I.B. 33-251-3

RECEIVING • INSTALLATION • MAINTENANCE

INSTRUCTIONS

"De-ion" Grid

OIL CIRCUIT BREAKER

Outdoor Type GC

Type 144-GC-100	14.4 kv	600 Amperes
Type 144-GC-250	14.4 kv	600 Amperes
Type 144-GC-250	14.4 kv	1200 Amperes
Type 144-GC-500	14.4 kv	600 Amperes
Type 144-GC-500	14-4 kv	1200 Amperes

WESTINGHOUSE ELECTRIC CORPORATION
POWER CIRCUIT BREAKER DEPT.

TRAFFORD PLANT • **TRAFFORD, PA.**

NEW INFORMATION

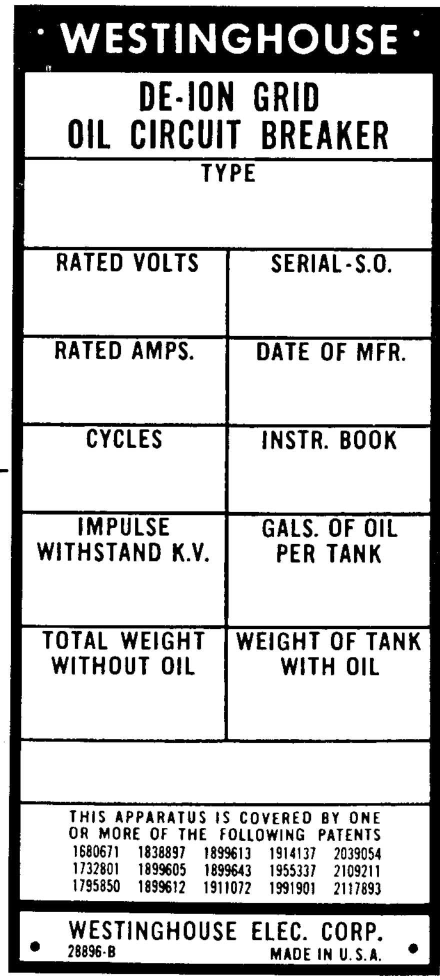
NOVEMBER, 1959

printed in U.S.A.

SPECIAL INQUIRIES

When communicating with Westinghouse regarding the product covered by this Instruction Book, include all data contained on the nameplate attached to the equipment.* Also, to facilitate replies when particular information is desired, be sure to state fully and clearly the problem and attendant conditions.

Please address all communications to the nearest Westinghouse representative as listed in the back of this book.



* For a permanent record, it is suggested that all nameplate data be duplicated and retained in a convenient location.

TABLE OF CONTENTS

TYPE GC OIL CIRCUIT BREAKER

The oil circuit breaker in a modern power system must always be ready to operate when called upon. It must close when the operator energizes the closing solenoid on electrically operated circuit breakers by moving the controller on the switchboard. It must open promptly when tripped by the operator moving the controller or when the protective relays function to energize the trip coil. It must open and interrupt the circuit, when a fault condition exists on the circuit, without damage to itself or adjacent apparatus, and continue to give satisfactory service with a minimum of maintenance.

The circuit breaker should be properly installed so that it will perform in the manner contemplated in the design. The construction should be such that maintenance can be carried out without undue skill being demanded on the part of the maintenance crew. A thorough knowledge of the construction of the circuit breaker and a complete understanding of the instructions given in this Instruction Book are essential to the satisfactory performance of the apparatus.

The breaker is made with two arrangements of terminals with relation to the mechanism and relay housing. In the standard arrangement of the breaker the circuit passes from left to right when facing the housing. The terminals on the left side are numbered 1, 3 and 5 from front to rear and 2, 4 and 6 on the right side. In the special 90° arrangement of the breaker the circuit passes from front to rear. The terminals behind the housing are numbered 1, 3 and 5 from left to right. The terminals at the rear are numbered 2, 4 and 6 from left to right.

PART ONE

RECEIVING, HANDLING AND STORING

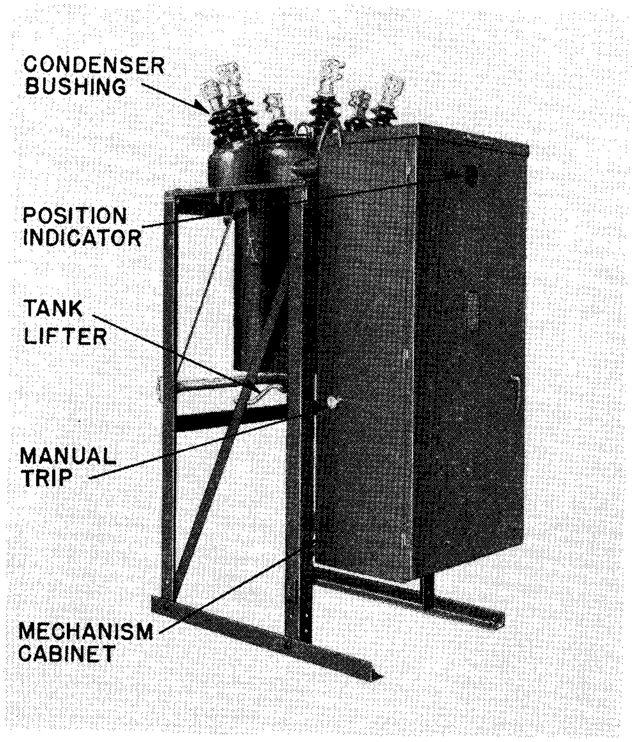


FIG. 1. Breaker Assembly

RECEIVING THE SHIPMENT

Each circuit breaker is completely assembled and tested at the factory, previous to being prepared for shipment. Immediately upon receipt an examination should be made for evidence of any damage which may have occured while enroute. If any damage is evident or indication of rough handling is visible, claims for damage should be filed at once with the Transportation Company and the nearest Westinghouse representative notified promptly.

STORING

The circuit breaker, when received, should be stored in a clean, dry location. Storing the circuit breaker near where construction work is still going on may result in considerable expense and work in cleaning and preparing it for service. It must not be exposed to dirt, to the action of corrosive gases such as chlorine, nor to possible mechanical injury. Dust incident to work on concrete structures is especially bad as the dust may work into the bearings or sliding parts causing undue friction or destructive abrasion.

Since the insulating parts such as condenser bushings, contact lift rods, and "De-ion" grid stacks may absorb moisture, ***it is strongly recommended that the tank be filled with oil*** as soon as possible after receipt of breaker.

HANDLING

The blocking around the skids and the tie bars holding the breaker down on the car should be removed first. This will permit moving the breaker on its skids to truck or other transport that will transfer it to its final location where the foundation should be ready to receive it. The skids can then be removed and the breaker bolted down in place.

In case clearances make it difficult to move the breaker standing up it can be laid down on its back on suitable blocking. Always see that the circuit breaker is in closed position before lying on the side. The lifting eyes on the back of the housing and in the center of the dome provide convenient places to attach slings or a chain hoist. ***Do not allow the slings to bear against the porcelains of the condenser bushings.***

Check the breaker against the shipping list to see that everything included is accounted for and in good condition. Keep identification tags and this instruction book handy until installation is complete then the book should be placed on file where it is available to the operating and maintenance staffs. A pocket inside the door provides a convenient place to keep this book and a copy of the diagram together with the card carrying the service record for the breaker. Additional copies can be obtained upon request to the nearest Sales Office of the Westinghouse Electric Corporation or any Westinghouse representative.

PART TWO

INSTALLATION

MOUNTING THE ASSEMBLY

1. Square up frame by placing wedges under the bottom angles. Tighten the mounting bolts. Fill the space under mounting angles with grout.

2. Remove the bolt holding the door handle. Open door and put stop rod in place to hold it open. Note door can be removed by taking out hinge pins.

3. Swing out relay panel, if one is included, and place hand closing lever in position to close the breaker. (See Figs. 8 and 12).

4. Examine solenoid closely and locate the wire holding trigger in latched position. Remove carefully so that trigger is not released.

5. Caution. Do not trip the solenoid mechanism while removing the wire ties because the breaker will move so fast that anyone caught in any moving parts may be seriously hurt.

6. Push down on hand closing lever in order to get enough overtravel to release the closing latch, Disengage closing latch with screw driver or small stick. (See Fig. 12).

7. Open the breaker slowly by releasing pressure on hand closing lever. Check for any friction other than normal friction due to stationary contact fingers and hinge contacts.

8. Remove the tank and examine the inside for evidence of moisture or foreign matter. Flush with benzine or circuit breaker oil. Tank should not be lowered in wet weather without provision for keeping out moisture.

9. Examine the contacts to see that they are clean and in alignment. See section covering adjustments in PART THREE.

10. Operate the breaker by hand several times, watching each pole and the operating mechanism to be sure that all parts move freely and that the moving contacts enter the "De-ion" grids without interference.

11. Check for 1/32" moving contact stop clearance under dome between middle crank lever and stop bolt (Fig. 4 or 5). With the solenoid mechanism closed and latched, the correct toggle position is obtained when two sides of the hexagonal operating shaft are exactly vertical. This position is controlled by adjusting the length of the operating rod to the solenoid mechanism—see Fig. 12. These adjustments should not require change unless the parts have been dis-assembled for some reason.

12. Check the auxiliary switch contacts to see that fingers are making good contacts on the rotor segments. Lighting out the circuits during initial installation is a good practice.

