DESCRIPTION • INSTALLATION • MAINTENANCE

INSTRUCTIONS

High-Voltage

METAL-CLAD SWITCHGEAR

with

Types "F" and "B"
Oil Circuit Breakers

WESTINGHOUSE ELECTRIC CORPORATION
SWITCHGEAR DIVISION.
EAST PITTSBURGH PLANT • EAST PITTSBURGH, PA.

NEW INFORMATION

EFFECTIVE SEPTEMBER, 1949

Printed in U.S.A.

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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 the 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. If stored, the switchgear must be protected from the weather and be kept free of condensation.

4. When uncrating, exercise care not to scratch or mar the panel finish.

5. On outdoor switchgear, energize heaters for a minimum period of 24 hours before equipment is energized.

6. Remove blocking of relay armatures, and check control circuits (except potential and current transformer circuits) for grounds before applying control power.

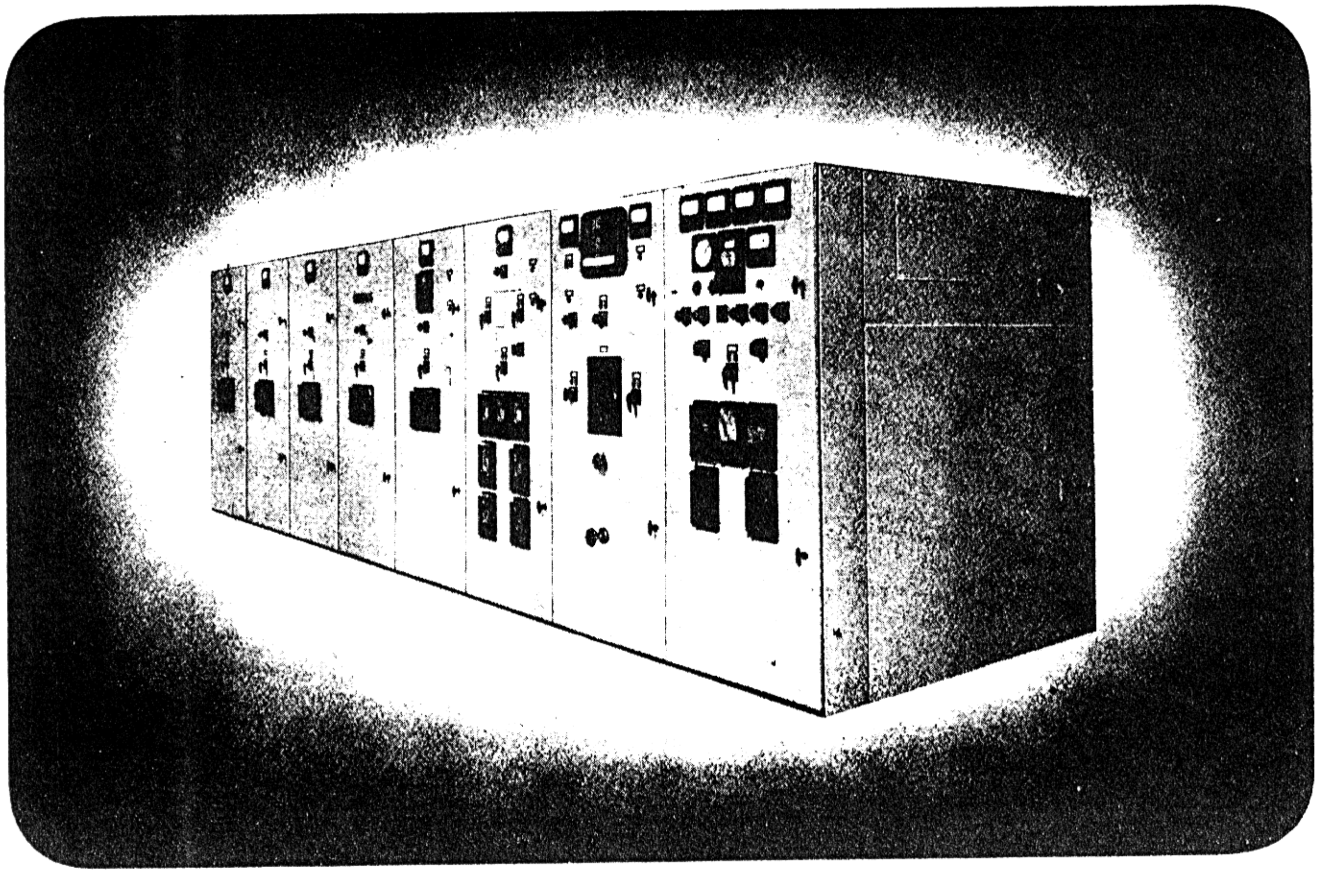
7. Check proper phasing of all circuits and check ground connections to the station ground before applying main high voltage power.

8. Do not work around "live" parts. The compartments of metal-clad switchgear are arranged so that any circuit may be deenergized and opened for maintenance without exposing any other circuits.

9. Never bring an exposed flame near the storage batteries, as the gases given off during charging form an explosive mixture.

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

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



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.

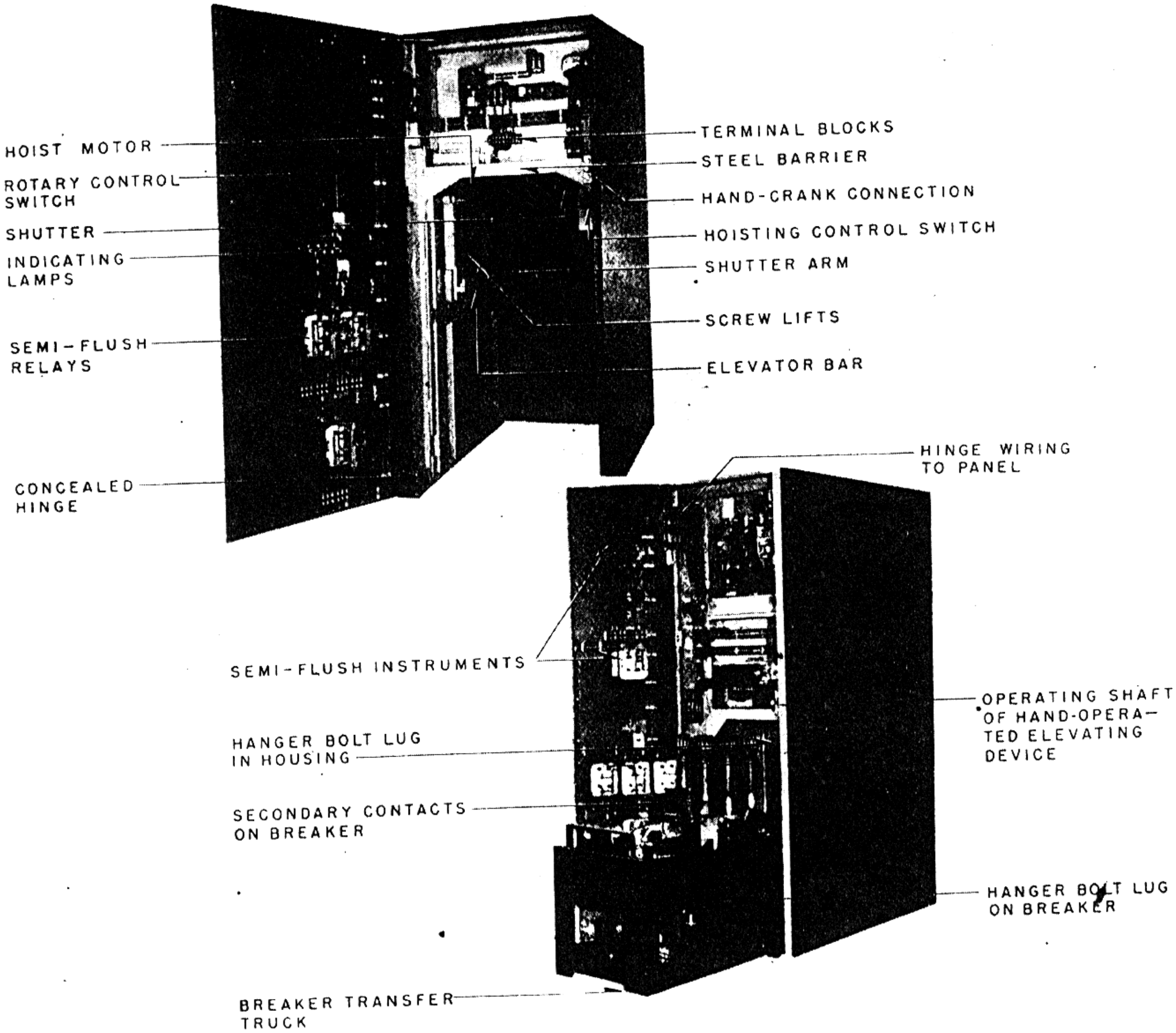


FIG. 1. Front Views of Typical Indoor Metal-Clad Units

Upper Left: Typical housing for 500,000 kva breaker with motor-operated elevating device.

Lower Right: Typical housing with 100,000 kva breaker about to be inserted into housing. Hand-operated elevating device.

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 an oil circuit breaker specially equipped for use in the metal-clad switchgear.

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 mounted in metal-clad switchgear are of the disconnecting type which insures that the primaries are disconnected and grounded before the fuses are accessible.

An automatic trip interlock on the breaker element insures that the breaker is tripped when moved into or out of the operating position. 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 described 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.

An exhaust header pipe is included in each housing to permit the gas products of an arc interruption to be discharged outside the housings. When the breaker is removed from the operating position a mechanically operated trap valve (see Fig. 2) automatically closes the header opening. The header pipe is welded in each unit and the joints between units are sealed with cork gaskets when they are assembled in rows.

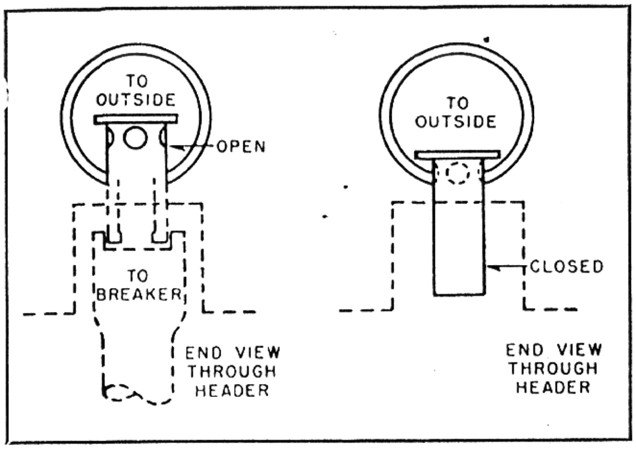


FIG. 2. Operation of Exhaust Header Valves

The heavy base angles for the unit also serve as rails for the transfer truck, automatically locating it accurately in the position to receive the breaker unit. The guide rails extend to the front of the housing and guide the transfer truck wheels as they enter the housing.

Each unit is equipped with a self-contained elevating and lowering device for handling the breaker unit between the operating and test positions. A removable hand crank is supplied for operating the elevating device. A portable motor-operating device with a universal motor can be supplied on special order.

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 side and breaker drawout sides. These doors are equipped with latch type stops that hold them in the full open position which permits the instrument panel to be opened 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 enclosing covers is supplied on the right end of the assembly as viewed from breaker side.

MAIN DISCONNECTING CONTACTS

The main disconnecting contacts are located in Moldarta or porcelain tubes which serve as a support for the stationary parts and to isolate them from accidental contact.

The stationary contact consists of a silver-plated stud mounted in the housing. The moving contact consists of a number of silver-plated segments, arranged in a circle, flexibly supported and self-aligning, assembled on the breaker stud. The segments are assembled in a collar with a flat spring behind each segment to exert contact pressure. When engaged the segments form a bridging contact from breaker stud to stationary contact which

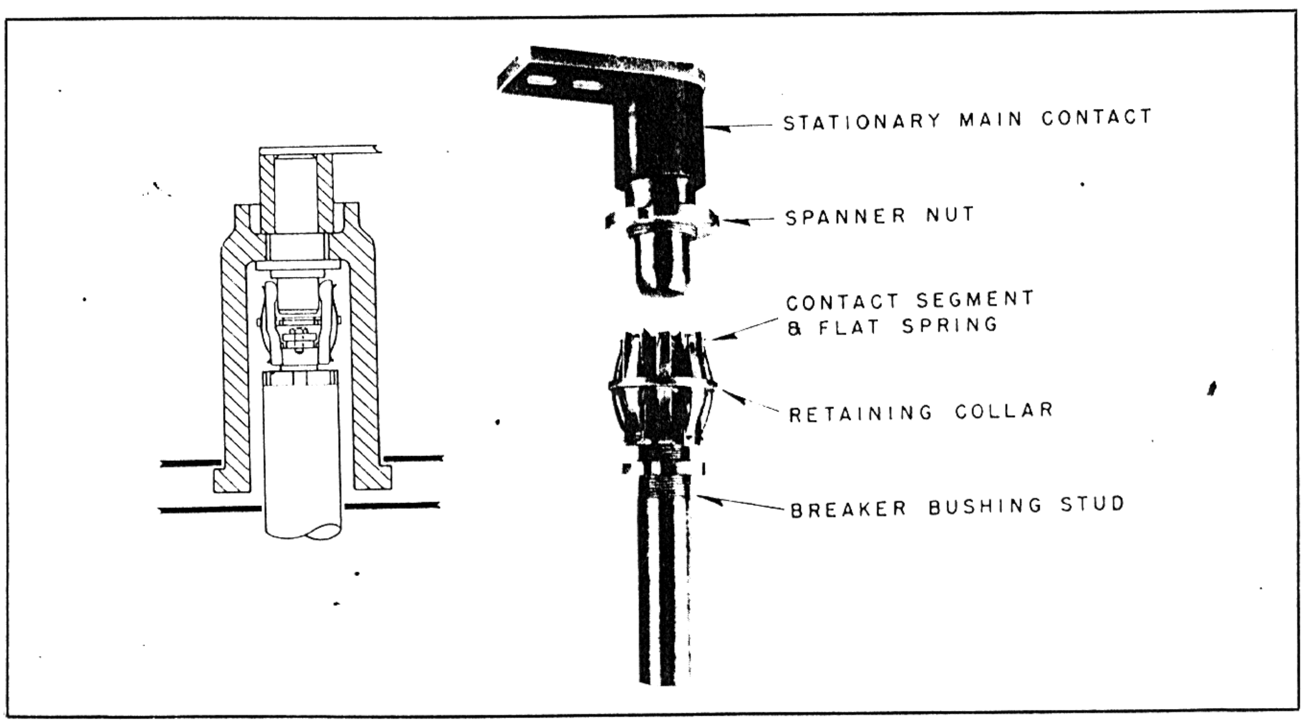


FIG. 3. Detail of Main Disconnecting Contacts—Closed and Separated

permits considerable flexibility in alignment. The contacts are shown in Fig. 3.

