Westinghouse

Types G-1, G-10, G-11, G-111, G-111-S, G-2, G-22, G-22-A, G-22-S, G-222, G-222-A, G-222-AS and G-222-S Oil Circuit Breakers

INSTRUCTION BOOK

Westinghouse Electric & Manufacturing Company

East Pittsburgh Works

East Pittsburgh, Pa.

I. B. 5235-C

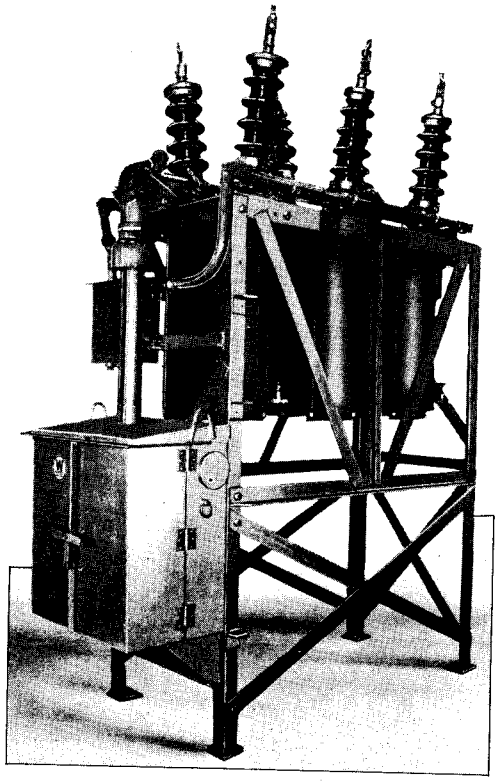


FIG. 1—TYPE G-11 34,500 VOLTS OUTDOOR OIL CIRCUIT-BREAKER

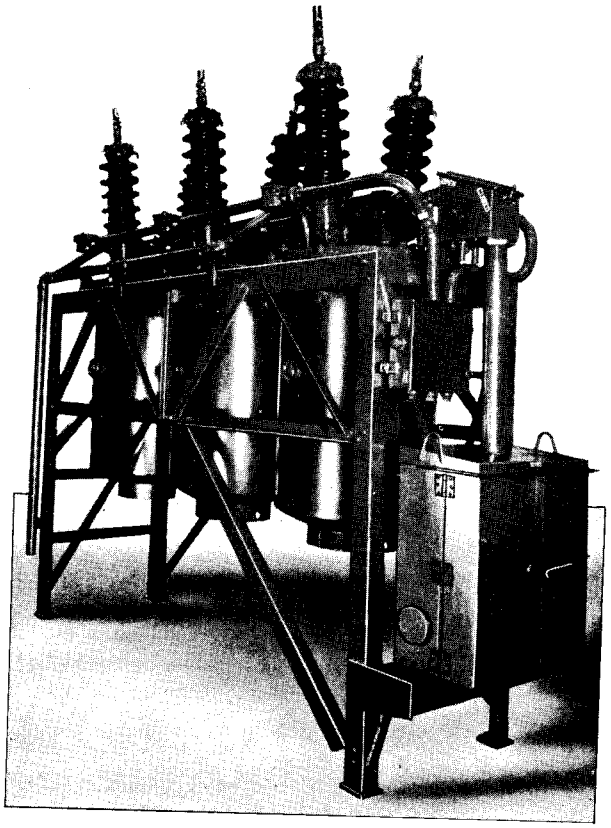


FIG. 2—TYPE G-22-S 50,000 VOLTS OUTDOOR OIL CIRCUIT-BREAKER

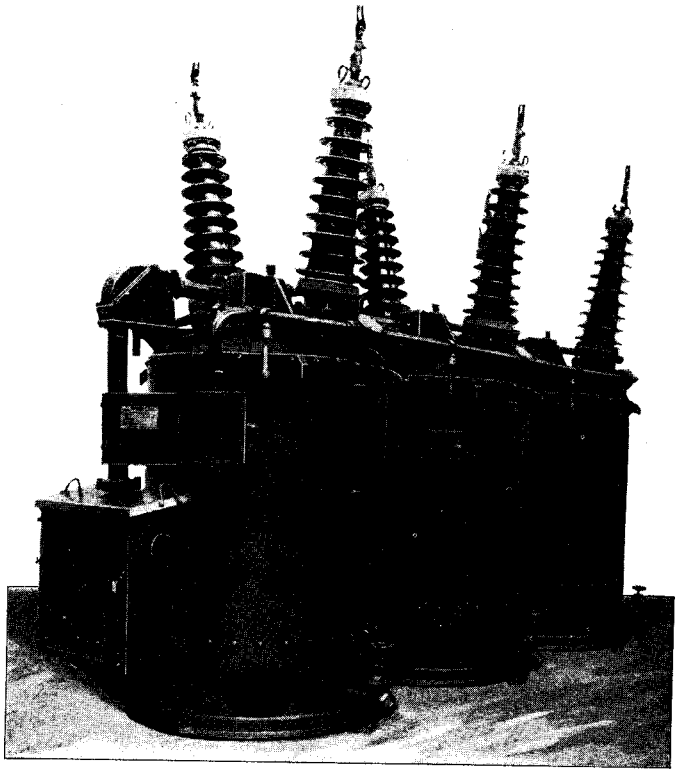


FIG. 3—TYPE G-11-S—110,000 VOLTS OUTDOR OIL CIRCUIT-BREAKER

Westinghouse

Types G-1, G-10, G-11, G-111, G-111-S, G-2, G-22, G-22-A, G-22-S, G-222, G-222-A, G-222-AS, G-222-S

Oil Circuit-Breakers

PART I
Installation

Application

The importance of the oil circuit breaker in a power system requires that it must always be ready to act properly in an emergency; and it is necessary that the breaker be correctly installed and kept in good operating condition at all times. Circuit-breakers should not be installed in places where they will be called upon to operate at voltages or currents greater than those specified at the time the breaker is purchased. Careful consideration should be given to the amount of short circuit current which the breaker may be called upon to open. A thorough knowledge of the construction of the breaker and a complete understanding of the instructions given herein are essential to the satisfactory performance of this apparatus. Attention is called to the Standards of the American Institute of Electrical Engineers, Section #19, published July, 1925, and to the N. E. M. A. Handbook for Power Switchboards and Switching Equipment, published October, 1927, by the National Electrical Manufacturers' Association. A number of the instructions for the general installation and care of circuit-breakers have been copied without change from the N.E.M.A. Handbook.

Shipment

Each oil circuit-breaker, before leaving the factory, is carefully inspected and packed by workmen experienced in the proper handling and packing of electrical equipment.

The frame mounted breakers are shipped assembled on temporary skids to facilitate handling. The electric mechanism, when not attached to the frame, is shipped as a separate unit. On the large frame mounted breakers, starting with the 46,000-volt breaker, the overall height is so great that it is necessary to remove the bushings for transportation. When this is done the contact details will be found packed in a separate crate. The large floor mounting breakers are shipped with each pole as a separate unit, the bushings and electric mechanism being removed and shipped separately.

Immediately upon receipt of a circuit-breaker an examination should be made for any damage sustained while enroute. If injury is evident, or indication of rough handling is visible, a claim for damage should be filed at once with the carrier (Transportation Company), and the nearest Westinghouse Sales Office notified promptly.

Storage

When an oil circuit-breaker can be set-up immediately in its permanent location, it is advisable to do so, even though it will not be placed in service for some time. The breaker should not be removed from the skids or the boxing taken from the insulators until after the breaker has reached its permanent location.

If the breaker cannot be installed in the final location immediately, and it is necessary to store the equipment, it should be kept in a clean, dry place. It must not be exposed to dirt, to the action of corrosive gases, such as chlorine, or to possible mechanical injury.

Special care should be given to the storage of breakers intended for indoor service. Machined parts of operating mechanism, etc., should be flushed to prevent rusting; and if the breaker is stored for any length of time, it should be inspected periodically to see that rusting has not started.

Particular care should be taken to protect insulating parts, which might absorb moisture. It is desirable that these parts be stored in a dry room.

It is very important that the bushings be kept dry. The lower portion, designed to operate under oil, is not weatherproof and must be kept dry. The black gummed tape covering is put on at the factory to protect the steps from moisture during shipment and must be removed before the bushing is installed but should not be removed until just before the bushing is put into the breaker.

Handling

Cranes are very convenient for handling heavy oil circuit-breakers. When using cable slings for supporting the apparatus, do not allow the slings to strike the bushing as any strain on these may cause them to crack or break. Do not lash the breaker down to a truck or car by the condenser terminals when transporting it. Use the top of the steel mounting frame for this purpose. The skids on which the breaker is mounted should be left with the circuit-breaker and will be found convenient for use in moving the breaker to its foundation. Special care must be exercised to see that the apparatus is not injured through shock or jars, due to rough handling.

The condenser terminal bushings must be handled with great care to avoid breakage or the entrance of moisture in the insulation before and during installation. The lifting of the bushing should be done entirely by the lugs on the cap at the top. Care must be taken not to strike the lower portion of the bushing as any bruises on the surface are liable to lead to a breakdown in service.

The center of gravity of some of these breakers is high, so, when handling, care should be taken to prevent their tipping over.

Unpacking

Upon receipt of a circuit-breaker, a careful check should be made against the shipping list of all the crates, making sure that all parts have been received and are available for installation at one time. Care should be used in unpacking the apparatus to avoid breaking of porcelain arc shields, weather casing and other details of a like nature. When unpacked, all excelsior, dust and other foreign substance should be completely removed. A careful inspection should be made so see that none of the parts are damaged. The insulation should be examined to see that it is all dry and in good condition.

See that this Instruction Book and tags are kept with the circuit breaker.

Location

When the breaker has been unpacked, the various parts should be placed in proper position for mounting on the permanent foundation. To avoid delay in assembly, the parts should be arranged so that they will be accessible and ready for use.

The circuit-breaker should be placed so as to be free from the destructive action of acid, alkali or gasses, and where good ventilation can be secured.

The breaker should be located so that it will be readily accessible for cleaning and inspection. Sufficient space must be provided for the easy removal of the oil tanks and operation of the hand closing levers. The breaker should be supported sufficiently high so that floor conditions will not cause water to enter the operating mechanism.

The foundation should be level so that all feet of the breaker frame rest solid.

Assembly

Breakers rated at 88,000 volts and be'ow are usually frame mounted. Breake s rated at 110,000 volts and above are floor mounted.

In case of the frame-mounted breaker, the frame should be removed from the skids and bolted into place with the electrical mechanism in position at the end of the frame. Frame mounted breakers must be set level. Shims or grout, may be used for leveling.

The foundation bolts should be left loose to permit the frame to be properly plumbed and leveled by inserting shims under the feet where necessary. After this has been done, the foundation bolts should be tightened and the frame securely fastened to its foundation.

With the breaker in place on its foundation, all wood blocking must be removed. In addition to the protection over the porcelain, blocks will be found holding the electric mechanism levers in the closed position; and, within the tanks will be found blocks holding the moving contacts rigidly in place.

Tanks should not be lowered in wet weather without making provision for keeping rain out of the tank and off of the internal parts of the breaker.

Some of the larger frame mounted breakers, because of their height, are shipped with the condenser bushings removed.

It is well to remember that details which have been removed from the breaker after test, are identified by number markings which corresponds to the serial number of the breaker and the terminal location. The left hand terminal of the pole unit, next to the mechanism, when facing the mechanism end of the breaker is 1, and the right hand terminal is 2. The left hand terinal of the second pole unit is 3 and the right hand terminal is 4. Likewise, the third pole unit has terminals 5 and 6. This same marking applies to the breakers which have rotating type quick

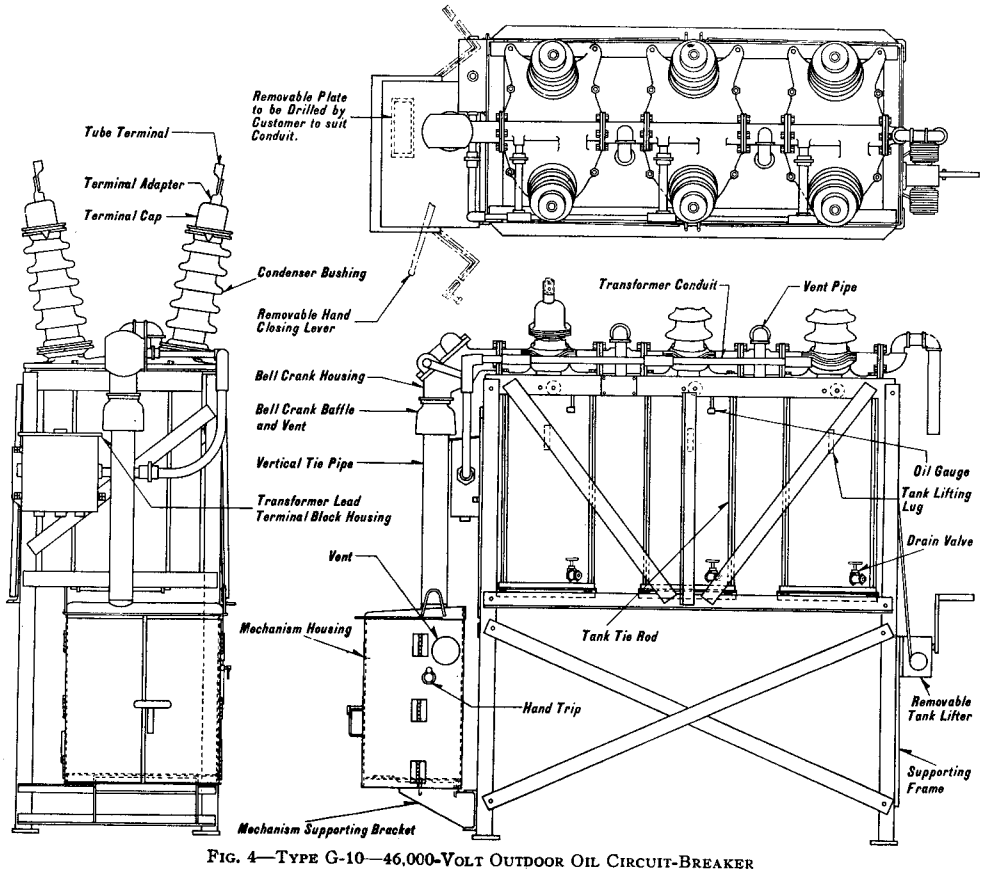


FIG. 4—TYPE G-10—46,000-VOLT OUTDOOR OIL CIRCUIT-BREAKER

break contacts, requiring one left hand rotation and one right hand rotation in each pole unit.

To remove the black gum tape covering, which is put on at the factory to protect the steps from moisture during shipment, start at the upper end of the winding (just below the clamping flange, taking hold of the projecting end of the tape and pull it off, down to the lower end. Then unwind the tape from the bottom end of the bushing, upward. Be sure that the steps are thoroughly clean before proceeding DO NOT CUT THE TAPE WITH A KNIFE! When working with the bushing in a horizontal position, be sure to support it on a clean, well padded surface. When putting bushings in the breaker, see that they do not strike the sides of he hole as they are being let down into place.

Care should be taken to be sure that the gasket is inserted between the condenser bushing and the top of the flange in the circuit-breaker top.

The flanges should be carefully tightened (uniformly) around the bushings with the gaskets in place, so as to prevent moisture from entering the breaker tank. Inasmuch as the breakers have been previously set up and adjusted carefully at the factory, very little change, or further adjustment should be necessary when making the installation.

The stationary contacts should be screwed onto the lower end of the condenser bushing and in line with the moving contacts, as explained more fully on pages 10 to 19.

After having the bushings and contacts properly installed, the next step is to connect the mechanism to the operating rods of the breaker unit. This connection is to be made with the breaker and mechanism in the closed position. After the operating rods have been put into place, the breaker should be slowly opened, by hand, to make sure that there is no undue friction or binding of the various parts, and then the final adjustment of the operating rods should be made. When checking the operation of the breaker by hand, care should be taken to see that the stops in the pole unit are from $\frac{3}{32}$ to $\frac{1}{8}$ of an inch of being tight. At the same time, the roller of the electric mechanism should engage with the trigger with a slight amount of over-travel. It will usually be found that the above set-up can be made without disturbing any of the adjustments which have been set at the factory. Refer to pages 8 to 15 for additional instructions on the toggle adjustments.

The electric closing mechanism especially should be gone over carefully to remove all particles of dirt from the cores, dash-pots, auxiliary switches, control relay, etc., and to see that they are in proper operating condition.

Further instructions on the subject of electric mechanism and control relays will be treated under a separate heading on pages 24 to 33.

Before placing oil in the breaker, and while the tanks are lowered, the mechanical operation of the breaker should be checked by hand. To do this, insert the hand closing lever while the breaker is in the closed position and take the weight of the breaker contact load off of the latch by pressing down on the lever so that the holding latch or trigger (See Figs. 37 to 44) can easily be released by hand. The breaker can then be opened slowly by raising the hand closing lever. All contacts should part at approximately the same time (See pages 16 to 19 and the breaker should come completely open against the bumpers (See pages 8 to 15).

Next, close the breaker slowly noting that the contacts all touch at approximately the same time, and that the mechanism latches properly (See pages 24 to 31), with the correct amount of over-travel. The stops in the pole units should not come up solid (See pages 8 to 15. The toggle settings should be left as received from the factory, unless it is obvious that they have been disturbed during shipment. It will be found somewhat difficult to set up the last pole unit of the breakers which have the accelerating spring. This work may be made easier by unbolting the cap at the rear end of the spring housing. This relieves a large portion of the pressure from the accelerating

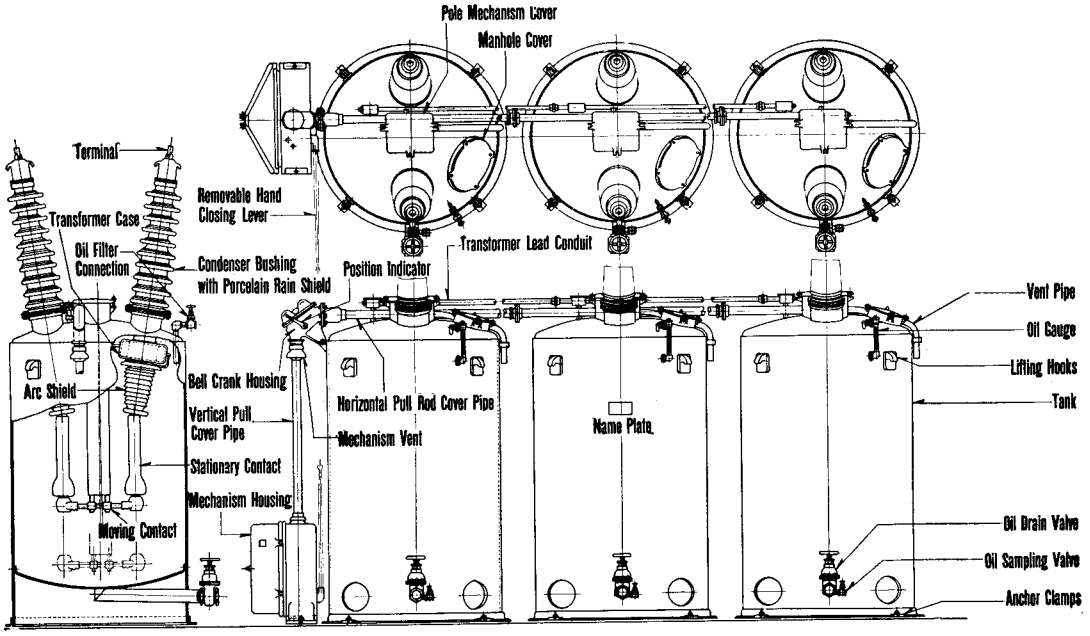


FIG. 5—TYPE G-22—132,000 VOLT OUTDOOR OIL CIRCUIT-BREAKER

spring. After this pole unit has been connected to the others, it can be closed in the usual manner and the cap can be easily replaced.

The movement of the breaker on opening and closing, should be free and without friction. The bolts on the bushing, flanges, tanks and fittings must be kept **tight.** It is essential that caution be taken to prevent entrance of moisture into any part of the breaker.

