Instructions for PorcelHline™ Metal-Clad Switchgear

Type DHP Housings Indoor and Outdoor

Westinghouse Electric Corporation

Switchgear Division, East Pittsburgh, Pa. 15112
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CAUTION

The metal-clad switchgear described in this book has been 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

This instruction book is expressly intended to cover the installation, operation, and maintenance of Type DHP Metal-Clad Switchgear.

For application information, refer to appropriate ANSI Standards, see Westinghouse Application Data 32-262, or consult your nearest Westinghouse sales office.

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, or the operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

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INTRODUCTION

Porcel-line metal-clad switchgear with type DHP horizontal drawout air circuit breakers controls and protects high voltage circuits up to 15 kV. The switchgear assembly is composed of housings that are arranged to suit the customer's specifications. The housings contain equipment such as buses, instrument transformers, relays, secondary control devices, and DHP air circuit breakers.

Porcel-line metal-clad switchgear is designed, manufactured, and tested in accordance with industry standards.

Porcel-line metal-clad switchgear is available for both indoor and outdoor installations. A typical indoor assembly is shown in Figs. 1a and 1b. An outdoor Shelterfor-M assembly is shown in Figs. 2a and 2b and an outdoor Aisle-less assembly is shown in Figs. 3a and 3b. Type DHP magnetic air circuit breakers are shown and described in I.B. 32-253-4A.

This instruction book has been prepared to familiarize the Purchaser's engineering, installation, and operating staffs with the metal-clad 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.

The following descriptions apply to standard metal-clad 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 drawings and diagrams for the switchgear assembly. Instructions on standard apparatus such as relays, instruments, and circuit breakers are included elsewhere in the complete instruction book for a particular metal-clad assembly.

SAFETY FEATURES

Westinghouse Porcel-line Metal-Clad Switchgear is manufactured with several built-in interlocks and safety related features. They are provided to promote the safety of operating personnel. Under no circumstances should they be made inoperative.

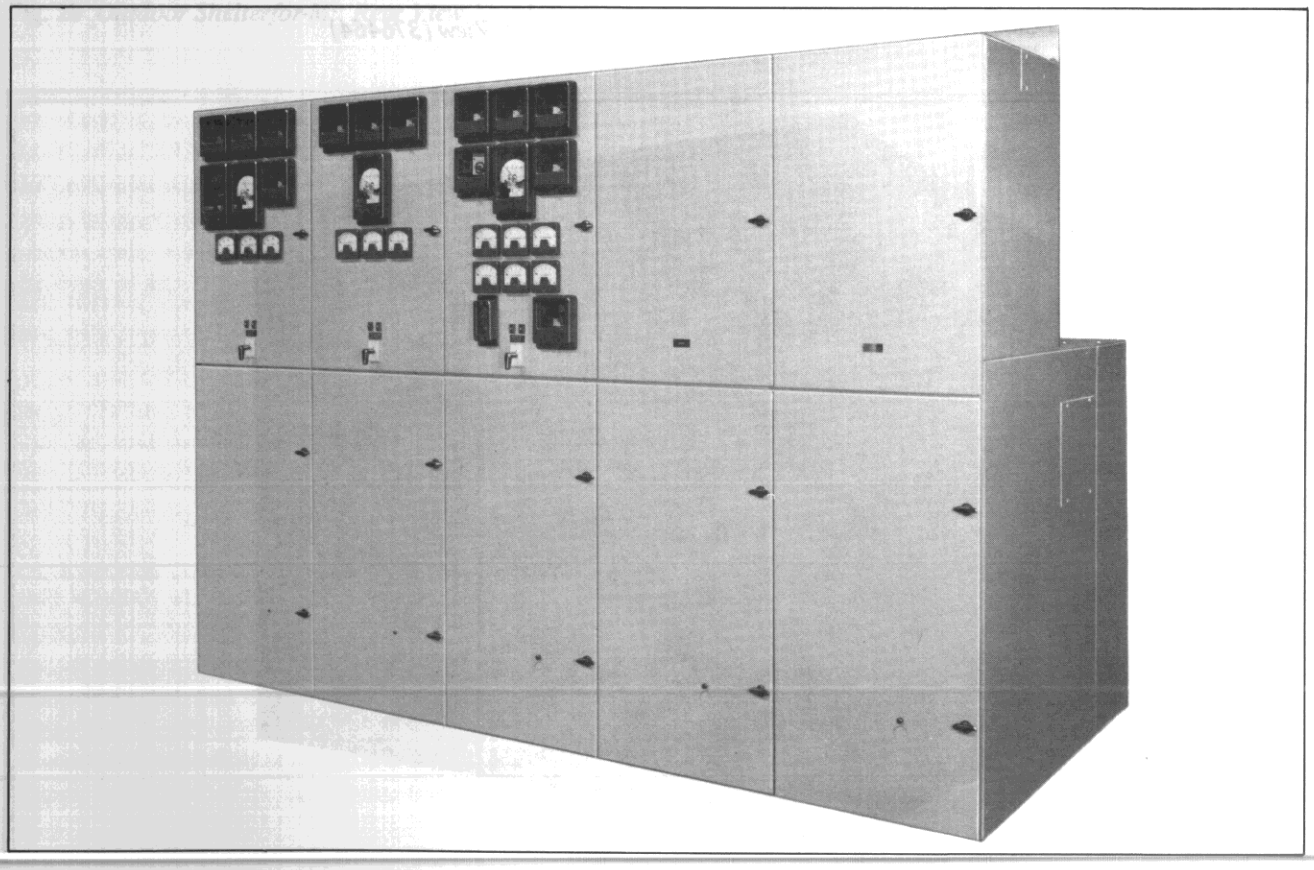


Fig. 1a *Porcel-line Metal-Clad Switchgear: Type DHP Indoor Housing-Front View (376457)*

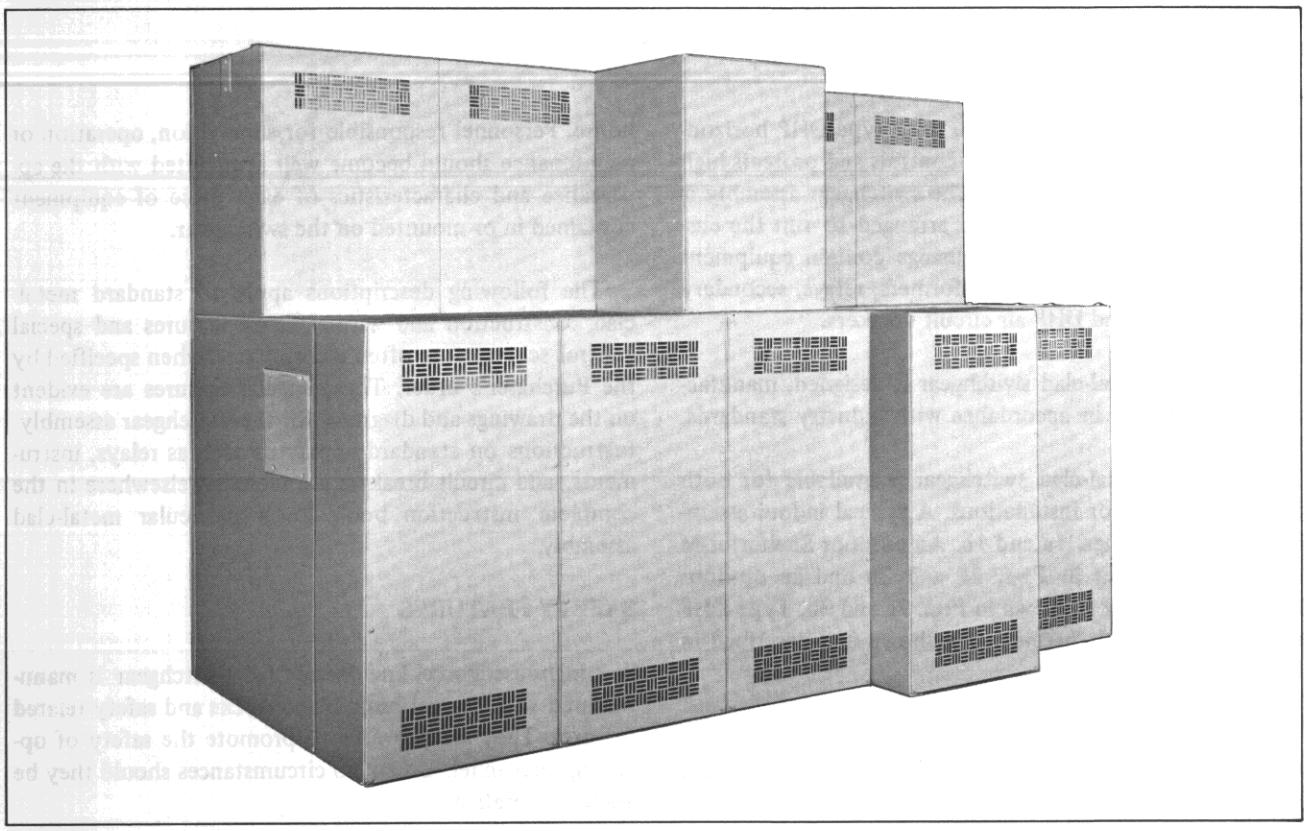


Fig. 1b *Porcel-line Metal-Clad Switchgear: Type DHP Indoor Housing-Rear View (376464)*

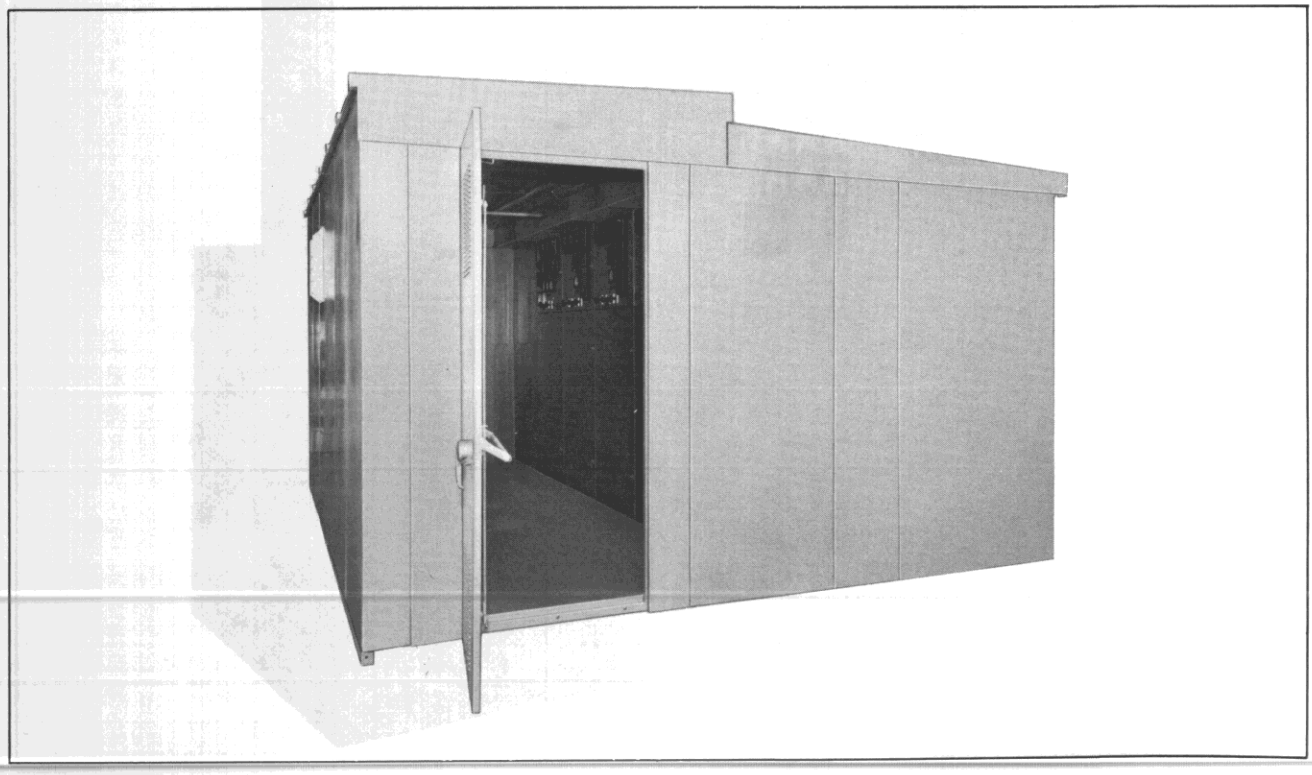


Fig. 2a *Outdoor Shelterfor-M: View of Aisle (393156)*

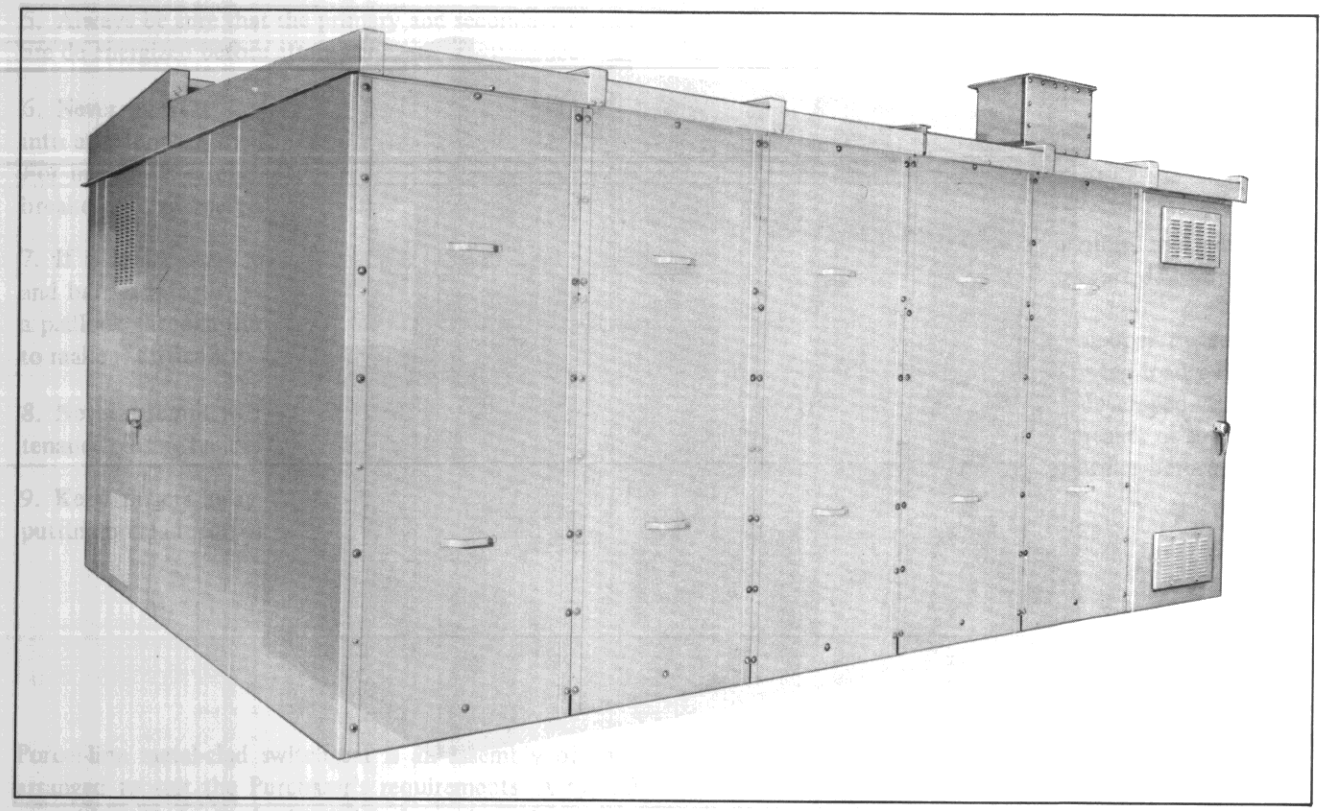


Fig. 2b *Outdoor Shelterfor-M: Rear View (393150)*

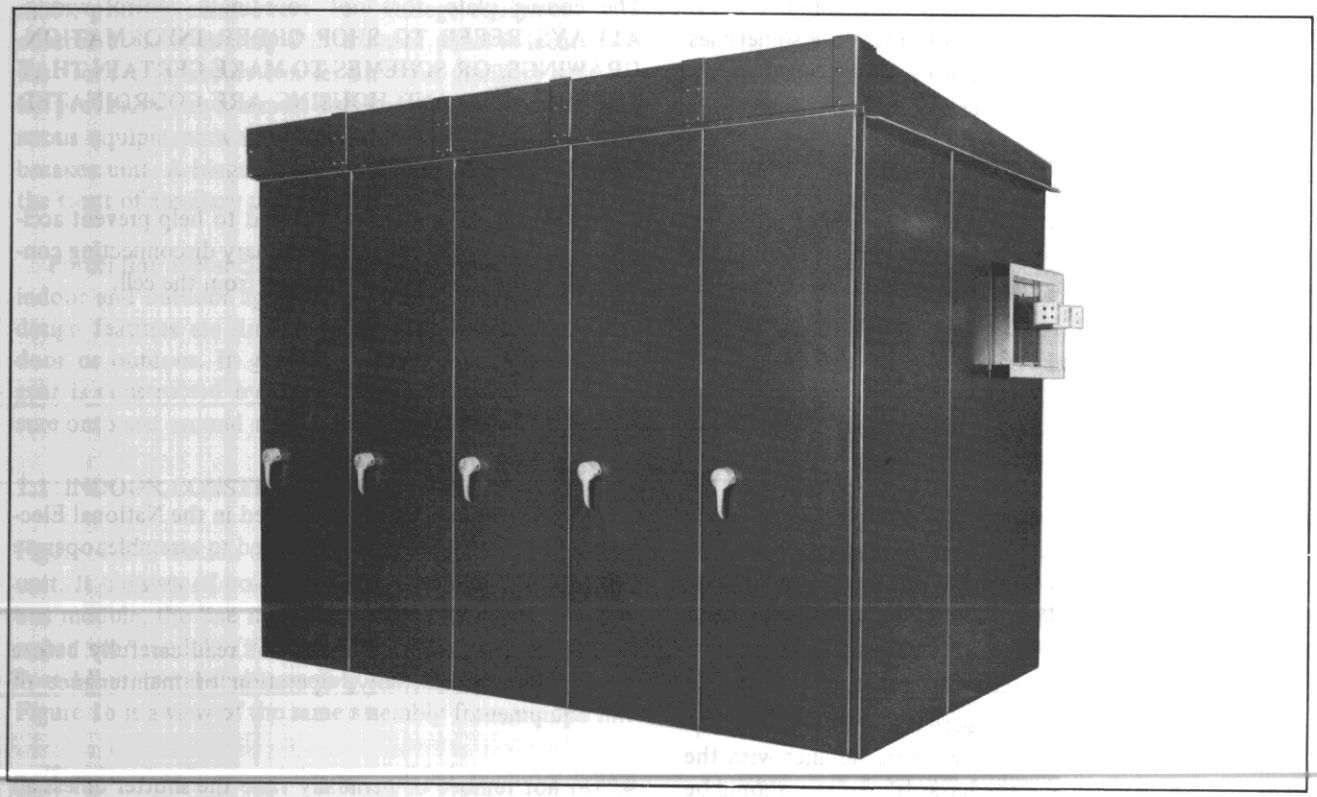


Fig. 3a *Outdoor Aisle-less 50DHF250 Shelterfor-M: Front View (393181)*

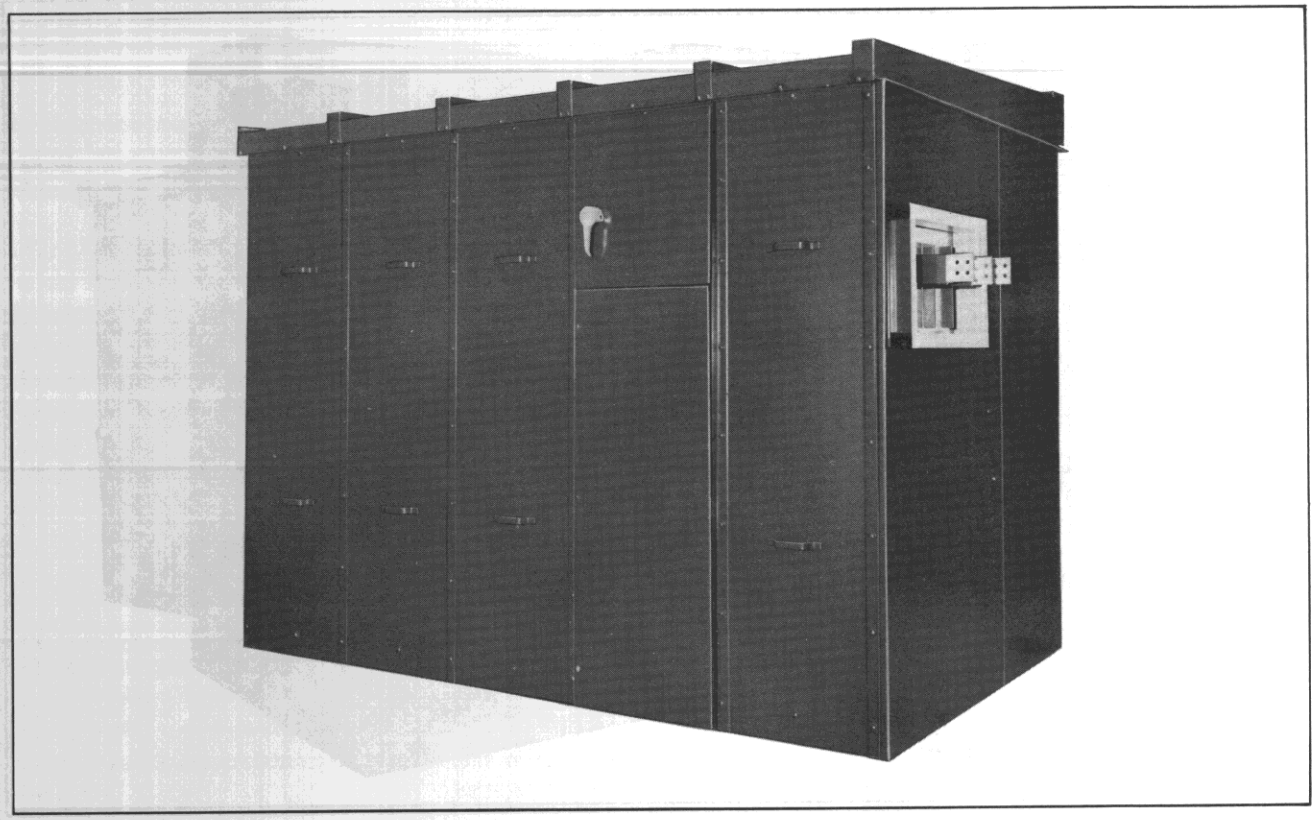


Fig. 3b *Outdoor Aisle-less 50DHP250 Shelterfor-M: Rear View (393175)*

The following are but two of the most common interlocks. Such a variety of special interlocks are sometimes provided as to make the listing of each and everyone impossible.

1. Each cell has a coding plate attached to the left side. This plate in conjunction with a co-operating plate on each Type DHP breaker acts as an interference interlock so that only breakers of the correct voltage, continuous current, and interrupting rating can be inserted in the cell. The coding plate does not coordinate control wiring. **ALWAYS REFER TO SHOP ORDER INFORMATION, DRAWINGS, OR SCHEMES TO MAKE CERTAIN THAT THE BREAKER AND HOUSING ARE COORDINATED FOR OPERATION TOGETHER.**

2. An automatic shutter is provided to help prevent accidental access to the primary stationary disconnecting contact when the breaker is withdrawn from the cell.

RECOMMENDED SAFE PRACTICES

Porcel-line Metal-Clad Switchgear is complex high voltage 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 voltage circuits. Only qualified electrical workers familiar with the work to be performed 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. This instruction book should be read carefully before attempting any assembly, operation or maintenance of this equipment.

4. Do not remove or manually raise the shutter unless all the main contacts are de-energized.

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

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

7. If it is necessary to put a breaker without arc chutes and barrier into the test position in an energized cell, put a padlock through the hole in the breaker levering-in shaft to make it difficult to engage the levering-in shaft.

8. Never attempt to close a circuit breaker with the maintenance closing handle on a live circuit.

9. Keep fingers away from top or sides of barrier when putting breaker into or out of cell.

10. Never leave a breaker in an intermediate position in a cell. Always have the breaker fully connected or withdrawn.

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

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

13. Do not attempt to disconnect or open the secondary circuit of a current transformer carrying load current because a dangerous high voltage is developed. Either de-energize the circuit by opening the breaker or short circuit the secondary of the current transformer before proceeding with the work.