The stationary contact mounting base and flange are jig-drilled with minimum clearance holes to accurately locate the mounting tubes. On the porcelain mounting tube a contact-aligning washer, which allows minimum clearance for locating the contact, is soldered in the porcelain with a jig. Hence, the contacts or supports can be removed or replaced interchangeably. The stationary contact supports are mounted in the bus and connection compartments from underneath so that they may be removed without removing the bus or connections.

A special spanner wrench is supplied with the equipment for tightening the spanner nuts in the stationary contacts inside the tubes.

SHUTTER

The shutter is an automatically operated movable metal barrier which covers the stationary main contact mounting tubes when the breaker is in the test position or removed from the housing. The shutter and its operation are shown in Figs. 4 and 5. The shutter is a part of the stationary housing and is moved by a roller on the breaker operating against the shutter arm when the breaker is raised into the operating position. When the breaker is removed the shutter is closed by spring tension on the operating arm.

When the breaker is in the test position the shutter is fully closed so as to provide a metal barrier between the breaker and the stationary main contacts which may be electrically "alive".

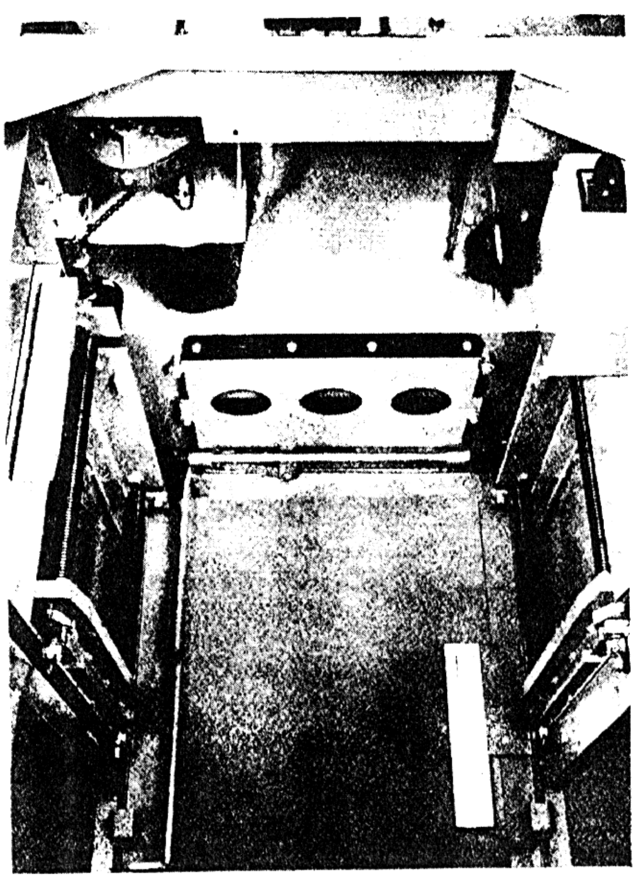


FIG. 4. Automatic Shutter Closed to Prevent Accidental Contact with Live Terminals. (Heavy-Duty Motor-Operated Lifter also Shown)

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 of the train-line-coupler type. Each individual contact consists of a round 4-segment silver-plated pin fitting into a silver-plated copper tube. The pins and tubes are molded into micarta blocks to form the plug and socket assemblies. These molded micarta 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.

The plug half of the assembled contact is mounted on a bracket on the breaker unit while the socket half is bolted to the housing. These second-

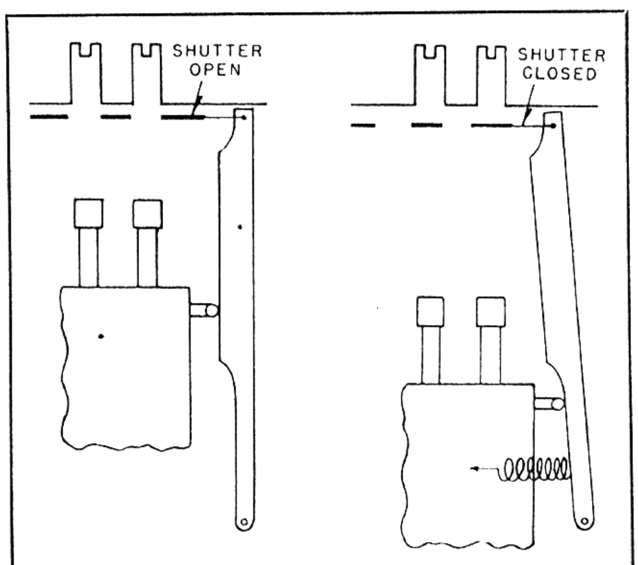


FIG. 5. Action of Shutter and Lever Arm

Metal shutter is held closed by spring pressure. When breaker is lifted into operating position, a roller on rear of breaker makes contact with lever arm, as shown, and opens shutter. In lowering breaker, action is reversed.

ary contacts engage automatically when the breaker unit is inserted to the operating position. The socket half is flexibly mounted with oversize holes on a shoulder bolt so that the contacts will be self-aligning.

A short jumper of multi-conductor cable with plug and socket contacts is provided to complete the control connections when the breaker is in the test 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. 6.

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,

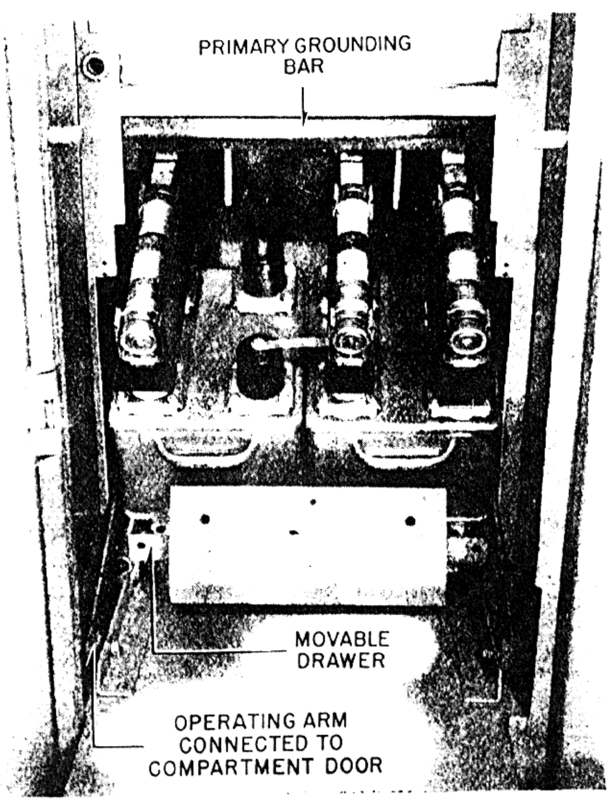


FIG. 6. Potential Transformers in Disconnect Position

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.

SELF-CONTAINED ELEVATING AND LOWERING DEVICE

Each housing is equipped with an elevating and lowering device to raise the breaker to the operating position and to lower the breaker to the test position or to place the breaker on the transport truck. Slightly different designs of lowering devices are used in the light-duty, the heavy-duty hand-elevated, and heavy-duty motor-elevated types of switchgear as described in the following paragraphs.

Light-Duty. The light-duty switchgear self-contained elevating and lowering device consists of a self-locking screw-operated mechanism which raises and lowers the breaker unit in the housing and which will support the breaker unit in any position. Stops on the housing prevent over travel and hold the breaker unit rigidly in the operating position. Guides located on both sides of the housing insure accurate alignment of the disconnecting contacts when the breaker unit is raised to the operating position. The light-duty lifter is illustrated in Figs. 7 and 8.

Heavy Duty Hand-Operated. The heavy-duty hand-operated elevating and lowering device consists of a rack-and-gear unit at each side of the housing connected together by a sprocket and chain. This mechanism is driven by a removable crank from a shaft located behind the hinged panel, and is shown in Fig. 9. After the breaker has been raised to the operating position it should be secured by inserting and tightening the hanger rods, and the elevating device backed off to transfer the breaker weight to the rods. To lower the breaker, first raise the breaker slightly so the hanger rods can be removed freely and then lower to the test position or transfer truck.

In lowering the breaker on to the transfer truck it is desirable not to place the transfer truck in the housing until the breaker is nearly lowered to the

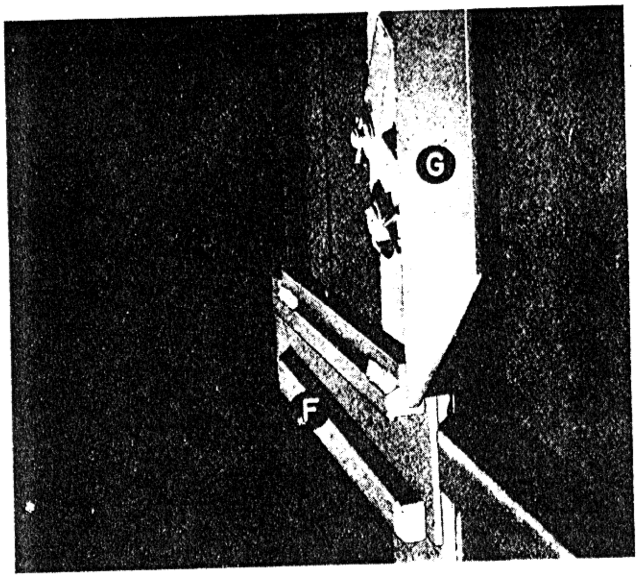


FIG. 7

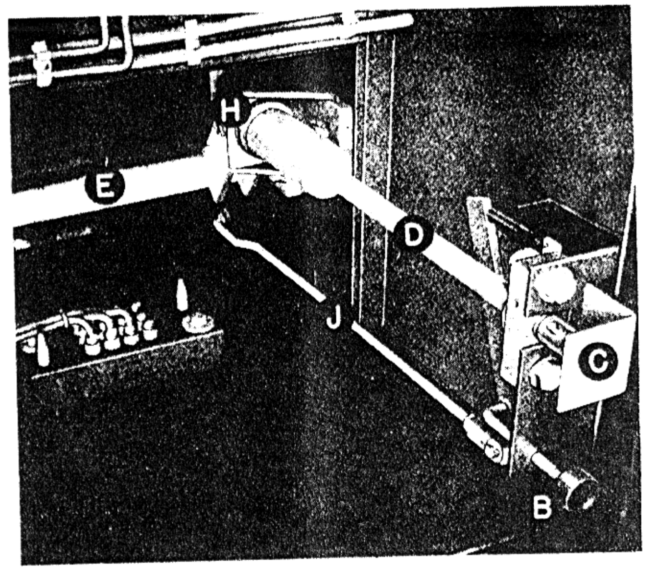


FIG. 8

Operation of Light-Duty Hand-Operated Elevating Device

Circuit breaker is supported on both sides. Fig. 7 shows one of the breaker supports (F) into which breaker lugs fit. Lugs on breaker engage in guides which keep breaker in alignment while being raised or lowered. Cam plate (G) actuates roller type trip lever, causing breaker to trip when raised or lowered.

Pressing button (B) trips breaker through lever (J) and drops guard (C), exposing end of crankshaft (D) so crank can be attached. Rotating the crankshaft turns the screw-operated jack-shaft (E) through screw device (H), thus raising or lowering the breaker support on each side of of the compartment.