13. Close the breaker with the trip circuit energized to make sure that the mechanism will trip free without hesitation.

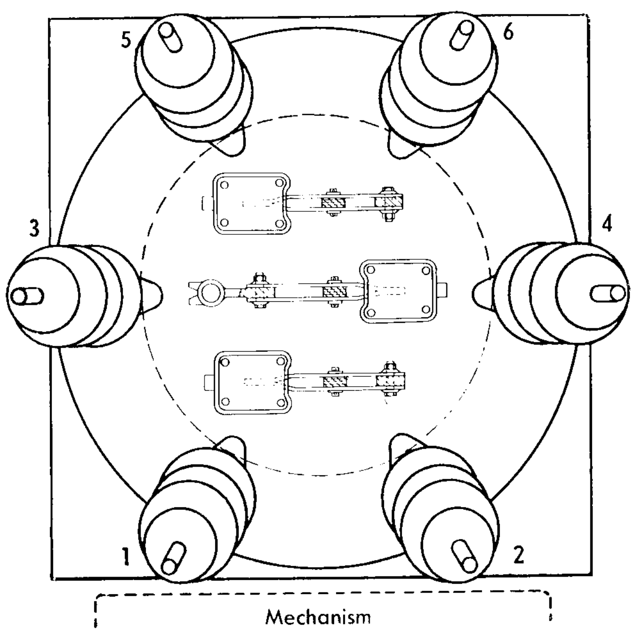


FIG. 2. Top View Standard Breaker

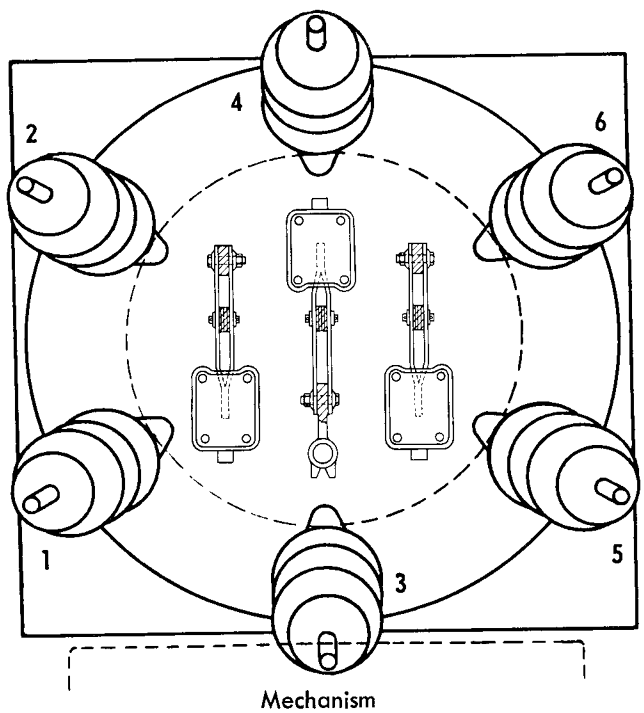


FIG. 3. Top View 90° Arrangement

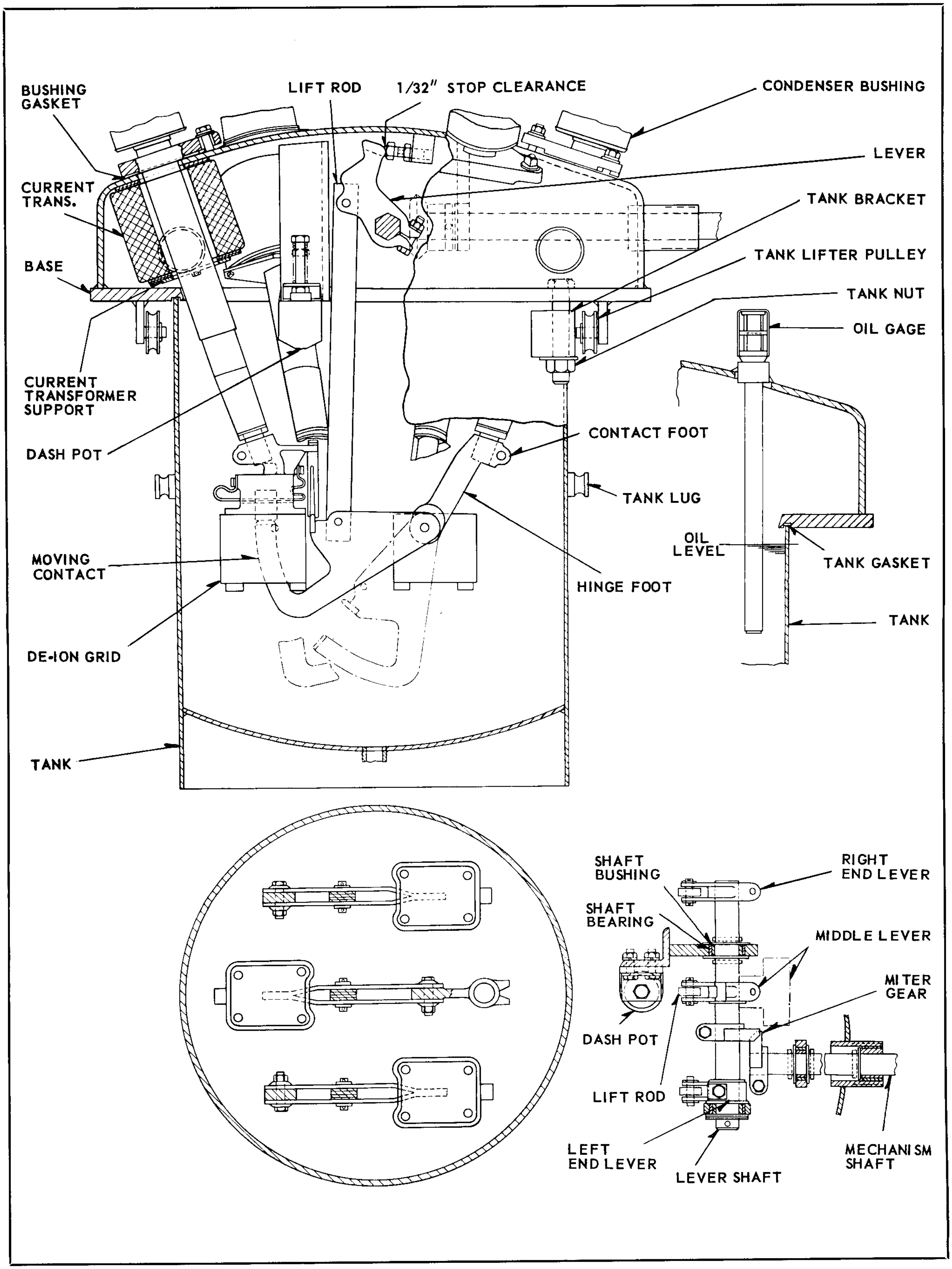


FIG. 4. Pole Unit Assembly—90° Arrangement

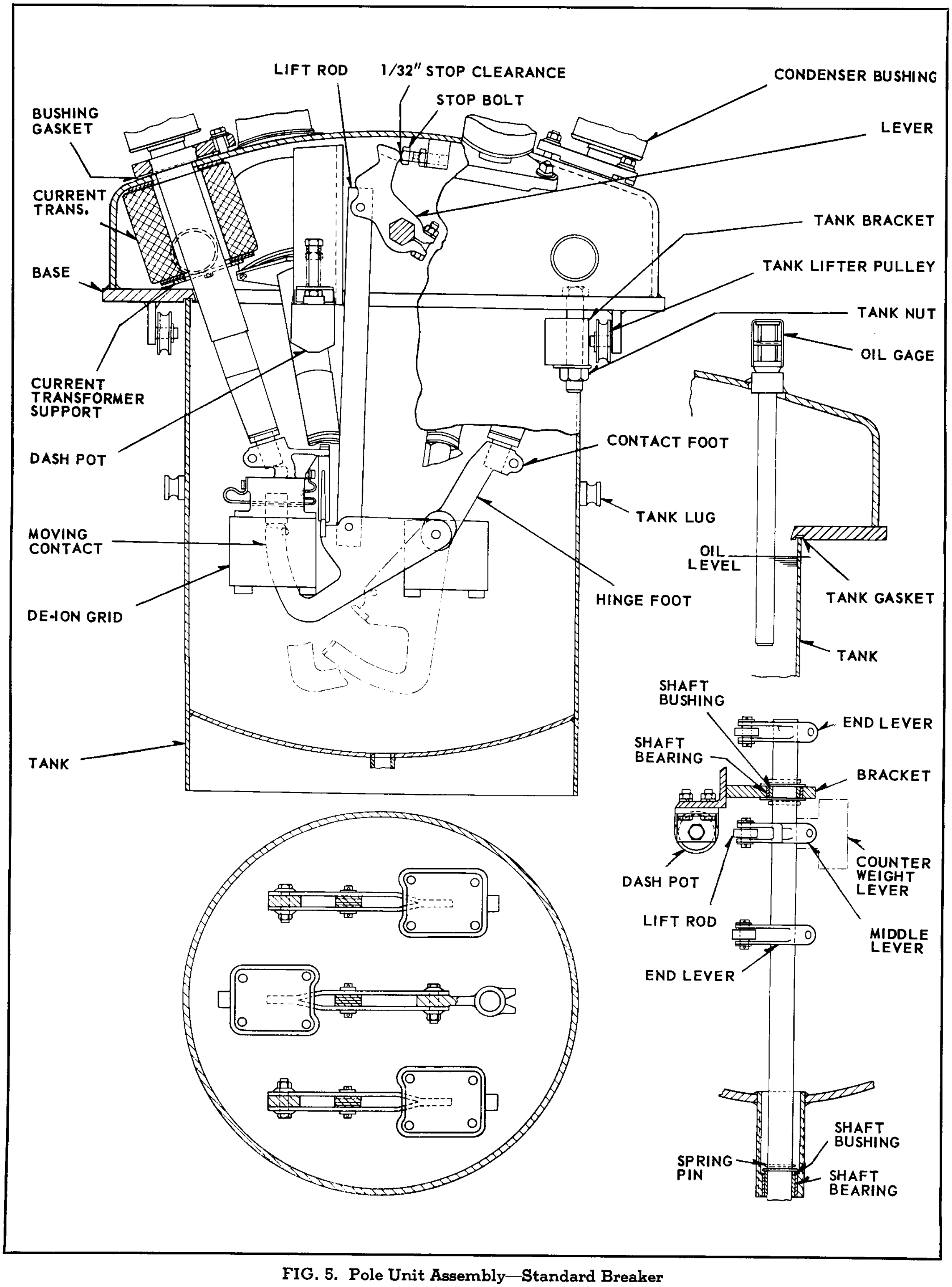


FIG. 5. Pole Unit Assembly—Standard Breaker

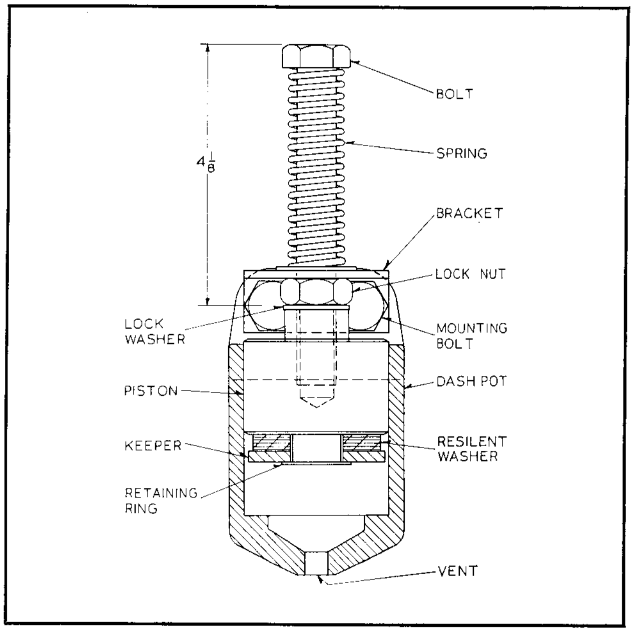


FIG. 6. Dash Pot Assembly

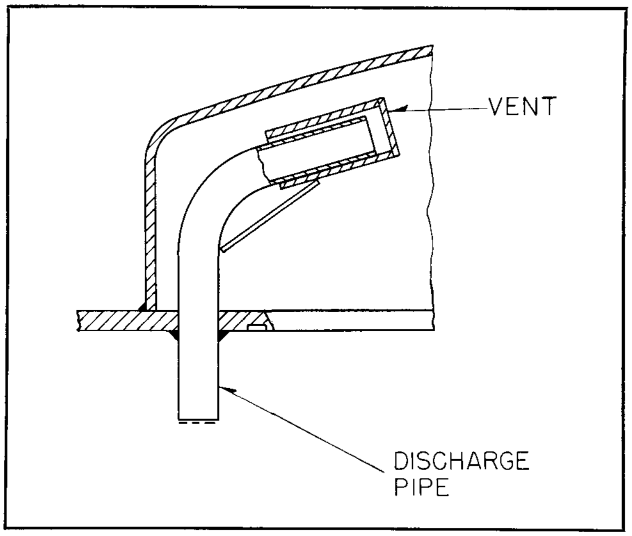


FIG. 7. Vent Assembly

Shaft Bearings. Bronze bushings broached to fit the shaft turn in oilite bearings which require no lubrication. The bearings are held in place by heavy washers backed up by spring pins. Where the shaft enters the solenoid cabinet the bushing is also cemented to the shaft to prevent gases from entering the cabinet during interruptions.

Vent. A baffled vent is provided to relieve the pressure due to the gases generated when interrupting the higher short circuit currents, while preventing the expulsion of oil.

Pole Unit Mechanism (90° Arrangement.) To relocate the mechanism housing 90° from the standard position the shaft with the pole unit levers is cut-off and provided with a bevel gear at one end. The shaft from the toggle mechanism entering the pole unit is similarly cut-off and provided with a mating bevel gear. These gears are not duplicates and must be reassembled, if ever removed, so as to maintain exactly the same relation between the two shafts with the hexagons exactly lined up. Gears should be positioned to mesh closely without binding. Tighten gear clamping bolts with torque wrench to 40 ft. lb.

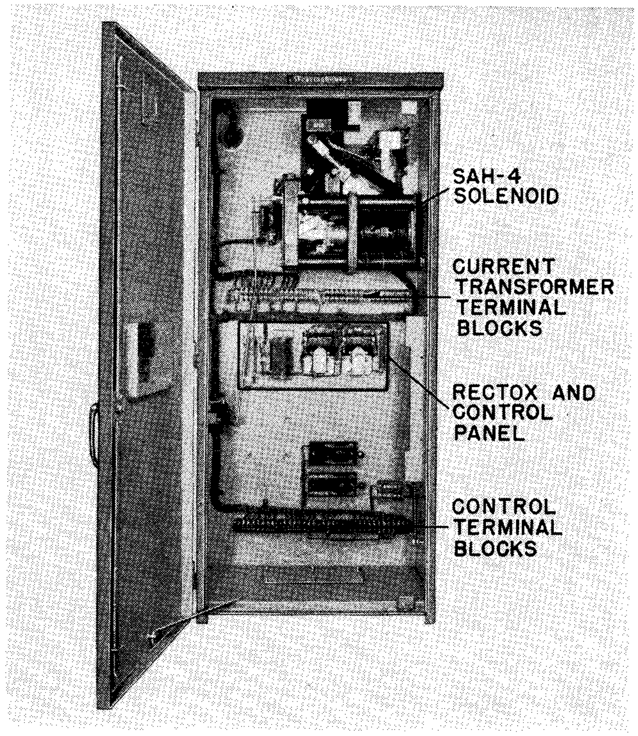


FIG. 8. Mechanism Housing Assembly

CONTROL LEADS

Remove the plate from the bottom of the mechanism housing and drill for the entrance of the conduit. Connect the control according to the diagram.

Be sure the leads which carry the closing current are large enough so that the voltage drop will not be excessive. Fuses, or other thermal protective devices, placed in the main control circuit should have a rating of 30% to 50% of the normal E/R current rating of the closing coil. This will permit passage of the closing current long enough to close the breaker without interrupting the control circuit and yet will interrupt it promptly if the breaker fails to close.

Note: The switch in the control should be open at all times while the breaker is being worked on. This prevents unintentional operation of the breaker by the switchboard attendant with possible injury to anyone caught by any of the moving parts of the breaker.

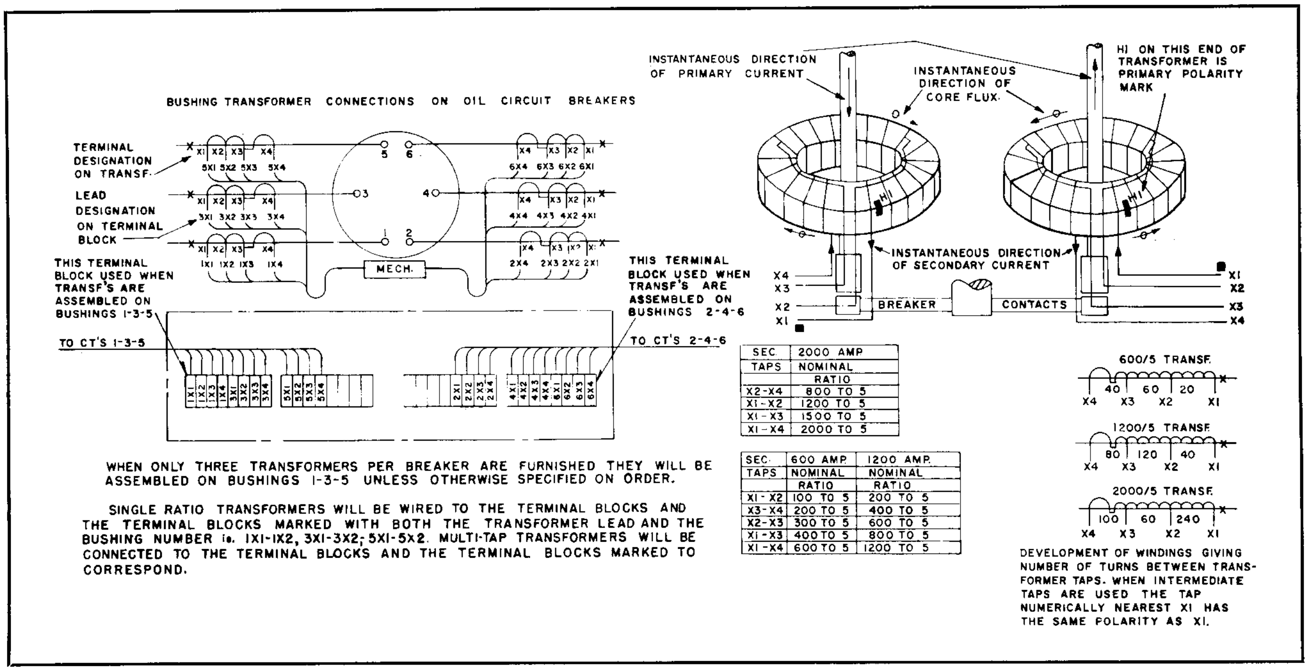


FIG. 9. Bushing Current Transformer Diagram—Standard Breaker

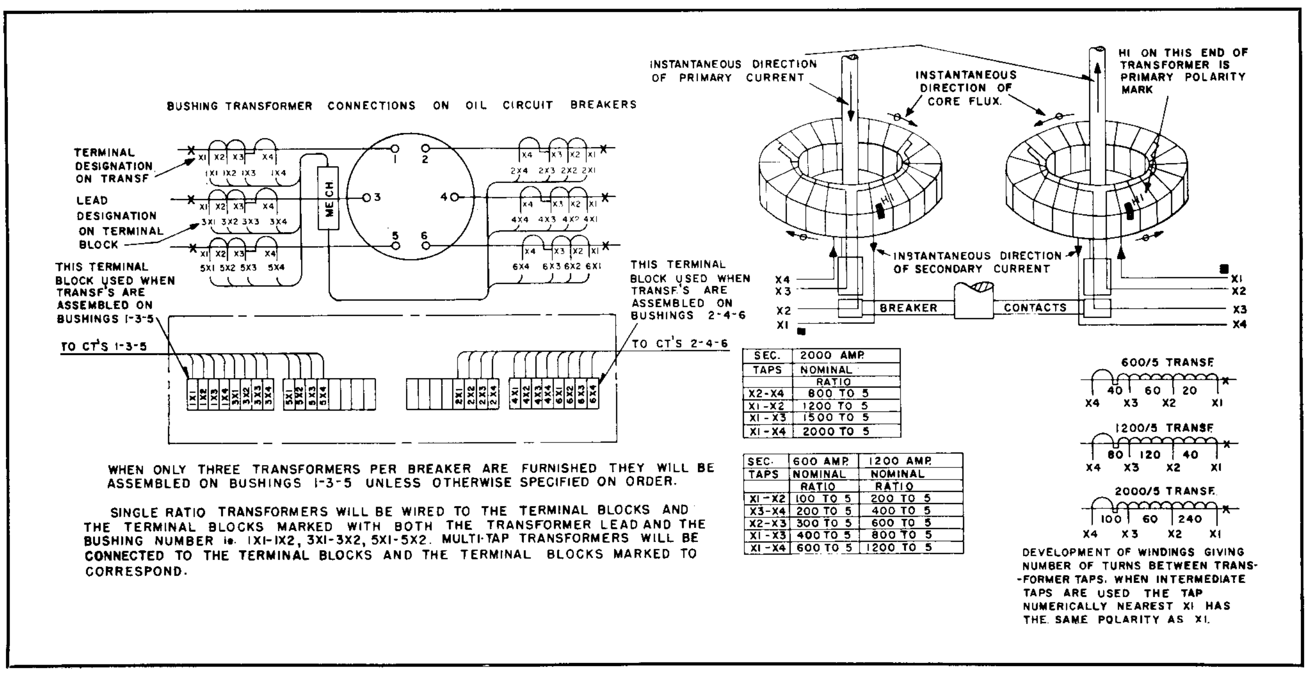


FIG. 10. Bushing Current Transformer Diagram—90° Arrangement

Check the control voltage at the breaker with a voltmeter when the closing coil is energized to see that the drop in the control bus will not interfere with operation. This measurement may be made by blocking the "Y" cutoff contactor. Be careful not to energize the closing coil more than 2 or 3 seconds at a time, since both the closing coil and Rectox (when used) are intermittent duty devices. While the operating solenoid will close the breaker at minimum control voltage, better all around performance will be obtained by keeping the potential near the normal control voltage shown on the name plate.

Caution. Always be sure the transformer secondary connections are completed before energizing the breaker. Short circuit unused transformers.

Transformer Taps. All taps on each transformer are brought to the terminal block. When overload coils or overcurrent relays are included they will be connected at the factory to the highest ratio tap. The bushing type current transformer nameplate should be used as an indication of the proper taps to use for relaying or current tripping for the particular load the breaker is to control. It is always necessary to check the proper taps by test.

Ground. Connect the circuit breaker frame to ground through the grounding pad on the breaker frame. **A permanent low resistance ground** should be provided which is capable of carrying the maximum line to ground current for the duration of the fault.

Connections. Install connections to the circuit breaker studs. The contact surfaces at all junctions must be carefully cleaned to remove all oxide. Copper surfaces can be rubbed with fine emery paper. Threaded copper surfaces can be brushed with a fine steel brush. A light coat of linseed oil on the threaded surface will make a better joint and will make breaking the joint easier when that becomes necessary.

The terminal studs are not designed to withstand undue cable or bus bar loads. An excessive strain, which at first may have no apparent affect, may eventually loosen the porcelain weather casing and permit moisture to enter the bushing. The power leads should have adequate capacity to carry the normal circuit load without overheating and to carry the possible momentary currents that may occur without excessive overheating. They should be properly braced to withstand the magnetic forces of the short circuit currents which may occur.

Preliminary Operation. Close and trip the breaker a few times to be sure operation is correct. Do not operate any more than is necessary for checking when the tank is lowered as a hydraulic dashpot, cushioning the stopping of the movement at the end of the opening stroke, is not in operation.

Tank. Fill the tank with oil to the level indicated on the nameplate. This is not quite enough to bring the oil gauge up to normal, but any more oil would be likely to spill out. Raise the tank into place with the tank lifter. Watch, in raising, to see that the studs on the underside of the base enter smoothly into the loops welded to the sides of the tank. As soon as studs pass through the loops start the nuts by hand. Raise the tank with the lifter just high enough to see that the tank rim registers in the groove in the base and against the packing. Draw the nuts up evenly all around. With the tank in place adjust the oil level by adding through the filling pipe at the right rear side of the base. In hot weather it is best to leave the oil slightly high and in cool weather slightly low, as the oil level will change with the temperature. A ratchet socket wrench with an extension reaching down below the lower edge of the tank makes removal and replacement easier. A "T" handle for the extension will help to drive the tank supporting nuts on TIGHT.

Check of Operation. With the tank in place and all connections made, the circuit breaker should be operated a number of times from the control switch to see that all circuits are clear.

1. Observe the response of the lights to the position of the breaker contacts.

2. Check each relay to see that it trips the breaker and that the target in the relay drops.

3. Check, if possible, to see that the solenoid closes and latches with 90 volts (for 125 volt control) across the closing coil with the coil energized, or 190 volts for 230 v. a-c control.

4. Check to see that 58% of normal potential on the trip coils trips the breaker.

5. Check to see that raising the trip coil plunger slowly by hand releases the primary latch when there is approximately 1/16" of travel left at the instant the latch releases.

6. Check time to close and part contacts with a cycle counter. This should not be over 24 cycles and 2 cycles respectively with normal control voltage at the breaker. If a Cincinnati timer is available it is desirable to make time-travel records of opening, closing, and reclosing operations when installing breaker for comparison during subsequent maintenance checks. Typical factory records are available on request.

The Cincinnati timer may be clamped to the floor of the mechanism cabinet and connected to the 10-32 tapped hole available at the position indicator. The 3/16 in. diameter operating rod should be reinforced by taping to a wood rod in order to prevent whipping.

PART THREE

OPERATION AND ADJUSTMENTS

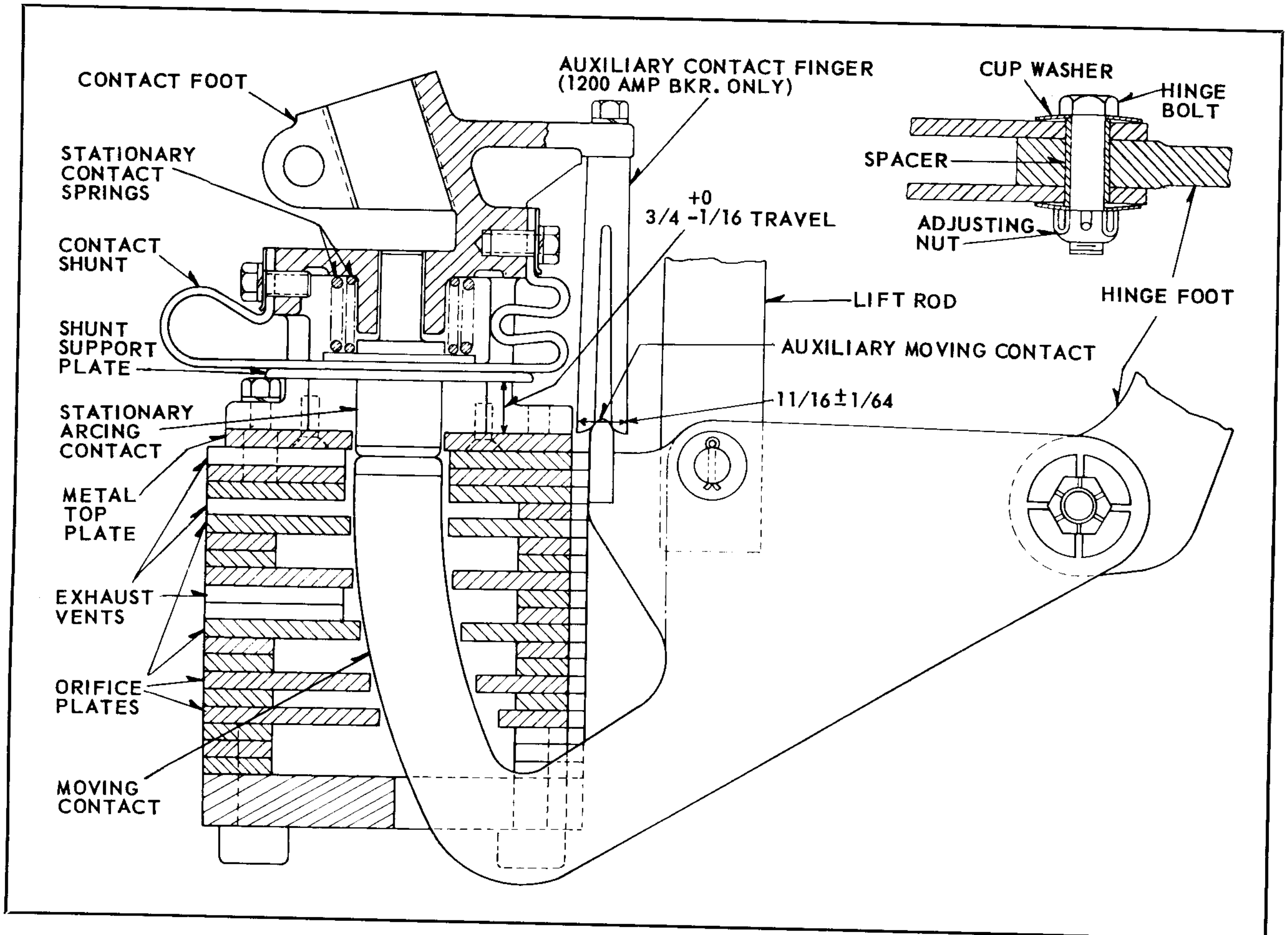


FIG. 11. De-ion Grid and Contact Assembly

CONTACT OPERATION

The "De-ion" Grid interrupters used on these breakers consist of a stack of horn-fibre plates arranged to provide orifice plates, oil pockets, and exhaust vents in such a manner that efficient high speed arc interruption is effected. When the contacts part on a fault operation, the heat of the arc causes the oil in the pockets to disintegrate and form un-ionized gas particles. The pressure built up inside the grid provides a turbulent action which causes these un-ionized particles to mix with the ionized particles in the arc stream and at the same time forces this mixture through the orifice plates and out the exhaust vents to cause rapid de-ionization of the arc stream. When sufficient dielectric strength is established between the separating contacts to withstand the system recovery voltage, the arc will be extinguished at the next current zero.

