busbar section (24) is secured at each end by nuts and internally toothed washers to two studs (97) protruding from an integral tee-off connection plate (98) in the busbar insulator and support moulding (23). On end panels, busbar packers (102) are fitted to the unused studs (97). Fishplate spacers (99) clamp the busbars (24) in place, carry busbar through currents across the joint and maintain the air circulation spaces between the laminations of multiple busbars.

4.64 Shrouds are provided for the busbar/tee-off connection junctions. These are fitted as follows (one phase described):

(a) The joint box (100) is factory-fitted in position round the tee-off connection plate (98) before the busbars are fitted, and is secured by two fillets, one internal and one external, of adhesive.

(b) The appropriate end pieces (101) are to be fitted at each end of each busbar section. There are four types of end piece:

101(a) Single type for 800 A busbar;
101(b) Double type for 1250 A busbars;
101(c) Double type for 2000 A busbars;
101(d) Single blank type for end panel.

(c) As the busbars (24) are located on the studs (97) the end pieces (101) are slid into engagement with the walls of the joint box (100).

(d) With all busbars and fishplates located and securely fastened, the joint box cover (103) is placed in position and snapped on.

(e) Special clamping arrangements are necessary at end panels of switchboards employing shrouded connections. See the diagrams for details of insulated clamp plates, screws etc.

4.65 Busbar end plates (96) must be fitted to the end panels of switchboards to block off the busbar apertures. The procedure is as follows:

(a) Working through the front of the busbar chamber, place the dished end plate (96) in position so that the bulge protrudes outwards through the sidewall, and the double flange at the top of the plate (96) is engaged on either side of the sidewall (i.e. one flange inside, the other outside).

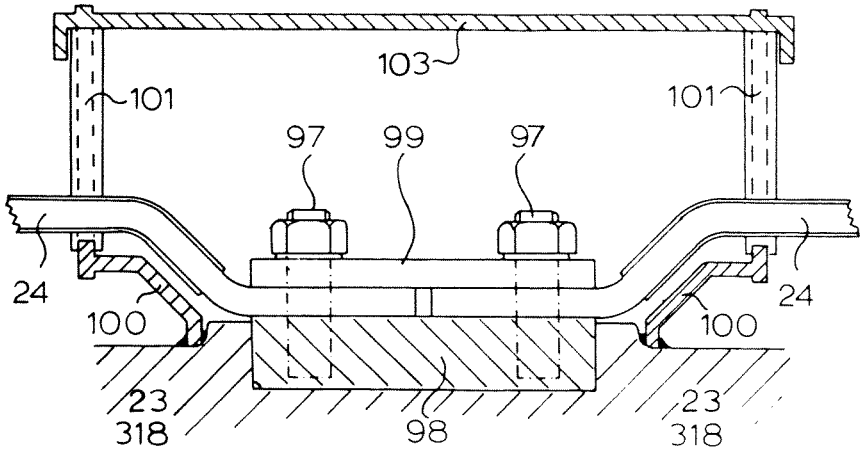
(b) Secure the plate (96) in position with the screw provided, which passes through a tapped hole in the plate (96) bottom flange and bears against the outside of the sidewall.

(c) Repeat at the other end of the switchboard.

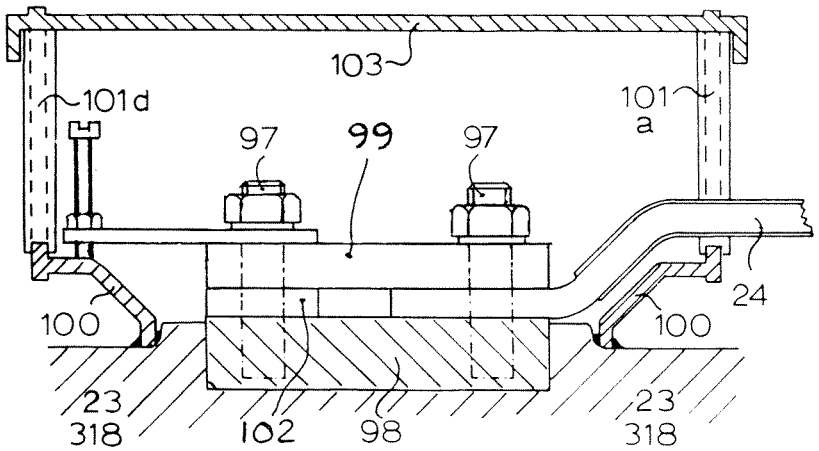
4.66 Clean the busbars (24) and tee-off mouldings (23, 318) as described in detail in the "Maintenance" section of the appropriate manual. Remove any foreign bodies from the busbar chambers. Replace and fasten tight all busbar chamber back plates (91, 346) and front plates (92, 347). Peel off the backing strips of the unit-to-unit busbar cover plates (177) and stick them in place between adjacent busbar chamber back plates (91, 346) and, in the case of units other than circuit breaker fixed portions, in the spaces between adjacent busbar chamber front plates (346) and across the spaces between adjacent chamber tops.

4.67 In the case of circuit breaker fixed portions, replace and secure the earthing device locating angles (90) on the sidewalls (50).

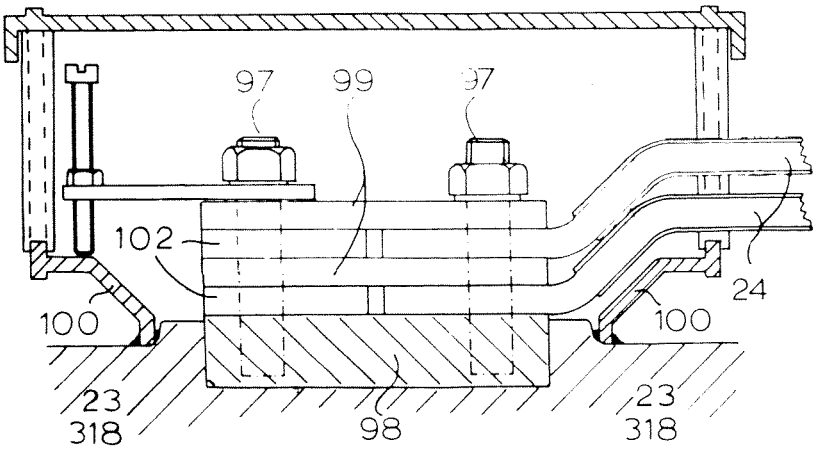
4.68 Fit the inter-unit sections of the main switchboard earth bar along the rear of the busbar chambers, ensuring that the earth connection from each fixed portion is connected to the main earth bar. Bond the switchboard earth bar to the substation earth according to local practice.



4.6 diagram 'D' i



4.6 diagram 'D' ii



4.6 diagram 'D' iii

4.69 Note that when a switchboard is to be extended, the new units can be erected whilst the end plate (96) of the original board remains in position. Remember that anti-vermin sealing strips (95) must be placed between the old and new units. When the new equipment is complete, the original switchboard is made dead and the busbars are earthed. The bus chamber back plate (91, 346) of the original end unit is removed, the end plate (96) is moved to the new end unit and busbars (24) are fitted between the adjacent new and original units. The normal completion procedures are then followed.

4.7 Jointing of Cables

4.71 The following method applies to standard designs of compound insulated, bottom entry cable box (1166).

However, only slight modifications are required for other cable boxes in our range. Compounds of the bituminous type are extensively used in metalclad switchgear cable boxes and if care is exercised in their use the equipment will function for long periods without further attention.

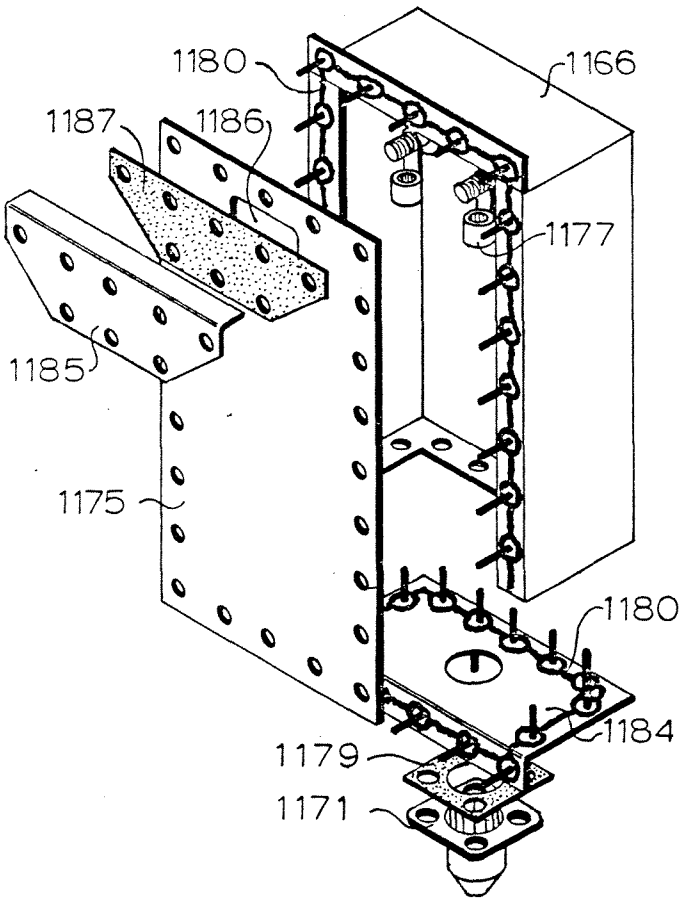
4.72 Prepare the cable box as follows:

(a) Remove the cable box front plate (1175) and note the positions of the cable sockets (1177) before removing them. Remove the bottom plate (1184), gasket (1179) and gland (1171) and make off the cable through them in the normal way, taking care that the gasket is refitted between plate and gland on re-assembly.

(b) Put pressure plastic around and between the front plate securing studs to seal in the compound, or, where neoprene-bonded gaskets (1146) have been specified, fit the front plate sealing gasket. Refit the front plate (1175) and fasten tight.

4.73 Prepare the bituminous compound (see sub-section 4.2). The following precautions must be observed:

4.7 diagram 'A'



4.74 Compound the cable box up as follows:

(a) Remove the filling aperture cover (1185) from the cable box and pre-heat the box, preferably by using radiant heaters, until an inserted thermometer shows an internal air temperature of 38°C (100°F). This removes surface moisture and prevents chilling and consequent voiding of the compound.

(b) With compound and cable box at their respectively correct temperatures, slowly but continuously pour in the compound (using a pourer or filler made from a section of the compound tin, or something similar, to guide the compound into the aperture) until the compound level reaches the bottom of the filling aperture (1186).
(c) Fit the filling aperture cover (1185) LOOSELY and leave the compound to cool and settle for up to two hours. Then, check whether the contracted level of the compound is sufficient without topping up. If not, top up with fresh compound whilst the original compound is still warm.

(d) Finally, fit the filling aperture gasket (1187) and cover (1185) and replace the securing nuts and washers and tighten the nuts.

4.75 On completion of topping up, clean the compound buckets and utensils of all compound whilst they are still warm to avoid contamination of future batches. Clean any spilled compound from the cable box, cable and floor so that there is no risk of maintenance staff wrongly thinking that the cable box is leaking during future inspections.

5. DELIVERY & ERECTION (OS-A0 & FS-A0)

5.1 Loading, Delivery, Unloading & Storage

5.11 Outdoor units may be carried on unsheeted vehicles for short journeys, or stored outdoors for short periods, but they should not be regarded as fully weatherproof until the procedures described in this section and section 7 of this manual have been satisfactorily completed. Prolonged storage should be in a warm, dry room.

5.12 It is possible for two men to load, unload and erect this switchgear without the use of lifting and handling equipment. However, for speed and safety the use of a small crane, forklift or similar equipment is recommended. The safe working load (SWL) should be at least twice the total weight of any load to be lifted; in the case of a crane, this should be the SWL at the maximum operating radius required by the site layout.

5.13 A 6 m (20 ft) circumference endless sling of manilla rope or suitable woven synthetic materials, SWL at least twice the total weight of the switch, should be looped under main structural components of the unit to crane lift it.

5.14 Do not attempt to operate any item of switchgear until the appropriate erection, preparation and commissioning procedures have been completed.

