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

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	· WESTING	GHOUSE ·
	METAL CLAD	SWITCHGEAR
	DE-ION AIR CI	CUIT BREAKER H
	STYLE OR SO	DATE OF MANUFACTURE
	SERIAL	BREAKER UNIT & CODE
	RÂTED KV	WILL FIT HOUSING CODE
	MAX DESIGN KV	TYPE MECHANISM
	AMPERES	CLOSING VOLTAGE
Ċ	CYCLES	TRIPPING VOLTAGE
V	PATENTS 2442199 2243038	2276968 2243040 2242905 2177014
	WESTINGHOUSE NP54068-C	ELECTRIC CORP. MADE IN U.S.A.

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

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### WESTINGHOUSE ELECTRIC CORPORATION SWITCHGEAR DIVISION

EAST PITTSBURGH PLANT

EAST PITTSBURGH, PA.

FEBRUARY, 1959

**NEW INFORMATION** 

Printed in U.S.A.

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FIG. 1. Type 50-DH-250-E, 1200 Ampere Breaker, Completely Assembled

One of the outstanding improvements in modern power distribution has been the development of the air circuit breaker by Westinghouse for distribution circuit voltages. On circuits where the duty on breakers is heavy, long life with a minimum of maintenance makes the De-ion air breaker an outstanding performer. In the type DH magnetic De-ion air circuit breakers, Westinghouse offers a complete standard line for circuits from 2.3 to 15 kv.

Each of the type DH air circuit breakers is three-pole, electrically operated, and is built as a complete horizontal drawout unit for metal-clad switchgear. Breaker units of the same rating are interchangeable so that changing breakers is a matter of minutes. Since they are drawn out horizontally, no lowering or lifting is necessary. Steel barriers and automatic interlocks prevent contact with live parts while the breakers are being changed.

As in the case of most high voltage electrical equipment, these breakers should be inspected and maintained at regular intervals in order to obtain the most dependable performance.

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### PART ONE

# DESCRIPTION

The type 50-DH-150-E and 50-DH-250-E air circuit breakers are three-pole, electrically operated, horizontal drawout units for use in metal-clad switchgear. The ratings of the breakers are tabulated on page 1.

Figure 1 shows the front and right side of a type 50-DH-250-E breaker completely assembled, while Fig. 2 shows the breaker from the left rear ready to be placed in the cell. Figure 3 is the same breaker with the main barrier removed, and shows the center-coil arc chutes in their operating positions. Part of the separating contacts, primary disconnecting contacts, insulated operating rods, auxiliary switch and part of the solenoid operating mechanism are visible. These components are supported on a welded steel frame which is mounted on flanged wheels for rolling into the metal-clad cell. In the lower part of the frame is located the leveringin device for moving the breaker into final contact engagement. This is interlocked with the mechanism to prevent inserting or withdrawing the breaker with the contacts closed, and also prevents closing the contacts unless the breaker is completely in or completely out of the cell. Also located in the lower part of the frame are the auxiliary switch, shunt trip, cut-off switch, latch check switch, operation counter, breaker contact position indicator, levering-in device position indicator, socket for maintenance closing lever, and secondary contacts for automatically disconnecting the control wiring when the breaker is in the withdrawn position.

The arc chutes on this breaker are of the centercoil design in which the magnetic circuit is Hshaped with the cross member of the H passing through the center of the arc chute. The blowout coils are wound around the cross member of the H, and are located inside the arc chute jacket. With this arrangement, the blowout magnet becomes an integral part of each arc chute assembly.

To provide accessibility for contact maintenance and inspection, the arc chutes are hinged at the rear. Figure 4 shows the breaker with the arc chutes tilted back. In this position, the contacts are readily available for inspection and maintenance.

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

The Type 50-DH-150-E and 50-DH-250-E air circuit breakers are arranged for use in metal-clad equipment from which they are drawn out horizon-



FIG. 2. Type 50-DH-250-E, 1200 Ampere Breaker, Completely Assembled, Rear View

tally. The series E breakers are interchangeable with the series D breakers of the same rating. As may be seen in Fig. 3, all parts are supported on a steel frame with four wheels, equipped with roller bearings, to facilitate moving the breaker. The wheel flanges engage with rails to align the breaker in the metal-clad cell.

