I.B. 32-150-4A

DESCRIPTION • INSTALLATION • MAINTENANCE

# INSTRUCTIONS

# METAL-CLAD SWITCHGEAR

with

## Type "DH" Air Circuit Breakers



**WESTINGHOUSE ELECTRIC CORPORATION**

SWITCHGEAR DIVISION

EAST PITTSBURGH PLANT • EAST PITTSBURGH, PA.

SUPERSEDES I.B. 32-150-4

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# IMPORTANT

Metal-clad switchgear is strongly built and provided with many safety features. Nevertheless, it controls high voltage circuits which are dangerous and the equipment contains many delicate devices. The following summarizes recommended *PRECAUTIONS* in handling, installing, and operating metal-clad switchgear:

**1.** Only authorized personnel should be permitted to handle or operate the switchgear.

**2.** Handle all switchgear (even if crated) with extreme care as it contains delicate instruments and relays which may be damaged by rough handling.

**3.** When uncrating switchgear, exercise care not to scratch or mar the panel finish.

**4.** Remove blocking of relay armatures and check control circuits (except potential and current transformer circuits) for grounds and short circuits before applying control power (Refer to "Loading Check" page 32).

**5.** Check proper phasing of all circuits and connect the switchgear to the station ground before applying high voltage power.

**6.** Do not work around "live" parts. The compartments of metal-clad switchgear are arranged so that, if a circuit has been de-energized, the compartment enclosing that circuit may be opened for maintenance without exposing any other circuit.

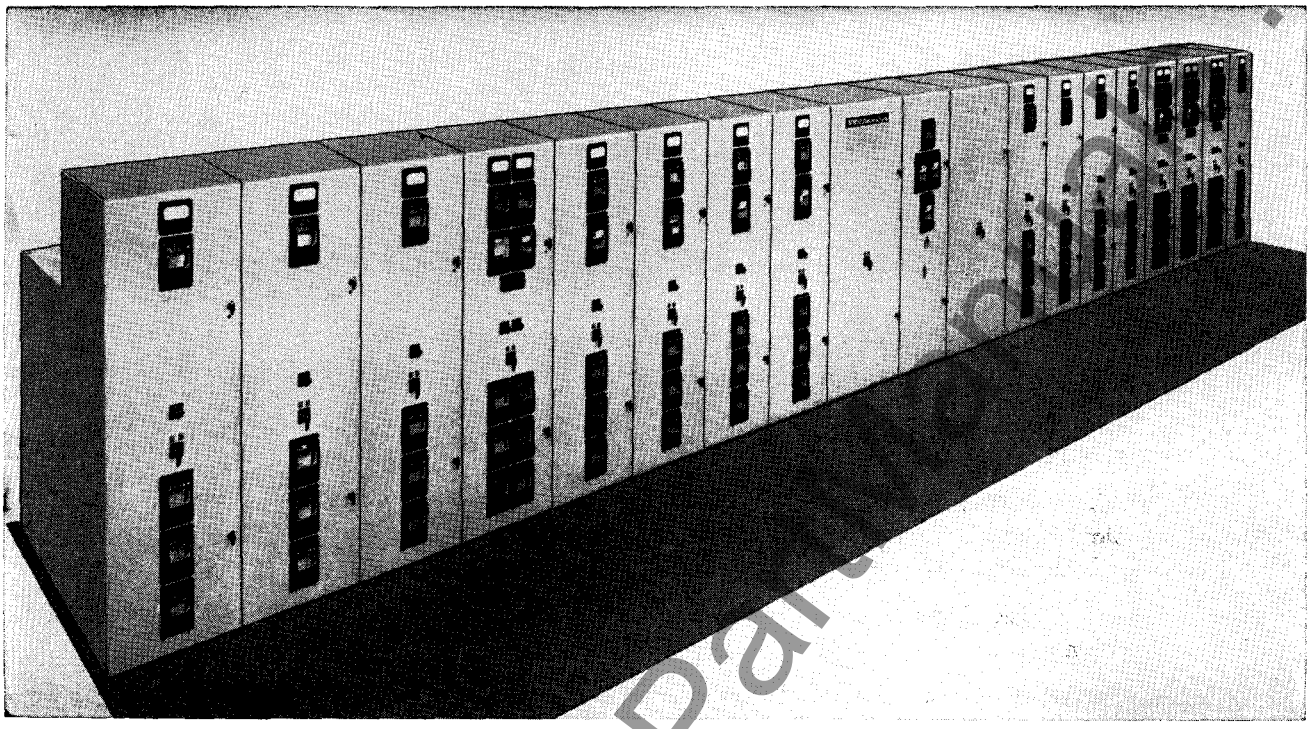
**7.** Never bring an exposed flame near the storage battery since the gasses given off during charging may form an explosive mixture.

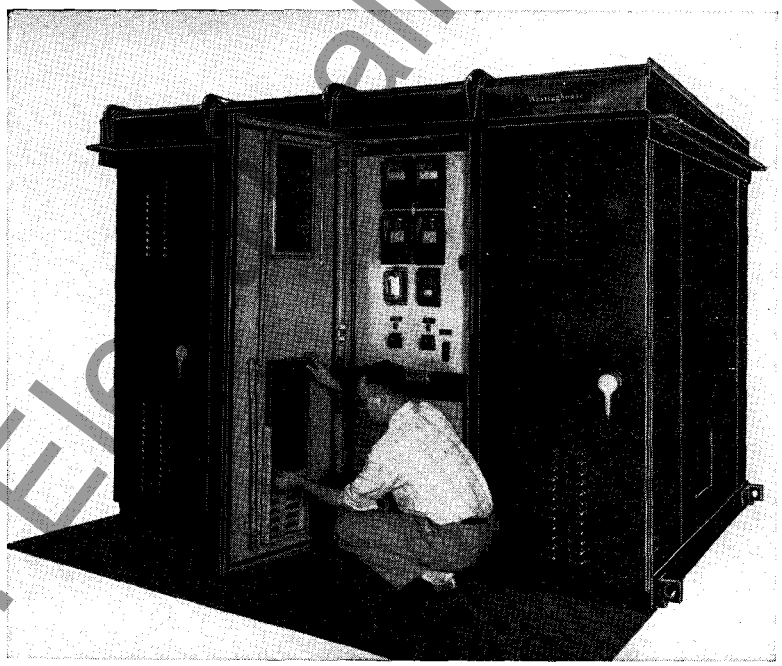
**8.** In case of fire do not use liquid fire extinguishers until all circuits have been made electrically "dead".

**9.** An ounce of prevention is worth a pound of cure. All personnel responsible for supervision and operation should be familiar with the switchgear and its functions. In time of emergency there is seldom time to consult the instruction material.

**10. Caution.** *If outdoor switchgear is to be stored prior to installation, provision must be made for energizing the space heaters to prevent condensation of moisture inside the switchgear.*

**11. Caution.** *If indoor switchgear is to be stored prior to installation, it must be protected from the weather and be kept free of condensation. Whenever possible store the indoor switchgear where it will not be exposed to sunlight or sustained temperatures of 120°F. and higher. If the switchgear has been so exposed, the strippable plastic coating supplied on the front panels* **must be removed within 30 days.**





# High-Voltage
# METAL-CLAD SWITCHGEAR

This instruction book has been prepared to familiarize the Purchaser's engineering, installation and operating staffs with the metal-clad switchgear supplied by Westinghouse for this assembly. 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 the 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 connection diagrams for the switchgear assembly. Instructions on standard apparatus such as relays, instruments and circuit breakers are included as required in the instruction book for a particular metal-clad assembly.

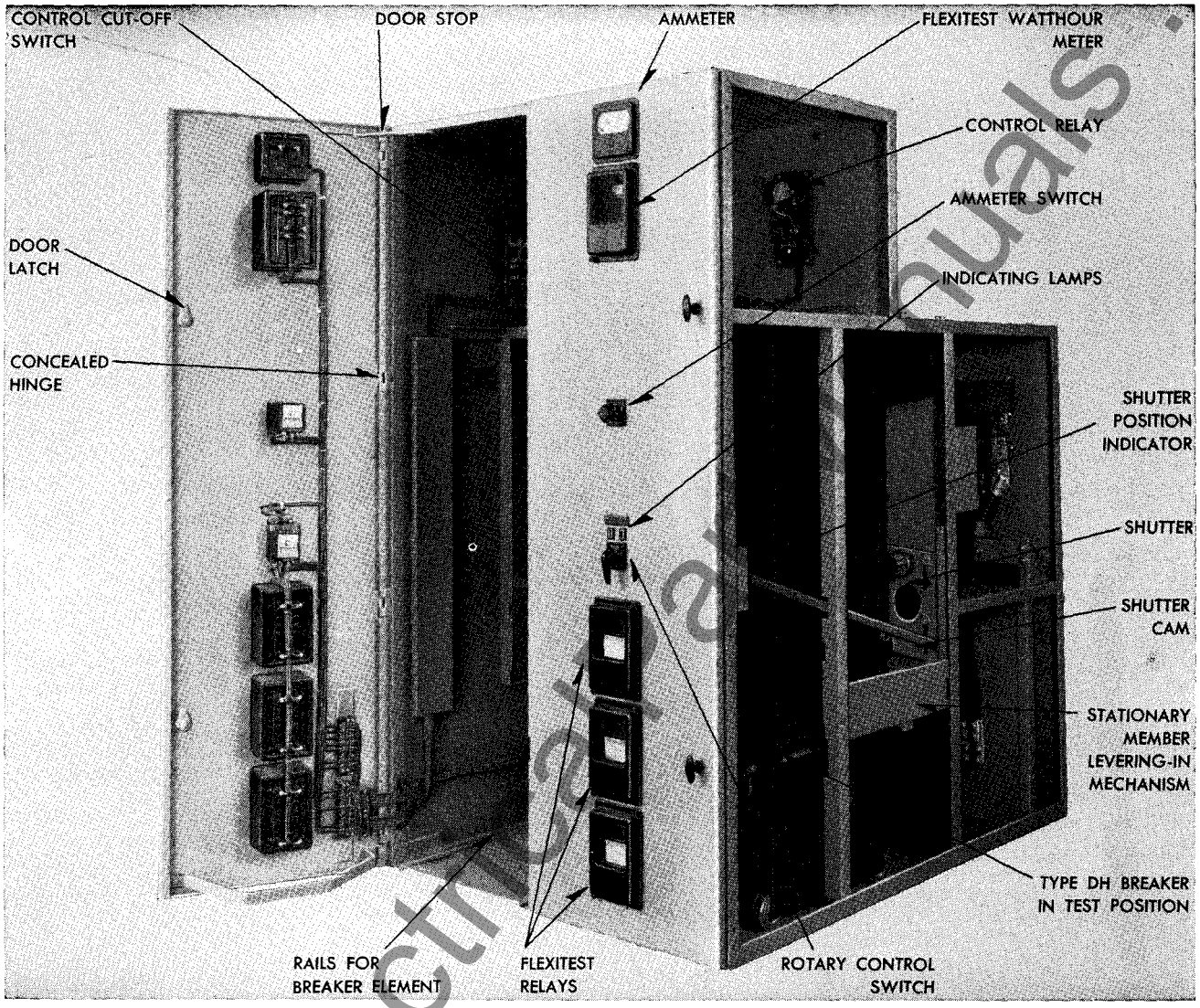



**FIG. 1. Front View of Typical Indoor Metal-Clad Switchgear Housing**

# DESCRIPTION

Metal-Clad switchgear is designed to accomplish the control of high voltage circuits. The necessary circuit breakers, busses, current transformers, potential transformers, protective relays and secondary control devices are all included in one metal-clad assembly. This assembly, in general, is composed of standard sub-assemblies or units arranged to provide the structure required by the Purchaser's order.

The general assembly and section drawings which are made for each switchgear installation present a picture of the complete assembly of component equipment. The designations of the circuits controlled, the voltage and current rating of the bus and circuit breakers and a simplified one-line diagram of the main connections are all normally included on these drawings.

Each metal-clad unit consists of a stationary housing and a removable breaker element. The housing supports the instrument panel and contains the busses, instrument transformers and circuit connections. The breaker element consists of a type "DH" air circuit breaker mounted on a wheeled frame.

Metal-clad switchgear is designed to provide maximum safety to the operator. During normal service there is no danger of accidental contact with high-tension line parts because all high-tension equipment and connections are enclosed in grounded, metal compartments. The removable feature of the breaker element affords the same protection as air break switches in isolating the circuit controlled.

Access to the control wiring and secondary connection compartments is provided by hinged doors or panels. These panels may be opened safely when the units are in service because steel barriers isolate these connection compartments from the high-tension circuits. Access to the high-tension compartments enclosing current transformers, busses and connections, is provided by removable bolted-on covers. These covers should not be removed unless the circuits to be exposed are de-energized. Potential transformers provided with metal-clad switchgear are of the disconnecting type which insures that the primaries are disconnected and grounded before the fuses are accessible.

A mechanical interlock on the levering device prevents moving the breaker into or out of the operating position unless the breaker is tripped. Other safety features such as key interlocks, locked panels, and electrical interlocking of control circuits are provided when specially ordered.

For outdoor use the switchgear is designed with a weather-proof housing, special under-frame or base, and with access doors at both front and rear of the unit. Also for outdoor use, space heaters and special ventilators are provided in each unit to reduce the possibility of condensation.

The following paragraphs describe in further detail the principal parts and features of the metal-clad switchgear construction.

## HOUSING

The housings are made of structural steel members and hot rolled stretcher-levelled steel sheets, securely welded together to form rigid, self-supporting, completely enclosed units with metal barriers between the different compartments. The housings are assembled in jigs which insure that all units will be uniform and accurate in size.

The front of the switchgear assembly is generally considered to be the instrument panel side of the switchgear. Fig. 1 shows the front view of typical indoor metal-clad switchgear housings. The removable breaker element is withdrawn on the instrument panel side for the standard indoor construction and on the side opposite the instrument panel for the outdoor construction. For special designs, the front instrument panel and breaker drawout sides are as marked on the general assembly and section drawings. A metal barrier isolates all high tension parts of the breaker from the enclosing panel on the breaker drawout side so that the control wiring and breaker mechanism may be inspected without exposing any high tension parts.

The outdoor weatherproof housings are constructed of framed sections of hot rolled stretcher-levelled steel. Weatherproof hinged doors are provided at both the instrument panel and breaker drawout sides. Typical views of the instrument panel and breaker drawout sides of outdoor switchgear are shown in Figs. 2 and 3. These

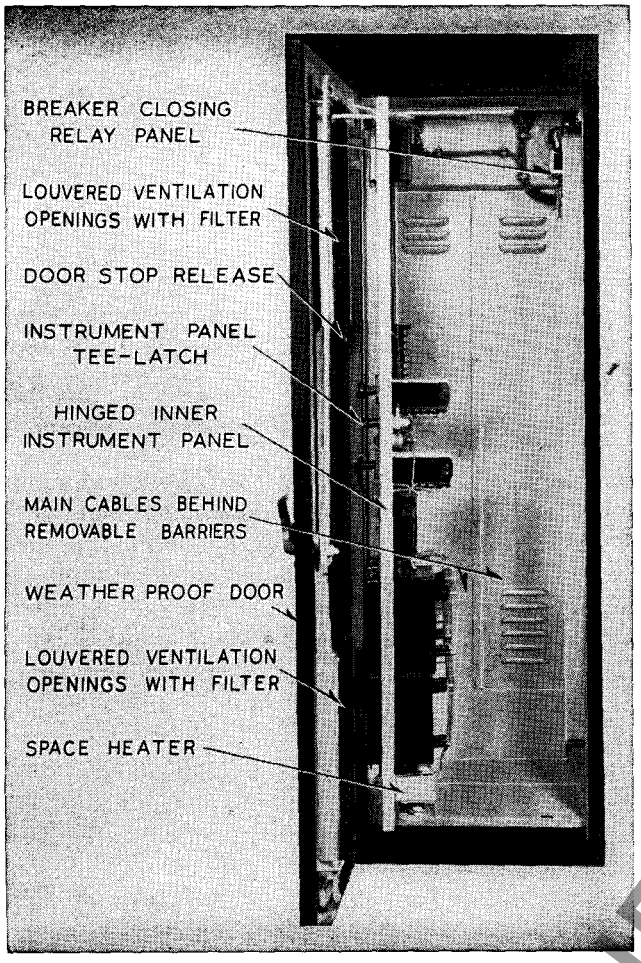



**FIG. 2. Instrument Panel Side of Typical Outdoor Metal-Clad Housing**

doors are equipped with latch type stops that hold them in the full open position which permits the instrument panel to be opened approximately 90°.

Adjacent housings for both indoor and outdoor designs are separated by a single common steel barrier. This barrier is the left side sheet of the unit when viewed from the breaker drawout side. A special set of removable enclosing covers is supplied on the right end of the assembly as viewed from breaker side. When, and if, additional units are added on this end of the assembly these special end covers must be removed and placed on the new unit.

## MAIN DISCONNECTING CONTACTS

The main disconnecting contacts (Fig. 5) are located in horizontal Moldarta or porcelain tubes mounted behind the barrier between the breaker and bus compartments.

The contact consists of a silver plated stud mounted in the tube on the stationary housing and a number of silver plated segments assembled on the circuit breaker bushing. The segments are arranged in a circle with contact pressure exerted by flat springs held in a collar around the finger assembly. In the engaged position, the fingers form a bridging contact between the circuit breaker stud and the stationary contact studs as shown in the cross section view of Fig. 5. This permits considerable flexibility in alignment without the use of flexible shunts.

The stationary contact mounting tubes are mounted in jig drilled mounting plates, accurately located in the housing and can be removed and replaced if necessary for contact maintenance without disturbing the alignment. A special tool is supplied with the equipment for removing and replacing the stationary stud.

