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

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

Westinghouse Electric Corporation
Construction Equipment Division, Greentree, PA 15220
I.B. 32-690-E Effective June 1992 Supersedes I.B. 32-690-D dated January, 1985

WARNING

The metal-enclosed switchgear assembly 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 death, 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 assemblies used with Types DS and DSL Circuit 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.

WARNING

Improperly installing and maintaining these products can result in death or serious personal injury. Before attempting installation or maintenance, read and understand all instructional materials related to the product. This should not be considered all inclusive. If further information is required, you should consult Westinghouse Electric Corporation.

Sale of the product discussed in this instruction book is subject to terms and conditions outlined in appropriate Westinghouse Electric Corporation selling policies or other contractual agreement between the parties. This literature is not intended to and does not enlarge or add to any such contract. The sole source governing the rights and remedies of any purchaser of this equipment is the contract between the purchaser and Westinghouse.

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These instructions do not cover all possible contingencies which may arise during installation, operation, or maintenance, or all details and variations of this equipment. 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 Circuit Breakers

Interrupting Ratings of Type DS Circuit 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	Without Instantaneous Trip ① ② 208-240V	480V	600V
DS-206	800	42,000	30,000	30,000	30,000	30,000	30,000
DS-206H	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-416H	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. DSL-840 includes DS-840 breaker and DS-4000 drawout fuse truck, in separate interlocked compartments.

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 equipped with an Amptector Trip Unit 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. Breakers equipped with Digitrip Type Trip Units can not be set to carry more than 100% of sensor rating.

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

A metal-enclosed switchgear assembly with Type DS Low Voltage A-C Power Circuit Breaker controls and protects power circuits up through 600 volts. The switchgear assembly is composed of vertical sections that are arranged to suit the customer's requirements. Each vertical section 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 transformers, instruments, meters, relays and secondary control devices. The rear of the vertical section will include busses and space for the main cables.

The metal-enclosed switchgear assembly is designed, manufactured and tested in accordance with industry standards. It is available for both indoor and outdoor installations. An indoor assembly is shown in Figs. 1 and 2. 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, operating and maintenance staffs with the metal-enclosed switchgear assemblies 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 assembly.

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.

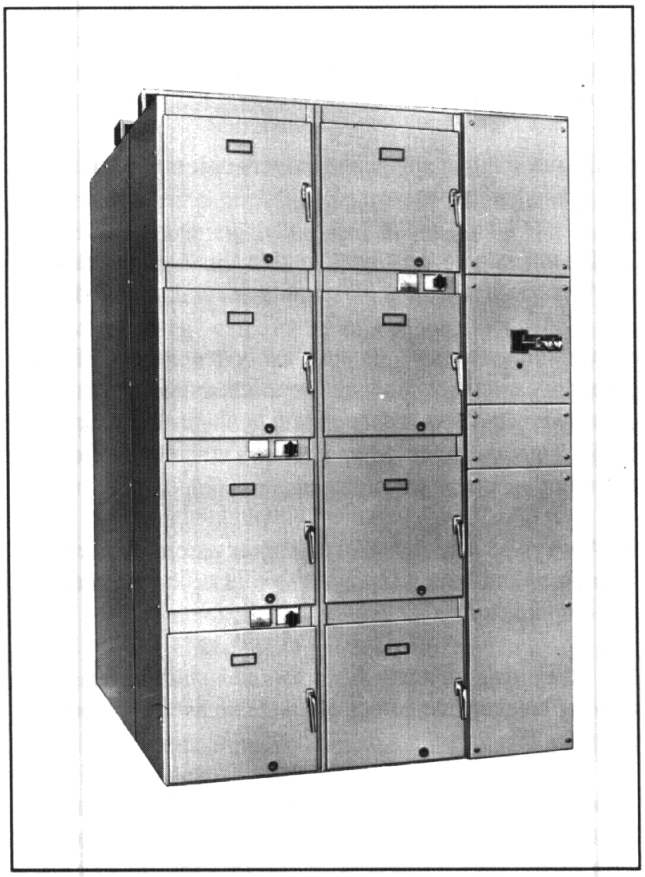


Fig. 1 *Type DS Indoor Metal-Enclosed Units: Front View*

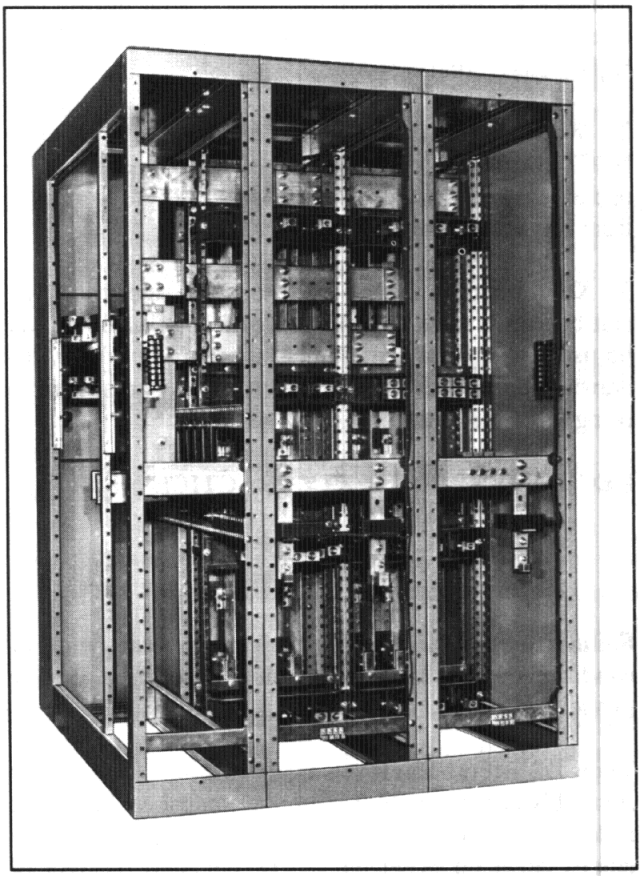


Fig. 2 *Type DS Indoor Metal-Enclosed Units: Rear Covers Removed*

WESTINGHOUSE SAFETY FEATURES

Each Westinghouse Type DS Metal-Enclosed Low-Voltage Switchgear assembly 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. (From hereon the word "breaker" will mean a type DS or DSL circuit breaker.)

1. Each compartment is provided with an interference interlock to prevent inserting 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.

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

RECOMMENDED SAFETY PRACTICES

WARNING

Failure to obey the following safety rules can result in conditions which may lead to death, bodily injury or property damage.

Type DS Metal-Enclosed Low-Voltage Switchgear Assembly is complex high current electrical equipment. It is designed to operate within the voltage and current limitations shown on its nameplates. Do not apply this type of switchgear assembly 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 completely connected or is shorted. An open-circuited secondary circuit can produce dangerously high voltages when primary current is flowing through the current transformer.

9. Always be sure that all switchgear assembly 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. 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.

WARNING

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

WARNING

Failure to obey the following precautions can result in conditions which may lead to death, bodily injury or property damage.

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

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

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

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

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

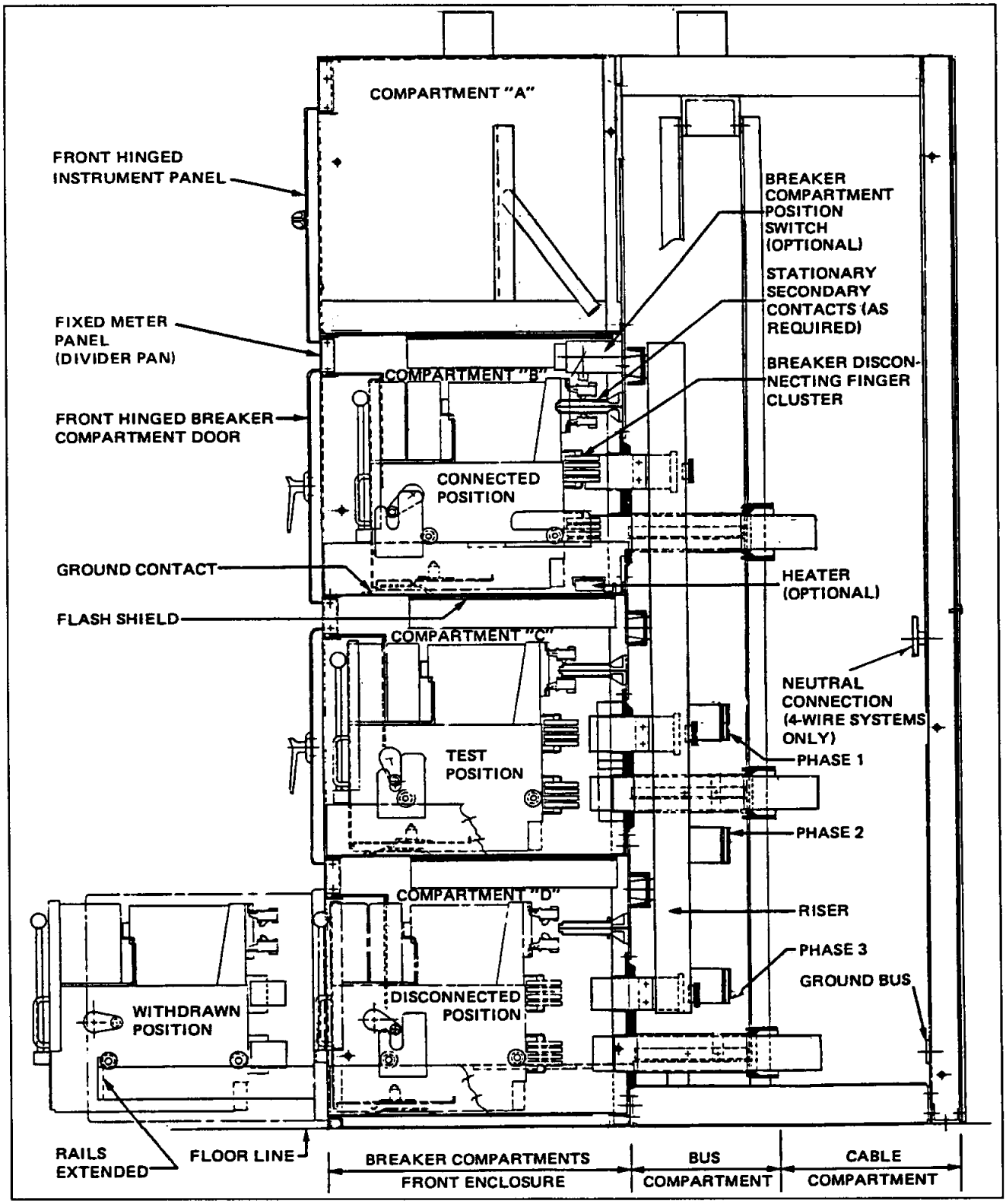


Fig. 3 *1600/2000 Ampere Vertical Section: Side View*

SECTION 1 – DESCRIPTION OF A TYPE DS SWITCHGEAR ASSEMBLY

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.

Each Low-Voltage (600 volts and below) indoor and outdoor metal-enclosed switchgear assembly 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 whenever possible, but if the number of vertical sections are too many to permit convenient handling and shipping or the customer has handling limitations, the lineup will be shipped in subassemblies of vertical sections. These subassemblies are referred to as shipping groups (a lineup that is shipped completely assembled is usually referred to as a shipping group also.)

The switchgear assembly consists of a stationary structure that includes one or more free-standing vertical sections mechanically and electrically joined to make a single coordinated installation. Each vertical section consists of three major parts: front enclosure, bus compartment, and cable and terminal compartment.

Type DS metal-enclosed switchgear assemblies are available for both indoor and outdoor applications. The circuit breakers and design features are similar whether the installation be indoor or outdoor. An outdoor metal-enclosed switchgear assembly is constructed by assembling a weatherproof enclosure onto and around a standard indoor switchgear assembly.

In the majority of installations, the switchgear assembly 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 transition unit or an 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 up to four individual compartments used to house circuit breakers (removable elements). Figs. 7 and 8 show 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.

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. This area is referred to as the "divider pan".

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. 5 and 7.

A molded glass polyester plate at the rear of the compartment supports the six stationary disconnecting contacts and up to three current transformers, if required. See Fig. 8.

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. 7.

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.