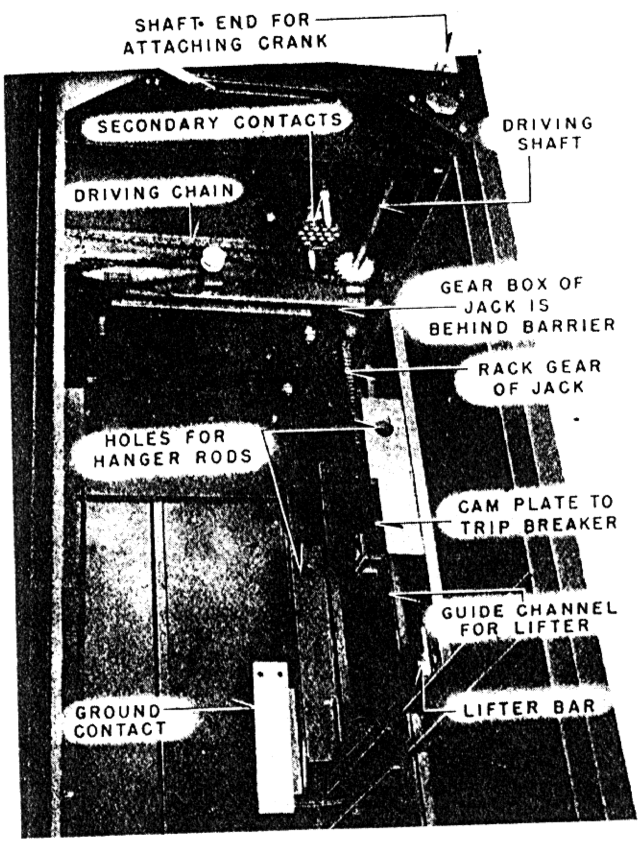


FIG. 9. Heavy-Duty Hand-Operated Elevating Device

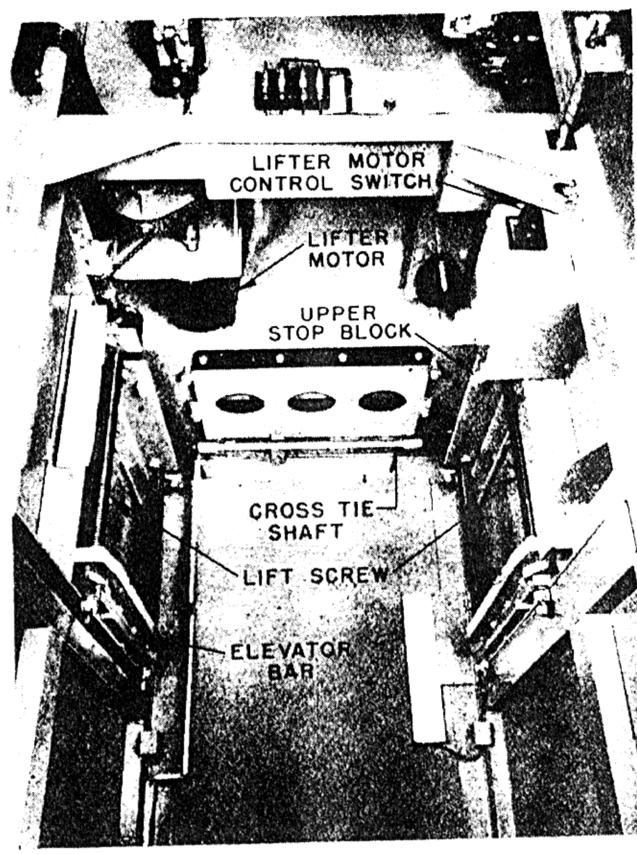


FIG. 10. Heavy-Duty Motor-Operated Elevating Device

test position. In this position the bevel on the front of the breaker lifting arms will guide the transfer truck arms and hold them in position to line up with the notches in the breaker lugs when it is lowered onto the truck.

Heavy-Duty Motor-Operated. The heavy-duty motor-operated device consists of an elevator worm gear connected to the lifter motor through a reduction gear and a chain drive. The motor mounting bolts pass through slotted holes in the supporting plate into tapped holes in a sliding plate above. This permits the adjustment of the driving chain by moving the motor until the proper tension of the driving chain is obtained. The motor operated lifter is shown in Fig. 10.

The motor control limit switches which govern the vertical travel of the lifter have been carefully set at the factory using a *breaker filled with oil* and should need no further adjustment. The upper limit switch is set to open the motor circuit an instant before the final end of the travel. This permits the lifter to coast against the mechanical stops or within $\frac{1}{32}$ inch of the stop and prevents overtravel of the disconnecting contacts. The lower limit switch is set so that the elevator coasts against the lower stop when lowering a breaker filled with oil onto a transfer truck. With this setting the elevator is not expected to reach the lower stop when lowering a breaker to the test position without a transfer truck. The disc which engages the toggle of the limit switch is threaded to permit close adjustment and is held in place by a lock nut.

If a breaker is *elevated without oil* for checking purposes during installation the lifting motor should be cut off by means of the control switch and not allowed to run until stopped by the limit switch. The increased speed and coast without oil may run the breaker against the stops with sufficient force to break the driving chain.

A crank is provided for manual operation of the elevator. Since the crank connects directly to the motor drive, DO NOT OPERATE THE MOTOR WITH THE CRANK IN PLACE.

REMOVABLE BREAKER UNIT

Description of the care and maintenance of the breakers which form the breaker units is covered in the detail instruction book describing the breaker. A typical breaker equipped for use in metal-clad switchgear is shown in Fig. 11.

The main disconnecting contacts are mounted directly on the circuit breaker studs and engage the stationary main contacts when the breaker unit is raised to the operating position. These disconnecting contacts have sufficient flexibility to compensate for any variation between the stationary and movable parts.

The secondary disconnecting contact plug assembly is mounted on a bracket which has been added to the breaker frame. The secondary contacts are wired to the operating coils of the breaker mechanism and to the auxiliary switch contacts in accordance with the metal-clad switch-gear connection diagram.

A heavy copper ground contact of the finger type is bolted to the breaker unit and makes contact with the ground bus before the main disconnecting contacts engage.

The bushings on breakers for use in metal-clad switchgear are assembled with a jig located from the breaker hanger rods to insure disconnecting contact alignment and interchangeability of units. If a bushing is removed, great care should be taken to make sure it is installed in proper alignment. If only one bushing is removed at a time, it can be readily realigned by using the remaining bushings as a guide.

Mechanical Trip Interlock. A mechanical interlock is provided which will automatically trip the breaker before the main contacts separate if it is closed and an attempt is made to lower it from the operating position. Also, if the breaker is closed when in the test position, and an attempt is made to raise it to the operating position, the breaker will automatically be tripped while the fixed and moving contacts are still a safe distance apart. This mechanical interlock also prevents the breaker from being closed, either electrically or mechanically, when between the test and operating positions.

The above results are accomplished as shown in Fig. 12 by means of a roller which is engaged by a fixed guide on the side of the housing except when the breaker unit is in the "operating" or "test" positions. This roller actuates the tripping lever of the mechanism at all points where it is engaged by the guide and thus makes the closing mechanism "trip free" except when in the "operating" or "test" positions. The roller is set with a jig at the factory and should not require adjustment.

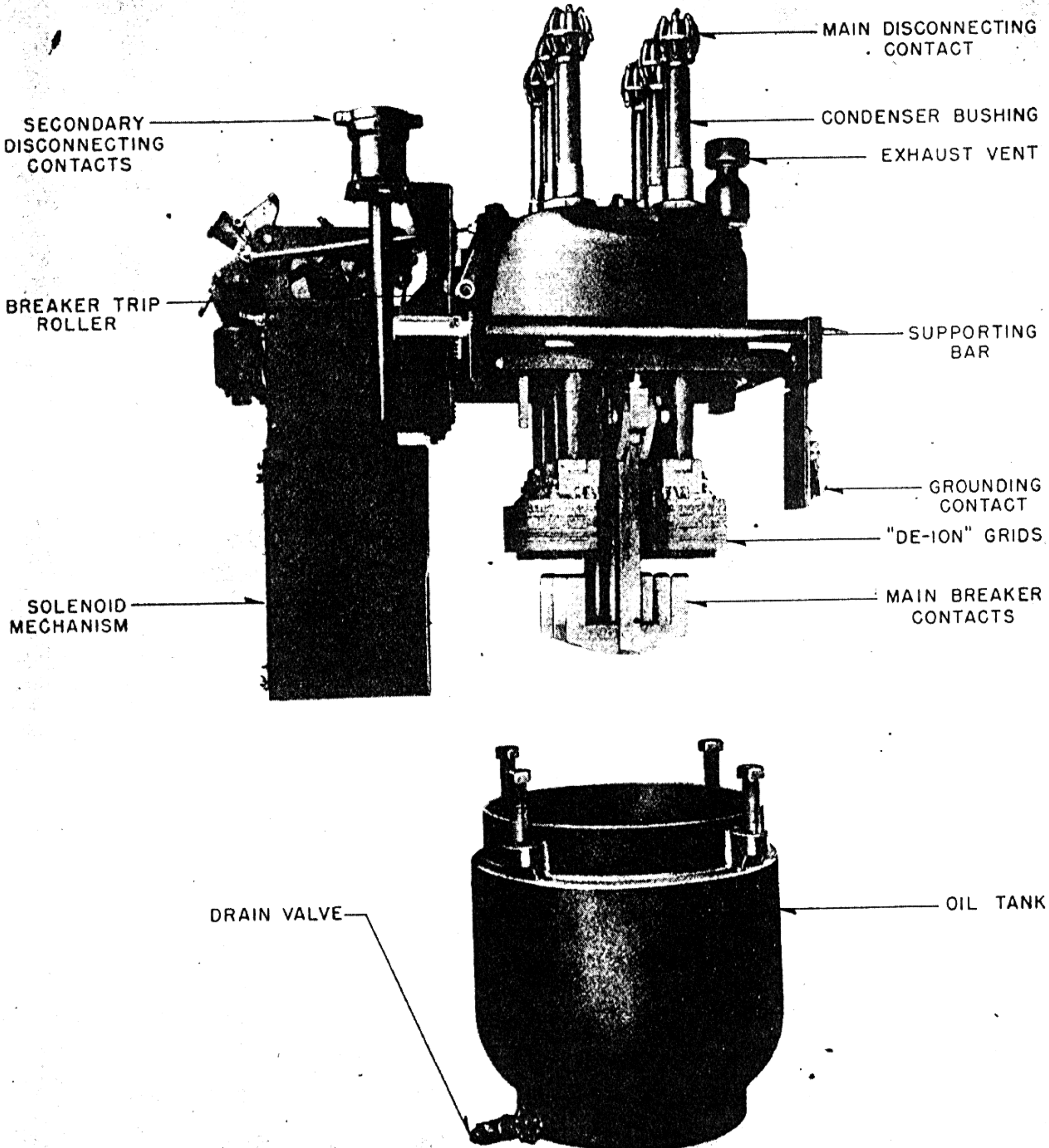


FIG. 11. Typical Oil Circuit Breaker for Metal-Clad Switchgear

Breaker illustrated is a Type B, rated 600 amperes, 15,000 volts, 150,000 kva interrupting capacity.

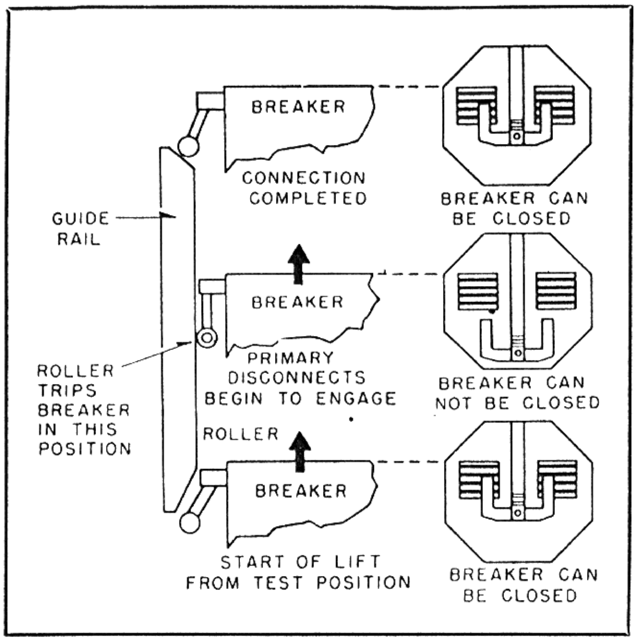


FIG. 12. Mechanical Trip Interlock

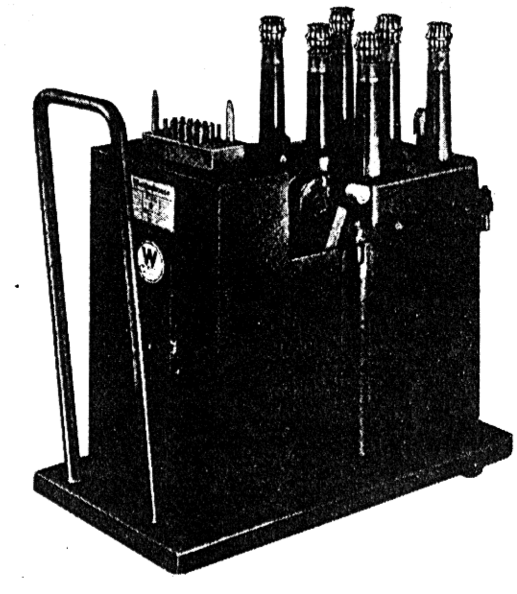


FIG. 14. Light-Duty Transfer Truck and Light-Duty Breaker

BREAKER TRANSFER TRUCKS

A transfer truck is supplied to transport the breaker unit in the station and place the unit in the housing to be picked up by the elevating and lowering device. This truck is equipped with swivel-caster wheels at the rear to facilitate placing the truck in the proper position for entering the housing.

For Heavy-Duty Switchgear. The transfer truck for heavy-duty breakers is designed to carry the breaker unit by side arms on the truck and is shown in Fig. 13. The arms have notches located to engage with similar notches in lugs on the breaker unit so that the unit is positively located and held in place on the truck. Flanged wheels at the front of the truck engage the housing rails to locate the truck properly when it is inserted in the unit.

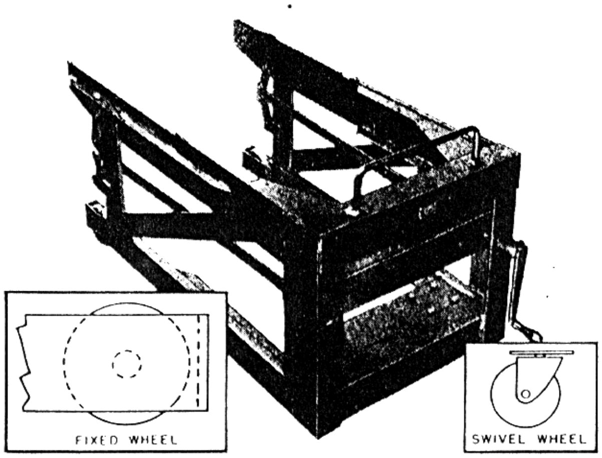


FIG. 13. Heavy-Duty Transfer Truck

Swivel wheels at rear and fixed wheels at front for quick positioning. This type truck is used for heavy duty breakers. Side rails can be raised and lowered by crank to pick up breaker from the floor.