## SECONDARY DISCONNECTING CONTACTS

Secondary disconnecting contacts provide connections for the control leads between the removable breaker element and the stationary housings. These consist of multiple plug and socket contacts (Fig. 6) of the train-line-coupler type. Each individual contact consists of a round 4-

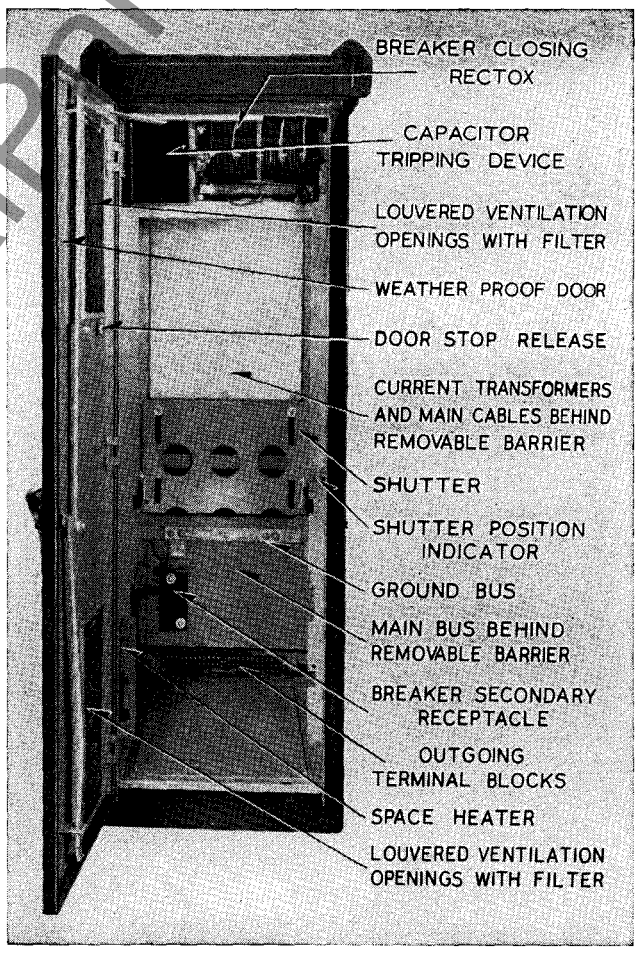



**FIG. 3. Breaker Drawout Side of Outdoor Housing**

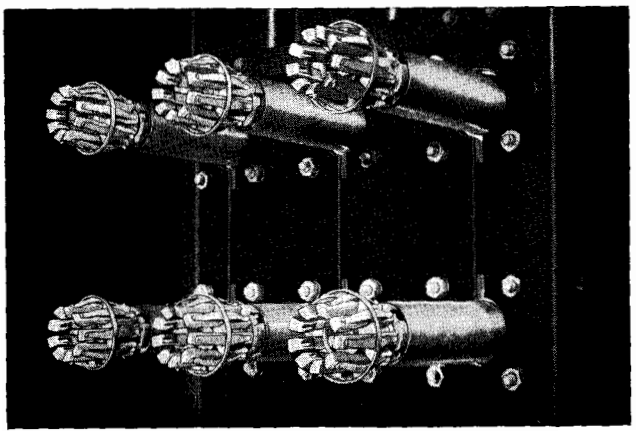


FIG. 4. Breaker Main Disconnecting Contacts

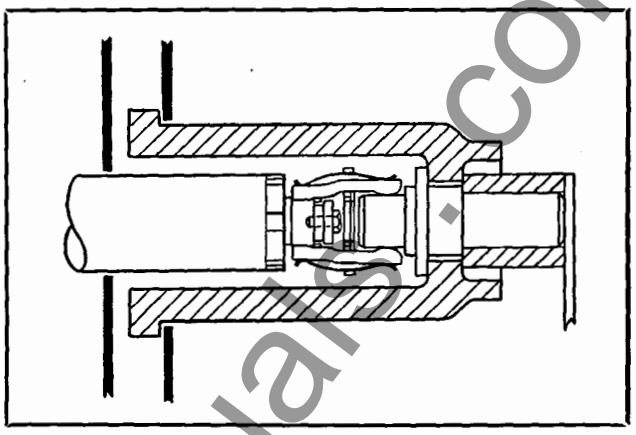


FIG. 5. Sectional View of Main Contacts in Connected Position

segment silver plated pin fitting into a silver plated copper tube. The pins and tubes are molded into Moldarta blocks to form the plug and socket assemblies. These molded assemblies are mechanically strong and provide a moisture resistant insulation of high quality. The secondary wiring is connected by soldering the wire in holes drilled in the connection end of the pin and tube contacts.

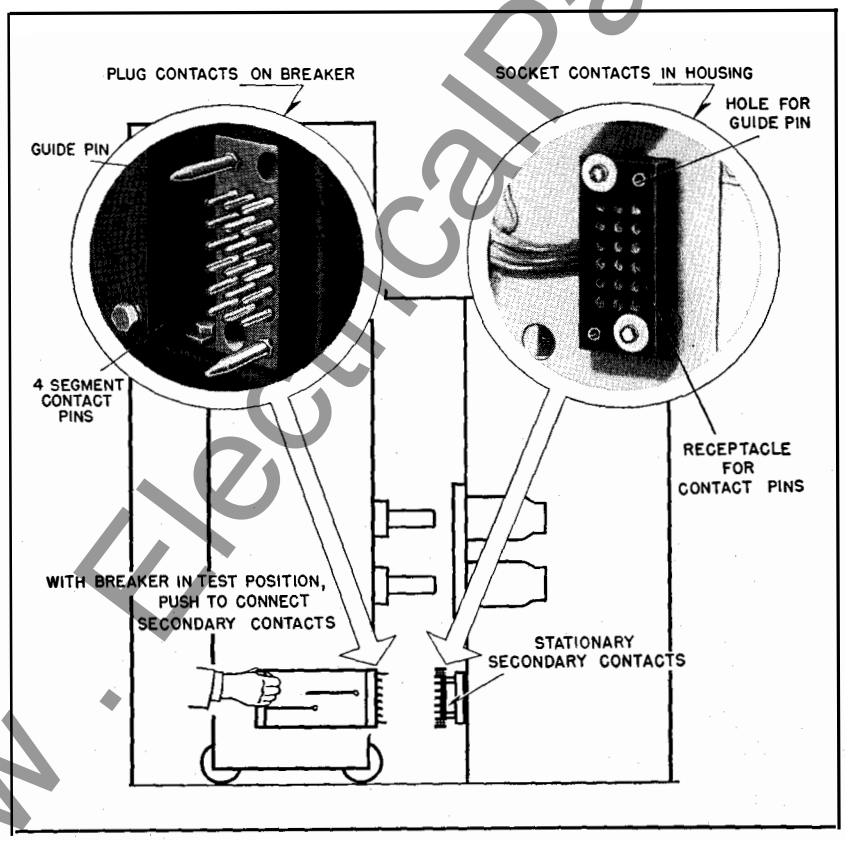


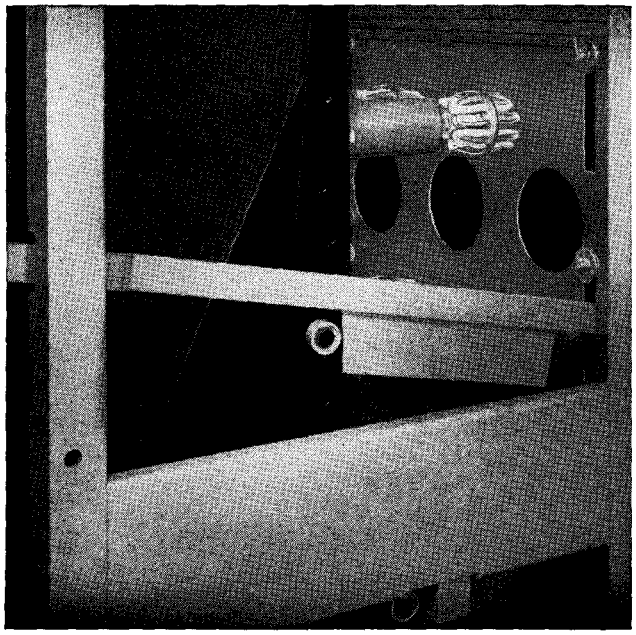

FIG. 6. Secondary Disconnecting Contacts
Contacts may be engaged with breaker in test position by releasing catch and pushing slide mounting on the breaker.

The plug half of the assembled contact is mounted on a sliding bracket assembly on the breaker unit while the socket half is bolted to the housing. These secondary contacts engage automatically when the breaker unit is inserted to the operating position. The guide pins are of different sizes so as to polarize he contacts. The socket half is flexibly mounted with oversize holes on a shoulder bolt so that the contacts will be self aligning. With the breaker in the test position the secondary contacts may be engaged for testing by releasing a catch lever and firmly pushing the sliding mounting bracket to the rear.

## SHUTTER

The shutter is an automatically operated movable metal barrier which covers the stationary main contact mounting tubes when the breaker is removed from the housing.

The shutter and its operation are shown in Figs. 3 and 7. The shutter is a part of the stationary housing and is raised by a roller on the breaker operating against the cam surface of the shutter arm when the breaker is levered into the operating position. When the breaker is removed, the shutter drops by gravity as the roller clears the cam surface. When the shutter is fully closed, it provides a metal barrier between the breaker and the stationary main contacts which may be electrically "alive".



Shutter closed—breaker roller engaging cam, about to raise shutter

Shutter opening—stationary contacts almost cleared for entry of breaker contacts

FIG. 7. Automatic Shutter Operating Sequence (Figure 3 on page 10 shows shutter fully closed)

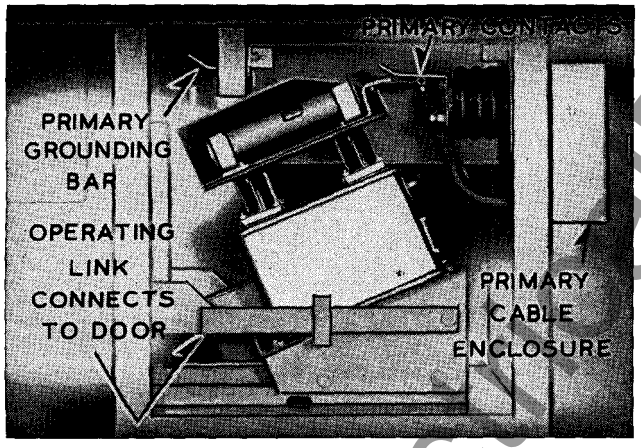



FIG. 8a. Potential Transformers in Operating Position.

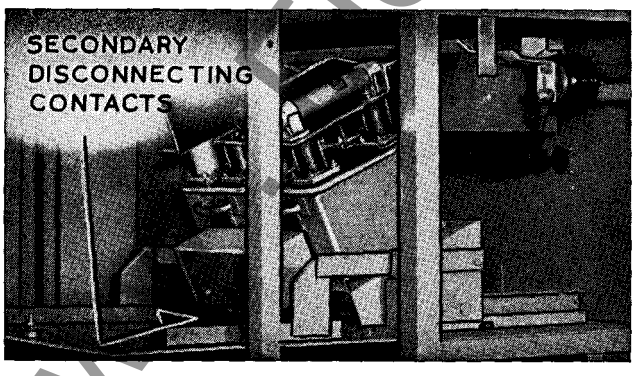



FIG. 8b. Potential Transformers in Disconnected Position

## DISCONNECTING TYPE POTENTIAL TRANSFORMERS

The potential transformers supplied in metal-clad switchgear are arranged on a disconnecting type of mounting which is designed to provide maximum safety for the inspection and replacement of the primary fuses. The transformers are mounted on movable drawers which are equipped with contacts for the primary connections and for grounding the movable element. The drawer is so arranged that it will be withdrawn to a safe distance with connections grounded before the fuses are accessible, as shown in Fig. 8b.

This disconnecting type potential transformer compartment is provided with a door which is hinged at the bottom and provided with a "T" handle latch at the top. A set of operating links, with one end attached to the door and the opposite end attached to the movable drawer, retracts the drawer to the disconnected position as the door is opened. Door stops located on each side of the compartment limit the opening of the door to approximately 90°. In this position the primary circuits are disconnected, separated a safe distance from all live parts, and grounded. The secondary connections are made with a sliding contact block assembly located underneath the front part of the drawer. The secondary contacts are disconnected when the compartment door is opened.

## REMOVABLE BREAKER ELEMENT

The removable circuit breaker elements are Type DH "De-ion" air circuit breakers, assembled directly on the removable frames. A typical removable element is shown in Fig. 9. Additional description of the breakers supplied with any particular metal-clad assembly will be found in the breaker instruction book.

The circuit breaker element is moved between the operating and test positions by a worm and gear levering device operated by means of a removable hand crank. The circuit breaker mechanism is interlocked with the levering shaft so that a

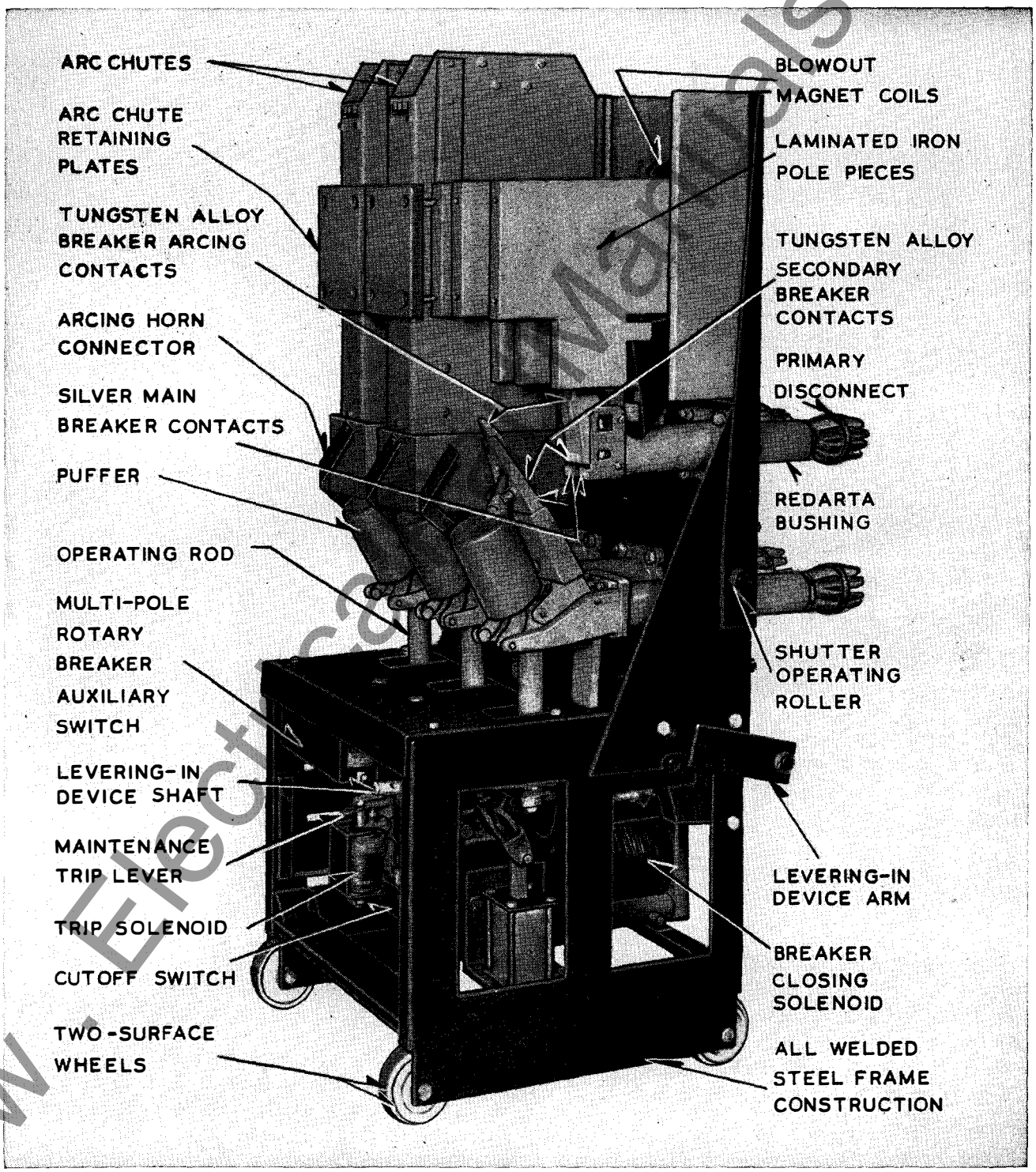



FIG. 9. Typical Removable Breaker Element (Type 50-DH-250) with Barrier and One Arc Chute Removed.

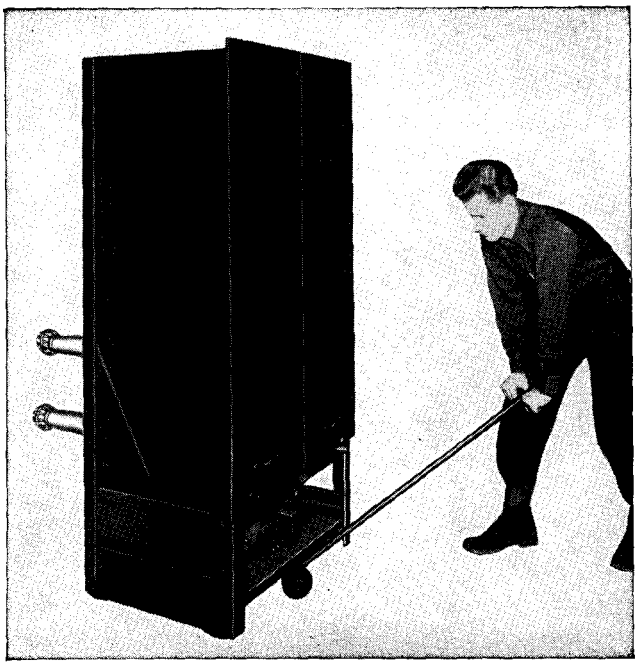


FIG. 10. Handling Dolly Being Used to Move a 150-DH-250 Breaker

closed breaker cannot be moved into or out of the operating position.

This interlock is released in the "disconnect" or "test" position to permit operating the circuit breaker and checking control and interlock connections without energizing the main circuits. The interlock also prevents the circuit breaker from being closed in any intermediate position between the operating and disconnected positions.

All ratings of breakers are equipped with wheels to facilitate moving the breakers into the housing and to allow the breakers to be moved about outside the metal-clad housing. The light duty breakers have two swivel wheels to permit turning. The heavy duty breakers have all wheels fixed.

## HANDLING DOLLY

A handling dolly is supplied on orders for indoor switchgear with heavy duty breakers to facilitate turning the removable element when moving it outside the housing. This handling dolly (Fig. 10) consists of two wheels, a handle, and an arm which engages in a hole in the front cross member of the breaker frame. Lowering the handle raises the front of the breaker to permit turning.