After the operation has been checked, the next step is to fill the tanks with oil and raise them into position. Before filling the tanks with oil, however, instructions for handling the oil and placing it in the breakers should be most carefully observed, (See Page 20 to 23). The tanks should be put in so that the drain valves extend toward the front of the breaker. The bolts are then put in and tightened up. Care should be taken to tighten all the bolts equally so the gasket will be compressed uniformly all the way around. It is advisable to re-check the bolts after a period of several weeks, particularly during the summer months if the installation has been made in cold weather. Tighten uniformly until the gaskets have attained a permanent set. A large size wrench and plenty of force should be used to tighten these bolts.

The setting of the muffler when supplied should be examined and, if it has not loosened during shipment, should be left alone. Otherwise, the setting should be made as explained on page 20.

When setting up the floor mounting breakers on their permanent foundation, care must be taken to have them line up, level, and on the same center line. The pull rods between pole units must be in one straight line and the mechanism must be placed in the proper position so that the pull rod from the mechanism to the breaker unit will be in a vertical position. The pole units should be spaced the proper distance apart and for this purpose a drilling plan or layout drawing is provided. All parts should be firmly bolted to the foundation to avoid movement when the breaker is operated electrically. The mechanism and adjacent pole which supports the bell crank, should be put into position first. Before moving the second pole unit into place, the horizontal pull rod connecting between these poles should be pushed into the pull rod housing, because it cannot be put in after the units are in position. When in p'ace, the flanges on the pull rod housing can be bolted together. The adjustment of the pull rod will follow the toggle and contact adjustments. Successive pole units will be set up in the same manner.

The bushings are installed in these breakers in the same manner as described for the large frame-mounted breakers and explained in more detail on page 10.

The arc shields should be installed before putting the stationary contacts in place.

The arc shields must be thoroughly clean and dry, inside and out, before installing. Special precautions should be taken. In damp weather it may be necessary to use artificial heat to warm up the porcelain, thus preventing condensation on the surface. Cleaning of the unglazed surfaces is best done by scrubbing with gasoline. Some form of rope sling should be provided for handling the shields until they are in place.

Referring to Fig. 6 which shows an assembly, an extra long flange is cemented around the bushing at the middle over the ground banding. At the lower end of the flange is an internal thread into which an adjustable hood is screwed. The under side of the hood is machined to receive two gaskets, one of vellumoid and one of cork. The cork gasket is placed next to the porcelain and the vellumoid, when used, next to the machined surface of the hood. This facilitates turning the hood for final adjustment previous to filling.

The static-shield cap below the porcelain also has a finished surface to fit a single cork gasket as shown. Both ends of the porcelain are ground flat and parallel. In all cases, have the cork gasket next to the porcelain. Cork gaskets should be inserted clean and dry and there is no necessity of covering them with shellac. When installing the stationary contacts and condenser bushings, the clearance to the side of the tanks should be checked to see that it is the same for both bushings. Be sure that the contacts line up properly with the moving element. The high speed arcing contacts must latch into place with slight overtravel. By putting proper compression on the main contacts, this condition will be obtained if the adjustments, as made at the factory, have not been disturbed. More complete instructions on the adjustment of contacts will be found on pages 10 to 17. After the breaker contacts have received final adjustment, lock the static shield in place with the nut or, when no nut is furnished, by turning it tight against the contact hood below.

Next, seal the space within the shield by turning the adjustable hood in such a direction that the cork gaskets are compressed sufficiently to prevent leak-

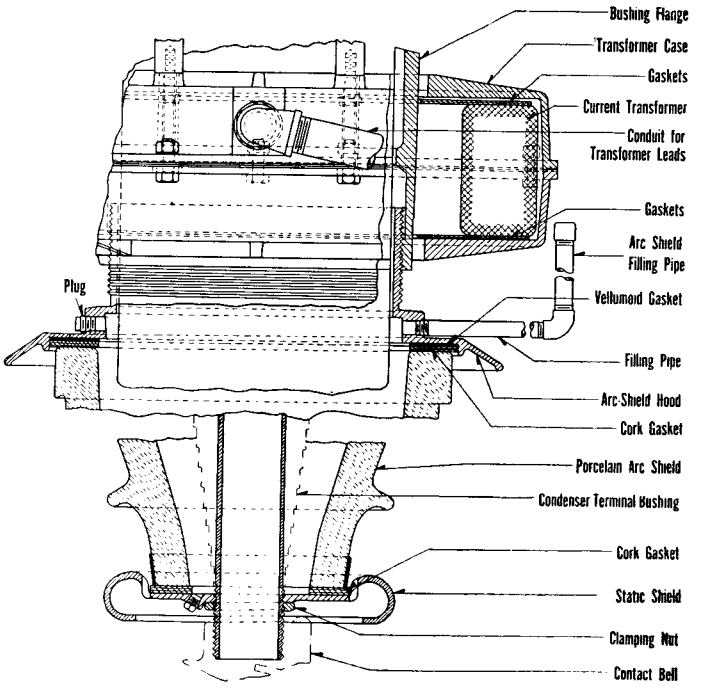


FIG. 6—187,000-VOLT, ARC SHIELD ASSEMBLY

age of oil. The hood may be turned by fitting a pipe threaded bar into the hole provided for the filling pipe or plug. When tight, fit the hole most convenient with the filling pipe.

Do not permit the oil filling pipe to touch the transformer case, as this would place a short circuited turn about the transformer and affect its ratio. Fill with oil, known to be clean and dry, until the level of the hole on the opposite side is reached. Plug this hole and fill to top of filling pipe and cap. A few drops of oil may pass the threads of the bottom of the bushing, but this is not serious as the important point is to retain clean oil in the shield and prevent the entrance of water or other foreign matter into the shield.

On the large floor mounting breakers, after the adjustments have been checked by slowly moving the breaker by hand, the tanks should be filled with oil and the electric operation checked out as explained on Page 24 to 31.

Connections

Before making any connections, every precaution must be taken to see that all leads to be connected to the oil circuit breaker are dead.

Leads should be flexible and brought down from above the circuit breaker if possible. Ample room must be provided between these leads and parts of the station or overhead steel structure.

All terminals must be fastened securely to the leads and tightly clamped to the connection studs. Connections to the breaker are usually made by copper tube terminals fastened to the ends of the bushings. When tightening the terminal or clamp bolts, care must be taken not to turn the studs in the insulator, or place unnecessary strain on the top of the condenser bushing.

All joints must be clean, bright and free from dents or burrs.

All nuts on the current carrying parts must be securely tightened to obtain good contact. If the joints are not made correctly, dangerous heating of the breaker may result at these points.

Cables should be properly supported so that the breaker is not subjected to unnecessary strain. Any strain which at first has no apparent effect may eventually loosen the insulator cap and permit moisture to enter the bushings.

To avoid heating, the connection leads must be of a current carrying capacity at least equal to that of the current carrying part of the breaker.

Control Wiring

All control wires should be run in conduit insofar as is practicable. A diagram is supplied with each breaker which shows the proper connections for operating circuits and indicating lamps (See page 32 for typical diagrams).

The control wiring should be so installed that trouble on one oil circuit breaker cannot be communicated to the control wiring on another breaker.

The transformer connections are illustrated by Fig. 30 on page 21.

The cover on the lower end of the transformer case must not touch the grounding band on the bushing.

Grounded Connections

The frame of each breaker should be permanently grounded. The usual practice is to connect a heavy cable to the frame and to the ground. A good permanent low resistance ground is essential for adequate protection. A poor ground may be worse than no ground at all, since it gives a false feeling of safety to those working around the equipment.

Final Installation Inspection

After the breaker has been installed with all mechanical and electrical connections completed, except energizing the power line, the following inspection and test should be made:

1. The electrical operation may be checked a few times without oil in the tanks. Excessive operation without oil may damage the breaker and should be avoided.
2. All installation and parts within the breaker tank, including the inside of the tank, should be wiped carefully to remove any dirt and moisture which may have collected. The tank linings should be examined for possible mechanical damage.
3. See that the breaker is properly set up and leveled on its foundation.
4. See that all bearing surfaces of the operating mechanism have been lubricated.
5. Close the breaker slowly by hand, noting that the operating rod and contacts are properly adjusted for correct alignment and that good contact is made when the breaker is closed. (See pages 10 to 19).
6. Inspect all insulated wiring to see that no damage has resulted during the process of installing it.
7. Test the wiring for possible grounds or short circuits.
8. See that all current carrying parts outside the oil tanks are correctly insulated in accordance with standard practice. See that all joints, in the control circuits, are made correctly.
9. Fill the oil tanks to the proper level with Wemco "C" oil. Special precaution must be used in handling the oil in accordance with Westinghouse Instruction Book 5336 and detailed instructions given on pages 20 to 23.
10. All nuts must be tightened so that moisture cannot enter the circuit-breaker.
11. Do not allow the tank-holding bolts to go without one or two inspections after the breaker is installed. The nature of the packing against which the tanks are drawn up, permits it to adjust itself under pressure only slowly. Draw the nuts as tight as possible when first installing the breaker, then after a period of from three (3) days to one (1) week take up whatever slack may be found. To insure a positive tight joint, a third inspection should be made after about twenty (20) days.

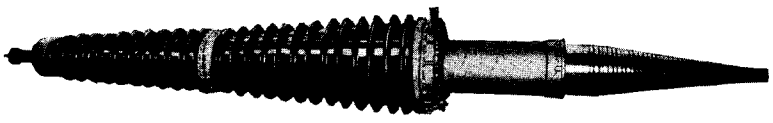


FIG. 7—220-KV. CONDENSER BUSHING WITHOUT ARC SHIELDS

PART II

Adjustment and Operation

General

While there is considerable variation in the construction of the different forms of type G breakers, they have many features in common. The general construction and relation of parts is given in the following paragraphs, together with a more detailed explanation of the necessary adjustments.

In case of trouble with any part of the circuit-breaker, it is necessary to understand thoroughly the construction and adjustment of the individual parts. In general, it is advisable to work only on a part which needs attention and not to disturb the rest of the apparatus. The various parts and adjustments are described in approximately the same order in which they are assembled at the factory.

Toggle Mechanisms

The toggle mechanism located in the upper part of each pole unit operates the lift rod which carries the moving contact. This mechanism is somewhat hidden from view and reference to illustrations, Figs. 8 to 20 inclusive should be helpful.

It will be noted that they are all of the same general construction and differ only in details. The moving contacts are attached through an insulated lift rod to the main lever. This lever is controlled by links in such a way that it gives a straight vertical motion to the lifting rod. The connection to the horizontal pull rod is made through a toggle link which straightens out in the closed position. thus giving a minimum force on the pull rod when the contacts are engaged. The horizontal pull rod operates inside a conduit which connects to the bell-crank housing and thus to the operating mechanism through the bell crank.

In general the main difference between the various toggle mechanisms is that the straight line motion of the lift rod is controlled by a floating link in some instances and by rollers and guides in others. The over-travel of the moving parts on closing the breaker is taken up by stops, which will be found in various positions as indicated in the several illustrations. Some of these have two stops, some only one, depending on the characteristics of the particular breaker.

Before making adjustment of the toggle mechanism, the terminal bush-

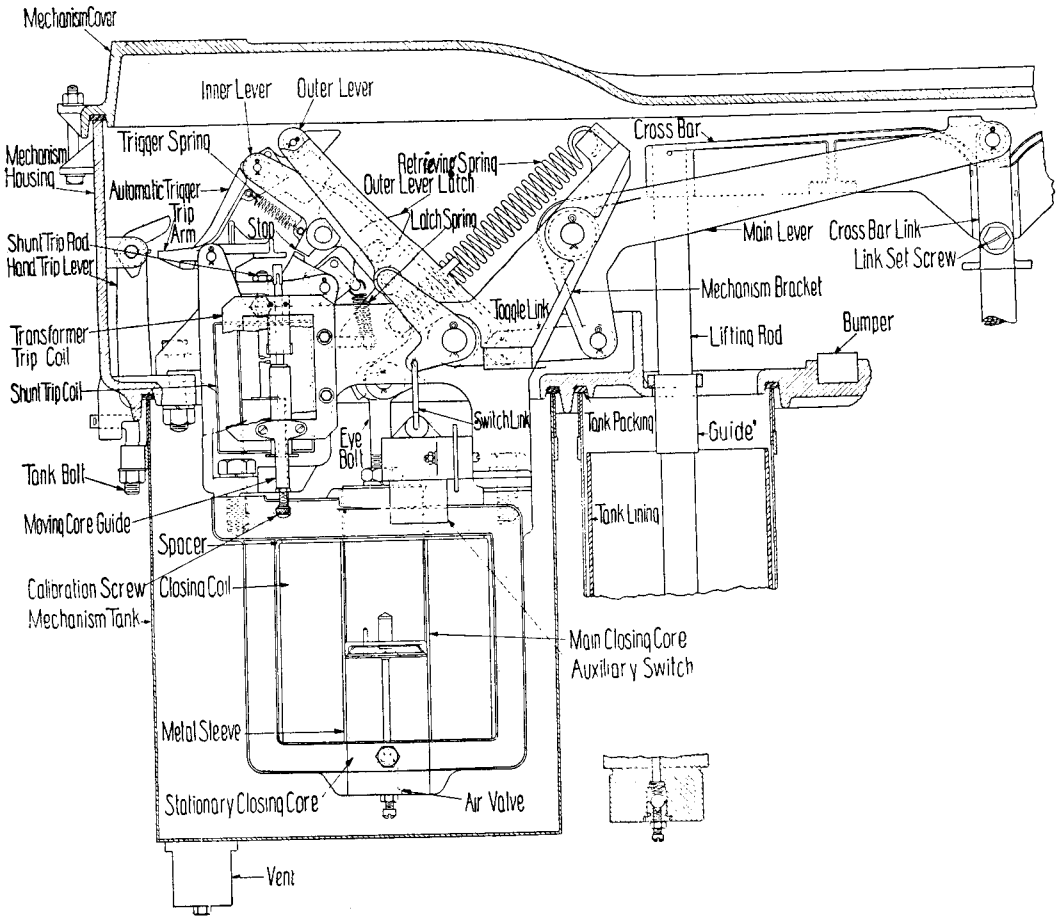


FIG. 8—TYPE G-1—7500, 15,000 AND 25,000 VOLT TOGGLE AND SOLENOID MECHANISM

ings and contacts must be put in the breaker, and the mechanism in position in line with the instructions found on the preceding pages.

The toggle mechanism on the frame-mounted breakers has been tested at the factory and it should only be necessary to see that the lever is about $\frac{3}{32}$ to $\frac{1}{16}$ of an inch from the stop when the contacts are in the closed position. Ordinarily, it is not necessary to adjust the length of the pull rods between the poles, however, if adjustment is necessary, the pin at one end of the pull rod should be removed and the rod end given a turn or two. Be sure to tighten the lock nut on the rod after making this adjustment.

The toggle mechanisms of the floor-mounted breakers must be adjusted one at a time. Starting with the pole nearest the mechanism, this pole unit is connected to the mechanism through the pull rod, and the other poles disconnected. The length of the pull rod from the mechanism to the breaker unit can be adjusted by screwing the rod end up or down on the end of the pull rod. With the breaker mechanism latched, and the breaker unit in the closed position, check the clearance beween the lever and the stop to see that the lever is approximately $\frac{3}{32}$ to $\frac{1}{16}$ inch from the stop. The breaker may then be opened and a check made to see that the moving parts strike against the bumper. With the breaker having been checked in both the open and closed position, it may then be tripped by hand to make sure that the action is correct and that the shock of opening is taken up by the bumper. The pull rod to the second pole unit can then be connected and the operation of this unit made to conform with that of the first pole unit. The adjustment of the horizontal pull rod between these units is made in the same manner as the vertical adjustment from the first unit to the operating mechanism. After the second unit has been checked and adjusted, the operation should be repeated with the third pole. When all of these poles have been adjusted in this way, a re-check should be made on the first and second, as some readjustments of the pull rods may be found necessary due to the added weight of the second and third poles. Each toggle position, stop and bumper, should be re-checked before attempting to operate the breaker with the operating mechanism. The breaker units should not be allowed to drop open freely more times than is absolutely necessary before the oil has been placed in the tanks because, without the cushioning effect of the oil, damage to the moving part is liable to occur. The breaker should now be ready for final check of the adjustment of the operating mechanism and connection to the control circuit.

Although there is a pronounced difference in the appearance of these toggle mechanisms, the adjustment and operations are very similar.

(a) The toggle should never pass over center.

(b) With the toggle too far from center in the closed position, the b eaker would be hard to close.

(c) When the toggle position and toggle stop have once been set correctly, this setting should not be changed.

(d) Adjustment of pull rods and contacts may be made, as explained, to bring these parts into proper relation with the toggle which has already been set.

Bumpers

All breakers are provided with bumpers. These bumpers are provided to

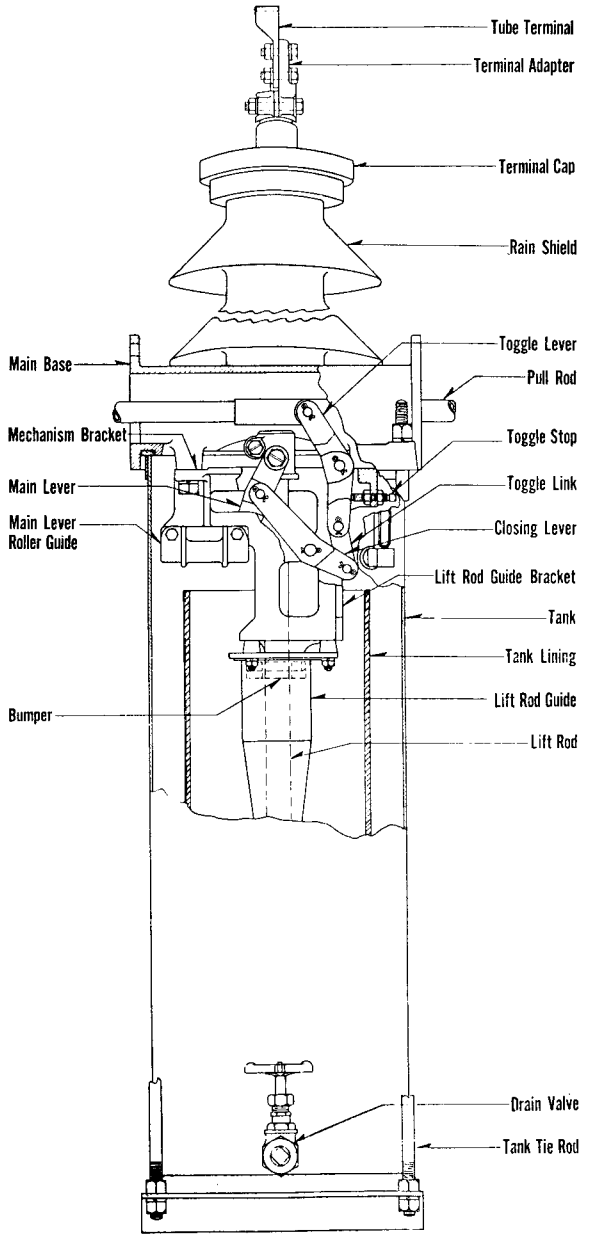


FIG. 9—POLE UNIT FOR G-11 34.5 KV. BREAKER INCLUDING TOGGLE MECHANISM FOR G-1, 37 KV. AND 50 KV., G-10 AND G-11, 15 TO 50 KV. INCLUSIVE

cushion the shock at the end of the opening stroke and to prevent excessive rebound. They may be leather, spring, or hydraulic bumpers. When adjusting the breakers, care should always be taken to adjust the breaker, so that when opening, the pole unit mechanisms come to rest on these bumpers and not on the open position stop in the electric operating mechanism. The preceding illustrations of the pole unit mechanisms clearly indicate the position of the bumpers.

Condenser Terminal Bushings

The condenser terminal bushings are made up of layers of insulating micarta wound around the terminal alternately with layers of tinfoil. The layers of tinfoil are stepped off at both ends to give the proper di-electric gradient. On the lower voltages, the micarta is wound full at the ends forming a protective layer. This type of construction is shown in Fig. 24. The insulation of the higher voltage types is stepped off with the tinfoil. Protection for the steps is provided by means of porcelain arc-shields (See Fig. 6.) The upper end of the bushing is protected, in the case of out-door breakers by a porcelain weather casing. The exposed upper end of the indoor bushings is protected by micarta tubing. A wire ground banding is provided at the middle of the bushing with a steel clamping flange over it, to serve as a support for the terminal bushing. A complete condenser terminal bushing is shown in Fig. 7.