The six main primary conductors project horizontally from the rear of the breaker, and are supported and insulated by Redarta bushings. At the rear of these main conductors are the primary disconnects which are clusters of contact fingers arranged to engage the primary conductors in the cell.

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- NA



FIG. 4. Type 50-DH-250-E, 1200 Ampere Breaker, with Barrier removed and Arc Chutes tilted back for Inspection

### PART TWO

# **RECEIVING, HANDLING, STORING**

**OPERATION** 

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. The complete breaker is shipped in a single crate. The breaker frame is located at the front of the crate, with the interphase barrier installed. The three arc chutes are individually packaged and are located at the rear of the crate.

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 improper handling of crow-bars or other tools, use a nail puller for the uncrating. Care must be used in handling the arc chutes since the splitter plates in 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.

### PART THREE

After the breaker is unpacked, the best way to move it is by rolling on its own wheels.

If it is necessary to lift the breaker after it is uncrated, lift it without the barrier or arc chutes in place. Slings may be placed under the breaker frame or hooks used in the holes provided near the top of the frame.

#### STORING

The arcing chambers are shipped in separate containers located at the rear of the crate 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 ASSEM- BLY	COM- Plete Breaker	
50-DH-150-E	1200	695	85	80	1030	ĺ
50-DH-150-E	2000	960	85	100	1315	
50-DH-250-E	1200	695	110	85	1110	
50-DH-250-E	2000	960	110	100	1390	
						i.

Before placing the circuit breaker in service, it is advantageous to become familiar with the construction and function of the various parts which are described in the following paragraphs. This material should be studied carefully.

The general arrangement of the breaker components is shown in Fig. 3. The solenoid coil is built to exert a horizontal force on the mechanically trip free linkage of the mechanism. This linkage, in turn, exerts an upward force on the three insulated operating rods which act on the moving contact arms to close the contacts. The breaker has two sets of contacts: the main contacts for carrying the continuous load current, and the arcing contacts for carrying the current during interruption. As the contacts close, the arcing contacts touch first to establish the circuit, and then the main contacts follow closed. On opening, the main contacts separate first and then the arcing contacts follow. This insures that the main contact surfaces will remain free of burning and pitting for good current carrying capacities. Above the arcing contacts are located the center-coil arc chutes for extinguishing the arc while the breaker contacts are separating. The breaker is tripped by lifting the primary latch either manually or electrically by means of the trip coil.

#### **MECHANISM**

The solenoid operating mechanism with its tripfree linkage is shown in Fig. 5, with the operation of the linkage diagrammed in Fig. 6. 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. This 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



TRIP LEVER NONTRIP FREE LEVER LOWER TRIP CLOSING LINK CLOSING

FIG. 5. Solenoid Operating Mechanism

to form a rigid member by the cam link and tripping cam. The tripping cam is prevented from rotating by the tripping latch.

When the solenoid is energized, the movable core pulls on the junction of the non-trip free lever and the lower trip free link through the closing link. This causes the system to rotate about the operating center as the parts move from the RESET POSITION, Fig. 6C, to the CLOSED POSITION, Fig. 6A. The trip free lever then exerts an upward force on the three operating rods to close the breaker contacts. The mechanism linkage is held in this position by the closing latch which locks on a pin at the bottom of the non-trip free lever.

The breaker is tripped either electrically or manually by lifting the primary latch which disengages the tripping latch. This allows the tripping latch to rotate counterclockwise and release the tripping cam so that it is free to rotate counterclockwise. Without the restraining force of the cam and cam links, the upper and lower trip free links collapse under the force of the contact springs, and the accelerating springs on the puffer rods. The junction of these links moves to the right, and the trip free lever rotates clockwise opening the breaker contacts. The position of the linkage is then as shown in the TRIP FREE POSITION, Fig. 6B.