SECTION 1 – DESCRIPTION

Porcel-line metal-clad switchgear is an assembly of units arranged to suit the Purchaser's requirements. A typical assembly includes both circuit breaker units and auxiliary units. A circuit breaker unit has provisions for a removable circuit breaker. It also includes high voltage equipment, primary connections, low voltage equipment, and control devices. A hinged instrument panel is located on the front of a circuit breaker unit. An auxiliary unit has no provisions for a circuit breaker. It contains miscellaneous equipment which cannot be contained in a circuit breaker unit. A hinged instrument panel is also located on the front of auxiliary units.

Porcel-line metal-clad 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-clad switchgear is constructed by assembling a weatherproof enclosure onto and around standard indoor units.

1.1 INDOOR CONSTRUCTION

Figure 4 is a section drawing of a typical indoor breaker unit. It consists of bolted together modules: the breaker/bus module, the line module, the control module, and an upper rear module (if required). Figure 1a is an indoor Porcel-line metal-clad assembly viewed from the front. Figure 1b is a view of the same assembly from the rear.

The breaker/bus module is a welded assembly which contains major functioning equipment such as the breaker itself, stationary disconnect contacts, main bus and current transformers. In addition, the breaker/bus module also contains the levering-in screw, shutter, interlocks, and additional auxiliary switches as required. The support for the main bus and main contacts are a part of this module.

The line module is bolted to the rear of the breaker/bus module. It provides space for line terminations such as cable connectors or potheads.

The control module is bolted to the top of the breaker/bus module and provides space for control function items such as fuses, control relays, molded case circuit breakers, terminal blocks, mechanism operated cell switches, etc.

The upper rear module, when provided, bolts to the top of the line module directly behind the control module. This module may contain such items as potential transformers, lightning arresters, special buses, etc.

Referring again to Fig. 4 note that the combination of these modules forms the complete metal-clad unit. Internal compartments provide metal isolation between secondary control devices, the circuit breaker, the main bus, and the primary line terminations. **Access to primary equipment is provided by bolted-on metal covers which should not be removed unless the circuits to be exposed are de-energized.**

Figure 5 is a section drawing of a typical auxiliary unit. It is composed of modules similar to those in the

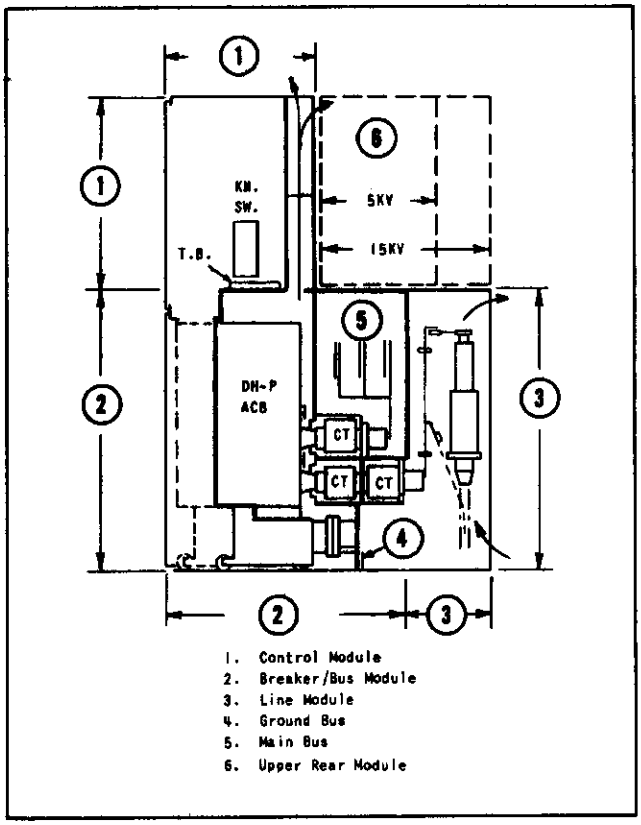


Fig. 4 *Indoor: 5 KV Breaker Unit*

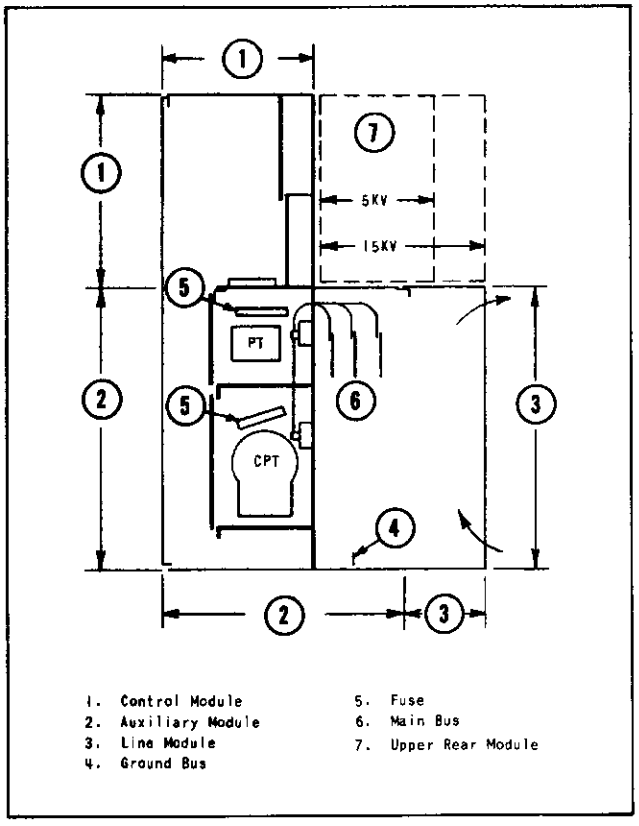


Fig. 5 *Indoor: 5 KV Auxiliary Unit*

breaker unit. There are no provisions for a breaker in the auxiliary unit. The auxiliary unit shown in Fig. 5 contains potential transformers and control power transformer. It is typical only and could instead include other types of equipment such as a battery tray, surge equipment, or motor field equipment.

1.2 OUTDOOR CONSTRUCTION

Outdoor Porcel-line metal-clad switchgear is available in two forms: Shelterfor-M and Aisle-less. (See Figs. 2 and 3).

Shelterfor-M switchgear is an assembly of a weatherproof enclosure built onto and around indoor units. It includes an operating or maintenance aisle where equipment is accessible without exposure to weather.

Aisle-less switchgear is an assembly of a weatherproof enclosure built onto and around indoor units, but *not* including an operating or maintenance aisle.

1.3 SHELTERFOR-M

Figure 6 is a section drawing of a typical Shelterfor-M assembly including a breaker unit. Figures 2a and 2b are photographs of Shelterfor-M viewed from the side and rear. Figure 2a is a side view of an assembly with the aisle door open. The aisle permits interchanging circuit breakers between units. A weatherproof door is located at each end of the aisle, and each is equipped with a panic exit mechanism permitting quick release for personnel exit from the inside even when the door is padlocked on the outside. Aisle lights, switches, and service receptacles are provided.

Shelterfor-M is basically:

1. The typical indoor units shown in Figs. 4 and 5.

2. A welded base to which the indoor units are securely bolted.

3. Weatherproof covers which are bolted to the rear and sides of the indoor units.

4. A weatherproof roof bolted to the indoor units.

5. An aisle floor which is bolted to the base and to the front mounting channel.

6. Weatherproof covers forming an aisle enclosure.

7. A weatherproof roof completing the aisle enclosure.

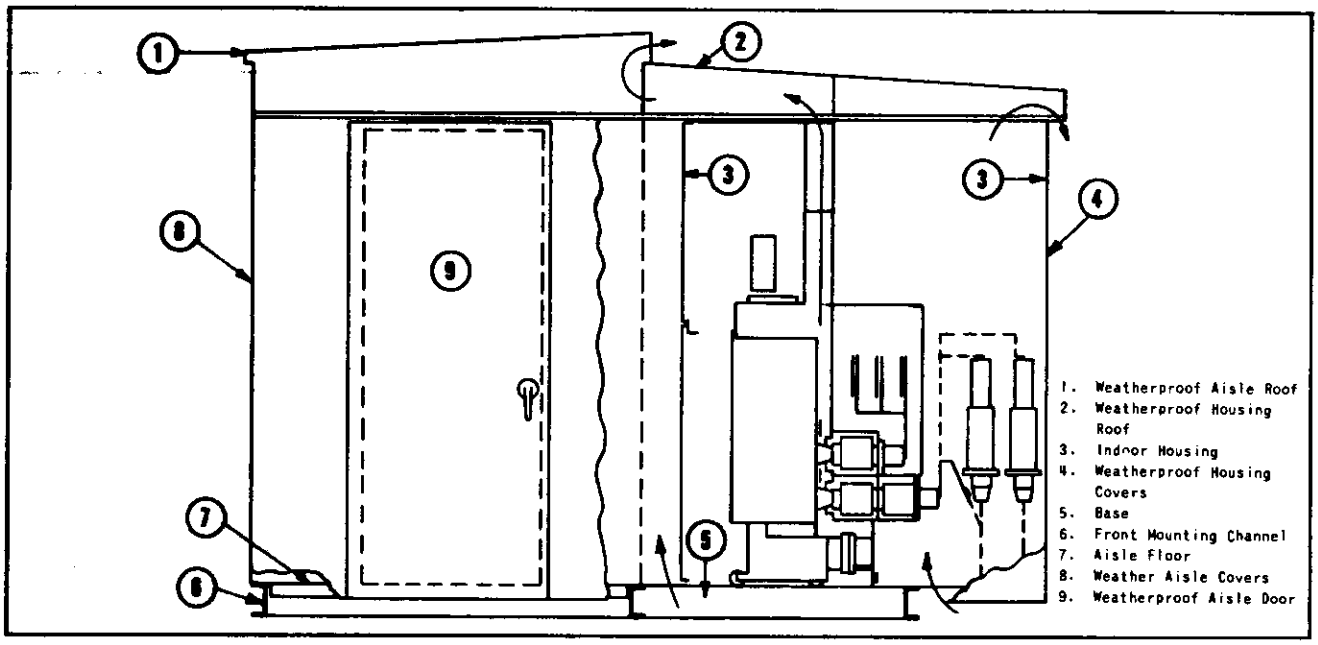


Fig. 6 *Shelterfor-M: 5 KV Breaker Unit* **(Ventilation indicated by arrows)*

The side covers and aisle covers are formed in such a way that bolts are installed from the inside: the vertical seams are internal. The rear covers are bolted externally, but the sheets are crimped and overlapped to form a weatherproof seal. The horizontal seams on all of these covers are at the top within the roof overhangs forming a weatherproof arrangement. The roof seams are flanged and turned back so that a seam cover may be simply locked in place. Foundation requirements are simple – the structure is supported by three base channels. Pier mounting is possible. No breaker drawout pad is required and indoor-type accessories are supplied.

1.4 AISLE-LESS

Figure 7 is a section drawing of a typical Aisle-less assembly including a breaker unit. Figures 3a and 3b are photographs of an Aisle-less assembly viewed from the front and rear. Weatherproof doors are located on the breaker drawout side of each unit. A light and service receptacle is available in each unit. Foundation requirements are simple – the structure is supported by two base channels. Pier mounting is possible but requires a breaker drawout pad. Outdoor-type accessories, including a transport truck, are supplied.

1.5 VENTILATION: INDOOR SWITCHGEAR

Refer to Figs. 4 and 1b. The rear sheets have grillwork at the top and bottom to allow ventilating air to pass through the line module as shown. A chimney and grillwork over the breaker allows for expansion of gases resulting from breaker interruption and ventilation of the breaker compartment.

1.6 VENTILATION: SHELTERFOR-M

Refer to Figs. 6 and 2b. The outdoor rear sheets have no grillwork, louvers, or openings. Ventilating air enters through a screen at the bottom of the line module, passes through it, and is expelled through a screen under the rear roof overhang. A chimney over the breaker allows for expansion of gases resulting from breaker interruption and ventilation of the breaker compartment.

1.7 VENTILATION: AISLE-LESS

Refer to Figs. 7 and 3b. The outdoor rear sheets have no grillwork, louvers, or openings and are identical to the Shelterfor-M rear sheets. Ventilating air enters through a screen at the bottom of the line module, passes through it, and is expelled through a screen under the rear roof overhang. A chimney over the breaker allows for expansion of gases resulting from breaker interruption and ventilation of the breaker compartment.

1.8 SPACE HEATERS

Heaters, to minimize condensation, are furnished as standard equipment on all outdoor equipment. One heater is mounted in the lower rear of the breaker module and another in the lower part of the line module. These

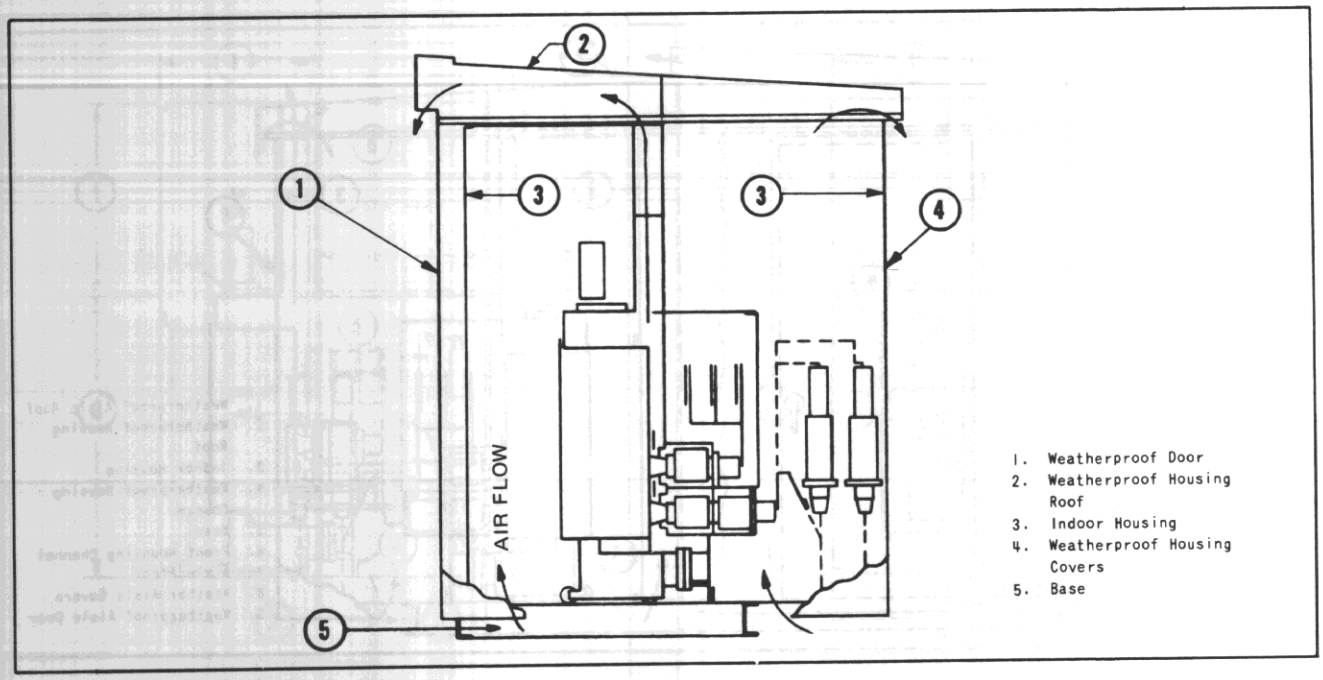


Fig. 7 *Aisle-less Shelterfor-M: 5 KV Breaker Unit (Ventilation indicated by arrows)*

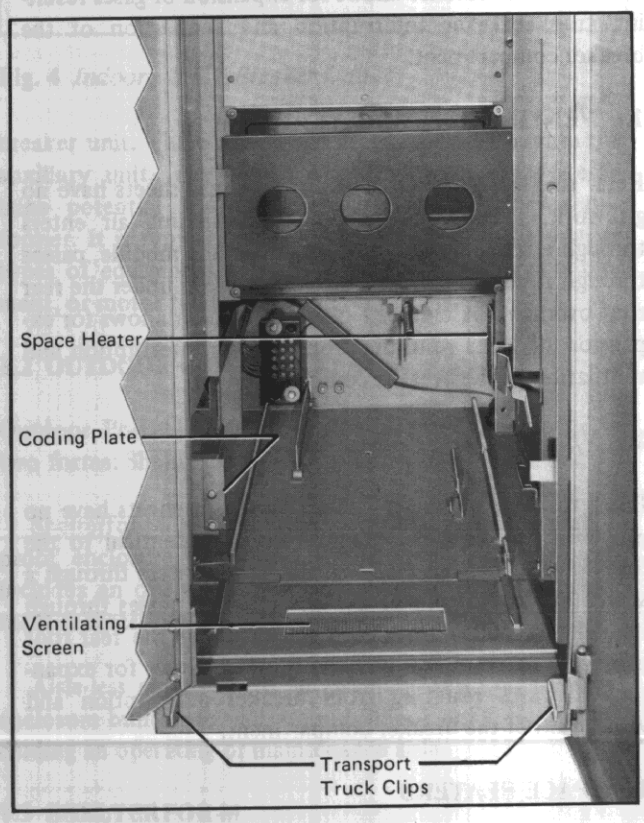


Fig. 8 *Outdoor Aisle-less 50DHP250 Breaker Housing with Space Heater, Coding Plate, Ventilating Screen, and Transport Truck Clips (393177)*

heaters are visible in Fig. 8. They are operated at half-voltage for long life.

1.9 INSTRUMENT PANELS: INDOOR AND SHELTERFOR-M

The standard breaker unit includes two hinged front panels located on the breaker drawout side of the unit. The upper panel is on the control module and is for mounting instruments, meters, and relays such as those shown in Fig. 9. The lower panel is on the breaker/bus module and is not an instrument panel. An access port in the lower panel permits levering the breaker between the operating and disconnected positions with the door closed.

When more instruments are required than can be accommodated on the control module panel, a front extension is provided which permits the use of a full height instrument panel.

A standard auxiliary unit includes a full height instrument panel which is arranged to line up with the breaker units.

1.10 INSTRUMENT PANELS: AISLE-LESS

Standard breaker and auxiliary units include essentially full-height front panels located on the breaker drawout

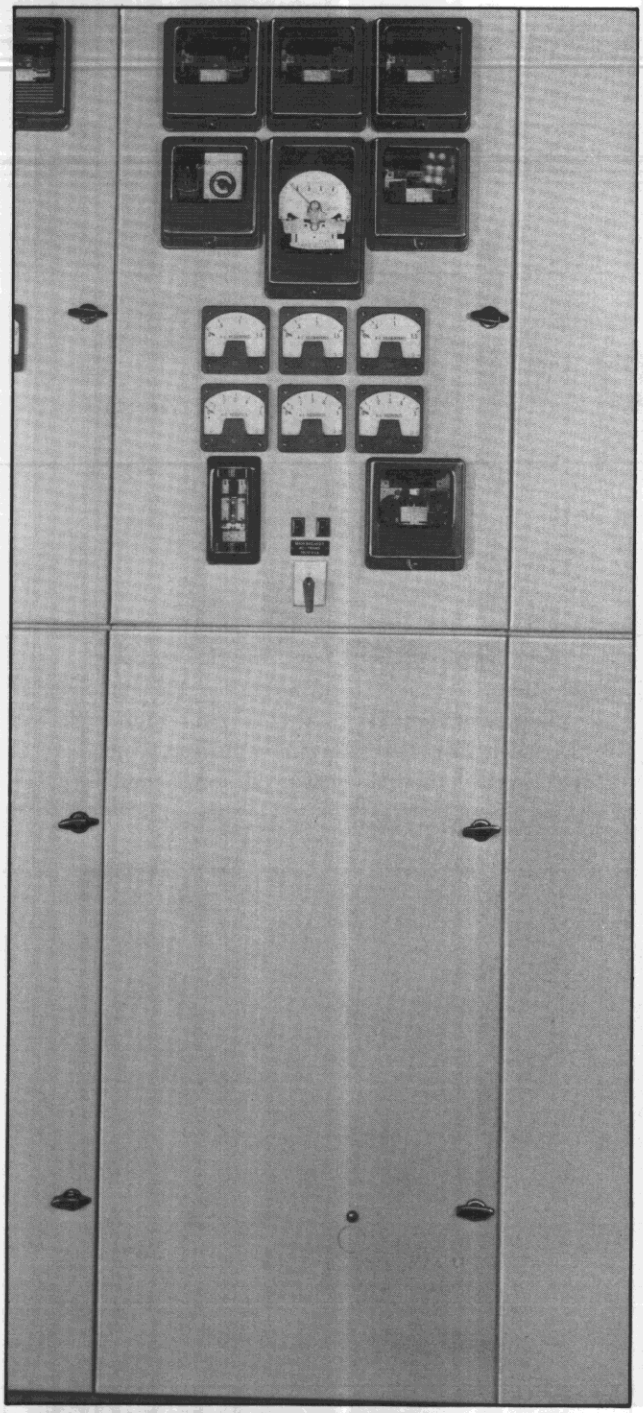


Fig. 9 *Indoor and Shelterfor-M: Typical Instrument Panel (376472)*

side of the units. These instrument panels are immediately behind the weatherproof doors and are hinged to permit insertion and removal of the circuit breakers from the same side. These panels permit mounting instruments, meters, and relays as shown in Fig. 10. Door stops are provided for both the weatherproof door and the instrument panel.

1.11 CONTROL EQUIPMENT

Figure 11 is a view looking into a breaker unit. A pull fuse for control power cutoff and terminal blocks for customer's control leads are furnished as standard equipment in the control module. As required, additional control equipment may be mounted in the control module, such as: capacitor trip devices, control and instrument fuses, resistors, auxiliary or interposing relays, and molded case breakers. Figure 12 shows the same unit with the PT Compartment door open.

1.12 SHUTTER AND BARRIER

Mounted in front of the main contact supports are insulating barriers and an insulating shutter. Figure 13 is a view of a breaker housing showing the shutter position with the breaker removed. An operating arm is pivoted to the side of the module and linked to the shutter. The shutter is automatically raised by the action of a roller on the breaker against the cam surface of the shutter arm when the breaker is levered into the connected position. When the breaker is levered out of the connected position, the shutter drops by gravity. The barriers and shutter, when closed, provide a physical barrier to the main contacts which may be energized. Opening the shutter as in Fig. 14 exposes the main contacts.

Caution: **DO NOT MANUALLY RAISE OR REMOVE SHUTTER UNLESS MAIN CONTACTS ARE DE-ENERGIZED AND SAFETY PROCEDURES HAVE BEEN INITIATED TO BE SURE THE CIRCUITS ARE NOT RE-ENERGIZED. FAILURE TO EXERCISE CAUTION MAY RESULT IN BODILY INJURY AND PROPERTY DAMAGE.**

1.13 CURRENT TRANSFORMERS

Ring-type current transformers are positioned around the main contact supports as shown in Fig. 15. They can be removed from the front if the primary circuit is de-energized. They may be located on the upper and/or lower main contact supports. If necessary, additional or special current transformers may be mounted in the line module.

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.

