Instructions for 34.5 KV High Voltage Metal-Clad Switchgear with Type SFP Drawout Magnetic Puffer Circuit Breakers

Westinghouse Electric Corporation

Switchgear Division, East Pittsburgh, Pa.
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INTRODUCTION

34.5 KV high voltage metal-clad switchgear with type SFP magnetic puffer circuit breakers controls and protects high voltage circuits up to 38 KV. The switchgear assembly is composed of housings that are arranged to suit the customer's requirements. The housings, in turn, contain equipment such as buses, instrument transformers, relays, secondary control devices, and SFP magnetic puffer breakers.

34.5 KV high voltage metal-clad switchgear is designed, manufactured, and tested in accordance with industry standards.

SFP metal-clad switchgear is available for both indoor and outdoor installations. A typical indoor assembly is shown in Fig. 1. An outdoor Shelterfor-M assembly is shown in Fig. 4. The type SFP magnetic puffer breaker is shown and described in I.B. 32-352-2.

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.

DESCRIPTION

34.5 KV high voltage metal-clad switchgear is an assembly of housings arranged to suit the Purchaser's requirements. There are circuit breaker housings and auxiliary housings.

A circuit breaker housing has provisions for a removable type SFP magnetic puffer circuit breaker. It also includes high voltage equipment, primary connections, low voltage equipment, and control devices.

An auxiliary housing has no provisions for a circuit breaker. It does include miscellaneous equipment and such equipment that cannot be contained in a circuit breaker housing.

34.5 KV high voltage 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 Shelterfor-M metal-clad switchgear is constructed by assembling a weatherproof enclosure onto and around standard indoor housings. Where applied in this way, the rear doors of the metal-clad units become part of the Shelterfor-M housing.

Indoor Construction

Figure 7 is a section drawing of a typical breaker housing. It is constructed of welded steel angles and sheets and contains a breaker compartment, a bus compartment and a line compartment. Figure 2 is a photograph of a 34.5 KV high voltage metal-clad assembly viewed from the front. Figure 3 is a view of a typical assembly from the rear.

The breaker compartment contains the secondary contacts, shutter, current transformers, lifting mechanism, interlocks, control panel and SFP circuit breaker.

The bus compartment contains the main bus, risers, primary disconnecting contacts, and the porcelain primary disconnecting contact support bottles.

The line compartment provides space for customer's cables, potheads and lightning arrestors.

Figure 8 is a section drawing of a typical auxiliary housing. It is constructed of welded steel angles and sheets similar to a breaker housing but with no provisions for a breaker.

Figure 8 depicts an auxiliary housing with rotating disconnect potential transformers. It is typical only and could instead include other equipment in the space occupied by the potential transformers.

Outdoor Shelterfor-M Construction

Figure 5 is a section drawing of a typical Shelterfor-M high voltage metal-clad switchgear assembly including a breaker housing. Figure 4 is a sketch of a typical Shelterfor-M unit with a bus run entering thru the roof of the near unit. Outdoor Shelterfor-M switchgear is an assembly of a weatherproof enclosure onto and around indoor housings and including an operating or maintenance aisle where equipment is accessible without exposure to weather. The aisle permits interchanging type SFP circuit breakers. A weatherproof door is located at each end of the aisle and each door is equipped with "crash" mechanisms permitting quick release from the inside when the door is padlocked on the outside. Aisle lights, switches, and service receptacles are provided. Shelterfor-M is basically:

1. The indoor housing shown in Figs. 1 and 2.

2. A suitable concrete foundation.

3. A structural steel framework which is anchored to the foundation.

4. Weatherproof side sheets which cover the sides of the indoor housing and form the weatherproof aisle.

5. A weatherproof roof which is bolted to the structural frame.

6. Weatherproof rear doors bolted to the structural frame.

Ventilation: Indoor

Refer to Figure 7. The rear doors have grillwork at the top and bottom to allow ventilating air to pass through the line compartment as shown. Grillwork in the breaker compartment doors and a chimney as shown in Fig. 7, provide additional ventilation for 3000 ampere breaker units.

Ventilation: Shelterfor-M

Refer to Fig. 5. The outdoor rear doors have no grillwork, louvers, or openings. Ventilating air enters through a screen at the bottom of the line compartment, passes through it, and is expelled through a screen under the rear roof overhang. The ventilating air thru the grill and chimney in the 3000 ampere breaker units is also exhausted through the roof overhang.

Access Doors

Refer to Fig. 2. Access to the breaker compartment is thru the lower pair of doors on the front of the switchgear unit. These doors are normally latched closed and may be padlocked if desired. The upper doors give access to the bus compartment. These doors are normally bolted closed. Access to the line compartment is thru a pair of full height doors on the rear of the switchgear. On the standard indoor unit these doors are a part of the indoor housing. On Shelterfor-M switchgear, these doors are part of the weatherproof housing.

Control Panel

The control panel is located across the front of the breaker compartment as seen in Fig. 15 and Fig. 13. It contains terminal blocks for customer's control leads, a toggle switch and fuse pull-outs for the AC and DC control, a fuse pullout for the heater circuit, a pushbutton switch for local control of the breaker, and a lift mechanism control switch.

Heaters

Heaters, to prevent condensation, are furnished as standard equipment on outdoor switchgear. One heater is mounted on each side in the lower part of the breaker compartment and another pair of heaters is mounted in the lower part of the line compartment. See Figs. 3 and 13.

Shutter

The metal shutter, Fig. 16, is located between the current transformers and the primary contact support bottles. The operating arms are pivoted to the sides of the cell and linked to the shutter at the top and the breaker lifting channels at the bottom. The shutter is automatically opened by the motion of the breaker lifting mechanism. The shutter is positively linked to the lifting mechanism and cannot be moved independently of the breaker lifting mechanism. See Fig. 9.

Current Transformers

Ring type current transformers are mounted below the shutter as shown in Figs. 11 and 16. They are removable and may be changed without having to de-energize the bus.

Main Bus, and Risers

The main bus and risers are shown in Fig. 2. The conductors are of either aluminum or copper as required. The main bus, main bus joints, and risers are insulated. The

bolted connections are silver-plated. The main bus supports are of porcelain.

Ground Bus

The ground bus is shown in Figs. 3 and 11.

Main Disconnect Contacts and Supports

The main disconnecting contacts are inside the supports shown in Fig. 12. The main disconnecting contacts are round, silver-plated studs. The contact assembly is secured within the bottle by a spanner nut threaded onto the front of the contact. A special tool 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. See Fig. 10.

Lifting Mechanism

The lifting mechanism as shown in Figs. 11, 13 and 18, consists of 4 jackscrews in the 4 corners of the cell coupled together with roller chain and driven by the lifting mechanism motor. The jackscrews engage nuts which are coupled to the 2 lifting channels. As the jackscrews turn, the lifting channels move up and down to raise or lower the breaker as required. Guide pins on the lifting channels engage holes in the breaker truck to insure proper alignment of the breaker and cell mating parts.

Guide Rail and Position Stop

Guide rails and breaker position stops are jig welded to the cell floor as shown in Figs. 11 and 13.

The guide rails serve to position the breaker laterally in the cell and the position stop positions the breaker in the correct front to back location so that the guide pins on the lifting channels will register with the holes in the breaker frame.

Automatic Trippers

The automatic trippers are the 3 vertical bars welded to the right hand breaker lifting channel as seen in Figs. 11 and 17. These bars actuate the spring release and trip triggers to discharge the breaker springs thru a linkage system which is mounted on the breaker. The upper 2 bars trip the breaker open and the lower bar closes the breaker. This arrangement assures that when a breaker is first moved into or removed from the cell, the breaker is open and all springs are discharged.

Interlocks

To insure that the contacts are open when the breaker is raised to the operating position, an interlock bar, see Fig. 17, on the right side of the cell acts on a linkage on the breaker to hold the breaker trip-free until the primary contacts are engaged.

To prevent lowering the breaker with the contacts closed, this same interlock trips the breaker open before the primary contacts part. In addition to this a contact in the lifting mechanism control switch makes up the breaker trip circuit when the switch is turned to the "lower" position.

To insure that the breaker is in the proper position to be raised, a pair of switches with overlapping contacts is provided in the lift circuit. The first of these switches is actuated by a pin on the breaker. The other switch is operated by the lifting channel. The lift mechanism will not operate if the breaker is not in position to make up the first switch. These switches are shown in Fig. 17.

Secondary Disconnect Contacts

The secondary disconnecting contacts are the socket-type and are mounted in a block at the rear of the control panel. A similar secondary disconnecting contact but of the plug-type is mounted on the breaker. They provide connections for the control leads between the removable breaker and the stationary housing. The plug-type block on the breaker has two different size guide pins while the socket-type block in the module has two different size guide holes that match the pins. This method of assembly polarizes the contacts and aligns the blocks. The secondary disconnecting contacts are shown in Figs. 12 and 16.

Test Cable

A test cable is provided for operating the breakers in the disconnected position. On one end is a plug that connects into the secondary contacts in the breaker compartment while on the other end is a socket that connects into the secondary disconnect contacts on the breaker itself. The test cable is wired in such a way that when it is used, the breaker can be closed and tripped only from the pushbutton on the control panel in the breaker compartment. The remote control of the breaker is in-operative. See Fig. 20 for test cable schematic.

Line Conductors and Customer's Connections

The line conductors and customer's connections are shown in Fig. 3. The line conductors are copper and are insulated. The bolted connections are silver-plated.

Space is available in the line compartment for the customer's primary connections and ground connections. Shown in Fig. 3 are flexible connections to connect to potheads. There is space in the line compartment for two 3-phase potheads.

Rotating Disconnect Potential Transformers

Rotating disconnect potential transformers are enclosed in their own compartment in the auxiliary unit. A set of potential transformers is shown in the connected position in Fig. 14. They are trunnion mounted off the cell floor and are tilted to the disconnected position by a gear mechanism which is accessible thru the cell door. In this position both the primary and secondary contacts are disconnected, and the fuses and high voltage winding of the transformers are grounded. The tilting mechanism and the cell doors are interlocked in such a way that the transformers must be rotated to the disconnected position before the cell door can be opened.

Type 345SFP1500 Circuit Breaker

See circuit breaker instructions I.B. 32-352-2.

Accessories

Each new 34.5 KV high voltage metal-clad switchgear installation is provided with a set of accessories. Depending upon customer requirements and the nature of the installation accessories will consist of one or more of the following:

1. A spanner nut wrench for removing, replacing, or checking tightness of the main contact in its porcelain support (or bottle). DO NOT USE WHEN MAIN CONTACTS ARE ALIVE.

2. Test plugs for use with Flexitest relays and meters.

3. A test cabinet may be furnished for electrically operating the breaker 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.

4. A turning dolly (Fig. 19) to facilitate turning the breaker when it is outside the housing. It should not be used to insert or remove the breaker from the housing.

RECEIVING, HANDLING, STORING

34.5 KV high voltage metal-clad switchgear is shipped in groups of one or more housings. The shipping group, depending upon the size of the order, may be the complete order or only part of it. Shipping groups are bolted to wooden skids and enclosed in a covering to protect them from the weather.