Many interruptions take place at the first current zero after parting contacts, especially on high currents where the gas pressure inside the grid is highest. However, if the rate of rise of system recovery voltage is sufficiently rapid, arcing may continue for one or two more half cycles until contact separation is sufficient to withstand the recovery voltage.

As may be seen in Fig. 11, butt contacts are used in order to get high speed contact parting time. The stationary and moving contacts are both tipped with silver tungsten which provides sufficient conductivity for the 600-ampere rating, while at the same time providing good resistance to arc erosion. An auxiliary "tuning-fork" finger contact is used outside the interrupter for the 1200-ampere rating. This contact parts first on an opening operation, so that all the arcing takes place inside the interrupter on the butt contacts. It will be noted that a single

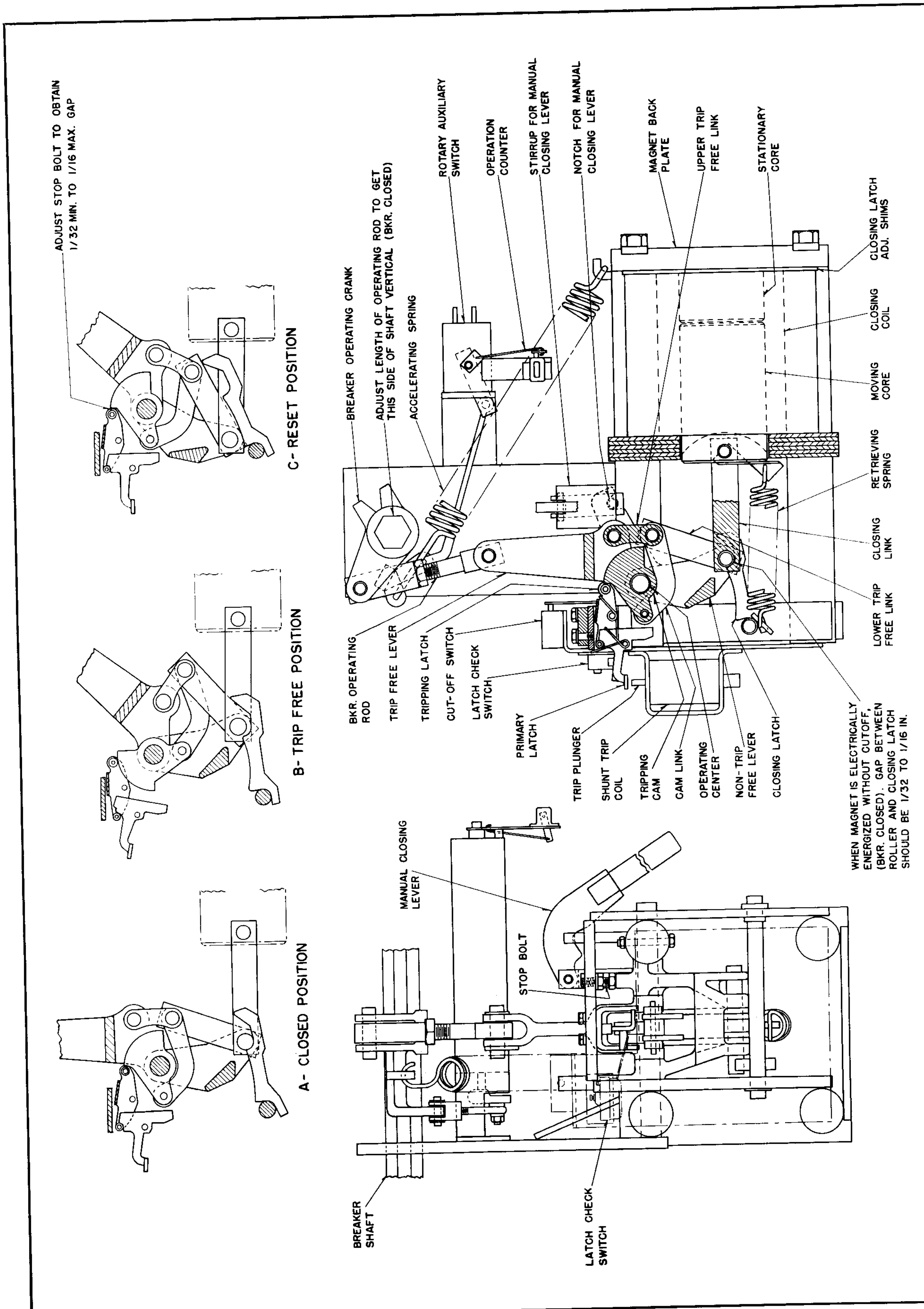


FIG. 12. Solenoid Operating Mechanism

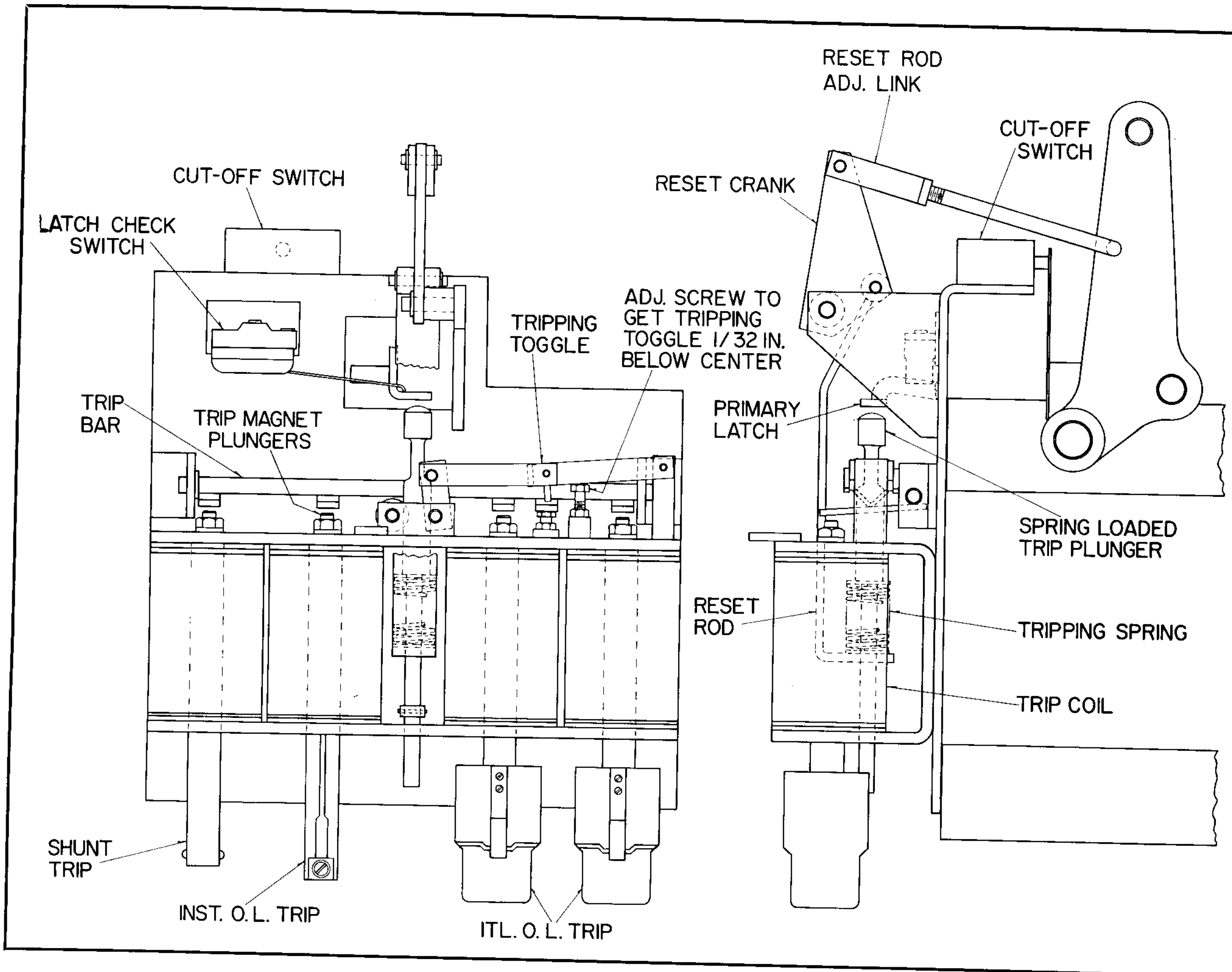


FIG. 13. Four-Coil Trip Attachment

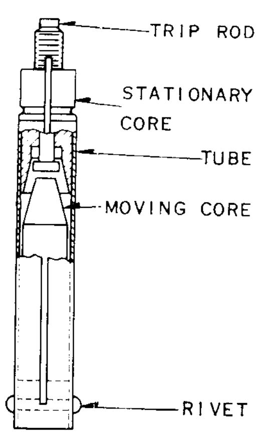


FIG. 14. Shunt Trip Assembly

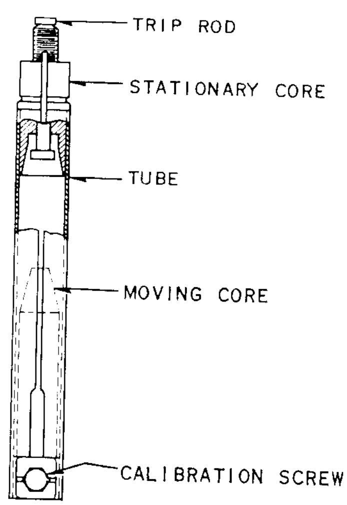


FIG. 15. Instantaneous Overload Trip Assembly

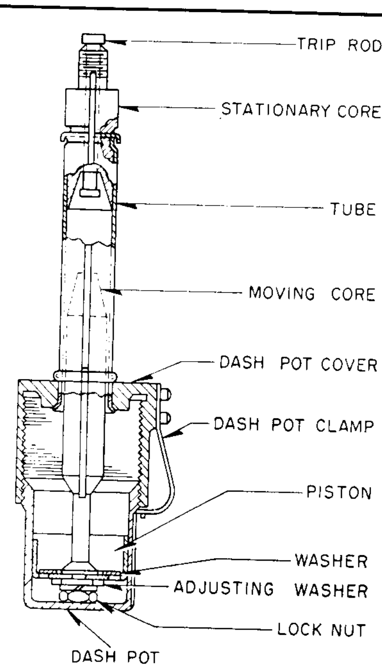


FIG. 16. Inverse Time Limit Trip Assembly

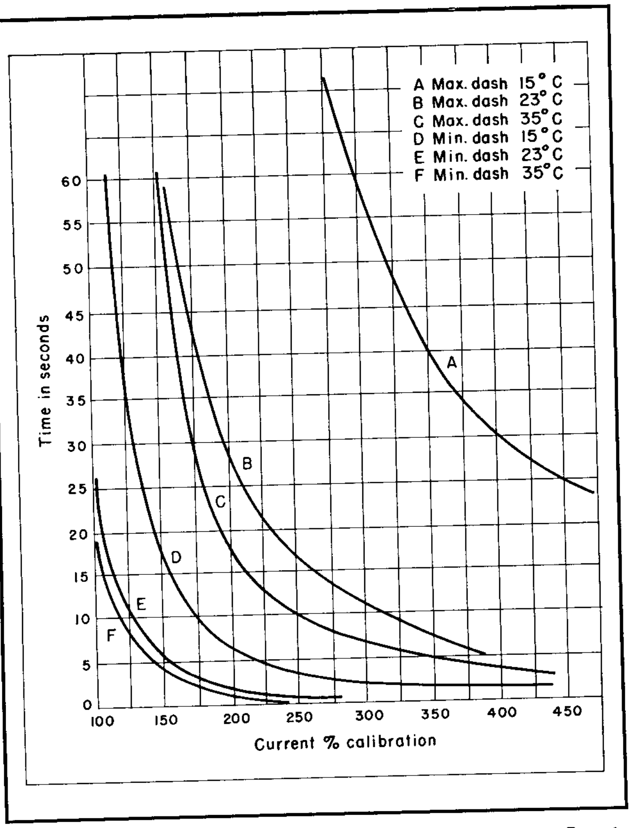


FIG. 17. Time Delay Curves for Inverse Time Limit Overload Trip

interrupter per phase is used, so that the moving contact is hinged on one side which eliminates the need for a lift rod guide.

CONTACT ADJUSTMENT

1. Refer to contact assembly Fig. 11. With the breaker closed and latched, the stationary arcing contact should be 3/4 +0 − 1/16″ above its open position. This may be observed by looking through the opening at the rear of the contact foot and checking the height of the shunt support plate above the metal top plate on the grid stack. When the auxiliary contact finger is used (1200-ampere breaker only), the finger should spread to 11/16 ± 1/64″ as shown. These adjustments are obtained by screwing the contact foot and hinge foot up or down on the condenser bushing studs. Note that adjusting the contact foot will affect both the arcing and auxiliary contact adjustments equally. However, adjusting the hinge foot will affect the arcing contact adjustment almost 3 times as much as the auxiliary contact adjustment; this is because the moving contact is pivoting about the lower lift rod pin when making this adjustment and the different radii of the arcing and auxiliary contact with respect to this pivot point. It is important not to spread the auxiliary contact finger beyond the specified dimension and to observe the 1/32″ overtravel stop clearance (Par. 11, Page 6) in order not to damage the finger.

2. See that the moving contact strikes centrally on the stationary arcing contact. This may be obtained by loosening the contact foot and hinge foot and turning on the condenser bushing studs. Lateral alignment may be obtained by loosening the condenser bushing flange nuts and shifting the bushing on its gasket seat. Use about 30 ft.-lb. on torque wrench when re-tightening these nuts. Alignment of the auxiliary contact finger (1200-ampere breaker) may be obtained by loosening the two bolts which secure it to the contact foot and shifting in clearance holes.

3. Check to see that the moving contact blade does not bind in the grid slot when the breaker is closed slowly by hand. Alignment of the grid stack may be obtained by loosening the nuts which secure it to the contact foot and rapping with rubber mallet.

4. Removal of the stationary arcing contact may be accomplished by (1) unbolting laminated shunt on both sides of the contact foot, (2) removing the grid stack from the contact foot, and (3) removing the metal plate on the under side of the contact foot. When replacing the stationary arcing contact, make sure that the long end of the shunt is placed toward the center of the tank. Note that one spring is used for the 100 MVA rating, while two are used for the 250 and 500 MVA ratings.

5. When replacing moving contacts avoid excess pressure on the hinge. Make contacts fit hinge snugly without spreading. Tighten nut and bolt finger tight and then take up to the next slot in the castle nut. This will provide enough pressure to just hold the weight of the moving contact when disconnected from the lift rod.

Caution: Always see that the flange of the condenser bushing does not touch the plate forming the lower part of the top cover or the current transformer support. Either of these conditions will affect the current transformer ratio.

Any slight roughness found on the contacts should be smoothed with a file. Contacts should be replaced if burns penetrating more than 1/16″ are found.

OPERATING MECHANISM

The type SAH-4 mechanism is a solenoid type operating on standard direct current control voltages or, when equipped with a rectifier unit, on alternating current. It is mechanically full automatic and trip free in all positions. The standard mechanism is supplied with a single shunt trip coil, a single plunger type cut-off switch, and a nine-pole rotary type auxiliary switch for trip coil cut-off and operation of indicating lights. Reclosing breakers are equipped with a latch checking switch.

The mechanism can be supplied with a shunt trip coil or a capacitor shunt trip, or three instantaneous or inverse time delay transformer trip coils.

Mechanism Operation. The solenoid operating mechanism with its trip-free linkage is shown in Fig. 12. In this mechanism, the horizontal pull of the solenoid coil is transmitted to the contact operating rods through a system of links which rotate counterclockwise about the operating center. The linkage system consists of four (4) major links: the non-trip free lever, trip free lever, upper trip free link, and lower trip free link. These members are arranged as shown and are held to form a rigid member by the cam link and tripping cam. The tripping cam is held fixed by the tripping latch.

When the solenoid is energized, it pulls on the junction of the non-trip free lever and the lower trip free link, causing the system to rotate about the operating center. The trip free lever then exerts an upward force on the operating rod to close the breaker. The breaker is held in this position by the closing latch.

The breaker is tripped electrically or manually by lifting the primary latch. This allows the tripping latch to release the tripping cam so that it is free to rotate. Without the restraining force of the cam and cam links, the major linkage collapses under the force of the contact springs and the accellerating spring. The junction of the upper and lower trip free links moves to the right, and the trip free lever rotates clockwise opening the breaker. The position of the linkage is then as shown in Fig. 12B.

In moving to this position, the lower trip free link has disengaged the closing latch. The retrieving springs now pull on the solenoid core which moves the linkage to the reset position as shown in Fig. 12C. In this position the tripping latch is reset and the breaker may be reclosed.

Manual Closing. The pin on the pivoting link of the manual closing lever engages a notch on the non-trip-free lever, while a notch near the end of the lever rests in the stirrup near the front of the mechanism. The manual lever is pushed downward until the mechanism reaches the latched position.

Manual Tripping. The manual trip knob located outside the mechanism cabinet operates a linkage which lifts the primary latch to trip the breaker.

Mechanism Adjustment. If a breaker fails to close contacts although the moving core of the mechanism moves to the closed position, a probable cause is failure to reset. Refer to "C", Fig. 12. The gap indicated between the tripping latch roller and cam is an essential requirement to permit the tripping latch to fall into the cam notch. Watch the primary latch (with words "lift to trip"), it should return to the horizontal position immediately after breaker has been opened.

If the trigger is prevented from returning to the full reset position by the primary latch roller above it, the cause may be that tripping latch roller cannot drop into cam notch. Using the hand closing lever, close the breaker part way, trip it, and then slowly retrieve the moving core. Note whether or not the tripping latch roller drops into the cam notch.

