INSTRUCTION MANUAL

FOR

THE

FS·A

RANGE OF METALCLAD

AUTOMATIC

OIL FUSE SWITCHES

EQUIPMENT RATED VOLTAGE UP TO 15.5kV

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.

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CONTENTS

1. THE FS-A" RANGE OF FUSE SWITCHES - GENERAL DESCRIPTION

1.1 Basic Design Concept

1.11 The "FS-A", "FS-AO" and "FS-AT" are three versions of the same oil fuse switch for three different applications, although the basic purpose of all of them is the fused protection and ON/OFF/EARTH control of a transformer. The basic FS-A is an indoor extensible unit, FS-AO is an outdoor extensible unit, and FS-AT is an outdoor non-extensible unit available as a free-standing or transformer-mounted equipment.

1.12 All versions of the fuse switch are suitable for system voltages up to 15.5kV and fault levels up to 21.9kA (12kV and 18.4kA to ESI 41-12). 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 Each unit incorporates a load-making, load-breaking oil switch (1101/1102) in series with high voltage oil immersed fuses (311) to give ON/OFF control and short-circuit protection of the rear outgoing circuit (1114). A separate fault-making oil switch (1197/1104) in the same tank (1202) can be used to earth the rear outgoing circuit (1114) and thus the connected transformer high voltage windings.

1.14 The fuse switch mechanism (1105), fuse carriage (1106), and earth switch mechanism (1107) are all mounted on a common mechanism frame (1108). This runs in guides on the insides of the tank walls, and springs (1129) within the frame sidemembers push the assembly upwards when the tank cover (1205) is unfastened. A cover roller (1128) at the top of the mainframe assembly engages a bracket (1159) on the underside of the cover.

1.2 Main Switch

1.21 The main switch gives ON/OFF control of the main circuit between the rear bushings (1114) and the busbars or front cable box. It is operated by fitting the removable handle (1126) to the operating handle stub (1121/1122) at the right hand side of the switch tank (1202).

1.22 The main switch incorporates three moving main contacts (1101), each comprising a sliding rod with a spade-shaped lower end. An annular sliding contact (1109) connects each rod to the lower fuse contact cup (1110) of that phase, whilst the spade end engages fixed spring contacts (1102) in series with the connection to the busbars or front cable box.

1.23 The vertical movement of the rods (1101) is produced by end-connected insulated drive links (1111) operated by cranks on the fuse switch mechanism (1105). See section 2 "Detailed Description of Main Switch" for detail of the independent manual, trip free, spring mechanism itself.

1.24 Positive ON/OFF indication is given in the tank window (1130).

1.3 Fuses

1.31 The oil immersed fuses (311) are to B.S.2692 and are of standard 359 mm (14.1/8 in) or 254 mm (10 in) length by 64 mm (2.1/2 in) diameter barrel size, with striker pins.

1.32 They are clip mounted in an insulated carriage (1106), which is fastened on the mechanism main frame (1108). The position of the lower fuse contact cups (1110) can be changed to suit either length of fuse (see sub-sections 9.5 and 9.6).

1.33 When a fuse (311) blows on fault, a striker pin is ejected from its upper end to raise the main switch trip bar (1112) and open all three phases of the switch (see section 2).

1.34 When the tank cover (1205) is raised and the mechanism mainframe (1108) rises with it (see paragraph 1.14 above), the fuses (311) are automatically isolated and discharged to earth and become accessible for inspection and/or replacement.

1.4 Transformer Earth Switch

1.41 This fault making oil switch takes the form of a single moving earth switch blade (1197), pivoted about an axis parallel to its own by a conventional independent manual toggle spring mechanism (1107) which is described in detail in section 3.

1.42 In the "EARTH ON" position, the blade (1197) shorts together three sets of spring contacts (1104) which are connected to the outgoing rear circuit connections (1114). A wiping contact (1195) at the end of the blade gives an earth connection to the earthed metalwork of the tank.

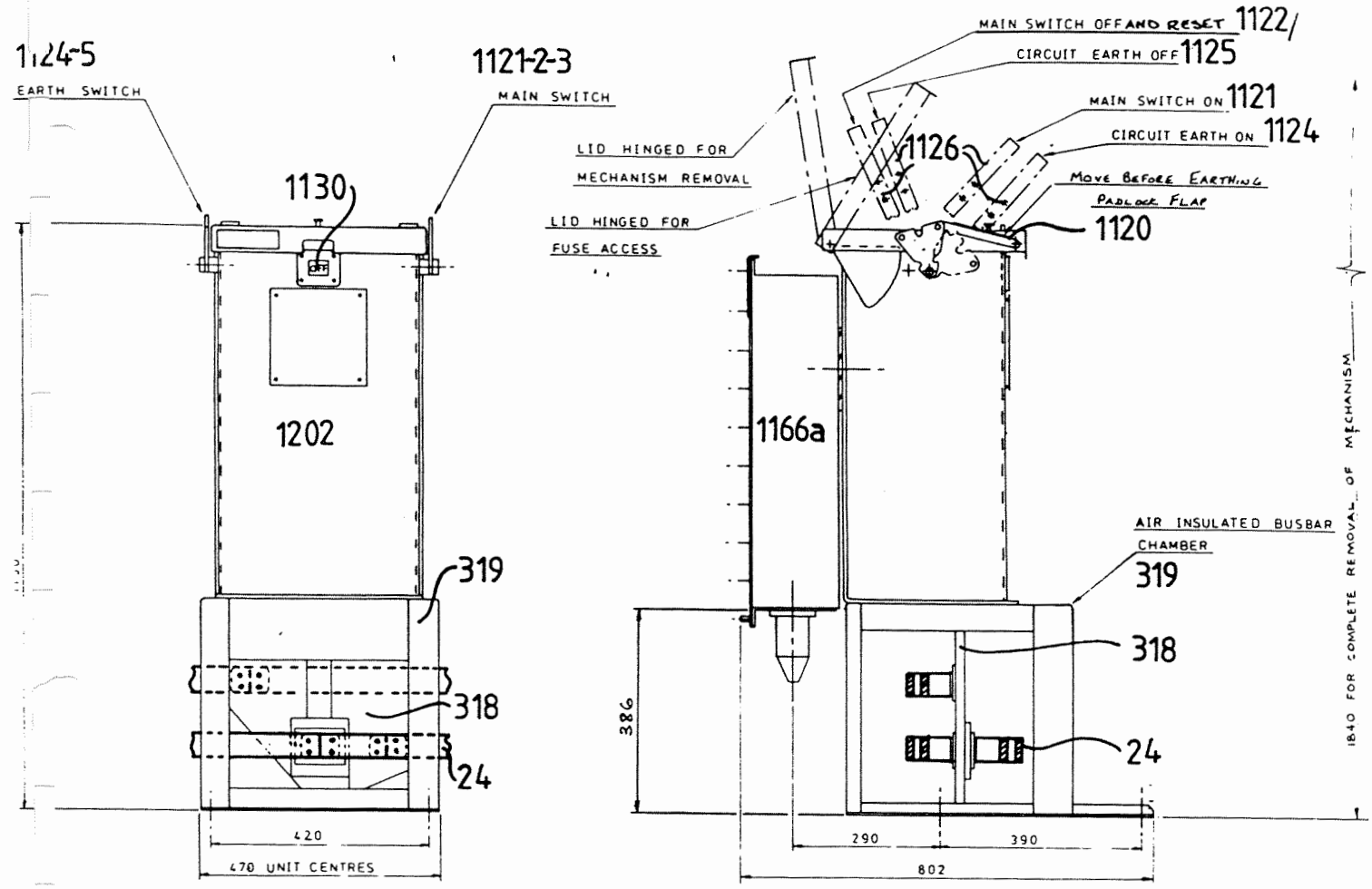
1.43 Positive EARTH ON indication (obscuring the main switch OFF indication) is given in the tank window (1130).

1.44 For further details, see Section 3 "Detailed Description of Transformer Earth Switch".

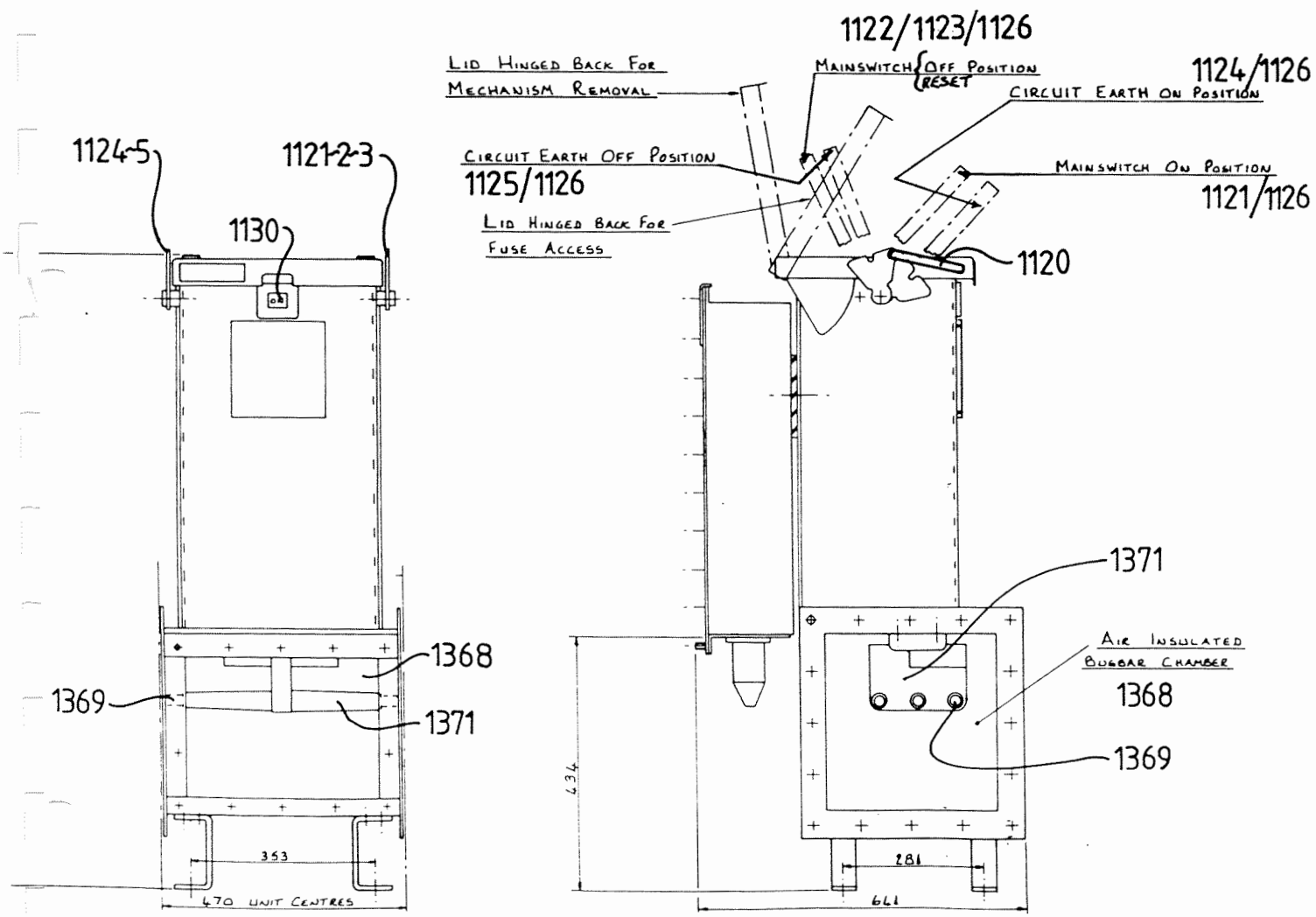
1.5 Circuit Connections

1.51 As will be evident from the foregoing, the rear-connected outgoing, fuse switch-protected feeder circuit to the transformer leaves the switch tank (1202) through bushings (1114) 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 FS-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 185 sq mm (0.3 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 (1205) will be provided.



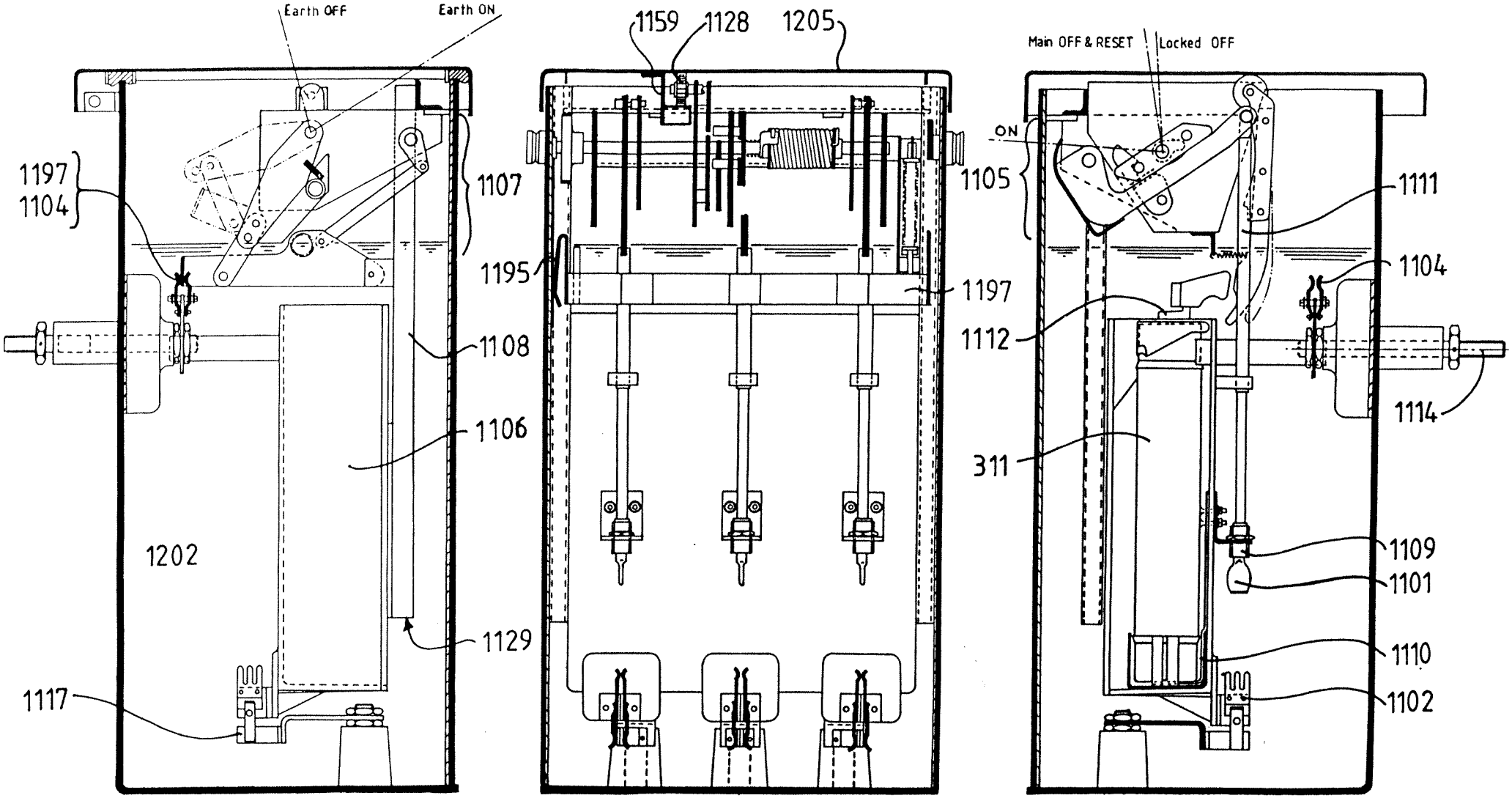
1.1 to 1.6 diagram 'B': FSA Indoor Extensible Oil Fuse Switch



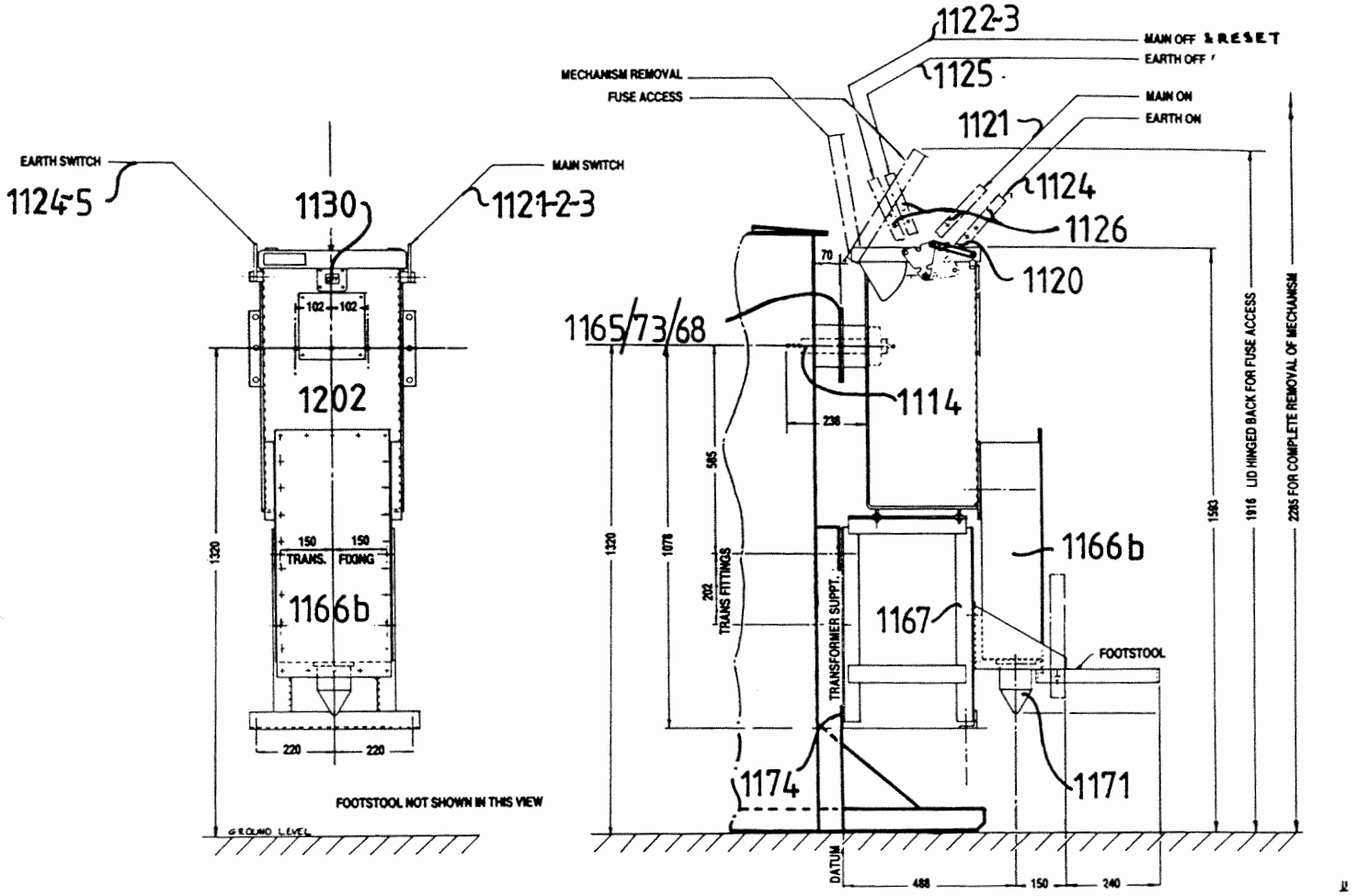
1.1 to 1.6 diagram 'C': FSAO Outdoor Extensible Oil Fuse Switch

1.1to1.6 diagram 'A'

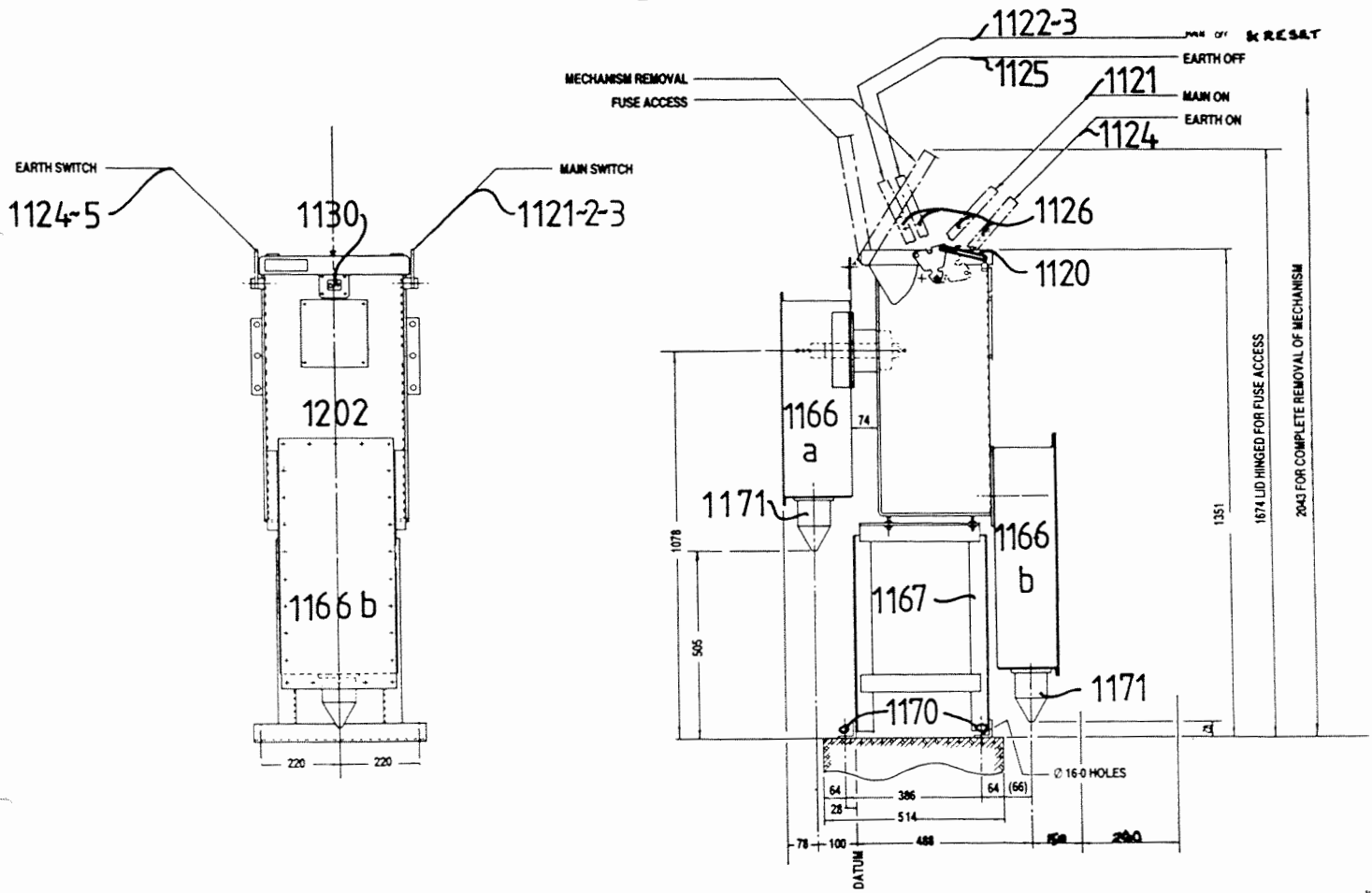
Sections through FSA range fuse switch tank



1.1 to 1.6 diagram 'C' : FSAT Transformer-Mounted Oil Fuse Switch



1.1 to 1.6 diagram 'D' : FSAT Freestanding Oil Fuse Switch



1.53 An FS-AT unit will have, in addition, a low-level front cable box of similar design.

1.54 Cable boxes designed to be compound filled once the cable is installed are 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 FS-A and outdoor extensible FS-AO employ different busbar systems.