The dolly is intended for use when the breaker is outside the housing and should not be used to insert or remove the breaker from the housing.

## TRANSPORT TRUCK

To facilitate handling the breaker elements with outdoor switchgear assemblies, a transport truck (Fig. 11) is supplied. The transport truck has two fixed and two swivel wheels which aid in aligning the rail extension guides on the truck with the stationary structure rails. The transport truck is approximately the same height as the switchgear base but can be adjusted plus or minus ½ inch to compensate for variations in the Purchaser's concrete pad. The transport truck is securely clamped to the stationary structure during the inserting or removal operation of the breaker element. The breaker element is securely hooked to the transport truck during movement external to the stationary structure.

FIG. 11. Outdoor Transport Truck

## ACCESSORIES

In addition to the handling dolly and transport truck previously described, each new switchgear installation is normally provided with a set of accessories. Depending upon the nature of the installation these accessories will consist of one or more of the following items:

**1.** Maintenance operating handle for the circuit breakers. As its name implies, this handle is to be used for operating the breaker mechanism when the breaker has been removed from the switchgear unit to permit observation of the various mechanical linkages and to determine if the proper clearances

and adjustments are maintained. NEVER USE THIS HANDLE TO CLOSE THE BREAKER WHEN THE BREAKER IS IN THE SWITCHGEAR.

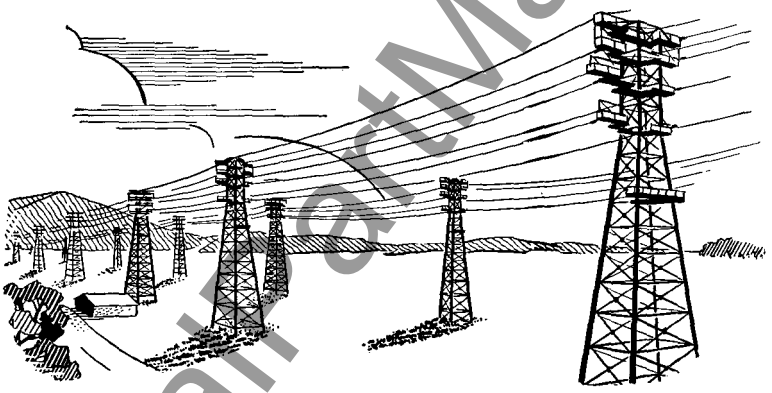
**2.** Levering crank for moving the circuit breaker from test to operate position.

**3.** Special wrench or pliers for removing stationary portion of breaker disconnecting contacts.

**4.** One set of test plugs for use with Flexitest relays and meters if such meters and relays are included as part of the switchgear assembly.

**5.** Test cable for use with outdoor switchgear assemblies to connect breaker control circuits to the switchgear when testing the circuit breaker outside of the switchgear unit.

**6.** Test cabinet supplied with indoor switchgear assemblies for use in testing the circuit breakers when they are removed from the switchgear units. This test cabinet includes the necessary test cable for connecting control power to the circuit breaker control circuits.



PART TWO

# RECEIVING, HANDLING AND STORING

The stationary steel housings of metal-clad switchgear are shipped as complete units, or groups of units, bolted together. Indoor metal-clad switchgear assemblies are shipped in crates for protection against weather. Normally the shipping groups consist of as many units as can be handled and shipped together, unless the Purchaser has specified smaller groups. The breaker elements and accessories are packed and crated separately from the housings.

## RECEIVING

When the switchgear reaches its destination, the Purchaser should check the material actually received against the shipping lists to be sure that all parts have been received. This will avoid delays in installation. 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 metal-clad switchgear is to be installed as soon as received, it is recommended that the unpacking be done as required for the installation as outlined under the paragraphs which follow. If the switchgear is to be stored or held for some time before installing, it is advisable to unpack the shipment sufficiently to check the shipment for completeness and condition.

## HANDLING FACILITIES

Each shipping group of housings is equipped with a lifting angle or frame for handling by a crane. Figs. 12a and 12b shows a typical shipping group of 5 kv indoor housings with its lifting angle. A balancing chain can be added as shown by dotted lines in Fig. 12a, if desired, as the single lifting angle is located slightly forward of the center of gravity of the units. On the larger 7.5 kv and 15 kv units, a lifting frame is used which consists of two angles and necessary braces.

Indoor switchgear groups are provided with a dual purpose bracing angle at each end of the shipping group. During shipment these heavy angles are used for cross bracing to the freight car. During installation they can be removed and bolted in the lower set of tie bolt holes (as shown in Fig. 12b) to make a handy lifting angle for jacks while removing the skids and lowering the group to the floor.

Fig. 13 shows a group of outdoor housings. It is preferable to handle the housings by a crane, but if a crane is not available the groups can be skidded into place with rollers made from conduit or pipe. Timbers should be placed between switchgear and rollers to protect the equipment.

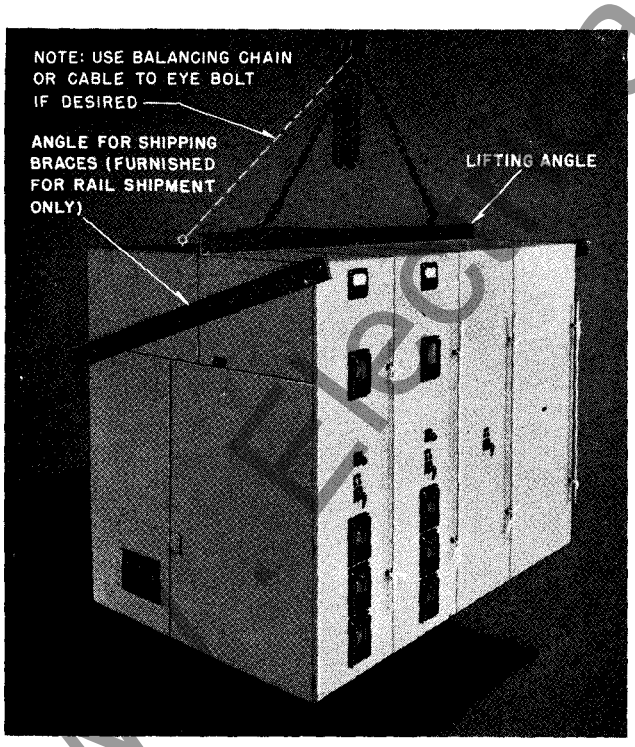



FIG. 12a. Typical Shipping Group of Indoor Housings

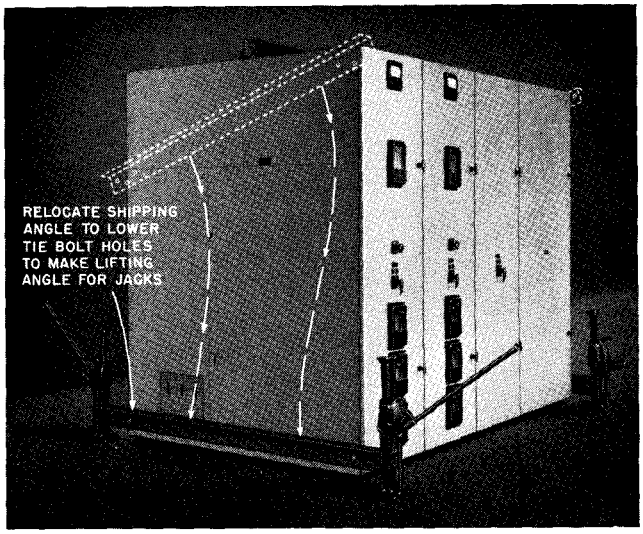



FIG. 12b. Use of Jacks to Lift Group of Units

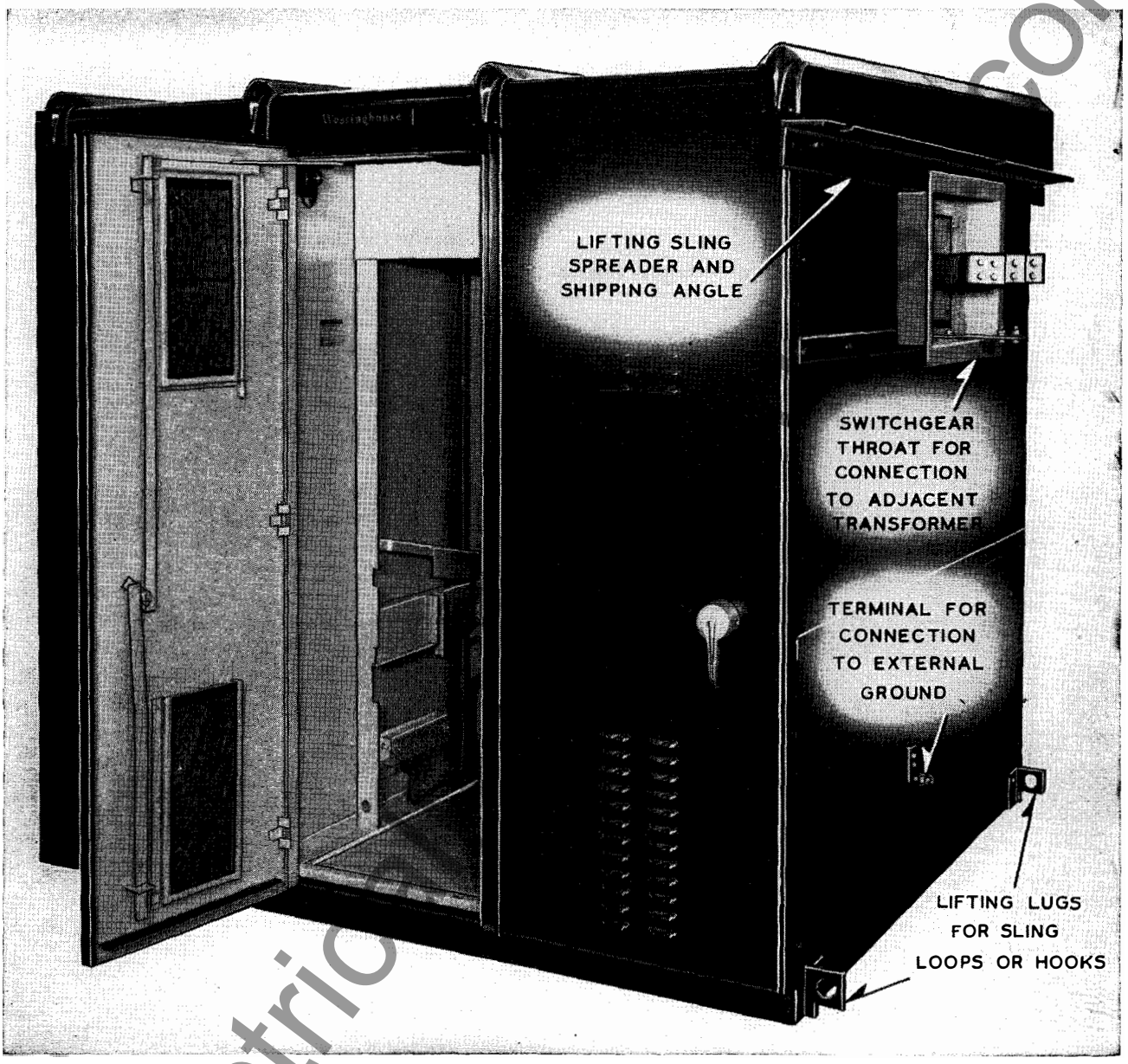



FIG. 13. Typical Shipping Group of Outdoor Housings

## STORING

Switchgear which is not or cannot be installed immediately should be stored in a dry, clean place. Trouble and delay will be avoided by having good storage facilities arranged so that the apparatus will be accessible only to authorized persons and so that it can be quickly located when required in the erection program. Crated apparatus will store much better if left crated; however, it should be inspected to make sure that no damage has been incurred during transit. Conditions such as dampness, changes in temperature, cement dust, and corrosive atmosphere, should be carefully guarded against. The longer the period of storage, the greater must be the care taken for protection of the equipment.

**Indoor Switchgear.** It is preferable to store indoor metal-clad switchgear indoors in a heated building. If this is impossible, some special precautions should be taken to keep the equipment warm enough to prevent condensation until it is placed in service. Where necessary install temporary heating equipment in switchgear. The equipment should be kept covered and dry and located in such a place as to prevent exposure to sunlight or temperatures above 120°F. During storage the steel housings should be placed on as level a surface as possible to prevent unnecessary strain and possible distortion. If indoor switchgear has been ex-

posed to sunlight or to sustained temperatures of 120°F. and higher, the strippable panel coating **MUST BE REMOVED WITHIN 30 DAYS.** If equipment is stored or located in a cool and dark location, strip off the plastic coating within 18 months.

**Outdoor Switchgear.** If outdoor metal-clad switchgear is received before installation is scheduled, or if the switchgear is not immediately energized after installation, temporary power must be made available for the operation of the space heaters provided in the switchgear in order to prevent condensation of moisture within the housing.

Compartments are provided with louvered openings and dust filters, both front and rear, top and bottom, so arranged as to permit a good circulation of air. Filters should not be removed except for maintenance.

## CONTROL STORAGE BATTERIES

Storage batteries should be given special attention as soon as they are received, but due to the number of battery manufacturers and the variety of types and sizes of batteries only general instructions can be given in this publication. In all cases, the descriptive material supplied with the battery by the battery manufacturer should be followed in installing, using, and maintaining any particular storage battery.

These instructions will pertain to control storage batteries of the lead-acid type most usually supplied for use with switchgear. As soon as practicable after a battery is received it should be unpacked and inspected for any shipping damage which might have occured. If such damage is found, file a claim against the carrier and advise the nearest Westinghouse representative at once. In general, batteries which do not have to be shipped overseas are supplied with electrolyte already in the cells. If spillage has occured such that the electrolyte level is lower than one half inch below the tops of the plates, the cell is probably permanently damaged and a claim should be filed against the carrier for the price of the damaged cells. For batteries shipped overseas, the electrolyte is normally drained from the cells and shipped in bulk containers.

After the cells have been thoroughly inspected, install them in place on the trays or racks provided. Wipe clean all contact surfaces on cell posts and intercell connectors. Do not scrape or use abrasives on lead-plated posts or connectors; wipe clean only. Apply a thin film of NO-OX-ID grease or vaseline. Bolt the connectors to the posts tightly being careful to connect the positive post of one cell to the negative post of the next adjacent cell.

Each battery should be given a freshening charge before being placed in service. If the battery is not placed in service shortly after receipt, it should be given a freshening charge no later than 6 months after receipt and at least once in every 6 months period thereafter until it is placed in service. To give the battery a freshening charge, set the charger between 2.30 and 2.35 volts per cell. During the period that the battery is charging, tabulate hydrometer readings for each cell once each hour. The charge should continue until the specific gravity reading of the lowest reading cell shows no further increase in four consecutive hourly readings.

After the battery has been given a freshening charge, it is ready to be placed in service. Readjust the charging voltage to 2.15 volts per cell and maintain the charging voltage at that value. Hydrometer readings for each cell should be tabulated at least once a month during the period of service. If during the course of making monthly readings a particular cell shows a low specific gravity it will be necessary to apply an equalizing charge. This is accomplished by increasing the charging voltage to 2.35 volts per cell for approximately 24 hours. Readings of the specific gravity of the low reading cells should be checked several times during the time that an equalizing charge is being applied. Charging should continue until the lowest reading cell shows no further increase. After the completion of the equalizing charge, the charging voltage must be decreased to the normal floating value of 2.15 volts per cell.

If in handling of the batteries or as a direct result of shipment of the batteries a slight spillage has occurred, add water to the cells or preferably add electrolyte of 1.210 specific gravity and give the battery a full freshening charge. During the life of the battery never allow the water level to get lower than the low level line.

Since the battery contains acid, the usual precautions to protect personnel and materials should be observed. Proper ventilation in the battery room should be provided to prevent an accumulation of hazardous fumes or an explosive mixture of the hydrogen produced during charging. It should be emphasized that a battery requires reasonably frequent inspection and care if it is to have a long life of reliable service. Operating personnel should be familiar with the battery manufacturer's instructions and should observe those instructions in any case of conflict with the general instructions given above. If additional information is required on the operation and care of the battery, the battery manufacturer's service engineer should be contacted immediately.

# INSTALLATION

## FOUNDATION OR FLOOR

Westinghouse metal-clad switchgear is accurately built on true and level bedplates to insure ease of operation and interchangeability. Equal care in laying out and preparing the foundation will be amply repaid in reduced costs of labor and installation time.

Proper specifications for concrete mixtures and proper procedures for laying and finishing of floors and foundations are usually common practice with construction contractors and the construction departments of large public service companies. Mechanical, structural and hydraulic concrete construction data is available through professional concrete contractors or from the manufacturers of Portland Cement.

The concrete floor or foundation upon which the switchgear is to be erected must be designed for sufficient strength to withstand the weight of the structure plus the shock of the breakers opening under short circuit conditions. Table No. 1 gives approximate dead weights and impact weights for the various ratings of metal-clad switchgear. Actual weights will vary somewhat with the individual units, depending on the type and amount of auxiliary equipment that is specified for the unit. Adequate safety factors must, of course, be used in designing the floor or foundation.

**Indoor Switchgear.** For indoor switchgear the careful preparation of the concrete floor is vitally important because simplicity of erection and easy and satisfactory operation depends entirely upon

### Table No. 1. APPROX. WEIGHTS OF METAL-CLAD SWITCHGEAR UNITS

*Note: Actual weight of units will vary in proportion to amount and type of auxiliary equipment in the units.*

| CLASS OF SWGR. | TYPE OF UNIT | INDOOR SWITCHGEAR | | OUTDOOR SWITCHGEAR | |
|---|---|---|---|---|---|
| | | Dead Weight Including Breaker POUNDS | Total Impact and Dead Weight POUNDS | Dead Weight Including Breaker POUNDS | Total Impact and Dead Weight POUNDS |
| Light Duty | 50-DH-50 Breaker Unit | 2100 | 2400 | 3300 | 3600 |
| | Auxiliary Unit | 1800 | .... | 3200 | .... |
| 5 Kv Heavy Duty | 50-DH-{150 Breaker 600 A. / 250 Unit 1200 A.} | 3000 | 3600 | 4200 | 4800 |
| | 2000 A. | 3500 | 4200 | 4700 | 5400 |
| | Auxiliary Unit | 2000 | .... | 3200 | .... |
| 7.5 Kv and 15 Kv Heavy Duty | {75 / 150}-DH-{150 / 250 / 500} Breaker Unit | 4000 | 4800 | 5500 | 6300 |
| | Auxiliary Unit | 3000 | .... | 4000 | .... |

**BREAKERS ONLY**

**Approximate Weight**

*Note: Actual weight of breakers will vary slightly, depending on current and interrupting capacity.*

50-DH-50 ..... 600 pounds

50-DH-{150 / 250} ..... 1100 pounds

{75 / 150}-DH-{150 / 250 / 500} ..... 1700 pounds

the accuracy and trueness of the concrete floor upon which the switchgear is to be erected. 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 MEMBERS.**

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 installating and removing the circuit breaker elements will be facilitated by a smooth hard floor surface.