If it is necessary to increase the clearance to get 1/32 inch, loosen the locknut and adjust the stop bolt until the cam to roller clearance is within limits. The hand closing lever should be removed during this adjustment.

ATTACHMENTS

Shunt Trip Magnet. The shunt trip magnet is a small electro-magnet which is used to trip the breaker electrically. It may be equipped with a coil for d-c, a-c or capacitor tripping. When the shunt trip magnet is energized, the core is drawn up into the magnet yoke. A plunger attached to the core strikes the trip lever directly above it which disengages the primary latch to trip the breaker.

Rotary Auxiliary Switch. A nine-pole rotary auxiliary switch mounts on the upper right side of the solenoid. This switch is operated by the breaker crank lever which turns the rotor approximately 90°. The 1st and 3rd contact segments are connected in series with the trip coil. These segments are wider than the others, so that they will complete the trip circuit ahead of breaker contacts touching on a closing operation. The rotor segments are arranged alternately with the odd numbered ones (52-a on diagram) making contact when the breaker closes, and the even numbered ones (52-b) making contact when the breaker opens. The segments may be changed from one position to the other by disassembling the rotor. Check the contacts during maintenance to see that the flexible finger follows in and makes good contact with the rotor segment. Burns from arcing should be smoothed, or the contacts replaced when necessary.

Operation Counter. The operation counter mounts on the nine-pole auxiliary switch bracket. The operating arm is set so that the counter advances one number on each tripping operation.

Cut-Off Switch. The cut-off switch (52-aa on diagram) is a plunger type switch operated by an

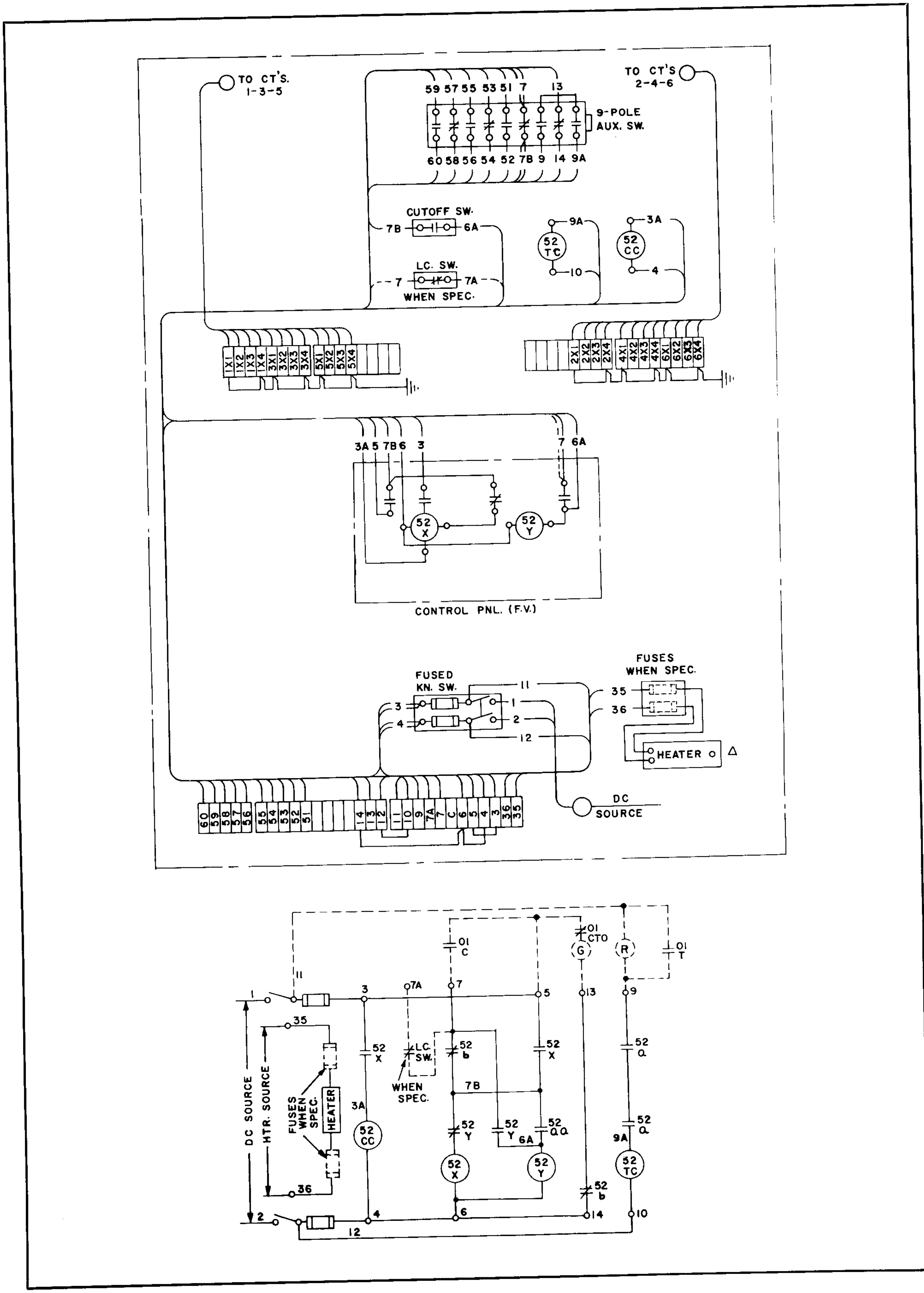


FIG. 18. D-C. Diagram

arm attached to the non-trip-free lever in the mechanism. This switch energizes the "Y" relay in order to cut off the closing coil current at the end of the closing stroke. The contacts on this switch must make positively just before the end of the closing stroke so that the closing current will always be cut off. However, the contacts must not make too early, or the mechanism might fail to latch. Proper action will be obtained when the switch plunger has 1/32 to 1/8 inch over travel remaining when the breaker is closed and latched. If it should be necessary to change the switch adjustment, this may be accomplished by bending the switch operating arm slightly.

Latch Check Switch. The latch check switch is a small, light force, snap action switch which is operated by the primary latch. When a breaker is to be automatically reclosed after being tripped free, it is necessary to arrange the electrical control scheme so that the closing solenoid will not be energized to start the closing motion until the mechanism has completed the linkage motion to get to the reset position. See B and C of Fig. 12. For this purpose, the switch is arranged to be closed when the primary latch is reset, because the primary latch is the last part to reset in the sequence of linkage motions required to reset the mechanism. The action of this switch may be checked as follows. With the breaker open, raise the primary latch arm to end of its travel. Lower it slowly listening for the snap action of the switch. Note the position of the arm when the switch snaps closed. The switch should close when the latch arm is in an interval from 3/8 to 1/8 inch above the normal reset position measuring at the shunt trip plunger centerline. If switch action must be made earlier or later, bend the switch arm near the middle of its length.

Four-Coil Trip Attachment. Whenever overload tripping is required where the energy for tripping is obtained solely from the bushing current transformers, it is necessary to use a four-coil trip attachment, sometimes called a "light-trip" attachment. This attachment is equivalent to a mechanical relay which reduces the tripping energy requirements to the level obtainable from bushing current transformers. The usual arrangement is to have three 5-ampere transformer overload coils (one per phase) and an A-C shunt trip coil for operation from a remote control switch.

Referring to Fig. 13, the 4-coil attachment is bolted in the same place occupied by the standard shunt trip magnet. A spring loaded trip plunger is restrained by a toggle linkage that engages a shoulder on the plunger. Raising the plunger on any of the four trip coils to strike the trip bar releases the toggle linkage which allows the spring-loaded plunger to disengage the primary latch in the usual manner. When the mechanism opens, the reset rod moves downward to allow the trip plunger to drop down and be re-engaged by the toggle linkage. Then when the mechanism closes, the plunger spring is compressed in readiness for the next tripping operation.

Check the adjusting screw to see that the tripping toggle linkage is 1/32 inch below center. This should be enough to insure positive latching, and any more than this will increase the energy required to release the toggle. The reset rod is operated through a crank and adjustable link from the trip-free lever. The length of the link should be such that the toggle linkage drops into place positively when the mechanism opens.

Current Transformer Overload Trip. Overload trip magnets operated directly from the bushing current transformers are similar to the shunt trip magnet except that a means is provided to vary the air gap between the plunger and its stationary core. The position of the plunger is calibrated between 5 and 9 amperes, and the calibration is stamped on the plunger tube. Tripping may be obtained at the desired primary current by using a suitable current transformer ratio. The overload trip magnet shown in Fig. 15 will trip instantaneously when the selected current is applied.

The time delay overload trip shown in Fig. 16 is used where it is desired to delay tripping on small overloads, but to trip essentially instantaneously on fault currents. This is similar to the instantaneous trip with a dashpot added to restrain the trip plunger. The 5 to 9 ampere calibration is obtained by screwing the dashpot up or down in its cover. The dashpot piston has a series of holes in the bottom with an adjusting disc that may be rotated to change the number of holes uncovered. A loose washer above the piston allows quick resetting. The time delay varies with the percent overload and the viscosity of the oil. Fig. 17 shows typical curves of the time delay that may be expected with standard dashpot oil as supplied. Since the viscosity of the oil changes somewhat with temperature, it is obvious that this device cannot be used where accurate settings are required. Accurate settings require the use of overload relays with D-C or capacitor shunt trip coils.

Rectifier for A-C Closing. Since many breakers are located where a station battery is not available, it is desirable to use a 230 V. A-C source for closing power through a rectifier unit to provide 125 V. D-C for the closing coil. A 3 K.V.A or larger supply

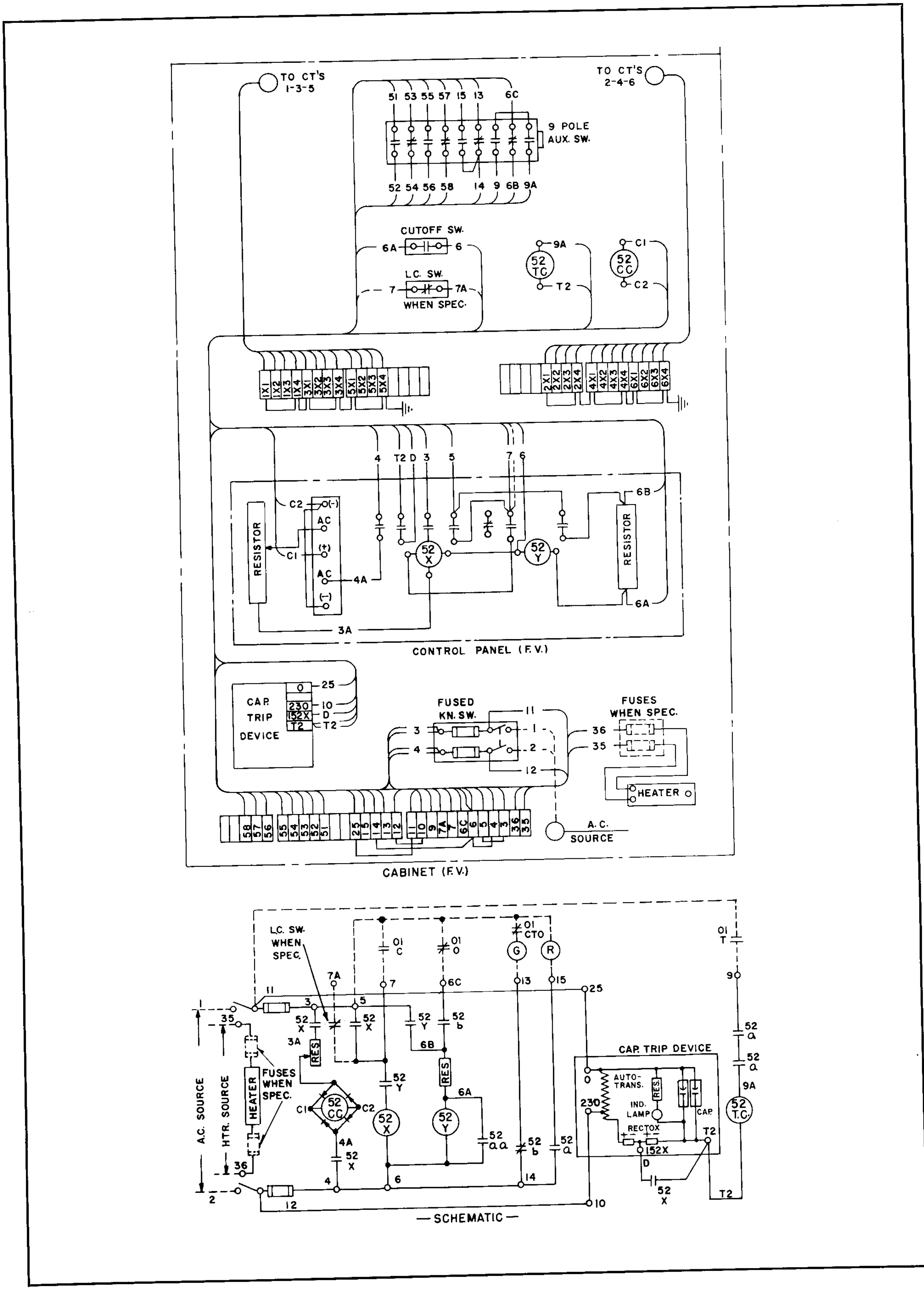


FIG. 19. A-C. Diagram

transformer located near the breaker is sufficient to avoid excessive regulation. The Rectox control panel includes a series resistor which may be adjusted if the A-C voltage at the breaker varies considerably from 230 volts (normal range is 190-250 V.A-C.). This resistor should be set so that the minimum closing voltage is about 40 volts below whatever the normal circuit voltage is at the breaker with closing coil current flowing. **Rectox is an intermittant duty device—do not energize for more than 3 seconds when making voltage measurements.** This resistor was used also to compensate for aging on the older copper-oxide rectifer units, but aging is negligible on the newer selenium units.

"XY" Closing Control. Referring to Figure 18 for D-C control, when the control switch is turned to close the breaker, the "52X" contactor is energized to complete the battery circuit to the "52CC" closing coil. When the breaker reaches the closed position, the "aa" cutoff switch closes to energize the "52Y" contactor. The "52Y" contactor in turn de-energizes the "52X" contactor by means of a "back" contact which then disconnects the closing coil automatically, and simultaneously parallels the "52aa" switch with the "52Y" seal-in contact. Thus, even if the breaker closes on a fault and "trips free", undesirable "pumping" is prevented because the "52Y" contactor remains energized to hold the closing coil circuit open as long as the control switch is held closed.

Referring to Fig. 19 for A-C control, the same results are accomplished in a slightly different manner. When the breaker is open, the "52Y" contactor is energized continuously through a "b" auxiliary switch (paralleled by "52Y" seal-in) to complete the circuit to the "52X" contactor except for the control switch. When the breaker is closed, the "aa" cutoff switch shorts out the "52Y" contactor (series resistor prevents short circuit across control bus) and causes it to drop out to de-energize the "52X" contactor and closing coil. In this case, "pumping" is prevented by the "O" contact on the control switch which opens when the control switch is closed, to keep the "52Y" contactor de-energized. The reason for this is that the A-C control source is usually taken through a station service transformer from the same power line the breaker is controlling—thus, if a fault near the breaker causes the A-C voltage to collapse, the "anti-pumping" feature is still retained.

Fig. 19 shows the capacitor trip device which is commonly used with distribution breakers in order to eliminate the need of a station tripping battery. However, either battery tripping or current transformer overload trip coils may be used instead if desired.

PART FOUR

MAINTENANCE

It has become the practice of operating companies to establish a system of regular inspection of their apparatus. Oil circuit breakers especially, due to the nature of their function, should be operated on a planned maintenance program. It is recommended that each new breaker be given a one year "shake-down" period to prove the initial installation and to establish the duty to which it is likely to be subjected. After this one year period, the oil should be drained from the tanks, and a thorough inspection made as outlined under "General Inspection Procedure". It is our standard practice to recommend that each breaker be given such a general inspection once a year. It is recognized, however, that many breakers operate so seldom that such yearly inspections may not be necessary, and on the other hand that some breakers are subjected to severe duty which makes more frequent servicing necessary.

Many companies compile detailed operating data on individual breakers, and from such information and past experience on various types of breakers are able to set up an inspection and maintenance program which fits more closely the duty performed. Following are some of the factors to be considered in setting up such a "tailor made" inspection schedule:

1. Time.

2. Number of switching and testing operations.

3. Number of overload and fault operations.

4. Severity of fault operations.

5. Condition of oil.

6. Cleanliness of atmosphere surrounding breaker.

7. Accumulated experience of breaker characteristics and duty.

Where an inspection schedule other than the yearly General Inspection is set up, we recommend that each breaker be given a "Routine" Inspection once yearly and that it be given a "General" Inspection at least once every three years. The significance of the two types of inspection are developed in the following paragraphs.

Regardless of what type maintenance program is adopted, it is further recommended that frequent visual inspections be made by operators touring the switchyard in order to catch any obvious abnormal condition. It is also considered good practice to operate the breaker from the switchboard at regular intervals to insure the integrity of all electrical circuits, as well as proper mechanical functioning of the breaker.

Caution: Before working on a breaker that has just been disconnected from the line, make sure that the condenser bushings have been discharged by grounding the terminal end.

ROUTINE INSPECTION PROCEDURE

The suggested Routine Inspection procedure is as follows:

1. Check mechanical operation of breaker.

2. Check dielectric strength of oil.

3. Check contact engagement by "lighting out" through contact circuit.

It naturally follows that any abnormal condition found during the Routine Inspection should be cause for lowering the tanks and giving the breaker a thorough General Inspection.

GENERAL INSPECTION PROCEDURE

General inspection of the breaker requires that the tanks be lowered on the breaker. Before any parts are disturbed, the following adjustments should be checked to give an indication of the condition of the breaker as removed from service for the inspection.

Caution: Open the control circuit at the breaker before starting to inspect or work on the breaker parts, so that accidental breaker operation cannot occur.

1. Close the breaker by power with the operating mechanism.

2. Check stop clearances for the moving contacts under the dome between the middle crank lever and stop bolt.

3. Inspect the stationary contact assemblies to determine the condition of the contact surfaces and the contact setting. Some burning on the contacts is not detrimental as long as the electrical conductivity and contact setting have not been materially changed. If the burning is severe the contacts should be removed and reconditioned or replaced.

4. Note the condition of the moving contacts, reconditioning or replacing them if necessary.

5. Note the condition of all parts now accessible. Check the bolts, nuts, spring cotters, etc., and tighten where necessary. Repair or replace any damaged parts.

6. Close the breaker slowly by hand and check the contact adjustment.

7. Clean the lower ends of the bushings and the Micarta lift rods with a clean cloth dampened with clean oil. Clean carbon from the grid stacks.

8. Check the operating mechanism for loose nuts and bolts and for missing spring cotters. Lubricate bearings with a few drops of lubricating oil. See paragraph below for detail maintenance instructions on mechanism.

9. Check latches to see that faces are in good condition and are properly adjusted. Apply rust inhibitor to latch faces. The inhibitor should be free flowing at all anticipated temperatures, non-hardening and self-healing (so that it will not wipe completely off in one operation). A light lubricant similar to Westinghouse 9921-4 or "Gunslick" is suggested.