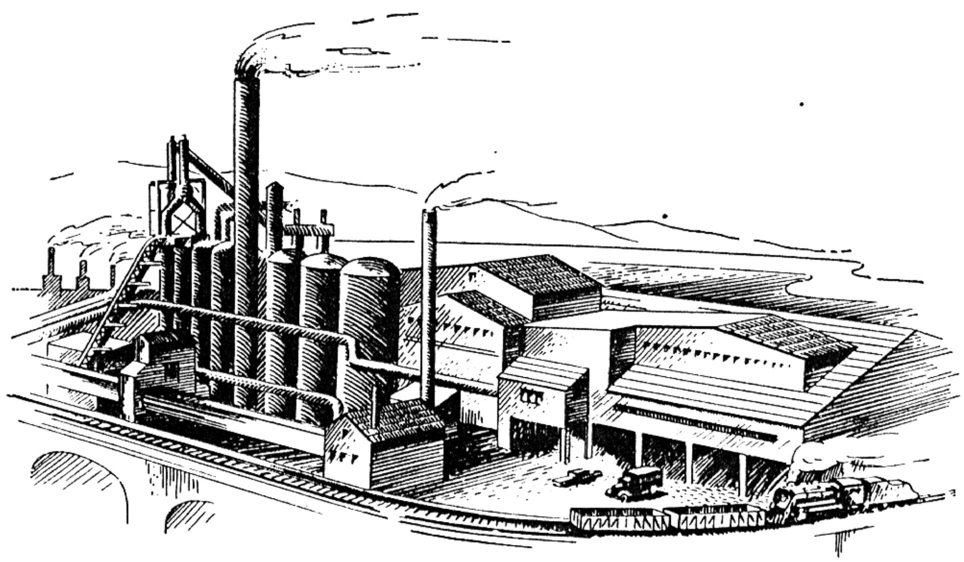
The holding-arm assembly is hinged at the rear with a toggle device supporting the front which permits lowering the arms sufficiently to run under the lugs of a breaker unit standing on the floor. When the truck is in position under the lugs, the lifting arms can be elevated by turning a hand crank which raises the unit off the floor ready to run into the housing and engage the self-contained elevating and lowering device.

The use of the elevating device on the transfer truck is a great convenience in making possible the loading or unloading of a breaker unit from the truck to the floor without requiring a crane or hoist.

For Light-Duty Switchgear. The transfer truck is of a platform design which is placed under the breaker tank, as shown in Fig. 14. Two trucks are normally supplied to facilitate placing a spare breaker into the unit with a minimum of handling effort.

Guides near the bottom of the sides of the housing center the transfer truck when it is pushed into the housing. Lugs on the platform of the transfer truck engage the breaker tank and hold the breaker in a fixed position on the transfer truck.

Outdoor Transport Truck. To facilitate handling the breaker elements with outdoor switchgear assemblies, a transport truck is supplied in addition to the transfer truck. The transport truck has two fixed and two swivel wheels which aid in the ease of aligning the rail extension guides on the truck with the stationary structure rails. The transport truck is the same height as the switchgear base and compensates for the elevation of the outdoor switchgear from steel floor level to the structure mounting base level. The transport truck is securely clamped to the stationary structure during the inserting or removal operation of the breaker element. The breaker is securely hooked to the transport truck during movement external to the stationary structure.



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 and crated for protection from the 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.

HANDLING FACILITIES

Each shipping group of housings is equipped with a lifting frame for handling by a crane. 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. The crating includes timbers under the shipping group sufficiently heavy to serve as skids for rolling.

RECEIVING

Uncrating. If the metal-clad switchgear is to be installed as soon as received it is recommended that the unpacking be done as outlined under the paragraphs which follow. If the switchgear is to be stored or held for a short time before installing it is advisable to unpack the shipment sufficiently to check for completeness and condition.

If damage is found or suspected the transportation company and the nearest representative of the Westinghouse Electric Corporation should be notified at once.

When uncrating great care should be taken not to damage the panel finish or any of the delicate instruments and relays mounted on the panels.

STORING

Switchgear which 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 caused by rain or change in temperature, cement dust, etc., 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, but if this is impossible some special precautions should be taken to keep the equipment warm enough to prevent condensation until placed in service. The equipment should be kept covered and dry.

The steel housings placed in storage prior to erection should be placed on a level surface to prevent unnecessary straining and distortion. This procedure insures trouble free installation when the switchgear is taken out of storage and placed into service.

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 operation of the heaters. This provides dry warm air to prevent condensation until placed in service.

As a further safeguard against excessive condensation the compartments are provided with ventilators. Both front and rear, top and bottom are arranged to permit a good circulation of air and to prevent entrance of snow or driving rain. The openings are screened to prevent entrance of insects and foreign matter. Space heaters are provided which should be used to prevent condensation during weather when high humidity prevails or whenever there is a probability of condensation within the equipment. It is important that these heaters be used—their purpose is to safeguard the equipment.

It is recommended that the heaters be energized for a ***minimum period*** of 24 hours after the installation is complete and before the equipment is energized.

Batteries. Storage batteries should be given special attention as soon as they are received. They should be unpacked immediately, their condition checked and charged if necessary. They should never be allowed to stand uncharged.

The battery manufacturer's instructions which are included with the batteries should be preserved and carefully followed in the installation and maintenance of the battery.

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 weight 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.

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 the accuracy

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 on the units.

CLASS OF SWGR.	TYPE OF UNIT	INDOOR SWITCHGEAR		OUTDOOR SWITCHGEAR	
		Dead Weight of Complete Unit with Breakers POUNDS	Total Weight Including Impact when Breaker Opens POUNDS	Dead Weight of Complete Unit with Breakers POUNDS	Total Weight Including Impact when Breaker Opens POUNDS
5 Kv	F-122, F-124 Breaker Unit	2100	2700	3100	3700
	Auxiliary Unit	1500	....	2800	....
5 Kv	F-100 Breaker Unit	3300	4200	4500	5400
5, 7.5 or 15 Kv	B-20-B, B-22-B Breaker Unit	3600	4600	4800	5800
7.5 or 15 Kv	B-28-BS, B-28-B Breaker Unit	5600	7600	7000	9000
	Auxiliary Unit	3300	....	4500	....

BREAKERS ONLY

Approximate Weight

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

F-122, F-124	600 pounds
F-100	900 pounds
B-20-B, B-22-B	1000 pounds
B-28-BS, B-28-B	2000 pounds

and trueness of the concrete floor upon which the ·hgear is to be erected. The entire concrete . . 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 installing and removing the circuit breaker elements will be facilitated by a smooth hard floor surface.

Fig. 15 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 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.

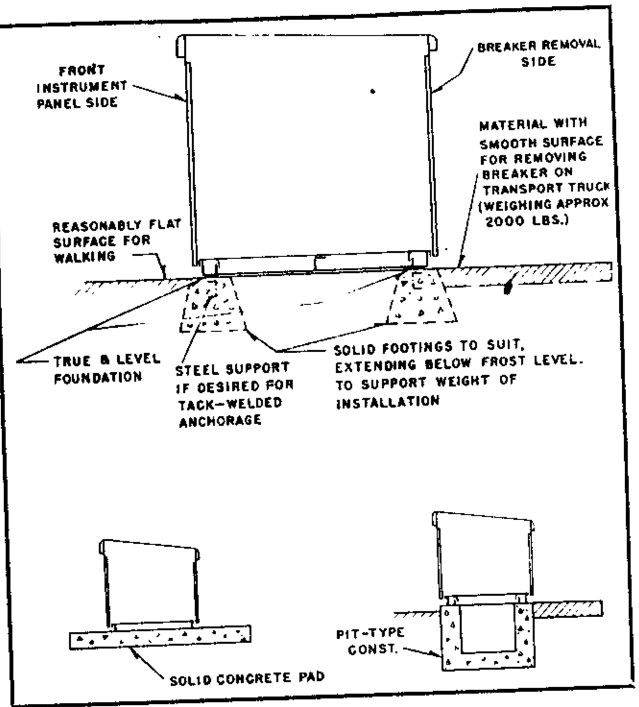
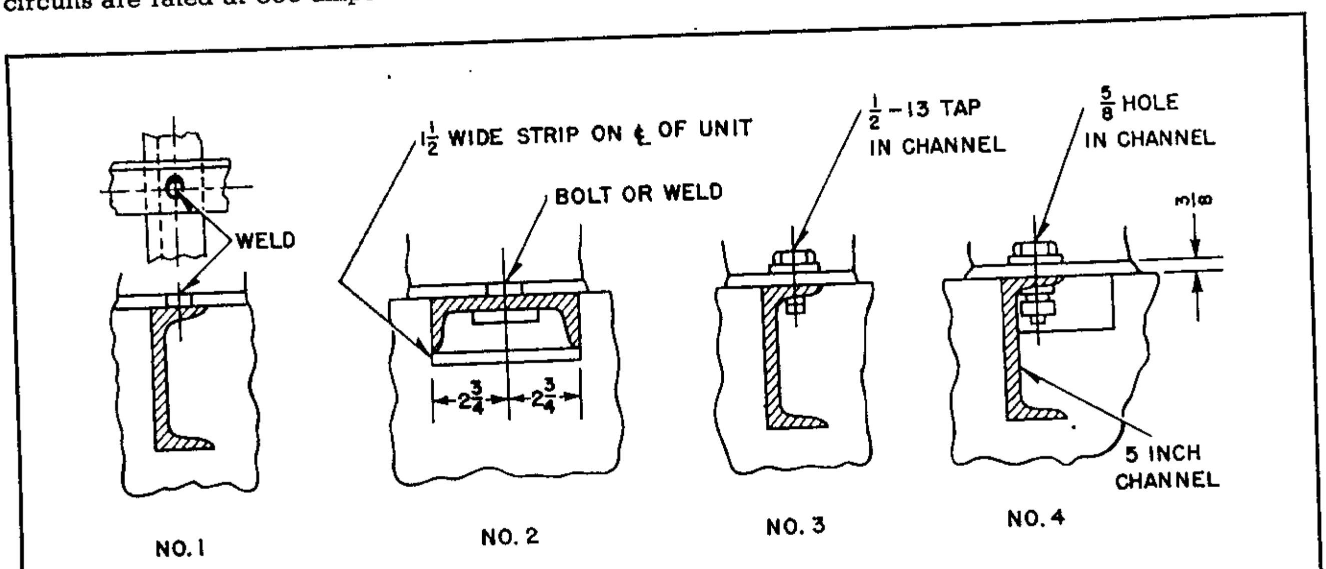


FIG. 16. Outdoor Foundation Base Constructions

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.

Fig. 16 shows the recommended types of foundation bases for outdoor metal-clad switchgear.



Floor steel to be supplied by the purchaser unless specifically ordered with the switchgear.

FIG. 15. Suggested Methods of Installing Steel Channels in Floor

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.

Fig. 17 presents typical floor plans and tables of dimensions for the various ratings of 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.

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.

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.

2. Remove all crating and foreign 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.

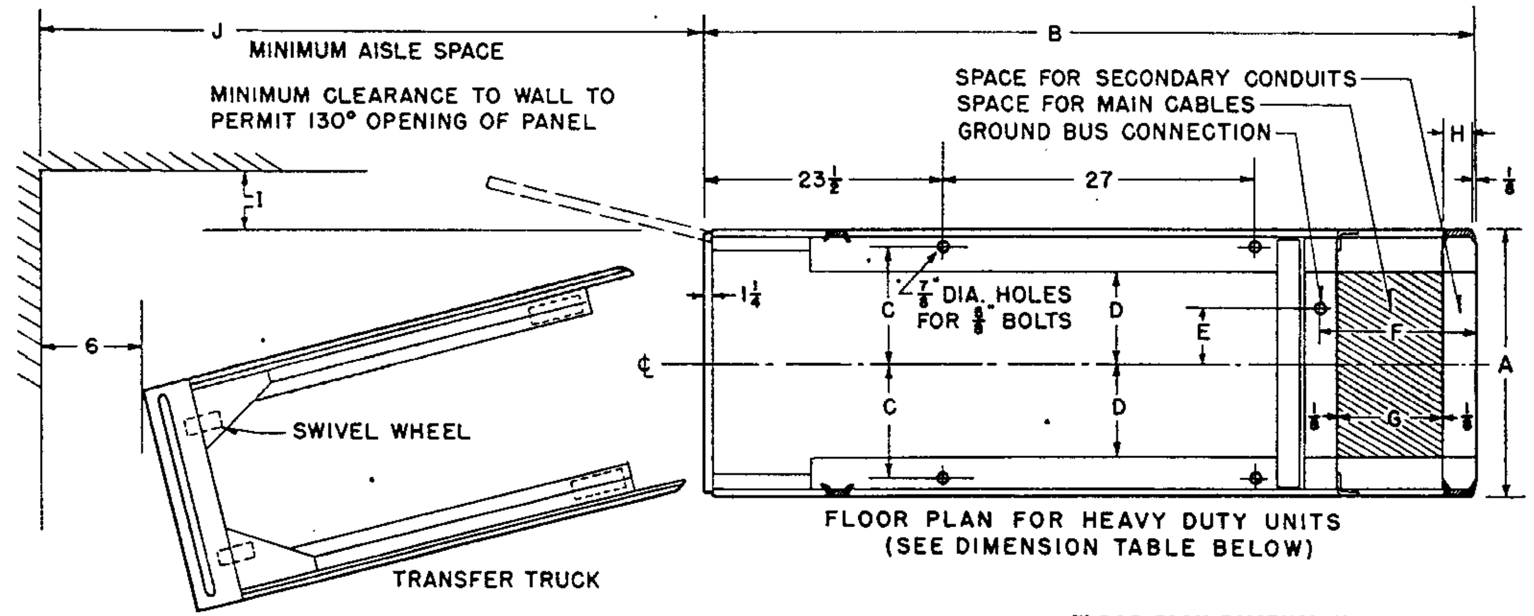
3. Move the first group of units into position either by crane or by pipe rollers. The rollers, if used, should be high enough to allow the switchgear to pass over the conduits projecting above the floor.