In the "connected" position, both the primary and secondary disconnecting devices are engaged, and the circuit

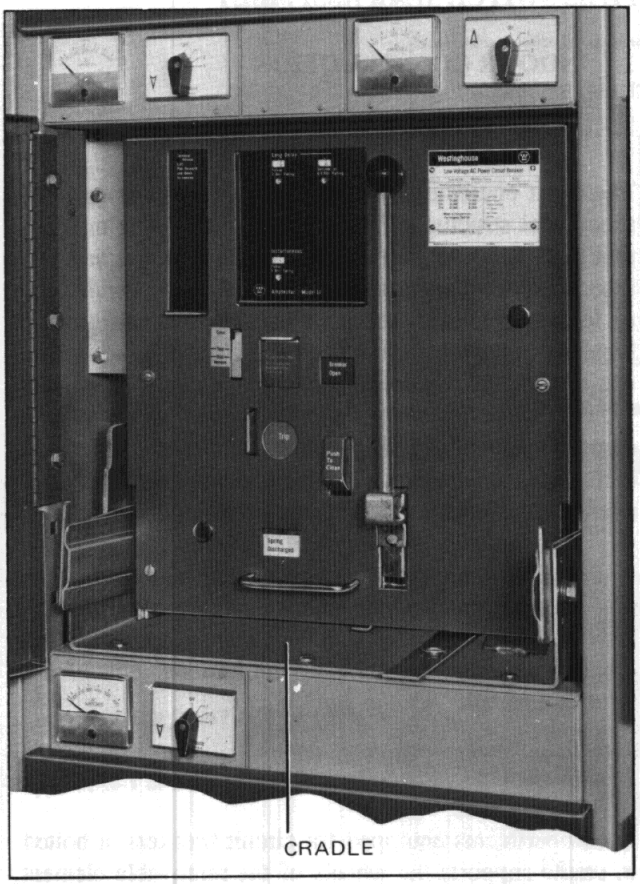


Fig. 4 *Type DS-206 Breaker in Connected Position (392506)*

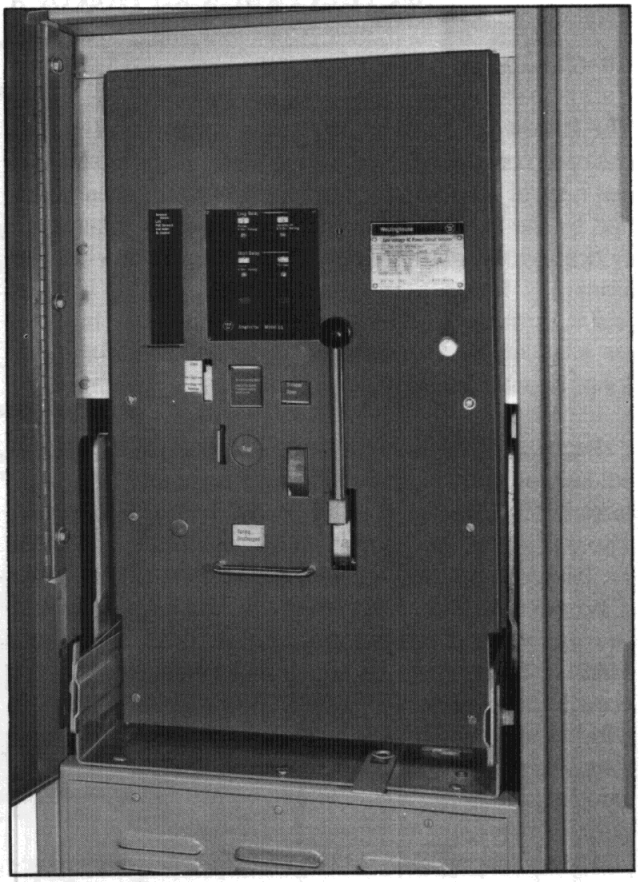


Fig. 6 *Type DS-632 Breaker in Connected Position (391179)*

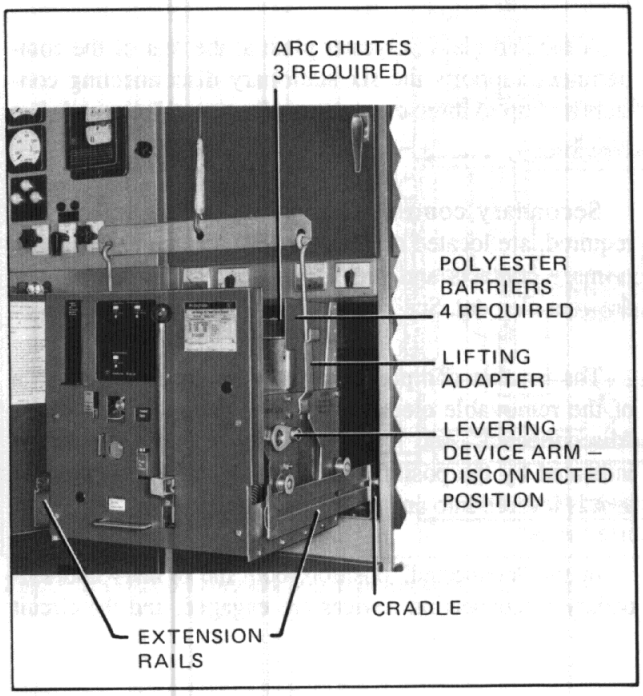


Fig. 5 *Type DS-206 Breaker on Extension Rails (392503)*

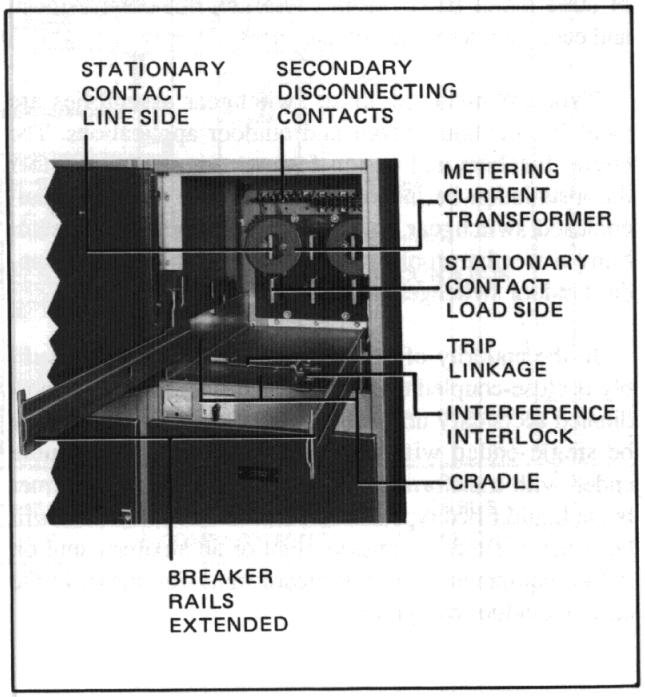


Fig. 7 *Type DSL-416 Breaker Compartment (392395)*

breaker is ready for operation. See compartment "B" Fig. 3. 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. 3. 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. 3.

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. 3). The compartment door may be closed and latched with the removable element in any one of the above positions.

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. 5 and 7. In compartment equipped for circuit breakers, two extendable rails are also supported by the bolted-in cradle.

To withdraw a breaker beyond the REMOVE position, pull out both extendable rails until the front ends drop to the horizontal positions. Pull the 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 and onto the rails.

1.1.4 Ground Contact

The stationary ground contact on the compartment floor engages a corresponding contact on the bottom of the breaker as it levered into the cell. When engaged, these contacts provide positive grounding of the breaker frame. See Fig. 8.

1.1.5 Trip Linkage

When the circuit breaker is in the CONNECTED position, the trip plate on the hinged compartment door will be operative. Inward pressure on this plate will trip open the breaker when the door is closed. See Fig. 8.

1.1.6 Compartment Ceiling Flash Shield

A polyester insulating flash shield is bolted to the ceiling of each breaker compartment to prevent flash-over from arc chutes to ground and to protect operating personnel. See Figs. 3 and 9.

1.1.7 Stationary Main Contacts

The six stationary main disconnecting contacts are supported by a molded glass polyester plate that is bolted to the rear wall of the breaker compartment. See Figs. 8 and 9.

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.

1.1.8 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. 8 and 14.

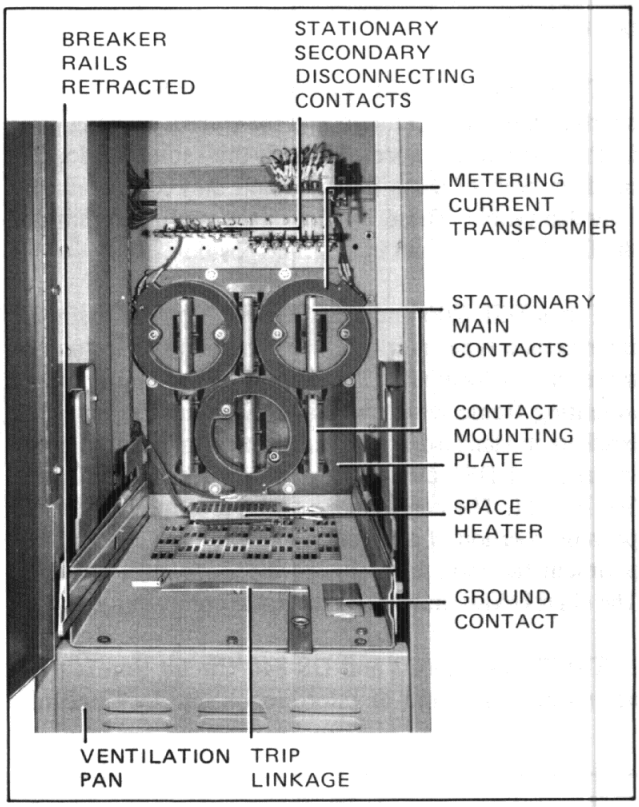


Fig. 8 *Type DS-632 Breaker Compartment (391181)*

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

1.1.9 Breaker Interference Interlocks

The frame width and height are the same for DS-206, DS-206H, DS-416, DS-416H and DS-420. They could be placed into compartments having the same dimensions. 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 pushed 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 the breaker is blocked by the compartment floor section preventing the breaker from moving far enough into the compartment to engage the levering device.

Fig. 10 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-416H 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 pieces 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. 11. 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.

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

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.

1.1.10 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 disconnected from the compartment. After this is done, a 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. See Figs. 12 and 13.

Key interlock mechanisms 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.