On the later design of breakers having voltage ratings of 88,000 volts and above, the condenser bushings are provided with a tap from the last step of the condenser. This tap provides a voltage drop to ground, which when used in conjunction with the Westinghouse Potential Device, gives a very satisfactory and economical source of potential for certain classes of metering and relaying.

Complete description of this potential device is contained in the Potential Device, Instruction Book I. B. 5441.

Instructions pertaining to the care in handling and installation of condenser bushings has been given under "Installation" on Pages 5 and 6.

Contacts

The contacts of all type G breakers are designed with the view of affording the maximum service with the least amount of maintenance. The current carrying contacts are of either the butt or finger type according to the amount

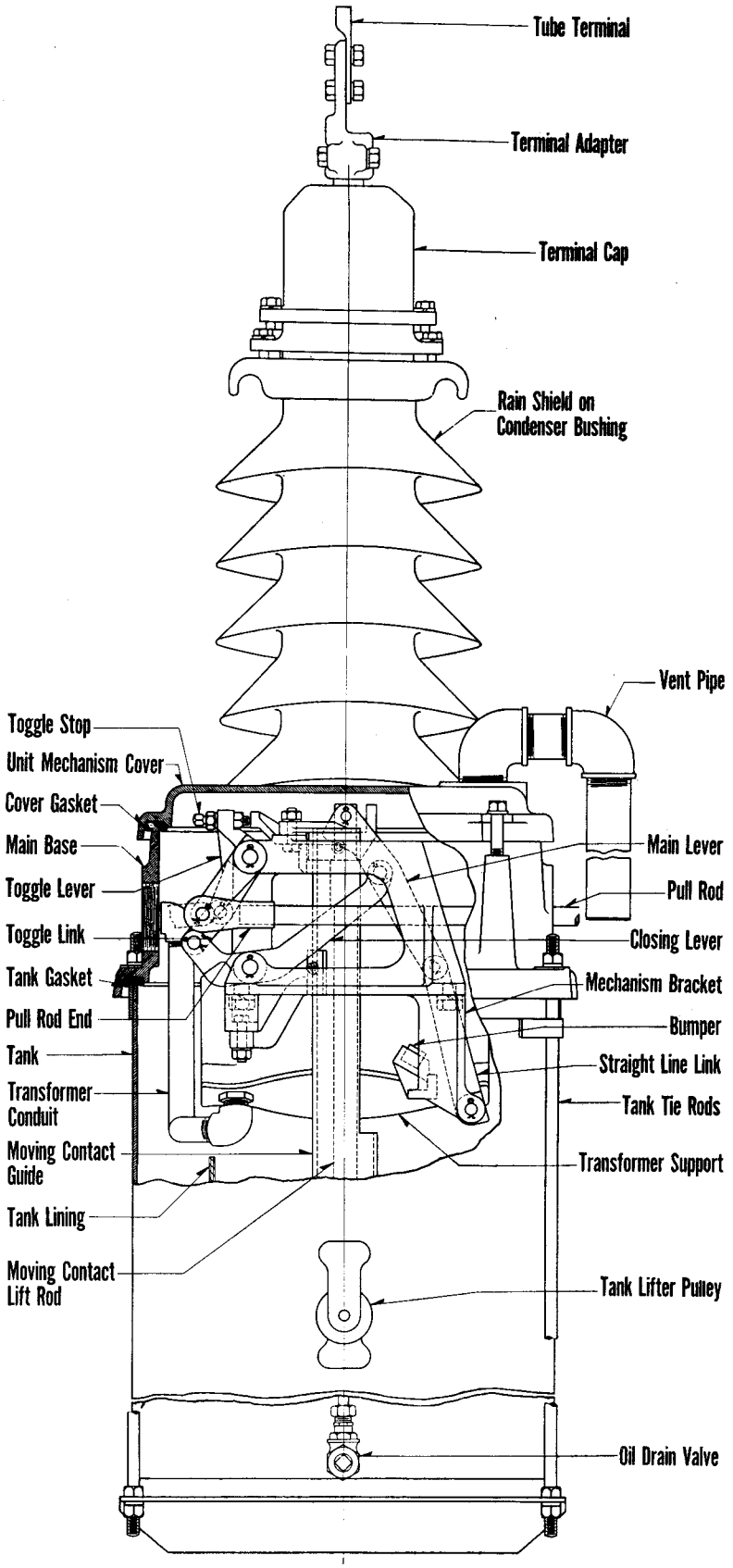


FIG. 10—POLE UNIT FOR G-10, 69 KV. ILLUSTRATING TOGGLE MECHANISM FOR G-1, G-10, G-11 AND G-2, 69 AND 73 KV. BREAKERS.