Fig. 14 shows the recommended methods of installing the floor channel steel for an adequate foundation. Methods 1 and 2 are preferred when welding equipment is available, to eliminate the need for accurate lining up of bolts. The steel supporting channels used in the floor should be brought to the true plane of the finished floor (preferably level) and held there until the concrete is set.

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.

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.

**Outdoor Switchgear.** For outdoor switchgear a base frame of steel members is included as part of the switchgear so that it is only necessary to install a suitable foundation on which to set the switchgear.

## CONDUIT LAYOUT AND SWITCHGEAR FLOOR PLAN

Provisions must be made in floor or 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 order. This 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, and be located according to the floor plan or base plan prepared especially for the individual metal-clad switchgear order. If more than one control conduit is required per unit, for indoor switchgear, these should be aligned in the space allotted for them on the floor plan.

Figs. 15 and 16 present typical floor plans and tables of dimensions for the various ratings of

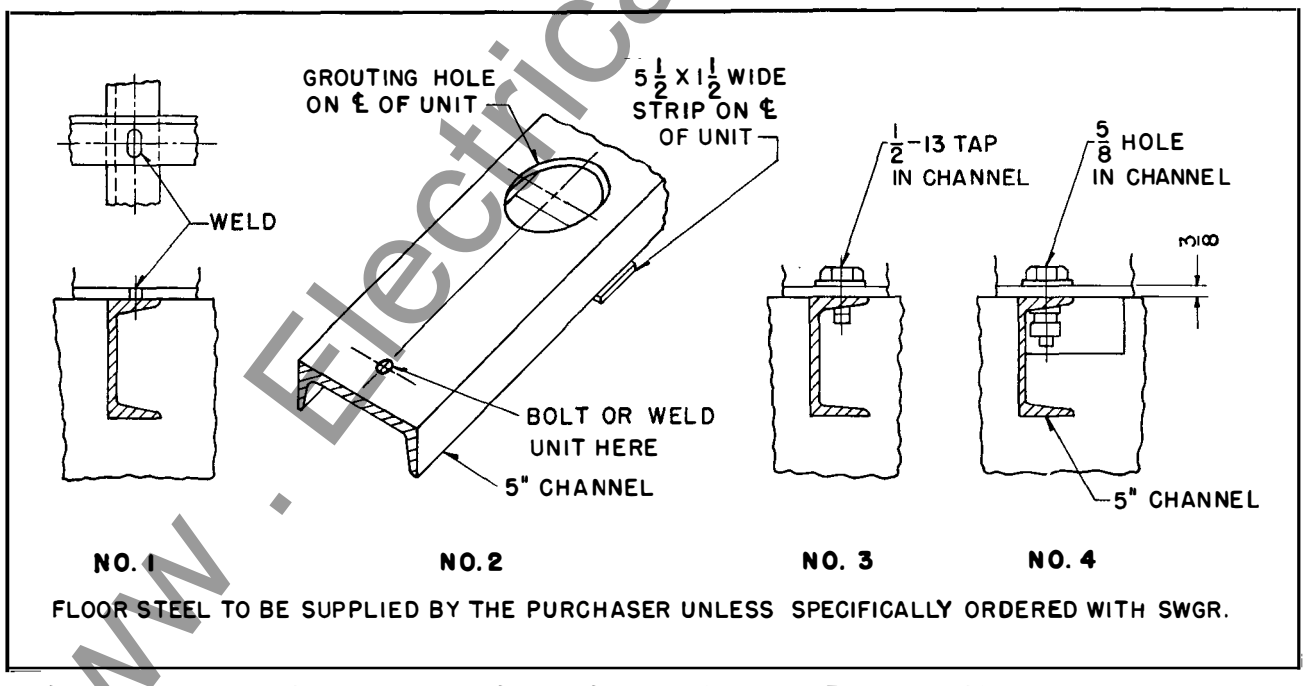



**FIG. 14. Suggested Methods of Installing Steel Channels in Floor**

metal-clad switchgear. These figures 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.

For indoor installations 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 as shown in Fig. 16 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.

## INSTALLATION OF HOUSINGS

When correctly installed the housings for both indoor and outdoor metal-clad switchgear should make a pleasing appearance and conform to the following requirements:

**1.** Front panels form a straight true line.

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

**3.** Rails level in all directions.

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

**Indoor Housings.** For indoor housings the following suggestions and general order of operations will assist in obtaining the above requirements without difficulty. Fig. 17 illustrates the general assembly of indoor housing groups and end covers.

**1.** When three or more shipping groups of the switchgear are to be arranged in one continuous assembly, **THE CENTER SHIPPING GROUP OF UNITS 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.

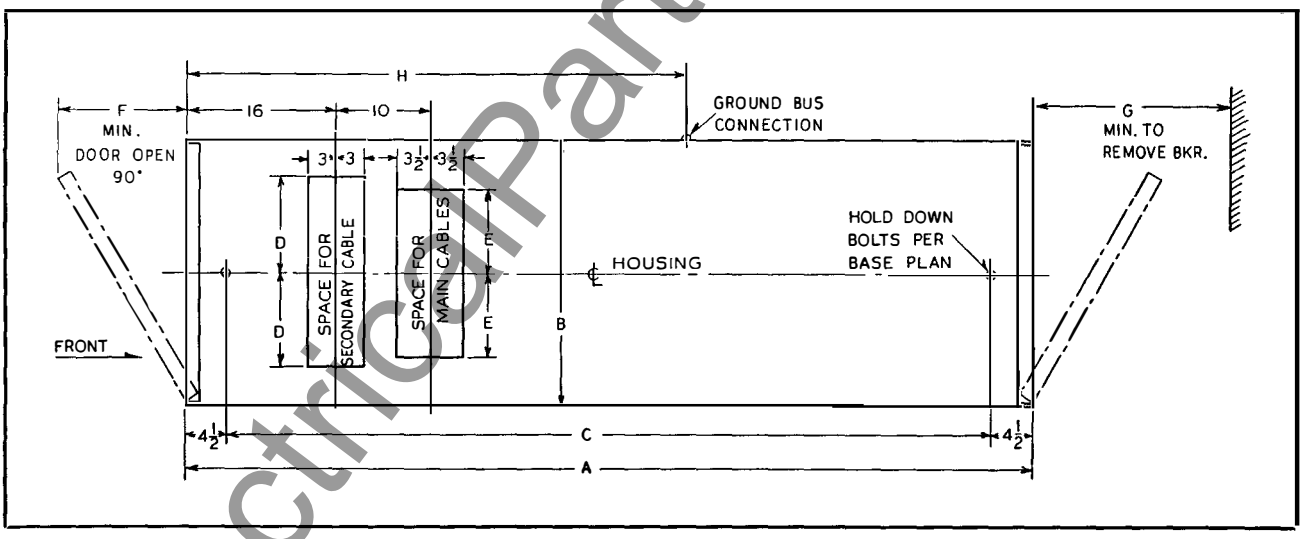



FIG. 15. Typical Base Plan for Outdoor Metal-Clad Switchgear

### Table No. 2. DIMENSIONS IN INCHES

Dimensions are approximate only. Refer to properly identified drawing for particular installation.

| UNIT | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 50-DH-50 Breaker Unit | 90 | 28 | 81 | 11⅜ | 10¼ | 28 | 42 | 53 |
| 50-DH-{150/250} Breaker Unit 1200A/2000A | 90 | 28 | 81 | 11⅜ | 10¼ | 28 | 42 | 53 |
| | | 38 | 81 | 16⅜ | 15¼ | 38 | 49 | |
| Auxiliary Unit {30″ Wide/38″ Wide} | 90 | 30 | 81 | .... | .... | 30 | 42 | 53 |
| | | 38 | | .... | .... | 38 | 49 | |
| 75/150 -DH- {150/250/500} Breaker Unit | 102 | 38 | 93 | 16⅜ | 15¼ | 38 | 49 | 60 |
| Auxiliary Unit | 102 | 38 | 93 | .... | .... | 38 | 49 | 60 |

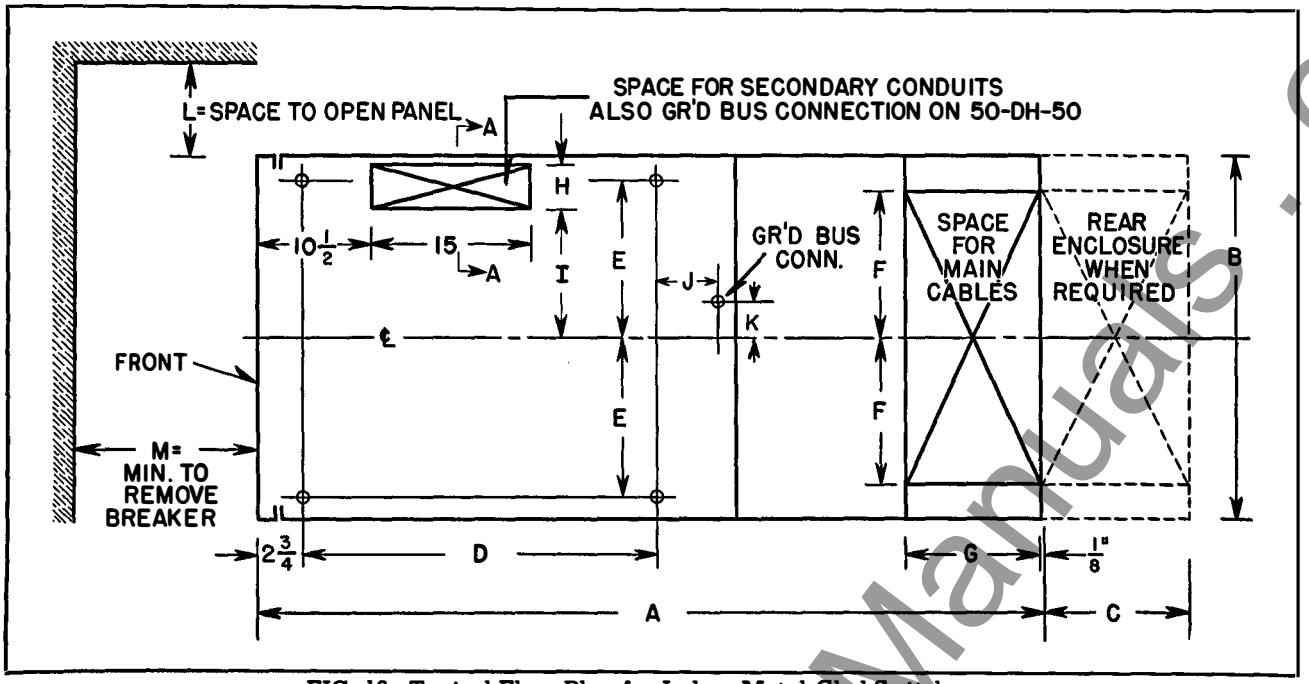



FIG. 16. Typical Floor Plan for Indoor Metal-Clad Switchgear

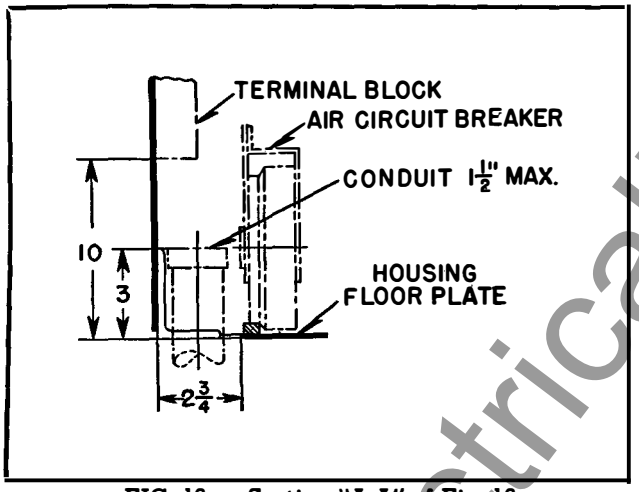



FIG. 16a. Section "A-A" of Fig. 16

**2.** Remove all crating and packing material, except skids from the first group to be erected. Great care should be taken in removing the crating so as not to damage any of the delicate instruments and relays which may be mounted on the switchgear.

**3.** Move the first group of units into position either by crane or by pipe rollers. The rollers, if used, should be high enough to allow the switchgear to pass over the conduits projecting above the floor.

## Table No. 3. DIMENSIONS IN INCHES

Dimensions are approximate only. Refer to properly identified drawing for any particular switchgear installation.

| UNIT | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50-DH-50 Breaker Unit | 64 | 20 | 10 | 32 | 8 13/16 | 7 15/16 | 7 1/4 | 2 3/4 | 7 3/16 | ..... | ..... | 13 | 36 |
| 20" Auxiliary Unit | | | | | | | | 4 | 3 15/16 | | | | |
| 30" Auxiliary Unit | | 30 | | | 13 13/16 | 12 15/16 | | | 8 15/16 | | | 20 | |
| 50-DH- 150/250 Breaker Unit 600-1200A | 74 | 26 | 10 | 36 | 11 13/16 | 10 15/16 | 9 3/4 | 2 3/4 | 10 3/16 | 5 | 0 | 17 | 36 |
| 2000A | | 36 | | | 16 13/16 | 15 15/16 | | | 15 3/16 | | 0 | 23 | 43 |
| 26" Auxiliary Unit | | 26 | | | 11 13/16 | 10 15/16 | | 4 | 6 15/16 | ..... | ..... | 17 | 36 |
| 36" Auxiliary Unit | | 36 | | | 16 13/16 | 15 15/16 | | | 11 15/16 | | | 23 | |
| 75/150-DH- 150/250/500 Breaker Unit | 86 | 36 | 12 | 47 | 16 13/16 | 15 15/16 | 9 1/8 | 2 3/4 | 15 3/16 | 5 | 5 1/2 | 23 | 49 |
| 36" Auxiliary Unit | | | | | | | | 4 | 11 15/16 | ..... | ..... | | |

**4.** Establish a base line a few inches in front of the group of housings 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.** With an accurate level check the rails for levelness, both laterally and longitudinally. These level checks should be made at points just inside the front doors and also about a foot from the rear barrier. Elevation errors should be corrected by inserting shims under the rails and side frame angles as shown in Fig. 18. These shims should always be inserted at the points where the units are to be fastened to the floor channels. If considerable shimming is required, the rail tips should be bent down slightly as shown in Fig. 19 to pick up the small wheel diameter when breaker is rolled into the housing.

**6.** Check the plumbness of the housing by dropping a plumb line from the center of the horizontal steel member at the top front of the housing. Place a steel bar across the rails just inside the door and mark on it the exact center between the rails. If the point of the plumb bob registers with the mark on the bar of steel the housing is plumbed satisfactorily. If the housing is not plumb, it may be due to insufficient accuracy in leveling the foundation members, or to distortion of the housing frames due to rough handling in shipment. Leveling may be remedied by checking the shimming. Distorted frames will usually be evident from bent frame members. Each housing of the group should be checked in this manner and corrected if necessary.

**7.** The second group should then be moved into position and the procedure outlined for the first group repeated. The groups should be bolted together by installing the tie bolts as illustrated in Fig. 17. Then a final check of each housing for levelness and plumbness should be made to insure that the housings have not shifted. Should it be necessary to use any shims in the final leveling, these shims should be inserted as described above.

**8.** After all units are properly aligned they should be fastened to the foundation by bolting or welding to the floor channels as shown on the floor plan drawing and in Fig. 14.

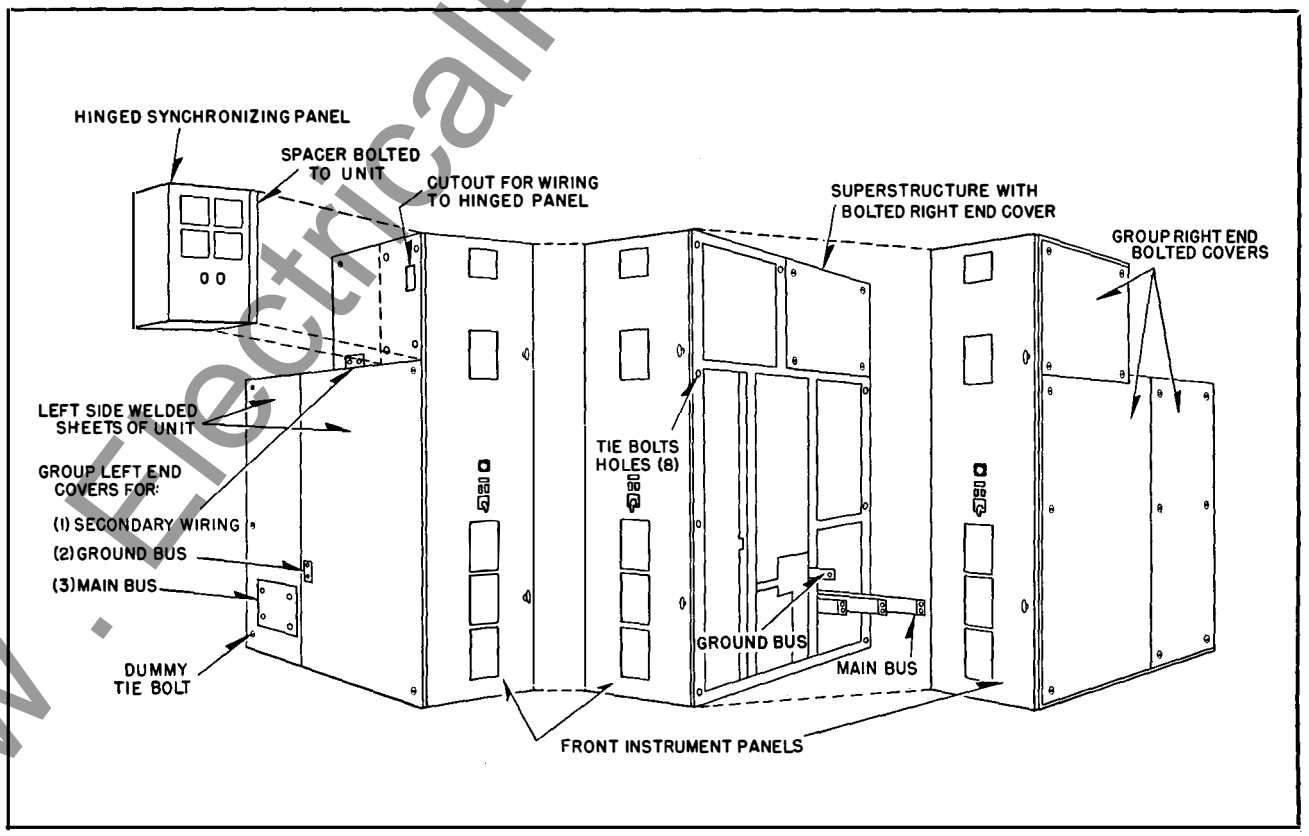



FIG. 17. Assembly of Typical Indoor Metal-Clad Switchgear

The preceding discussion and procedure is based on a level floor, as level floors are generally used, and because the level construction is a convenient method of obtaining a true flat floor. The switchgear will operate satisfactorily on a floor with a uniform slope provided the floor is true and flat and does not vary more than 1/8 inch in three feet in any direction. When installing switchgear housings on a floor with a uniform slope, the rails should be parallel to the floor and the vertical center line of the housings should be perpendicular to the floor instead of level and plumb as described in steps 5 and 6.