5.2 Delivery Weight, Oil and Compound Quantities

5.21 These are approximate values only.

5.22 Weight of FS-A0, busbar chamber and cable box, with no oil or compound : 131 kg (289 lb).

5.23 Volume of FS-A0 oil tank : 66 litre (14.5 gall).
Equivalent weight of oil : 56.5 kg (124 lb).

5.24 Weight of OS-A0, busbar chamber and cable box, with no oil or compound : 134 kg (295 lb).

5.25 Volume of OS-A0 oil tank : 43.5 litre (9.6 gall).
Equivalent weight of oil : 37.2 kg (82 lb).

5.26 Volume of rear cable box (FS or OS) : 28 litre (6.2 gall).
Equivalent weight of compound : 27 kg (60 lb).

5.3 Erection: Smooth Concrete Floor

5.31 Units may be erected directly onto a smooth concrete floor and secured with rag bolts or similar proprietary fittings. However, this requires that the floor has a smooth, trowelled finish to within the limits of a nominally flat floor as specified in British Standard Code of Practice C.P.204, Pt.1, 1965, i.e. ± 1/8 in. in 10 ft. (± 3 mm in 2880 mm).

5.32 If such a floor finish can be achieved, the unit fixing hole centres may then be marked out in accordance with the foundation plan. Note that ducts or a trench will be required at the rear of the switchboard to accommodate cables approaching from below. Take care to check that the diagonal measurements between centres match, showing that they have been marked out "square".

5.33 Alternatively, where only two or three panels are to be employed, they may be bolted up together and the busbars fitted (see below), and the units themselves may be used to mark the fixing centres on the floor.

5.34 Once the fixing centres have been determined, drill out clearance holes for 12 mm (1/2 in) dia. UNI-FIX or similar rag-bolt-type floor fixings (1170). Grout in the bolts with approximately 25 mm (1 in) of threaded shank protruding above finished floor level. Leave to set.

5.35 Fit the removable feet (1383) beneath the bottoms of the busbar chambers, using the nuts and washers provided.

5.36 Lower the switchgear units over the protruding rag bolt shanks. The bolts should be central in the holes in the unit feet. Add the washers and nuts to the fixing bolts and screw down loosely, noting that there is no distortion of the unit bodies. Check the horizontal surfaces of the units with a spirit level, and check that all feet are resting firmly on the floor. If any unit is not firm and level, lift it clear and add packing washers to the relevant fixing bolt or bolts.

5.37 As each unit is satisfactorily located and levelled, fasten it down firmly to the fixing bolts. Do not forget to place the gaskets between the busbar chamber flanges (1378) of adjacent units, and fasten the flanges together with the nuts, bolts and washers provided.

5.38 Fit the rainsheds (1382) (where provided) to the tops of the fastened flanges, to prevent rain resting on the top edges of the gaskets between units.

5.4 Erection: Unistrut Foundations

5.41 If it is felt that a floor as smooth as that discussed in paragraph 5.31 cannot be guaranteed, or if a particularly long switchboard is involved, we recommend that UNISTRUT channels, reference P3200 (181), and spring nuts, reference P1008 (183) be employed to ensure a level foundation. UNISTRUT fittings are available from ourselves, at an additional cost per switchboard panel, or directly from:

UNISTRUT Division of GKN Limited,
43-45 Broadwater Road,
Welwyn Garden City,
Herts.,
England.

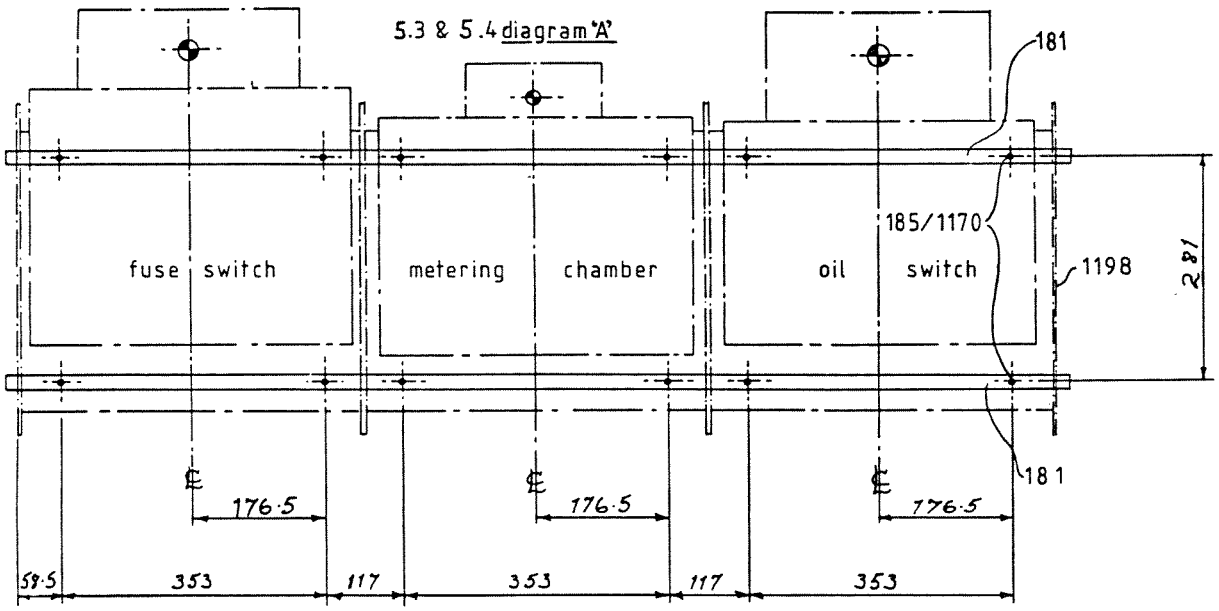
5.42 Prepare a sub-floor 40 mm (1.5/8 in) below the finished floor level, with chases a further 70 mm (2.3/4 in) deep by 100 mm (4 in) wide at 330 mm (13 in) centres, running at least the total ultimate length of the switchboard, including any future extensions which may be under consideration.

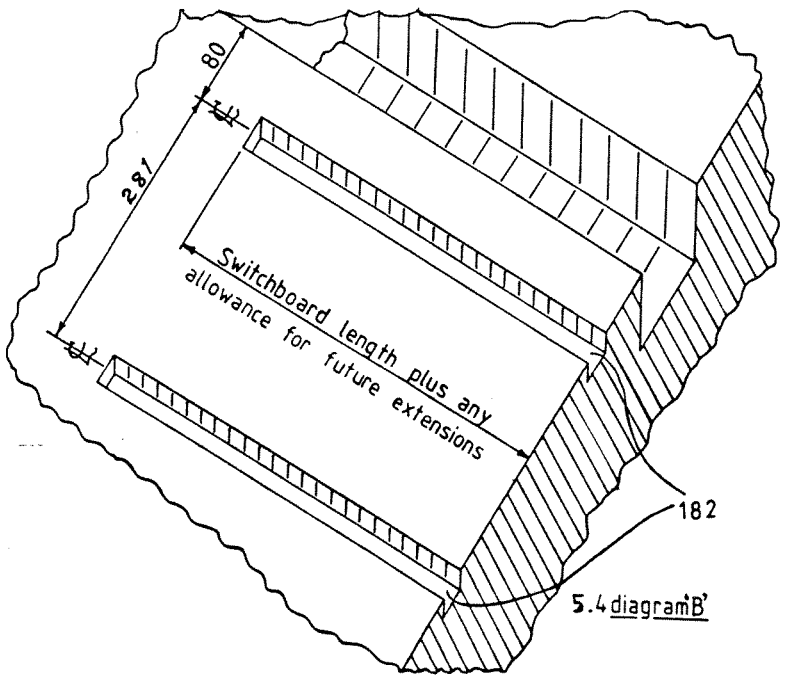
Note that ducts or a trench will be required at the rear of the switchboard to accommodate cables approaching from below.

5.43 Place the Unistrut runners (181) in their approximate positions in the chases (182) and burn 50 mm (2 in) gaps in the foam plastic filler at roughly 509 mm (20 in) centres, using a blowlamp or gas torch. Using the spring nuts (183) provided, fix tie bar jigs (1377) to the foundation runners at these gaps. By using a straight edge, and by measuring corresponding diagonals, check that the Unistrut/tie bar assembly is "square". Position small pieces of steel plate or similar material under the tie bar levelling screws and ensure that the longitudinal centreline of the rear runner is 80 mm (3.1/8 in) from the trench edge at both ends. Note that where two or more lengths of Unistrut are to be butted end to end, they must line up exactly.

5.44 Using a spirit level, a straight edge and the tie bar levelling screws, ensure that the Unistrut/tie bar assembly is level in both directions. Grout in the runners filling the chases with cement grout mix and carrying the grout half way up the outsides of the runners. Leave the grout to set hard, then remove the tie bar jigs and spring nuts from the runners. Float the finished floor between the runners, the level coinciding with the tops of the runners but not overflowing them. Do not let the concrete get into the previously burned-out parts of the runners. When the switchboard floor area has set, use it as a datum to float and level the rest of the switchboard floor.

5.45 Using the switchboard foundation plan as a guide, burn 50 mm (2 in) gaps in the foam plastic filler of the runners at the required fixing points, using a blow lamp or gas torch. Position the M10 spring nuts (183) in the runners at these points. Fit the removable feet (1383) beneath the busbar chambers (1368) using the nuts and washers provided.



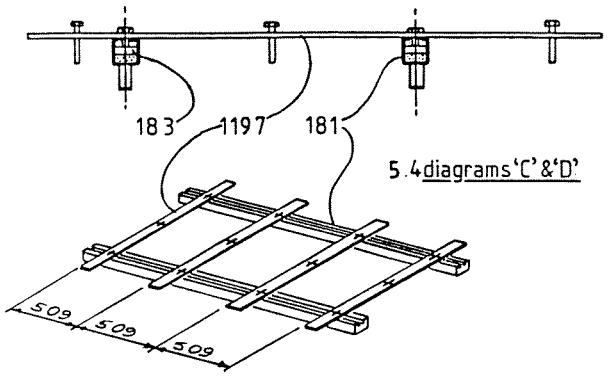


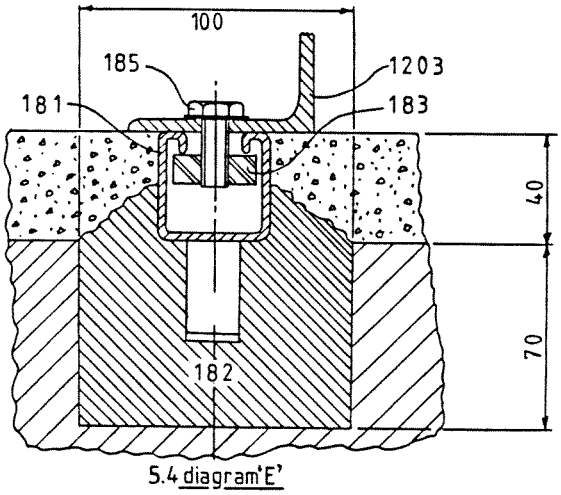
5.46 Place all units in position and fasten them down using the M10 x 40 mm long hexagonal headed screws and standard M10 washers. Check all units for level horizontal and upright vertical surfaces using spirit level and plumb line. Minor variations due to manufacturing tolerances may be rectified by the addition of washers beneath the unit feet. Use a straight edge or taut string to line the units up.

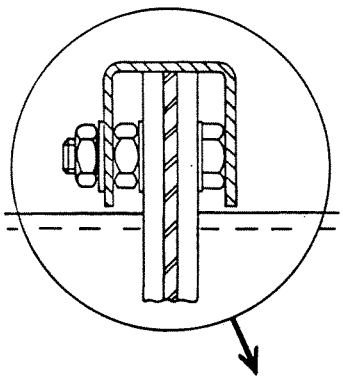
5.47 As the units are lined up and fastened down, fit the gaskets between adjacent busbar chamber flanges (1378) and fasten the flanges together with the nuts, bolts and washers provided.

5.48 Fit the rainsheds (1382) (where provided) to the tops of the fastened flanges, to prevent rain resting on the top edges of the gaskets between units.