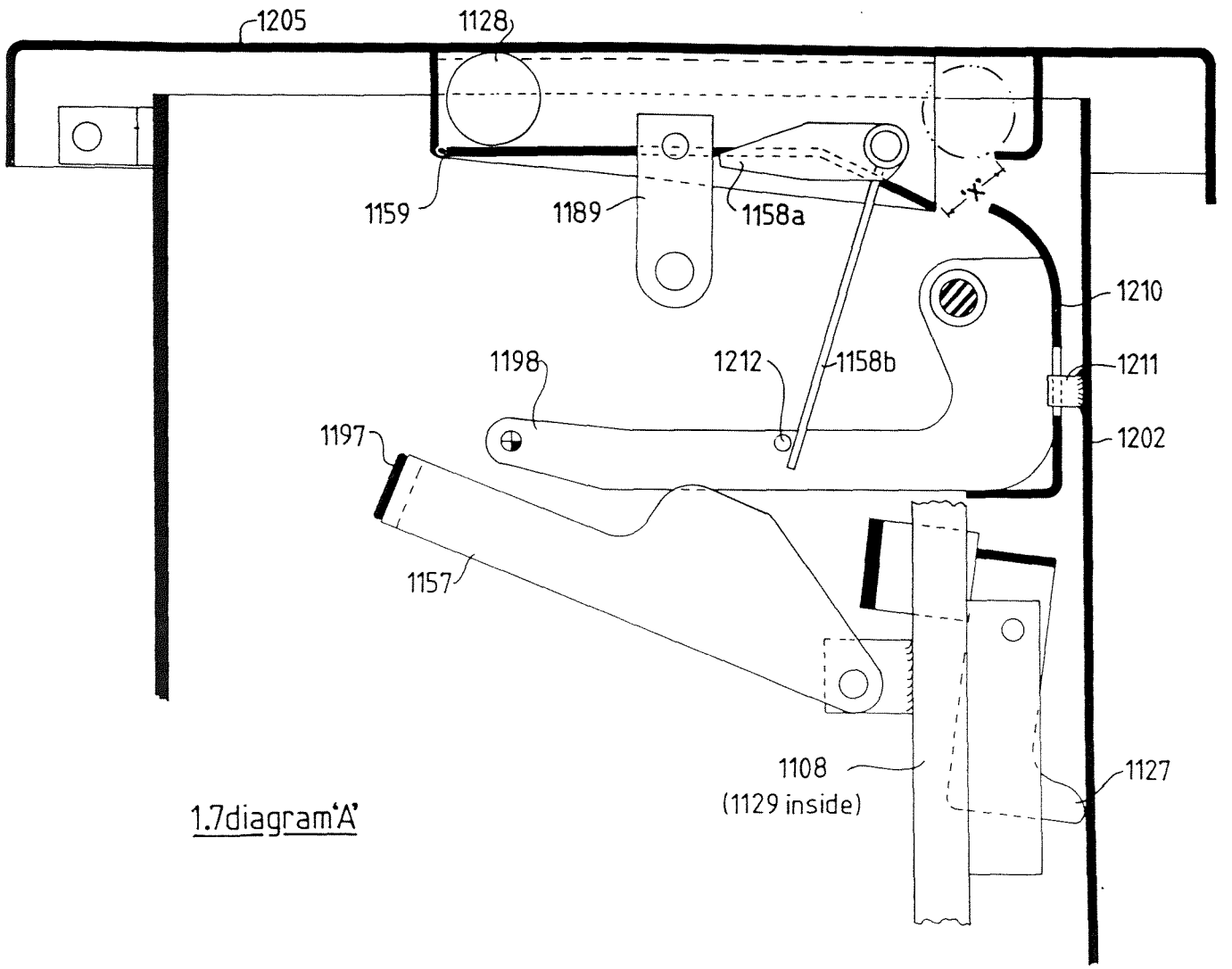
1.62 The busbar chamber (319) and fittings of the indoor FS-A are fully compatible with those of the complementary indoor circuit breaker and oil switch to permit the construction of composite indoor switchboards. The panel width of all standard units is the same, and only a brief busbar outage is necessary 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 (1202), where the three conductors are connected to the main switch lower fuse contacts (1110) via contacts (1117) and (1102).

1.63 The busbar chamber (1368) and fittings of the outdoor extensible FS-AO are fully compatible with those of the complementary outdoor extensible oil 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 lower fuse contacts (1110) via contacts (1117) and (1102) in the oil tank (1202). The unit-to-unit busbar connections are insulated by heat-shrinkable sleeves (1370) during erection.

1.7 Interlocks & Padlocking

1.71 At the left hand side of the fuse switch mechanisms assembly (1105 & 1107) is a pivoted interlock lever assembly (1158). This comprises a "head" (1158a) and a "tail" (1158b), secured to opposite ends of a spindle. When the main switch is operated to ON, the main switch main shaft (1133) rotates, as does the attached interlock cam (1190). The cam (1190) pushes the interlock lever "tail" (1158b) against the pressure of a return spring, so that the interlock lever "head" (1158a) is lowered to prevent the movement of the earth switch drive crank (1189). Thus, when the main switch is ON, the earth switch cannot be operated to EARTH ON.

1.72 In addition, as the main switch main levers (1198) move to the horizontal ON position, a pin (1212) on the left hand one engages the interlock lever "tail" (1158b) to hold it in the position to which the cam has moved it (see above). Thus, both the main switch mechanism main shaft (1133) and the main switch main levers (1198) must return to the OFF position before the return spring can pivot the interlock lever (1158) clear of the earth switch drive crank (1189) to permit operation to EARTH ON.



1.7diagram'A'

1.73 At the right hand side of the fuse switch mechanisms assembly (1105 & 1107) are the main switch drive crank (1207) and an interlock arm(1193) mounted on the earth switch blade side arm (1157). When the earth switch is operated to EARTH ON, the interlock arm (1193) moves so as to prevent rotation of the main switch drive crank (1207), so that the main switch cannot be operated to ON.

1.74 The tank cover (1205) (which can be padlocked closed) cannot be raised, even if unlocked and unfastened, when either switch is ON. The cover roller (1128) engages a bracket (1159) on the cover, so that the mechanism main frame assembly (1108) holds down the cover (1205), whilst the main frame assembly is in turn held down as follows:

(a) When the main switch is ON, a hole in the ON/OFF indicator plate (1210) on the central main switch main lever (1198) engages a pin (1211) on the front wall of the tank (1202);

(b) when the earth switch is set to EARTH ON, the interlock arm (1193) on the earth switch blade side arm (1157) engages a pin (1209) on the side wall of the tank (1202).

1.75 When the cover (1205) is raised, the cover roller and bracket (1128, 1159) pull up the mechanism mainframe assembly (1108), assisted by springs (1129) in the mainframe sidemembers. Should the switch have been tripped by a fuse operation, so that the mechanism has not been reset, a pin (1206) welded to the tank wall (1202) will rotate the main switch drive crank (1207) to reset the mechanism. As the assembly (1108) rises, the fork-and-pin connections between the operating lever stub assemblies and the mechanism drive cranks (1189, 1207) are automatically uncoupled.

1.76 When the cover (1205) and mechanism mainframe assembly (1108) have been raised sufficiently to give access for inspection or fuse changing, a weighted carriage retaining clip (1127) on the left hand side member of the main frame swings out as it clears the top of the tank (1202) and rests on top of the tank wall to prevent the mechanism assembly settling back if it is released. The fastener which secures the cover bracket (1159) may then be slackened off and the bracket slid back so that the gap "X" (see diagram) is sufficient to pass the roller (1128). This allows the main cover to be hinged back fully, and the complete mechanism assembly to be removed from the tank.

1.77 A captive padlockable cover (1120) labelled MOVE BEFORE EARTHING both covers and provides padlocking points for the earth switch handle stub (1124/1125). A fixed padlocking point (1119) is provided for the main switch handle stub (1121/1122/1123). The switch handle stubs themselves (1121-25) are of a type that prevents a reversal of the direction of operation without the removal and reversal of the detachable part of the handle (1126) (which is also used to raise the main cover (1205) of the switch). Thus an operator cannot close and then immediately re-open a switch, so that if it has been closed onto a fault there is time for the operation of protective devices before any attempt to break the circuit by manual switching. Also, the use of a detachable handle makes unauthorised operation more difficult.

1.8 Technical Specification

1.81 The FS-A automatic oil fuse switch is constructed to specification ESI.41-12, and in addition complies with the relevant requirements of:

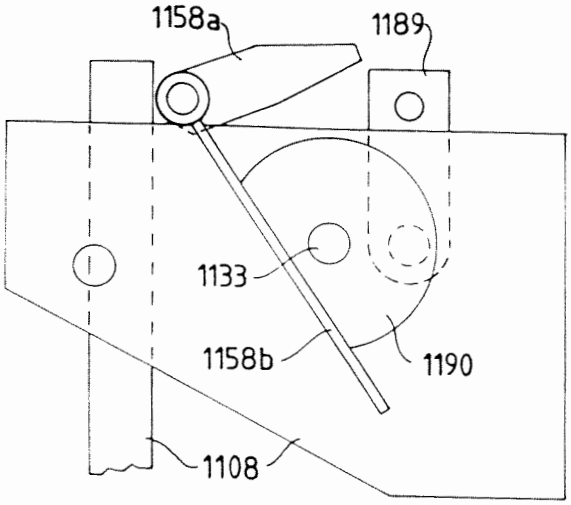
B.S.2692, B.S.2631 (11kV), B.S.5227, B.S.5463 (15.5kV), I.E.C. 265, I.E.C. 282-1, I.E.C. 298 and ASTA-22.

For optimum operation, fuse links with voltage and current ratings suited to the transformer to be protected must be employed in the fuse switch; under normal circumstances, the maximum size of transformer to be protected by the switch will be 1000kVA.

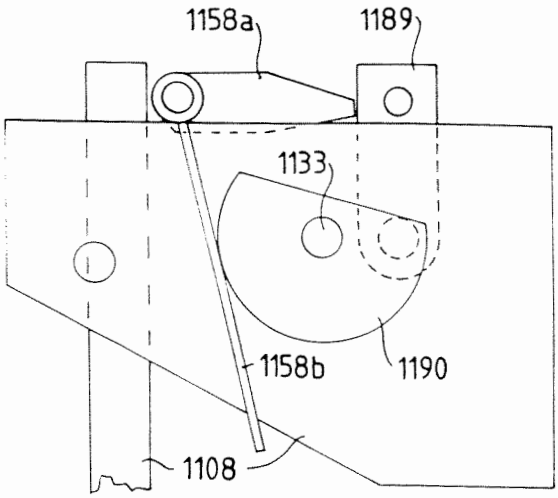
1.82 When fitted with fuse links to ESI standard 12-8, the equipment has a short circuit rating equivalent to 21.9kA at 15.5kV. The nearest ratings to this listed on ESI 41-12 are 18.4kA and 12kV, respectively.

1.83

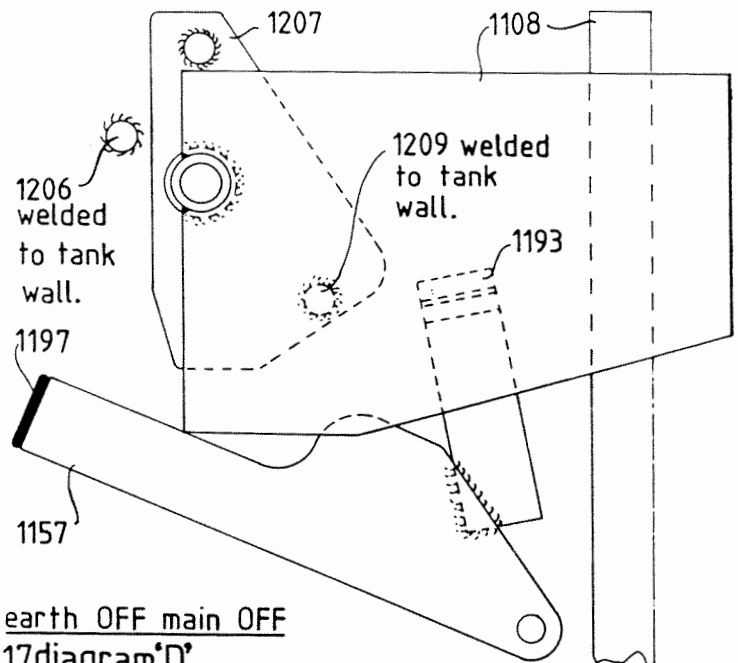
Service Voltage:	15.5kV
Frequency:	50-60Hz
Highest System Voltage:	15.5kV
Impulse Voltage Withstand Level:	95kV
Normal Current:	200A
Earth Switch 3 Second Short Time Current:	3.15kA
Earth Switch Peak Making Current:	7.87kA
Busbar Current Rating:	630/800A



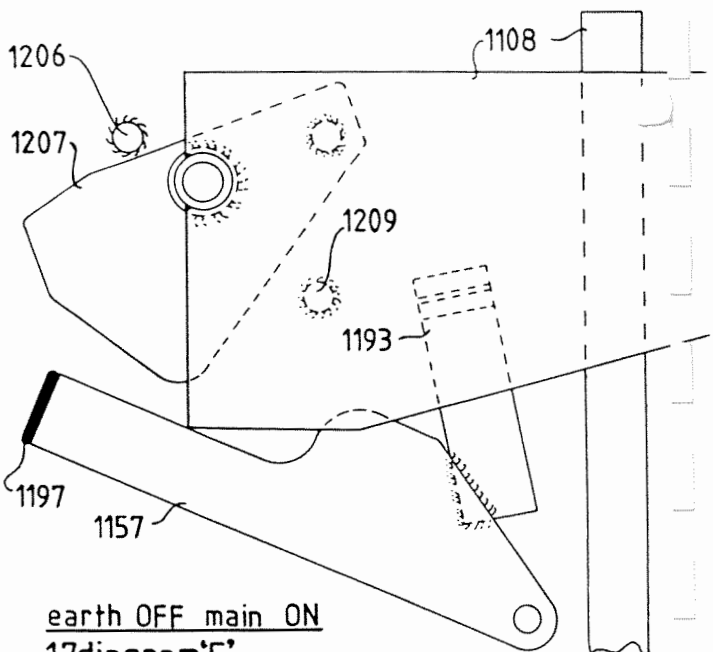
1.7diagram'B' earth OFF main OFF



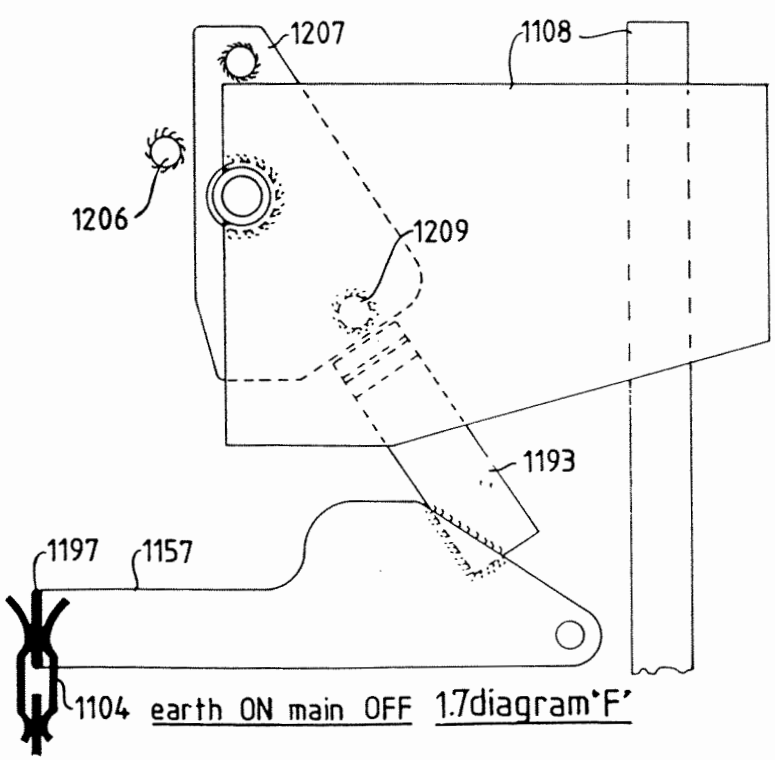
1.7diagram'C' earth OFF main ON



earth OFF main OFF
1.7diagram'D'



earth OFF main ON
1.7diagram'E'



earth ON main OFF 1.7diagram'F'

2 DETAILED DESCRIPTION OF FS MAIN SWITCH MECHANISM

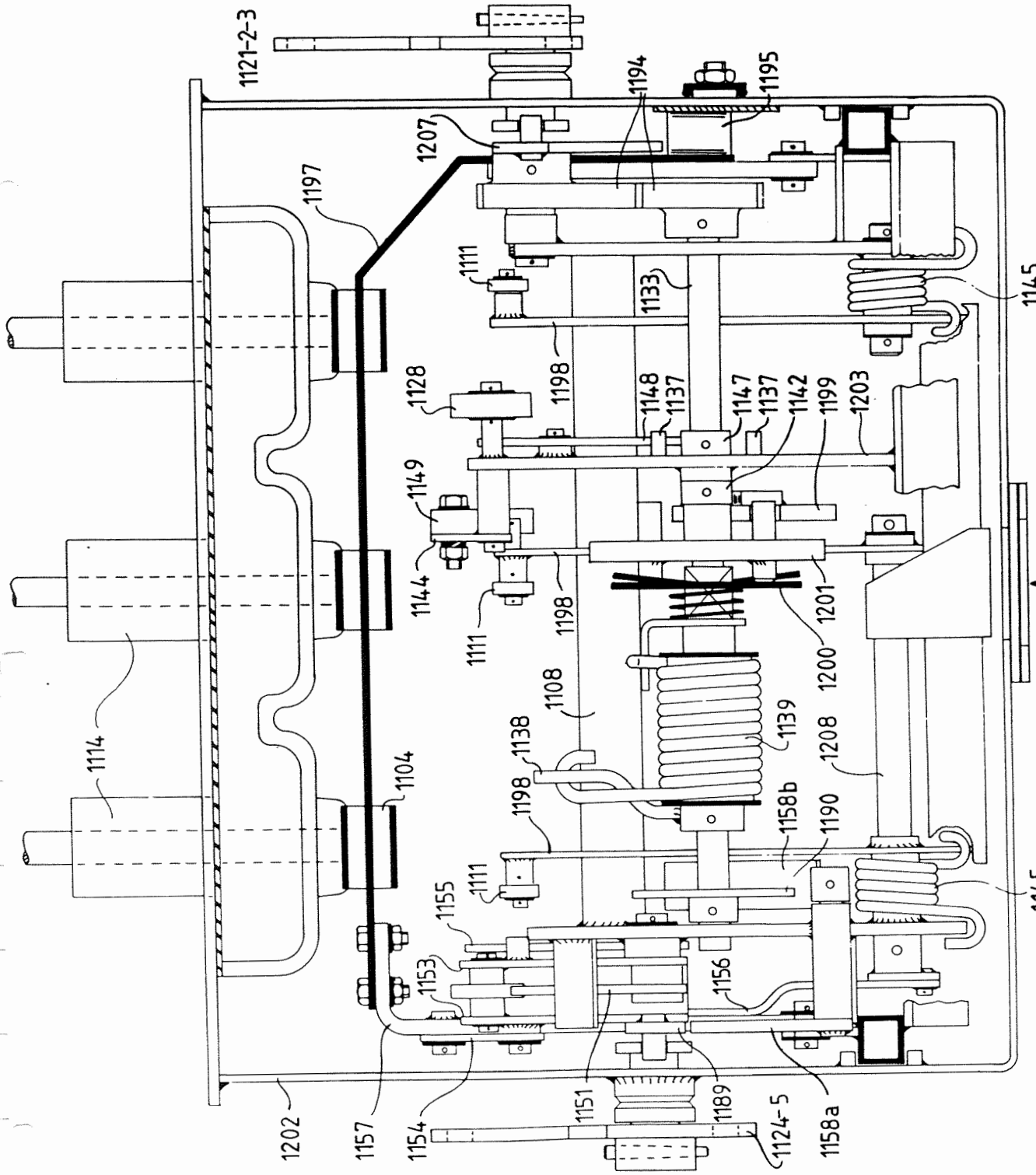
2.1 Principal Features

2.11 The load making, load breaking, independent manual spring operating mechanism (1105) fitted in the FS-A range of fuse switches is of a unique design.

2.12 A rotary "unwinding" movement of the previously charged closing spring (1139) is transferred to a rotor (1201), one end of which pushes down one of the linked set of three main levers (1198).

2.13 Insulated linkages (1111) at the ends of these levers impart a longitudinal movement to the moving main contacts (see sub-section 1.2).

2.14 A forwards movement of the main switch operating handle (1126/1121) as far as it will go closes the switch, whilst a backwards movement (1126/1123) to the limit of travel first trips, then resets the mechanism.

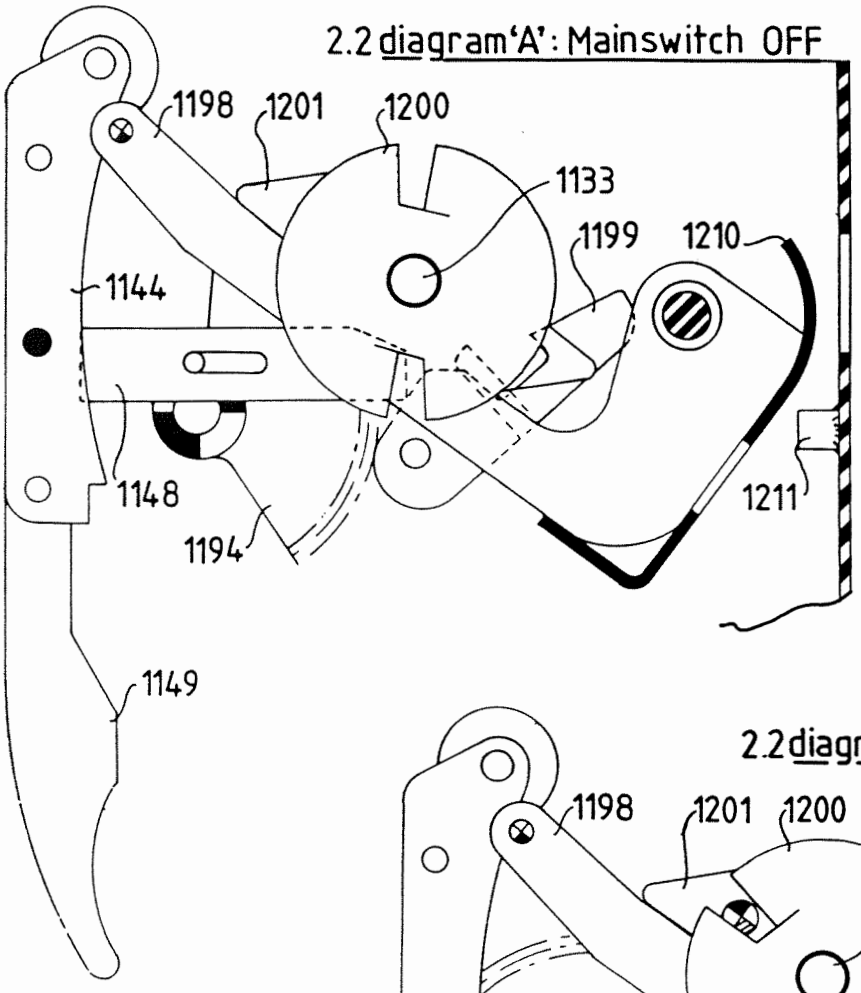


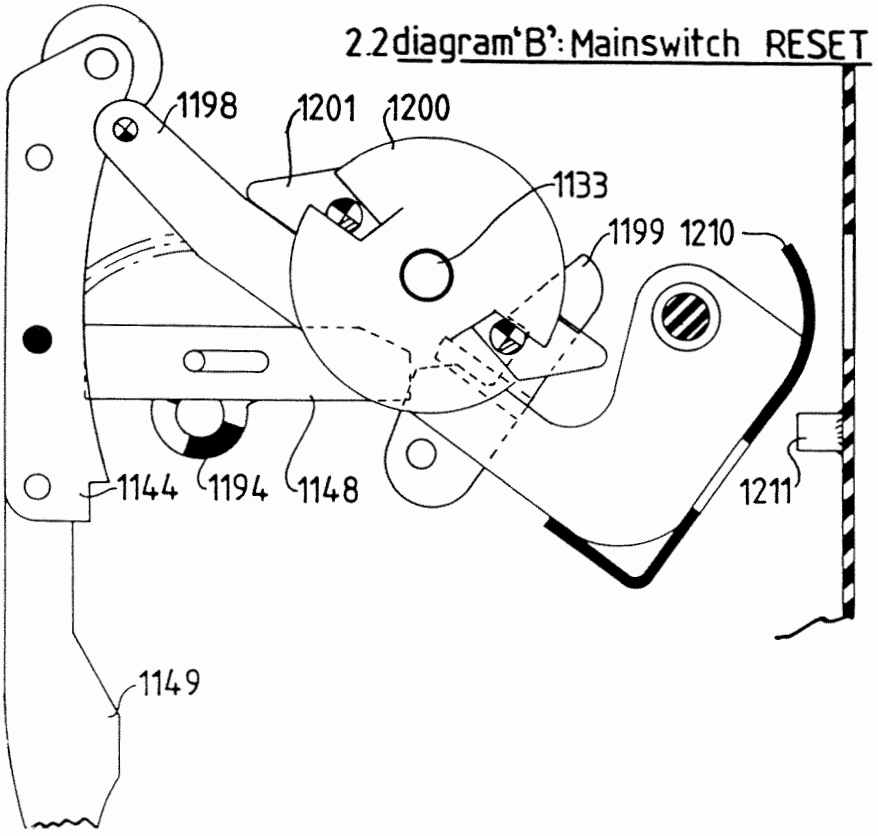
SECTIONS 2 & 3: Plan View of Fuse Switch Mechanisms (1105&1107)

2.2 Operating Sequence

2.21 With the mechanism in the OFF position, but not RESET, the operating handle (1126/1122) is pushed fully back to the RESET (1123) position.

2.22 The anti-clockwise motion of the handle (looking from the left) as it is pushed backwards is converted, by linkages and gears (1194), into a clockwise rotation (looking from the left) of the main switch main shaft (1133). The disc rachet (1200) rotates with the shaft until it latches against two drive pins on the rotor (1201). A stop lever (1147) on the main shaft then comes against a stop pin (1137) on the main frame (1108) assembly to prevent further rotation of the main shaft. The mechanism is now fully RESET.