**Outdoor Housings.** For outdoor housings each unit is provided with a formed steel base with a heavy structural steel member at the front and rear which supports the unit on the Customer's base pad. When field handling facilities permit or the overall installation of outdoor metal-clad units does not exceed four to six units the complete assembly will be shipped in one group.

To install a single group assembly it is merely necessary to move it to the desired location on the foundation or base pad and bolt it down.

For installations consisting of two or more shipping groups the installation of the shipping groups should begin with the center group using a base line as outlined for indoor metal-clad switchgear except when installing a unit substation. When installing a unit substation, 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. The additional switchgear groups should then be installed using a base line as above.

Fig. 20 indicates field assembly for outdoor metal-clad switchgear, and should be followed closely to insure that all weatherproofing trim plates are installed between shipping groups, that groups are securely bolted together, and that weatherproof end sheet and roof end cover are installed.

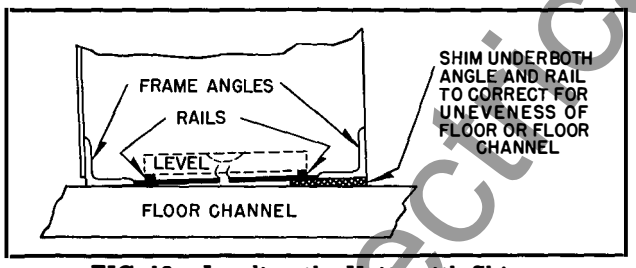



FIG. 18. Leveling the Units with Shims

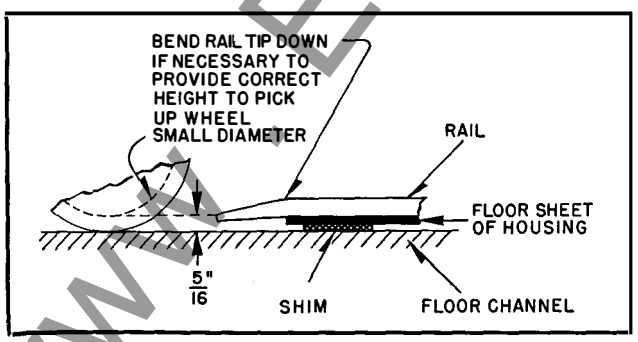



FIG. 19. Adjusting Rail Tips

## POWER TRANSFORMER CONNECTIONS

Switchgear assemblies are frequently located adjacent to power transformers to form Unit Substations or Power Centers. In such cases the power connections between the switchgear and transformer are included as part of the assembly. The design of these power connections may be divided into three general types as follows:

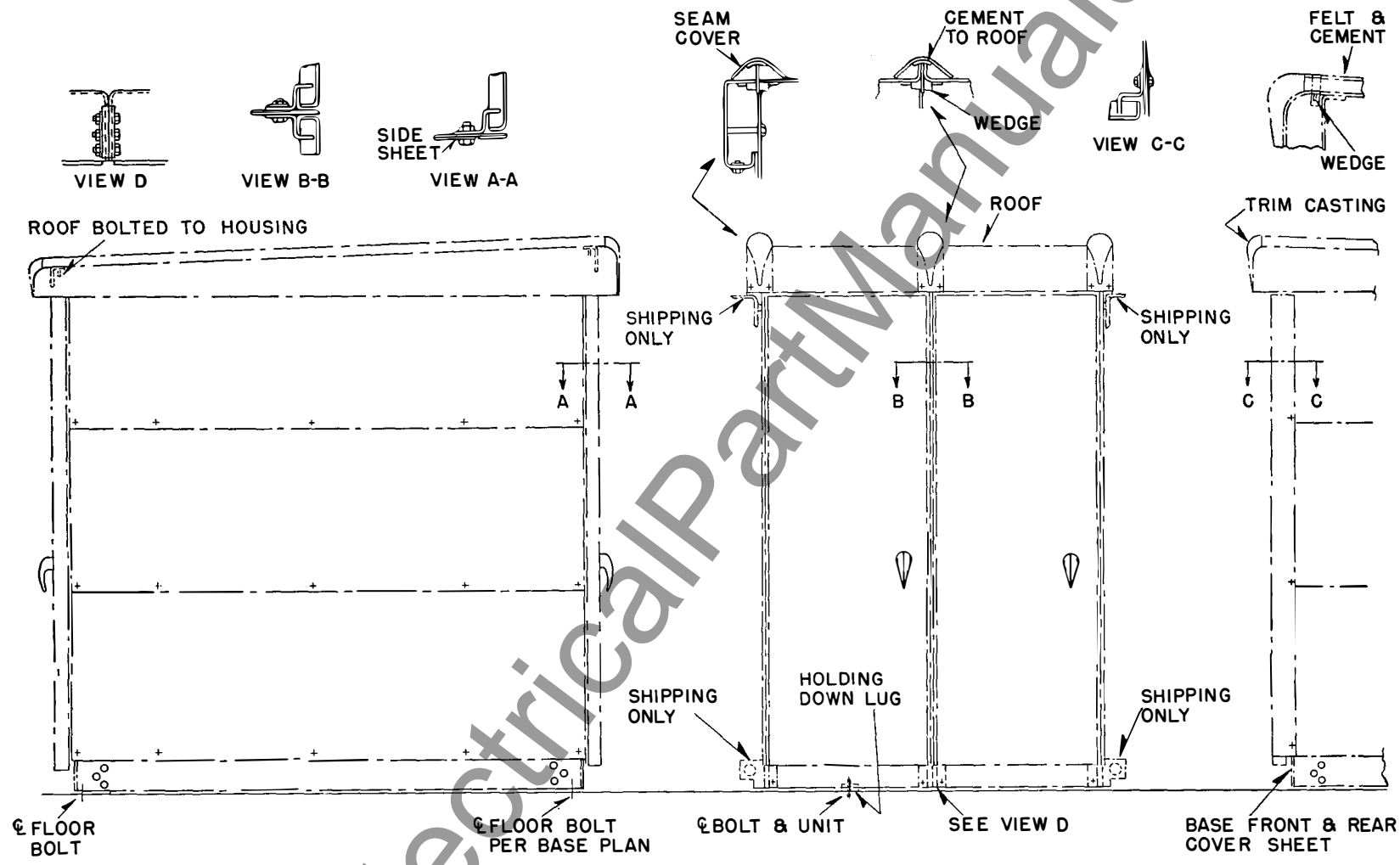
**1.** Bus run type with throat connection.

**2.** Removable box enclosure type with throat connection.

**3.** Close-coupled type (for dry type indoor transformers).

For outdoor substations these connections must have weatherproof enclosures and must provide flexibility for the connections between the transformer terminals and the switchgear bus. The design of such connections for indoor substations is similar except to omit the weatherproof features.

**Bus Run Type.** Figure 21 shows the construction details of an outdoor bus run type of throat connection with the bus run extending from the left hand of the assembled switchgear. A variation of this type would have the bus run emerging through the roof of the switchgear assembly rather than the end unit. For this type of installation the switchgear group adjacent to the transformer and the transformer should be installed first in accordance with the base plan. The flanges of the switchgear bus run and the transformer throat should normally then be in alignment with one another. Apply cement to both flanges on the outside surfaces and cement felt in place in accordance with details shown in Figure 21. The felt is used to seal against entrance of dust and to prevent possible vibration of the sealing section due to resonance produced by the transformer. Install the sealing section by sliding the frame down from the top and secure in place with the screws supplied on the bottom section.




**1. Assembly of Shipping Groups**

**(a)** Line up adjacent groups—install front, rear, and base tie bolts—draw bolts tight to get continuous close contact of all adjacent sheets.

**(b)** Install roof seam covers—L.H. removable side sheets and R.H. finishing trims.

**2. Assembly of New Group to Group Already Installed**

**(a-1)** If new group is added to L.H. end of old group, remove L.H. side sheets from old group—place new group in position and make assembly per 1 (a & b).

**(b-1)** Assemble side sheet and roof seam cover from (a-1) on L.H. side of new group.

**(c-1)** If new group is added to R.H. end of old group, remove R.H. finishing strips from old group. Place new group in position and make assembly per 1 (a & b).

**(d-1)** Assemble finishing strips and roof seam cover from (c-1) on R.H. side of new group.

FIG. 20. Field Assembly—Typical Outdoor Metal-Clad Switchgear

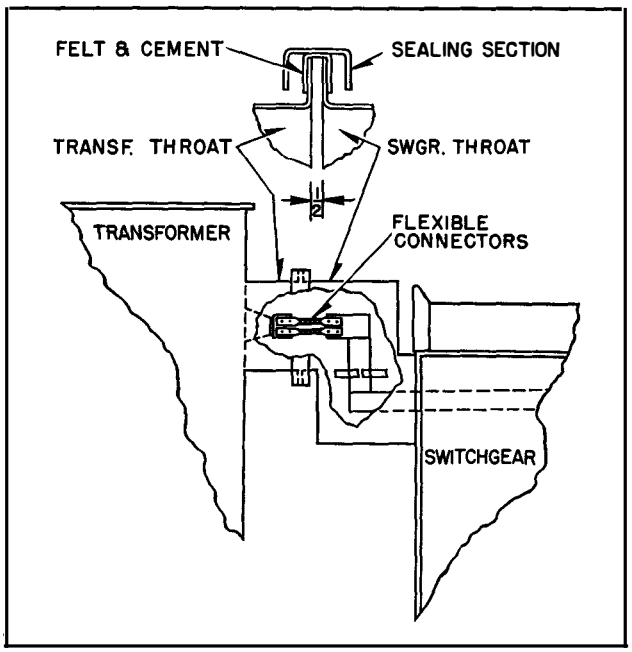



FIG. 21. Bus Run Throat Connection to Transformer

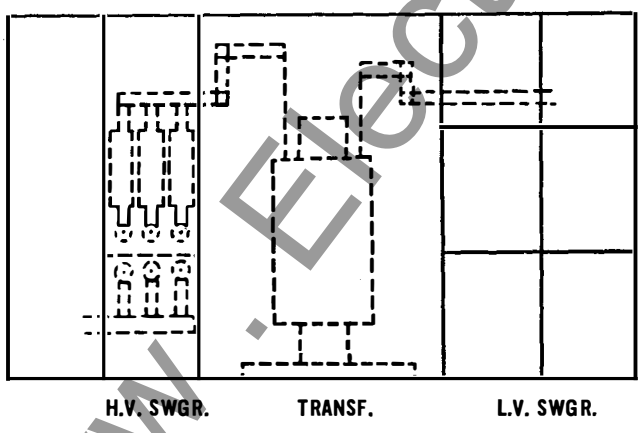
**Box Enclosure Type.** This type as its name suggests consists of a box which can be assembled in the field to enclose the connections between transformer and switchgear. This type of connection is generally limited to use with outdoor switchgear assemblies. IL 48-300-1 included with the transformer instruction book gives complete assembly instructions.

Install the transformer and first group of switchgear in accordance with the base plan drawing supplied with the equipment; then install the box enclosure. The flanges of both the transformer and switchgear throats should project a short distance within the box enclosure.

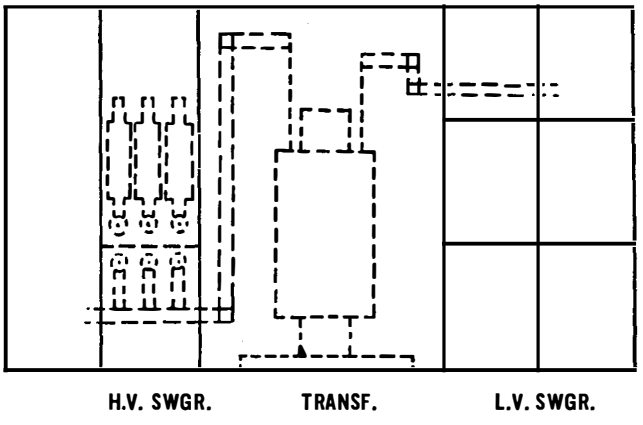
**Close-Coupled Type.** This type of connection is limited to installations involving indoor equipment comprising a dry type power transformer and indoor switchgear assembly. Typical front view sketches of two types of close-coupled assemblies are shown in Figure 22 and a photograph of a typical transformer connection is shown in Figure 23. The specific details of the power connections for any particular combination of transformer and switchgear are shown on the assembly drawings supplied with the equipment.

For installations of this type, locate the transformer and adjacent switchgear unit in accordance with the base plan supplied with the equipment. The transformer and switchgear generally will be arranged so that the front panels of both are located in the same vertical plane. The end unit of switchgear and the transformer should be bolted together using the tie bolt holes provided for that purpose. Connection between the switchgear ground bus and the ground pad in the transformer should be installed at this time.

**Control Conduit.** For installations where the power transformer and switchgear assembly are located adjacent to one another in accordance with one of the three methods previously described, there is frequently a requirement for connecting certain control circuits from the switchgear to the transformer. These connections are usually made through control conduit installed between the switchgear and the transformer. The specific means provided for any given assembly will be shown on the drawings for that installation.




TRANSFORMER CONNECTED TO "LINE" SIDE OF HIGH VOLTAGE BREAKER




TRANSFORMER CONNECTED TO "BUS" SIDE OF HIGH VOLTAGE SWITCHGEAR

FIG. 22. Typical Sketches of Close-Coupled Indoor Unit Substations

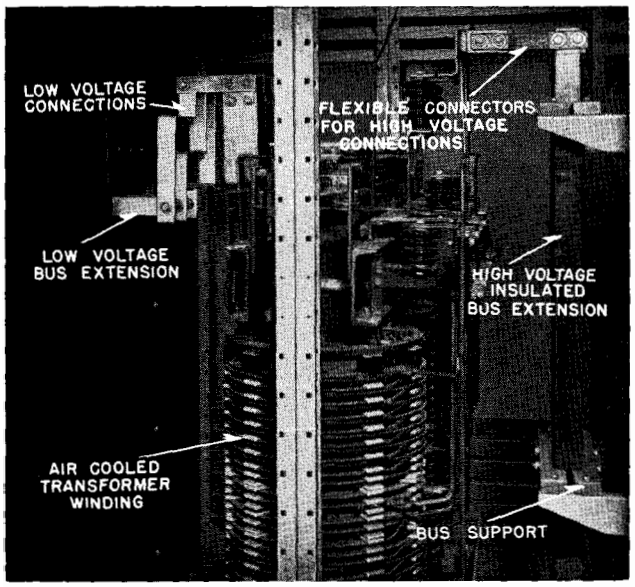



**FIG. 23. Connections to Transformer. (Taping has been omitted from the flexible connectors to illustrate method of installation.)**

## INSTALLATION OF BUS CONNECTIONS

The main bus and any transfer bus or tie bus connections are all completely assembled and fitted at the factory. Sections of bus for the shipping group breaks are then removed, identified, and shipped as detail items for final installation in the field. Figures 24, 25 and 26 show a typical plan view and details of the bus construction.

The following steps should be followed in making the final installation of main copper connections:

**1.** Clean the silver plated contact surfaces by rubbing lightly with crocus cloth and then wipe with a cloth moistened in a cleaning solvent such as Stoddard's Solvent (Westinghouse number 1609-a petroleum hydro-carbon solvent). *CAUTION—This is a flammable liquid having a flash point of 100°F. Keep sparks and flames away. Do not breath large quantities of vapor. Avoid continuous or excess contact with the skin.*

**2.** Bolt the bus bars together using the splice plates and hardware supplied for that purpose. Bear in mind that the conductivity of a bolted or clamped joint is proportional to the pressure applied. Note however that excessive pressure applied to the hardware will result in stressing it beyond the yield point so that further tightening is impossible. Recommended tightness for various types of hardware are shown in Table 4.

**3.** Install compound boxes over the joint as shown in Figure 26. Boxes are held in place by means of four molded clamping members which slide over matching tapered lugs on the two halves of the box. In installing the clamps note the taper and slide them over the lugs on the box from the center out. A light coating of varnish should be applied to the wedge before clamping to seal it in place. Pressure of a thumb and finger is sufficient to clamp the box in place.