In moving to this position, the lower trip free link presses the closing latch downward, and disengages the pin in the non-trip free lever. The retrieving spring now pulls on the solenoid core which moves the linkage and the tripping cam to the reset position as shown in Fig. 6C. In this position the tripping latch is reset, and the breaker may be reclosed.

#### **MECHANISM PANEL**

The mechanism panel is mounted on the front of the closing mechanism as shown in Fig. 7. On it are mounted the following auxiliary devices included as standard on all breakers:

**Shunt Trip Magnet.** The shunt trip magnet is a small electromagnet which is used to trip the

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50-DH-150 &-250 AIR CIRCUIT BREAKERS



50-DH-150 &-250 AIR CIRCUIT BREAKERS

i.B. 32-251-



FIG. 7. Mechanism Front Panel

breaker electrically from an external source. It may be equipped with a coil for direct current, alternating current, or capacitor tripping. When the shunt trip magnet is energized, the moving core is drawn up into the magnet yoke toward the stationary core. An extension of the moving core protrudes through the top of the magnet assembly. As the core moves up, this extension moves against the trip lever directly above it. The force of the solenoid is sufficient to raise the trip lever which disengages the primary latch tripping the breaker. A bracket at the bottom of the assembly retains the moving core, and limits its travel to about 3/4 inch. A thin brass washer prevents the moving core from being retained by residual magnetism in the raised position after the coil is de-energized.

**Cut-Off Switch.** The cut-off switch is a single pole normally open contact which acts with the

breaker control relays to cut off the closing coil current after the breaker is closed. The switch is operated by an arm attached to the trip-free lever in the mechanism and the contact remains closed as long as the breaker is closed.

**Contact Position Indicator.** The contact position indicator gives a positive indication that the breaker contacts are either open or closed. It operates directly on the trip-free lever in the mechanism.

**Interlock Position Indicator.** The interlock position indicator gives a positive indication of the position of the breaker interlock. It operates from the levering-in device shaft. When the indicator points to the word OPERATE, the interlock is free and the breaker may be closed or tripped. When the indicator points to the word INTERLOCKED, the interlock is functioning and the breaker cannot be closed. Since the interlock is operative only when

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#### OPERATION,

the breaker is in an intermediate position between fully engaged and fully withdrawn, it also serves as a means of indicating that the breaker is in the Operating Position and the main disconnecting contacts fully engaged, or that it is in the Test Position with the contacts separated.

**Operation Counter.** The operation counter records each operation of the breaker. It advances one count for each tripping operation. A spring type link from the trip free lever operates the counter.

**Auxiliary Switch.** The auxiliary switch is a nine pole rotary type, and is operated by a link from the trip free lever in the mechanism. There are five "a" contacts (closed when the breaker is closed), and four "b" contacts (closed when the breaker is open). These are arranged alternately, starting with an "a" contact nearest the operating lever.

The first and third segments of the rotor are longer than the others, and are connected on each side of the shunt trip coil. When the breaker closes, these complete the trip coil circuit just as the main contacts touch. The rotor turns approximately 90°, and is adjusted by the serrated operating lever.

Each contact is able to carry 20 amperes continuously, and interrupt the following current.

VOLTAGE	NON-INDUCTIVE	INDUCTIVE
125 d-c	8.	4.
250 d-c	2.	1.
600 d-c	0.5	0.2
125 a-c	50.	30.
250 a-c	25.	15.
600 a-c	5.	3.

**Latch Check Switch.** The latch check switch is a small, light force, snap action switch which is operated by the primary latch of the mechanism. When a breaker is to be automatically reclosed after being tripped free, the links in the mechanism must be completely returned to the Reset position before the closing solenoid is energized. See B and C of Fig. 6. Since the primary latch is the last part of the mechanism to reset, the switch will hold its contact open until the latch returns to its normal position.

In addition to the above items which are standard on all breakers, the following special devices may also be mounted on the mechanism panel when required.