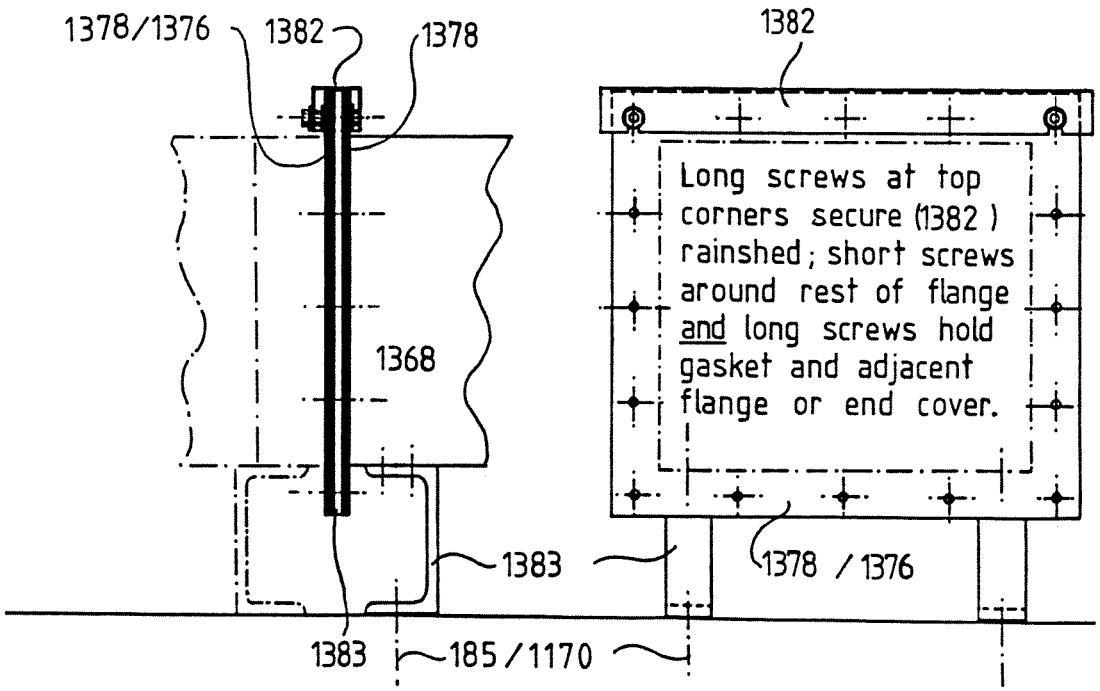
5.49 Use pieces of Unistrut clip-on plastic cover to seal any exposed lengths of Unistrut runner, e.g. where provision has been made for future extensions.







5.3 & 5.4 diagram 'F'



5.5 Jointing the Busbars

5.51 READ THE WHOLE OF THIS SUB-SECTION AT LEAST TWICE BEFORE STARTING WORK. The following are the significant features of the busbar system employed:

i) The unit length busbars (1369) are incorporated in a moulding (1371) which is an integral part of each switch unit.

ii) Only the last few millimetres of each busbar end are exposed, and the ends of adjacent unit bars must be connected up by split metal sleeves (1372), which are fastened in place by means of special heat-shrinkable metal locking rings (1373).

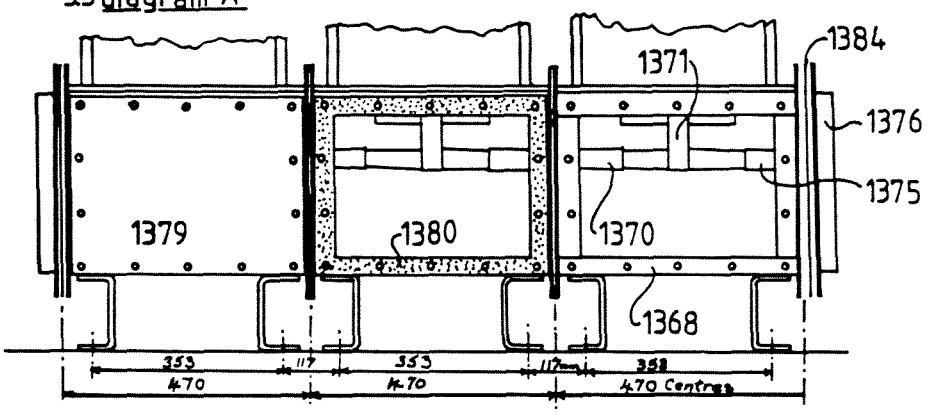
iii) To ensure complete encapsulation of the busbar system, heat-shrinkable insulating sleeves (1370) are fitted over these electro-mechanical joints.

iv) On end panels, the unconnected ends of the busbars are fitted with one-piece metal bushes (1374) and insulated by heat-shrinkable shrouds (1375).

v) Busbar jointing kits incorporate all of the above components, plus aluminium foil for use as heat shields, as described later.

The following text explains how to joint and insulate the unit busbar ends.

5.5 diagram 'A'



5.52 Remove the busbar chamber front cover plates (1379) and their gaskets (1380) from the switchboard. Clean each chamber (1368) of any dust, and wipe the busbars resin moulding (1371) with a lint-free, non-metallic, non-synthetic cloth and inhibited 1.1.1 trichloroethene. Two brands available in the U.K. are:

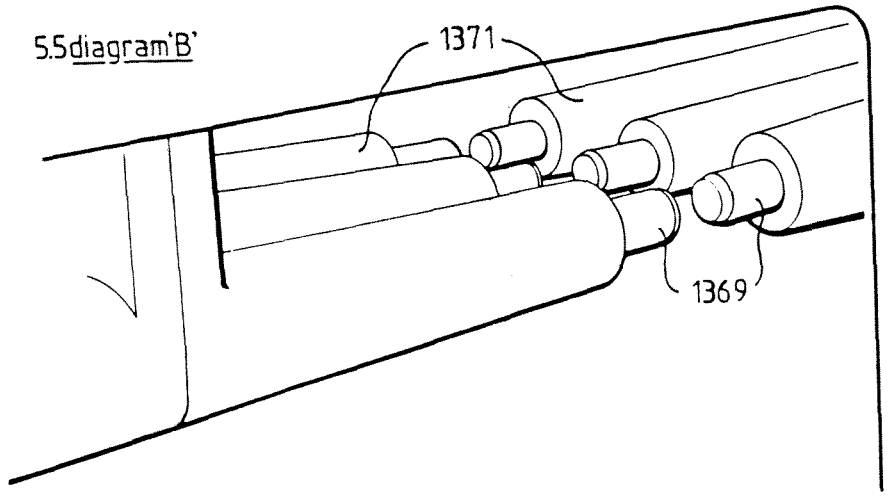
i) "ICI Genklene LV",
available from:

Ellis & Everard,
Dudley Hill Chemical Works,
Holme Lane,
BRADFORD, 4,
West Yorkshire.

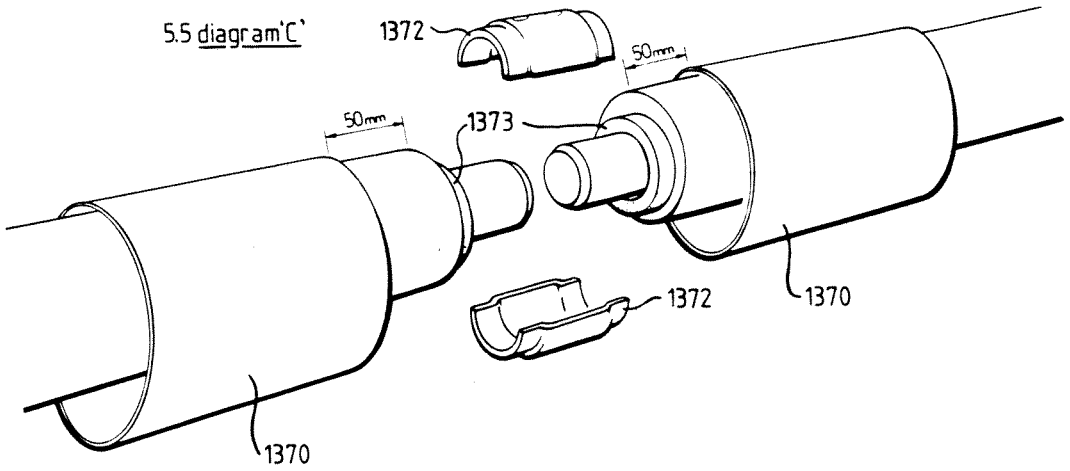
ii) "Electrolube Ultraclene V",
available from:

Automation Facilities Ltd.,
Blakes Road,
WARGRAVE,
Berkshire,
RG10 8AW.

5.5 diagram 'B'



5.5 diagram 'C'



5.53 At each inter-panel joint, slip an insulating sleeve (1370) over each of the busbar moulding limbs to be joined, and move the sleeves along the limbs as far as possible so that they are at least 50 mm (2 in.) clear of the protruding metal busbar ends (1369). Then slip one metal locking ring (1373) on each busbar end and slide it back against the end of the moulded insulation (1371).

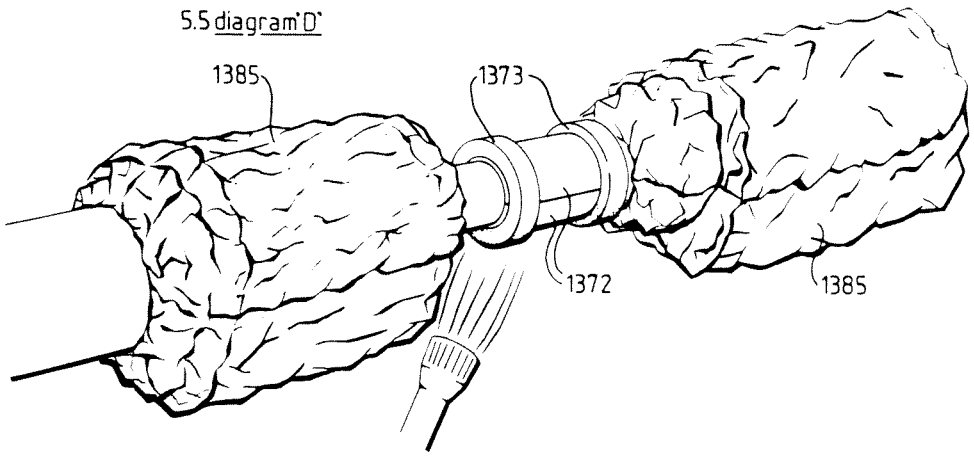
Fit the two halves of the split metal sleeve (1372) to each pair of busbar ends, and secure them loosely in place by sliding the locking rings (1373) into position around the reduced diameter end sections of the sleeves.

5.54 Wrap the aluminium foil (1385) around the sleeves (1370) and the two sets of busbar moulding limbs (1371) to protect them from the heat, and then use a gas torch (preferably propane, but butane is acceptable) to heat up the locking rings (1373) and cause them to shrink and so fasten the metal split sleeves (1372) in place. The torch flame should be blue, "hard" and narrow so that it can be precisely directed at the rings and "spill" a minimum of heat elsewhere. Apply the heat evenly around the circumference of each ring, and continue heating it until the green marker spot darkens to show that sufficient heat has been absorbed. Allow the rings to cool naturally, when it will be found that they have shrunk to form a tight fit on the sleeves beneath.

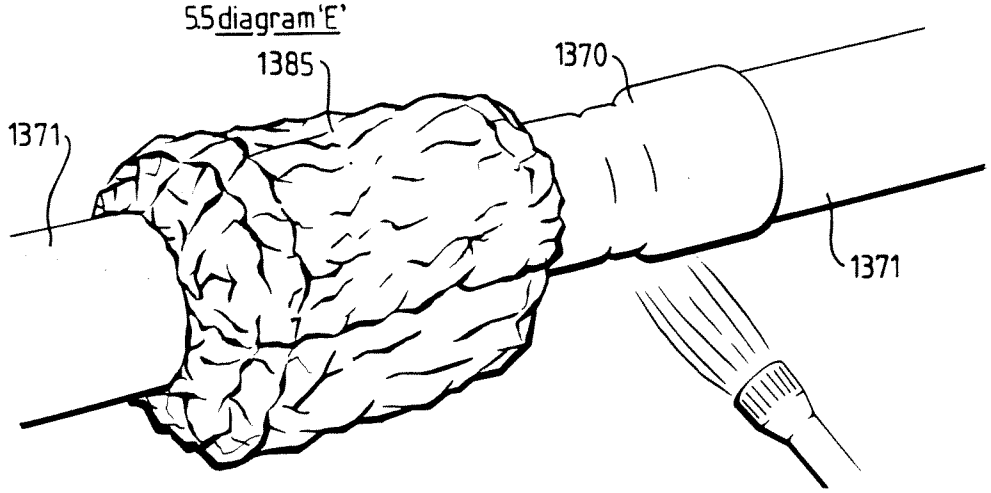
5.55 Once all the rings have been shrunk into place and allowed to cool, remove the aluminium foil (1385) from one insulating sleeve (1370), and slide the sleeve over the made-off busbar joint until it comes up against the shoulder of the opposite resin moulding (1371). Shrink fit the sleeve into position as follows:

Using the gas torch again, but with the flame adjusted to a "soft" blue with a yellow tip, gently warm the insulating sleeve (1370). Keep the flame continually moving over the surface to prevent scorching and hot spots. Heat the sleeve overall but, as it begins to shrink, work from the centre outwards so as to avoid trapping air in the middle. When the sleeve is fully shrunk, the outer surface should be smooth and wrinkle-free, and should follow the shape of the components beneath it.

