Instructions for
Type DS
Metal-Enclosed Low-Voltage
Power Circuit Breaker Switchgear

READ AND UNDERSTAND THESE INSTRUCTIONS
BEFORE ATTEMPTING ANY UNPACKING, ASSEMBLY,
OPERATION OR MAINTENANCE OF THIS SWITCHGEAR

Westinghouse Electric Corporation
Switchgear Division, East Pittsburgh, Pa. 15112
I.B. 32-690-C Effective May, 1980 Supersedes I.B. 32-690-B dated June, 1970

CAUTION

The metal-enclosed switchgear described in this book was designed and tested to operate within its nameplate ratings. Operation outside of these ratings may cause the equipment to fail, resulting in bodily injury and property damage.

PURPOSE

The instruction book is expressly intended to cover the installation, operation and maintenance of Type DS Metal-Enclosed, Low-Voltage, Power Circuit Breaker Switchgear used with Types DS and DSL Breakers.

For application information, consult your nearest Westinghouse sales office, see Westinghouse Descriptive Bulletin 32-850, or appropriate ANSI Standards.

For installation, operation and maintenance of Low Voltage Power Circuit Breakers, Types DS and DSL, see Westinghouse Instruction Book I.B. 33-790-1.

SAFETY

All Safety Codes, Safety Standards and/or Regulations must be strictly observed in the installation, operation and maintenance of this equipment.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

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Table 1 – Ratings of Type DS Breakers

Interrupting Ratings of Type DS Breakers at System Voltages are given in the following table.

Breaker Type	Frame Size, Amp.	Interrupting Ratings, RMS Symmetrical Amperes With Instantaneous Trip 208-240V	480V	600V	With Short Delay Trip ① ② 208-240V	480V	600V
DS-206	800	42,000	30,000	30,000	30,000	30,000	30,000
DS-206S	800	50,000	42,000	42,000	42,000	42,000	42,000
DS-416	1600	65,000	50,000	42,000	50,000	50,000	42,000
DS-416S	1600	65,000	65,000	50,000	65,000	65,000	50,000
DS-420	2000	65,000	65,000	50,000	65,000	65,000	50,000
DS-632	3200	85,000	65,000	65,000	65,000	65,000	65,000
DS-840	4000	130,000	85,000	85,000	85,000	85,000	85,000

① Also short-time ratings.
② Short circuit ratings of non-automatic breakers except the DS-840 which is 65,000.

Maximum voltages at which the interrupting ratings apply are:

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

Interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15 second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of 1/2 second each, with a 15-second interval of zero current between the two periods.

Current Limiting Type Breakers and Combinations

Type	DSL-206	DSL-416	DSL-632	DSL-840
Frame Size, Amperes	800	1600	3200	4000
Max. Interrupting Rating, RMS Symm. Amp., System Voltage 600 or Below	200,000	200,000	200,000	200,000

Notes: DSL-206 and DSL-416 include limiters integral with drawout breaker elements. DSL-632 includes DS-632 breaker and DS-3200 drawout fuse truck, in separate interlocked compartments. Maximum continuous rating limited to 3000A when fuse compartments is above breaker compartment in same unit. DSL-840 includes DS-840 breaker and DS-4000 drawout fuse truck, in separate interlocked compartments. Maximum interrupting rating limited to 150,000 amperes when 6000A fuses are used.

Continuous Current Ratings

Circuit breakers are maximum-rated devices and have no built-in temporary overload current ratings. Consequently, it is vital that each application take into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any Type DS breaker is limited to 125% of the sensor rating, or the frame size current rating, whichever is the lesser. For instance, a Type DS-416 1600 ampere frame breaker with 800 ampere sensors has a maximum continuous rating of 800 times 1.25 or 1000 amperes, but the same breaker with 1600 ampere sensors is limited to 1600 amperes maximum.

All current ratings are based on a maximum ambient air temperature of 40°C (104°F) outside of the switchgear enclosure.

See Item 8.6, Sensors, I.B. 33-790-1.

INTRODUCTION

Metal-enclosed switchgear with Type DS Low Voltage AC Power Circuit Breaker controls and protects power circuits up through 600 volts. The switchgear assembly is composed of units that are arranged to suit the Customer's requirements. Each breaker unit is divided into two or more compartments containing one or more Type DS Drawout Air Circuit Breakers. An instrument compartment may be included that will contain potential transformers, instruments, meters, relays and secondary control devices. The rear of the unit will include busses and space for the main cables.

The metal-enclosed switchgear is designed, manufactured, and tested in accordance with industry standards. It is available for both indoor and outdoor installations. Typical indoor assemblies are shown in Figs. 1 to 4. The Types DS and DSL Air Circuit Breakers are shown and described in I.B. 33-790-1.

This instruction book has been prepared to familiarize the Purchaser's engineering, installation, and operating staffs with the metal-enclosed switchgear supplied by Westinghouse. Personnel responsible for supervision, operation or maintenance should become well acquainted with the appearance and characteristics of each piece of equipment contained in or mounted on the switchgear.

Proper installation, operation, and maintenance are necessary to assure continued satisfactory service from the equipment. It should not be installed in places where it will be called upon to operate at voltages, currents, or fault capacities greater than those for which it was designed, or where the environment is unsuitable.

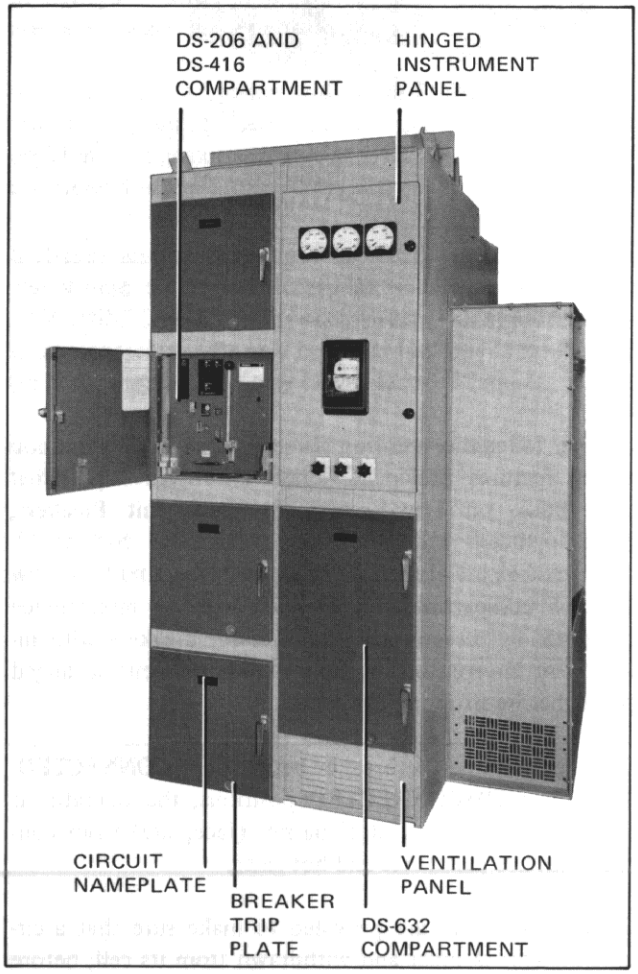


Fig. 1 *Type DS Indoor Metal-Enclosed Units: Front View (388880)**

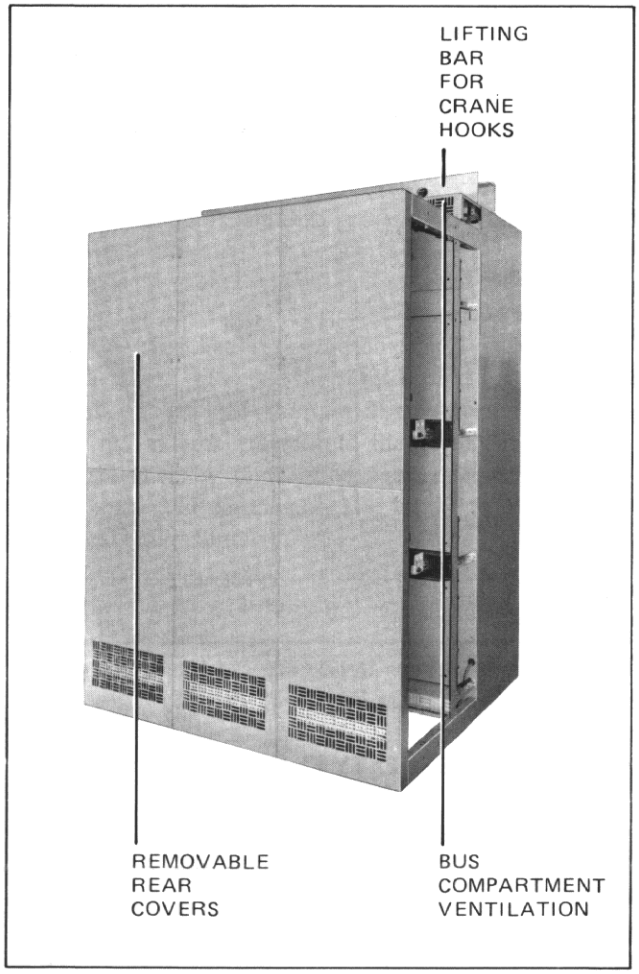


Fig. 2 *Type DS Indoor Metal-Enclosed Units: Rear View (391316)**

*Photo Identification Number

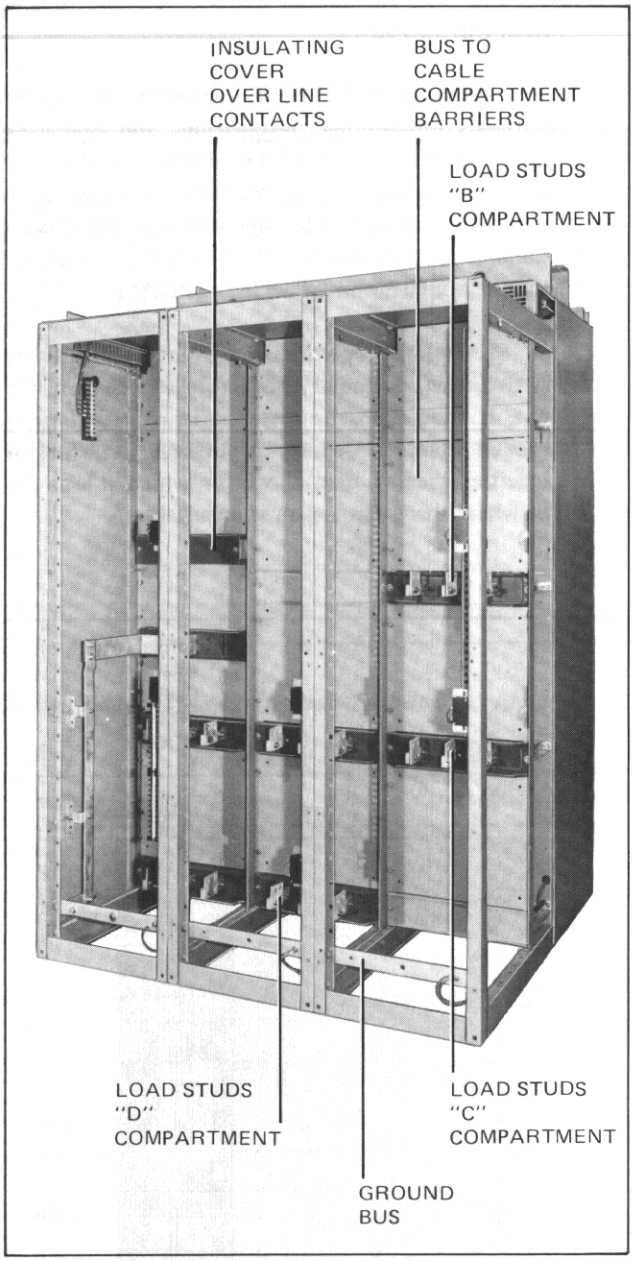


Fig. 3 *Type DS Indoor Metal-Enclosed Units: Rear View with Rear Covers Removed (391315)*

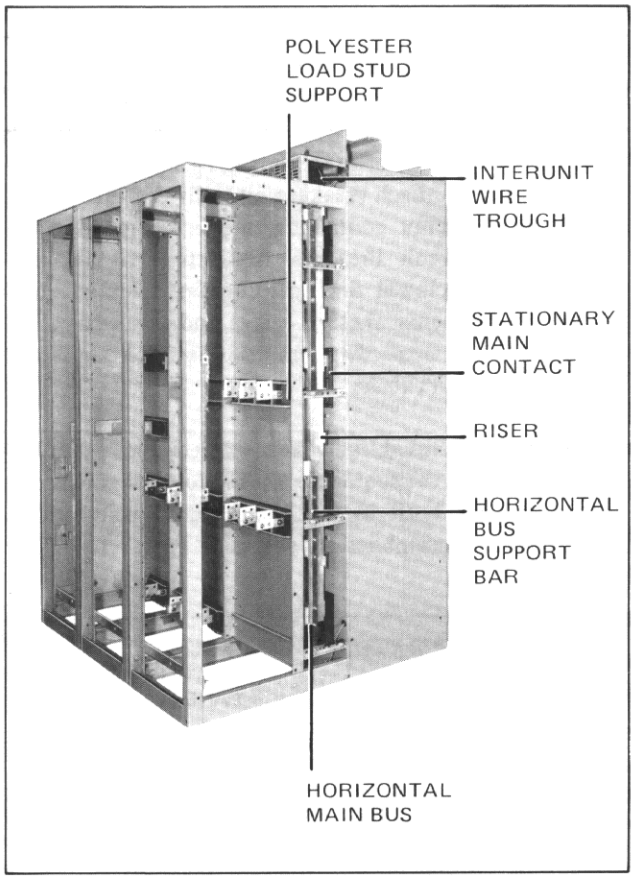


Fig. 4 *Type DS Indoor Metal-Enclosed Units: Side View with Rear Covers Removed (391313)*

WESTINGHOUSE SAFETY FEATURES

Westinghouse Type DS Metal-Enclosed Low-Voltage Switchgear is manufactured with several built-in interlocks and safety-related features. They are provided to reduce hazards to operating personnel and provide proper operating sequences. **UNDER NO CIRCUMSTANCES SHOULD THEY BE MADE INOPERATIVE AS THIS MAY RESULT IN BODILY INJURY OR PROPERTY DAMAGE.**

The following are but three of the most common safety features provided. Others are listed in Instruction Book on Low-Voltage Power Circuit Breakers, I.B. 33-790-1.

1. Each compartment is provided with an interference interlock to prevent inserting. Circuit breakers with insufficient interrupting ratings into compartments arranged for higher interrupting capacities.

2. When levering the breaker between the **CONNECTED, TEST and DISCONNECTED** positions, the operator is fully protected by a steel barrier (faceplate) from contact with live parts, arcs and hot gases.

3. Key Interlocks are provided to make sure that a circuit breaker is open and withdrawn from its cell, before the key can be used in another position. Also, with the key withdrawn, interlock mechanism blocks any breaker from being levered into the cell.

RECOMMENDED SAFETY PRACTICES

Type DS Metal-Enclosed, Low-Voltage Switchgear is complex high current electrical equipment. It is designed to operate within the voltage and current limitations shown on its nameplates. Do not apply these units to systems with voltages and/or currents in excess of these limits.

1. To perform work on this type of equipment requires personnel with training and experience in high current circuits. Only qualified electrical workers familiar with the construction and operation of such equipment and the hazards involved, should be permitted to work on this equipment.

2. Only Qualified Persons as defined in the National Electric Safety Code should be permitted to assemble, operate or maintain this equipment.

3. Always be sure that the primary and secondary circuits are de-energized before attempting any maintenance.

4. Never insert a breaker without arc chutes and barriers into an energized metal-enclosed cell beyond the test position. For maximum safety, only insert a completely assembled breaker into an energized cell.

5. Never leave breaker in an intermediate position in a compartment. Always have the breaker either in the **DISCONNECTED, TEST or CONNECTED** position because control circuits may be either improperly connected (or disconnected) and may cause electrical failures.

6. Do not remove any access covers unless the circuits to be exposed are de-energized.

7. Do not attempt any work within this equipment without first confirming that all circuits are de-energized.

8. After maintenance be sure every current transformer secondary circuit is completely connected or is shorted. An open-circuited secondary can produce dangerously high voltages when power current is flowing through the current transformer.

9. Always be sure that all switchgear hardware is in place and bolted tightly before inserting breaker into its compartment.

10. Keep fingers away from top and side barrier when moving breaker into or out of cell. Use handle on breaker panel for this purpose.

Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear assemblies are strongly built and provided with many safety features. When all doors are closed and all covers properly installed, there is No. 11 gage steel between the power circuits and nearby personnel. Nevertheless, they contain power circuits with high fault capacity which are dangerous. When any door is opened or any cover removed, it is possible to make contact with bare conductors or terminals which may be "live" when the assembly is energized or if a separate control power source is connected. The voltages and power levels available in this equipment make this type of exposure extremely dangerous. All power should be turned off or adequate protective equipment should be used when working inside this equipment. Do not guess – be sure that the power is off and take the necessary steps to insure that it stays off until the doors and covers are again properly installed. Only qualified persons should be permitted to install, operate, or maintain this equipment. In addition to the hazards inherent to the switchgear assembly itself, operation by unqualified persons may cause damage to connected equipment, and injury to operators of connected equipment.

QUALIFIED PERSONS

For the purpose of operating switchgear assemblies a person who has been thoroughly trained in the operation of the circuit breakers and instrumentation included in the assembly and who has complete knowledge of the loads connected to the switchgear assembly may be considered to be a QUALIFIED PERSON.

For the purposes of installing, inspecting and maintaining switchgear assemblies, a QUALIFIED PERSON must also be thoroughly trained in regard to the hazards inherent to working with electricity and in the proper way to perform such work. He should be able to de-energize, clear and tag circuits in accordance with established safety practices. He should be equipped with, and trained in the use and care of, protective equipment such as rubber gloves, rubber blankets, flash clothes, etc. for those occasions when it is not possible to de-energize all circuits before doing maintenance work in the area.

Even a QUALIFIED installer, inspector, or maintenance person

1. Should be thoroughly familiar with all of the information in this book.

2. Should never work alone.

3. Should never work on an energized circuit.

4. Should never work in the vicinity of energized circuit without using proper safety equipment.

5. Should exercise extreme caution in handling tools and equipment in the vicinity of exposed energized equipment.

6. Should exercise care in removing all foreign equipment such as tools, etc. before replacing equipment covers.

PRECAUTIONS

1. If any relays are included, remove all blocking. Check control circuits (except potential and current transformer circuits) for grounds and short circuits before applying control power.

2. Connect the switchgear to the station ground before applying any power.

3. In case of fire do not use liquid fire extinguishers until all circuits have been made electrically "dead".

4. If outdoor switchgear is to be stored prior to installation, provision must be made for energizing the space heaters to control condensation of moisture inside the switchgear.

5. If indoor switchgear is to be stored prior to installation, it must be protected from the weather and be kept free of condensation.

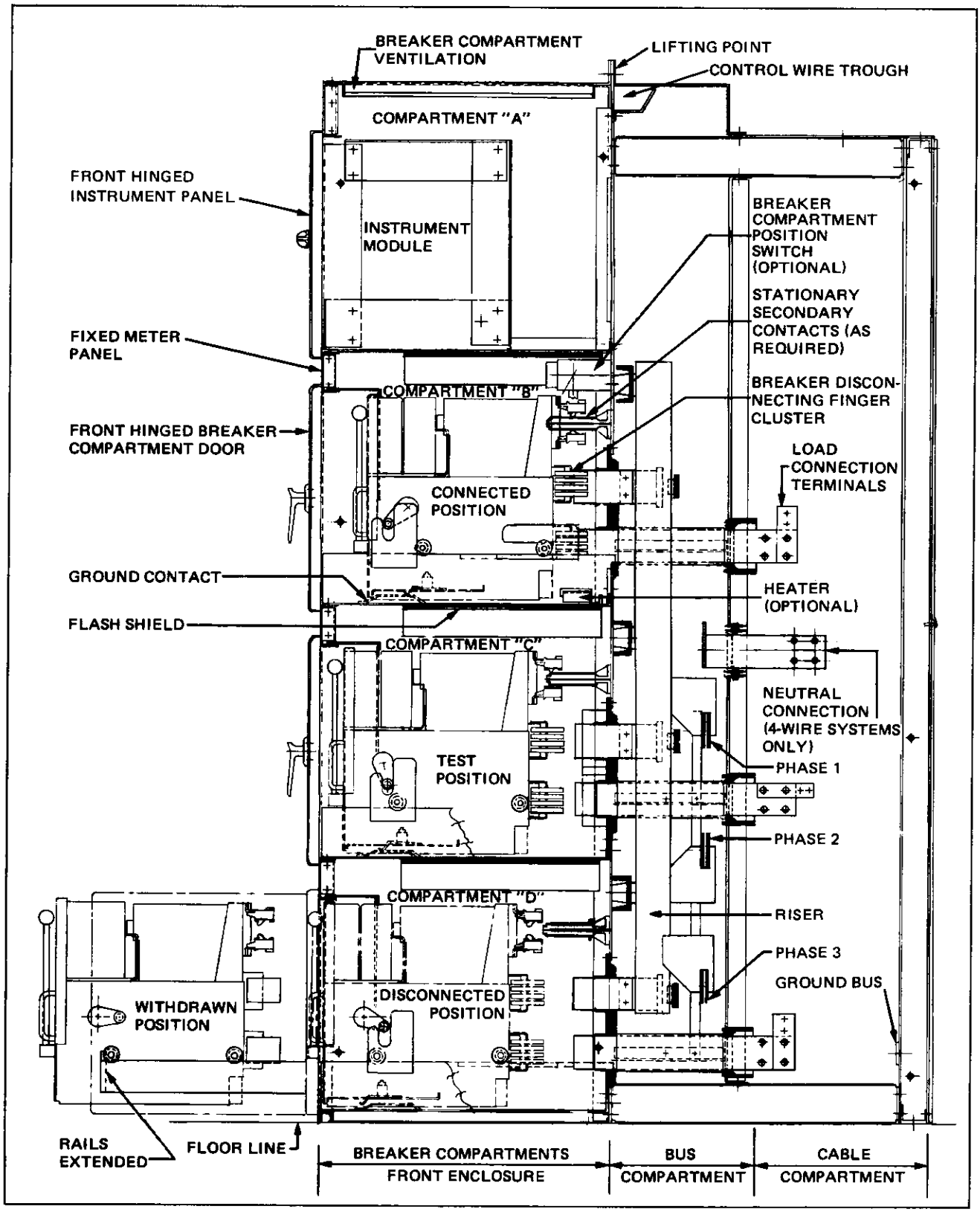


Fig. 5 *1600/2000 Amp Unit with Aluminum Bus: Side View*

SECTION 1 – DESCRIPTION OF TYPE DS SWITCHGEAR

1.0 GENERAL

The following descriptions apply to standard metal-enclosed construction and wiring. Extra features and special control schemes are often incorporated when specified by the Purchaser's order. These special features are evident on the drawing and diagrams for the switchgear assembly. Instructions on standard apparatus such as relays, instruments, control switches, and circuit breakers are included elsewhere in the complete instruction book for a particular metal-enclosed assembly.