For Shelterfor-M installations, the weatherproof housing is packaged and shipped separately from the switchgear housings. SFP breakers, accessories, and installation materials are packaged and crated separately from the housings. Other items such as bus runs and potheads are also packaged separately.

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 claim 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.

Handling

Each shipping group is equipped with a lifting angle assembly for handling by a crane. Figure 6 shows a typical shipping group of 34.5 KV high voltage metal-clad housings with its lifting angle.

Storing

Switchgear which cannot be installed and put into service immediately should be stored in a dry, clean place preferably indoors in a heated building. Conditions such as dampness, changes in temperature, cement dust, and corrosive atmosphere should be carefully guarded against. If necessary to store outdoors special precautions will be required to keep it clean and warm enough to prevent condensation. It will be necessary to cover the switchgear and install temporary heating equipment. During storage the shipping groups should be placed on level surfaces to prevent unnecessary strain and possible distortion.

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.

INSTALLATION

Proper installation of Westinghouse 34.5 KV high voltage 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. See General Notes for Concrete Foundations Drawing 665A524.

Foundation

Westinghouse 34.5 KV high voltage metal-clad switchgear is accurately built upon true and level bedplates to insure ease of operation and interchangeability. Equal care by the customer in laying out and preparing the foundation will result in reduced installation costs as well as good switchgear performance.

The foundation upon which the switchgear is to be mounted is a concrete floor. It must have sufficient strength to withstand the weight of the structure plus the shock or impact resulting when circuit breakers open under short circuit conditions. A typical 34.5 KV high voltage metal-clad cell weighs 5000#. Actual weight will vary depending upon the type and amount of equipment in the individual housings. Adequate safety factors must be used. See I.B. 32-352-2 for weights of SFP breakers.

Careful preparation of the foundation is vitally important for simplicity of erection, ease of operation, and good performance. The foundation should consist of rugged floor steel channels imbedded in an accurate and true concrete floor. The entire concrete floor upon which the switchgear will be erected must be true and flat (preferably level) and in no place should it vary more than 1/8 inch in any square yard, and 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 rapidity and convenience in installing and removing the circuit breaker elements will be facilitated by a smooth hard floor surface.

When installing metal-clad switchgear on existing floors, it will usually be desirable to pour a new finish floor with embedded channels, or to cut slots in the floor for embedding and leveling the supporting channels.

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 such conduits enter the switchgear from below. A floor plan or base plan drawing is made 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. It will simplify moving the groups into place if the conduits are approximately flush with the concrete, and extension conduits 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 structures.

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

Shipping Groups

The following recommendations and general order of operations will assist in the installation of the 34.5 KV high voltage metal-clad shipping groups:

1. When three or more shipping groups of the switchgear are to be arranged in one continuous assembly, THE CENTER SHIPPING GROUP SHOULD BE THE FIRST LOCATED. The other shipping groups should then be installed in successive order in each direction from the center of the structure.

2. Remove crating and packing material from the groups to be erected.

3. Move the first group into position by crane. (Refer to the section on HANDLING).

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 an accurate level, check the levelness of 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 foundation leveling may be corrected by inserting shims at the points where the individual housings are fastened to the floor steel channels. As can be seen, level foundations are desirable since they automatically 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 instead of level and plumb.

6. Subsequent shipping groups should be moved into position and the procedure outlined in paragraphs 3, 4, and 5 for the first group 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. Remove lifting angle assembly from top of cells.

Shelterfor-M Assembly

The Shelterfor-M housing is shipped separately from the switchgear units. It should be assembled around the switchgear following the instructions furnished with the Shelterfor-M parts.

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 at the power transformer or bus run enclosures require insulation where metal-clad standards are applicable and where electrical clearances so warrant it.

The switchgear high voltage bus connections (such as the main bus and any transfer bus or tie bus) 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, the 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 cleaning solvent such as Stoddard's Solvent (or Westinghouse #1609-1).

CAUTION

KEEP SPARKS AND FLAMES AWAY. DO NOT BREATHE LARGE QUANTITIES OF VAPOR. AVOID EXCESS CONTACT WITH SKIN.

2. Bolt the bus bars together using the splice plates and hardware supplied. See Fig. 21 for hardware placement. Recommended tightness for various types of hardware is shown in Table No. 1.

TABLE NO. 1
Bolt Tightness for Bus and Connections

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

3. Insulate the joint or connection in line with instructions shown on standard drawings 134D043, 348A832, 348A833, 666A486 and 666A487.

Main Power Connections

34.5 KV high voltage metal-clad switchgear is usually provided with potheads for terminating main power cables.

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

When forming cables for termination within switchgear assemblies, avoid sharp turns, corners, and edges in order to prevent damage to, or weakening of, the cable insulation. The cable manufacturer's instructions should be followed closely in determining the minimum bending radii of cables 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.

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 so as to avoid strain on the pothead insulators. The flexible connectors are to be taped in accordance with standard drawing 348A832 and 348A833 along with the complete joint.

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.

Terminals of the solderless type 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 is recommended that the connection to the station ground have a cross section of 500,000 circular mils or greater if the soil in which it is buried is of such character as to cause appreciable corrosion. This is especially true where electrolysis from stray currents or contact with dissimilar metals exists. The resistance of the soil surrounding a station ground depends on the condition of the soil as well as its chemical content. Dry, loose, sandy or frozen soils will have a high resistance as compared with moist soils or soils containing ashes, cinders or salt solution. A variety of methods is available for providing the ground, two of which will be described.

Plate Ground: A very effective ground is obtained by using a copper or brass plate from 10 to 25 square feet area, depending on station capacity, and one-half inch thick. Drill a number of one-half inch holes in this sheet. Place the sheet on a 2-foot layer of charcoal in a pit of sufficient depth to insure contact with permanently moist soil of good conductivity, and deep enough for protection from mechanical damage to plate or cables.

Make permanent connection to the ground plate with stranded cable of at least 500,000 cm area. Fan three feet of the strands over the plate surface and solder or braze them securely. Cover the plate with a two-foot layer of charcoal and fill the pit with earth, settling it with a salt solution.

Pipe Ground: A satisfactory ground can also be made from ten pieces of 1-1/2" galvanized iron pipe of sufficient length to reach moist earth (no less than 12 feet). Drive these pipes into the earth placing them symmetrically over an area at least 25 feet square. Connect all the pipes together by a 500,000 cm cable and clamp connections. Bury the cable a sufficient distance below the surface to prevent mechanical injury.

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.

The switchgear is usually shipped with the lifting mechanism partially elevated to permit access to the conduits where the control wiring is brought into the cells. After the wiring is complete, the lifting mechanism must be returned to its proper position to accept the breaker. See Stationary Main Disconnect section under INSPECTION AND MAINTENANCE in this book.

Loading Check: It is suggested that the loading of the control busses be checked with an ohmmeter to insure against short circuits in the control wiring before energizing initially. If an ohmmeter is not available, serious damage to the control wiring may be avoided by temporarily connecting a small fuse in series with the control source for the initial check.

Shipping Groups: Openings in the sides of the cells provide access for control

connections between housings. When shipment 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.

Rotating Disconnect Potential Transformers

For shipment, the rotating disconnect potential transformers are in the connected position. Before placing the switchgear in operation, the rotating assemblies should be checked as follows:

1. Remove shipping braces.

2. Make rough check of engagement between all moving and stationary contacts in both the connected and disconnected (or grounded) positions. This contact engagement may be checked simply by "lighting-out" or "ringing-out" with a flashlight or bell. Contact engagement is factory adjusted and under normal circumstances will check out properly. However, undue stresses from shipping or handling, or improper leveling may result in poor contact engagement. If adjustments are required, they may be made through the operating link which has an adjustable length.

3. Check fuses to be sure they are good and make proper contact in clips.

Key Interlocks

Key interlocks are often supplied in conjunction with the rotating disconnect potential transformers and special compartments where access is to be denied unless the circuit breaker is 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.

To facilitate manufacture and installation procedures, extra keys are supplied with each lock. The extra keys will also provide a set of spares for the Purchaser, but should be kept where they will not be accessible to operating personnel.

CAUTION

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.

Moving Parts

There are few moving parts in 34.5 KV high voltage metal-clad switchgear and, in general, they do not require installation as they are factory-installed. However, it is recommended that all moving parts be operated during installation to assure that no binding or damage has occurred during shipment or handling. In addition, foreign matter may have accumulated during long periods of storage under unfavorable conditions.

Type SFP Circuit Breaker

Refer to Instruction Book 32-352-2 for complete installation instructions for the type SFP magnetic puffer circuit breaker.

Accessories

Other than the test cabinet, none of the standard accessories listed in the "Description" section of this instruction book require field installation. It is recommended that all the accessories be stored and the test cabinet installed in a clean and dry location convenient to the switchgear.