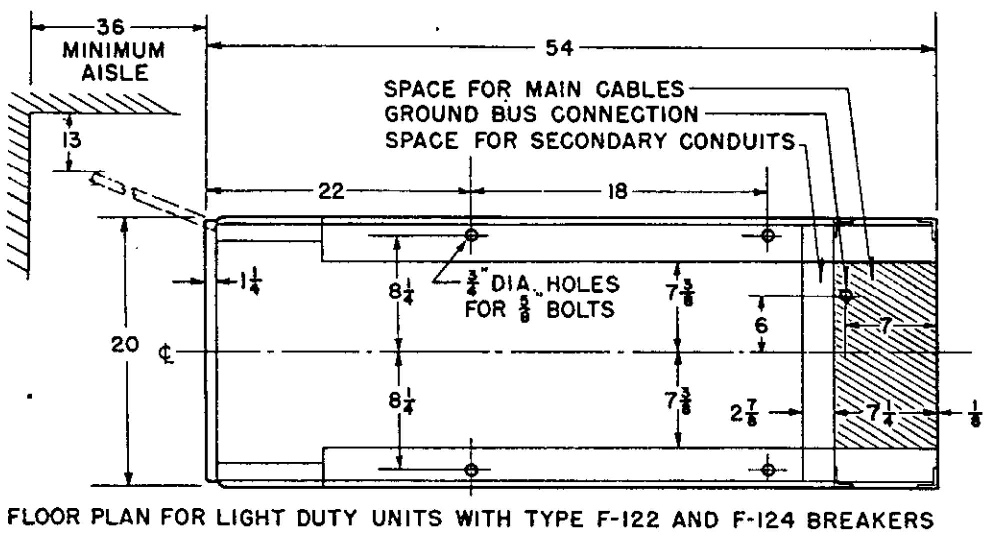
4. Establish a base line a few inches in front of the group of housings and parallel with the desired front of the structure. Equalize the distances from the front of the housings to the base line, thus making the face of the group parallel to the base line.

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. These shims should always be inserted at the points where the units are to be fastened to the floor channels.

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. 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 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. 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.

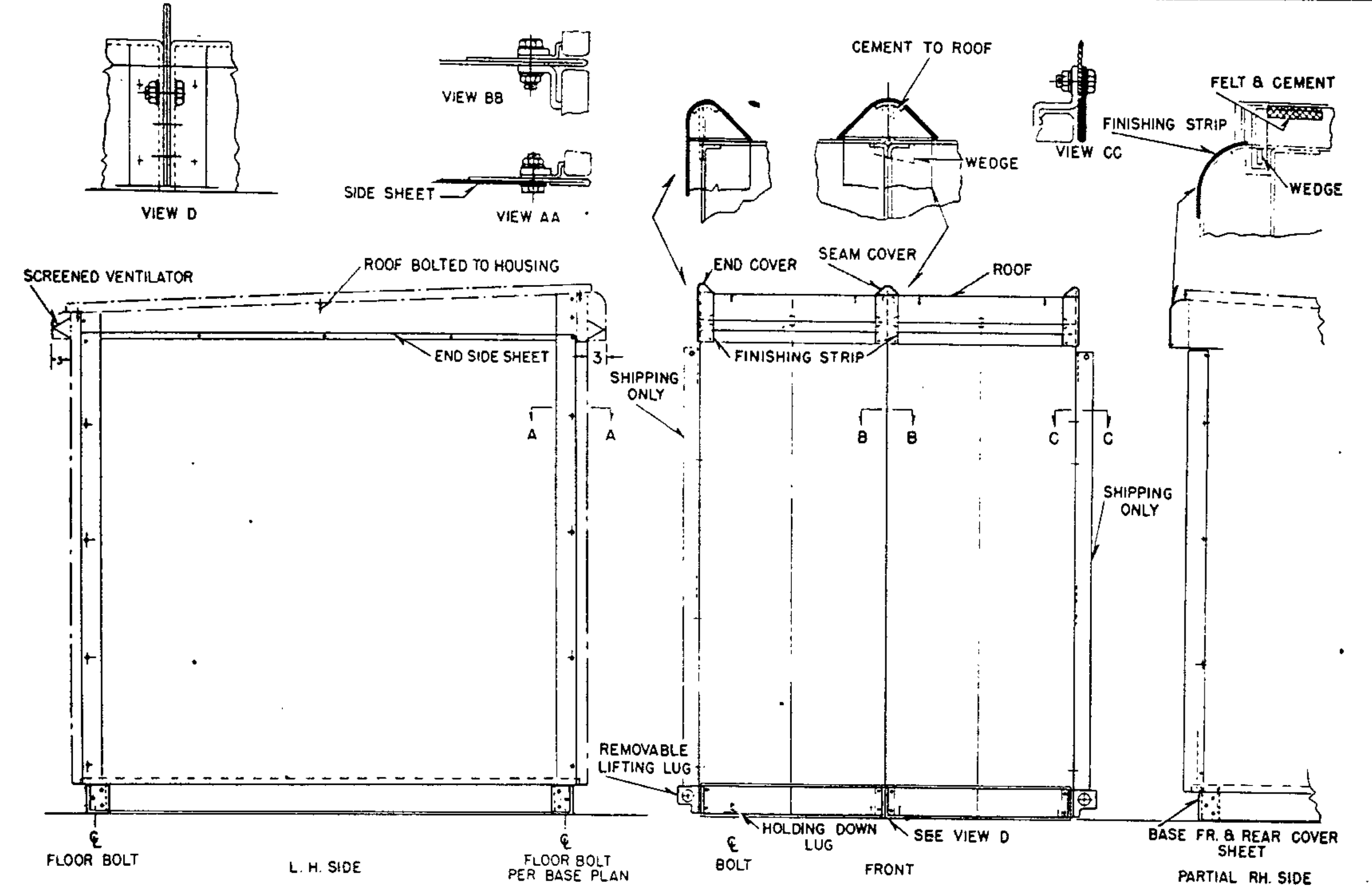




FLOOR PLAN DIMENSIONS

UNIT	INTERRUPT. CAPACITY KVA	AMPS.	A	B	C	D	E	F	G	H	I	J
F-100	100,000	600 1200 2000	24	70	10¾	8⅜	5	14	9⅛	2⅞	16	56½
B-20-B	150,000	600 1200	28	70	12⅞	10⅜	6	12	6⅝	2⅞	18	61
B-22-B	250,000	600 1200										
B-28-BS	250,000	2000	36	78	16⅝	15 7/16	14	11	8¼	3⅞	23	62
B-28-B	500,000	600 1200 2000										
AUXILIARY COMPARTMENTS	To line up with: F-100	...	28	70	12⅞	11⅜	..	..	..	2⅞	18	...
	B-20-B B-22-B	... ...	36	70	16⅝	15⅜	..	..	..	2⅞	23	...
	B-28-B	...	36	78	16⅝	15⅜	..	..	..	3⅞	23	...

FIG. 17. Typical Floor Plans for Indoor Metal-Clad Switchgear



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 sheet 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. 18. Shop and Field Assembly—Typical Outdoor Metal-Clad Switchgear

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. 15.

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. 18 indicates shop and field assembly for outdoor metal-clad switchgear and should be followed closely to insure that all weather proofing trim plates are installed between shipping groups, that groups are securely bolted together, and that weather-proof end plates and top ventilator screens are installed.

UNIT SUBSTATION POWER TRANSFORMER CONNECTIONS

Unit substations are an assembly of switchgear and power transformers with direct coupled main power connections. For close coupled connections the designs may be divided into three general types as follows:

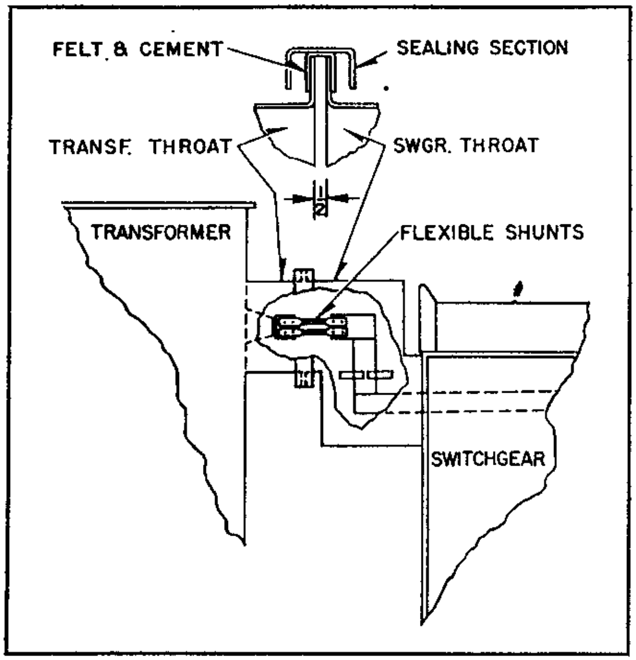


FIG. 19. Bus Run Throat Connection to Transformer

1. Bus run type of throat connection.

2. Removable box enclosure type of throat connection.

For unit substations these connections must have weather-proof enclosures when used outdoors as well as provide flexibility for the connections between the transformer terminals and switchgear bus.

Bus Run Type. Fig. 19 shows the construction details of the outdoor bus run type of throat connection for typical installations.

After switchgear and transformer have been brought together to give an alignment of the flanges (within one half inch) apply cement to outside surfaces of both flanges (over top and both sides). Cement felt in place. The felt is to seal against entrance of dust and prevent possible vibration of the sealing section produced by transformer resonances.

To install sealing section, slide frame down from top and install bottom section, securing in place with two screws supplied with bottom section.

Box Enclosure Type. Fig. 20 shows the assembly of a flexible throat connection using a removable box enclosure. The large exploded drawing (Fig. 21) gives details of box enclosure construction.

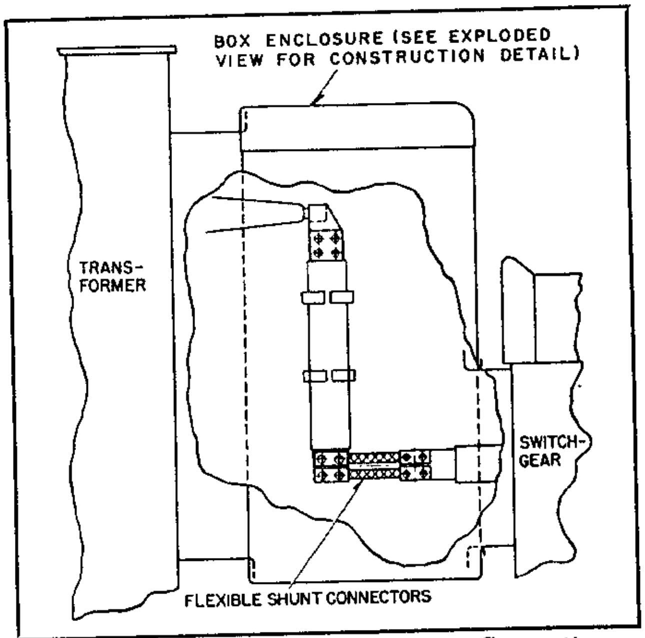


FIG. 20. Removable Box Type Throat Connection

INSTALLATION OF BUS CONNECTIONS BETWEEN GROUPS

The main bus and any transfer bus or bus tie connections are all completely assembled and fitted at the factory. The sections of bus for the shipping group breaks are then removed, identified and shipped as detail items for final installation in the field. Figs. 22, 23 and 24 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 washing with a cleaning fluid such as Triclene (a Du Pont product) or Tromex (a Westvaco product), or carbon tetrachloride if these are not available. Be careful not to remove the silver plating.

2. Bolt the joints, bearing in mind that the conductivity of a bolted or clamped joint is proportional to the pressure applied at the joint.