10. Check control wiring for loose connections.

11. Check gasket joints, conduit and tank fittings to make sure no water can enter the breaker.

12. Check dielectric breakdown strength of the oil.

13. Check oil bumper cylinder to be sure it is not jammed.

14. Raise and secure tank after replacing oil if required. Check closing and tripping operations, using all usual relays and circuits involved in the operation of the breaker. Be sure all relay contacts are clean.

15. Check closing and tripping at reduced voltage to insure safety margin.

Note: If it is necessary to make any re-adjustments, it is recommended that a recheck of the operating speed be made.

OPERATING MECHANISM

During inspection the following points should be kept in mind. (1) Remove loose dust and dirt with a compressed air stream. (2) Wipe off latch and roller surfaces. (3) With hand closing lever, move mechanism parts slowly closed to point where arcing contacts just touch, and then allow contact arms to fall slowly to open position, observing for any evidence of stickiness or excessive friction. (4) Holding primary latch up, move hand closing lever up and down slowly. The core should move freely in the solenoid and the linkage system should reset positively when the weight of the hand close lever is removed slowly.

Lubrication. If any excessive friction or binding is discovered on the above inspection, relieve it either by adding oil or if necessary by cleaning old dried lubricant from the bearing surfaces. In general, the addition of a few drops of oil should be sufficient in most cases. In a few cases, after long service, the accumulation of dried or oxidized lubricant may make it necessary to disassemble parts and clean them. Carbon tetrachloride is a good solvent for this.

Apply a small amount of a light oil to pins and wearing surfaces. Use a stable oil with a low rate of oxidation and with a low pour point. A light lubricant similar to Westinghouse 9921-4 or "Gunslick" is recommended for latching surfaces.

Clearances. After a mechanism has operated several thousand times, the following points should be checked as part of routine inspection. With the breaker open and the mechanism reset, there should be 1/32 to 1/16 clearance between the tripping latch roller and the cam. See Fig. 12. If readjustment is necessary, see explanation under mechanism adjustments.

To permit the closing latch to move up to its holding position the roller at the lower end of the non-trip free lever must overtravel the latch surface slightly. With the breaker closed, look at the closing latch and roller and energize the close coil for one or two seconds several times. The overtravel should be approximately 1/32 minimum to 1/16 maximum. With wear in the link holes and pins, this overtravel may decrease. Adjustment is made with steel shim washers between the magnet back plate and the four large magnetic return studs.

After about 15,000 operations, replacement of some parts may be required. During routine maintenance, the amount of wear should be observed on latch surfaces, rollers, pins and pin holes. If it becomes impossible to obtain correct adjustments or if latches fail to hold, replacements should be considered.

CONDENSER BUSHINGS

Maintenance and power factor testing of condenser bushings should be given consideration during breaker inspection. An instruction leaflet is sent with each condenser bushing. This leaflet should be studied for complete recommendations on maintenance of bushings.

Important. When placing bushings in breaker, do not permit the metal flange on the bushing to touch the metal support which holds the transformer in place. This has the effect of a short circuiting turn around the transformer, and affects the ratio.

BUSHING CURRENT TRANSFORMER

If it should be necessary for any reason to replace a current transformer, stationary contact and

"De-ion" Grid should be removed first so that the transformer may be taken out.

The transformer may be disconnected at the terminal block in the mechanism cabinet. When the transformer is removed, it will be necessary to remove the gas plug in the mechanism cabinet. Care should be taken to see that the packing on top and bottom of the transformer is in place. See Figs. 4 or 5.

Be sure to place the end of the transformer carrying the white polarity mark upward. Also, see that the transformer is not thrown off ratio by allowing the support to touch the metal grounding band on the condenser bushing.

Caution: Be sure that proper transformer connections are made and a burden or short circuit placed across the terminals at the blocks in the mechanism housing before the breaker is closed on the line. Otherwise dangerous voltage may appear across the open secondary terminals.

CARE OF OIL

Wemco "C" oil is recommended for use in all circuit breakers. Westinghouse cannot assume responsibility for circuit breakers if an inferior grade of insulating oil is used, or if the dielectric strength of the oil is not properly maintained.

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 test, and to purfiy the oil whenever necessary to maintain it in good condition. The more handling the insulating oil receives, the greater are the chances for it to become contaminated, unless adequate precautions are taken.

It is recommended that operators prepare a schedule for inspection based on operating conditions. Reference to the station log of the operation of the circuit breakers, together with the record of dielectric tests of the oil, should determine the frequency of inspection and test. This period between successive inspections should never be longer than six months. When the dielectric 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 16,500 volts when tested in a standard test cup with electrodes spaced 0.1 in. apart. It is essential that the proper oil level be maintained in the circuit breakers. Considerable change may be caused by changing temperature or possible leakage of oil. Low oil levels may cause flashover of bushings or failure to handle heavy interruptions properly. Oil bumpers may be uncovered and fail to provide proper cushioning effect.

Attention is called to Westinghouse Instruction Book 44-820-1. This book covers the care and maintenance of oil and should be referred to before any attempt is made to test or purify the oil.

RENEWAL PARTS

A list of renewal parts recommended to be maintained in stock will be furnished on request. When ordering renewal parts, specify the name of the part. Identify the breaker by including the type, amperes, volts and Shop Order (S.O.) Number, as engraved on the nameplate.

WESTINGHOUSE

Instructions for "De-ion" Grid

Oil Circuit Breaker Outdoor Type GC

Type 144-GC-100	14.4 kv	600 Amperes
Type 144-GC-250	14.4 kv	600 Amperes
Type 144-GC-250	14.4 kv	1200 Amperes
Type 144-GC-500	14.4 kv	600 Amperes
Type 144-GC-500	14.4 kv	1200 Amperes

Westinghouse Electric Corporation
Power Circuit Breaker Division
I.B. 33-251-3B Effective January, 1967. Supersedes I.B. 33-251-3A
Printed in U.S.A.

Special Inquiries

When communicating with Westinghouse regarding the product covered by this Instruction Book, include all data contained on the nameplate attached to the equipment.* Also, to facilitate replies when particular information is desired, be sure to state fully and clearly the problem and attendant conditions.

Please address all communications to the nearest Westinghouse representative.

Westinghouse

Type **Power Circuit Breaker**

	Serial—S.O.	Date of Mfr.
Rated Max. KV.	Rated Continuous Amp.	Rated Freq. Cycles
FW Imp. Withstand KV.	Rated Short-Ckt. Amp.	KV Range Factor K
Rated Inter. Time Cycles	Gal. of Oil Per Tank	Lbs. of Gas Per Bkr.
Wt. Bkr. With Oil/Gas Lbs.	Instruction Book	

Westinghouse Electric Corporation 184P066H01 MADE IN U.S.A.

*For a permanent record, it is suggested that all nameplate data be duplicated and retained in a convenient location.

Table of Contents

Type GC Oil Circuit Breaker

The oil circuit breaker in a modern power system must always be ready to operate when called upon. It must close when the operator energizes the closing solenoid on electrically operated circuit breakers by moving the controller on the switchboard. It must open promptly when tripped by the operator moving the controller or when the protective relays function to energize the trip coil. It must open and interrupt the circuit, when a fault condition exists on the circuit, without damage to itself or adjacent apparatus, and continue to give satisfactory service with a minimum of maintenance.

The circuit breaker should be properly installed so that it will perform in the manner contemplated in the design. The construction should be such that maintenance can be carried out without undue skill being demanded on the part of the maintenance crew. A thorough knowledge of the construction of the circuit breaker and a complete understanding of the instructions given in this Instruction Book will be helpful in the installation, maintenance and use of this equipment.

Part One
Receiving, Handling and Storing

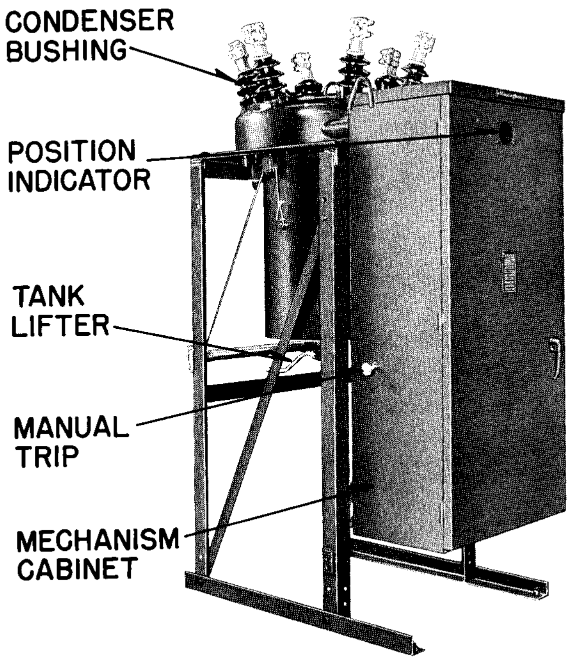


Fig. 1 Breaker Assembly

RECEIVING THE SHIPMENT

Each circuit breaker is completely assembled and tested at the factory, previous to being prepared for shipment. Immediately upon receipt an examination should be made for evidence of any damage which may have occurred while enroute. If any damage is evident or indication of rough handling is visible, claims for damage should be filed at once with the Transportation Company and the nearest Westinghouse representative notified promptly.

STORING

The circuit breaker, when received, should be stored in a clean, dry location. Storing the circuit breaker near where construction work is still going on may result in considerable expense and work in cleaning and preparing it for service. It must not be exposed to dirt, to the action of corrosive gases such as chlorine, nor to possible mechanical injury. Dust incident to work on concrete structures is especially bad as the dust may work into the bearings or sliding parts causing undue friction or destructive abrasion.

Since the insulating parts such as condenser bushings, contact lift rods, and "De-ion" grid stacks may absorb moisture, it is strongly recommended that the tank be filled with oil as soon as possible after receipt of breaker.

HANDLING

The blocking around the skids and the tie bars holding the breaker down on the car should be removed first. This will permit moving the breaker on its skids to truck or other transport that will transfer it to its final location where the foundation should be ready to receive it. The skids can then be removed and the breaker bolted down in place.

In case clearances make it difficult to move the breaker standing up it can be laid down on its back on suitable blocking. Always see that the circuit breaker is in closed position before lying on the side. The lifting eyes on the back of the housing and in the center of the dome provide convenient places to attach slings or a chain hoist. Do not allow the slings to bear against the procelains of the condenser bushings.

Check the breaker against the shipping list to see that everything included is accounted for and in good condition. Keep identification tags and this instruction book handy until installation is complete then the book should be placed on file where it is available to the operating and maintenance staffs. A pocket inside the door provides a convenient place to keep this book and a copy of the diagram together with the card carrying the service record for the breaker. Additional copies can be obtained upon request to the nearest Sales Office of the Westinghouse Electric Corporation or any Westinghouse representative.

Part Two Installation

MOUNTING THE ASSEMBLY

1. Square up frame by placing wedges under the bottom angles. Tighten the mounting bolts. Fill the space under mounting angles with grout.

2. Remove the bolt holding the door handle. Open door and put stop rod in place to hold it open. Note door can be removed by taking out hinge pins.

3. Swing out relay panel, if one is included, and place hand closing lever in position to close the breaker. (See Figs. 9 and 15).

4. Examine solenoid closely and locate the wire holding trigger in latched position. Remove carefully so that trigger is not released.

5. CAUTION. Do not trip the solenoid mechanism while removing the wire ties because the breaker will move so fast that anyone caught in any moving parts may be seriously hurt.

6. Pull up on hand closing lever in order to get enough over-travel to release the closing latch. Disengage closing latch with screw driver or small stick. (See Figs. 9 and 15).

7. Open the breaker slowly by releasing pressure on hand closing lever. Check for any friction other than normal friction due to hinge contacts.

8. Remove the tank and examine the inside for evidence of moisture or foreign matter. Flush with benzine or circuit breaker oil. Tank should not be lowered in wet weather without provision for keeping out moisture.

9. Examine the contacts to see that they are clean and in alignment. See section covering adjustments in PART THREE.

10. Operate the breaker by hand several times, watching each pole and the operating mechanism to be sure that all parts move freely and that the moving contacts enter the "De-ion" grids without interference.

11. Check for 3/32" moving contact stop clearance under dome between middle crank lever and stop bolt (Fig. 3). With the solenoid mechanism closed and latched, the correct toggle position is obtained when two sides of the hexagonal operating shaft are

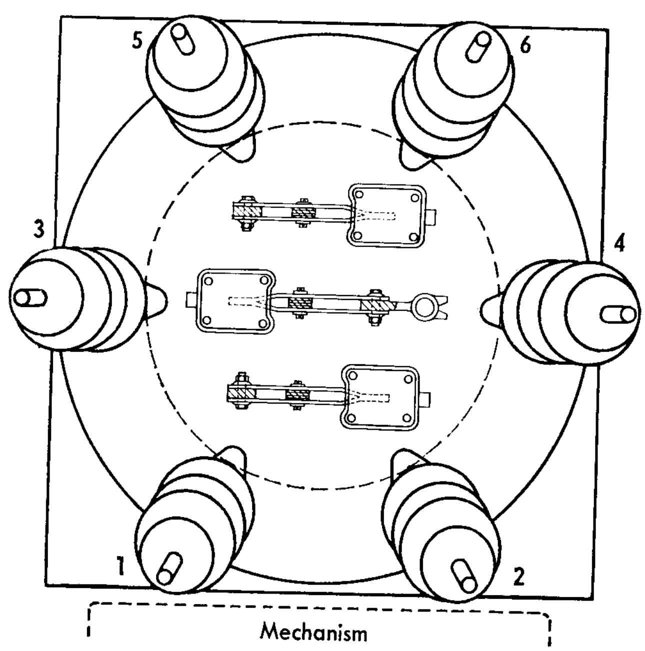


Fig. 2 Top View of Breaker

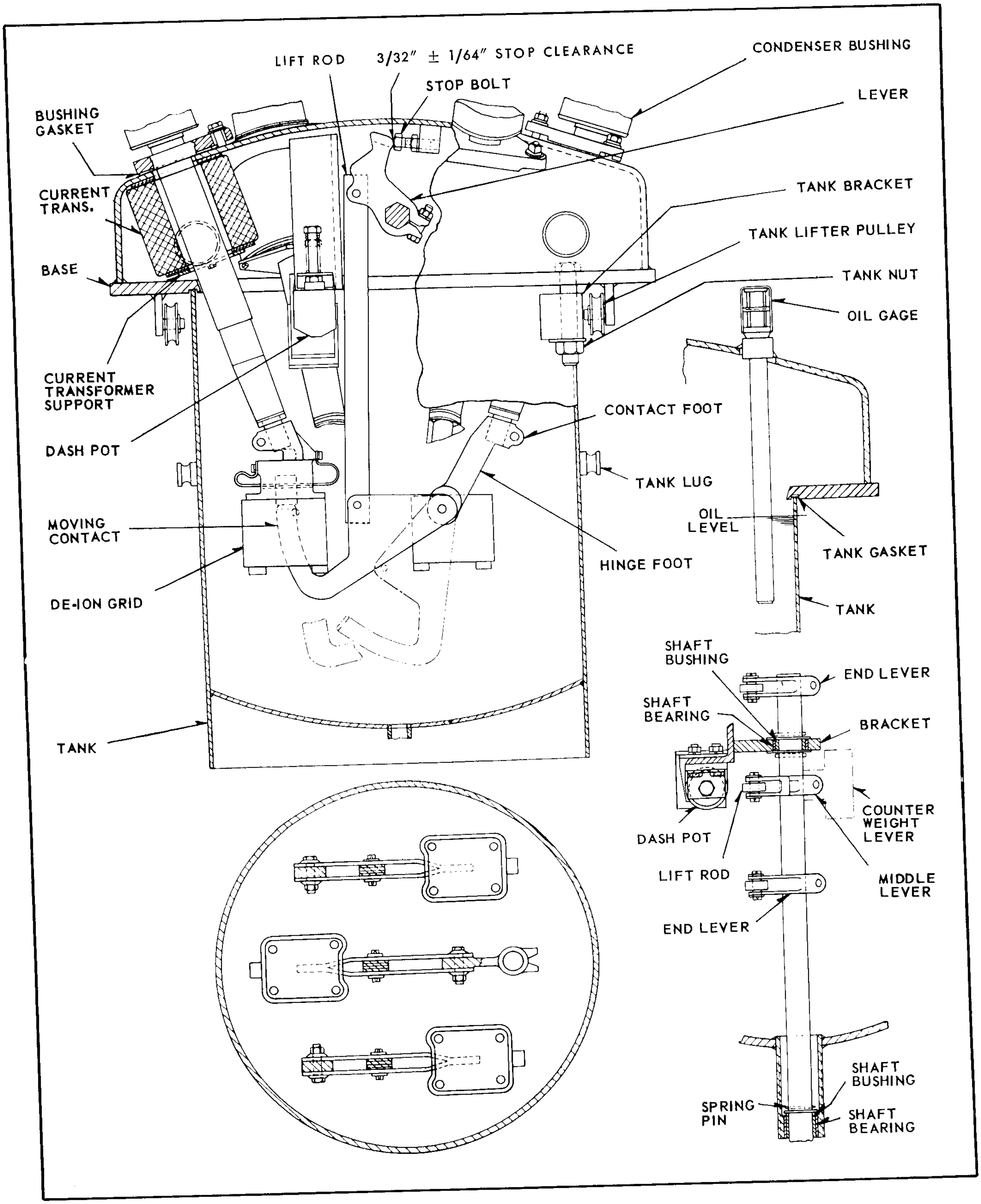


Fig. 3 Pole Unit Assembly - Standard Breaker

exactly vertical. This position is controlled by adjusting the length of the operating rod to the solenoid mechanism. (See Fig. 9). These adjustments should not require change unless the parts have been disassembled for some reason.

12. Check the auxiliary switch contacts to see that fingers are making good contacts on the rotor segments. Lighting out the circuits during initial installation is a good practice.

13. Close the breaker with the trip circuit energized to make sure that the mechanism will trip free without hesitation.

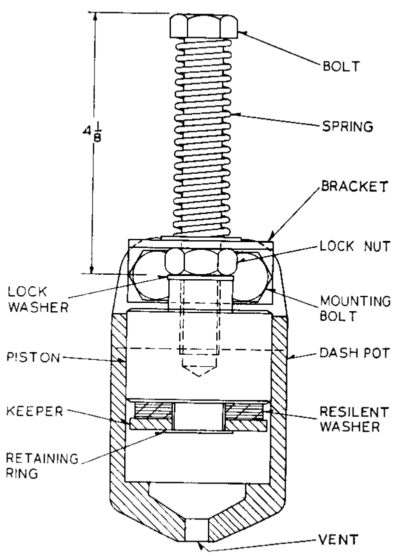


Fig. 4 Dash Pot Assembly

Shaft Bearings

Bronze bushings broached to fit the shaft turn in oilite bearings which require no lubrication. The bearings are held in place by heavy washers backed up by spring pins. Where the shaft enters the solenoid cabinet the bushing is also cemented to the shaft to prevent gases from entering the cabinet during interruptions.

