



DESCRIPTION • INSTALLATION • MAINTENANCE

# INSTRUCTIONS

## Low-Voltage METAL-ENCLOSED SWITCHGEAR

**WESTINGHOUSE ELECTRIC CORPORATION**  
SWITCHGEAR DIVISION

EAST PITTSBURGH PLANT

EAST PITTSBURGH, PA.

SUPERSEDES I.B. 5992

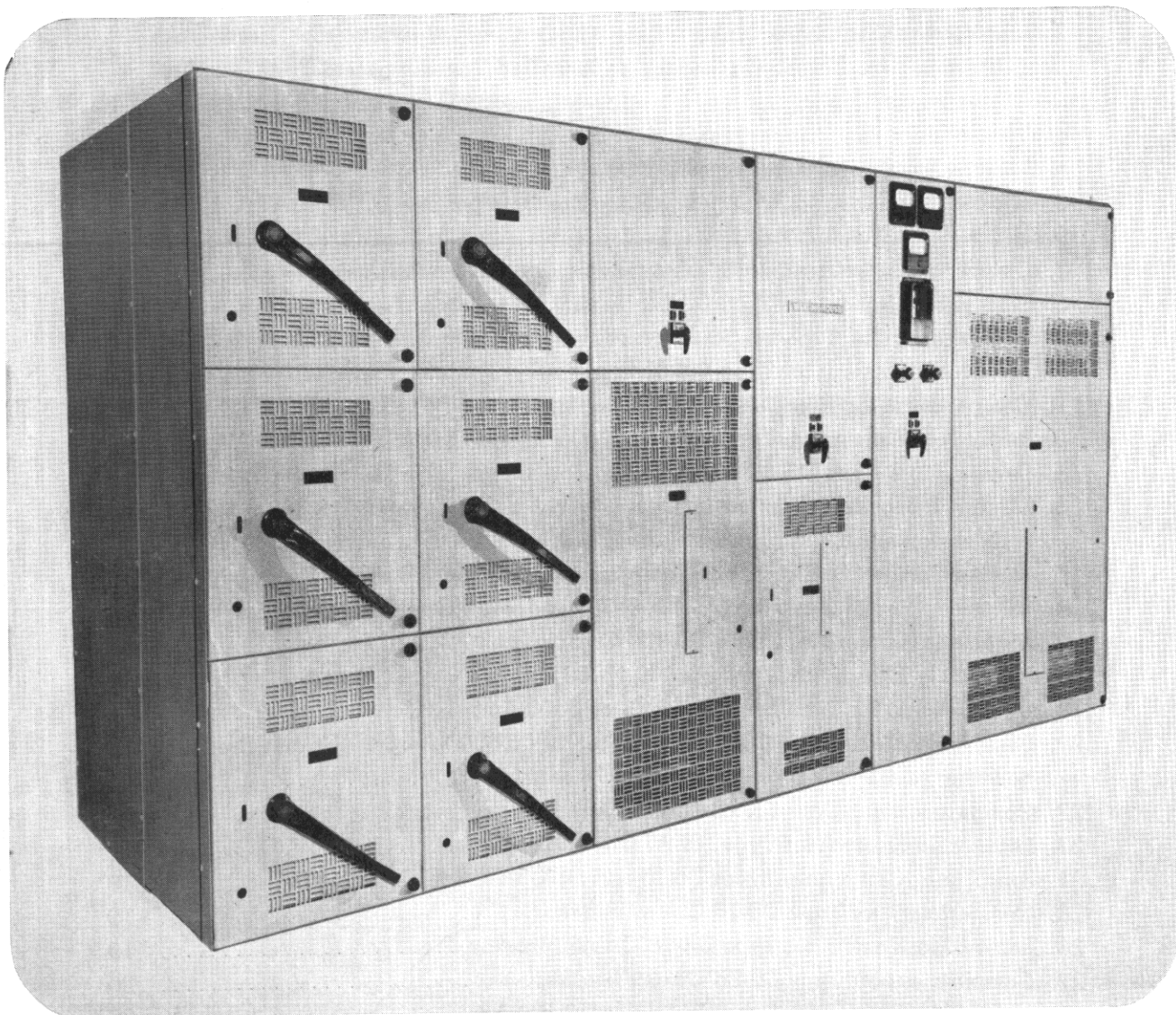
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## Low-Voltage METAL-ENCLOSED SWITCHGEAR

This instruction book has been prepared to familiarize the purchaser's engineering and operating staff with the low-voltage (600 volts or lower) metal-enclosed switchgear supplied by Westinghouse. The information contained herein should be carefully studied before attempting to install or operate the equipment.

Proper installation, operation and maintenance are necessary to assure continued satisfactory service from the equipment. It should not be installed in places where it will be called upon to operate at voltages or currents greater than those for which it was designed.

For instructions pertaining to a particular piece of apparatus supplied as part of the switchgear equipment, refer to the instruction book or leaflet applying to that particular type of apparatus. Copies of the applicable publications are furnished along with this book for each switchgear installation.

**Caution:** Only authorized and properly trained personnel should be permitted to operate or handle any portion of the switchgear.

## PART ONE

# DESCRIPTION

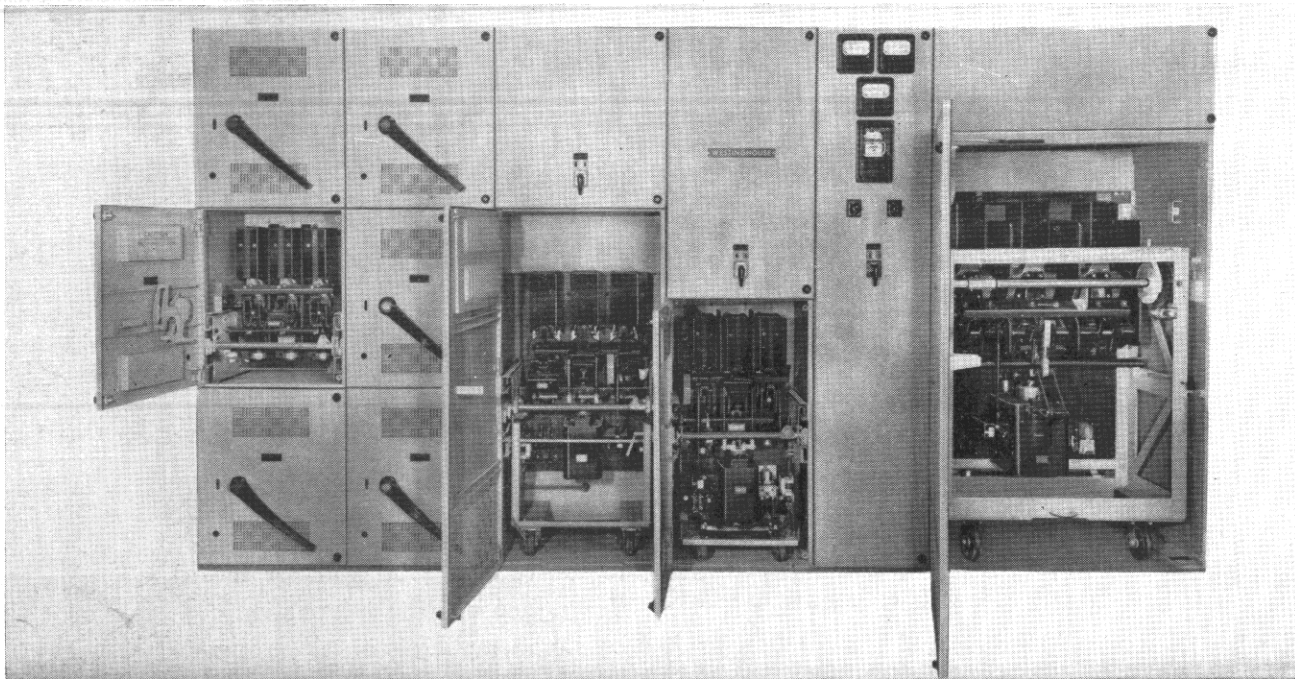


FIG. 1. Front View of Indoor Metal-Enclosed Switchgear Containing Types DA-50, DA-75 and DA-100 Electrically-Operated and Type DA-50 Manually-Operated Circuit Breakers as Removable Elements



FIG. 2. Low-Voltage Switchgear Installed in an Outdoor Weatherproof House and Arranged for Throat Connection to a Power Transformer to Form an Outdoor Power Center

Low-voltage (600 volts or lower) indoor and outdoor metal-enclosed switchgear having drawout-mounted type DB, DK or DA air circuit breakers is completely factory assembled and tested. It is arranged for the minimum amount of labor for installation. See Figs. 1 and 2. Shipments are made completely assembled or in sections of one or more housings to suit the handling facilities at the point of installation.

The switchgear consists of a fixed part called the stationary structure, and drawout-type circuit breakers called the removable elements. The switchgear provides for three positions, "operating", "test", and "disconnect", of the removable element.

In the "operating" position, both the primary and secondary disconnecting devices are engaged, and the circuit breaker is ready for operation. In the "test" position, only the secondary disconnecting devices are engaged, and the circuit breaker can be operated without energizing the power circuit. In the "disconnect" position, both the primary and secondary disconnecting devices

are disengaged and the entire circuit breaker is isolated.

### SWITCHGEAR HAVING TYPES DA-50 AND DA-75 CIRCUIT BREAKERS

**Stationary Structure.** The stationary structure is an assembly of one or more steel housings, each consisting of a formed and welded front enclosure containing the circuit breaker compartments, and a rear enclosure for the bus copper, cables, instrument transformers and other detail equipment. See Fig. 3. The front compartments are completely enclosed, segregating each circuit breaker from the other breakers.

Each circuit breaker compartment is provided with the main stationary contacts and a rail along each side for supporting the removable element. These rails permit the removable element to be moved between the "operating" and "disconnect" positions, with a positive stop for each position, and by use of the rail extensions, completely out of the compartment.