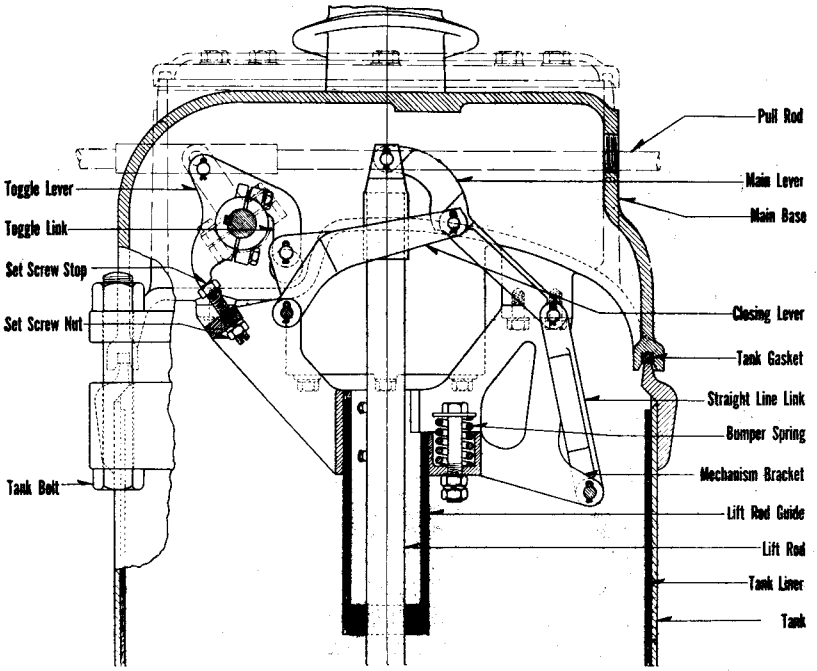


FIG. 11—TYPE G-22, 50 KV. TOGGLE MECHANISM

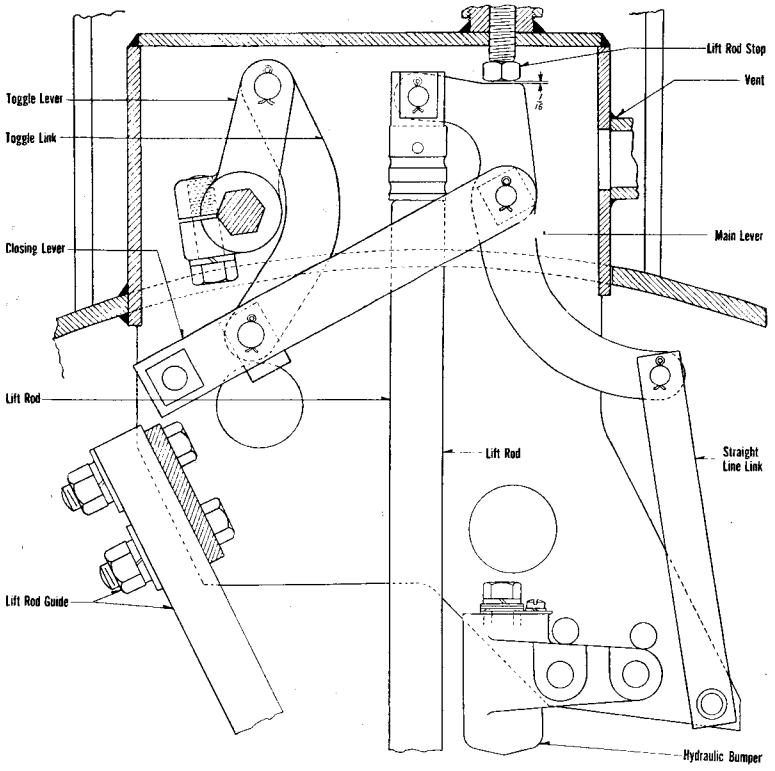


FIG. 12—TYPE G-22-S, 50 KV. TOGGLE MECHANISM

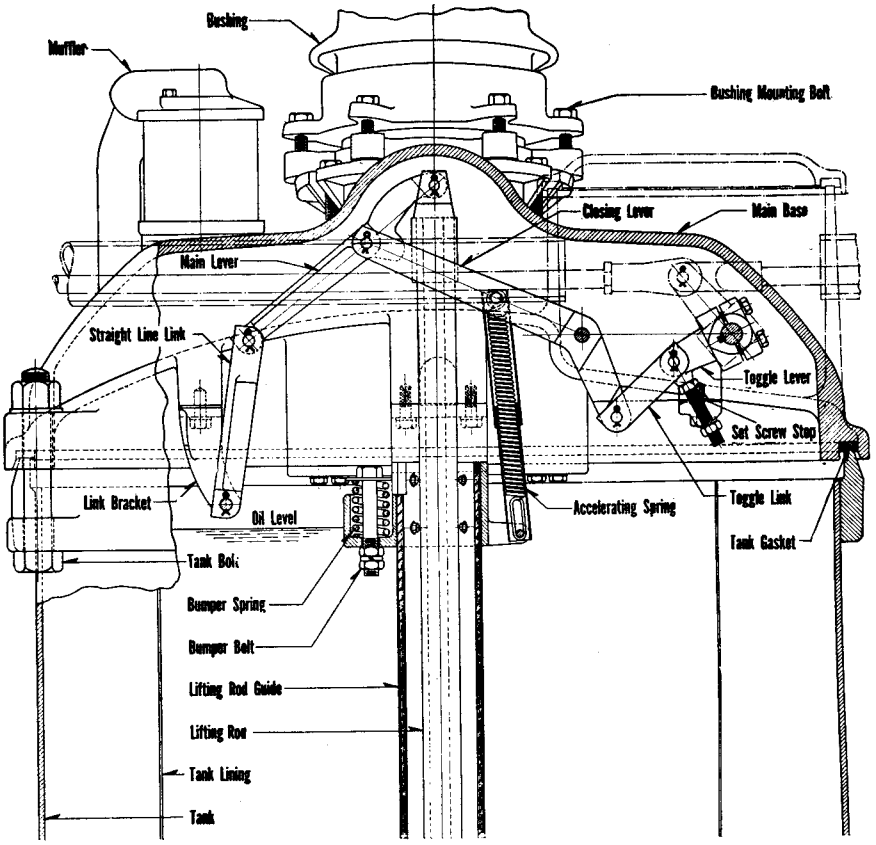


FIG. 13—TYPE G-222-S, 73-KV. TOGGLE MECHANISM

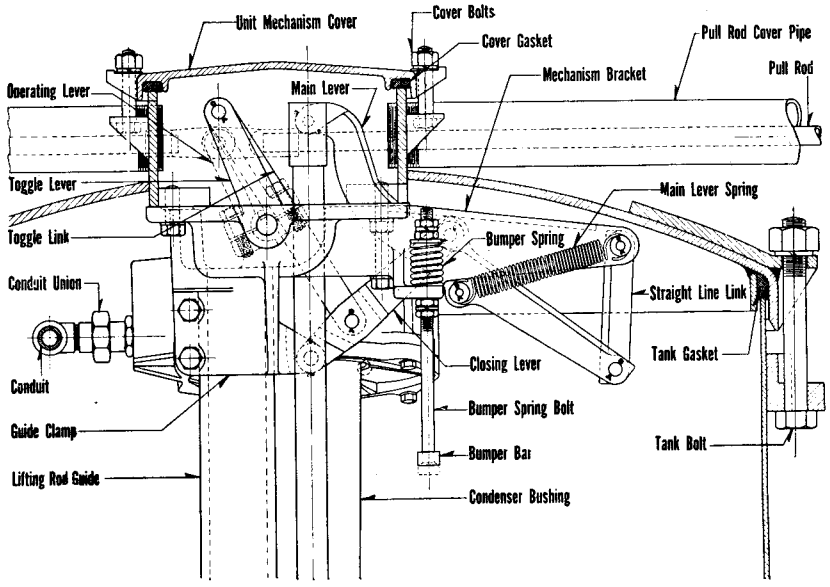


FIG. 14—TYPE G-222-A, 73-KV. TOGGLE MECHANISM

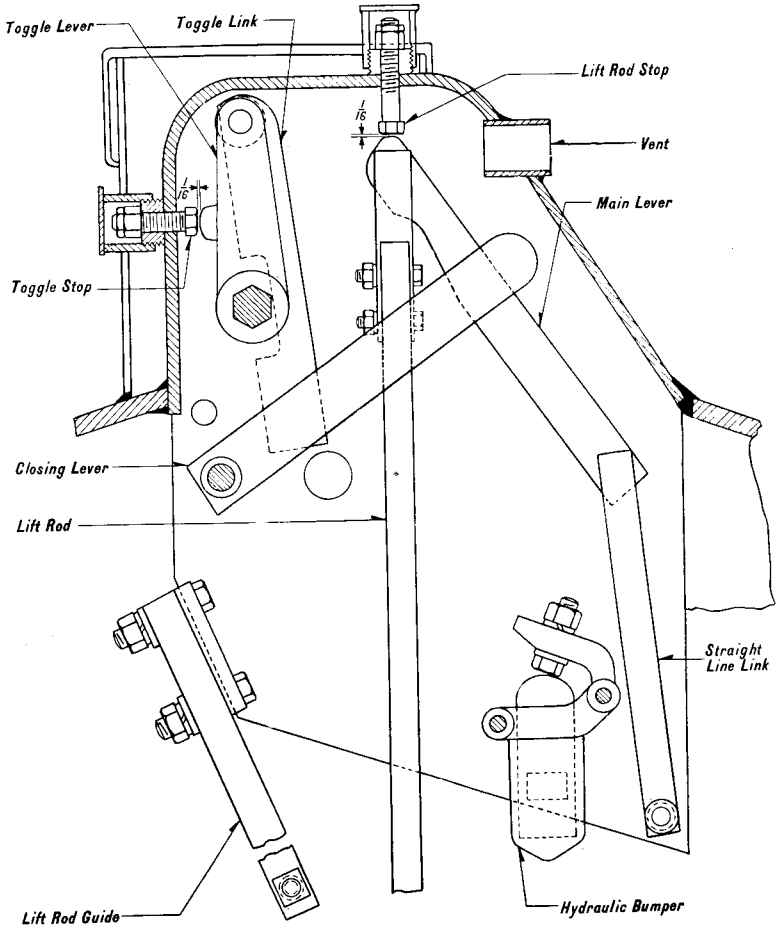


FIG. 15—TYPES G-222-S, AND G-222-AS, 73-KV, TOGGLE MECHANISM

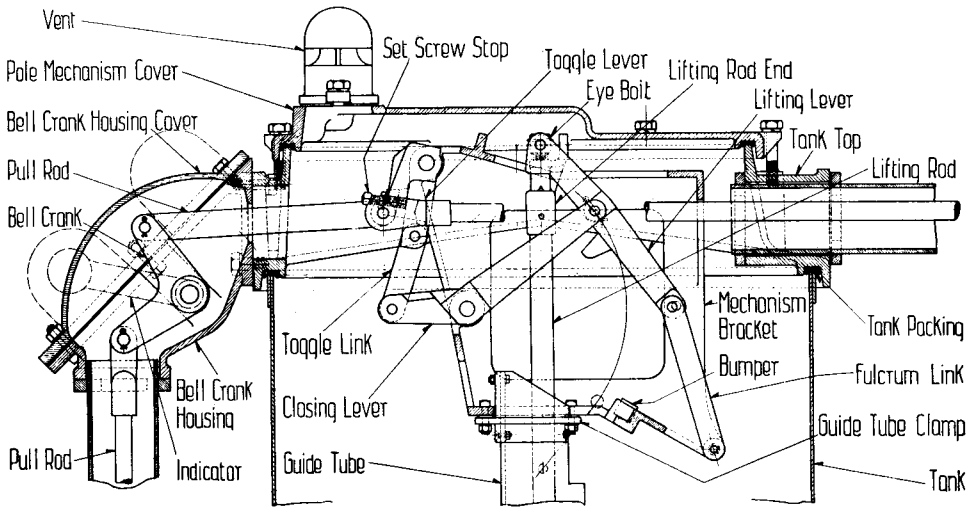


FIG. 16—TYPES G-1 AND G-11, 95 AND 110-KV, TOGGLE MECHANISM

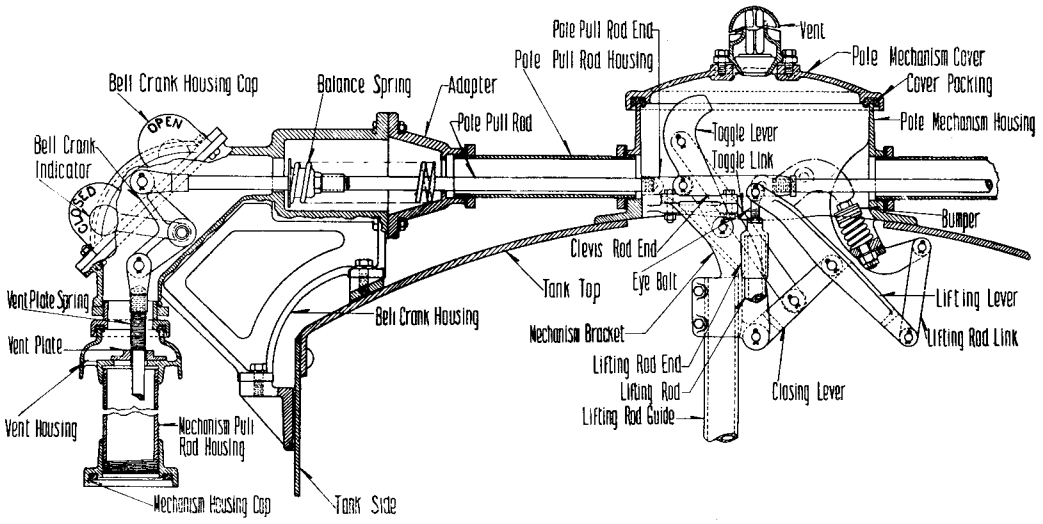


FIG. 17—TYPES G-1, G-11 AND G-2, 132 TO 187-KV. TOGGLE MECHANISM

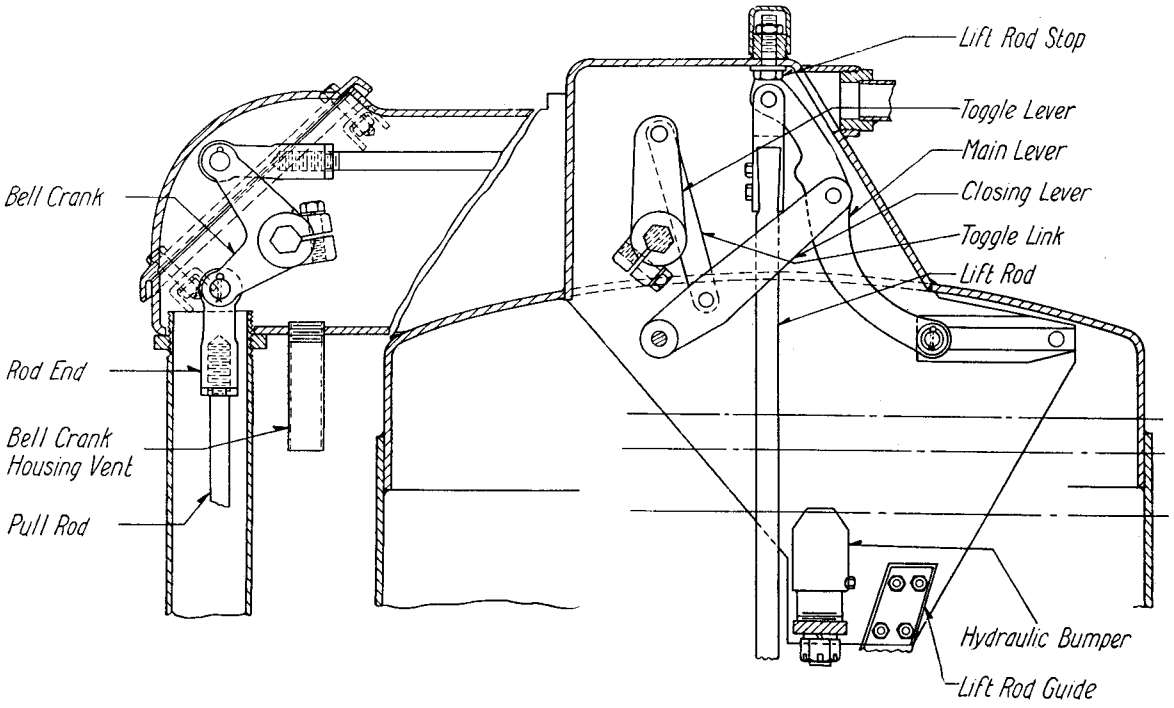


FIG. 18—TYPES G-10, G-111, G-111-S, G-22-S AND G-222-S, 110-KV. TOGGLE MECHANISM

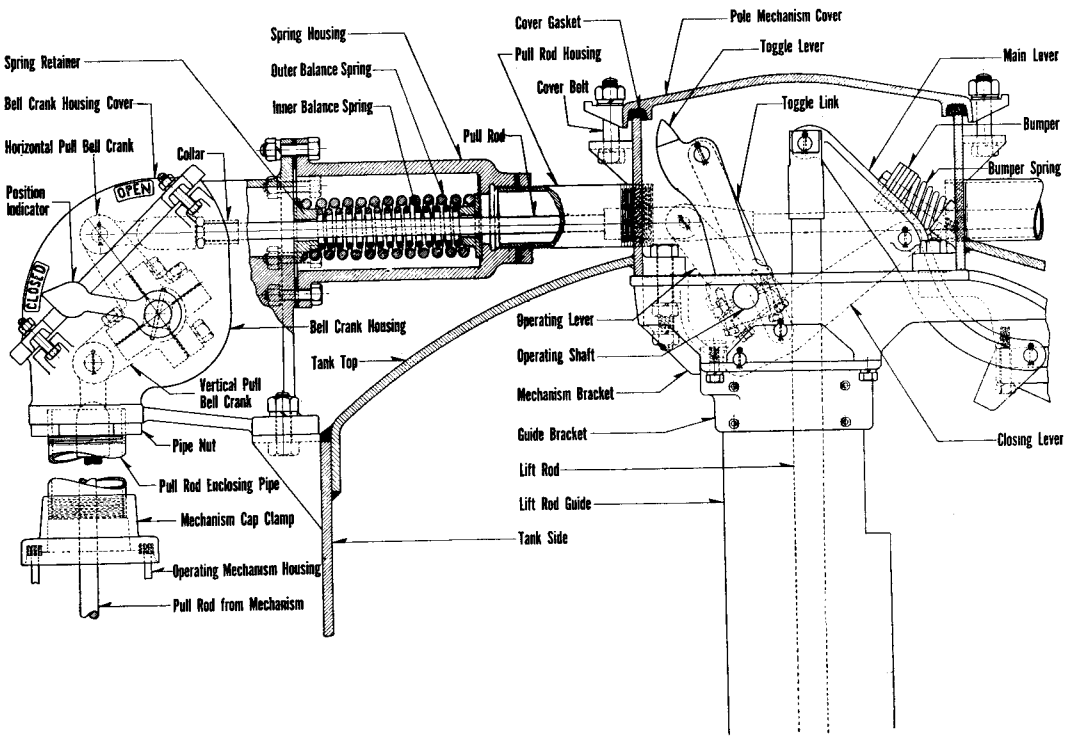


FIG. 19—TYPE G-22, 110 TO 220-KV. TOGGLE MECHANISM

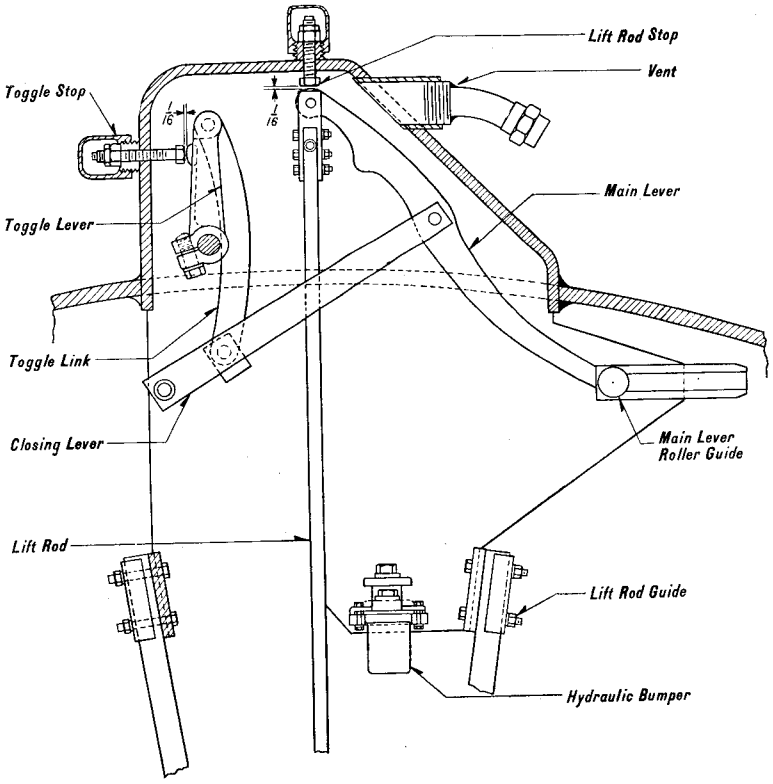


FIG. 20—TYPES G-22-S, G-222-S, G-22-A, AND G-222-A, 110 TO 220-KV. TOGGLE MECHANISM

of current to be handled and, in all cases, are protected by arcing contacts. In cases of the types G-1, G-10, G-11 and G-111-S breakers, of 110,000 volts and below, the arcing contacts are of the plain break type (See Figs. 21 and 23) while on the other breakers, they are of the high speed type. There are two forms of high speed arcing contacts, namely, the Lever type, shown in Figs. 24 to 26 and used on the types G-2, G-22 and G-222, up to and including the 88,000 volt breakers; and the Bayonet type used on the higher voltage breakers of these types. (See Figs. 27, 28, and 29.)

Butt Type of Contact—Fig. 21 and 23 (400 Amp.) shows the ordinary butt type of contact construction using one large main butt contact for carrying the main circuit, and an auxiliary arcing tip butt contact. This contact is readily adjustable, and is used on 400 ampere rating for the 7,500 to 88,000 volt types, G-1, G-10 and G-11, on the 400 ampere, type G-1 and G-11; and on the 600 Amp. G 10, and G-111-S, 110000 volt breakers. Contact pressure is maintained by a heavy spring under each butt, and current is carried into the plunger by a shunt. The plunger usually is mounted on the stationary part of the contact.

In the plain break type, the arcing tip should make contact approximately ½ inch before the main butts, and should break ½ inch after the main butts have parted. Both the main and auxiliary contacts are readily renewable, and the arcing contact should always be renewed before it has burned so far that there is danger of destructive arcing on the main contacts. The moving contacts should be adjusted on the lifting rods so that all arcing tips meet practically together. The main contacts should be compressed approximately ½ inch when the breaker is in the closed position. Care should be taken to see that the plungers are not down solid on the contact casting. All contact tips and lock nuts throughout the contact construction should be tightened securely before placing the breaker in operation.

Wedge Type Finger Contacts—Figs. 21 and 23 (600-Amp.) show the wedge type of finger contact used on all types G-1, G-10, and G-11 breakers of 600 amperes and over, up to and including 110,000 volt except the G-10, and G-111-S, 110,000 volt breakers. These finger contacts are extremely flexible in all planes. The moving contacts use a wedge of cast copper accurately machined and provided with a butt type arcing tip which is renewable.

Each of the stationary fingers is machined on the contact surface and provided with a laminated copper shunt backed up by a steel spring. Pressure is exerted on each finger by a pressure spring. Before putting a breaker in operation, these fingers and the face of the moving contacts should be rubbed up with fine emery paper, to remove

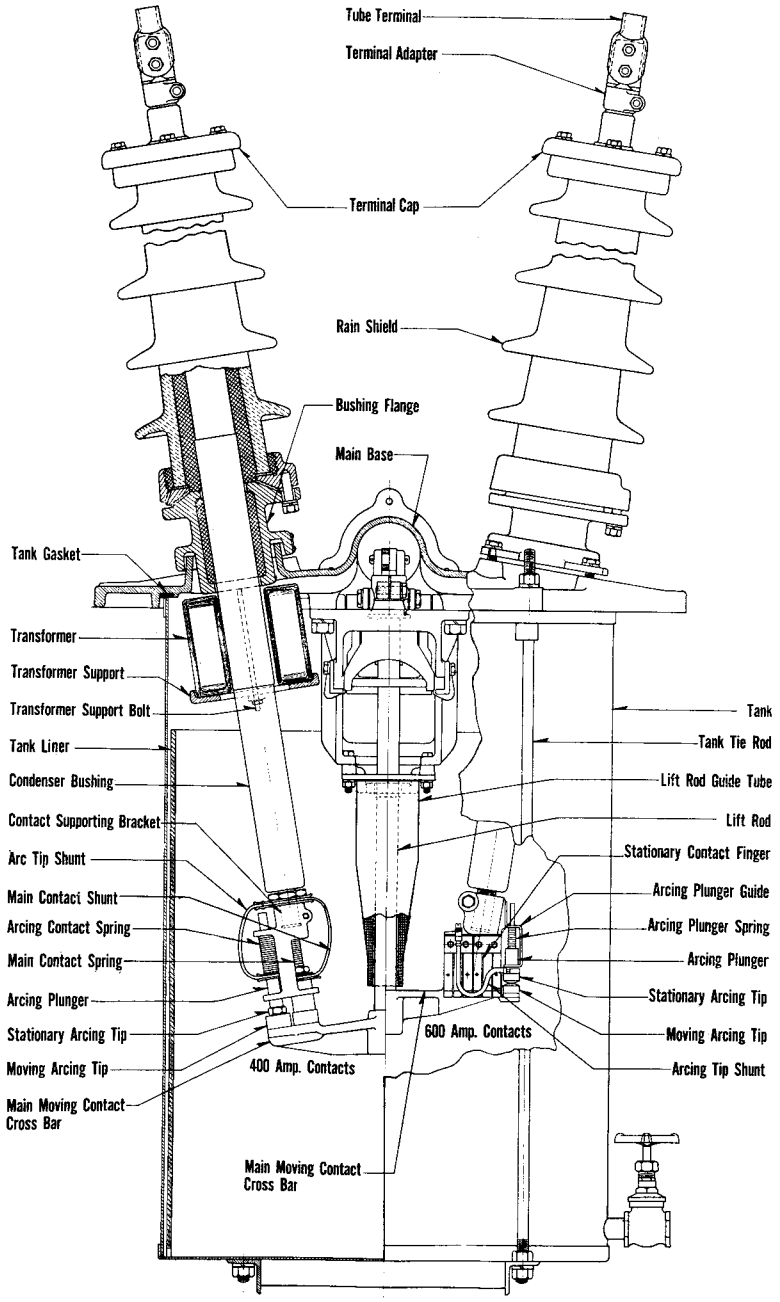


FIG. 21—TYPE G-11, 34.5-KV. OUTDOOR POLE UNIT

oxide. The arcing tip of the plunger type is described under butt contacts. The finger type contacts should be adjusted so that the arcing tips engage approximately 1⅛ inches before the main contacts are closed. The contacts should be adjusted so that the arcing tips of all poles meet practically simultaneously. The moving contacts should move far enough up into the fingers so that contact is made over the entire surfaces of the fingers and so that the fingers are raised away from their stops but not so far that the heel of the finger touches the stop in the closed position. Where necessary, full turn adjustment of the stationary contacts can be made on the contact studs. See that all parts are securely locked in position before the breaker is put in operation.

Lever Type of High-Speed Contact, as shown in Figs. 22 and 24 to 26 is used on the types G-2, G-22, G-22A, G-222 and G-222-A, G-22-S, G-222S, and G-222AS, 88,000 volts and below. The main contact consists of a set of heavy fingers mounted on the terminal foot and engaging with the blades on the moving element. The arcing contact fingers are mounted on the terminal foot and engaging with the arc-tips which are fastened on the ends of moving levers pivoted at the center of the moving element and actuated by springs as shown. This type is known as the "roll-in" type because of the rolling motion of the arcing fingers as the moving arcing tip passes between them. A shoulder on the finger parts prevents the moving tip from releasing before the proper time.

Fig. 25, Page 19 illustrates the design of lever type quick-break contacts used on the earlier types of "G-2", "G-22" and "G-222" breakers. The principal of this design has remained the same, but of course various improvements in details have constantly taken place. Figures 24 and 26 show the late designs of these contacts.

As the breaker opens, the main contacts are disengaged in the first ½ inch of travel but the arc-tips are held in contact until the main contacts have moved approximately one-half their travel at which time the arc-tips are released. They snap quickly to their stops, thus giving a very quick breaking of the arc. The adjustment of the contacts is made in connection with that of the toggle mechanism previously explained. As the breaker is set up and adjusted complete before leaving the factory, it should not be necessary to change any adjustment. However, if necessary, vertical adjustment of the moving member can be obtained by moving the nuts on the adjustment screws at the bottom of the lifting rod.

Bayonet Type High Speed Contacts—Figs. 27, 28 and 29 show the bayonet type contact. This contact is used on the G-22 and G-22A from 110,000 volts up, the G-111, 110,000 volts, and the G-1,G-10 and G-11 from 132,000 volts up. Both the main and arcing contacts are of the butt type. The main contacts have short movement and are backed by heavy pressure springs. The high speed element carries the arc-tip and a hardened steel finger which engages with a steel latch on the moving element. It is controlled by a compression spring and a heavy shunt is provided to carry the current.

As the breaker opens, the main contacts are disengaged after about ½ inch of travel. The high speed element moves downward compressing the large spring above. It is automatically released at from one-third to one-half of the breaker travel and quickly returns to its normal position under the action of the spring.

The adjustment of the Bayonet type contact (Figs. 28 and 29) should be checked by moving the contact slowly up and down by hand. The setting of the moving contact can be changed by adjusting the length of the lift rod. This adjustment is made in connection with that of the toggle mechanism stop which was previously explained. Horizontal adjustment can be obtained only by proper setting of the bushings. This should be checked when the bushings are installed by taking care to have them centered properly. Only slight adjustments, if any, should be necessary if the terminals are properly placed.

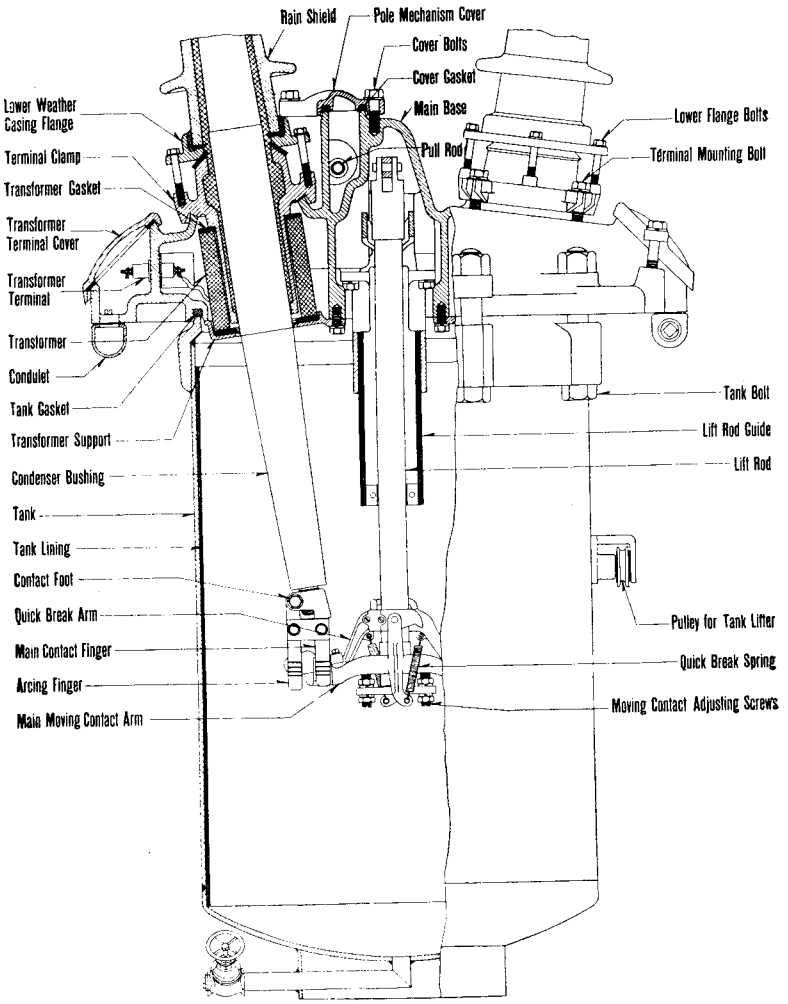


FIG. 22—TYPE G-22, 73-KV. OUTDOOR POLE UNIT

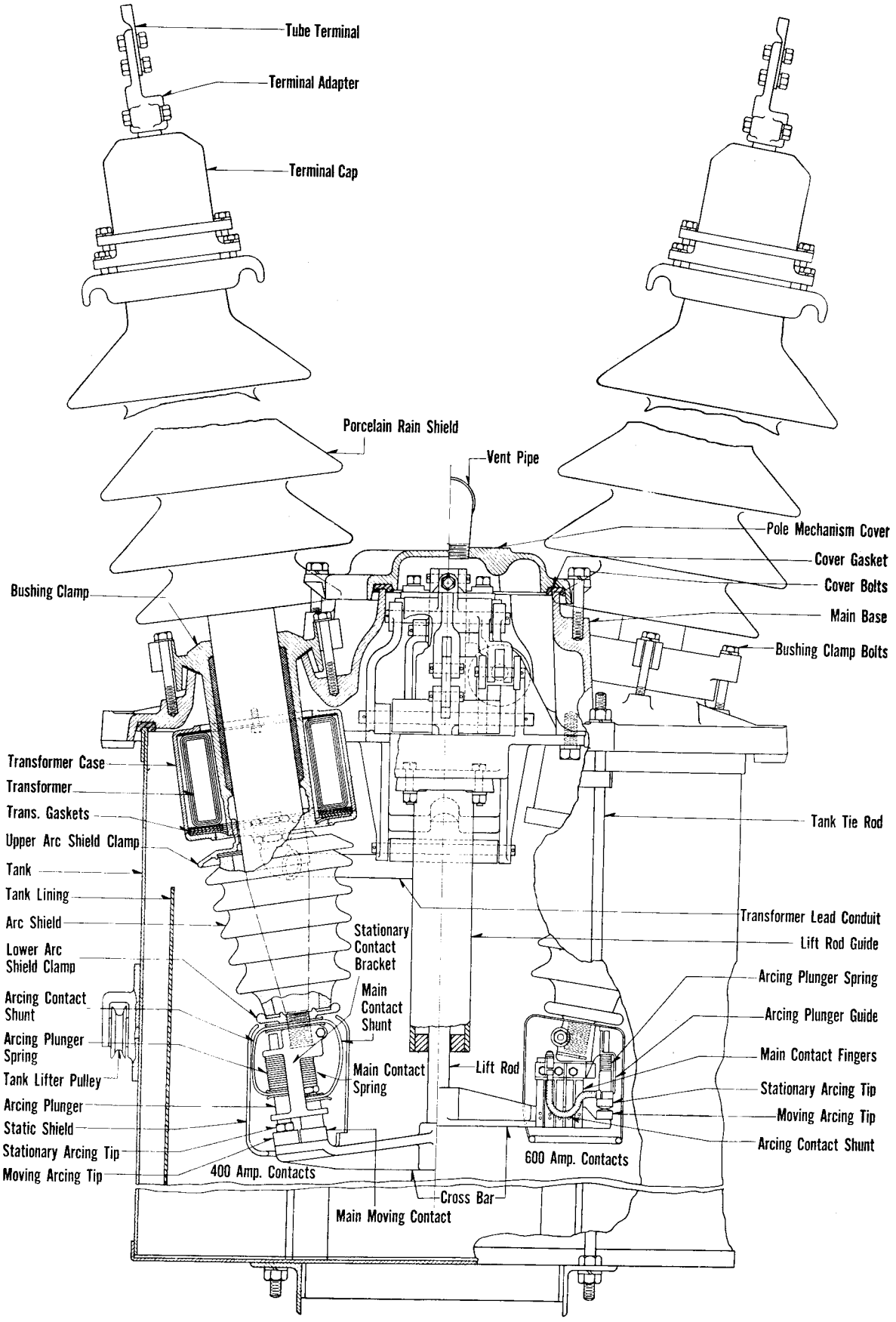


FIG. 23—TYPE G-10, 69-KV. OUTDOOR POLE UNIT

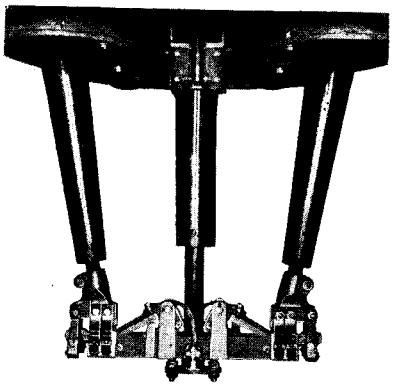


FIG. 24—FINGER AND WEDGE TYPE OF CONTACTS, WITH LEVER-TYPE ARCING TIP (CLOSED POSITION)

The arc-tips and main contacts are renewable and should be replaced if heavy duty has caused burning.