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

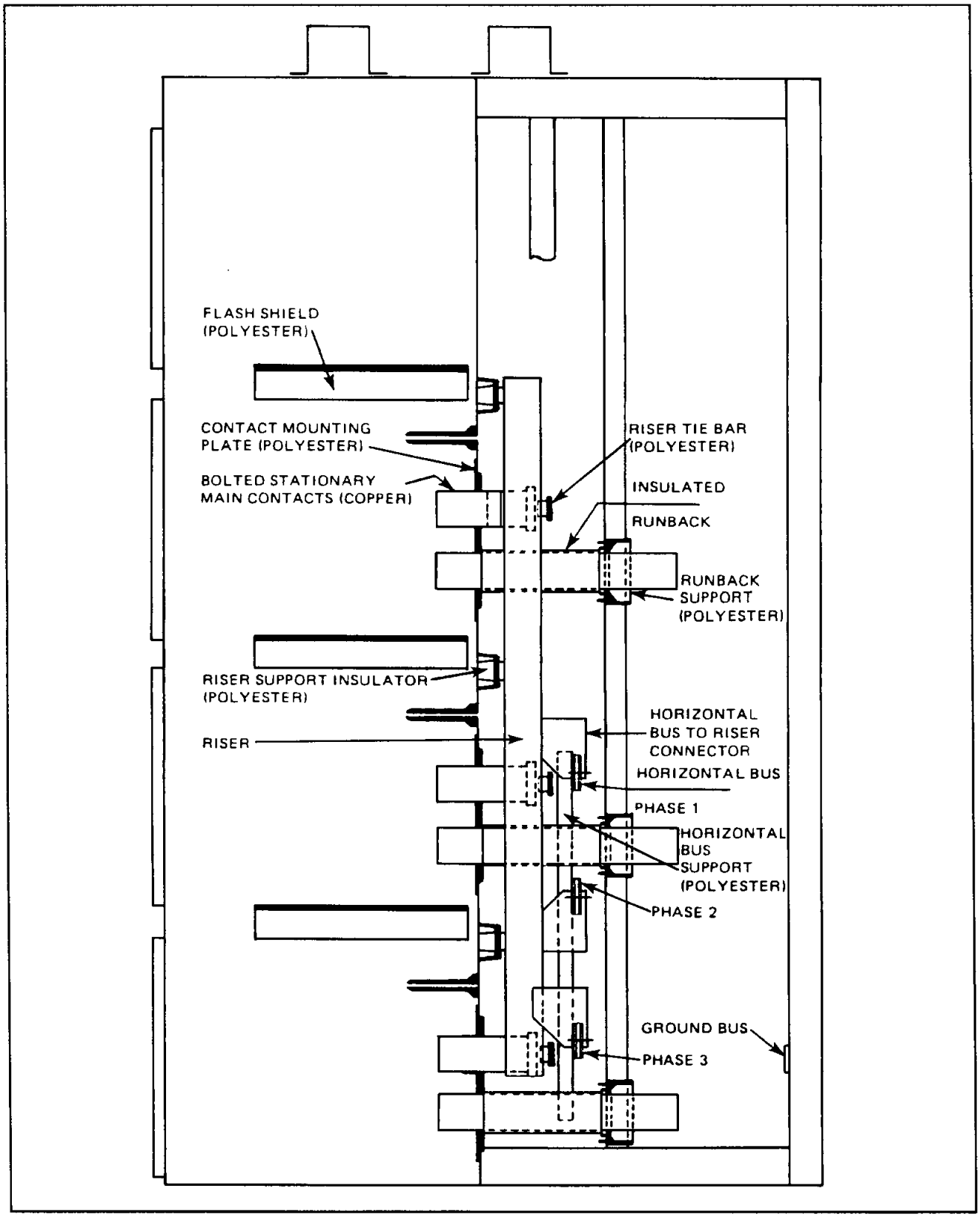


Fig. 9 *Bus and Insulation for 1600/2000 Ampere Bus*

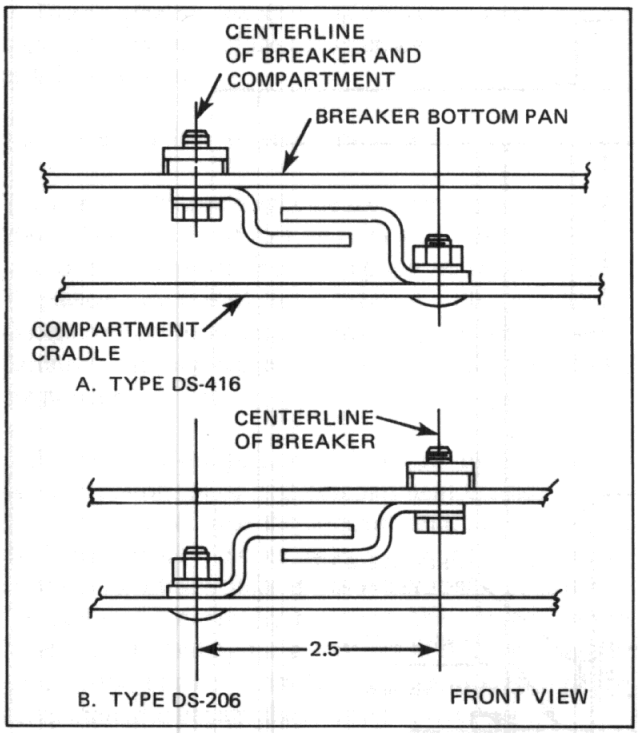


Fig. 10 *DS-206/416 Breaker Interference Interlock*

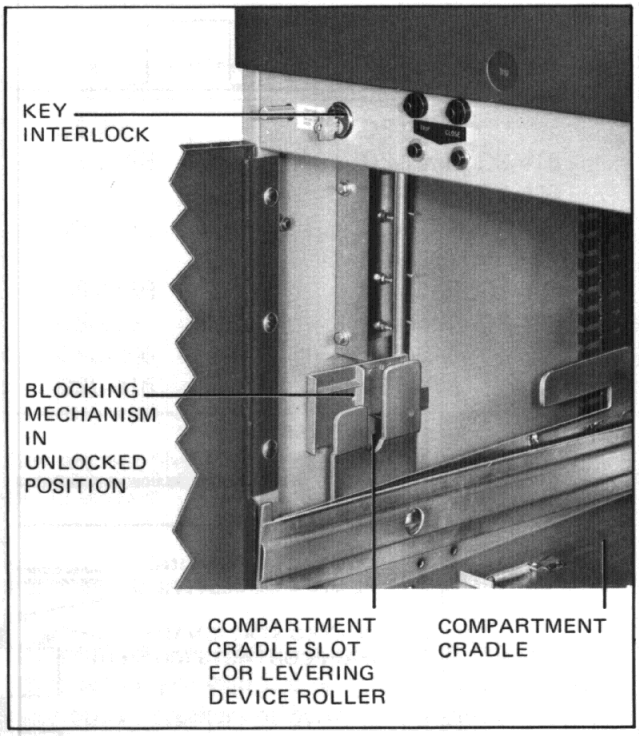


Fig. 12 *Key Interlock Mechanism in Unlocked Position: Allows Insertion of Levering Device Roller into Cradle Slot (384830)*

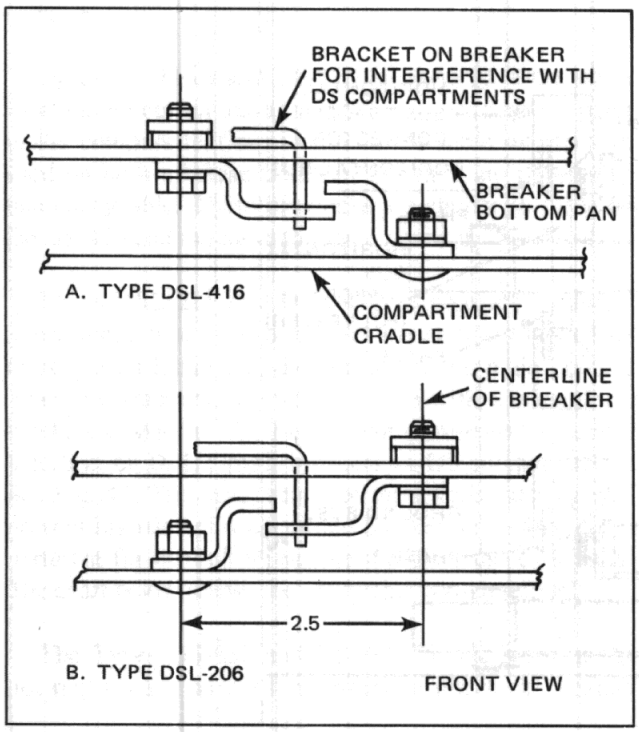


Fig. 11 *DSL-206/416 Breaker Interference Interlock*

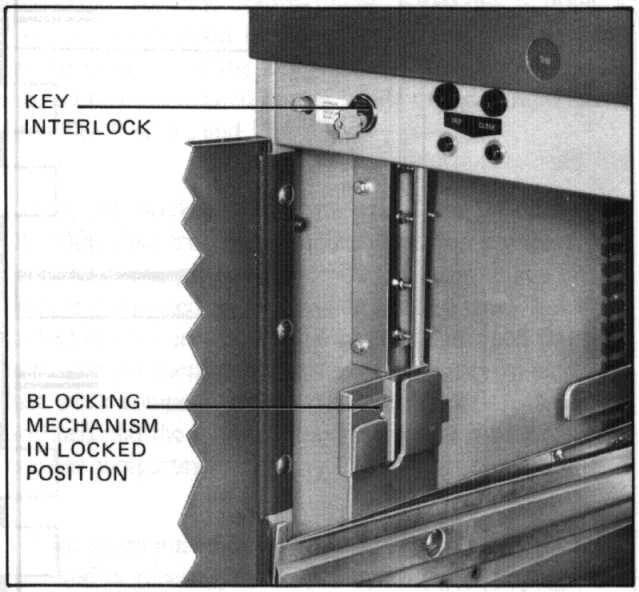


Fig. 13 *Key Interlock Mechanism in Locked Position: Blocks Insertion of Levering Device Roller into Cradle Slot (384831)*

CAUTION

To facilitate manufacture and installation procedures, a key is supplied with each lock. Before placing a switchgear assembly 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 the improper use of spare keys will defeat the interlocking scheme.

1.1.11 Metering Current Transformers

When required for metering, ring-type current transformers are positioned around the stationary main contacts as shown in Fig. 8. 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. (2 on top, 1 on bottom)

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.

WARNING

IF THE SECONDARY CIRCUIT OF ANY CURRENT TRANSFORMER IS LEFT OPEN WITHOUT LOAD, AND ITS PRIMARY CIRCUIT IS

Table 2 – Metering Accuracies

Meter Type Current Transformers for Mounting in Circuit Breaker Compartments

For Breaker Type DS-416 DS-416H DSL-416 DS-632	ANSI Meter Accuracy Classification			For Breaker Type DS-206 DS-206H DSL-206 DS-420 DS-840
	Ratio	B-0.1**	B-0.2**	
	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	
	2400/5	0.3	0.3	
	2500/5	0.3	0.3	
	3000/5	0.3	0.3	
	3200/5	0.3	0.3	
	4000/5	0.3	0.3	
	5000/5	0.3	0.3	
	6000/5	0.3	0.3	

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

ENERGIZED, A DANGEROUSLY HIGH VOLTAGE IS DEVELOPED ACROSS TRANSFORMER SECONDARY TERMINALS.

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

1.1.12 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 the breaker compartment. A lever connected to the switch shaft is actuated by the frame of the breaker as it is levered into or out of the 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. 14.

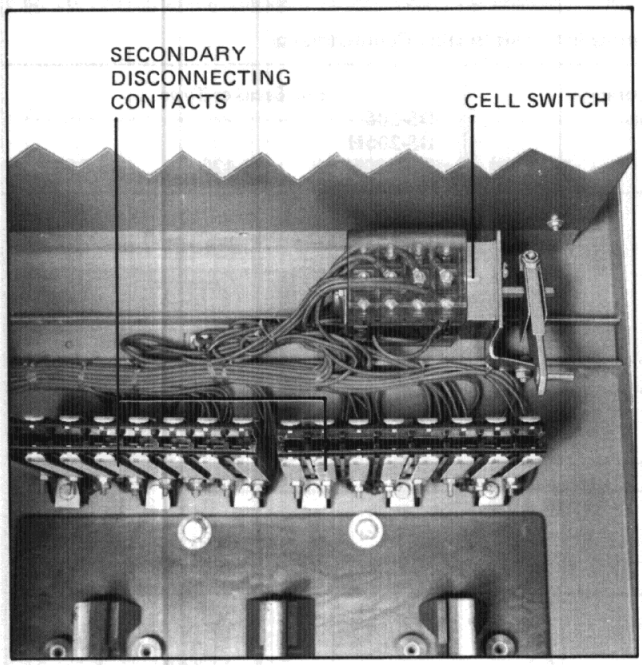


Fig. 14 *Cell Switch and Secondary Disconnecting Contacts (385216)*

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

1.1.13 Space Heaters

To minimize condensation, heaters are furnished as standard equipment on outdoor switchgear assemblies. As shown in Fig. 8, a heater is placed at the rear of the "D" position breaker compartment floor.

Other heaters may be placed near the floor of the bus and cable compartments as required.

1.1.14 Instrument Panels: Indoor

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.

1.1.15 Control Equipment

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

Voltage 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.

Control and voltage transformers are protected by both primary and secondary fuses.

1.1.16 Fixed Meter Panels

For feeder circuit instrumentation, small ammeters, with or without ammeter switches, can be mounted on the divider panels separating breaker compartment doors. The ammeters are connected to nearby breaker circuits for monitoring current. See Fig. 4.

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. 18.

Removable covers provide access to any wiring behind the panel.

1.1.17 Control Wiring

The standard wire used in DS Switchgear Assemblies is Type SIS stranded copper, No. 14 AWG.

1.1.18 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 ventilators in the top compartment roof. DS-632 and DS-840 compartments have a panel below the breaker compartment door for ventilating air entrance. See Figs. 8 and 15.

The bus and cable compartments are ventilated by means of air entering the ventilation openings in the bolted rear sheets, and leaving through a ventilator in the bus compartment roof.

1.1.19 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.

1.1.20 Bus Compartment

The bus compartment, located between the front breaker enclosure and the rear cable compartment, contains the horizontal main bus that ties the vertical sections together electrically, and the vertical bus that feeds the individual breaker compartments. It also includes all supporting insulators. See Figs. 3 and 15.

1.1.21 Cable and Terminal Compartment

The cable and terminal compartment is located behind the bus compartment and provides adequate room for easy cable installation. Bus bars extend the load side of the stationary disconnecting contacts into the cable compartment. See Fig. 3. 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 bus bars. For 2-hole lugs, drillings are arranged at 45 degrees to accommodate top or bottom cable entry. See Fig. 16.

On four wire systems, an isolated neutral bus extends the length of the line-up and includes a tap for the outgoing neutral cable in each vertical section. A connection to the ground bus is furnished in one of the vertical sections for four wire Service Entrance Labeled Boards. Provision is made to locate a current transformer in this grounding connection, if required.

1.1.21.1 Ground Bus Connection

CAUTION

A permanent low resistance ground is essential for adequate protection.

A terminal 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.

1.1.22 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. 16.

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. 17.

1.2.2 Insulating covers or "boots" are furnished on live main stationary disconnecting contacts in compartments equipped for future breakers.