Low-voltage (600 volts and below) indoor and outdoor metal-enclosed switchgear having drawout mounted type DS and DSL (integrally fused) air circuit breakers is factory assembled and tested. It is designed to require a minimum amount of labor for installation. Shipments are made with the lineup completely assembled, or may be divided into one or more shipping groups, depending upon the number of units, total length and limitation of handling facilities at the point of installation.

The switchgear consists of a stationary structure that includes one or more free standing units mechanically and electrically joined to make a single coordinated installation. Each unit consists of three major parts: Front Enclosure, Bus Compartment, and Cable and Terminal Compartment. See Fig. 5.

Type DS metal-enclosed switchgear is available for both indoor and outdoor applications. The circuit breakers and design features are similar whether the installation be indoor or outdoor. In general, outdoor metal-enclosed switchgear is constructed by assembling a weatherproof enclosure onto and around standard indoor housings. See Figs. 25 and 26.

In the majority of installations the line-up is close-coupled to a main transformer to form a coordinated secondary unit substation. These substations may be single-ended with only one transformer, or double ended with transformers on both ends. If the transformer is the liquid filled type, the bus transition connections will be made in either a reduced size transition unit or a full sized auxiliary unit on indoor equipment or in a standard transition throat in the case of outdoor equipment.

1.1 INDOOR CONSTRUCTION

1.1.1 Front Enclosure

The front enclosure consists of a welded heavy gauge sheet steel structure. This structure may be an auxiliary unit used to house instruments, relays, switches and their associated auxiliary equipment or it may be divided into from two to four individual compartments used to house circuit breakers (removable elements). Figs. 6 and 8 show removable elements in their compartments. Figs. 9 and 10 are close-ups of compartments with breakers removed. These individual compartments may also be used as instrument compartments by omitting the circuit breaker and its associated stationary parts. The hinged door then becomes available for mounting instruments, relays, etc. This is shown in the upper right compartment in Fig. 1.

Between vertical compartments are bolted-in panels that may be blank or may be used for mounting small instruments, instrument switches, pushbuttons, lights or other devices within the space limitations. The compartment doors employ a piano type hinge to insure rigidity.

1.1.2 Breaker Compartments

In compartments equipped for circuit breakers, a bolted-in cradle supports the wheels of the removable element, provides the stationary engagement for the levering device and includes the stationary ground contact and trip linkage. See Figs. 7 and 9.

A molded glass polyester plate at the rear of the compartment supports the six stationary disconnecting contacts and up to three metering current transformers, if required. See Fig. 10.

Secondary control disconnecting contacts when required are located on the rear wall above the stationary primary contacts and provide the control circuits to the drawout element. See Fig. 9.

The breaker compartment provides for four positions of the removable element, namely; "connected", "test", "disconnected", and "remove". Each specific position is indicated by the position indicator on the circuit breaker as it is levered into and out of the compartment.

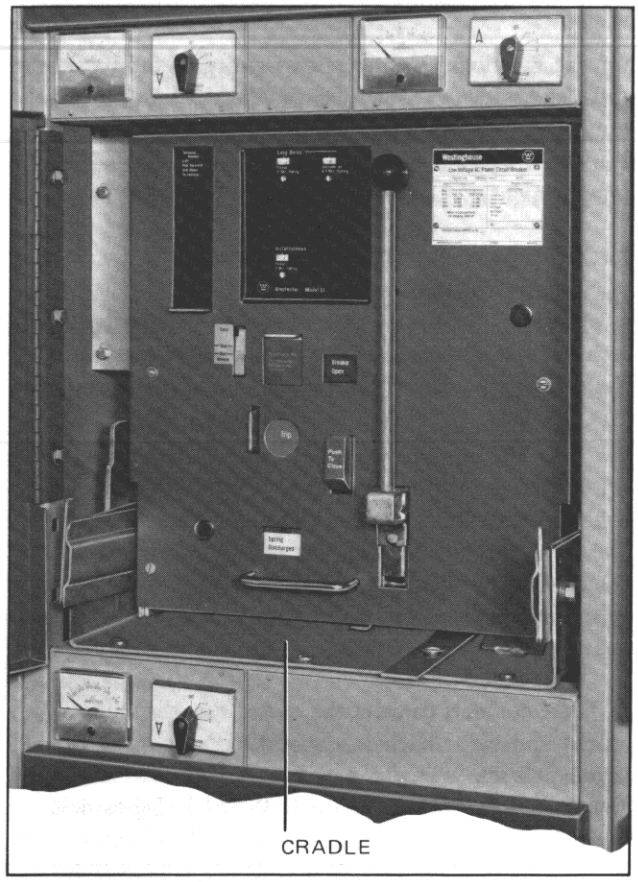


Fig. 6 *Type DS-206 Breaker in Connected Position (392506)*

Fig. 8 *Type DS-632 Breaker in Connected Position (391179)*

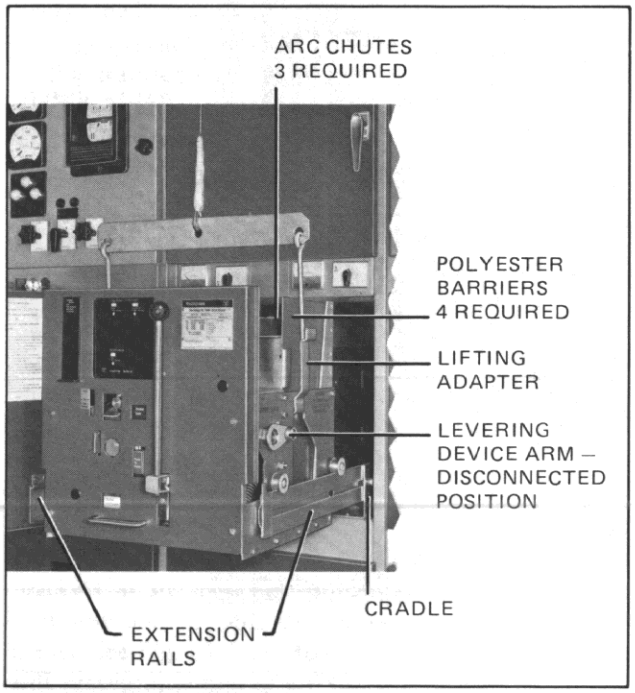


Fig. 7 *Type DS-206 Breaker on Extension Rails (392503)*

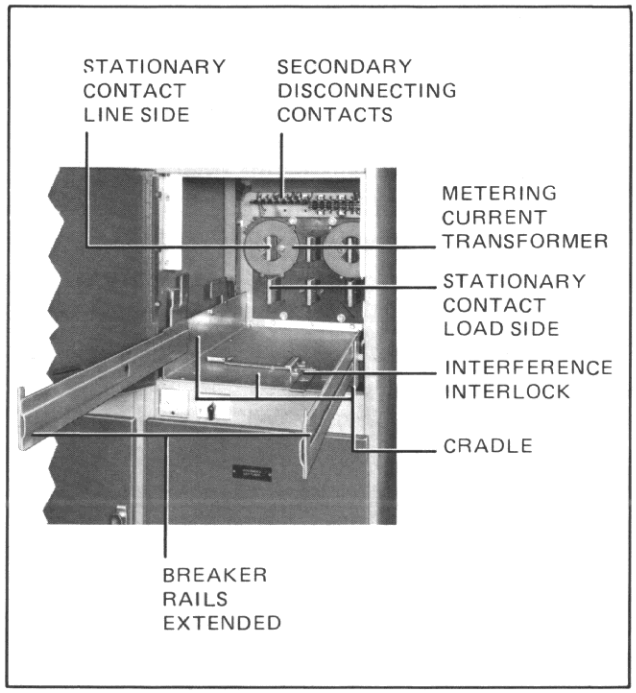


Fig. 9 *Type DSL-416 Breaker Compartment (392395)*

In the "connected" position, both the primary and secondary disconnecting devices are engaged, and the circuit breaker is ready for operation. See compartment "B" Fig. 5. In the "test" position, only the secondary disconnecting devices are engaged, and the circuit breaker can be operated without energizing the power circuit. See compartment "C" Fig. 5. In the "disconnected" position, both the primary and secondary disconnecting devices are disengaged, and the entire circuit breaker is isolated. The removable element is still held captive in the compartment in this position. See compartment "D" Fig. 5.

The levering device is moved to the "remove" position by one to three additional turns of the levering crank. The circuit breaker can then be freely rolled out of the compartment onto the extension rails (see compartment "D" Fig. 5). The compartment door may be closed and latched with the removable element in any one of the above positions. See Fig. 7 also.

The breakers are provided with finger clusters that engage the stationary main contact stabs at the rear of the compartment when in the connected position. Secondary disconnecting contacts connect the control circuits when in the test and connected positions. The positive interlock on the levering-in device insures proper operating sequence, and this is described in detail in the air circuit breaker Instruction Book I.B. 33-790-1.

1.1.3 Breaker Rails

Refer to Figs. 9 and 10. In compartments with circuit breakers two extendable rails are also supported by the bolted-in cradle.

To withdraw breaker beyond the REMOVE position, pull out both extensible rails until front ends drop to horizontal positions. Pull handle on the front breaker panel. This force will cause the breaker, with two flanged wheels on each side, to roll out of the cell on the rails.

1.1.4 Ground Contact

Stationary ground contact on the compartment floor engages a corresponding contact on the bottom of the breaker as it is levered into the cell. When engaged these contacts provide positive grounding of the breaker frame. See Fig. 10.

1.1.5 Trip Linkage

When the circuit breaker is in the CONNECTED position, the trip plate on hinged compartment door will be operative. Inward pressure on this plate will trip open the breaker when the door is closed. See Fig. 10.

1.1.6 Seismic Positioner

Seismic Positioner increases the rigidity of the breaker to withstand sideways forces due to vibrations on earthquake condition. It is mounted on the top rear of the breaker frame and engages with a spring-loaded counterpart in the compartment.

1.1.7 Compartment Ceiling Flash Shield

A polyester insulating plate is bolted to the ceiling of each breaker compartment to prevent flash-over from arc chutes to ground to protect operating personnel. See Figs. 5 and 11.

1.1.8 Stationary Main Contacts

The six butt-type main disconnecting contacts are supported by a molded glass, polyester plate that is bolted to the rear wall of the breaker compartment. See Figs. 10 and 11.

These contacts connect the circuit breaker to the power source and load. Each is engaged between rows of self-aligning, spring-loaded finger clusters on the rear of the breaker as it is levered into the CONNECTED position.

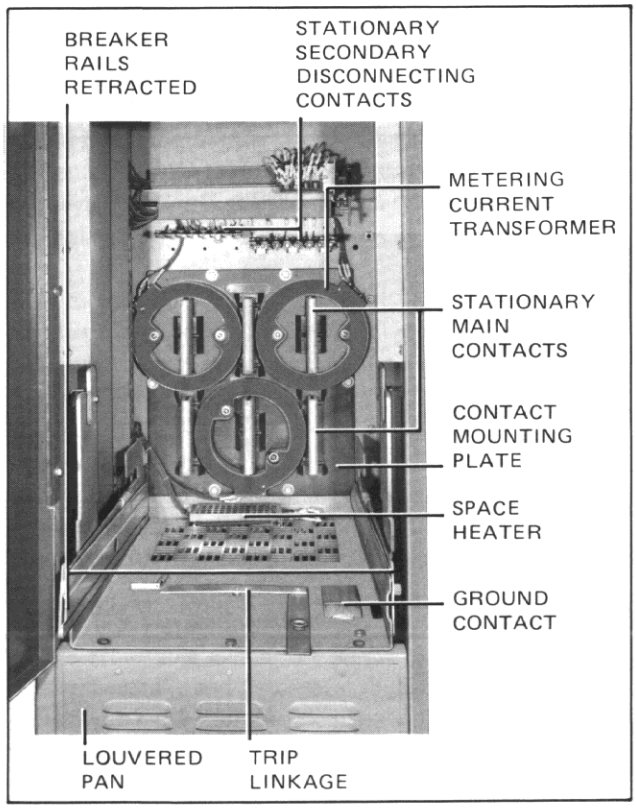


Fig. 10 *Type DS-632 Breaker Compartment (391181)*

1.1.9 Secondary Disconnecting Contacts

The breaker control wiring is arranged for drawout disconnecting. Stationary contacts are bolted to the rear wall of the breaker compartment. They are aligned to connect the movable contacts on the rear of breaker as it is levered into the TEST and CONNECTED positions. See Figs. 10 and 16.

These secondary disconnecting contacts connect the electrical operating parts of the circuit breaker to the control circuits in the housing.

1.1.10 Breaker Interference Interlocks

The frame width and height are the same for DS-206, DS-206S, DS-416, DS-416S and DS-420. They could be placed into compartments having the same dimensions. But, to prevent insertion of circuit breakers with mismatching disconnects or insufficient interrupting ratings into compartments carrying higher current, interference interlocks are provided.

These are Z-shaped, steel brackets located on the breaker bottom plate and compartment cradle. As the breaker is levered into the compartment, the bracket on the breaker bottom moves under a corresponding bracket on the compartment floor if the two sections are matched correctly. If incorrectly matched, the bracket on breaker is blocked by the compartment floor section. The breaker cannot be moved far enough into the compartment to engage the levering device.

Fig. 12 shows the positions of the interlock brackets for two frame ratings. These brackets hold the drawout unit approximately 5.38 inches from the "connected" position.

Types DS-416S and DS-420 breakers have the same short-circuit current ratings and the current carrying parts in the compartment are identical, the same interlock is used on both of these breakers and they are physically interchangeable. These interlocks are similar to those of the DS-416 and mount in the same position.

Types DSL-206 and DSL-416 incorporate a similar interference type interlock, with the addition of one or more piece located at the bottom of the main contact mounting frame which will interfere with the interlock brackets in standard DS breaker compartments to prevent insertion of DSL circuit breakers in DS compartments. See Fig. 13. The engagement of the levering device will prevent insertion of a DS circuit breaker into a DSL compartment far enough to engage the disconnect contacts. The chart below shows the acceptable combinations.

The Types DS-632 and DS-840 Circuit Breakers do not require any kind of interference interlock because they are not physically interchangeable with any other circuit breaker.

This Compartment	Will Accept These Breakers
DS-206	DS-206
DS-206S	DS-206S, DS-416 DS-416S, DS-420
DS-416	DS-416, DS-416S DS-420
DS-416S	DS-416S, DS-420
DS-420	DS-416S, DS-420
DSL-206	DSL-206
DSL-416	DSL-416

1.1.11 Key Interlocks

Key interlocks are often supplied when it is necessary to insure the proper sequence of operation between two or more circuit breakers or between a circuit breaker and fuse truck or disconnect switch. The interlock mechanism provided in a circuit breaker compartment functions by preventing a circuit breaker from being levered into the compartment. This insures that before the interlock key can be removed to be used in another location, the compartment door must be opened and the circuit breaker withdrawn from the compartment. After this is done the blocking mechanism is moved into place, the key lock can be turned and the key removed. Detailed operating instructions are located on the inside of the compartment door whenever an interlock is provided. See Figs. 14 and 15.

A special version of this blocking type key interlock makes use of a pull-out padlock hasp for use with the customer's padlock instead of the key lock mechanism normally supplied.

Key interlock mechansims used with DS-3200 and DS-4000 fuse trucks are mounted on the compartment door. This arrangement is intended to insure that a circuit breaker connected in series with the fuse truck has been locked out before the key is available to open the fuse truck compartment door. It is also necessary to close the fuse truck compartment door before the door lock can be operated and the key withdrawn to return it to the circuit breaker compartment.