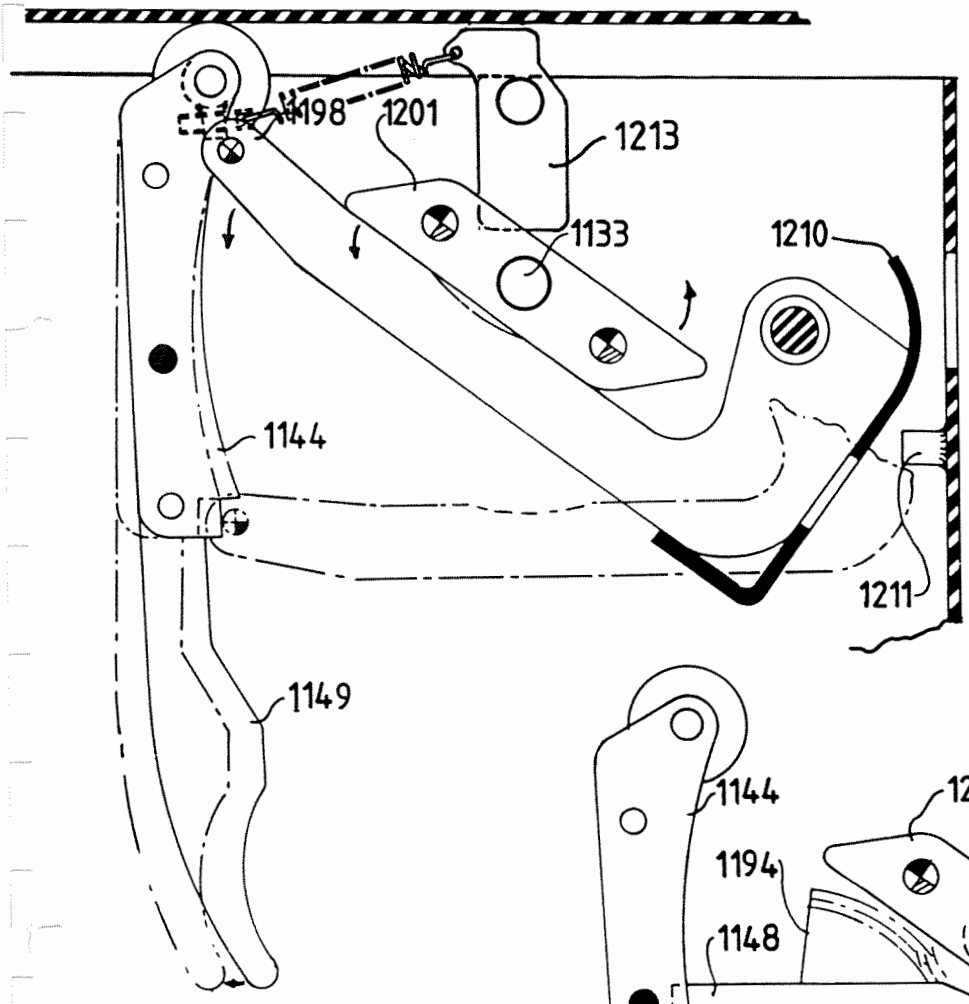


2.23 The operating handle (1126/1123) is then moved forwards smoothly to the ON position (1121).

2.24 The main switch main shaft (1133) rotates anti-clockwise (looking from the left), carrying round the closing spring winding lever (1138) to wind the closing spring (1139) from its left hand end, and thus charge it. The right hand end of the closing spring attempts to pull round the disc ratchet drive

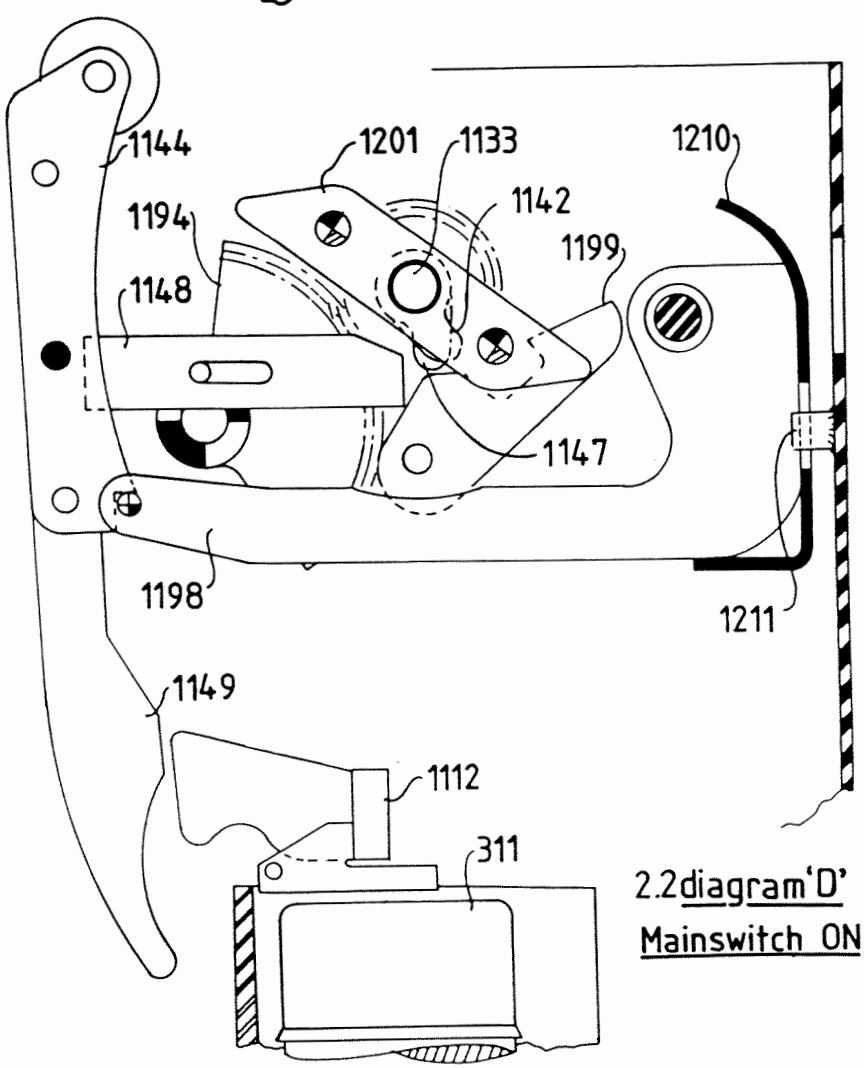
lever (1140), to which it is secured, but the disc ratchet is held back by the pins on the rotor (1201) which is in turn secured by the rotor release catch (1199) which is mounted on the main frame (1108) assembly.

2.25 When the main shaft (1133) has rotated to the position at which the closing spring (1139) is fully charged, a release lever (1142) on the shaft disengages the rotor release catch (1199), to release the rotor (1201). The rotor, under the pressure of the closing spring, rapidly rotates anti-clockwise (looking from the left hand side) through 180°. As it does so, one end of it pushes down on the centre main lever (1198) of the 3 phase main lever assembly. Insulated links (1111) at the ends of the main levers operate to close the contacts (1101/1102) as described in sub-section 1.2. The trip catch (1144) engages above the centre main lever to prevent the switch re-opening under the influence of the opening springs (1145). The stop lever (1147) and stop pin (1137) prevent the main shaft revolving too far in the anti-clockwise direction. The rotor is now poised ready for the next closing operation. The rotor arrestor spring catch (1213) ensures that the rotor does not come to rest in a position which might interfere with the subsequent opening movement of the central main lever (1198).



2.2 diagram'C'

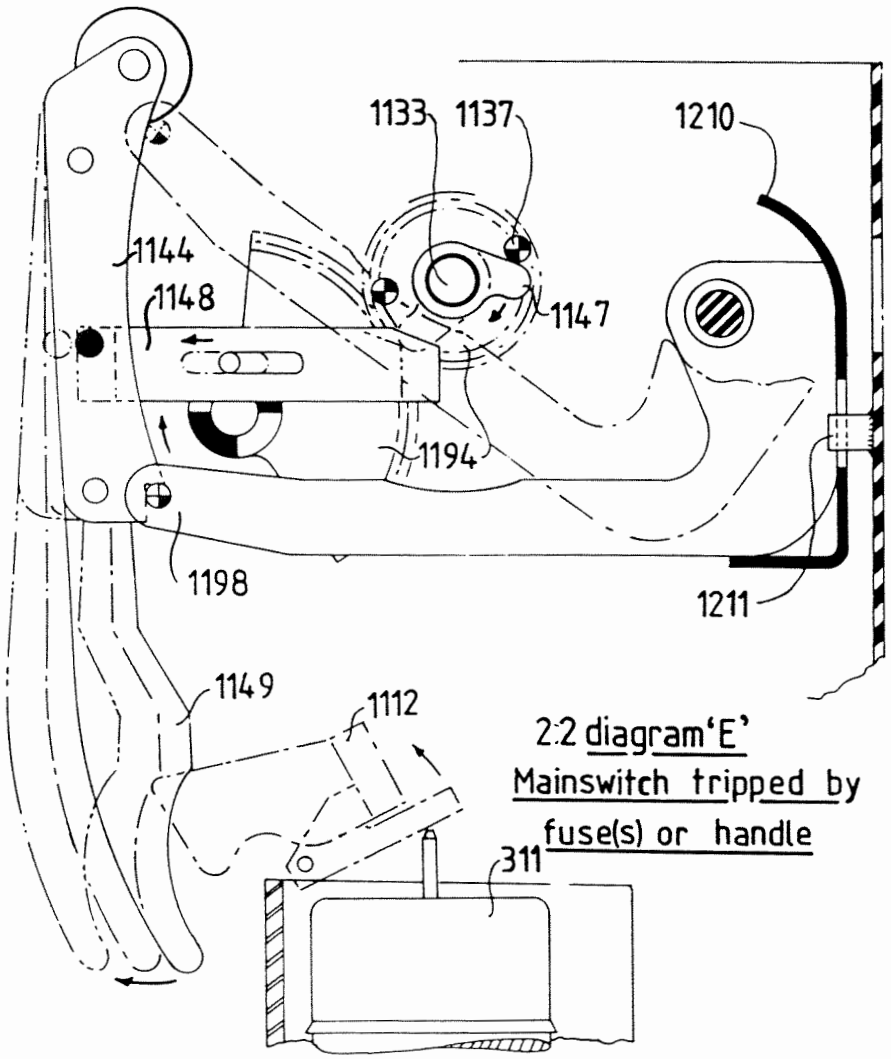
Mainswitch moves to ON



2.2 diagram'D'

Mainswitch ON

2.26 To manually trip the switch, the operating handle (1126/1121) is pushed back part way, and the main shaft (1133) rotates clockwise (looking from the left). A reverse motion trip lever (1147) on the main shaft pushes a sliding reverse motion trip bolt (1148), which pushes the trip catch (1144) clear of the main lever. Freed from this constraint, the main lever assembly (1198) rises under the influence of the opening springs (1145) to separate the contacts (1101/1102) to the OFF position.



2.2 diagram 'E'
Mainswitch tripped by fuse(s) or handle

2.27 When the mechanism is tripped by the blowing of a fuse or fuses (311), the striker pin(s) cause the trip bar (1112) to rise, and a trip lever (1149) pushes the trip catch (1144) clear and the operation is then as described in the last sentence of paragraph 2.26.

2.28 Further backwards manual movement of the operating handle repeats the RESET sequence described in paragraphs 2.21, 2.22.

2.29 The mechanism ON/OFF indication visible through the tank window (1130) is mounted directly on the shaft of the main lever assembly (1198), so that it positively indicates the position of the mechanism (1105) and not merely that of the handle (1126).

3 DETAILED DESCRIPTION OF TRANSFORMER EARTH SWITCH

3.1 Principal Features

3.11 The fault making, load breaking, independent manual earth switch mechanism (1107) is of a conventional overtoggle spring type.

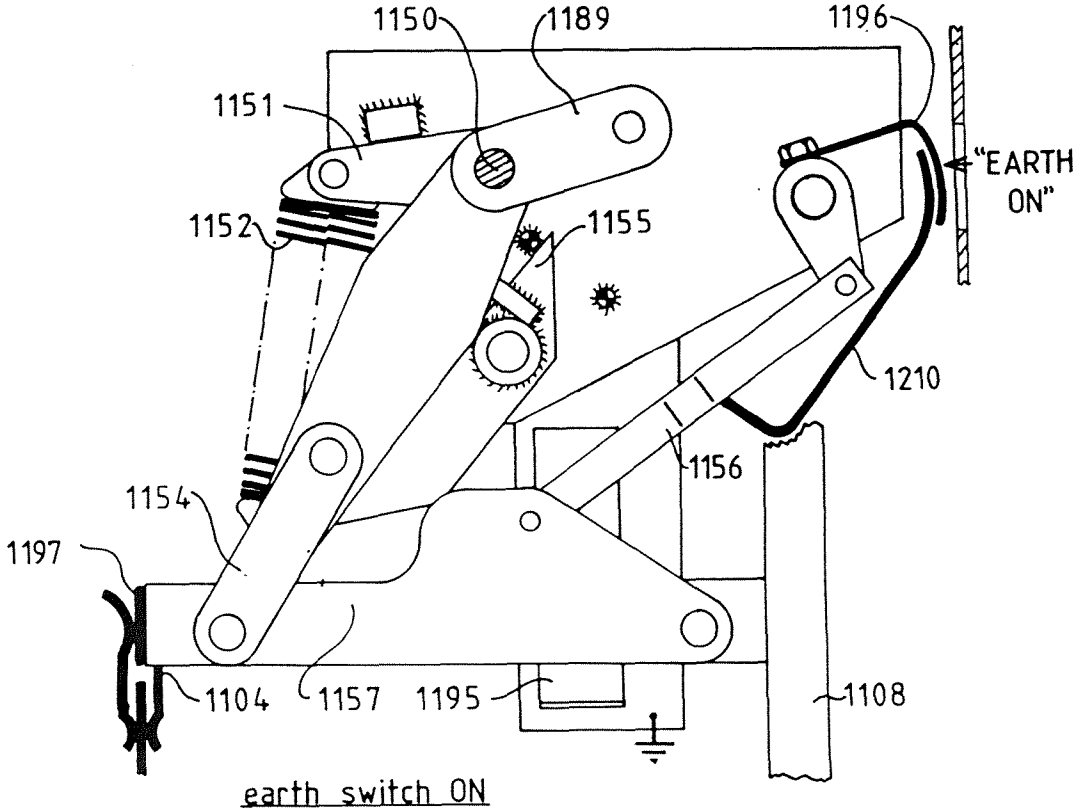
3.12 It drives a single blade (1197) which shorts together three sets of spring contacts (1104) which are in turn mounted on the outgoing circuit bushings (1114). A wiping contact (1195) at the end of the blade gives an earth connection through to the earthed metalwork of the tank (1115).

3.2 Operating Sequence

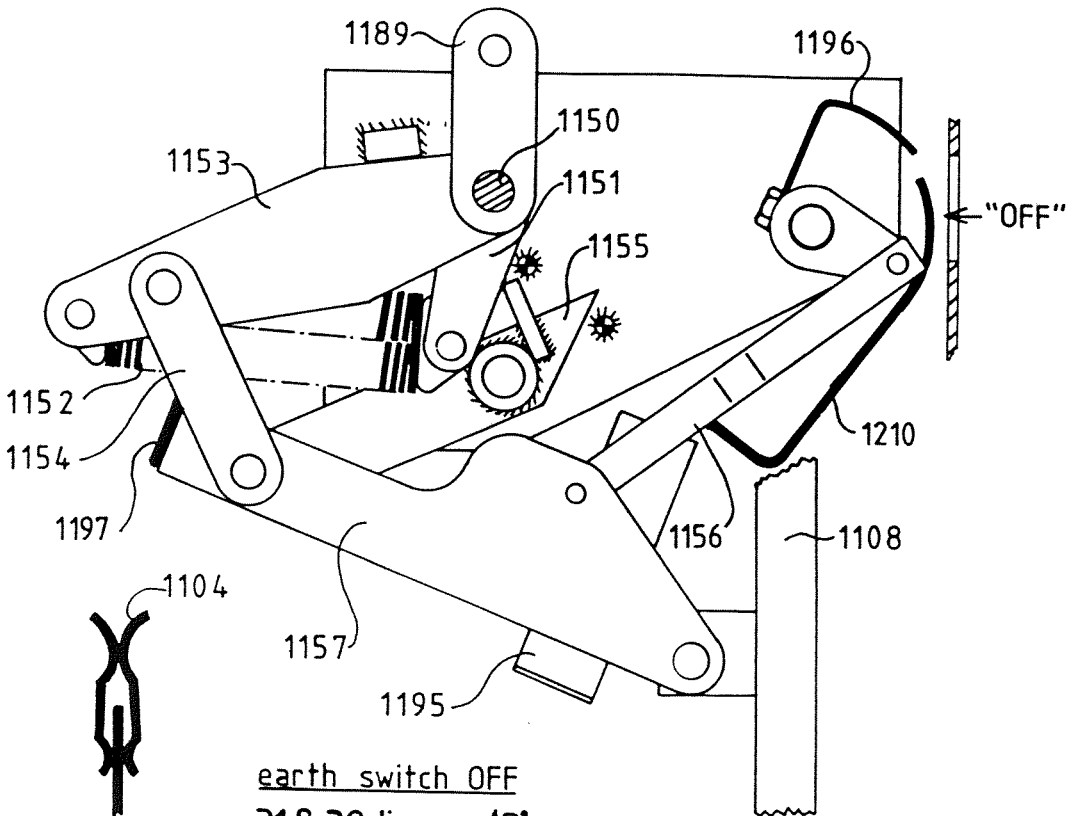
3.21 When the earth switch handle (1126/1125) is moved downwards fully to the EARTH ON position (1124), the earth switch mechanism shaft (1150) rotates clockwise (looking from the left) and the spring compression lever (1151) compresses the springs (1152) between the two limbs of the toggle lever (1153). As the springs pass the point of maximum compression, the toggle lever is forced to pivot downwards, driving the toggle drive link (1154) and thus the star point blade (1197) into contact with the spring contacts (1104). The springs cannot fully expand again, but push against the "knee" of the toggle linkage.

3.22 When the handle (1126/1124) is raised from EARTH ON to OFF (1125), the motion of the mechanism is reversed. The springs (1152) are re-compressed, then drive to break the toggle linkage and open the switch (1197). Also, a nudger (1155) is pivoted by the spring compression lever (1151) to give a positive upwards drive to the star point blade assembly (1197/1157).

3.23 An indication drive link (1156) from the side arm (1157) of the star point blade assembly drives the EARTH ON indicator plate (1196) which, in the EARTH ON position, shields the OFF indication (1210) in the window (1130).



earth switch ON
3.1 & 3.2 diagram 'A'



earth switch OFF

3.1 & 3.2 diagram 'B'

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

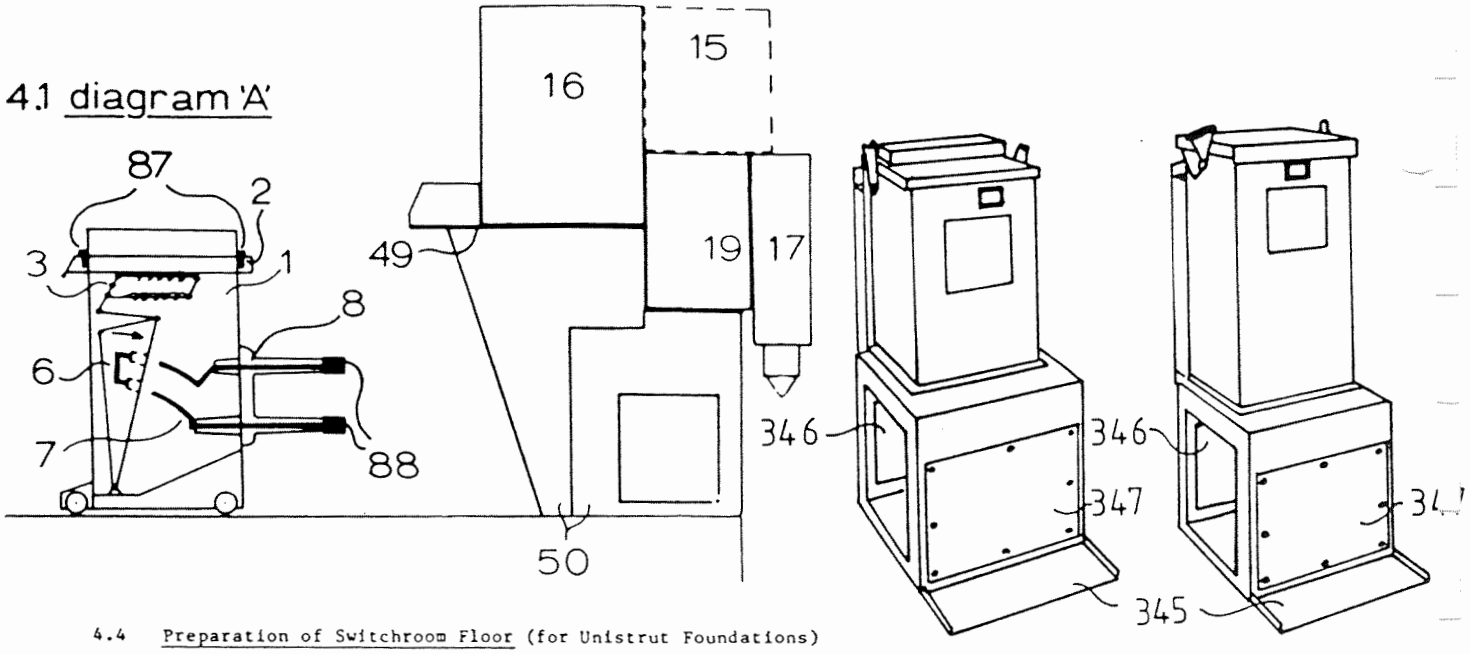
N.B. Cable box compounds with a pouring temperature above 130°C must not be used.

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'

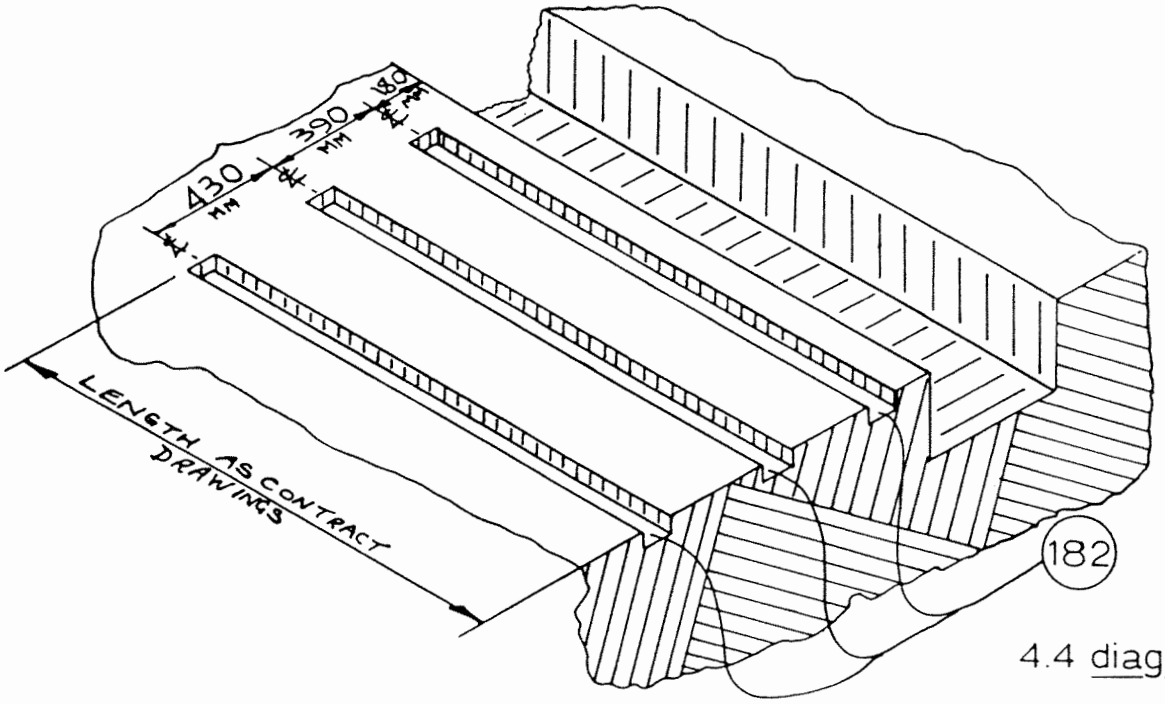


4.4 Preparation of Switchroom Floor (for Unistrut Foundations)

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.