1.3 OPTIONAL ACCESSORIES

1.3.1 Key Interlocks. See Item 1.1.10

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

1.3.3 Traveling Circuit Breaker Lifter that is rail mounted on top of an indoor switchgear assembly. See Item 2.5.

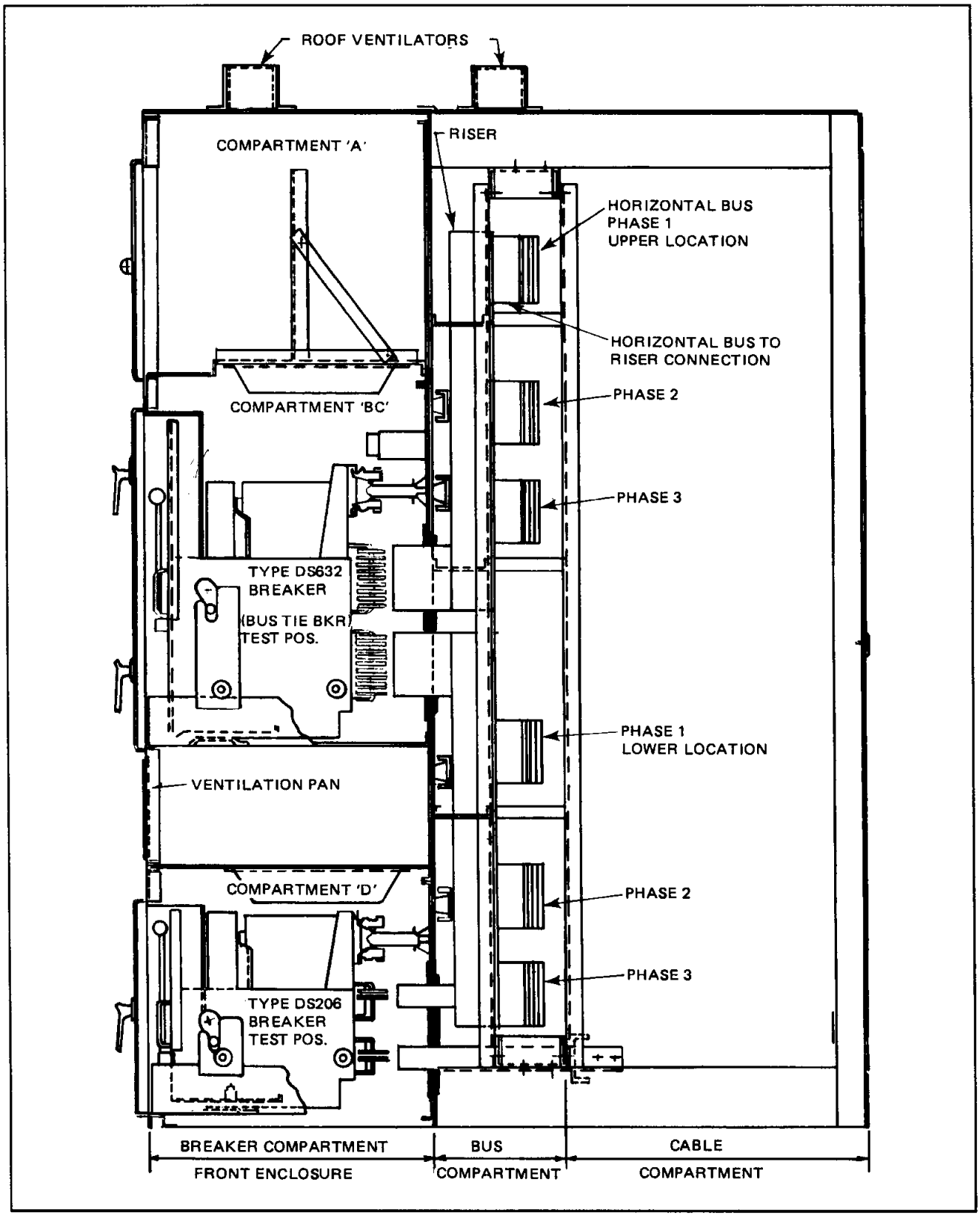


Fig. 15 *Type DS-3200 Amp Unit with Bus Risers Arranged as a Bus Tie Unit*

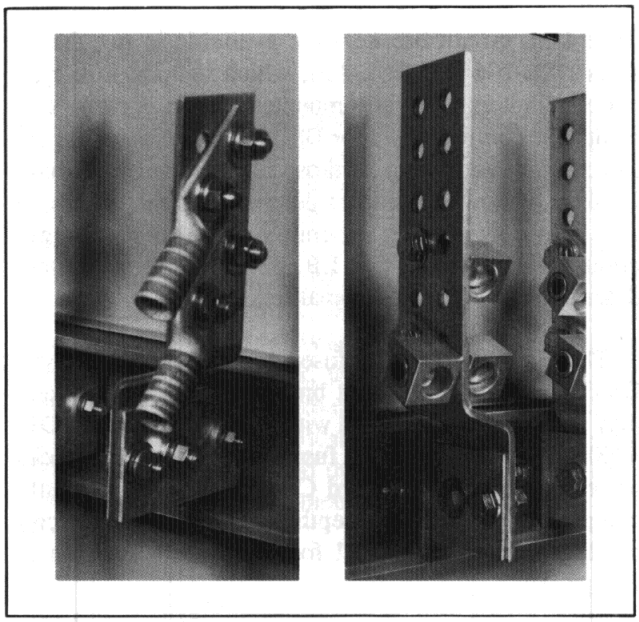


Fig. 16 *Compression Lug (Left) Mechanical Lug (Right) Landings*

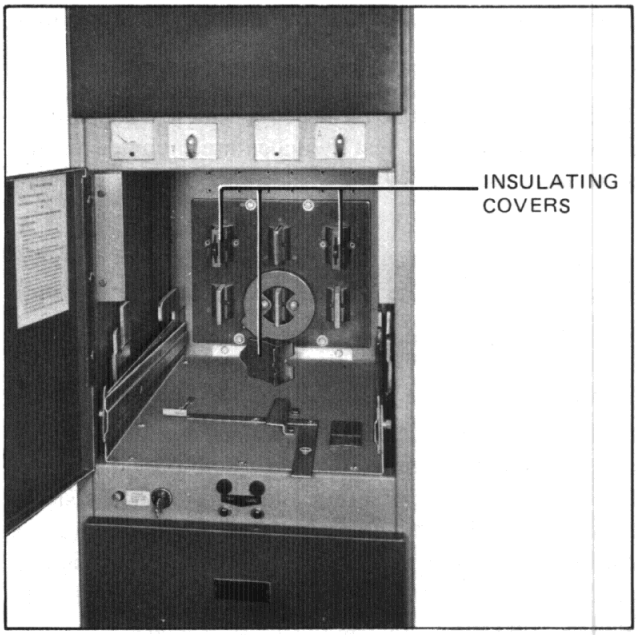
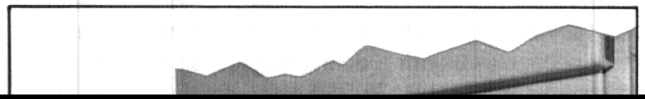


Fig. 18 *Insulating Covers for Main Stationary Disconnecting Contacts (384829)*



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

1.3.5 Test plugs can be furnished when Flexitest cases or Flexitest Type FT-1 test switches are mounted on the switchgear. See Fig. 19.

1.4 OUTDOOR CONSTRUCTION

1.4.1 Type DS Outdoor Switchgear Assembly

A Type DS outdoor switchgear assembly consists of standard indoor switchgear vertical sections assembled within a weatherproof enclosure. The enclosure provides a continuous "walk-in" operating and maintenance aisle in front of the indoor structure. The rear of the enclosure is equipped with hinged doors for access to the bus and cable compartments. These doors are equipped with latches, wind stops, and padlocking provisions.

Standard features of Type DS outdoor switchgear include:

1. Ventilation openings with externally removable filters.
2. Traveling breaker lifting device.
3. Interior lighting and GFI protected duplex receptacles.
4. Fabricated base structure for pad.
5. Walk-in aisle is shipped assembled.
6. Asphalt coating on underside of base.
7. Space heaters for prevention of condensation.
8. Hinged rear doors for access to cable and bus compartments with latches, wind stops, and padlocking provisions.

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 and 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-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 equipment may be provided in Type DS outdoor switchgear assemblies.

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

SECTION 2 – RECEIVING, HANDLING AND STORAGE

2.0 GENERAL

Type DS metal-enclosed switchgear assembly is shipped assembled in one or more shipping groups depending on the number of vertical sections, 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 weatherproof covering. When shipment is made in an enclosed or covered truck, the weatherproof 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.

A Type DS outdoor switchgear assembly is inherently weatherproof. If an assembly is separated into more than one shipping group, the matching ends are rigidly braced and provided with weatherproof covering as required.

All vertical sections 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 a switchgear assembly 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 assembly 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 assembly 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.

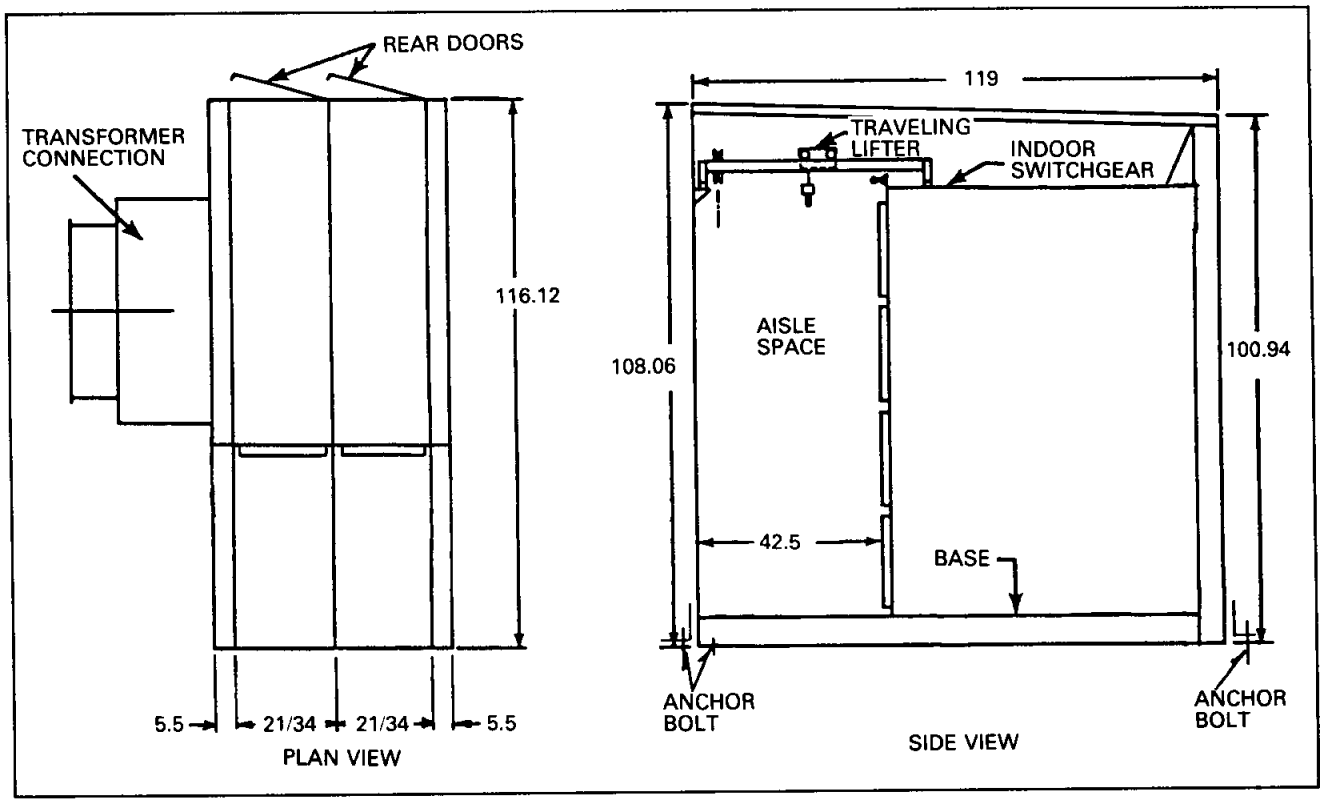


Fig. 20 *DS Outdoor Housing Outline*

If shipping braces described in Section 3.6 are removed for inspection at an intermediate location, they must be replaced before shipping to final destination in order to prevent damage during transit.

2.2 HANDLING

For ease of handling by a crane, each indoor shipping group is equipped with lifting angles extending the length of the shipping group. On long lineups, a suitable spreader should be used with the crane sling to prevent any horizontal compressive loads on the lifting angles. The lifting angles should be removed and discarded after installation is complete.

It is preferable to lift the shipping groups into position by a crane. However, if a crane is not available, they can be skidded into place on rollers or by forklift. 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 OR FORKS ENGAGE THE SWITCHGEAR DIRECTLY — DISTORTION AND DAMAGE MAY RESULT.

One method for removing the rollers and skids and lowering the switchgear assembly 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 inch. Two 2.0 x .50 inch slots are also provided in the front of the unit for this purpose as shown in Fig. 21.

Each outdoor switchgear assembly is equipped with lifting lugs attached to the base. Cable spreaders attached to upper portion of the end walls to expedite lifting by crane will be required.

Handle all crated or uncrated switchgear assemblies 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 shipping groups, care should be exercised to avoid breakage and scratching or marring of the panel finish.