Current Transformers

In all type G breakers, space is provided for mounting bushing-type current transformers.

Current transformers which are supplied only when ordered, are mounted in the top of the pole units and may be single ratio compensated for a given loading, or may be of the standard multi-ratio type as illustrated by Figs. 30 and 31. All of the leads are brought out and numbered for external connection.

If it should be necessary for any reason to replace a current transformer, care must be taken to see that the end of the current transformer carrying the white mark is placed upward. The terminal foot or stationary contact must be removed. After disconnecting the transformer, the support for it is removed and the transformer slid down over the bushings. In replacing the transformer, care must be taken that the Micarta disc at the top is in position and that the pad on the support is in place. **The transformer case must not touch the ground banding on the terminal bushings.**

Do not confuse the polarity of the bushing transformers. The diagram. Fig. 30 shows how to distinguish the polarity and how to connect the transformers to their circuit.

Multi-ratio transformers are shown schematically by Fig. 31. Ratio tables for standard transformers are shown on Page 21. These transformers are not compensated for any given loading. Where accuracy of load ratio is required, ratio curves should be referred to. The curves for standard transformers may be obtained from the East Pittsburgh Works. A separate curve sheet is made for each turn ratio on the transformer. Ratio curves are not available for special transformers except where provision was made for these curves at the time the order is entered. In requesting curves, approximate burden and normal ratio should be specified, together with the stock order number, and

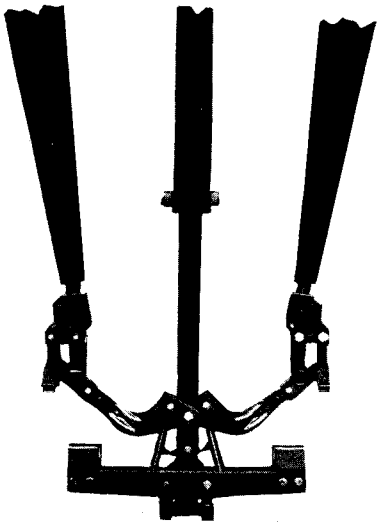


FIG. 26—FINGER AND WEDGE TYPE OF CONTACTS, WITH LEVER-TYPE ARCING TIP (AT POINT OF BREAK)

breaker type and rating, as given on the nameplate. A typical curve is illustrated by Fig. 32.

Single and double ratio transformers are compensated for the loading specified when ordered. The diagram for these transformers and their markings correspond to that of the multi-ratio transformers. Lead "A" is always of subtractive polarity and the direction of flux and current are the same as for the multi-ratio transformers. The low ratio is A-B, the next higher ratio A-C and the next higher ratio A-D, etc., fo higher steps.

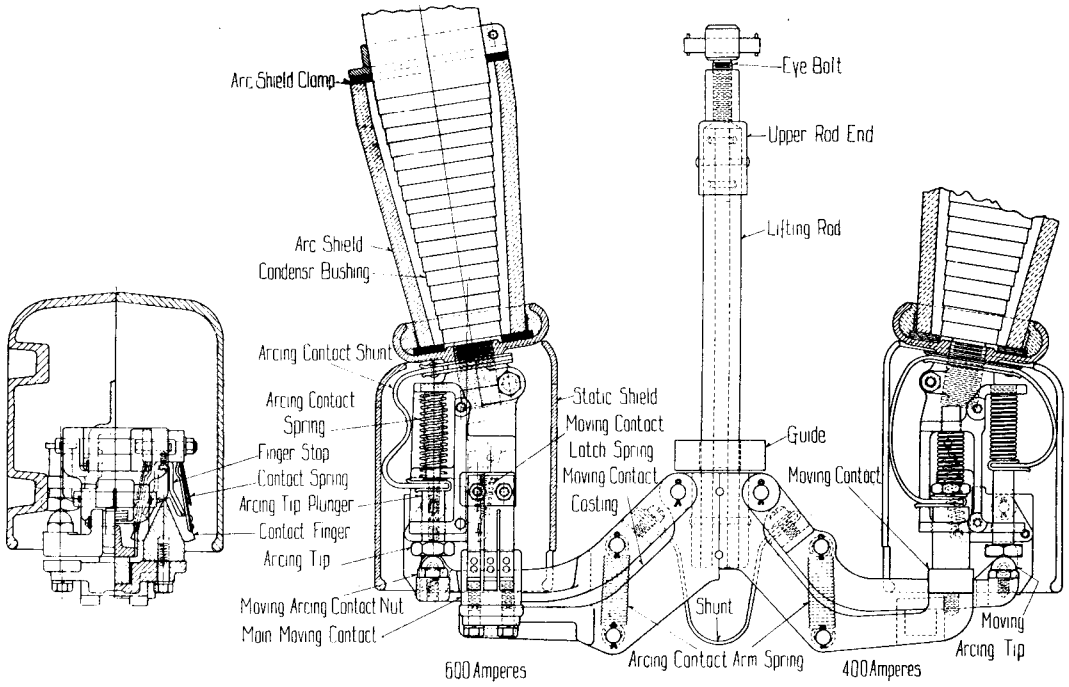


FIG. 25—CONTACTS FOR TYPE G-2, 73-KV. BREAKER (CLOSED POSITION)

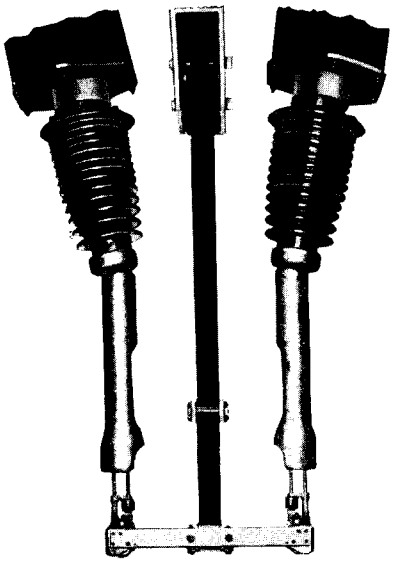


FIG. 27—BUTT TYPE CONTACT WITH BAYONET TYPE HIGH-SPEED ARCING CONTACTS, (MAIN CONTACTS OPEN, ARCING CONTACTS CLOSED)

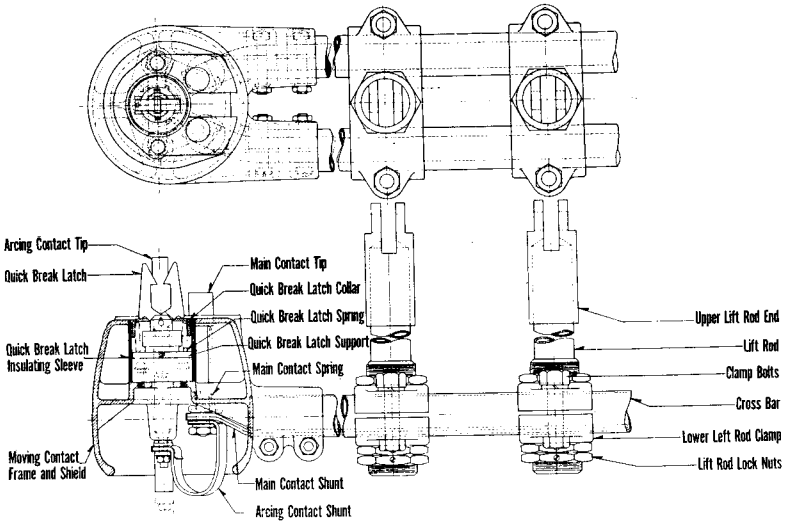


FIG. 29—BUTT TYPE CONTACT WITH BAYONET TYPE HIGH SPEED ARCING CONTACT (MOVING MEMBER).

Hipernik transformers of special nickel steel are used for accurate metering and very low load ratios. When used for watthour metering, special ratio transformers with ratio and phase angle curves for each transformer are recommended. When phase-angle curves have been made on individual transformers, the transformers are identified by serial numbers on the nameplate. This serial number should be given as reference when extra copies of curves are required for this transformer.

Venting

Some types of the G breakers are supplied with adjustable mufflers, while others simply have vent pipes. When the muffler is supplied, the setting should not be changed unless local conditions require it. Then the change should only be made after it has been shown to be necessary. Fig. 33 shows the muffler assembly, illustrating the valve. When shipped from the factory, the valve setting is one-half open. This adjustment should be satisfactory for all ordinary installations. The function of the muffler is to separate the oil from the arc gasses, which are discharged when the breaker interrupts the circuit, and to return the oil to the tank. If it becomes evident that too much oil is being discharged from the muffler, the lock nut on the adjusting screw should be loosened and valve screwed in a fraction of a turn. On the other hand, if there is evidence of high pressure in the breaker and very little discharge from the muffler, it may be advisable to open the valve a little more. From the closed position, three-quarters turn to the left will give one-quarter opening, one and one-half turns to the left is equivalent to one-half opening which is the normal setting. A three-quarters opening is obtained with two and one-quarter turns to the left, while full opening requires three and one-eighth turns.

Non-adjustable valve screws are provided in the later type of mufflers. The screw for half open is usually supplied.

¼ Open Screw Style #	555629
½ Open Screw Style #	555630
¾ Open Screw Style #	555631
Gasket Style #	555632

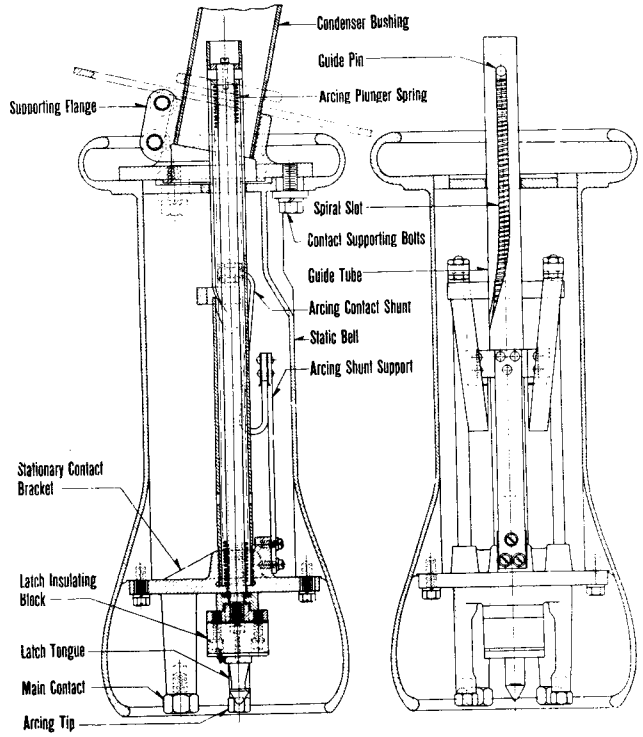


FIG. 28—BUTT TYPE CONTACT WITH BAYONET TYPE HIGH SPEED ARCING CONTACT, (STATIONARY MEMBER)

Insulating Oil

Notwithstanding the fact that many central stations carefully inspect the

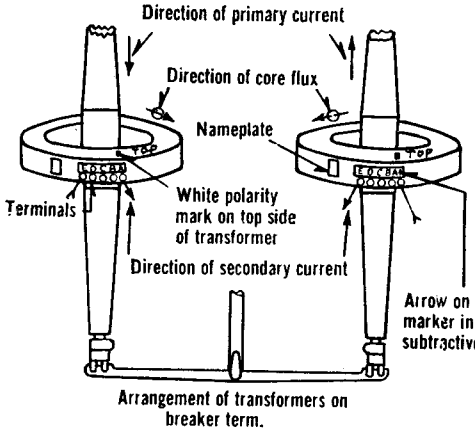
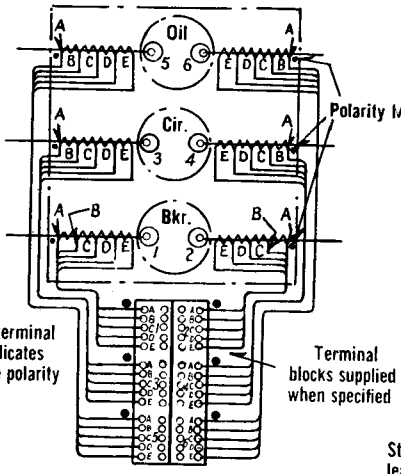
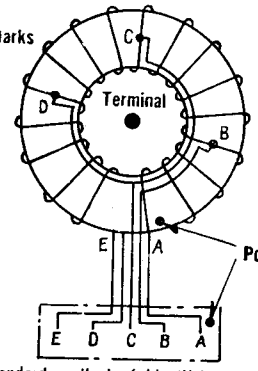


Fig. A



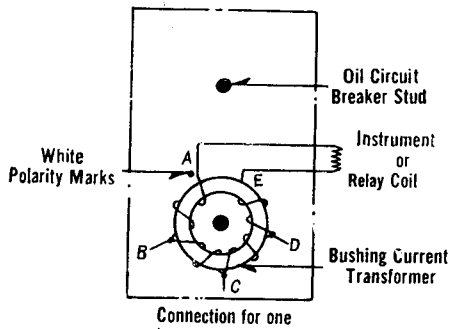
Transformers on multi-pole breakers when one trans. per pole is used trans. are located on terminals 2-4-6 unless other wise specified.

Fig. B



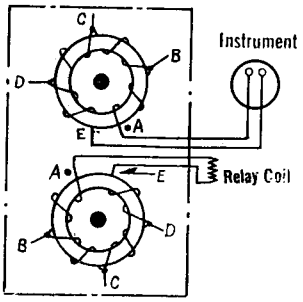
Standard method of identifying transformer leads, with any combination of taps, the tap nearest A has the same relative polarity as terminal A.

Fig. C



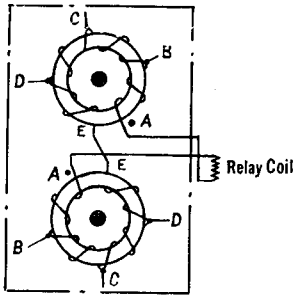
Connection for one transformer per breaker pole

Fig. D



Preferred Connections for two transformers per breaker pole when instrument and relaycoil are used

Fig. E



Connections for two trans. per pole without instruments. Instruments may be connected in series with coil but is not recommended.

Fig. F

400-AMPERE MULTI-RATIO TABLE

Approximate *Ratio	Turn Ratio	Secondary Taps
**	5 to 1	A—B
75 to 5	15 to 1	B—C
100 to 5	20 to 1	A—C
125 to 5	25 to 1	C—D
175 to 5	35 to 1	D—E
200 to 5	40 to 1	B—D
225 to 5	45 to 1	A—D
300 to 5	60 to 1	C—E
375 to 5	75 to 1	B—E
400 to 5	80 to 1	A—E

1200-AMPERE MULTI-RATIO TABLE

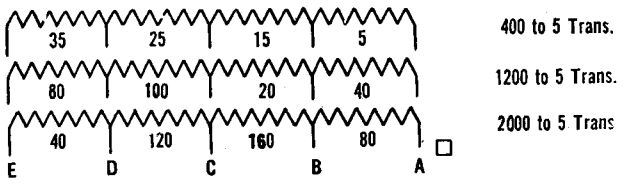
Approximate *Ratio	Turn Ratio	Secondary Taps
100 to 5	20 to 1	B—C
200 to 5	40 to 1	A—B
300 to 5	60 to 1	A—C
400 to 5	80 to 1	D—E
500 to 5	100 to 1	C—D
600 to 5	120 to 1	B—D
800 to 5	160 to 1	A—D
900 to 5	180 to 1	C—E
1000 to 5	200 to 1	B—E
1200 to 5	240 to 1	A—E

2000-AMPERE MULTI-RATIO TABLE

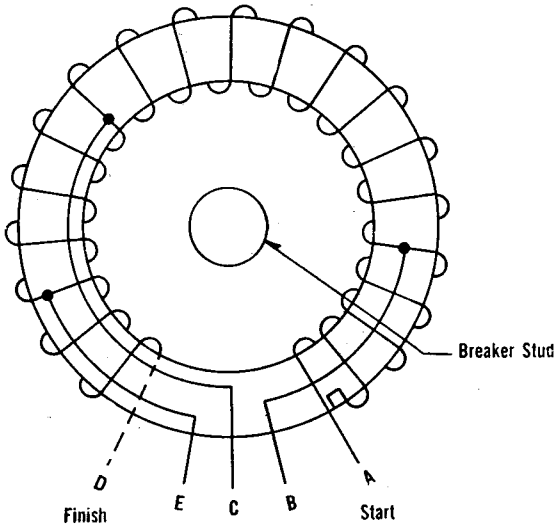
Approximate *Ratio	Turn Ratio	Secondary Taps
800 to 5	160 to 1	B—C
1200 to 5	240 to 1	A—C
1400 to 5	280 to 1	B—D
1600 to 5	320 to 1	B—E
1800 to 5	360 to 1	A—D
2000 to 5	400 to 1	A—E

*Not compensated for secondary loading. See ratio curves for various loadings.
**Requires special calibration.

FIG. 30—TYPICAL BUSHING TYPE CURRENT TRANSFORMER CONNECTIONS



Development of winding giving number of turns between taps



Subtractive polarity indicated by white polarity mark. With any combination of taps. The tap nearest A has the same relative polarity as terminal A.

Bushing-Type current transformer

FIG. 31—MULTI-RATIO B. T. C. TRANSFORMER

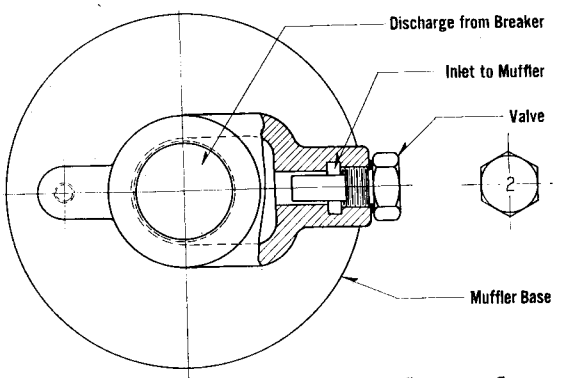


FIG. 33—MUFFLER BASE SHOWING SECTION OF THE VALVE

oil in their apparatus, it is believed that the importance of this subject justifies the publishing of a special manual for care and maintenance of insulating oils. Instruction Book No. 5336 has been prepared and should be referred to before any attempt is made to test or purify the oil.

The Westinghouse Electric & Manufacturing Company assumes the responsibility of circuit-breaker operation, only, when the insulating oil employed is in accordance with its recommendations. WEMCO-C oil is recommended for all oil circuit-breakers.