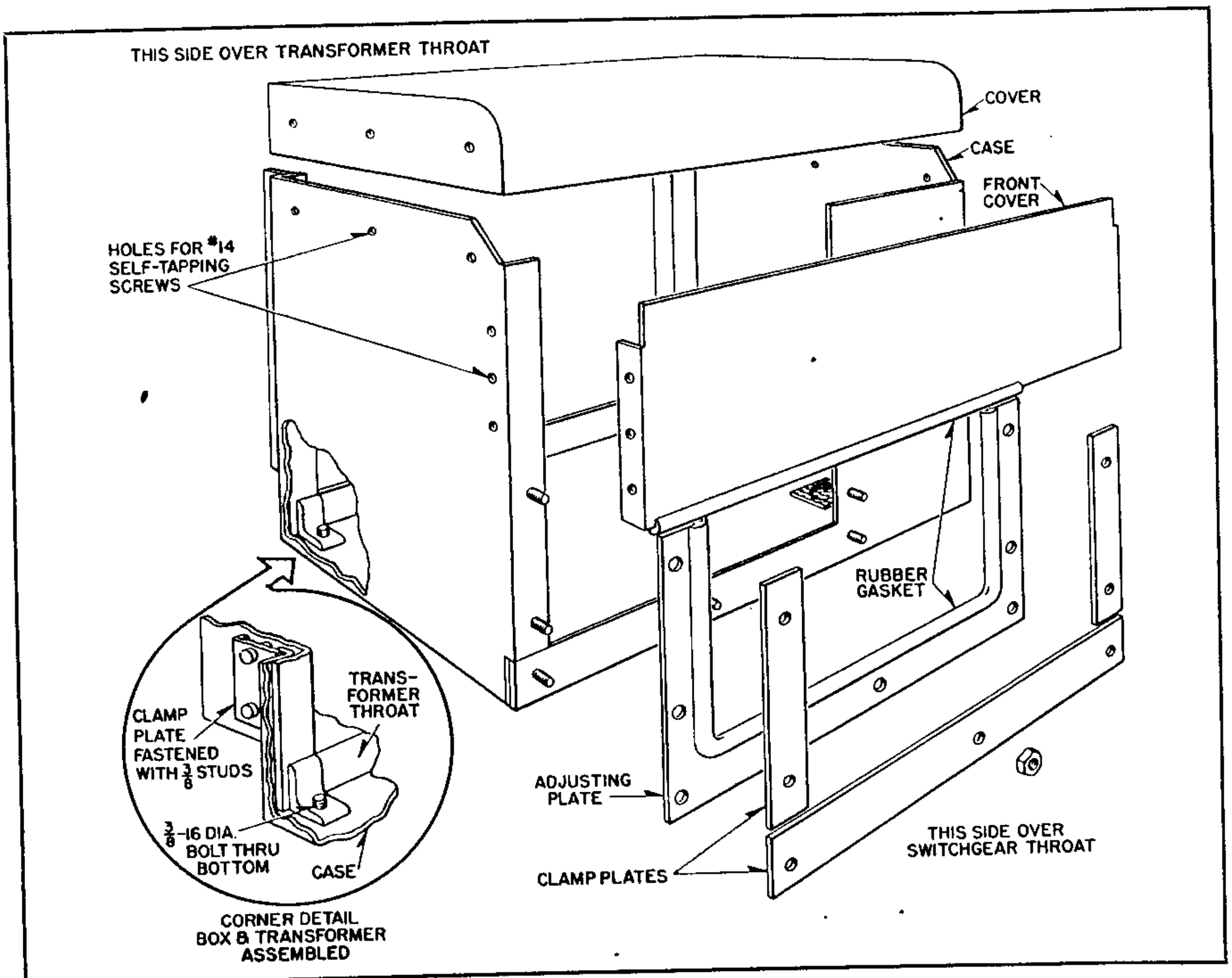


FIG. 21. Assembly of Removable Box Enclosure

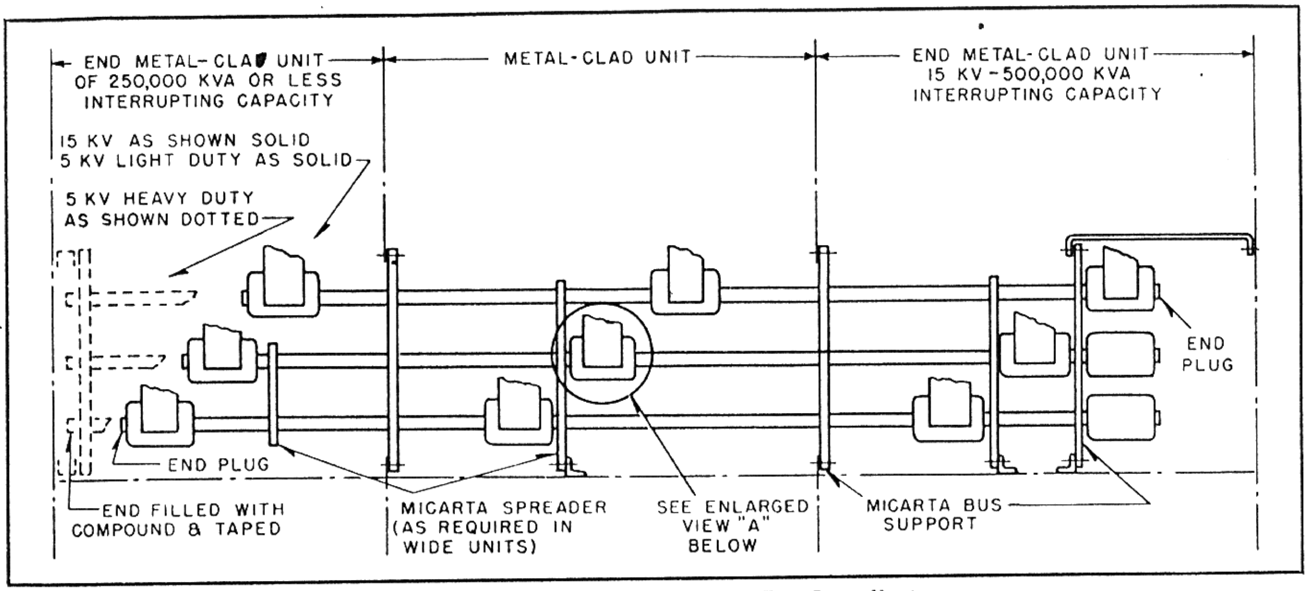


FIG. 22. Plan View of Typical Main Bus Installations

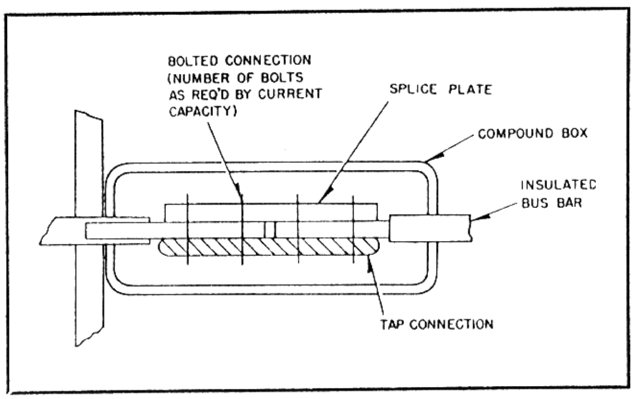


FIG. 23. View "A"—Detail of Bolted Joint

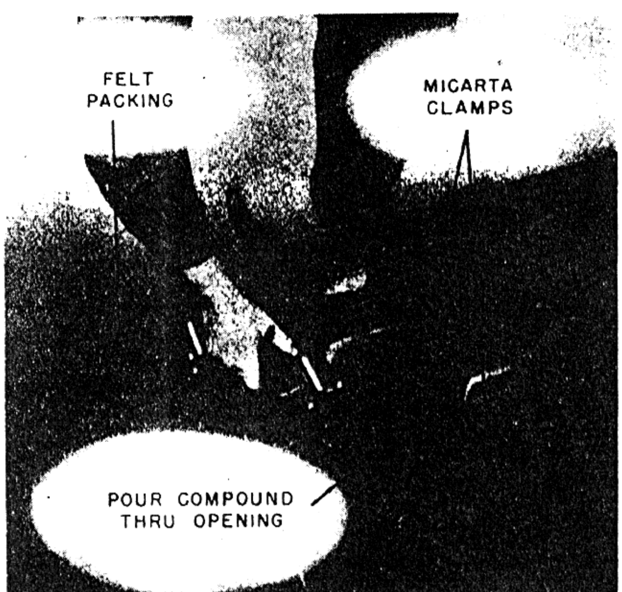


FIG. 24. Installation of Compound Box

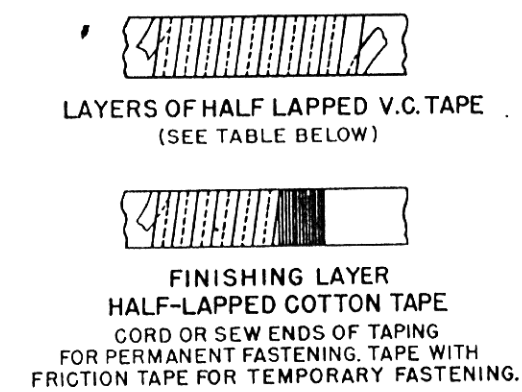
3. Install compound boxes over the joints at circuit breaker tap connections as shown on Fig. 24. This box is clamped in place by means of four molded clamping members which slide over the tapered lugs on the two halves of the box. Note the taper on the clamping members and slide them over the lugs on the box from the center out. Varnish should be applied to the wedge before clamping to seal it in place. Pressure of the thumb and finger is sufficient to clamp the box in place.

4. Fill the boxes with Westinghouse compound #1001, which is supplied for the purpose. The compound should be heated to a temperature between 150 and 160 degrees Centigrade 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. A funnel, with an extension of flexible conduit soldered to it, will facilitate the filling of these insulating boxes.

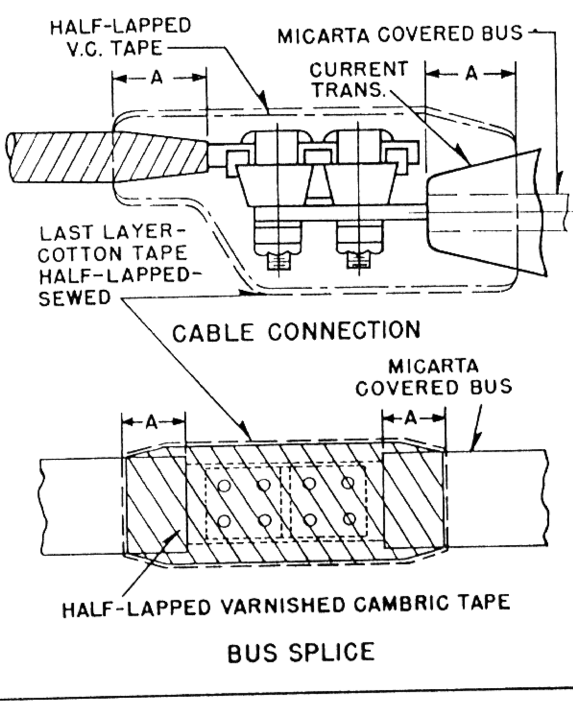
5. All other joints not insulated with compound boxes should be taped in accordance with Fig. 25. Tape and varnish are included with the switchgear shipment for this purpose.

Taping. Wrap with half-lapped layers of .010 inch varnished cambric tape (Westinghouse No. 1266 tan treated cloth) applying as many layers as given in the table (Fig. 25). Apply a coat of #3395 clear insulating varnish between layers.

Tape over the cambric with one layer of .007 inch cotton tape #7560 and wrap the ends with cord to keep them in place. Finish with two coats of the colored insulating varnish supplied with the switchgear.



SERVICE VOLTAGE	LAYERS OF V. C. TAPE	'A' CREEPAGE
5000	8	1 1/2
15000	22	2



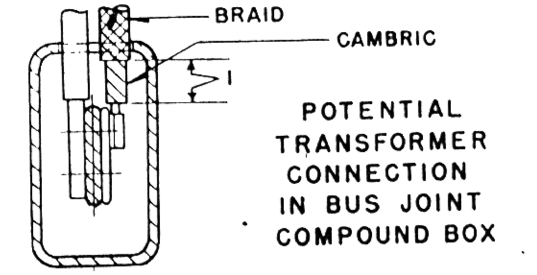


FIG. 25. Taping Procedure

MAIN POWER CONNECTIONS

Provision for connecting the main power cables in metal-clad switchgear is usually afforded by either solderless cable connectors, sealed potheads, or a compound box.

When making up the connections the circuits should be properly phased in accordance with the connection diagram. Also when more than one cable is used per phase and all cables cannot be run in a single conduit; one cable of each phase should be run in each iron conduit or else conduits of non-magnetic material should be used.

Any connections removed for shipping should be replaced and the cable connections made by cleaning and bolting as described for bus connections.

Potheads. Connections of cable into potheads should be made in accordance with the pothead manufacturer's instructions included in the supplementary instructions, or included with the potheads. Flexible shunts are provided to connect the pothead aerial lugs to the copper connections of the switchgear so as to avoid strain on the pothead insulators. (See Fig. 26).

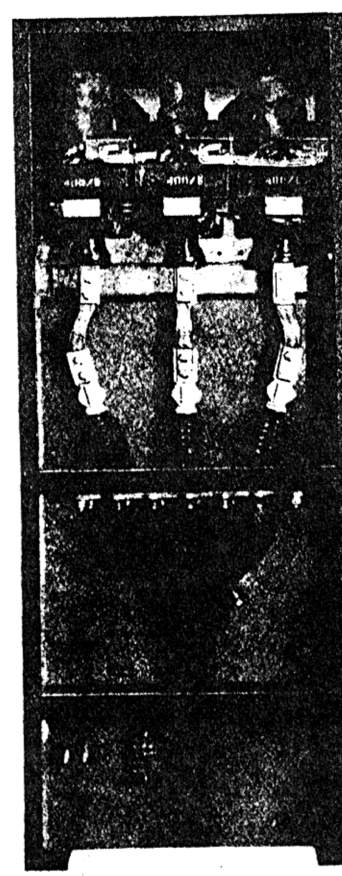


FIG. 26. Typical Pothead Installation
(Flexible shunts to be taped after cable connection is completed)

Compound Boxes. The compound box is a simple means of terminating lead covered cables. The lead sheath is to be wiped to the sleeve on the box and after the conductors are connected to the solderless connectors the box is filled with #1001 insulating compound to seal the cable against the entry of moisture.

After connecting the cables by any of the means provided, all terminals, shunts and bolted connections should be taped in accordance with Fig. 25.

Cable Clamps. Micarta cable clamps are supplied when only solderless connectors are furnished. These clamps are to separate the cables and to support the weight of the cables. The clamps are drilled at the factory when the outside diameter of the cable is known, otherwise they must be drilled to suit when the switchgear is installed.

In general, when making cable connections from the end of a conduit to the cable terminal, avoid sharp turns, corners, and edges in order to prevent weakening of the cable insulation. The radius of bends for power cables should never be less than the recommended minimum of the cable manufacturer for the type and size of the cable involved.

GROUND BUS CONNECTIONS

The ground bus in the switchgear housings is a copper bar assembled in sections with a joint in each unit. 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 circuits 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 them securely. Cover the plate with a two-foot layer of charcoal and fill the pit with earth, settling it with a salt solution.