If an indoor switchgear assembly 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

An indoor switchgear assembly 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 assembly and install temporary heating equipment. Approximately 250 watts per vertical section are required for average conditions. Outdoor storage of an indoor

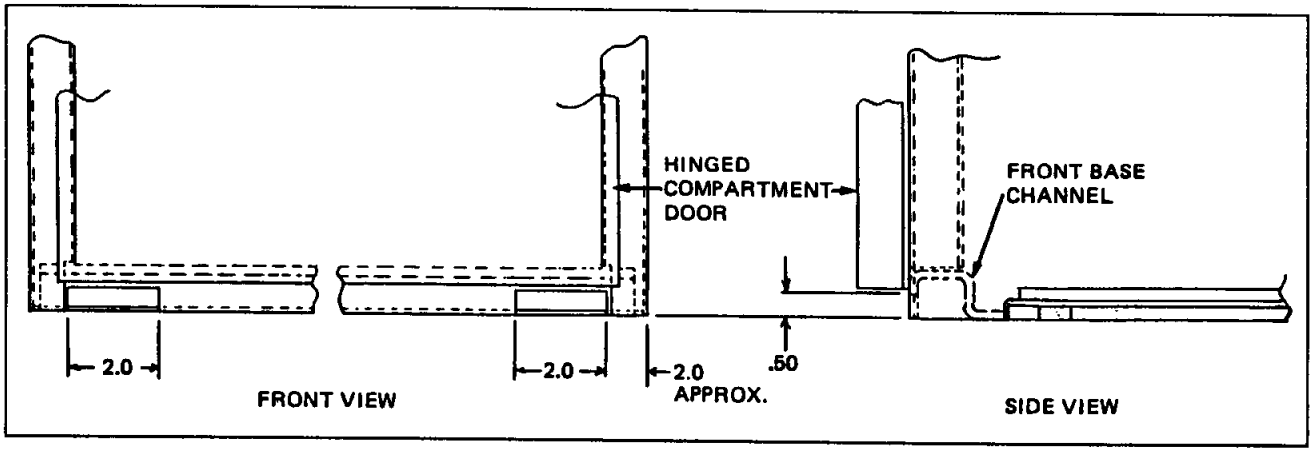


Fig. 21 *Location of Pry Slots at Front*

switchgear assembly, even for a brief period, is not recommended and should be avoided if at all possible. The covering which may have been provided during shipment is NOT adequate protection during outdoor storage. Covering must be adequate to protect the assembly from dust and falling debris, but loose enough to permit adequate ventilation. Blocking on the roof of the equipment which extends above the roof vent boxes will keep covering material from restricting the flow of air.

A Type DS outdoor switchgear assembly requires a minimum of care during outdoor storage. Additional protection will be required for the exposed ends at shipping breaks if the equipment is shipped in more than one shipping group. 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.

WARNING

Precautions such as opening disconnects and removing secondary fuses of control power transformers must be made when energizing heaters directly at secondary voltage. This will prevent backfeeding 600V bus to dangerous levels.

During storage, switchgear assembly 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, 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. These weights, however, 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 Assemblies	
Circuit Breaker Vertical Sections - Less Breakers	
21 inches wide	1400
34 inches wide	1500
Auxiliary Vertical Sections	
21 inches wide	1100
34 inches wide	1200
Standard Transformer Transition Vertical Section	1000
Outdoor SwitchgearAssemblies	
End Trims – One Set per Assembly	1300
Circuit Breaker Vertical Sections – Less Breakers	
21 inches wide	2100
34 inches wide	2400
Auxiliary Vertical Sections	
21 inches wide	1800
34 inches wide	2100
Standard Transformer Transition Throat	600
Drawout Elements (1)	
DS-206 Circuit Breaker	150
DS-206H Circuit Breaker	195
DS-416 Circuit Breaker	195
DS-416H Circuit Breaker	200
DS-420 Ciruit 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

(1) Impact weight equals 1.50 times breaker static weight.

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. 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 assembly. The breaker must be pulled completely to the end of the rails for removal.

There are two different lifting which may 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. The lifting adapter is then attached to the circuit breaker and the breaker is lifted from rails using the hoist mechanism.

The truck can then be rolled away from the compartment and the circuit breaker lowered. 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. 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 of the bridge-type rather than cantilever.

SECTION 3 – INSTALLATION

3.0 GENERAL

Proper installation of a Westinghouse Type DS Low Voltage Metal-Enclosed Switchgear Assembly 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, floor plan, schematic and connection diagrams.

3.1 LOCATION

In locating a Type DS Indoor Switchgear Assembly, 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 a Type DS Outdoor Switchgear Assembly, sufficient space must be provided for the doors to be opened.

3.2 FOUNDATION

Each Westinghouse Type DS metal-enclosed switchgear assembly is fabricated in welding fixtures. Since the tolerances and adjustments are kept to a minimum, it must be installed on a smooth level base. A slope of 0.12 inches per foot in any direction is acceptable.

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

The floor or foundation must be strong enough to support the weight of the equipment without sagging. Table 3 tabulates the approximate weights for the various ratings of switchgear assemblies. 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 an indoor switchgear assembly is by fastening it to steel channels which are properly embedded in the concrete floor. Fig. 22 shows a typical indoor plan that may be used for estimating purposes. Detailed floor plans for drilling and locating this steel are supplied with each order.

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. 23. 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 assembly in place and eliminates the layout of the mounting holes in the channels.

Floor channels are not required for a Type DS Outdoor Switchgear Assembly. See Fig. 23 for anchor bolt details.

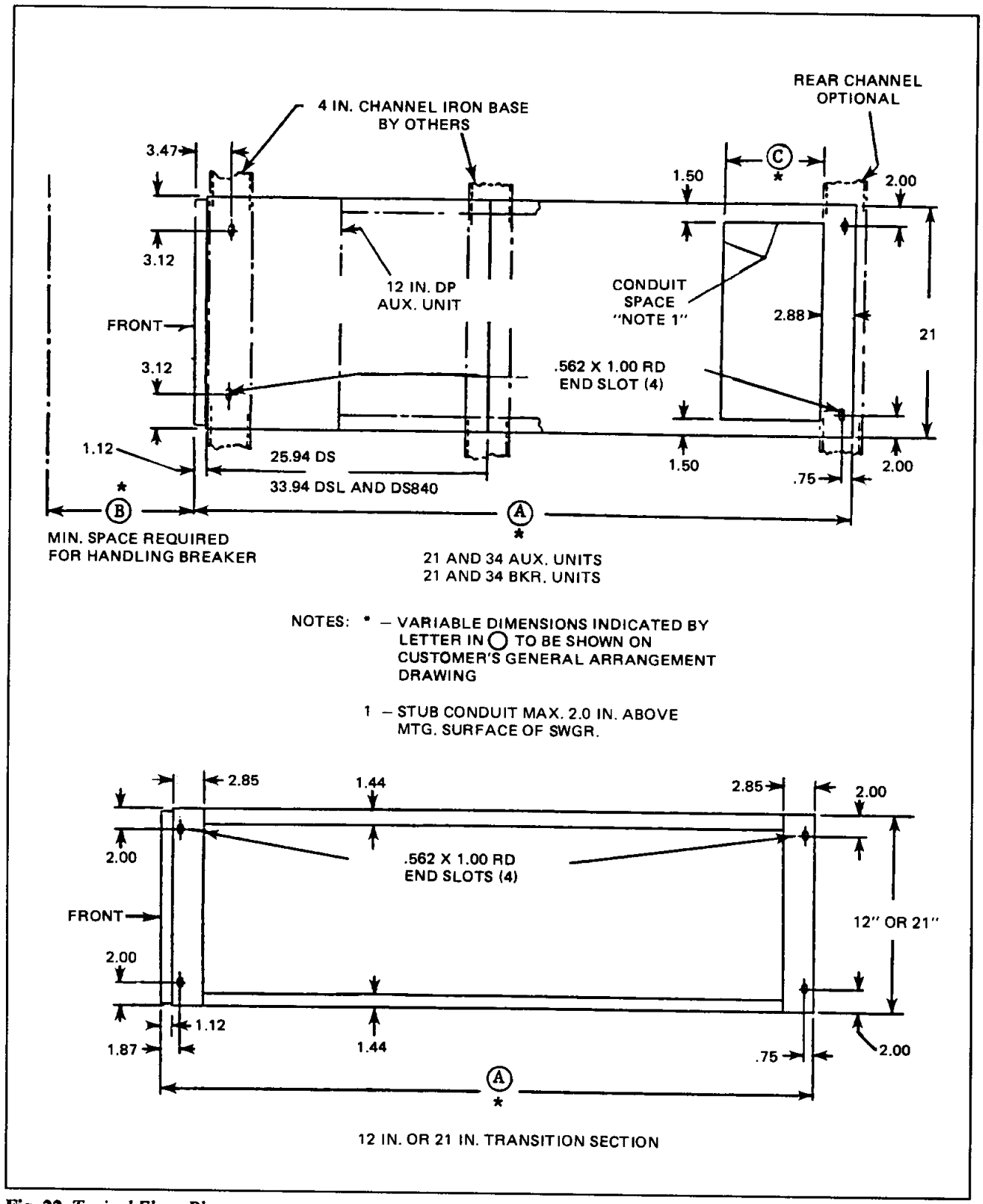


Fig. 22 *Typical Floor Plan*

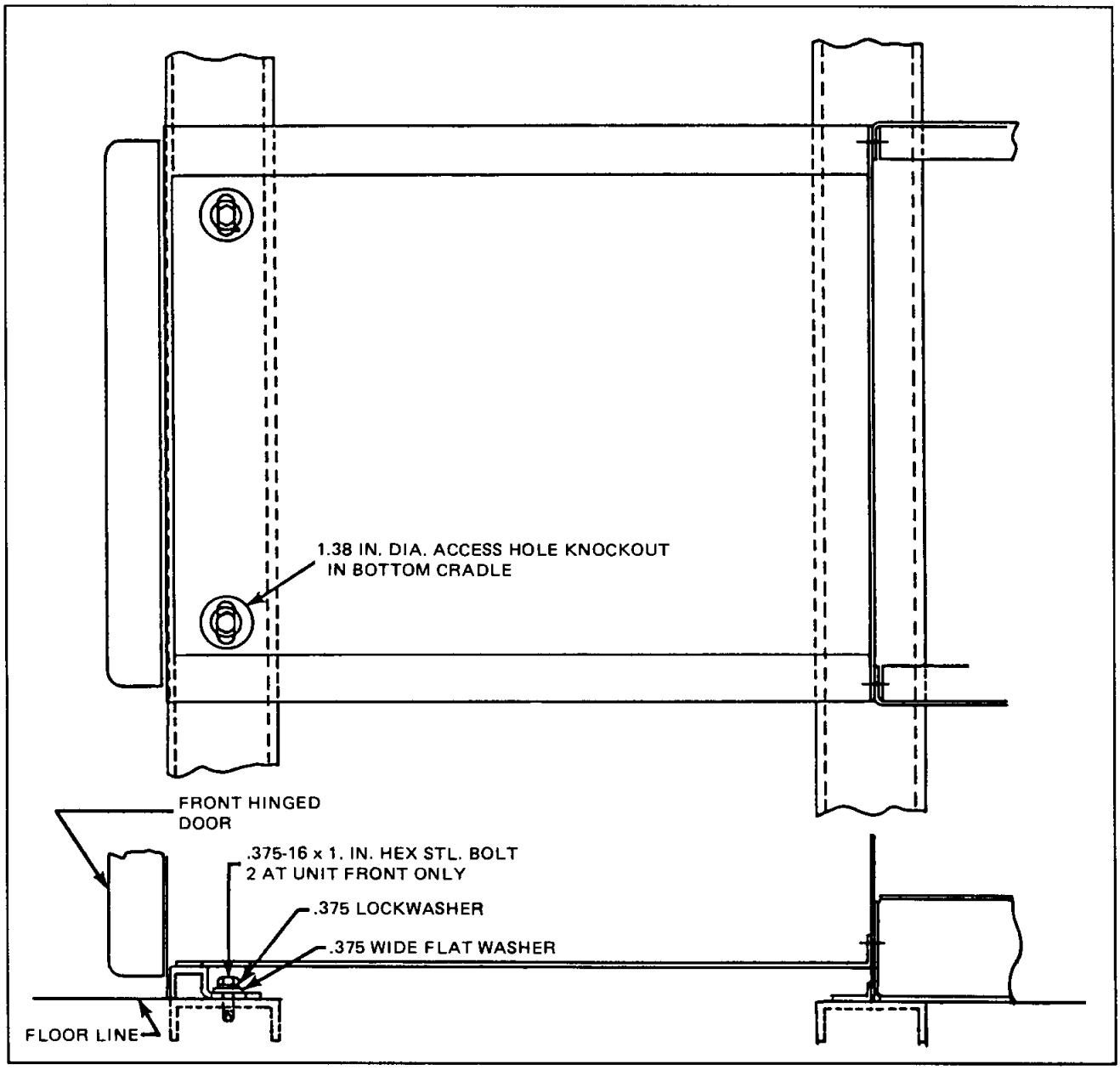


Fig. 23 *Anchor Bolt Detail*

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 assembly 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 vertical section.