All oil used in circuit-breakers is subject to deterioration in service due to carbonization and to the presence of water, even under the most favorable conditions. It is, therefore, essential to provide for periodic inspection and

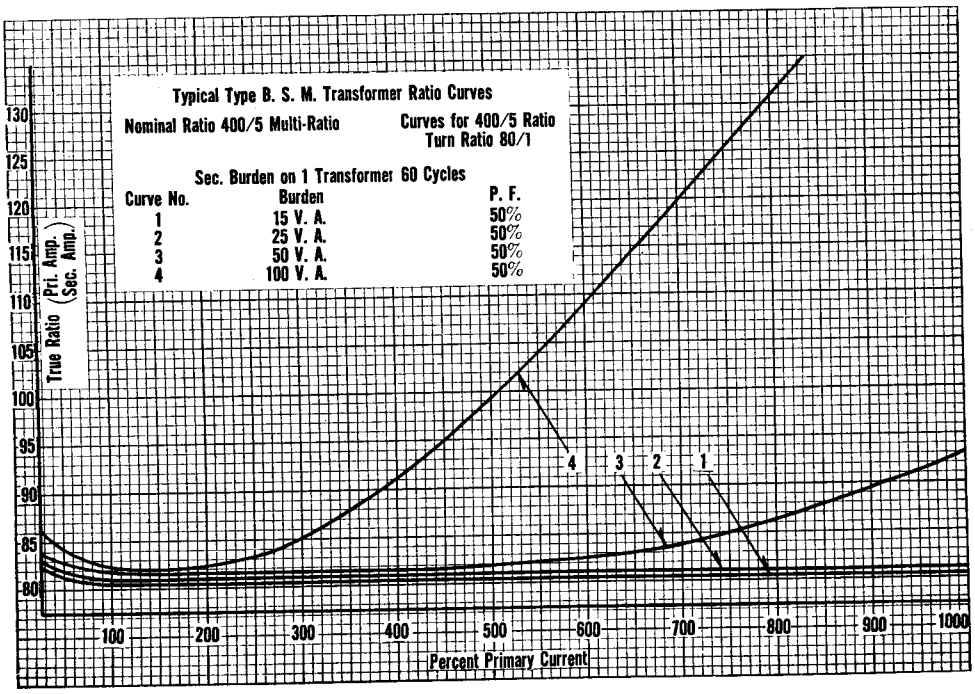


FIG. 32—TYPICAL TRANSFORMER RATIO CURVE

test and to purify the oil wherever this is necessary in order to maintain it in good condition. The more handling which an insulating oil receives, the greater the opportunity for contamination, unless adequate precautions are taken.

Placing Oil in Service

The most careful precautions must be taken to insure the absolute dryness and cleanliness of the apparatus before filling it with oil, and to prevent the entrance of water and dirt during the transfer of the oil to the apparatus. When putting a new circuit-breaker into service, see that the tank is free from moisture and foreign material. When carbonized oil is removed from a circuit-breaker in service, thoroughly clean all carbon from the interior of the circuit-breaker, so that the new oil will not be contaminated. This may be done by flushing with clean insulating oil and wiping with clean dry cotton cloths. Cotton waste is undesirable on account of the lint which may be introduced into the oil. The preparation and filling of outdoor apparatus should be preferably done on a clear dry day; if this is not practicable, protection against water must be provided.

Precaution should be taken against the handling of oil at a temperature different from the container into which the oil is being poured as condensation will occur and moisture will be introduced into the oil. Extra care must be taken in case oil drums are exposed and stored in open weather. Sufficient clearance from ground is essential to permit circulation of air to prevent condensation. As far as possible, lowering the tanks should be avoided at times when there is an appreciable difference between the temperature of the oil and the surrounding air.

Oil which has been used in lightning arresters contains water and harmful chemical impurities which cannot be removed without refining, and must not be used in circuit-breakers.

It is recommended that operators prepare a schedule for inspection based on operating conditions. Reference to the station log on the operation of the circuit-breakers, together with the record of di-electric tests of the oil should determine the frequency of inspection and test. The period between successive inspections should never be longer than three months. When the di-electric strength of the oil drops to 20,000 volts, the oil should be looked upon with suspicion and in no case should it be allowed to drop below 18,000 volts when tested by one of the usual methods with electrodes 1″ diameter spaced 0.1 inch apart. It is essential that the proper oil level be maintained in the circuit-breakers. Considerable change may be caused by changing of temperature, evaporation, rupturing of heavy currents, or possible leakage of oil. Low oil levels may cause flashover of bushings, or failure to properly handle heavy overloads.

PART III

Operating Mechanisms

General

The electric operating mechanism contains a number of moving joints and operating parts all of which are subject to wear or corrosion, if not kept in proper condition. All outdoor breakers of later design have heaters installed in the mechanism housings to prevent the accumulation of moisture in the housing, thus materially reducing the corrosive action. These heaters should be connected to an a-c. or d-c. source of supply of the same voltage as used for closing. The heater consumes approximately 220 watts, and may be disconnected during times when the climatic conditions will permit. It is desirable to inspect the mechanism at regular intervals and be assured of its good condition by making a number of operations, regular adjustments and repairs. It is desirable to apply a light lubricating oil to the various pins and links, but it should not be done to the extent of causing the joint to become gummed. It is necessary to keep the moving parts, particularly the trigger and latch, clean and free from foreign substance.

Inspection at regular intervals is recommended for the mechanism and it is suggested that a log of the operation be kept and that inspections be made after approximately every 100 operations. During extreme cold weather and in moist seasons, heat should be provided to avoid accumulation of moisture or corrosion of the various parts. When making the regular inspection, the contacts of the auxiliary switches should be examined to be sure that they have not become burned or pitted so as to affect the operation of the switches. The contactors on the panels should be inspected and the contacts kept in good condition.

Manual Operating Mechanisms are all mechanically trip free, thus preventing the holding of the oil circuit-breaker closed against a short circuit.

The mechanism as shown in Fig. 34 is in the closed position. Should a short circuit or over load occur in the circuit, the tripping mechanism will engage the trigger lever and release the trigger from its roller, allowing the main lever to rise, accelerated and forced to open position by the accelerating device.

When the lever rises, the lock lever is released and allowed to slip through the slotted end of the closing lever, thus releasing the closing lever which is pulled open by the retrieving spring, if the operator has released the handle. As the closing lever reaches its final open position, the trigger engages the roller on the main trip lever making the two levers a unit ready to operate again.

The cushioning effect of the dashpot should be regulated by adjusting the needle valve in the bottom of the dashpot cylinder to suit the operating conditions and the particular size of breaker.

When closing the breaker, the operator should pull the handle to the closed position as rapidly as possible. Keep all parts of the mechanism clean and free from dirt and grit. Keep the piston leather well oiled.

In a great many instances breakers are made manually-operated by use of one of the standard mechanically trip free, solenoid-operating mechanisms, described on the following pages, by omitting control panel, closing coil and closing cores.

Solenoid Mechanisms are standard for the type G line of breakers and may be the non-automatic type as shown by Fig. 36 or the full-automatic as illustrated by Fig. 37.

The size of the solenoid is usually designated by the diameter of the moving core, as 3-inch, 4-inch, or 6-inch, and is selected to suit the size of breaker to be operated.

The non-automatic solenoid mechanism such as illustrated by Fig. 36 con-

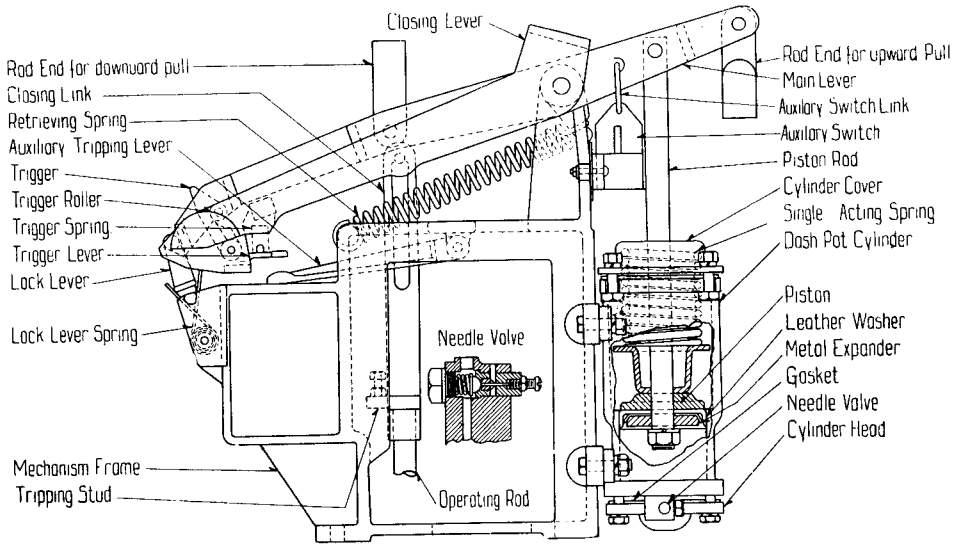


FIG. 34—FLOOR-MOUNTED, MANUALLY-OPERATED MECHANISM

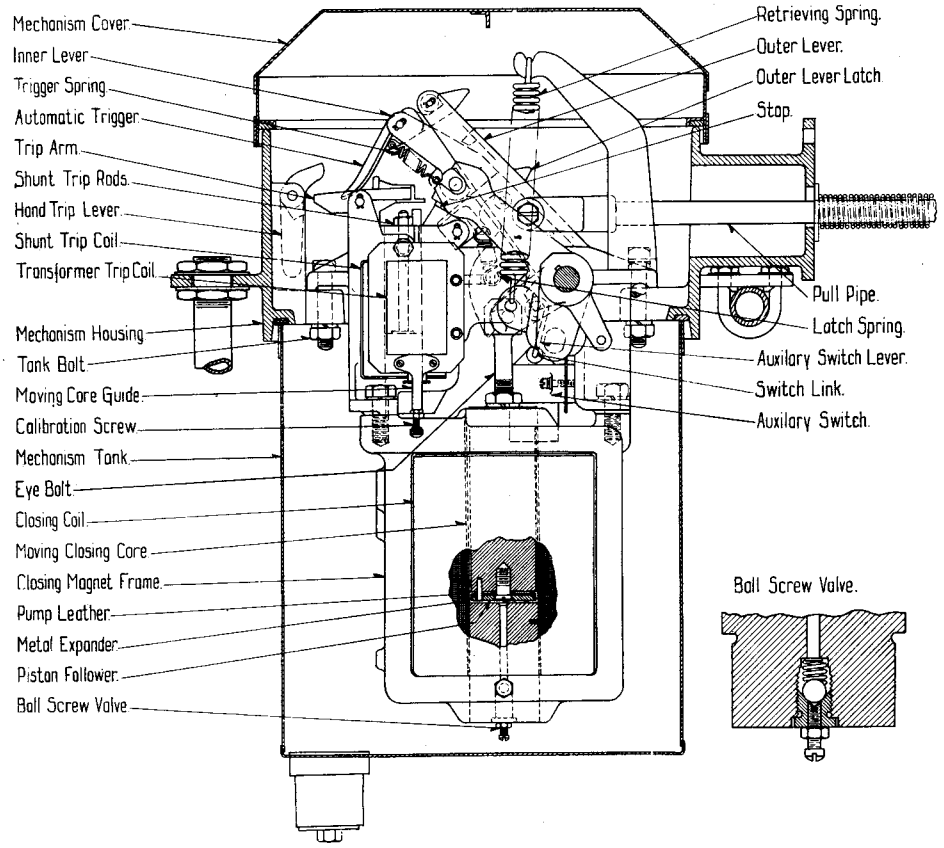


FIG. 35—OVERHEAD SOLENOID-OPERATED MECHANISM

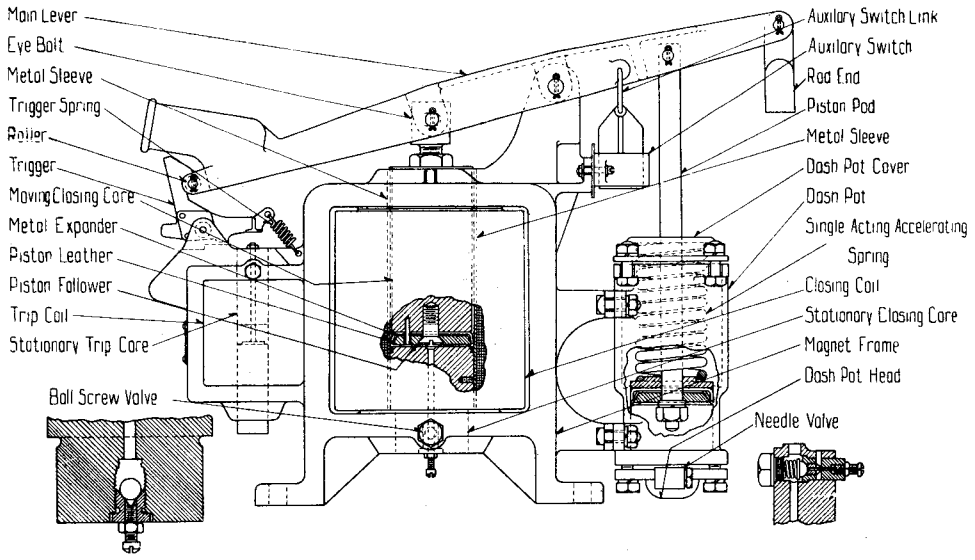


FIG. 36—FLOOR-MOUNTED, NON-AUTOMATIC, SOLENOID-OPERATED MECHANISM

sists essentially of a moving core operating on a main lever to close the circuit-breaker, the main lever being retained in the closed position by the trigger until tripped free by the hand trip device, or the shunt trip solenoid. The mechanism is equipped with an accelerating device to speed up the opening of the circuit-breaker, and this accelerating device is provided with a dash-pot which retards the operation on the end of the opening stroke.

Mechanically trip free mechanisms have gone through various stages of development. Figs. 34 and 35 show two of the earlier types used on the lower voltage "G" breakers. Fig. 37 shows an earlier design of the 4-inch mechanically trip free mechanism, while pages 27 to 31 are devoted to a rather complete description of the latest designs of mechanically trip free mechanisms.

The mechanism shown in Fig. 37 is very similar to the non-automatic solenoid mechanism, except that the main lever only is connected to the pull rod of the circuit-breaker and the closing solenoid core is connected to a closing lever which rotates about the same fulcrum as the main lever. For normal operation these two levers are secured together by a latch and act as a unit in closing the circuit-breaker, the closing lever being engaged by a lock lever at the end of the closing stroke and retained in the closed position. The latch which secures these two levers together is connected through linkage to a tripping lever actuated by the tripping solenoid, and so arranged that if the tripping coil be energized during any part of the closing stroke the latch will be released. Releasing the latch allows the main lever to return to the open position of the breaker while the closing lever is drawn on down by the closing solenoid to the end of the closing stroke, or until the closing solenoid is de-energized.

The lock lever is so arranged that it will retain the closing lever in the closed position only when the main lever is latched to it. Upon release of the main lever latch the lock lever releases its hold on the closing lever and allows it to pass to the full-open position, due to the action of the retrieving spring. On reaching the open position it again latches to the main lever ready for another closing operation.

By this arrangement the circuit-breaker is free to open at any point in its closing movement, even though current be maintained in the closing coil.

The following adjustments apply to all the solenoid mechanisms just described.

In the past, it has been the practice to provide means for cushioning the opening and closing of the electric mechanism and thus reduce the shock on the pole unit parts. For such mechanisms now in service and any which may be supplied in the future with piston leathers and air valves, the necessary instructions are given below.

However, recent improvements and the more rugged construction of the outdoor breakers have made it possible to omit dashpots and do away with the cushioning of the moving parts. This precludes the possibility of leather absorbing moisture and freezing during cold weather, under which conditions, the operation will be more sluggish than desired on the opening and closing strokes.

Permanent removal of piston leathers and valves from mechanisms now in service should not be done without checking with the Engineering Department at East Pittsburgh Works to determine if other parts of the mechanism and breaker are suitable for use without the cushioning.

When an adjustable air valve is used, it is placed in the bottom of the station-

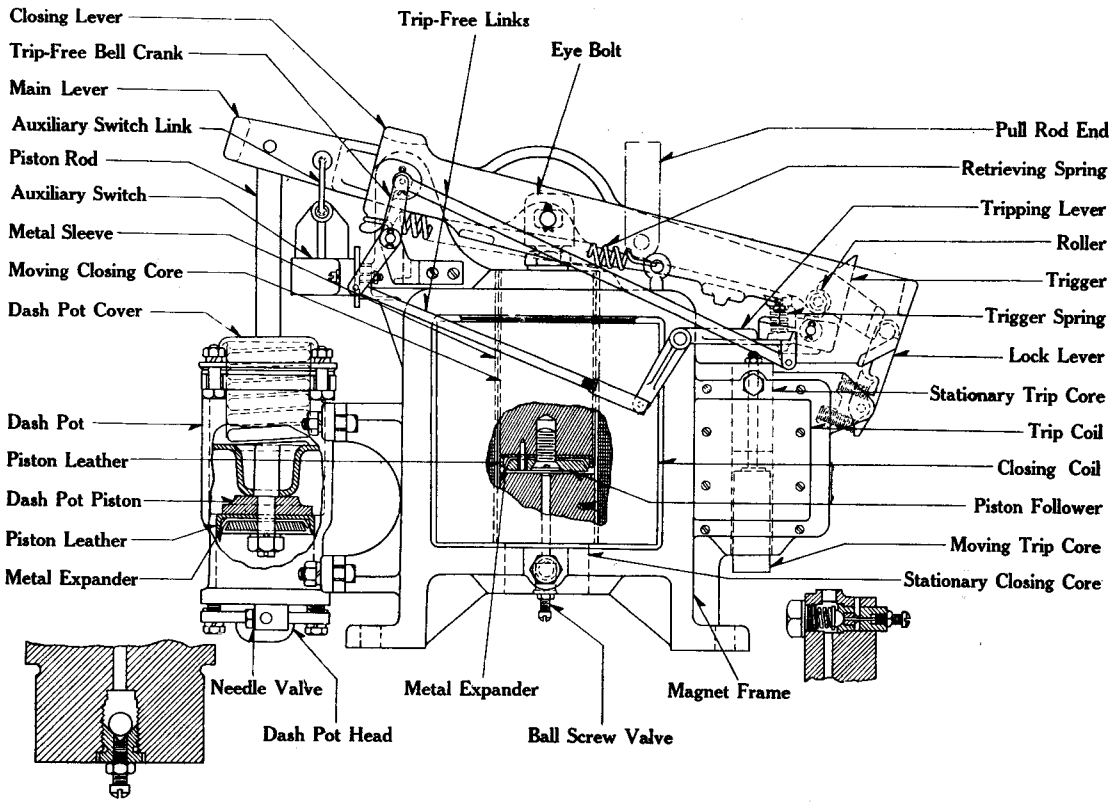


FIG. 37—FLOOR-MOUNTED, FULL-AUTOMATIC, SOLENOID-OPERATED MECHANISM

ary core as shown in Fig. 37, so that the escapement of air from the closing core dashpot can be regulated. When the moving closing core is drawn down by the solenoid, air is entrapped in the space between the two cores giving a cushioning action on the end of the closing stroke. The leather washer mounted on the end of the moving closing core, which slides down inside the metal sleeve, is kept pushed out against the metal sleeve by the metal expander. Turning the screw, shown on the bottom of the stationary core, to the right raises the ball from its seat and facilitates the escape of air, thus reducing the cushioning effect and allowing speedier closing. Rotation of the valve screw to the left drops the ball into its seat and limits the escapement of air from the dashpot, thus cushioning the closing action of the circuit-breaker. This closing core dashpot should be adjusted for each particular circuit-breaker to give the best closing operation with the control voltage that will actually be used.

The trigger is adjusted and tested before leaving the factory, and the proper action will be obtained if the engaging surface is smooth and clean.

The accelerating device consists of a powerful spring attached to the operating lever. In the non-automatic mechanisms, the accelerating device is equipped with an air dashpot consisting of a follower casting on the rod, a leather washer and a metal expander for holding the leather washer against the sides of the dashpot piston. The dashpot head is equipped with a needle valve which allows a regulated escapement of air from the dash-pot on the end of the opening stroke of the circuit-breaker. Regulation of this valve is obtained by an adjusting screw, rotation of the screw to the right causing the valve to be lifted from its seat and facilitating the exit of air from the dashpot, and rotation of the screw to the left causing the valve to return to its seat, thus closing the valve opening.

The moving closing core of the mechanism is connected to the main lever by an eye bolt which is adjustable in the core to secure the proper position of the roller on the main lever with respect to the latch when the closing cores come together. The mechanism is adjusted at the factory to latch properly when the moving closing core draws the lever down so that there is a clearance of $\frac{1}{16}$ inch between the roller and the latching surface at the trigger, with the coil energized. This condition should be kept as closely as possible in actual operation. Owing to lost motion in the linkage, it will be possible to draw the lever down by hand to obtain a somewhat greater back lash than the $\frac{1}{16}$ inch.