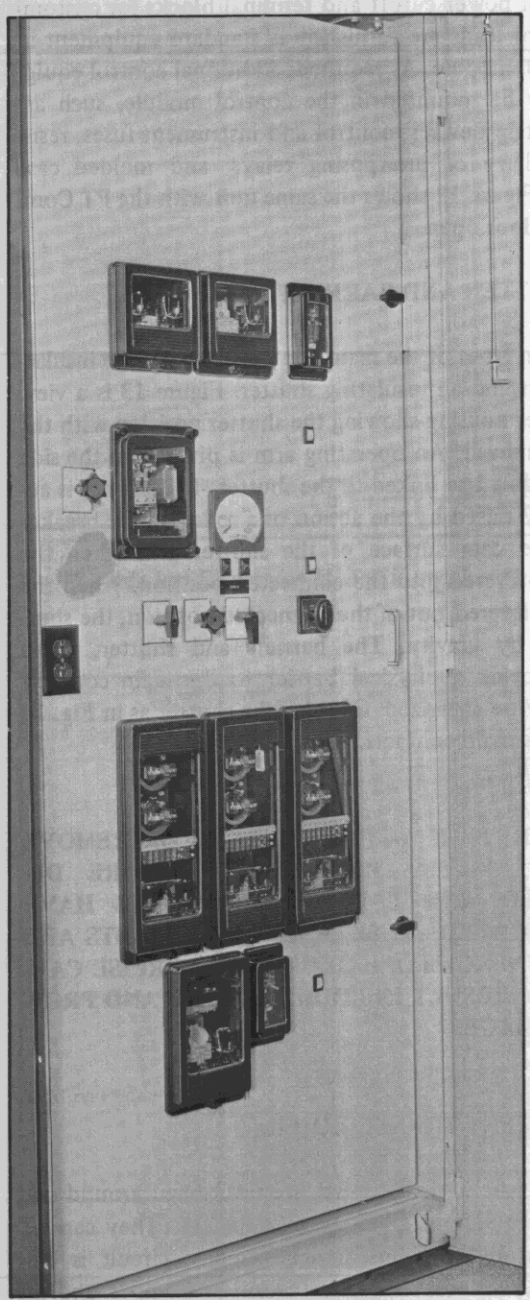


Fig. 10 *Aisle-less Housing: Typical Instrument Panel (376641)*

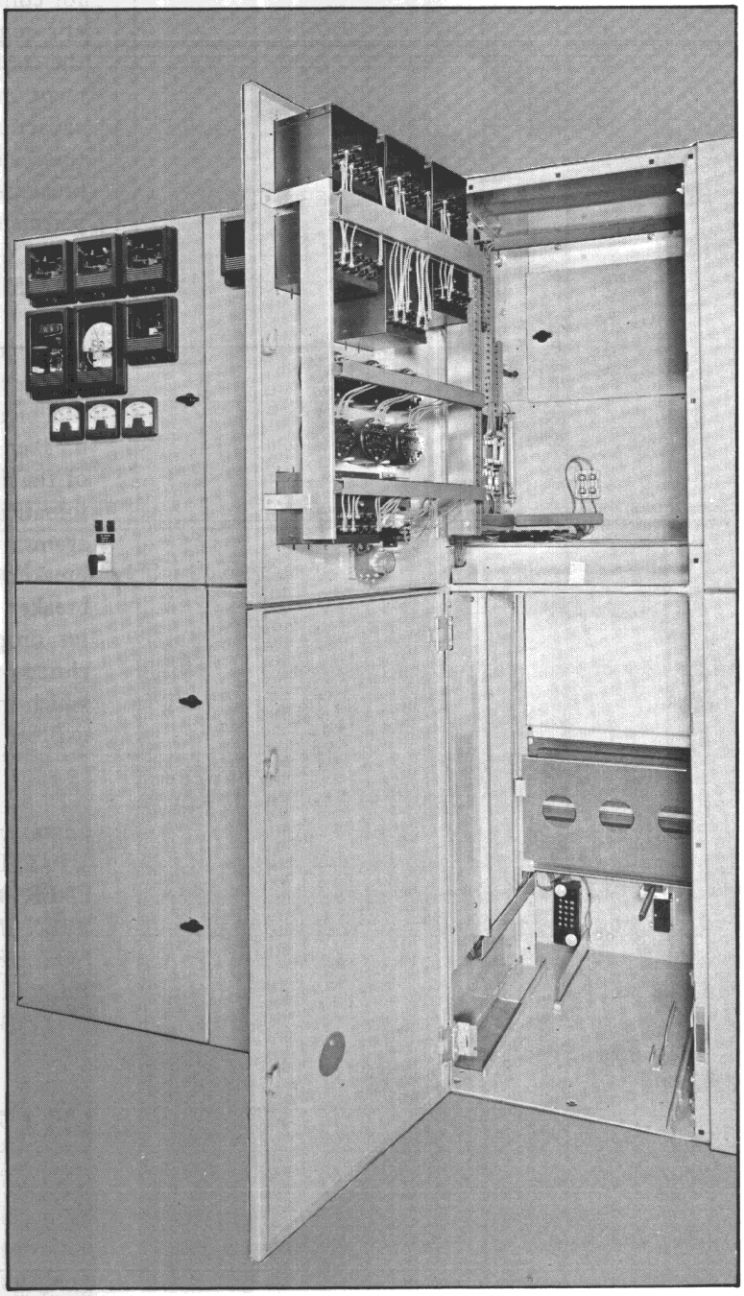


Fig. 11 *Indoor and Outdoor: 5 KV Breaker Housing Showing Control Equipment with Potential Transformer Compartment Door Closed (376468)*

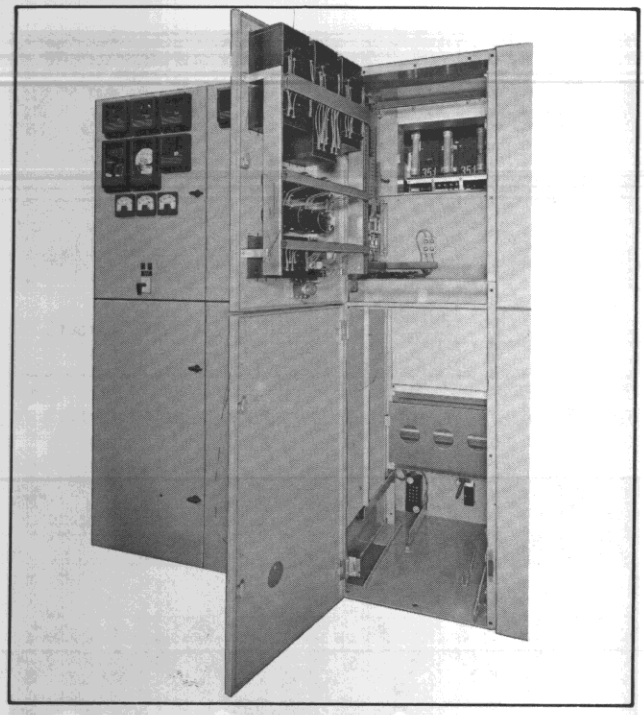


Fig. 12 *Indoor and Outdoor: 5 KV Breaker Housing Showing Control Equipment with Potential Transformer Compartment Door Open (376467)*

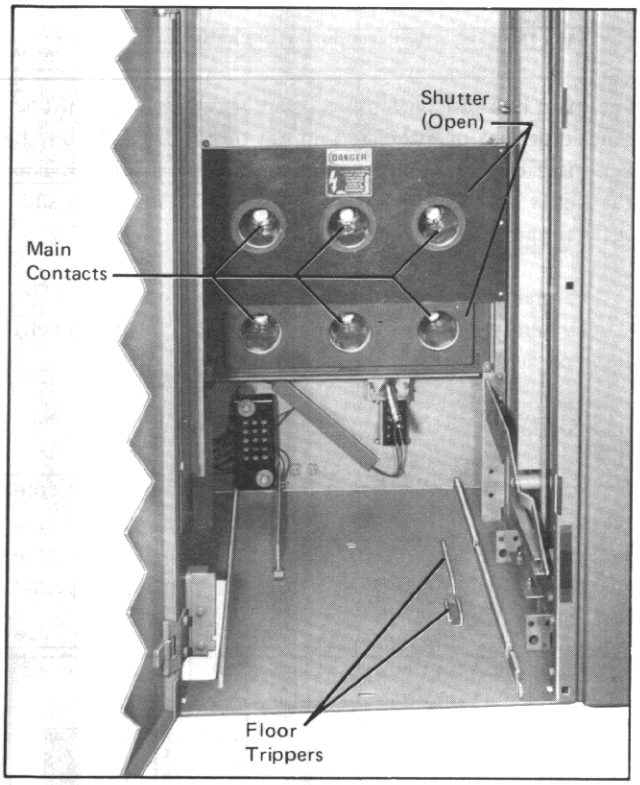


Fig. 14 *Indoor 50DHP250 Breaker Housing with Shutter Open (393184)*

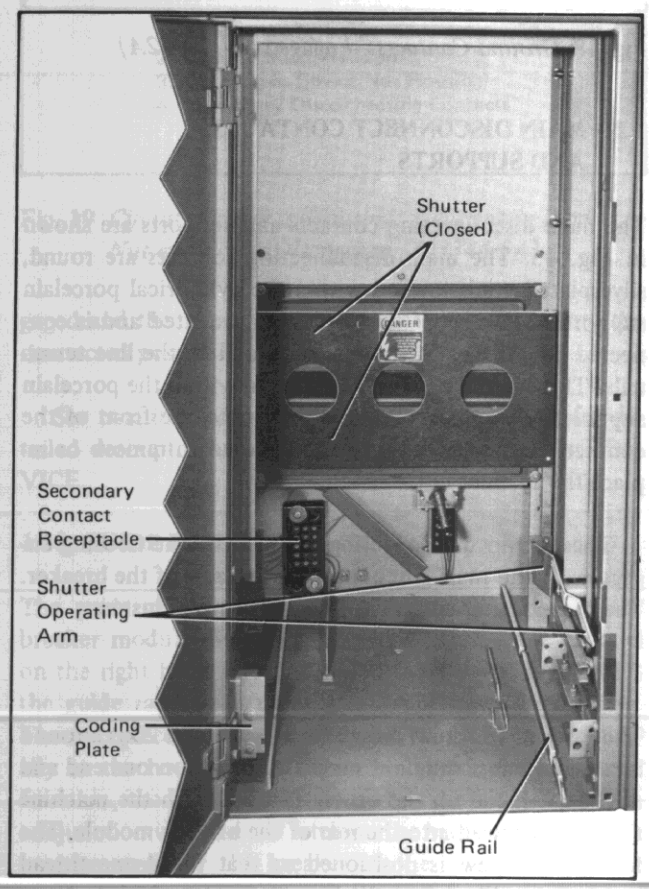


Fig. 13 *Indoor 50DHP250 Breaker Housing with Shutter Closed (393185)*

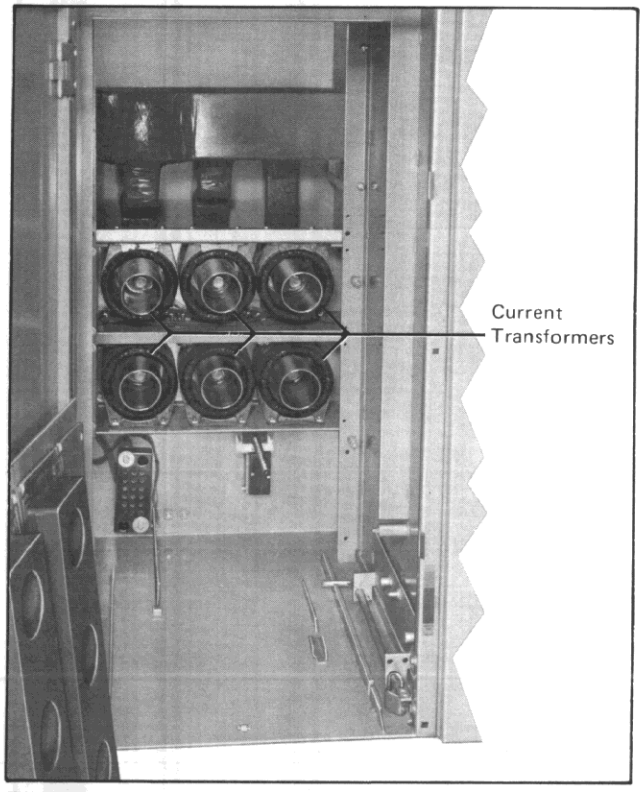


Fig. 15 *Indoor Housing with Insulating Shutter and Barriers Removed: Front View Showing Current Transformers, Main Bus and Main Bus Taps, Main Disconnect Contacts and Supports (376460)*

1.14 MAIN BUS AND MAIN BUS TAPS

The main bus and main bus taps are shown in Fig. 16. The conductors are of either aluminum or copper as required. The main bus, main bus joints, and taps are insulated. The bus joints are silverplated and bolted. The main bus supports are porcelain.

The main bus is accessible from either the front or the rear by removing bolt on covers only after the equipment has been de-energized.

1.15 GROUND BUS

The ground bus is shown in Fig. 16. The breaker is connected to an extension of the ground bus as soon as it is put into the disconnected or test position. It is continuously grounded as it is moved from the test to the operate position. See Figs. 17 and 18.

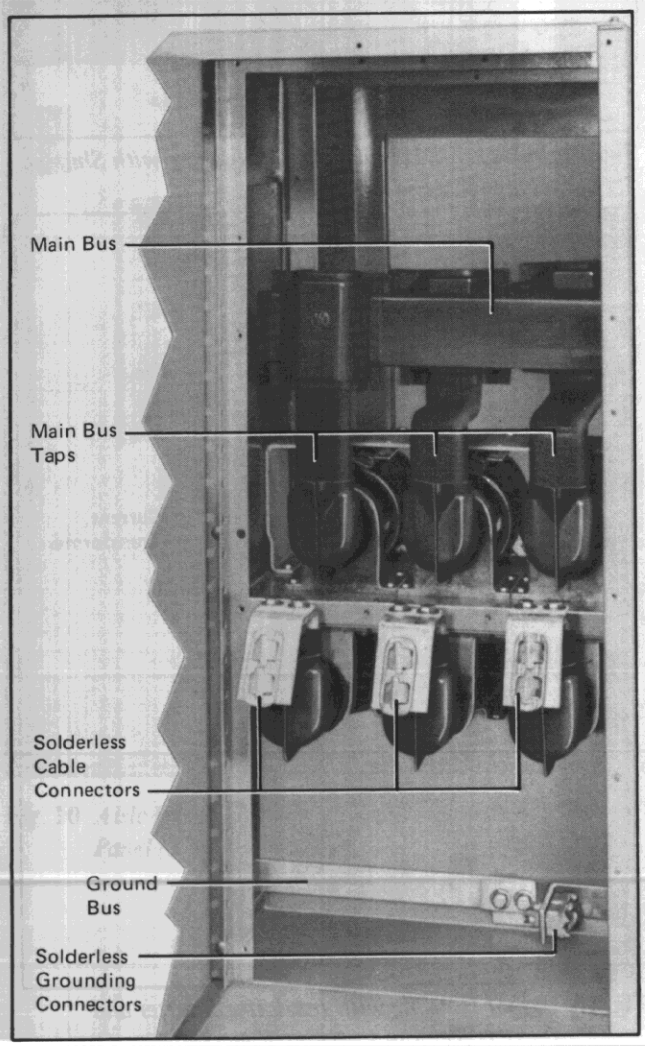


Fig. 16 *Indoor Housing: Line Module with Rear Sheet Removed (374224)*

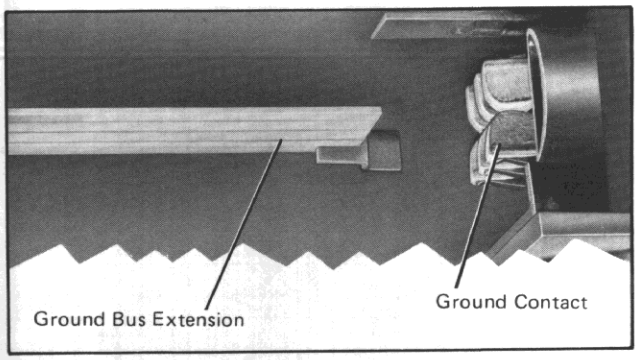


Fig. 17 *Ground Contacts: Disengaged (393344-3A)*

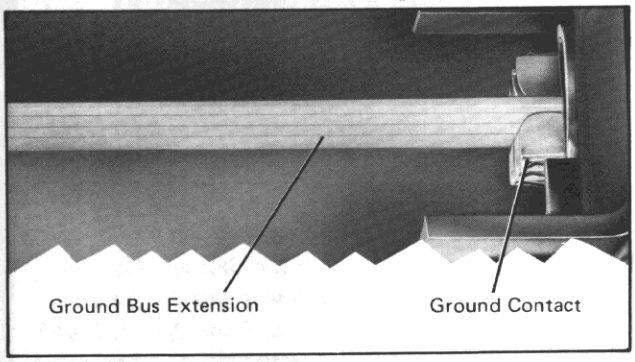


Fig. 18 *Ground Contacts: Engaged (393344-2A)*

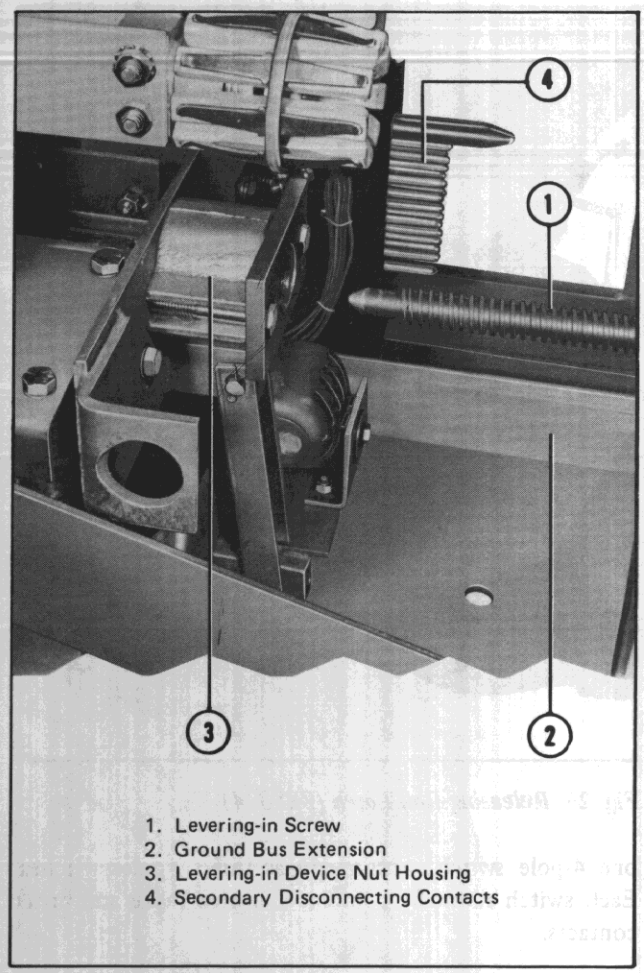
1.16 MAIN DISCONNECT CONTACTS AND SUPPORTS

The main disconnecting contacts and supports are shown in Fig. 15. The main disconnecting contacts are round, silverplated studs located within the cylindrical porcelain supports. The rear of the contact is insulated and is connected to the tap to the main bus and to the line terminals. The contact assembly is secured within the porcelain support by a spanner nut threaded onto the front of the contact. A special tool, Fig. 35, is used to remove or replace the spanner nut.

These main disconnecting contacts in the housing engage with the main disconnecting contacts of the breaker. The breaker contacts are self-aligning finger clusters.

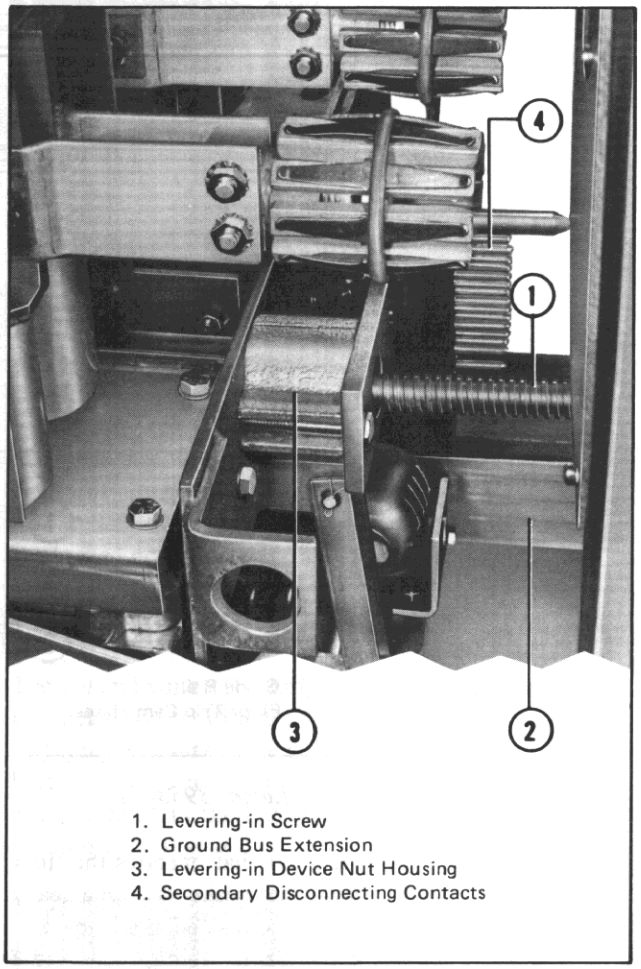
1.17 LEVERING-IN DEVICE

The levering-in screw shown in Figs. 19 and 20 is a round bar which has a standard machine thread on one end and an Acme thread on the other. The end with the machine thread is screwed into the rear of the breaker module. The levering-in screw is positioned so that the Acme thread end is "aimed" toward the levering-in nut which is a part of the breaker. When the levering-in screw and nut are en-



1. Levering-in Screw
2. Ground Bus Extension
3. Levering-in Device Nut Housing
4. Secondary Disconnecting Contacts

Fig. 19 *Circuit Breaker in Housing: Levering-in Device Nut and Screw Disengaged (393344-5A)*



1. Levering-in Screw
2. Ground Bus Extension
3. Levering-in Device Nut Housing
4. Secondary Disconnecting Contacts

Fig. 20 *Circuit Breaker in Housing: Levering-in Device Nut and Screw Engaged (393344-7A)*

gaged and the nut is rotated, the breaker is pulled into the connected position.

See circuit breaker instructions I.B. 32-253-4A for detailed description and operation of the LEVERING DEVICE.

1.18 GUIDE RAIL

The guide rail is a steel bar welded to the floor of the breaker module. See Figs. 13 and 21. The guide channel on the right hand side sheet of the circuit breaker engages the guide rail as the breaker is levered into the housing. The two pieces acting together position the breaker laterally in the housing. In addition to performing the guide function, the guide rail is notched at the front so that in conjunction with the rail latch on the breaker it provides a positive stop for the breaker in the test position. The notch in the guide rail and the rail latch also act together to prevent damage to the levering-in screw when the breaker is pushed into the cell. Refer to breaker I.B. 32-253-4A for detailed description of rail latch.

1.19 FLOOR TRIPPERS

There are two floor trippers on the floor of a breaker module. See Fig. 14.

The front floor tripper is a machined channel. The right leg operates the floor tripping interlock on the bottom of the breaker to automatically trip the breaker when it is inserted or removed from the cell.

The left leg of the front floor tripper operates the closing spring release interlock on the bottom of the breaker. As a result, if the closing spring is charged, it is discharged as the breaker is inserted into or withdrawn from the breaker module.

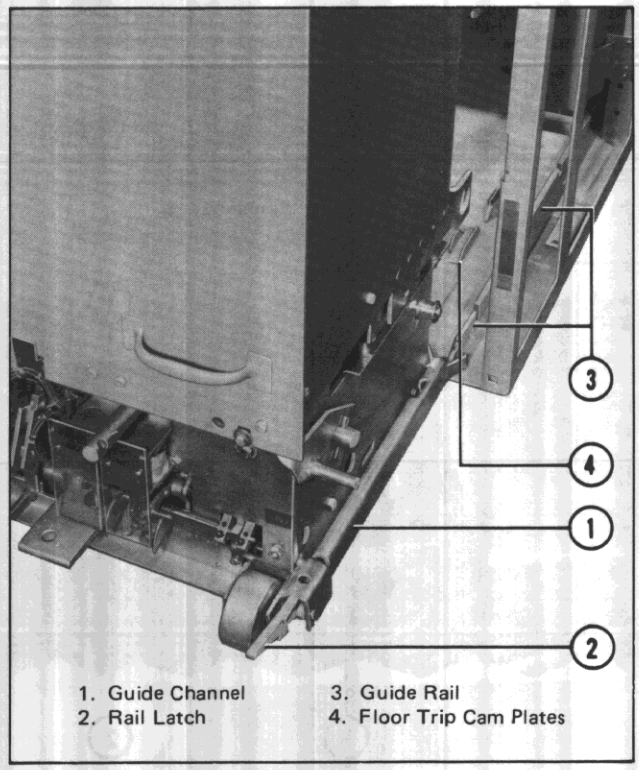


Fig. 21 *Breaker Guide and Rail Latch (393301)*

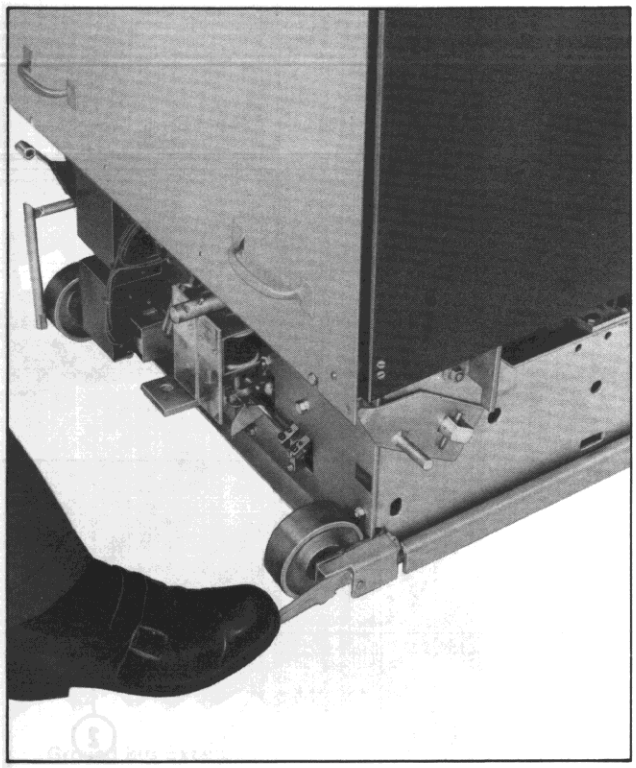


Fig. 22 *Releasing Rail Latch (388824)*

The rear floor tripper is a bar that operates the floor tripping interlock. As a result, the breaker is mechanically trip-free between the test and connected positions. See breaker I.B. 32-253-4A for detailed description of the floor trippers.