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 an indoor switchgear assembly. It will simplify moving the groups into place if the conduits are flush with the concrete surface and

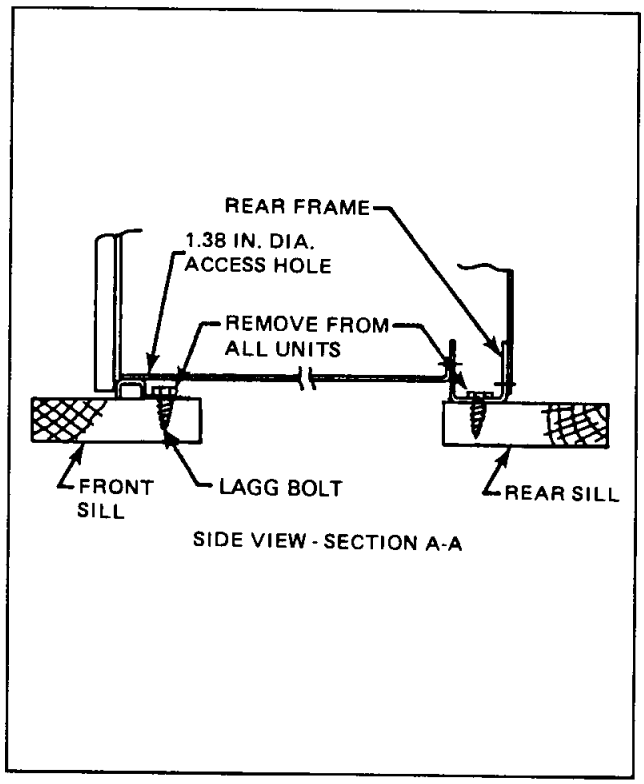


Fig. 24 *Removal of Shipping Skid*

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.

3.5 SHIPPING SKIDS

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

Refer to Fig. 24. The front and rear wood sills of the skid are fastened to the bottom of the vertical sections of each shipping group by lagg bolts. Open doors or remove covers to gain access to the lagg bolts.

3.6 CIRCUIT BREAKERS

Circuit breakers are shipped as standard in their own separate cartons. If specifically requested, or if used to verify the function of complicated assembly control schematics during production testing, some, or all, of the circuit breakers may be shipped from the factory installed in their compartments. When this is the case, they should be withdrawn, visually inspected, and mechanically operated to confirm no damage occurred during shipment and handling. See I.B. 33-790-1 for complete circuit breaker testing instructions.

SECTION 4 – ASSEMBLY AND INSTALLATION OF SHIPPING GROUPS

4.0 GENERAL

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

1. Front panels form a straight true line.

2. Vertical sections correctly spaced from center to center and plumb.

3. Entire assembly of vertical sections 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 shipping groups is to establish a base line a few inches in front of the switchgear assembly and parallel to the final location. Equalize the distances from the front of the shipping groups to the base line, thus making the face of the switchgear assembly parallel to the base line.

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

After the first shipping group has been located, the second shipping group should be moved into position and similarly checked. The shipping groups are fastened together at locations which are shown in Fig. 25. Special

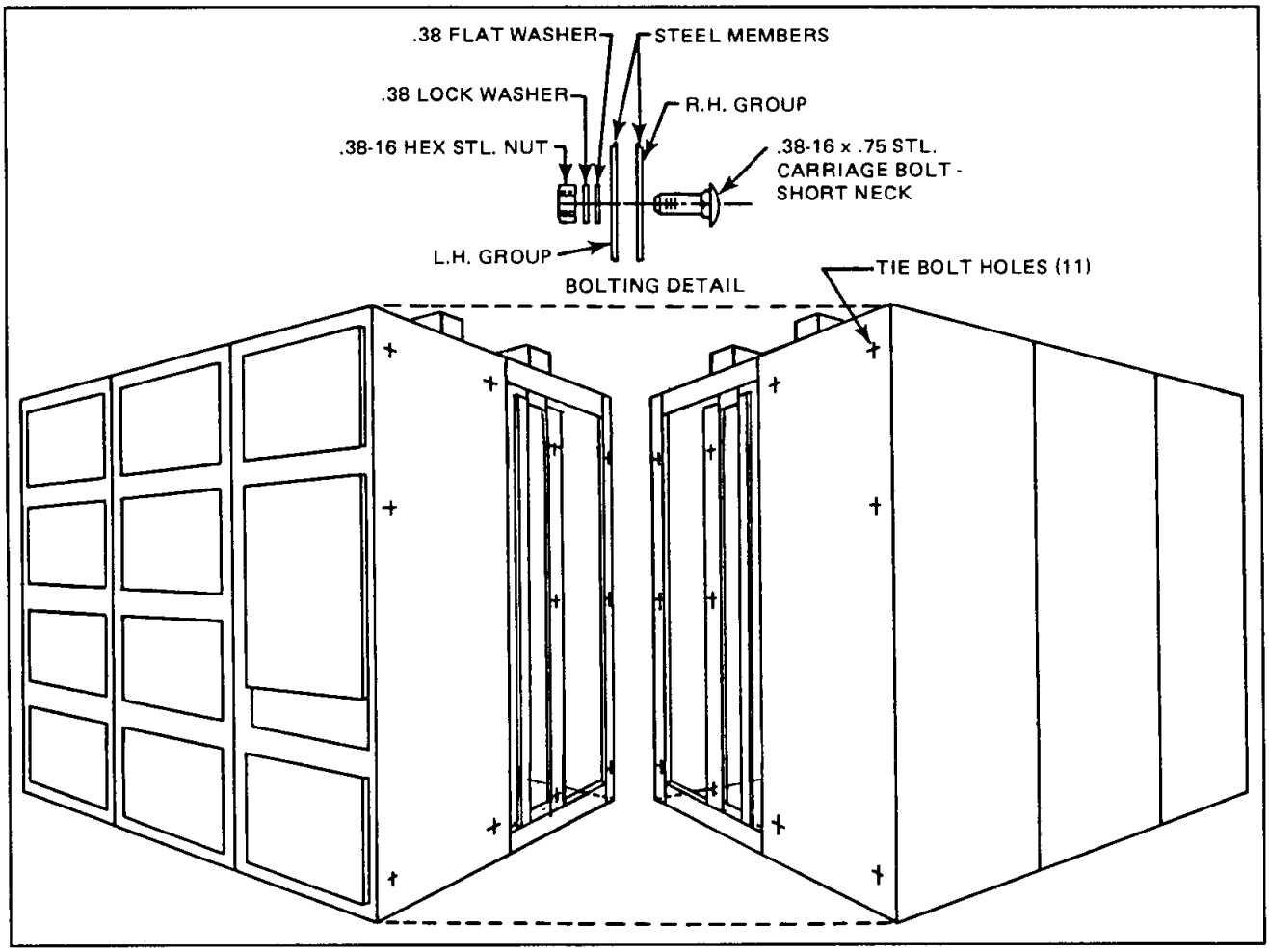


Fig. 25 *Tie Bolt Locations for Joining at Shipping Break*

short neck .38-016 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 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 buses and the ground bus at shipping breaks are made by means of bolted splice plates. These are always plated, bolted joints. 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.

Table 4 shows the standard copper bus size and quantity for various ratings of horizontal main bus.

Table 4
Bus Sizes

Bus Size	Qty.	Rating (Amps)
Copper Horizontal Bus		
1/4 x 4	1	800
1/4 x 6	1	1600
1/4 x 4	2	2000
1/4 x 6	2	3200
1/4 x 5	3	4000

4.1.1 Ground Bus

The joint in the ground bus is made by means of a single splice plate bolted directly to the inside of the rear steel frame. See Fig. 31.

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. Dirt, grease, and other foreign material must be removed from the surfaces before they are joined. Use a lint-free cloth, slightly dampened with water to clean off the joint area. Wipe it dry. If the lint-free, water-dampened cloth does not produce satisfactory results, use a lint-free cloth dampened with a mild solvent such as mineral spirits, Stoddard solvent, or isopropyl alcohol. Again, wipe it dry after cleaning.

CAUTION

THE MILD SOLVENTS DESCRIBED ARE FLAMMABLE. PROVIDE ADEQUATE VENTILATION AND KEEP AWAY FROM FLAMES AND OTHER IGNITION SOURCES. CONSULT YOUR SAFETY DEPARTMENT BEFORE USING.

4.3 BOLT TIGHTNESS

All bolts holding structural members, barriers and covers are installed in the factory tight 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 supplied only when 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.

4.4 BARRIERS

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

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.

4.5 MAIN POWER CABLES

Each switchboard assembly is provided with either compression or mechanical lug landings, mounted on a 45 degree angle, up or down, for terminating the main power cables (Figure 16). Unless otherwise specified, mechanical lugs will be provided.

To insure the short circuit ratings of the switchboard, and comply with cable bracing as outlined by Underwriters Laboratories, it is necessary to install cable lashing (Figure 29). The bracing will prevent movement during short circuit conditions.

Before making up the connections, the phase of each cable must be determined. Normally, a switchgear assembly is supplied with connections for phase sequence 1-2-3, (left to right, top to bottom, front to back, facing front) unless otherwise required.

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.