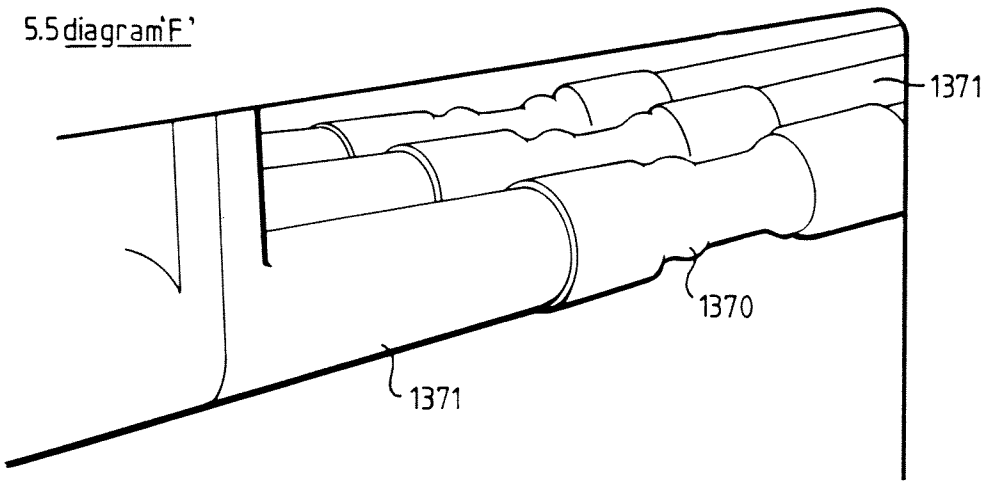
5.5 diagram 'D'



5.5 diagram 'E'



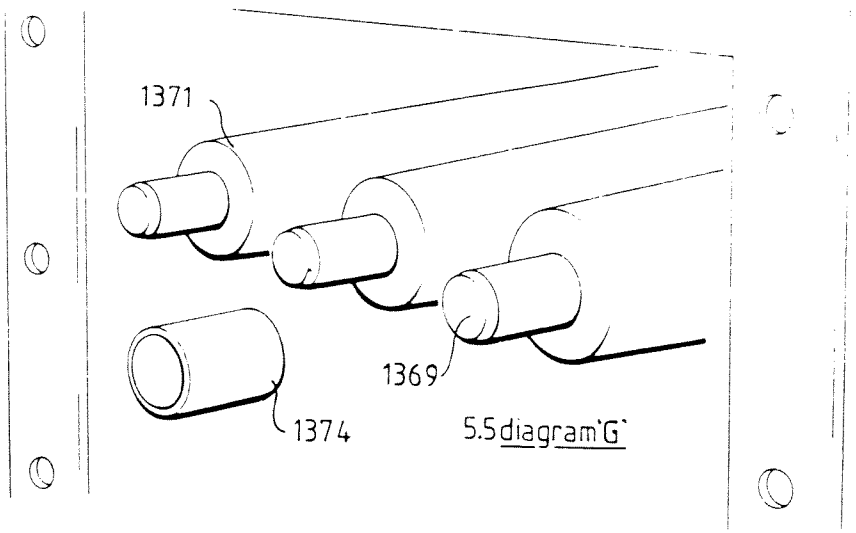
5.5 diagram 'F'



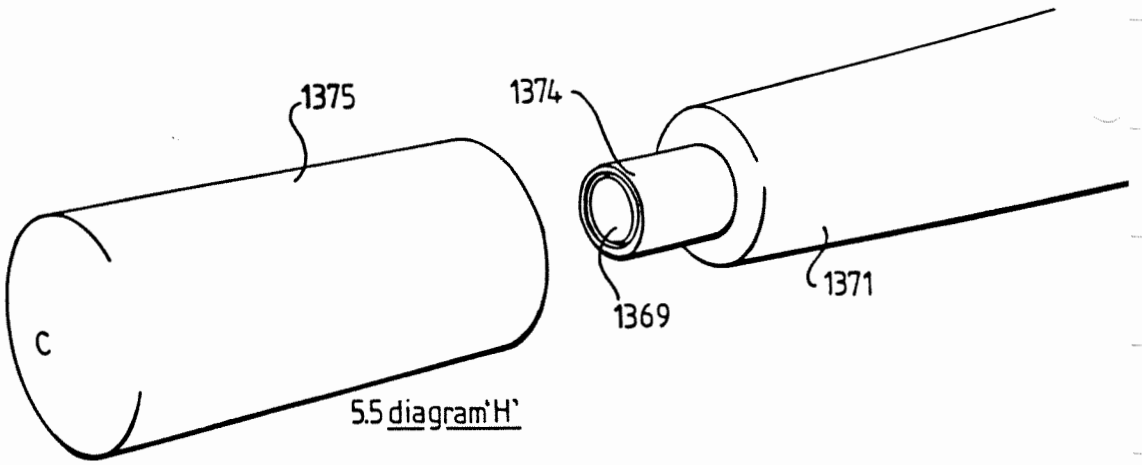
5.56 Now, remove the aluminium foil from the opposite sleeve and slide it over the one you have just shrunk, again moving it until it comes up against the (now shrouded) shoulder of the opposite resin moulding (1371). Shrink this overlapping sleeve into place as described above.

Repeat these procedures for all three phases at each inter-panel busbar joint location.

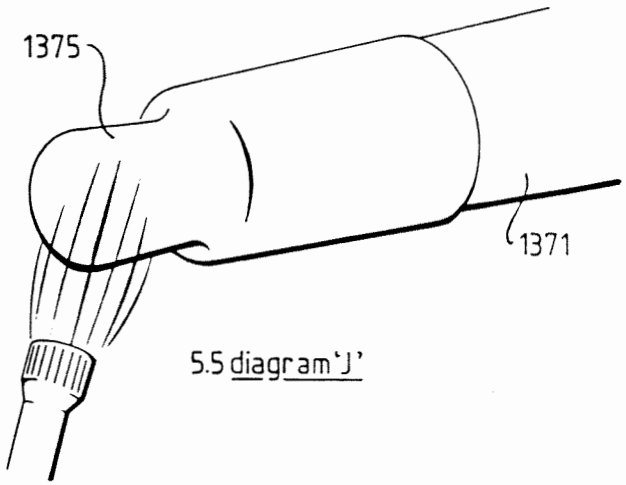
5.57 On the outer end of the busbar moulding (1371) of an end panel, push the non-shrinking metal bushes fully home (1374) onto the ends of the busbars (1369). Put the insulating "boots" (1375) in place over them, push them on as far as they will go and shrink them into position as in paragraph 5.56 above, taking care to work from the closed to the open ends of the "boots" to ensure a good fit and to expel excess air from the interior.



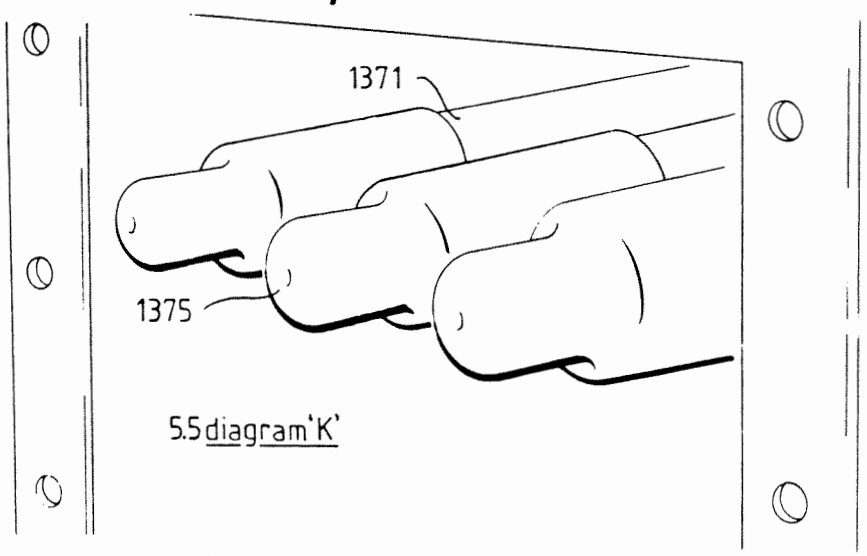
5.5 diagram 'G'



5.5 diagram 'H'



5.5 diagram 'J'



5.5 diagram 'K'

5.58 When all of the inter-panel and end panel busbar ends (1369) have been dealt with, clean out the busbar chambers (1368), checking that no tools or materials are left in them, then fit the front cover plate gaskets (1380) and the plates themselves (1379) and replace and fasten tight their nuts and washers. Similarly fit and fasten the dished busbar chamber end covers (1376) and gaskets (1384). Fit rainsheds (1382) to the tops of the end cover flanges.

5.59 Connect the unit earth bars of adjacent units together using the nuts/screws/washers provided and connect the whole switchboard earth bar system to the substation H.V. metalwork earth according to local practice.

5.6 Jointing of Cables

The cable jointing procedure is basically the same as that employed on indoor units: please see sub-section 4.7 of this manual.

6. DELIVERY & ERECTION (OS-AT)

6.1 Loading, Delivery, Unloading and Storage

6.11 Outdoor units may be carried on unsheeted vehicles for short journeys, or stored outdoors for short periods, but they should not be regarded as fully weatherproof until the procedures described in this section and section 7 of this manual have been satisfactorily completed. Prolonged storage should be in a warm, dry room.

6.12 It is possible for two men to load, unload and erect this switchgear without the use of lifting and handling equipment. However, for speed and safety the use of a small crane, forklift or similar equipment is recommended. The safe working load (SWL) should be at least twice the total weight of any load to be lifted; in the case of a crane, this should be the SWL at the maximum operating radius required by the site layout.

6.13 A 6 m (20 ft) circumference endless sling of manilla rope or suitable woven synthetic material, SWL at least twice the total weight of the switch, should be looped under main structural components of the unit to crane lift it.

6.14 Do not attempt to operate any item of switchgear until the appropriate erection, preparation and commissioning procedures have been completed.