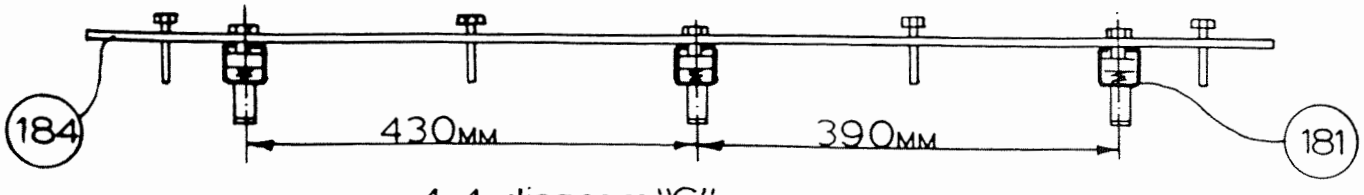
4.42 Foundation details vary from switchboard to switchboard. Reference should always be made to the foundation plan supplied for the individual installation. A cable trench or conduits, of size and layout to suit the cables to be used, will usually be required at the rear of the switchboard. Rear access 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.

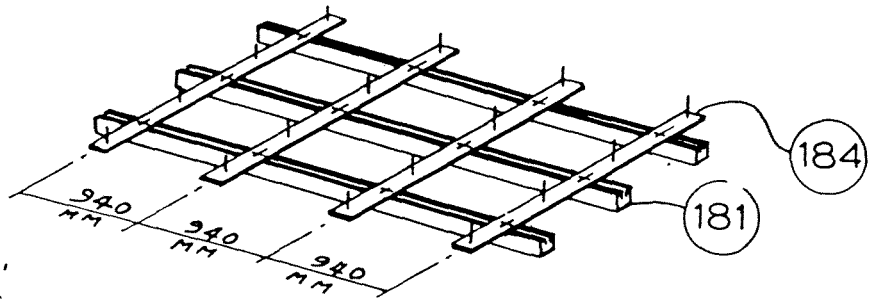


4.4 diagram "B"

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"

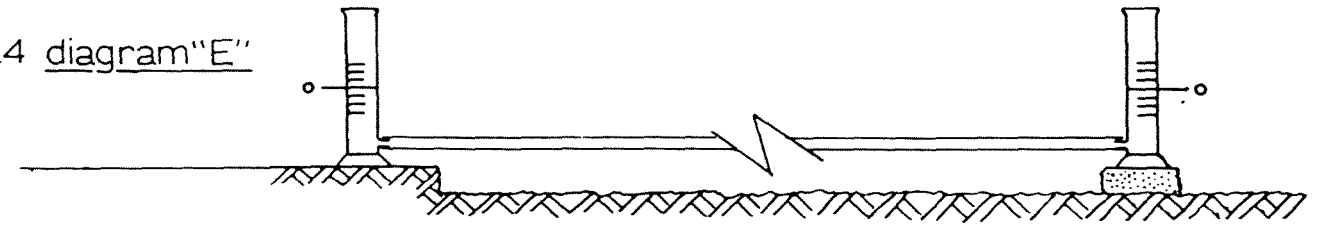


4.4 diagram "D"

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"

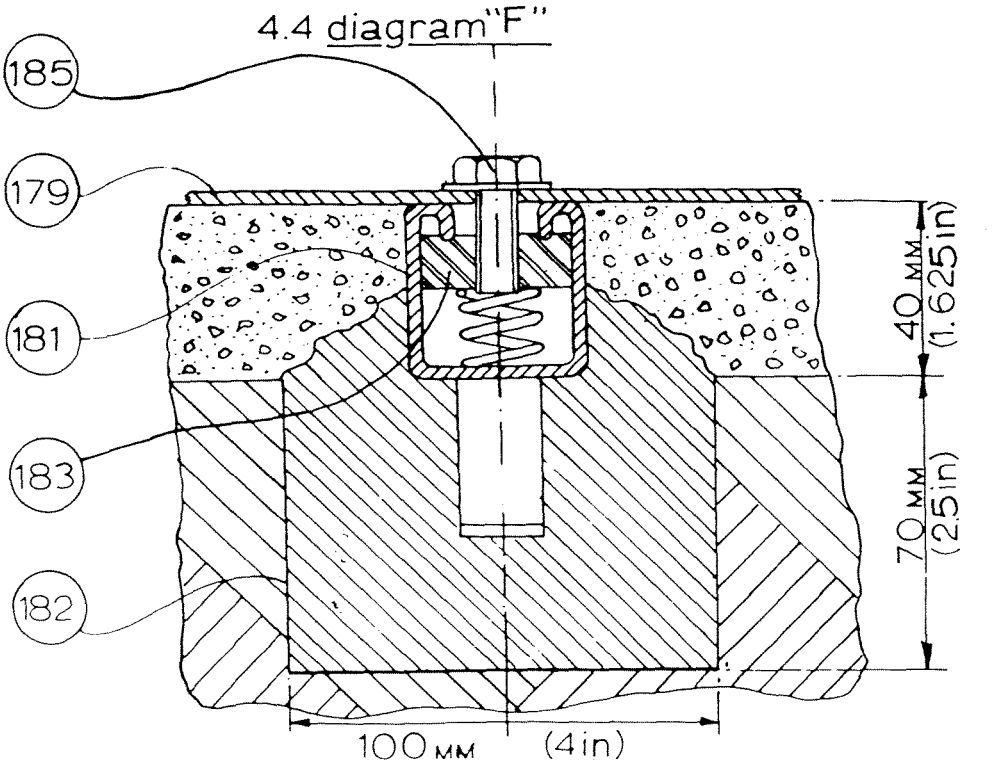


4.47 Leaving one of the water level jars on the datum, place the other on top of each runner (181) in turn along the length of the switchboard, each time adjusting the local jacking screws until the previously noted common water level is attained. This will result in the runners being level over the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

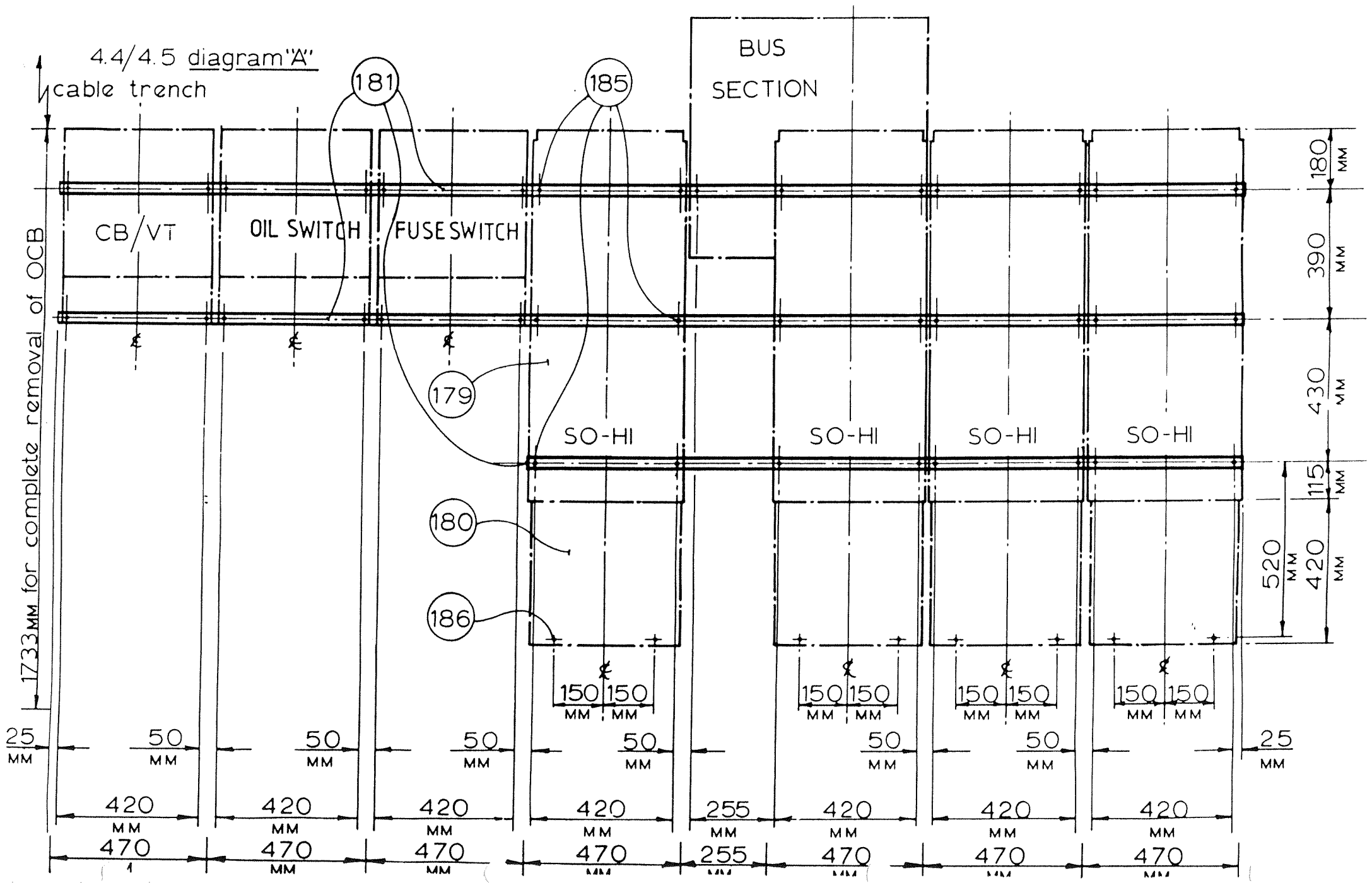
4.4 diagram "F"



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
SO-HI
SO-HI
SO-HI
SO-HI
180
186
1733MM for complete removal of OCB
180 MM
390 MM
430 MM
115 MM
520 MM
420 MM
150 150 MM 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.

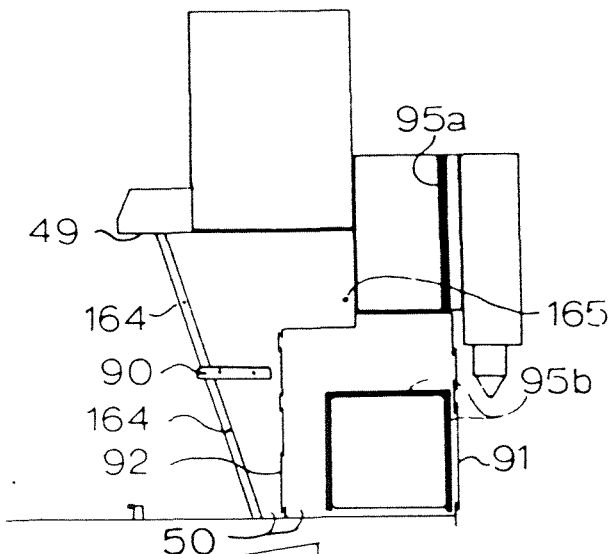
4.57 CIRCUIT BREAKER fixed portions can then have their removable front aprons (180) fitted to the fronts of their baseplates (179) as follows.

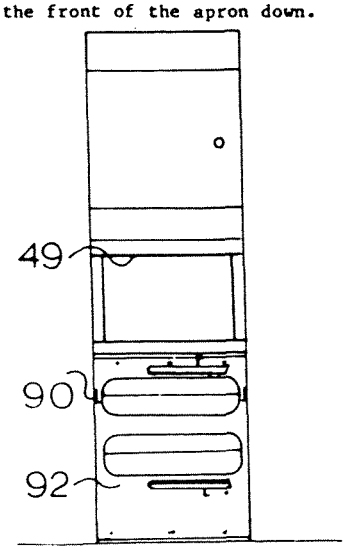
(a) Secure each apron (180) to the front of its baseplate (179) using the three studs and nuts provided.

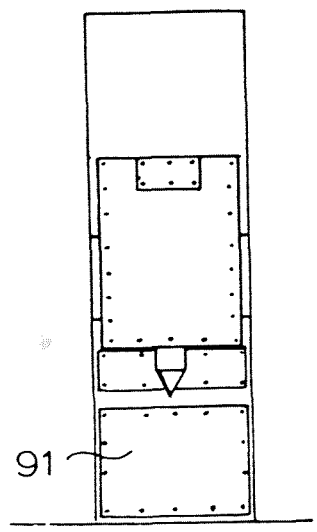
(b) Using the two countersunk holes at the front of the apron as guides, drill two 7 mm (9/32 in) diameter by 50 mm (2 in) deep pilot holes in the floor.

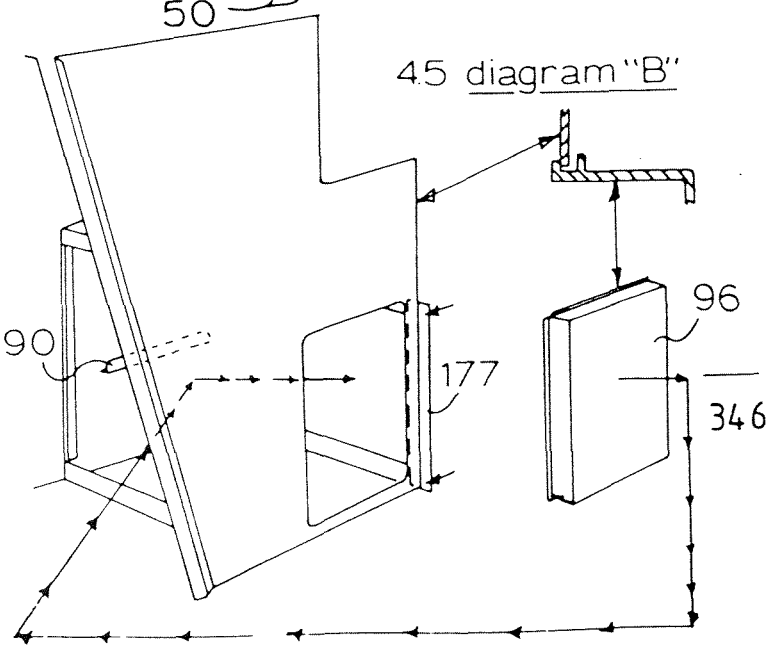
(c) Unfasten and remove the apron and open out the holes in the floor to 9 mm (3/8 in) diameter.

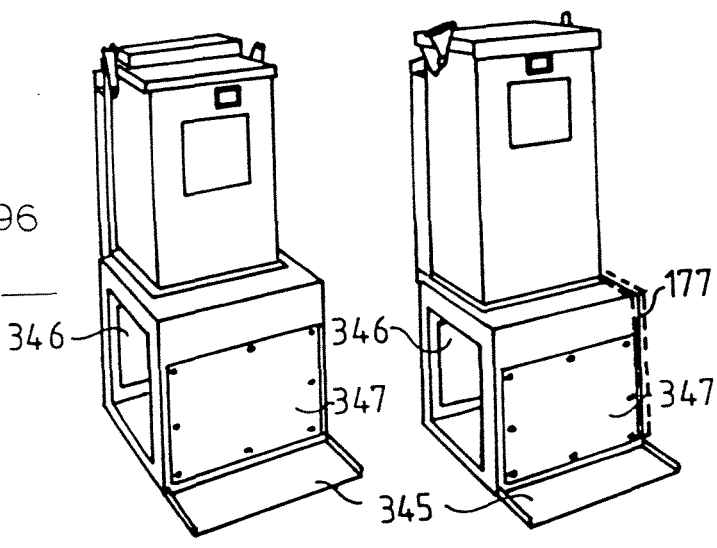
(d) Fit a 'UNI-FIX' plug type P5 in each hole, replace the apron and secure it by the nuts and studs mentioned in (a) above, then drive a No. 14 x 1.1/2 in long countersunk Phillips-headed wood screw (186) through each of the front two holes to hold the front of the apron down.











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

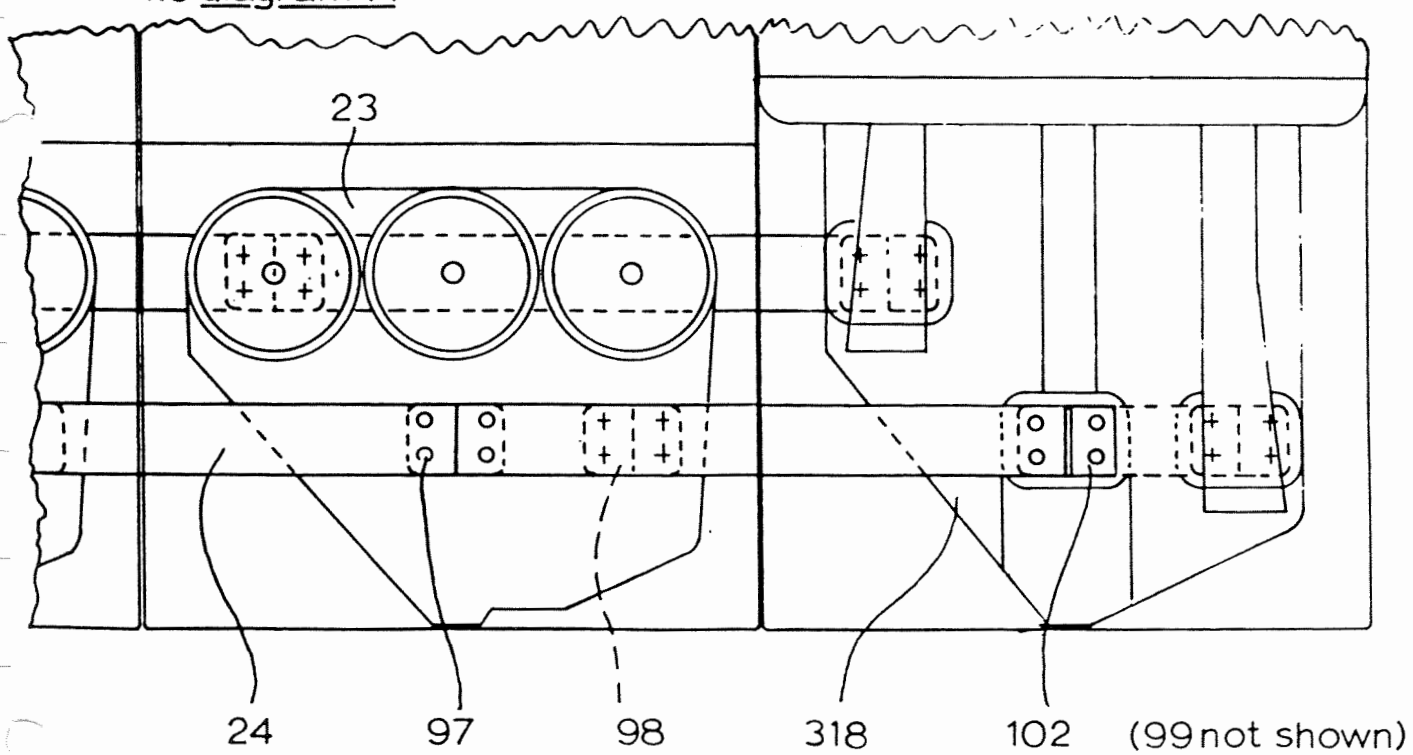
4.61 The busbars (24) can now be fitted between adjacent units.

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

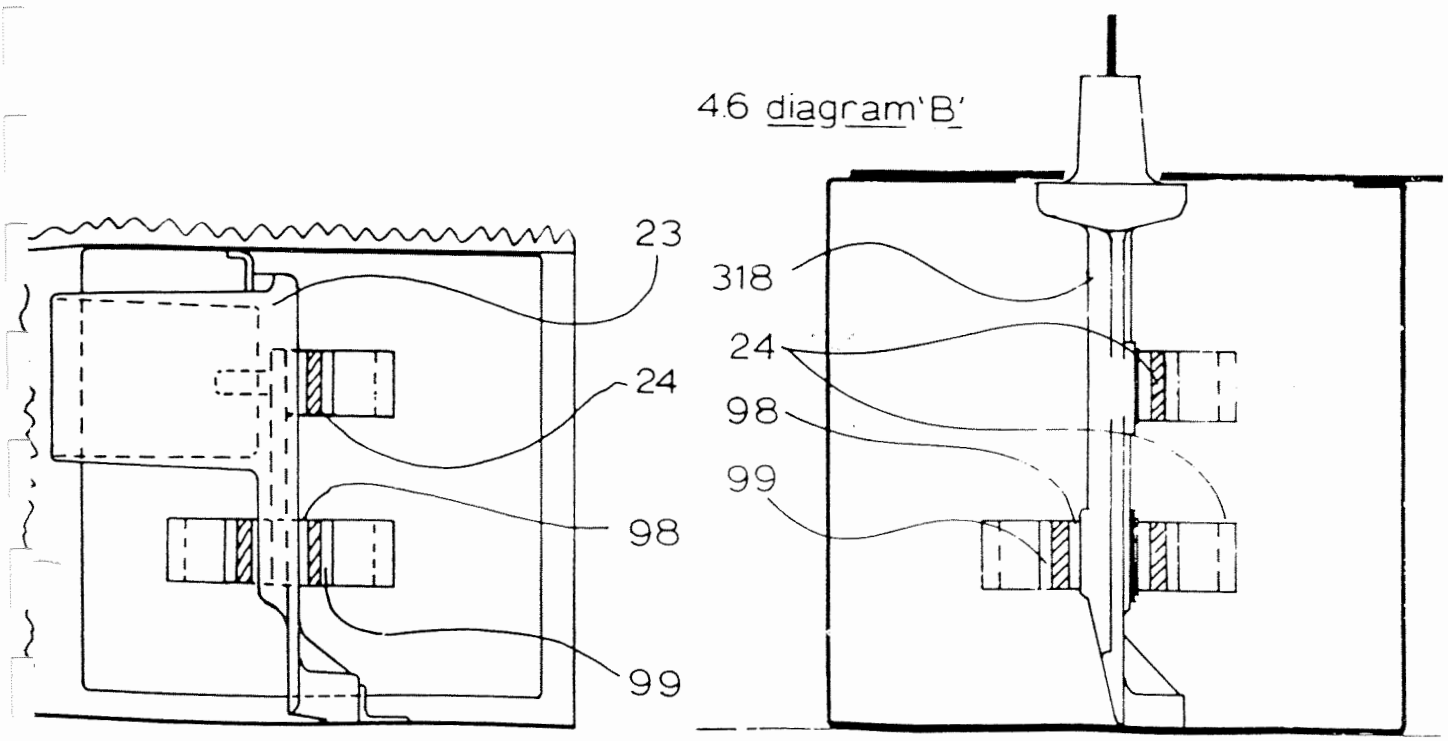
4.62 Unit length, resin coated busbars are employed in the following arrangements:

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'

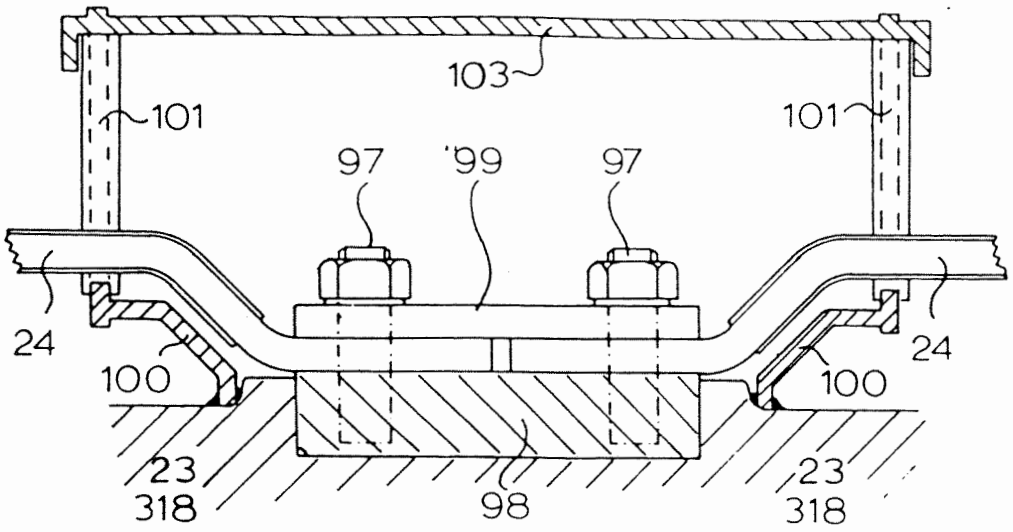


4.6 diagram 'B'

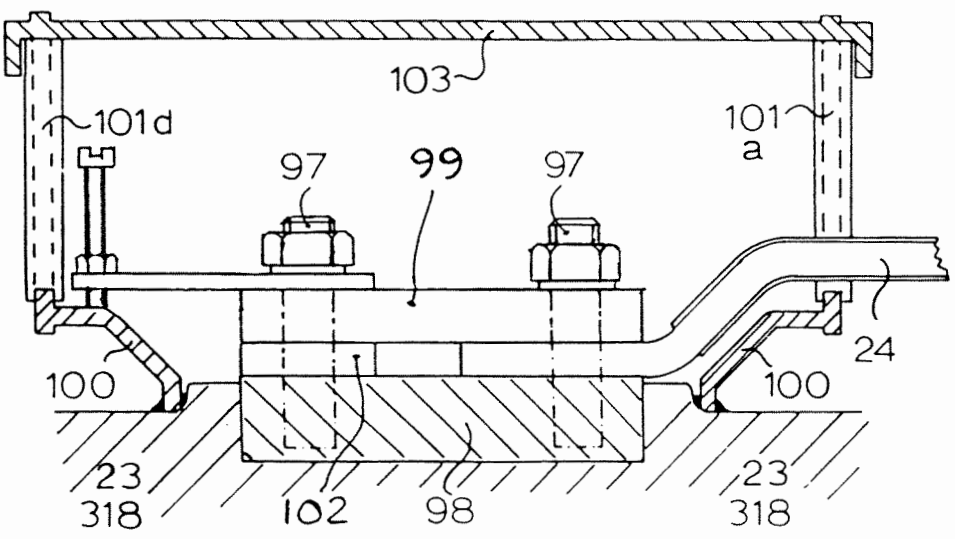


4.67 In the case of circuit breaker fixed portions, replace and secure the earthing device locating angles (90) on the sidewalls (50).