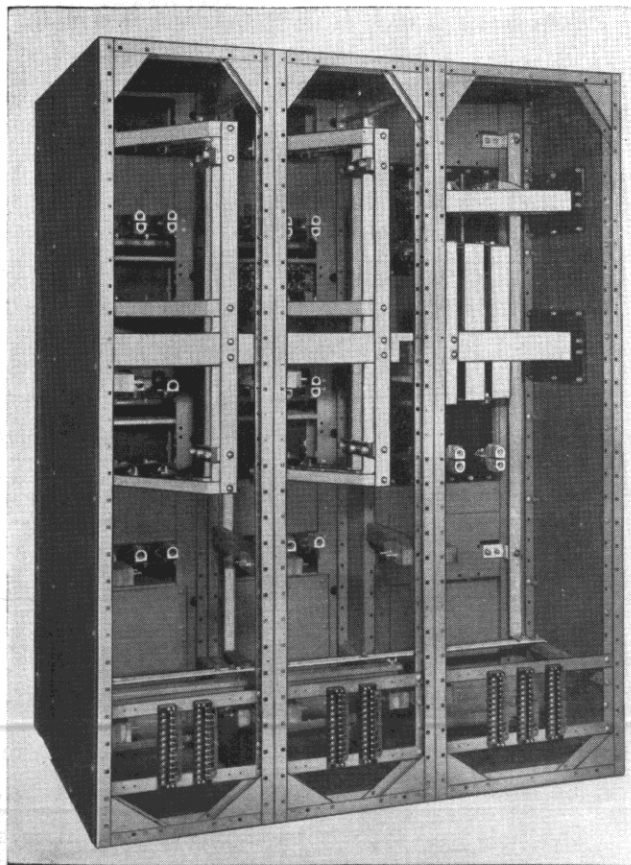


FIG. 3. View of Rear Bus Compartment

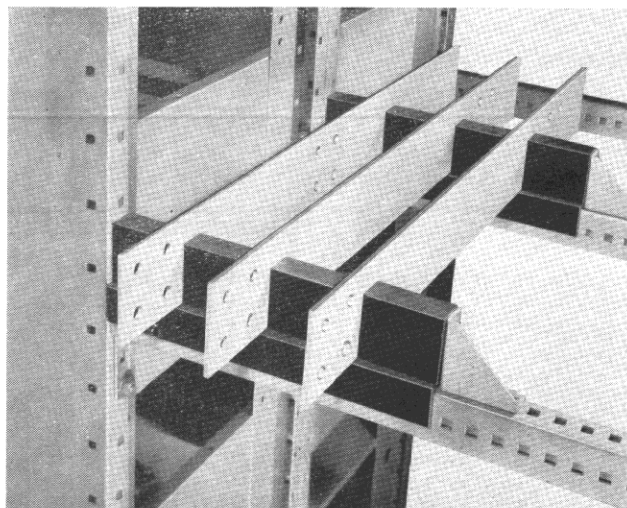


FIG. 4. Micarta Bus Supports Arranged for One Bus Bar per Phase

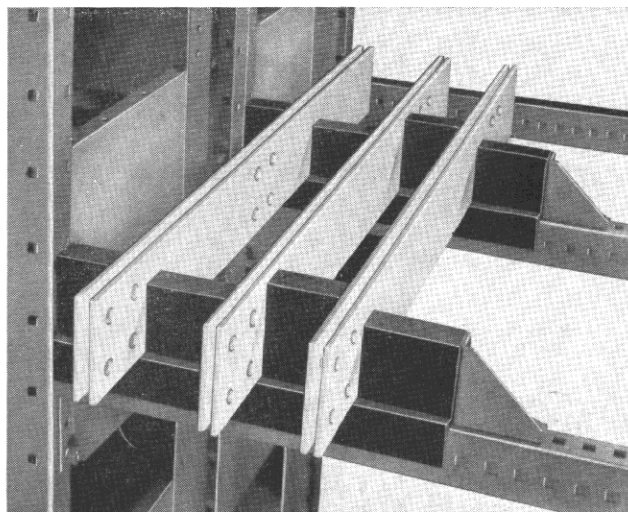


FIG. 5. Micarta Bus Supports Arranged for Two Bus Bars per Phase

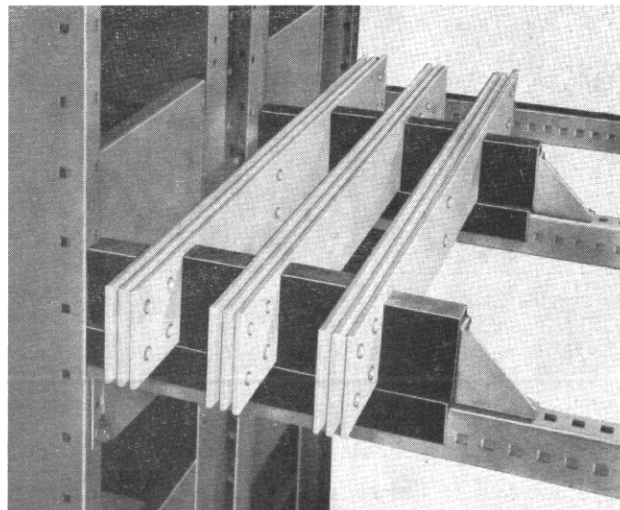


FIG. 6. Micarta Bus Supports Arranged for Three Bus Bars per Phase



## DESCRIPTION

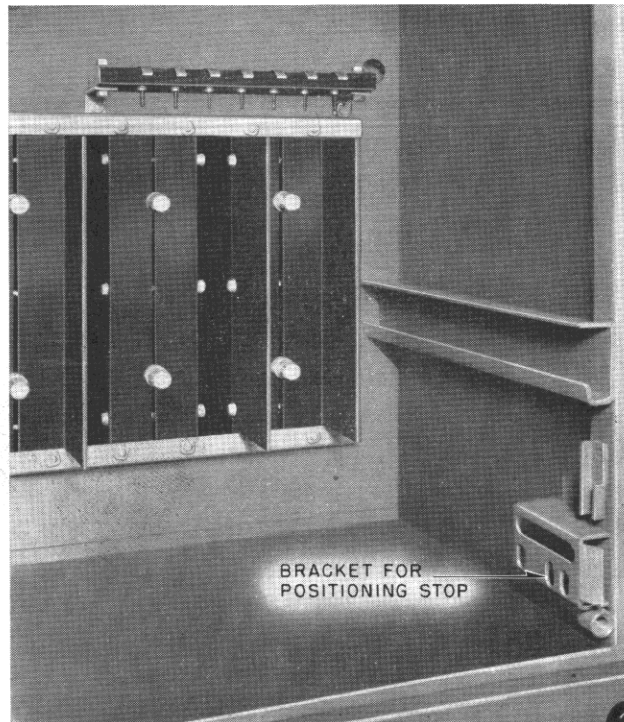
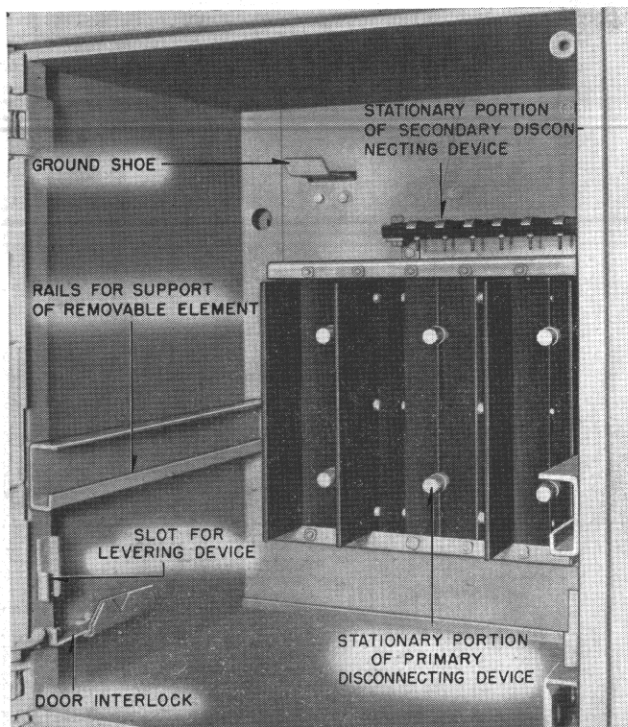


FIG. 7. Compartment for Type DA-50 Manually-Operated Circuit Breaker

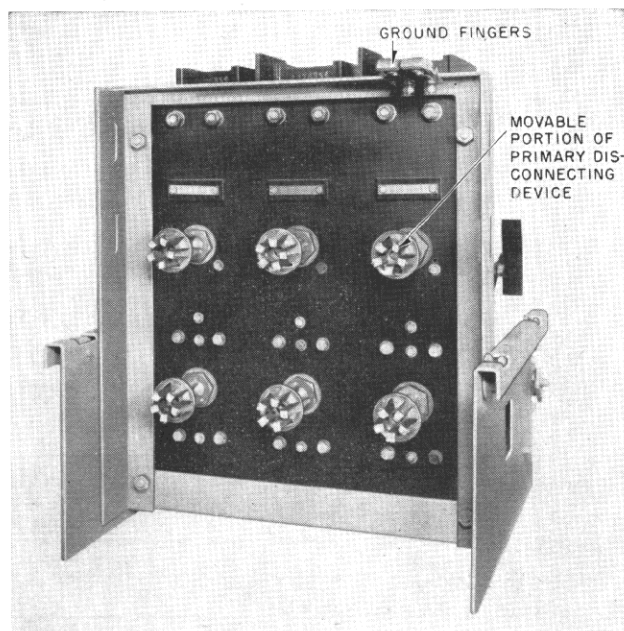
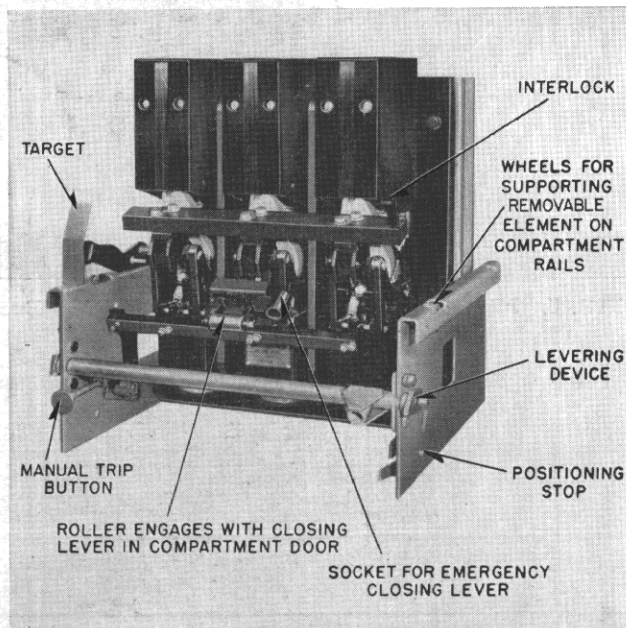


FIG. 8. Removable Element for Type DA-50 Manually-Operated Circuit Breaker

The rear enclosure is made up of the rear frames, tie members, top sheets and rear covers, all bolted together and to the rear of the front compartment. The rows of square holes which are punched in the rear frame, tie members, and the rear flange of the

front compartment permit changes and additions to be made without cutting, welding or drilling.

The universal type Micarta bus support blocks can be arranged to permit the use of one, two or three bars per phase. Thus, by a simple re-ar-

range of the insulating blocks, additional copper bars may be added to the bus in the field as future load requirements dictate. Figs. 4, 5 and 6 illustrate the arrangements of the Micarta blocks for one, two and three bars per phase, respectively.

When automatic shutters are supplied for type DA-75 circuit breaker compartments, they close and isolate the fixed portion of the primary dis-

connecting devices when the removable element is withdrawn. These shutters are arranged to close when the removable element is approximately half withdrawn from the cell.

**Removable Element.** The removable element consists of the air circuit breaker equipped with primary and secondary disconnecting devices,

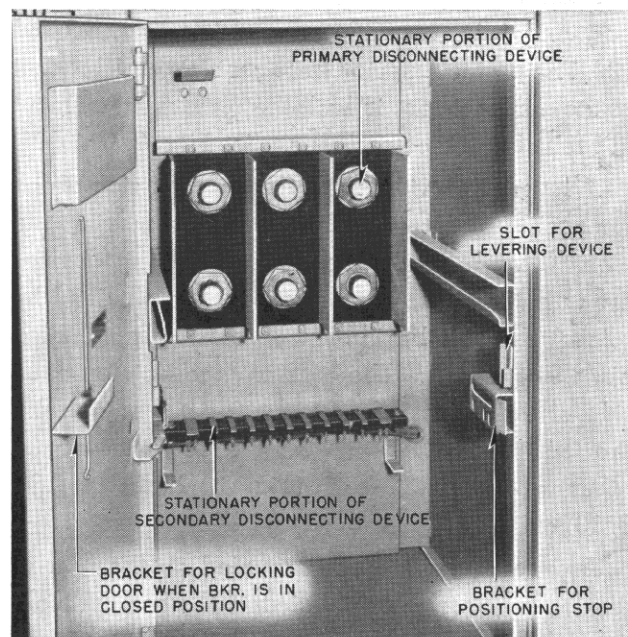
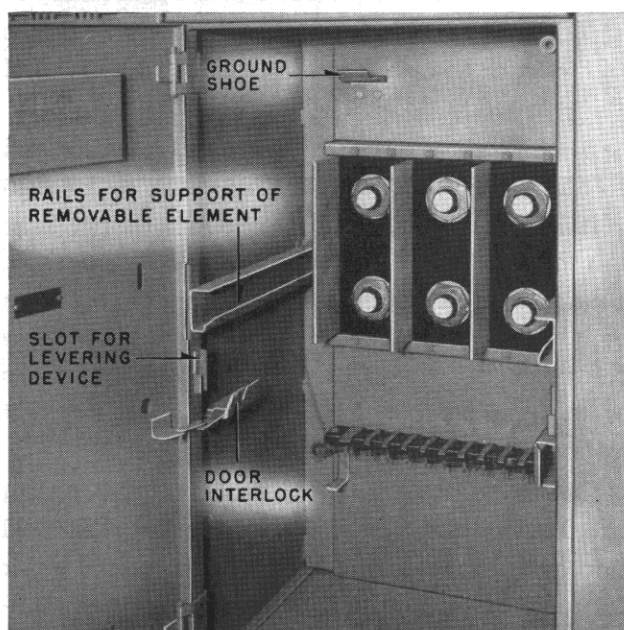