1.20 AUXILIARY SWITCHES

Spare auxiliary switch contacts on the circuit breaker are limited in number by the breaker control requirements. Usually one 'a' and two 'b' contacts for ac control or two 'a' and two 'b' contacts for dc control are available.

When additional auxiliary contacts are needed, optional mechanism operated cell (MOC) switches can be supplied. MOC switches may be supplied for operation in the connected position only or for operating in both the test and connected position.

An optional truck operated cell (TOC) switch operates when the circuit breaker is levered into or out of the connected position.

1.21 MECHANISM-OPERATED CELL SWITCH (MOC SWITCH)

The MOC switch is an assembly of switches that is operated by a pin on the breaker mechanism. It can contain one 4-pole switch or as many as three 9-pole switches. Each switch normally contains alternate make and break contacts.

The MOC switch is mounted on the right hand side of the control module. It is operated by a lever which is connected to a vertical rod. The vertical rod extends down into the breaker module and connects to a pantograph on the side of the breaker module. The pantograph is operated by a pin on the breaker mechanism. As a result, the MOC switch moves with the breaker contacts and can be used to electrically indicate whether the breaker is closed or open.

There are three modes of MOC switch operation available. They are:

1. Operates with the breaker in the connected position only.

2. Operates with the breaker in the connected and test position.

3. Operates with the breaker in the connected position and can be made to operate or not in the test position at discretion of the operator.

An MOC switch can be seen in Fig. 23.

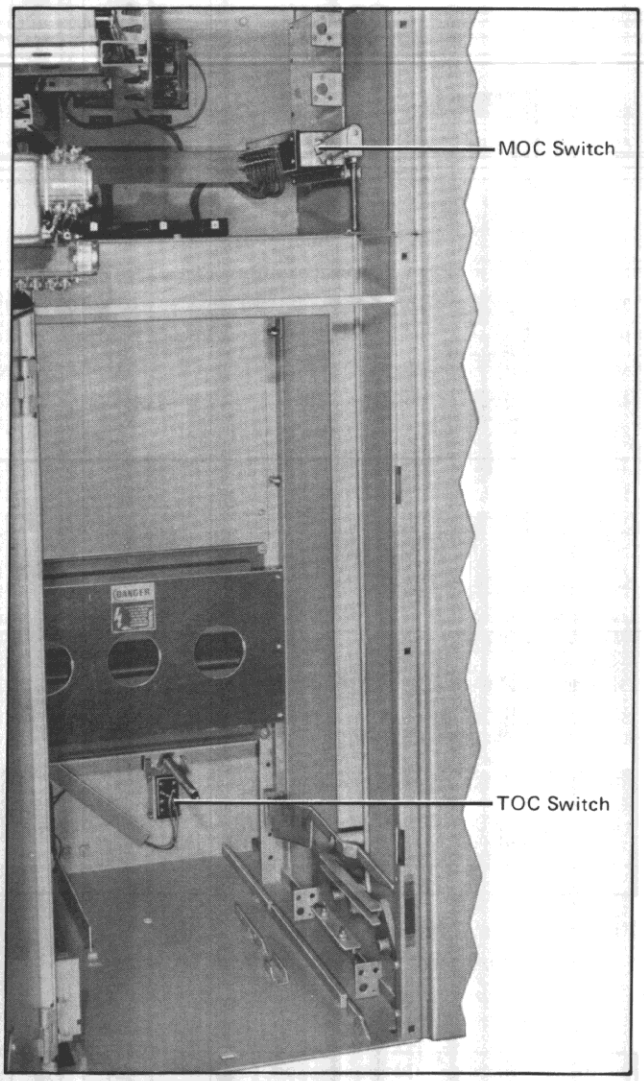


Fig. 23 *Indoor 50DHP250 Circuit Breaker Housing with MOC and TOC Switches (393174)*

1.22 TRUCK-OPERATED CELL SWITCH (TOC SWITCH)

The TOC switch is an assembly of one, two or three 4-pole switches. Each switch has two make and two break contacts. The TOC switch is mounted at the rear of the breaker module. It is operated by a lever mounted on the levering-in screw assembly and this lever is, in turn, actuated by the breaker frame when the breaker is levered into the connected position. As a result, the TOC switch can be used to electrically indicate whether or not the breaker is in the connected position. See Fig. 23.

1.23 BREAKER POSITION INTERLOCK

The breaker position interlock is a device to prevent putting the breaker into the test position. It stops the breaker before the levering-in device can be engaged. Thus when the breaker position interlock is operative, the breaker cannot be put into the test position.

The breaker position interlock is a mechanical, manually operated assembly mounted on the lower right hand side of the breaker module. The main part of the assembly is a formed round bar which is spring retained in the unlocked position. This bar may be rotated into a notch in the guide rail and held in place by means of a padlock or a key interlock thus effectively locking the breaker out of the test position. Figure 24 shows the interlock in the unlocked position while Fig. 25 simulates its position if it were padlocked. Figures 24 and 25, which are closeups, show the position interlock in the unlocked and locked positions using a key interlock. Note that the interlock key is held in the unlocked position but is removable in the locked position.

1.24 SECONDARY DISCONNECTING CONTACTS

The control wiring is arranged for drawout disconnecting by means of a 15-point female receptacle in the cell arranged to connect to a male plug on the rear of the breaker. The female receptacle has a floating mounting and is located in the left rear of the breaker module near the floor. See Fig. 26.

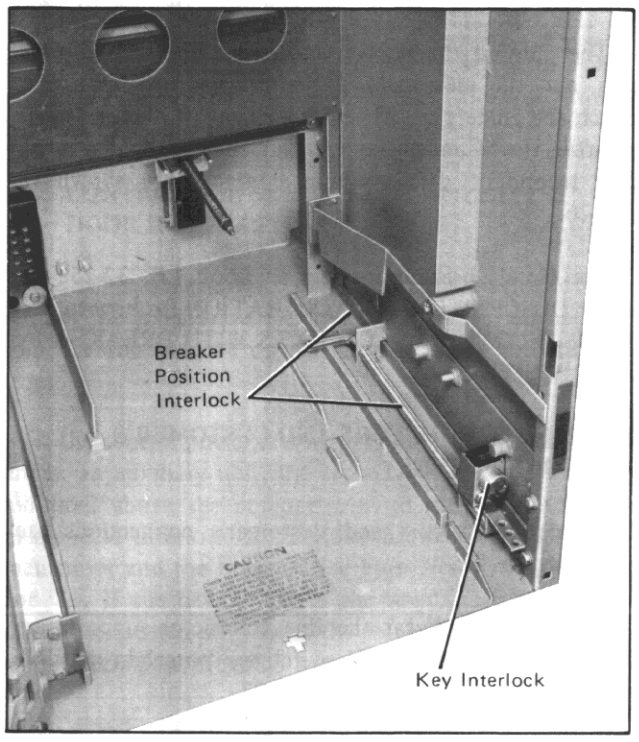


Fig. 24 *Breaker Position Interlock-Unlocked Position (376474)*

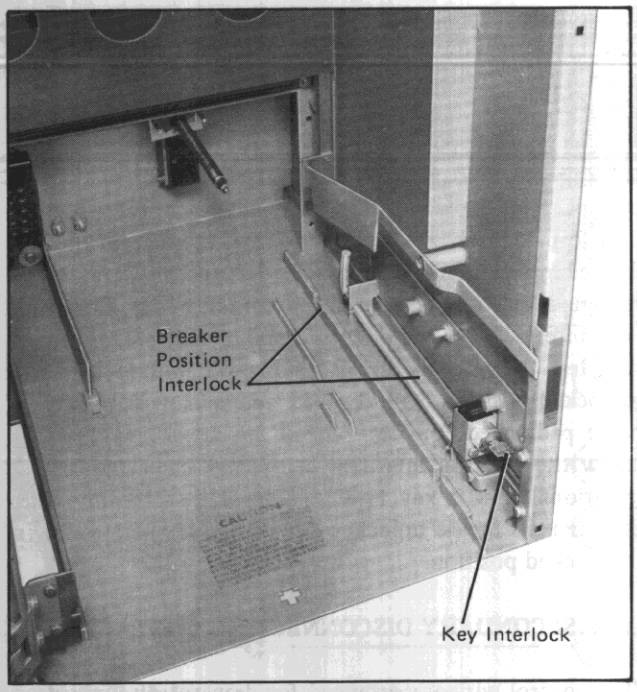


Fig. 25 *Breaker Position Interlock-Locked Position (376476)*

The secondary disconnecting contacts are the connections for the control leads between the removable breaker and the stationary housing.

The plug on the breaker has two different size guide pins, and the receptacle in the cell has two holes that match the guide pins. This arrangement of pins and holes polarizes the secondary contacts and aids in aligning them. The secondary disconnecting contacts are shown in Fig. 26.

See circuit breaker instruction book I.B. 32-253-4A under DESCRIPTION AND OPERATION for how to ENGAGE SECONDARY CONTACTS WITH BREAKER IN TEST POSITION.

1.25 LINE CONDUCTORS AND CUSTOMER'S CONNECTIONS

The line conductors and customer's connections are shown in Fig. 27.

In 5 kV switchgear the line conductor supports are glass polyester. In 15 kV switchgear porcelain standoff supports are used as shown in Fig. 27.

Space is available in the line module for the customer's primary connections and ground connections. Fig. 27 shows solderless cable terminals. However, the line mod-

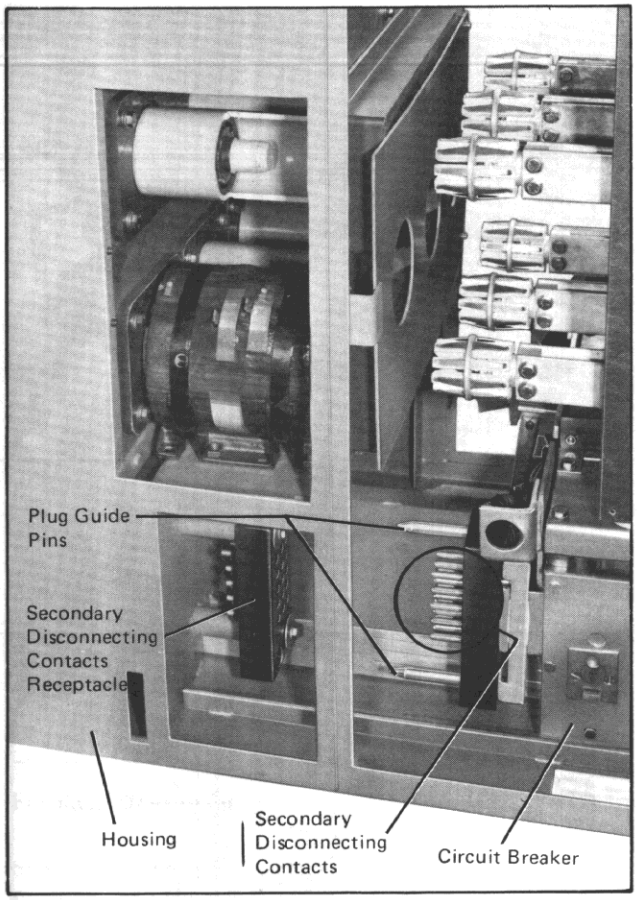


Fig. 26 *Circuit Breaker 50DHP250 in Housing: Disconnected Position Showing Secondary Disconnecting Contacts (393306)*

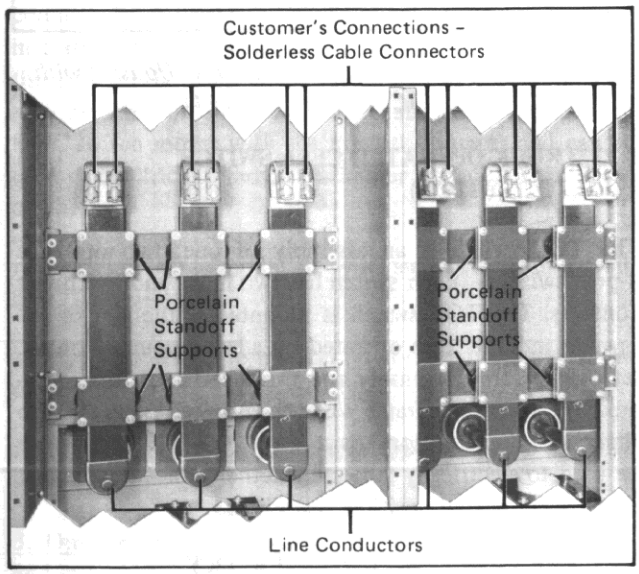


Fig. 27 *15 KV Line Conductors and Customer's Connections, Solderless Cable Connectors, Porcelain Standoff Supports*

ule, depending upon requirements, may be equipped with potheads, connections to a bus run, etc.

Customer's connections must be insulated after cables or other devices are installed. See taping drawings 3706A97 and 3706A98.

1.26 DISCONNECTING TRANSFORMERS

Disconnecting potential and control power transformers up to 15 KVA, single phase, are enclosed within their own compartments. They are mounted on a cradle which is linked to the door of the compartment. When the door is closed, both the primary and secondary disconnecting contacts are engaged. When the door is opened, the cradle and transformers are automatically rotated about a horizontal axis disconnecting both the primary and secondary contacts, and grounding the fuses and the high voltage winding of the transformers. A shutter comes down to block access to the primary contacts, and a catch secures the door in the open position. In this position the fuses may be readily removed. Figure 28 show a 5 kV potential transformer compartment mounted in an upper rear module. It is accessible from the front of the switchgear unit in type 50DHP75 and 50DHP250 Metal-Clad switchgear. In all other ratings where transformers are located in the upper rear module of a breaker unit, the transformers are accessible from the rear of the unit and the main power cables must exit from the bottom of the unit.

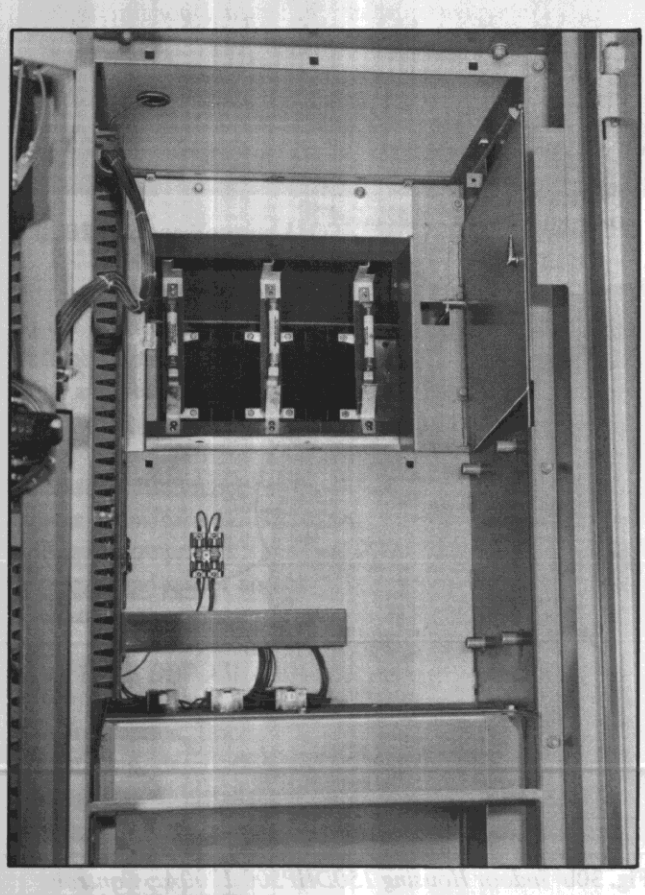


Fig. 28 *Aisle-less 50DHP250 Housing: 5 KV Disconnecting Potential Transformer with Door Open (393186)*

The control power transformer door is interlocked with a secondary disconnecting device. See Control Power Transformer Door Interlock below.

1.27 DISCONNECTING FUSES

When load conditions require a control power transformer larger than 15 KVA single phase, it is fixed mounted in some convenient location, usually an auxiliary unit, in the switchgear line-up and fuses are mounted in their own compartment as close to the transformer as is convenient. The fuses are mounted upon an insulating plate which is fabricated to form a cradle which is in turn linked to the compartment side-hinged door. With the door closed the primary disconnecting contacts are engaged. Upon opening the door the cradle and fuse assembly is automatically rotated around a horizontal axis; the primary contacts are disconnected; and both ends of the fuses are grounded. A catch secures the door in the open position. In this position the fuses may be readily removed. Generally fuse compartments are in an auxiliary housing.

The fuse compartment door is interlocked with a CPT secondary disconnecting device. See Control Power Transformer Door Interlock below.

1.28 CONTROL POWER TRANSFORMER DOOR INTERLOCK

A control power transformer door interlock is provided to require the transformer secondary breaker be opened before the door can be opened to disconnect the primary fuses.

If the control power transformer or disconnecting fuses are in an auxiliary unit, the secondary breaker is usually mounted above the compartment in such a way that a mechanical interlock is provided between the compartment door and the breaker. See Figs. 29a, 29b, 30a, 30b and 31. If the devices are in the upper rear module or otherwise located away from the secondary breaker, a key type interlock is provided to perform the same function.

1.29 MISCELLANEOUS EQUIPMENT

Depending upon customer specifications additional equipment may be furnished. Generally this equipment will be

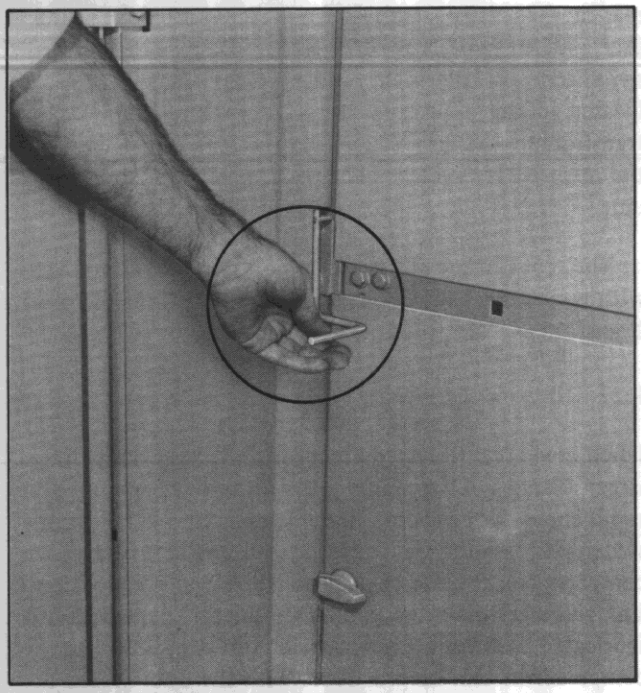


Fig. 29a *Indoor Housing 150DHP500 1200A: Control Power Transformer Mechanical Door Interlock in Down Position; Blocks Opening of CPT Door (393009)*

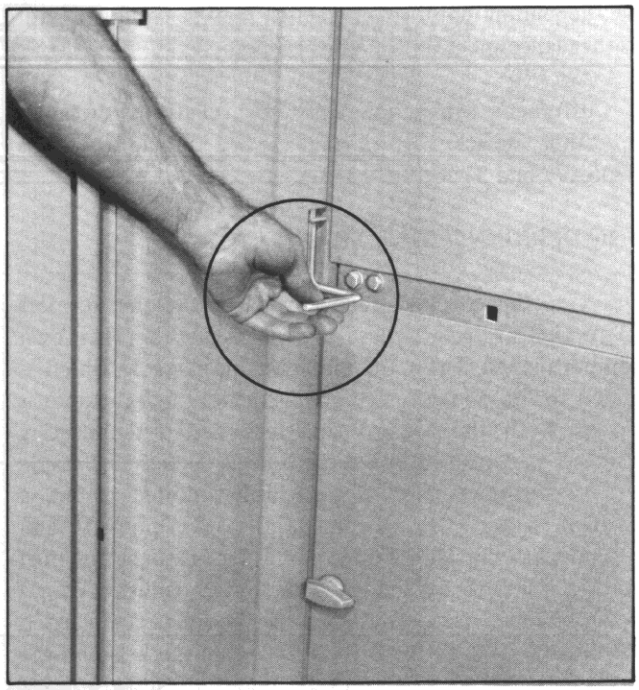


Fig. 30a *Indoor Housing 150DHP500 1200A: Control Power Transformer Mechanical Door Interlock in Up Position; Permits Opening of CPT Door (393007)*

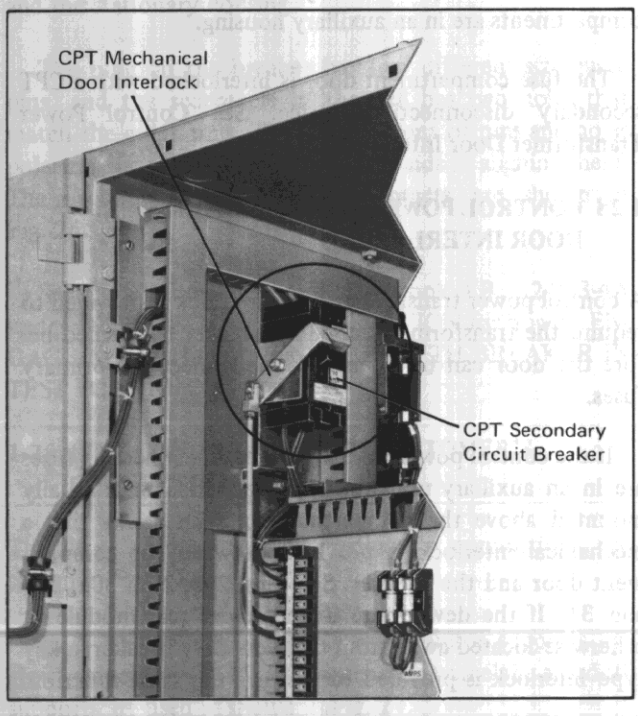


Fig. 29b *Indoor Housing 150DHP500 1200A: Control Power Transformer Mechanical Door Interlock in Down Position; Permits Closing of Circuit Breaker (393012)*

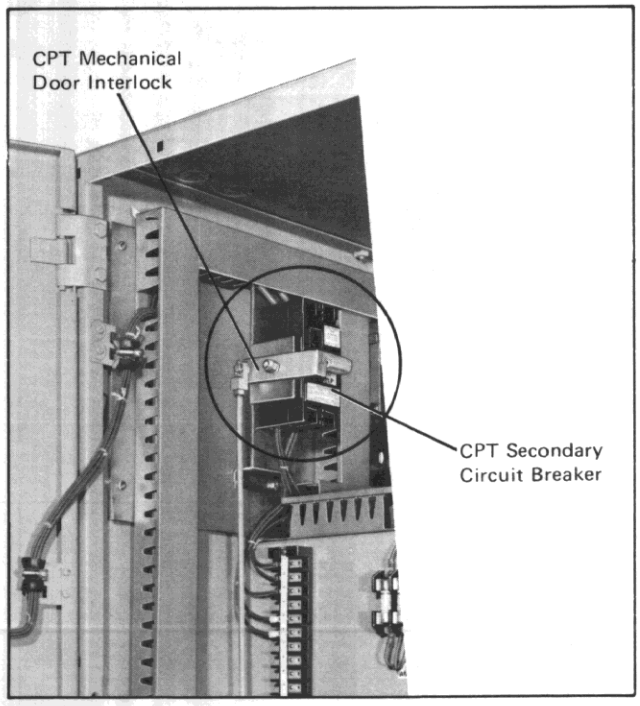


Fig. 30b *Indoor Housing 150DHP500 1200A: Control Power Transformer Mechanical Door Interlock in Up Position; Blocks Closing of CPT Secondary Circuit Breaker*

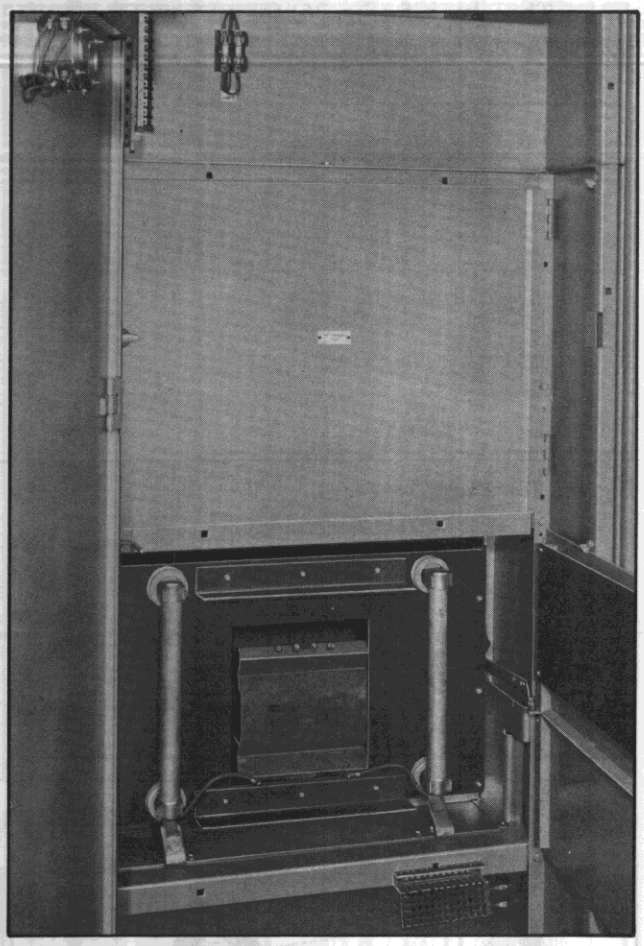


Fig. 31 *Indoor Housing 150DHP500 1200A: Control Power Transformer Door Open (393022)*

in its own compartment and, if it is connected to high voltage circuits, it will be isolated from other major circuits and personnel by grounded metal barriers and covers. Some of the various types of optional high voltage equipment are: lightning arresters, surge capacitors, gang-operated disconnect switches, and stationary control power transformers. Some examples of additional low voltage equipment are: tripping batteries, battery chargers, and motor and generator field control apparatus. Field control equipment is shown in Fig. 32.

