WESTINGHOUSE

INSTRUCTION BOOK

De-ion®

AIR CIRCUIT BREAKER

Type 50-DH-HS (High Speed)

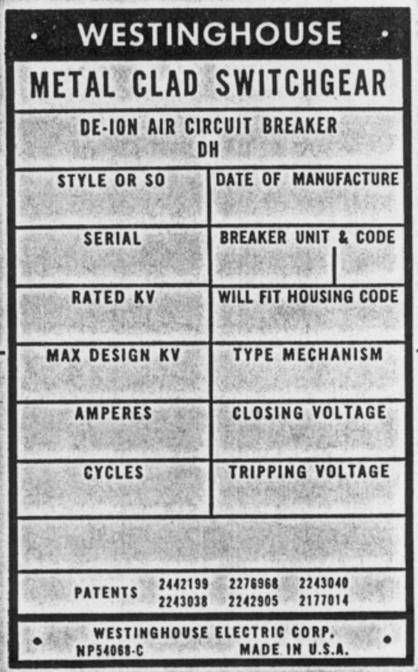
Westinghouse Electric Corporation

I.B. 32-251-2

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.

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

LIST OF ILLUSTRATIONS

Figure **Page**

DESCRIPTION

The type 50-DH-HS air circuit breaker is a three-pole, electrically operated, horizontal drawout unit for metal-clad switchgear. In the type designation, the numbers preceding DH indicate the voltage rating in hundreds of volts, and the letters HS following DH indicate the high speed of interrupting. This breaker has similar structural features and many parts in common with other DH breakers of the same voltage class.

Fig. 1 shows the breaker with the main barrier assembly and one arc chute removed. This shows clearly the arrangement of the arc chutes and blowout magnet assemblies, the contacts and insulated operating rods, and the solenoid operating mechanism. These components are supported in a welded steel frame mounted on flanged wheels for guiding it into the metal-clad cell. In the lower part of the frame also is located the levering-in device for moving the breaker into final contact engagement. This device is interlocked with the mechanism to prevent inserting or withdrawing the breaker with the contacts closed. Also located in the lower part of the frame are the secondary contacts for automatically disconnecting the control wiring when the breaker is withdrawn, the auxiliary switch, and other auxiliary devices.

A barrier assembly is placed on the breaker before it is rolled into its cell. The front sheet is of one-eighth inch steel to form a grounded barrier between personnel and live parts when the unit is in the cell.

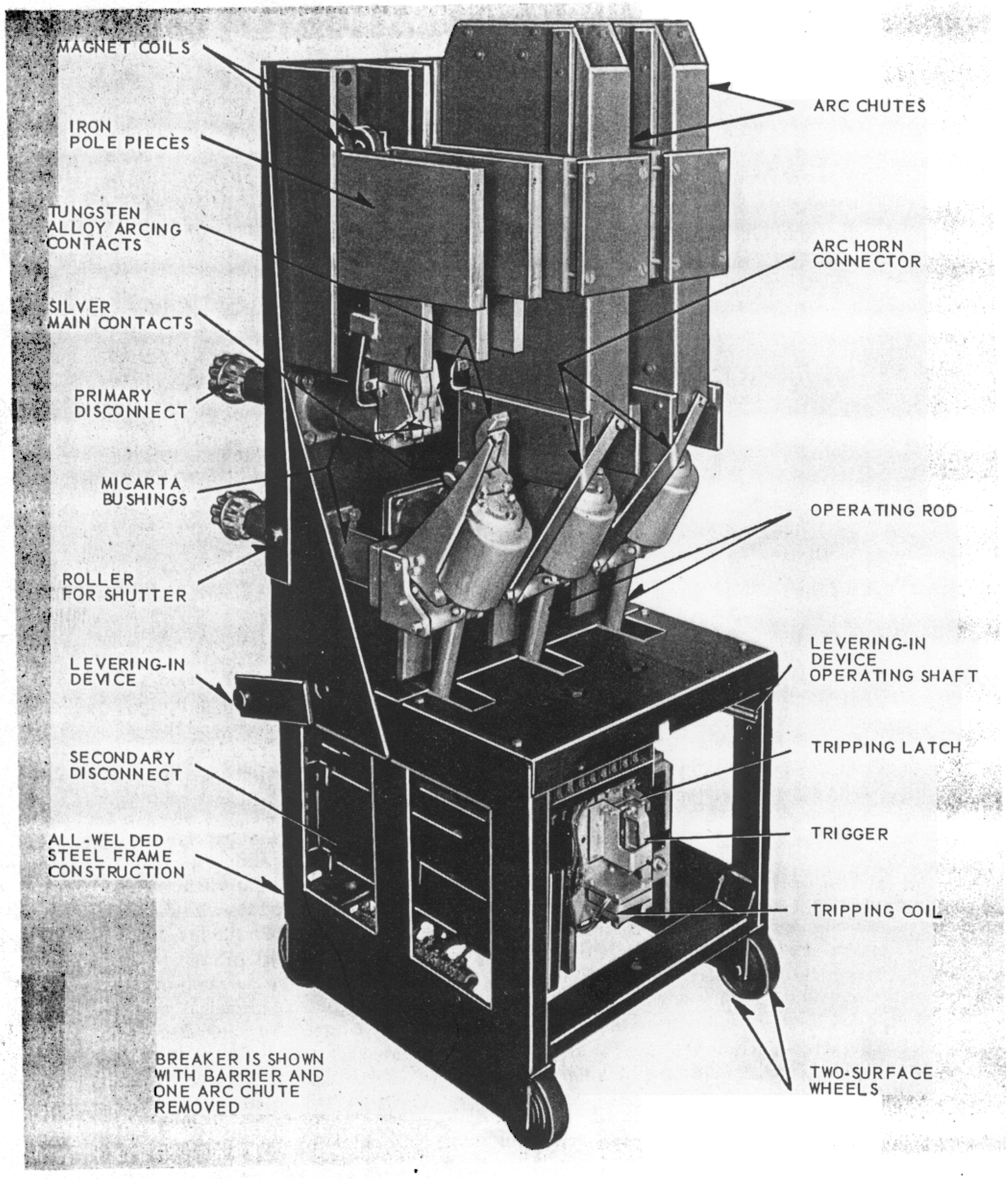


FIG. 1. Type 50-DH-HS Circuit Breaker with Main Barrier and One Arc Chute Removed

RECEIVING, HANDLING, STORING

All type DH breakers are assembled and given operating tests at the factory, after which they are carefully inspected and prepared for shipment by workmen experienced in the proper handling and packing of electrical equipment. In order to afford maximum protection against damage, the main barrier assembly and the arc chutes are packed separately. For each three-pole breaker there is one barrier assembly and three arc chutes.

After the equipment has been unpacked, make a careful inspection for any damage which may have occurred in transit. If the apparatus has been damaged, file a claim immediately with the carrier and notify the nearest Westinghouse Sales Office.

HANDLING

Remove the crating and packing carefully to avoid damage from negligent handling of crowbars or other tools. Use a nail puller for the uncrating. Care must be used in handling the arc chutes, since the splitter plates within them are made of a ceramic material which may break if dropped.

The base of the crate may be used as a skid for moving the breaker, or the breaker may be lifted with slings under the crate. If the breaker is to be lifted with slings, move it while it is still crated. After the breaker is unpacked, the best way to move it is by rolling it on its own wheels.

If it is necessary to lift the breaker after it is uncrated, lift it without the arc chutes or barriers in place. Slings may be placed under the breaker frame or in holes provided in the frame. Use a spreader to prevent the cables from distorting the blowout magnets.

STORING

The arcing chambers are shipped in separate containers to guard against damage from rough handling and for better protection from dust and water or liquids. Store them in their shipping containers until ready for use.

Store all components of these breakers in a clean dry place. During the storage period, keep them sufficiently warm to prevent moisture condensation

TABLE OF APPROXIMATE WEIGHTS
(In Pounds)

BREAKER TYPE	AMPERE RATING	BREAKER WITHOUT CHUTE & BARRIER	SINGLE ARC CHUTE	BARRIER ASSEMBLY	COMPLETE BREAKER
50-DH-HS	600	900	45	75	1110

INSTALLATION

With the exception of the arcing chambers and barriers, these breakers are shipped completely assembled and adjusted. No adjustments should be required and none should be made unless obviously needed.

When the breaker has been removed from the crate, remove braces which support the blowout magnet pole pieces during shipment.

Caution: Severe injury may be sustained if any part of the body is struck by the contact arms since they move very rapidly on the opening stroke. Personnel working about the breaker should stay clear of the space in which the contact arms move while breaker is closed or being closed. If breaker has been closed by hand, always remove hand closing lever before tripping.

The following sequence of operations should be performed in preparing the breaker for use:

1. Breakers are usually shipped with the contacts closed and with a tie on the trip lever to prevent tripping. After the breaker is unpacked and the shipping ties and braces removed, take off the tie on the trip lever and trip the breaker. Then close the breaker carefully by hand, using the removable hand closing lever. Make certain that all parts are functioning properly and that there is no binding or excessive friction. As the contacts touch near the end of the closing stroke, the force necessary to close the breaker increases rapidly.