FIG. 9. Compartment for Type DA-50 Electrically-Operated Circuit Breaker

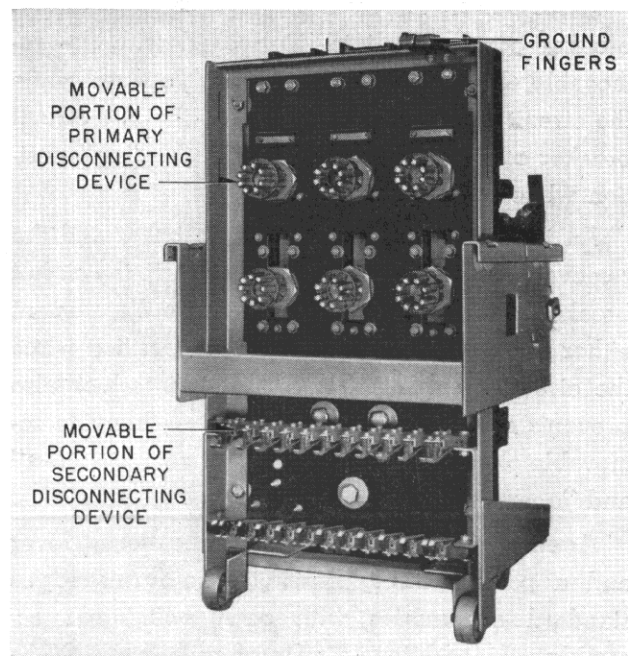
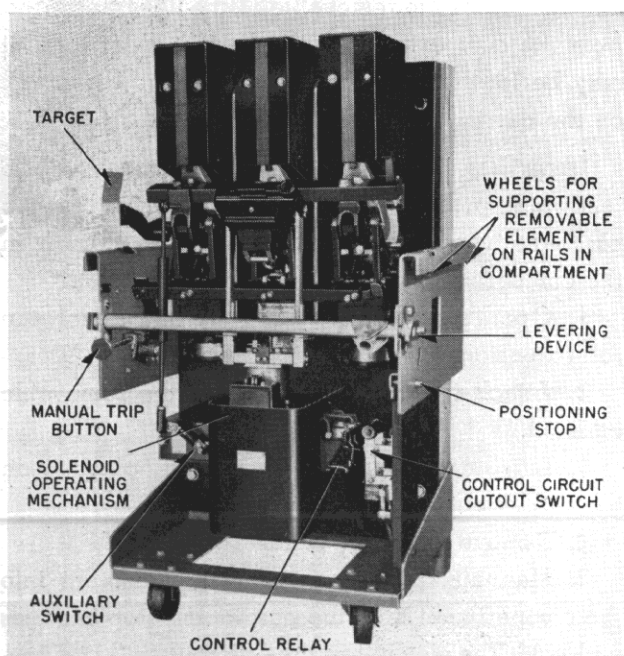


FIG. 10. Removable Element for Type DA-50 Electrically-Operated Circuit Breaker

## DESCRIPTION

an operating mechanism, trip button, position indicator and interlocks, all mounted upon a supporting frame or truck. The truck is provided with wheels which engage the side rails in the compartment to support and guide the removable element. All removable elements, except the manually-operated type DA-50, have their trucks mounted on wheels so that they may be rolled on the floor.

Each removable element is provided with a positioning stop located as shown in Figs. 8, 10 and 12. The positioning stop engages slots on a bracket in the compartment to lock the removable element in each of the three positions. See Figs. 7, 9 and 11.

A levering device, mounted on each side of the removable element truck, is used in moving the element while the primary disconnecting devices are in contact. The levering action is obtained by rotating a shaft having an eccentrically mounted pin on each end. The pins engage slots on each side of the compartment. The shaft is rotated by the emergency closing handle for the circuit breakers. The levering device is shown in Figs. 8, 10 and 12.

A ground clip may be mounted on the rear of the removable element to contact the compartment ground shoe when the element is inserted into, or beyond, the "test" position.

**Interlocks.** The front hinged door of the circuit breaker compartment is interlocked with the removable element so that it cannot be opened while the circuit breaker is closed and so that the circuit breaker cannot be closed in the "operating" position while the door is open.

An interlock between the compartment and the removable element will automatically trip the circuit breaker if an attempt is made to move the element either into or out of the "operating" position while the circuit breaker is closed. This interlock also prevents closing the circuit breaker when the removable element is at any point between the "test" and "operating" positions.

**Accessories.** An emergency hand closing lever and a pair of lifting brackets are furnished as standard accessories with each switchgear assembly. In addition, a pair of rail extensions is supplied for switchgear assemblies containing

type DA-50 manually-operated circuit breakers or type DA-50 electrically-operated breakers mounted in upper compartments.

The emergency closing lever is inserted in the socket on the circuit breaker operating mechanism for closing, and should be removed after the closing operation. The lever is also used to lever the removable element into or out of the "operating" position. This is shown in Fig. 13.

The lifting brackets attach to slots on the sides of the truck and are used to facilitate the lifting of the removable element with a hoist.

The rail extensions, when required, are attached to the compartment rails for convenience in completely withdrawing the removable element from the compartment. For floor-wheeled removable elements mounted in the lower compartments, the rail extensions are not required. Fig. 14 illustrates the use of the lifting brackets and extension rails when handling a type DA-50 removable element with a hoist.

The handling carriage for type DA-50 circuit breakers, illustrated in Fig. 15, is an additional accessory available and furnished on special order for use where other hoisting facilities are not available. The carriage is equipped with rails which connect to the compartment rails by means of latches. After the removable element is transferred from the compartment to the handling carriage, it may be lowered or raised by means of the crank on the carriage.

**Inserting the Removable Element.** The following procedure should be followed when placing a type DA-50 manual removable element in the compartment by the use of a chain hoist.

1. Open the compartment door and attach the rail extensions to the compartment rails.
2. Attach the lifting brackets to the removable element.
3. Lift the removable element and place it on the rail extensions as shown in Fig. 14.
4. Remove the lifting brackets.
5. Manually push the removable element into the compartment until the positioning stop engages and holds the element in the "disconnect" position.
6. Remove the rail extensions.



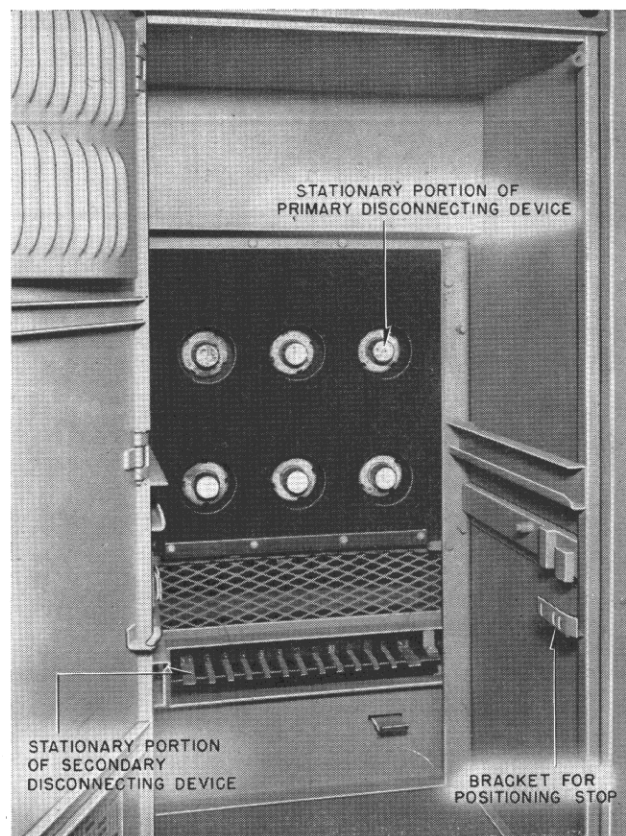
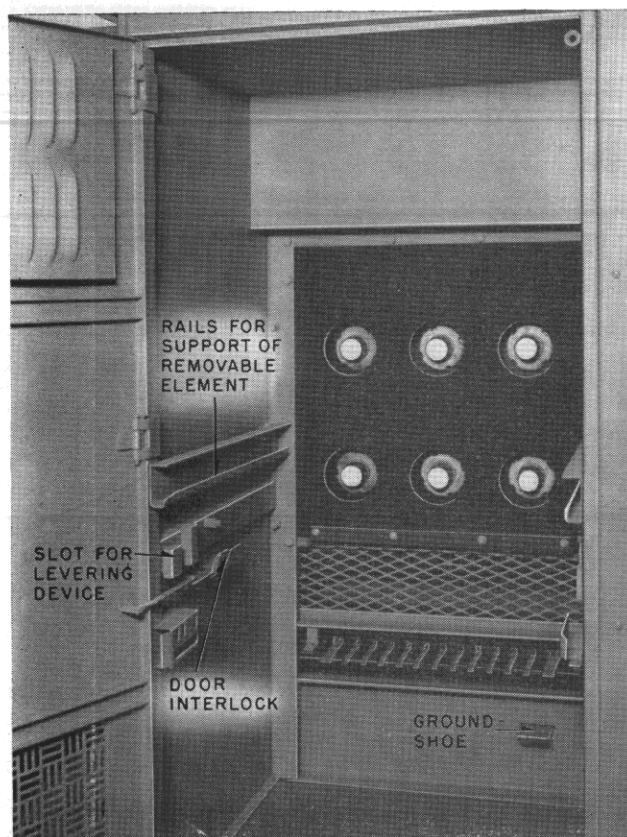


FIG. 11. Compartment for Type DA-75, 2000-Ampere Circuit Breaker

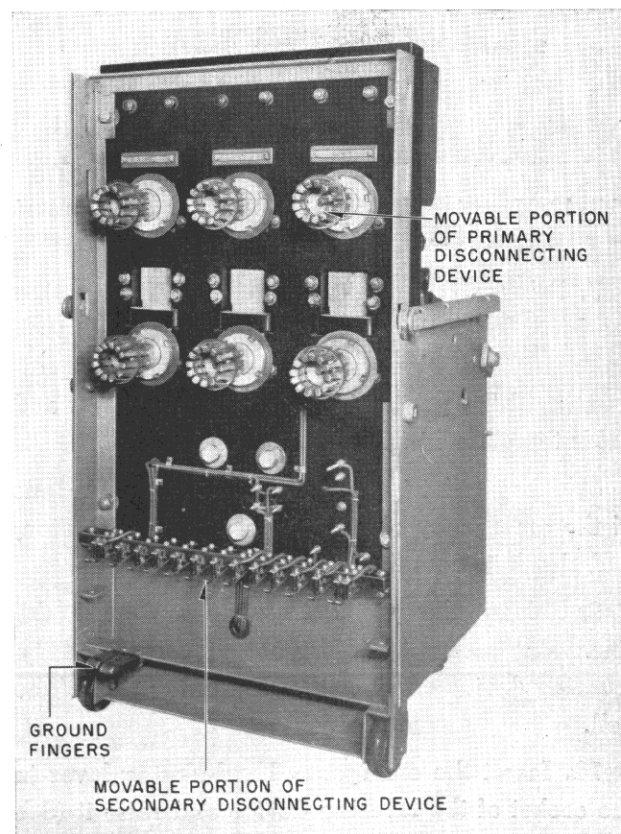
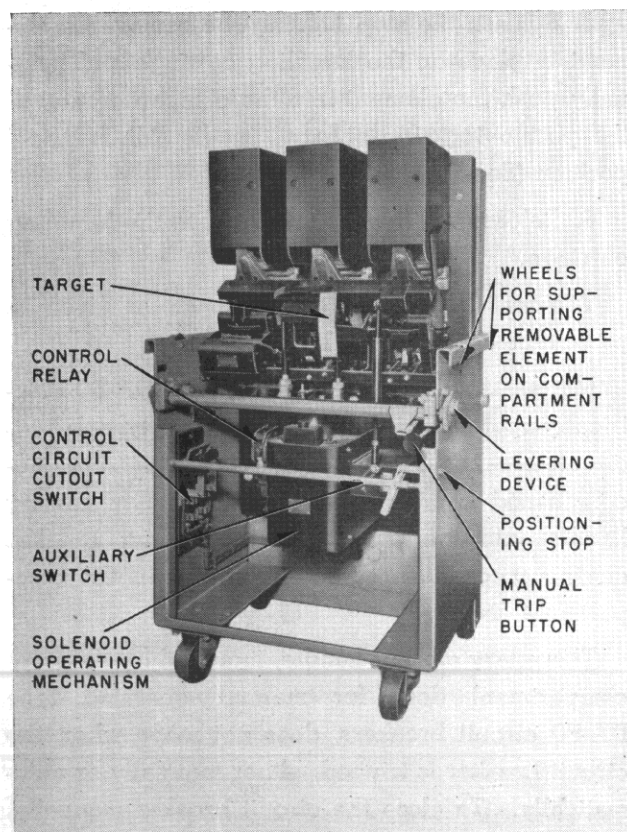


FIG. 12. Removable Element for Type DA-75, 2000-Ampere Circuit Breaker



FIG. 13. Levering in a Type DA-50 Manually-Operated Removable Element

7. Release the positioning stop by depressing the lever on the right side of the truck and push the removable element further into the compartment until the positioning stop again engages and holds the element in the "test" position.

8. Close and trip the circuit breaker by means of the emergency closing handle and trip button, and check its operation in general.

9. Release the positioning stop and push the removable element into the compartment until the levering device engages the slots in the side of the cell.