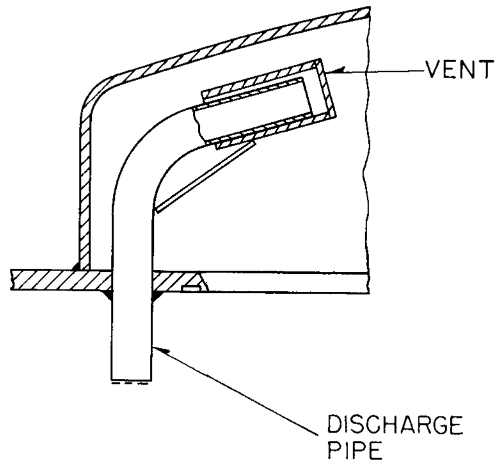


Fig. 5 Vent Assembly

Vent

A baffled vent is provided to relieve the pressure due to the gases generated when interrupting the higher short circuit currents, while preventing the expulsion of oil.

CONTROL LEADS

Remove the plate from the bottom of the mechanism housing and drill for the entrance of the conduit. Connect the control according to the diagram.

Be sure the leads which carry the closing current are large enough so that the voltage drop will not be excessive. Fuses, or other thermal protective devices, placed in the main control circuit should have a rating of 30% to 50% of the normal E/R current rating of the closing coil. This will permit passage of the closing current long enough to close the breaker without interrupting the control circuit and yet will interrupt it promptly if the breaker fails to close.

NOTE: The switch in the control should be open at all times while the breaker is being worked on. This prevents unintentional operation of the breaker by the switchboard attendant with possible injury to anyone caught by any of the moving parts of the breaker.

Check the control voltage at the breaker with a voltmeter when the closing coil is energized to see that the drop in the control bus will not interfere with operation. This measurement may be made by blocking the "Y" cutoff contactor. Be careful not to energize the closing coil more than 2 or 3 seconds at a time, since both the closing coil and Rectox (when used) are intermittent duty devices. While the operating solenoid will close the breaker at minimum control voltage, better all around performance will be obtained by keeping the potential near the normal control voltage shown on the nameplate.

CAUTION: Always be sure the transformer secondary connections are completed before energizing the breaker. Short circuit unused transformers.

Transformer Taps

All taps on each transformer are brought to the terminal block. When overload coils or overcurrent relays are included they will be connected at the factory to the highest ratio tap. The bushing type current transformer nameplate should be used as an indication of the proper taps to use for relaying or current tripping for the particular load the breaker is to control. It is always necessary to check the proper taps by test.

Ground

Connect the circuit breaker frame to ground through the grounding pad on the breaker frame. A permanent low resistance ground should be provided which is capable of carrying the maximum line to ground current for the duration of the fault.

Connections

Install connections to the circuit breaker studs. The contact surfaces at all junctions must be carefully cleaned to remove all oxide. Copper surfaces can be rubbed with

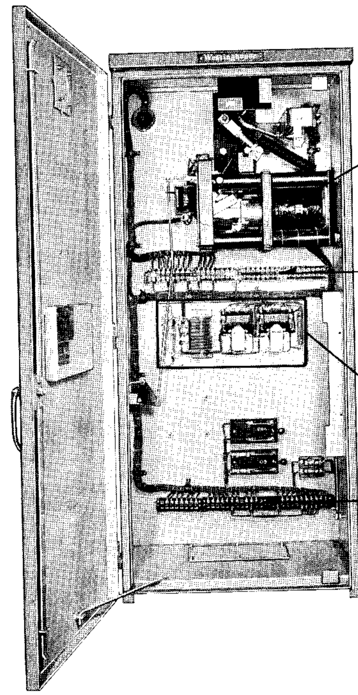


Fig. 6 Mechanism Housing Assembly

fine emery paper. Threaded copper surfaces can be brushed with a fine steel brush. A light coat of linseed oil on the threaded surface will make a better joint and will make breaking the joint easier when that becomes necessary.

The terminal studs are not designed to withstand undue cable or bus bar loads. An excessive strain, which at first may have no apparent affect, may eventually loosen the porcelain weather casing and permit moisture to enter the bushing. The power leads should have adequate capacity to carry the normal circuit load without overheating and to carry the possible momentary currents that may occur without excessive overheating. They should be properly braced to withstand the magnetic forces of the short circuit currents which may occur.

Preliminary Operation

Close and trip the breaker a few times

to be sure operation is correct. Do not operate any more than is necessary for checking when the tank is lowered as a hydraulic dashpot, cushioning the stopping of the movement at the end of the opening stroke, is not in operation.

Tank

Fill the tank with oil to the level indicated on the nameplate. This is not quite enough to bring the oil gauge up to normal, but any more oil would be likely to spill out. Raise the tank into place with the tank lifter. Watch, in raising, to see that the studs on the underside of the base enter smoothly into the loops welded to the sides of the tank. As soon as studs pass through the loops start the nuts by hand. Raise the tank with the lifter just high enough to see that the tank rim registers in the groove in the base and against the packing. Draw the nuts up evenly all around. With the tank in place adjust the oil level by adding through the filling pipe at the right rear side of the base.

In hot weather it is best to leave the oil slightly high and in cool weather slightly low, as the oil level will change with the temperature. A ratchet socket wrench with an extension reaching down below the lower edge of the tank makes removal and replacement easier. A "T" handle for the extension will help to drive the tank supporting nuts on TIGHT.

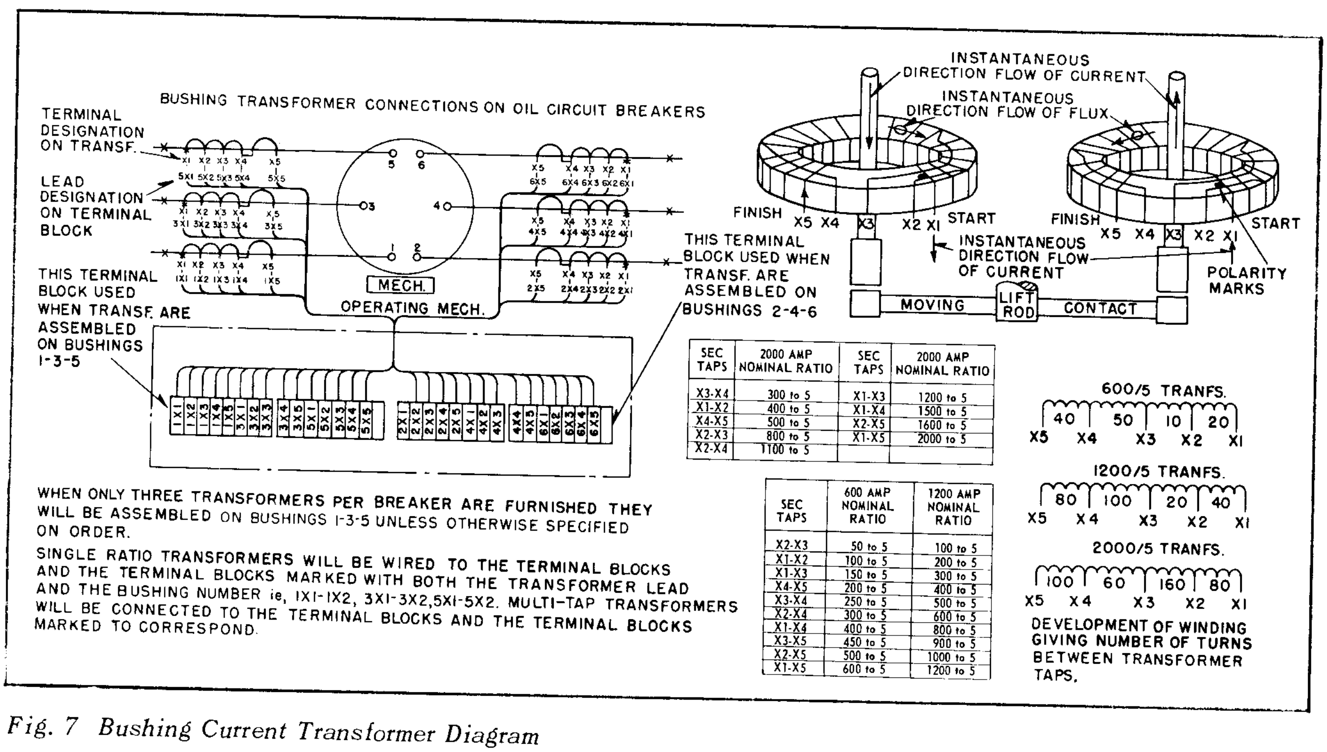
Check of Operation

With the tank in place and all connections made, the circuit breaker should be operated a number of times from the control switch to see that all circuits are clear.

1. Observe the response of the lights to the position of the breaker contacts.

2. Check each relay to see that it trips the breaker and that the target in the relay drops.

3. Check, if possible, to see that the



SEC TAPS	2000 AMP NOMINAL RATIO	SEC TAPS	2000 AMP NOMINAL RATIO
X3-X4	300 to 5	X1-X3	1200 to 5
X1-X2	400 to 5	X1-X4	1500 to 5
X4-X5	500 to 5	X2-X5	1600 to 5
X2-X3	800 to 5	X1-X5	2000 to 5
X2-X4	1100 to 5		

SEC TAPS	600 AMP NOMINAL RATIO	1200 AMP NOMINAL RATIO
X2-X3	50 to 5	100 to 5
X1-X2	100 to 5	200 to 5
X1-X3	150 to 5	300 to 5
X4-X5	200 to 5	400 to 5
X3-X4	250 to 5	500 to 5
X2-X4	300 to 5	600 to 5
X1-X4	400 to 5	800 to 5
X3-X5	450 to 5	900 to 5
X2-X5	500 to 5	1000 to 5
X1-X5	600 to 5	1200 to 5

Fig. 7 Bushing Current Transformer Diagram

solenoid closes and latches with 90 volts (for 125 volt control) across the closing coil with the coil energized, or 190 volts for 230 v. a-c control.

4. Check to see that 58% of normal potential on the trip coils trips the breaker.

5. Check to see that raising the trip coil plunger slowly by hand releases the primary latch when there is approximately 1/16" of travel left at the instant the latch releases.

6. Check time to close and part contacts with a cycle counter. This should not be over 24 cycles and 2 cycles respectively with normal control voltage at the breaker. If a Cincinnati timer is available it is desirable to make time-travel records of opening, closing, and reclosing operations when installing breaker for comparison during subsequent maintenance checks. Typical factory records are available on request.

The Cincinnati timer may be clamped to the floor of the mechanism cabinet and connected to the 10-32 tapped hole available at the position indicator. The 3/16 in. diameter operating rod should be reinforced by taping to a wood rod in order to prevent whipping.

Part Three Operation and Adjustments

CONTACT OPERATION

The "De-ion" Grid interrupters used on these breakers consist of a stack of fibre plates arranged to provide orifice plates, oil pockets, and exhaust vents in such a manner that efficient high speed arc interruption is effected. When the contacts part on a fault operation, the heat of the arc causes the oil in the pockets to disintegrate and form un-ionized gas particles. The pressure built up inside the grid provides a turbulent action which causes these un-ionized particles to mix with the ionized particles in the arc stream and at the same time forces this mixture through the orifice plates and out the exhaust vents to cause rapid de-ionization of the arc stream. When sufficient dielectric strength is established between the separating contacts following a current zero to withstand the system recovery voltage, the arc will be extinguished. Many interruptions take place at the first current zero after parting contacts, especially on high currents where the gas pressure inside the grid is highest. However, if the rate of rise of system recovery voltage is sufficiently rapid, arcing may continue for one or two more half cycles until contact separation is sufficient to withstand the recovery voltage.

As may be seen in Fig. 8, butt contacts are used in order to get high speed contact parting time. The stationary and moving contacts are both tipped with silver tungsten which provides sufficient conductivity for both the 600 and 1200 ampere continuous-current ratings while at the same time providing good resistance to arc erosion. It will be noted that a single interrupter per phase is used, so that the moving contact is hinged on one side which eliminates the need for a lift rod guide.

CONTACT ADJUSTMENT

1. Refer to contact assembly, Fig. 8. With the breaker closed and latched, the stationary arcing contact should be 3/4 + 0 - 1/16" above its open position. This may be observed by looking through the opening at the rear of the contact foot and checking the height of the shunt support plate above the metal top plate on the grid stack.

2. See that the moving contact strikes centrally on the stationary arcing contact.

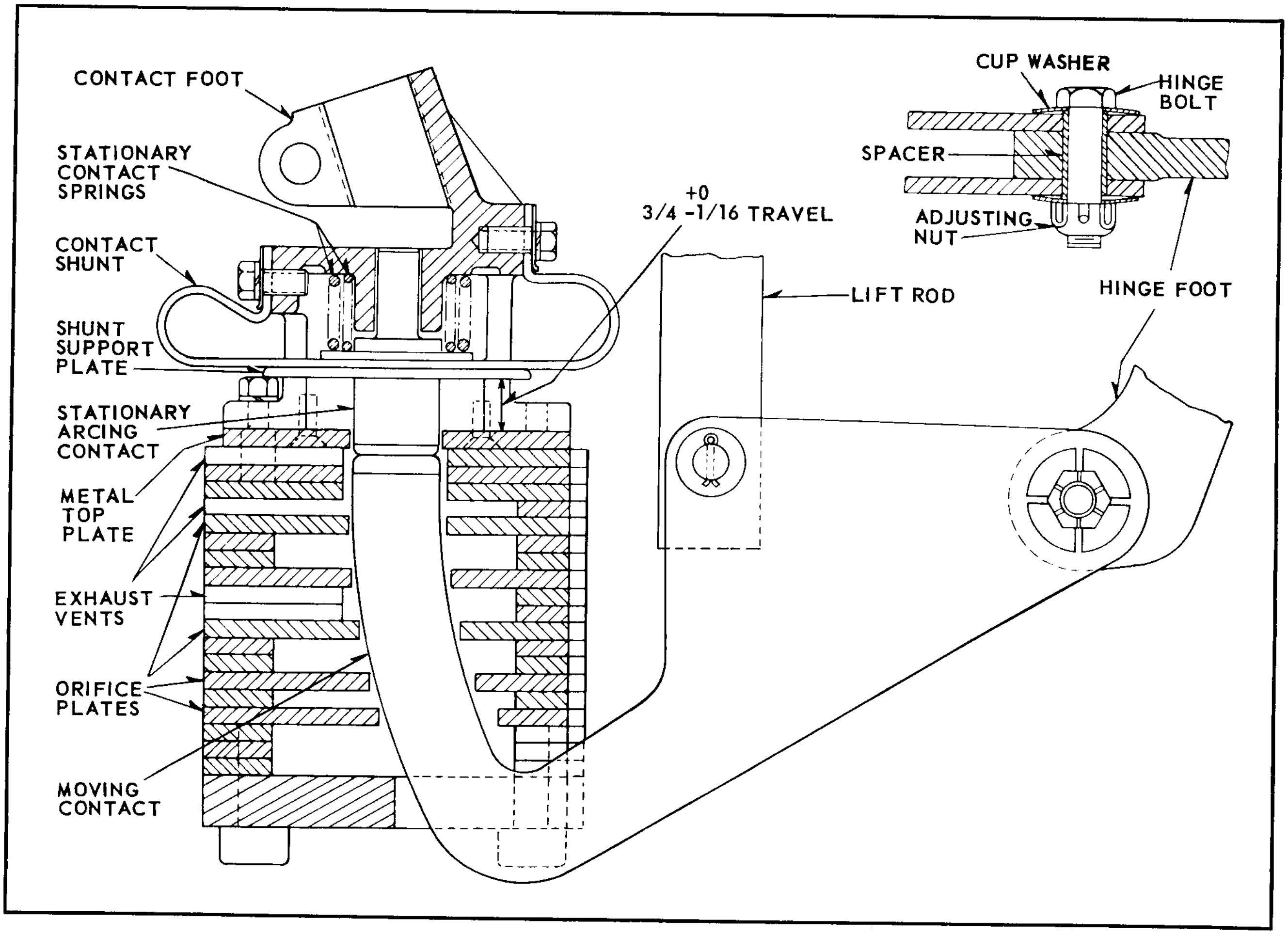


Fig. 8 De-ion Grid and Contact Assembly

This may be obtained by loosening the contact foot and hinge foot and turning on the condenser bushing studs. Lateral alignment may be obtained by loosening the condenser bushing flange nuts and shifting the bushing on its gasket seat. Use about 30 ft.-lb. on torque wrench when re-tightening these nuts.

3. Check to see that the moving contact blade does not bind in the grid slot when the breaker is closed slowly by hand. Alignment of the grid stack may be obtained by loosening the nuts which secure it to the contact foot and rapping with rubber mallet.

4. Removal of the stationary arcing contact may be accomplished by (1) unbolting laminated shunt on both sides of the contact foot, (2) removing the grid stack from the contact foot, and (3) removing the metal plate on the under side of the contact foot. When replacing the stationary arcing contact, make sure that the long end of the shunt is placed toward the center of the tank. Note that one spring is used for the 100 MVA rating, while two are used for the 250 and 500 MVA ratings.