Approximately, the moment required to close the breaker is approximately 50 foot-pounds through the first 30 degrees of closing handle movement then this moment increases rather rapidly and at the end of the stroke it is approximately 250 foot-pounds. These figures are, only approximate and serve only for guidance.

2. With the breaker in the closed position, check the contacts to make certain that the adjustments have not been disturbed. For proper settings, refer to Fig. 6. If adjustments are required, they may be made as described under the respective paragraph.

A light film of grease is applied to both the arcing and main contacts before the breaker is operated at the factory. This film is normally removed before shipment. Before the arc chutes are placed in position, inspect all contacts to see that they are free of oil or grease.

3. The breaker is more easily handled with the arc chutes and barriers removed; mount these parts after the breaker has been moved near the metal-clad cell structure.

Before installing the arc chutes, play a stream of dry compressed air through them from each end to remove any dust or foreign matter. Then examine the chutes to make certain that the vents and slots are open and free from foreign material. Assemble the arc chutes on the breaker by removing the retaining straps from the front of the magnet pole pieces and sliding the chutes into position, making sure that the rear arcing horn connectors properly engage the contacts on the blowout coils.

After a chute has been placed in position, make sure

(1) that it is centrally located so that there is no interference with the travel of the moving contacts and

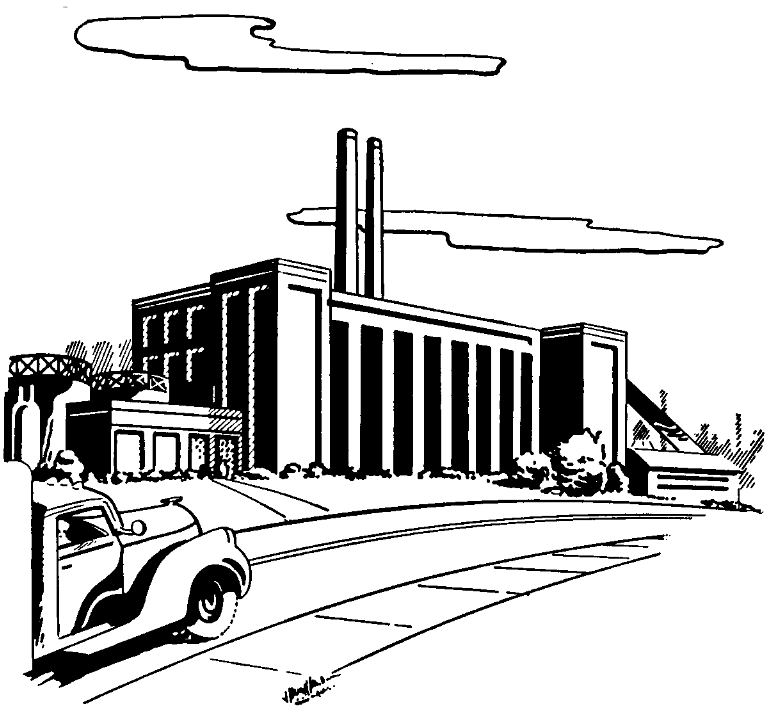
(2) that it is securely held in position by the retaining strap with top of the chute parallel to the top of the laminated pole faces. Connect the shunt strap to the front arcing horn in the chute. Tighten the lower connection of the shunt strap since it may have loosened during transit. The arc chute is now completely installed. Make a final check by operating the breaker slowly by hand to see that there is no interference in the movement of the moving contact.

4. The interpole barrier assembly should now be put in place. The 5 kv breakers have a one piece assembly. Blowout magnet micarta channels have their front edges beveled to help guide barrier plates into place. The lower rear corner of the outside micarta plate goes inside the steel gusset of the frame. The front steel sheet of the barrier assembly is centered on the breaker by a notch on the bottom edge at the middle, which should engage a locating pin on front edge of breaker frame. Two bolts at lower front corners hold assembly in place.

5. The breaker is now ready to be operated electrically. Each breaker should be closed and tripped electrically several times before being connected to high voltage. These operations may be made at the test position in the cell or by means of other test facilities provided. See page 15 of this instruction book and I.B. 32-150-4, page 33, for information concerning placing the breaker in the cell. The hand closing lever must always be removed from socket in mechanism before making electrical operation. If electrical operation is quick and positive on both close and open, breaker is now ready to be levered into operating position.

Caution: Do not attempt to close by hand, against an energized circuit, any breakers covered by this instruction book. To insure sufficient closing force and speed, these breakers should be closed electrically from an adequate power source. See NEMA Standard SG 6-213.

When this drawout equipment is put into the cell and moved in beyond the test position, the high voltage parts of the breaker will be energized. If the barrier is completely assembled on the breaker, personnel will be protected from contact with the live parts. If, however, the barrier assembly is left off and the breaker rolled into the cell, live parts are exposed. The breaker should never be rolled into an energized cell structure beyond the test position without having the complete barrier assembly in place.



OPERATION AND ADJUSTMENT

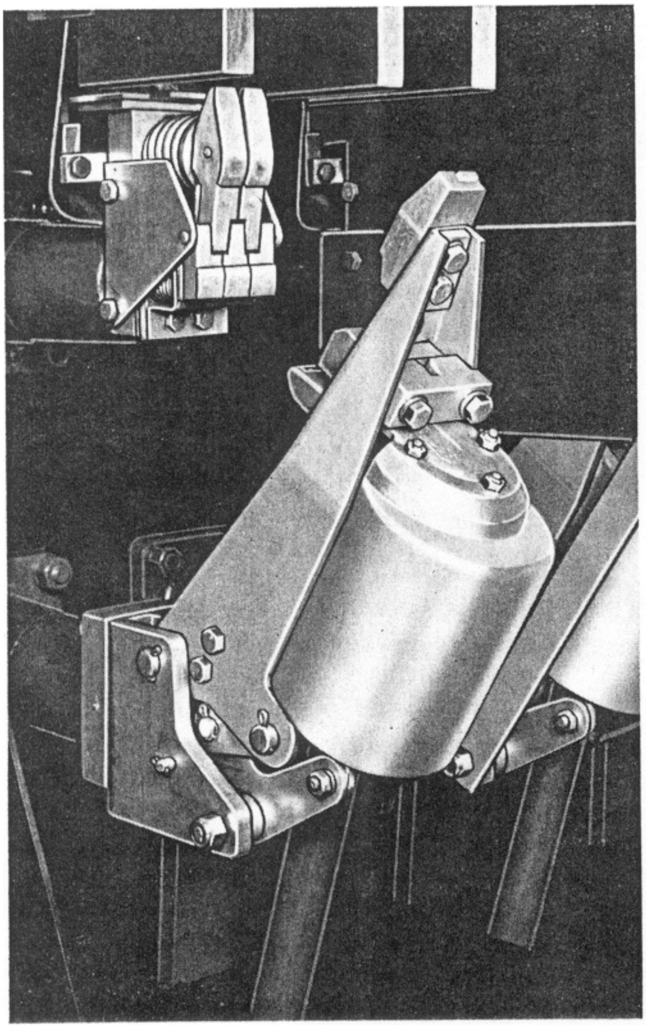


FIG. 2. Contact Assembly Shown in Open Position

Before adjusting a circuit breaker, it is advantageous to become familiar with the construction and function of the various parts. The following paragraphs describe the operation and the various adjustments which can be made. This material should be studied carefully before doing any work on the breaker.

The general arrangement of the breaker components is shown in Fig. 1. The solenoid coil is built to exert a horizontal force on the mechanically-trip-free linkage. This linkage, in turn, exerts an upward force on the pole unit insulating operating rods. The moving contact arms carry the main and arcing contacts. On opening, these contacts separate in the order named; on closing, they touch in the reverse order.

On the outer ends of the bushings are clusters of finger contacts for engaging the main circuit contacts in the cell. Above the arcing contacts are located the blowout magnets and arc chutes. The breaker is tripped either electrically by means of the trip coil, or manually.

Manual tripping is accomplished by pushing the trigger (refer to Fig. 4-D) to the left. The tripping latch should not be actuated directly as there is a danger of injury to the operator due to the fast movement of the latch during the tripping cycle.

OPERATING MECHANISM

The solenoid operating mechanism with its trip-free linkage is shown in Fig. 4. In this mechanism the horizontal pull of the solenoid coil is transmitted to the contact operating rods through a system of links which rotates counter-clockwise about the operating center. The linkage system consists of four 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.