10. Insert the emergency hand-closing lever in the socket of the levering device and raise it (See Fig. 13) until the positioning stop engages and

holds the removable element in the "operating" position.

11. Close and fasten the compartment door. When closing the door, rotate the manual operating mechanism on the door until the yoke on the mechanism engages the roller on the circuit breaker.

The following procedure should be used if an elevating carriage is used in place of a chain hoist:

1. Lower the rails of the handling carriage sufficiently to permit the carriage to be wheeled to a position where the rails slide under the wheels on the removable element.

2. The element should be moved on the handling carriage rails to the position where the positioning pin drops into the slot on the carriage.

3. Raise the element, by means of the crank on the carriage, to the desired elevation.

4. Wheel the carriage into position so that the carriage rails can be latched to the compartment rails. Care should be taken that the carriage rails are latched to the compartment before attempting to move the element. The extension rails are not required when using the handling carriage.

5. Release the stop holding the removable element in place on the handling carriage and manually push the element into the compartment until the positioning stop engages in the "disconnect" position (See Fig. 15).

6. Release the latches and remove the handling carriage.

The remaining steps are the same as given in paragraphs 7 through 11 on this page.

Manual emergency closing of type DA-50 electrically-operated circuit breakers and type DA-75 circuit breakers in the "operating" position is accomplished by inserting the emergency closing handle into the socket on the circuit breaker closing mechanism through the slot in the compartment door.

The rotary closing handle, mounted on the front compartment door for manually-operated type DA-50 circuit breakers, does not move when the circuit breaker is tripped, either manually or automatically. To close the circuit breaker manually, with the breaker in the "operating" position and



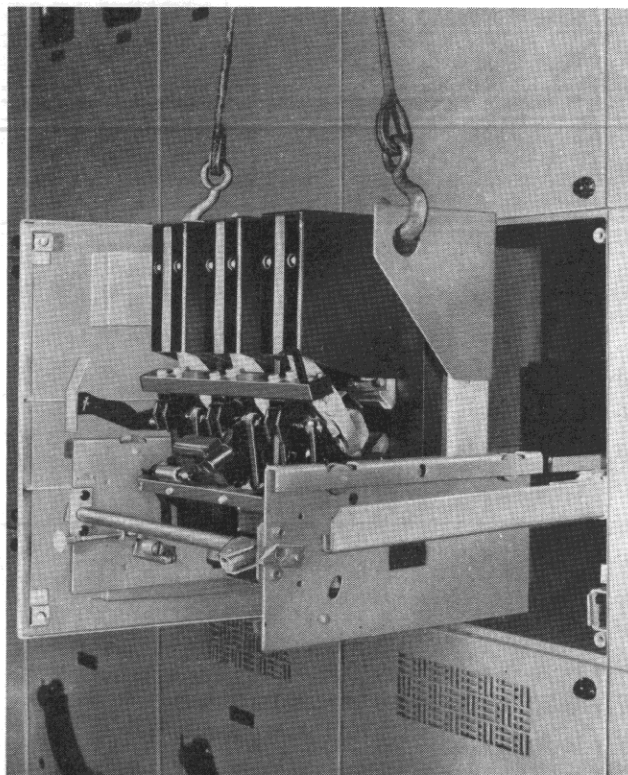


FIG. 14. Placing Removable Element in Compartment by use of a Hoist. Note that Rail Extensions and Lifting Brackets are in Place

the compartment door closed, the handle must be rotated counter-clockwise until the breaker closing mechanism latches, and then rotated clockwise until the circuit breaker latches closed.

When inserting type DA-50 electric or type DA-75 removable elements, the trucks of which are mounted on wheels, the rail extensions are not used, and the element is rolled directly from the floor onto the compartment rails, after which the procedure is the same as described for the manual type DA-50 circuit breaker.

**Removing the Element.** The following procedure should be followed in removing the type DA-50 manual removable element.

1. Trip the circuit breaker and open the compartment door.
2. Attach the rail extensions and insert the levering handle.
3. Disengage the positioning stop and pull down on the levering device handle until it reaches the limit of its travel. Remove the levering handle.

4. Depress the positioning stop lever and pull the element onto the extension rails.

5. Attach the lifting brackets, hoist the removable element off the rails and lower it to the floor.

When using the handling carriage to remove an element, the procedure is similar except that the carriage rails are latched in position instead of the extension rails described in step 2.

### SWITCHGEAR HAVING TYPE DA-100 CIRCUIT BREAKERS

The construction of the switchgear having type DA-100 removable elements is slightly different from that previously described for the types DA-50 and DA-75 switchgear.

**Stationary Structure.** The stationary structure is an assembly of one or more steel housings, each consisting of a front circuit breaker compartment and a rear bus enclosure. The housing is a complete welded structure, fabricated from steel sheets and angles, in contrast to the bolted



FIG. 15. Placing Removable Element in Compartment using the Handling Carriage

## DESCRIPTION

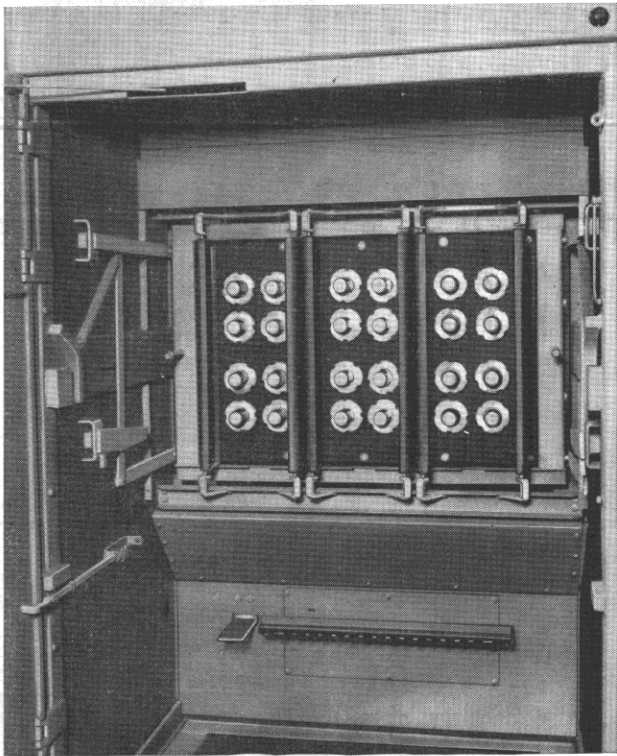


FIG. 16. Automatic Shutters in a Type DA-100 Compartment, Open Position

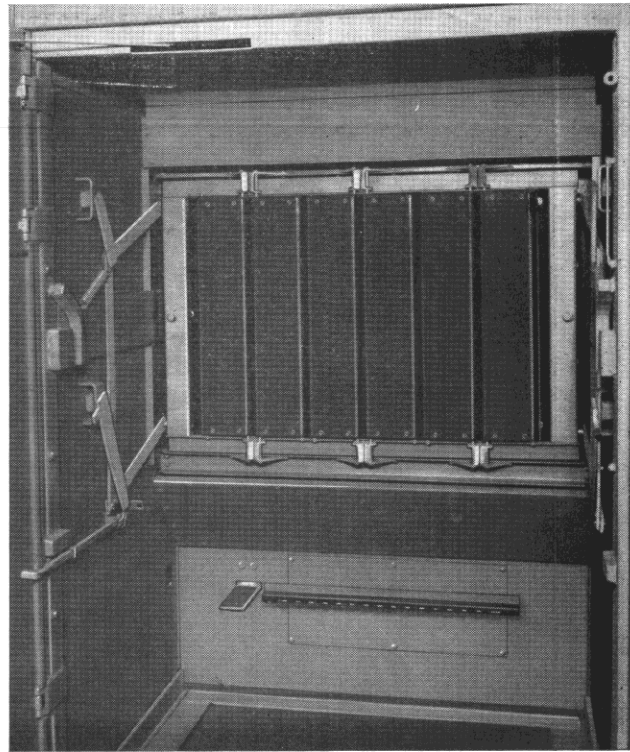


FIG. 17. Automatic Shutters in a Type DA-100 Compartment, Closed Position

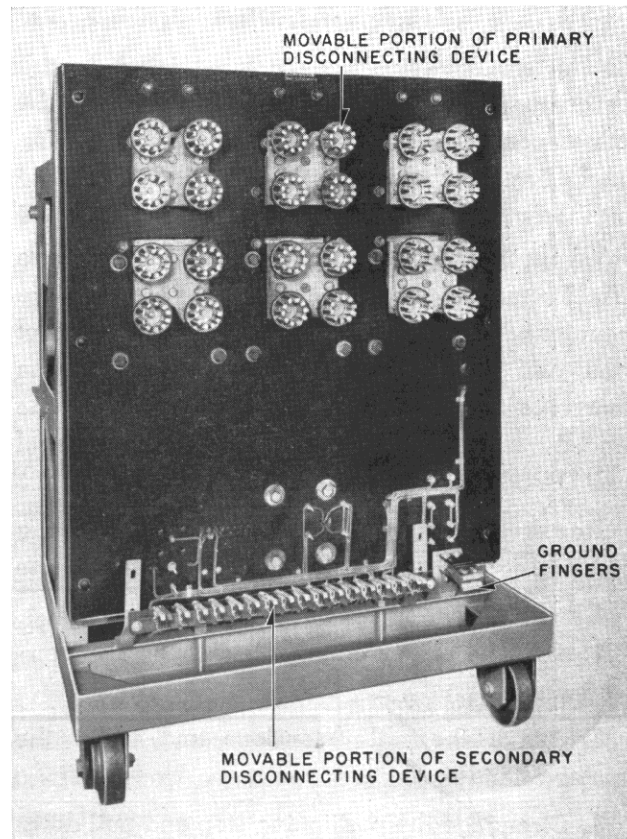
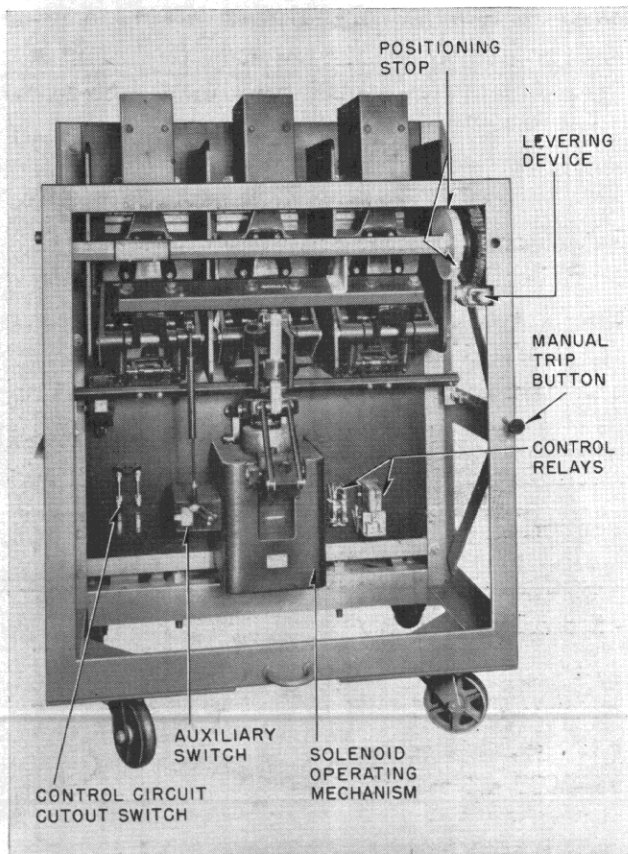


FIG. 18. Removable Element for Type DA-100, 4000-Ampere Circuit Breaker

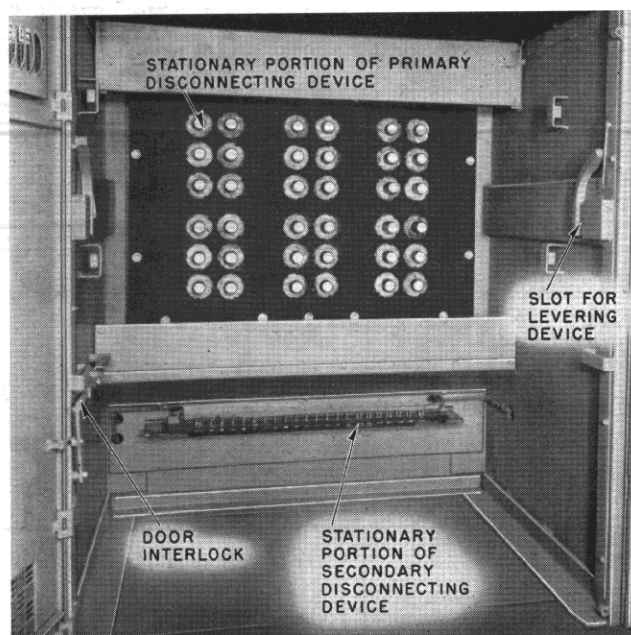


FIG. 19. Compartment for Type DA-100, 5000- or 6000-Ampere Circuit Breaker

type of construction used on the DA-50 and DA-75 switchgear housings. The side sheets extend from the front to the rear, thus providing complete segregation between units, even in the rear bus compartment. The main copper bus is carried between units through heavy Micarta supports bolted over rectangular openings in the side sheets.