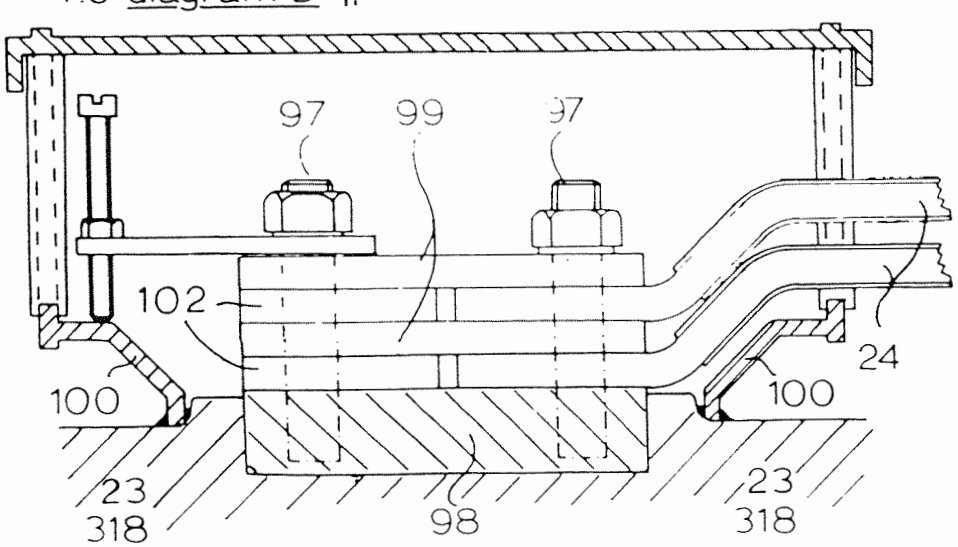
4.68 Fit the inter-unit sections of the main switchboard earth bar along the rear of the busbar chambers, ensuring that the earth connection from each fixed portion is connected to the main earth bar. Bond the switchboard earth bar to the substation earth according to local practice.



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.

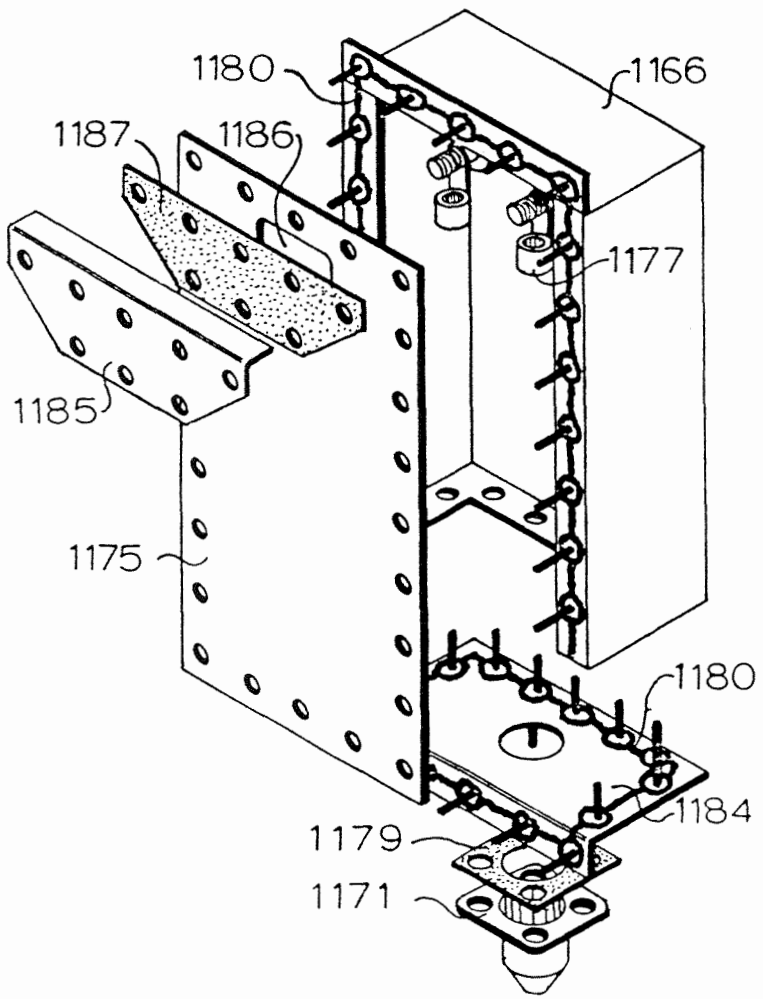
4.72 Prepare the cable box as follows:

(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-AO & FS-AO)

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-AO, busbar chamber and cable box, with no oil or compound : 131 kg (289 lb).

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

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

5.25 Volume of OS-AO 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.

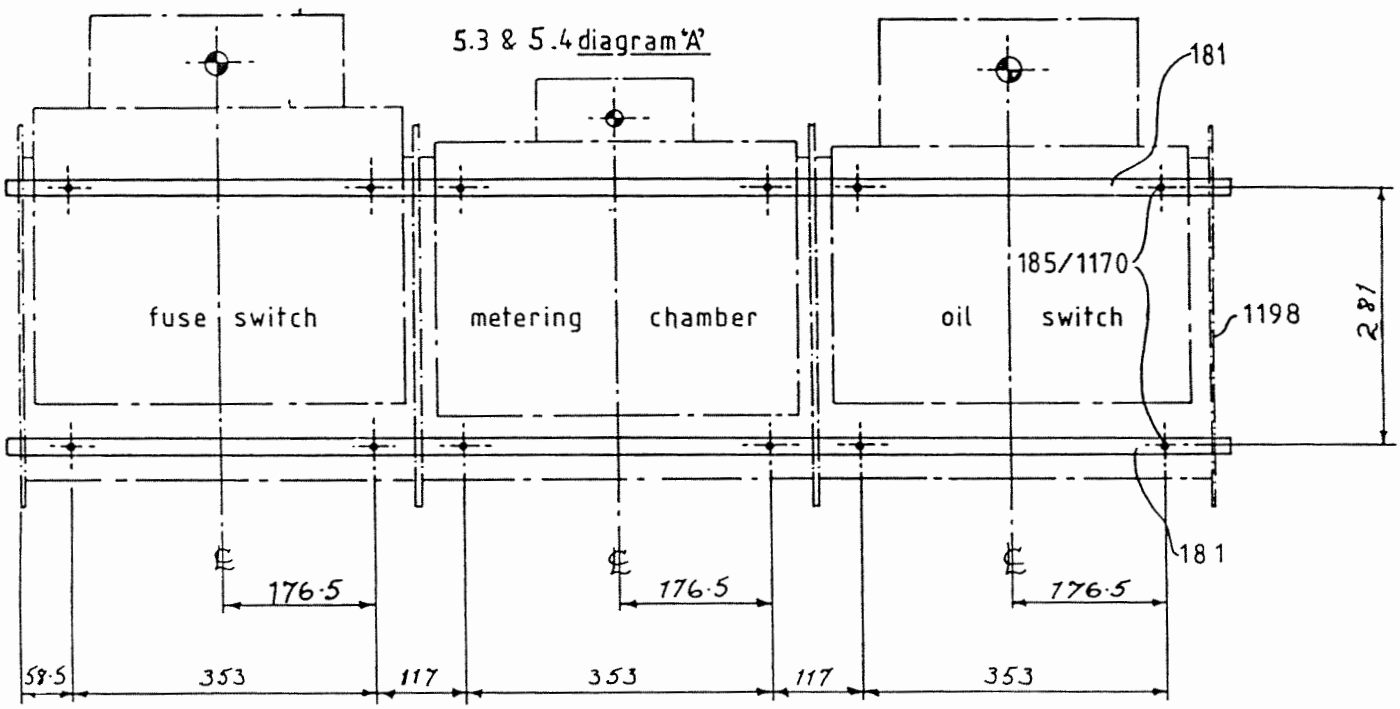
5.42 Prepare a sub-floor 40 mm (1.5/8 in) below the finished floor level, with chases a further 70 mm (2.3/4 in) deep by 100 mm (4 in) wide at 281 mm (11.1/16 in) centres, running at least the total ultimate length of the switchboard, including any future extensions which may be under consideration.

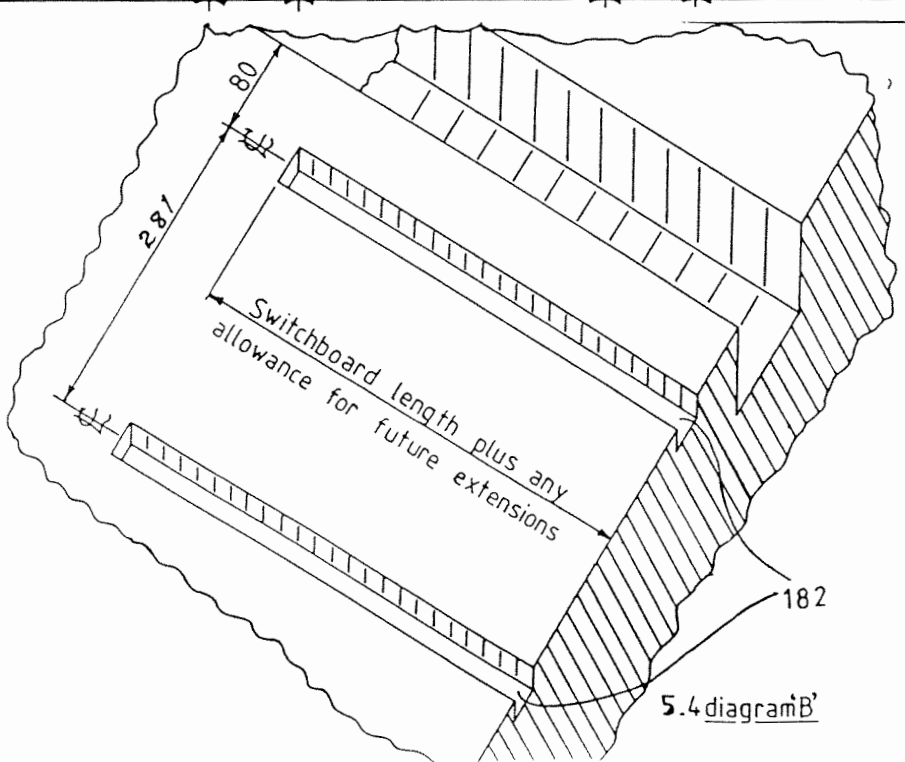
Note that ducts or a trench will be required at the rear of the switchboard to accommodate cables approaching from below.

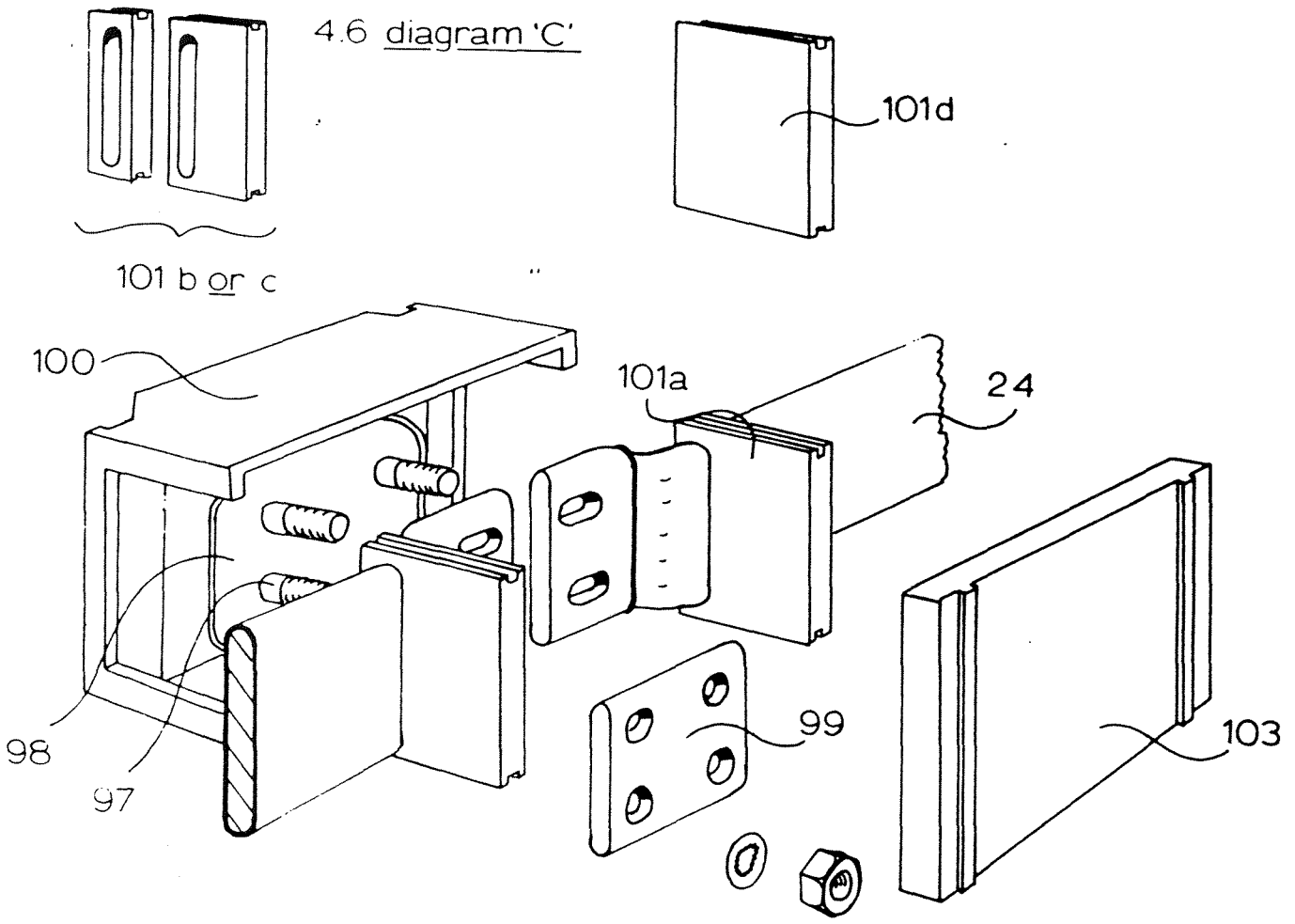
5.43 Place the Unistrut runners (181) in their approximate positions in the chases (182) and burn 50 mm (2 in) gaps in the foam plastic filler at roughly 509 mm (20 in) centres, using a blowlamp or gas torch. Using the spring nuts (183) provided, fix tie bar jigs (1377) to the foundation runners at these 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.







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.

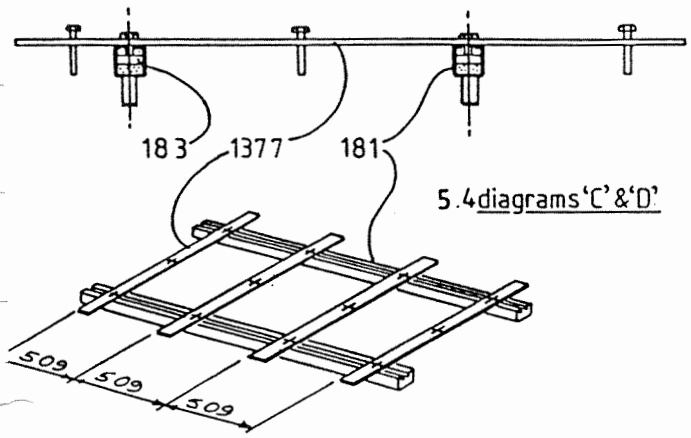
4.66 Clean the busbars (24) and tee-off mouldings (23, 318) as described in detail in the "Maintenance" section of the appropriate manual. Remove any foreign bodies from the busbar chambers. Replace and fasten tight all busbar chamber back plates (91, 346) and front plates (92, 347). Peel off the backing 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.

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.

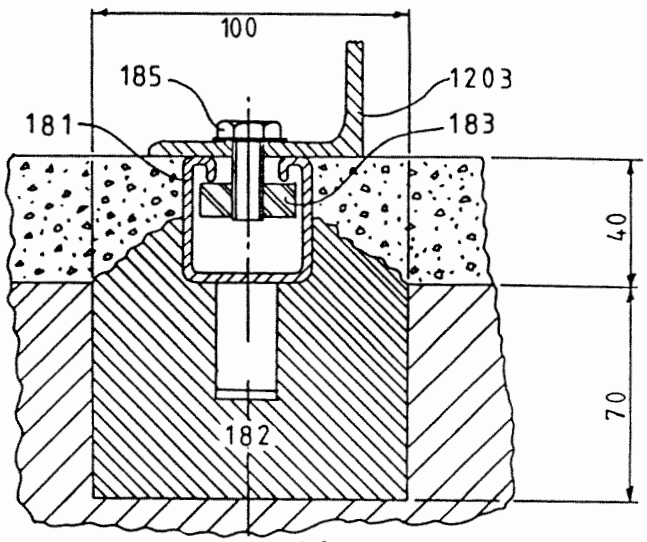
5.47 As the units are lined up and fastened down, fit the gaskets between adjacent busbar chamber flanges (1378) and fasten the flanges together with the nuts, bolts and washers provided.

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.

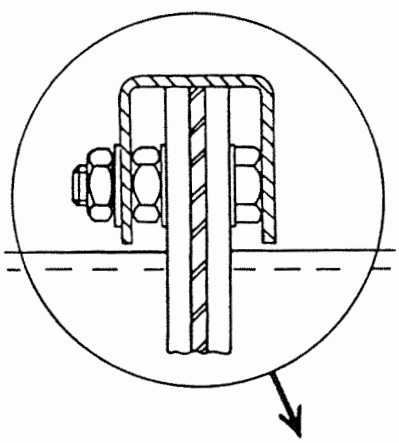
5.49 Use pieces of Unistrut clip-on plastic cover, to seal any exposed lengths of Unistrut runner, e.g. where provision has been made for future extensions.

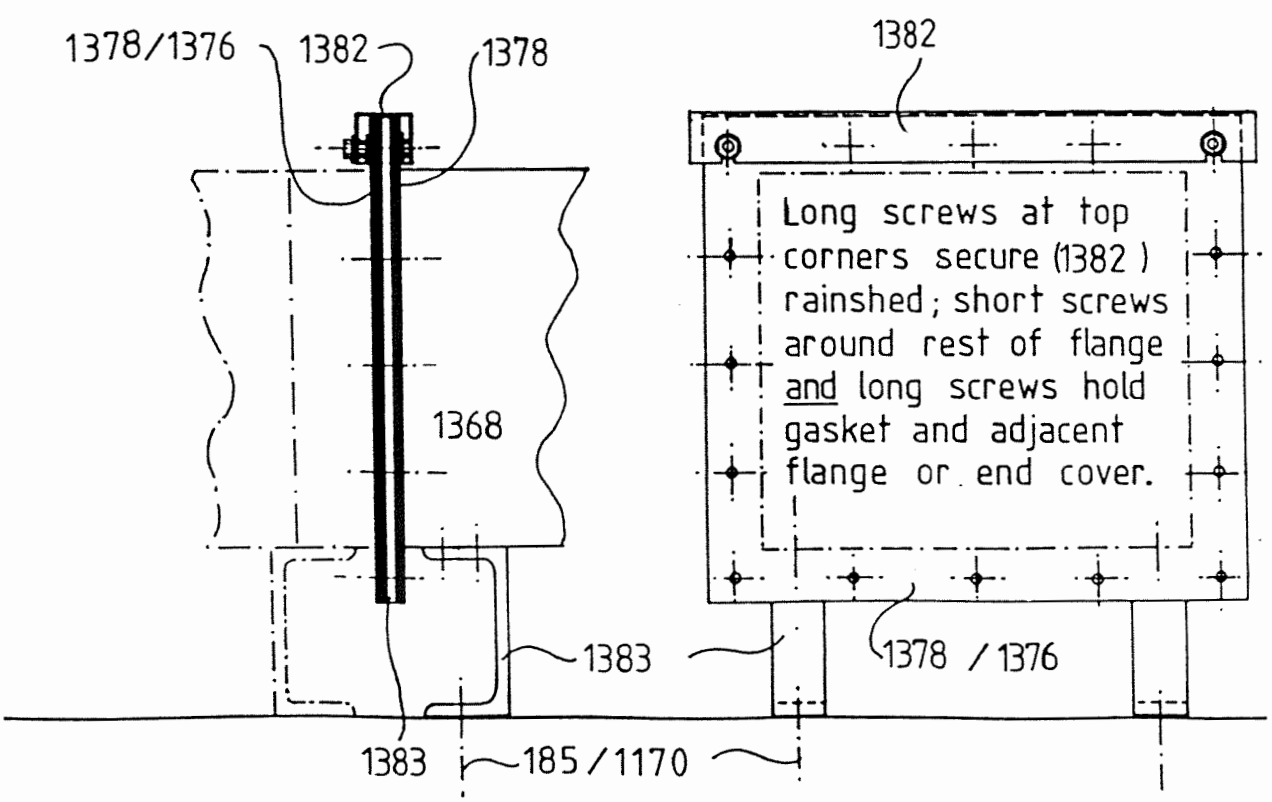


5.4 diagrams 'C' & 'D'



5.4 diagram 'E'


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).

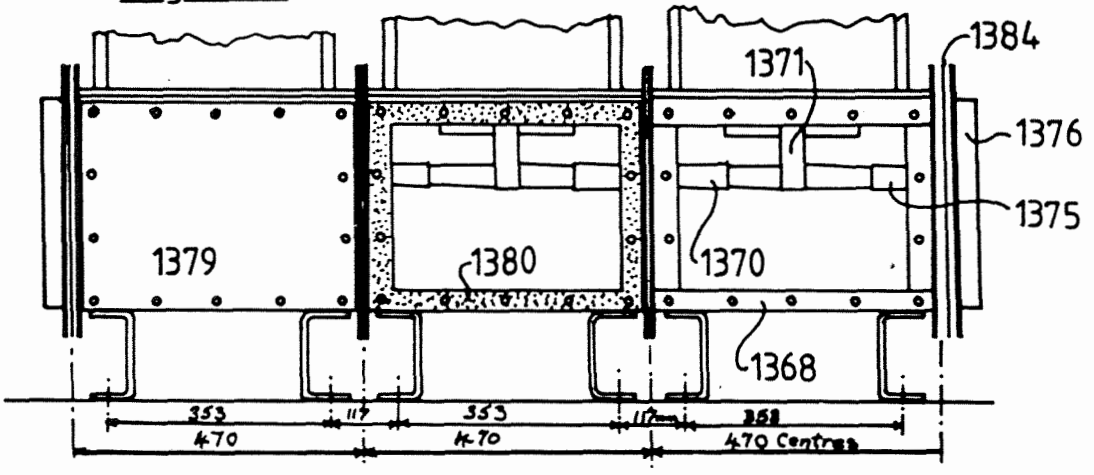
iii) To ensure complete encapsulation of the busbar system, heat-shrinkable insulating sleeves (1370) are fitted over these electro-mechanical joints.