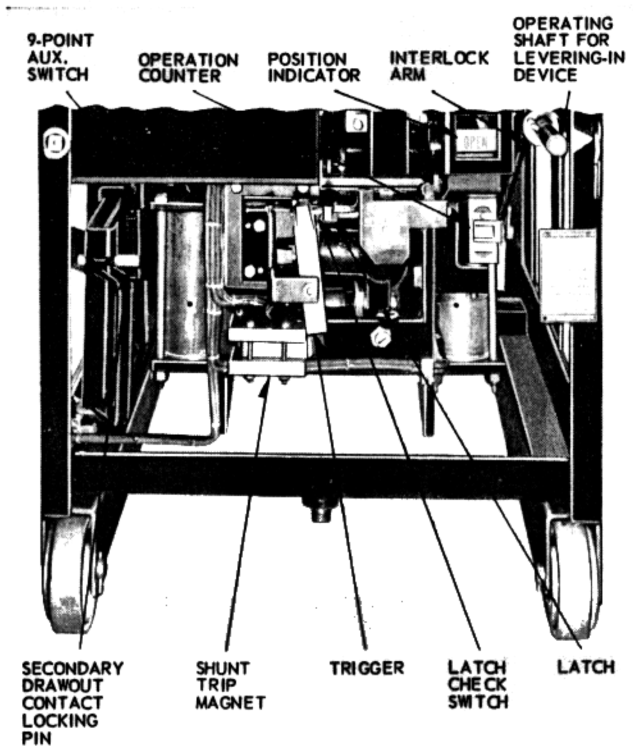


FIG. 3. Front View of the Mechanism

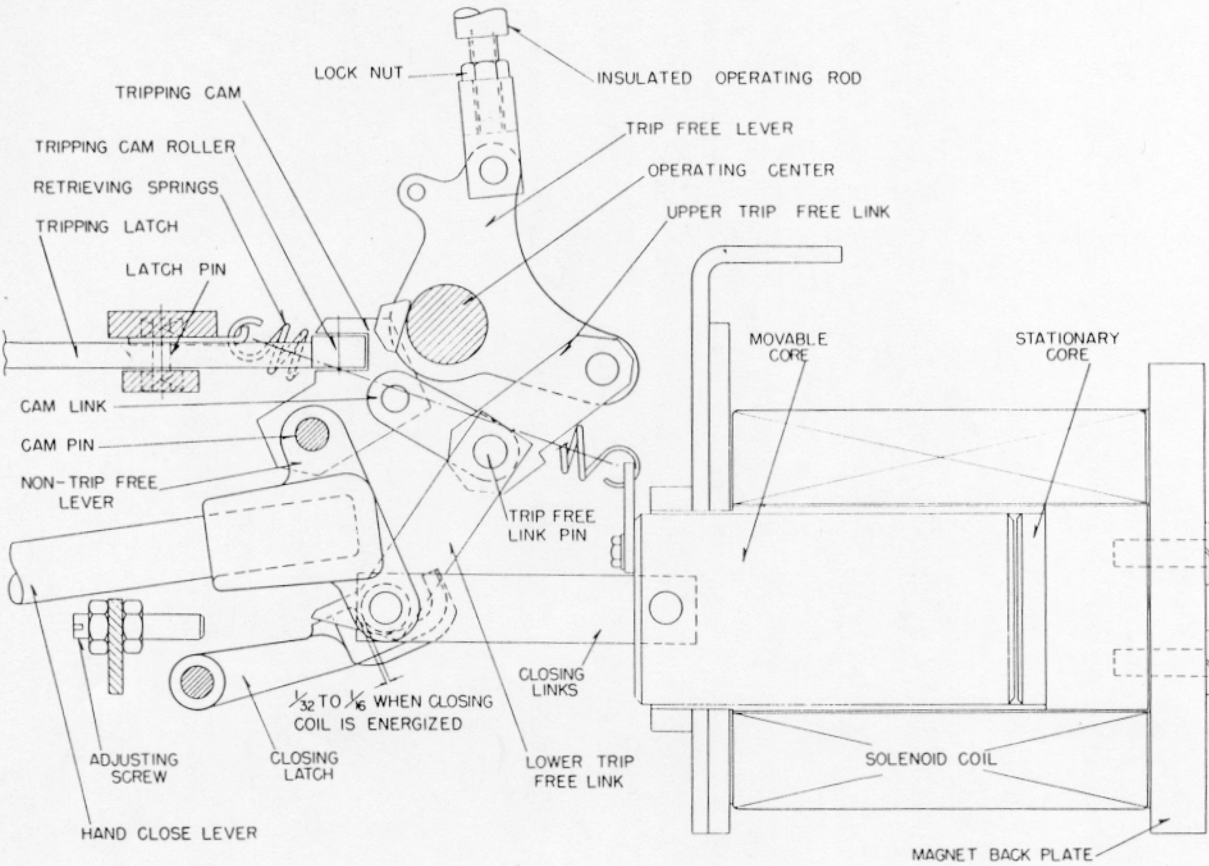


FIG. 4-A CLOSED POSITION

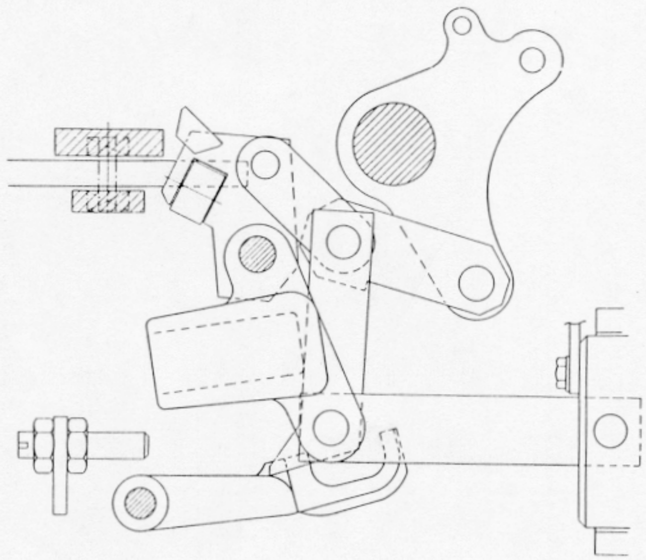


FIG. 4-B TRIP-FREE POSITION

FIGS. 4-A & 4-B. Solenoid Operating Mechanism Shown in Closed and Trip-Free Positions

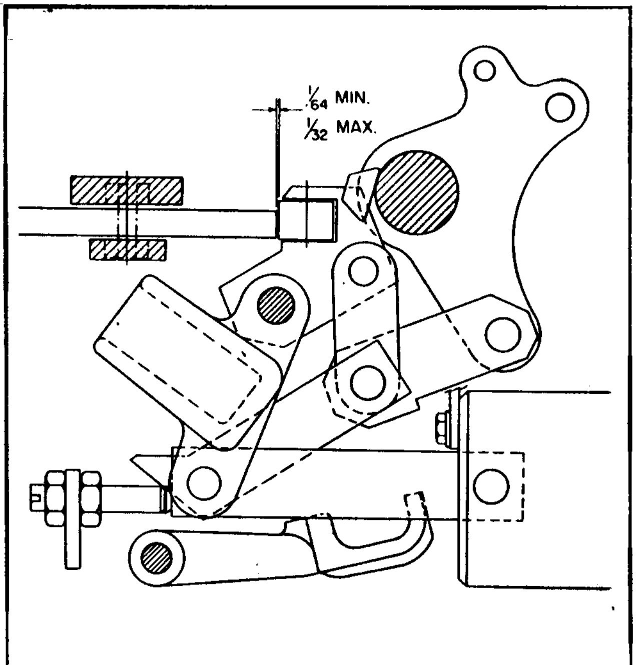


FIG. 4-C. Solenoid Operating Mechanism Shown in Reset Position

It should be noted that there is one trip free lever for each pole, all three levers being welded on the operating center shaft. The mechanism actuates directly the center pole operating rod, the left and right pole operating rods are actuated through the operating center shaft and respective levers.

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 levers then exert an upward force on the operating rods to close the breaker. The breaker is held in this position by the closing latch and the tripping latch.

The breaker is tripped either electrically or manually in the manner described previously. When the tripping latch is moved out of the latched position, the tripping cam is released and is free to rotate. Without the restraining force of the cam and the cam link, the major linkage collapses under the force of the contact springs and the accelerating springs which are located in two air bumpers (one on each side of the closing magnet). These springs are acting on trip free lever through the operating center shaft.

The junction of the upper and lower trip free links moves to the right and the trip free lever rotates clockwise, thus opening the breaker. The position of the linkage is then that shown in Fig. 4-B.

In moving to this position the roller on the lower trip free link has disengaged the closing latch. The retrieving springs now move the solenoid core which moves the linkage to the reset position as shown in Fig. 4-C. In this position the tripping latch is reset and the breaker may be reclosed.

MECHANISM PANEL

Actually, there is no formal panel provided on this breaker. However, the standard auxiliary devices are provided as listed below and are mounted as shown in Fig. 3.

Shunt Trip Magnet. This device is equipped with a coil for direct current tripping. The control voltage may be either 48 volts or 125 volts but the resistor connected in series with the tripping coil must be properly connected. Connections are made according to Fig. 5. The resistor is mounted on the side of the breaker under the movable bracket of the secondary connector block.

Cut-Off Switch. This switch causes the supply to the closing solenoid to be cut off after the breaker is closed.

Position Indicator. This device gives positive indication of the position of the breaker contacts.

Operation Counter. This counter records each operation of the breaker.

Latch Check Switch. 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 motions to get to the reset position. See "B" and "C" of Fig. 4. For this purpose, a switch is arranged to be closed when the primary latch moves to the reset position, because the latch is the last part to move in the sequence of linkage motions required to reset the mechanism. To keep necessary tripping force small, the resetting spring torque used on the latch is small. Therefore, the latch check switch is a small, light force, snap action switch. See Fig. 3.