5. When replacing moving contacts avoid excess pressure on the hinge. Make contacts fit hinge snugly without spreading. Tighten nut and bolt finger tight and then take up to the next slot in the castle nut. This will provide enough pressure to just

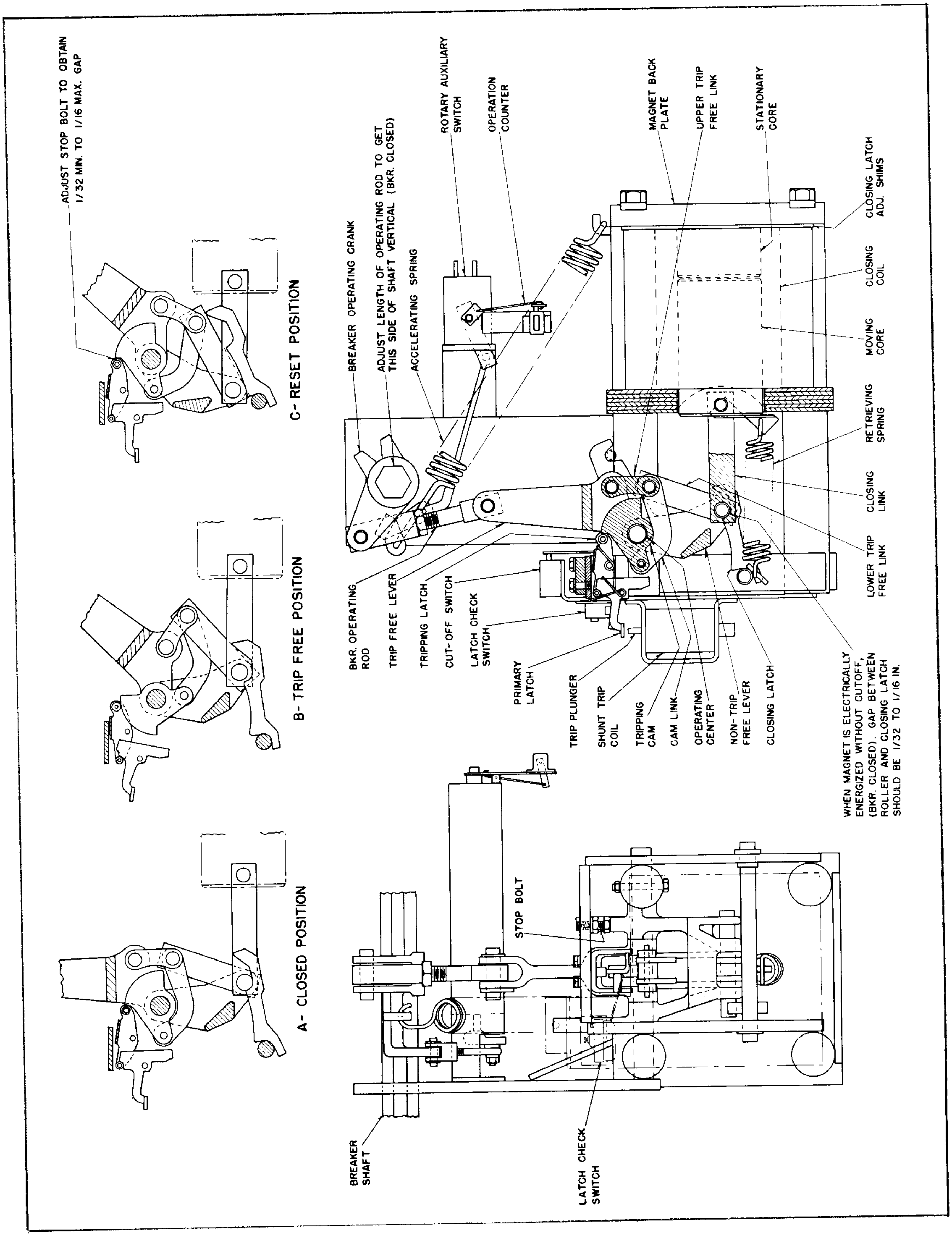


Fig. 9 Solenoid Operating Mechanism

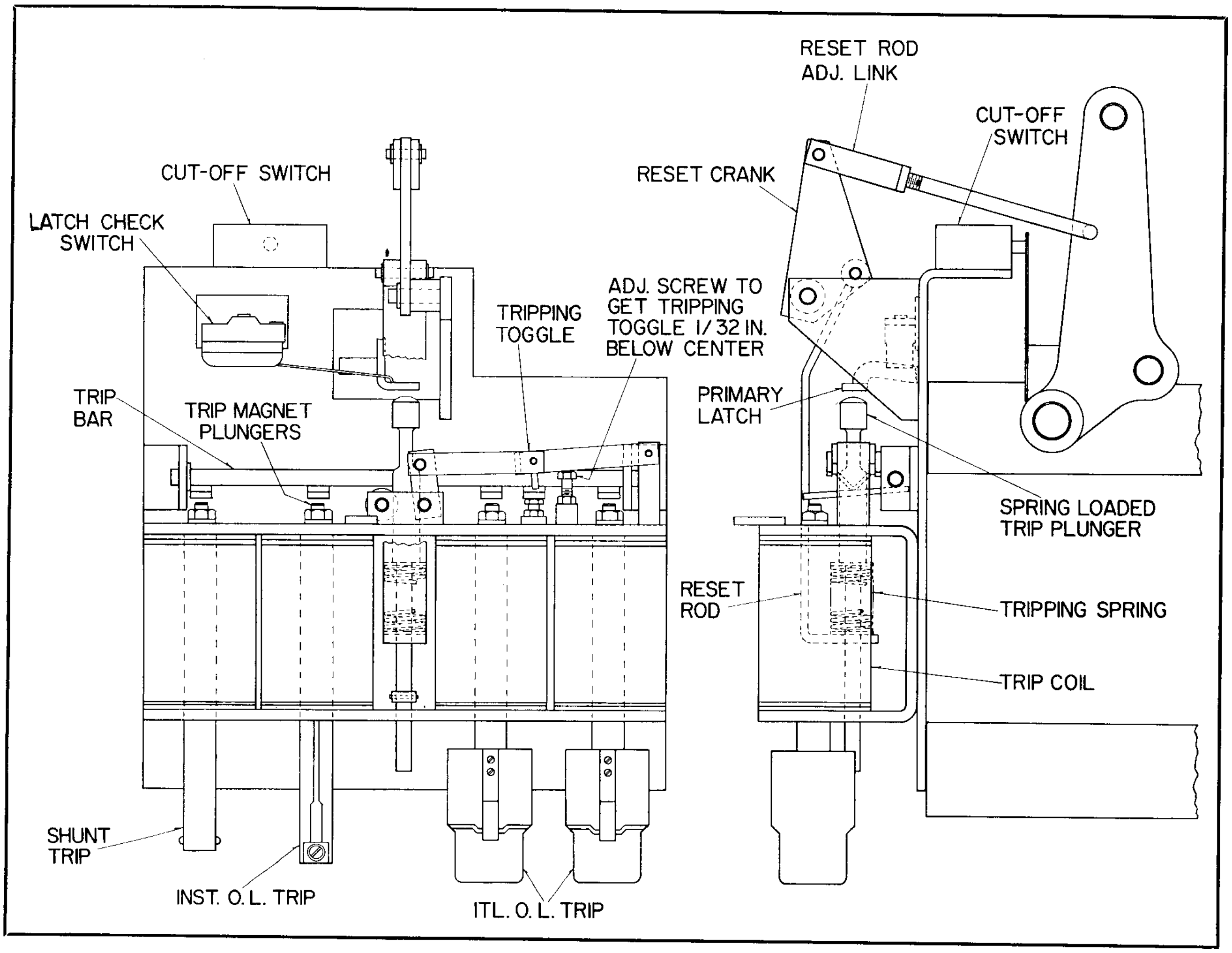


Fig. 10 Four-Coil Trip Attachment

hold the weight of the moving contact when disconnected from the lift rod.

CAUTION: Always see that the flange of the condenser bushing does not touch the plate forming the lower part of the top cover or the current transformer support. Either of these conditions will affect the current transformer ratio.

Any slight roughness found on the contacts should be smoothed with a file. Contacts should be replaced if burns penetrating more than 1/16" are found.

OPERATING MECHANISM

The type SAH-4 mechanism is a solenoid type operating on standard direct current control voltages or, when equipped with a rectifier unit, on alternating current. It is mechanically full automatic and trip free in all positions. The standard mechanism is supplied with a single shunt trip coil, a single plunger type cut-off switch, and a nine-pole rotary type auxiliary switch for trip coil cutoff and operation of indicating lights. Reclosing breakers are equipped with a latch checking switch.

The mechanism can be supplied with a shunt trip coil or a capacitor shunt trip, or three instantaneous or inverse time delay transformer trip coils.

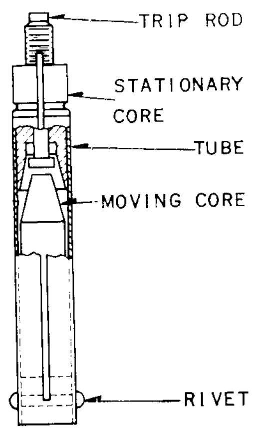


Fig. 11 Shunt Trip Assembly

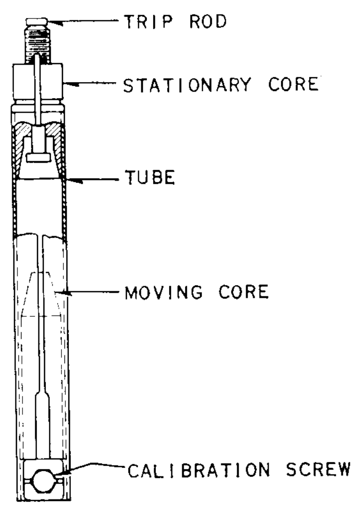


Fig. 12 Instantaneous Overload Trip Assembly

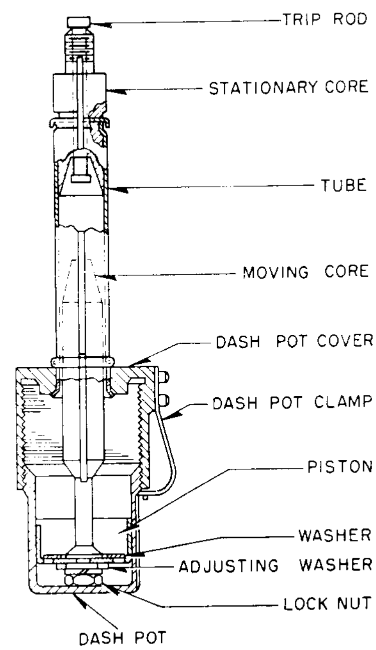


Fig. 13 Inverse Time Limit Trip Assembly

Mechanism Operation

The solenoid operating mechanism with its trip-free linkage is shown in Fig. 9. In this mechanism, the horizontal pull of the solenoid coil is transmitted to the contact operating rods through a system of links which rotate counterclockwise about the operating center. The linkage system consists of four (4) major links: the non-trip free lever, trip free lever, upper trip free link, and lower trip free link. These members are arranged as shown and are held to form a rigid member by the cam link and tripping cam. The tripping cam is held fixed by the tripping latch.

When the solenoid is energized, it pulls on the junction of the non-trip free lever and the lower trip free link, causing the system to rotate about the operating center. The trip free lever then exerts an upward force on the operating rod to close the breaker. The breaker is held in this position by the closing latch.

The breaker is tripped electrically or manually by lifting the primary latch. This allows the tripping latch to release the tripping cam so that it is free to rotate. Without the restraining force of the cam and cam links, the major linkage collapses under the force of the contact springs and the accelerating spring. The junction of the upper and lower trip free links moves to the right, and the trip free lever rotates clockwise opening the breaker. The position of the linkage is then as shown in Fig. 9B.

In moving to this position, the lower trip free link has disengaged the closing latch. The retrieving springs now pull on the solenoid core which moves the linkage to the reset position as shown in Fig. 9C. In this position the tripping latch is reset and the breaker may be reclosed.

Manual Closing

The manual closing lever has a horizontal and vertical plate with drilled holes

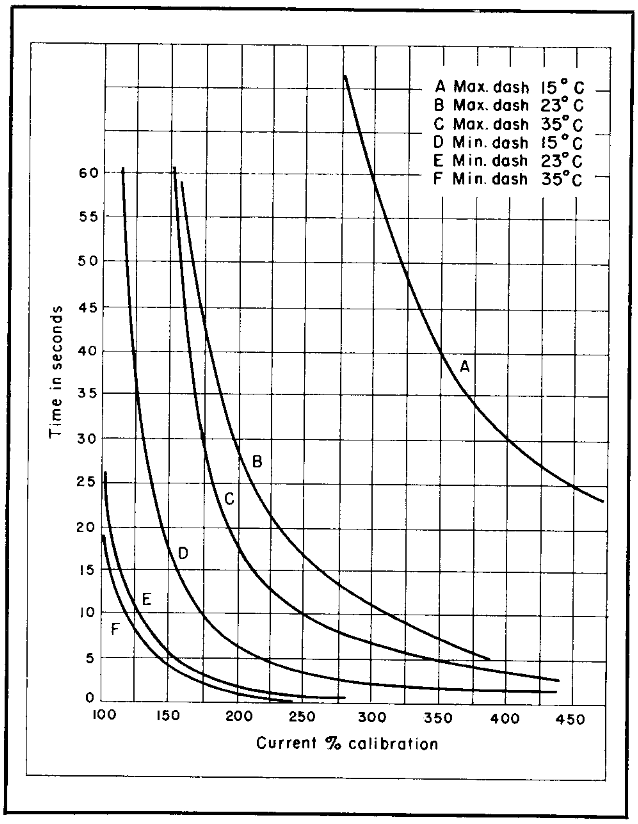


Fig. 14 Time Delay Curves for Inverse Time Limit Overload Trip

on one end. It is attached to the mechanism by guiding the pin which projects to the front of the mechanism from the "Operating Center" into the hole in the vertical plate, and the pin projecting from the closing link into the hole in the horizontal plate. The breaker is closed by rotating the lever from left to right. (See Figs. 9 and 15).

Manual Tripping

The manual trip knob located outside the mechanism cabinet operates a linkage which lifts the primary latch to trip the breaker.

Mechanism Adjustment

If a breaker fails to close contacts although the moving core of the mechanism moves to the closed position, a probable cause is failure to reset. Refer to "C", Fig. 9. The gap indicated between the tripping latch roller and cam is an essential requirement to permit the tripping latch to fall into the cam notch. Watch the primary latch (with words "lift to trip"), it should return to the horizontal position immediately after breaker has been opened.

If the trigger is prevented from returning to the full reset position by the primary latch roller above it, the cause may be that tripping latch roller cannot drop into cam notch. Using the hand closing lever, close the breaker part way, trip it, and then slowly retrieve the moving core. Note whether or not the tripping latch roller drops into the cam notch.

If it is necessary to increase the clearance to get 1/32 inch, loosen the locknut and adjust the stop bolt until the cam to roller clearance is within limits. The hand closing lever should be removed during this adjustment.

ATTACHMENTS

Shunt Trip Magnet

The shunt trip magnet is a small electromagnet which is used to trip the breaker electrically. It may be equipped with a coil for d-c, a-c or capacitor tripping. When the shunt trip magnet is energized, the core is drawn up into the magnet yoke. A plunger attached to the core strikes the trip lever directly above it which disengages the primary latch to trip the breaker.

Rotary Auxiliary Switch

A nine-pole rotary auxiliary switch mounts on the upper right side of the solenoid. This switch is operated by the breaker crank lever which turns the rotor approximately 90°. The 1st and 3rd contact segments are connected in series with the trip coil. These segments are wider than the others, so that they will complete the trip circuit ahead of breaker contacts touching on a closing operation. The rotor segments are arranged alternately with the odd numbered ones (52-a on diagram) making contact when the breaker closes, and the even numbered ones (52-b) making contact when the breaker opens. The segments may be changed from one position to the other by disassembling the rotor. Check the contacts during maintenance to see that the flexible finger follows in and makes good contact with the rotor segment. Burns from arcing should be smoothed, or the contacts replaced when necessary.

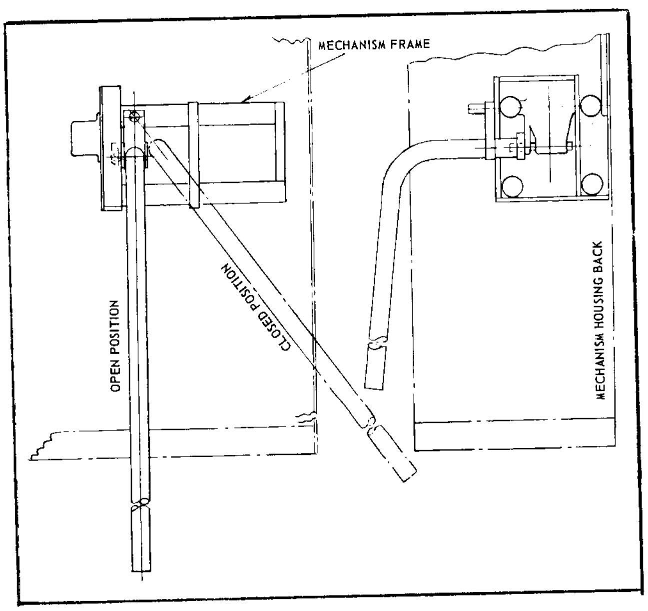


Fig. 15 Assembly of Hand Closing Lever on Mechanism

Operation Counter

The operation counter mounts on the nine-pole auxiliary switch bracket. The operating arm is set so that the counter advances one number on each tripping operation.

Cut-Off Switch

The cut-off switch (52-aa on diagram) is a plunger type switch operated by an arm attached to the non-trip-free lever in the mechanism. This switch energizes the "Y" relay in order to cut off the closing coil current at the end of the closing stroke. The contacts on this switch must make positively just before the end of the closing stroke so that the closing current will always be cut off. However, the contacts must not make too early, or the mechanism might fail to latch. Proper action will be obtained when the switch plunger has 1/32 to 1/8 inch over travel remaining when the breaker is closed and latched. If it should be necessary to change the switch adjustment, this may be accomplished by bending the switch operating arm slightly.

Latch Check Switch

The latch check switch is a small, light force, snap action switch which is operated by the primary latch. When a breaker is to be automatically reclosed after being tripped free, it is necessary to arrange the electrical control scheme so that the closing solenoid will not be energized to start the closing motion until the mechanism has completed the linkage motion to get to the reset position. (See B and C of Fig. 9.) For this purpose, the switch is arranged to be closed when the primary latch is reset, because the primary latch is the last part to reset in the sequence of linkage motions required to reset the mechanism. The action of this switch may be checked as follows. With the breaker open, raise the primary latch arm to end of its travel. Lower it slowly listening for the snap action of the switch. Note the position of the arm when the switch snaps closed. The switch should close when the latch arm is in an interval from 3/8 to 1/8 inch above the normal reset position measuring at the shunt trip plunger centerline. If switch action must be made earlier or later, bend the switch arm near the middle of its length.

Four-Coil Trip Attachment

Whenever overload tripping is required where the energy for tripping is obtained solely from the bushing current transformers, it is necessary to use a four-coil trip attachment sometimes called a "light-trip" attachment. This attachment is equivalent to a mechanical relay which reduces the tripping energy requirements to the level obtainable from bushing current transformers. The usual arrangement is to have three 5-ampere transformer overload coils (one per phase) and an A-C shunt trip coil for operation from a remote control switch.

Referring to Fig. 10, the 4-coil attachment is bolted in the same place occupied by the standard shunt trip magnet. A spring loaded trip plunger is restrained by a toggle linkage that engages a shoulder on the plunger. Raising the plunger on any of the four trip coils to strike the trip bar releases the toggle linkage which allows the spring-loaded plunger to disengage the primary latch in the usual manner. When the mechanism opens, the reset rod moves downward to allow the trip plunger to drop down and be re-engaged by the toggle linkage. Then when the mechanism closes, the plunger spring is compressed in readiness for the next tripping operation.

Check the adjusting screw to see that the tripping toggle linkage is 1/32 inch below center. This should be enough to insure positive latching, and any more than this will increase the energy required to release the toggle. The reset rod is operated through a crank and adjustable link from the trip-free lever. The length of the link should be such that the toggle linkage drops into place positively when the mechanism opens.

Current Transformer Overload Trip

Overload trip magnets operated directly from the bushing current transformers are similar to the shunt trip magnet except that a means is provided to vary the air gap between the plunger and its stationary core. The position of the plunger is calibrated between 5 and 9 amperes, and the calibration is stamped on the plunger tube. Tripping may be obtained at the desired primary current by using a suitable current transformer ratio. The overload trip magnet shown in Fig. 12 will trip instantaneously when the selected current is applied.

The time delay overload trip shown in Fig. 13 is used where it is desired to delay tripping on small overloads, but to trip essentially instantaneously on fault currents. This is similar to the instantaneous trip with a dashpot added to restrain the trip plunger. The 5 to 9 ampere calibration is obtained by screwing the dashpot up or down in its cover. The dashpot piston has a series of holes in the bottom with an adjusting disc that may be rotated to change the number of holes uncovered. A loose washer above the piston allows quick resetting. The time delay varies with the percent overload and the viscosity of the oil. Fig. 14 shows typical curves of the time delay that may be expected with standard dashpot oil as supplied. Since the viscosity of the oil changes somewhat with temperature, it is obvious that this device cannot be used where accurate settings are required. Accurate settings require the use of overload relays with D-C or capacitor shunt trip coils.