1.30 TYPE DHP AIR CIRCUIT BREAKER

See Instruction Book 32-253-4A for receiving, handling and storing, description and operation, initial inspection and operation, installation, adjustments, maintenance, circuit breaker data, and renewal parts.

1.31 ACCESSORIES

Each new Porcel-line switchgear installation is provided with a set of accessories. Depending upon customer's specifications and the nature of the installation, the accessories will include one or more of the following:

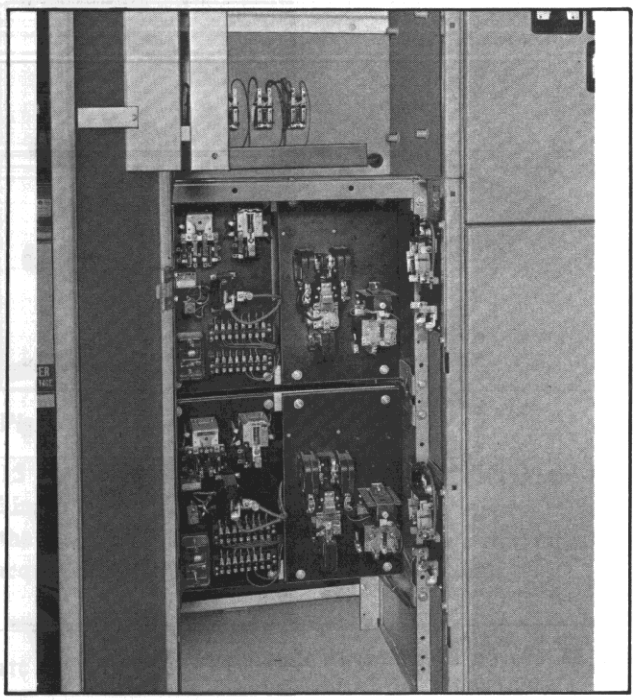


Fig. 32 *Indoor and Outdoor Housing: Field Control Equipment (376478)*

1.31.1 **A MAINTENANCE HANDLE**, Fig. 33 is used for manually closing the circuit breaker outside the housing. It also is to be used for maintenance and inspection of the breaker contacts and mechanism. There is an interference bar welded to the handle to prevent its use for closing the breaker when the breaker is in the housing.

Warning: **THE BREAKER MUST NEVER BE SLOW CLOSED WHILE IN THE HOUSING. FAILURE TO DO SO COULD RESULT IN BODILY INJURY AND/OR EQUIPMENT DAMAGE. DO NOT REMOVE THE INTERFERENCE BAR FROM THE MAINTENANCE HANDLE.**

The maintenance handle is also used to manually charge the breaker closing spring. It may be used this way for maintenance or in an emergency if the electrical charging source should fail.

See breaker I.B. 32-253-4A for details of use of the maintenance handle.

1.31.2 **A LEVERING-IN CRANK** (Fig. 34) for moving the breaker between the test and connected positions. This crank is used for rotating the levering-in nut which is a part of the breaker.

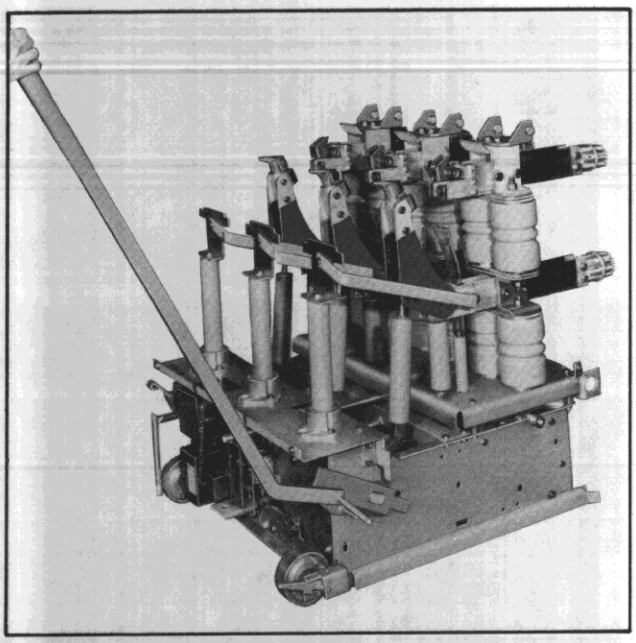


Fig. 33 *Closing Breaker with Maintenance Handle (391368)*

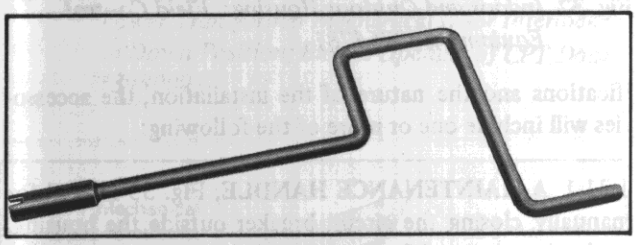


Fig. 34 *Levering-in Crank (376453)*

1.31.3 **A SPANNER NUT WRENCH** (Fig. 35) for removing, replacing, or checking tightness of the main contact in its porcelain support (or bottle). WARNING: DO NOT USE WHEN MAIN CONTACTS ARE ENERGIZED. TO DO SO COULD RESULT IN BODILY INJURY OR ELECTROCUTION. WHEN ENERGIZED, MAIN CONTACTS CARRY LETHAL HIGH VOLTAGES.

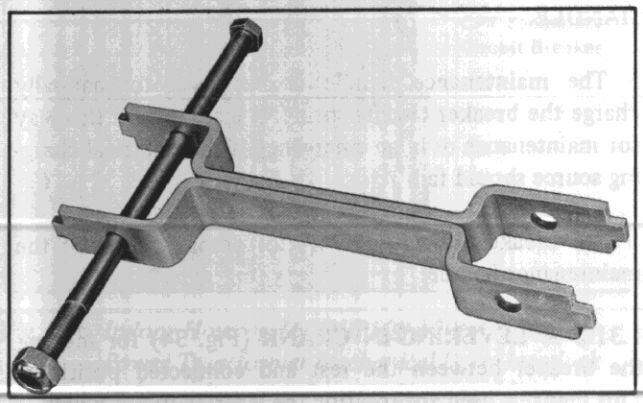


Fig. 35 *Spanner Nut Wrench (376449)*

1.31.4 **TEST PLUGS** (Fig. 36) for use with Flexitest relays and meters.

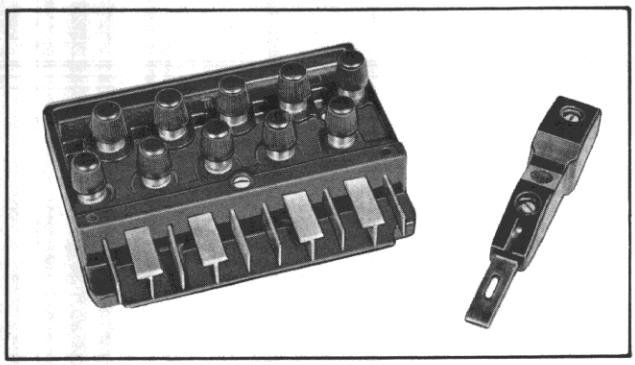


Fig. 36 *Test Plugs (376448)*

1.31.5 **A TEST CABLE** (Fig. 37) is furnished with indoor or outdoor installations for electrically operating the breaker while out of its housing. One end is a plug that connects into the secondary disconnect contacts in the breaker module while the other end is a socket that engages the secondary disconnect contacts on the breaker itself.

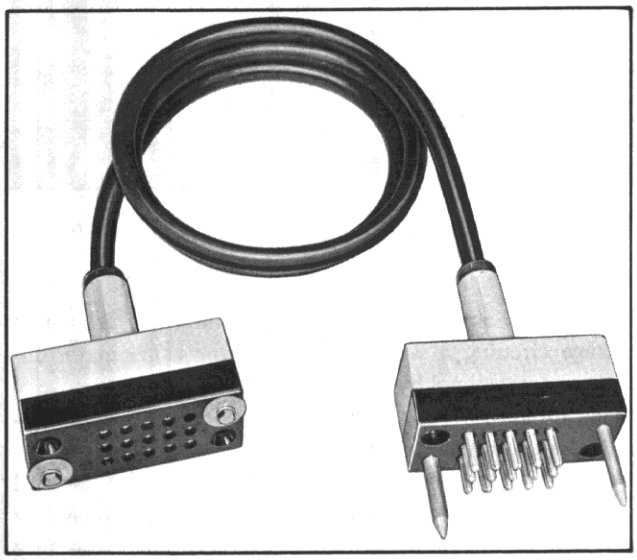


Fig. 37 *Test Cable (376447)*

1.31.6 **A TURNING DOLLY** (Fig. 38) is furnished with indoor and Shelterfor-M installations to facilitate turning the breaker when it is outside the housing. It is not to be used to insert or remove the breaker from the housing. Using the turning dolly this way could cause the floor trippers to not function properly or it could cause the MOC switch operating pin on the breaker to not properly engage the pantograph in the cell.

1.31.7 **A TRANSPORT TRUCK** (Fig. 39) is furnished with outdoor Aisle-less installations to facilitate handling

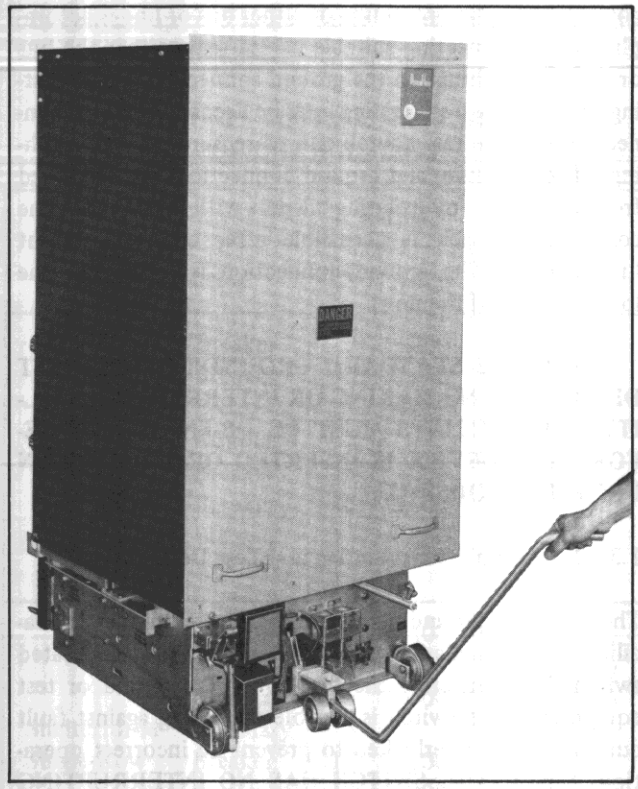


Fig. 38 *Using Turning Dolly (391371)*

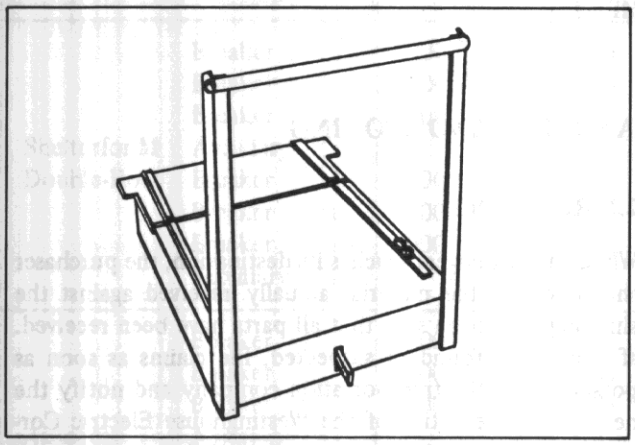


Fig. 39 *Transport Truck*

breaker when it is outside of the housing. The floor of the truck is the same height as the floor of the outdoor Aisle-less switchgear. The truck height automatically compensates for some variations in the customer's concrete pad up to plus or minus 1/4 inch. The transport truck must be aligned and secured to the Aisle-less base when removing or inserting the breaker. In addition, the breaker must be secured to the transport truck during transportation.

1.31.8 **AN ARC CHUTE LIFTER** (Fig. 40) assists in tilting back the arc chutes on the 50DHP350 and all 8.25 and

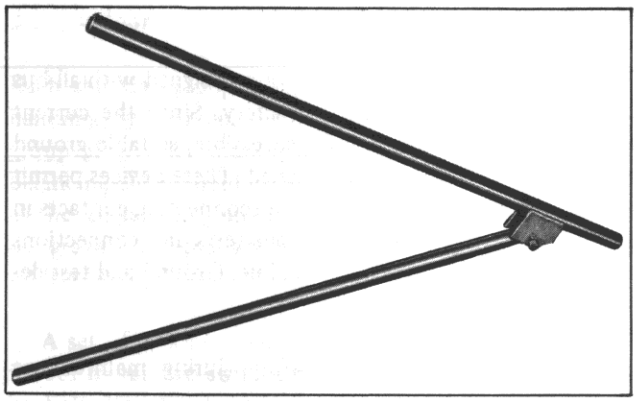


Fig. 40 *Arc Chute Lifter (376450)*

15 kV type DHP air circuit breakers. In addition, the hinged leg of the lifter serves as a brace or support to hold the arc chutes in the tilted position. No arc chute lifter is required for 50DHP75 and 50DHP250 breakers.

Refer to breaker I.B. 32-253-4A for details of use of arc chute lifters.

1.32 OPTIONAL ACCESSORIES

1.32.1 **A TEST CABINET** (Fig. 41) for electrically operating the breaker when it is out of its housing. The cabinet includes control power connections, a cutoff switch, necessary control equipment, and a cable which has one end connected to terminals in the test cabinet. The other end of the cable is a socket that connects into the secondary disconnect contacts on the breaker itself.

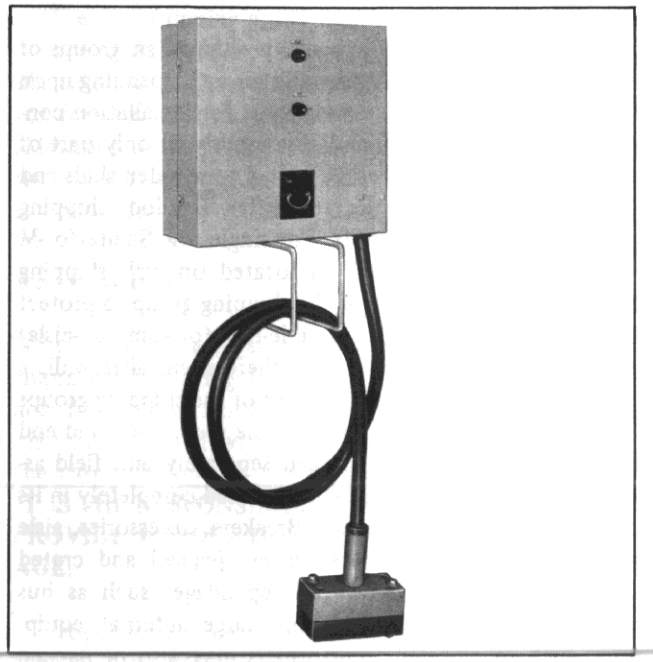


Fig. 41 *Test Cabinet (376456)*

1.32.2 Ground and Test Devices

Metal-clad switchgear assemblies are designed with all bus work completely insulated for safety. Since the current carrying parts are not readily accessible, suitable ground and test devices have been designed. These devices permit access to the stationary primary disconnecting contacts in the housing and thus allow various tests and connections to either the bus or the outgoing line. Ground and test devices provide for:

a. Grounding a circuit for safety during maintenance work.

b. Application of potential for cable testing.

c. Access to both bus and line circuits for "phasing out" tests.

d. A variety of other tests which the user might require.

1.32.2.1 Standard Grounding and Test Device

The standard grounding and test device consists of a drawout element that is inserted into the air circuit breaker housing in the same manner as the drawout air circuit breaker element. The device includes six insulated bushings arranged with isolating barriers and ground bus connections. The grounding of either bus or line is accomplished by connecting suitable cables from either the bus or the line bushings to the ground connection. Cable testing or "phasing out" testing may be accomplished by connecting suitable test equipment, as required, to the bushings. The bus, line, and ground connections are separated from each other by isolating barriers with the bus and line connections. Each is accessible after opening a front hinged door. The ground connection is located in the lower section of the unit.

SINCE THE STANDARD GROUNDING AND TEST DEVICE HAS NO MAKING OR INTERRUPTING ABILITY, THE CIRCUITS MUST BE DE-ENERGIZED BEFORE THE DEVICE IS INSERTED OR WITHDRAWN FROM THE HOUSING.

1.32.2.2 Complete Grounding and Test Device

The complete grounding and test device combines the facility of the standard device with an electrically operated switch for connecting the test circuit to ground or test equipment. The switch is capable of closing against fault current and is interlocked to prevent an incorrect operation. **SINCE THE SWITCH HAS NO INTERRUPTING ABILITY, FAULTS MUST BE CLEARED BY AN INTERRUPTER ON THE SOURCE SIDE OF THE EQUIPMENT.**

SECTION 2 – RECEIVING, HANDLING AND STORING

Porcel-line metal-clad switchgear is shipped in groups of one or more housings. A shipping group, depending upon the number of units, the weight, or for installation convenience, may be the complete assembly or only part of it. Indoor shipping groups are bolted to wooden skids and shipped by weather protected carrier. Outdoor shipping groups do not require skids. For single-row Shelterfor-M installations the aisle wall is located on wall shipping brackets across the front of the shipping group to protect the instrument panels. For double-row (or common-aisle) Shelterfor-M installations, since there is no aisle wall, a covering is located across the front of the shipping groups to protect the instrument panels. The roof, floor, and end sections of the aisle are shipped separately and field assembled. Aisle-less switchgear is enclosed completely in its own weather-proof enclosure. Breakers, accessories, aisle parts, and installation materials are packed and crated separately from the housings. Appendages such as bus runs, synchronizing panels, and large internal equipment such as oil-filled transformers may also be packed and crated separately.

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. If damage is found or suspected, file claims as soon as possible with the transportation company and notify the nearest representative of the 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.

2.2 HANDLING

Because of size limitations, weight limitations or for installation convenience, a metal-clad switchgear line-up may be divided into two or more shipping groups. A 5 kV indoor, Shelterfor-M or aisle-less shipping group can be made up of up to 7 units. A 8.25 or 15 kV shipping group

can contain up to 5 units. Table 1 gives the approximate weights of DHP housings.

TABLE NO. 1 – APPROXIMATE WEIGHTS OF DHP HOUSINGS

Type of Housing		Rating kV	Rating Amps	Weight (Lbs.)	(1)
Indoor	Breaker	5	1200	1600	
	Breaker	5	2000	1800	
	Breaker	5	3000	2400	
	Auxiliary	5		2200	
	Breaker	15	1200	2000	
	Breaker	15	2000	2200	
	Breaker	15	3000	2400	
	Auxiliary	15		2800	
Shelterfor-M Single-Row	Breaker	5	1200	2150	(2)
	Breaker	5	2000	2350	(2)
	Breaker	5	3000	3100	(2)
	Auxiliary	5		2750	(2)
	Breaker	15	1200	2700	(2)
	Breaker	15	2000	2900	(2)
	Breaker	15	3000	3100	(2)
	Auxiliary	15		3500	(2)
Shelterfor-M Double-Row	Breaker	5	1200	4000	(3)
	Breaker	5	2000	4400	(3)
	Breaker	5	3000	5800	(3)
	Auxiliary	5		5200	(3)
	Breaker	15	1200	5000	(3)
	Breaker	15	2000	5400	(3)
	Breaker	15	3000	5800	(3)
	Auxiliary	15		6600	(3)
Aisle-less	Breaker	5	1200	1950	(4)
	Breaker	5	2000	2150	(4)
	Breaker	5	3000	2800	(4)
	Auxiliary	5		2550	(4)
	Breaker	15	1200	2400	(4)
	Breaker	15	2000	2600	(4)
	Breaker	15	3000	2800	(4)
	Auxiliary	15		3200	(4)

Notes: **(1) Does not include breaker weight for breaker weight, see I.B. 32-253-4A**
(2) Includes One Indoor Housing Plus Weatherproofing Plus Aisle.
(3) Includes Two Indoor Housings Plus Weatherproofing Plus Aisle.
(4) Includes One Indoor Housing Plus Weatherproofing.

2.2.1 Indoor

Each shipping group is equipped with a lifting angle for handling by a crane. Figure 42 shows a typical shipping group of 4.76 kV indoor housings with its lifting angle. A balancing chain should be added as shown by dotted lines as the single lifting angle is located slightly off the center of gravity of the group. See drawings 503B550 and 437B432.

A set of jacking angles is furnished with each order of indoor metal-clad switchgear. During installation they can be bolted to the lower set of tie bolt holes as shown in Fig. 42 to make a jack support for removing skids and lowering the group to the floor.

It is preferable to lift the groups into position by a crane. However, if no crane is available they can be skidded into place on rollers. See Handling and Installation Instruction drawing 437B432 shipped with the equipment.

2.2.2 Outdoor

Each group of Shelterfor-M or Aisle-less switchgear is equipped with lifting lugs for slings or hooks and spreaders as shown in Fig. 43. THE SPREADERS MUST BE USED TO PREVENT THE POSSIBILITY OF UPSETTING THE GROUP WHEN IT IS LIFTED. THE SPREADER MUST NOT BE USED ALONE FOR LIFTING.

The first shipping group may be lifted into position by a crane or skidded into place on rollers. Timbers should be placed between the outdoor base channels and the rollers for front to back movement; no timbers are required for sidewise movement. Jacks may be placed under the lifting lugs of the first group. See handling and installation instruction drawing 503B954 shipped with the equipment.