MECHANISM ADJUSTMENTS

The mechanism in this air circuit breaker is adjusted at the factory and is designed to give long trouble-free performance. Do not make any adjustment unless faulty operation is observed.

Tripping Latch. 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 ot Fig. 4-C. The gap indicated between tripping latch and cam roller is an essential requirement to permit tripping latch to fall into

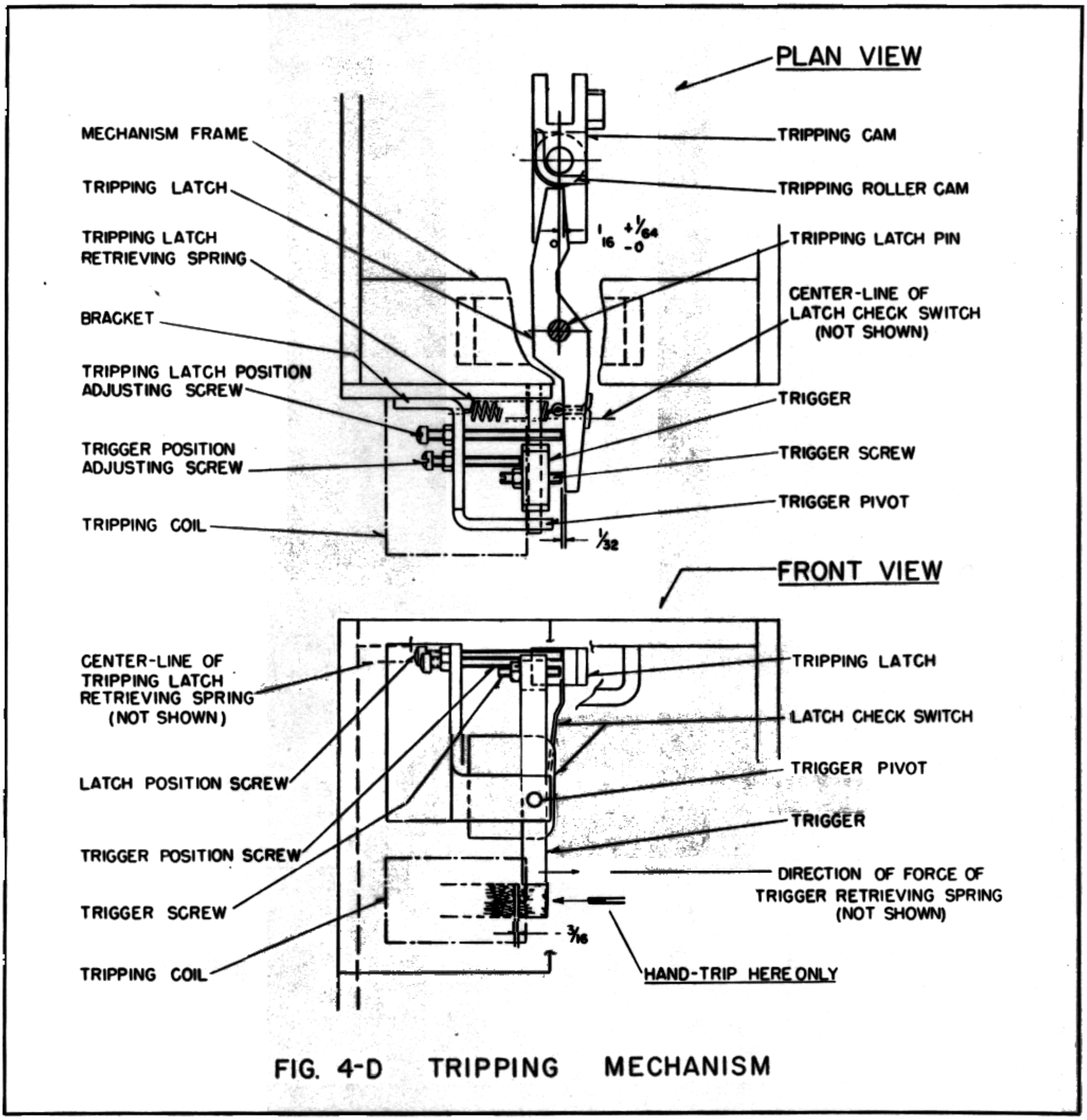


FIG. 4-D. Tripping Mechanism

proper position against the tripping cam. It should return into its normal position immediately after breaker has opened.

If the tripping latch does not return to full reset position, cause may be that the tripping cam roller does not move out of the way far enough and the gap between the tripping latch and the tripping cam roller has a negative magnitude. To correct this condition, adjust the adjusting screw to stop the closing magnet links as shown in Fig. 4-C; to do that trip the breaker manually and loosen the lock nut on the adjusting screw. Turn the screw until the proper size of the gap between the tripping latch and the cam roller is obtained. Then re-tighten both nuts or the adjusting screw to insure its setting will not change.

Another cause of failure of the tripping latch to return to its proper position may be the position of the adjustments of the latch and of the trigger.—see Fig. 4-D.

In the closed position the cam roller is resting against the latch as shown. The edge of the latch should be the specified dimension to the right of the line connecting the center of the roller and the center of the latch pivot. If this dimension were smaller, the latch may slip out thus permitting the tripping cam to rotate and the breaker to open. Large dimension is adverse to the operating speed of the mechanism. The adjustment of the latch is accomplished by means of the latch adjusting screw.

The trigger is adjusted so that the gap between the tripping coil (magnet) core and the respective yoke mounted on the trigger is as shown. This is accomplished by means of the trigger adjusting screw—see Fig. 4-D.

The trigger screw adjustment has an effect on the mechanism speed in such manner that large gap between the trigger screw and the tripping latch affects the operating speed adversely and too small gap may not permit the latch to return in its proper position.

If any adjustments are to be made, the proper sequence is to adjust first the latch, second the trigger and third (and last) the trigger screw.

During the work of these adjustments extreme care should be exerted to prevent the breaker from tripping as during the tripping cycle the latch flies between its extreme positions with a great speed and may cause severe injury to the operator, also on opening the breaker the contact arms and other moving parts are extremely dangerous.

Cut-Off Switch. Operation of this switch must occur at proper time in closing stroke. Contacts must make positively before end of motion so that current will always be cut off. In other direction, cut off must not occur too early in stroke or mechanism might fail to complete closing stroke. Proper action will be obtained when the switch will click in the instant when the closing magnet movable core is approximately 1/4 inch before the end of its stroke. Ordinarily no adjustment in the field will be needed. If it should be necessary to change this adjustment, close the breaker electrically and mark the position of the switch arm. Then trip the breaker and move the arm of the switch listening for it to snap. The position of the switch arm when it snaps should correspond to the position specified above; if not, bend the arm of the switch in approximate middle of its length correspondingly.

Latch Check Switch. The action of this switch may be checked as follows. Breaker being open, move the tripping latch to end of travel. Release slowly, listening for snap action. Note position of latch when switch snaps closed. Switch should close when the latch is 1/32 to 3/64 before the end of its travel. Bend the arm of the switch in approximate middle of its length to obtain the desired adjustment. If breaker is out of cell, switch action may be indicated electrically from drawout plugs number 17 and 18. (Note: Some models of this breaker are provided with latch check switch with arm adjustable by a setting screw. Use small Allen hexagonal wrench to turn the screw.)

CONTACT ADJUSTMENT

The design of contacts is shown in Fig. 6. In this contact design, the main moving contact is bolted solidly to the moving contact arm. All resilience is put in the stationary contact members. Conductivity from lower bushing to moving main contact is through a flexible shunt at contact arm hinge point. Main contacts are made of a high conductivity silver alloy. The arcing contacts are made of an arc refractory tungsten silver alloy. The movable arcing contacts are also solidly bolted to the moving