**Undervoltage Trip Attachment.** The undervoltage trip attachment, shown in Fig. 8, is a magnetically held device which will trip the breaker when its control voltage drops below a predetermined value. This device uses the energy stored in



FIG. 8. Undervoltage Trip Unit

a spring during the breaker closing stroke to lift the primary latch of the breaker mechanism. The holding magnet coil may be directly connected to a d-c control source, or it may be supplied with low voltage d-c obtained from an a-c control voltage through a small transformer and Rectox assembly mounted in the cell structure. Normally the moving core of • the device is held magnetically against the stationary core to hold the rod and consequently the reset lever in the reset position. When the coil voltage is reduced sufficiently, the reset lever spring overcomes the magnetic attraction of the cores and rotates the reset lever clockwise. As the reset lever rotates, the pin pushes against the latch to release it from its latch plate. When the latch releases, the trip spring rotates the trip lever to trip the breaker. The linkage is reset by the trip free lever of the mechanism as the breaker opens.

For time delay release on tripping, a very high resistance coil is employed in the holding magnet, and is supplied with about 300 volts d-c from a transformer, Rectox, and capacitor device mounted in the cell. The capacitor is connected across the coil, and provides a slowly decaying holding current. The time delay is adjusted by varying the charging voltage to the capacitor by a four step resistor, giving approximately one to three seconds delay.

**Three-Coil Trip Attachment.** The three-coil trip attachment, when supplied, mounts on the mechanism panel and is used in addition to the

50-DH-150 &-250 AIR CIRCUIT BREAKERS

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FIG. 9. Type 50-DH-150-E, 1200 Ampere Breaker Contacts Viewed from Rear

shunt trip magnet. It is designed to accommodate three instantaneous current transformer trip assemblies. The calibration of each current trip coil is engraved with the values of current required to trip the breaker.

#### CONTACTS

Each pole of the type 50-DH-150-E and 50-DH-250-E breakers is equipped with both main and arcing contacts. When the breaker is tripped, the main contacts separate first and then the arcing contacts follow. When the breaker is closed, they make up in the reverse order.

For the 1200 ampere rating, the body of the moving contact is a copper forging to which is brazed the main contact inlay. This assembly is bolted between two formed copper blades which hinge on the lower bushing foot and form the moving contact arm. See Fig. 9. These are moved between the closed and open positions by the mechanism through the Redarta operating rods. The load current is conducted across the hinge through silver electroplated surfaces, with pressure being supplied by spring washers on either side.

The moving arcing contact is hinged to the top of the main contact and the arcing current is carried by means of a flexible shunt inside the assembly. For the type 50-DH-150-E breaker the moving arcing contact consists of a single casting with a silvertungsten inlay. See Fig. 9. On the Type 50-DH-250-E breaker, this contact is divided for carrying the higher interrupting current and is shown in Fig. 10.

For both the 50-DH-150-E and 50-DH-250-E ratings, the 2000 ampere breakers use the same moving contact as the 1200 ampere Type 50-DH-250-E breaker. However, four moving blades are employed instead of two, and five contact bolts instead of three. The four blades are hinged to a casting on the lower bushing as shown in Fig. 11.

All contact resiliance is built into the stationary contact assembly. Because of the high momentary rating of these breakers the stationary contacts have been divided to give multiplicity of contact surfaces.

The 1200 ampere Type 50-DH-150-E breaker employs four movable fingers for the main contact, each backed by a separate finger spring. Each has a silver inlay that mates with the moving main contact. The stationary arcing contact is located directly above. See Fig. 12.

The 1200 ampere Type 50-DH-250-E breaker stationary contact is shown in Fig. 13 and is similar with the exception that the arcing contact is wider.

The 2000 ampere rating employs six fingers on each stationary contact, and is shown in Fig. 14. Cooling fins are located on each side of the contact.

With this contact design, all current breaking and interrupting parts are completely enclosed by the arc chutes.