The front circuit breaker compartment is similar to that supplied for DA-50 and DA-75 switchgear except that there are no side rails for rolling in the removable element. The removable element truck is equipped with wheels which rest on the bottom steel members of the compartment when the element is in place. The same safety interlocks are furnished as described for the types DA-50 and DA-75 circuit breakers. See Figs. 16 and 17 for the shutters supplied as optional equipment on DA-100 switchgear.

**Removable Element.** The removable element consists of the circuit breaker mounted in a rigid truck constructed of welded steel angles.

The levering device is arranged so that it moves the removable element between the "disconnect" and "operating" positions, and is operated by a removable hand crank through a worm and gear (See Figs. 18 and 20). The positioning stop is built into the levering device and requires a manual

release only when moving away from the "test" position.

No lifting brackets or extension rails are furnished or required for type DA-100 units.

### Inserting the Removable Element.

1. Open the compartment door and roll the element into the compartment until the roller on the movable portion of the levering device engages the compartment portion of the device.

2. Attach the hand crank to the truck levering device and turn in a clockwise direction until the element reaches the "test" position. At this point a pin will drop into a slot on the levering device, preventing further travel of the element.

3. Close and trip the circuit breaker by means of the emergency closing handle and trip button, and check its operation in general.

4. Raise the pin to release it from the slot, and continue to rotate the crank in a clockwise direction until the element is in the "operating" position. On the 5000- and 6000-ampere removable elements, two gear ratios are provided on the levering device. After the main contacts on the element have started to engage the stationary main contacts in the compartment, the crank should be removed from the upper position and transferred

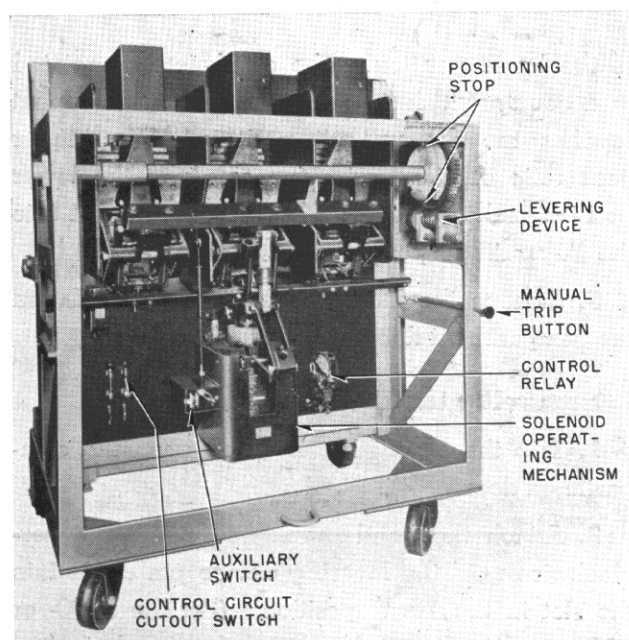


FIG. 20. Removable Element for Type DA-100, 5000- or 6000-Ampere Circuit Breaker





FIG. 21. Levering in a Type DK-25 Removable Element

to the lower position. The crank is then rotated in a counter-clockwise direction until the element reaches the "operating" position. The higher gear ratio obtained with the crank in the lower position makes it easier to lever the element into the "operating" position.

5. Remove the hand crank. Close and fasten the compartment door.

### Removing the Element.

1. Trip the circuit breaker and open the compartment door.

2. Attach the hand crank and rotate counter-clockwise until the levering device pin drops into the slot in the "test" position. (For the 5000- or 6000-ampere circuit breakers, the crank is first attached in the lower position and rotated in a clockwise direction until the main contacts are

disengaged, after which the crank is transferred to the upper position and rotated in a counter-clockwise direction).

3. Raise the stop pin and continue to rotate the crank in a counter-clockwise direction until the element is in the "disconnect" position.

### SWITCHGEAR HAVING TYPE DK CIRCUIT BREAKERS

The general features of type DK-15 and type DK-25 drawout switchgear are essentially the same as explained previously for the type DA-50 switchgear. Both the manually-operated and electrically-operated circuit breakers are mounted in the same type of truck, and because of the relatively small size and light weight, floor wheels are not included on these trucks. The side handles permit the removable element to be lifted either manually, or by means of a hoist, with no lifting brackets required.

**Interlocks.** The interlocks between the compartment and removable element for type DK switchgear are similar to those described previously for switchgear containing types DA-50 and DA-75 circuit breakers, except that the compartment door is not locked while the circuit breaker is closed. If an attempt is made to open the door while the circuit breaker is closed, the circuit breaker will automatically trip when the door has been opened approximately 25 degrees.

### Inserting the Removable Element.

1. Open the compartment door and attach the rail extensions. See Fig. 22.

2. Lift removable element and place it on the rail extensions.

3. Push the removable element into the compartment until the positioning stop drops into the first slot, thus holding the element in the "disconnect" position.

4. Remove the rail extensions.

5. Release the positioning stop pin and push the removable element further into the compartment until the pin engages the second slot, thus holding the element in the "test" position.

6. Close and trip the circuit breaker and check

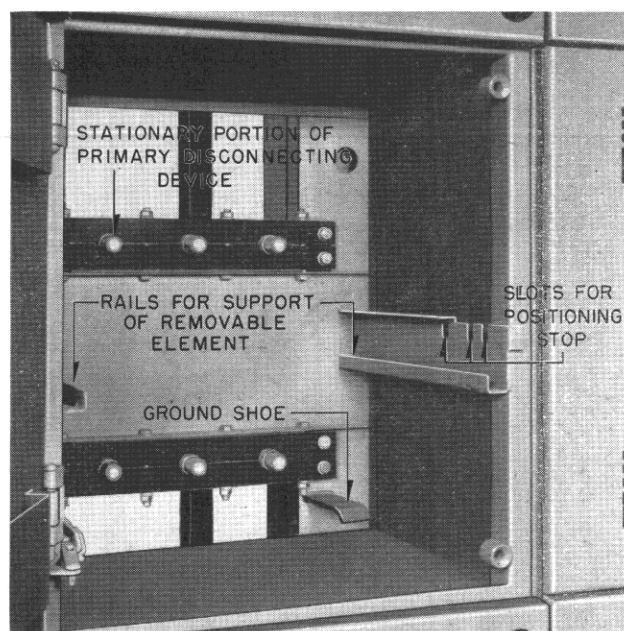
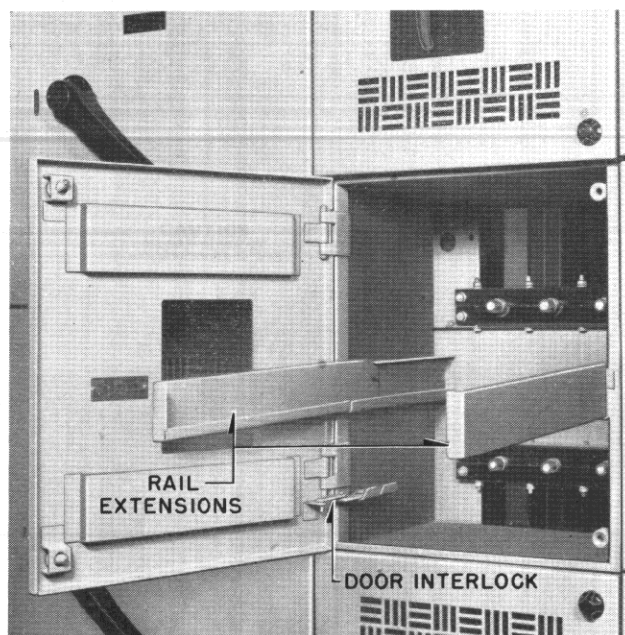


FIG. 22. Compartment for Type DK-25 Circuit Breaker. The Compartment is shown With Rail Extensions (left) and Without Rail Extensions (right)

its operation in general. The circuit breaker is closed by rotating the operating handle in a clockwise direction and tripped by turning the handle in the opposite direction.

7. Release the positioning stop pin and push the element into the compartment until the movable and stationary portions of the primary disconnecting devices start to engage.

8. Insert the levering device into the rails and removable element truck. Lift up on the levering handle until the positioning stop engages the last slot and holds the element in the "operating" position. See Fig. 21.

9. Remove the levering device. Close and latch the compartment door.

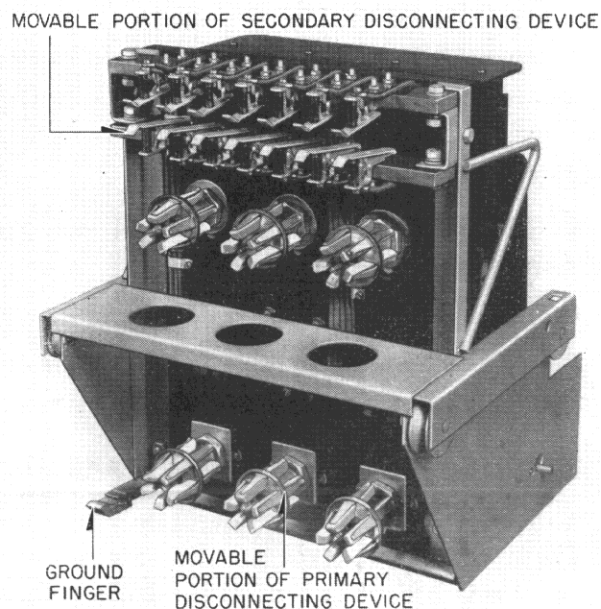
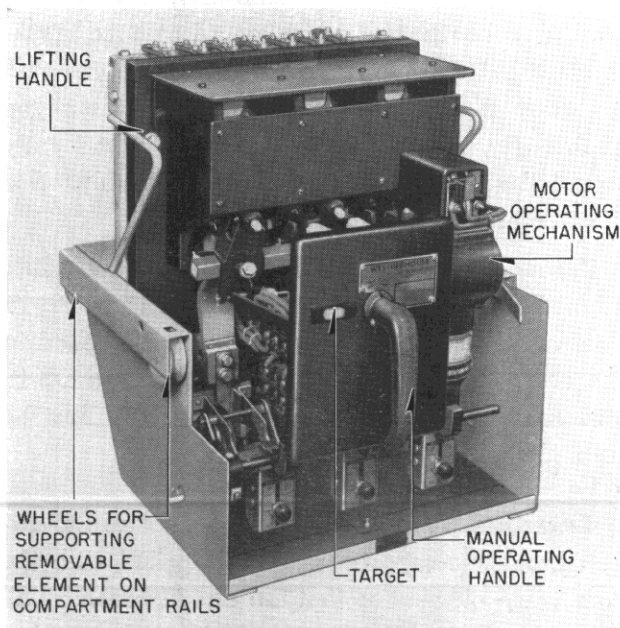