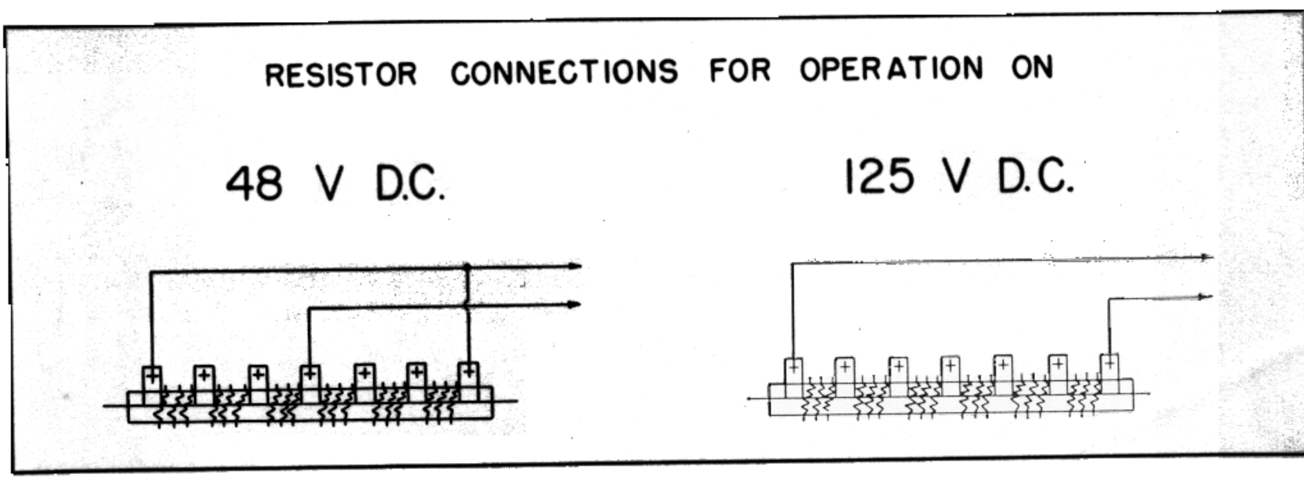


FIG. 5. Trip Coil Series Resistor

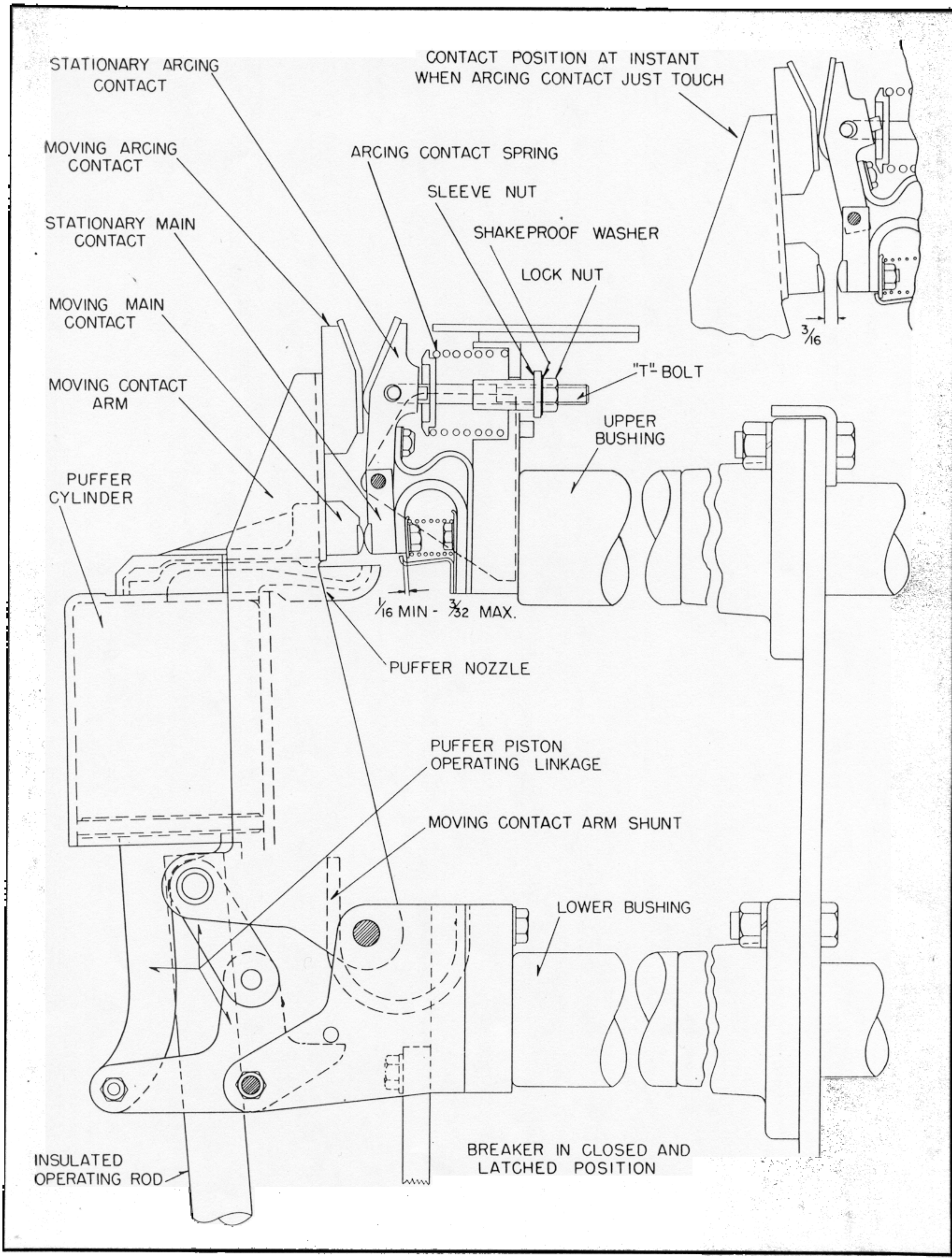


FIG. 6. Contact Adjustment Dimensions.

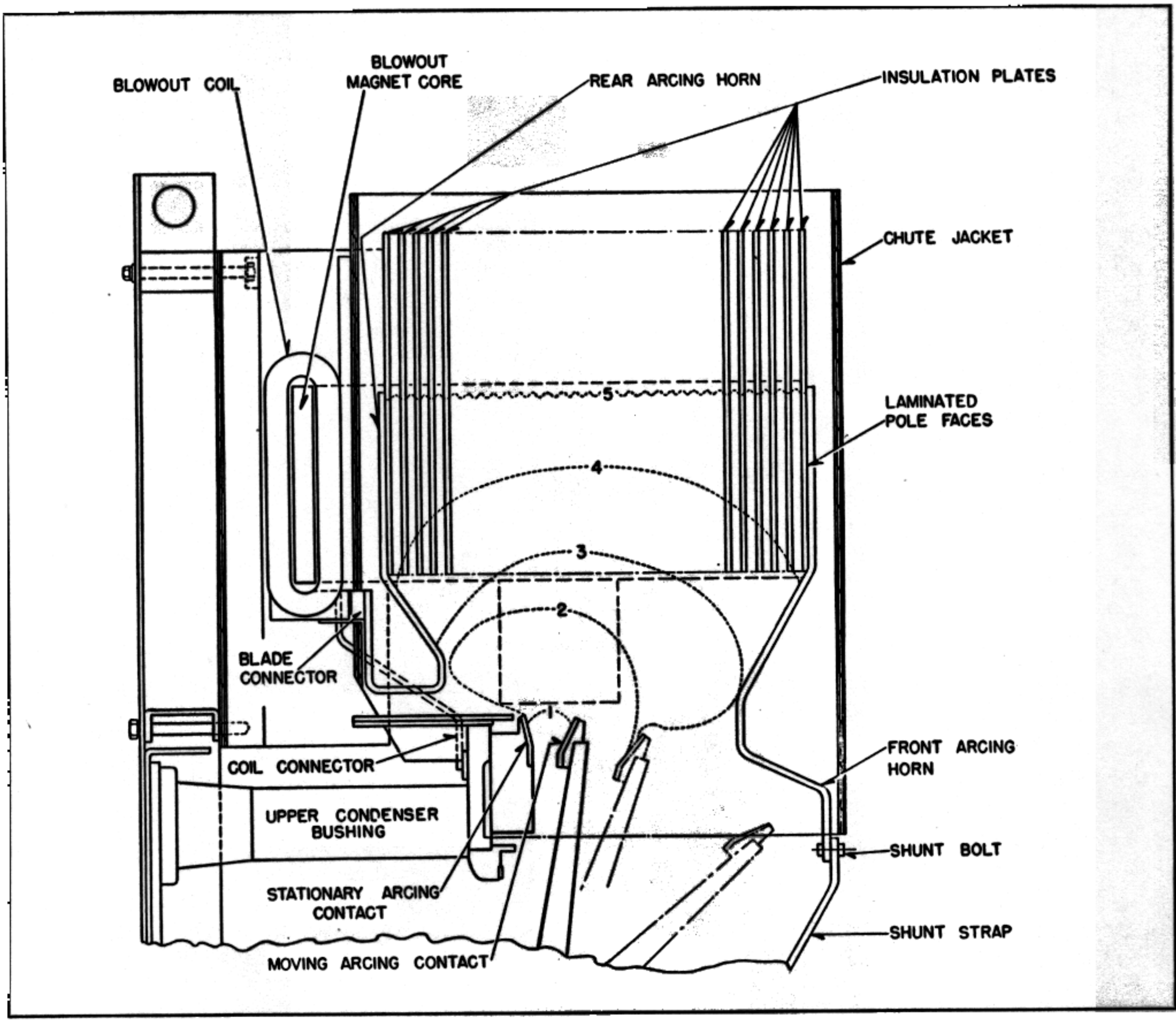


FIG. 7. Arc Chute and Blowout Coil

arm. Resilience of the arcing contacts is also put into the stationary contacts.

Stationary main contacts are split into 3 parts in order to increase the current carrying properties. Each of the three contacts is brazed on a copper finger which is hinged at the upper end on a pin. The fingers are attached to the upper bushing block through a copper shunt. In the breaker open position the contacts are pushed forward by helical springs arranged between the back of the contacts and bushing block. In the breaker closed position the contacts are pushed back by the movable contact. The movement should be as specified in Fig. 6. Springs provide contact pressure.

There are two stationary arcing contacts for each pole, brazed on copper fingers. These are hinged on the same pins as the stationary main contacts.