Adjustment of this back lash, which is very important to successful operation of the circuit-breakers, is made by loosening the lock nut on the eye bolt and running the moving closing core up or down on the eye bolt until correct adjustment is obtained. Make sure that the lock nut on the eye bolt is drawn down securely after any adjustment. The cores of the mechanism must come together to stop the travel of the moving parts with clearance at the stops.

Should it become necessary to remove the moving closing core of the non-automatic mechanism from the metal sleeve, it can be replaced readily by first forcing a tube of the same inside diameter down over the leather and then lining up the two tubes so that the leather slides freely. Another satisfactory method is to draw the leather in, with a string wrapped around it several times and drawn tight. The string can be removed after starting the leather into the sleeve. The leather washers on the metal expander are held in the end of the moving closing core by means of the piston follower. A steel pin passes through the follower, the expander and the leather washer into the moving closing core, thus preventing the turning of these three parts. The metal sleeve is fastened to the stationary closing core by means of screws and the joint between the two is packed to make it air tight.

The following instructions will cover the latest design of mechanically trip free mechanisms, as exemplified by the 3-inch "SA", the 4-inch "SA", and the 6-inch "SA" mechanisms.

The 3-inch type SA Solenoid mechanism is illustrated in Fig. 38. This mechanism is mechanically trip-free at any point in the closing stroke, making it impossible to hold the breaker in the closed position under predetermined conditions of overload on the line. Like the other types of SA mechanisms this mechanism has no air valve, dash-pot, or piston leathers.

Operation—In closing the circuit-breaker, it should be noted that the roller at the end of the trip-free lever is properly latched, the moving core of the solenoid is then drawn up inside of a brass tube, until it has sufficiently raised the main pin in the closing lever to a point that allows the locking lever to snap under it and hold it in place. This position is maintained until the breaker is tripped out.

Adjustments—All adjustments are made at the factory before the mechanism is shipped and it should not be

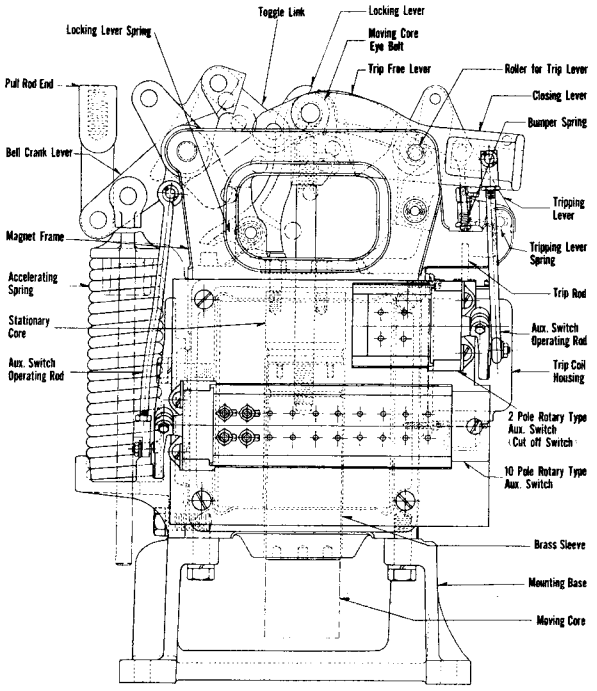


FIG. 38—TYPE 3-INCH "SA" SOLENOID MECHANISM

necessary to alter these in any way when placing the mechanism in service.

The moving closing core of the mechanism is suspended from the closing lever pin by a hooked type rod end with a tight. It is sometimes necessary to slightly alter this adjustment in order to secure positive latching with electric operation.

The backlash may be checked elec-

The trigger stop controls the action of the trigger. Adjustment is made by loosening the nuts on the accessory bolt and rotating it to the proper position. The nut must be securely tightened

Westinghouse Type "G" Oil Circuit-Breakers

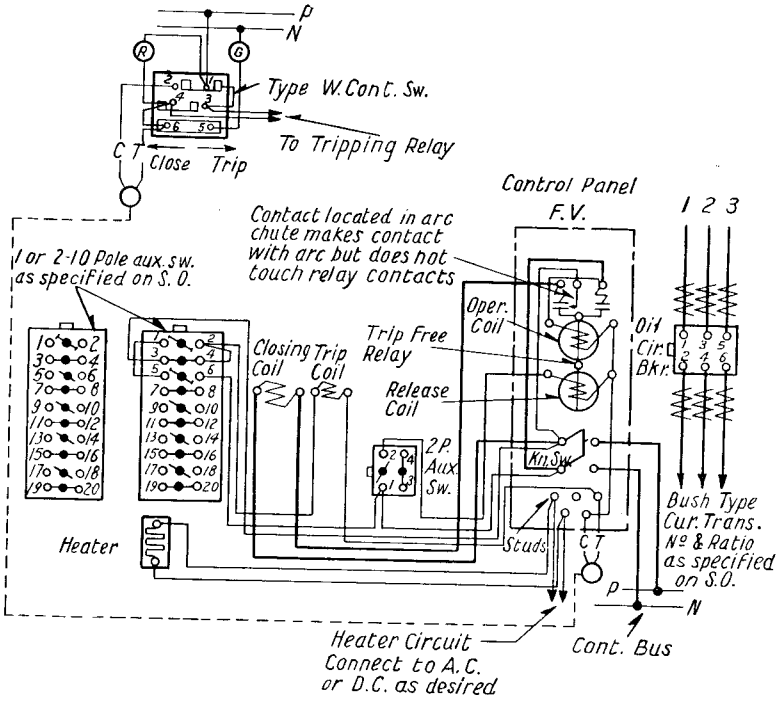
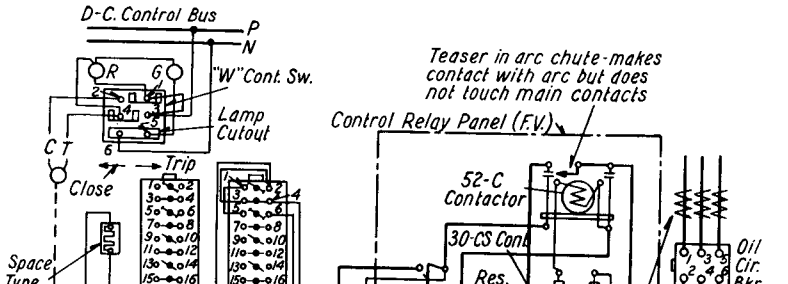


FIG. 46—TYPICAL CONTROL SCHEME FOR 3 AND 4-INCH MECHANISM USING S-1 CONTROL RELAY

two-pole relay. The coil of the cut-off relay is in parallel with the coil of the two-pole contactor except for a resistance which is of high enough value to prevent this coil from opening the contacts before the auxiliary switch closes and shunts out the resistor. When this cut-off relay has functioned, the contacts will remain open as long as the control switch is held in the closed position, because, although the auxiliary switch contacts should open, the current which would be permitted to pass through the resistor and the coil would be sufficient to hold the contacts in the open position. This will prevent "pumping" of the circuit-breaker if the overload should trip the breaker while the operator holds the control switch closed. The two-pole auxiliary switch shown in the diagram, Fig. 47 is connected to the mechanism levers attached to the core which will continue to move to its closed position although the trip-free latch should operate during the closing stroke and permit the breaker levers to fall back to the open position.



The type "CF-1" and type "CF-2" motor mechanism control panel consists of two "30-F2" contactors, necessary interlocking and a two-pole, single throw, knife switch. This control panel is wired in accordance with the diagram that is shipped with the breaker and will give electrical trip free operation. It will also prevent the breaker from pumping. Whenever work is being done on the mechanism or control, the two pole, single throw, knife switch should always be open. More detailed description and instructions pertaining to the control of these mechanisms will be found in the instruction books referred to on Pages 30 and 31.

When Rectox rectifiers are furnished for operation with circuit-breakers, Instruction Card #1782 is shipped with each Rectox and must be carefully followed both for installation and operation. There are several possible control schemes, dependent upon the a-c. supply voltage, the method of tripping, and other conditions. A wiring diagram is shipped with each breaker and should be followed carefully. Special care is required because this apparatus is for intermittent duty only. In case more than one breaker is operated from the same Rectox, care should be taken that only one breaker is connected to the Rectox at any given time.

If at the end of approximately one-second from the time of energizing the control switch the breaker fails to close, the operator should release the control switch in order to prevent injury to the Rectox. This time is ample to permit ordinary closing, and since tests show that the Rectox will not burn out for many seconds, this one-second rating gives a large factor of safety.

A resistor is connected in series with the a-c. side of the Rectox and is adjusted at the factory to give the necessary d-c. voltage to operate the breaker. However, due to an inherent characteristic of the Rectox the internal resistance increases with age, thereby decreasing the d-c. voltage, and should be compensated for by varying the adjustable resistor.

Additional data pertaining to the Rectox rectifier may be obtained from the nearest district office.

Maintenance

It has become the practice of operating companies to establish a system of regular and frequent inspection of their apparatus. Oil circuit-breakers, especially, due to the nature of their function, should be inspected thoroughly at least once every three months. Oil samples should be taken out and tested and the operation tried out.

More frequent inspection is necessary if the breaker is called upon to operate very often. The best service is obtained from breakers which are always in the best condition.

At any time the breaker fails to operate properly and you are not able to remedy or locate the trouble, you should notify the nearest Westinghouse Sales Office or Service and Repair Shop which maintains a corps of experts for this purpose. A list of these offices and shops can be found on back of this book.

Arcing contacts are renewable and should be replaced befo e burning has progressed to a point where further service would cause burning of the main contacts. The main contacts can be dressed with a file in case they are pitted and can easily be renewed if undue burning should occur on them due to neglect.

PART IV
Renewal Parts

When ordering renewal parts, specify the name of the part and give reference to the illustration in this instruction book. **Give the type, rating, and S. O. number as found on the name plate.**

For example: One stationary contact casting for type G-222, 73,000-volt, oil circuit-breaker, S. O. 78-D-945.

The following is a list of the renewal parts and the minimum quantities of each that should be carried in stock. These are the parts most subject to wear in ordinary operation, and to damage or breakage due to possible abnormal conditions. The maintenance of such stock will minimize service interruptions due to breakdowns.

Types G-1, G-10, G-,11 G-111, G-111-S, G-2, G-22, G-22A, G-22-S, G-222, G-222-A, G222-AS and G-222-S

Total number of breakers up to and including.....2.....5.....15

Name of Part	No. Per Breaker	Recommended for Stock		
Pole unit complete	3	0	0	1
Lifting rod complete	3	1	2	3
Moving contact	3	1	2	3
Arcing contact	6	6	12	24
Condenser type terminal bushing comp.	6	1	2	3
Stationary main contact—400 amp	12	6	12	24
Stationary arcing contact	6	3	6	12
Main contact plunger spring	12	6	12	24
Arcing contact plunger spring	12	6	12	24
Arcing contact latch	12	3	6	12
Latch bracket	6	2	3	6
Latch tongue	6	3	6	12
Latch spring	6	3	6	12
Spring holder	6	2	3	6
Contact finger—600 amp	24	24	48	96
Contact finger spring	24	12	24	48
Shunt	6	2	3	6
Tank lining	3	0	1	1
Closing coil	1	0	1	1
Trip coil	1	0	1	1
Dash pot spring	1	1	1	2
Auxiliary switch	1	1	1	2
Leather bumper	3	3	6	9
Trigger	1	1	1	2
Trigger spring	1	1	2	3
Trigger roller	1	1	1	2
Retrieving spring	1	1	1	2

Types G-1, G-10, G-11 and G-111

Total number of breakers up to and including.....2.....5.....15

Name of Part	No. Per Breaker	Recommended for Stock		
Pole unit complete	3	0	0	1
Lifting rod complete	3	1	2	3
Moving contact	3	1	2	3
Contact bar	3	1	2	3
Main contact	6	6	12	24
Arcing contact	6	6	12	24
Plunger for main contact	6	2	3	6
Plunger for arcing contact	6	2	3	6
Spring for main contact	6	3	6	12
Spring for arcing contact	6	3	6	12
Condenser type terminal bushing	6	1	2	3
Contact Foot	6	2	3	6
Stationary arcing contact	6	6	12	24
Shunt complete	6	2	3	6
Contact nut	6	2	3	6
Arcing screw	6	6	12	24
Contact finger assembly for 600 and 800 ampere breakers	24	12	24	8
Tank lining	3	0	1	41
Closing coil	1	0	1	1
Shunt trip coil	1	0	1	1
Transformer trip coil	1	0	1	1
Overload trip coil	1	0	1	1
Transformer	6	1	1	3
Piston leather	1	1	2	3
Piston leather expander	1	1	2	3
Follower for expander	1	1	1	2
Automatic trigger	1	1	1	2
Spring for automatic trigger	1	1	2	3
Roller for automatic trigger	1	1	1	2
Retrieving spring	1	1	1	2
Leather bumper	2	2	4	8
Auxiliary switch complete	1	1	1	2

Recommendations for stocking Renewal Parts for your complete equipment will be supplied upon request to the nearest Sales Office.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Headquarters—306 4th Ave., Pittsburgh, Pa. P.O. Box 1017

*AKRON, OHIO, 106 South Main St.
*ALBANY, N. Y., 456 No. Pearl St.
*ALBUQUERQUE, NEW MEXICO, 219 First Nat'l. Bank Bldg.
*ALLENTOWN, PA., 522 Maple St.
*APPLETON, WISC., 210 N. Appleton St., P.O. Box 206
¶#†*ATLANTA, GA., 426 Marietta St., N. W.
xATTICA, N. Y.
*†AUGUSTA, MAINE, 9 Bowman St.
*BAKERSFIELD, CALIF., 2224 San Emedio St.
¶*BALTIMORE, MD., 118 E. Lombard St.
†BALTIMORE, MD., 4015 Foster Ave.
xBALTIMORE, MD., 2519 Wilkens Ave.
*†BATON ROUGE, LA., 128-134 So. Sixteenth St.
*BEAUMONT, TEXAS, 1213 American National Bank Bldg.
*BINGHAMTON, N. Y., Suite 704, Marine Midland Bldg., 86 Court St.
*BIRMINGHAM, ALA., 1407 Comer Bldg.
¶*BLUEFIELD, W. VA., 208 Bluefield Avenue
¶*BOSTON, MASS., 10 High St.
†#BOSTON, MASS., 235 Old Colony Ave., So. Boston, Mass.
¶*†BRIDGEPORT, CONN., 540 Grant St.
¶*BUFFALO, N. Y., 814 Ellicott Square
†#BUFFALO, N. Y., 1132 Seneca St.
*BURLINGTON, VER., 208 Flynn Ave.
*BUTTE, MONTANA, 129 West Park St.
#BUTTE, MONTANA, Iron & Wyoming Sts.
*CANTON, OHIO, 120 W Tuscarawas St.
xCANTON, OHIO, Raff Road, S.W., P. O. Box 710
*CEDAR RAPIDS, IOWA, 361 21st St., S E., P. O. Box 148
*†#CHARLOTTE, N. C., 210 East Sixth St.
①*CHARLESTON, S. C., 2 Greenhill St., P.O. Box 303
*CHARLESTON, W. VA., 1415 Oakmont Rd., P. O. Box 865
*CHATTANOOGA, TENN., Volunteer State Life Bldg., GeorgiaAve. & East Ninth St.
¶*CHICAGO, ILL., 20 N. Wacker Drive, P.O. Box B
†#CHICAGO, ILL., 2211 W. Pershing Road, P.O. Box 1103
¶*†#CINCINNATI, OHIO, 2 07 West Third St.
①¶*†#CLEVELAND, OHIO, 1216 W. Fifty-Eighth St.
①†CLEVELAND, OHIO, 5901 Breakwater Avenue. Station A
*COLUMBUS, OHIO, 85 E. Gay St.
*COLUMBIA, S. C., 125 S. Waccamaw Ave.
*DALLAS, TEXAS, 209 Browder St.
#DALLAS, TEXAS, 1712 Laws St.
*DAVENPORT, IOWA, 206 E. Second St., P.O. Box 55
*DAYTON, OHIO, 30 North Main St.
¶*DENVER, COLORADO, 910 Fifteenth St.
#DENVER, COLORADO, 1700 Sixteenth St.
†DENVER, COLORADO, 988 Cherokee St.
xDERRY, PA.
*DES MOINES, IOWA, 1400 Walnut St.
¶*†#DETROIT, MICH., 5757 Trumbull Ave., P.O. Box 828
¶*DULUTH, MINN., 10 East Superior St.
x#EAST PITTSBURGH, PA.
*EL PASO, TEXAS, Oregon and Mills St.
#EL PASO, TEXAS, 450 Canal St.
①#*†EMERYVILLE, CALIF., 5915 Green St.
*ERIE, PA., 1003 State St.
①*EVANSVILLE, IND., 201 N. W. First St.
*†FAIRMONT, W. VA., 10th and Beltline Sts. P.O. Box 1161
*FORT WAYNE, IND., 1010 Packard Ave.
*FRESNO, CALIF., 872 Peralta Way, P.O. Box 1249
*GARY, IND., 846 Broadway
*GRAND RAPIDS, MICH., 511 Monroe Ave., N. W.
*GREENSBORO, N. C., Apartment H-3, Country Club Apartments
*GREENVILLE, S. C., 110 W. Tallulah Drive, P.O. Box 1591
*HAMMOND, IND., 235 Locust St.
*HARTFORD, CONN., 36 Pearl St.
*HONOLULU, T. H., Hawaiian Elec. Co. Agt.
¶*HOUSTON, TEXAS, 1314 Texas Ave.
#HOUSTON, TEXAS, 2301 Commerce Ave.
†HOUSTON, TEXAS, 2315 Commerce Ave.
¶†*#HUNTINGTON, W. VA., 1029 Seventh Ave.
¶*INDIANAPOLIS, IND., 137 S. Penna. St.
†INDIANAPOLIS, IND., 551 West Merrill St.
*ISHPEMING, MICH., 433 High St.
*JACKSON, MICH., 212 West Michigan Ave.
*JACKSONVILLE, FLA., 37 South Hogan St., P.O. Drawer K
*†JOHNSTOWN, PA., 107 Station St.
¶*KANSAS CITY, MO., 101 W. Eleventh St.
①#KANSAS CITY, MO., 2124 Wyandotte St.
*KNOXVILLE, TENN., Gay & Clinch St.
xLIMA, OHIO
¶*†#LOS ANGELES, CALIF., 420 So. San Pedro St.
*LOUISVILLE, KY., 332 West Broadway
xLOUISVILLE, KY., P.O. Box 1860
*MADISON, WISC., 1022 E. Washington Ave.
xMANSFIELD, OHIO, 246 E. Fourth St.
*MEMPHIS, TENN., 130 Madison Ave.
*MIAMI, FLA., 11 N. E. Sixth St., P.O. Box 590
¶*MILWAUKEE, WISC., 538 N. Broadway
†MILWAUKEE, WISC., 4560 No. Port Washington Rd.
¶†*#MINNEAPOLIS, MINN., 2303 Kennedy St., N.E.
*MONROE, LA., 1503 Emerson St., P.O. Box 1851
*NASHVILLE, TENN., 219 Second Ave., N.
*NEWARK, N. J., 1180 Raymond Blvd.
†#NEWARK, N. J., Haynes Ave. & Lincoln Highway
xNEWARK, N. J., Plane & Orange Sts.
*NEW HAVEN, CONN., 42 Church St., P. O. Box 1817
¶*NEW ORLEANS, LA., 333 St. Charles St.
#NEW ORLEANS, LA., 527 Poydras St.
¶*NEW YORK, N. Y., 40 Wall St.
*NIAGARA FALLS, N. Y., 253 Second St.
*NORFOLK, VA., 320 City Hall Ave.
*OKLAHOMA CITY, OKLA., 120 N. Robinson St.
#OKLAHOMA CITY, OKLA., Third & Alie Sts.
*OMAHA, NEB., 409 South Seventeenth St.
*PEORIA, ILL., 418 S. Washington St.
¶*†#PHILADELPHIA, PA., 3001 Walnut St.
*PHOENIX, ARIZONA, 11 West Jefferson St.
#PHOENIX, ARIZONA, 425 Jackson St.
xPITTSBURGH, PA., Nuttall Works, 200 McCandless Ave.
¶z*PITTSBURGH, PA., 306 4th Ave., Box 1017
#†PITTSBURGH, PA., 543 N. Lang Ave.
¶*PORTLAND, OREGON, 309 S. W. Sixth Ave.
†PORTLAND, OREGON, 2138 N. Interstate Ave.
#PORTLAND, OREGON, 720 N. Thompson St.
¶*†PROVIDENCE, R. I., 16 Elbow St.
*RALEIGH, N. C., 803 North Person St., P.O. Box 2146
*RICHMOND, VA., 301 S. Fifth St.
*ROANOKE, VA., 726 First St., S. E.
*ROCHESTER, N. Y., 1048 University Ave.
*ROCKFORD, ILL., 130 South Second St.
*SACRAMENTO, CALIF., Twentieth & "R" Sts.
¶*ST. LOUIS, MO., 411 North Seventh St.
①†ST. LOUIS, MO., 717 South Twelfth St.
①#ST. LOUIS, MO., 710 N. Twelfth Blvd., c/o Central Terminal Co.
§*SALT LAKE CITY, UTAH, 10 West First South St.
①†SALT LAKE CITY, UTAH, 346 A Pierpont Ave.
①#SALT LAKE CITY, UTAH, 520 West Second South St.
*SAN ANTONIO, TEXAS, 115 W. Travis St.
*SAN DIEGO, CALIF., 861 Sixth Ave.
¶*SAN FRANCISCO, CALIF., 1 Montgomery St.
§SAN FRANCISCO, CALIF. 1355 Market St.
¶#†*SEATTLE, WASH., 3451 East Marginal Way
§SEATTLE, WASH., 1051 First Ave., So.
xSHARON, PA., 469 Sharpsville Ave.
*SIOUX CITY, IOWA, 2311 George St.
*SOUTH BEND, IND., 216 East Wayne St.
xSOUTH PHILA. WKS., Essington, Pa. First-class mail, P.O. Box 7348, Phila., Pa.
*SPOKANE, WASH., 158 S. Monroe St.
*SPRINGFIELD, ILL., 601 E. Adams St., Box 37
¶*†SPRINGFIELD, MASS., 395 Liberty St.
xSPRINGFIELD, MASS., 653 Page Boulevard
*SYRACUSE, N. Y., 420 N. Geddes St.
*TACOMA, WASH., 1115 "A" St.
*TAMPA, FLA., 417 Ellamae Ave., Box 230
*TOLEDO, OHIO, 245 Summit St.
xTRAFFORD, PA.
*TULSA, OKLA., 303 East Brady St.
¶*†#UTICA, N. Y., 113 N. Genesee St.
¶*WASHINGTON, D. C., 1434 New York Ave., N. W.
*WATERLOO, IOWA, 328 Jefferson St., P.O. Box 147
*WICHITA, KANSAS, 233 S. St. Francis Ave.
¶*†WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
*WORCESTER, MASS., 507 Main St.
*YORK, PA., 143 So. George St.
*YOUNGSTOWN, OHIO, 25 E. Boardman St.