#### OPERATION,



FIG. 10. Type 50-DH-250-E, 1200 Ampere Breaker Contacts, Viewed from Rear



FIG. 11. Type 50-DH-150-E/250-E, 2000 Ampere Breaker Contacts, Viewed from Rear

1.2.30

50-DH-150 &-250 AIR CIRCUIT BREAKERS

I.B. 32-251-3



FIG. 12. Type 50-DH-150-E, 1200 Ampere Breaker Contacts, Viewed from Front



FIG. 13. Type 50-DH-250-E, 1200 Ampere Breaker Contacts, Viewed from Front

#### **OPERATION**



FIG. 14. Type 50-DH-150-E/250-E, 2000 Ampere Breaker Contacts, Viewed from Front

#### **ARC CHUTES**

The arc chute consists of an H-shaped blow-out magnet, blow-out coils, transfer arc horns, transfer stacks, main interrupter stacks, a front arc horn, and a rear arc horn all assembled in and about a fabricated rectangular Redarta chute jacket. The arc chute is hinged to the breaker; and when it is in the normal position, its lower end completely surrounds the contact structure. Fig. 15 is a schematic cross section of the arc chute showing the component parts.

The blow-out magnet is located so that the core passes through the center of the arc chute. A blowout coil is wound near each end of the core and lays in a window cut in the side sheet of the chute jacket. One terminal of each coil connects to a transfer, or center arc horn, and the other terminals are joined at the top of the shading coil. Two transfer stacks are placed in the space between the transfer arc horns and the shading coil. To either side of the transfer arc horns are the main interrupter stacks which are made up of a series of insulating refractory plates. These plates have inverted V-shaped slots molded into them. The slots are offset so that when the plates are stacked with the slots alternating from one side to the other, the arc must take a serpentine path as it moves up into the arc chute increasing the length of the arc and at the same time restricting the diameter of the arc.

To either side of the main interrupter stacks are two metallic arc horns to which the arc transfers from the arcing contacts. The front arc horn is connected electrically to the moving contact, and the rear arc horn is connected to the stationary contact.

The action of a breaker in interrupting an arc is as follows. Referring to Fig. 15, when the arcing contacts part and an arc is drawn, it loops up and impinges on the lower ends of the two transfer arc horns and the shading coil. The two short segments of the arc, from the transfer arc horns to the shading coil, then move up into the transfer stacks and are quickly interrupted placing the blow-out coils in series with the arc.

When the current starts to flow in the blow-out coils, a magnetic field is established and the arc, which by this time is two separate arcs extending from the front and rear arc horns to the transfer horns, is driven very rapidly into the slots of the refractory plates of the main interrupter stacks under the influence of the powerful magnetic force. As the arc moves to the closed end of the slots, it is restricted, lengthened, and cooled. All of these forces result in rapid de-ionization of the arc space; and for the arc to maintain itself, it must continuously ionize fresh gas. At current zero the formation of new ionization momentarily ceases, but the de-ionization continues so that dielectric strength is established in the arc space and the circuit is interrupted.



**OPERATION\_** 

50-DH-150 &-250 AIR CIRCUIT BREAKERS

1.B. 32-251-3



Figure 16 is a photograph of partly assembled arc chutes. The Type 50-DH-250-E arc chute is on the left with the left pole of the magnet and the left side sheet removed. The front interrupter stack has been removed to show the front center arc horn. Similar parts have been removed from the right side of the Type 50-DH-150-E arc chute shown on the right of Fig. 16.

#### **LEVERING-IN DEVICE**

In order to move the breaker in or out of the metal clad cell against the resistance of the contact fingers on the rear of each bushing, a levering-in device is provided on each breaker. There is an arm on each side mounted on a common shaft across the back of the breaker. On each arm is a roller which engages a groove in the sidewall of the cell. A remov-



FIG. 16. Partially Assembled Arc Chutes



FIG. 17. Levering-In Device in position for Rolling into Cell

able crank engages another shaft in the right front corner of the breaker which turns the arms through a worm gear and pinion arrangement.

Before a breaker is rolled into a cell, the arms with rollers, at each side of the breaker must point to the rear and slightly downward as shown in Fig. 17. The arms travel 193 degrees and assume the horizontal position shown in Fig. 18 when the breaker is cranked into the operating position in the cell. To put the arms in the position shown in Fig. 17, place the crank on the operating shaft at the front right corner of the breaker (Refer to Fig. 3) push in, and rotate to engage the coupling in the levering-in device. The breaker contacts must be open to engage the coupling, and the indicator will show "Interlocked". Rotate the crank counterclockwise to the end of the travel. During this time the interlock mechanism will hold the coupling engaged. At the end of the travel, the interlock will release, the crank will move to the front, and the indicator on the mechanism panel will point to the word "OPERATE".