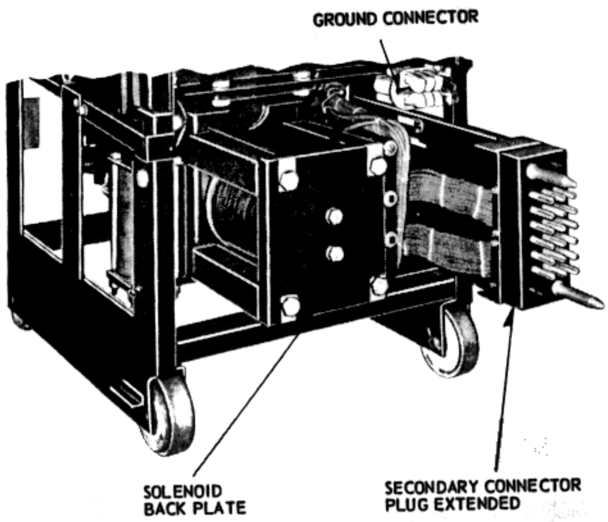


FIG. 8. Secondary Connector Plug Extended

At the other end the fingers are located on the cross piece of a T-bolt. Arcing contact spring provides necessary contact pressure as well as a directional force for fast contact movement during the opening cycle.

When the breaker opens, the movable arm with its contacts moves away from the stationary ones. First, both stationary contacts (main as well as the arcing ones) follow until the stationary main contacts are stopped by their respective stop and a gap starts forming between stationary and main contacts. The stationary arcing contacts still follow the movable ones for a little more distance until they are stopped by the flange of the sleeve nut at the end of the T-bolt.

Naturally, certain relationship between these distances must be maintained and for that reason definite adjustments are required.

Firstly, main stationary contacts should be adjusted so, that

(1) they are at approximately same line on all three poles,

(2) that the spring compression between open and closed positions is approximately 1/16 to 3/32, to provide adequate contact pressure in the closed position.

Condition (1) is obtained at the factory and is fulfilled by geometry of the arrangement. Condition (2) is obtained by adjusting each of the movable arms individually. The adjustment if needed, is made on the insulated operating rods. Remove the pin in the lower end of the operating rod assembly (at the lever of the operating center shaft), loosen the lock nut and rotate the operating rod end piece until the desired length of the rod assembly is obtained. Retighten the locknut and reassemble the pin.

The next step is adjustment of the stationary arcing contacts. Loosen the locknut at the back of the T-bolt, move the sleeve nut to obtain the desired contact setting and retighten the lock nut. The contact setting should be such that the gap between the main stationary and main movable contacts is 3/16 inch when arcing contact (stationary and movable) just touch.

Further condition for contact adjustment is that corresponding contacts on all 3 poles should close or open at approximately same instant. (This means that they should be at approximately same line for each set of contacts). For best results, the corresponding contacts should be within 1/8 inch from the straight line.

ARC CHUTES AND BLOWOUT MAGNETS

The arc chutes on the type DH air circuit breaker consists of an assembly of insulating refractory plates enclosed in a rectangular Micarta tube or jacket. In position on the breaker, the jacket is between the poles of the blowout magnet and the lower end is immediately above the arcing contacts.

The refractory plates have inverted V-shaped slots starting immediately over the arcing contacts so that the arc is drawn into these slots. The slots in the plates are alternately off center on opposite sides to increase the length of the arc path as the arc progresses up the chute.

Inside the front and rear surfaces of the chute are metallic arcing horns to which the arc transfers from the arcing contacts. The front horn is connected electrically to the moving contact, the rear horn through the blowout coil to the stationary contact. Thus when the arc transfers to the horns the blowout coil is included in the circuit.

The action of the breaker in interrupting an arc is shown in Fig. 7. When the arcing contacts separate, an arc is drawn between them without the blowout coil carrying current as indicated by postion 1. The arc rises rapidly from this position under the influence of magnetic forces and thermal air currents. These cause the arc to impinge on the arcing horns, thus including the blowout coil in series with the arc.

When current starts to flow in the blowout coil, the arc is driven very rapidly into the slots in the refractory plates by the magnetic field. Successive positions of the arc are shown in Fig. 7.

Because the slots are staggered, the arc is lengthened as it progresses up the chute by being extended laterally from one slot to the next. This exposes a large part of the arc to the relatively cool surfaces of the plates and to the de-ionizing effect of the blowout magnet field, which results in fast and positive interruption of the circuit.

HORIZONTAL DRAWOUT ARRANGEMENT

All type DH air circuit breakers are arranged for use in metal-clad equipment from which they may be drawn out horizontally. As may be seen in Fig. 9, all parts are supported on a steel frame with four wheels with roller bearings to facilitate moving the breaker, and flanges which engage with rails to align the breaker in the cell.

The main conductors project horizontally from the rear of the breaker, and are supported and insulated from the steel back plate of the frame by

Micarta condenser bushings. On the ends of these main contactors are circular clusters of contact fingers arranged to engage the circular bar conductors in the cell.

The control circuit wiring also is arranged for drawout disconnection by means of an 18-point connector block arranged to plug into a mating block mounted on the cell. This secondary connector block is mounted on a movable bracket on the lower left-hand side of the breaker frame. This permits the plug-in connector to be extended to the rear of its normal position so that the control circuits may be connected and the breaker operated electrically while the main contacts are disengaged. See Fig. 8.

This test position occurs at the outer limit of breaker travel obtained by operation of the levering-in device crank. If it is desired to connect the control circuits when the breaker has been cranked to this position, pull out the secondary contact locking pin shown in Fig. 4. While holding this pin out, push the secondary contact bracket toward the rear of the breaker until the secondary contacts engage fully. The main barriers may be removed and the breaker operated safely in this position since the main contacts are disconnected.

When the breaker is in the cell far enough to be connected to the high voltage bus, the frame work of the breaker is effectively grounded by a special connector located immediately above or below the secondary plug-in connector block. This connector jaw engages a copper bar which is mounted in the cell and connected to the cell ground bus.

Levering-In Device. In order to move the breaker in or out of the cell against the resistance of the contact fingers, a levering-in device is provided on each breaker. There is a lever on each side mounted on a common shaft across the back of the breaker. On each lever is a roller which engages a groove on the side wall of the cell. A removable crank engages another shaft at the right front corner of the breaker which turns the levers through a worm gear arrangement.

Before a breaker is rolled into a cell, the levers with rollers at each side of the breaker must be at their rear and slightly down position as shown in Fig. 9. The position of the levers shown in Fig. 9 is that which the levers take after the breaker is cranked into operating position. To put the levers in the position shown in Fig. 9, place the crank on the operating shaft at front right corner of breaker. Press in and rotate to engage slot. Breaker must be open to engage slot. Rotate crank counterclockwise to the end of travel against solid stop. With levers to the rear and down as in Fig. 9 the breaker is ready to be rolled into cell as far as the test position. The rollers on the levers strike a vertical angle on the cell wall and stop the breaker at the test position. If the breaker is to be operated at this position, remove the crank, and push in the secondary control connector as previously described.

To move breaker from test position into fully engaged operating position, put crank on shaft. Push in and rotate to engage. Crank clockwise. Torque required will increase slightly when primary connector fingers engage the stud in the cell. Continue cranking until lever shaft meets solid stop. Remove crank. If the cranking operation was completed, removal of the crank will permit the interlock pin, see Fig. 5 (also "A", Fig. 36 in I.B. 32-150-4), to withdraw from the trip-free lever in the mechanism.

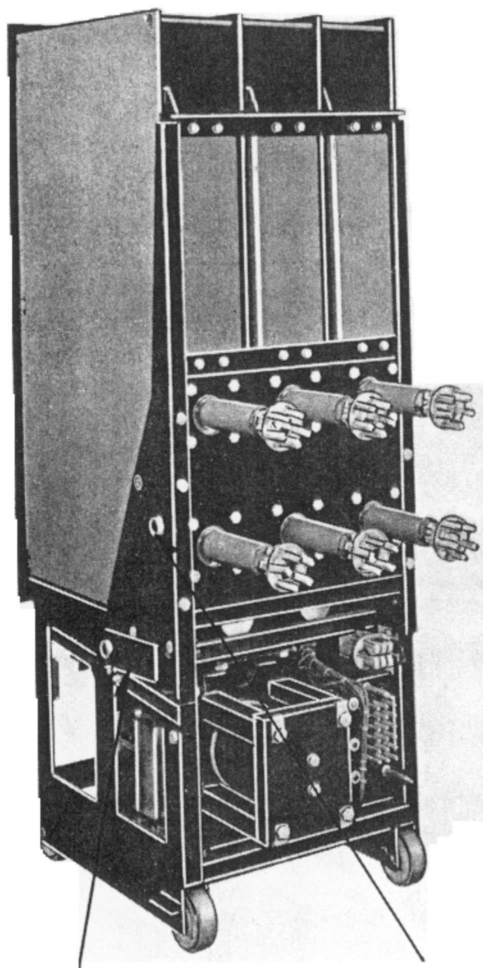
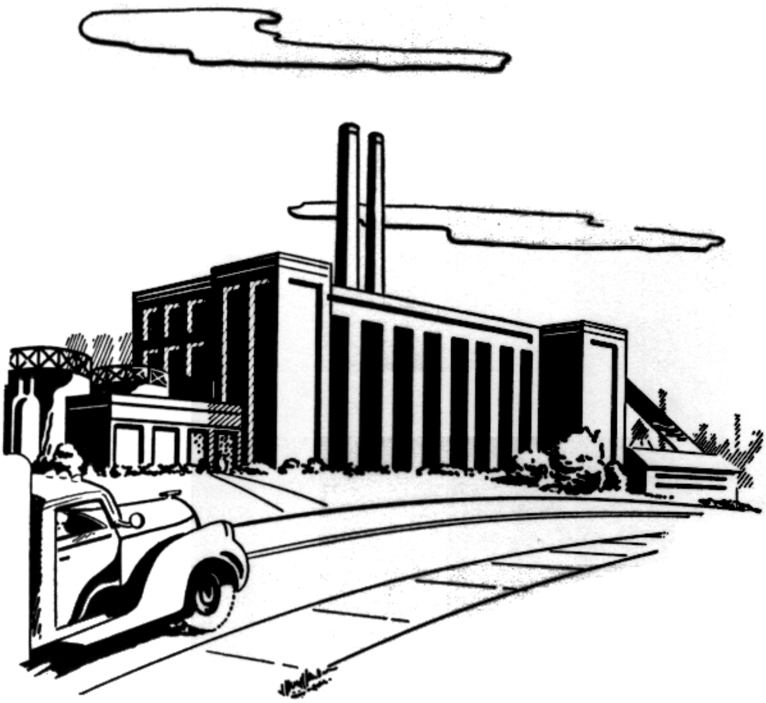