2.3 STORING

Westinghouse packages switchgear for protection during shipment. Packaging for shipment is not necessarily suitable for storage. Moreover, part of the original packaging may be discarded when the switchgear is removed from the carrier or opened for the initial receiving inspection. **IT IS THE RESPONSIBILITY OF THE PURCHASER TO PROVIDE ADEQUATE PROTECTION DURING STORAGE.**

Proper storage must protect the switchgear from moisture, contamination, and physical damage. This protection must be accomplished with proper:

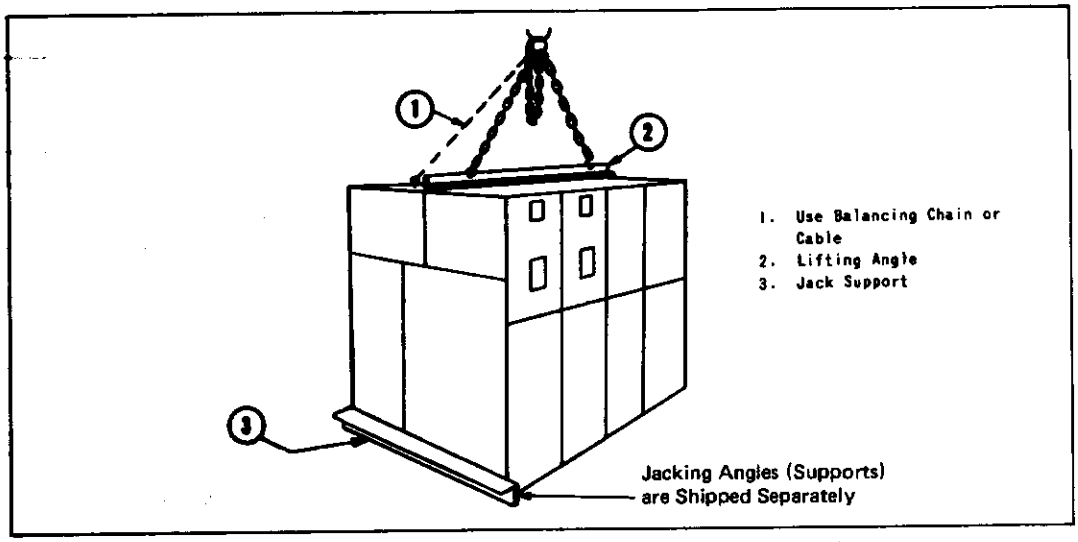


Fig. 42 *Handling of Indoor Shipping Group*

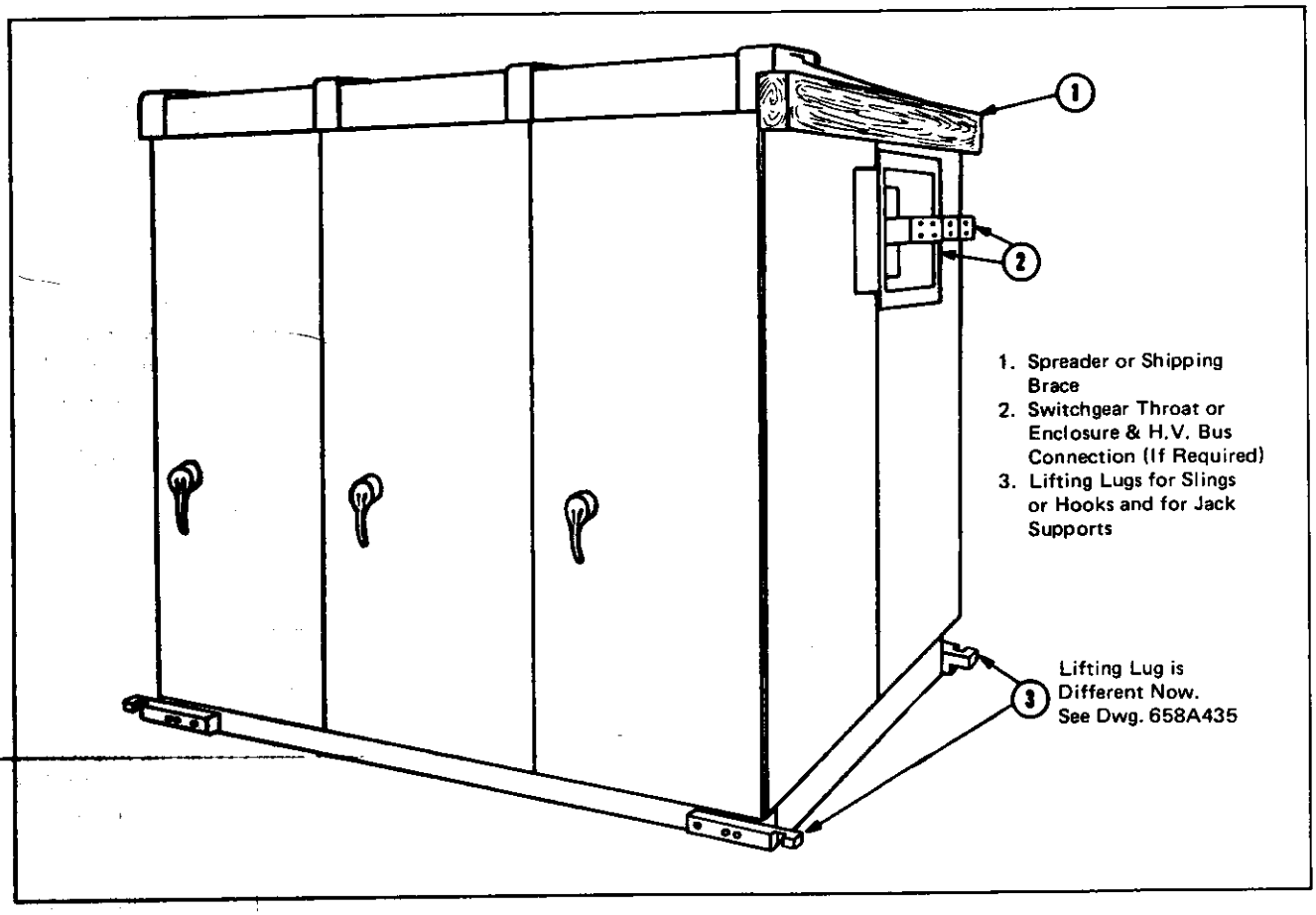


Fig. 43 *Handling of Outdoor Shipping Group*

a. Ventilation

b. Heat

c. Supporting Foundation

d. Shelter

2.3.1 Ventilation

To prevent moisture condensation, ventilating air must be provided through and around the switchgear.

2.3.2 Heat

To prevent moisture condensation, heat may be required depending on the shelter, rate of temperature change, extremes of temperature change, humidity, etc., in the locality. When in doubt, heat is recommended.

2.3.3 Supporting Foundation

To prevent distortion and stress in the switchgear, the foundation of the storage area must be reasonably true and flat.

To minimize the effects of ground temperature and moisture and to permit air circulation, it may be advisable to place the switchgear on supports to elevate it above ground level. **THE FOUNDATION MUST BE WELL DRAINED AND STANDING WATER MUST BE AVOIDED.**

2.3.4 Shelter

To properly protect the switchgear during storage, the shelter should provide protection against rain, snow, wind, dust, dirt, drippings, moving vehicles, local construction, etc. The shelter must incorporate the ventilation, heat, and supporting foundation features already described.

FOR DETAILED STORAGE INSTRUCTIONS REFER TO WESTINGHOUSE SWITCHGEAR STORAGE INSTRUCTIONS DRAWING 437B600, A COPY OF WHICH IS ATTACHED TO EACH SWITCHGEAR SHIPPING GROUP.

2.4 MISCELLANEOUS EQUIPMENT

There may be other equipment besides switchgear which will require special attention. (For example: storage batteries.) **THE DESCRIPTIVE MATERIAL SUPPLIED WITH THE EQUIPMENT OR ELSEWHERE IN THE COMPLETE INSTRUCTION BOOK SHOULD BE CAREFULLY FOLLOWED IN RECEIVING, HANDLING, OR STORING.**

SECTION 3 – INSTALLATION

3.1 INSTALLATION AND ASSEMBLY DRAWINGS

Proper installation of Westinghouse Porcel-line metal-clad switchgear is of prime importance. Too much emphasis cannot be placed upon this operation. For this reason, and to assist the customer's installation, Westinghouse has prepared a series of standard installation and field assembly drawings. One or more of these standard drawings is supplied on each shop order in addition to the shop order assembly drawings. The standard installation and field assembly drawings will be referred to extensively in the text of this section. Following is a tabulation and description of them:

3710A82 – Installation Data
505A863 – Floor Plan
} 50DHP75/250 - Indoor

3711A39 – Installation Data
801A985 – Floor Plan
801A986 – Floor Plan
} 50DHP250 with 50DHP350 - Indoor

3710A79 – Installation Data
799A803 – Floor Plan
} 50DHP350 - Indoor

3708A86 – Installation Data
505A864 – Floor Plan
} 75/150DHP500 - Indoor

3708A85 – Installation Data
806A686 – Floor Plan
} 150DHP750C/1000 - Indoor

508A050 – Typical Foundation - All ratings - Shelterfor-M

508A051 – Base Plan - 50DHP75/250 - Shelterfor-M

799A806 – Base Plan - 50DHP250 with 50DHP350 and 50DHP350 - Shelterfor-M

508A052 – Base Plan - 75/150DHP500 - Shelterfor-M

3700A78 – Base Plan - 150DHP750C/1000 - Shelterfor-M

508A061 – Base Plan - 50DHP75/250 - Aisle-less

799A811 – Base Plan - 50DHP250 with 50DHP350 and 50DHP350 - Aisle-less

508A062 – Base Plan - 75/150DHP500 - Aisle-less

3701A12 – Base Plan - 150DHP750C/1000 - Aisle-less

509A796 – 5 kV, 781A748 – 15 kV } Aisle Section Assembly - Shelterfor-M

509A797 – 5 kV, 781A764 – 15 kV } Aisle End Assembly - Shelterfor-M (Single Row)

509A798 – 5 kV, 781A749 – 15 kV } Aisle End Assembly - Shelterfor-M (Double Row)

509A799 – 5 kV, 781A753 – 15 kV } Aisle Light Assembly - Shelterfor-M

509A800 – 5 kV, 781A750 – 15 kV } Roof End Trim Assembly - Aisle-less

3614A95 – Terminal Boot Installation

663A003 – Boot Assembly Installation

800A501 – 5 kV, 800A502 – 15 kV } Bus Support Installation

3706A97 – Field Taping Procedure

3706A98 – Field Taping Illustrations

437B432 – Indoor Handling and Installation Instruction

503B954 – Outdoor Handling and Installation Instruction

781A691 – Switchgear Throat Sealing Ring

3.2 FOUNDATION: GENERAL

The foundation upon which the switchgear is to be mounted may be a concrete floor, pad, footers, or pillars depending upon the type of gear. It must have sufficient strength to withstand the weight of the structure and the weight of the breaker, plus the shock or impact resulting when circuit breakers open under short circuit conditions. Table No. 1 tabulates the approximate dead weights for the various ratings of indoor and outdoor switchgear units only. See I.B. 32-253-4A for weights of DHP breakers. The shock or impact weight is 1.5 times the weight of the breaker.

Actual weights will vary depending upon the amount of equipment in the individual housings. Adequate safety factors must be used.

3.3 FOUNDATION: INDOOR

Careful preparation of the foundation is important for simplicity of erection, ease of operation, and good performance. The foundation should consist of steel channels imbedded in a level concrete floor. The steel channels must be in a true, flat and level plane within the limits of 1/8 inch in 3 feet in any direction. The non-supporting areas of the foundation MUST NOT PROJECT ABOVE THE LEVEL OF THE SUPPORTING FLOOR CHANNEL STEEL.

Special attention should also be paid to the accurate leveling of the floor adjacent to the housings on the breaker drawout side since the convenience and speed of insertion or removal of the circuit breaker elements will be facilitated by a smooth hard floor surface.

Standard drawings 505A863, 505A864, 801A985, 801A986, 799A803, and 806A686 show the recommended method of installing the floor channel steel. Welding the floor steel to the channels is preferred over bolting since it eliminates the need for accurate lining up of bolts.

When installing metal-clad switchgear on existing floors, it is recommended that a new finish floor with embedded channels be poured or slots be cut in the floor for embedding and leveling the supporting channels.

3.4 FOUNDATION: OUTDOOR

Outdoor switchgear has an integral base frame of steel channels. Therefore, it is only necessary to install a suitable foundation upon which to bolt down the switchgear. The foundation for Shelterfor-M may be a simple concrete pad, footers, or pillars as shown on Drawing 508A050. The recommended foundation for Aisle-less switchgear is a full concrete pad under the assembly extending to the front of it for breaker drawout area. The Aisle-less foundation also could be footers or pillars but a breaker drawout pad would still be required.

Foundation bolting details are similar for Shelterfor-M or Aisle-less switchgear and are shown on standard drawings 508A051, 508A052, 508A061, and 508A062.

3.5 FLOOR PLAN AND CONDUIT LAYOUT

Provisions must be made in the foundation for the conduits which carry the main cables, control wiring, and ground cable when these conduits enter the switchgear from below. A floor plan or base plan drawing is furnished for each metal-clad switchgear shop order. This shop order drawing must be used for determining the final conduit layout, spacing of floor channels, and floor space required for each metal-clad switchgear structure.

Conduits should project above the finished floor approximately two inches for indoor switchgear and approximately 8 inches above the foundation for outdoor switchgear. It will simplify moving the groups into place if the conduits are approximately flush with the concrete, and extension conduits are added after the units are in their final location. Otherwise, it will be necessary to raise the units on timbers a sufficient height for the pipe rollers to clear the tops of the conduits.

If more than one control conduit is required per housing, they must be aligned in the space allotted for them on the floor plan. It is desirable to provide a blocked out slot in the floor or to provide clearance holes around the secondary conduits so that minor bending of the conduits can be made when the switchgear is installed. The space available for the conduits is quite limited and minor bending of the conduits is sometimes necessary to correct for errors in locating the conduits and for accumulated positive tolerances in long switchgear assemblies.

Standard drawings 505A863, 505A864, 508A051, 508A052, 508A061, and 508A062 show typical floor plans and tables of dimensions for the various ratings of metal-clad switchgear. These drawings are for standard units and may be used for preliminary layouts or for planning future additions. *For final layouts, only the properly identified floor plan or base plan supplied by the factory should be used.*

Encircling loops of reinforcing or building steel around single phase conductors rated 600 amps or more should be avoided to prevent overheating due to induced currents.

3.6 SHIPPING GROUPS

Because of size or weight limitations, or for installation convenience, a metal-clad switchgear assembly may be divided into two or more shipping groups. The following recommendations and general order of operations will assist in the installation of the metal-clad shipping groups.

1. Remove crating and packing material from the groups to be erected. The skids should not be removed from indoor groups if rollers are to be used. For single-row Shelterfor-M installations remove and set aside the aisle wall with attached base channel from across the front of the shipping group and discard wall shipping brackets. For double-row Shelterfor-M installations remove the protective covering from across the front of the shipping group.

2. When three or more shipping groups of the switchgear are to be arranged in one continuous assembly, **THE CENTER SHIPPING GROUP SHOULD BE INSTALLED FIRST.** The other shipping groups should then be installed in each direction from the center of the line-up.

When installing a unit substation or power center which includes metal-clad switchgear, the power transformer and the adjacent metal-clad group should first be lined up and set in position in accordance with the dimensions on the base plan drawing for the installation. Any additional groups should then be installed. (Also see section on POWER TRANSFORMER ENCLOSURES.)

3. Move the first group into position either by crane or by pipe rollers. (Refer to the section on HANDLING). The rollers, if used, should be high enough to allow the switchgear to pass over the conduits projecting above the floor. If main cables enter at the bottom of any of the outdoor groups, it will be necessary to remove the rear sheet and the rear floor sheet. As the bottom rear cable entrance compartment will then be completely open, the units may be moved over the projecting conduits.

4. Establish a base line a few inches in front of the group and parallel with the desired front of the structure. 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.

5. Using a level, check each housing both laterally and longitudinally. These checks should be made on the floor of the housing on the paths upon which the circuit breaker wheels travel. Using a plumb line, also check each housing for plumbness. If the housings are not level or plumb, it may be the result of poor leveling of the foundation members. Poor indoor foundation leveling may be corrected by inserting shims at the points where the individual housings are fastened to the floor steel channels. Poor outdoor foundation leveling may be corrected by inserting shims at the points where the integral base frame is fastened to the concrete foundation. As can be seen, level foundations are desirable since they automati-

cally produce true, level, and plumb switchgear installations. However, switchgear will operate satisfactorily on a true and flat foundation which has a uniform slope of no more than 1/8 inch in three feet. When installing switchgear housings on a foundation with a uniform slope, the floor of the housings should be parallel to the foundation and the vertical center line of the housings should be perpendicular to the floor.

6. Subsequent shipping groups should be moved into position and the procedure outlined in paragraphs 3, 4, and 5 for the first group should be repeated. The groups should then be bolted together with tie bolts and given a final check for levelness and plumbness. The complete installation should then be fastened to the foundation by bolting or welding.

7. For double row Shelterfor-M installations it is important that the groups facing one another be accurately spaced so that the aisle parts will fit properly. Refer to the shop order drawings for proper spacing.

8. All lifting angles, lugs, and shipping angles should be removed.

3.7 SHELTERFOR-M AISLE SECTION

After completing the installation of SHIPPING GROUPS as outlined, the Shelterfor-M Aisle Sections should be erected. Refer to standard drawing 509A796, 781A748 or 3702A11. Assemble parts in the order and in the numerical sequence shown on the standard drawing.

1. Aisle wall with attached base channel: Furnished for single row installations. Locate and level the wall assembly in relation to the previously installed shipping groups. Brace temporarily with 2 x 4's between the top of the wall and the main structure. *Loosen* (do not remove) bolts between adjacent wall sections and between wall sections and base channel.

2. Tie down clip (404): Use to secure wall base channel to foundation. *Tighten* bolts.

3. Floor plates (405, 406, 407): Set in place and bolt *tightly* to appropriate channels.

4. Floor filler (408): Furnished for installations without front extensions. Set in place.

5. Aisle roof (409): Remove temporary wooden braces and bolt on the individual roof sections *loosely*.

6. Aisle seam cover (410): Lock in place and *loosely* bolt down at rear.

7. Aisle seam cover cap (411): *Loosely* bolt on as shown.

8. Housing seam cover (412): Furnished for installations of more than one shipping group. Lock in place and *tightly* bolt down over each shipping break.

9. See Shelterfor-M Aisle Adjustment for final installation operations.

3.8 SHELTERFOR-M AISLE ENDS

After completing the assembly of the Shelterfor-M Aisle Section as outlined, the Shelterfor-M Aisle Ends should be erected. Refer to standard drawings 509A797 or 781A764 for single row installations and standard drawings 509A798 or 781A749 for double row installations. Assemble parts in the order and in the numerical sequence shown on the standard drawings.

1. Door and frame (416-417): *Loosely* bolt on as shown.

2. Aisle end filler (418-419): Furnished for single row installations. *Loosely* bolt on as shown.

3. Roof end trims (420-421-422-423): Lock in place and *loosely* bolt down.

4. See Shelterfor-M Aisle Adjustment for final installation operations.

3.9 SHELTERFOR-M AISLE ADJUSTMENT

After completing the assembly of the Shelterfor-M Aisle Section and Shelterfor-M Aisle Ends as outlined, the aisle should be adjusted and bolts tightened in a sequence to properly weatherproof the aisle. Always work from the aisle ends toward the middle wall sections or roof sections. Line up and adjust the relationship between the roof end trims, aisle end fillers, door frames, roof sections, and wall sections to eliminate gaps along the line between roof end trims and roof sections, and between aisle end fillers and wall sections.

As the relationships are being adjusted, proceed to tighten bolts in the following sequence:

1. Roof end trims
2. Aisle end fillers
3. Door frames
4. Roof and wall sections adjacent to end fillers
5. Intermediate roof and wall sections
6. Aisle seam covers and caps

3.10 SHELTERFOR-M AISLE LIGHTS

After completing the assembly and Adjustment of the Shelterfor-M Aisle Section and Ends as outlined, the Shelterfor-M aisle lights should be installed. Refer to standard drawing 509A799 or 781A753 and assemble parts in the order and in the numerical sequence shown on the standard drawing.

1. L.H. switch assembly (441): The two voltage source wires from the housing must first be run in their trough and connected to the unmounted L.H. switch assembly (to the latch side of the aisle door) in the vertical position shown. Run the wires vertically and lay them in their trough for connecting to the first light assembly in paragraph 2.

2. Light assembly (442): Bolt the assembly to the aisle roof laying the wires in the channels. Note that the light assembly closest to the L.H. switch assembly should have one wire removed. Match-up and connect wires between L.H. switch assembly and first light assembly and between adjacent light assemblies. The wires from the last light assembly should be connected to the R.H. switch assembly in paragraph 4.

3. Light assembly trim (444): Bolt on the light assembly trim (or channels) between adjacent light assemblies.

4. R.H. switch assembly (445): Bolt switch to the latch side of the aisle door in the vertical position shown. Run the wires vertically, lay them in their trough, match-up and connect to the wires from the last light assembly.

3.11 AISLE-LESS WEATHERPROOFING

After completing the installation of Shipping Groups as outlined, the Aisle-less weatherproofing parts should be assembled. Refer to the standard drawings indicated and assemble the parts as follows:

1. Housing seam cover and cap (411-412): Refer to drawings 509A796 or 781A748. For installations consisting of more than one shipping group, lock in place and bolt down seam cover over each shipping break. Then bolt on cap as shown.

2. Roof end trims (420-421): Refer to drawings 509A800 or 781A750. Lock in place over the housing end roof sections and bolt as shown.

3.12 POWER TRANSFORMER AND BUS RUN ENCLOSURE CONNECTIONS

Switchgear assemblies are frequently installed adjacent to power transformers to form Unit Substations or Power Centers. See paragraph #1 under installation of SHIPPING GROUPS. Switchgear also frequently ties into bus runs. In such cases, the connection to the transformer or bus run is a part of the installation or field assembly.

There are five general types of enclosure connections between switchgear and power transformers or bus run. A shop order drawing showing the assembly of these connections is normally included on the customer's drawing list.

1. Flange-less type: See Fig. 44C. This enclosure connection may be used for either indoor or outdoor installations. It is the most common type used. There are no flanges. A crimped and formed band is furnished for joining the mating enclosures. To install, align the mating enclosures, slide the band down from the top, and secure in place with bolts. Refer to standard drawing 3645A50. For

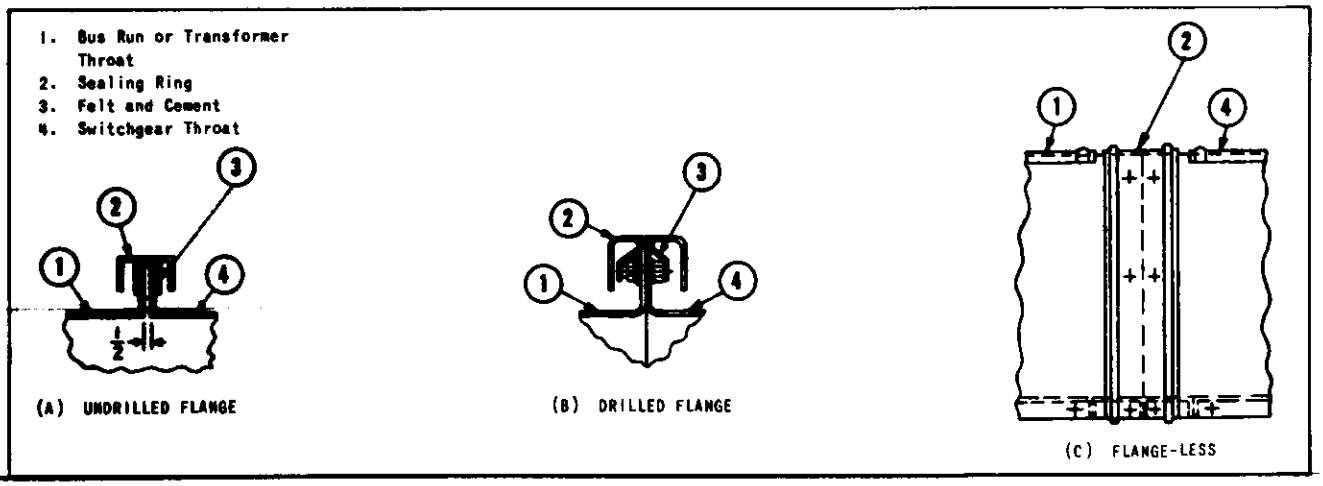


Fig. 44 *Sealing Rings for High Voltage Enclosures*

outdoor weatherproofing, gaskets are furnished to be installed in the field.