Rectifier for A-C Closing

Since many breakers are located where a station battery is not available, it is desirable to use a 230 V. A-C source for closing power through a rectifier unit to provide 125 V. D-C for the closing coil. A 5 K.V.A. or larger supply transformer located near the breaker is sufficient to avoid excessive regulation. The Rectox control panel includes a series resistor

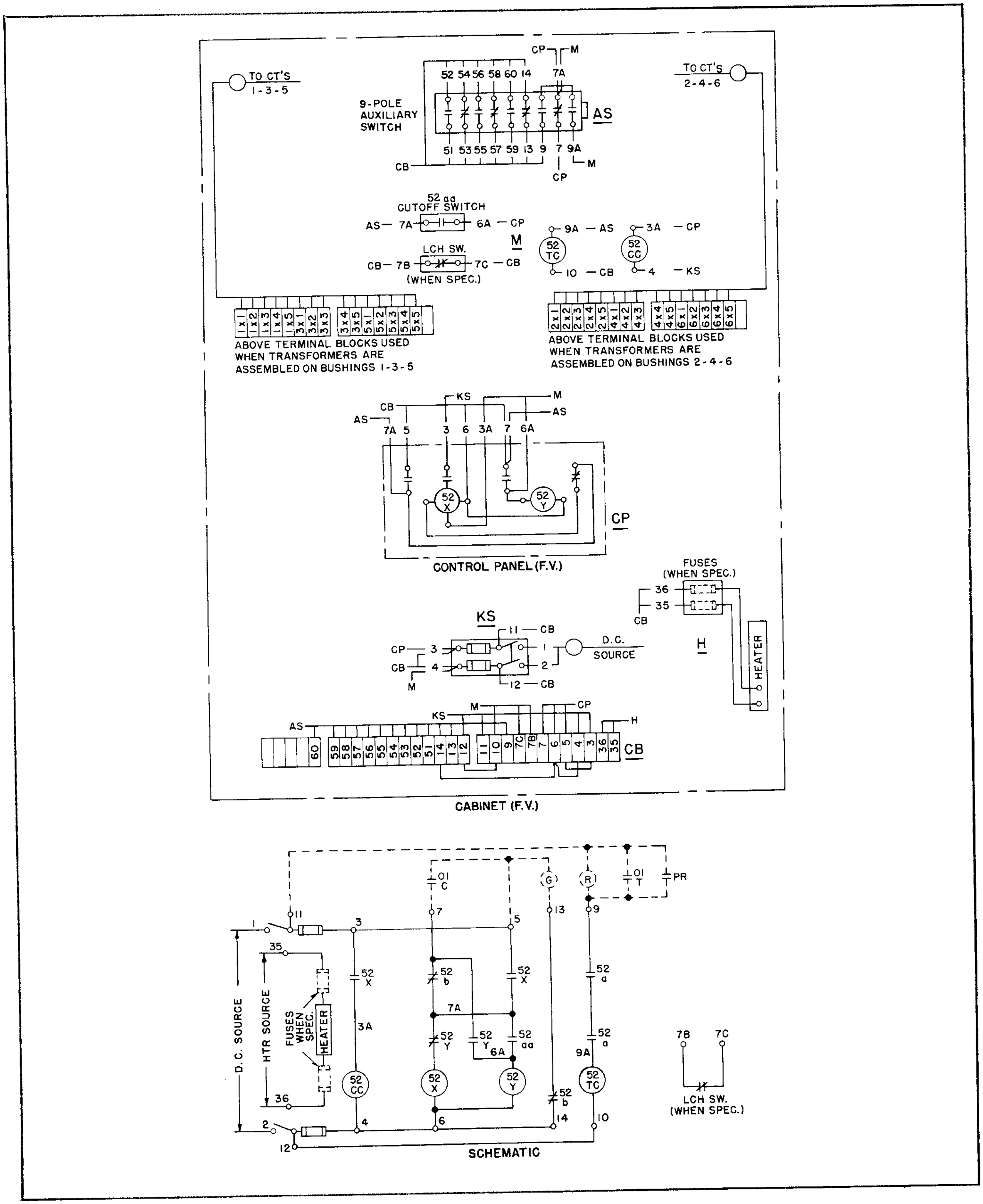


Fig. 16 D-C Diagram

which may be adjusted if the A-C voltage at the breaker varies considerably from 230 volts (normal range is 190-250 V. A-C). This resistor should be set so that the minimum closing voltage is about 40 volts below whatever the normal circuit voltage is at the breaker with closing coil current flowing. Rectox is an intermittent duty device - do not energize for more than 3 seconds when making voltage measurements. This resistor was used also to compensate for aging on the older copper-oxide rectifier units, but aging is negligible on the newer selenium units.

"XY" Closing Control

Referring to Fig. 16 for D-C control, when the control switch is turned to close the breaker, the "52X" contactor is energized to complete the battery circuit to the "52CC" closing coil. When the breaker reaches the closed position, the "aa" cutoff switch closes to energize the "52Y" contactor. The "52Y" contactor in turn de-energizes the "52X" contactor by means of a "back" contact which then disconnects the closing coil automatically, and simultaneously parallels the "52aa" switch with the "52Y" seal-in contact. Thus, even if the breaker closes on a fault and "trips free", undesirable "pumping" is prevented because the "52Y" contactor remains energized to hold the closing coil circuit open as long as the control switch is held closed.

Referring to Fig. 17 for A-C control, the same results are accomplished in a slightly different manner. When the breaker is open, the "52Y" contactor is energized continuously through a "b" auxiliary switch (paralleled by "52Y" seal-in) to complete the circuit to the "52X" contactor except for the control switch. When the breaker is closed, the "aa" cutoff switch shorts out the "52Y" contactor (series resistor prevents short circuit across control bus) and causes it to drop out to de-energize the "52X" contactor and closing coil. In this case, "pumping" is prevented by the "O" contact on the control switch which opens when the control switch is closed to keep the "52Y" contactor de-energized. The reason for this is that the A-C control source is usually taken through a station service transformer from the same power line the breaker is controlling - thus, if a fault near the breaker causes the A-C voltage to collapse, the "anti-pumping" feature is still retained.

Fig. 17 shows the capacitor trip device which is commonly used with distribution breakers in order to eliminate the need of a station tripping battery. However, either battery tripping or current transformer overload trip coils may be used instead if desired.

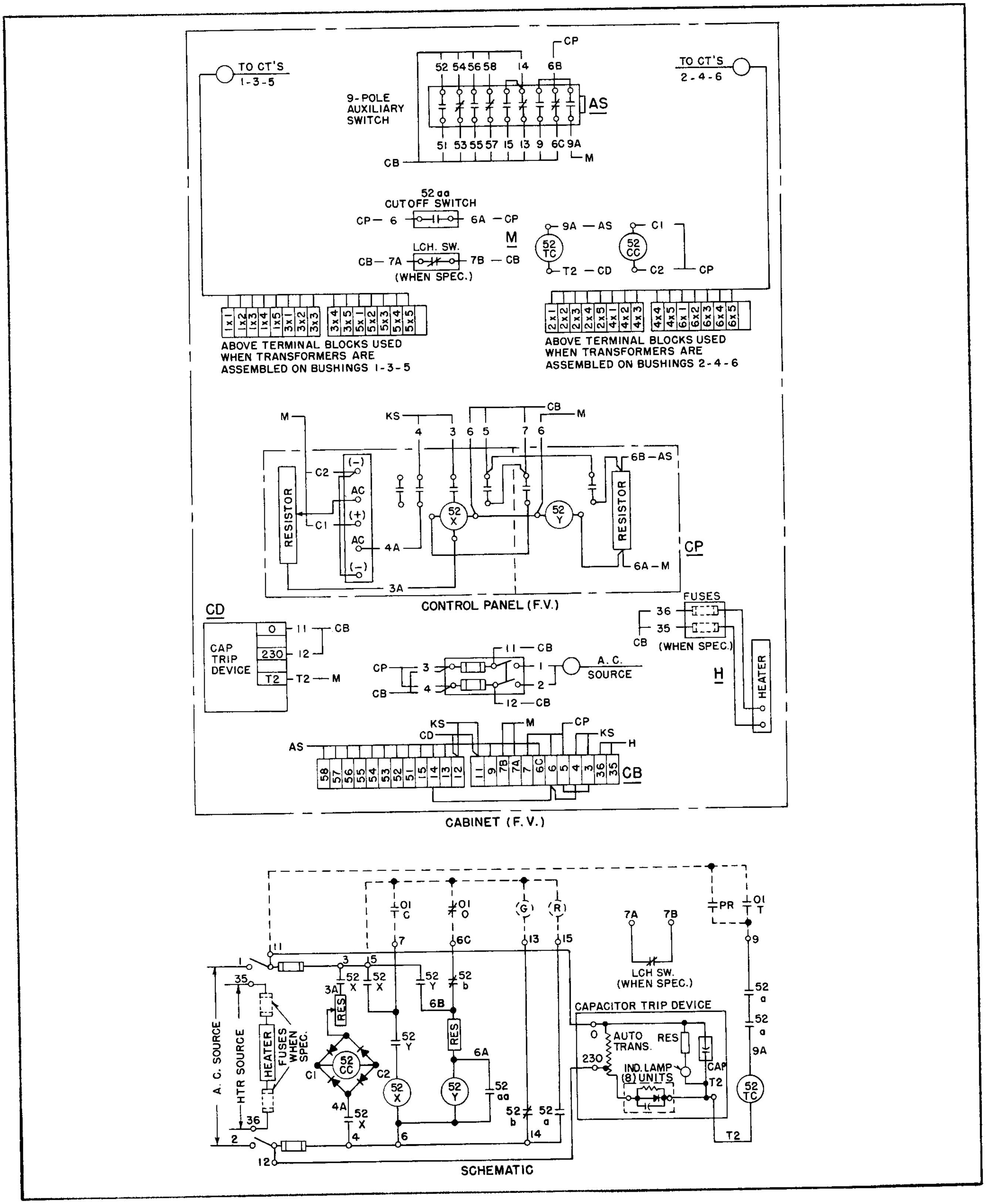


Fig. 17 A-C Diagram

Part Four Maintenance

It has become the practice of operating companies to establish a system of regular inspection of their apparatus. Oil circuit breakers especially, due to the nature of their function, should be operated on a planned maintenance program. It is recommended that each new breaker be given a one year "shake-down" period to prove the initial installation and to establish the duty to which it is likely to be subjected. After this one year period, the oil should be drained from the tanks, and a thorough inspection made as outlined under "General Inspection Procedure". It is our standard practice to recommend that each breaker be given such a general inspection once a year. It is recognized, however, that many breakers operate so seldom that such yearly inspections may not be necessary, and on the other hand that some breakers are subjected to severe duty which makes more frequent servicing necessary.

Many companies compile detailed operating data on individual breakers, and from such information and past experience on various types of breakers are able to set up an inspection and maintenance program which fits more closely the duty performed. Following are some of the factors to be considered in setting up such a "tailor made" inspection schedule:

1. Time.

2. Number of switching and testing operations.

3. Number of overload and fault operations.

4. Severity of fault operations.

5. Condition of oil.

6. Cleanliness of atmosphere surrounding breaker.

7. Accumulated experience of breaker characteristics and duty.

Where an inspection schedule other than the yearly General Inspection is set up, we recommend that each breaker be given a "Routine" Inspection once yearly and that it be given a "General" Inspection at least once every three years. The significance of the two types of inspection are developed in the following paragraphs.

Regardless of what type maintenance program is adopted, it is further recommended that frequent visual inspections be made by operators touring the switchyard in order to catch any obvious abnormal condition. It is also considered good practice to operate the breaker from the switchboard at regular intervals to insure the integrity of all electrical circuits, as well as proper mechanical functioning of the breaker.

CAUTION: Before working on a breaker that has just been disconnected from the line, make sure that the condenser bushings have been discharged by grounding the terminal end.

ROUTINE INSPECTION PROCEDURE

The suggested Routine Inspection procedure is as follows:

1. Check mechanical operation of breaker.

2. Check dielectric strength of oil.

3. Check contact engagement by "lighting out" through contact circuit.

It naturally follows that any abnormal condition found during the Routine Inspection should be cause for lowering the tanks and giving the breaker a thorough General Inspection.

GENERAL INSPECTION PROCEDURE

General inspection of the breaker requires that the tanks be lowered on the breaker. Before any parts are disturbed, the following adjustments should be checked to give an indication of the condition of the breaker as removed from service for the inspection.

CAUTION: Open the control circuit at the breaker before starting to inspect or work on the breaker parts, so that accidental breaker operation cannot occur.

1. Close the breaker by power with the operating mechanism.

2. Check stop clearances for the moving contacts under the dome between the middle crank lever and stop bolt.

3. Inspect the stationary contact assemblies to determine the condition of the contact surfaces and the contact setting. Some burning on the contacts is not detrimental as long as the electrical conductivity and contact setting have not been materially changed. If the burning is severe the contacts should be removed and reconditioned or replaced.

4. Note the condition of the moving contacts, reconditioning or replacing them if necessary.

5. Note the condition of all parts now accessible. Check the bolts, nuts, spring cotters, etc., and tighten where necessary. Repair or replace any damaged parts.

6. Close the breaker slowly by hand and check the contact adjustment.

7. Clean the lower ends of the bushings and the Micarta lift rods with a clean cloth dampened with clean oil. Clean carbon from the grid stacks.

8. Check the operating mechanism for loose nuts and bolts and for missing spring cotters. Lubricate bearings with a few drops of lubricating oil. See paragraph below for detail maintenance instructions on mechanism.

9. Check latches to see that faces are in good condition and are properly adjusted. Apply rust inhibitor to latch faces. The inhibitor should be free flowing at all anticipated temperatures, non-hardening and self-healing (so that it will not wipe completely off in one operation). A light lubricant similar to Westinghouse 9921-4 or "Gunslick" is suggested.

10. Check control wiring for loose connections.

11. Check gasket joints, conduit and tank fittings to make sure no water can enter the breaker.

12. Check dielectric breakdown strength of the oil.

13. Check oil bumper cylinder to be sure it is not jammed.

14. Raise and secure tank after replacing oil if required. Check closing and tripping operations, using all usual relays and circuits involved in the operation of the breaker. Be sure all relay contacts are clean.

15. Check closing and tripping at reduced voltage to insure safety margin.

NOTE: If it is necessary to make any readjustments, it is recommended that a recheck of the operating speed be made.

OPERATING MECHANISM

During inspection the following points should be kept in mind. (1) Remove loose dust and dirt with a compressed air stream. (2) Wipe off latch and roller surfaces. (3) With hand closing lever, move mechanism parts slowly closed to point where arcing contacts just tough, and then allow contact arms to fall slowly to open position, observing for any evidence of stickiness or excessive friction. (4) Holding primary latch up, move hand closing lever up and down slowly. The core should move freely in the solenoid and the linkage system should reset positively when the weight of the hand close lever is removed slowly.

Lubrication

If any excessive friction or binding is discovered on the above inspection, relieve it either by adding oil or if necessary by cleaning old dried lubricant from the bearing surfaces. In general, the addition of a few drops of oil should be sufficient in most cases. In a few cases, after long service, the accumulation of dried or oxidized lubricant may make it necessary to disassemble parts and clean them. Carbon tetrachloride is a good solvent for this.

Apply a small amount of a light oil to pins and wearing surfaces. Use a stable oil with a low rate of oxidation and with a low pour point. A light lubricant similar to Westinghouse 9921-4 or "Gunslick" is recommended for latching surfaces.

Clearances

After a mechanism has operated several thousand times, the following points should be checked as part of routine inspection. With the breaker open and the mechanism reset, there should be 1/32 to 1/16 clearance between the tripping latch roller and the cam. (See Fig. 9). If readjustment is necessary, see explanation under mechanism adjustments.

To permit the closing latch to move up to its holding position the roller at the lower end of the non-trip free lever must overtravel the latch surface slightly. With the breaker closed, look at the closing latch and roller and energize the close coil for one or two seconds several times. The overtravel should be approximately 1/32 minimum to 1/16 maximum. With wear in the link holes and pins, this overtravel may decrease. Adjustment is made with steel shim washers between the magnet back plate and the four large magnetic return studs.

After about 15,000 operations, replacement of some parts may be required. During routine maintenance, the amount of wear should be observed on latch surfaces, rollers, pins and pin holes. If it becomes impossible to obtain correct adjustments or if latches fail to hold, replacements should be considered.

CONDENSER BUSHINGS

Maintenance and power factor testing of condenser bushings should be given consideration during breaker inspection. An instruction leaflet is sent with each condenser bushing. This leaflet should be studied for complete recommendations on maintenance of bushings.

IMPORTANT: When placing bushings in breaker, do not permit the metal flange on the bushing to touch the metal support which holds the transformer in place. This has the effect of a short circuiting turn around the transformer, and affects the ratio.

BUSHING CURRENT TRANSFORMER

If it should be necessary for any reason to replace a current transformer, moving contact, stationary contact and "De-ion" Grid should be removed first so that the transformer may be taken out.

The transformer may be disconnected at the terminal block in the mechanism cabinet. When the transformer is removed, it will be necessary to remove the gas plug in the mechanism cabinet. Care should be taken to see that the packing on top and bottom of the transformer is in place. (See Fig. 3).

Be sure to place the end of the transformer carrying the white polarity mark upward. Also, see that the transformer is not thrown off ratio by allowing the support to touch the metal grounding band on the condenser bushing.

CAUTION: Be sure that proper transformer connections are made and a burden or short circuit placed across the terminals at the blocks in the mechanism housing before the breaker is closed on the line. Otherwise dangerous voltage may appear across the open secondary terminals.

CARE OF OIL

Wemco "C" oil is recommended for use in all circuit breakers. Westinghouse cannot assume responsibility for circuit breakers if an inferior grade of insulating oil is used, or if the dielectric strength of the oil is not properly maintained.

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 test, and to purify the oil whenever necessary to maintain it in good condition. The more handling the insulating oil receives, the greater are the chances for it to become contaminated, unless adequate precautions are taken.

It is recommended that operators prepare a schedule for inspection based on operating conditions. Reference to the station log of the operation of the circuit breakers, together with the record of dielectric tests of the oil, should determine the frequency of inspection and test. This period between successive inspections should never be longer than six months. When the dielectric 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 16,500 volts when tested in a standard test cup with electrodes spaced 0.1 in. apart. It is essential that the proper oil level be maintained in the circuit breakers. Considerable change may be caused by changing temperature or possible leakage of oil. Low oil levels may cause flashover of bushings or failure to handle heavy interruptions properly. Oil bumpers may be uncovered and fail to provide proper cushioning effect.

Attention is called to Westinghouse Instruction Book 45-063-100. This book covers the care and maintenance of oil and should be referred to before any attempt is made to test or purify the oil.

RENEWAL PARTS

A list of renewal parts recommended to be maintained in stock will be furnished on request. When ordering renewal parts, specify the name of the part. Identify the breaker by including the type, amperes, volts and Shop Order (S.O.) Number, as engraved on the nameplate.

Memorandum

Memorandum