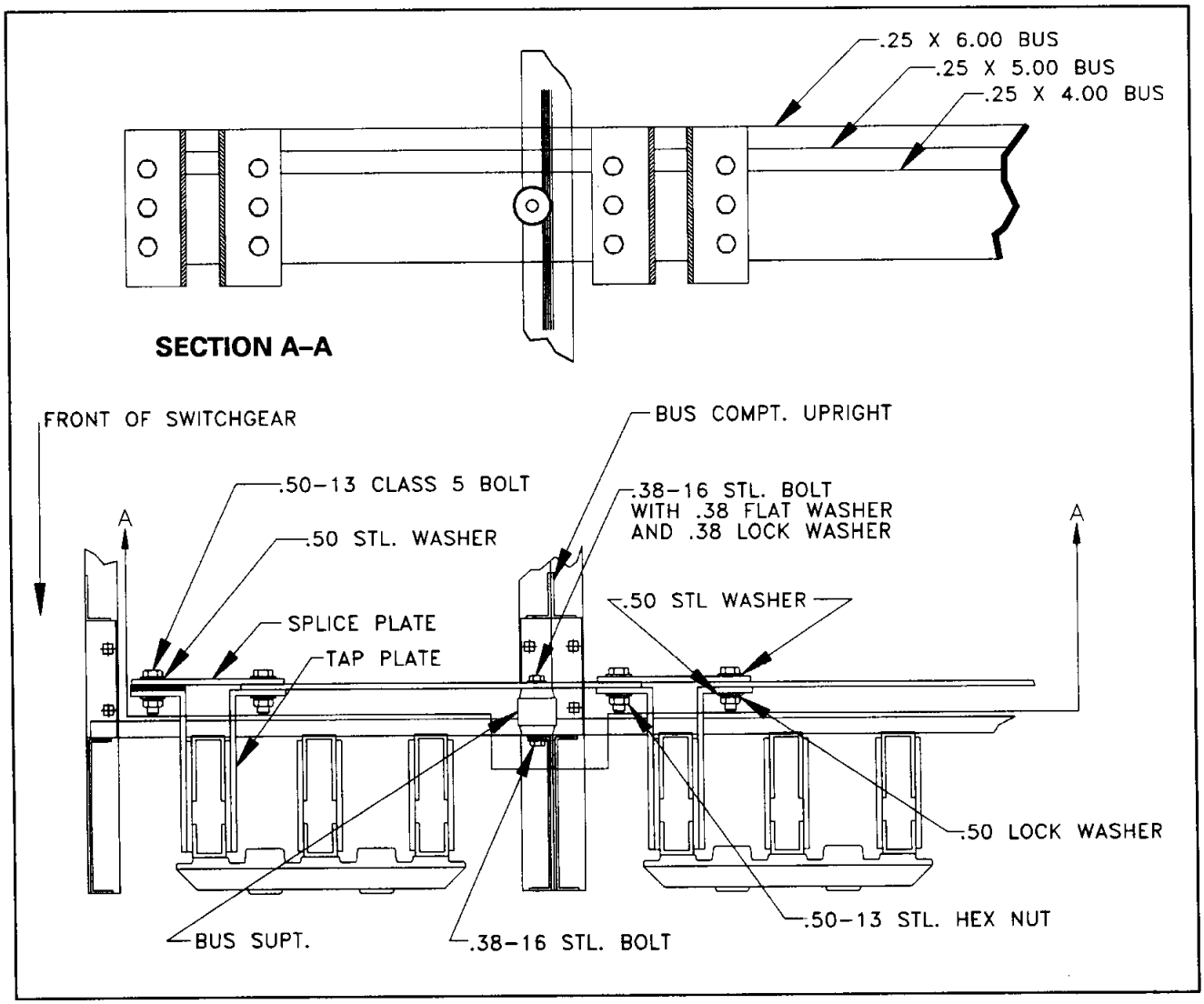


Fig. 26 *Field Assembly of Single Bus Bar Joints*

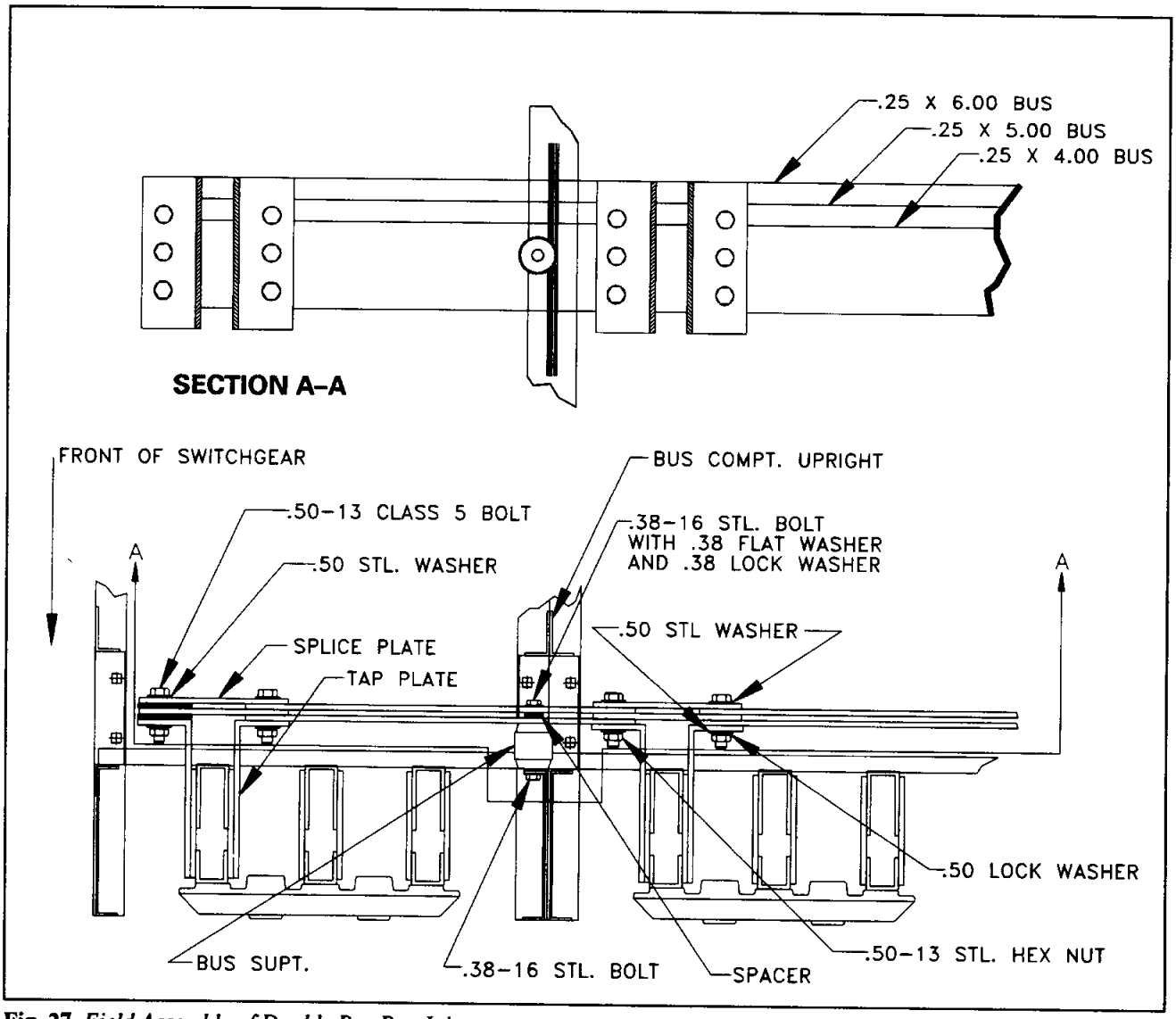


Fig. 27 *Field Assembly of Double Bus Bar Joints*

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. See figure 29.

4.6 GROUND BUS CONNECTIONS

Terminals of the solderless type are provided on the ground bus in one or more of the vertical sections, depending upon the number in the lineup. These are for the connection 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.

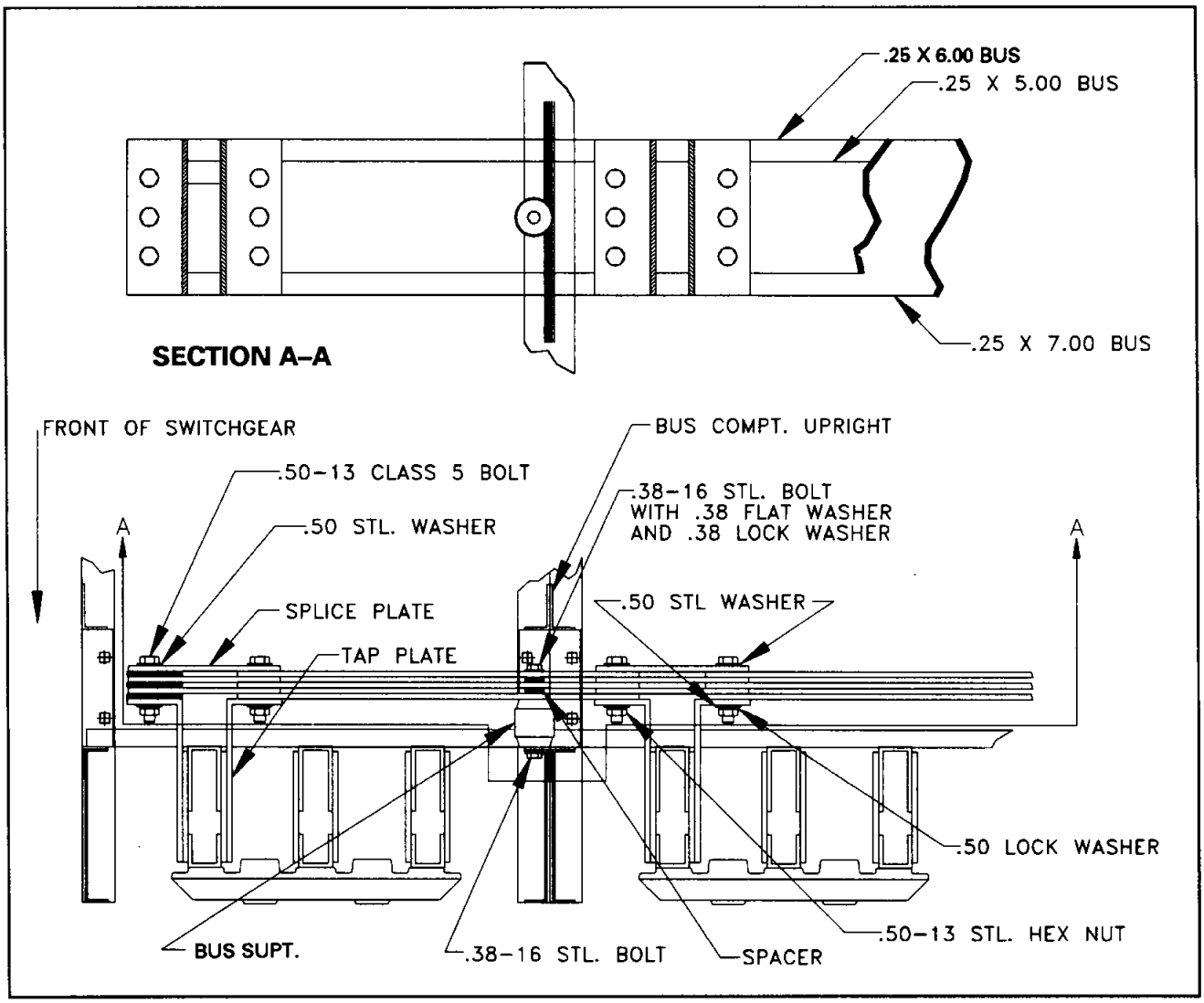


Fig. 28 *Field Assembly of Triple Bus Bar Joints*

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", ANSI STD. C114.1/IEEE STD. 142, "GROUNDING OF INDUSTRIAL AND COMMERCIAL POWER SYSTEMS".

4.7 CONTROL CONNECTIONS

All control wires that connect between two shipping groups 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 appropriate vertical sections.

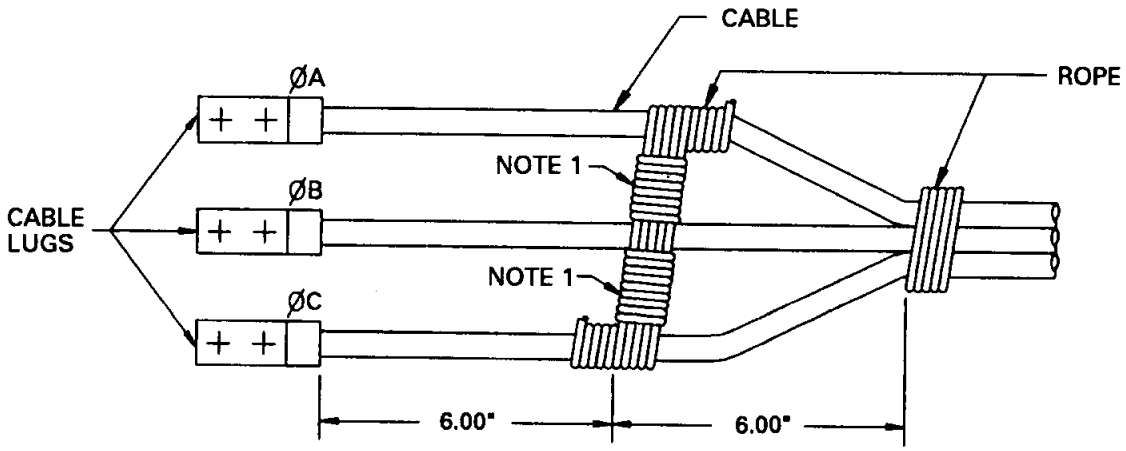
To insure the short circuit ratings of this equipment, cable lashing is necessary per the following instructions:

1. Short circuit ratings above 10KA require all line and load cables, for 2000 amp and under circuits, be lashed as shown below.

2. The following 3/8" dia. 3 strand nylon twisted rope must be used.

   Size #12, 3/8" dia. with the following minimum strengths

Tensile/Breaking Strength	**Working Load**
3340 lbs.	278 lbs.



After cable is routed as close together as possible, the rope is to be wrapped around the cable 6" from lugs.
Second wrap is to be applied 6" from the first wrap.
Each set of wraps contains 5 loops.

Note 1:
When the cable is not completely together, rope wrap should be placed around the rope to firm up supports.

Fig. 29 *Cable Brace Instructions*

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 voltage 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 assembly 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 a metal-enclosed switchgear assembly, 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

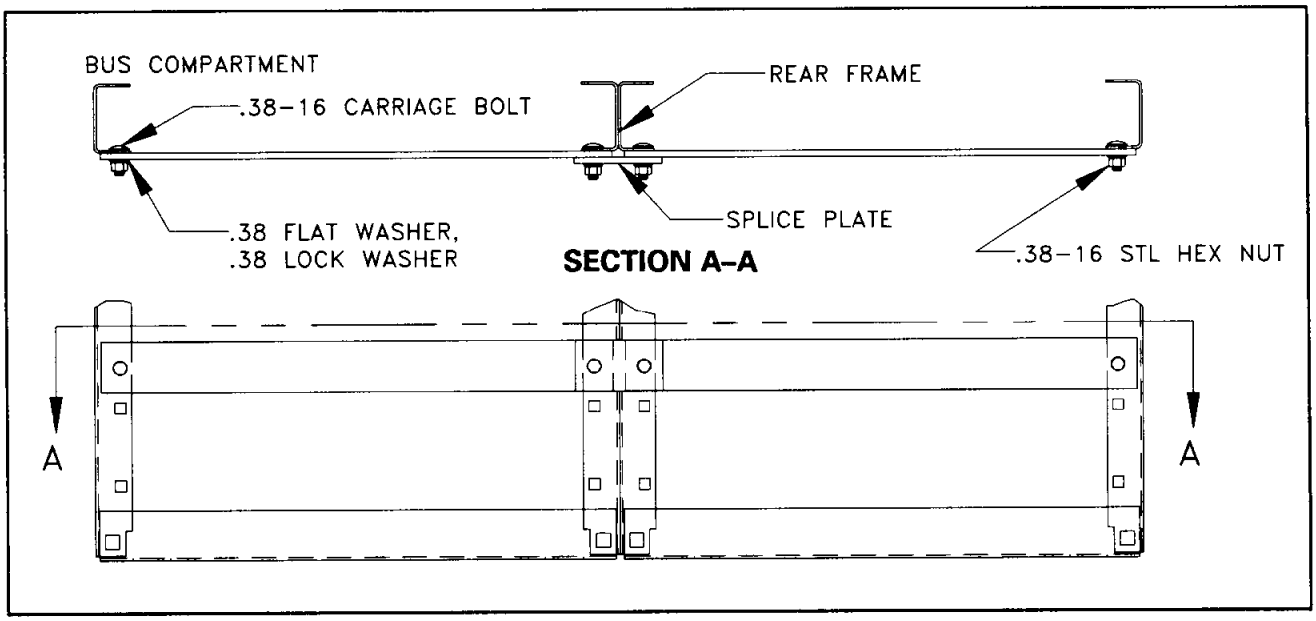


Fig. 30 *Field Assembly of Joints in Ground Bus*

operated automatically) to assure that no binding or damage has occurred during shipment of 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.

4.10 TRAVELING CIRCUIT BREAKER LIFTER

The traveling overhead circuit breaker lifter is a standard device with outdoor weatherproof assemblies, and comes already installed. Check to be certain that the carriage assembly moves freely across the entire length of the switchboard.

Indoor switchboard assemblies are supplied with overhead lifters as an optional item. When an optional lifter is supplied, it is shipped in a separate carton with instructions for assembly.

In general, the installation of the lifter assembly is not difficult. Certain steps should, however, be carefully followed to insure smooth operation.