**4.** Fill the boxes with Westinghouse compound No. 1001 which is supplied for that purpose. (Do not use pothead compound ) This compound should be heated to a temperature between 150 and 160°C. and then poured into the box through the opening in the top. A second filling should be made to take care of any shrinkage after the first filling of compound has cooled. The final cold level of compound

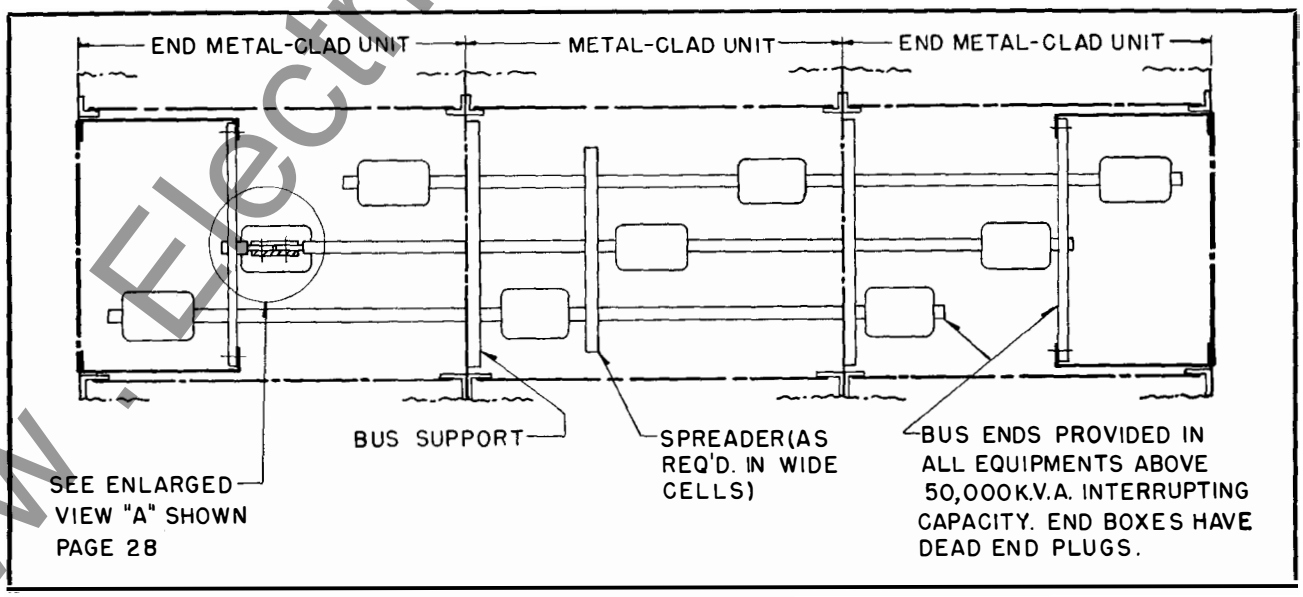



**FIG. 24. Plan View of Typical Main Bus Installations.**

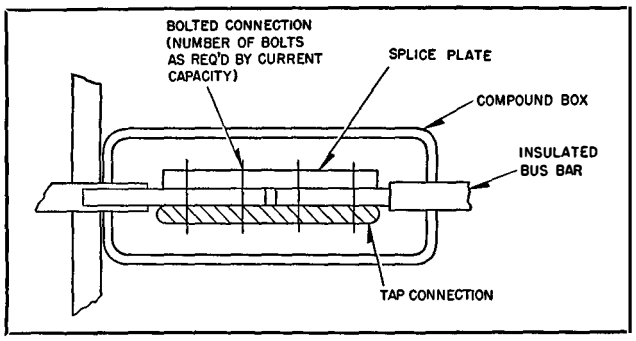



FIG. 25. View "A"—Detail of Bolted Joint

should be approximately 3/8" below the top of the box. The pouring of compound will be facilitated by using a funnel that has an extension of flexible conduit soldered to it.

**5.** Besides the joints in the bus assemblies, compound boxes are supplied for enclosing the joint between the breaker upper main stationary disconnecting contacts and current transformers and also between the breaker lower main stationary disconnecting contacts and copper connections to the main bus. General procedure as outlined for the bus type compound boxes will apply of these other types of joints.

**6.** All other joints not insulated with compound boxes, including flexible connectors, should be taped in accordance with Figure 27 and taping instructions which follow. Tape and varnish are included with the switchgear shipment for this purpose.

DO NOT FAIL TO COMPLETE TAPING AND POURING OF COMPOUND BEFORE PUTTING EQUIPMENT IN SERVICE.

### Table No. 4. BOLT TIGHTNESS FOR BUS AND CONNECTIONS

**Use the following torque values for tightening bus and connection joints (tolerance, plus or minus 25%).**

**Use widest standard flat washers consistant with bolt spacing.**

| | TORQUE IN FOOT POUNDS FOR BOLT DIAMETER | | | | |
|---|---|---|---|---|---|
| BOLT MATERIAL | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 |
| HEAT TREATED STEEL | 5 | 12 | 22 | 55 | 75 |
| SILICON BRONZE | 5 | 10 | 15 | 40 | 55 |

## TAPING

Wrap with half-lapped layers of .010 inch varnished cambric tape (Westinghouse No. 1266 tan treated fabric) applying as many layers as given in the Table Figure 27. Apply a coat of number 3395 clear insulating varnish between layers.

Cover the varnished cambric with one layer of .007 inch cotton tape No. 7560-1 and wrap the ends with cord or friction tape to keep them in place. Apply one coat of shellac No. 1133-2 and finish with one coat of colored insulating enamel (No. 7260-4 black or No. 5928-3 red). The color of the final finish to be used on any particular taped joint should match the color of the component parts adjacent to the joint.

A properly taped joint will have the tape wound tightly following as closely as possible the contour of the joint so as to eliminate dead air spaces under the tape. When finished, the taped joint should be smooth and glossy to facilitate wiping away dust and should present a pleasing appearance. One important thing to note is the fact that it is unnecessary to wait for the various layers of insulating paint to dry before proceeding with successive layers of tape or other finishes. The various insulating paints may remain tacky for as long as 8 hours or more after being applied. However it is not necessary to wait the complete drying of these paints before energizing the equipment as there is no appreciable difference in insulating qualities between the wet and dry conditions. Normal elevations of temperature which occur during operation of the equipment will speed up the drying process.

## MAIN POWER CONNECTION

Metal-clad switchgear is usually provided with either solderless cable connectors or sealed potheads for connecting to main power cables. The

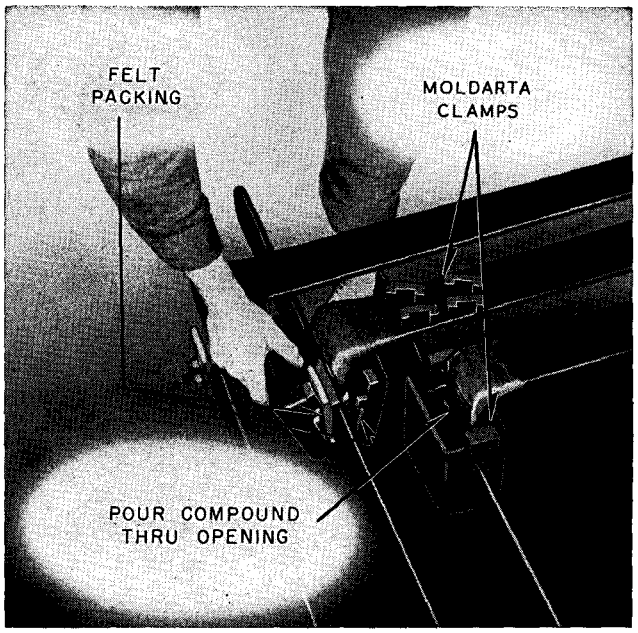



FIG. 26. Installation of Compound Box

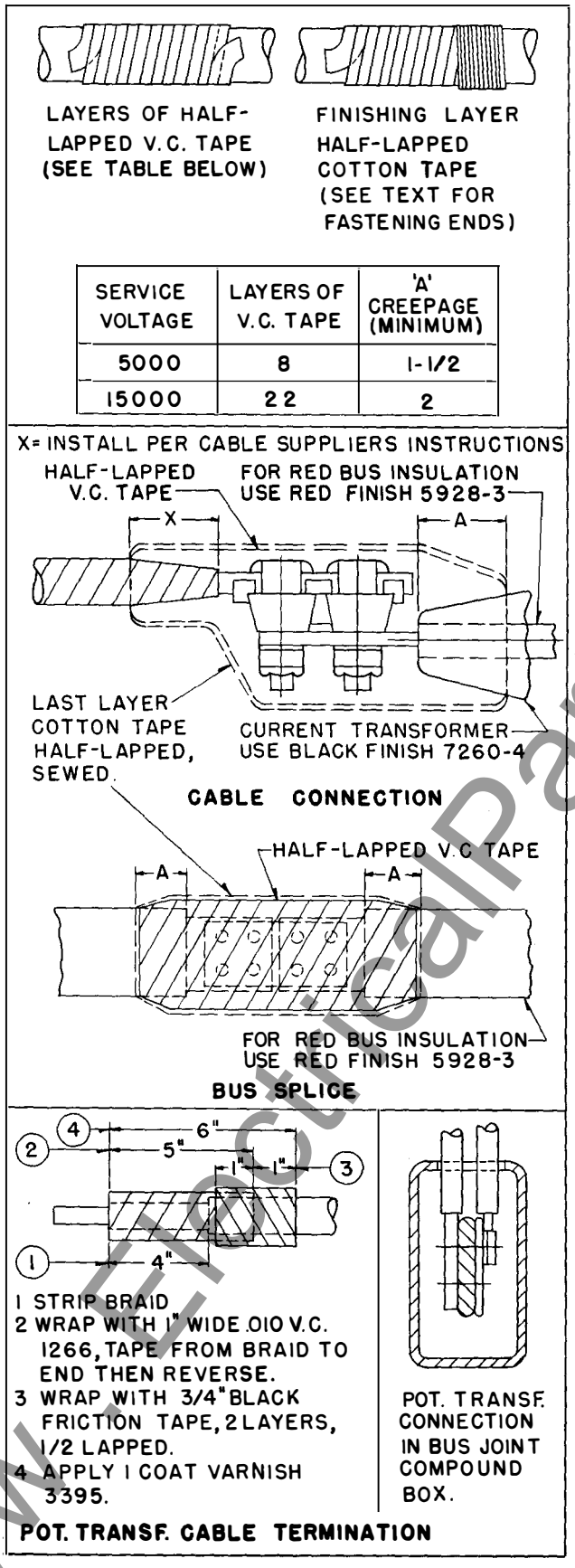



FIG. 27. Taping Instructions

pictures shown in Figure 28 are typical of these two types of termination.

Before making up the connections, the phase of each cable should be determined in accordance with the connection diagram and the cables should be tagged accordingly. Normally Westinghouse switchgear is supplied with connections for phase rotation 1-2-3 per N.E.M.A. Standards unless otherwise noted on the connection diagrams.

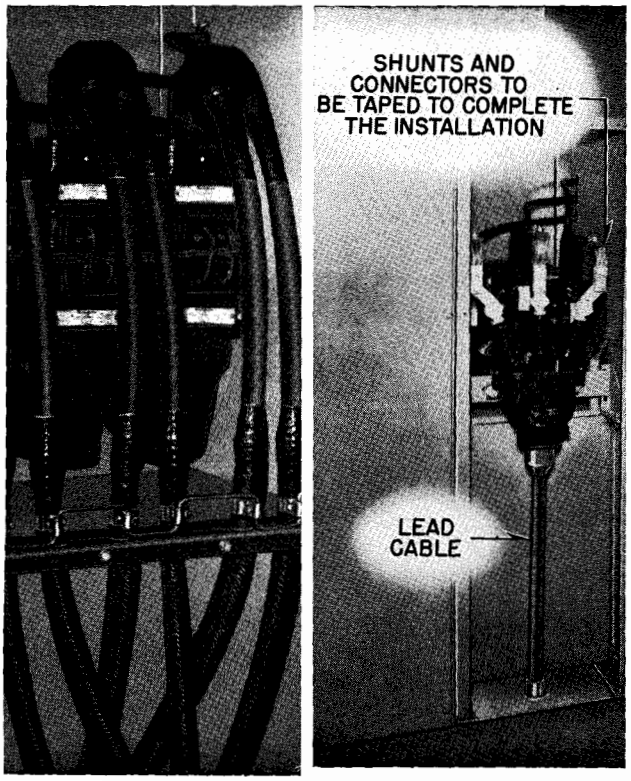
When more than one cable is used per phase and all cables cannot be run in a single conduit, one cable from each phase should be run in each iron conduit; or conduits of non-magnetic material should be used.

Any connections that may have been removed for shipping purposes should be reconnected in accordance with previoulsy described methods for cleaning and bolting main bus connections.

**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 the copper bars in the switchgear so as to avoid strain on the pothead insulators. Potheads are normally shipped mounted in the switchgear units without the flexible connectors being bolted, and such connections must be completed in the field. It should be noted that flexible connectors are to be taped in accordance with instructions previously given for taping main bus connections.

**Solderless Connectors.** Solderless connectors are normally furnished for terminating non-leaded cable. In addition insulating clamps are normally provided to separate the cables and to support their weight. The cable manufacturer's instructions should be consulted for the exact details required in terminating any given type of power cable. Cable clamps when supplied 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.

**Flexible Connectors.** Flexible connectors are provided to relieve the strain on pothead insulators and may be used with bus runs to allow for expansion of copper bus bars due to heating or in transformer throats or similar applications to facilitate lining up




Solderless Connectors and Micarta cable clamp. Two conductors per phase with final taping completed.

Sealed Pothead for 3/c cable Flexible shunts prevent strain on pothead porcelains.

FIG. 28. Typical Main Cable Installation.

of adjacent copper bars. No matter when they are applied, **FLEXIBLE CONNECTORS MUST BE TAPED** to provide adequate insulation. Taping instructions previously noted for bus bar connections and/or power terminal connections will apply.

**General.** 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.

## ADDITION OF UNITS TO EXISTING ASSEMBLIES

When additional units or groups of units have been supplied for extending existing installations, the procedures outlined for installing the initial equipment should be followed. In such cases it becomes necessary to remove the compound boxes from the end unit of the existing switchgear assembly in order to extend the main bus into the new units. Any one of the following procedures are recommended for removing the compound from the existing bus joints:

**1.** With the compound at room temperature chip away the existing box and compound with a dull chisel being careful not to damage the insulating tubing on the bus or the bus itself.

**2.** Enclose the compounded joint in a cardboard box or other suitable container and pack with dry ice to freeze the compound. Allow the joint to be exposed to the dry ice for approximately two hours, remove the packing, and chip as described in paragraph 1 above. Care must be exercised in handling the dry ice to prevent injury to personnel.

**3.** Apply sufficient heat to the joint to soften the compound using heat lamps. Do not use open flames as they are apt to mar the finish or cause other damage within the equipment. After the compound has been softened, scrape away using putty knife or similar tool.

After the bulk of the compound has been removed by one of the three methods suggested above, apply a solvent to the remaining compound such as Stoddard's Solvent (Westinghouse No. 1609) to remove the bits of compound that may still adhere to the joint. In using the solvent apply it sparingly to reduce possibility of it migrating into the space between the copper bar and insulating tubing. Repeated applications of a cloth moistened in the solvent is recommended. Remove the bus joint hardware as soon as sufficient compound has been removed to make the bolts accessible. A wire brush lightly applied to the joint may also assist in removing the final bits of compound. After the hardware has been removed, the contact surfaces must be thoroughly cleaned using the cleaning solvent suggested.

When the joint has been thoroughly cleaned the bus may be extended into the new units using the copper bar supplied for that purpose. The bus end brackets and insulating bus support removed from the end unit of the existing gear should then be installed in the new end unit. Compound boxes supplied with the new assembly should then be installed and compound No. 1001 should be poured as previously described.

The above procedures described for removing compound from main bus joints will also be applicable to cases where it becomes necessary to remove any other compound joints.

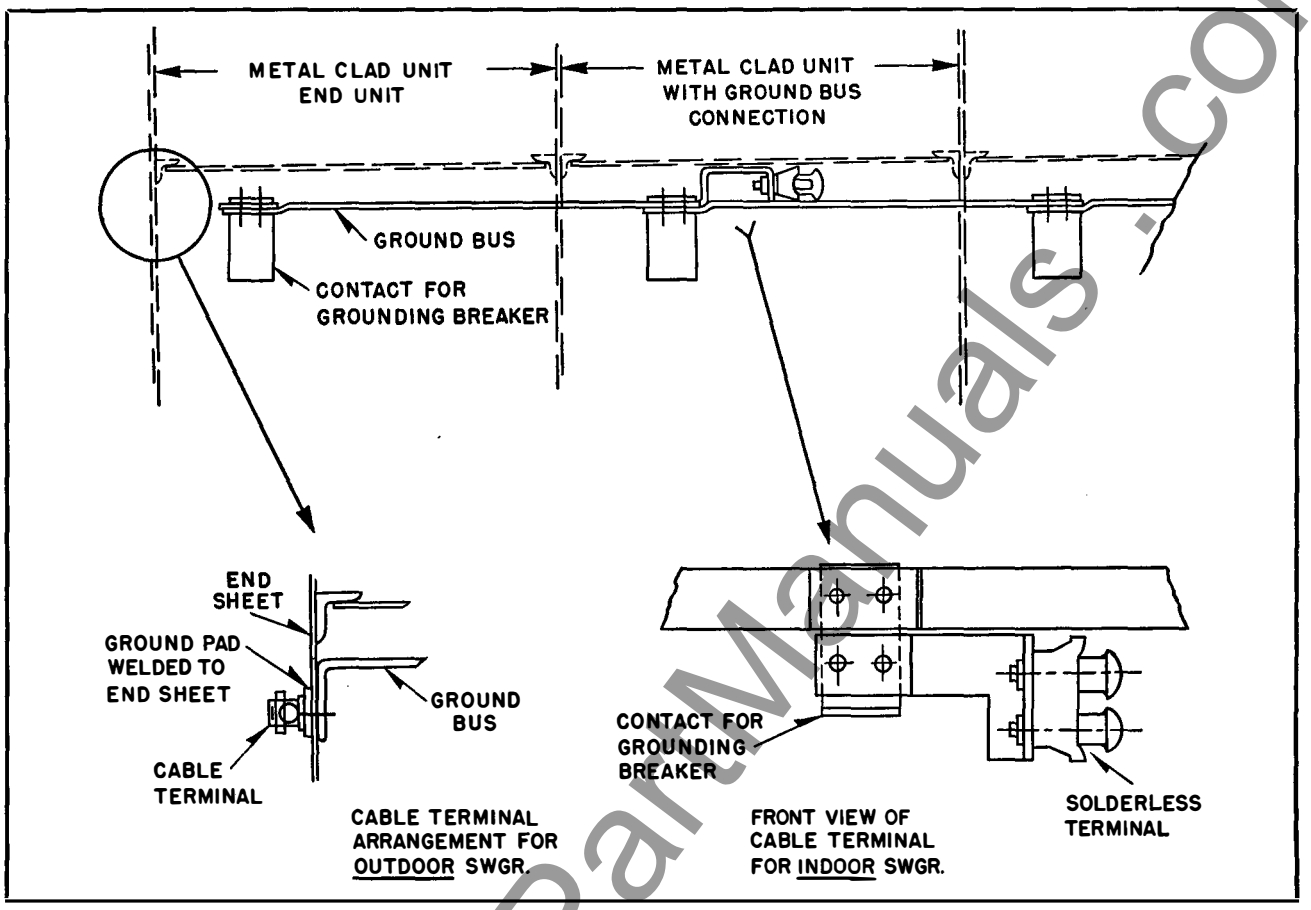



FIG. 29. Plan View and Details of Typical Ground Bus Installation

## GROUND BUS CONNECTIONS

The ground bus in the switchgear housings is a copper bar assembled in sections with a joint in each unit. Fig. 29 illustrates the ground bus construction. The section of ground bus between units at shipping group breaks is removed for shipment and must be reinstalled when the units are assembled.