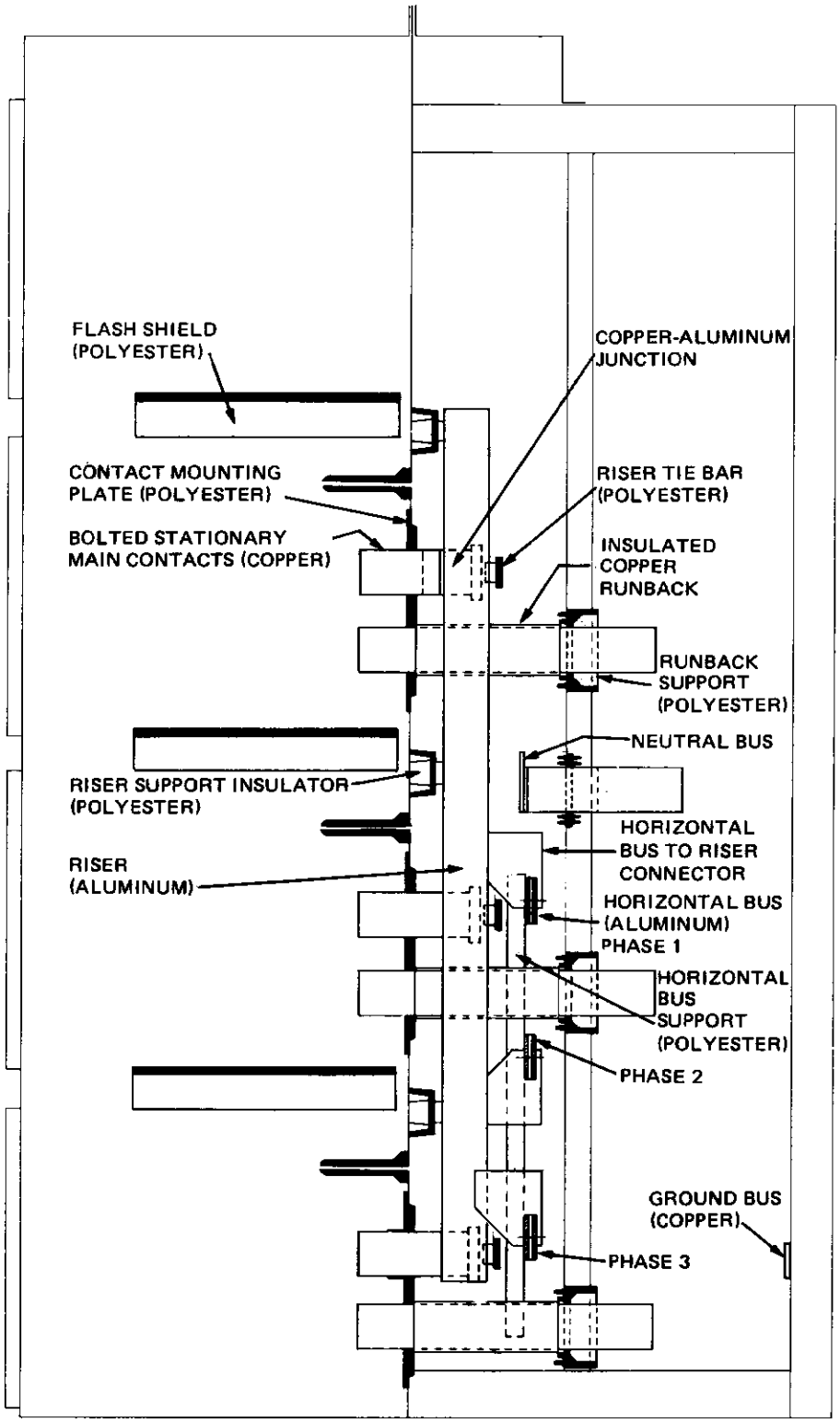


Fig. 11 *Bus and Insulation for 1600/2000 Amp Welded Aluminum Bus*

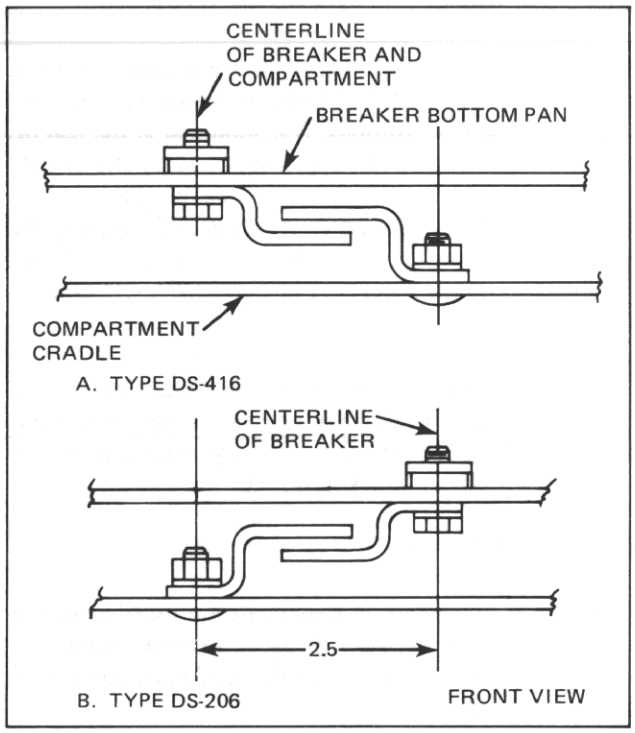


Fig. 12 *DS-206/416 Breaker Interference Interlock*

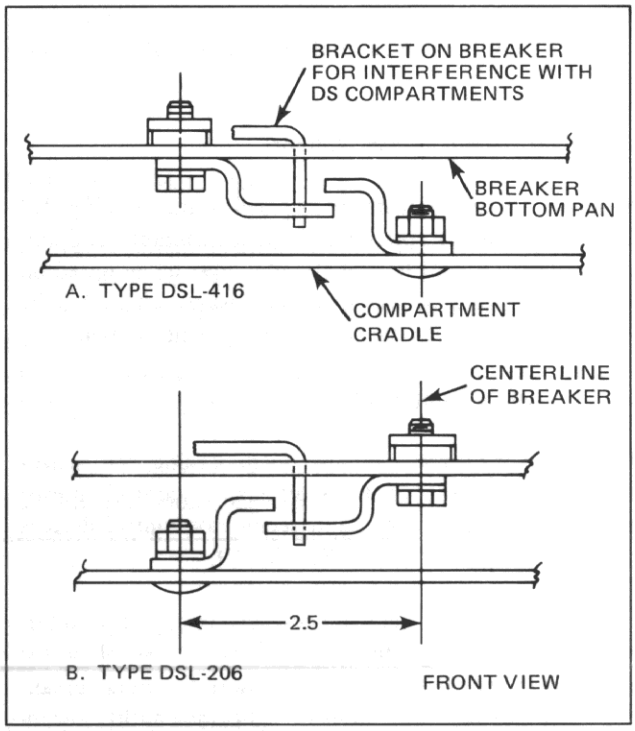


Fig. 13 *DSL-206/416 Breaker Interference Interlock*

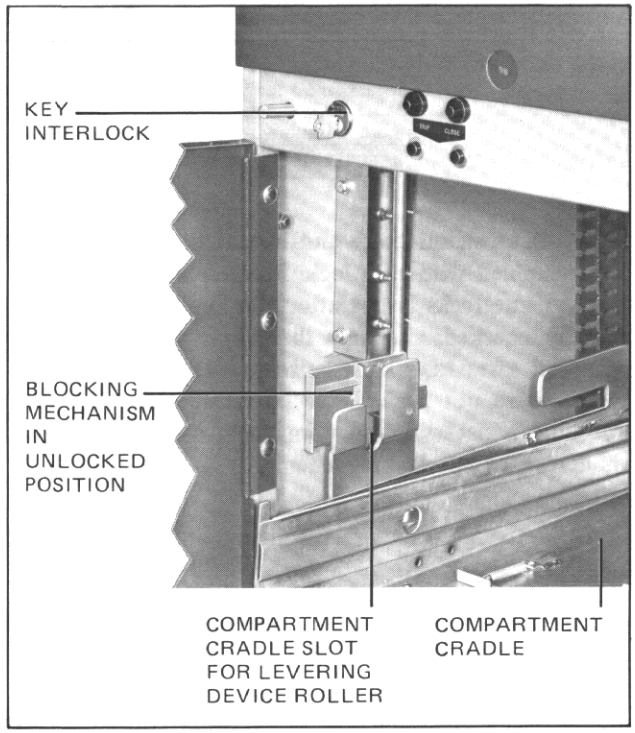


Fig. 14 *Key Interlock Mechanism in Unlocked Position: Allows Insertion of Levering Device Roller into Cradle Slot (384830)*

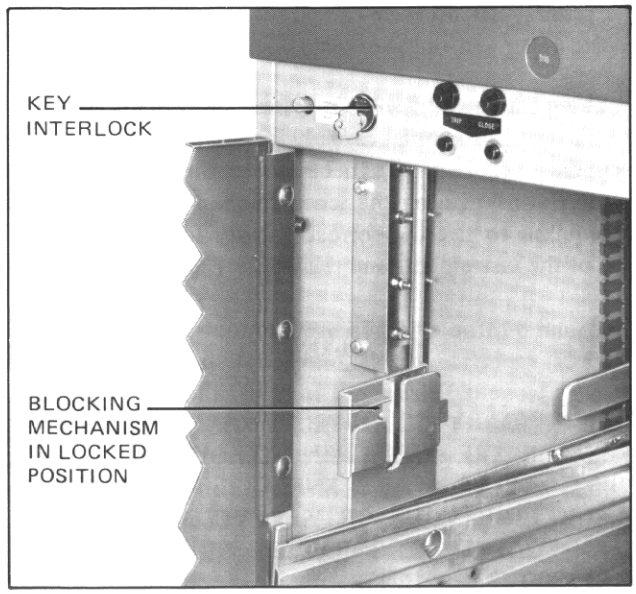


Fig. 15 *Key Interlock Mechanism in Locked Position: Blocks Insertion of Levering Device Roller into Cradle Slot (384831)*

The operation of key interlock systems may be complex and is generally described by a note or keying chart on the order assembly drawings.

CAUTION

To facilitate manufacture and installation procedures, a key is suppled with each lock. Before placing switchgear with key interlocks in operation, the key scheme must be carefully checked; and only the proper keys left in the locks. All extra keys must be removed and destroyed or stored where not available to operating personnel. This procedure is necessary since improper use of spare keys will defeat the interlocking scheme.

1.1.12 Metering Current Transformers

When required for metering, ring-type current transformers are positioned around the stationary main contacts as shown in Fig. 10. Each is mounted on the molded glass polyester main contact support plate. They may be used to feed a small ammeter and transfer switch located on the fixed meter panel between compartments or a meter on the hinged instrument panel. The metering accuracies are given in Table 2.

These transformers can be removed from the front if the primary circuit is de-energized. They may be located on the upper and/or lower main contacts.

The polarity marks on current transformers indicate the relative instantaneous polarities of the primary and secondary windings. Connections to the current transformers are shown on the schematic and wiring diagrams as required to give the correct polarity for proper operation of the instruments and relays.

WARNING

IF SECONDARY CIRCUITS OF CURRENT TRANSFORMERS ARE LEFT OPEN WITHOUT LOAD, AND THESE CIRCUITS ARE ENERGIZED, A DANGEROUSLY HIGH VOLTAGE IS DEVELOPED ACROSS TRANSFORMER SECONDARIES, OR IN BUS AND CABLE COMPARTMENTS.

TO PREVENT BODILY INJURY OR ELECTRICAL SHOCK, EITHER DE-ENERGIZE THE CIRCUIT BY OPENING THE BREAKER OR SHORT CIRCUIT CURRENT TRANSFORMER SECONDARY BEFORE PROCEEDING WITH MAINTENANCE WORK.

1.1.13 Cell Switch

An optional switch, with six or twelve contacts, is operated by the movement of the circuit breaker between the connected and test positions. It is mounted at the rear of breaker compartment. A lever connected to the switch shaft is actuated by the frame of the breaker as it is levered between the TEST and CONNECTED position. As a result, the cell switch can be used to electrically indicate whether or not the breaker is in the CONNECTED position. See Fig. 16.

Its most common uses are for disconnecting remote control circuits of electrically operated breakers, and for bypassing "b" interlocking auxiliary contacts, when breaker is withdrawn to test position.

1.1.14 Space Heaters

To minimize condensation heaters are furnished as standard equipment on outdoor switchgear. As shown in Fig. 10, a heater is placed at the rear of the breaker compartment floor.

Other heaters are placed near the floor of the bus and cable compartments as required. See Fig. 17.

Heaters are operated at half their rated voltage for long life.

1.1.15 Instrument Panels: Indoor

A typical DS indoor instrument panel is shown in Fig. 18. A voltmeter and voltmeter switch, an ammeter and ammeter switch, a watt-hour meter etc., may be mounted on the hinged panel of the front enclosure, which can be opened for entry into the control equipment module.

1.1.16 Control Equipment

Within the instrument compartment behind the instrument panel, potential transformers, a control power transformer, fuses, relays, and secondary control devices can be mounted as required. See Fig. 19.

Potential transformers provide low voltage for metering and which are protected by fuses. A control power transformer provides A-C control power to circuit breakers, space heaters, fans, housing lights, and utility receptacles.

Like potential transformers, control transformers are also protected by both primary and secondary fuses.

Table 2 – Metering Accuracies

Type RCT Meter Type Current Transformers for Mounting in Circuit Breaker Compartments

For Breaker Type*		ANSI Meter Accuracy Classification			For Breaker Type*		
DS-416	DS-632	Ratio	B-0.1**	B-0.2**	DS-206	DS-420	DS-840
		100/5	1.2	–			
		150/5	1.2	–			
		200/5	1.2	1.2			
		300/5	0.6	0.6			
		400/5	0.6	0.6			
		600/5	0.6	0.6			
		800/5	0.3	0.3			
		1200/5	0.3	0.3			
		1500/5	0.3	0.3			
		1600/5	0.3	0.3			
		2000/5	0.3	0.3			
		2500/5	0.3	0.3			
		3000/5	0.3	0.3			
		4000/5	0.3	0.3			
		5000/5	0.3	0.3			
		6000/5	0.3	0.3			

*Also for Types DSL-206, DSL-416, DSL-632 and DSL-840 limiter equipments.

Current transformers with meter accuracy classifications at higher burdens and/or suitable for relaying are also available. They will be mounted in the rear cable connection compartment.

**At 60 Hz Standard Burden

1.1.17 Fixed Meter Panels

For feeder circuit instrumentation small ammeters, with or without Type W-2 Ammeter Switches, can be mounted on the horizontal stationary panels separating breaker compartment doors. The ammeters and directly connected to nearby breaker circuits for monitoring current. See Figs. 6, 9 and 18.

Other small devices, such as key interlocks control pushbuttons, indicating lights and test switches, can be mounted on these panels within their space limits. See Fig. 23.

Removable covers provide access to any wiring behind the panel.

1.1.18 Control Wiring

For protection, wiring in DS Switchgear is routed throughout the housing and circuit breakers in slotted plastic troughs whose covers are removable. Steel troughs are used to support and protect interunit cross wiring.

The standard wire used in DS Switchgear is Type SIS, stranded copper, polyethylene insulated, No. 14 AWG minimum, with crimped insulation grip and ring-tongue terminals.

1.1.19 Switchgear Ventilation

The front hinged doors have slots in the bottom flange to allow ventilating air to enter each compartment. The air passes upward at the sides of the breaker support cradles and is exhausted through the grillwork in the top compartment roof. A drip pan immediately below the grill prevents any foreign material from reaching the equipment. DS-632 and DS-840 compartments have a louvered pan below the breaker for ventilating air entrance. See Figs. 1, 10 and 20.

The bus and cable compartments are ventilated by means of air entering the grillwork at the bottom of the bolted rear sheets, and leaving through a grill in the bus compartment roof. See Fig. 2.

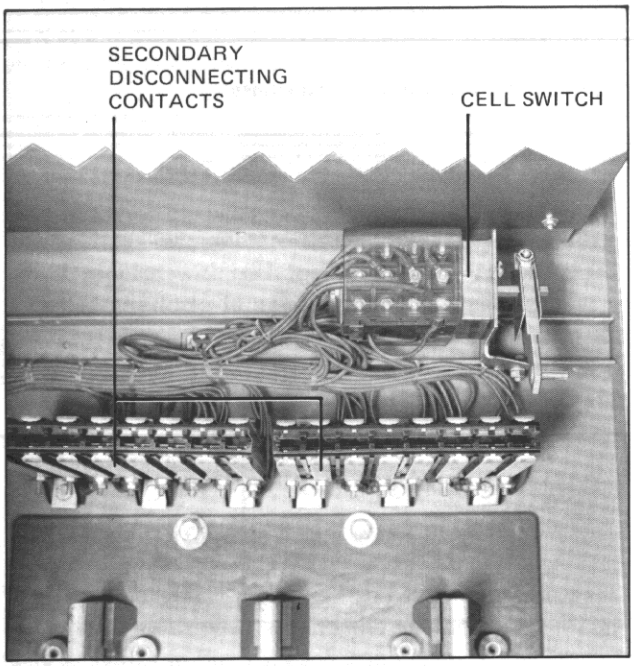


Fig. 16 *Cell Switch and Secondary Disconnecting Contacts (385216)*

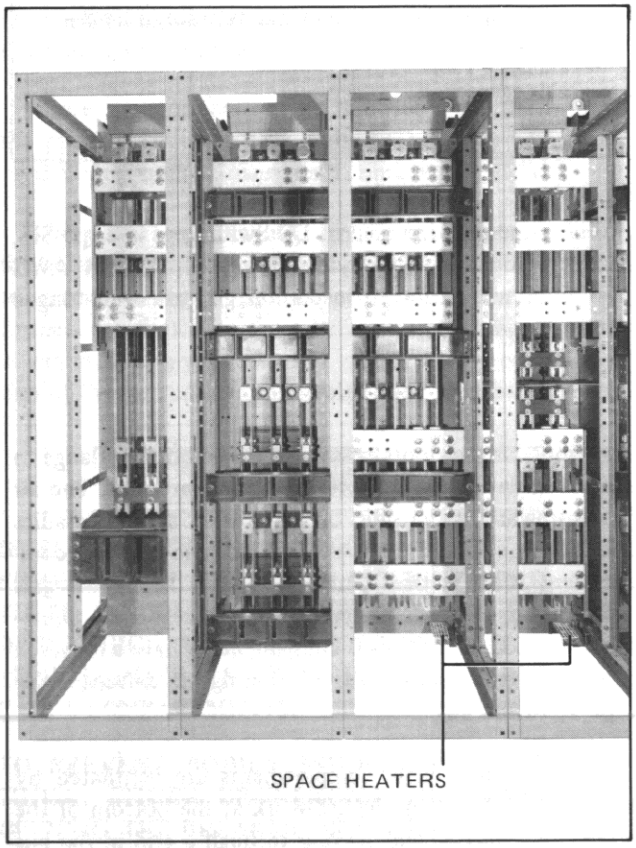


Fig. 17 *Space Heaters in Bus Compartments (390894)*

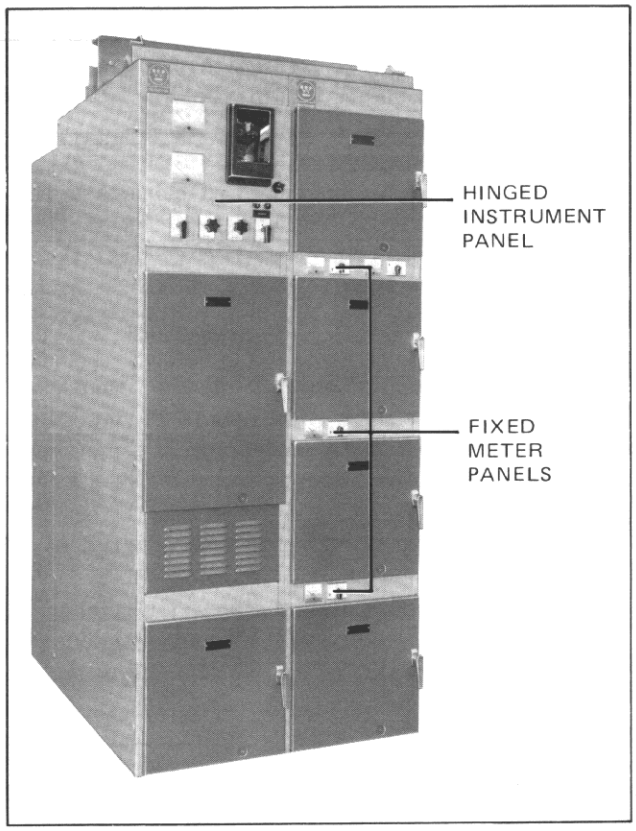


Fig. 18 *Type DS Indoor Switchgear with Hinged Instrument Panel and Fixed Meter Panels (382742)*

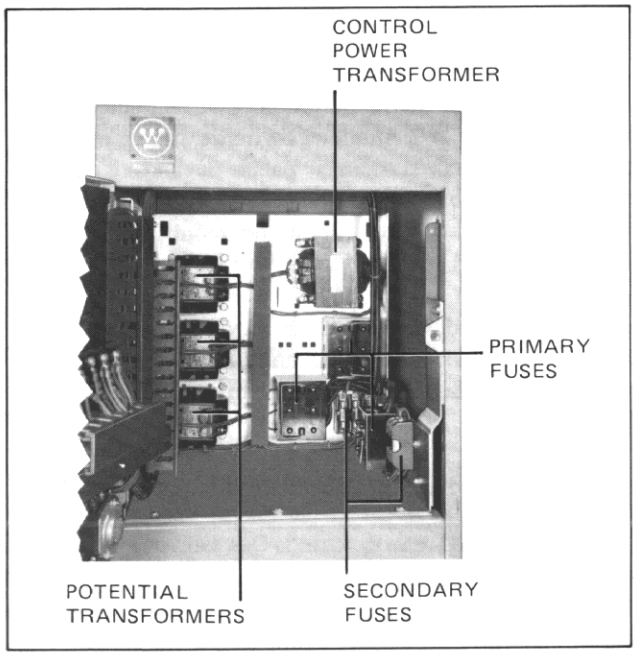


Fig. 19 *Potential Transformer and Control Power Transformer with Primary and Secondary Fuses (384824)*

Because of their higher current interrupting capacities, DSL-206 800 ampere frame and DSL-416 1600 ampere frame breakers have rectangular slots on their faceplates to increase compartment ventilation.

1.1.20 Type DS Circuit Breakers

See Instruction Book I.B. 33-790-1, Low-Voltage Power Circuit Breakers, Types DS and DSL for receiving, handling and storing, description and operation, initial inspection and operation, installation, adjustments, maintenance, circuit breaker data, and renewal parts.

1.1.21 Bus Compartment

The bus compartment, located between the front breaker enclosure and the rear cable compartment, contains the horizontal main bus that ties the units together electrically and the vertical bus that feeds the individual breaker compartments. It also includes all supporting insulators. The bus compartment is available in different depths depending upon bus rating. See Figs. 5 and 20.

The incoming line is isolated from the main bus to reduce the possibility of fault transmission between them. Bus sections are also isolated at a bus tie breaker.

1.1.22 Cable and Terminal Compartment

The cable and terminal compartment is located behind the bus compartment and provides adequate room for easy cable installation. Copper bars extend the load side of the stationary disconnecting contacts into the cable compartment. See Fig. 5. Standard NEMA drilling is provided on the plated ends for the outgoing cables for exit through either the top or bottom of the units. The drilling will accommodate either single or multiple terminals on each phase. On higher current installations, bus duct may be connected to the copper bars.

On four wire systems, an insulated neutral bus approximately 44 inches above the floor extends the length of the line-up and includes a tap for the outgoing neutral cable in each unit. See Fig. 5. A connection to the ground bus may be furnished as optional equipment in one of the units for grounded four wire systems. Provision is made to locate a current transformer in this grounding connection if desired.

1.1.22.1 Ground Bus Connection

CAUTION

A permanent low resistsnce ground is essential for adequate protection.

The standard ground bus consists of a .25 inch x 2 inch copper bus bar bolted to the rear frames of the units near the floor, and extending the length of the group. A clamp-type terminal accommodating a cable range of 4/0 to 500 MCM is included for connection to the station ground. Where the line-up is split into several shipping groups, a splice plate and hardware will be furnished to bridge the shipping break at installation.

1.1.23 Customer's Connections

Control circuit terminal blocks are mounted on the rear frame where they are accessible for customer's connections and inspection.

Cable terminals for power connections may be oriented to suit cable entrance. A typical arrangement is shown in Fig. 21.

1.2 SWITCHGEAR ACCESSORIES

Each new Type DS Switchgear assembly is provided with a set of accessories. Depending upon customer's specifications and the nature of the installation, the standard accessories will include one or more of the following:

1.2.1 A levering-in crank for moving a breaker anywhere between the REMOVE and CONNECTED positions; this crank is used for turning the levering-in nut which is a part of the breaker. See Fig. 22.

1.2.2 Insulating covers or "boots" are furnished on live main stationary disconnecting contacts in compartments equipped for future breakers. One additional set is provided for each size breaker furnished. See Fig. 23.

1.2.3 Test plugs are furnished when Flexitest cases or Flexitest Type FT-1 test switches are mounted on the switchgear. See Fig. 24.

1.3 OPTIONAL ACCESSORIES

1.3.1 Key Interlocks. See Item 1.1.11

1.3.2 Floor-running, movable circuit breaker, transport truck with manual lifting mechanism. See Item 2.5.

1.3.3 Traveling Circuit Breaker Lifter that is rail mounted on top of indoor switchgear. See Item 2.5 and Fig. 29.

1.3.4 Test Cabinet for electrically operated breakers with pushbuttons, control cable and receptacle for separate mounting.