FIG. 9. Rear View of 50-DH-HS Ready to Roll into Cell

To remove a breaker from operating position, first check that breaker has been opened. Put crank on operating shaft. Push and rotate to engage. Turn counterclockwise until stop is reached. Remove crank. Again the interlock pin will withdraw from the trip-free lever if the cranking operation was completed. Breaker may now be operated at the test position or rolled out of cell.



PART FOUR

MAINTENANCE

Westinghouse type DH air circuit breakers are designed ot have a long life with a minimum of maintenance when operating duty is ordinary or average. However, the operating duty will vary greatly as to frequency of operation and as to size and power factor of current interrupted, with the many types of applications of these breakers. Therefore, the frequency of inspection and the amount of maintenance for any particular application must be chosen with due regard to the kind of duty a breaker is performing. The following remarks are intended as a general guide. Experience on a particular application may show a need for different maintenance practices.

Breakers which operate only a few times per year with light to medium currents being interrupted, will require only light routine maintenance. This maintenance should consist of a general inspection and a cleaning of deposited dust and dirt particularly from insulation surfaces, and a few "exercising" operations. When making these exercising operations, observe the mechanical motions to be sure they are quick, snappy, and positive and that there is no tendancy of any parts to stick. If there is any stickiness or sluggish motion, operate slowly by hand to locate the place with high friction. See paragraphs on "Lubrication", page 21. It is recommended that breakers which remain closed continuously without any automatic operations, be tried for proper operation at least once a year.

For breakers which operate a moderate number of times, say 100 to 1000 per year, mechanical stickiness is unlikely to develop and there will be no need for exercising operations. However, on inspections, more attention should be paid to cleanliness of the interrupter especially if there are many fault current interruptions. Large current arcs glaze the ceramic surfaces inside the arc chute but leave them clean electrically. On the other hand, frequent operation at low or medium currents (about 1000 amperes or less) tends to cause the accumulation of soot and condensed metal on the parts inside the arc chute, particularly on the ceramic arc shields near the contacts. These deposits may be conducting and may have to be removed as explained later under "Arc Chutes".

Breakers which have opened large fault currents near the maximum rating, should be inspected as soon as practical. The condition of the contact surfaces and the contact pressure adjustments should be checked. (See page 19, "Contacts".) Also the interior of the arc chutes should be inspected for cleanliness, degree of erosion, etc.

For breakers, which operate very frequently such as those on motor starting and arc furnace switching, more maintenance will be required especially when breaker opens large fault currents as well as ordinary load currents. Until experience has been acquired on such an application, inspection should be scheduled at least every two months or every 2000 operations whichever comes sooner. At inspection, such breakers will need close checking of contact and mechanism wear. Also they may need cleaning in the arc chutes and re-adjustments in the mechanism.

ARC CHUTES

The insulating parts of the arc chute remain in the circuit across the contacts at all times. During the time that the contacts are open, these insulating parts are subjected to the full potential across the breaker. Ability to withstand this potential depends upon the care given the insulation.

On general inspections blow out the arc chute with dry compressed air by directing the stream upward from the contact area and out through each of the slots between the arc splitter plates. Also direct the dry air stream thoroughly over the arc box shields. These are the ceramic liners in the lower end of the chute where the arc is drawn.

The arc chutes may be removed periodically for a thorough inspection. Remove any residue or dirt or arc products with a cloth or by a light sanding. Do not use a wire brush or emery cloth for this purpose because of the possibility of embedding conducting particles in the ceramic material.

When inspecting an arc chute, look for following:

1. **Broken or Cracked Ceramic Parts.** Small pieces broken out of ceramics, or small cracks are not important. But large breaks and particularly cracks from the inverted V slot in the interrupter plates out to the edge of the plate or to the top may interfere with proper performance of the interrupter. Hence if more than one or two broken or badly cracked plates are apparent, renewal of the ceramic stack is indicated.

2. **Erosion of Ceramics.** When an arc strikes the ceramic parts in the arc chute, the surface of the ceramic will be melted slightly. When solidified again, the surface will have a glazed whitish appearance. At low and medium currents, this effect is very slight. However large current arcs repeated

many times may boil away appreciable amounts of the ceramic. When the width of the slot at its upper or narrow end (originally 1/16) has been eroded to twice its original size, (or about 1/8 inch) the ceramic stack assembly should be replaced.

3. **Dirt in Arc Chute.** In service the arc chute assembly will become dirty from three causes. First, dust deposited from the air can readily be blown out of the chute with a dry compressed air stream. Second, loose soot deposited on the inside surfaces of the arc chute in the lower portions near the contacts may be removed by wiping with cloths free of grease or metallic particles. Third, some deposits from the arc gasses will adhere very tightly to the ceramic arc shields near the contacts. These deposits from the metal vapors boiled out of the contacts and arc horn, may accumulate to a harmful amount only in breakers which get many operations at low or medium interrupted currents.

Cleaning Arc Shields. Cleaning methods for the first two types of dirt are obvious as mentioned above. Particular attention should be paid also to any dirt on Micarta surfaces exposed to the arc below the ceramic arc shield. Wipe clean if possible. If wiping will not remove dirt, rub with sand paper and refinish these inside Micarta surfaces with Westinghouse red enamel No. 672 or equivalent. On breakers which get thousands of operations at low and medium interrupted currents, tightly adhering dirt may accumulate on the ceramic arc shields sufficiently to impair proper interrupting performance. This tightly adhering dirt can be removed only by rubbing with coarse sandpaper or other non-conducting abrasive paper. Doing this by hand inside the arc chute is slow and tedious. It is better to remove the ceramic arc shields from the arc chute and clean them with a power buffer or sander.

The ceramic arc shields may appear dirty and yet have sufficient dielectric strength. The following insulation test may be used as a guide in determining when this complete or major cleaning operation is required. 4.16 kv breaker arc chutes should withstand 15 kv, 60 cycles for one minute between front and rear arc horns. 7.2 and 13.8 kv breaker arc chutes should withstand 28 kv. Also the dirty surface of the ceramic near the contacts should withstand approximately 10 kv per inch when test prods are put directly onto the ceramic surface. When test voltage is applied, there should be no luminous display in the black deposits. If, after wiping and a light sanding in place, the ceramic surfaces will not withstand above insulation test, they should be removed and thoroughly cleaned with a power sander. While the ceramic arc shields or fire plates are out of the arc chute, the micarta surfaces behind them should be wiped clean, sanded lightly and refinsished with Westinghouse No. 672 enamel.

After an arc chute has been replaced, inspect it to make certain that the contact of the rear arcing horn has engaged the connector on the blowout coil, that the upper edge of the jacket is substantially parallel to the magnetic pole faces, and that the front arcing horn is securely connected to the lower bushing by means of the shunt strap.

CONTACTS

In normal operation the arc will make terminal marks all over the arcing contacts and to a lesser extent on nearby metal parts. High current arcs will erode arc contact material more rapidly, but high current arcs move upward very quickly off the contacts. Low current arcs move very slowly and their terminals may hop around the arcing contacts for several cycles. Hence a breaker which has had many operations at low currents, may be expected to have numerous small burned spots and pock marks all over the metal parts supporting the arcing contacts. When inspecting arcing contacts the important condition to be observed is the extent of the erosion of the contact material. When half of the original one eighth inch thickness has gone, the contact should be replaced. This is because the remaining 1/16 inch thickness will be mechanically weak and might be broken away suddenly.

On high fault current operations there may be occasional slight burning on main contacts. Also after many operations, main contacts will sometimes become roughened. A fine flat file should be used lightly on the main contact silvers, removing only enough to take off the high spots. A moderate amount of pitting on the main contact surfaces will not appreciably impair their current-carrying ability because of the high contact pressure.