FIG. 23. Removable Element for Type DK-25 Circuit Breaker

## DESCRIPTION

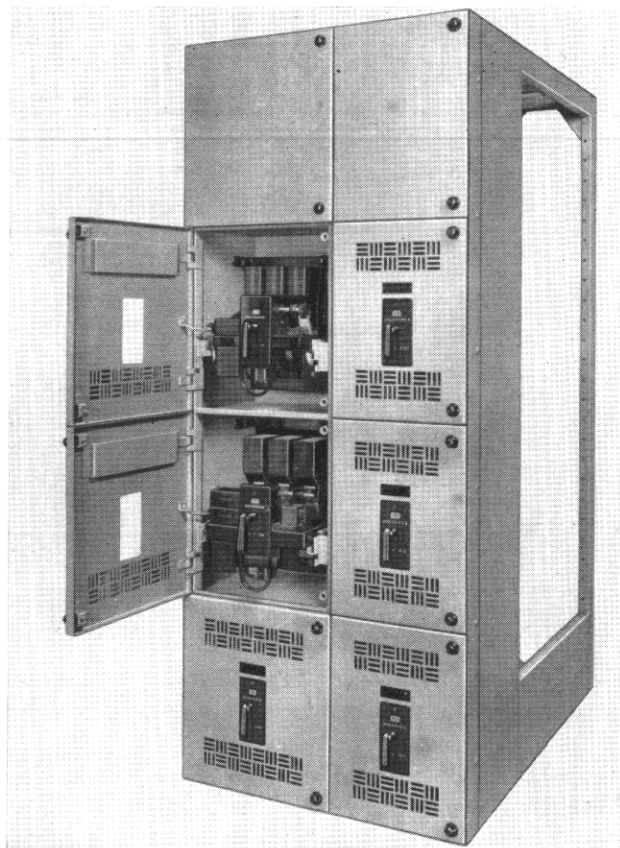
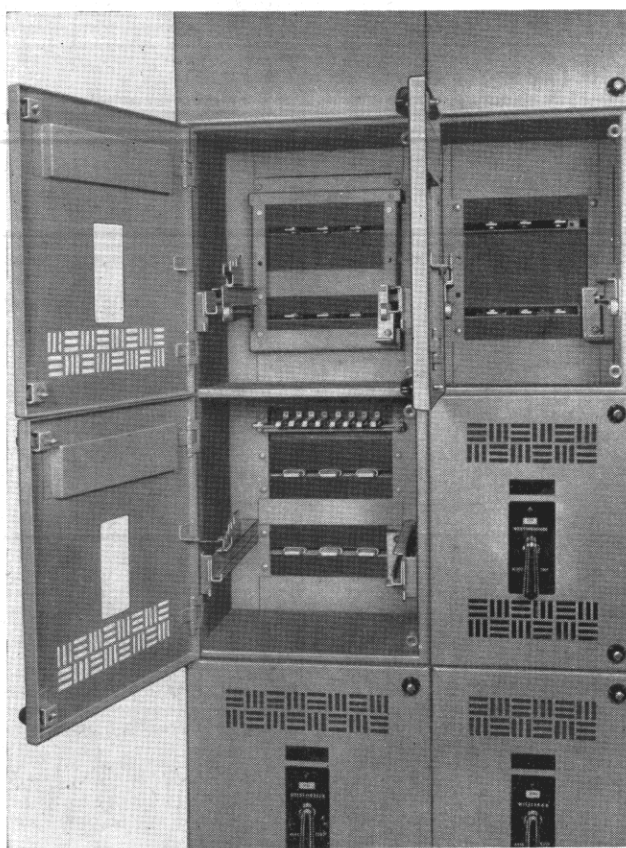


FIG. 24. Switchgear Containing Types DB-15 and DB-25 Removable Elements

### Removing the Element.

1. Trip the circuit breaker and open the compartment door.
2. Insert the levering device handle.
3. Release the positioning stop and pull down on the levering handle until it reaches the limit of its travel, and then remove the levering device.
4. Attach the rail extensions.
5. Release the positioning stop and pull the element out on the rail extensions.
6. Lift the removable element off the rails.
7. Remove the rail extensions. Close and fasten the compartment door.

### SWITCHGEAR HAVING TYPES DB-15 AND DB-25 CIRCUIT BREAKERS

The general features of type DB-15 and DB-25 drawout switchgear (see Fig. 24) are similar to those explained previously for the type DA-50 switchgear. However, there are no separate trucks for

the DB-15 and DB-25 circuit breakers. For the DB-25 breaker, the four wheels which engage the compartment rails are mounted directly on the sides of the circuit breaker assembly, while for the DB-15 breaker the two rear wheels are on the breaker assembly, and the two front wheels are mounted on the sides of the compartment. For either type of breaker, the lifting bracket is permanently mounted at the top of the breaker assembly. See Figs. 26 and 28.

A set of conjunction parts may be used to adapt a type DB-25 compartment for use with a type DB-15 removable element. These parts are all bolted in the compartment, and of course, the type DB-15 stationary primary disconnecting devices must be used in such a modified compartment.

**Interlocks.** The front hinged door of the circuit breaker compartment is interlocked with the removable element so that the circuit breaker will automatically trip if an attempt is made to open the door when the circuit breaker is closed. This



## L.V. METAL-ENCLOSED SWITCHGEAR

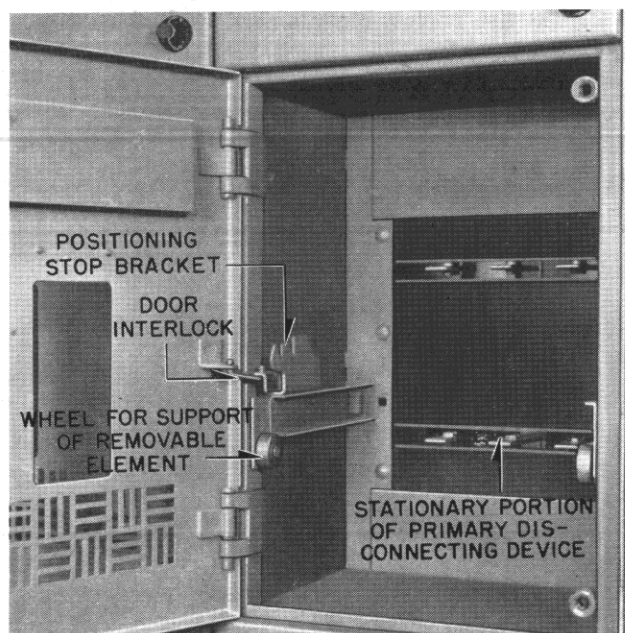


FIG. 25. Compartment for Type DB-15 Circuit Breaker

interlock also prevents closing the circuit breaker while in the "operating" position with the door open. With the removable element withdrawn to the "test" position, however, the breaker may be closed with the compartment door open.

An interlock between the compartment and the removable element will automatically trip the cir-

cuit breaker if an attempt is made to move the element into the "operating" position while the circuit breaker is closed. This interlock also prevents closing of the circuit breaker when it is at any point between the "test" and "operating" positions.

Before the removable element may be withdrawn from the "operating" position, the lever on the left side of the element must be depressed. This causes the positioning pin to move out of the positioning slot, and at the same time it causes the circuit breaker to trip if it is closed. Thus the element cannot be withdrawn from the "operating" position while the breaker is closed.

**Accessories.** Standard accessories furnished for type DB-25 switchgear include a set of rail extensions and a levering device. Figs. 29 and 30 illustrate the manner in which the rail extensions are used in completely withdrawing the element from the compartment and show the method of moving the element into, or out of, the "operating" position by use of the levering device.

There are no accessories required for switchgear having type DB-15 removable elements. The element may be moved into, or out of, the "operating" position without the use of the levering device.

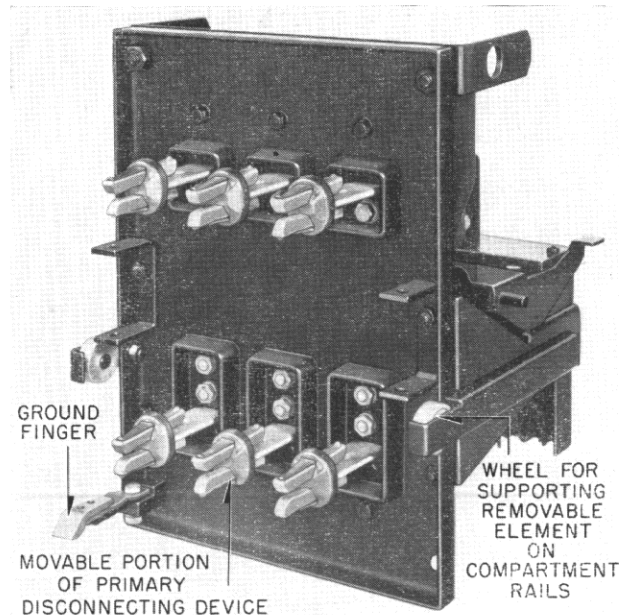
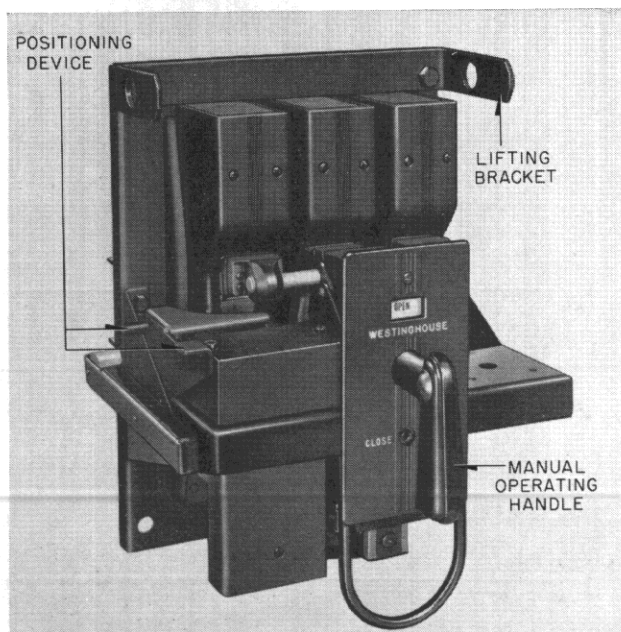


FIG. 26. Removable Element for Type DB-15 Circuit Breaker

## DESCRIPTION

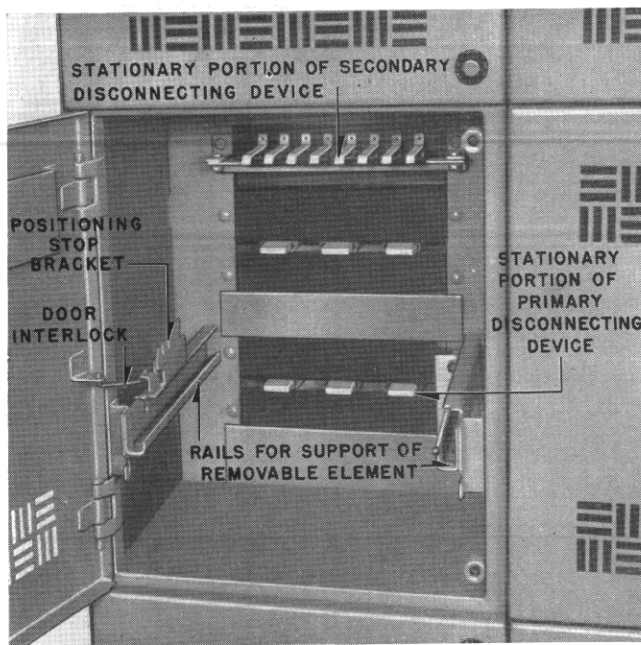


FIG. 27. Compartment for Type DB-25 Circuit Breaker

**Inserting the Removable Element.** For type DB-25 removable element, proceed as follows:

1. Open the compartment door and attach the rail extensions.

2. Lift the removable element and place it on the rail extensions.

3. Push the removable element into the compartment until the positioning pin drops into the first slot, thus holding the element in the "disconnect" position.

4. Remove the rail extensions.

5. Release the positioning stop pin by depressing the lever on the left side of the removable element, and push the element further into the compartment until the pin engages the second slot, holding the element in the "test" position.

6. Close and trip the circuit breaker and check its operation in general. The circuit breaker is closed by rotating the operating handle in a clockwise direction and tripped by turning the handle in the opposite direction.

7. Release the positioning stop pin and push the element into the compartment until the movable and stationary portions of the primary disconnecting devices start to engage.