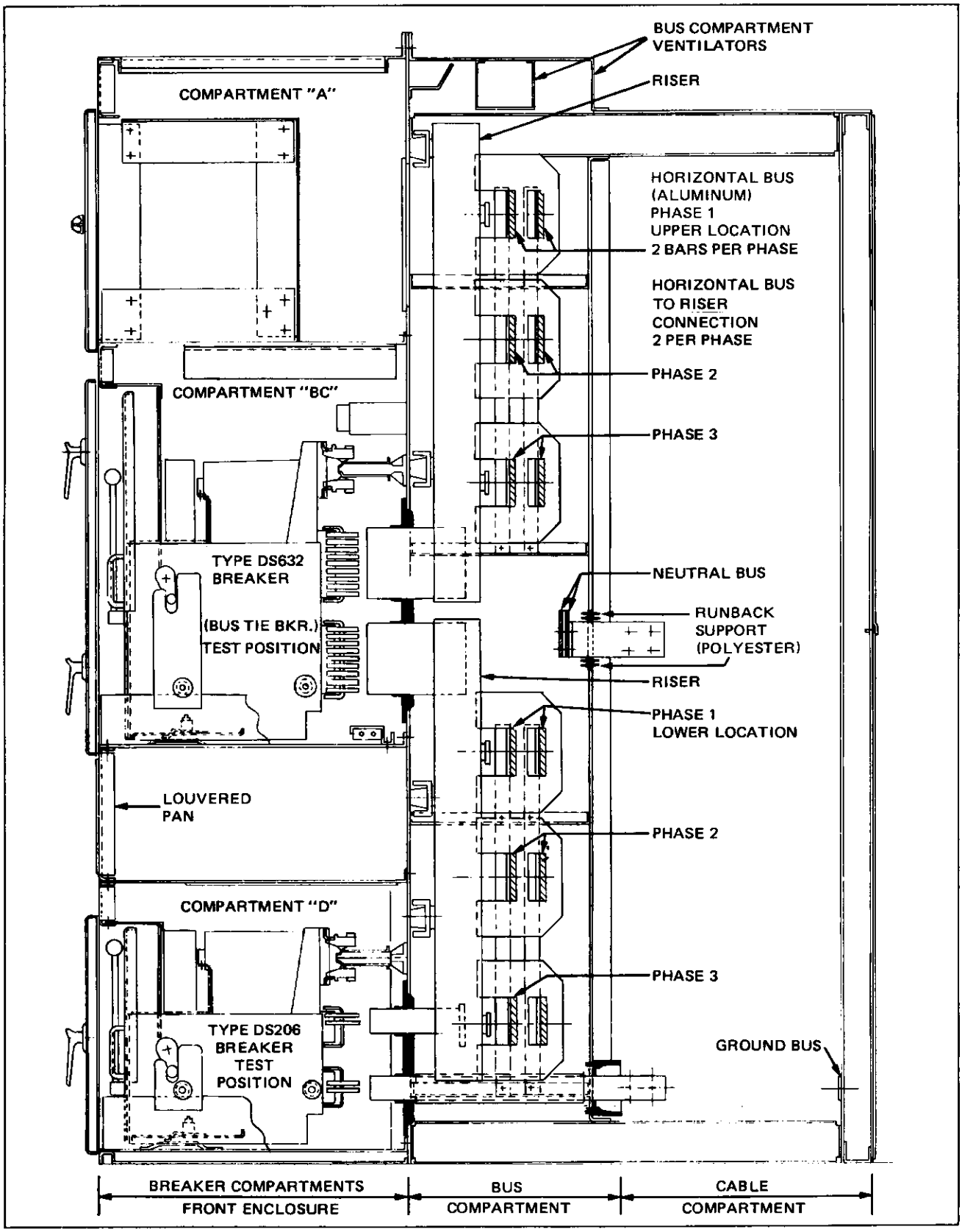


Fig. 20 *Type DS-3200 Amp. Unit with Welded Aluminum Bus Risers Arranged as a Bus Tie Unit: Side View*

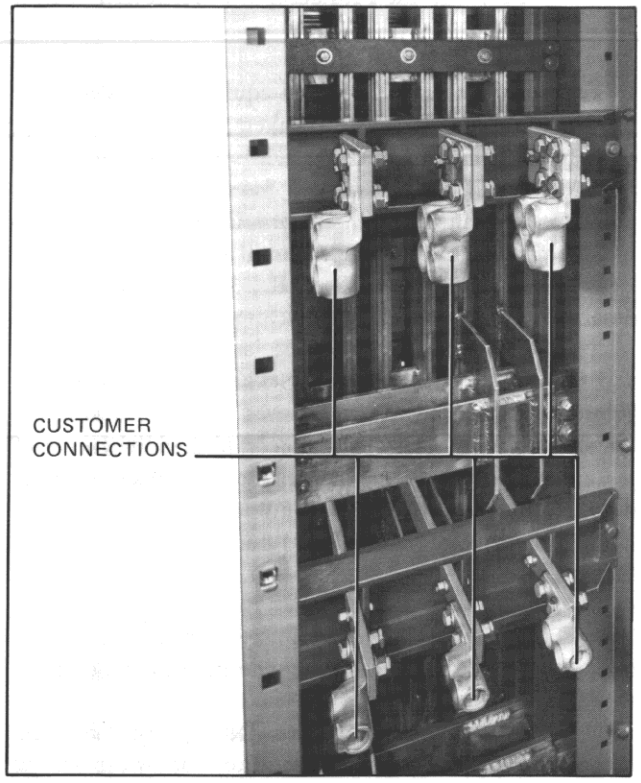


Fig. 21 *Cable Terminals for Power Connections (384825)*

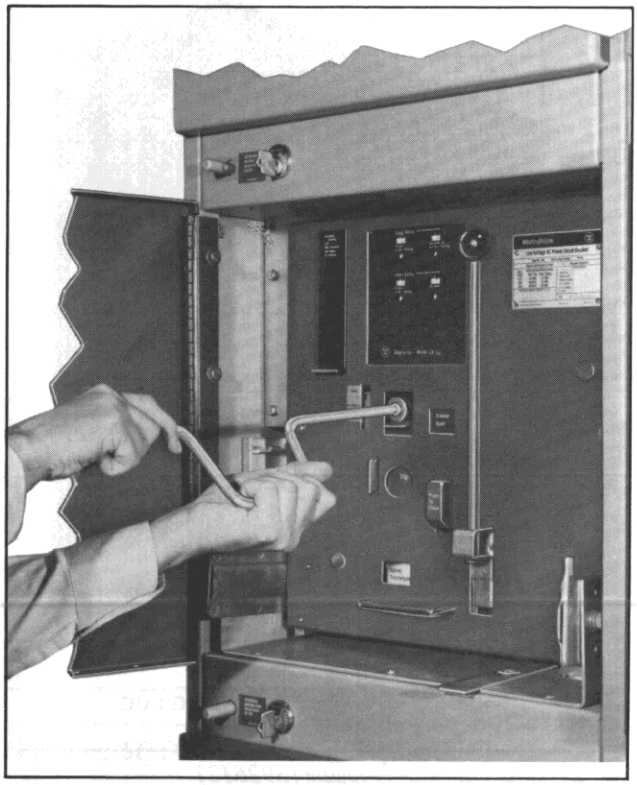


Fig. 22 *Using Levering-In Crank (391177)*

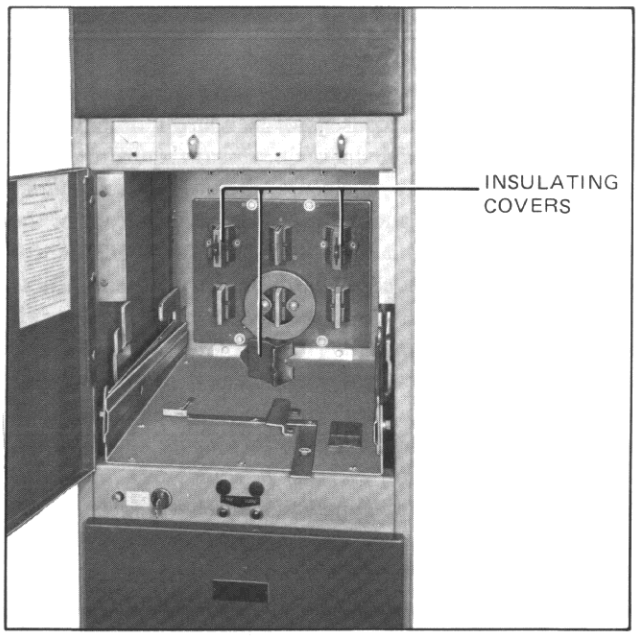


Fig. 23 *Insulating Covers for Main Stationary Disconnecting Contacts (384829)*

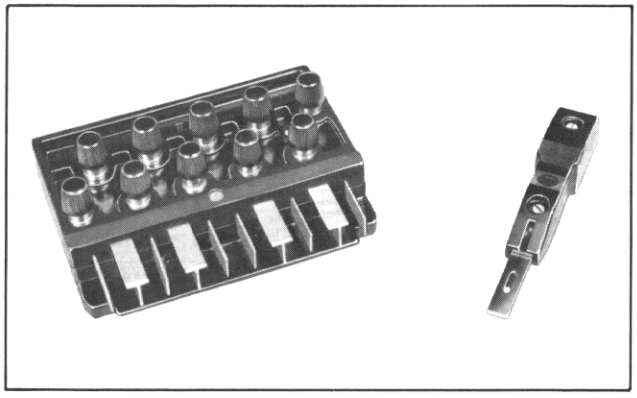


Fig. 24 *Test Plugs for Flexitest Cases and Test Switches (376448)*

1.4 OUTDOOR CONSTRUCTION

1.4.1 Type DSO Switchgear

Type DSO switchgear consists of standard indoor switchgear structures assembled within a heavy gauge weatherproof enclosure. The enclosure provides a continuous "walk-in" operating and maintenance aisle in front of the indoor structure. This aisle has large reinforced entry doors equipped with crash hardware at each end. These doors can be opened from the inside even when the outside doors are padlocked. The rear of the enclosure is equipped with hinged covers for access to the bus and cable compartments. These covers are bolted closed, and equipped with a padlock hasp for locking.

Standard features of Type DSO switchgear include:

1. Labyrinth type door openings – no gaskets required.
2. Filtered ventilation openings.
3. Traveling, geared breaker lifting device.
4. Interior lighting and duplex receptacles.
5. Rigid fabricated base structure for pad or foundation.
6. Walk-in aisle is shipped assembled.
7. Dark gray weather resistant exterior finish.
8. Asphalt coating on underside of base.
9. Space heaters for prevention of condensation.
10. Removable covers in base for easy conduit installation.
11. Bolted hinged rear doors for access to cable and bus compartments.

For easy assembly into coordinated secondary unit substation, large transition throats with removable covers are provided for connection to transformer. See Figs. 25 and 26.

1.4.2 Type DSOA Switchgear

Outdoor switchgear is also available as Type DSOA. This switchgear is similar to Type DSO except it does not have a "walk-in aisle" or a "traveling-geared, lifting device" as described above. A removable-geared, lifting device is supplied.

1.5 TYPE DSL CIRCUIT BREAKERS

Type DSL circuit breakers are available in two frame sizes DSL-206 and DSL-416 which include fuse type current limiters integrally mounted on the drawout element. The compartments for DSL circuit breakers are the same height and width as those for standard DS circuit breakers but are eight inches deeper. The front enclosure and indoor switchgear assembly are correspondingly eight inches deeper. See I.B. 33-790-1 for complete description of DSL circuit breakers.

There are no integrally fused equivalents of the Type DS-632 and DS-840 circuit breakers, but these breakers may be used in combination with separately mounted DS-3200 or DS-4000 drawout fuse trucks. These fuse trucks are equipped with standard Class L fuses and fit into compartments the same depth as the DSL-206 and DSL-416 circuit breakers. See I.B. 33-790-1 for complete description of fuse trucks.

Each combination of a DS-632 or DS-840 circuit breaker with a fuse truck requires key interlocking between the two devices. This is accomplished by the use of a standard key interlock in the circuit breaker compartment cooperating with a door interlock on the fuse truck compartment. See I.B. 33-790-1 for details of this interlocking.

All of the above equipments may be provided in Type DSO outdoor switchgear without any increase in depth.

Handling and installation of switchgear assemblies incorporating Type DSL circuit breakers or fuse trucks is the same as for standard DS assemblies.

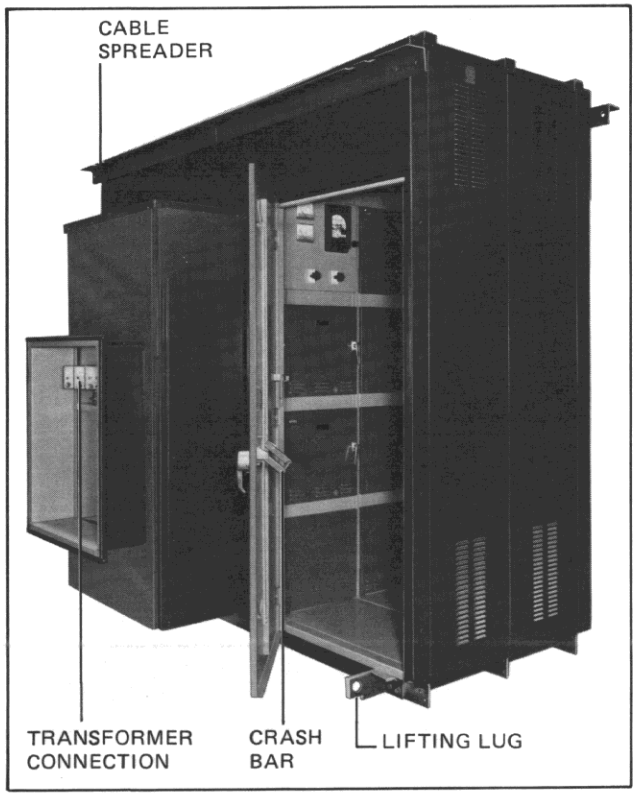


Fig. 25 *DSO Outdoor Housing (392612)*

SECTION 2 – RECEIVING, HANDLING AND STORAGE

2.0 GENERAL

Type DS or DSO metal-enclosed switchgear is shipped assembled in one or more groups depending on the number of units, total length or limitations of handling facilities at the installation site. Indoor shipping groups are bolted to longitudinal wooden skids located at the front and rear of the assembly. If shipment is made by rail or open truck the equipment is enclosed in a weather proof covering. When shipment is made in an enclosed or covered truck the weather proof covering is omitted. Each shipping group is plainly marked with or accompanied by an identification Shop Order number, the General Order number and the shipping weight. A list of the contents of each shipment is included with the shipping papers.

Type DSO outdoor switchgear is inherently weatherproof, has a rigid fabricated base and requires no special covering or skids for shipment. If an assembly is separated into more than one group for shipping, the matching ends are rigidly braced and provided with weatherproof covering as required.

All units are given commercial tests at the factory, after which they are carefully inspected and prepared for shipment by personnel experienced in the proper handling of electrical equipment.

2.1 RECEIVING

When the switchgear reaches its destination, the Purchaser should check the material actually received against the shipping list to be sure that all parts have been received. This should be done prior to discarding the packing material to avoid loss of small parts. If damage is found or suspected, file claims as soon as possible with the transportation company and notify the nearest representative of Westinghouse Electric Corporation. If the switchgear is to be installed as soon as received, it is recommended that the unpacking and handling be done as outlined in the paragraphs that follow. If the switchgear is to be stored or held for some time, it is advisable to unpack sufficiently to check the shipment for completeness and condition; then reseal packing for protection until installation.

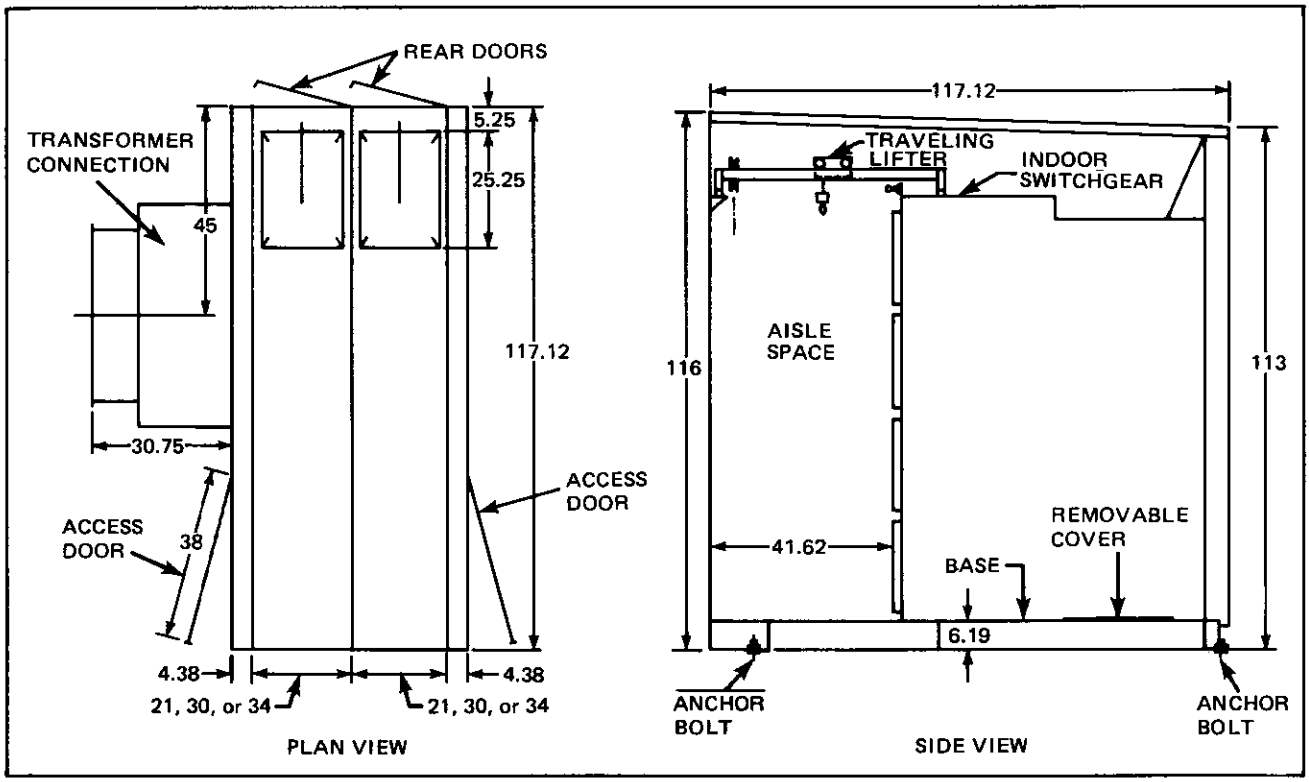


Fig. 26 *DSO Outdoor Housing Outline*

2.2 HANDLING

For ease of handling by a crane, each indoor shipping group is equipped with a lifting bar extending the length of the group. The bar has two 2 inch diameter holes to accept the crane hooks. On long lineups, a suitable spreader should be used with the crane sling to prevent any horizontal compressive load on the lifting bar. The bar is located approximately above the center of gravity, but variations in equipment may cause a slight tilt either forward or backward. The lifting bar may be removed and discarded after installation is complete.

It is preferable to lift the groups into position by a crane. However, if a crane is not available, they can be skidded into place on rollers. The longitudinal wooden skids provided at the front and rear for shipment may be used directly when rolling sideways, but for front-to-back rolling additional temporary skids must be provided in this direction. **NEVER LET THE ROLLERS ENGAGE THE SWITCHGEAR DIRECTLY – DISTORTION AND DAMAGE MAY RESULT.**

One method for removing the rollers and skids and lowering the switchgear into place, is the use of long wedges fabricated from 4 x 4's cut on the diagonal. With a large crowbar each corner may be lowered alternately a fraction of an inch. Two 2.0 x .50 inch slots are also provided in the front of the unit for this purpose as shown in Fig. 28.

Outdoor switchgear is equipped with lifting lugs attached to the base and cable spreaders attached to upper portion of the end walls to expedite lifting by crane. It may be placed directly on rollers for moving without additional skids.

Handle all crated or uncrated switchgear with extreme care since the drawout air circuit breakers may be shipped in their compartments and the front panels may contain delicate instruments, meters, or relays which may be damaged by rough handling. When handling the units care should be exercised to avoid breakage and scratching or marring of the panel finish. Instructions for removing the shipping braces from the drawout breaker element are included later in this book.

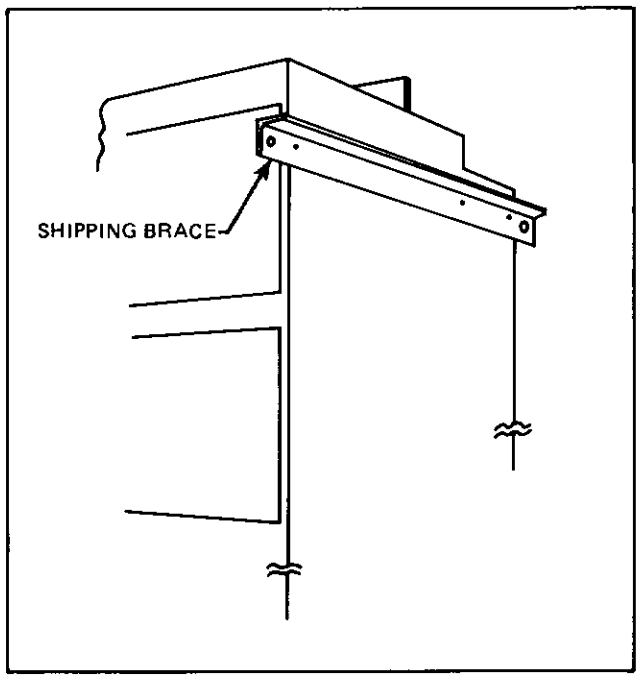


Fig. 27 *Shipping Brace*

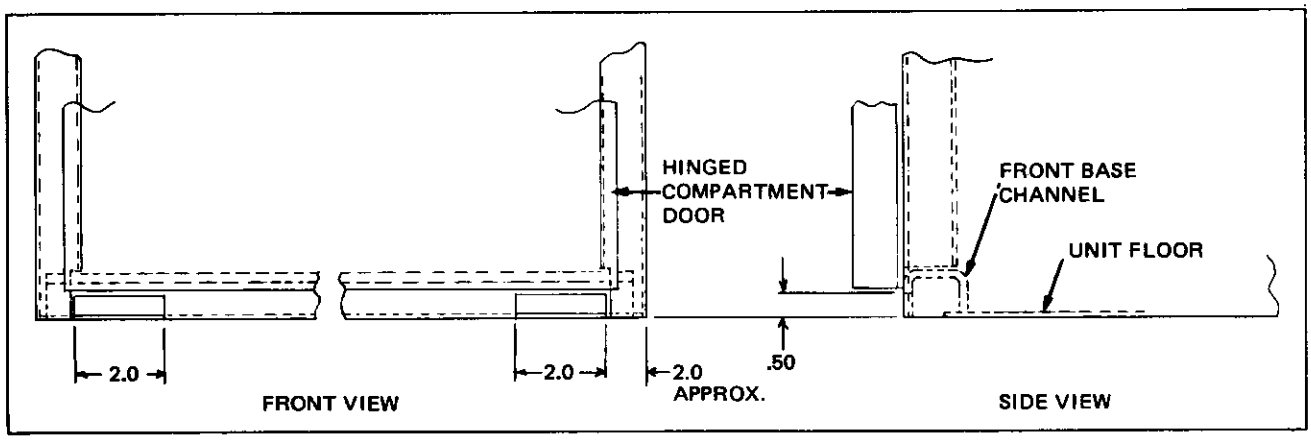


Fig. 28 *Location of Pry Slots at Front*

If indoor switchgear will be exposed to dust and dirt during construction, prior to being placed in service, it should be covered for protection. Removable elements should be stored in their compartments or covered separately.