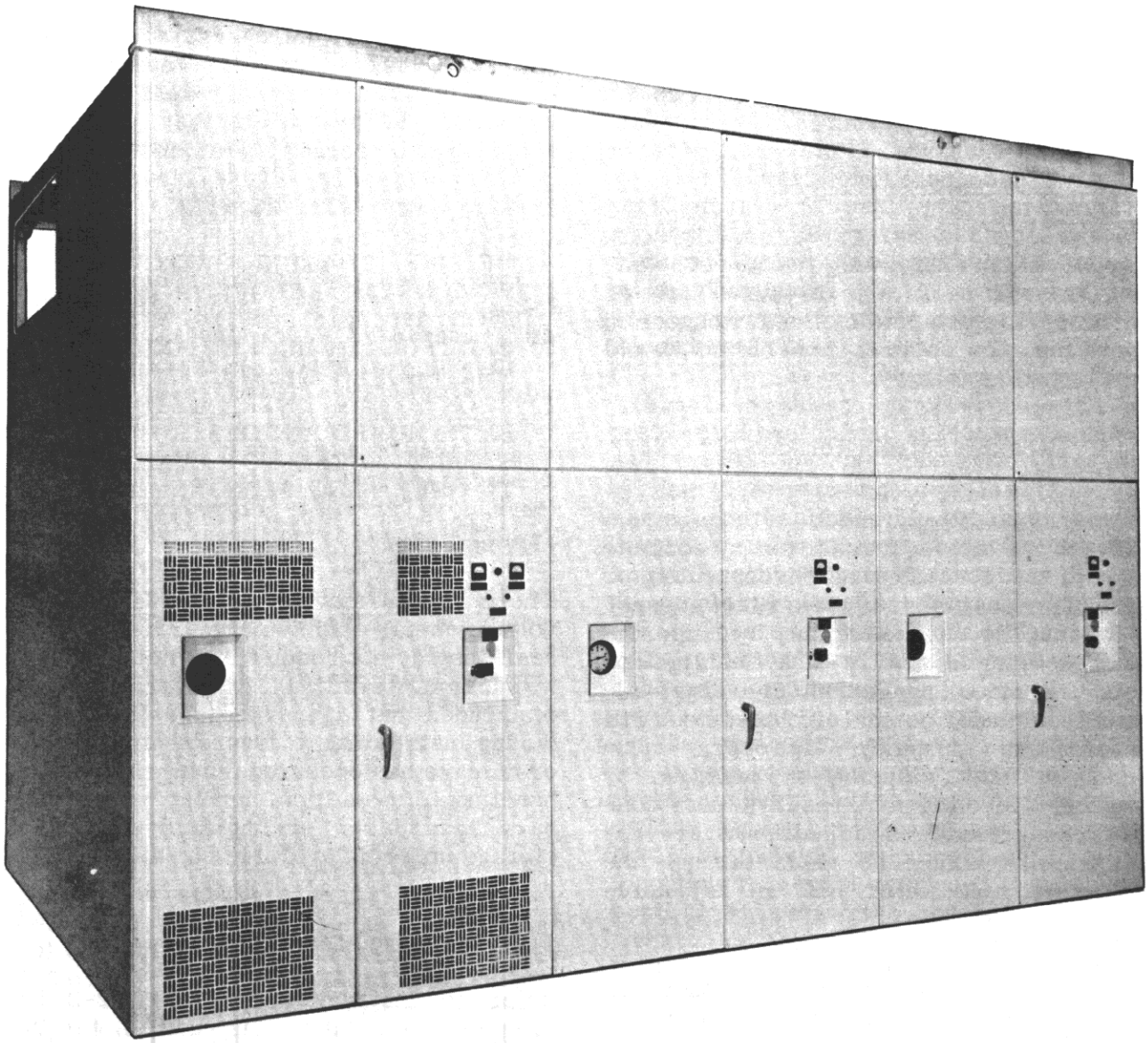


Fig. 1. Indoor Assembly: Front View

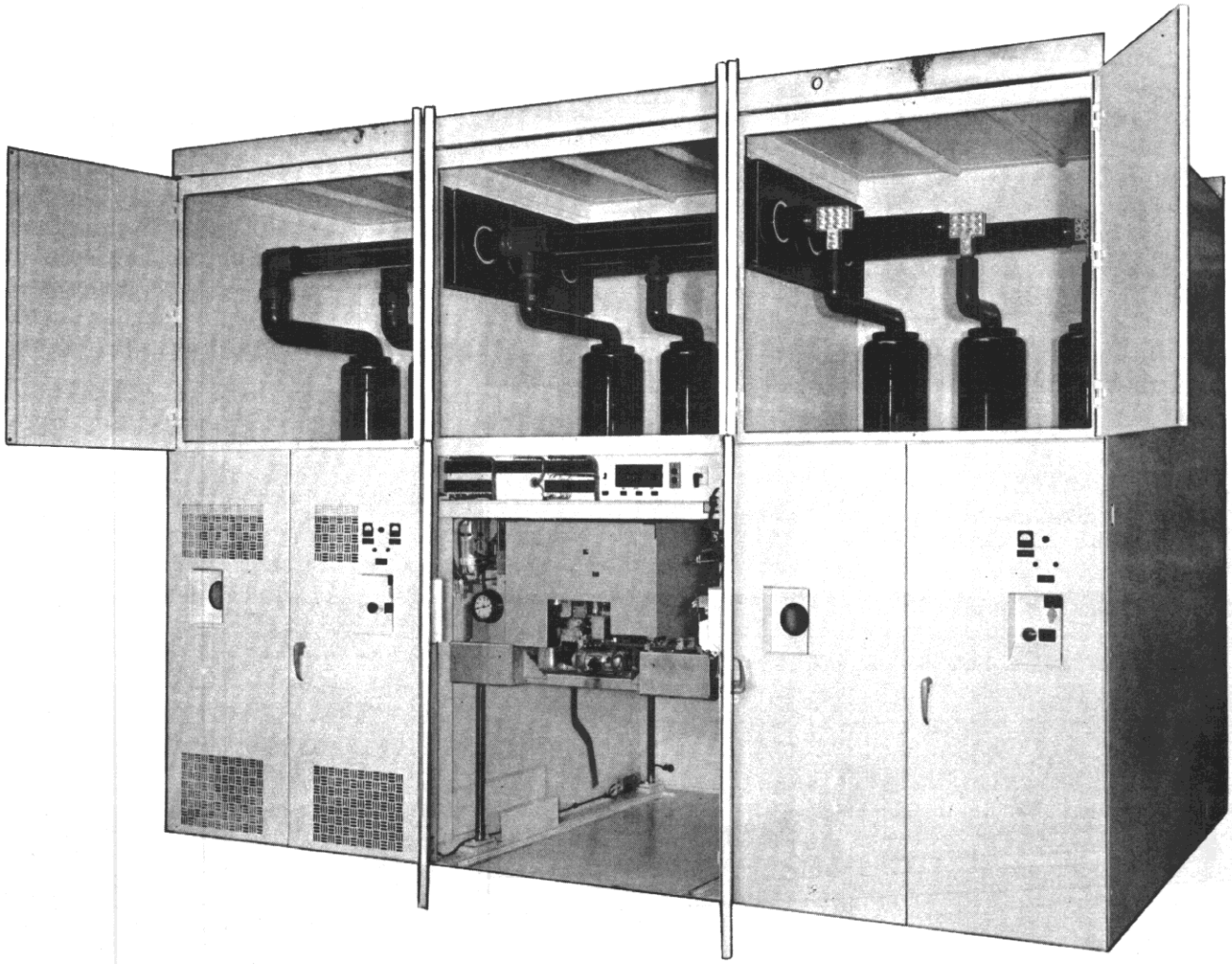


Fig. 2. Indoor Assembly: Breaker in Operating Position

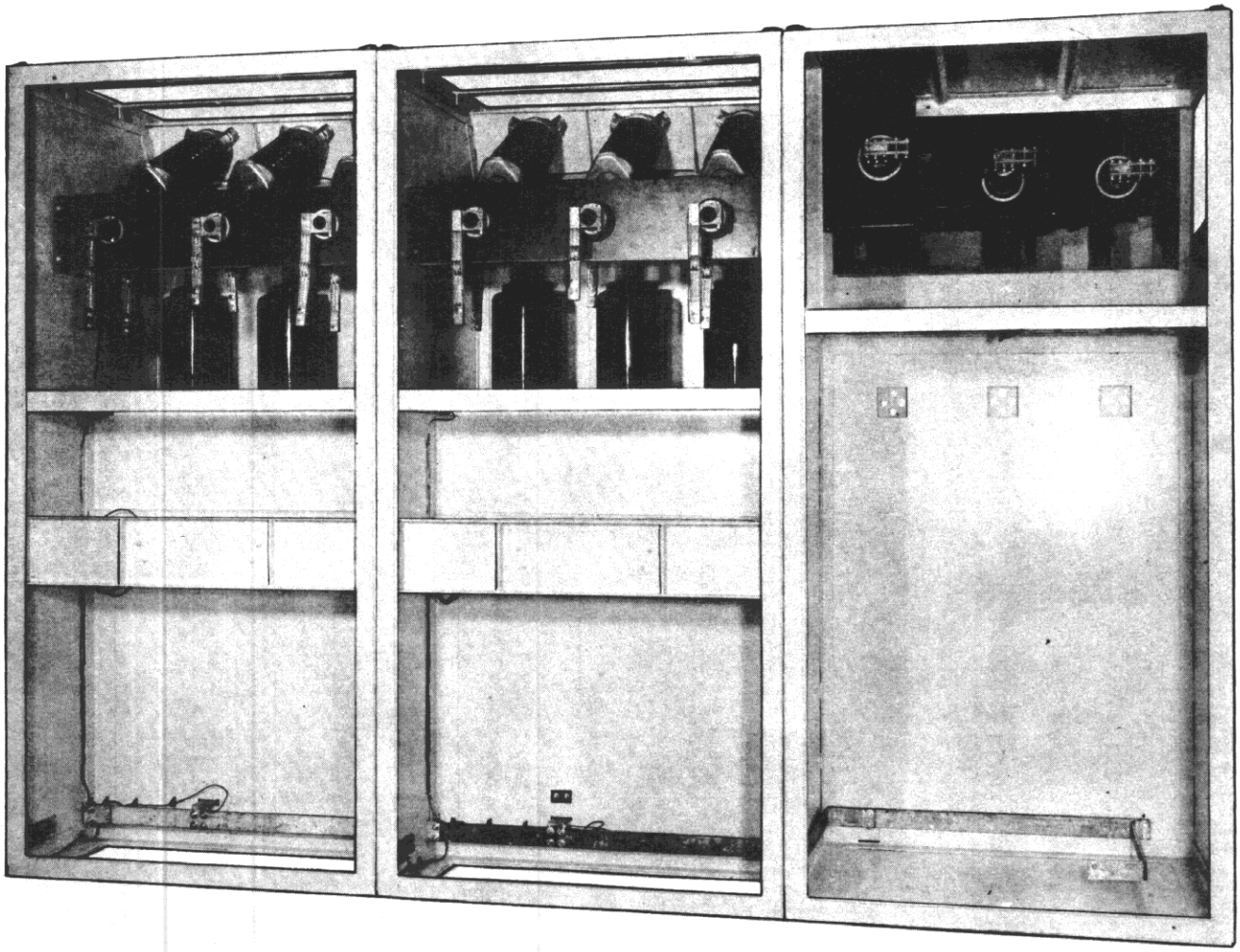


Fig. 3. Indoor Assembly: Rear View

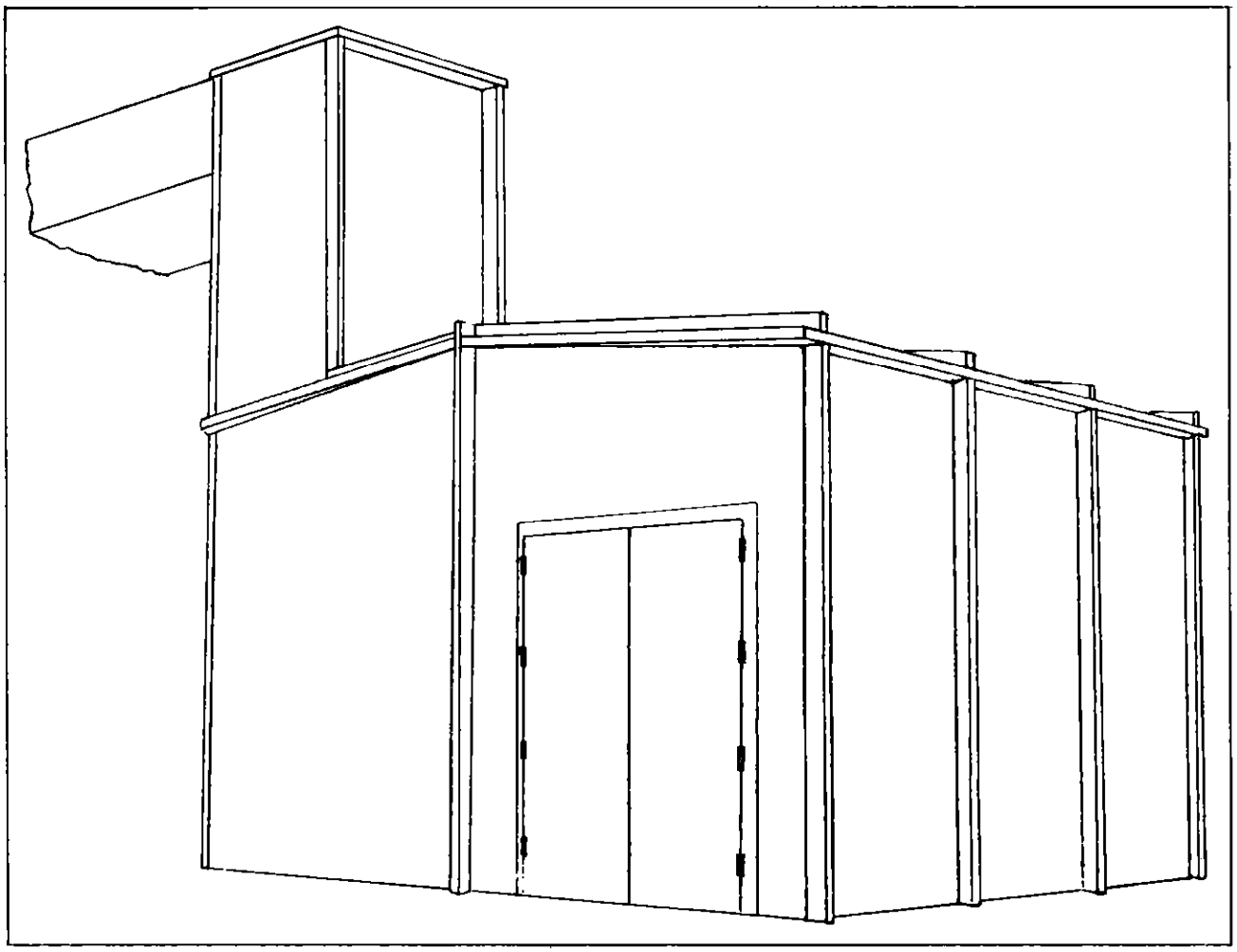


Fig. 4. Typical Shelterfor-M

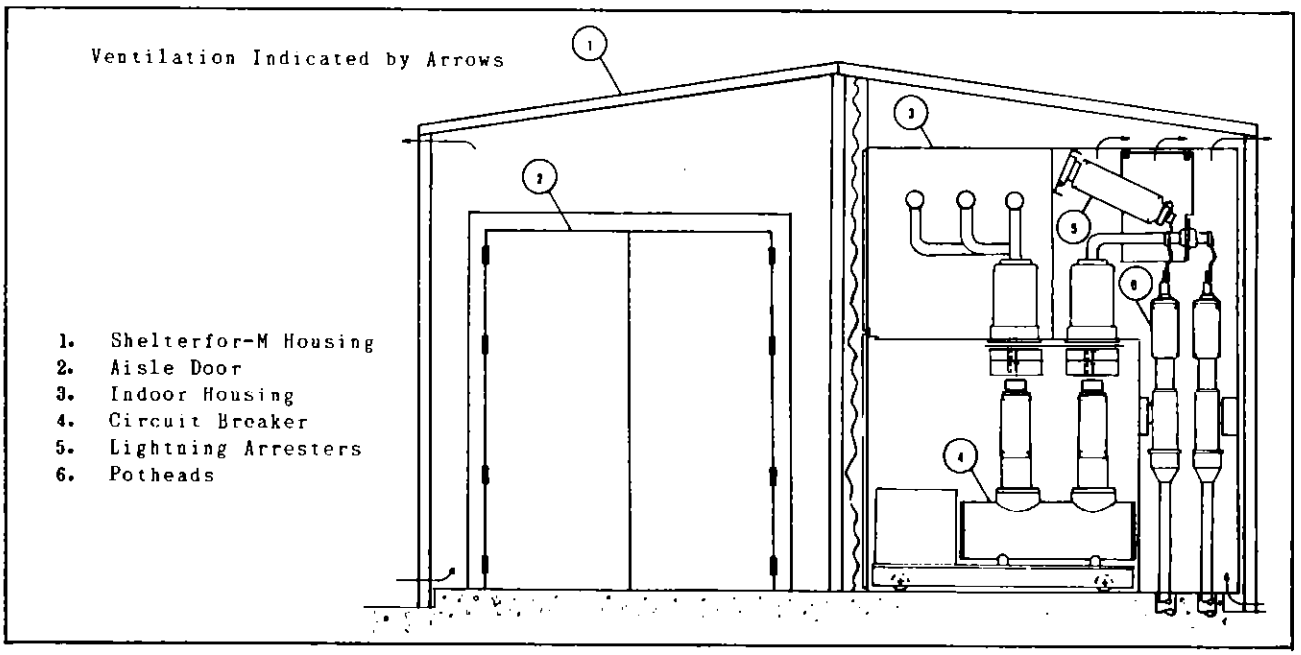


Fig. 5. Shelterfor-M: Section View

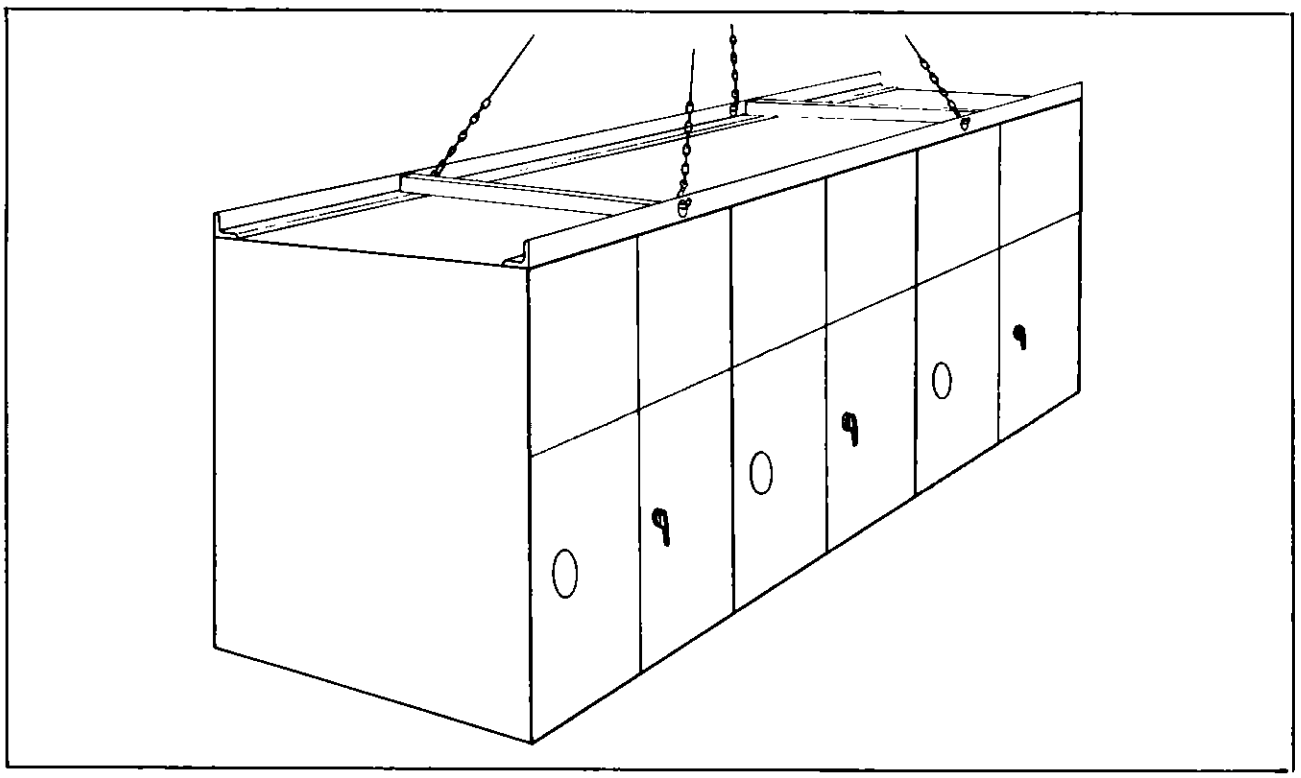


Fig. 6. Handling of Shipping Group

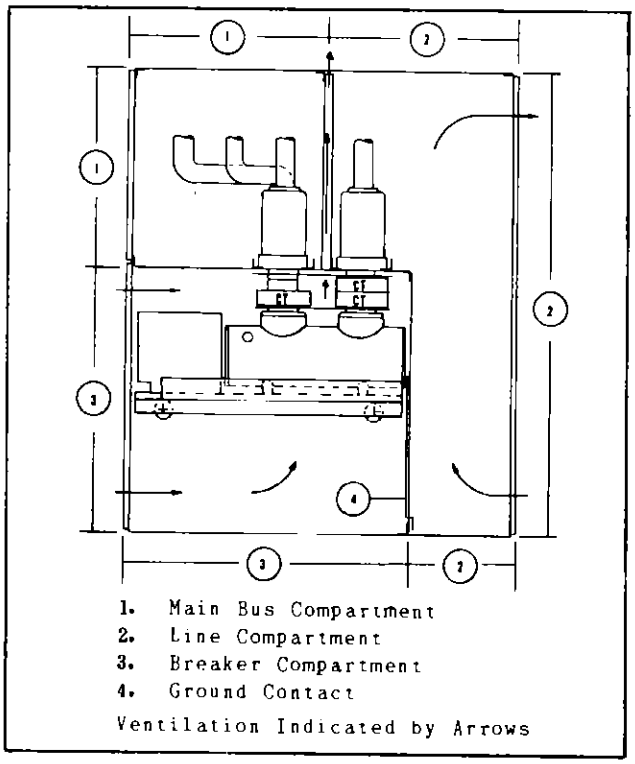


Fig. 7. Typical Breaker Unit

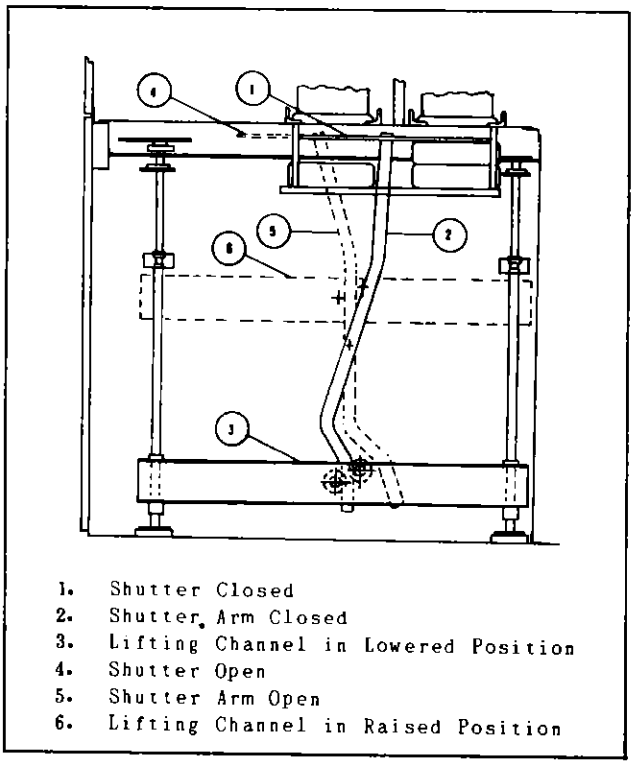


Fig. 9. Shutter Operating Mechanism