8. Insert the levering device and lift up on the

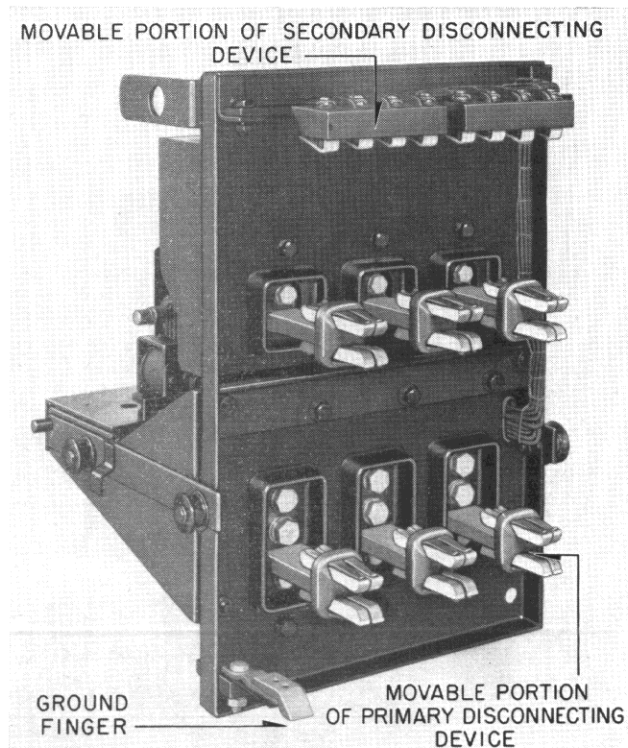
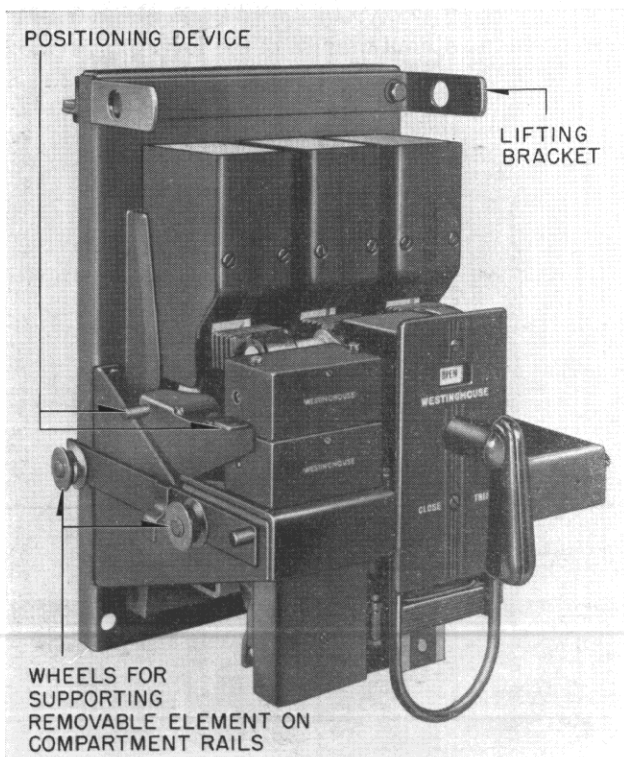


FIG. 28. Removable Element for Type DB-25 Circuit Breaker



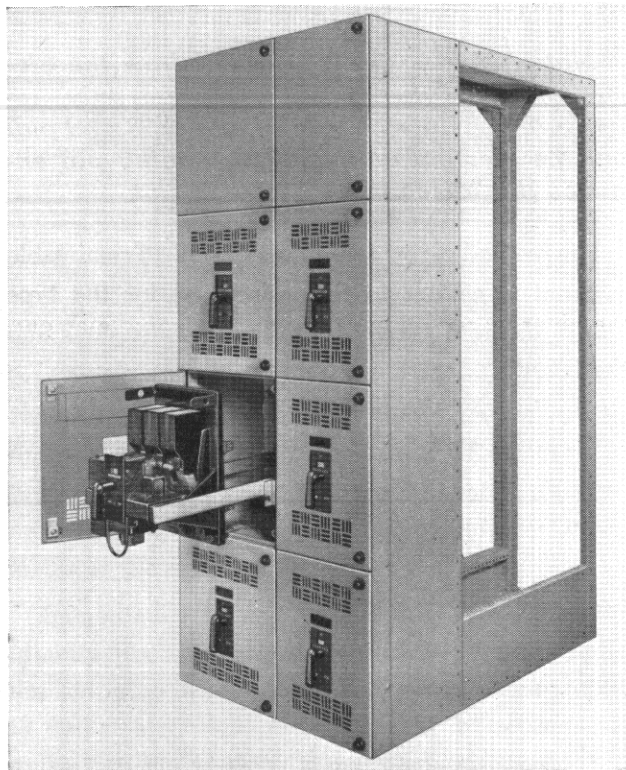


FIG. 29. Type DB-25 Element in Position on Rail Extensions Ready for Insertion in the Compartment

handle until the removable element reaches the "operating" position. This will be noted when the two rear wheels strike the stops located in the cell rails. See Fig. 30.

9. Remove the levering device. Close and latch the compartment door.

The method of inserting the type DB-15 removable element is similar to that explained for the type DB-25 element except that the element is lifted and placed directly on the compartment rails instead of on the rail extensions, and the levering device is not required to move the element between the "test" and "operating" positions.

**Removing the Element.** For type DB-25 breakers, proceed as follows:

1. Trip the circuit breaker and open the compartment door.

2. Insert the levering device handle.

3. Pull down on the levering handle until it reaches the limit of its travel, and then remove the levering device. Pull out the element until the

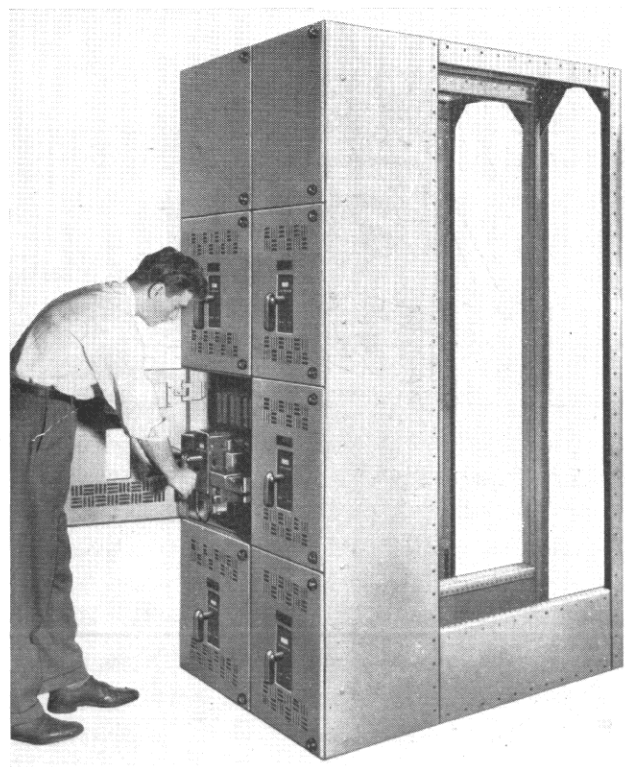


FIG. 30. Inserting a Type DB-25 Removable Element

## DESCRIPTION

positioning pin engages the "test" position slot.

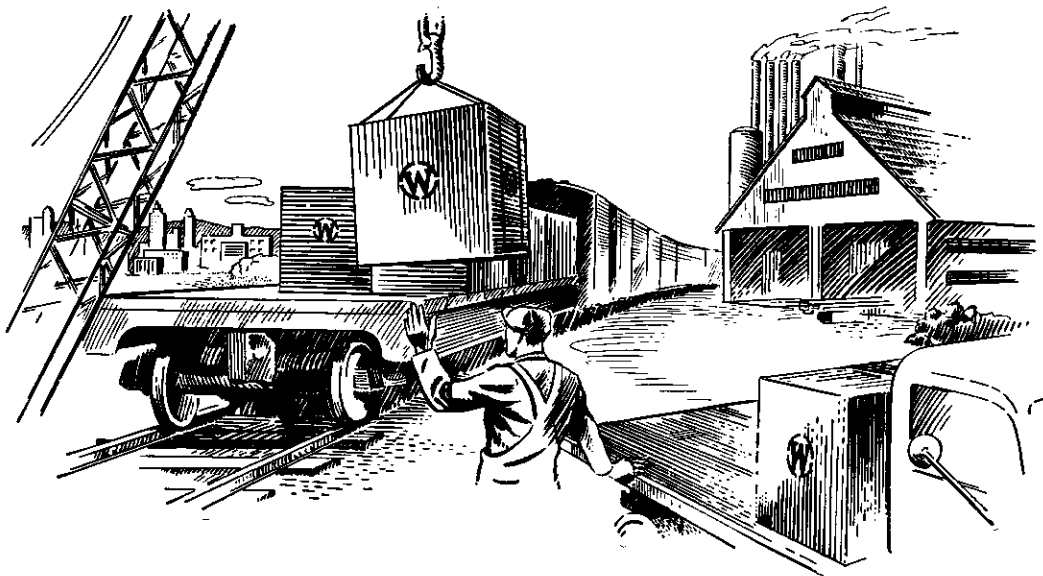
*Note: Operation may be checked in this position without removing the element from the compartment.*

4. Attach the rail extensions.
5. Release the positioning stop pin and pull the element out onto the rail extensions.
6. Lift the removable element off the rails.
7. Remove the rail extensions. Close and fasten

the compartment door.

*Note: If it is desired to withdraw the element to the "disconnect" position only, release the positioning pin after step 3 and pull out the element until the positioning pin engages the "disconnect" position slot.*

The method of removing the type DB-15 removable element is similar to that described for the type DB-25 element except that the rail extensions and the levering device are not required.



# RECEIVING, HANDLING AND STORING

## RECEIVING

The switchgear is assembled, wired, adjusted and given complete commercial tests at the factory, after which it is carefully inspected and prepared for shipment. See Fig. 31. The removable air circuit breakers are packed in separate crates from the stationary switchgear housings. Each crate or box is plainly marked with an identification number, and a complete list of its contents is included in the shipping papers.

Immediately upon receipt of the shipment, identify all component parts and check them against the shipping list. Make a thorough examination to detect any damage which may have been incurred during transit. If any damage or evidence of rough handling is discovered, file a claim immediately with the transportation company, and notify the nearest Westinghouse Sales Office promptly.

## HANDLING

Handle all crated or uncrated switchgear with extreme care since the panels contain delicate instruments and relays which may be damaged by rough handling.

Lifting irons are bolted to the top of the switchgear housings for use in handling the equipment where hoisting facilities are available. If hoisting facilities are not available, the section of the skids on the bottom of the crates permit the use of pipe rollers.

When uncrating switchboards, care should be exercised to avoid breakage and scratching or marring of the panel finish.

Special care must be taken in unpacking the removable circuit breaker elements; the applicable circuit breaker Instruction Book, I.B. 5965 for type DK breakers, I.B. 35-225-1 for type DB breakers or I.B. 5943 for type DA breakers, should be carefully read before starting to unpack the circuit breakers.

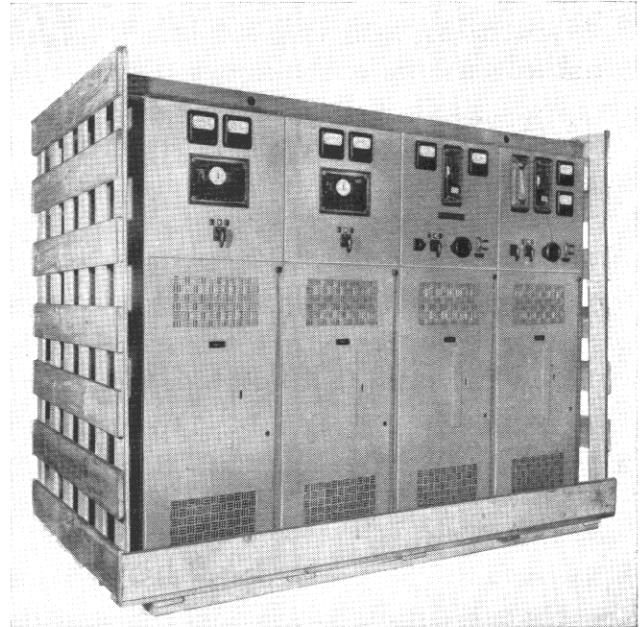


FIG. 31. Metal-Enclosed Switchgear Prepared for Shipment. Shipping Angles on the Top may be used for Handling by a Crane, or Skids on Bottom Provide for Movement on Pipe Rollers

After the crates have been removed, both the switchgear housings and the removable circuit breaker elements should be covered during the construction period for protection against dust and dirt.

## STORING

Switchgear which is not to be installed immediately should be stored in a clean, dry 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 can be quickly located when required in the erection program. Crated apparatus will store much better if not unpacked. However, this must not prevent the inspection of the equipment as described previously. Conditions such as dampness, extreme temperature changes, dust and dirt should be carefully guarded against.

## PART THREE

# INSTALLATION

### FOUNDATION

The switchgear is fabricated in welding jigs and assembled on level steel bedplates and is kept square and plumb at all times during erection and adjustment. Since the tolerances and adjustments are kept to a minimum, it must be installed on a smooth level base to retain the easy operation of the removable elements and the correct adjustments.

The preferred method of anchoring the indoor switchgear is by fastening it to steel channels which are embedded in the concrete floor. Floor plans for drilling and locating this steel are supplied with each contract. The top surfaces of the channels must be smooth, level and flush with the finished floor, and in the same plane.

**Important:** The surface of the floor between the channels must not project above the channels, and the floor in front of the channels should not vary more than  $\frac{1}{8}$  inch in any square yard and must not project above the level of the floor steel.

Each housing is fastened to the floor channels by either bolting or welding as shown in Figs. 32 and 33. If bolting is to be used, the mounting bolts must be placed in the floor steel before the concrete is poured to assure that the tapped holes will not fill with concrete. Welding is a quick and easy method of securing the switchgear in place and eliminates the layout of the mounting holes in the channels.