6.2 Delivery Weight, Oil and Compound Volumes

6.21 These are approximate values only.

6.22 Weight of OS-AT, cable box and support bracket, with no oil or compound : 134 kg (295 lb).

6.23 Volume of oil tank : 43.5 litre (9.6 gall.)
Equivalent weight of oil : 37.2 kg (82 lb.)

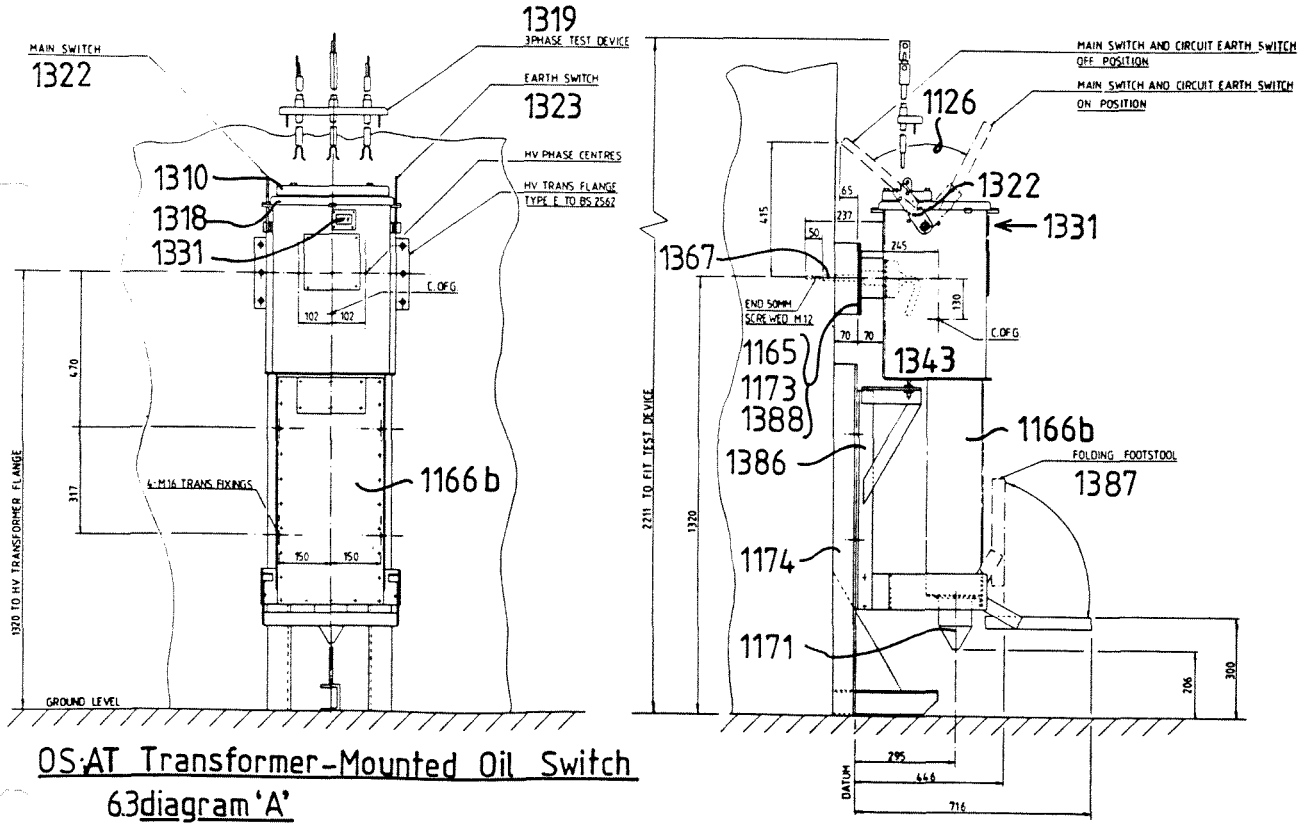
6.24 Volume of front cable box : 31.7 litre (7 gall.)
Equivalent weight of compound : 30.6 kg (67.5 lb.)

6.3 Mounting the Switch on the Transformer

6.31 The OS-AT is supported by a bracket (1386) which bolts to angle pieces welded on the transformer tank. The front faces of the angles must be in line with the face of the transformer flange (1165). A folding operating platform (1387) on the bracket (1386) enables the operator to reach the top of the unit with ease for operation or inspection.

6.32 Note that cable ducts or a trench will generally be required beneath the front cable box (1166b).

6.33 Where the transformer is equipped with an HV disconnection chamber, take the cover off this chamber. Otherwise, remove the transformer lid and lower the level of the transformer oil (this oil is similar to switch oil - see sub-section 7.2 for precautions to be observed), until it clears the bottom of the HV terminal aperture. Remove the aperture blanking plate and gasket.



OS-AT Transformer-Mounted Oil Switch
6.3 diagram 'A'

6.34 Using a crane or other handling equipment if available (see sub-sections 6.1 and 6.2) raise the switch unit and offer it up on its bracket (1386) to the transformer so that the bushings (1367) protrude into the transformer tank (or disconnection chamber). Raise or lower the unit until the mating flanges (1165/1388) are aligned and flush together, with the gasket (1173), supplied with the unit, between them. The four holes in the rear flanges of the bracket (1386) should now also be aligned with the studs or bolt holes in the transformer tank bulkhead support angles (1174).

6.35 Fasten the mounting bracket (1386) to the bulkhead angles (1174), using packing washers if necessary, to ensure alignment of the mating HV flanges (1165/1388) without distortion of the switch tank. Use the screws and nuts at the top of the stand to give fine adjustment vertically. DO NOT use the flange fastenings to pull the switch to the transformer, but when the flanges are correctly mated with the gasket (1173) between them, fasten them securely together with the nuts, bolts and washers supplied. Bond the unit earth bar to the substation HV metalwork earth.

6.36 If on-site pressure testing of the switch unit alone is required, then the procedure described in sub-sections 7.1, 7.2 and 7.3 should be undertaken at this stage, before the HV connections to the incoming supply and to the transformer are made.

6.37 Connect the transformer HV leads to the bushing connections (1367) in the transformer tank or disconnection chamber. Top up the tank or chamber with oil to the marked operating level (see sub-section 7.2), replace the lid and gasket and fasten down.

6.38 The incoming cable can now be jointed into the front cable box (1166b) according to approved local practice (see sub-section 4.7). All structural steelwork and cable glands (1171) are bonded to the unit earth bar.

6.39 The preparation and commissioning procedures detailed in section 7 can now be undertaken, if this was not done previously.

6.4 Erecting a Free-Standing Switch with Rear Cable Box

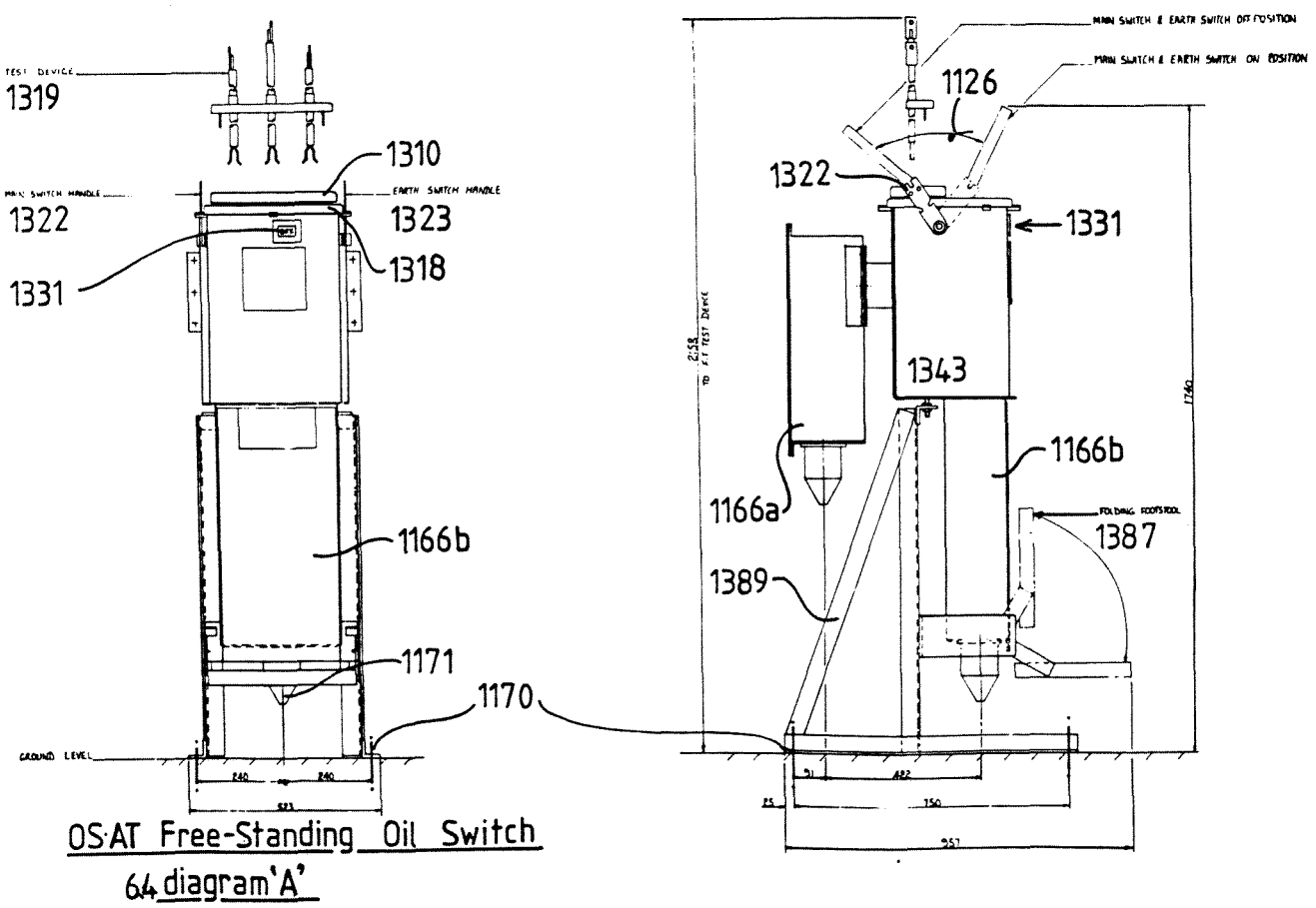
6.41 Place the unit, complete with stand (1389), in the appropriate position on a level concrete floor and secure it there with four, 12 mm (1/2 in) diameter UNI-FIX or similar rag-bolt-type fixings (1170).

6.42 Note that the two cable boxes (1166a, b) require cable ducts or trenches beneath them to accommodate the cables.

6.43 Bond the unit earth bar to the substation HV metalwork earth.

6.44 If on-site pressure testing of the ring main unit alone is required, then the procedures described in sub-sections 7.1, 7.2 and 7.3 should be undertaken at this stage, before the HV cable connections to the incoming supply and to the transformer are made.

6.45 The front and rear cables can now be jointed into their respective boxes (1166a, b) according to approved local practice (see sub-section 4.7). All structural metalwork and cable glands (1171) are bonded to the unit earth bar.



OSAT Free-Standing Oil Switch
64 diagram 'A'

6.46 The preparation and commissioning procedures in section 7 can now be undertaken if this was not done previously.

6.5 Jointing of Cables

The cable jointing procedure is basically the same as that employed on indoor units: please see sub-section 4.7 of this manual.

IMPORTANT NOTE ON OIL FILLED CHAMBERS

During the erection and preparation of switchgear, it is important that all oil-filled chambers on both fixed and moving portions (i.e. not only circuit breaker and switch tanks, but also certain voltage transformer, current transformer and connection chambers) be opened, examined and filled to the correct level with switch oil. Some chambers may be already filled with oil, e.g. certain voltage or current transformer chambers, but the oil level should still be checked and carefully topped up if necessary. Look for the label:

> NOTE
>
> Before the switchgear is energised, this chamber must be filled to the level shown with switch oil conforming to British Standard 148, and the site tests specified in the relevant British Standards must be completed.

7 PREPARATION & COMMISSIONING

7.1 Preparation of Tank & Mechanisms

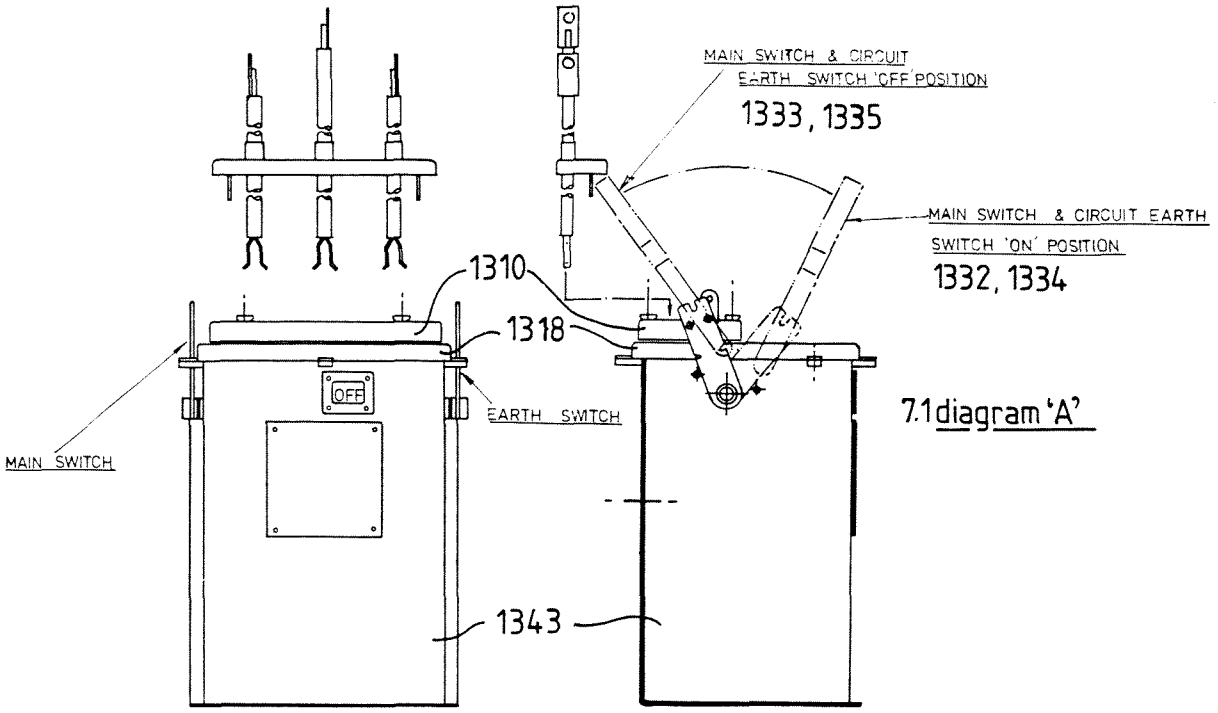
7.11 WITH BUSBARS (IF ANY) AND CIRCUIT CONNECTIONS (1166a, 1166b, 1367) DEAD, remove all packing materials, wipe down the outside of the switch tank (1343) and set the operating handle stubs to OFF (1333) and EARTH ON (1334) respectively. Unfasten the four screws securing the main cover (1318) to the tank top and remove the cover with its subsidiary test cover (1310).