FIG. 18. Levering-In Device with Arms in position taken when Breaker is in Operating Position in Cell

#### **OPERATION**

With the arms to the rear and down as shown in Fig. 17, the breaker is ready to be rolled into the cell as far as the test position. The rollers on the arms strike vertical angles 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 engage the secondary contacts in the manner described in the section under Secondary Contacts. To move the breaker from the test position to the fully engaged operating position, put the crank on the shaft, push in and rotate to engage the leveringin coupling, and crank clockwise. The torque required will increase when the primary contact fingers engage the stationary contact studs in the cell. Continue cranking to the end of the travel where the interlock will again fall free, pushing the crank back out. Remove the crank. The indicator on the panel will again point to the word "OPERATE".

To remove the breaker from the operating position, first check that the breaker is open. The levering-in device cannot be engaged unless the breaker contacts are open. Put the crank on the operating

#### 50-DH-150 &-250 AIR CIRCUIT BREAKERS

I.B. 32-251-3

shaft, push in and rotate to engage the coupling, and turn counterclockwise until the breaker returns to the test position. Remove the crank. The breaker may now be operated at the test position or rolled out of the cell.

#### TEST POSITION

The breaker may be rolled into the metal clad cell until the rollers on the levering-in device stop against a pair of vertical angles welded into the cell. The levering-in device is not operated. This is the test position in which the breaker primary contacts are separated from the energized contacts in the cell, and a metal shutter is closed completely isolating all high voltage parts from the breaker. The secondary contacts may be engaged and the breaker operated safely for test purposes without the arc chutes or barrier.

**Caution:** THE BREAKER SHOULD NEVER BE MOVED BEYOND THE TEST POSITION WITHOUT THE ARC CHUTES AND BARRIER IN PLACE.



FIG. 19. View of Lower Part of Breaker from Rear

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FIG. 20. Operating Secondary Contacts



FIG. 21. Secondary Contacts extended for Completing Control Circuits when Breaker is in Test Postion

#### **OPERATING POSITION**

The breaker may be moved from the test to the operating position by engaging the levering-in device and rotating the levering-in crank clockwise. As the breaker travels beyond the Test Position, the metal shutter covering the high voltage primary contacts will be automatically opened by the shutter rollers which are located on each side of the breaker frame at the rear. See Fig. 17. At the end of the travel, all the breaker contacts are engaged. This is the Operating Position.

**Caution:** WHEN THE BREAKER IS IN THE OPERATING POSITION IT SHOULD NEVER BE CLOSED BY THE MAINTENANCE CLOS-ING HANDLE.

#### INTERLOCK

The interlock on the DH breakers has two functions to perform. First, it prevents the breaker from being moved from the test to the operate position or vice versa with the contacts closed. Second, if the breaker is in some intermediate position between the test and operate positions, it prevents the contacts from being closed.

This interlocking action is accomplished by having a rod, operated by the breaker mechanism, and a pin operated by the levering-in device, move at right angles to each other.

The puffer diaphragm is operated by two puffer rods extending through the puffer casting and connected to the trip-free lever of the mechanism. The right hand rod also extends beyond the rear of the diaphragm support plate and is directly above the levering-in gear housing, and at right angles to the interlock pin. See Fig. 19. When the breaker is closed, this puffer rod moves over the interlock pin and prevents the latter from moving upwards. This prevents the engagement of the split coupling on the levering-in crank shaft through the action of a bell-crank casting.

When the breaker is open, the puffer rod is clear of the interlock pin. As the levering-in crank is pushed toward the rear to engage the split coupling, the bell crank casting lifts the interlock pin which in turn will block any movement of the puffer rod. Thus the solenoid operating mechanism cannot move from the open position.