Terminals of the solderless type are provided on the ground bus for indoor switchgear in one or more units as indicated on the floor plan drawing. For outdoor switchgear, the ground bus terminal is located on a welded ground pad on the end of the structure. These terminals are for the connections to the station ground which should be as direct a connection as possible and should not be run in metal conduit.

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 standard cable of at least 500,000 cm area. Fan three feet of the strands over the plate surface and solder or braze then 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 1½" galvanized iron pipe

of sufficient length to reach moist earth (not 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 AND CONTROL CONNECTIONS

All secondary and control connections on metal-clad switchgear are factory wired in accordance with the connection diagram applying to the installation. The secondary and control connections which are to be connected to apparatus remote from the switchgear are wired to terminal blocks near to the secondary conduit entrance location.

Openings in the side sheets of control compartments provide access for control connections between housings. When shipment is made in groups of several units, the cross connections are installed in one group at the factory and provisions are made for connecting to the adjacent groups.

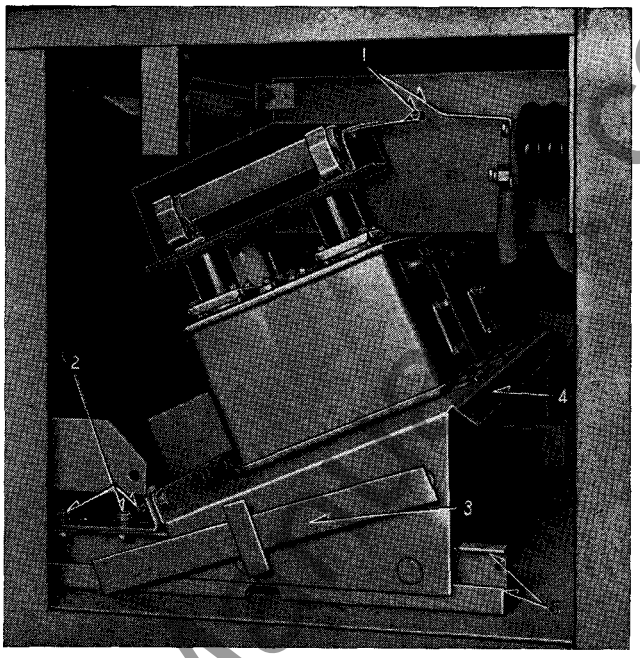
**Voltage Drop.** The control bus for electrically operated breakers is usually of larger size than the balance of the control wiring to reduce the voltage drop, particularly in a long structure. The feed connection to this bus should be checked for voltage drop at the maximum breaker closing current and sufficiently large cable used to insure proper operating voltage at the breaker solenoid. Make sure that the polarity of all the connections from d-c control sources is as shown on the connection diagram.

All connections should be made mechanically and electrically strong and should be checked for proper electrical sequence before being energized. All control and secondary cables to remote apparatus should be connected to the terminal blocks provided and carefully checked for accuracy against the connection diagram.

**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.

## DISCONNECTING TYPE POTENTIAL TRANSFORMERS

For shipment, the operating links of the potential transformer drawer are disconnected from the hinged door and the drawer clamped in a position with the contacts disconnected. This is to prevent wear of the contacts due to vibration during transit.




1. Primary contacts separated during shipment to prevent wear by vibration
2. Shipping clamp bolted to drawer and rail.
3. Operating arm disconnected from door and resting on floor of compartment.
4. Movable drawer.
5. Rail.

FIG. 30. Disconnecting Type Potential Transformers in Shipping Position (See also Fig. 8).

The clamps are small angle shaped pieces which are bolted both to the transformer drawer and to the rails on which the drawer operates as shown in Fig. 30. The links are dropped and laid inside the compartment frame angles.

Before placing the switchgear in operation, the disconnecting drawer assembly should be prepared for operation as follows:

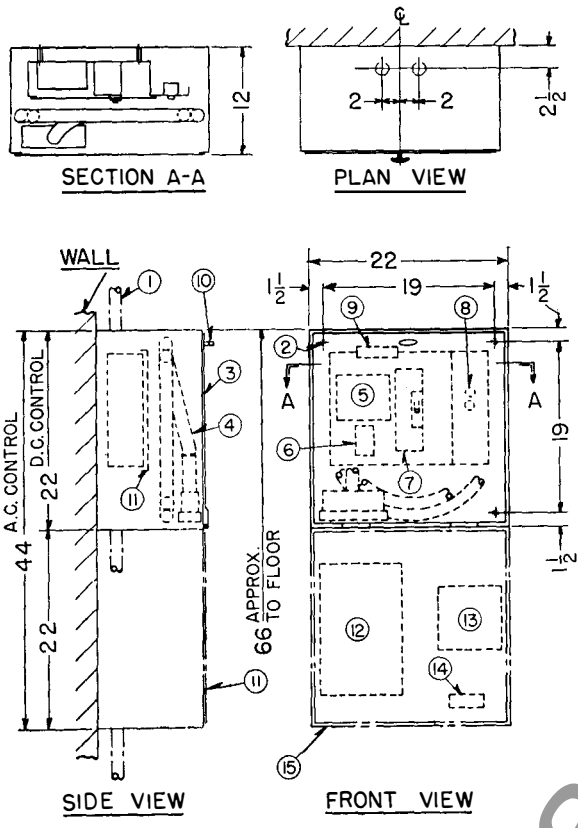
**1.** Remove angle clamps.

**2.** Check contact engagement in operating position. The primary contacts should spring between 1/4" and 1/2" when engaged.

**3.** Raise door to approximately 30° opening position and connect links to the clips on the door.

**4.** Check operation of disconnecting drawer assembly and also check engagement of primary contacts with grounding bar.

**5.** Check fuses to be sure they are good and make proper contact in the clips.




**EQUIPMENT IDENTIFICATION**

| ITEM | IDENTIFICATION | |
|---|---|---|
| 1. | 1 or 1¼ conduit may enter top or bottom | |
| 2. | 4 9/16 dia. holes for mtg. cabinet to wall | |
| 3. | Door hinged at bottom (has 180° travel) | |
| 4. | Sec. cont. cable for conn. to cir. bkr. (10 ft. lg.) | |
| 5. | Control relay (X) | |
| 6. | Control relay (Y) | |
| 7. | AB breaker | |
| 8. | Pushbuttons (close & trip) | |
| 9. | Terminal block (8 or 12 PT.) | |
| 10. | T-Handle latch | |
| 11. | Removable cover | |
| 12. | Rectox | for A-C control |
| 13. | Capacitor or inst. trip device | |
| 14. | Terminal block (4 PT.) | |
| 15. | Rectox & bkr. attachment cabinet | |

FIG. 31. Test Control Cabinet.

## TEST CABINET

The test cabinet is designed for wall mounting and provides means for testing the breaker operation after it has been removed from the structure. The cabinet includes "close" and "trip" push buttons, control relay, a control circuit interrupting device and secondary disconnecting devices with multiconductor extension cable. A closing Rectox and capacitor trip device is supplied, when required.

Fig. 31 is a drawing of the test cabinet and shows the wall mounting dimensions. The cabinet must be provided with control power and provision is made for a conduit to enter the cabinet.

For indoor switchgear the test cabinet should be located on a wall or building column convenient to the switchgear where the routine testing and maintenance work will be done on the circuit breakers.

For outdoor switchgear a long test jumper is normally supplied to facilitate checking operation of the breaker while on the transport truck outside the housing. When ordered, an indoor type test cabinet is supplied for mounting inside a maintenance building. A special outdoor housing is also available with space for the test cabinet and storage of a spare breaker.

## PREPARING BREAKERS FOR SERVICE

The removable breaker elements should be uncrated carefully and thoroughly inspected. The supplementary instruction book for the breaker should be consulted for additional description of the breaker and its operation. The following summarizes the steps to be followed in preparing the breaker for service:

**1.** Remove any special bracing added to the breaker for shipment.

**2.** Remove any blocking used to hold the breaker closed during shipment. This blocking may be released by pulling the breaker tightly closed with the maintenance operating handle.

**3.** Inspect the breaker unit carefully for loose or broken parts or for any foreign material which may interfere with the breaker operation. Repair or replace any broken parts. (Enter a claim with the carrier for any damage that may have occurred during shipment).

**4.** Check the circuit breaker contacts and the operation of the mechanism as outlined in the air circuit breaker instruction book.

**5.** Inspect the main disconnecting contacts for damage to the fingers or insulators.

**6.** Close the breaker slowly with the maintenance operating lever to check the operation of the mechanism and the adjustment of the contacts.

**7.** Install the arc extinguishing stacks after the above steps have shown the breaker to be in good condition. Inspect the stacks thoroughly before installation for breakage or presence of foreign substances as recommended in the breaker instruction book.

**8.** After the arc extinguishing stacks have been installed on the breaker, check for proper engage-

ment of the rear arcing horn connection and bolt the front arcing horn connectors to the stacks.

**9.** Operate the breaker slowly by hand to be sure that moving contacts clear the arc stacks.

**10.** Install the metal insulating barriers. **Never insert a breaker in its unit without having the stacks and the barriers installed.**

**11.** Check the control wiring for grounds and shorts.

**12.** Before inserting the circuit breaker in its switchgear unit, insert the levering-in handle and turn it counter-clockwise to extend the levering-in device arm toward the rear of the breaker unit. Continue turning the handle until the arm reaches its stop.

## KEY INTERLOCKS

Key interlocks are often supplied in conjunction with disconnecting switches, dummy breakers 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 switchgear 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.**

## ADJUSTING AND TESTING

After the switching equipment 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. This is necessary to insure that the equipment has been correctly installed and that all connections are complete. 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 required will depend entirely on the size and type of installation. Portable voltmeters—both a-c and d-c with a wide range of scales will usually be required and for large and complicated installation, both a-c and d-c 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.

Although the inspection and tests given the switching equipment at the factory insures that all the connections on the switchgear are correct and in good order when it leaves the factory the connections should be examined to make sure that they have not been loosened or damaged during shipment or installation. All bolted connections and joints should be tightened to insure good contact.

After installation, the connections to the equipment apart from the switchgear such as instrument transformers, remote control and interlock circuits, auxiliary switches, etc., should either be rung or 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, however, be definite assurance that all 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 and determined in accordance with the Purchaser's standards or operating practice. If it becomes necessary to modify these relay settings after the switchgear has been installed, the instruction leaflet for the relay involved should be carefully studied before attempting such modification. These instruction leaflets show typical connection diagrams only and may not necessarily agree with the connections furnished. The schematic and wiring diagrams furnished with the switchgear equipment should be referred to for the actual connections applying to this installation.

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 as these are made either partly or entirely of glass. 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 and diagrams 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. This is necessary in order that there will be no confusion in handling future orders for changes or extensions.

# OPERATION

The operation of horizontal drawout metal-clad switchgear is similar to that of permanently fixed breakers with the added advantages of greater flexibility, safety and ease of maintenance, plus ease of testing and checking control circuits.

All circuit breaker units of the same rating are identical and interchangeable and have the same control wiring so that it is possible to replace any breaker unit with any other unit of the same rating. In addition, the 600 ampere and 1200 ampere breakers of the heavy duty units (i.e. 100,000 kva interrupting capacity and over) are interchangeable so that a 1200 ampere breaker may be used as a spare for either rating, or a 600 ampere breaker can be used in a 1200 ampere housing in an emergency provided that, at the time, the load requirement does not exceed the 600 ampere rating of the circuit breaker. **ALWAYS REFER TO THE NAMEPLATE INTERCHANGEABILITY DATA TO MAKE CERTAIN THAT BREAKER UNIT AND HOUSING ARE SUITABLE FOR OPERATION TOGETHER.**

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

The control circuits may be checked accurately and safely by moving the breaker to the test position where the main circuits are disconnected and the control circuits can be completed by moving the secondary contact assembly to the engaged position. (See Fig. 32). No jumpers are needed.

All Type "DH" air circuit breakers are equipped for electrical operation. A maintenance operating handle is supplied as part of the accessories to permit manual operation of the breaker during maintenance. THIS DEVICE MUST NOT BE USED TO CLOSE THE BREAKER ON ANY ENERGIZED CIRCUIT.

## PLACING BREAKER UNIT IN HOUSING

No attempt should be made to place the removable breaker elements in the housings until after the housing installation is complete. The

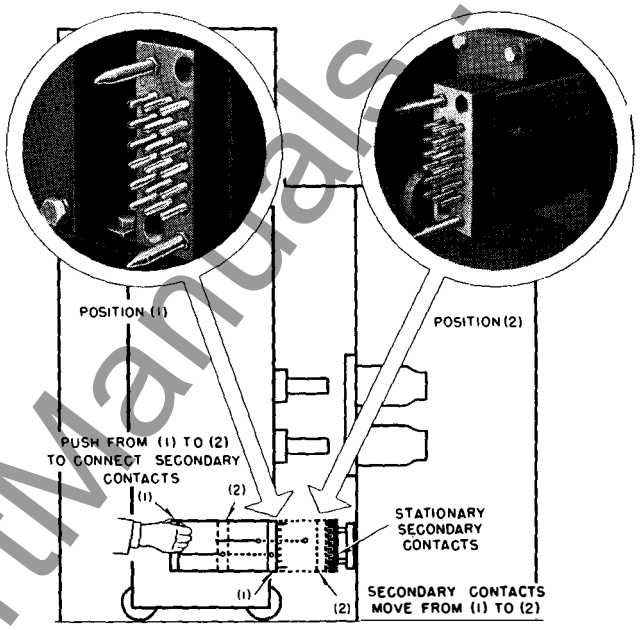



FIG. 32. Engaging Secondary Contacts with Breaker in "Test Position"

insertion of the breaker into the housing is accomplished in three major steps as illustrated in Fig. 33 and as described in the following paragraphs.

**1.** First, place a breaker unit so that it is directly in front of the housing and aligned so that the wheels will engage with the guides or rails. The handling dolly may be used with the heavy duty indoor units until the breaker is lined up and then it should be removed. For outdoor switchgear the breaker will be on the transport truck and the transport truck is brought up to the housing, the rails matched and the truck then latched to the housing.

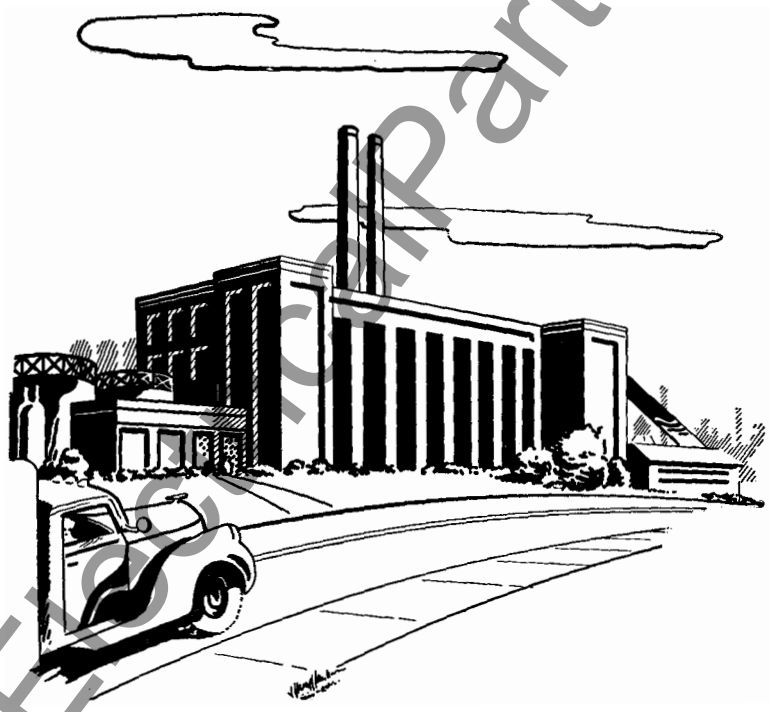
**2.** The second step is to move the breaker by hand to the test position. The levering device arm must be in the rear position against its stop. The breaker should be moved slowly into the housing, making sure that the wheels engage the housing guides and watching carefully for any interference. The breaker should never be slammed into the housing. The test position is reached when the breaker is stopped by the levering device roller.

operating conditions and are usually backed up by some additional tripping means to open the breaker should a fault occur. Shunt trip coils may also be supplied where a separate source of tripping energy such as a storage battery is available.

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 Rectox which charges a capacitor. In such cases the energy stored in the capacitor is discharged through a special trip coil when the control switch is operated to the tripping position or when one of the protective relays closes its contact to trip the breaker.

Additional tripping schemes using undervoltage release coils and transformer tripping coils are occasionally supplied. In such cases the use of these devices will be clearly indicated on the schematic diagrams supplied with the equipment.

**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 co-ordinate with the other parts of the power system in accordance with the Purchaser's standards and operating practices.



# 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 men expecting to work on them assure themselves personally that the circuits are dead, and every possible precaution should be taken to see that there is no chance of a circuit being energized while the men are 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 on page 31.