7.12 Wipe out the tank (1343) with a clean, dry, lint free, non-metallic cloth. Examine the mechanisms, bearings and contacts and check that all fastenings are secure. Check for foreign bodies in the tank bottom.

7.13 Fill the tank (1343) to the marked level with switch oil (see sub-section 7.2, "Oil Filling of Switchgear") pouring the oil over those parts of the mechanism which are above the marked oil level.

7.14 Examine the gaskets on the main (1318) and test access (1310) covers, then re-fit and fasten down both covers with the switches in the OFF and EARTH ON positions.

7.15 As far as possible, check the operation of the handle and handle stubs, of the mechanisms and of the interlocks in accordance with Section 8, "Routine Oil Switch Operation".



7.1 diagram 'A'

7.2 Oil Filling of Switchgear

7.21 Switchgear is normally despatched without oil and when the equipment is filled on site it is necessary to observe certain precautions to ensure satisfactory operation. These precautions are also applicable to the handling of transformer oil.

7.22 The oil must be of the correct grade (normally B30 for switchgear), should preferably be used from sealed drums, and must have an electrical strength of not less than that specified by BS 148. Clean oil must not be stored in drums which have held dirty oil.

7.23 All pumps, pipes and other filling utensils must be clean and dry and must have a temperature similar to that of the oil and switchgear. Separate equipment should be used for clean and dirty oils.

7.24 Rubber tubing or any other material which is soluble in oil should not be used.

7.25 All components of the switchgear which are to be immersed in the oil must be thoroughly cleaned with lint-free, non-metallic cloths. Do not use cleaning solvents, which might contaminate the oil.

7.26 To avoid condensation, oil and switchgear should be at least as warm as the surrounding air, and in addition the switchgear should be dry; this condition can be obtained by allowing the warm air to circulate through the switchgear with the tanks open. All parts inside the chamber or tank will then quickly attain atmospheric temperature. If this method cannot be used, achieve the same result by placing bags of silica gel dessicant in the chambers for a period of some hours. Care must, however, be taken to ensure that all of these bags are removed before filling commences. When the equipment is completely dry, no moisture will appear on a mirror held inside the chamber.

7.27 The correct oil level is marked on the inside of the oil switch and fuse switch chambers and on the outside of circuit breaker and voltage transformer tanks.

7.28 After filling it is advisable to operate the switchgear several times before applying voltage in order to release any air which may be trapped.

7.29 WARNING: No naked light should be permitted in the vicinity of open tanks or in other situations where switch oil is directly exposed to the atmosphere (this precaution is particularly important during post-fault maintenance).

7.3 High Voltage Tests

7.31 The application of a high voltage pressure test is often called for, for example, before commissioning or during maintenance of metalclad switchgear, according to local regulations.

BS.5227:1975 specifies the following one minute power frequency test voltages for such site tests:

MAIN CIRCUIT RATED VOLTAGE	MAIN CIRCUIT SITE TEST VOLTAGE
kV	kV
3.6	8.6
7.2	15.2
12.0	24.0
17.5	32.0

Auxiliary circuits : 2.0kV

7.32 The first test should be applied thus:

(a) all phases to earth with switch closed;

(b) between phases with switch closed;

(c) across the break of the open switch.

7.33 If the equipment is not large enough to produce the correct test voltage, a prolonged test at reduced voltage in accordance with the table below may be applied.

POWER-FREQUENCY VOLTAGE TESTS FOR DURATIONS EXCEEDING ONE MINUTE (AFTER ERECTION ON SITE)	
Duration of test Minutes	Percentage of one-minute test voltage according to paragraph 7.31
1	100
2	83.5
3	75
4	70
5	66.6
10	60
15	57.7

7.34 D.C. Testing:

The use of D.C. test sets for cable testing is now widespread and the use of this equipment for the pressure testing of switchgear is often convenient. The case against D.C. testing is that the insulation is not stressed in the same manner as when an A.C. voltage, for which it was designed, is applied, but experience has not indicated that initiation of breakdown is more likely with D.C. than with A.C. In the event of a D.C. voltage test being applied to the switchgear, the values must be in accordance with the table below, the duration of test to be 15 minutes.

D.C. TEST VOLTAGES	
Rated Voltage	Site Test Voltage
kV	kV
3.6	7.0
7.2	15.0
12.0	25.0
17.5	32.0

7.35 If high voltage testing of the connecting cable or cables is required once they have been jointed into the switchgear, B.S.5227 specifies the following d.c. values:

RATED VOLTAGE OF SWITCHGEAR	*BETWEEN PHASES OF BELTED CABLES	BETWEEN ALL PHASES AND EARTH
kV	kV (d.c.)	kV (d.c.)
3.6	10.0	7.0
7.2	20.0	15.0
12.0	34.0	25.0
17.5	-	37.0

*With midpoint of test supply earthed.

7.4 Paintwork

All components are given a high quality protective finish before leaving the works, but the paintwork may be damaged during transport, erection or service. Any scratches or chipped portions of the paintwork should be touched up immediately they are noticed, otherwise the metalwork may rust.

Suitable touch up paint is available from Yorkshire Switchgear, or it may be obtained from any reputable manufacturer. The specification is:-

"Glossy Synthetic Air Drying Enamel for Outdoor Use". Quote the appropriate colour references:

Colour	Colour No. (BS 381C: 1948)
Dark Admiralty Grey	632

Or such other colour as may have been specified for a particular installation.

8 ROUTINE OIL SWITCH OPERATION

8.1 To Close the Main Switch to ON

8.11 Note that the indication in the tank window (1331) is OFF.

8.12 Unlock the padlockable main switch handle stub (1322) at the left of the switch. Fit the removable operating handle (1126) to the stub.

8.13 Move the operating handle (1126) firmly but smoothly forwards to the ON position (1332) to close the main switch (1308/1309). The indication in the tank window (1331) will change to ON.

8.14 Remove the operating handle (1126). Padlock the handle stub (1322) unless access for emergency opening is required.

8.2 To Open the Main Switch to OFF

8.21 Note that the indication in the tank window (1331) is ON.

8.22 Unlock the padlockable main switch handle stub (1322) at the left of the switch. Fit the removable operating handle (1126) to the stub.

8.23 Move the operating handle (1126) firmly but smoothly backwards to the OFF position (1333) to open the main switch (1308/1309). The indication in the tank window (1331) will change to OFF.

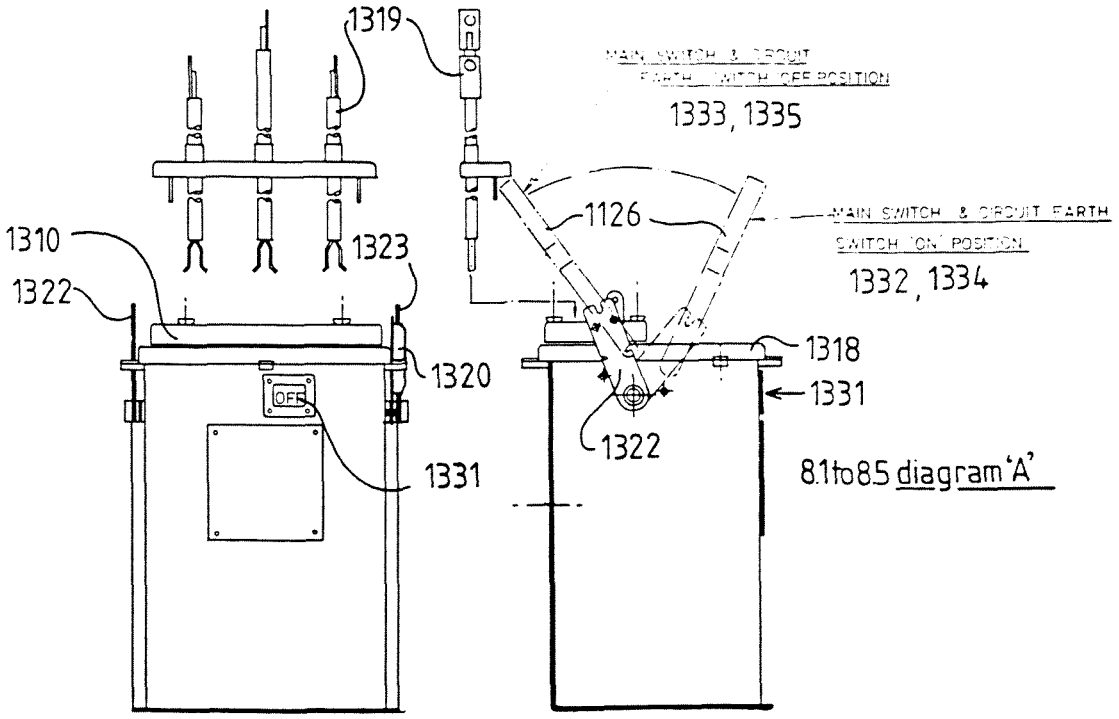
8.24 Remove the operating handle (1126). Padlock the handle stub (1322).

8.3 To Earth the Rear Circuit

8.31 Note that the indication in the tank window (1331) is OFF.

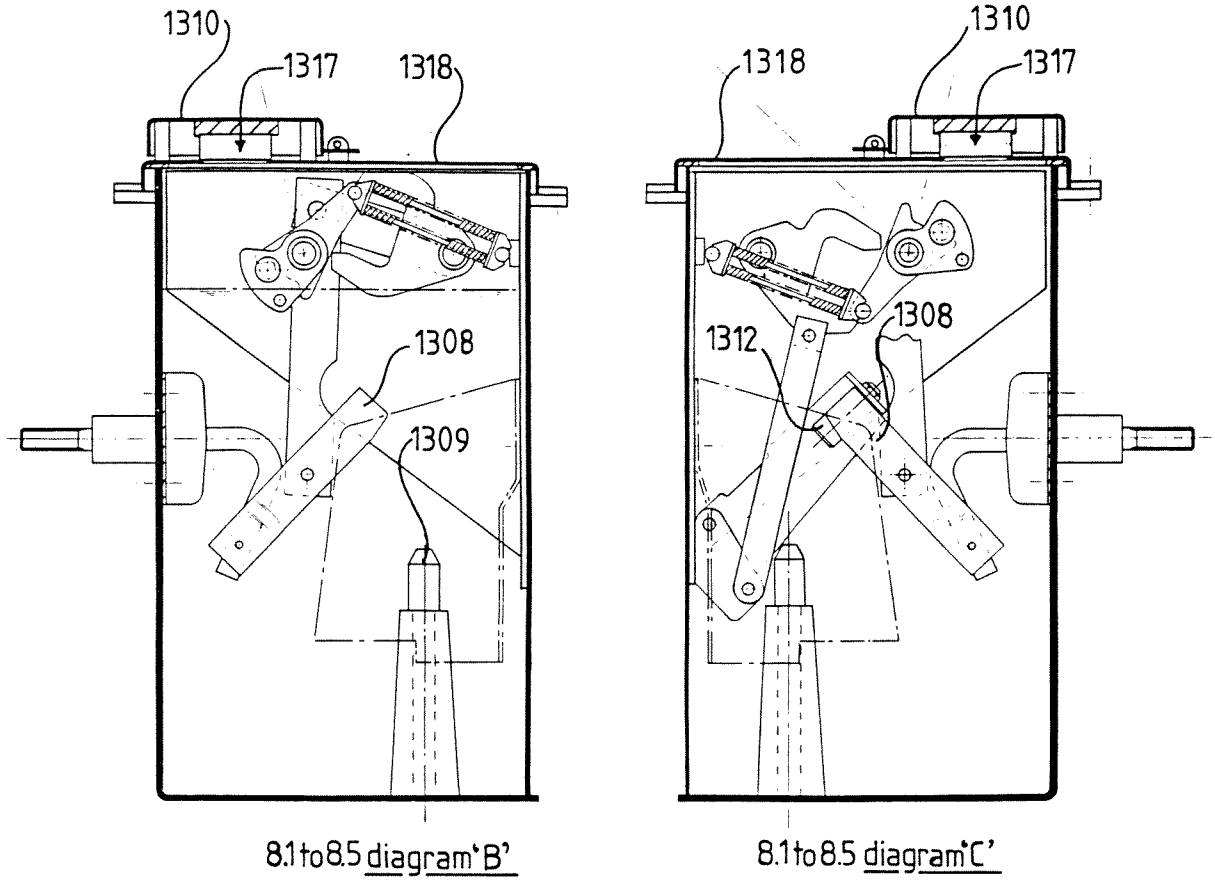
8.32 Unlock the padlockable earth switch interlock cover (1320) (labelled MOVE BEFORE EARTHING) at the right of the switch and move it clear of the earth switch handle stub (1323). Fit the removable operating handle (1126) to the stub.