2. Undrilled-flange type: See Fig. 44A. This enclosure connection is generally used for outdoor installations between transformers or generators and switchgear where it is desirable to isolate the switchgear from vibration. The flanges are turned outward and not drilled. A sealing ring assembly with felt and cement is furnished for joining and weatherproofing the mating enclosures. To install, align the mating flanges and enclosures, and cement the felt to the outside surfaces of both flanges in such a way as to seal any gap between them. Then slide the frame of the sealing ring down from the top and secure in place by bolting on the bottom section.

3. Drilled-flange type: This enclosure connection may be used for either indoor or outdoor installations. The flanges of the indoor type are turned inward while the flanges of the outdoor type are turned outward. To install the indoor type, align the mating flanges and enclosures and simply bolt together. To install the outdoor type, align the mating flanges and enclosures. If gaskets are to be used, insert gaskets between the mating flanges and then bolt together. If a sealing ring assembly is to be used as shown in Fig. 44B, bolt flanges together and cement felt to the outside surfaces of both flanges. Then slide the frame of the sealing ring down from the top and secure in place by bolting on the bottom section.

4. Box-enclosure type: This enclosure generally encloses connections and transitions between outdoor switchgear and outdoor power transformers. Instruction Leaflet I.L. 48-069-30, which is included with the power transformer instruction book, gives complete assembly instructions.

5. Close-coupled type: This enclosure is limited to indoor assemblies. It generally encloses connections and transitions between indoor switchgear and indoor power transformers. For both dry-type and liquid-type transformers, the connection and transition compartment, or enclosure, may be part of the transformers or the switchgear. To install, align the adjacent switchgear housing against the transformer transition compartment, butt together, and secure with tie bolts. Generally the front panels of the dry-type transformer are located in the same vertical plane as those on the switchgear.

3.13 HIGH VOLTAGE BUS CONNECTIONS

There are certain high voltage bus joints or connections that must be made in the field. These connections fall into two categories: (1) Between switchgear and power transformers or bus runs and (2) between switchgear shipping groups. In general, the connecting procedures are the same for both categories.

The high voltage bus connections within power transformer or bus run enclosures require insulation where metal-clad standards require it and/or where electrical clearances so warrant it. Strict attention must be given to proper insulation of those joints using flexible connectors. Flexible connectors have a tendency to bow or bunch, particularly under short circuit conditions, reducing the electrical clearance between them. Certain high voltage connections, such as the close-coupled type between indoor switchgear and indoor dry-type power transformers, require insulation even though the non-switchgear conductors are bare. In other words, high voltage insulation is required on all metal-clad switchgear conductors and connections up to and including the joint to the non-switchgear equipment.

The switchgear high voltage bus connections are completely assembled and fitted at the factory. However, at the shipping group break, sections of bus are removed, identified, packed, and shipped separately and must therefore be connected in the field. After aligning and bolting together the power transformer or bus run enclosures and the switchgear shipping groups, the following steps should be followed:

1. Clean the silver-plated contact surfaces lightly with crocus cloth and wipe with a non-flammable solvent.

Caution: **DO NOT BREATHE LARGE QUANTITIES OF ANY SOLVENT VAPORS. AVOID EXCESS CONTACT WITH SKIN.**

2. Bolt the bus bars together using the splice plates or flexible connectors and hardware supplied. Recommended tightness for various types of hardware is shown in Table No. 2.

TABLE NO. 2A
BOLT TIGHTNESS FOR BUS AND CONNECTIONS

Bolt Material	Torque in Foot-Pounds for Bolt Diameter					
	1/4	5/16	3/8	1/2	5/8	3/4
Heat Treated Steel	5	12	20	50	95	125
Silicon Bronze	5	10	15	40	55	-

TABLE NO. 2B					
Torque in Foot Pounds for Bolt Diameter on a Flexible Shunt Connection					
Bolt Material	Bolt Size				
	.250-20	.312-18	.375-16	.500-13	.625-11
Heat Treated Steel	6 Ft Lbs	15 Ft Lbs	25 Ft Lbs	60 Ft Lbs	115 Ft Lbs
Silicon Bronze	6 Ft Lbs	12 Ft Lbs	18 Ft Lbs	50 Ft Lbs	65 Ft Lbs

3. Insulate the joint or connection in line with instructions shown on standard drawings 663A003 or 3706A97 and 3706A98.

3.14 MAIN POWER CONNECTIONS

Porcel-line metal-clad switchgear is usually provided with either solderless cable connectors or potheads for terminating main power cables. Figure 27 shows solderless cable connectors.

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

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 since these could cause 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 and the proper tapering of insulation to establish necessary voltage gradients. Such instructions will vary with the type and size of cable involved as well as with the service voltage for which the cable is designed to operate.

3.14.1 Solderless-Type

Solderless connectors are normally furnished for terminating non-leaded cable. The complete connection must be insulated or taped in accordance with the cable manufacturer's recommendations or in accordance with standard drawings 3706A97 and 3706A98 if taping material is furnished with the order.

Insulating clamps are provided to separate the cables and to support their weight only when specifically ordered by the customer. The cable manufacturer's instructions should be consulted for the exact details required in terminating any given type of power cable. When supplied, cable clamps may be drilled at the factory if the outside diameter of the cable is known. Since it is frequently impossible for the factory to determine the exact outside diameter of the cable that will be used, these insulating clamps will be supplied with 1/4" diameter pilot holes and must be redrilled to exact size in the field. After drilling, the insulating clamps should be saw-cut longitudinally through the center line of the drilled holes to facilitate installation and to provide proper clamping action.

3.14.2 Potheads

Connections of cable into potheads should be made in accordance with the pothead manufacturer's instructions included in supplementary instructions or with the potheads. Flexible connectors are provided to connect the pothead aerial lugs to conductors in the switchgear to avoid strain on the pothead insulators. The complete joint including the flexible connectors are to be taped in accordance with standard drawings 3706A97 and 3706A98.

3.15 ZERO SEQUENCE CURRENT TRANSFORMERS

When zero sequence current transformers (BYZ) are provided, the power cables must pass through the transformer and terminate at the switchgear terminals or at a pothead in accordance with the instructions on standard drawing 786A506.

3.16 GROUND BUS CONNECTIONS

The ground bus in metal-clad switchgear is assembled in sections with a joint in each housing. The section at a shipping group break is removed, identified, packed, and shipped separately, and must be reinstalled in the field. Solderless terminals are provided on the ground bus in one or more housings as shown on the shop order floor plan drawing. These terminals are for connecting the switchgear ground bus to the station ground. The connection to the station ground should be as direct as possible and should not be in metal conduit. It should be of sufficient size to adequately carry the ground fault current of the installation.

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 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.

3.17 SECONDARY CONNECTIONS

Internal secondary and control wiring on metal-clad switchgear is factory connected as required by the schematic diagrams. Wiring to remote apparatus is factory connected to terminals or terminal blocks. Secondary and control cables from remote apparatus must be field connected to these terminals or terminal blocks. The field connections must be mechanically and electrically strong and should be thoroughly checked before being energized. See Fig. 45.

3.17.1 Loading Check

It is suggested that the loading of the control busses be checked with an ohmmeter to guard against short circuits in the control wiring before energizing initially. If an ohmmeter is not available, serious damage to the control wiring may be guarded against by temporarily connecting a small fuse approximately one-fourth of the normal circuit rating, in series with the control source for the initial check.

3.17.2 Shipping Groups

Openings in the sides of control modules provide access for control connections between housings. When shipment

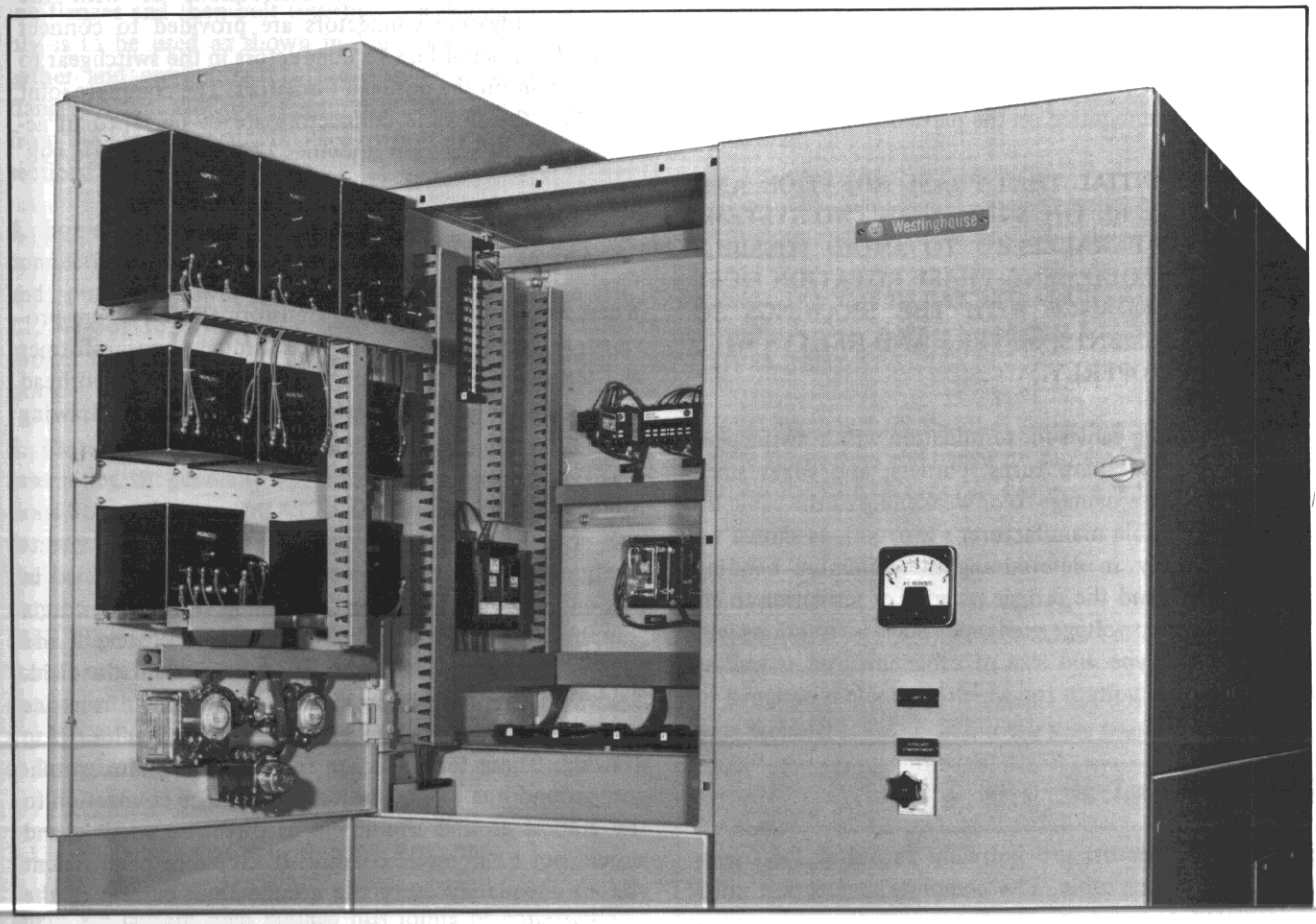


Fig. 45 *Indoor Housing 50DHP250 - Secondary Connections: Internal Secondary and Control Wiring (393164)*

is made in groups, the cross connections are factory-installed in one group, coiled, and identified for connecting in the field to the adjacent group.

3.17.3 Power Transformers and Bus Runs

Openings or couplings in the housings provide access for control connections between switchgear and power transformers and for heater connections between switchgear and bus runs when required. Where no conduit is supplied, the cross connections are factory installed in one assembly, coiled, and identified for connection in the field to the adjacent assembly. Where conduit is supplied, the conduit and wire between adjacent assemblies must be installed and connected in the field as shown on the shop order assembly drawings.

3.18 POTENTIAL AND CONTROL POWER TRANSFORMERS

After assembly, testing, and final adjustments have been made at the factory, the operating link is detached at the door and the disconnecting assembly is bolted to its support on each side to prevent movement and possible damage during shipment.

Caution: **THE SWITCHGEAR MUST NOT BE PLACED IN SERVICE UNTIL THE FOLLOWING PROCEDURES HAVE BEEN COMPLETED. FAILURE TO DO SO COULD RESULT IN BODILY INJURY AND/OR EQUIPMENT DAMAGE.**

1. Remove shipping bolts on each side of rotating assembly.

2. Connect operating link to bracket on door.

3. Check primary and secondary contact engagement by "ringing" or "lighting-out" as door is closed. Contacts should make when door is a minimum of 1/2 inch from being fully closed.

4. Check that fuse ground contacts make in fully disconnected position ("door-open"/latch engaged).

5. Check fuses for continuity and that proper contact is made in fuse clips.

6. Check mechanical or key interlocking of control power transformers for correct operation, i.e., it should not be possible to open the compartment door without first opening the breaker in the secondary circuit of the transformer.

3.19 DISCONNECTING FUSES

These are ready for operation as received. However, the following should be checked before placing in service:

1. Contact engagement - by ringing-out or lighting-out (as in (3) above).

2. Operation of mechanical or key interlock - see (6) above.

3. Continuity of fuses and proper contact in fuse clips.

3.20 KEY INTERLOCKS

Keylock interlocks are often supplied in conjunction with disconnecting switches, dummy breakers and special compartments to which access is to be denied unless the circuit breakers controlling the power to these non-switching devices have been withdrawn to the test position. The operation of key interlock schemes is generally described by a note or keying chart on the shop order assembly drawings.

Caution: **TO FACILITATE MANUFACTURE AND INSTALLATION PROCEDURES, A KEY IS USUALLY SUPPLIED 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.**

3.21 MOVING PARTS

There are few moving parts in Porcel-line metal-clad switchgear and, in general, they do not require field installation as they are factory-installed. However, it is recommended that all moving parts be operated manually (even if normally operated automatically) to assure that no binding or damage has occurred during shipping, handling or storage.

3.22 TYPE DHP CIRCUIT BREAKER

Refer to Instruction Book 32-253-4A for complete installation instructions for the type DHP Magnetic Air Circuit Breakers.

3.23 ACCESSORIES

Other than the optional test cabinet, none of the standard accessories listed in the "Description" section of this instruction book require field installation. It is recommended that the test cabinet be installed and all the accessories be stored in a clean and dry location convenient to the switchgear. The test cabinet is designed for wall mounting as shown on standard drawing 3710A80 or 3710A81. The cabinet also has provisions for conduit entrance of control power.

3.24 SEPARATE EQUIPMENT

As mentioned under "Receiving, Handling, and Storing", appendages such as bus runs, synchronizing panels, and large internal equipment such as oil-filled transformers may be packed and crated separately. They should be uncrated and installed per the shop order assembly drawings.

3.25 UN-BLOCKING

Many pieces of equipment are blocked or braced for shipment. As an example, refer to the "Disconnect Transformer and Fuses" previously discussed. Other apparatus, such as meters and relays, must be examined and all blocking or bracing must be removed. The time dials of the relays are set at zero to close the relay contacts for shipment.

3.26 ADJUSTING AND TESTING

After the switchgear and the apparatus which it is to control has been installed and all inter-connections made, it should be given a final check and test before being put into service. Care must be exercised to prevent the controlled equipment from being connected to the system while the preliminary tests are being conducted.

The testing equipment will depend on the size and type of installation. Portable voltmeters will be required. Some simple device for "ringing" or "lighting-out" circuits should be included in the testing equipment.

Wiring connections, 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 instrument transformers, remote control and interlock circuits, and auxiliary switches should be "lighted-out" to make sure that they are also correct. All connections must be correct before an attempt is made to operate the equipment.

The relays have been checked and adjusted at the factory to a recommended setting commensurate with the system information available. 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 change the relay settings, the instruction leaflet for the relay involved should be referred to. These instruction leaflets show typical connection diagrams only and may not necessarily agree with the connections furnished. The schematic diagrams furnished for the shop order should be referred to for the actual connections.

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.

After the switchgear has been installed and put into operation, the drawings supplied with the equipment should be reviewed and marked to show any revisions made during the installation. A set of these should be returned to Westinghouse so that the tracings can be changed for permanent record.

SECTION 4 – OPERATION

The operation of horizontal drawout Porcel-line metal-clad switchgear has the advantages of flexibility, safety, and ease of maintenance, plus ease of testing and checking of control circuits.

During operation, all live parts are enclosed by barriers which permit the operator to perform his work safely.

All type DHP air circuit breakers are equipped for electrical operation. A maintenance handle is supplied as part of the accessories to permit manual operation of the breaker during maintenance. **CAUTION: THIS DEVICE MUST NOT BE USED TO CLOSE THE BREAKER ON ANY ENERGIZED CIRCUIT. SEE ACCESSORIES SECTION OF THIS INSTRUCTION BOOK. TO DO SO**

COULD RESULT IN BODILY INJURY AND/OR EQUIPMENT DAMAGE.

The control circuits can be checked by moving the breaker to the test position where the main circuits are disconnected and the control circuits can be completed by engaging the secondary contacts.

4.1 INSERTION AND WITHDRAWAL OF BREAKER FROM HOUSING

No attempt should be made to place the circuit breaker in the housing until the housing installation is complete. If attempted earlier, trouble may occur from foreign material in the housing, from an un-level foundation, or from distortion caused during shipment or handling.

As a deterrent to the insertion of a breaker into a switchgear housing of a different rating, a coding system is provided. The coding system consists of a pin on the left side of the breaker frame and a notched coding plate bolted to the lower left of the housing. The notched coding plate can be seen in Fig. 8. **CAUTION: FOR SAFETY, SINCE THE CODING PLATES DO NOT COORDINATE CONTROL WIRING, ALWAYS REFER TO SHOP ORDER INFORMATION, DRAWINGS, OR SCHEMES TO MAKE CERTAIN THAT THE BREAKER AND HOUSING ARE COORDINATED FOR OPERATION TOGETHER. FAILURE TO DO SO COULD CAUSE CIRCUIT MALFUNCTION, AND COULD RESULT IN BODILY INJURY AND/OR EQUIPMENT DAMAGE.**

To prepare the circuit breaker for insertion into the housing, mount the arc chutes, connect the shunt straps, and mount the barrier as described in breaker I.B. 32-253-4A, Installation, parts 1 thru 4, pages 27 and 28.

For indoor and Shelterfor-M installations, position the breaker in front of the cell as described in breaker I.B. 32-253-4A, Installation, part 5, page 28.

For Aisle-less installations, since the breaker must be on the transport truck (Fig. 39), the breaker will automatically be aligned when the transport truck is properly attached to the housing. To properly attach the transport truck to the Aisle-less housing, visually align the truck then push forward slowly but firmly. The truck will be guided into proper position by angled and beveled clips welded to the housing and visible in Fig. 8. In addition, the truck will attach itself as the bridge portion rides up the clips and drops down to lock behind the clips. To release the breaker from the transport truck, simply press down on the rail latch. To detach the transport truck from the housing, simply step on the release bar and pull truck away.

The breaker is now ready for insertion into the test position and then into the connected position. This procedure is fully described in the circuit breaker instructions, I.B. 32-253-4A, Installation, parts 6 thru 10, pages 28 and 29.

To *withdraw* the breaker from the connected to the test position and from the housing, follow the procedure fully described in I.B. 32-253-4A, Installation, parts 11 thru 13, page 29.

4.2 BREAKER OPERATION AND MECHANICAL INTERLOCKS

Refer to circuit breaker instructions I.B. 32-253-4A for detailed operating instructions.

4.3 DISCONNECTING TRANSFORMERS AND FUSES

4.3.1 Connecting

Before connecting any of the transformer assemblies to an energized circuit for the first time, the procedure outlined under Installation, items 3.18 and 3.19, must be carried out.

Close and latch the door.

4.3.2 Disconnecting

Open door to fully open position making sure that the "door-open" latch or detent is properly engaged.

4.4 ELECTRICAL OPERATION

4.4.1 General

A one-line diagram and a schematic diagram is prepared for each metal-clad switchgear assembly. These should be thoroughly studied and completely understood by the operators of the metal-clad switchgear.

The reading of indicating and recording instruments and meters is common knowledge to electrically trained personnel. The use of instrument switches, rheostat con-

trol, and governor motor control switches is also common. Synchronizing switches are usually provided on generator and incoming line units with a synchronizing switch contact wired in series with the breaker control switch "close" contact. The synchronizing switch should always be turned "ON" first and the circuits adjusted to be in synchronism as indicated by the synchroscope before the circuit breaker is closed.

Lamp indication is provided by a green light to indicate that the breaker is open, and a red light to indicate that the breaker is closed. For the d-c control schemes, the red light is also arranged to supervise the trip coil and indicate that the trip coil circuit has continuity.

4.4.2 Protective Relays

A large variety of relays may be applied to protect the system during faults or other unusual operating conditions. When such applications are made, pertinent descriptive literature on each type of relay is included in the switchgear instruction book. **FINAL SETTINGS OF SUCH RELAYS SHOULD BE MADE IN THE FIELD** to coordinate with the other parts of the power system in accordance with the Purchaser's standards and operating practices.

4.4.3 Breaker Control Schemes

The details of circuit breaker operating schemes may vary widely on different metal-clad switchgear installations. However, all schemes are derived from basic control schemes which are shown in their simplest form in Figs. 46, 47, and 48. They comply with requirements formulated and approved by AEIC, IEEE, NEMA, and ANSI. A comparison between the basic schemes and the schematic diagram for any particular assembly will reveal which basic scheme has been employed to meet the requirements for that particular application. All of the schemes are designed to electrically co-ordinate with the mechanical design of the breaker.

Combination schemes, such as closing and tripping on different voltages, and schemes with a-c closing and d-c tripping are in common use. Sequence interlocking with other equipment, various arrangements of local and remote control, and automatic reclosing schemes are frequently encountered.

4.4.4 Breaker Tripping Schemes

A variety of circuit breaker tripping schemes may be used with the basic control schemes:

1. D-c shunt trip coils are most frequently used with the d-c control scheme. The d-c shunt trip is shown in Figs. 46, 47, and 48.

2. On schemes using a-c control where no separate reliable tripping source is available a capacitor tripping device is often employed. On this type of device a-c power is continuously supplied to a rectifier which charges a capac-

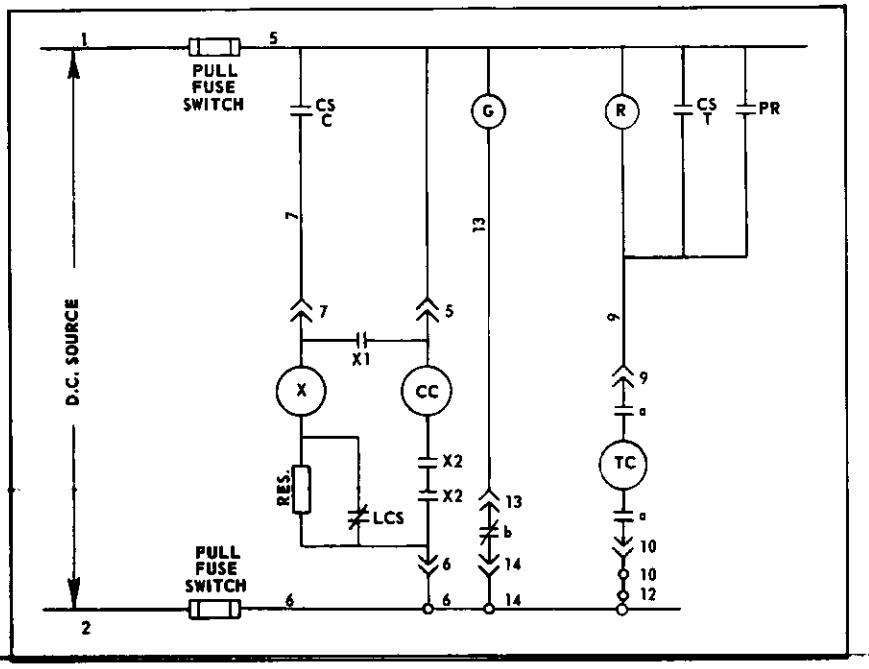


Fig. 46 *Solenoid Breaker with DC Control and DC Shunt Trip*

itor. In such cases the energy stored in the capacitor is discharged through a special trip coil to trip the breaker when the control switch is placed in the tripping position or when one of the protective relays closes its contacts. The capacitor trip device is included in Fig. 48.

3. A-c shunt trip coils are sometimes supplied with a-c control schemes where the tripping power is derived from the same control source as the closing power. However, such trip coils are only relied upon to trip the breaker under normal operating conditions and are usually backed up by some additional tripping means to open the breaker should a fault occur. The a-c shunt trip is shown in Fig. 48.