Where address and P. O. box are both given, send mail to P. O. box, telegrams to address indicated.

WESTINGHOUSE AGENT JOBBERS

Westinghouse Electric Supply Company—Headquarters—150 Varick St., New York, N. Y.

Fully equipped sales offices and warehouses are maintained at all addresses.

ALBANY, N. Y., 454 No. Pearl St.
ALLENTOWN, PA., 522 Maple St.
ATLANTA, GA., 96 Poplar St., N. W.
AUGUSTA, MAINE, 90 Water St.
BALTIMORE, MD., 40 South Calvert St.
BANGOR, MAINE, 175 Broad St.
BINGHAMTON, N. Y., 87 Chenango St.
BOSTON, MASS., 88 Pearl St.
BURLINGTON, VT., 208 Flynn Ave.
BUTTE, MONTANA, 50 East Broadway
CHARLOTTE, N. C., 210 East Sixth St.
CHICAGO, ILL., 113 North May St.
CLEVELAND, OHIO, 6545 Carnegie Ave.
COLUMBIA, S. C., 915 Lady St.
CORPUS CHRISTI, TEXAS, North end of Mesquite St.
DALLAS, TEXAS, 405 No. Griffin St.
DAVENPORT, IOWA, 402 E. Fourth St.
DES MOINES, IOWA, 1400 Walnut St.
DETROIT, MICH., 547 Harper Ave.
DULUTH, MINN., 308 W. Michigan St.
EVANSVILLE, IND., 201 N. W. First St.
FLINT, MICH., 1314 N. Saginaw St.
FORT WAYNE, IND., 612 S. Harrison St.
FORT WORTH, TEXAS, 210 Jones St.
GRAND RAPIDS, MICH., 511 Monroe Ave. N. W.
GREENVILLE, S. C., 226 Pendleton St.
HOUSTON, TEXAS, 1903 Ruiz St.
INDIANAPOLIS, IND., 137 S. Pennsylvania St.
JACKSONVILLE, FLA., 37 South Hogan St.
LOS ANGELES, CALIF., 905 East Second St.
MADISON, WISC., 1022 E. Washington Ave.
MEMPHIS, TENN., 366 Madison Ave.
MIAMI, FLA., 11 N. E. Sixth St.
MILWAUKEE, WISC., 546 N. Broadway
MINNEAPOLIS, MINN., 215 South Fourth St.
NEWARK, N. J., 49 Liberty St.
NEW HAVEN, CONN., 240 Cedar St.
zNEW YORK, N. Y., 150 Varick St.
NORFOLK, VA., 320 City Hall Ave.
OAKLAND, CALIF., Tenth & Alice Sts.
OKLAHOMA CITY, OKLA., 850 N. W. Second St.
OMAHA, NEB., 117 North Thirteenth St.
PEORIA, ILL., 412 S. Washington St.
PHILADELPHIA, PA., 1101 Race St.
PHOENIX, ARIZONA, 315 West Jackson St.
PITTSBURGH, PA., 575 Sixth Ave.
PORTLAND, OREGON, 134 N. W. Eighth Ave.
PROVIDENCE, R. I., 66 Ship St.
RALEIGH, N. C., 319 W. Martin St.
①READING, PA., Fourth and Elm Sts.
RICHMOND, VA., 301 South Fifth St.
ROANOKE, VA., 726 First St., S. E.
ROCHESTER, N. Y., 1048 University Ave.
SACRAMENTO, CALIF., 20th and "R" Sts.
ST. LOUIS, MO., 1011 Spruce St.
ST. PAUL, MINN., 145 East Fifth St.
SALT LAKE CITY, UTAH, 235 West South Temple St.
SAN ANTONIO, TEXAS, 1211 E. Houston St.
SAN FRANCISCO, CALIF., 260 Fifth St.
SEATTLE, WASH., 1051 First Ave., So.
SIOUX CITY, IOWA, 1005 Dace St.
SPOKANE, WASH., 152 So. Monroe St.
SPRINGFIELD, MASS., 46 Hampden St.
SYRACUSE, N. Y., 961 W. Genesee St.
TACOMA, WASH., 1115 "A" St.
TAMPA, FLA., 417 Ellamae St.
TERRE HAUTE, IND., 234 So. Third St.
TOLEDO, OHIO, 1920 N. Thirteenth St.
①TRENTON, N. J., 444 S. Broad St.
TULSA, OKLA., 307 East Brady St.
UTICA, N. Y., 113 N. Genesee St.
WASHINGTON, D. C., 1216 "K" St., N. W.
WATERLOO, IOWA, 328 Jefferson St.
WHEELING, W. VA., 1117 Main St.
WICHITA, KANSAS, 233 So. St. Francis Ave.
WILLIAMSPORT, PA., 348 W. Fourth St.
WILMINGTON, DEL., 216 E. Second St.
WORCESTER, MASS., 17 Mulberry St.
YORK, PA., 143 S. George St.

* Sales Office † Mfg. and Repair Shop x Works # Warehouse § Merchandising Products Only z Headquarters ¶ District Eng. and Service Dept.

①**Changed or added since previous issue.**

WESTINGHOUSE AGENT JOBBERS—Continued

Other Agent Jobbers

ABILENE, KAN., Union Electric Co.
AKRON, OHIO, The Moock Electric Supply Co.
BIRMINGHAM, ALA., Moore Handley Hdwe. Co.
BLUEFIELD, W. VA., Superior-Sterling Co.
BUFFALO, N. Y., Buffalo Electric Co., Inc.
CANTON, OHIO, The Moock Electric Supply Co.
‡CHATTANOOGA, TENN., Mills & Lupton Supply Co.
CHICAGO, ILL., Hyland Electrical Supply Co.
CINCINNATI, OHIO, The Johnson Electric Supply Co.
COLUMBUS, OHIO, Pixley Electric Supply Co.
‡DENVER, COL., The Mine & Smelter Supply Co.
‡EL PASO, TEX., Mine & Smelter Supply Co.
ERIE, PA., Star Electrical Co.
HUNTINGTON, W. VA., Banks Miller Supply Co.
KANSAS CITY, MO., Columbian Elec'l. Co.
KANSAS CITY, MO., Continental Elec. Co.
LEXINGTON, KY., Tafel Elec. & Supply Co.
LOUISVILLE, KY., Tafel Electric & Supply Co.
MONROE, LA., Monroe Hardware Co.
NASHVILLE, TENN., Tafel Electric & Supply Co.
NEW ORLEANS, LA., Electrical Supply Co.
NEW YORK, N. Y., Times Appliance Co., Inc.
SAN DIEGO, CALIF., The Electric Supplies Distributing Co.
SCRANTON, PA., Penn Elec'tl Engineering Co.
YOUNGSTOWN, OHIO, Moock Electric Supply Co.

WESTINGHOUSE ELECTRIC & MFG. CO., LAMP DIVISION

Headquarters—Clearfield Ave., Bloomfield, N. J.

*ALBANY, N. Y., 454 N. Pearl St.
#*ATLANTA, GA., 426 Marietta St.
*BALTIMORE, MD., 118 E. Lombard St.
xBELLEVILLE, N. J., 720 Washington Ave.
zxBLOOMFIELD, N. J., Clearfield Ave.
*BLOOMFIELD, N. J., Clearfield Ave.
#yBLOOMFIELD, N. J., Clearfield Ave.
*BOSTON, MASS., 10 High St.
#BOSTON, MASS., 44 Farnsworth St.
*BUFFALO, N. Y., 295 Main St.
*CHICAGO, ILL., 20 North Wacker Drive
*#CHICAGO, ILL., 2211 W. Pershing Road
*CINCINNATI, OHIO, Third & Elm Sts.
*CLEVELAND, OHIO, 1216 W. 58th St.
*COLUMBUS, OHIO, 85 E. Gay St.
*DALLAS, TEXAS, 209 Browder St.
*DAVENPORT, IOWA, 206 East Second St.
*DENVER, COLO., 910 Fifteenth St.
#*DETROIT, MICH., 5757 Trumbull Ave.
*EMERYVILLE, CALIF., 5915 Green St.
#xFAIRMONT, W. VA., P. O. Box 1144
*HOUSTON, TEXAS, 1314 Texas Ave.
*HUNTINGTON, W. VA., 1029 Seventh Ave.
*INDIANAPOLIS, IND., 137 So. Penna. St.
*JACKSON, MICH., 212 W. Michigan Ave.
*KANSAS CITY, MO., 101 W. Eleventh St.
#*LOS ANGELES, CALIF., 420 S. San Pedro St.
*LOUISVILLE, KY., 332 West Broadway
*MEMPHIS, TENN., 130 Madison St.
*MILWAUKEE, WISC., 546 North Broadway
*MINNEAPOLIS, MINN., 2303 Kennedy St., N. E.
*NEW ORLEANS, LA., 333 St. Charles St.
*NEW YORK, N. Y., 150 Varick St.
*OKLAHOMA CITY, OKLA., 850 N.W.Second St.
*OMAHA, NEB., 409 So. Seventeenth St.
*#ORANGE, N. J., Joyce St.
*PHILADELPHIA, PA., 3001 Walnut St.
*PITTSBURGH, PA., 306 4th Ave., Box 1017
*#PITTSBURGH, PA., 543 N. Lang Ave.
*ROCHESTER, N. Y., 1048 University Ave.
*ST. LOUIS, MO., 411 No. Seventh St.
#ST. LOUIS, MO., 1219 Gratoit St.
*SALT LAKE CITY, UTAH, 1st South & Main Sts.
*SAN FRANCISCO, CALIF., 1 Montgomery St.
#SAN FRANCISCO, CALIF., 60 Federal St.
*#SEATTLE, WASH., 3451 East Marginal Way
*SYRACUSE, N. Y., 961 W. Genesee St.
#xTRENTON, N. J., 400 Pennington Ave.
*WASHINGTON, D. C., 1434 N. Y. Ave., N. W.

WESTINGHOUSE ELECTRIC & MFG. CO., X-RAY DIVISION

Headquarters—21-16 43rd Ave., Long Island City, N. Y.

*ATLANTA, GA., 565 W. Peachtree St., N. E.
*BALTIMORE, MD., 118 East Lombard St.
*BOSTON, MASS., 270 Commonwealth Ave.
*CHICAGO, ILL., 14 No. Franklin St.
*CLEVELAND, OHIO, 7016 Euclid Ave.
*DALLAS, TEXAS, 207 Browder St.
*DENVER, COLO., 910 Fifteenth St.
#*DETROIT, MICH., 5757 Trumbull Ave.
*KANSAS CITY, MO., 410 Professional Bldg.
zxLONG ISLAND CITY, N. Y., 21-16 43rd Ave.
*LOS ANGELES, CALIF., 420 S. San Pedro St.
*MILWAUKEE, WISC., 534 North Broadway
*NEW ORLEANS, LA., 427 Baronne St.
*NEW YORK, N. Y., 173 E. Eighty-Seventh St.
*OMAHA, NEB., 117 N. Thirteenth St.
*PHILADELPHIA, PA., 3001 Walnut St.
*PITTSBURGH, PA., 3702 Fifth Ave.
①*PORTLAND, OREGON, 1210 S. W. Morrison St.
*ROCHESTER, N. Y., 1048 University Ave.
*SAN FRANCISCO, CALIF., 870 Market St.
*SEATTLE, WASH., 3451 E. Marginal Way

WESTINGHOUSE ELECTRIC ELEVATOR COMPANY

Headquarters—150 Pacific Ave., Jersey City, N. J.

BALTIMORE, MD., 39 West Lexington Ave.
BOSTON, MASS., 10 High St.
BROOKLYN, N. Y., 58 Schermerhorn St.
BUFFALO, N. Y., 806 Ellicott Sq. Bldg.
CHICAGO, ILL., 222 No. Bank Drive
CINCINNATI, OHIO, 419 Provident Bank Bldg., Vine and Seventh Sts.
CLEVELAND, OHIO, 842 Rockefeller Bldg.
DALLAS, TEXAS, 720 Santa Fe Bldg.
◆DENVER, COLO., 1052 Gas & Electric Bldg.
◆DES MOINES, IOWA, 1408 Walnut St.
DETROIT, MICH., 5757 Trumbull Ave.
◆DUBUQUE, IOWA, c/o Roshek Store
◆HARTFORD, CONN., 410 Asylum St.
◆HOUSTON, TEXAS, 2315 Commerce St.
◆INDIANAPOLIS, IND., 551 W. Merrill St.
zxJERSEY CITY, N. J., 150 Pacific Ave.
◆KANSAS CITY, MO., 101 W. Eleventh St.
◆LANSING, MICH., 522 W. Kilborn Ave.
LOS ANGELES, CALIF., 420 So. San Pedro St.
NEWARK, N. J., 17 Academy St.
NEW YORK, N. Y., 9 Rockefeller Plaza
NEW YORK, N. Y., 260 E. 161st St., Bronx
PHILADELPHIA, PA., 3001 Walnut St.
PITTSBURGH, PA., 435 Seventh Ave.
◆PORTLAND, ORE., 415 Terminal Sales Bldg.
◆SACRAMENTO, CALIF., 719 "K" St.
ST. LOUIS, MO., 1601 Ambassador Bldg.
SAN FRANCISCO, CALIF., 110 Sutter St.
◆SHREVEPORT, LA., 1812 Marshall St.
◆STEUBENVILLE, OHIO, 551 N. Fifth St.
◆TULSA, OKLA., 303 East Brady St.
WASHINGTON, D. C., 1112 21st St., N. W.

WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY

Headquarters—40 Wall St., New York, N. Y., U. S. A.

*ARGENTINE, BUENOS AIRES, Paseo Colon 221
①*AUSTRALIA, WATERLOO, N.S.W., P.O. Box 23
*BRAZIL, RIO DE JANEIRO, Caixa Postal 1320
*BRAZIL, SAO PAULO, Caixa Postal 4191
*COLOMBIA, MEDELLIN, Apartado 43
①*CHILE, SANTIAGO, °/o Wessel Duval & Cia., Casilla 86-D
*CUBA, HAVANA, Apartado 2289
*ENGLAND, LONDON, W.C. 2, 2 Norfolk St., Strand
*INDIA, BOMBAY, Westinghouse Electric Co. of India Ltd., 294A Bazargate St.
*ITALY, MILANO, Piazza Crispi 3
*MEXICO, D. F. Mexico, Cia. Westinghouse Electric Internacional, Edificio la Nacional, Apartado 78 Bis.
*PANAMA, REPUBLIC, Panama, Apartado 742
*PERU, LIMA, Casilla 1685
*PHILIPPINE ISLANDS, Manila. P.O. Box 998
*PUERTO RICO, San Juan, P.O. Box 1748
*SOUTH AFRICA, JOHANNESBURG, Westinghouse Electric Co. of South Africa, Ltd., P.O. Box 6067
*TRINIDAD, B.W.I., Port-of-Spain, P.O. Box 551

BRYANT ELECTRIC COMPANY

Headquarters—1421 State St., Bridgeport, Conn.

*BOSTON, MASS.
zxBRIDGEPORT, CONN., Main Plant, 1421 State St.
xBRIDGEPORT, CONN., Plastics Division Plant, 1105 Railroad Ave.
*#CHICAGO, ILL., 844 West Adams St.
*#LOS ANGELES, CALIF., 420 S. San Pedro St.
*NEW YORK, N. Y., 101 Park Ave.
*#SAN FRANCISCO, CALIF., 325 Ninth St.

WESTINGHOUSE RADIO STATIONS, INC.

Headquarters—1619 Walnut St., Philadelphia, Pa.

STATION KDKA, Grant Bldg., Pittsburgh, Pa.
STATION KYW, 1619 Walnut St., Philadelphia, Pa.
STATION WBZ, 275 Tremont St., Boston, Mass.
STATION WBZA, Hotel Kimball, Springfield, Mass.
STATION WOWO, 925 So. Harrison St., Fort Wayne, Ind.
STATION WGL, 925 So. Harrison St., Fort Wayne, Ind.
STATION WBOS, 275 Tremont St., Boston, Mass.

CANADIAN WESTINGHOUSE COMPANY, LIMITED

Headquarters—Hamilton, Ontario, Canada

*†#CALGARY, 320 Eighth Avenue, West Calgary, Alberta, Can.
#*EDMONTON, 10127, 104th St., Armstrong Block, Edmonton, Alberta, Can.
①#*FORT WILLIAM, 112 McVicar St., P.O. Box 10, Fort William, Ontario, Can.
①#*HALIFAX, 158 Granville St., Halifax, Nova Scotia, Can., P.O. Box 547
xz*HAMILTON, Hamilton, Ontario, Can.
*LONDON, 504 Huron & Erie Bldg., London, Ontario, Can.
*MONTREAL, 720 Dominion Sq. Bldg.
§MONTREAL, 400 McGill St., Montreal, Quebec, Can.
#†MONTREAL, 1844 William St., Montreal, Quebec, Can.
#*OTTAWA, Ahearn & Soper Limited, P.O. Box 794, Ottawa, Ontario, Can.
*†#REGINA, 2408 Eleventh Ave., Regina, Saskatchewan, Can.
*SASKATOON, 238 First Ave. N., Saskatchewan, Can.
†#*SWASTIKA, Swastika, Ontario, Can.
*†#TORONTO, 355 King St., West, Toronto, Ontario, Can.
*TRAIL, B.C., Room 3, Strand Theater Block, 1350 Cedar Ave.
*VANCOUVER, 1418 Marine Bldg., Vancouver, B. C., Can.
†#VANCOUVER, 1090 Homer St., Vancouver, B. C., Can.
#*†WINNIPEG, 158 Portage Ave. East, Winnipeg, Manitoba, Can.

①Changed or added since previous issue.

* Sales Office † Mfg. and Repair Shop x Works # Warehouse z Headquarters y Executive Office § Merchandising Products Only ‡ Apparatus Products Only
◆ Service Office only

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