After contacts have been worn and dressed off as above, contact adjustments should be checked. See discussion on contact adjustment.

ORGANIC INSULATION

Organic insulating materials are used in high voltage air circuit breakers for pole unit supports, operating rods, barriers, braces, arc chutes and similar purposes, where it has been found to be more suitable than porcelain. The material used on Westinghouse breakers is Micarta, which has a long established record for insulating and mechanical dependability. To ensure long continued electrical resistance, the Micarta surface is protected with high grade insulating varnish which may be either clear or pigmented, depending on the place of use and the apparatus design requirements.

The purpose of the varnish is to retard moisture absorption and to provide an easily cleaned surface. Like all other insulating surfaces, whether organic or inorganic, a varnished Micarta surface should receive periodic attention in order to maintain the insulation resistance at the highest possible value.

The objects of maintenance are two-fold, first to remove dust and other foreign air borne materials as well as chemical oxides which result from aging of the varnish, and second to make sure that the varnish provides a continuous protective film over the entire insulating surface.

In addition to the usually recommended periodic equipment inspections, on breakers that have been in service for three to five years, the insulation should be inspected, cleaned, and the varnish renewed if the surface indicates it to be needed.

Cleaning. While the surface of the insulation is dry, contamination does not usually cause any large change in insulation value. However, if while it is present, moisture is added in the form of condensation, or by more direct means, the surface electrical leakage may be greatly increased, even to the point of electrical breakdown. The first object of maintenance therefore is cleaning. A clean varnished surface will be smooth, glossy, and free from foreign material either loose or adhering to the surface.

To obtain a clean surface, it is necessary to loosen the adhesive dirt by scrubbing and washing. This is best accomplished in the following manner:

1. Wash with normal heptane, obtainable from the major oil companies such as Esso Standard. Use clean paper towels wet in the heptane. Use a fresh towel on each part.

Caution: Heptane is flammable and no open flames or sparks should be allowed near the work. Provide ample ventilation. Avoid long continued contact to skin by using neoprene gloves.

Normal heptane is recommended for this use because, (a) it will not harm the varnish, (b) it will quickly vaporize, (c) it will leave no residue which might tend to cause wetting action, and (d) it is practically non-toxic assuming good ventilation. If normal heptane is not available, any substitute should meet all above requirements. Acceptable substitutes are straight petroleum distillates such as mixed heptanes, white or non-leaded gasoline without benzol additives, Westinghouse solvent No. 1609-1, or -2, Stoddard solvent, mineral spirits, and cleaners' naptha.

2. After the heptane has evaporated, which requires only a minute or two, wash with de-ionized water, sometimes called demineralized water, or distilled water.

Note: De-ionized or demineralized water can be obtained in small quantities from many firms that maintain chemical laboratories, particularly storage battery manufacturers or electroplaters.

Use fresh paper towels and keep the water in a handy size glass bottle. Wet the towel from the bottle, wash the part and dry immediately with a fresh towel. Use fresh towels for each part.

Inspection. When inspecting the insulating parts preparatory to cleaning, wipe off superficial dirt with a dry cloth and note the condition of the varnish and of the Micarta. If the varnish appears in good condition, i.e., fairly smooth and with liberal coverage, proceed with cleaning.

If the varnish appears thin, and is not uniform in coverage, is cracked, or can be peeled off with the fingernail, the parts should be revarnished.

Varnishing. Varnishing can be done with the parts in position on the breaker, as follows:

1. Sandpaper when needed to remove loose varnish and wipe off all dust from sanding.

2. Apply three coats of varnish, Westinghouse M#135-2. Allow 24 hours drying time between coats at ordinary temperatures. Drying time may be decreased by preheating parts with infrared lamps to a temperature of 40 to 50 degrees C before applying varnish and likewise heating each coat for about 4 to 8 hours, or until the varnish has set up to the point where it will not be lifted by applying the succeeding coat.

Laminated Insulation. Resin bonded laminated insulating materials are formed under pressure at high temperature. The release of pressure, reduction of temperature and some further shrinking of the resin bond produces internal stresses. Relieving of these stresses may result in the formation of minute cracks or checks along the laminated edges of the insulation. Such cracks, if small, are sealed by the varnish and are not harmful.

OPERATING MECHANISM

With average conditions, the breaker operating mechanism may be expected to operate 5000 times or more with only routine inspection and lubrication.

During inspection the following points should be kept in mind. Remove loose dust and dirt with a compressed air stream. Wipe off latch and roller surfaces. 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. Holding trigger move hand closing lever up and down slowly. The core should move freely in the solenoid and the linkage system should reset positively when weight of hand close lever is removed slowly.

Lubrication. If any excessive friction or binding is discovered on above inspection, relieve it either by adding oil or if necessary by cleaning old dried lubricant from 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 light oil to the wearing surfaces. Use a stable oil with a low rate of oxidation and with a low pour point. Wemco C is suggested. Avoid putting oil on insulating material surfaces. Also put no oil on the breaker contacts, nor on the auxiliary switch. Soft petrolatum may be used on the drawout connectors both primary and secondary.

For the puffer pistons use a few drops of Wemco C oil or of good grade of light machine oil. Spread the oil on the cylinder walls and operate a few times to spread lubricant around.

For the air bumpers, which have bronze pistons and rings in a brass cylinder, a small amount of graphite grease (W) Material No. 1022-1 is recommended.

For the closing magnet core use graphite grease (W) No. 1022-1. Apply small quantity all around the core when breaker is in the open position and close and open several times to work the grease in.

For levering-in device rollers and washers as well as for roller for shutter, grease (W) Material No. 8577-2 is recommended.

For levering-in device pins and shafts at their bearings use a small quantity of lubricant (W) Material No. 5435, or a few drops of (W) "C" oil.

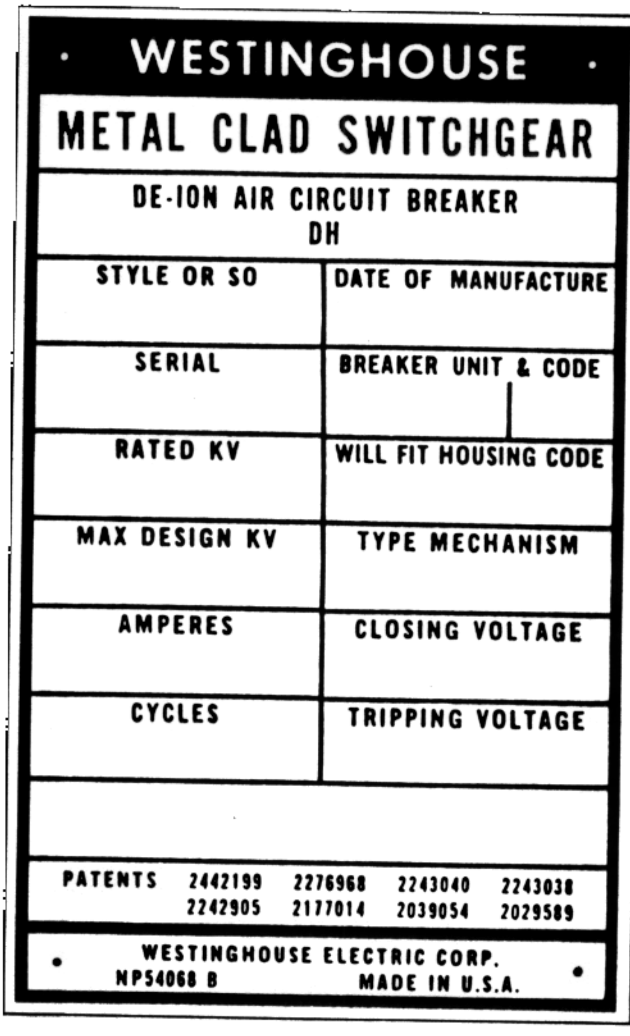
Any good grade of grease can be used for breaker wheels but for best results use grease (W) Material No. 1749-1.

As it was pointed out elsewhere this breaker is equipped for best performance with several roller or ball bearings; these are:

(1) Tripping cam roller.
(2) Tripping cam roller bearing.
(3) Tripping latch pin bearing.
(4) Upper trip-free link roller.
(5) Operating center shaft bearings.

All of these bearings are lubricated "for life", however it is recommended that they should be periodically examined and, if it appears necessary supplementary lubricant can be injected in the bearings by means of a hypodermic needle. Only the best grade of ball bearing grease should be used such as (W) Material No. 9921-4.

In dusty, dirty locations, surplus oil may catch and hold grit near bearings and latches and cause faster wear. In such locations, it is recommended that oil be omitted, and the steel parts in the mechanism be lubricated by rubbing with (W) Molkolube Powder (W) Material No. 8565-3).



Clearances. After a mechanism has operated several thousand times, the following points should be checked as part of routine inspection. With breaker open and mechanism reset there should be 1/64 to 1/32 clearance from tripping latch to cam roller. If re-adjustment 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 breaker closed, look through the slot in panel with a flashlight 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 3/32 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.

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.

Renewal Parts. A list of renewal parts recommended to be kept in stock will be furnished upon request. When ordering renewal parts, specify the name of the part, and include all of the information given on the breaker nameplate.