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:

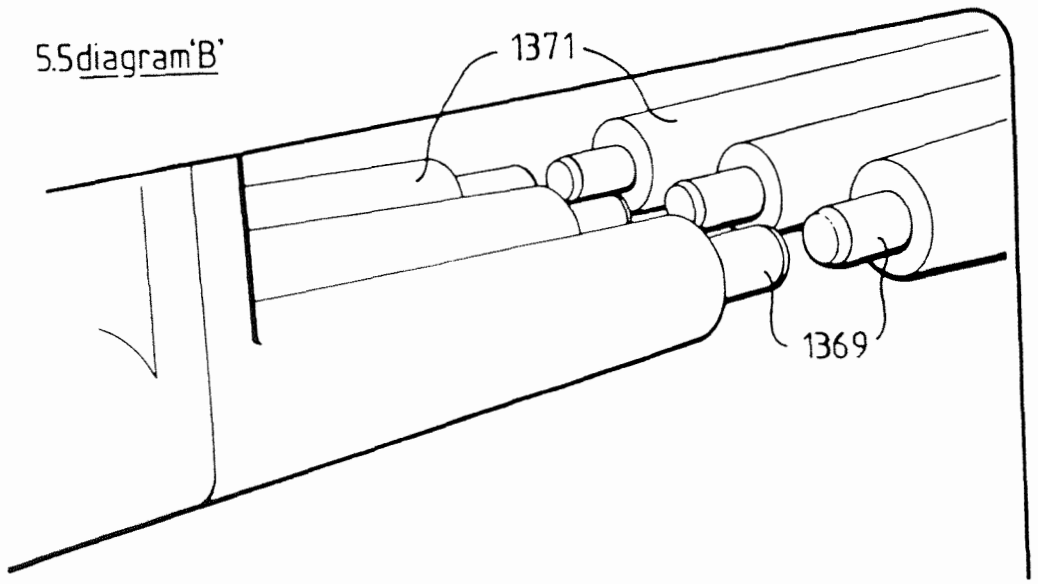
i) "ICI Genklene LV",
available from:

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

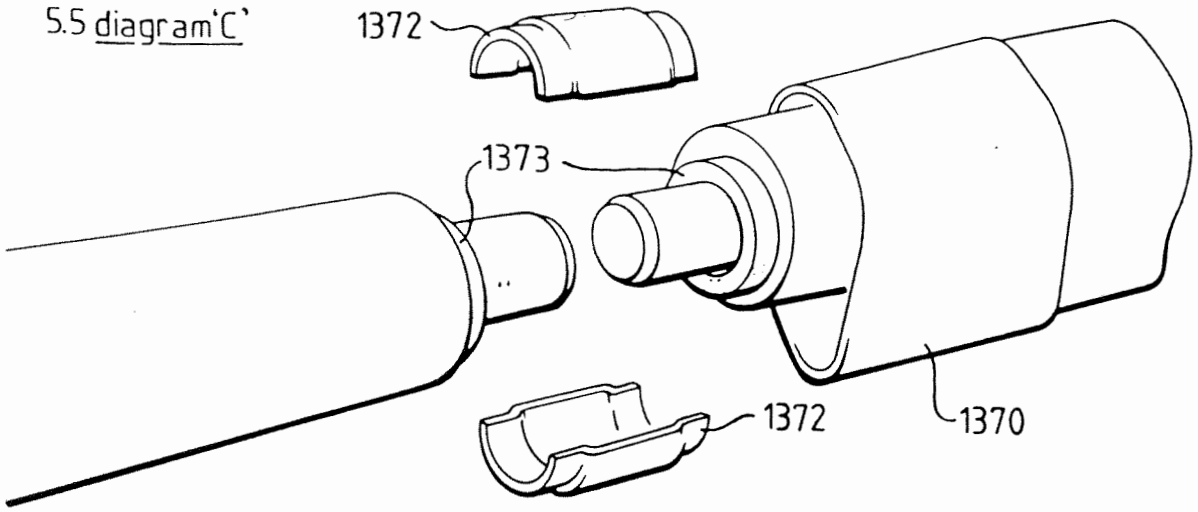
ii) "Electrolube Ultraclene V",
available from:

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

5.5 diagram 'B'



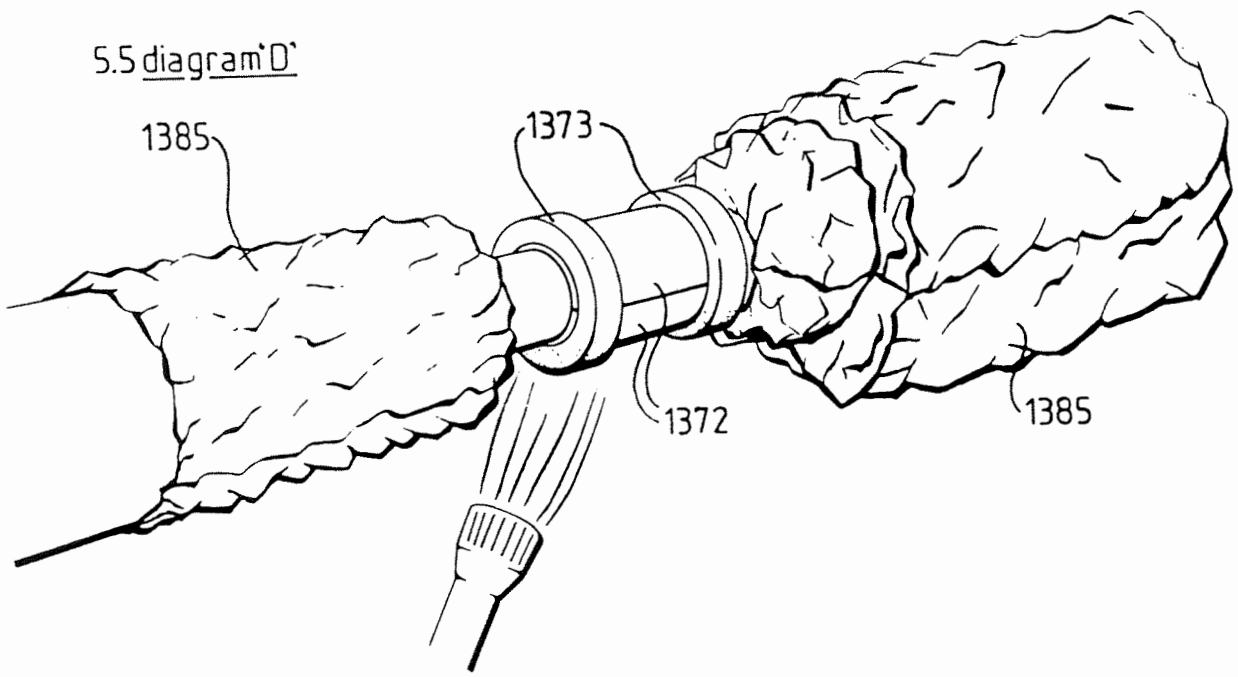
5.5 diagram 'C'



5.53 At each inter-panel joint, slip an insulating sleeve (1370) over one of each pair of busbar moulding limbs to be joined, and roll or fold the sleeves back at least 50 mm (2 in) clear of the busbar metal ends. Then, slip one metal locking ring (1373) on each busbar end and slide it back against the end of the moulded insulation.

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.

5.5 diagram 'D'



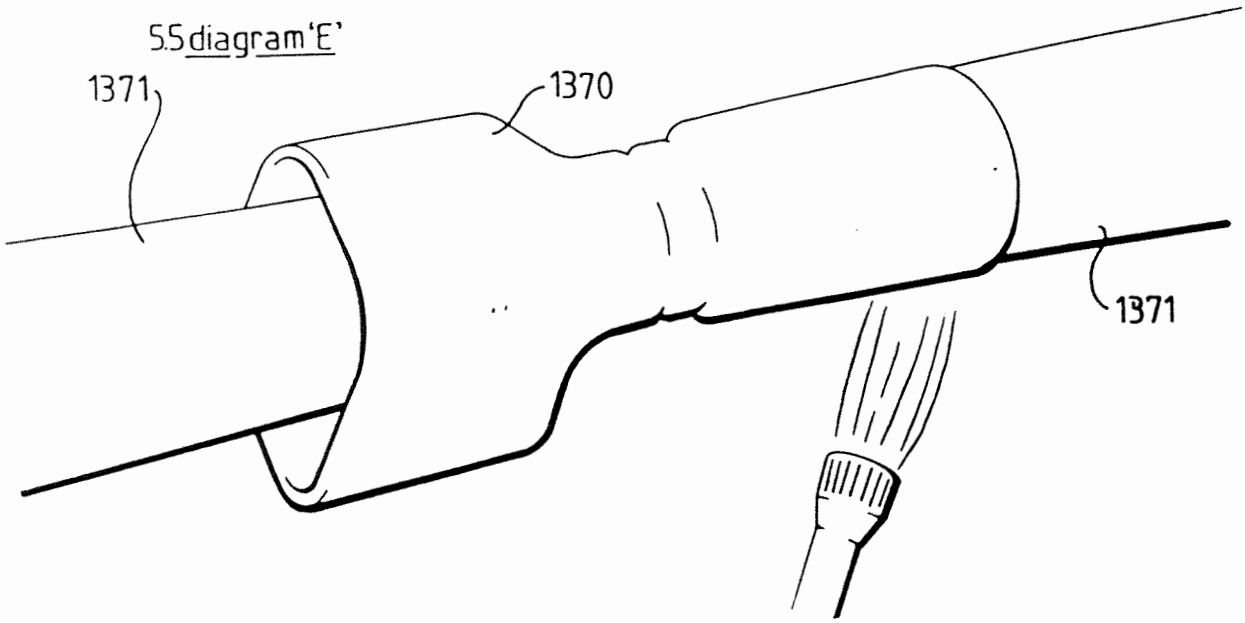
5.54 Wrap the aluminium foil (1385) around the folded-back sleeves (1370) and the two sets of busbar moulding limbs (1371) to protect them from the heat, and then use a gas torch (preferably propane, but butane is acceptable) to heat up the locking rings (1373) and cause them to shrink and so fasten 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 in place and allowed to cool, remove the aluminium foil (1385) from one insulating sleeve (1370), and roll the sleeve out to its full length. Position the sleeve centrally over the busbar joint made off as above, and shrink-fit it into position as follows:

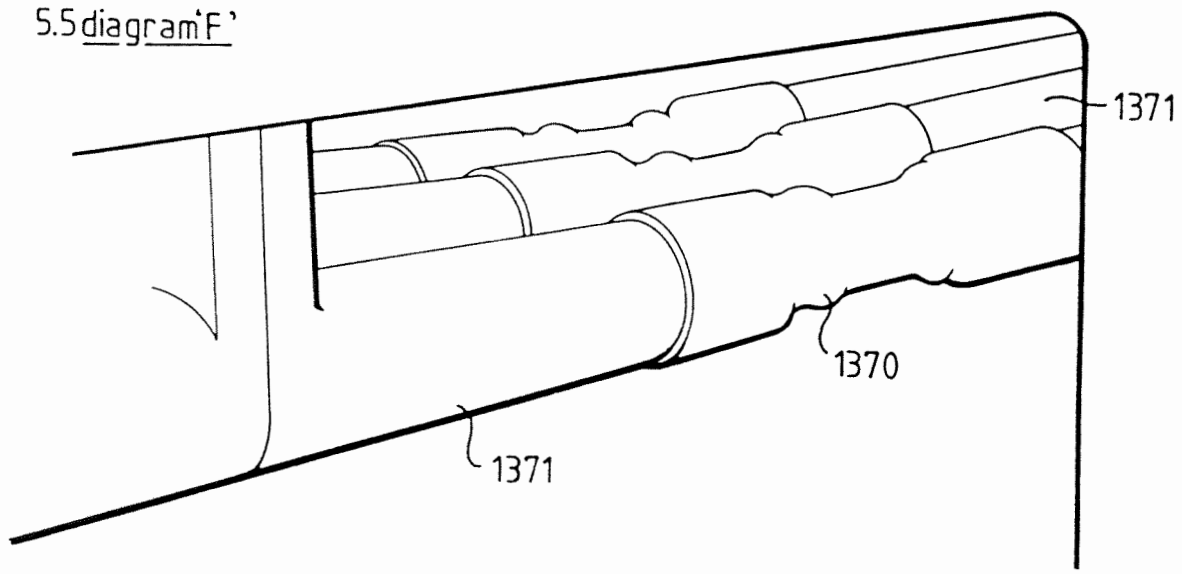
5.56 Using the gas torch again, but with the flame adjusted to a "soft" blue with a yellow tip, gently warm the insulating sleeve (1370). Keep the flame continually moving over the surface to prevent scorching and hot spots. Heat the sleeve overall but, as it begins to shrink, work from the centre outwards 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.

Repeat for the insulating sleeves on all three phases at each inter-panel busbar joint location.

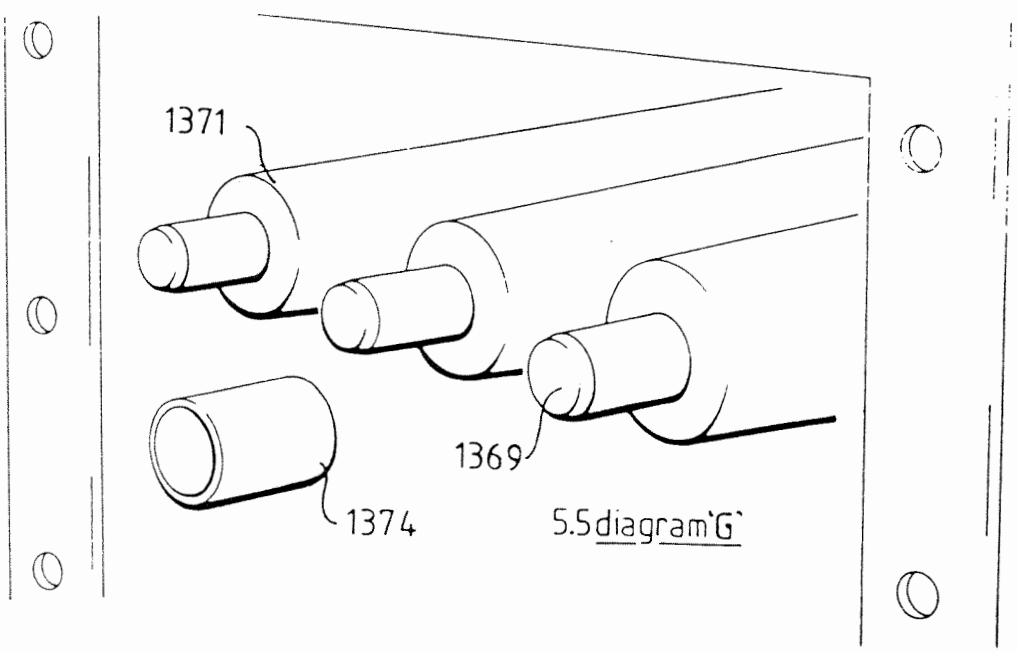
5.5 diagram 'E'



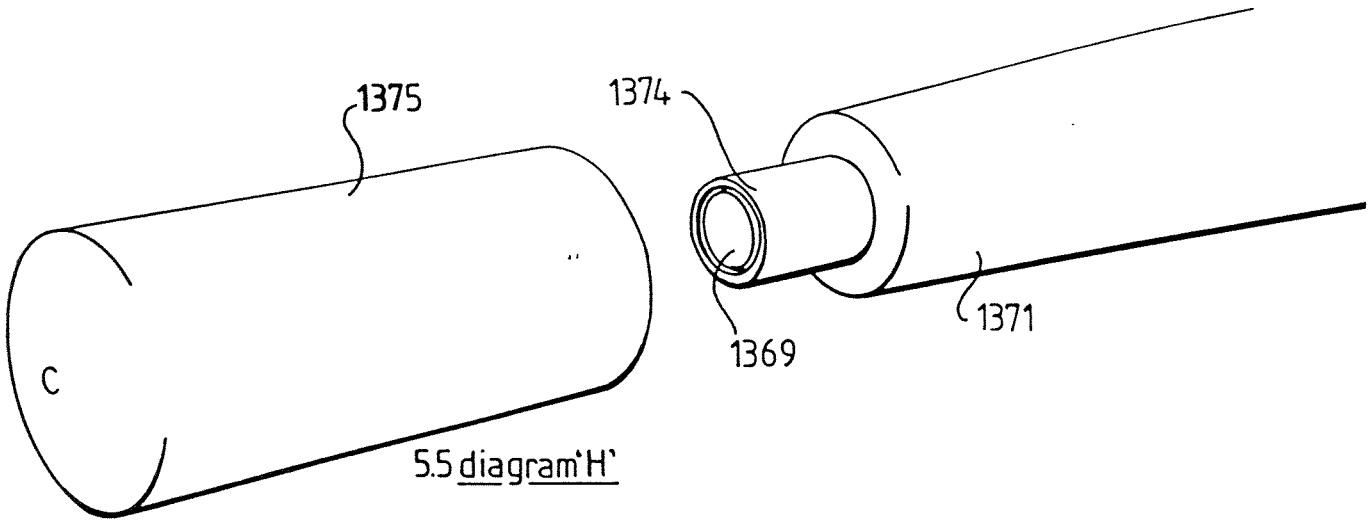
5.5 diagram 'F'



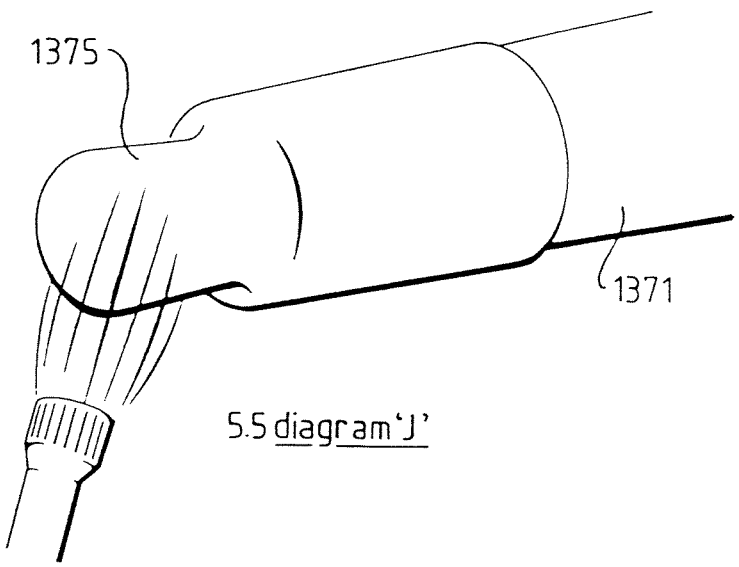
5.57 On the outer end of the bushar moulding (1371) of an end panel, push the non-shrinking metal bushes fully home (1374) onto the ends of the busbars (1369). Put the insulating "boots" (1375) in place over them, push them on as far as they will go and shrink them into position as in paragraph 5.56 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.



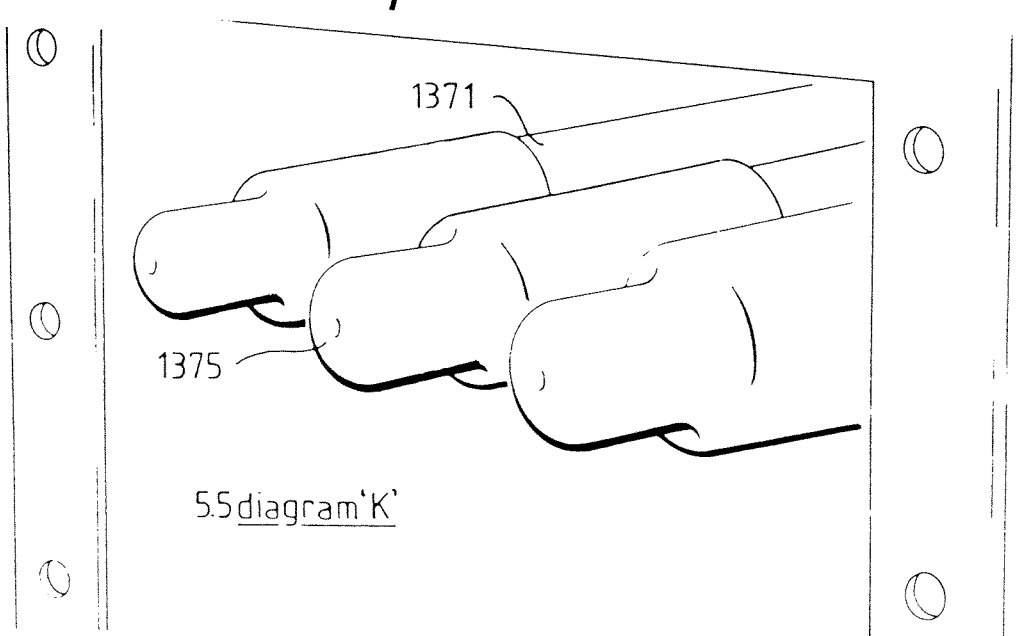
5.5 diagram 'G'



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 (FS-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 FS-AT, front cable box and support bracket, with no oil or compound: 131 kg (289 lb)

6.23 Volume of oil tank: 66 litre (14.5 gall).
Equivalent weight of oil: 56.5 kg (124 lb).

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

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

6.26 Weight of rear cable box (empty): 25 kg (55 lb).

6.3 Mounting the Switch on the Transformer

6.31 The FS-AT is supported by a stand (1167) 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 (1169) on the stand (1167) 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.

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 stand (1167) to the transformer so that the bushings (1114) protrude into the transformer tank (or disconnection chamber). Raise or lower the unit until the mating flanges (1165/1168) are aligned and flush together, with the gasket (1173), supplied with the unit, between them. The four holes in the rear flanges of the stand (1167) should now also be aligned with the studs or bolt holes in the transformer tank bulkhead support angles (1174).

6.35 Fasten the mounting stand (1167) to the bulkhead angles (1174), using packing washers if necessary, to ensure alignment of the mating HV flanges (1165/1168) 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 (1114) 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.

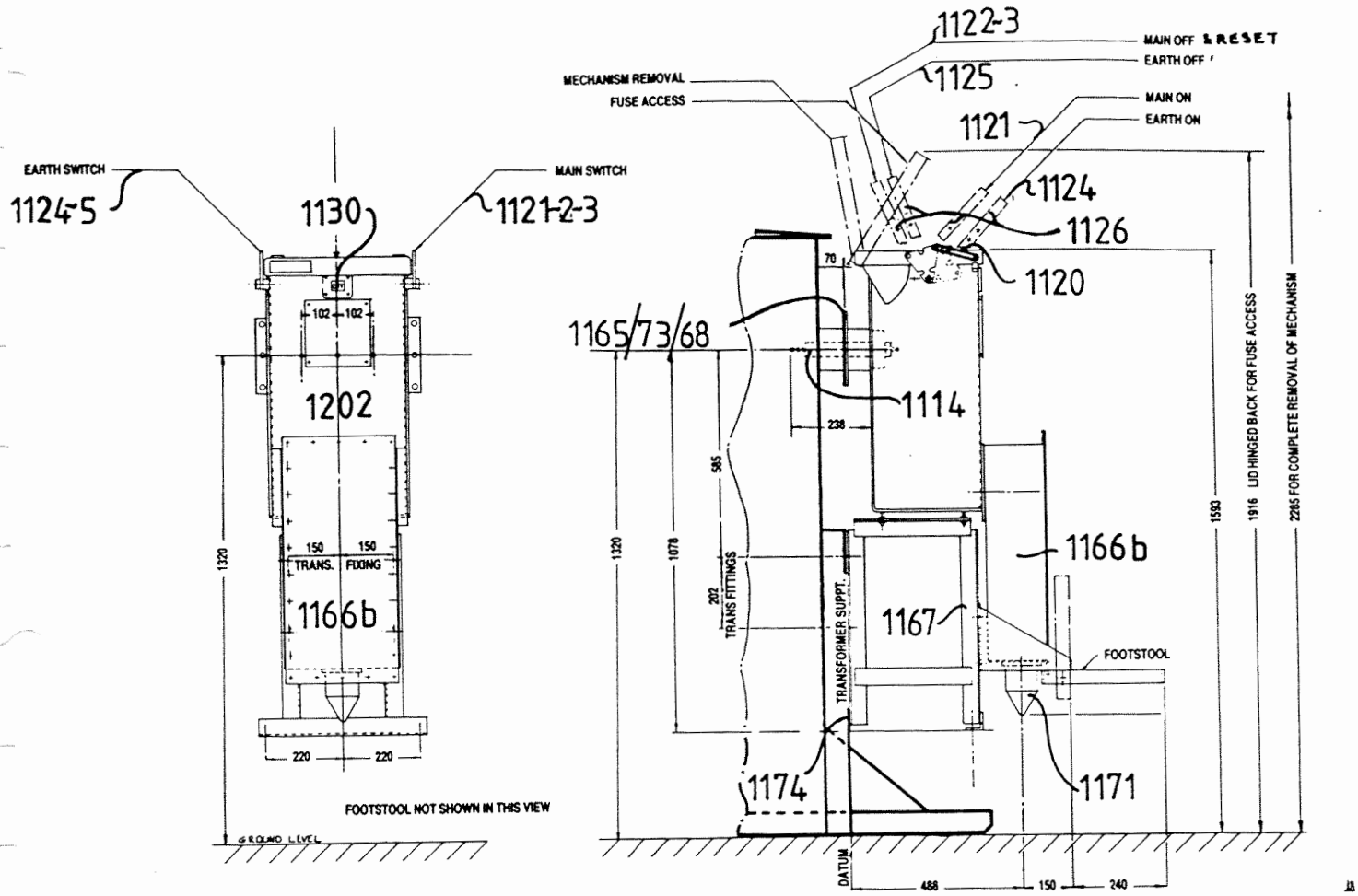
6.38 The incoming cable can now be jointed into the front cable box (1166b) according to approved local practice (see sub-section 4.7). All structural steelwork and cable glands (1171) are bonded to the unit earth bar.