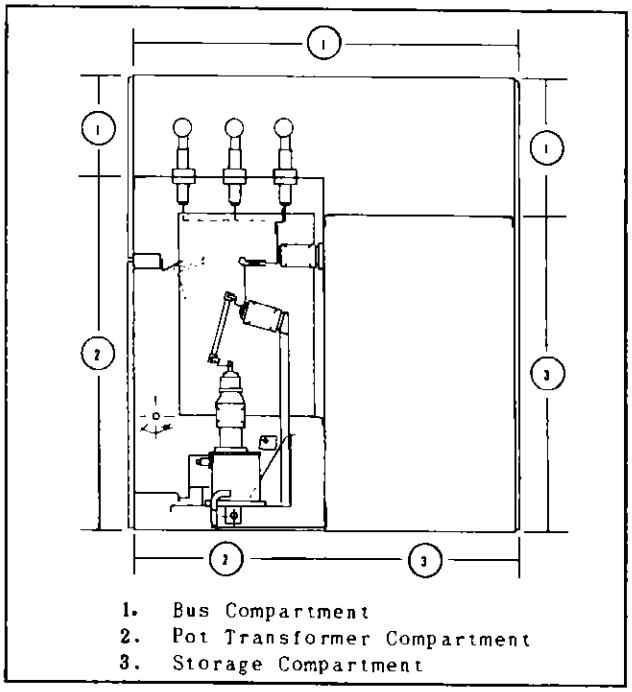


Fig. 8. Typical Auxiliary Unit

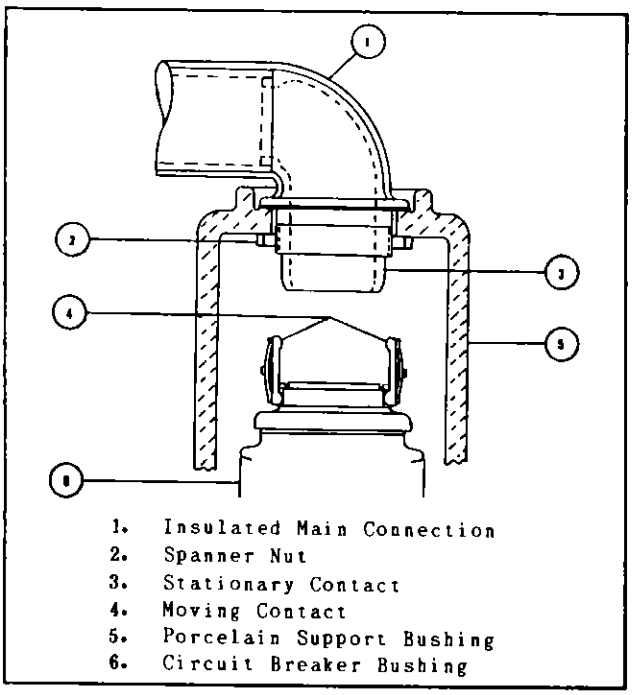


Fig. 10. Primary Disconnecting Contacts

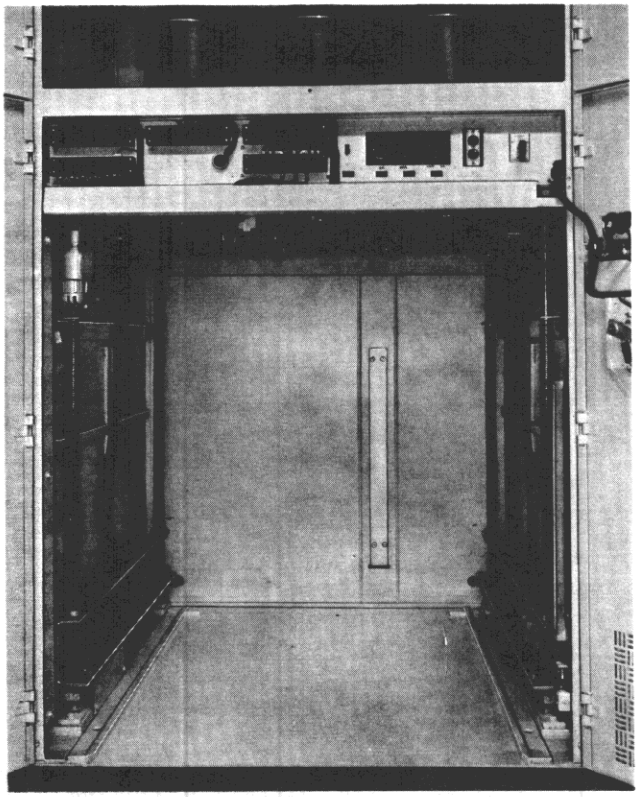


Fig. 11. Breaker Compartment

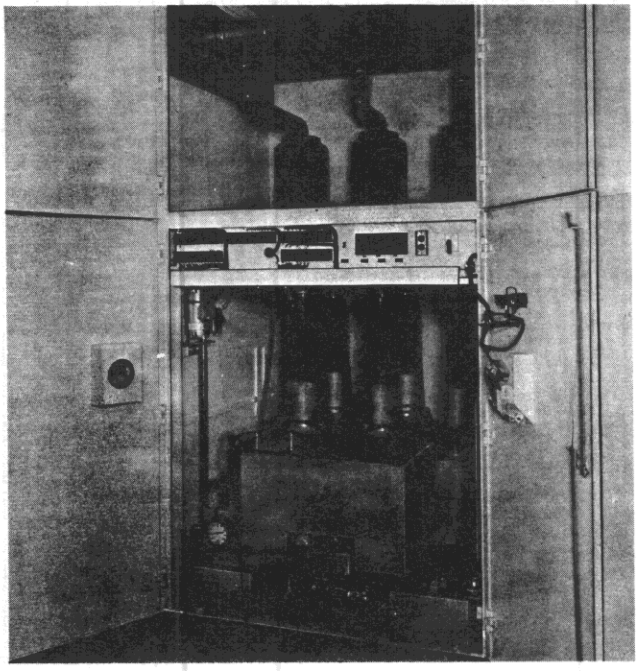


Fig. 12. Breaker in Disconnected Position

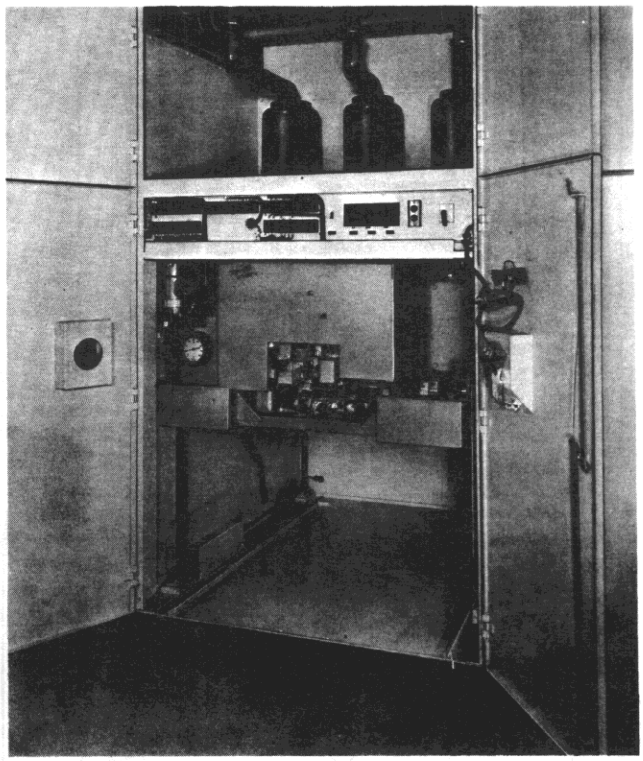


Fig. 13. Breaker in Connected Position

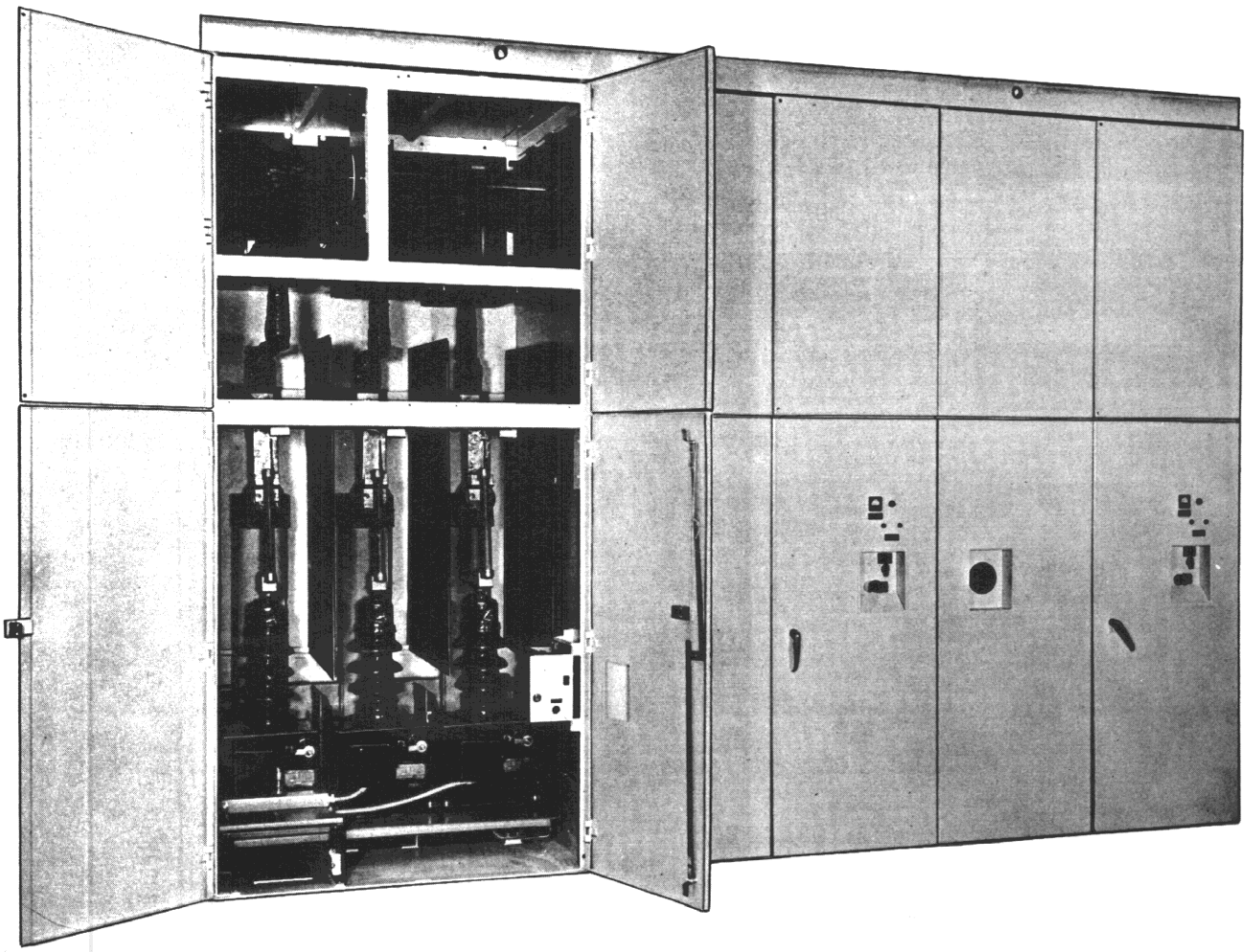


Fig. 14. Auxiliary Compartment with Potential Transformers

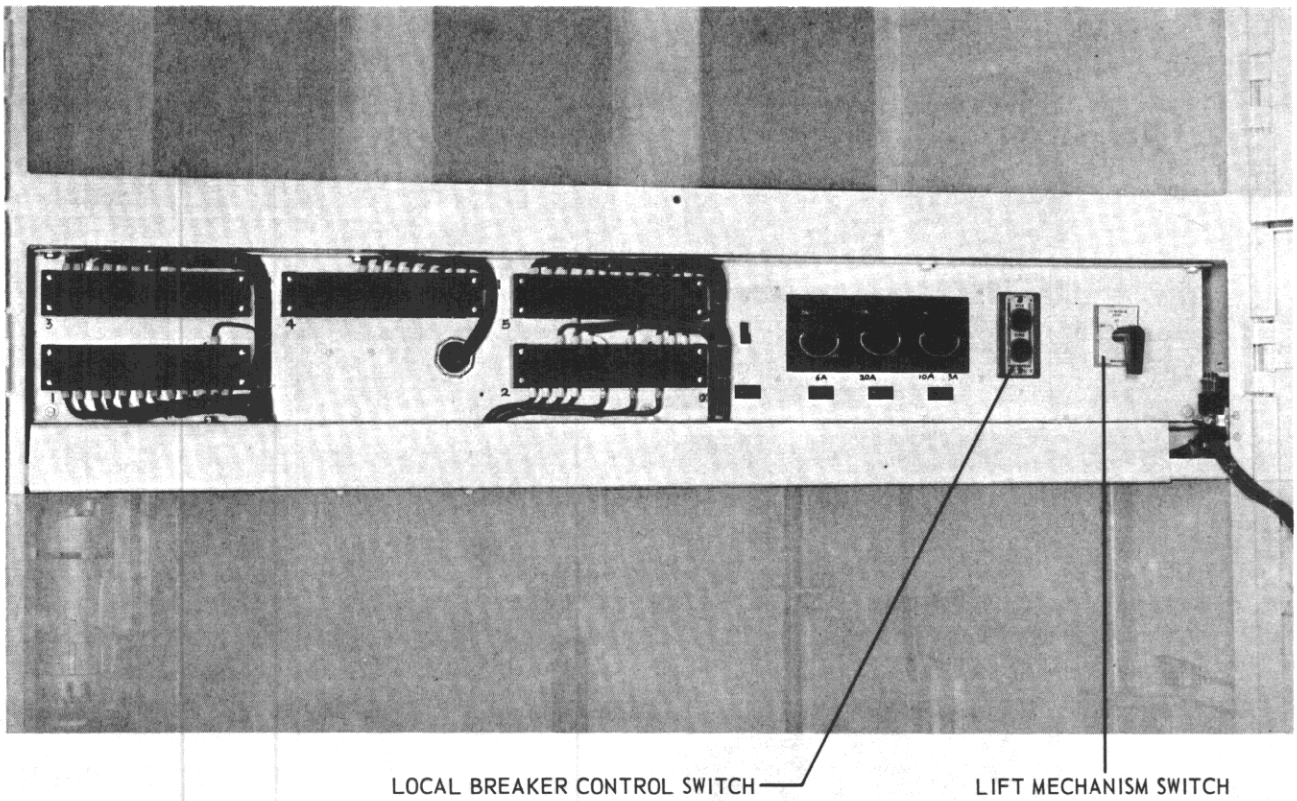


Fig. 15. Control Panel

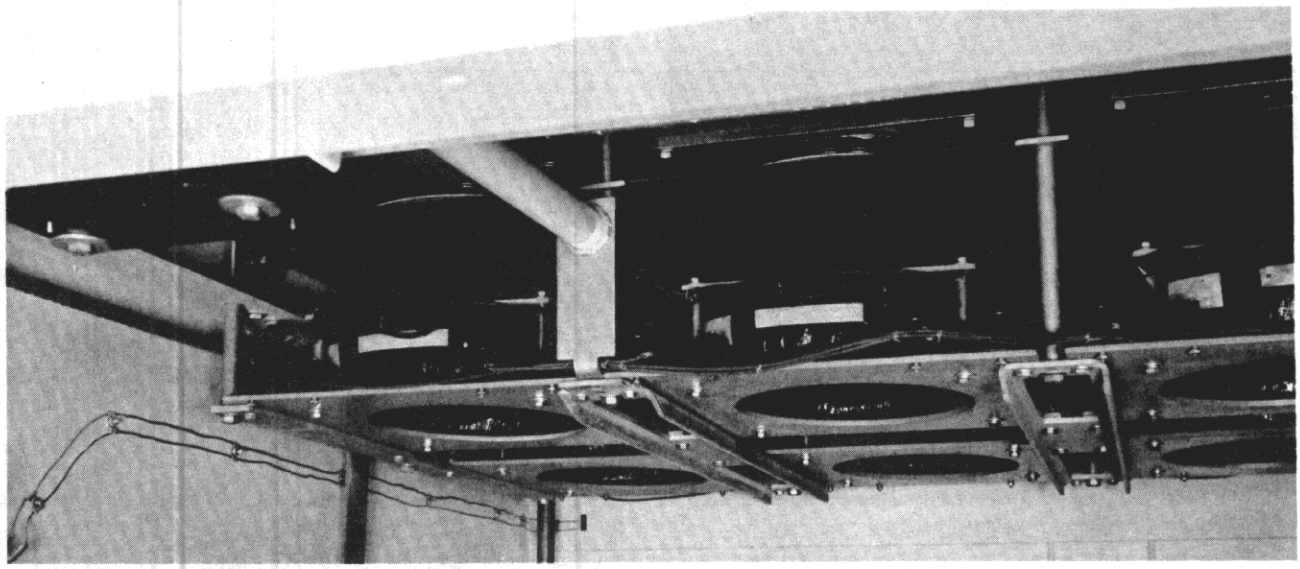


Fig. 16. Current Transformers

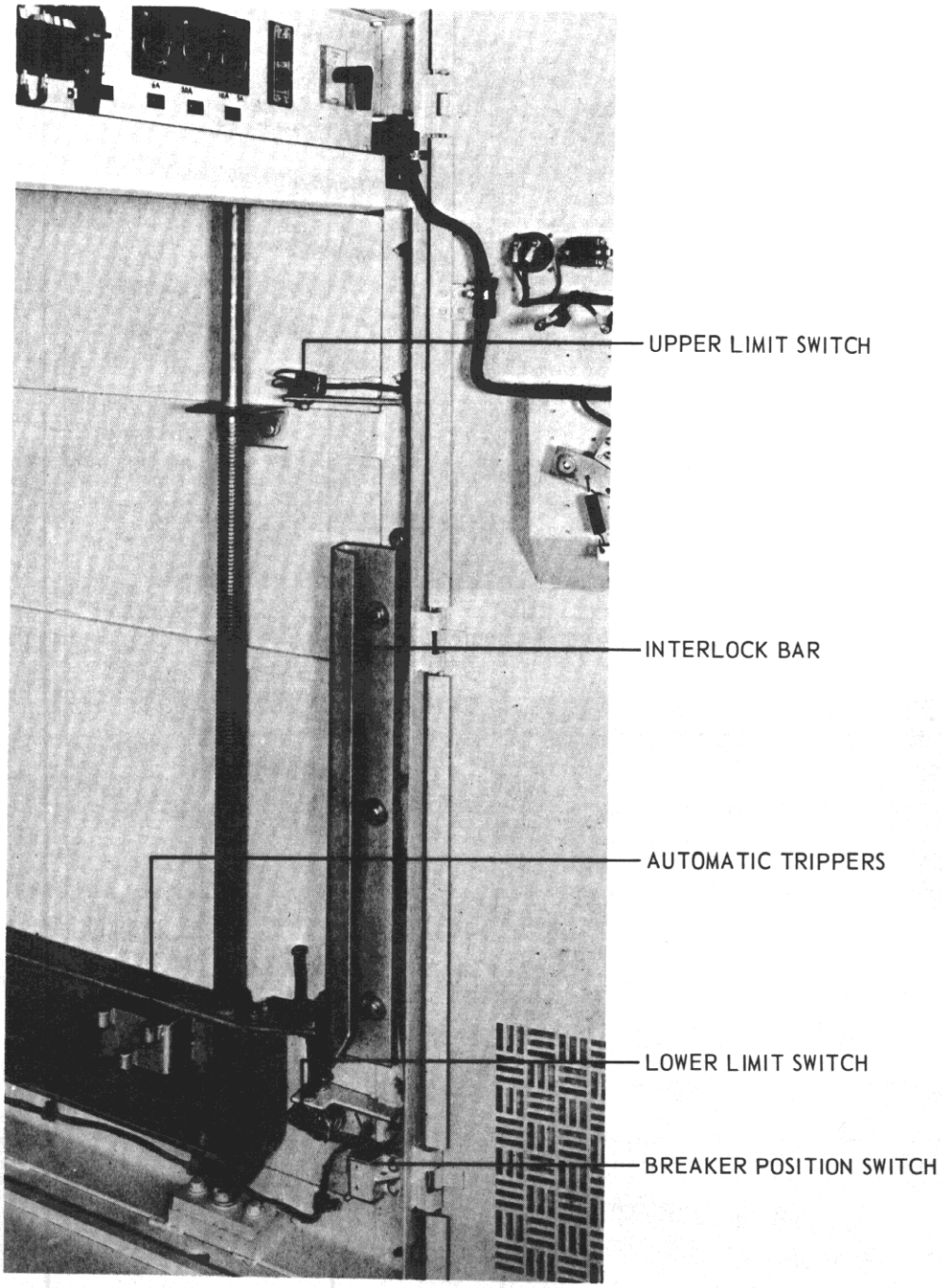