2.3 STORING

Indoor switchgear which cannot be installed and put into service immediately should be stored in a dry, clean place, preferably indoors, in a heated building. Trouble and delay will be avoided by having good storage facilities arranged so that the apparatus will be accessible only to authorized persons, and can be quickly located when required in the erection program. Conditions such as dampness, changes in temperature, cement dust, and corrosive atmosphere should be carefully guarded against. If necessary to store outdoors, special precautions will be required to keep it clean and warm enough to control condensation. It will be necessary to cover the switchgear and install temporary heating equipment. Approximately 250 watts per unit are required for average conditions. Outdoor storage of indoor switchgear, even for a brief period is not recommended and should be avoided if at all possible. The weatherproof covering which may have been provided during shipment is *not* adequate protection during outdoor storage.

Type DSO outdoor switchgear requires a minimum of care during outdoor storage. The area should be reasonably free from dust and corrosive gases and the space heaters which are a standard feature of this equipment should be energized to prevent condensation. Additional protection will be required for the exposed ends at shipping breaks if the equipment is shipped in more than one group.

During storage the switchgear shipping groups, either indoor or outdoor, should be placed on smooth and level surfaces to prevent unnecessary strain and possible distortion.

2.4 WEIGHTS

Weights listed in Table 3 are approximate. They will vary according to the actual complement of equipment supplied on the switchgear assemblies, depth of units, bus material and bus rating. Circuit breaker weights will vary slightly due to the differences in functional components on the individual breaker and the size of the current limiting elements supplied on DSL breakers. Fuse truck weights will vary due to the difference of available fuse sizes.

However, these weights are sufficiently accurate to be used in planning foundations and scheduling handling equipment at the point of installation.

Table 3 – Type DS Switchgear Weights (Approximate Pounds)

Indoor Switchgear	
Circuit Breaker Units – less Breakers	
21 inches wide	1400
34 inches wide	1500
Auxiliary Units	
21 inches wide	1100
30 or 34 inches wide	1200
Standard Transformer Transition Unit	300
Outdoor Switchgear	
End Trims – One Set per assembly	1300
Circuit Breaker Units – less Breakers	
21 inches wide	2100
34 inches wide	2400
Auxiliary Units	
21 inches wide	1800
30 or 34 inches wide	2100
Standard Transformer Transition Throat	600
Drawout Elements	
DS-206 Circuit Breaker	150
DS-206S Circuit Breaker	160
DS-416 Circuit Breaker	195
DS-416S Circuit Breaker	200
DS-420 Circuit Breaker	200
DS-632 Circuit Breaker	300
DS-840 Circuit Breaker	400
DSL-206 Circuit Breaker	200
DSL-416 Circuit Breaker	260
DS-3200 Fuse Truck	325
DS-4000 Fuse Truck	430

2.5 LIFTING THE BREAKER

When it is necessary to lift the breaker off the rails, all lifting should be done only with the accessory lifting adapter. DO NOT ATTEMPT TO LIFT BREAKER WITH ORDINARY CRANE HOOKS, ROPES, CHAINS ETC., AS VITAL PARTS SUCH AS WIRING, BARRIERS AND ARC CHUTE PARTS MIGHT BE DAMAGED. Fig. 29 shows a view of the breaker with the lifting adapter in place. The lifter consists essentially of two sheet steel hooks specially shaped to hook under the top edges of the large openings on each circuit breaker side sheet, or in the specially provided lifting lugs on some breakers, and a

spreader. Actual lifting may be with a crane, chain block or with the optional lifting mechanisms which can be supplied with the switchgear. The breaker must be pulled completely to the end of the rails.

There are two different lifting devices which may be supplied as options with an indoor assembly. One is a movable transport truck which can be rolled up in front of a circuit breaker compartment. Its integral lifting adapter is then attached to the circuit breaker and the breaker is lifted from the rails using the crank operated geared hoist mechanism. The truck can then be rolled away from the compartment and the circuit breaker lowered to the truck's base platform for movement to another location. **DO NOT ATTEMPT TO TRANSPORT THE CIRCUIT BREAKER WHILE IT IS STILL SUSPENDED IN MID AIR.**

The more common accessory is the cantilever Traveling Lifter which is mounted permanently on the top of the assembly. See Fig. 29. The boom of the lifter is equipped with rollers so it can be positioned in front of any compartment. With the integral lifting adapter attached to the circuit breaker, the breaker can be lifted from the rails using the crank-operated, geared, hoist mechanism and either moved to any other location in the assembly or lowered to the floor. This device does not provide transport means to move the breaker to or from the assembly.

Type DS Outdoor Switchgear Assemblies are provided with a traveling lifter as standard equipment. This lifter is similar to the one described above for indoor equipment with the exception that due to space limitations the geared, hoist mechanism is driven by a chain fall type operator instead of by a crank, and is of the bridge-type rather than cantilever.

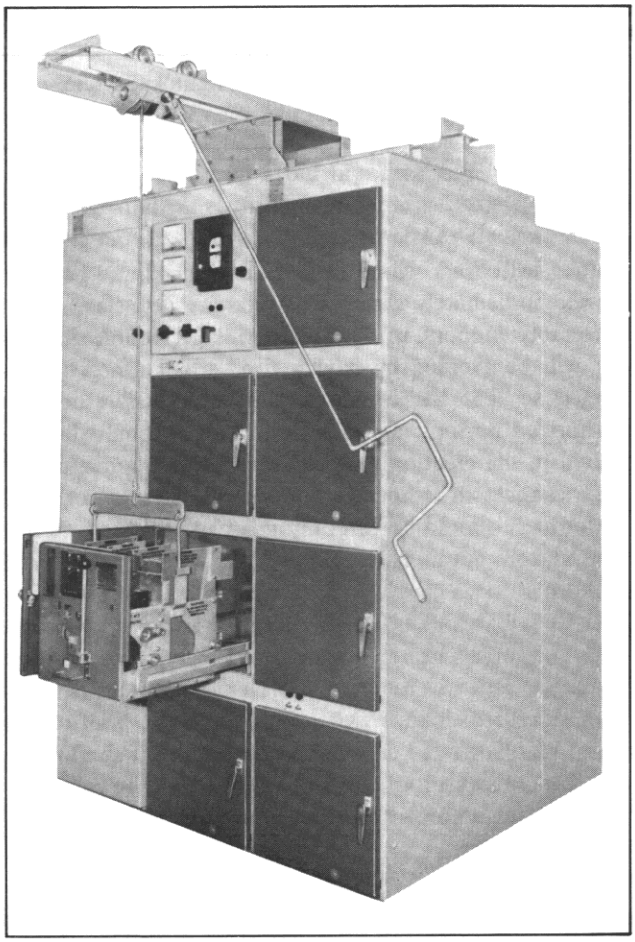


Fig. 29 *Type DS Breaker showing Top-of-Switchgear Traveling Lifter*

SECTION 3 – INSTALLATION

3.0 GENERAL

Proper installation of Westinghouse Type DS Low Voltage Metal Enclosed Switchgear is of prime importance. Too much emphasis cannot be placed upon this phase of the work. Study the associated instruction books and all drawings carefully. In most cases, all drawings will be sent to the Purchaser some time previous to the shipment of the gear to enable adequate advance planning. These drawings will include general assembly, front view, plan view, floor plan, schematic and connection diagrams.

3.1 LOCATION

In locating Type DS Indoor Switchgear, consideration must be given to the aisle space required at the front and rear of the equipment as well as space at the ends of the lineup. The recommended minimum aisle space is shown on the floor plan drawing furnished with the order. Fig. 30 shows a typical floor plan and a table of dimensions for the various depth units. The space at the front must be sufficient to permit the opening of doors, the insertion and withdrawal of the breakers and their transfer to other compartments by means of the hoist. The space at the rear must be sufficient for installation of cables, inspection, and maintenance.

For Type DSO Outdoor Switchgear, sufficient space must be provided for the side doors and hinged rear doors to be opened. The front covers are not removable but a front space of at least 24 inches is recommended for inspection and maintenance of the structure.

3.2 FOUNDATION

Westinghouse Type DS metal-enclosed switchgear is fabricated in welding fixtures and assembled on true and level bedplates to insure ease or operation at all times. Since the tolerances and adjustments are kept to a minimum, it must be installed on a smooth level base.

Extra care by the Purchaser in laying out and preparing the foundation will result in reduced installation costs as well as good switchgear performance.

The station floor or foundation must be strong enough to support the weight of the equipment without sagging. Table 2 tabulates the approximate weights for the various ratings of indoor switchgear. Actual weights will vary depending upon the type and amount of equipment in the individual units. Adequate safety factors must be used. If the foundation is subject to vibration, special mounting must be provided to prevent the transmission of vibration or shock to the equipment.

The preferred method of anchoring the indoor switchgear is by fastening it to steel channels which are properly embedded in the concrete floor. Fig. 30 shows a typical indoor floor plan that may be used for estimating purposes. Detailed floor plans for drilling and locating this steel are supplied with each order.

Installations subject to seismic accelerations require special foundations. This is a common requirement in nuclear generating stations wherever they may be located.

3.3 FLOOR STEEL

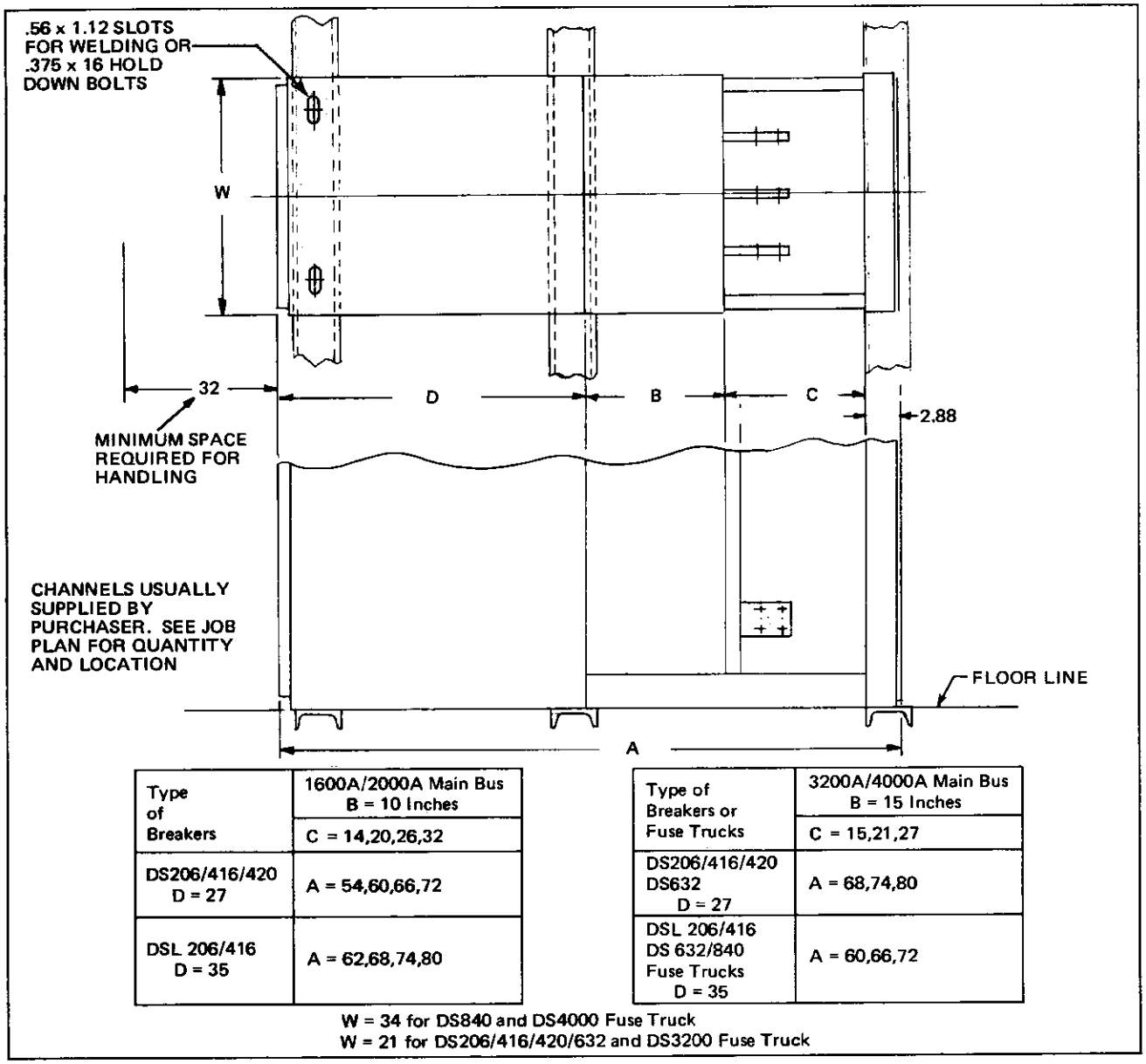
Anchor bolts, floor steel, and other foundation material are to be furnished by the Purchaser.

A 4 inch (5.4 lb.ft.) structural channel is recommended as a minimum size for the average lineup of indoor equipment. When large unit substation transformers are included in the installation, the floor steel under the transformer should be installed in accordance with the transformer manufacturer's recommendations.

IMPORTANT: THE FRONT AND REAR CHANNELS MUST BE SET LEVEL AND ALIGNED WITH EACH OTHER AND MUST BE LEVEL OVER THEIR ENTIRE LENGTH TO AVOID DISTORTION OF THE SWITCHGEAR STRUCTURE. THE FINISHED FLOOR MAY HAVE A SLIGHT PITCH AWAY FROM THE CHANNELS, BUT IN NO CASE SHOULD THE FINISHED FLOOR BE HIGHER THAN THE CHANNELS.

Each unit is fastened to the floor channels by either bolting or welding as shown in Fig. 31. If bolting is to be used, the mounting bolts must be placed in the floor steel before the concrete is poured to assure that the tapped holes will not fill with concrete. Welding is a quick and easy method of securing the switchgear in place and eliminates the layout of the mounting holes in the channels.

Floor channels are not required for Type DSO Outdoor Switchgear. See Fig. 26 for anchor bolt locations. Holddown lugs are supplied with the switchgear for use with anchor bolts.



Type of Breakers	1600A/2000A Main Bus B = 10 Inches
	C = 14,20,26,32
DS206/416/420 D = 27	A = 54,60,66,72
DSL 206/416 D = 35	A = 62,68,74,80

Type of Breakers or Fuse Trucks	3200A/4000A Main Bus B = 15 Inches
	C = 15,21,27
DS206/416/420 DS632 D = 27	A = 68,74,80
DSL 206/416 DS 632/840 Fuse Trucks D = 35	A = 60,66,72

W = 34 for DS840 and DS4000 Fuse Truck
W = 21 for DS206/416/420/632 and DS3200 Fuse Truck

Fig. 30 *Typical Floor Plan*

3.4 CONDUITS

Provisions must be made in the foundation for the conduits which carry the main cables, control wiring, and ground cable when such conduits enter the switchgear from below. The specific floor plan must be used for determining the final conduit layout, spacing of floor channels, and floor space required for each switchgear unit.

Encircling loops of reinforcing or building steel around single phase conductors should be avoided in the areas for main cables when these circuits are rated at 600 amperes or above.

Conduits should project above the finished floor approximately two inches for indoor switchgear. It will simplify moving the groups into place if the conduits are flush with the concrete surface and appropriate extension sleeves added after the units are in their final location. Otherwise it will be necessary to raise the units on timbers a sufficient height to clear the tops of the conduits.

Consideration should be given to installing conduits for future circuits at this time.

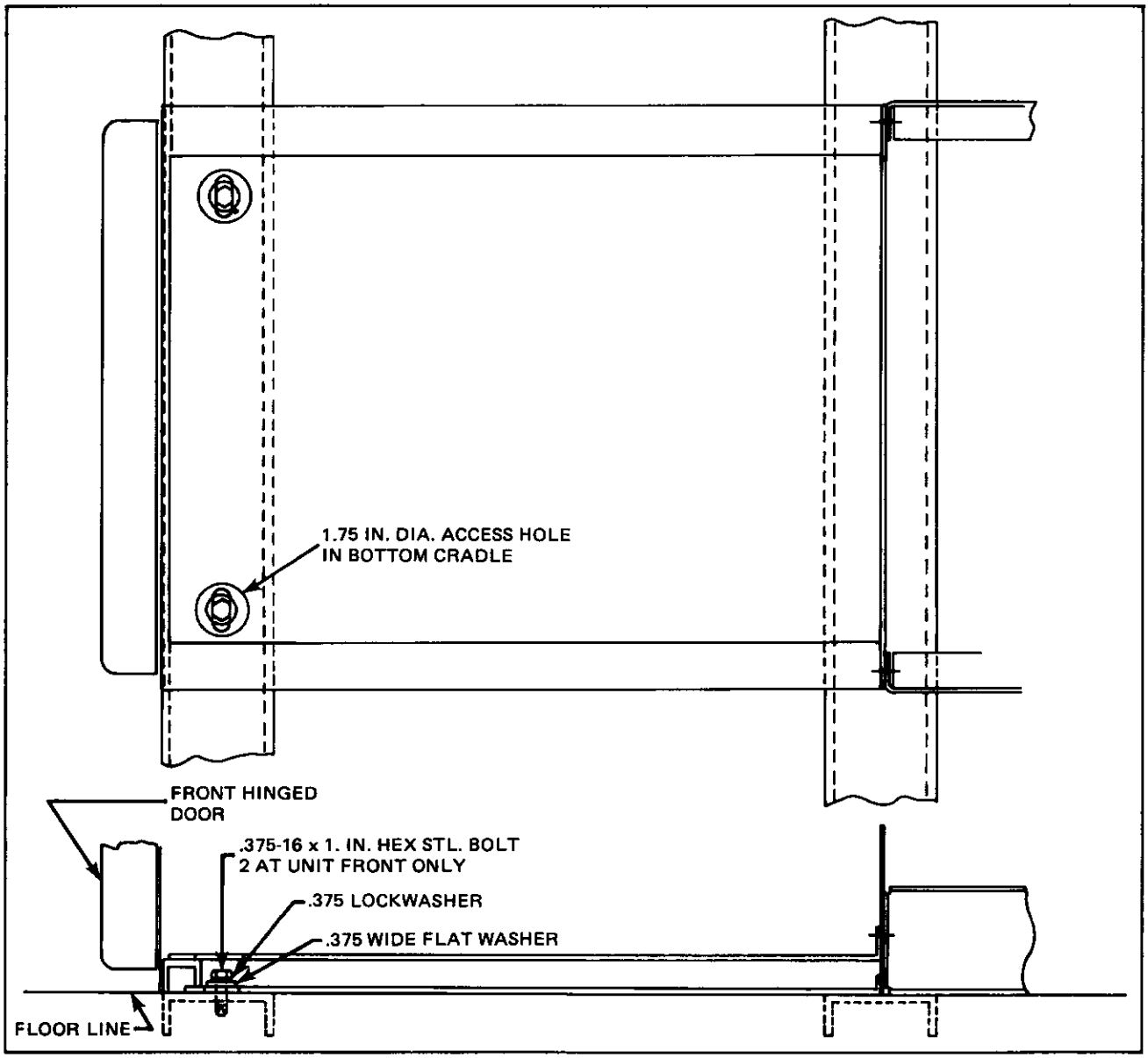


Fig. 31 *Anchor Bolt Detail*

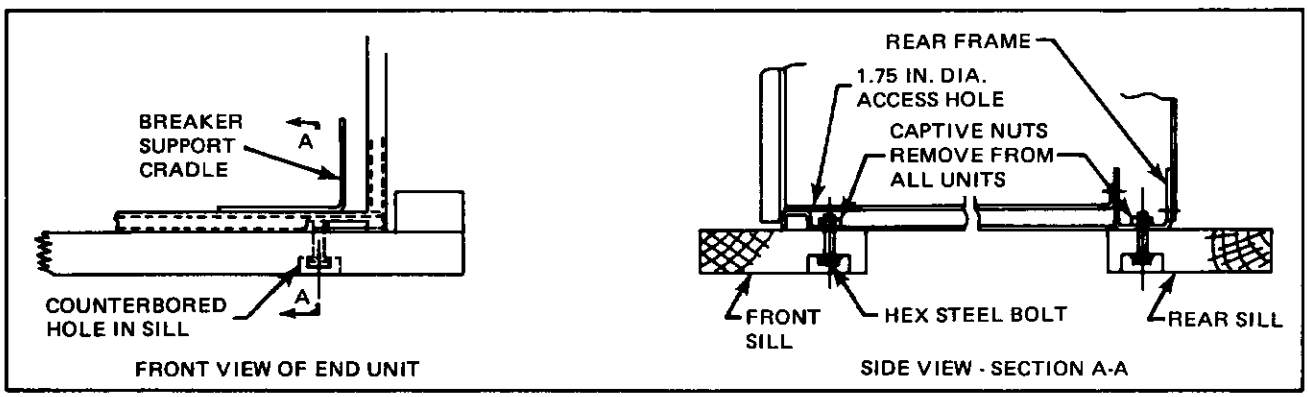


Fig. 32 *Removal of Shipping Skid*

3.5 SHIPPING SKIDS

If possible, the shipping skid should remain on each group until it is at or near its final location. This will allow the use of pipe rollers for moving the group; and will also lessen any chance of distortion during final positioning. See Fig. 35.

Refer to Fig. 32. The front and rear wood sills of the skid are fastened to the bottom of the end units of the group by a total of four steel bolts – one in each corner. To remove the bolts, the skid must be raised a minimum of 6 inches above the floor; and a standard hex socket wrench used.