1. If the shipping angles have not already been removed, remove and discard them at this point (Figure 31).

2. Replace the front shipping angle with the front wheel rails running from unit to unit (Figure 32). Make sure the rails are aligned between adjacent units and tighten the bolts securely. Check to make sure that wheel stops are positioned on the end unit rails (Figure 34).

3. Install rear rails utilizing hardware provided in roofsheet (Figure 32). Where rear rail is broken into multiple sections, splice together with gussets provided (Figure 33).

4. Install the movable carriage and move the lifter assembly across the entire length of the switchboard. If the carriage does not move freely and binding occurs, check the alignment of the front rails between units.

5. Install the winch on the carriage assembly. The orientation of the winch can be to either end of the switchboard assembly (Figure 35).

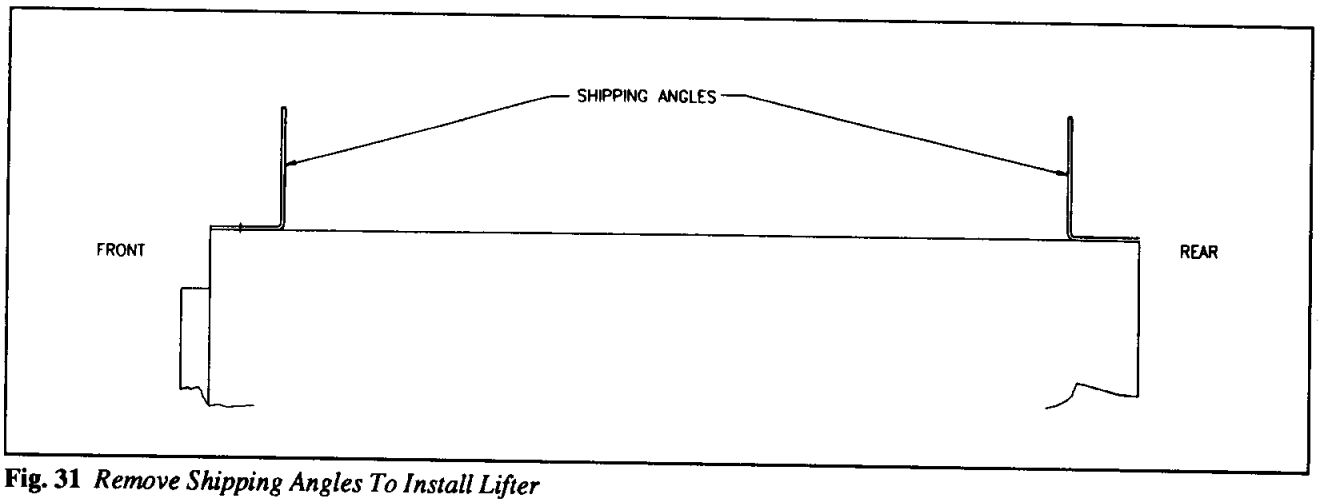


Fig. 31 *Remove Shipping Angles To Install Lifter*

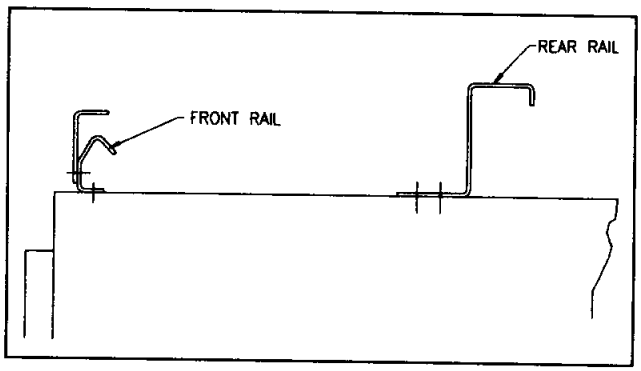


Fig. 32 *Replace Shipping Angles With Front Rails*

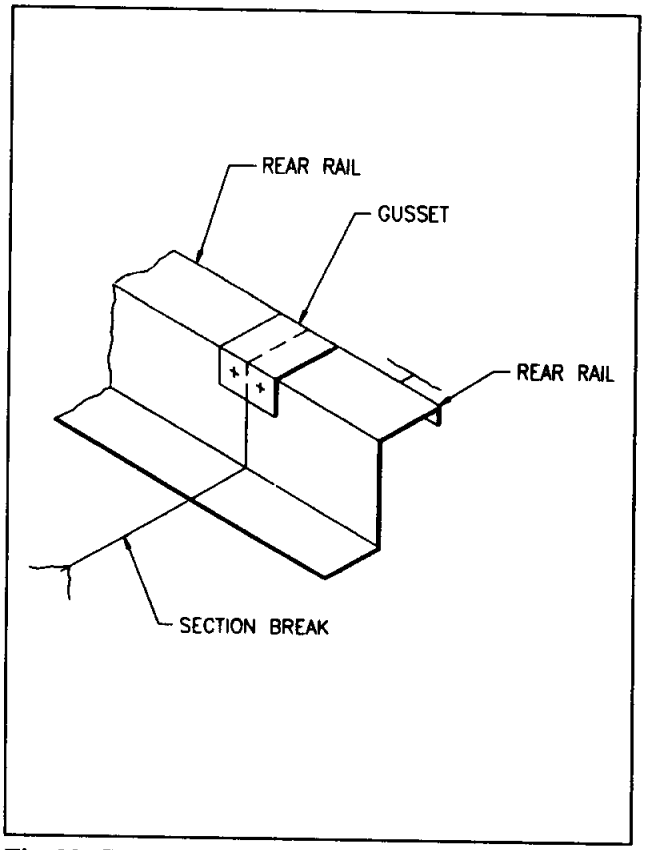


Fig. 33 *Gusset Placement - Rear Rail*

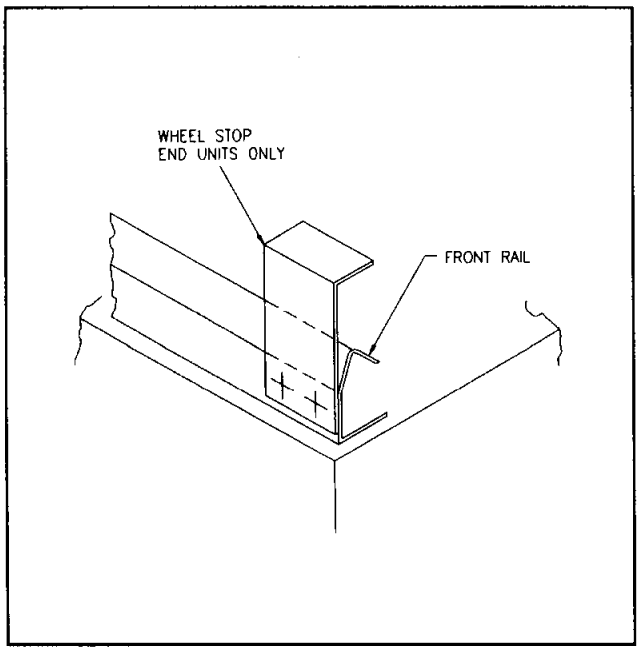


Fig. 34 *Wheel Stops In Place*

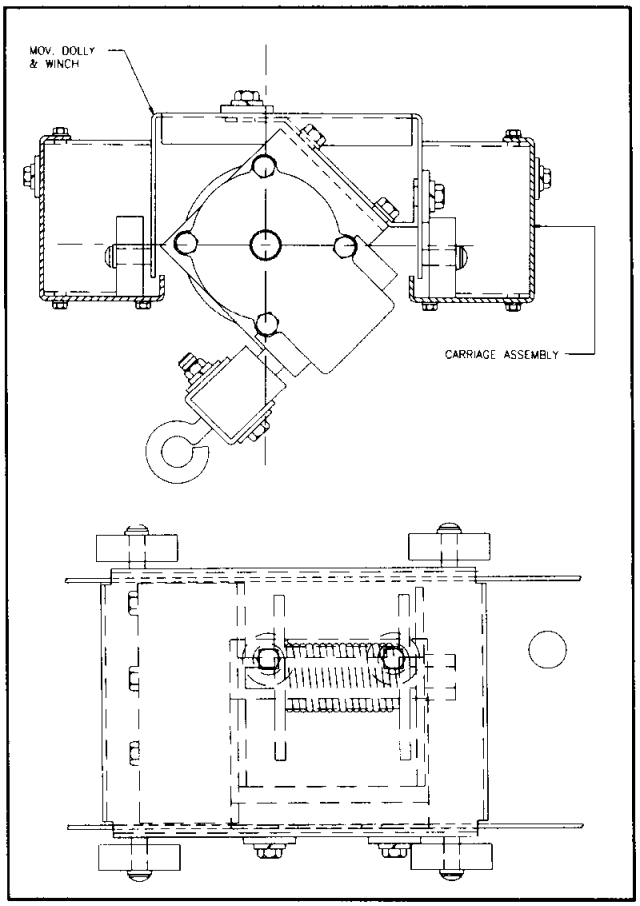


Fig. 35 *Carriage And Winch Installed*

SECTION 5 – PREOPERATION CHECK AND TEST

5.0 GENERAL

WARNING

AFTER THE SWITCHGEAR ASSEMBLY 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. PLEASE REFER TO PAGES 2 AND 3, AND RE-READ THE SAFETY PRACTICES AND PRECAUTIONS BEFORE PROCEEDING WITH ANY WORK.

TO AVOID DEATH, 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 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 of less than 10 volts may be used for making continuity checks.

A one-minute dielectric test was performed on all bus at the factory in accordance with ANSI C37.20.1. Repeating these tests is not required for field installation unless the equipment has been in extended or outdoor storage, or major bus modifications have been made. If required, 1650 Vac should be applied between each phase, and each phase-to-ground. All connections to the bus from control power or metering circuits must first be isolated from the bus. Circuit breakers must be in the withdrawn or removed positions. Devices such as lightning arresters and capacitors must also be disconnected.

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 durring shipment or installation.

The connections to the equipment apart from the switchgear assembly such as remote control and interlock circuits, and auxiliary switches should be continuity checked 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 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 integral 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 control power is available. Not more than four power-operated breakers 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 – INSPECTION AND MAINTENANCE

6.1 SAFETY PRECAUTIONS

WHEN INSPECTING, REPAIRING, AND PERFORMING MAINTENANCE ON A DS SWITCHGEAR ASSEMBLY, 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 DEATH, 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 change 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 assembly 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.

5. Review the safety practices and precautions set forth in pages 2 and 3.

6.2 ACCESS TO SWITCHGEAR ASSEMBLY PARTS

6.2.1 Main Bus and Cable Compartment Access

A DS Low-Voltage, Metal-Enclosed switchgear assembly is designed so that internal compartments provide isolation between the DS circuit breaker compartment, and the main bus and the power circuit 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.

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 DEATH, 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 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. The following general requirements should be helpful in setting up the program.

WARNING

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 DEATH, 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 instructions 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 assembly installation should be given a thorough overall maintenance check at least annually, when plant, operating, and local conditions are normal. Where conditions are abnormal, more 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. Record these readings. Inspect for signs of overheating or weakened insulation. Remove as much dirt, dust and other foreign material as possible from the insulation and conductors with minimum exposure to any solvents. The recommended cleaning procedure is to use an industrial quality vacuum cleaner and/or a lint-free cloth. In most cases, this will be sufficient. For accumulations which cannot be removed by the above procedure, a lint-free cloth, slightly dampened with water, can be used. Allow the switchgear apparatus to dry for at least four hours at room temperature before energizing. If a lint-free water-dampened cloth does not produce satisfactory results, use a lint-free cloth dampened with a mild solvent such as mineral spirits, Stoddard solvent, or isopropyl alcohol. Dry the same as when using a water-dampened cloth.

CAUTION

THE MILD SOLVENTS DESCRIBED ARE FLAMMABLE. PROVIDE ADEQUATE VENTILATION AND KEEP AWAY FROM FLAMES AND OTHER IGNITION SOURCES. CONSULT YOUR SAFETY DEPARTMENT BEFORE USING.

After buses and insulation have been dusted, wiped clean, and dried, 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. 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. Follow the cleaning instructions in 6.3.2.1 Buses and Connections. Check each breaker while it is out of the housing for all items recommended in the instruction book.

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 be checked for correct contact operation and function.

6.3.2.6 Secondary Wiring

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

6.3.2.7 Mechanical Parts

Visually check and manually operate mechanical moving parts such as cell switches, the key 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 air passages for obstructions and accumulations of dirt. When filters are used, check and replace or clean when dirty.

6.3.2.9 Records

The condition of each switchgear vertical section 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 assembly 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 THE SWITCHGEAR ASSEMBLY AT RECOMMENDED FREQUENCIES COULD RESULT IN FAILURE OF EQUIPMENT TO OPERATE PROPERLY UNDER FAULT CONDITIONS, WHICH COULD CAUSE DEATH, 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

A metal-enclosed, low-voltage switchgear assembly 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 may 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.

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, vertical section and compartment numbers and shop order number of the metal-enclosed switchgear assembly 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.

Ground Fault Test Record should be retained by those in charge of the building's electrical installation in order to be available to the authority having jurisdiction.

GROUND FAULT TEST RECORD FORM

Test Date	Circuit Breaker No.	Results	Tested By