4. Additional tripping schemes using under-voltage release coils or transformer trip coils are occasionally supplied. In such cases the use of these devices will be clearly indicated on the schematic supplied with the equipment.

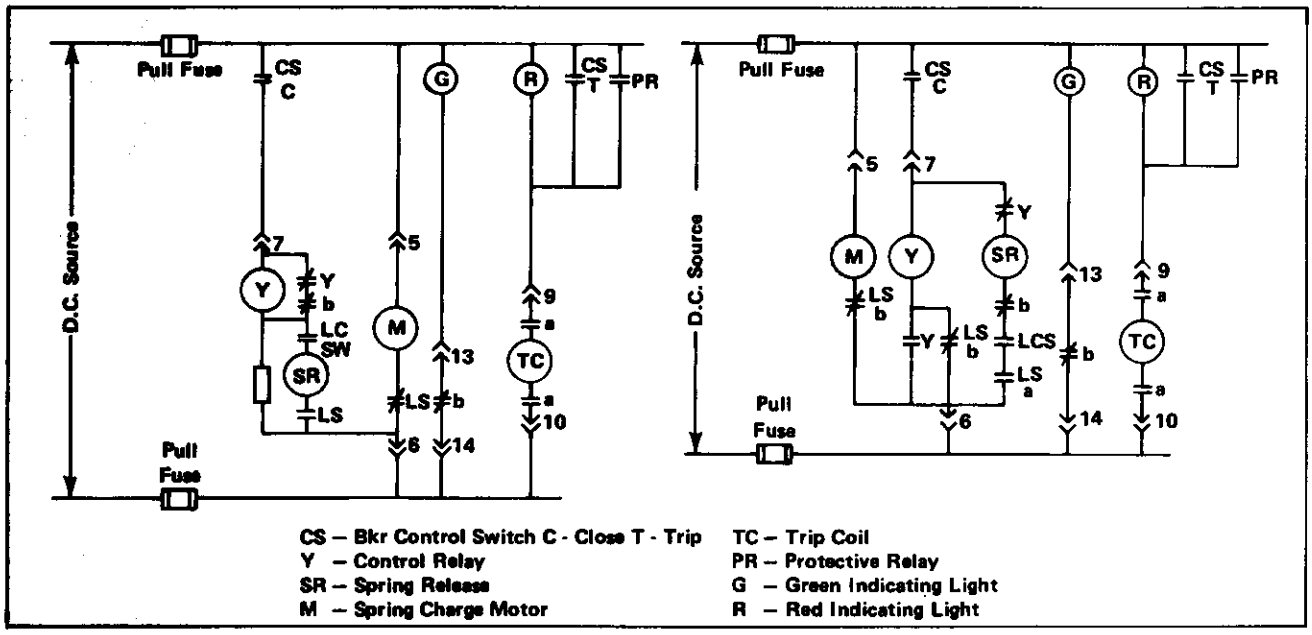


Fig. 47 *D-C Control Schemes – Stored Energy – Typical*

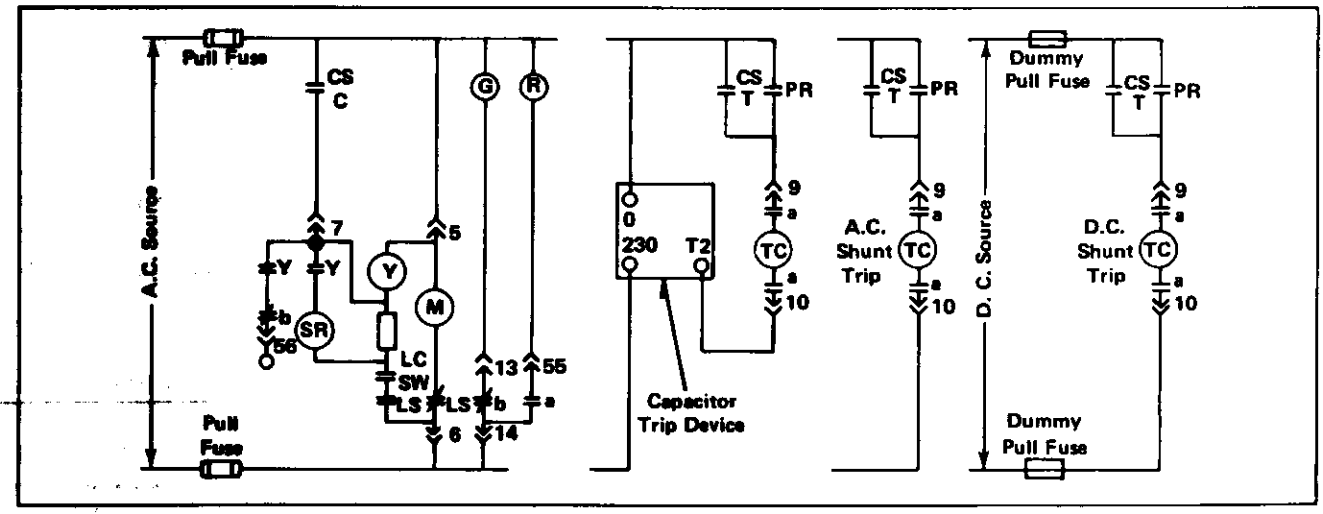


Fig. 48 *A-C Control Schemes – Stored Energy – Typical*

SECTION 5 – INSPECTION AND MAINTENANCE

5.1 SAFETY PRECAUTIONS

WHEN INSPECTING, REPAIRING, AND PERFORMING MAINTENANCE ON METAL-CLAD 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 HIGH VOLTAGE PARTS. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY OR PROPERTY DAMAGE.

Some common general precautions for high voltage work 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 current at high voltage 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.**

5.2 ACCESS TO SWITCHGEAR PARTS

5.2.1 High Voltage Parts

Porcel-line metal-clad switchgear is designed so that internal compartments provide metal isolation between the DHP circuit breaker compartment, the main bus, and the primary line terminations. Access to high voltage parts is provided by removable covers and barriers WHICH SHOULD NOT BE REMOVED UNLESS THE PARTS TO BE EXPOSED ARE DE-ENERGIZED. Figures 15 and 27 are photographs in which covers have been removed to expose the main bus and the primary line terminations.

5.2.2 Main Contacts and Current Transformers

Both the stationary main disconnecting contacts and the ring-type current transformers are located just behind the insulating shutter and molded barriers as shown in Fig. 13, 14 and 15. Upper and/or lower 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 VOLTAGE PARTS ARE DE-ENERGIZED. FAILURE TO DO SO COULD CAUSE PERSONAL INJURY OR PROPERTY DAMAGE.**

5.2.3 Disconnecting Transformers and Fuses

Figure 28 is a picture of a disconnecting potential transformer. Simply opening the hinged door automatically disconnects and grounds the moving high-voltage parts. The cable and stationary contacts are accessible either by removing back covers or by removing the complete assembly.

Caution: **DO NOT ATTEMPT TO REMOVE THE BACK COVERS, THE DISCONNECTING ASSEMBLIES OR SHUTTERS UNLESS THE HIGH VOLTAGE CIRCUIT TO THE COMPARTMENT IS DE-ENERGIZED AND PRECAUTIONS TO PREVENT RE-ENERGIZING HAVE BEEN TAKEN. FAILURE TO DE-ENERGIZE THE CIRCUIT AND TO TAKE PRECAUTIONS TO PREVENT RE-ENERGIZING IT COULD RESULT IN BODILY INJURY OR ELECTROCUTION. WHEN ENERGIZED, CIRCUIT CARRIES LETHAL HIGH VOLTAGES.**

5.2.4 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.

5.3 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 ELECTROCUTION. WHEN ENERGIZED, CIRCUIT CARRIES LETHAL HIGH VOLTAGES.**

5.3.1 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.

5.3.2 Overall Installations

The switchgear installation should be given a thorough overall maintenance check at the end of the first year in service because it provides an opportunity to evaluate conditions at an early point in the life of the equipment. Where conditions are abnormal, more frequent inspection and maintenance is necessary. Where conditions warrant, a longer period of time between maintenance periods may be used. No equipment should be left in service longer than three years without being inspected. The following items require attention:

5.3.2.1 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 SOLVENT VAPORS. 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 lowering of the insulation resistance.

Periodic high potential tests are not required and are recommended only after repair of high voltage buses or insulation, or when the trend of megger readings indicates it to be advisable. This field test should be made before the main cables are connected and should not exceed 14.25 kV, 60 Hz, 1 minute, for 4.76 kV switchgear and 27 kV, 60 Hz, 1 minute for 8.25 kV and 15.0 kV switchgear. Transformer primary fuses should be removed during high potential tests.

5.3.2.2 Main Disconnecting Contacts and Supports

Remove each breaker from its housing. De-energize primary circuits and expose primary contacts and their porcelain supports (or bottles). 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. If necessary, these can be removed by a light application of crocus cloth. 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. See I.B. 32-253-4A.

5.3.2.3 Other Disconnecting Contacts

Inspect all primary and secondary disconnecting contacts such as those on rotating transformers for abnormal wear, fatigue, or overheating. Replace if necessary. Otherwise treat the same as Main Disconnecting Contacts above.

5.3.2.4 Control Contactors

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

5.3.2.5 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 period relay tests.

5.3.2.6 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.

5.3.2.7 Mechanical Parts

Visually check and manually operate mechanical moving parts such as the shutter, TOC and MOC switch assem-

blies, the position interlock, hinged doors, and the rotating features of the transformers and fuses. Examine mechanical mating parts such as the levering-in screw, the guide rail and floor trippers.

5.3.2.8 Ventilation

Check all labyrinths, grillwork, and air passages for obstructions and accumulations of dirt. The air space under outdoor switchgear, which is necessary for the entrance of ventilating air, should be cleaned of leaves and other foreign matter.

5.3.2.9 Battery and Charging Equipment

THE CONTROL BATTERY IS SUCH AN IMPORTANT ITEM IN SWITCHGEAR OPERATION THAT IT MUST BE GIVEN SPECIAL PERIODIC ATTENTION IF IT IS TO GIVE RELIABLE SERVICE FOR A LONG PERIOD OF TIME. Periodic inspections and tests are recommended in the battery supplier's instructions. At the same time the battery is checked, inspect the battery charger and remove accumulations of dust and dirt. On all chargers having a manual transfer switch for setting the charging rate, check carefully to be sure that the selector switch is returned to the value appropriate for a floating charge at the end of the periodic inspection. **SERIOUS DAMAGE TO THE CONTROL BATTERY CAN OCCUR IF THE CHARGER IS LEFT ON A HIGH CHARGING RATE FOR AN EXTENDED PERIOD OF TIME.**

5.3.2.10 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. Megger tests are suggested for checking the insulation. A series of these tests will indicate any tendency toward a reduction in dielectric strength of the insulation. Megger readings should be taken before and after cleaning the equipment and, where possible, under similar conditions at successive periods. Records should include the megger reading, the temperature and the humidity. The readings will vary with the extent and design of the bus structure. In contrast with a small installation, the longer switchgear assemblies will have a more extensive bus structure with a greater number of insulators and, thereby, a larger number of parallel insulation resistance paths to ground which will tend to decrease megger readings. This variation in insulation resistance between different switchgear assemblies emphasizes the value of a series of readings which can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized.

5.3.2.11 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.

5.4 LUBRICATION

Porcel-line metal-clad 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 disconnection contacts. The application of the lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

5.5 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-clad housing in which the part is to be used.

The following parts are suggested as spares for a typical installation. The size and complexity of the particular installation will cause variations. As a further guide, spare parts lists are usually included in the specific instructions for individual devices.

1 – Set of primary fuses for potential and control power transformers.

1 – Package of indicating lamps.

1 – Package of secondary fuses.

1 – Set of contacts for control, instrument, and auxiliary switches.

1 – Set of contacts and coils for auxiliary relays.

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DWG. 3706A97	SHT 2	

MATERIALS FOR TAPING

FILLER - A putty-like material. Trade Names: – Duxseal, Duct Sealer, Scotchfil, Ⓜ No. 5335188 and 5[illegible]51WX. Pieces of insulating tape may be used.

INSULATING TAPE - High voltage EPR insulating tape. Trade Name: Scotch 23, Ⓜ No. 45151RX. or Trade Name: Scotch 130R, Ⓜ No. 45151SE. *

FINISH TAPE - Pressure sensitive PVC tape. Trade Name: Scotch 66, Ⓜ No. 44791DC.

OR INSULATING ENAMEL - A red, air dry insulating enamel. Trade Name: Benolite B 6-670, Ⓜ No. 32230JF or equivalent. * Note: When Ⓜ No. 45151SE is used, enamel or finish tape is not required. Reverse roll position with adhesive side inside.

FIELD TAPING METHODS

GENERAL

1. Elongate insulating tape 10 to 25 percent during application to insure a smooth, tight fit. On pads elongate corners only.
2. Should a tape roll expire, start the new role by overlapping the previous end by 1/2 turn.

JOINT-NO HARDWARE

1. Clean area of dirt and foreign matter.
2. Apply one turn of 1 inch tape so 1/2 of the tape filler is on the conductor and 1/2 is on the pre-insulation. Overlap tape ends 1-1/2 inches.
3. Apply one layer of insulating tape, lapping as specified in the chart, overlapping any pre-insulation by 1-1/2 inches.
4. Apply red insulating enamel to completely cover tape (or apply one layer of finish tape.)*

JOINT WITH-HARDWARE

1. Clean area of dirt and foreign matter.
2. Apply filler over bare conductor and hardware to cover and smooth out the surface. Blend contour into pre-insulation surfaces. Cover conductors and hardware with at least 1/8 inch of filler.
3. Apply pad(s) of insulating tape of sufficient width to overlap pre-insulation by one inch or more.
4. Apply one layer of insulating tape, lapping as specified in the chart, overlapping any pre-insulation or pads by 1-1/2 inches.
5. Apply red insulating enamel to completely cover tape (or apply one layer of finish tape.)*

TAPING CHART

KV ON SWGR	PRE-INSULATION OR PAD OVERLAP MIN., INCHES	INSULATING TAPE LAP OF TAPE	NO. OF LAYERS	NO. OF PADS
UP TO 5	1 1/2	1/2	1	1
7.5 & 15	1 1/2	2/3	1	2
		FINISH TAPE *		
ALL RATINGS	1 1/2	1/2	1	1

DEFINITIONS

JOINT - Area to be covered with tape. Consists of bare conductor and 1-1/2 inches of any pre-insulation next to the bare conductor.

PRE-INSULATION - Any insulation covering or adjacent to an exposed conductor prior to taping.

PAD - Any insulating tape applied which is wider than one inch. Includes a band of tape consisting of one or more turns wrapped directly on top of each other.

LAYER - Insulating tape, 1 inch wide, wrapped from one end of the joint to the other (or to a pad) so each succeeding turn laps the previous turn by the amount specified in the chart.

OVERLAP - A specified distance measured along the pre-insulation starting from the point where the pre-insulation ends and the exposed conductor begins.

SWGR	METAL CLAD SWITCHGEAR FIELD TAPING PROCEDURE (SEE FIG. 1 to 3 DWG 3706A98)	5 TO 15 KV	3706A97

WESTINGHOUSE ELECTRIC CORPORATION	SWITCHGEAR	EAST PITTSBURGH, PA., U. S. A.
DWG. 3706A98	SHT 1	

FIG. 1, TYPICAL TAPE JOINT NO HARDWARE

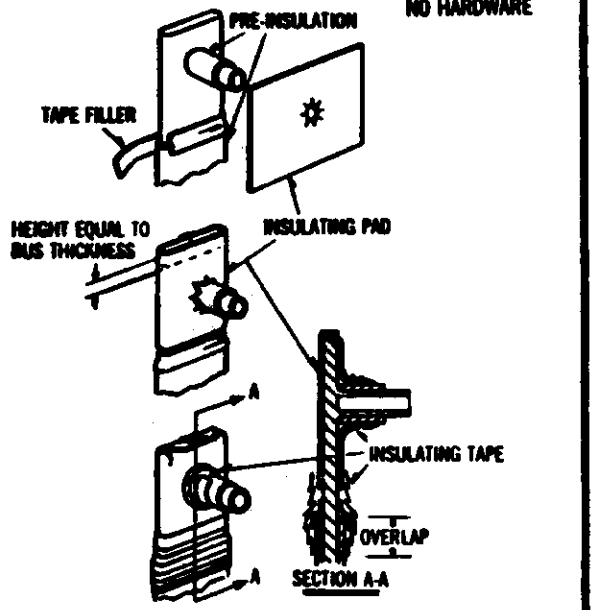
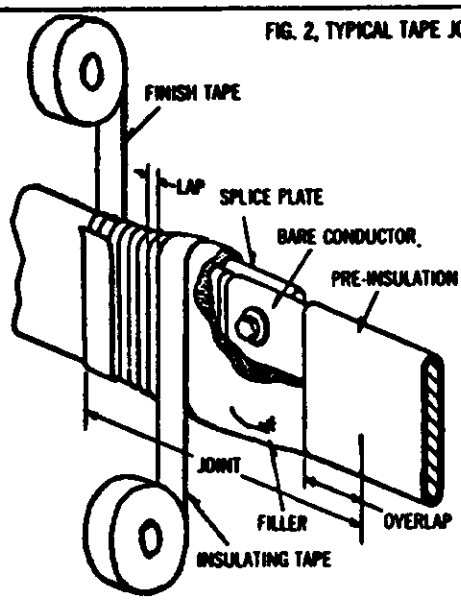
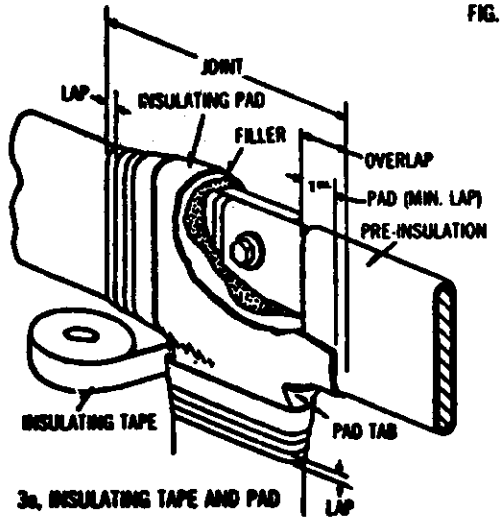


FIG. 2, TYPICAL TAPE JOINT

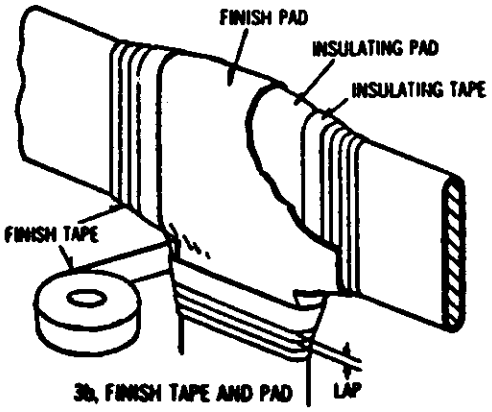


NOTE: Roll position during taping is different for each tape.

FIG. 3, TYPICAL TAPE AND PAD JOINT



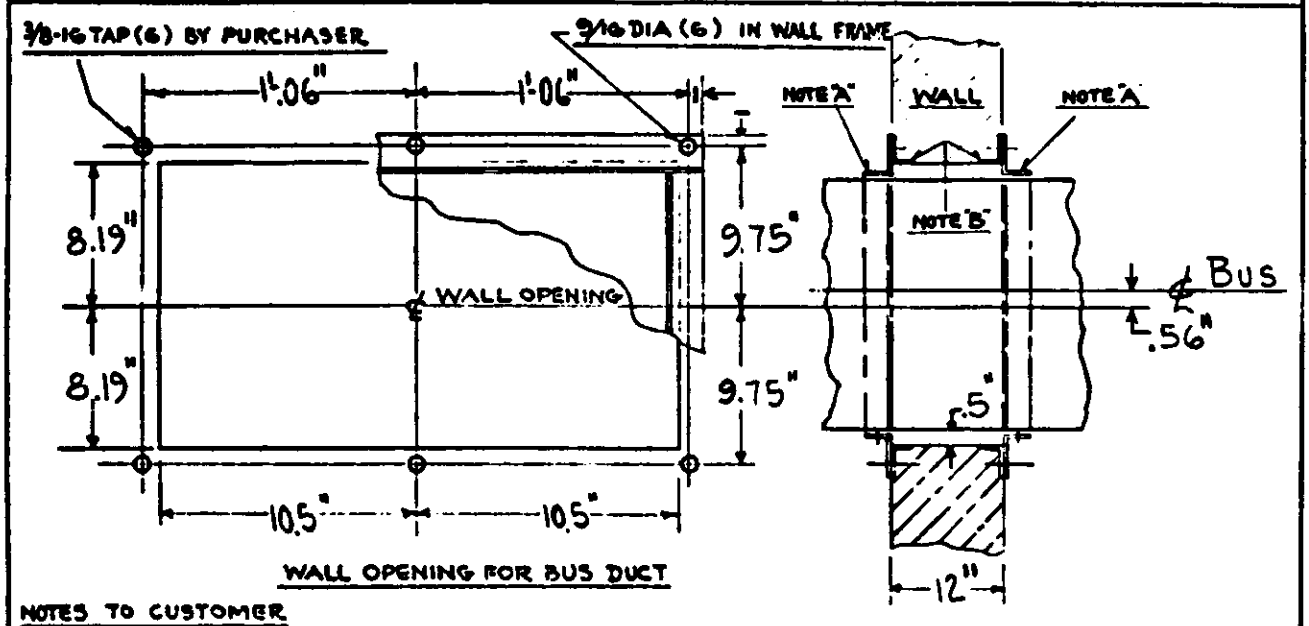
3a, INSULATING TAPE AND PAD



3b, FINISH TAPE AND PAD

SWGR	TYPICAL 5 TO 15 KV TAPING ILLUSTRATIONS REF. DWG 3706A97 FOR METHODS.	3706A98

WESTINGHOUSE ELECTRIC CORPORATION	ASSEMBLED SWITCHGEAR & DEVICES	EAST PITTSBURGH, PA., U. S. A.
DWG. 781A691	SUB 2	



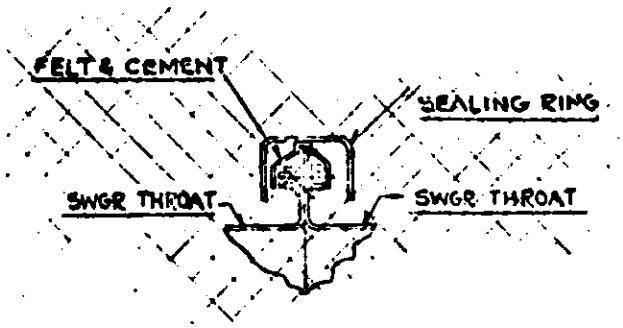
WALL OPENING FOR BUS DUCT

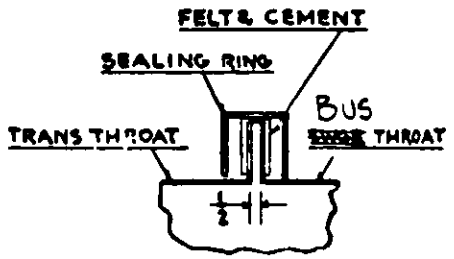
NOTES TO CUSTOMER

A. INDOOR & OUTDOOR WALL SEAL SUPPLIED BY WESTINGHOUSE

B. PURCHASER TO PROVIDE ANGLES OR 3/8-16 SCREW ANCHORS FOR BOXING IN WALL OPENING.

C. PURCHASER TO CAULK ALL AROUND FOR WEATHER PROOFING WHEN BUS RUN IS IN PLACE.





AFTER SWGR & TRANSF. HAVE BEEN BROUGHT TOGETHER TO GIVE AN ALIGNMENT OF THE FLANGES (WITHIN 1/2") APPLY CEMENT TO OUTSIDE SURFACES OF BOTH FLANGES (OVER TOP & BOTH SIDES) CEMENT FELT IN PLACE. THE FELT IS TO SEAL AGAINST ENTRANCE OF DUST & PREVENT POSSIBLE VIBRATION OF THE SEALING RING PRODUCED BY TRANSF. RESONANCE.

TO INSTALL SEALING RING, SLIDE FRAME DOWN FROM TOP & INSTALL BOTTOM SECTION, SECURING IN PLACE WITH 2 SCREWS SUPPLIED WITH BOTTOM SECTION.

BUS RUN WALL OPENING		CODE 99261	781A691
SWGR THROAT SEALING RING			