Pipe Ground. A satisfactory ground can also be made from ten pieces of 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 pipe 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 to the switchgear are wired to terminal blocks near to the secondary conduit entrance location.

Control connections between housings are provided for by openings in the side sheets of the control compartments. When shipment is made in groups of several units, the cross connections are installed in the group at the factory and provisions made for connecting to the adjacent groups.

Voltage Drop. The operation bus for electrically operated breakers is usually of larger sections 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 correct and 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.

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. 27. The links are raised and laid inside the compartment frame angles.

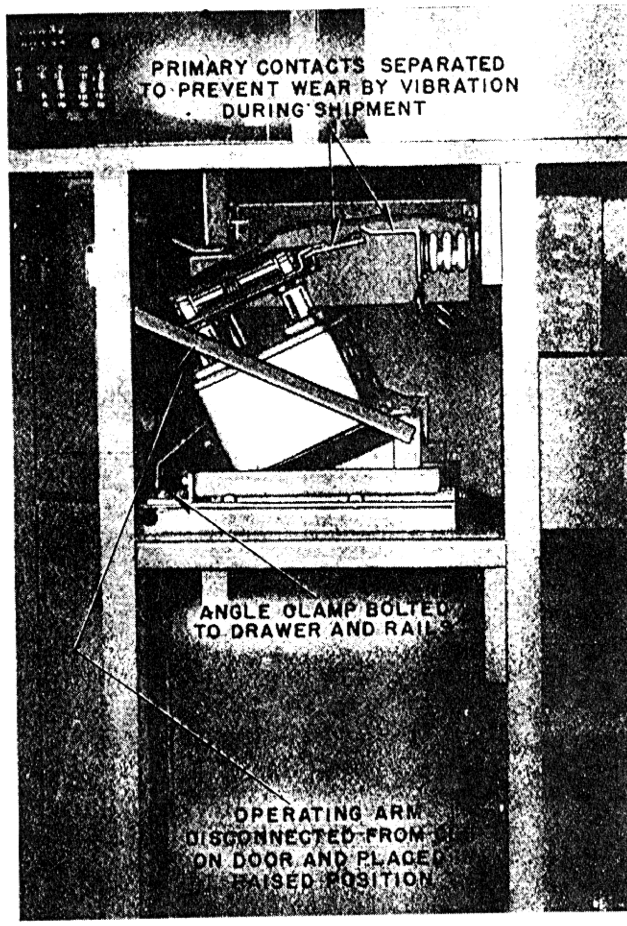


FIG. 27. Disconnecting Type Potential Transformers in Shipping Position

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

1. Remove 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° open position and connect links to the clips on the door.

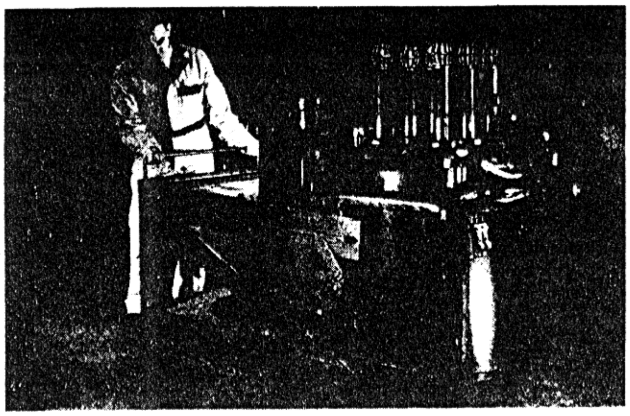
4. Check operation of disconnecting drawer assembly and also check engagement of primary contacts with grounding bar.

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

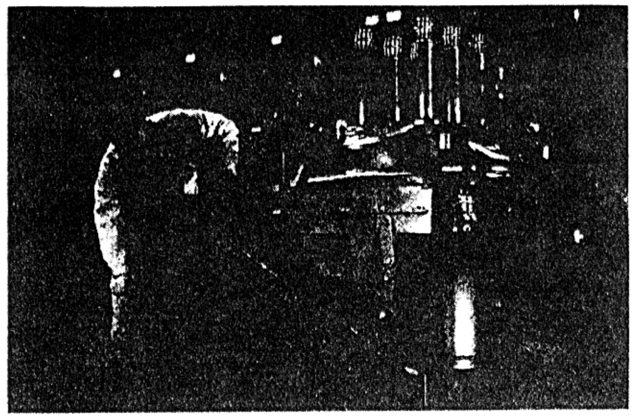
THE TEST RACK

A test rack is supplied to facilitate the maintenance of the breaker units as illustrated in Fig. 28. This rack consists of two vertical members with a cross member at the top designed for maximum accessibility. This frame is equipped with an elevating device for raising the breaker unit out of the tank. A control relay, pushbuttons or control switch, secondary contact jumper and plug are supplied to permit operation of the breaker electrically when checking contact and mechanism adjustment. A closing rectox and capacitor trip device are also supplied if a-c operated breakers are furnished.

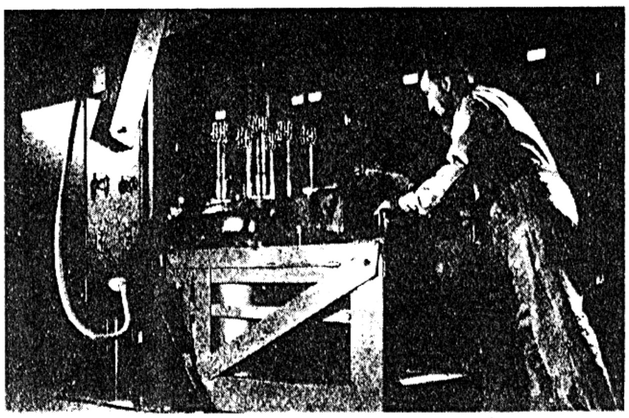
The breaker transfer truck is so designed that it can be used in connection with the test rack for removing the tank from a breaker which has been placed in the test rack. For the heavy-duty transfer trucks, a removable tray is placed across the lower transfer truck members, the breaker is lowered in the test rack until it rests on the tray. The tank bolts are removed and the breaker unit is then lifted by the test rack until the breaker contacts clear the tank. The oil tank can then be easily transported on the truck.



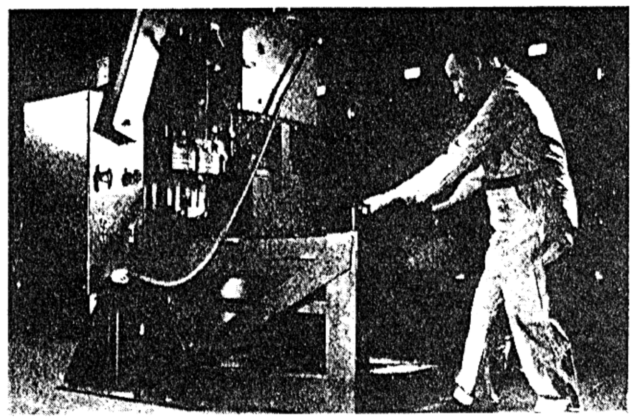
A Insert truck under breaker. Rear wheels have swivel action for accurate positioning of truck under lift brackets.



B Self-loading truck lifts breaker. No hoist required. Loading mechanism exerts powerful lift, but is easy to crank.



C Place breaker in test rack. One test rack is sufficient for any switchgear installation.



D Breaker is lifted from tank. Adapter on transfer truck used to remove tank with oil in it.

FIG. 28. Use of Test Rack and Transfer Truck Supplied with Heavy-Duty Metal-Clad Switchgear

The tank can be removed from a breaker unit in the test rack without the use of the transfer truck, but the tank cannot be easily removed from the test rack without the use of the transfer truck.

On the motor-operated elevator-type of test rack a lifter motor and gear reducer are supplied. They are of the same type as supplied in the housings. Separate control switches are used for the motor operation and breaker control. To prevent over-travel of the lifter mechanism, limit switches are provided which are completely adjusted at the factory.

For outdoor switchgear an indoor type test rack is usually supplied which should be located inside a building where the routine breaker testing and maintenance will be performed. When specially ordered an outdoor housing is supplied in which the test rack is mounted and space provided for the storage of a spare breaker.

PREPARING BREAKERS FOR SERVICE

The removable breaker elements should be uncrated very 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 in preparing the breaker for use:

1. Remove the tanks (shipped dry) from the circuit breakers. Inspect and clean the tanks if necessary. There should be no grease, sludge or moisture in the tank which might contaminate the insulating oil.

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 lever.

3. Inspect the breaker units carefully for loose or broken parts or any foreign material which may interfere with the breaker operation.

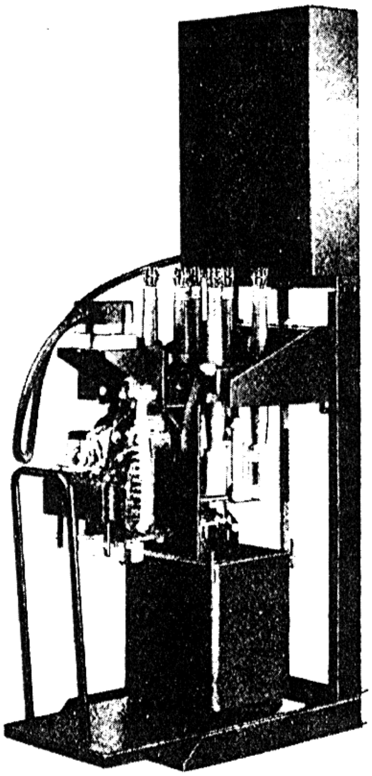


FIG. 29. Test Rack for Light-Duty-Units

Handy test and inspection rack with elevating mechanism enables circuit breaker to be lifted out of tank and raised to a convenient height for inspecting or adjusting contacts. Unit may be raised high enough to remove oil tank. For electrically-operated breakers, a cabinet with control switch and relay is supplied.

4. Check the circuit breaker contacts and the operating mechanism as outlined in the instruction book for the oil circuit breaker.

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

6. Close the breaker with the maintenance operating lever to check its operation and contact adjustment.

7. Replace the breaker tanks filled to proper level with WEMCO-C univeral circuit breaker oil.

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, two 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.

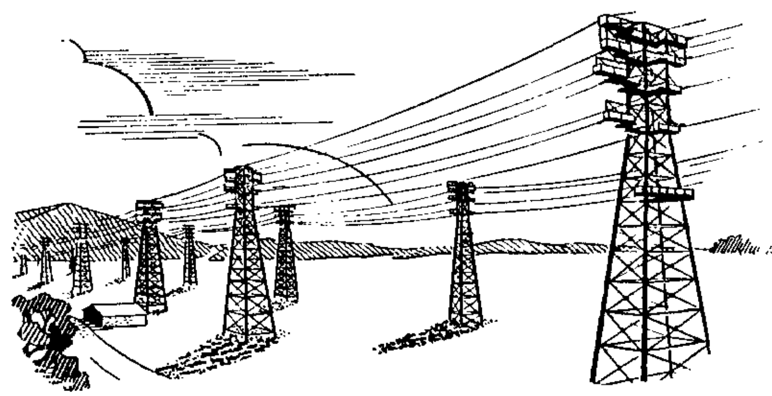
Although the inspection and tests given the switching equipment at the factory insures that all the connections on the switchgear are correct and in good order when it leaves the factory the connections should be examined to make sure that they have not been loosened or damaged during shipment or installation. 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 the company 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 vertical lift 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 with operating sequences.

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.

A maintenance operating device is supplied as part of the accessories on each order which includes electrically operated breakers. This device permits manual operation of the breaker during maintenance. IT MUST NOT BE USED TO CLOSE A BREAKER ON AN ENERGIZED CIRCUIT.

PLACING BREAKER UNIT IN HOUSING

It is now assumed that the housings have been erected as previously described and all electrical and mechanical connections properly made and checked. The housings are now ready to receive the breakers.

1. First, take up a breaker unit on the transfer truck by means of its elevating device or place a light-duty breaker on a transfer truck. Check to see that the breaker is open, squarely located on the transfer truck with the notches in the bottom of the lugs on the breaker unit frame engaged in the notches on the truck arms. See that the elevating device in the cell is at the bottom of its travel.

2. Move the breaker carefully into the housing until the projections on the breaker engage the guides on the housing.

3. The breaker should then be raised by means of the lifting device until it is in the operating position with the breaker fully elevated.

4. The holding rods (on the heavy-duty hand-elevated units) should now be put in place and tightened and the lifting device lowered slightly so the breaker unit will be supported from the holding rods.

The breaker may be placed directly in the test position on the housing lugs from the transfer truck by means of the transfer truck elevating device without manipulating the housing elevating device.

If it is desired to test the operation of the breaker while disconnected from the main contacts, the test jumper assembly can be connected between the secondary contacts while the breaker is in the test position. In this position the distance between the main disconnect contacts on the breaker and those in the housing is sufficiently great to safely insulate the breaker from the main bus. The test jumper must be removed before raising the breaker unit to the operating position where the secondary contacts will engage automatically.

ELECTRICAL OPERATION

General. The control of the circuit breakers and the instrumentation and relaying of the circuits fed from metal-clad switchgear is the same as the control of such circuits from a switchboard or control desk, for the instrument panels of the metal-clad switchgear in effect form a vertical steel switchboard.

A one-line diagram, schematic diagram, and detailed connection diagrams are prepared for each metal-clad switchgear assembly. These diagrams, especially the one-line and schematic, should be thoroughly studied and completely understood by the operators of the metal-clad switchgear.

The reading of indicating and recording instruments and meters is common knowledge to electrically trained personnel. The use of instrument switches, rheostat control, and governor motor control switches are also common and the nameplate markings make the use of these switches obvious. Synchronizing switches are usually provided on generator and incoming line units with a synchronizing switch contact wired in series with the breaker control switch close contact. The synchronizing switch should always be turned "ON" first and the circuits adjusted to be in synchronism as indicated by the synchroscope before the circuit breaker is closed.