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

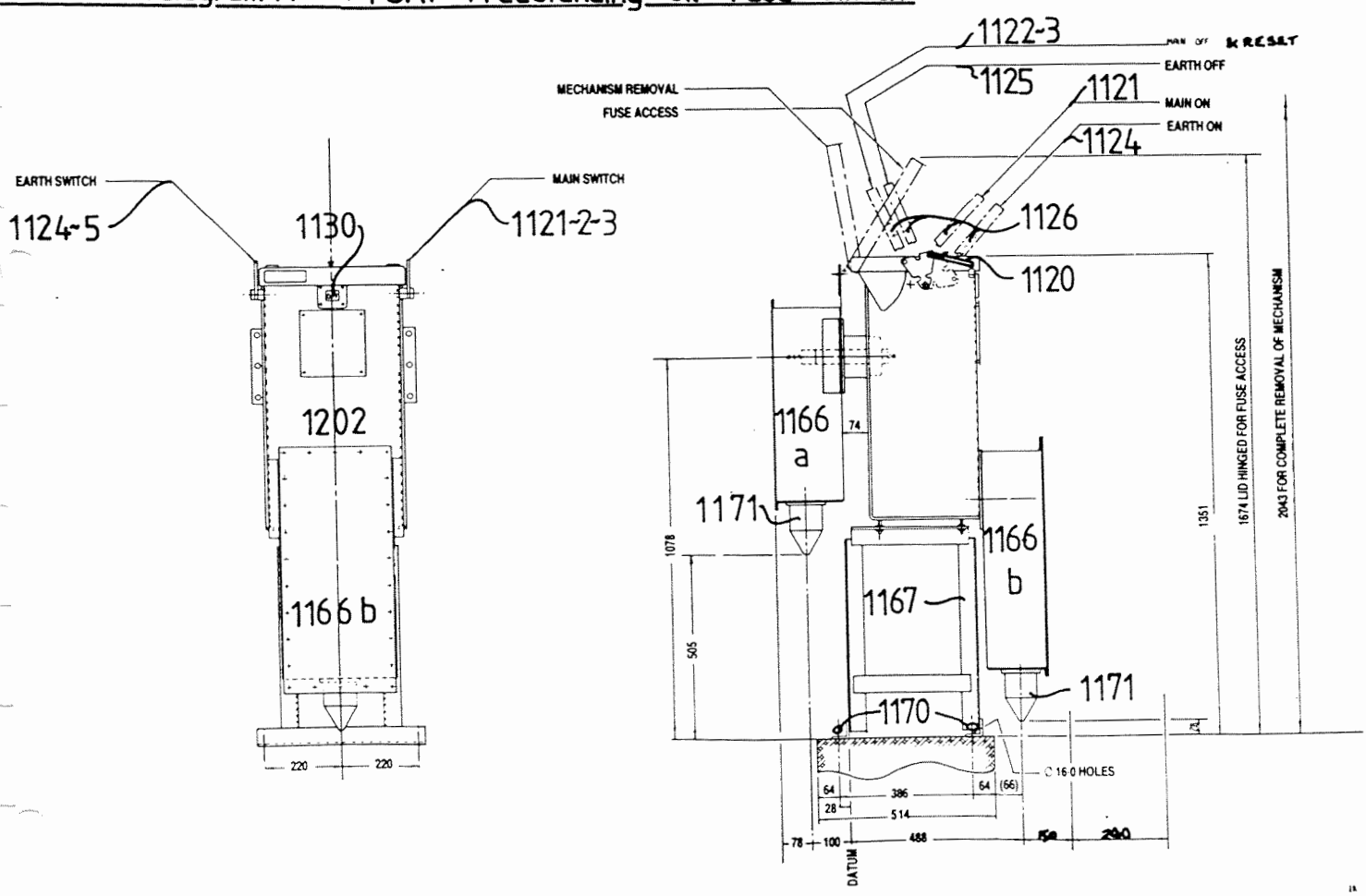
6.4 Erecting a Free-Standing Switch with Rear Cable Box

6.41 Place the unit, complete with stand (1167), 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).

6.3 diagram 'A' : FSAT Transformer-Mounted Oil Fuse Switch



6.4 diagram 'A' : FSAT Freestanding Oil Fuse Switch



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.

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-sections 4.7 and 6.2 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

NOTE: Do not operate either switch unless the cover (1205) is securely fastened down.

7.1 Preparation of Tank & Mechanisms

7.11 WITH BUSBARS (IF ANY) AND OUTGOING CIRCUIT CONNECTIONS (1114, 1166a, 1166b) DEAD, remove all packing materials, wipe down the outside of the tank (1202) and, with operating handle stubs set to the RESET (1123) and EARTH OFF (1125) positions as indicated by OFF in the tank window (1130), unfasten the main cover retaining screws and raise the cover (1205). The spring-loaded mechanism mainframe (1108) will rise with it. A carriage retaining clip (1127) on the left hand mainframe member will swing out to support the frame and lid.

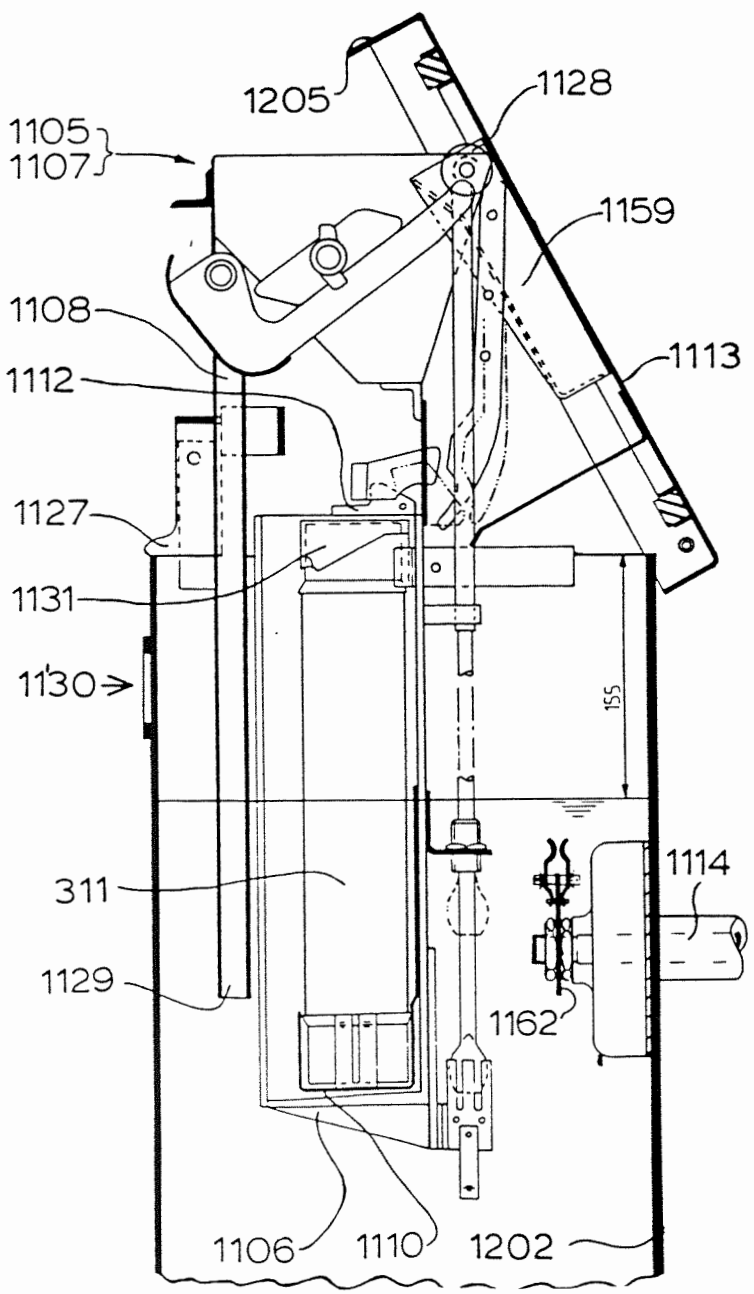
7.12 Slacken off the front fastener on the roller bracket (1159) on the underside of the cover (1205) and slide the bracket clear of the roller (1128) on the mainframe. The mechanism mainframe can now be lifted out of the tank for detailed examination.

7.13 Wipe out the tank (1202) with a clean, dry, lint-free, non-metallic cloth. Check for foreign bodies in the tank bottom. Examine all bearings, contacts and the mechanisms on the mainframe (1108) for loose components or fastenings.

7.14 Make sure that the switch handle stubs are still set to EARTH OFF (1125) and RESET (1123) and replace the mechanism mainframe (1108) in its guides in the tank.

7.15 Check that the correct fuses (311) are fitted. If not, raise the mechanism trip bar (1112), raise the hinged upper contact fuse retaining clips (1131) and remove the fuses that have been supplied (if any). Check the fuses for damage, then place them in their lower fuse contact cups (1110) with striker pin ends upwards (see markings on fuse bodies). Twist and press each fuse down firmly to ensure that it is seated satisfactorily, and press down the hinged clips (1131) around the tops of the fuses. Lower the trip bar (1112) across the tops of the fuses.

7.16 Fill the tank (1202) to the marked level with switch oil as described in sub-section 5.2. Pour oil over the mechanisms mounted in the mainframe (1108). Note the oil level label on the fuse carrier: "Oil to be level with this plate with mechanism on hold up catch and fuses fitted".



7.1 diagram 'A'

7.17 Re-engage the top roller (1128) with the roller bracket (1159) on the underside of the cover (1205) and slide and fasten the bracket into its original position. Close and fasten down the cover after checking that its gasket is secure and in good condition. Check the operation of the handles and interlocks (as far as possible) by reference to section 8 of this manual.

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 It is preferable to replace the fuses by conducting links if these are available, but the fuses may be left in place otherwise.

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 FUSE SWITCH OPERATION

NOTE: Do not operate either switch unless the cover (1205) is securely fastened down.

8.1 To Close the Main Fuse Switch to ON

8.11 Note that the indication in the tank window (1130) is OFF.

8.12 Unlock the main switch handle stub (1122) from its padlock point (1119) at the right hand side of the cover (1205). Fit the removable operating handle (1126) to the stub (1122).

8.13 Move the operating handle (1126) backwards as far as it will go, to the RESET position (1123), to engage the closing mechanism. Remove the handle and re-locate it for the forward stroke on the same stub.

8.14 Move the operating handle (1126) firmly forwards to the ON position (1121) to close the main switch (1101/1102). The indication in the window (1130) will change to ON.

8.15 Remove the operating handle (1126). Padlock the handle stub (1121) to its padlock point (1119) unless access for emergency tripping is required.

8.2 To Trip the Main Fuse Switch to OFF

8.21 Note that the indication in the tank window (1130) is ON.

8.22 Unlock the main switch handle stub (1121) from its padlock point (1119) at the right hand side of the cover (1205). Fit the removable operating handle (1126) to the stub (1121).

8.23 Move the operating handle (1126) backwards to the OFF position (1122), but not as far as the RESET position (1123). At the OFF position, you will hear the mechanism trip and see the tank window indication (1130) change to OFF.

8.24 Remove the operating handle (1126). Padlock the stub (1121) (1123 if reset) in position.

8.3 Fuse Operation on Fault

8.31 If any fuse (311) operates on fault or overload, a striker pin is ejected from its top end. This raises the main switch mechanism trip bar (1112) and moves the trip catch (1144) to trip the fuse switch (1101, 1102, 1105) and prevents the switch being successfully reclosed, as the mechanism cannot latch in with the trip bar raised. However, there is nothing to prevent a momentary closure of the contacts, so DO NOT operate the mechanism to ON until the fuses have been replaced. All three fuses must be replaced, even though they may not all have blown: internal damage may not show.

8.32 See also sub-section 9.4

8.4 To Earth the Transformer Circuit

8.41 Note that the indication in the tank window (1130) is OFF. Ensure that the outgoing transformer circuit is isolated and locked off from any alternative supply at the remote end (e.g. via the medium) voltage circuits fed by the transformer) or any intermediate point (e.g. feeds via tee joints on the outgoing cable of a free-standing fuse switch).

8.42 Unlock the hinged MOVE BEFORE EARTHING padlockable link (1120) at the left hand side of the cover (1205) and move it clear of the earth switch handle stub (1125). Fit the removable operating handle (1126) to the stub.

8.43 Move the operating handle (1126) firmly forwards as far as it will go, to the EARTH ON position (1124) to earth the outgoing circuit (1197, 1104, 1114). The indication in the tank window (1130) will change to EARTH ON.

8.44 Because of the design of collapsible handle employed on the earth switch (1124, 1126) it is impossible for an operator to immediately re-open a closed earth switch; the operating handle (1126) must be removed and relocated from the rear to the front position. 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.

8.45 On completion of the earthing operation, remove the operating handle (1126). Pivot the padlockable MOVE BEFORE EARTHING link (1120) back to the stub (1124) and padlock it in position.

8.5 To Remove the Earth from the Transformer Circuit

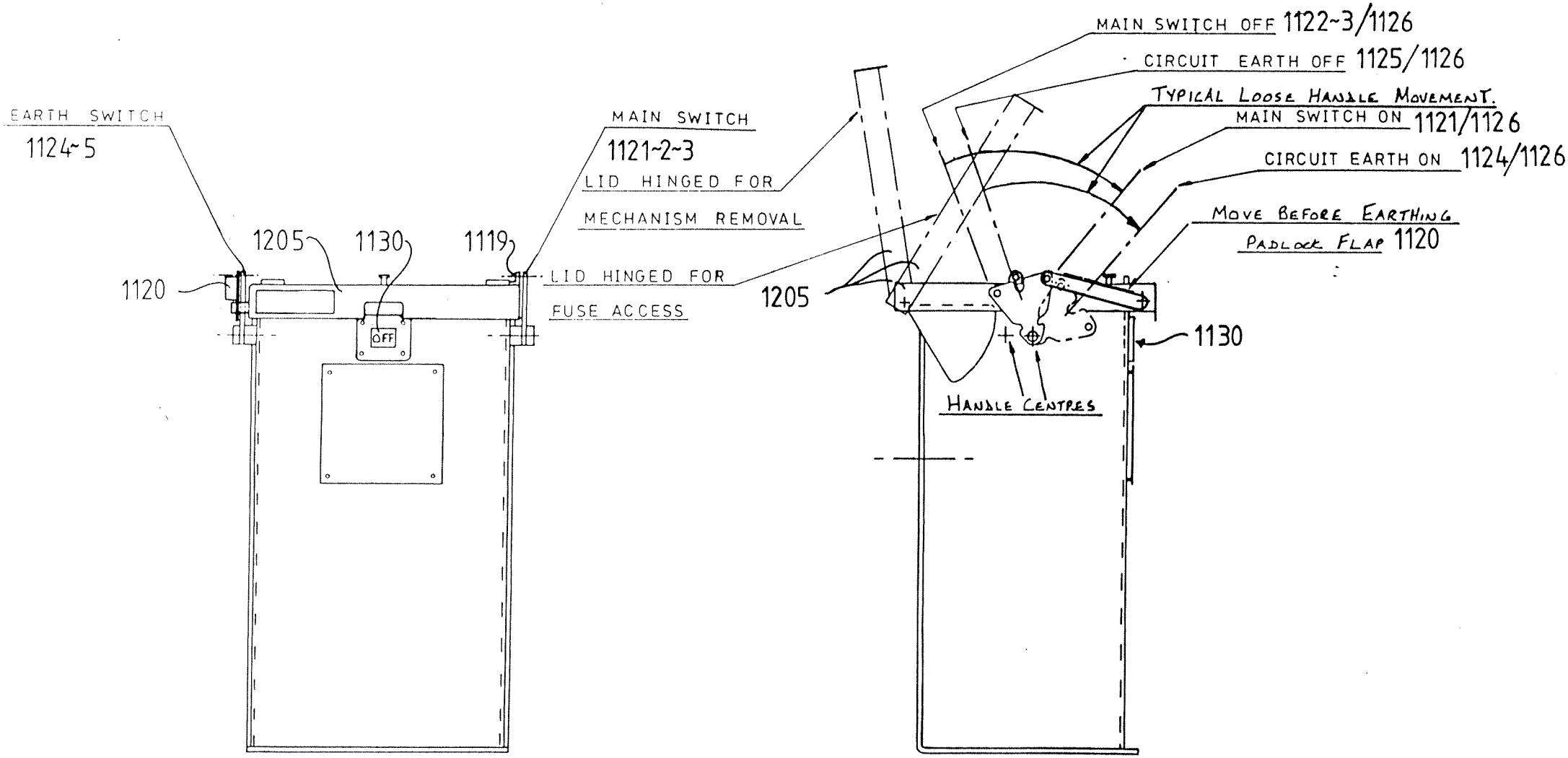
8.51 Note that the indication in the tank window (1130) is EARTH ON.

8.52 Unlock the hinged MOVE BEFORE EARTHING padlockable link (1120) at the left hand side of the cover (1205) and move it clear of the earth switch handle stub (1124). Fit the removable operating handle (1126) to the stub.

8.53 Move the operating handle (1126) firmly but smoothly backwards as far as it will go to the EARTH OFF position (1125) to remove the earth from the outgoing circuit. The indication in the tank window (1130) will change to OFF.

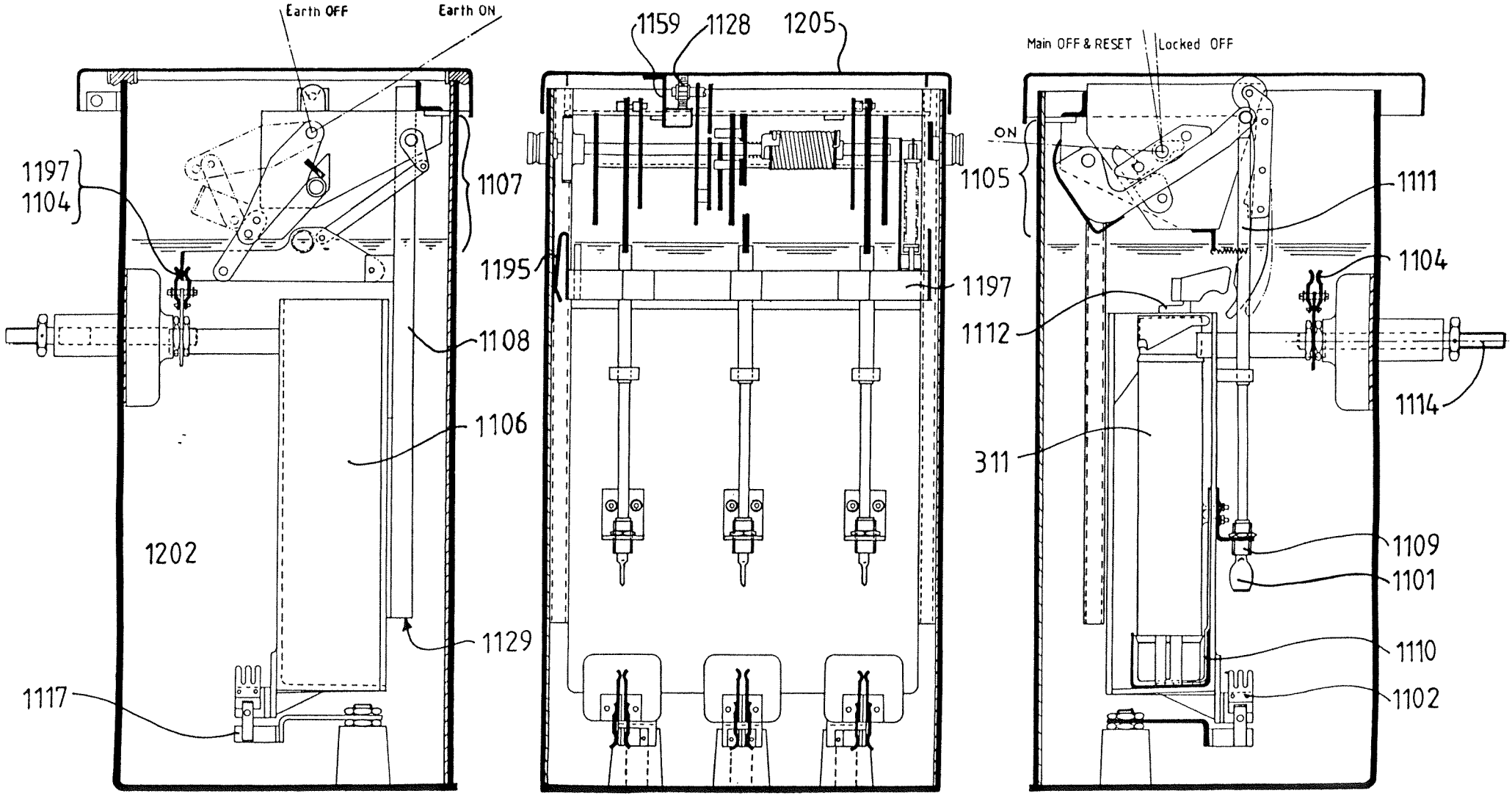
8.54 On completion of the opening operation, remove the operating handle (1126). Pivot the padlockable MOVE BEFORE EARTHING link (1120) back to the stub (1125) and padlock it in position.

Section 8, diagram 'A'



Section 8, diagram 'B'

Sections through FSA range fuse switch tank



9 MAINTENANCE

NOTE: Do not operate either switch unless the cover (1205) is securely fastened down.

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 operation in accordance with section 8 of this manual if this is desired, and if system operating constraints permit it.

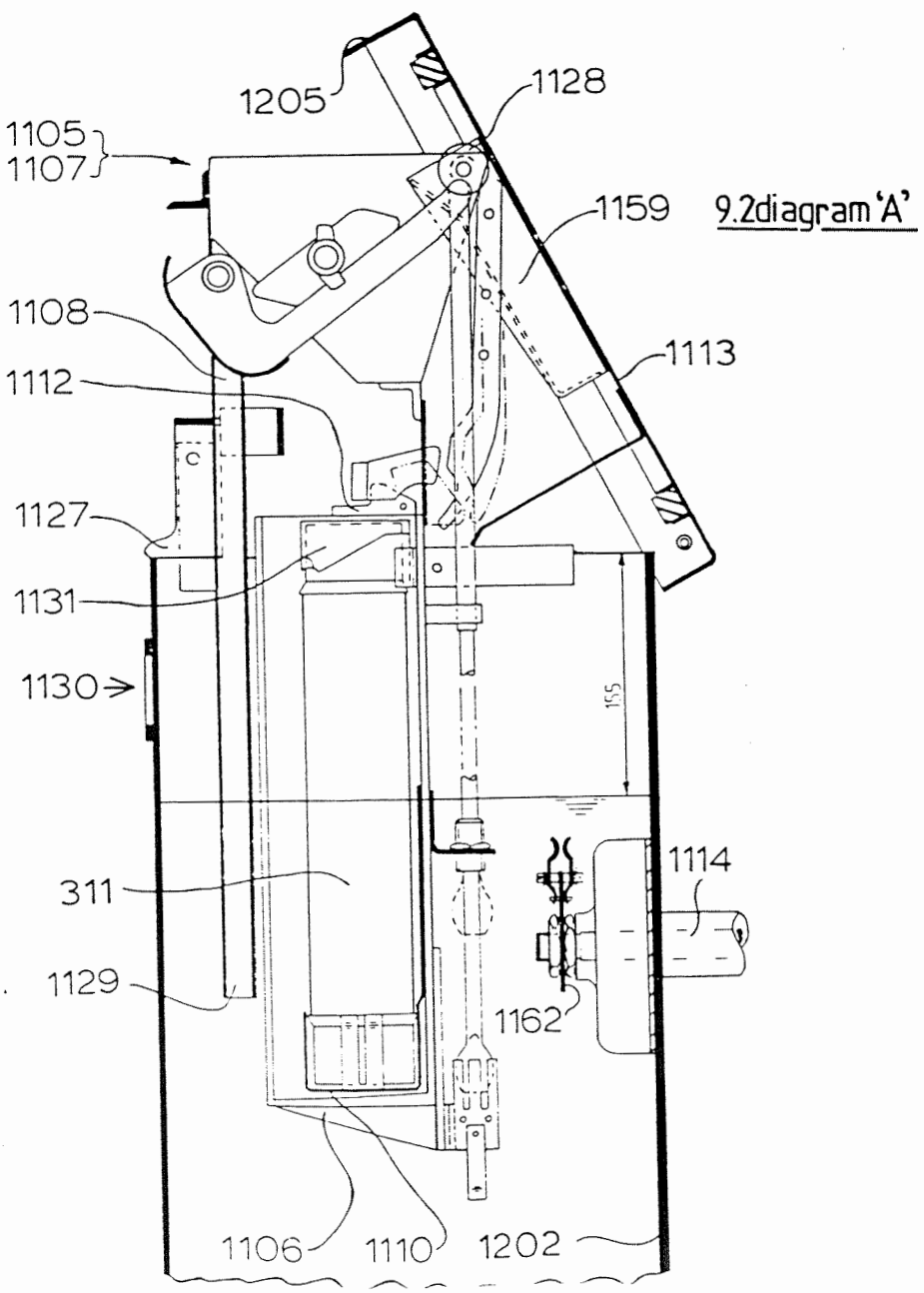
9.14 Internal examination/overhaul of the equipment (sub-section 9.2, 9.3, 9.7), with any repairs and replacements which may be found necessary, should be undertaken at intervals of not more than 10 years, and more frequently if at all possible.

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

9.16 Since the FS-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 and 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 with cloths having no loose fibres or metallic threads. Do not use any synthetic cloths in conjunction with cleaning solvents.



9.2diagram 'A'

9.22 WITH THE SWITCHBOARD BUSBARS (IF ANY) AND OUTGOING (1114) CIRCUIT CONNECTIONS MADE DEAD, LOCKED OFF AT ALL POSSIBLE POINTS OF SUPPLY AND EFFECTIVELY EARTHED, set the earth switch to EARTH OFF and the main switch to OFF and RESET (see section 8) positions as indicated by OFF in the tank window (1130). Unfasten the main cover retaining screws and raise the cover (1205). The spring loaded mechanism mainframe (1108) will rise with it. A carriage retaining clip (1127) on the left hand mainframe member will swing out to support the frame and lid. Slacken off the captive fasteners on the roller bracket (1159) on the underside of the cover (1205) and slide the bracket clear of the roller (1128) on the mainframe. The cover can now be swung back, clear of the tank top, and the mechanism mainframe (1108) can be lifted out.