Although only one bolt is used at the corner of each shipping group, several captive nuts may be furnished in each unit. All should be removed prior to fastening the units to the floor steel. The nuts at the front of the unit are located below 1.75-inch diameter access holes in the front of the breaker support cradle in the bottom compartment. If breakers are furnished in these compartments, they must be removed as the shipping braces cover the access holes. Refer to section on shipping braces below.

The rear captive nuts are located in the bottom channel of the unit rear frame. Remove the bolted rear covers for access to these nuts. The clips holding these captive nuts may be pried out with a screwdriver.

3.6 SHIPPING BRACES

Circuit breakers may be shipped either in separate cartons or secured in their own compartments. If the circuit breakers are shipped in separate cartons, they should be unpacked carefully to avoid damage. If they are shipped in their own compartments, the instructions in this section should be followed. **SEE ITEM 2.5 ON LIFTING THE BREAKER.**

Before the circuit breaker element can be withdrawn from its compartment for the first time, the shipping braces must be removed from the lower part of the breaker front panel. Refer to Fig. 33. During shipment, the front wheels of the breaker are lifted approximately 1/16 inch above the compartment rails, and the unit is held part way between disconnected and test positions by means of its levering device.

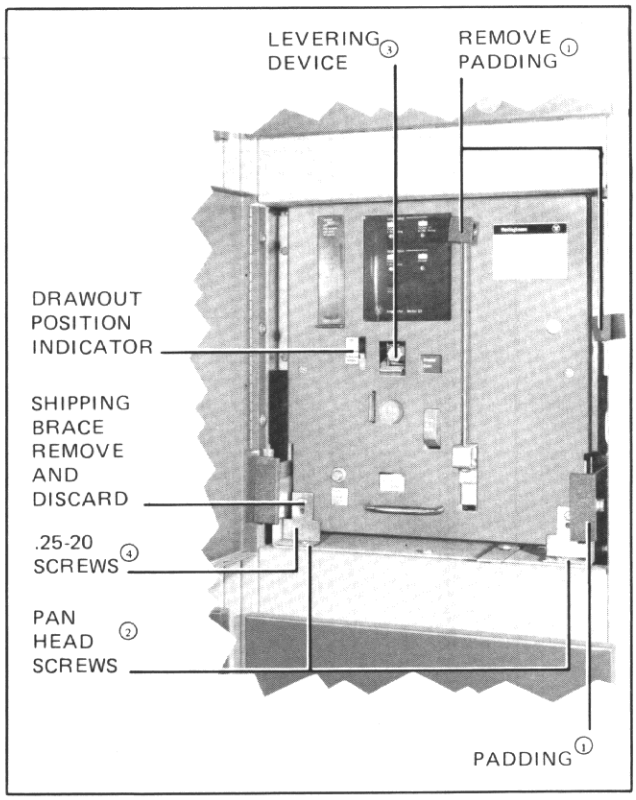


Fig. 33 *Front View of Type DS-416 Breaker Shipped in Compartment (390896)*

NOTE

Preliminary operation and inspection of the drawout breaker unit are covered in detail in Instruction Book 33-790-1.

Fig. 34 is a drawing showing the side view of a typical breaker in its compartment as received. Study this figure and the following steps carefully before proceeding.

NOTE: **Step numbers below correspond to numbers on Fig. 34.**

1. Remove the sponge rubber padding and tape from the compartment rails and the knob on the top of the spring charging handle. (Shown in Fig. 33.)

2. With a screwdriver, remove the two (2) outside .25-20 pan head screws from the bottom leg of the shipping braces. Do not discard, as later they will be returned to their tapped holes Do not remove the center screw.

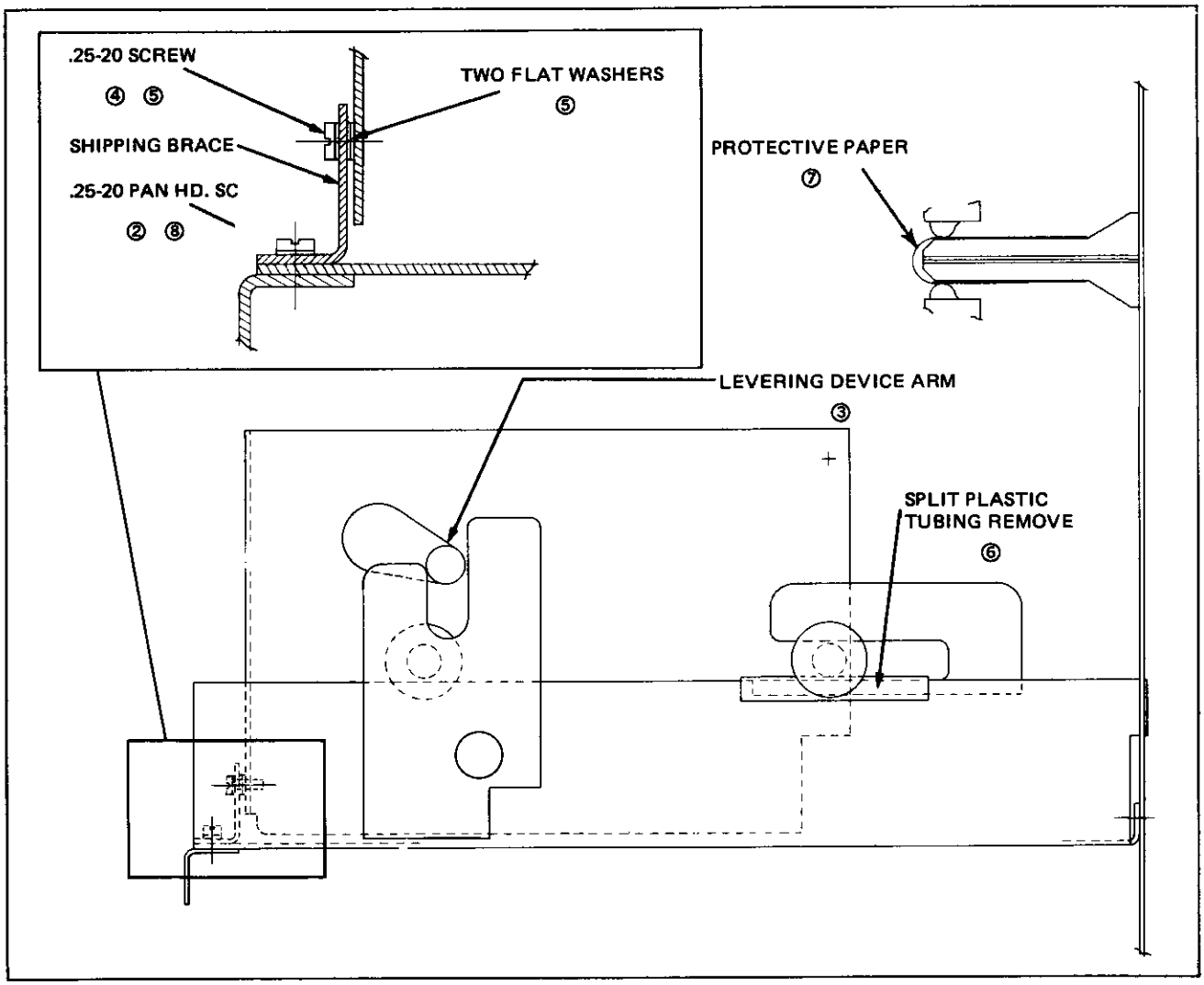


Fig. 34 *Section View of Type DS Breaker Shipping Details*

3. Using the crank to operate the levering device, release the breaker from the shipping position. The crank will be shipped in a box of separate details. This procedure is covered in detail in the breaker I.B. 33-790-1. When the position indicator shows the levering device to be in the "remove" position, and the hand crank will no longer turn, remove the hand crank. Pull the breaker out onto the extended rails. This will require more effort than normal as the rear wheels are jammed by two lengths of plastic tubing used for shipping only.

4. Remove the two (2) .25-20 screws holding the shipping braces to the front panel of the breaker. Care must be exercised to prevent marring the front panel. Two or more flat washers are used between the braces and front panel for shipping. Discard the braces.

5. Immediately replace the two .25-20 screws in the front panel, discarding all washers.

6. With the breaker pulled completely to the end of the rails, remove the two (2) three inch long pieces of split plastic tubing that are on the top rear of the stationary rails immediately below the hold-down hooks. This tubing is for shipping purposes only and is to be discarded.

7. If secondary disconnecting contacts are supplied, a sheet of protective paper is inserted between the stationary and moving contacts during shipment. This must be removed and discarded.

8. Push the breaker back into its compartment, and replace the two (2) .25-20 pan head screws at the front edge of the cradle.

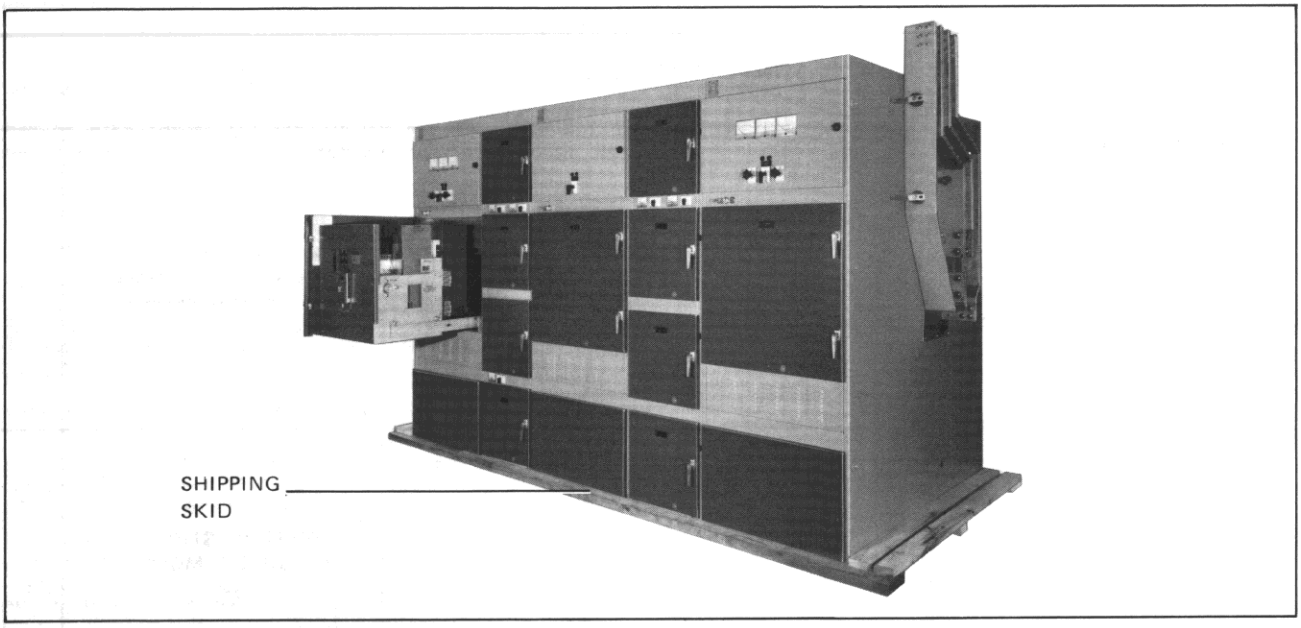


Fig. 35 *Front View of DS Metal-Enclosed Units including DS-840 (391312)*

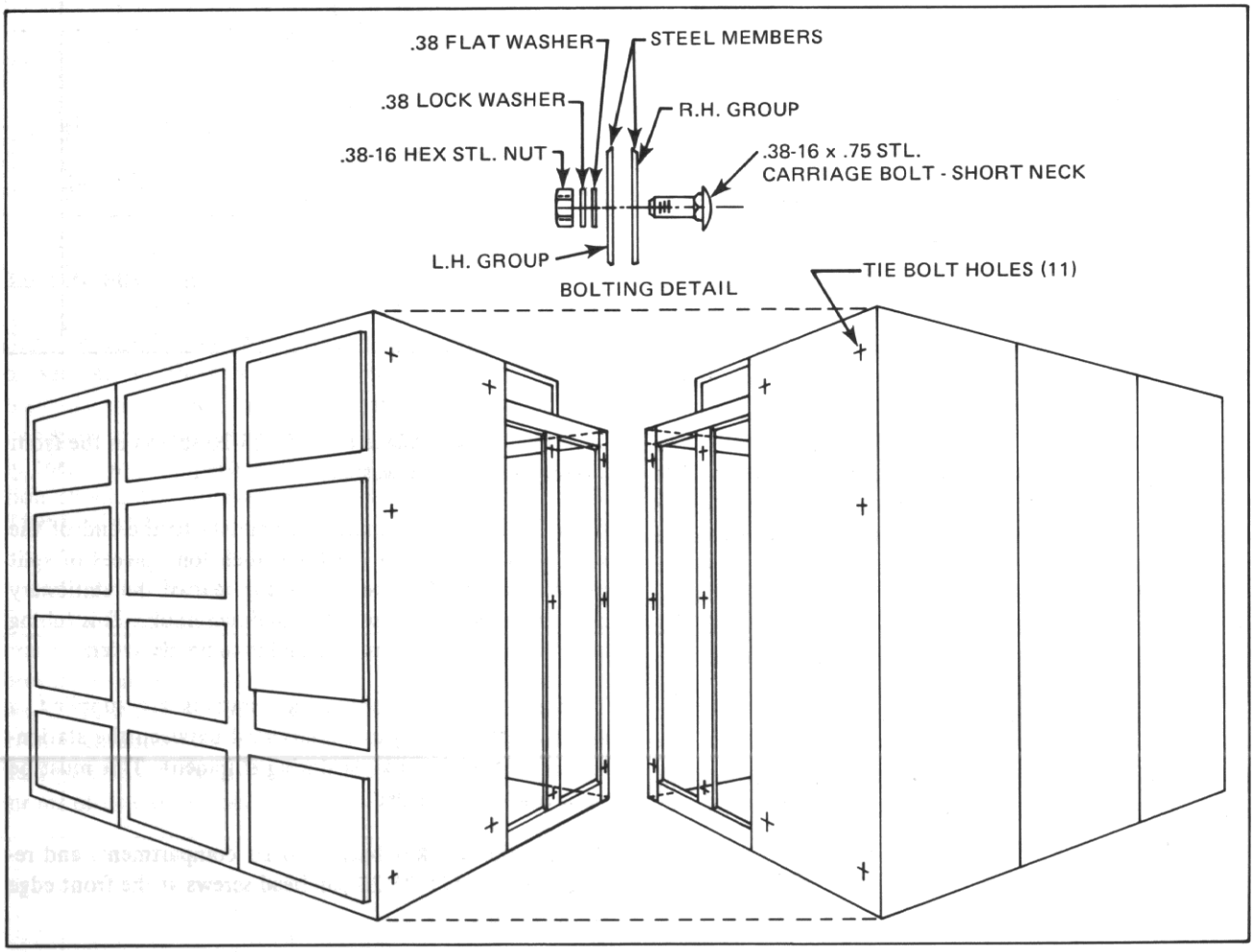


Fig. 36 *Tie Bolt Locations for Joining at Shipping Break*

SECTION 4 – ASSEMBLY OF SHIPPING GROUPS

4.0 GENERAL

When correctly installed, the units for both indoor and outdoor metal-enclosed switchgear should conform to the following requirements:

1. Front panels form a straight true line; and when transformers and/or other gear are included, the fronts should line up or form parallel planes.

2. Units correctly spaced from center to center and plumb.

3. Entire assembly of housings securely fastened to floor channels or base pad.

4. Shipping groups must be securely bolted together, and all bus and control wiring connections properly made.

A suggestion for lining up the units is to establish a base line a few inches in front of the housings and parallel to the final location. Equalize the distances from the front of the housings to the base line, thus making the face of the group parallel to the base line.

Check the plumbness of the units by dropping a plumb line from the exact center or the horizontal steel member at the top front of the unit. It should align with the center of the bottom cross channel.

After the first group has been located, the second group should be moved into position and similarly checked. The steel housings are fastened together at eleven (11) locations which are shown in Fig. 36. Special short neck .38-16 x .75 steel carriage bolts are furnished for this purpose. It will facilitate assembly to locate the bolt head in the right hand unit with the nut and washers

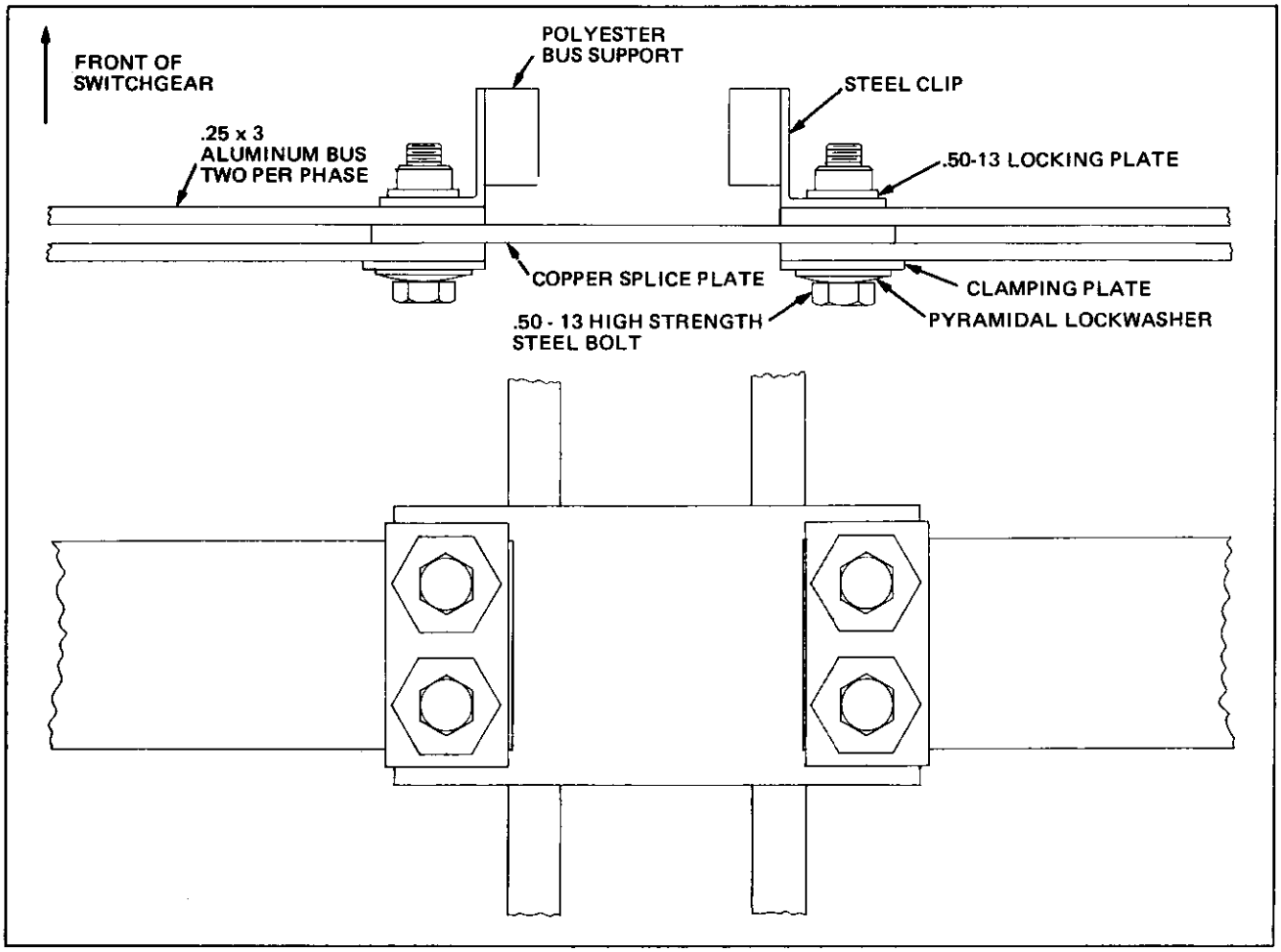


Fig. 37a *Field Assembly of Joints in 1600/2000 Amp. Aluminum Bus*

in the left hand unit. These should be tightened to the torque as shown in Table 5.

4.1 BUS CONNECTIONS

All connections of the main and neutral busses and the ground bus at shipping breaks are made by means of bolted copper splice plates. These are always plated, bolted joints, and no field welding of aluminum is required. All necessary hardware and splice plates are included. Provision is made at the ends of the lineup not adjacent to transformers for future expansion by means of bolted joints.

The following figures show in detail the methods employed for joining the various types and ratings of main bus.

4.1.1 1600/2000 Amp. Aluminum Bus

Two (2) .25 x 3.0 inch aluminum bars per phase are used, with a single .25 x 4.0 copper splice plate at bolted connections. See Fig. 37a, 37b, and 37c.

A total of four (4) .50-13 high strength steel bolts and "Pyramidal" lock washers are used in each plate. The heads of the bolts face toward the rear of the units. They must be tightened to the torque shown in Table 5.

4.1.2 3200 Amp. Aluminum Bus

This rating employes two (2) .50 x 3.0 inch aluminum bars per phase. Each bar is joined by means of two (2) .25 x 4.0 inch copper splice plates at bolted connections. Each pair of splice plates uses front (4) .50-13 high strength steel bolts and "Pyramidal" lock washers. It will be easiest to join the bus bar that is nearest to the front of the switchgear first. See Fig. 38a, 38b and 38c.

4.1.3 4000 Amp. Aluminum Bus

This rating employs two (2) .50 x 4.0 inch aluminum bars per phase. Each bar is joined by means of two (2) .25 x 4.0 inch copper splice plates at bolted connections. Each pair of splice plates uses four (4) .50-13 high strength steel bolts and "Pyramidal" lock washers. It will be easiest to join the bus bar that is nearest to the front of the switchgear first. See Fig. 38a.

4.1.4 1600/2000 Amp. Copper Bus

One (1) .25 x 4 copper bar is used per phase with one (1) .25 x 4 copper splice plate used at each bolted connection. A total of eight (8) .50-13 high strength steel bolts and "Pyramidal" washers are used at each bolted connection. See Fig. 39a and 39b.