8.33 Move the operating handle (1126) firmly but smoothly forwards to the EARTH ON position (1334) to close the earth switch (1312/1308) and earth the outgoing (or incoming) circuit cable connections (1367). The indication in the tank window (1331) will change to EARTH ON.



8.34 Because of the design of collapsible handle (1126/1323) employed, it is impossible for an operator to immediately re-open a closed earth switch; the operating handle (1126) must be re-located first. Thus, should an earth be inadvertently applied to a live circuit, the operator cannot instinctively re-open the non-fault-breaking earth switch at once, with the possibility of breaking the fault current, before remote protection has had time to operate.

8.35 On completion of the earthing operation, remove the operating handle (1126). Padlock the handle stub (1323) in position.



8.1 to 8.5 diagram 'B'

8.1 to 8.5 diagram 'C'

8.4 To Remove the Earth from the Rear Circuit

8.41 Note that the indication in the tank window (1331) is EARTH ON.

8.42 Unlock the earth switch handle stub (1323) at the right of the switch. Fit the removable operating handle (1126) to the stub.

8.43 Move the operating handle (1126) firmly but smoothly backwards to the EARTH OFF position (1335) to remove the earth from the circuit cable connections (1367) by opening the earth switch (1312/1308). The indication in the window (1331) will change to OFF.

8.44 Remove the operating handle (1126). Move the padlockable earth switch interlock cover (1320) over the stub (1323) and padlock it in position.

8.5 Cable Testing through the Oil Switch

8.51 Set the switch controlling the cable to be tested to OFF as described in sub-section 8.2 of this manual.

8.52 With the cable to be tested safely isolated and locked off at the far end and at any possible intermediate points of supply, set the earth switch to EARTH ON as described in sub-section 8.3 of this manual.

8.53 Unfasten the screws and padlock (if fitted) which secure the test access cover (1310) and open the cover to reveal the test access orifices (1317) in the switch main cover (1318).

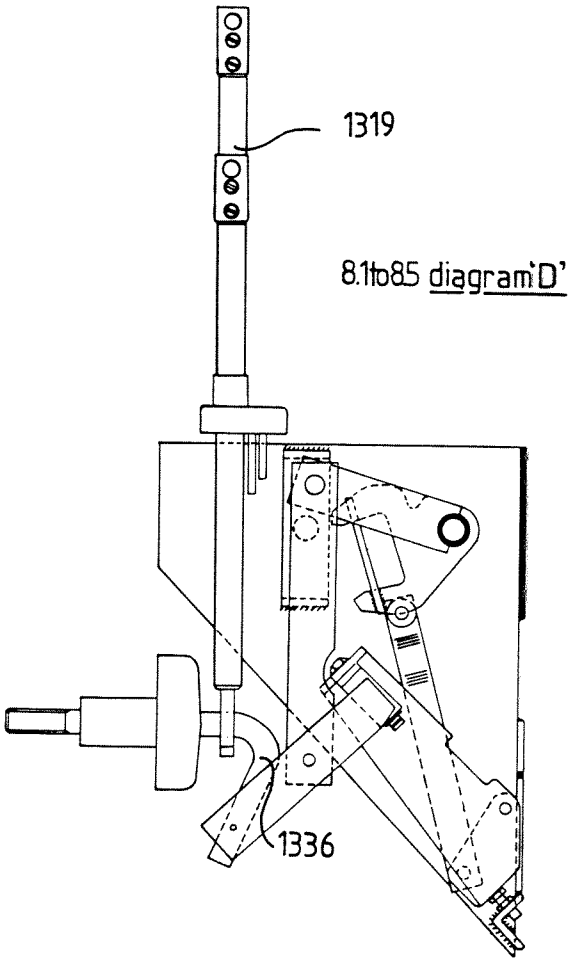
8.54 Fit the test device (1319) by inserting the contacts into the test orifices and pushing the device home onto the internal connections (1336).

8.55 Set the earth switch to EARTH OFF, as described in sub-section 8.4 of this manual.

8.56 The test device is now trapped in position, the main switch is held OFF by the action of internal interlocks (as described in sub-section 1.7) and the cable can safely be tested via the test device terminations.

8.57 On completion of testing, operate the earth switch to EARTH ON as described in sub-section 8.3 of this manual. Remove the test device (1319) pausing to let the oil drip back into the tank. Reclose and fasten down the test access cover (1310) padlocking it if required.

8.58 The earth can now be removed from the cable as described in sub-section 8.4 of this manual, and the unit can be operated as usual.


1319
8.1to85 diagram 'D'
1336

9 MAINTENANCE

9.1 Frequency of Maintenance

9.11 Wide variations in operating duty and environment make it impossible to specify a uniform frequency of maintenance for all switchgear installations.

9.12 However, all equipment should be inspected prior to commissioning and again during the initial 12 months guarantee period, particular attention being paid to the tightness of fastenings and fixings. It should then be possible to assess future maintenance requirements.

9.13 In accordance with British Standard BS 5405, "Code of Practice for the maintenance of electrical switchgear for voltages up to and including 145kV", we recommend that the equipment be externally inspected (see paragraph 9.21 below) at least once a year. This inspection may include operational in accordance with section 8 of this manual if this is desired, and if system operating constraints permit it.

9.14 Internal examination/overhaul of the equipment (sub-sections 9.2, 9.3, 9.5), with any repairs and replacements which may be found necessary, should be undertaken at intervals of not more than 10 years, and more frequently if at all possible.

9.15 Non-routine maintenance is considered in sub-section 9.4, "Post Fault Maintenance".

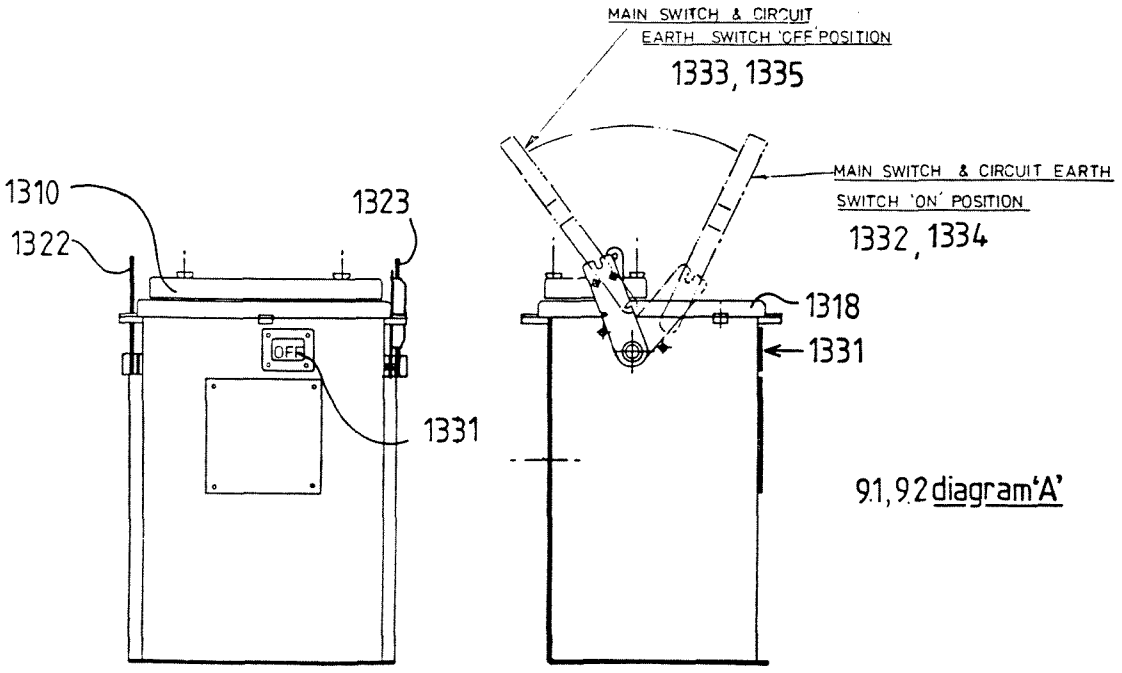
9.16 Since the OS-A range is non-isolatable, ALL MAINTENANCE OTHER THAN EXTERNAL CLEANING REQUIRES THAT THE UNIT BE MADE DEAD. THUS THE CIRCUIT CONNECTIONS AND THE SWITCHBOARD BUSBARS (IF ANY) MUST BE SWITCHED OFF, ISOLATED AND EARTHED.

9.2 Maintenance of Tank & Mechanisms

9.21 With the switch still alive, inspect the general condition of the station to see that it is clean, secure and undamaged. Look for oil or compound leaks, listen for any audible discharge, note any unusual smells. Should anything be amiss, investigate the cause and arrange for its correction. Clean down the outside of the unit(s) with cloths having no loose fibres or metallic threads. Do not use synthetic cloths in conjunction with cleaning solvents.

9.22 WITH THE SWITCHBOARD BUSBARS (IF ANY) AND CIRCUIT CONNECTIONS MADE DEAD, LOCKED OFF AT ALL POSSIBLE POINTS OF SUPPLY, AND EFFECTIVELY EARTHED, set the main switch to OFF (1333) and the earth switch to EARTH ON (1334) (see Section 8) as indicated in the tank window (1331). Unfasten the four screws which hold down the main cover (1318) and remove the cover.

9.23 WARNING: NO NAKED LIGHT SHOULD BE PERMITTED IN THE VICINITY OF OPEN TANKS OR DRUMS OF SWITCH OIL.



9.24 Sample and test the switch oil as described in sub-section 9.3. If the oil is clear, it will be possible to carry out the rest of the routine inspection with the oil still in the tank. Should the oil be murky, or fail any of the tests prescribed, or should the inspection show that maintenance work within the tank is necessary, then the tank must be emptied and later refilled. See sub-section 7.2 for the precautions to be observed.

9.25 Examine the mechanisms and contacts within the tank. Any contact burning or pitting may be corrected with a file or glasspaper (not emery or carborundum) with the tank empty of oil; any filings must be removed from the tank bottom before it is refilled. Look for loose fastenings and tighten any which are found. Examine the bakelised wood operating links (1358) for signs of splitting, damage or carbonisation and replace if necessary. Remove any foreign bodies from the tank bottom.

9.26 Refill or top-up the tank to the marked oil level (see sub-section 7.2). Pour oil over those parts of the mechanism which are normally above oil level.

9.27 Inspect the gaskets on the main (1318) and test (1310) covers for signs of deterioration, and replace if necessary. With the handle stubs still set to OFF and EARTH ON (1331), replace and fasten down the covers (1318, 1310).

Lubricate the external pivot points, hinges etc. with any good quality lubricating oil. Touch up any damaged paintwork (see sub-section 7.4). Check the operation of the handles, mechanisms and interlocks as far as possible, in accordance with Sections 1, 2, 3 and 8 of this manual.

9.28 Return the switch to service in accordance with normal operating practices.

9.3 Switch Oil Sampling and Testing

9.31 Users are recommended to consult British Standard B.S.5730 "Code of Practice for Maintenance of Insulating Oil" or any locally applicable standard for more detailed information on this subject. The following procedures are based on those advocated in B.S.5730.