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

Breaker Closing Schemes. The details of the circuit breaker schemes may vary widely on various metal-clad switchgear assemblies; however, the control schemes are all derived from three basic schemes which will be described. These three basic schemes are:

1. D-c control with type S-1 trip free control relay.
2. D-c control with "X-Y" control panel.
3. A-c control.

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

Fig. 30 shows the three basic control schemes in their simplest form. A comparison of this figure with the schematic diagram for any particular metal-clad assembly will reveal which basic scheme has been used to design the control for that metal-clad assembly. All of the schemes are electrically trip free and the breaker mechanisms are all of the mechanically trip-free design. The basic control schemes operate as follows:

(A). D-C Control with Type S-1 Trip Free Control Relay (Fig. 30a). This scheme uses the type S-1 relay which contains both operating and release coils and is so designed that the contacts can be released and opened even though the operating coil is energized. Closing of the control switch close contacts energizes the S-1 operating coil which closes the relay contacts. The operation of the S-1 relay energizes the breaker closing coil. When the breaker mechanism operates, the cut off switch "aa" energizes the S-1 release coil which mechanically releases the S-1 contacts even if the operating coil remains energized. The mechanical construction of the S-1 relay prevents its contacts reclosing to cause breaker "pumping" if the breaker trips before the control switch is released as the operating coil must be de-energized before the mechanical latch is reestablished.

(B). D-C Control with "X-Y" Control Panel (Fig. 30b). The "X-Y" Control panel utilizes two separate relays to accomplish the electrical trip-free control scheme. Closing the control switch close contacts energizes the "X" relay. The "X" relay then energizes the breaker closing coil. When the breaker mechanism operates, the "aa" cut off switch picks up the "Y" relay which opens the "X" relay circuit and this de-energizes the closing coil. The "Y" relay also has a contact paralleling the "aa" contact so that it will remain energized as long as the control switch is held in the "CLOSE" position and this prevents "pumping" of the breaker in the event the breaker trips before the control switch is released.

A variation of this scheme sometimes used is to include a resistor in series with the "X" relay coil and then to cut off the "X" relay with a "Y" contact shorting the "X" relay coil. This scheme provides a slightly slower cut off and is used on the larger breakers to insure latching of the mechanism if closed against a fault.

(C). A-C Control (Fig. 30c). The a-c closing scheme employs a two relay "X-Y" control panel and a rectox to provide 125 volts d-c to the breaker closing coil. The "Y" relay is normally energized to set up the "X" relay circuit provided the breaker is open, the control switch "OFF", and control power available. Turning the control switch to "CLOSE" will energize "X" relay and this in turn energizes the rectox and closing coil to close the breaker. The breaker mechanism "aa" cut off switch de-energizes "Y" relay by shorting the relay coil and "Y" then opens the "X" relay circuit to de-energize the closing coil. The control switch "off" contact in the "Y" relay pickup circuit prevents "pumping" by blocking the pickup of "Y" relay if the breaker trips before the control switch is released or if the a-c control source fails due to closing on a faulted circuit. For a-c operation the trip coil operating energy is supplied from a capacitor in the capacitor trip device so that adequate tripping energy is available even though the control voltage drops due to a fault condition.

Breaker Tripping Schemes. Tripping schemes for the types of control shown in Fig. 30 use a shunt trip coil which is energized by the

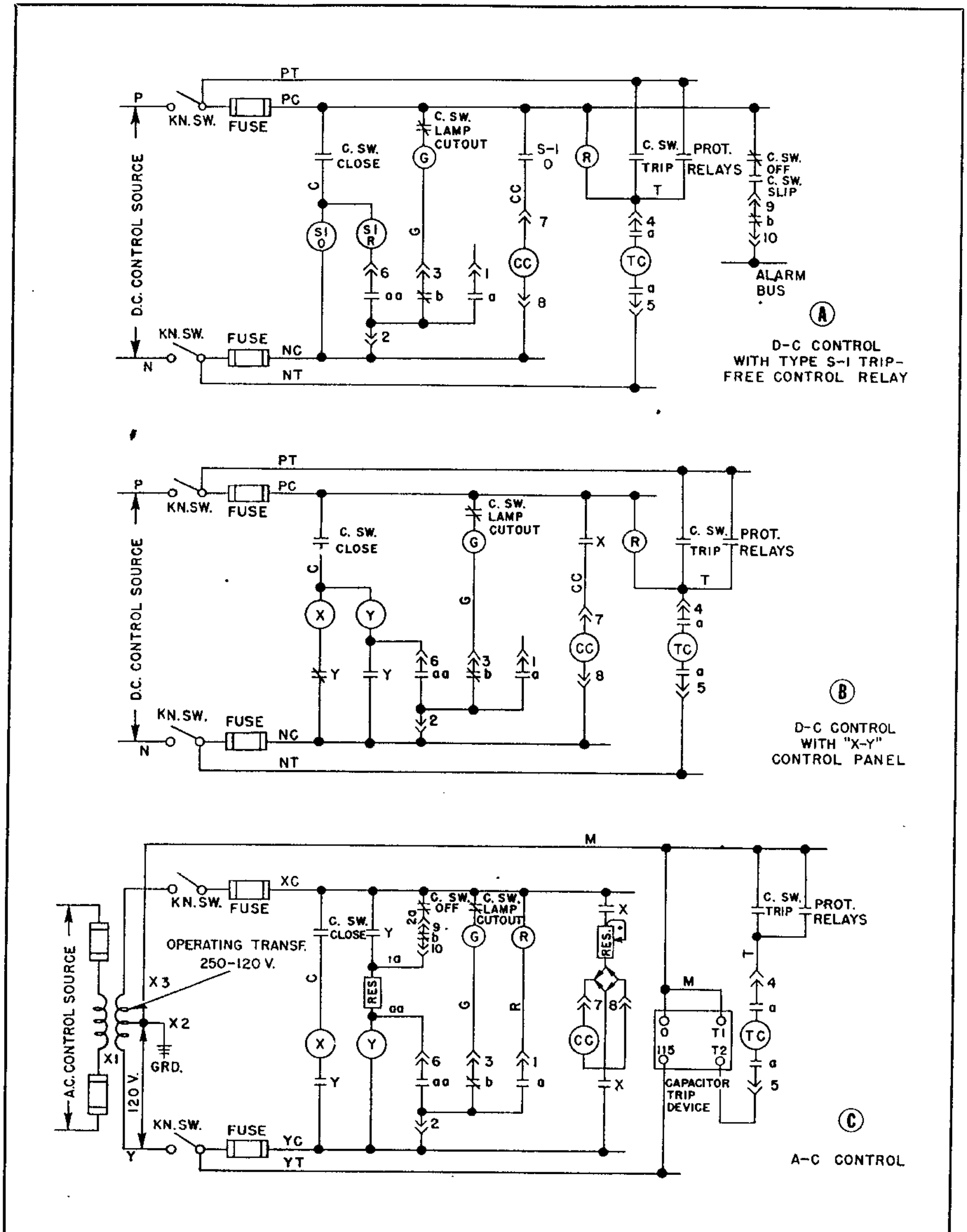
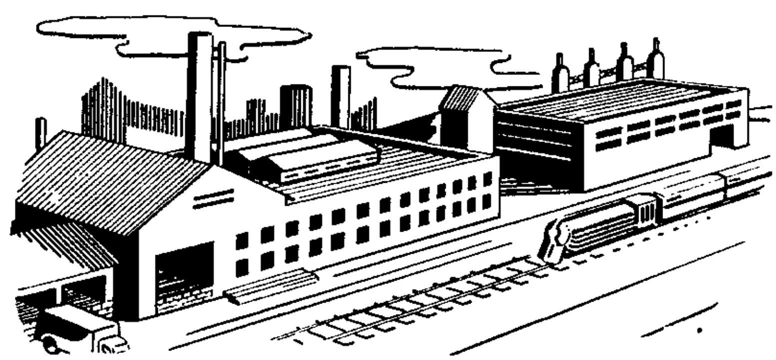


FIG. 30. **Basic Circuit Breaker Control Schemes**

control switch trip contact or by any of the protective relays provided the breaker is closed. The auxiliary switch contacts set up the trip coil circuit when the breaker is closed and interrupt the trip coil current so as not to impose any current interrupting duty on the protective relay contacts. Protection of the circuits is provided by the relays as shown in the trip circuit on the schematic diagram made for the particular metal-clad assembly.

Tripping schemes using undervoltage release coils and transformer trip coils are occasionally supplied. The use of these devices will be clearly indicated on the schematic diagram.

Settings made at the factory on the protective relays are only preliminary settings. Final settings should be made in the field to coordinate with other parts of the power system and according to the purchaser's standards and operating practice.



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 28.

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 rear bolted cover of the unit.

The bus compartment is opened by removing the top or roof sheet over the bus.

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. 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. On designs with the permanently connected secondary wire loop, it is also necessary to disconnect the secondary wires from the transformers and unbolt the terminal board from the drawer.

Breaker Contacts. The breaker main and arcing contacts and "De-ion" grids are exposed for inspection and maintenance by removing the breaker from the tank using the test rack as described on pages 29 and 30.

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 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. After de-energizing the primary circuits, coverplates should be removed from all compartments enclosing them. Inspect for abnormal conditions which might indicate overheating or weakened insulation. Dust accumulations should be removed from bus supports and enclosure surfaces. A vacuum cleaner with a long nozzle is suitable for this work. The busses and supports should be wiped clean with cloths dampened with Triclene (a DuPont product) or Tromex (a Westvaco product). If neither of these is available, carbon tetrachloride is a satisfactory substitute.

Busses should be "meggered" to ground and between phases, keeping a record of the readings.

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 advisable. Such a high voltage test should not exceed 75% of the factory test values given in AIEE Standard #27 for new switchgear. Potential transformer high tension 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. Clean with cloth dampened with Triclene, Tromex or carbon tetrachloride. Inspect for abnormal wear or overheating. Discoloration of the silvered 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 light film of vaseline to all contacts before replacing the breaker. Maintenance operations on the contacts and other parts of breaker itself should be performed with the breaker in the test rack.

3. Elevating 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 accumulations of dust and grit.

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

5. Instruments, Relays, and other Panel Mounted Devices. The individual devices should be maintained according to their specific instructions. All relay covers should be removed and interior of cases inspected for dust or dirt. This will usually have been taken care of by relay test personnel during periodic relay tests. Control, transfer and instrument switches should have contacts inspected and dressed when necessary.

6. Secondary Wiring. Check all connections for tightness, including those at the current and potential transformers and at the terminal blocks where circuits leave the switchgear.

7. Battery and Charging Equipment. The control battery is such an important item in the switchgear operation that it should be given special periodic attention as recommended in the Supplier's Instructions. Similar care should be given the charger, whether of the rotating machine, electronic, or Rectox type.

8. Records. The condition of each switchgear unit at the time of inspection should be listed in a permanent record which will 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 as a series of these tests will indicate any tendency toward a reduction in the dielectric strength of the insulation. Megger readings should be taken before and after cleaning the equipment and, so far as possible, under similar conditions at the successive periods. The record should include the megger reading, the temperature and the humidity (either by definite reading or description).

No definite limits can be given for satisfactory megger readings. These limits will vary with the extent and design of the bus structure and the number of insulators involved (in other words, the number of parallel insulation resistance paths to ground). This emphasizes the value of a series of readings which can be charted so that progressive weakening of the insulation can be recognized.

9. Abnormal Conditions. Where local conditions are known to be abnormal, such as high humidity, salt-laden atmosphere, corrosive gasses, or severe circuit operating conditions, inspection should be made frequently, possibly quarterly, until sufficient data is obtained to determine the intervals which will be adequate. As soon as the progressive effects of the local conditions are determined, a schedule can be established which will maintain the equipment satisfactorily.

In locations which are so bad that the frequency of maintenance interferes with production schedules, the use of cleaned air should be considered for the switchgear installation. The installation should provide for enclosing the switchgear equipment in a relatively tight room, and supplying sufficient cleaned air to maintain a positive pressure within the room. Under these conditions the maintenance schedules should be returned to the normal annual basis. Such an arrangement might also provide cooling where the ambient temperature is relatively high, thus further improving the operating conditions.

LUBRICATION

The elevating device racks or screw and nut assemblies should be lubricated periodically on metal-clad vertical lift type switchgear to insure free and easy operation. A semi-fluid grease of a 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 for the elevating device, disconnecting switch shafts, and any other bearing points to promote ease and smoothness of operation.

The interlocking arrangement supplied with disconnecting switches, or special arrangements of breaker interlocking, 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.

Lubrication of the built-in motor operated type assemblies is particularly important due to the generally higher speeds at which the mechanism operates. The gear reducer is filled with a light lubricating oil of approximately SAE-20 grade.

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.

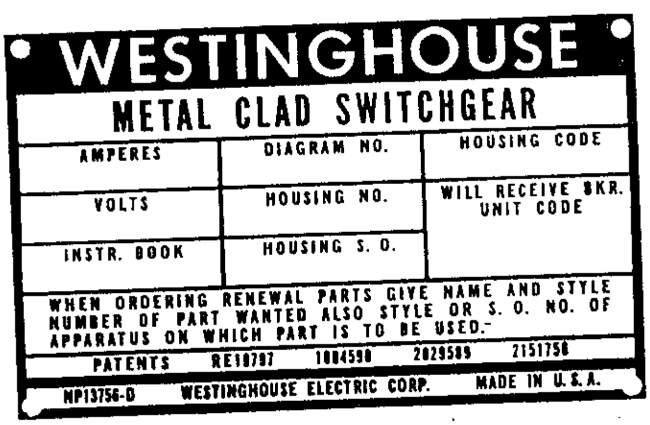


FIG. 31. Facsimile of Housing Nameplate