## ACCESS TO SWITCHGEAR PARTS

Metal-clad switchgear is designed so that all high tension parts are enclosed by steel barriers and so that different portions of the circuits are in separate compartments. The design is also such that all of these compartments can be opened for inspection and maintenance by removing a few bolted covers and barriers. The general assembly section drawing has these removable covers identified by the notation "RC".

**Control Equipment.** The control equipment, control wiring and breaker mechanism are accessible without exposing high tension connections. On indoor switchgear this is done by opening the front instrument panel. On outdoor switchgear, opening the front weatherproof door exposes the instrument panel and control equipment, and opening the breaker side weatherproof door exposes the breaker mechanism. These panels and doors are of the latched type and may be opened without removing bolts.

**High Voltage Parts.** Access to current transformers and main cable connections is gained by removing the bolted cover as illustrated in Fig. 36.

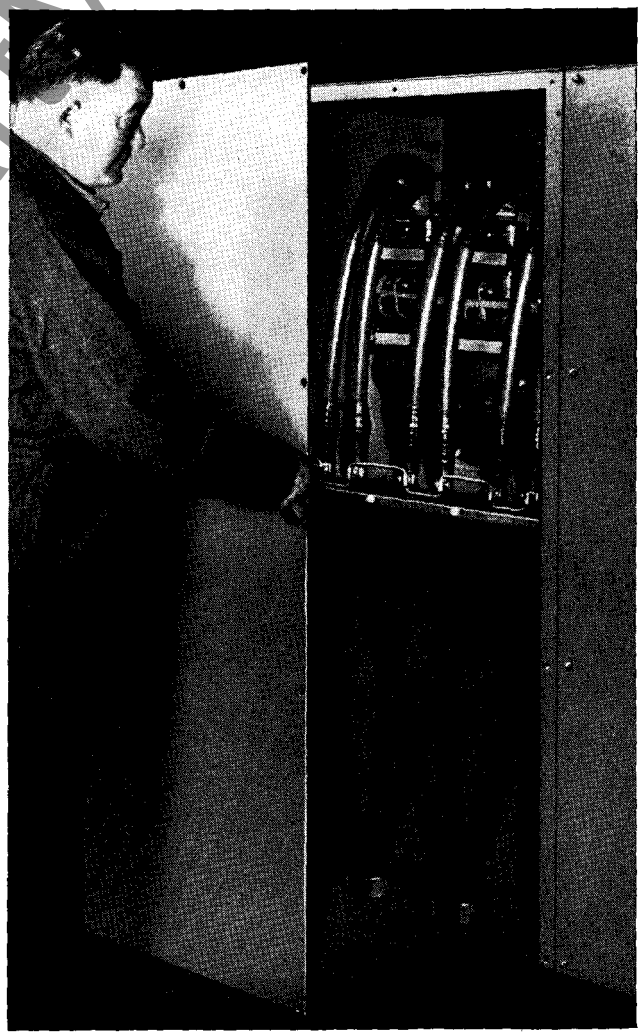


FIG. 36. Removing Rear Barrier—(For inspection of current transformers and main cable connections).

The bus compartment is opened by removing a two section bolted barrier as shown in Fig. 37, or by removing a bolted cover in the breaker compartment after the breaker is removed.

**Potential Transformers.** Potential transformers are provided with disconnecting type mountings so that the transformers are disconnected and grounded automatically as the latched door of the compartment is opened as shown in Fig. 38. Access to the cables connecting the transformers to the bus or line is gained by removing covers as indicated on the general assembly section drawing.

The movable drawer of the drawout potential transformer assembly may be completely withdrawn from the compartment if necessary for repairs.

To completely remove the drawer, open the door, disconnect the operating links from the door clips and pull the drawer out.

**Breaker Contacts.** The breaker contacts are exposed for inspection and maintenance by removing the interphase barrier and arc chutes as shown in Figs. 39 and 40. For the 5 kv breakers the barriers are all in one assembly, while for the larger 7.5 kv and 15 kv breakers the barriers, as shown in Fig. 41, are arranged in two sections to facilitate handling. The arc interrupting chutes are released by removing the strap bolted to the magnet frames and the shunt to the lower main contact. The chutes should be handled carefully to avoid breaking any of the ceramic parts. Additional information on the breaker inspection and maintenance will be found in the instruction book covering the particular rating of breaker supplied with the metal-clad switchgear.

## MAINTENANCE SCHEDULE

In order to assure the high quality service for which the switchgear has been designed, a definite maintenance schedule, systematically followed, is essential. Plant, operating, and local conditions vary to such an extent that the actual schedule must be prepared to suit the local conditions. However, the following general requirements should be helpful in setting up the necessary program.

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

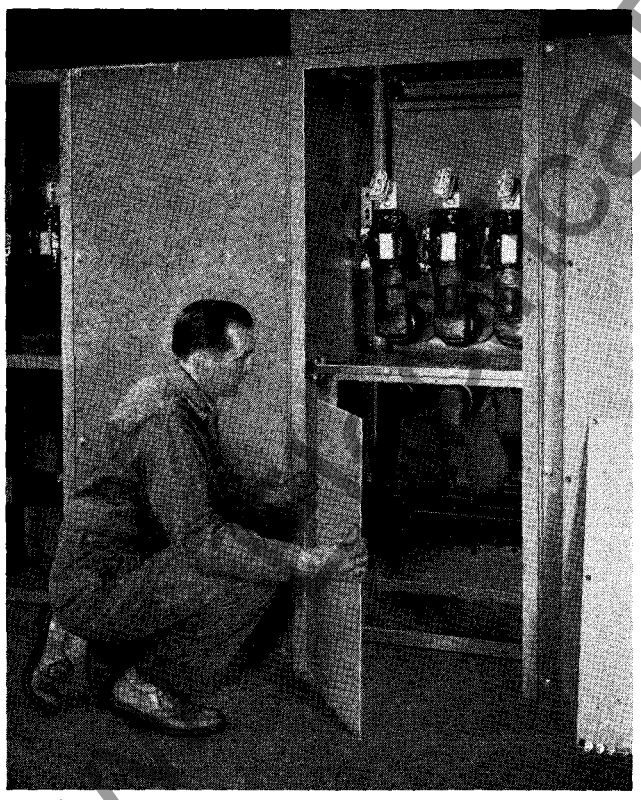


FIG. 37. Removing Barriers of Main Bus Compartment. (Busses are also accessible from breaker side of housing by removing bolted section of barrier).

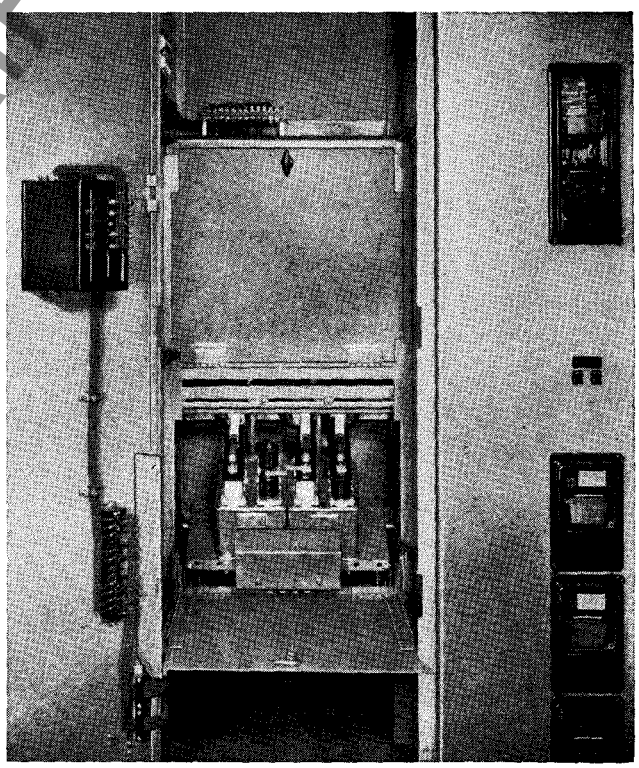


FIG. 38. Access to Potential Transformers. (Disconnecting type arrangement disconnects both primary and secondary and grounds primary when door is opened for access to fuses).

program to result in the least operating inconvenience and circuit shut-down.

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

**1. Busses and Connections.** Deenergize the primary circuits and remove all cover plates from the primary compartments. Inspect for abnormal conditions which might indicate overheating or weakened insulation. Remove dust accumulations from bus supports and enclosure surfaces. Use a vacuum cleaner with a long nozzle to assist in this work. Wipe all busses and supports clean with cloths moistened in a cleaning solution such as Stoddard's Solvent (Westinghouse No. 1609, a petroleum hydrocarbon solvent).

**CAUTION**—*This is a flammable liquid having a flash point of 100°F. Keep sparks and flames away. Do not breath large quantities of vapor. Avoid continuous or excess contact with the skin.*

After busses have been dusted and wiped clean, take "megger" readings between the busses 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 busses 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 in AIEE Standard No. 27 for new switchgear. Potential transformer primary fuses should be removed during high potential tests.

**2. Primary and Secondary Disconnecting Contacts.** Each breaker should be removed from its housing for inspection of the primary and secondary disconnecting contacts and their supporting insulation. 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. Apply a thin film of vaseline to all contacts before replacing the breaker. 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.

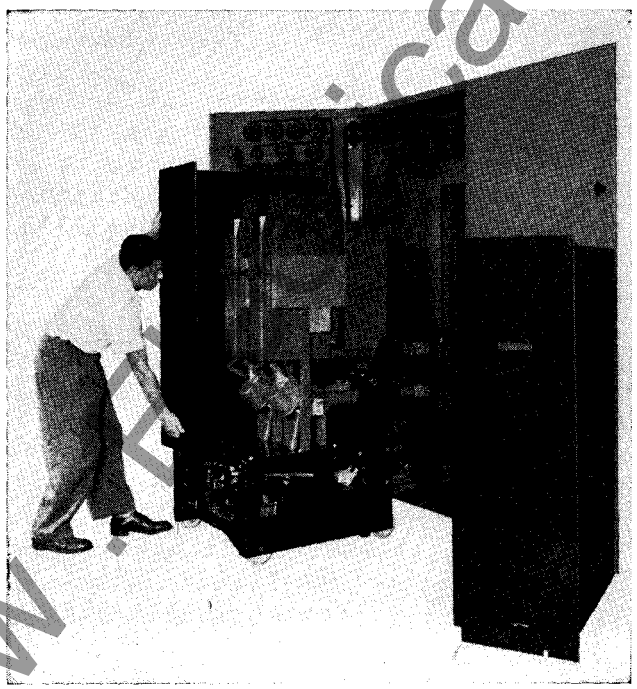


FIG. 39. Removing Interphase Barrier. (Loosen holding bolts and slide barrier forward to expose arc chutes).

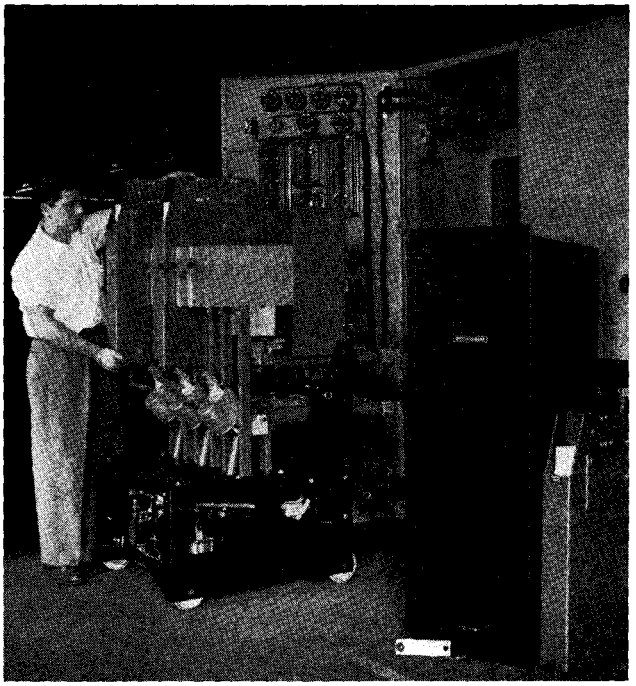


FIG. 40. Removing Arc Chutes. (A few accessible bolts clamp the chutes in place and connect the shunt to the arcing contact).

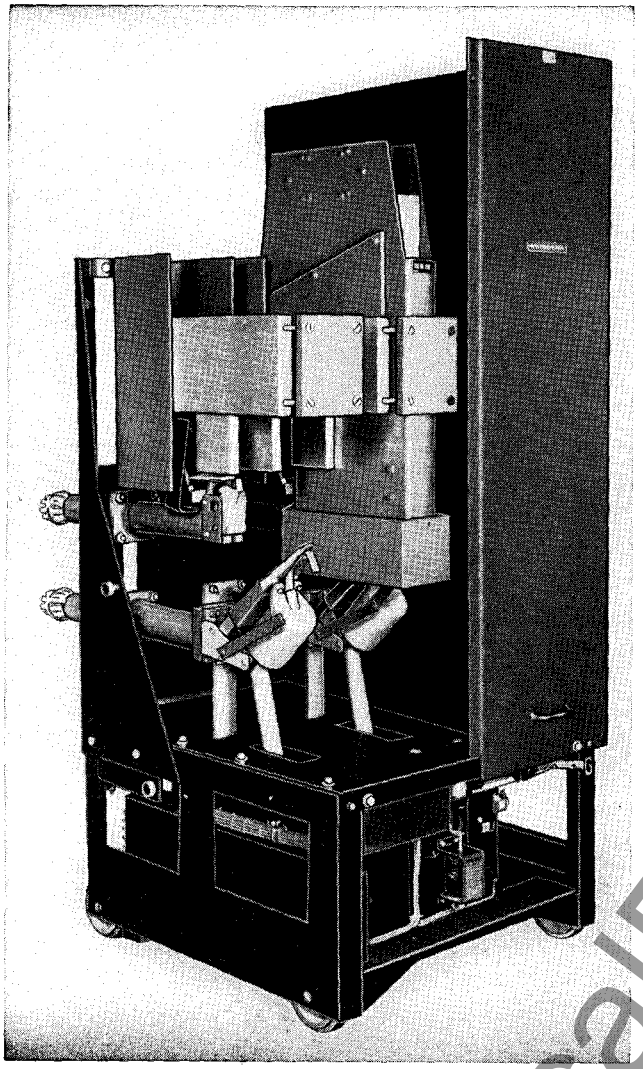


FIG. 41. 15 KV Type "DH" Breaker. (Showing one half-section of barrier and one arc chute removed).

**3. Levering Device and Shutter.** These devices should be cleaned, a few drops of oil applied to bearings, and a thin film of grease to guide surfaces, racks, screws and bolt threads. The application should be thorough, but not excessive, to prevent the accumulations of dust and dirt.

**4. Control Relays.** 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. Dust Filters.** Check all dust filters for excessive accumulation of dust and dirt and replace them as necessary.

**7. 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.

**8. 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.

**9. Records.** The condition of each switchgear unit at the time of inspection should be listed in a permanent record to become a guide for anticipating the need for replacements or for special attention between the regular maintenance periods. 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 emphasises the value on a series of readings which

can be charted to establish a normal insulation level so that progressive weakening of the insulation can be recognized.

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

It should be emphasized that a series of inspections should be made at quarterly intervals until the progressive facts of the local conditions can be analyzed to determine a schedule which will maintain the equipment in satisfactory condition.

**11.** 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

The worm and gear type levering-device on the horizontal draw-out switchgear should be lubricated periodically to insure free and easy operation. A semi-fluid grease of consistency similar to 600-W, sufficiently heavy to remain in place for a long period of time and at the same time not channel, is most suitable for this purpose.

A lighter type of oil can be used on the various shaft bearings, the levering-in device, and disconnecting switch shafts and any other bearing points to promote ease and smoothness of operation.

The bearings or sliding parts of any interlocking arrangement supplied with disconnecting switches or special arrangements of breaker interlocking should be lubricated occasionally with a light oil. Never oil the cylinder of Yale, Corbin, or similar locks.

The operating mechanism of the shutters for the horizontal draw-out type equipment should be lubricated occasionally with a light oil at all pivot points. The guide ways or slots on these assemblies can also be lubricated to good advantage.

## RENEWAL PARTS

The convenience and advantage that may be gained by carrying in stock a few well chosen, comparatively inexpensive renewal parts, is so great that the advisability of so doing cannot be over emphasized. In spite of the care which may be exercised, it is inevitable that at some time a vital part, such as a main disconnecting contact, will become damaged beyond use—possibly causing delay at a very inopportune time.

The following parts are suggested as spares for a typical layout although recommendations may vary for particular installations:

### Recommended Stock of Renewal Parts

1—Set of circuit breaker parts for each type of breaker, consisting of:
1—Set of arcing contacts
1—Main disconnecting contact assembly
1—Shunt trip coil
1—Lift or pull rod
1—Set primary fuses for potential transformers
1—Standard package of indicating lamps and secondary fuses
1—Lot of fingers and segments for control, instrument, and auxiliary switches.
1—Set of contacts and coil for each type of auxiliary or control relay.

These renewal parts should be ordered as soon as possible if not ordered at the time that the initial equipment was purchased. They will then be available during the installation period, should any mishap occur, and prompt ordering may avoid delay in obtaining parts after a breakdown.

**Instructions for Ordering.** When ordering renewal parts, give the nameplate reading, the name of the part wanted, and the shop order number of the apparatus on which the part is to be used. Refer to the back cover of this book for the nearest District Office from which to order parts.

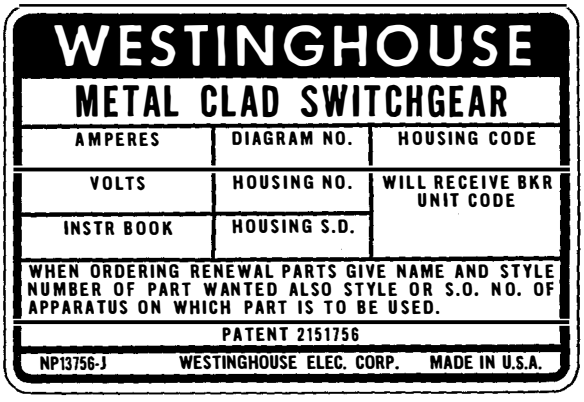



FIG. 42. Facsimile of Housing Nameplate.

**MEMORANDA**

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MO/DO

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600
+1000

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