9.32 First, remove a sample of oil for testing. Use a pipette-type 'thief' tube, keeping the upper end sealed with your thumb until the lower end is about 100 mm (4 in) from the bottom of the tank. Release the upper end and allow the oil to rise up the tube. Re-seal the top with your thumb, remove the tube and transfer the oil sample to a clean, ground-glass-stoppered sample jar of about 1 litre (2 pints) capacity. The first two samples should be used to flush the thief tube and sample jar. Fill, seal and label the jar, giving details of the time and date, the location and the serial number of the unit. The oil may be tested on site if facilities are available, or at a central laboratory.

9.33 If it is not possible to carry out the detailed tests (described later in this sub-section) on site, examine the oil by sight and smell. Moisture may be visible as droplets, or as cloudiness in the oil. Cloudiness can also be due to suspended solids. Solid sludge or impurities will be readily visible. A dark brown colour suggests the presence of dissolved asphalts. Green indicates the presence of copper soaps and means that rapid deterioration is imminent. An acrid smell may indicate volatile acids liable to cause corrosion, whilst an odour of petrol or acetylene may indicate a low flash point due to the effects of a fault. If the oil exhibits any of these symptoms to a marked degree it should be removed and reconditioned or discarded and the switch should be examined to determine the cause.

9.34 For greater precision, oil may be subjected to an electric strength test. However, this requires special equipment and near-laboratory conditions for consistent and reliable results. For a detailed description of the equipment and procedures involved, see British Standard BS.148:1972, Appendix C, "Method of test for electric strength" or I.E.C. Publication 156, 1st edition, 1963.

9.35 Suitable moisture tests are the gentle boiling of a small sample of oil over a bunsen flame, or the plunging of a dully red-hot steel rod into a quarter litre (1/2 pint) of oil. In either test, a crackling sound indicates the presence of moisture and the failure of the sample. Two samples out of three should be crackle-free if the oil is to be passed as suitable.

9.36 The presence of dissolved sludge may be detected by diluting a sample of the oil with petroleum spirit and filtering it to see if any sludge is precipatated.

Other tests are best performed only in the laboratory, under controlled conditions.

9.37 Should the oil need to be replaced, clean the tank, mechanisms and contact systems and refill with clean oil, observing the precautions detailed under 7.2, "Oil Filling of Switchgear".

9.38 Whilst the tank is empty, check the mechanisms and contact systems as described in sections 9.25 and 9.26.

9.39 Top up the oil to the marked level in the tank. New oil may be added to old oil, provided that both comply with the requirements of British Standard BS 148 and the old oil is in reasonably good condition.

9.4 Post Fault Maintenance

9.41 The following cases must be considered:-

9.42 Where the closed main switch has carried a through fault current, no action is necessary beyond routine maintenance when this falls due.

9.43 Where the open main switch has been closed onto a fault, or the earth switch has been closed with the circuit cable alive, the switch must not be operated again until it has been made dead and maintained as described in the preceding pages of this manual.

9.5 Maintenance of Busbar Chamber

9.51 WITH THE SWITCHBOARD BUSBARS MADE DEAD, LOCKED OFF AT ALL POSSIBLE POINTS OF SUPPLY AND EFFECTIVELY EARTHED, remove the busbar chamber front plate (347, 1379) and back plate (346) (where fitted).

9.52 In the case of an OS-A indoor switchboard, check that the busbars (24) are securely fastened to the contact pads in the bushing moulding (318) which is itself securely fastened to the chamber floor. Check that all tee-off shrouds are securely in position (see section 4.6 "Fitting the Busbars" for details of the shroud assembly).

9.53 In the case of an OS-AO outdoor switchboard, check that the shrink-fitted insulation (1370) at the busbar joints is secure, and that the joints themselves are not loose.

9.54 Check that there is no oil leak from the switch tank (1343) at the point where the bushing moulding passes through from the tank to the busbar chamber.

9.55 Clean all accessible insulator surfaces, including the busbar castings, using inhibited 1.1.1 trichloroethane and a lint-free, non-metallic, non-synthetic cloth. Inspect all insulator surfaces for signs of damage (minor scratches are not important; splitting or cracking are). Should damage be found, the unit must be taken out of service.

9.56 Inhibited 1.1.1 trichloroethane may be obtained in the U.K. as:

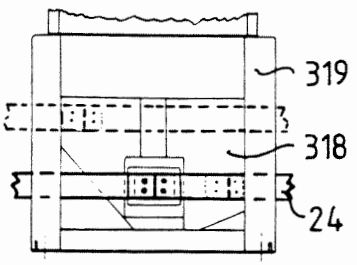
i) "ICI Genklene LV", available from:

Ellis & Everard,
Dudley Hill Chemical Works,
Holme Lane,
BRADFORD, 4,
West Yorkshre.

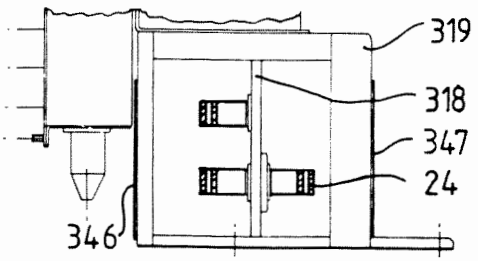
ii) "Electrolube Ultraclene V", available from:

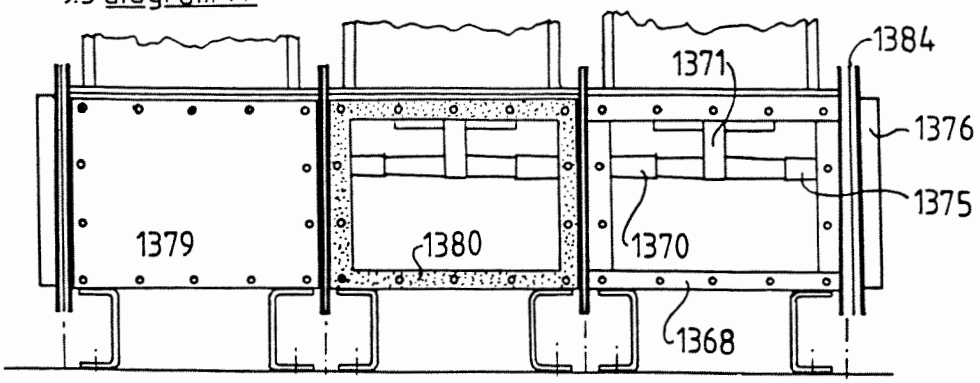
Automation Facilities Ltd.,
Blakes Road,
WARGRAVE,
Berkshire,
RG10 8AW.

9.57 Check for foreign bodies in the chamber, then replace the front and (where fitted) back plates and their gaskets and fasten them securely.



9.5 diagram 'A'





10 SPARES & TOOLS

10.1 Spare Parts

10.11 Service experience with earlier designs of oil switch has shown that the need for the replacement of any part of an OS-A oil switch will very rarely arise.

10.12 In view of this factor, of the wide variety of duties and environments to which units may be subjected and of the detailed variations in equipment between individual installations, it is our policy to recommend spare parts on an individual contract basis rather than to issue a general list of recommended spares.

10.13 Should any part be required which was not initially provided as a spare, the enquiry should include the serial number of the unit, the information quoted on the data plate and, where possible, the original contract number. Where relevant, references to illustrations and part key numbers used in this manual may assist in the identification of the component to be renewed, e.g:

10.14 OS-A oil switch, serial No. 0100234, 15kV, 21.9kA, 500 A, 50/60 Hz.

Earth switch ON interlock catch, key No. 1349, as illustrated in 1.7 diagram "C", in the manual dated January, 1981, reference: D22-P1-15.

10.15 Whilst not all of the information quoted will always be directly relevant or essential, it may help to distinguish between designs having minor detail variations.

10.2 Tools

10.21 No special tools are required for this equipment.

10.22 Open-ended and ring spanners:

Metric dia:	M4	M5	M6	M10	M12	M16
Metric A/F:	7 mm	8 mm	10 mm	13 mm	17 mm	24 mm

10.23 Plus normal workshop tools such as screwdrivers, pliers, drifts, hammers, files etc.

11 KEY TO ILLUSTRATIONS (OS-A, OS-AO, OS-AT)

24 Busbars (OS-A)
95 Flexible anti-vermin strips (OS-A)
96 Busbar end plate (OS-A)
97 Busbar securing studs (OS-A)
98 Busbar tee-off connection plates (inset) (OS-A)
99 Busbar fishplate spacers (OS-A)
100 Busbar joint box (OS-A)
101 Busbar joint box end piece (OS-A)
101(a) single type for 800A busbars
101(b) double type for 1250A busbars
101(c) double type for 2000A busbars
101(d) single blank type for end panel
102 Busbar packer for use on end panels (OS-A)
103 Busbar joint box cover (OS-A)
177 Unit-to-unit rigid cover plates to protect busbars (OS-A)
181 Unistrut channels Ref. P3200
182 Floor chases to take (181)
183 Spring nuts, M10, for (181), Ref. P1008
184 Tie bar jigs for (181)
185 M10 bolts for (183)
318 Cast resin busbar support insulator (OS-A)
319 Air insulated busbar chamber (OS-A)
345 Busbar chamber baseplate (OS-A)
346 Busbar chamber back plate (OS-A)
347 Busbar chamber front plate (OS-A)
1126 Removable Operating handle
1146 Neoprene bonded gaskets as alternative to (1180) on cable box
1165 Transformer flange
1166 Cable Box (a) rear mounted (b) front mounted
1170 Rag-bolt type floor fixings
1171 Cable gland
1173 Gasket between (1165) and (1388) (OS-AT)
1174 Transformer tank bulkhead support angles
1175 Cable box (1166) front plate
1177 Cable sockets in (1166)
1179 Gasket between (1184) and (1171)
1180 Pressure plastic - alternative to (1146) on cable box
1184 Cable box (1166) bottom plate
1185 Cable box (1166) filling aperture cover
1186 Cable box (1166) filling aperture
1187 Cable box (1166) filling aperture gasket
1306 Switch mechanism mainframe
1307 Main switch mechanism
1308 Main switch blades
1309 Fixed busbar contacts engaged by (1308)
1310 Test access cover
1311 Earth Switch mechanism
1312 Star connected earthing contacts
1317 Test access orifices
1318 Main cover
1319 Cable test device
1320 "MOVE BEFORE EARTHING" padlockable cover
1322 Main switch handle stub
1323 Earth switch handle stub
1331 ON/OFF/EARTH ON indication
1332 Main switch ON position of handle
1333 Main switch OFF position of handle
1334 Earth switch EARTH ON position of handle
1335 Earth switch EARTH OFF position of handle
1336 Connections at inner end of (1367) engaged by (1319)
1343 Oil tank
1345 Interlock bar
1346 Main switch drive cam
1347 Earth switch drive cam
1348 Test access interlock hook to engage (1310) or (1319)
1349 Earth switch ON interlock catch
1350 Main switch OFF interlock catch
1352 Main switch mechanism drive shaft
1354 Main switch mechanism spring compression lever
1355 Main switch mechanism operating springs
1356 Main switch operating claw
1357 MAin switch blades operating shaft
1358 Main switch bakelised wood drive links
1360 Earth switch contacts operating shaft
1363 Earth switch mechanism drive shaft
1364 Earth switch mechanism spring compression lever
1365 Earth switch mechanism operating springs
1366 Earth switch operating claw
1367 Rear bushing assembly
1368 Busbar chamber (OS-AO)
1369 Busbars (OS-AO)
1370 Heat shrinkable busbar connection insulating sleeve (OS-AO)
1371 Resin moulding incorporating (1369) (OS-AO)
1372 Split metal sleeve for busbar joint (OS-AO
1373 Heat shrinkable metal locking rings to secure (1372) in position (OS-AO)

1374 Metal bush for end of (1369) on end panel (OS-AO)
1375 Heat shrinkable insulating "boot" for (1369/1374) on end panels (OS-AO)
1376 Busbar chamber end cover (OS-AO)
1377 Unistrut tie bar jigs (OS-AO)
1378 Busbar chamber flange (OS-AO)
1379 Busbar chamber front cover (OS-AO)
1380 Gasket for (1379) (OS-AO)
1382 Busbar chamber rainsheds (OS-AO)
1383 Removable feet (OS-AO)
1384 Gasket for (1376) (OS-AO)
1385 Aluminium foil heat sheild for (1370) (OS-AO)
1386 Supporting bracket for transformer mounting (OS-AT)
1387 Operating platform on (1386) (OS-AT)
1388 Flange around (1367) (OS-AT)
1389 Stand for free-standing unit (OS-AT)