4.1.5 3200 Amp. Copper Bus

This rating employs two (2) .25 x 5.0 inch copper bars per phase and two (2) .25 x 5.0 inch copper splice plates per phase at each bolted joint. A total of eight (8) .50-13 high strength steel bolts and "Pyramidal" washers are used at each bolted connection. See Fig. 40a and 40b.

4.1.6 4000 Amp. Copper Bus

This rating employs three (3) .25 x 5.0 inch copper bars per phase and three (3) .25 x 5.0 inch copper splice plates per phase at each bolted joint. Otherwise the assembly is the same as the 3200 ampere rating. See Fig. 40a.

4.1.7 Neutral Bus

When required on a four wire system an insulated neutral bus is supplied, located in the bus compartment approximately 44 inches above the floor. The neutral bus is always copper, regardless of the main bus material. See Fig. 5. Available neutral bus sizes are listed in Table 4.

Table 4 – Neutral Bus Sizes

Main Bus Rating	Minimum Neutral Bars	Maximum Neutral Bars
1600 or 2000 Amp.	1 – .25 x 2.0 in	1 – .25 x 4.0 in
3200 Amp.	1 – .25 x 4.0 in	2 – .25 x 4.0 in
4000 Amp.	2 – .25 x 4.0 in	3 – .25 x 4.0 in

4.1.8 Copper Ground Bus

The joint in the .25 x 2.0 inch copper ground bus is made by means of a single copper splice plate bolted directly to the inside of the rear steel frame. See Fig. 41.

4.2 PREPARATION OF BUS JOINTS

The bolting areas of all bus materials are plated to provide the optimum joint. In some atmospheres the plating will become tarnished, but this does not reduce its effectiveness. However, dirt, grease, and other foreign material must be removed from the surfaces before they are joined. Wipe clean with a non-flammable solvent such as 1,1,1 Trichloroethane (Methyl Chloroform).

CAUTION

DO NOT BREATHE LARGE QUANTITIES OF SOLVENT VAPORS. AVOID EXCESS CONTACT WITH SKIN.

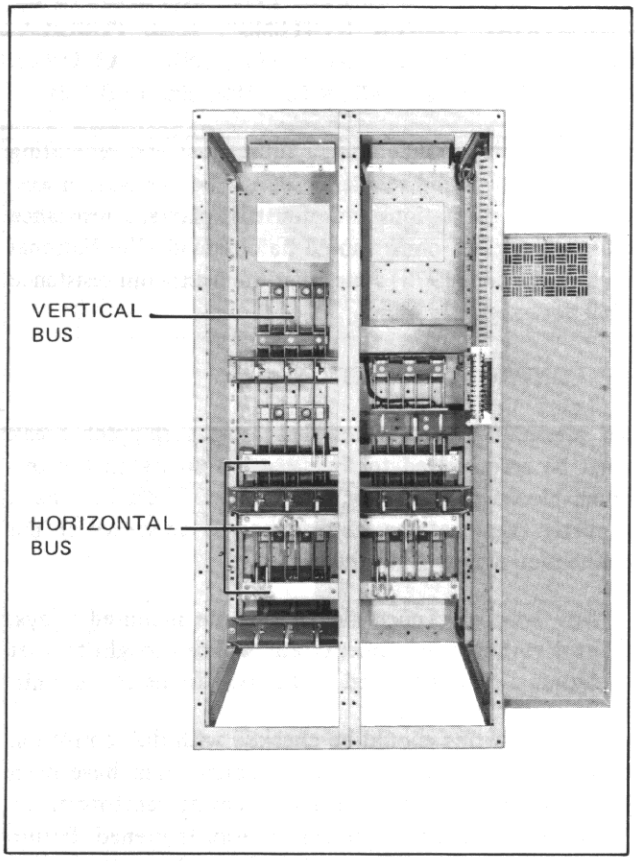


Fig. 37b *1600/2000 Amp. Welded Aluminum Bus (391319)*

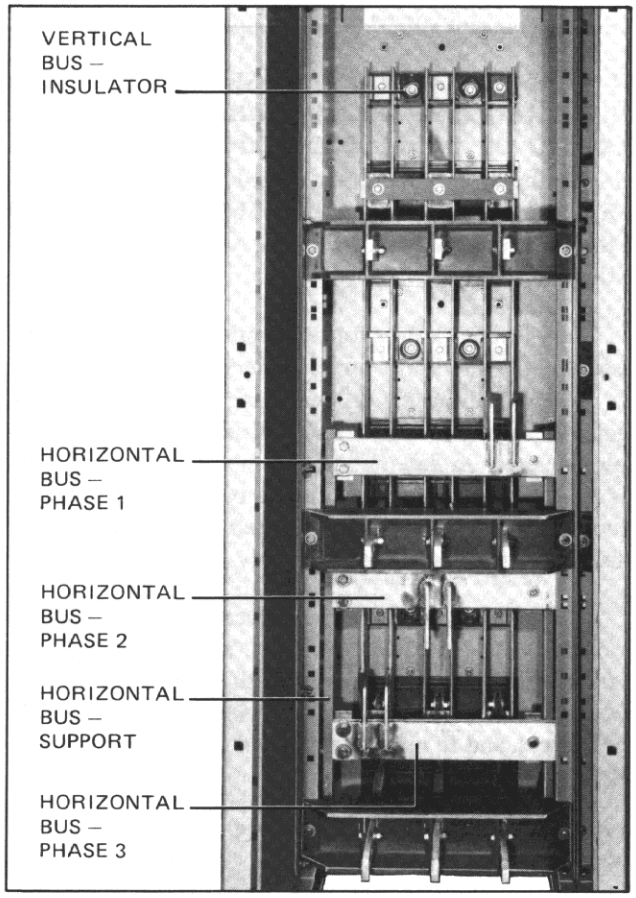


Fig. 37c *1600/2000 Amp. Welded Aluminum Bus (391317)*

4.3 MAIN POWER CONNECTIONS

Low voltage metal-enclosed switchgear is usually provided with solderless cable connectors for terminating the main power cables. See Fig. 21.

Before making up the connections, the phase of each cable must be determined. Normally, switchgear is supplied with connections for phase sequence 1-2-3 unless otherwise required on the particular order.

4.4 BOLT TIGHTNESS

All bolts holding structural members, barriers and covers are installed in the factory tightly enough to insure rigidity of the assembly and to prevent rattling of the covers after the equipment is energized. When covers or barriers are removed during installation care should be taken to solidly tighten all bolts after replacing.

Bolts installed in bus joints and connections are normally high strength steel. Silicon bronze hardware is sometimes supplied, if specified by the customer. The reliability of current conducting joints is dependent upon the tightness of the joint. Therefore, extreme care must be taken when making or remaking bus joints in the field to insure their tightness. Bolts in bus connections should be tightened according to Table 5.

Table 5 – Bolt Tightness for Bus Connections

Bolt Material	Torque in Foot-Pounds for Bolt Size				
	.25-20	.31-18	.38-16	.50-13	.62-11
High Strength Steel	5	12	20	50	95
Silicon Bronze	5	10	15	40	55

4.5 BARRIERS

Steel barriers separating the bus and cable compartments are optional items. When barriers have been provided on a switchgear assembly, they should be in place before feeder cables are installed. Those one-piece barriers located between the runbacks from the feeder compartments will be fastened by means of four .38-16 hex head steel bolts and lockwashers. A few of the larger barriers may have six

bolts. These should be securely tightened to the prescribed torque to prevent vibration during operation.

IT IS ESSENTIAL THAT PHASE ROTATION AND PHASE ANGLE BE THE SAME WHEN TWO SYSTEMS ARE TO BE PARALLELED TO AVOID POSSIBLE DAMAGE TO EQUIPMENT. PHASE ROTATION MUST BE IN ACCORDANCE WITH THE DRAWINGS SO THAT INSTRUMENTS, METERS AND RELAYS WILL FUNCTION PROPERLY.

When forming cables for termination within switchgear assemblies, avoid sharp turns, corners, and edges in order to prevent damage to, or weakening of the cable insulation. The cable manufacturer's instructions should be followed closely in determining the minimum bending radii of cables. This will vary with the type and size of cable involved. Cable supports as required may be attached to the frame of the switchgear assembly.

Adequate electrical and mechanical clearances must be provided between cables, conduits, and bus in this compartment. Where the cables enter the unit, they must be securely lashed and supported to withstand any short circuit forces, and to prevent any strain or load on the terminals.

4.6 GROUND BUS CONNECTIONS

Terminals of the solderless type are provided on the copper ground bus in one or more of the units, depending upon the number in the lineup. These are shown on the floor plan drawing, and are for the connections to the station ground which should be as direct a connection as possible, and should not be run in metal conduit. The grounding conductor should be capable of carrying the maximum line-to-ground current for the duration of the fault.

CAUTION

A PERMANENT LOW RESISTANCE GROUND IS ESSENTIAL FOR ADEQUATE PROTECTION. A POOR GROUND MAY BE WORSE THAN NONE SINCE IT GIVES A FALSE FEELING OF SAFETY TO THOSE WORKING AROUND THE EQUIPMENT.

NOTE

IT IS NOT THE INTENT OF THIS INSTRUCTION BOOK TO COVER THE DESIGN AND INSTALLATION OF GROUNDING SYSTEMS. BUT SINCE THE IMPORTANCE OF ADEQUATE GROUNDING CANNOT BE OVERLOOKED, REFERENCE SHOULD BE MADE TO "ELECTRIC POWER DISTRIBUTION FOR INDUSTRIAL PLANTS", IEEE STD. 141; "GROUNDING OF INDUSTRIAL POWER SYSTEMS", IEEE PUBLICATION 141 (FORMERLY AIEE 953); AND "NATIONAL ELECTRICAL CODE, ARTICLES 100, 200 AND 250."

For solidly-grounded larger substations and generating stations, the ground resistance should be one ohm or less. For smaller substations and industrial plants, a resistance of less than five ohms should be obtained. The National Electrical Code (1978) states that the maximum resistance shall not exceed 25 ohms.

4.7 CONTROL CONNECTIONS

All interunit control wires that cross a shipping break must be reconnected to their correct points on the terminal blocks provided for this purpose. These have been properly tagged at the factory and will be shown on the connection diagrams for the order.

Any control connections to remote mounted relays, control switches, instruments, etc. will be brought to a set of terminal blocks located on the rear frame of the unit.

Control wiring should be checked with the connection diagram to make certain that all connections have been properly made, all fuses installed, current transformer circuits completed, and loose connections tightened. Before applying control energy, check all control circuits, except current and potential transformer secondary circuits for grounds; and make sure that all circuits are clear.

If the control power source is other than a self-contained control power transformer, the cables from the source to the switchgear must be of adequate size to avoid excessive voltage drop during operation.

4.8 MOVING PARTS

There are few moving parts in the stationary structures of metal enclosed switchgear; and in general, they do not require installation as they are factory-installed. However, it is recommended that all moving parts be carefully operated by hand (even if normally operated automatically) to assure that no binding or damage has occurred during shipment or handling. In some cases, accessories may be blocked or braced for shipment; or foreign matter may have accumulated or lodged in the equipment during long periods of storage under unfavorable conditions.

4.9 REMOVAL OF BLOCKING AND BRACING

Some apparatus, such as meters and relays, must be thoroughly checked for forms of blocking or bracing which must be removed.