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

9.24 Inspect the fuse links (311) for signs of mechanical or thermal damage, and replace any which show such signs. Find and correct the cause of any such fuse damage (e.g. loose contacts in the fuse carrier). Examine the switch mechanism (1105, 1107) for signs of wear, loose fastenings, burnt or split insulation etc., and tighten or replace as necessary. Inspect all contacts on the mainframe (1108) and fuse carriage (1106) for signs of burning or wear. Smooth with a file or replace any which require attention.

9.25 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 (1202). Should the oil be murky, or fail any of the prescribed tests, or should inspection show that maintenance work within the tank is required, then the tank must be emptied and later refilled. See sub-section 7.2 for the precautions to be observed.

9.26 Examine the mechanism components and the various fixed contacts within the tank (1202). 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 before it is refilled. Alternatively, in serious cases replacement may be necessary. Remove any foreign bodies from the tank bottom.

9.27 Make sure that the switch handle stubs are still set to EARTH OFF (1125) and RESET (1123) and replace the mechanism mainframe (1108) in its guides in the tank. Refill or top up the tank (1202) to the marked level with switch oil as described in sub-section 7.2. Pour oil over the mechanisms on the mainframe (1108). Lower the trip bar (1112) across the fuse tops.

9.28 Re-engage the top roller (1128) with the roller bracket (1159) on the underside of the cover (1205) and slide and fasten the bracket in its original position. Close and fasten down the cover after checking that its gasket is secure and in good condition.

9.29 Lubricate all external pivot points on the equipment with any good quality lubricating oil. Touch up any damaged paintwork (see sub-section 7.4). Check the operation of the handles and interlocks in accordance with sections 1, 2, 3 and 8 of this manual. Return the switch to service in accordance with section 8 of this manual.

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 precipitated.

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 and Fuse Renewal

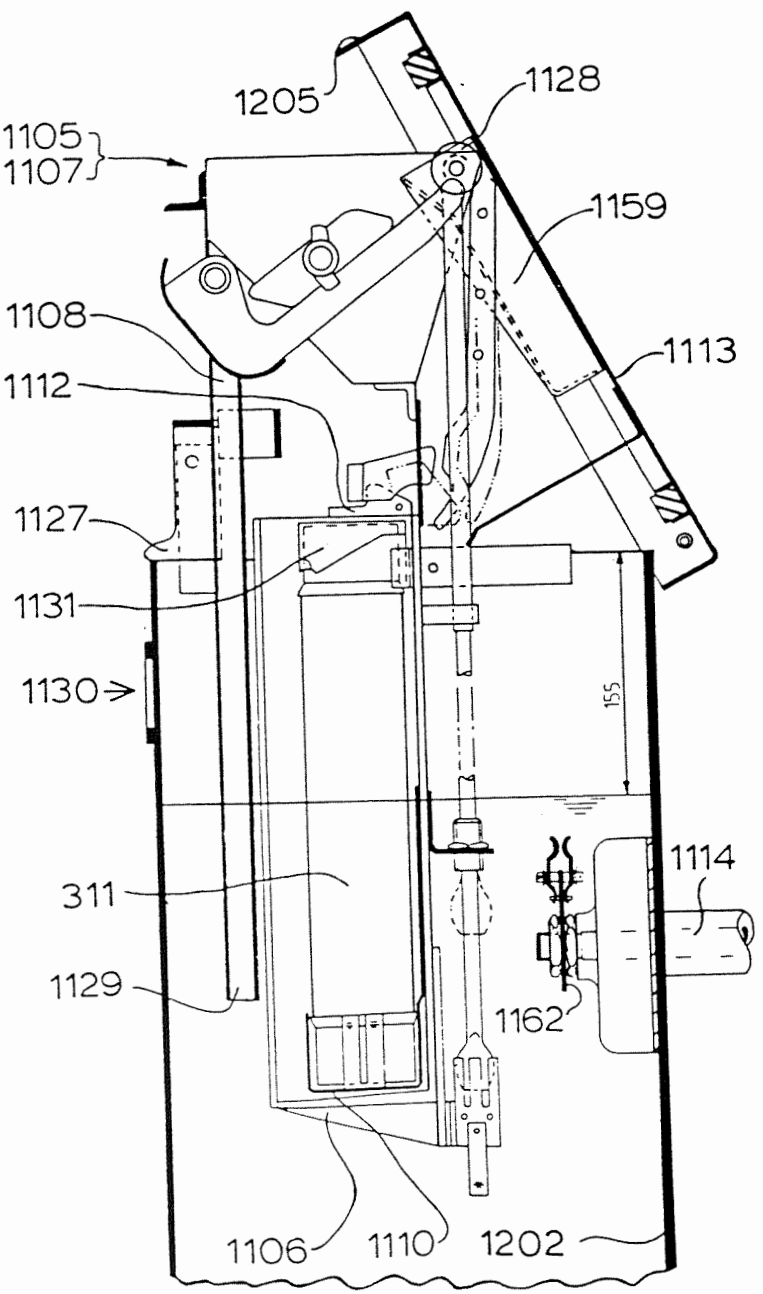
9.41 Either of two types of post-fault maintenance may be required. Where the fault making earth switch has been inadvertently closed onto a live cable (e.g. due to feedback through the protected transformer), routine maintenance as described in sub-section 9.2 should be undertaken. Where the fuses have operated to clear a through fault and tripped the main fuse switch, it is sufficient to replace all three fuses (blown or not). The switch contacts will only have operated to interrupt normal load current on the healthy phase or phases, and to isolate the outgoing circuit after the blowing of the fuse(s) on the faulty phase(s).

9.42 Fuses are to B.S.2692:1975, of oil-immersed type with striker pins and of barrel size 63 mm (2.1/2 in) diameter by 359 mm (14.1/8 in) or 254 mm (10 in) length, according to the design of lower fuse contact cup assembly (1110) which is fitted. Kits for conversion to take the alternative fuse size are available from our Leeds Office - see sub-sections 9.5 and 9.6.

9.43 Set the earth switch to OFF and the main switch to RESET as described in section 6.

9.44 Unfasten the screws securing the switch cover (1205) and raise the cover until the carriage retaining clip (1127) on the left hand mainframe member swings forward to support the carriage. The mechanism mainframe (1108) and its integral fuse carriage (1106) will rise with it under the influence of lifting springs (1129). The fuses are now accessible; raise the mechanism trip bar (1112) and the hinged contact clips (1131) of all three fuses. Remove and destroy or discard all three fuses, since any which have not blown may nonetheless have suffered some damage during the fault.

9.4 diagram 'A'



9.45 Insert the bottom contact (i.e. the end without a striker pin, as indicated on the fuse body) of each new fuse (311) in turn into its retaining cup (1110) in the fuse carriage (1106). Press each fuse down firmly to ensure that it is satisfactorily seated. Secure the hinged clips (1131) over the tops of the fuses and lower the trip bar (1112) across the tops of the fuses.

9.46 Take the weight of the cover (1205) with your right hand, disengage the retaining clip (1127) with your left hand and close and fasten the cover.

9.47 Padlock the main switch handle stub (1123) if immediate operation is not required.

9.5 Changing from 254 mm (10 in) to 359 mm (14.1/8 in) Fuses

9.51 Note that the following text applies where the existing fuse carriage (1106) is retained, but the lower fuse contact cups (1110) are re-positioned lower down in the carriage.

9.52 WITH THE SWITCHBOARD BUSBARS (IF ANY) AND OUTGOING (1114) CIRCUIT CONNECTIONS MADE DEAD, LOCKED OFF AT ALL POSSIBLE POINTS OF SUPPLY AND EFFECTIVELY EARTHED, set the earth switch to EARTH OFF and the main switch to OFF and RESET (see section 8) positions as indicated by OFF in the tank window (1130). Unfasten the main cover retaining screws and raise the cover (1205). The spring loaded mechanism mainframe (1108) will rise with it. A carriage retaining clip (1127) on the left hand mainframe member will swing out to support the frame lid. Slacken off the captive fasteners on the roller bracket (1159) on the underside of the cover (1205) and slide the bracket clear of the roller (1128) on the mainframe. The cover can now be swung back, clear of the tank top. The mechanism mainframe (1108) can now be lifted out.

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

9.54 Remove the fuses (if any) from the carriage (1106) and unfasten the eight screws and washers which secure the insulated carriage to its insulated front cover plate (1132) and to the mainframe (1108); lift the mainframe clear, so that it is only joined to the carriage by the main switch drive links (1111).

9.55 Unfasten the two nuts and washers securing each contact cup (1110) and remove the cups. Remove the nuts and washers from the two lowest studs beneath each cup. Replace the cups on the lowest studs to take the longer 359 mm (14.1/8 in) fuse size. Replace and tighten the washers and nuts on all four studs (i.e. those within the cup and those highest above it) on each phase.

9.56 Replace the mainframe (1108) and cover plate (1132) and replace the eight screws and washers to fasten them to the carriage (1106). Check that the new (i.e. longer) fuses fit into the carriage as they should. Leave them in position.

9.57 Make sure that the switch handle stubs are still set to EARTH OFF (1125) and RESET (1123) and replace the mechanism mainframe (1108) in its guides in the tank. Refill or top up the tank (1202) to the marked level with switch oil as described in sub-section 7.2. Pour oil over the mechanisms on the mainframe (1108). Lower the trip bar (1112) across the fuse tops.

9.58 Re-engage the top roller (1128) with the roller bracket (1159) on the underside of the cover (1205) and slide and fasten the bracket in its original position. Close and fasten down the cover after checking that its gasket is secure and in good condition.

9.6 Changing from 359 mm (14.1/8 in) to 254 mm (10 in) Fuses

9.61 Note that the following text applies where the existing fuse carriage (1106) is retained, but the lower fuse contact cups (1110) are re-positioned higher up in the carriage.

9.62 WITH THE SWITCHBOARD BUSBARS (IF ANY) AND OUTGOING (1114) CIRCUIT CONNECTIONS MADE DEAD, LOCKED OFF AT ALL POSSIBLE POINTS OF SUPPLY AND EFFECTIVELY EARTHED, set the earth switch to EARTH OFF and the main switch to OFF and RESET (see section 8) positions as indicated by OFF in the tank window (1130). Unfasten the main cover retaining screws and raise the cover (1205). The spring loaded mechanism mainframe (1108) will rise with it. A carriage retaining clip (1127) on the left hand mainframe member will swing out to support the frame and lid. Slacken off the captive fasteners on the roller bracket (1159) on the underside of the cover (1205) and slide the bracket clear of the roller (1128) on the mainframe. The cover can now be swung back, clear of the tank top. The mechanism mainframe (1108) can now be lifted out.

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

9.64 Remove the fuses (if any) from the carriage (1106) and unfasten the eight screws and washers which secure the insulated carriage to its insulated front cover plate (1132) and to the mainframe (1108); lift the mainframe clear, so that it is only joined to the carriage by the main switch drive links (1111).

9.65 Unfasten the two nuts and washers securing each contact cup (1110) and remove the cups. Remove the nuts and washers from the two highest studs above each cup. Replace the cups on the highest studs to take the shorter 254 mm (10 in) fuse size. Replace and tighten the washers and nuts on all four studs (i.e. those within the cup and those lowest beneath it) on each phase.

9.66 Replace the mainframe (1108) and cover plate (1132) and replace the eight screws and washers to fasten them to the carriage (1106). Check that the new (i.e. shorter) fuses fit into the carriage as they should. Leave them in position.

9.67 Make sure that the switch handle stubs are still set to EARTH OFF (1125) and RESET (1123) and replace the mechanism mainframe (1108) in its guides in the tank. Refill or top up the tank (1202) to the marked level with switch oil as described in sub-section 7.2. Pour oil over the mechanism on the mainframe (1108). Lower the trip bar (1112) across the fuse tops.

9.68 Re-engage the top roller (1128) with the roller bracket (1159) on the underside of the cover (1205) and slide and fasten the bracket in its original position. Close and fasten down the cover after checking that its gasket is secure and in good condition.

9.7 Maintenance of Busbar Chamber

9.71 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).

9.72 In the case of an FS-A indoor unit, 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).

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

9.74 Check that there is no oil leak from the switch tank (1202) at the point where the bushing moulding passes through from the tank to the busbar chamber.

9.75 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.

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

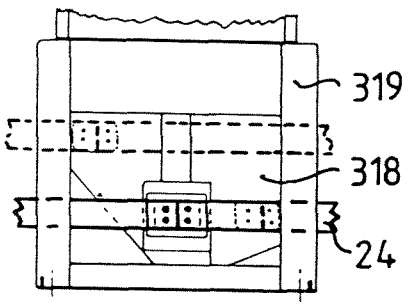
i) "ICI Genklene LV",
available from:

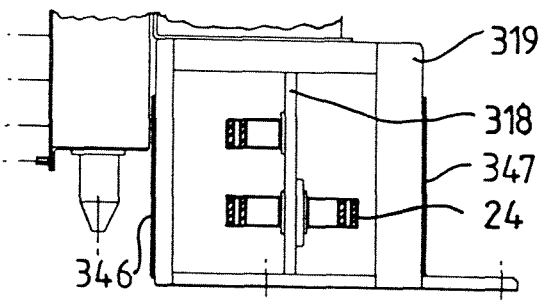
Ellis & Everard,
Dudley Hill Chemical Works,
Holme Lane,
BRADFORD, 4.
West Yorkshire.

ii) "Electrolube Ultraclene V",
available from:

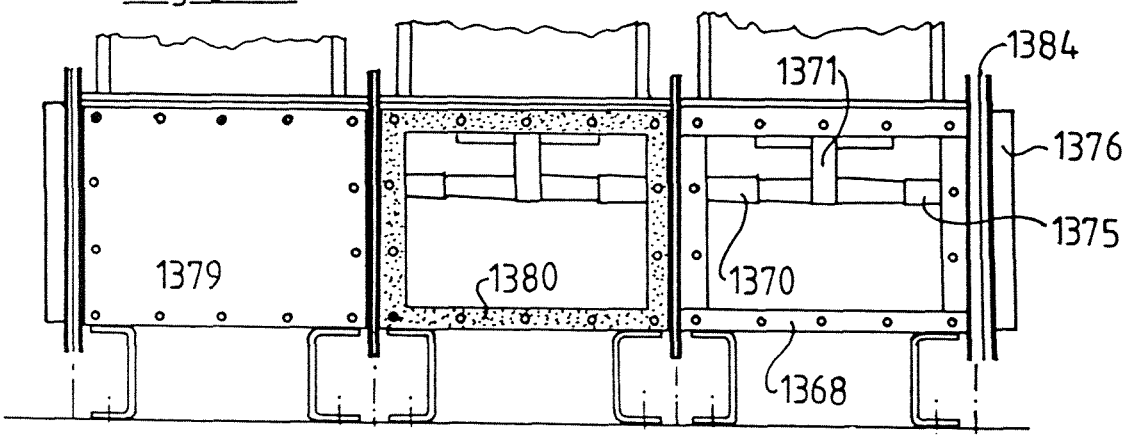
Automation Facilities Ltd.,
Blakes Road,
WARGRAVE,
Berkshire,
RG10 8AW.

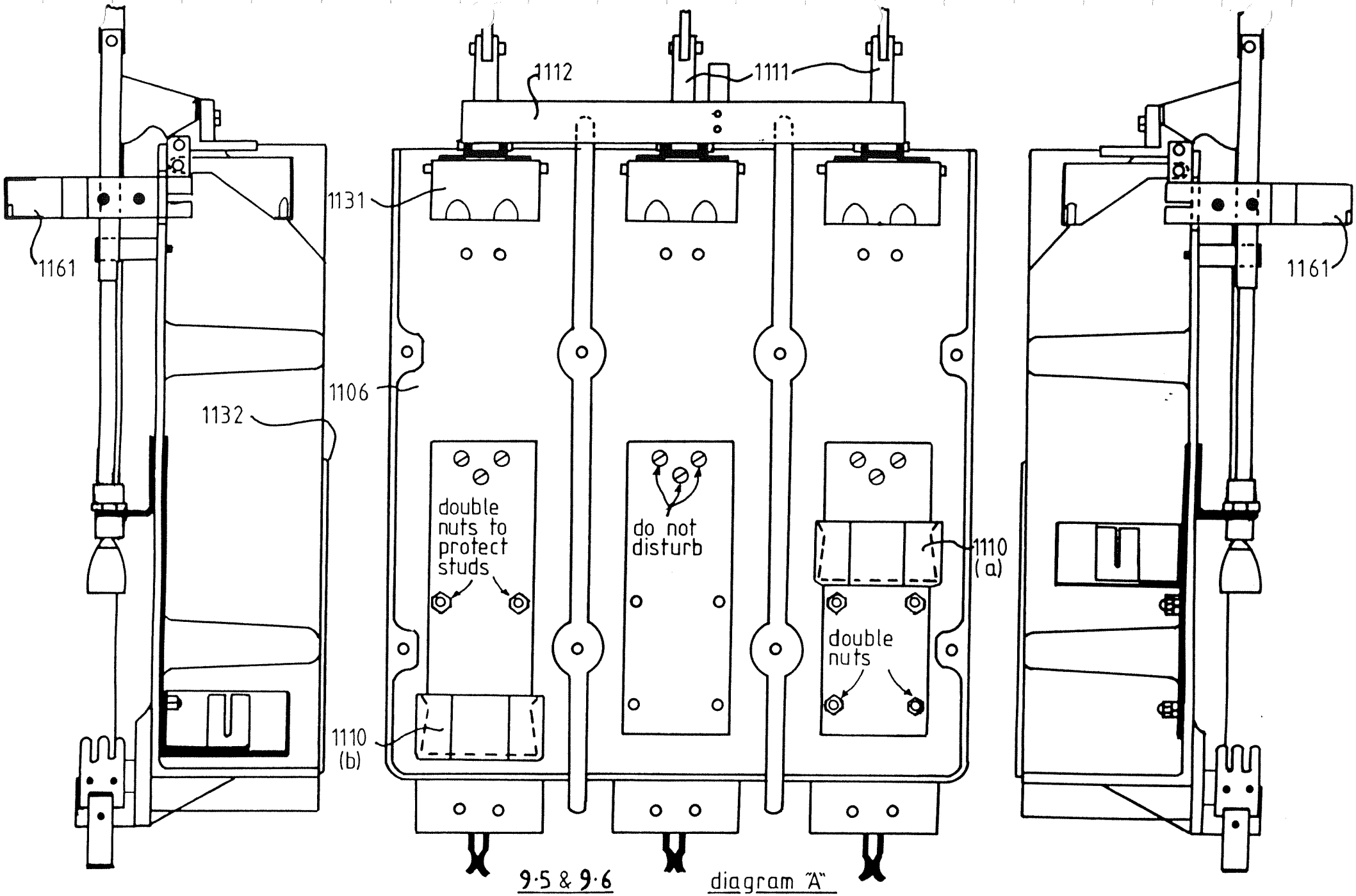
9.77 Check for foreign bodies in the chamber, then replace the front and (where fitted) back plates and their gaskets and fasten them securely.





9.7 diagram 'A'





9·5 & 9·6 diagram "A"

10 SPARES AND TOOLS

10.1 Spare Parts

10.11 Service experience with earlier designs of fuse switch has shown that the need for the replacement of any part of an FS-A fuse 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 FS-A fuse switch, serial No. 0100234, 15.5kV, 21.9kA, 150A, 50/60Hz.

Trip bar assembly, key No. 1112, as illustrated in 2.1 and 2.2 diagram "D", in the manual dated August, 1981, reference: D49-P1-39.

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	M8	M10	M12	M16
Metric A/F:	7 mm	8 mm	10 mm	13 mm	17 mm	17 mm	24 mm

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

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

24 Busbars (FS-A)
95 Flexible anti-vermin strips (FS-A)
96 Busbar end plate (FS-A)
97 Busbar securing studs (FS-A)
98 Busbar tee-off connection plates (inset) (FS-A)
99 Busbar fishplate spacers (FS-A)
100 Busbar joint box (FS-A)
101 Busbar joint box end piece (FS-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 (FS-A)
103 Busbar joint box cover (FS-A)
177 Unit-to-unit rigid cover plates to protect busbars (FS-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)
311 Fuses
316 Earth bar
318 Cast resin busbar support insulator (FS-A)
319 Air insulated busbar chamber (FS-A)
345 Busbar chamber baseplate (FS-A)
346 Busbar chamber back plate (FS-A)
347 Busbar chamber front plate (FS-A)
1101 Main fuse switch moving contacts
1102 Main fuse switch fixed contact assemblies, engaged by (1101) and (1117)
1104 Earth switch fixed contacts
1105 Main fuse switch mechanism
1106 Fuse carriage (insulated construction) on (1108)
1107 Earth switch mechanism
1108 Mechanism mainframe
1109 Annular sliding contact with (1101)
1110 Lower fuse contact cups (a) for 254 mm (10 in) fuses
(b) for 359 mm (14.1/8 in) fuses
1111 Insulated drive links between (1105) and (1101)
1112 Main fuse switch trip bar
1114 Outgoing circuit bushings
1117 Fixed contacts connected to (318)
19 Main switch padlock point
1120 Hinged MOVE BEFORE EARTHING Padlockable link
1121 Main switch handle stub: ON position
1122 Main switch handle stub: OFF position
1123 Main switch handle stub: RESET position
1124 Earth switch handle stub: EARTH ON position
1125 Earth switch handle stub: EARTH OFF position
1126 Removable operating handle (designs vary)
1127 Carriage retaining clip
1128 Cover roller at top of (1108): engages (1159)
1129 Mainframe lifting springs to raise (1108)
1130 ON/OFF/EARTH ON indication visible through tank window
1131 Hinged upper fuse contact clip
1132 Insulated front cover plate to (1106)
1133 Main switch main shaft
1137 Main switch stop pin engaged by (1147)
1138 Main switch closing spring winding lever
1139 Main switch closing spring
1140 Main switch disc ratchet drive lever
1142 Main switch rotor release lever
1144 Main switch trip catch
1145 Main switch opening springs
1146 Neoprene-bonded gaskets as alternative to (1180) on cable box
1147 Main switch stop and reverse motion trip lever on (1133)
1148 Main switch reverse motion trip bolt
1149 Main switch trip bar trip lever
1150 Earth switch mechanism shaft
1151 Earth switch spring compression lever
1152 Earth switch operating springs
1153 Earth switch toggle lever
1154 Earth switch toggle drive link
1155 Earth switch toggle nudger
1156 Earth switch indication drive link
1157 Earth switch side arms at ends of (1197)
1158 Main switch/earth switch interlock lever (a) head
(b) tail
1159 Mechanism/cover roller bracket engaged by (1128)
1161 Outgoing circuit moving isolating contact on (1106)
1162 Outgoing circuit fixed isolating contact on (1114)
1165 Transformer HV flange
1166 Cable box (a) rear mounted
(b) front mounted (FS-AT)

1167 Angle iron stand (FS-AT)
1168 Flange around (1114) (FS-AT)
1169 Operating platform (FS-AT)
1170 Rag-bolt floor fixings (FS-AO, AT)
1171 Cable glands
1173 Gasket between (1165) and (1168) (FS-AT)
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
1189 Earth switch drive crank
1190 Interlock cam on (1133) interacts with (1158b)
1193 Interlock arm on (1157) interacts with (1207) and (1209)
1194 Main switch mechanism spur gears
1195 Earth switch mechanism wiping contact
1196 EARTH ON indicator plate
1197 Earth switch moving contacts
1198 Main switch main levers (set of three)
1199 Main switch rotor release catch
1200 Main switch disc ratchet
1201 Main switch rotor
1202 Oil tank
1203 Mechanism frame member
1204
1205 Tank cover
1206 Interlock pin on tank side (engages 1207)
1207 Main switch drive crank
1208 Earth switch indication drive shaft driven by (1156)
1209 Interlock pin on tank side (engages 1193)
1210 ON/OFF indicator plate on central main lever (1198)
1211 Pin on tank front wall engaged by (1210)
1212 Pin on (1198) engaged by (1158b)
1213 Rotor arrestor spring
1368 Busbar chamber (FS-AO)
1369 Busbars (FS-AO)
1370 Heat shrinkable busbar connection insulating sleeve (FS-AO)
1371 Resin moulding incorporating (1369) (FS-AO)
1372 Split metal sleeve for busbar joint (FS-AO)
1373 Heat shrinkable metal locking rings to secure (1372) in position (FS-AO)
1374 Metal bush for end of (1369) on end panel (FS-AO)
1375 Heat shrinkable insulating "boot" for (1369/1374) on end panels (FS-AO)
1376 Busbar chamber end cover (FS-AO)
1377 Unistrut tie bar jigs (FS-AO)
1378 Busbar chamber flange (FS-AO)
1379 Busbar chamber front cover (FS-AO)
1380 Gasket for (1379) (FS-AO)
1382 Busbar chamber rainsheds (FS-AO)
1383 Removable feet (FS-AO)
1384 Gasket for (1376) (FS-AO)
1385 Aluminium foil heat shield for (1370) (FS-AO)