Fig. 17. Interlocks and Limit Switches

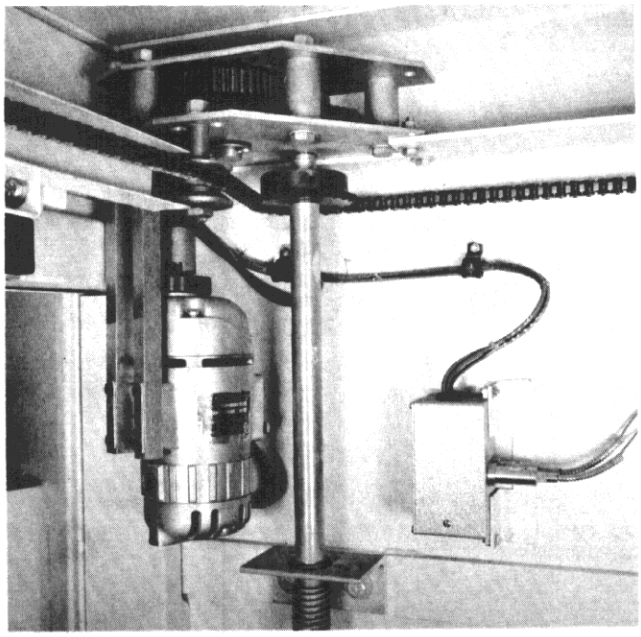


Fig. 18. Lifting Mechanism Gear Box

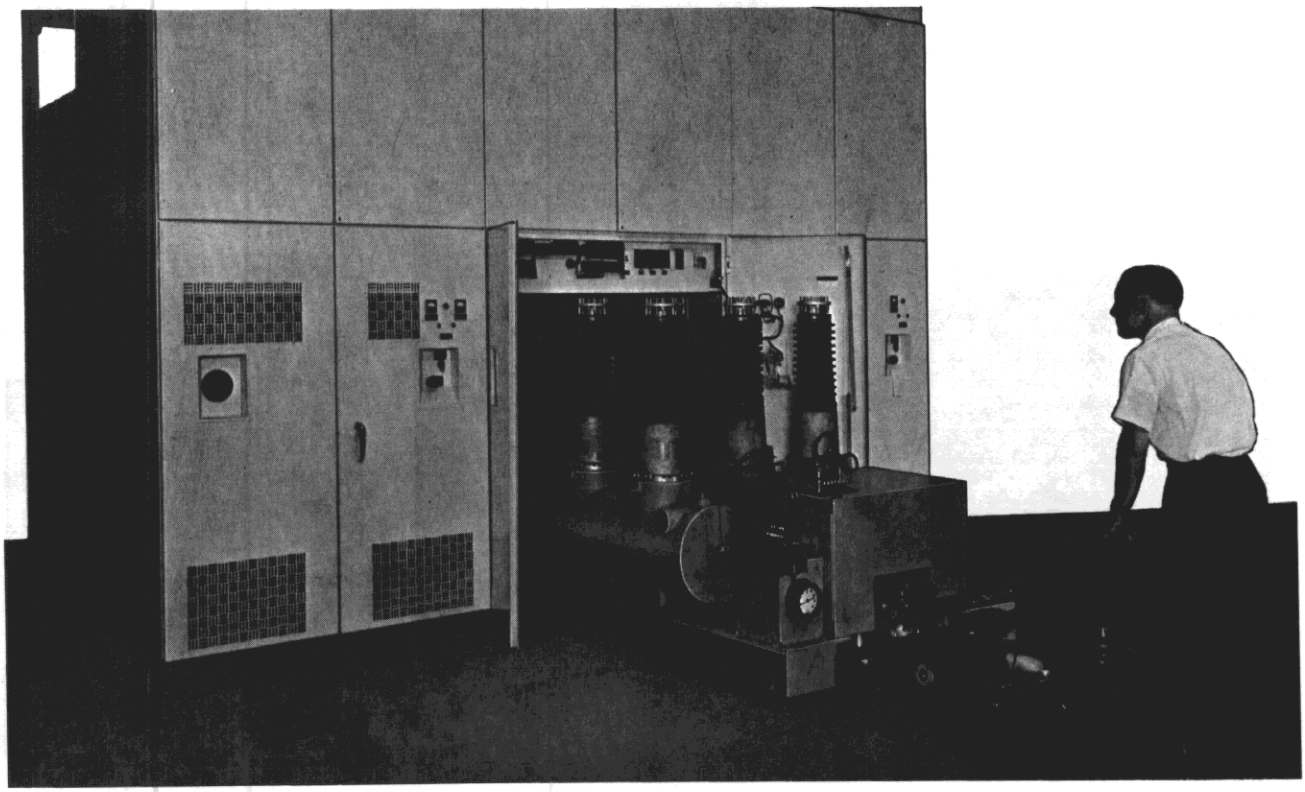
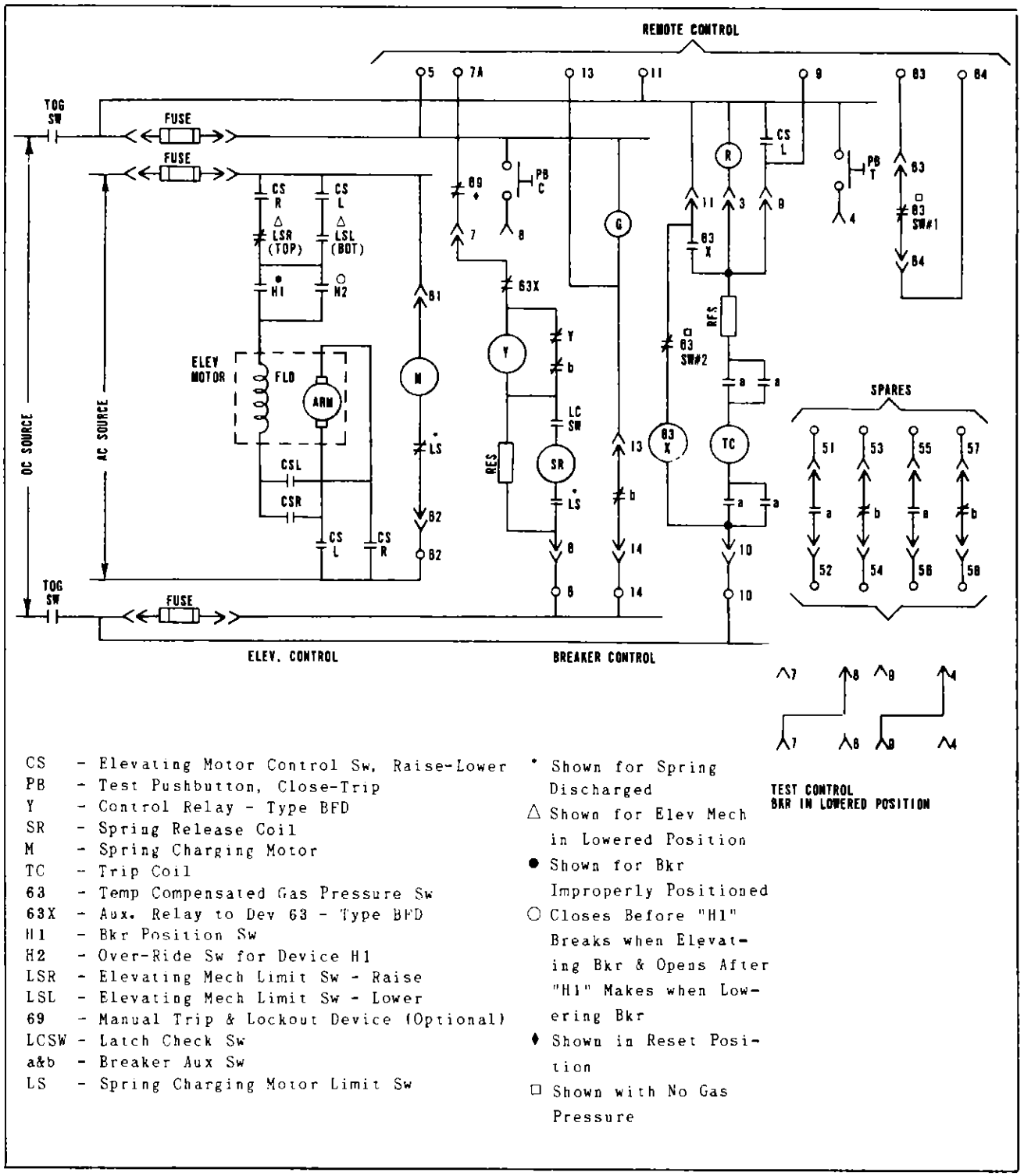


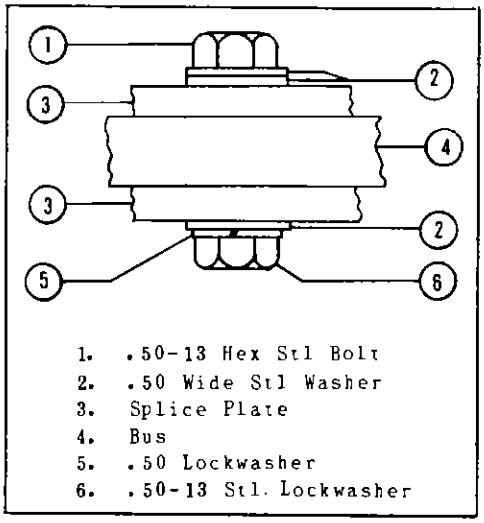
Fig. 19. Turning Dolly



CS - Elevating Motor Control Sw, Raise-Lower
PB - Test Pushbutton, Close-Trip
Y - Control Relay - Type BFD
SR - Spring Release Coil
M - Spring Charging Motor
TC - Trip Coil
63 - Temp Compensated Gas Pressure Sw
63X - Aux. Relay to Dev 63 - Type BFD
H1 - Bkr Position Sw
H2 - Over-Ride Sw for Device H1
LSR - Elevating Mech Limit Sw - Raise
LSL - Elevating Mech Limit Sw - Lower