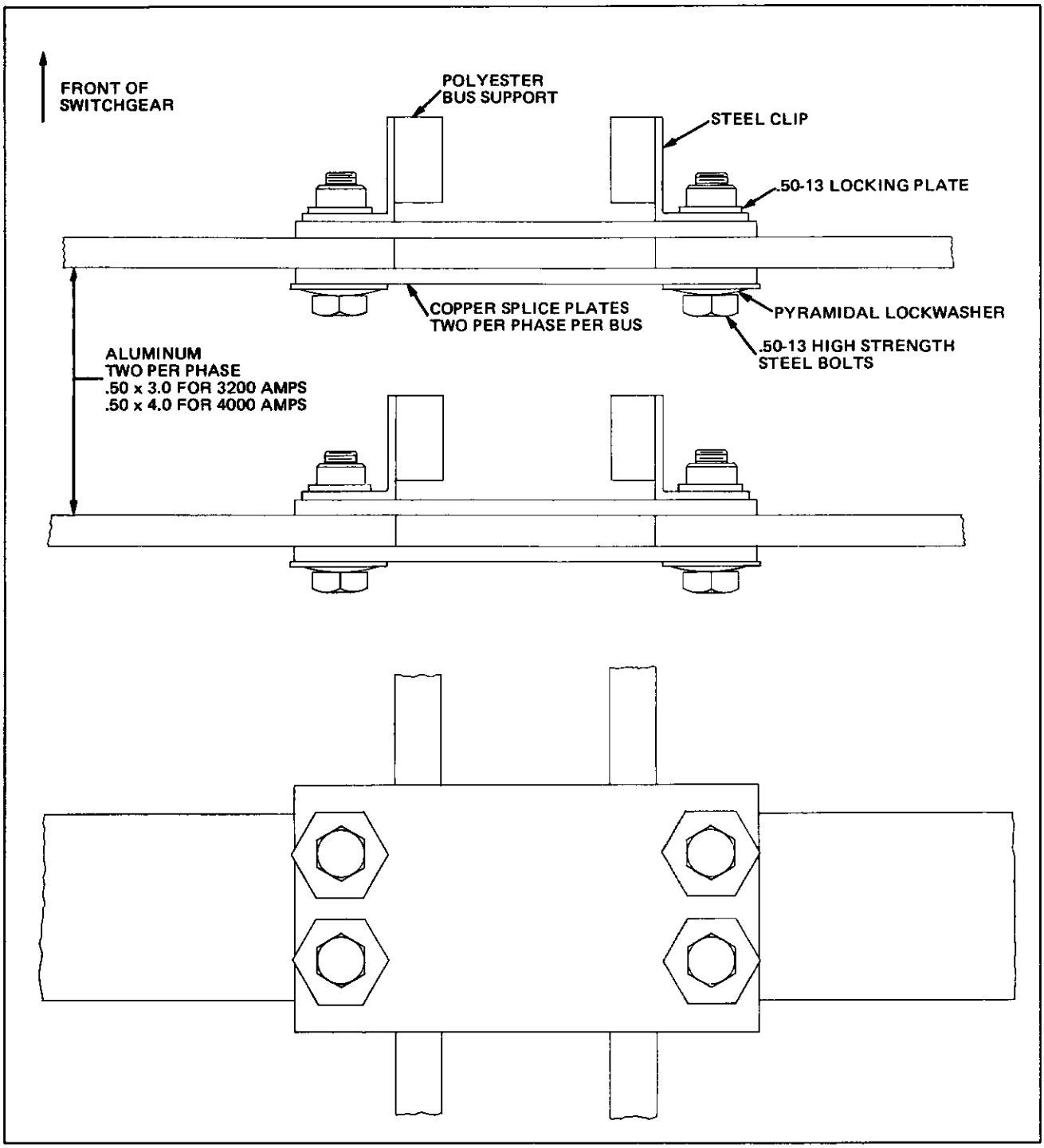


Fig. 38a *Field Assembly of Joints in 3200/4000 Amp. Aluminum Bus*

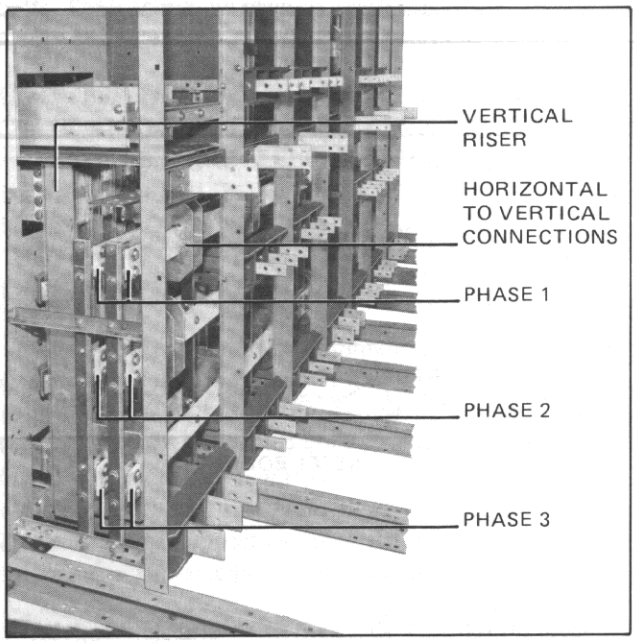


Fig. 38b *3200 Amp. Welded Aluminum Bus (391183)*

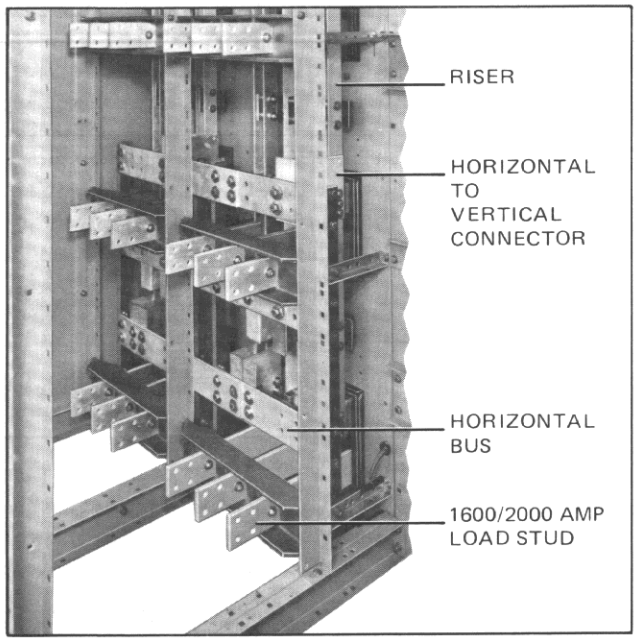


Fig. 39a *1600/2000 Amp. Bolted Copper Bus (392611)*

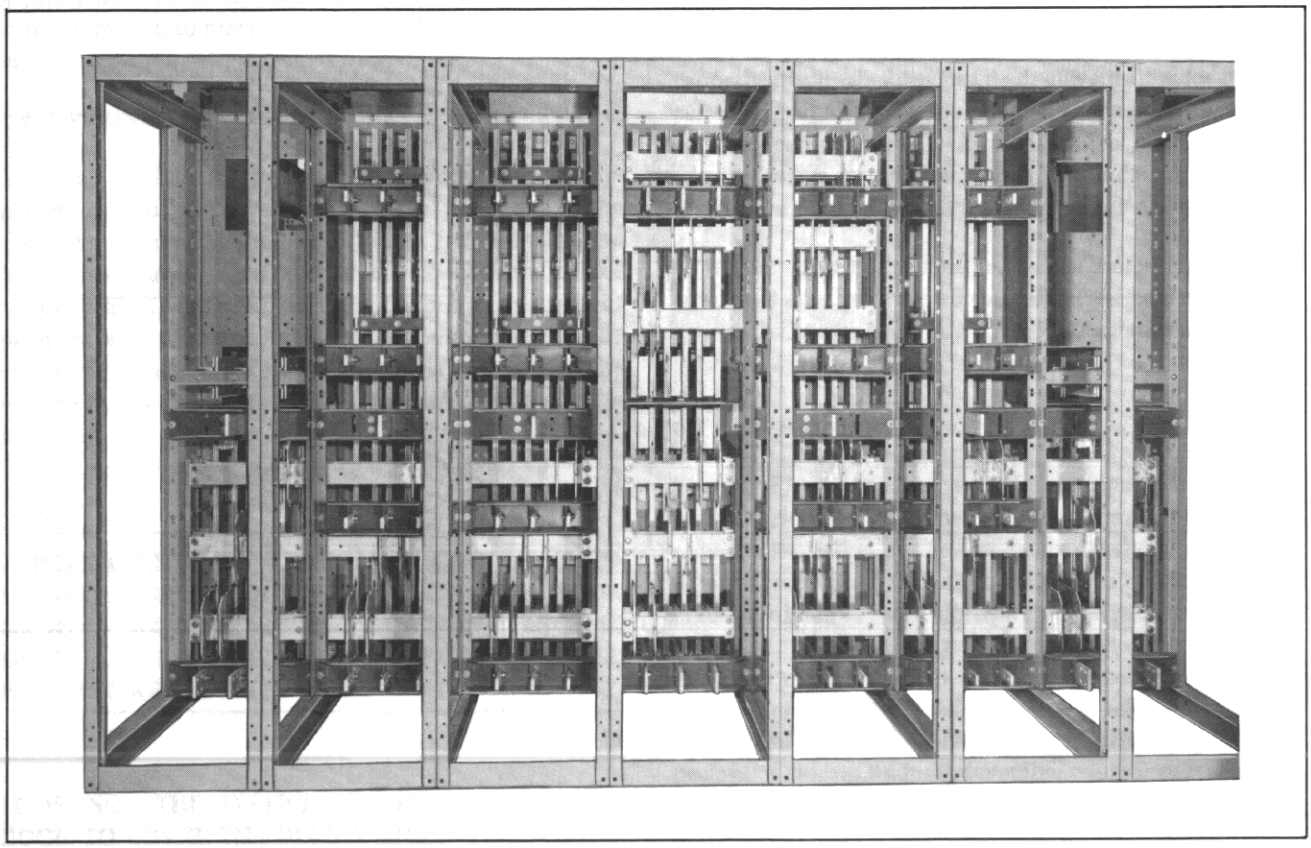


Fig. 38c *3200 Amp. Welded Aluminum Bus (391180)*

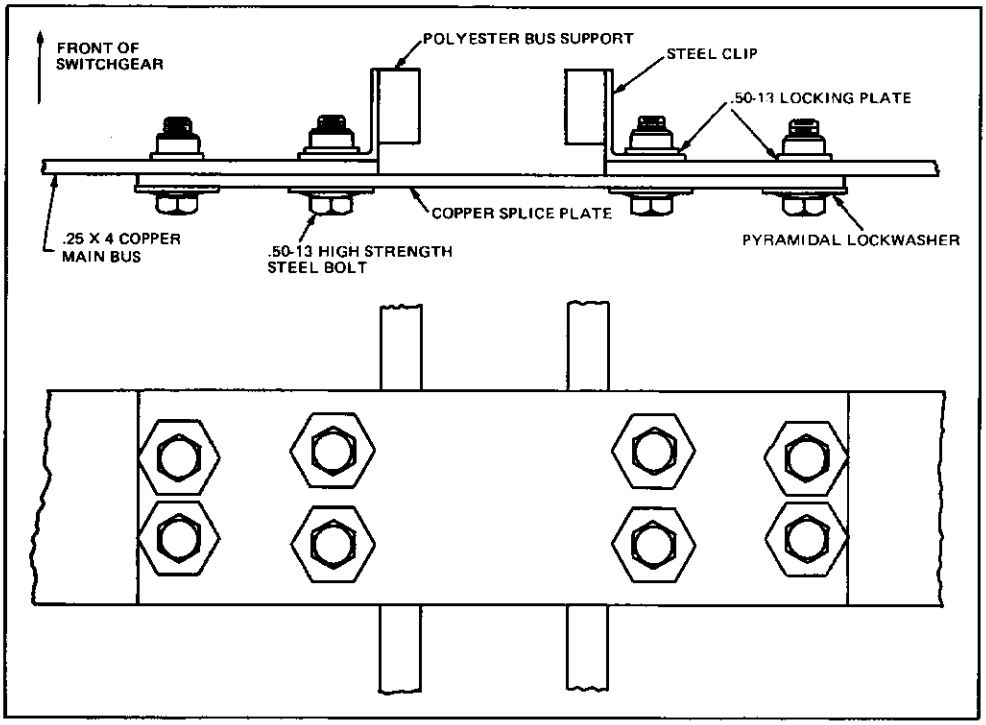


Fig. 39b *Field Assembly of Joints in 1600/2000 Amp. Copper Bus*

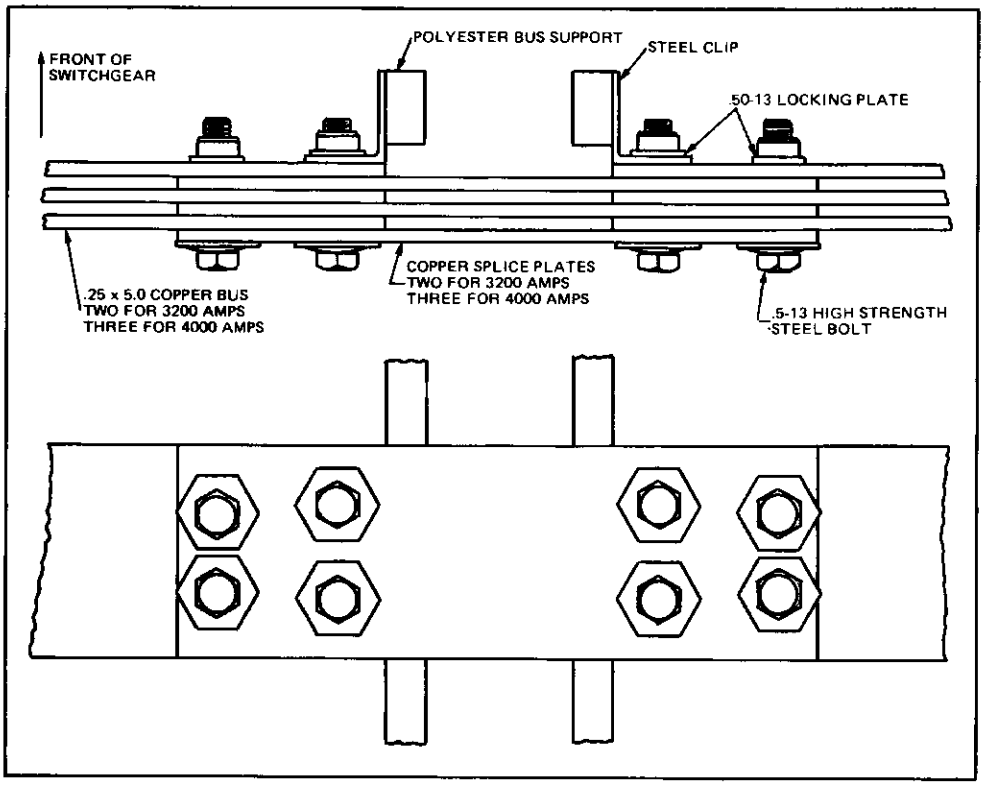


Fig. 40a *Field Assembly of Joints in 3200/4000 Amp. Copper Bus*

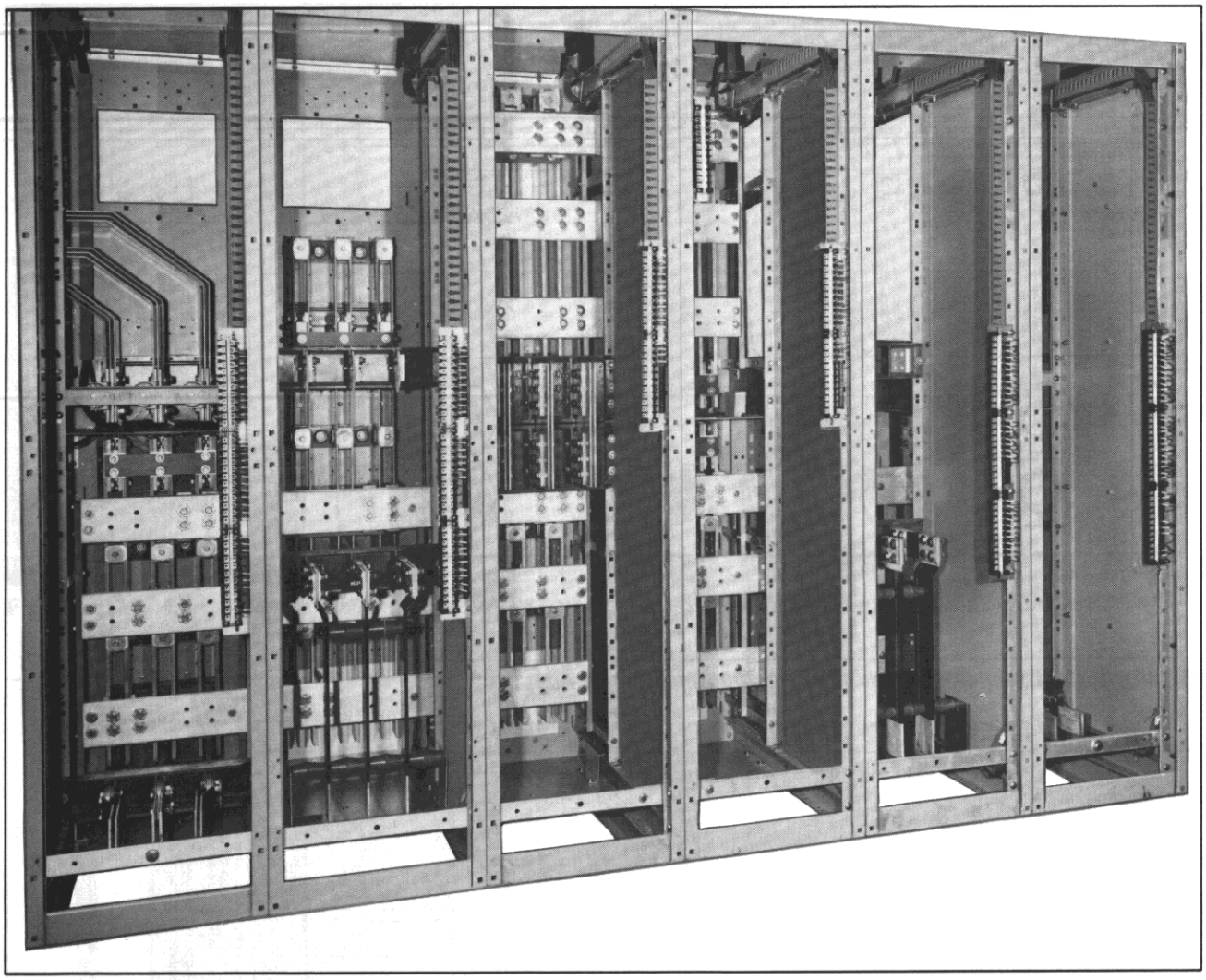


Fig. 40b *3200 Amp. Bolted Copper Bus (391318)*

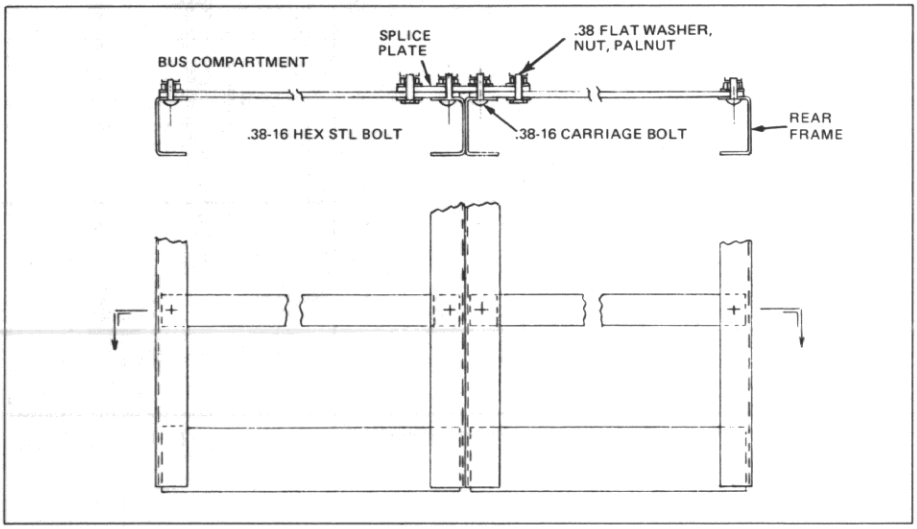


Fig. 41 *Field Assembly of Joints in Ground Bus*

SECTION 5 – PRE-OPERATION CHECK AND TEST

5.0 GENERAL

After the switchgear equipment and apparatus to be controlled have been installed and all interconnections made, the equipment should be given a final check and tested before being placed in service. This is necessary to assure that the equipment has been correctly installed and that all connections are complete and have been properly made.

CAUTION

TO AVOID BODILY INJURY OR ELECTRICAL SHOCK, EXTREME CARE MUST BE EXERCISED TO PREVENT THE EQUIPMENT FROM BEING CONNECTED TO THE POWER SYSTEM WHILE THE PRELIMINARY TESTS ARE BEING CONDUCTED. IF DISCONNECTING SWITCHES ARE NOT AVAILABLE, LINE LEADS SHOULD BE DISCONNECTED TO ACCOMPLISH THIS.

5.1 TEST EQUIPMENT

The test equipment needed will depend on the size and type of installation. Portable voltmeters of the multi-scale type, if available, will be required. For large and complicated installations, ammeters should be available in case unexpected trouble develops. Although insulation resistance will vary greatly due to the multiplicity of parallel paths in equipment of this type, an ohmmeter and "megger" will be valuable to insure that there is no breakdown of insulation. Initial insulation values may be recorded for comparison to values determined at a later date during inspection and maintenance. A continuing comparative record is valuable to help detect any progressive deterioration of insulation. A simple portable device for "ringing" or "lighting-out" circuits may be used for making continuity checks.

5.2 WIRE AND BUS CONNECTIONS

Wire connections, accessible bolted bus connections, and insulated joints should be examined to make sure that they have not been loosened or damaged during shipment or installation.

The connections to the equipment apart from the switchgear such as remote control and interlock circuits, and auxiliary switches should be "lighted-out" to make sure that they are also correct. The extent to which this will have to be done depends on the thoroughness of the installation work. There must be definite assurance that connections are correct before an attempt is made to operate the equipment.

If heaters are supplied, they should be energized to confirm correct operation.

5.3 RELAYS

Any relays included on the hinged instrument panel have been checked at the factory and are normally set at "minimum" for shipment. The final settings of the relays should be coordinated with other parts of the system in accordance with the Purchaser's standards or operating practice. If it becomes necessary to modify these relay settings, the instruction leaflet for the relay involved should be carefully studied. These instruction leaflets show typical connection diagrams only and may not necessarily agree with the connections furnished. The schematic diagrams furnished for the order should be referred to for the actual connections.

5.3.1 Covers

The covers for meters, relays, and other devices which have to be removed during the course of installation and test should be carefully handled when removed. The covers should be put back in place promptly to keep dust and dirt from collecting on the vital relay parts.

5.4 DRAWOUT ELEMENT

The trip settings of the Amptector trip devices should be checked to be sure that they are in accordance with the requirements of the circuits. For information on complete testing and maintenance of the circuit breakers see I.B. 33-790-1.

5.5 POWER-OPERATED BREAKERS

Power-operated Type DS Breakers have their closing springs charged by a motor that is energized automatically when the breaker is open and control power is available. Not more than four power-operated breakers in a single assembly, should be in the test or connected position with their springs uncharged and control power off. Energizing the control power would run all motors at the same time and could draw enough current to blow fuses.

SECTION 6 – INSEPCTION AND MAINTENANCE

6.1 SAFETY PRECAUTIONS

WHEN INSPECTING, REPAIRING, AND PERFORMING MAINTENANCE ON DS SWITCHGEAR, THE FACT THAT DANGEROUS VOLTAGES MAY EXIST MUST BE KEPT IN MIND; AND PRECAUTIONS MUST BE TAKEN TO INSURE THAT PERSONNEL DO NOT COME IN CONTACT WITH ENERGIZED PARTS. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY OR ELECTRICAL SHOCK.

Some common general precautions for high power circuits are:

1. All connections should be considered energized until the crew expecting to work on them is assured that the circuits are de-energized, and until every possible precaution has been taken to see that there is no chance of a circuit being energized while the crew is working.

2. Switches which have been opened to de-energize a circuit to permit work on equipment should be locked or blocked open and a suitable visible warning device placed on them.

3. Do not work on parts normally carrying high current until these parts have been disconnected from the system and connected to the ground bus. Provision should be made by the Purchaser for connecting adequate flexible ground leads to every part of the switching equipment.

4. A good and reliable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to take care of any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus. See **GROUND BUS CONNECTIONS.**

6.2 ACCESS TO SWITCHGEAR PARTS

6.2.1 Main Bus and Cable Compartment Access

Low-Voltage, Metal-Enclosed switchgear is designed so that internal compartments provide isolation between the DS circuit breaker compartment, the main bus, and the primary line terminations. Access to high current parts is provided by removable covers and barriers WHICH SHOULD NOT BE REMOVED UNLESS THE PARTS TO BE EXPOSED ARE DE-ENERGIZED. Figs. 3 and 17 are photographs in which covers have been removed to expose the main bus and the primary line terminations.

6.2.2 Main Disconnecting Contacts and Current Transformers

The stationary main disconnecting contacts and the ring-type current transformers are located on the breaker compartment rear wall. These contacts and transformers are *easily* exposed. For this reason **CAUTION MUST BE EXERCISED. DO NOT EXPOSE ANY CONTACTS OR TRANSFORMERS UNLESS ALL UPPER AND LOWER HIGH CURRENT PARTS ARE DE-ENERGIZED. FAILURE TO DO SO COULD CAUSE PERSONAL INJURY OR ELECTRICAL SHOCK.**

6.2.3 Control Equipment

With the exception of apparatus such as current transformers and rear mounted heaters, control equipment and wiring is generally accessible without exposing high voltage parts.

6.3 INSPECTION AND MAINTENANCE SCHEDULE

To assure high quality service, a definite maintenance schedule, systematically followed, is essential. Plant, operating, and local conditions vary to such an extent that the schedule must be prepared to suit the conditions. However, the following general requirements should be helpful in setting up the program.

CAUTION

BEFORE ATTEMPTING ANY INSPECTION OR MAINTENANCE BE SURE THAT ALL PRIMARY AND CONTROL CIRCUITS HAVE BEEN DE-ENERGIZED AND GROUNDED AS REQUIRED AND THAT PROPER STEPS HAVE BEEN TAKEN TO BE SURE THAT THEY WILL REMAIN DE-ENERGIZED UNTIL ALL WORK IS COMPLETED. FAILURE TO DO SO COULD RESULT IN BODILY INJURY OR ELECTRICAL SHOCK. WHEN ENERGIZED, A CIRCUIT BREAKER IS PART OF A HIGH POWER SYSTEM.

6.3.1 Individual Devices

The maintenance schedule for individual devices such as circuit breakers, relays, meters, etc. should be based upon recommendations contained in the individual instruction book for the device. These operations should be coordinated with the overall program to result in the least operating inconvenience and circuit shutdown.

6.3.2 Overall Installations

The switchgear installation should be given a thorough overall maintenance check at least annually, when plant, operating, and local conditions are normal. Where conditions are abnormal, move frequent inspection and maintenance is necessary. The following items require attention:

6.3.2.1 Buses and Connections

De-energize primary circuits and remove cover plates from the primary compartments. Before cleaning take "megger" readings between phases and to ground. Inspect for signs of overheating or weakened insulation. Remove dust from buses, connections, supports, and enclosure surfaces. A vacuum cleaner with a long nozzle will be of assistance. Wipe clean with a non-flammable solvent.

CAUTION

DO NOT BREATHE LARGE QUANTITIES OF VAPOR. AVOID EXCESS CONTACT WITH SKIN.

After buses have been dusted and wiped clean, take "megger" readings again between the buses and ground and between phases. Keep a record of these readings for future reference in determining when trends occur that would indicate a decrease of resistance.

6.3.2.2 Main Disconnecting Contacts and Supports

Remove each breaker from its housing. De-energize all circuits and expose primary contacts and their supports. Wipe clean with a cloth moistened in a non-flammable solvent. Inspect for abnormal wear or overheating. Discoloration of the surfaces is not harmful unless corrosion due to atmospheric conditions is severe, leaving deposits on the surface. Any deposits must be removed by rubbing with a clean cloth, or a new contact installed. Check each breaker while it is out of the housing for all items recommended in the instruction book applying to that particular type of breaker.

6.3.2.3 Other Disconnecting Contacts

Inspect all secondary disconnecting contacts for abnormal wear, fatigue, or overheating. Replace if necessary; otherwise treat the same as Main Disconnecting Contacts.

6.3.2.4 Control Contactors

Contacts should be inspected and dressed or replaced when the surface becomes pitted. Unless high repetitive duty has been experienced, little attention should be required.

6.3.2.5 Instruments, Relays and Other Panel Mounted Devices

Individual devices should be maintained according to the specific instructions supplied for each device. Remove all relay covers and inspect the interiors for dust or dirt. This operation can most readily be performed by relay test personnel during periodic relay tests. Control switches, transfer switches, and instrument switches should have their contacts inspected.

6.3.2.6 Secondary Wiring

Check all wiring connections for tightness including those at the current and potential transformers and at the terminal blocks where circuits leave the switchgear. Make sure that all secondary wiring connections are properly connected to the switchgear ground bus where so indicated.

6.3.2.7 Mechanical Parts

Visually check and manually operate mechanical moving parts such as truck operated cell switches, the position interlock, emergency trip linkage, and hinged doors. Examine mechanical parts such as the levering-in arms, and the rail extensions.

6.3.2.8 Ventilation

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. When filters are used, check and replace when dirty.

6.3.2.9 Records

The condition of each switchgear unit at the time of inspection should be listed in a permanent record to become a guide for anticipating the need for replacements or for special attention between the regular maintenance periods.

6.3.2.10 Abnormal Conditions

Local conditions such as high humidity, salt-laden atmosphere, corrosive gases, heavy dust, or severe circuit operating conditions, are considered to be abnormal; and will require more frequent inspections.

It should be emphasized that a series of inspections should be made at quarterly intervals until the progressive facts of the local conditions can be analyzed to determine

a schedule which will maintain the equipment in satisfactory condition.

In some locations conditions may be so bad that the frequency of maintenance will interfere with operating and production schedules. In such cases, consideration should be given to the possibility of enclosing the switchgear equipment in a relatively tight room and to supplying a sufficient quantity of clean air to maintain a positive pressure in the room. Under such conditions maintenance schedules may then be established on a more normal basis. Such an arrangement might also provide for cooling the air where the ambient temperature is relatively high, thus further improving operating conditions.

WARNING

FAILURE TO INSPECT, CLEAN, LUBRICATE AND MAINTAIN SWITCHGEAR AT RECOMMENDED FREQUENCIES COULD RESULT IN FAILURE OF EQUIPMENT TO OPERATE PROPERLY UNDER FAULT CONDITIONS, WHICH COULD CAUSE EQUIPMENT DAMAGE AND/OR BODILY INJURY.

6.3.2.11 Power-Operated Breakers

See Section 5.5 for precautions on re-applying control power when power-operated breakers are involved.

6.4 LUBRICATION

Metal-enclosed, low-voltage switchgear is designed so that lubrication is not required under normal conditions. However, abnormal local conditions such as high humidity, salt-laden atmosphere, corrosive gases, or severe circuit operating conditions may demand the use of lubricants. In such cases a dry or powder lubricant should be used on moving or mating mechanical parts and a thin film of vaseline on disconnecting contacts. The application of the lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

The lubrication of the drawout breaker is covered in its instruction book. In general, there is nothing that will require any lubrication in the stationary housings. The main disconnecting finger clusters and stationary contacts should be cleaned periodically but KEPT DRY. Vaseline or grease should NOT be applied to these contact surfaces as it will hold dirt and particles of plating which will cause an increase in the levering-in force required.

6.5 RENEWAL PARTS

When ordering renewal or spare parts, include as much information as possible. In many cases the style number of the new part can be obtained from identification on the old part. Always include a description of the part. Specify the rating, housing number, and shop order number of the metal-enclosed housing in which the part is to be used. As a further guide, renewal parts lists are usually included in the specific instructions for individual devices.

One set of spare fuses and lamp bulbs is included with the accessories for each order.