### PLACING OF STATIONARY STRUCTURE

After the foundation is completed, the complete switchgear assembly or section is set into place. The assembly drawings furnished with the switchgear should be referred to in making the installation. If the structure has been shipped in more than two sections, the center section should be placed in position first and fastened down. The remaining sections are then added progressively toward either

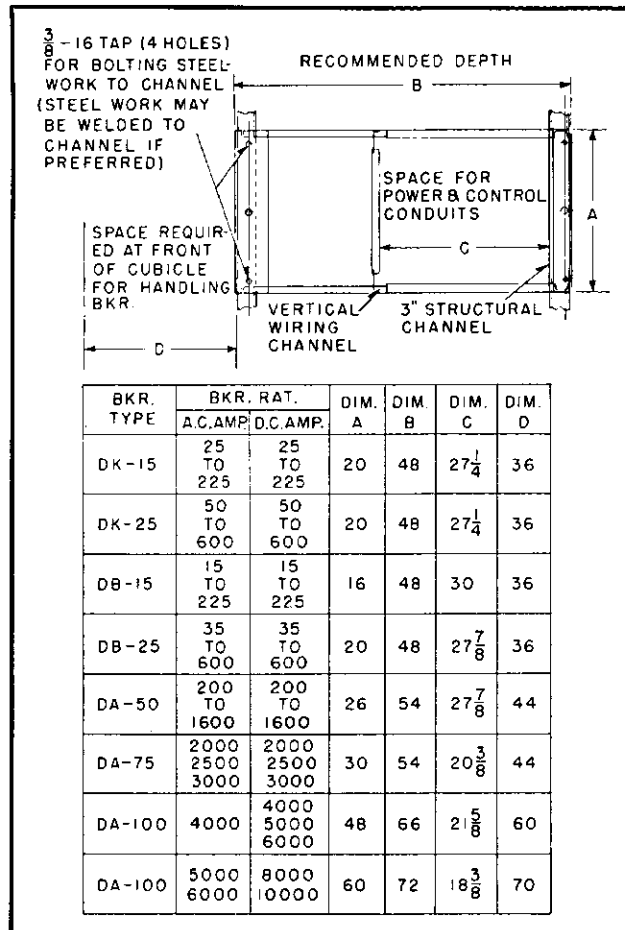


FIG. 32. Dimensions for Locating Stationary Structure

end, bolting them together and fastening them to the floor steel. The lifting irons are removed from the top of each section after it is in place.

### POWER CONNECTIONS

When the switchgear consists of two or more shipping sections, the main copper bus is necessarily disconnected between the shipping sections. These bus connections should be completed first, with particular attention to the pressure between the contact surfaces. It is essential that the connections be securely bolted, since the conductivity of the joint is proportional to the applied pressure rather than to the area.

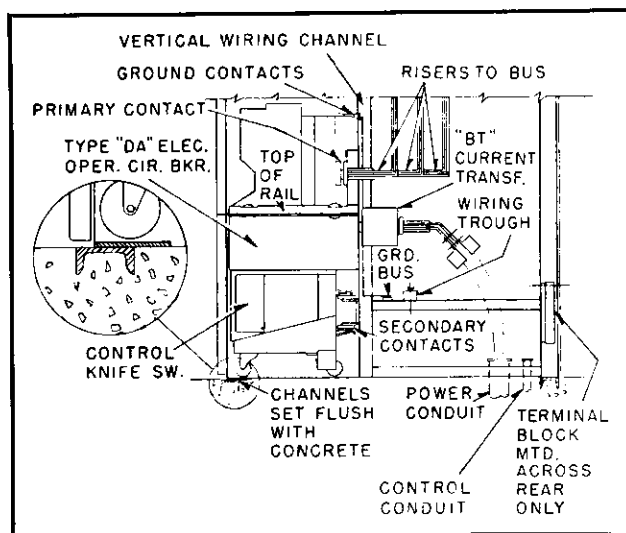


FIG. 33. Suggested Methods for Fastening Housing to Floor Channels

Clamping blocks are provided in the rear compartments to support the incoming cables to the terminals on the circuit breaker studs. Make sure that the connections to the switchgear are properly phased in accordance with the arrangement shown on the connection diagrams furnished with the switchgear.

Care must be exercised in the arrangement of cables when used in parallel. All three phases of an alternating-current circuit must be run in the same steel conduit. When there are two or more leads per phase and all cables cannot be run in a single conduit, one cable of each phase should be run in each conduit. When a number of cables are bunched, the inner ones will be unable to dissipate the required amount of heat, and excessive temperature may result. Lead-covered or weather-proof cable must be used where moisture is present.

In making connections from the end of a conduit to the cable terminals, avoid sharp turns, corners and edges in order to prevent weakening of the cable insulation. The radius of a bend for rubber-covered, varnished cambric or lead-covered cable should never be less than six times the outside diameter of the cable. With a small braided conductor, the radius of a bend may be five times the outside diameter of the cable.

## GROUND CONNECTION

A copper ground bus runs the full length of the switchgear. A copper riser in each unit connects this ground bus to each circuit breaker compartment ground shoe when supplied. A ground clip mounted on the rear of the removable element would then contact the stationary ground shoe when the element is inserted into, or beyond, the "test" position.

A good ground should be connected to the cable terminal provided on the ground bus. The grounding conductor should be capable of carrying the maximum line-to-ground current for the duration of the fault.

**Caution:** A permanent low resistance ground is essential for adequate protection. A poor ground may be worse than none since it gives a false feeling of safety to those working around the equipment.

## CONTROL CONNECTIONS

Any cross-panel control wires which have been disconnected for shipping purposes should first be reconnected. These wires have been properly tagged at the factory to facilitate the correct connections.

The terminal blocks for control circuit interconnections between the housings and the outgoing control cables are mounted across the rear of the switchgear, either at the bottom or the top, depending upon which direction the control cables leave the housing.

Relays designed to use movable armatures or rotating discs have these parts tied or blocked before shipment to protect them against possible damage in transit. Remove all ties and blocking from the relay armatures or discs after the switchgear is installed and before control energy is applied.

The connections between the control wiring in the switchgear and any remote equipment must be of adequate size. The size of conductor required will depend upon the distance and amount of current to be carried. When selecting wire or cable

## INSTALLATION

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sizes for instrument transformer circuits, the losses in the conductor should be calculated and a check made to assure that the combination of instrument load and conductor losses does not exceed the capacity of the transformer.

For electrically-operated breakers, it is important that the voltage drop in the supply circuit be checked to assure proper operation. This is especially true where a low voltage trip source is used. See NEMA air circuit breaker standards for the range of control voltages at the terminals of the operating mechanism.

The outside covering of control circuit connections will depend on local conditions. If they are to be installed in a dry place, braid-covered cable will be satisfactory. If moisture is present, the cable will require either a lead sheath or a weather-proof covering.

Make sure that the polarity of the connections from d-c control sources is correct. The polarity is shown on the connection diagram.

When connecting external cables to the terminal blocks on the switchgear, exercise care to assure that the connections are properly made.

### PRE-OPERATION CHECKS

After the switchgear equipment and apparatus to be controlled have been installed and all interconnections made, the equipment should be tested and given a final check before being placed in service. This is necessary to assure that the equipment has been correctly installed and that all connections are complete and have been properly made.

**Caution:** Extreme care must be exercised to prevent the equipment from being connected to the power system while the preliminary tests are being conducted. If disconnecting switches are not available, line leads should be disconnected to accomplish this.

The testing equipment required will depend entirely on the type of installation. Portable voltmeters, both a-c and d-c, with a wide range of scales, will usually be required. If the equipment

to be put into service is quite extensive and complicated, 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. A convenient method for the latter is to add a solid contact point to the lens end of a flashlight. At some other convenient place on the flashlight add a binding post. The battery and lamp should be connected in series between the contact point and the binding post. One end of a flexible wire, four or five feet in length, can be attached to the binding post and the other end provided with a spring clip for quick attachment to the point to be tested. Touching the contact point at the other end of the circuit whose continuity is being checked should complete the circuit through the lamp. Lighting of the lamp will indicate that the circuit is intact.

Although the inspection and tests given the switching equipment at the factory assure that all the connections on the switchboard are correct and in good order, they should be examined to make sure that they have not been loosened or damaged during shipment or installation. Tighten all bolted connections and joints to assure good contact.

Ring or light out the connections to the equipment apart from the switchboard, such as instrument transformers, circuit breaker operating mechanisms, and auxiliary switches to make sure they are correct. The extent to which this will have to be done depends on the thoroughness of the installation work.

**Important:** There must be definite assurance that all connections are correct before an attempt is made to operate the equipment.

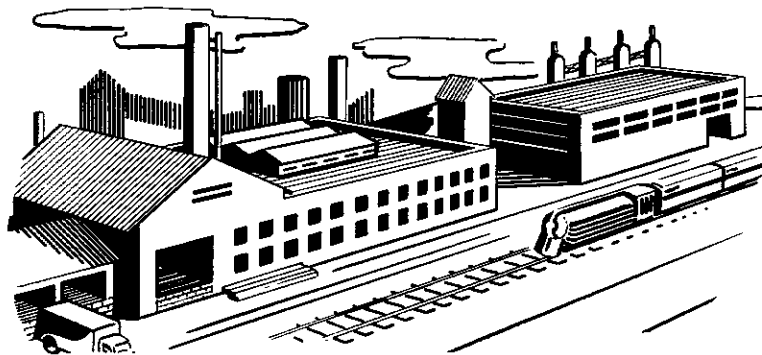
Before applying control energy, check all control circuits, except current and potential transformer secondary circuits, for grounds, and make sure that all circuits are clear.

In order to show up any errors in the installation, try out the different parts by putting current through them at reduced voltage. Continue this procedure progressively until all parts have been

proved. Remedy any incorrect operations during the trial period.

Carefully store the covers for instruments, meters, relays and other devices which have to be removed during the course of installation and test. Since these are made either partly or entirely of glass, they may be broken if not properly protected. If anything, such as the end of the working day, temporarily stops the test work, replace all covers to keep dust and dirt from collecting on the vital parts of the equipment.

Any protective relays included with the equipment have been tested for correct connection and operation at the factory, but the settings of the relays for current, voltage or other quantities must be made by the purchaser in accordance with his standard practices to coordinate with the other portions of his system. Study carefully the applicable relay instruction leaflets, supplied with the switchgear equipment, before attempting to set the relays.



## PART FOUR

# INSPECTION AND MAINTENANCE

In order to obtain satisfactory service from the switchgear, it must have proper inspection and maintenance regularly.

The intervals between the inspections will be determined by the operating and atmospheric conditions. Where dust is rapidly deposited within the switchgear, especially if it is abrasive or has a high conductivity, or where condensation occurs within the switchgear, the inspection and cleaning should be frequent.

The inspection must be done by experienced personnel and should cover all the devices and connections. Inspectors should be thoroughly instructed and experienced in both the function and adjustment of the various devices and should have a uniform method of making the inspection. Good results can very often be obtained by furnishing the inspectors with detailed lists covering points which need to be checked and reported at stated intervals. Prints of all drawings and copies of all instruction books, cards and leaflets should be readily available in case of trouble; the maintenance personnel can refer to them for such detailed information as may be required to correct the situation.

Extreme care must be exercised that no circuits are shorted or grounded and that the inspector experiences no personal harm. Correct any defect which is discovered, immediately.

**Caution:** Do not work around live parts except in extreme emergencies. If work must be performed on live equipment, take every possible precaution to guard against accidents. Tools should be insulated, and rubber gloves and insulating mats should be provided.

Consider all connections live 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 on it. Lock or block open and place a suitable warning on switches which have been opened to de-energize equipment for maintenance purposes. In low-voltage metal-enclosed drawout switchgear, the removable elements can be readily withdrawn to the "test" or the "disconnect" position in which the primary circuits are dead.

**Caution:** Do not touch a circuit breaker under any circumstances when the removable element is in the "Operating" position. Some of the exposed parts may be live even though the breaker is open.

Keep the premises, particularly the switchgear room, clean. Compressed air or a hand bellows may be used to remove dust from the interior of the switchgear and from the removable elements. Use an air hose equipped with an insulating nozzle to prevent contact with live circuits, and filter the air. Remove dirt which cannot be blown from the contact surfaces of the circuit breakers and disconnecting devices with a cloth saturated with carbon tetra-chloride. Do not use abrasive material for cleaning silverplated surfaces since the plating will be removed, leaving the base material unprotected. The exterior of the switchgear may be cleaned by wiping with a chamois skin which has been immersed in luke warm water and wrung partially dry.

Before attempting inspection, maintenance or adjustment of any devices such as circuit breakers, relays, meters or instruments, read carefully the instruction book covering the particular device.