69 - Manual Trip & Lockout Device (Optional)
LCSW - Latch Check Sw
a&b - Breaker Aux Sw
LS - Spring Charging Motor Limit Sw

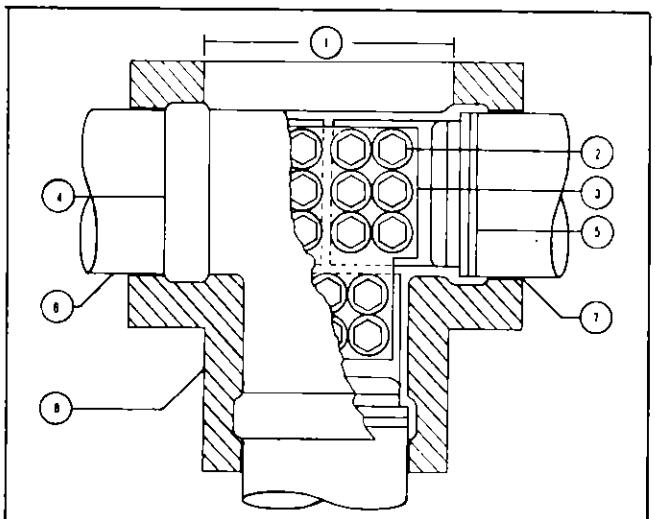
* Shown for Spring Discharged
△ Shown for Elev Mech in Lowered Position
● Shown for Bkr Improperly Positioned
○ Closes Before "H1" Breaks when Elevating Bkr & Opens After "H1" Makes when Lowering Bkr
♦ Shown in Reset Position
□ Shown with No Gas Pressure

Fig. 20. Breaker Control Scheme



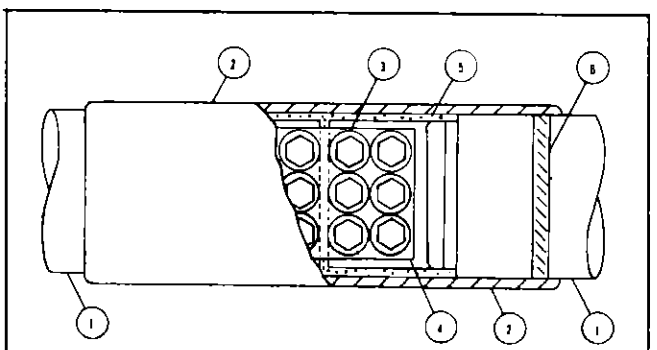
1. .50-13 Hex Stl Bolt
2. .50 Wide Stl Washer
3. Splice Plate
4. Bus
5. .50 Lockwasher
6. .50-13 Stl. Lockwasher

Fig. 21. Typical Bolted Bus Joint Construction



1. Fill Opening
2. .50 Steel Hardware
3. Splice Plate
4. Silicone Rubber (Red) Joint Potting Compound
5. .50 Bead of RTV Adhesive (White)
6. Insulated Conductor
7. Sealing Compound
8. PVC Boot

Fig. 22. Typical Potted Bus Joint



1. Insulated Bus
2. Silicone Rubber Tape (1/2 Lap)
3. .50" Steel Hardware
4. Splice Plate
5. Duxseal
6. .50" Bead of RTV Adhesive (White)

Fig. 23. Typical Taped Bus Joint

Separate Equipment

As mentioned under "Receiving, Handling, and Storing", appendages such as bus runs and potheads are packed and crated separately. They should be uncrated and installed per the shop order assembly drawings.

Unblocking

Many pieces of equipment are blocked or braced for shipment. As an example, refer to the "Rotating Disconnect Potential Transformers" previously discussed. Other apparatus, such as meters and relays, must be scrutinized for forms of blocking or bracing which must be removed.

Adjusting and Testing

After the switchgear together with 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. Extreme care must be exercised to prevent the equipment to be controlled 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. For large and complicated installations ammeters should be available in case unexpected trouble develops. Some simple portable device for "ringing" or "lighting-out" circuits should be included in the testing equipment.

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

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

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 Purchaser's standards or operating practice. If it becomes necessary to modify these relay settings, the instruction leaflet for the relay involved should be carefully studied. These instruction leaflets show typical connection diagrams only and may not necessarily agree with the connections furnished. The schematic diagrams furnished for the 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 gone over and notations made on them of any deviation made during the installation. A set of these should be returned to Westinghouse so that the tracings may be changed for permanent record.

OPERATION

The operation of 34.5 KV high voltage metal-clad switchgear has the advantages of flexibility, safety, and ease of mainte-

nance, plus ease of testing and checking out control circuits.

All circuit breakers with the same rating and control wiring are identical and interchangeable so that it is possible to replace any breaker or housing with another of the same rating and control wiring.

During operation, all live parts are enclosed by barriers which permit the operator to perform his work with maximum safety. Separate doors are provided over each different compartment, so that any compartment of a housing may be exposed without exposing other compartments.

The control circuits may be checked accurately and safely by moving the breaker to the disconnected position where the main circuits are disconnected and the control circuits can be completed by connecting the test cable.

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 unlevel foundation, or from distortion caused during shipment or handling.

As a check to prevent the insertion of a breaker into a switchgear housing of a higher rating, an interference interlock is provided. The interference interlock consists of bars on the rear of the breaker frame and bars welded to the floor of the housing. However, for safety and since the interference interlock 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.

For both indoor and Shelterfor-M installations, the turning dolly (Fig. 19) should be used to assist the alignment between the breaker and the housing.

Installation of Breaker in Cell

The following steps should be carefully followed when installing a breaker in a cell. NOTE: Breaker must be filled with SF_6 gas to 75 psig before placing in service. The alarm will sound if the pressure is below 50 psig and the breaker will trip and lockout if the pressure is below 45 psig. See breaker I.B. 32-352-2 for instructions on filling the breaker with SF_6 gas.

1. Move breaker into cell as far as it will go.

2. The automatic trip device will discharge the springs if they have been charged while the breaker is outside the cell. See Interlock section of circuit breaker I.B. 32-352-2.

3. The breaker may now be operated in the disconnected position by connecting the test cable. As soon as the control circuit is completed thru the test cable, the closing spring motor will start to charge the closing springs. The breaker may now be electrically operated with the "Close and Trip" pushbutton on the control panel. The remote "Close and Trip" are inoperative.

4. Trip the breaker and remove the test cable. The breaker is now ready to raise to the operating position.

5. Turn the lifting mechanism switch to the "Raise" position. The breaker will raise to the operate position.

NOTE: The breaker must be all the way in the cell so that the guide pins on the lifting channels engage the holes in the breaker truck. The breaker must be in the

proper position or the lift mechanism circuit will not be completed and the lift mechanism will not operate. This is accomplished by switch H1 in the control scheme. This switch is actuated by the breaker and can be seen in Fig. 17.

6. As the breaker starts to raise to the operate position, the interlock bar, see Fig. 17, will hold the breaker mechanically trip free till it reaches the engaged position.

7. When the breaker reaches the engaged position, the upper limit switch, see Fig. 17, will shut off the lifting mechanism.

8. The correct breaker travel is 29-7/8 ± 1/8 inches.

9. The breaker can now be operated from the remote position. The push-button on the control panel is inoperative.

10. To remove the breaker, trip the breaker open and turn the lift mechanism switch to the "Lower".

11. Two interlocks are provided to insure that the breaker is open before the primary contacts part. First, a contact in the lift mechanism switch makes up the trip circuit when the switch is in the "Lower" position. Second, the interlock bar in the cell, Fig. 17, will mechanically trip the breaker before the primary contacts part.

12. The lower limit switch, Fig. 17, will shut off the lift mechanism when the breaker is fully lowered.

13. The breaker may now be removed from the cell.

Breaker Operation and Mechanical Interlocks

Refer to circuit breaker instructions I.B. 32-352-2 for detailed operating instructions.

Electrical Operation

General: A one-line or three-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.

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.

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.

Breaker Control Scheme: The details of circuit breaker operating schemes may vary widely on different metal-clad switchgear installations. However, all schemes are derived from the basic control scheme which is shown in its simplest form in Fig. 20. It complies with requirements formulated and approved by AEIC, IEEE, NEMA, and ASA.

Capacitor Switching: CAUTION: AFTER A CAPACITOR BANK HAS BEEN REMOVED FROM THE LINE, IT SHOULD NOT BE RE-ENERGIZED FOR AT LEAST 5 MINUTES TO ALLOW THE CAPACITORS TO DISCHARGE.

INSPECTION AND MAINTENANCE

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 taken to insure that no personnel come in contact with a "live" high-tension part. Common general precautions for high voltage work are:

1. All connections should be considered "alive" until the crew expecting to work on them is assured that the circuits are "dead", 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 thereon.

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, therefore, be made by the Purchaser for connecting adequate flexible ground leads so as to reach 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.

Access to Switchgear Parts

High Voltage Parts: 34.5 KV high voltage metal-clad switchgear is designed with metal isolation between the SFP circuit breaker compartment, the bus compartment, and the line compartment. Access to high voltage parts is thru doors WHICH SHOULD NOT BE OPENED UNLESS THE PARTS TO BE EXPOSED ARE "DEAD".

Stationary Main Disconnecting Contacts: The stationary main disconnecting contacts are inside the porcelain bottles in the bus compartment. See Figs. 7 and 10. They are accessible from the breaker compartment.

To gain access to the main disconnecting contacts, the breaker must be removed from the cell and the shutter opened.

The shutter is operated by the motion of the breaker lifting mechanism and this mechanism normally will not raise unless the breaker is in the proper position in the cell. To raise the lifting mechanism to open the shutter without the breaker being in the cell, proceed as follows:

1. BE SURE THAT THE CIRCUIT ON BOTH BUS AND LINE SIDE ARE "DEAD". DO NOT OPEN THE SHUTTER UNLESS ALL HIGH VOLTAGE CIRCUITS ARE "DEAD".

2. Turn lift mechanism switch to "RAISE" position. The lift mechanism will not raise at this time because the breaker is not in the cell.

3. Actuate the breaker positioning switch, See Fig. 17, by hand. It will be necessary to hold the switch until the mechanism has raised about 1/2 inch. The mechanism will then continue to raise without this switch being held.

4. Shut-off lift mechanism when the shutter is open.

To close the shutter and return the lift mechanism to the proper position to accept

a breaker, reverse the procedure above. It will be necessary to operate the position switch as above to return the lift mechanism to the final position.

Current Transformers: The current transformers are mounted in the breaker compartment below the shutter, See Fig. 16. When the breaker is removed from the cell the shutter is closed and the CT's are completely isolated from the high voltage.

To change CT's, disconnect the wiring from the terminal block and remove the four bolts that hold the CT assembly to the CT support members. Slide the CT assembly forward off the support members.

Rotating Disconnect Potential Transformers: Figures 8 and 14 are pictures of rotating disconnect potential transformers. The compartment doors and the tilting mechanism are key interlocked so that the transformers must be rotated to the disconnected position before the door can be opened.

CAUTION

DISCONNECTING THE TRANSFORMERS DOES NOT DE-ENERGIZE THE STATIONARY CONTACTS. DO NOT ATTEMPT ANY WORK ON THESE CONTACTS UNLESS THE MAIN BUS IS "DEAD".

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.

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 co-ordinated with the overall program to result in the least operating inconvenience and circuit shutdown.

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

1. Buses and connections: De-energize primary circuits and open compartment doors. Before cleaning take "megger" readings between phases and to ground. Inspect for symptoms which might indicate 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 solvent such as Stoddard's Solvent (or Westinghouse #1609-1).

CAUTION

KEEP SPARKS AND FLAMES AWAY. DO NOT BREATHE LARGE QUANTITIES OF VAPOR. AVOID EXCESS CONTACT WITH SKIN.

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

voltage test should not exceed 75% of the factory test values given for new switchgear. Transformer primary fuses should be removed during high potential tests.

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 Stoddard's Solvent. (See preceding paragraph.) 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 breaker instruction book. (See I.B. 32-352-2).

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.

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

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

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.

7. Mechanical Parts: Visually check and manually operate mechanical moving parts such as the shutter, hinged doors, and the rotating features of the transformers. Examine mechanical mating parts such as the lifting mechanism, the guide rail and cell trippers.

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 possible debris.

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 have a long life of reliable service. 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.

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, insofar as possible, under similar conditions at successive periods. Records should include the megger reading, the temperature and the humidity (either by definite reading or description). These limits 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.

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 local 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 so as 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.

Lubrication

34.5 KV high voltage metal-clad switchgear is designed so that minimum lubrication is required under normal conditions. A thin film of good gear grease should be kept on the lifting mechanism gears and the jack screws. All the bearings in the lifting mechanism except the thrust bearings under the jackscrews are oil impregnated bronze bearings and should not normally require lubrication. An occasional drop of oil should be applied to the shutter rollers, the shutter operating arm pivots, and the jackscrew thrust bearings. The roller chain is prelubricated. A very thin film of vaseline may be used on the primary disconnecting contacts. The application of the lubricants should be held to a minimum to reduce the accumulation of dust and dirt.

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.