As the crank is turned, a cam on the levering-in shaft holds the interlock pin in the raised position until the arms are at either end of their travel. At this time the spring on the interlock pin will pull the pin down and separate the split coupling.

#### SECONDARY CONTACTS

The breaker control wiring is arranged for drawout disconnection by means of an 18-point connector plug arranged to connect to a mating receptacle mounted in rear of the cell. See Fig. 19. The secondary connector plug is mounted on a moveable bracket on the lower left hand side of the breaker frame. This permits it to be extended to the rear while the breaker is in the test position, and to make contact with the stationary receptacle so that the control circuits are completed. Sufficient clearance is provided in the mounting of both plug and receptacle,

#### **OPERATION**

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**GROUND CONTACT** 

and two large tapered pins on the plug provide positive alignment. The secondary contacts of the plug are made from high conductivity copper alloy and are slotted to provide a spring action which insures a good electrical contact. The flexible control wires are soldered to each plug and are arranged in a loop to allow free movement of the contact slide.

To engage the secondary contacts while the breaker is in the test position, place the breaker maintenance closing handle in the socket on the secondary contact slide at the lower left hand side of the breaker, Fig. 20. Push forward slightly to release the latch, then raise up on the handle to the end of travel. See Fig. 21. To disengage the secondary contacts, the maintenance closing handle is inserted into the socket and lowered. If the breaker is levered into the operating position, the secondary plug and slide will automatically return to the normal position; and the latch will hold it in place when the breaker is later moved to the test position.

### A ground contact is located at the left rear of the breaker frame directly above the 18-point secondary

plug, Fig. 19. Six spring loaded floating contact fingers engage the ground contact at the rear of the cell and insure a low impedance path to the ground.

#### PUFFER ASSEMBLY

Directly above the solenoid coil of the mechanism is a puffer arrangement that supplies a jet of air through an insulating tube and nozzle to each of the contacts. The diaphragm and clamping ring of the puffer are visible in Fig. 19. On low current interruptions the blow-out force of the small arcs is very light, so a jet of air is released at the instant the breaker is tripped. This facilitates the movement of the arc upward into the arc chute where it is quickly interrupted. The nozzle location is shown in Figs. 9 and 11. The diaphragm is connected to the trip free lever of the operating mechanism by means of two operating rods which also carry the accelerating



FIG. 22. "M-O-C" Switch Operating Arm

springs. As the breaker trips open, the diaphragm is drawn into the cavity expelling the air which is directed to the contacts by the three puffer nozzles. The diaphragm is made of a longlasting wide temperature range material and should never require replacement unless through accidental puncturing.

#### MECHANISM OPERATED CONTROL SWITCH

Some installations require more auxiliary switch contacts than are available on the nine pole auxiliary switch on the breaker. For this purpose additional rotary switches are mounted in the cell and are mechanically linked to the breaker mechanism.

An operating arm, shown in Fig. 22, on the right hand side of the breaker frame is connected to the trip free lever and moves with the mechanism. The knob at the end of the arm engages a link in the cell to operate the additional switches. This link may be arranged for operation of the switches when the breaker is in the operating position only, or both testing and operating positions.

#### SECONDARY CONTROL WIRING

The low voltage control wiring from the 18-point secondary plug to the various components consists of flexible stranded copper wire having flame retardant, moisture resistant insulation. The standard breaker internal wiring is shown on Connection Diagram, Fig. 23.

When an undervoltage trip device is used on the breaker, its coil is connected between secondary contacts 15 and 16; and the "a" contact at the end of the auxiliary switch is not wired. One lead from each of the three current trip coils is connected to secondary contacts 13, 14 and 15 with the common connection from the three coils going to contact 16 when this type of tripping is used. This eliminates the connection to the last "a" and "b" contact of the auxiliary switch.



FIG. 23. Diagram of Breaker Internal Wiring

### PART FOUR

# INSTALLATION

With the exception of installing the arcing chambers these breakers are shipped completely assembled and adjusted. No change in adjustments should be required and none should be made unless it is obvious they have been disturbed.

**Caution:** Severe injury may be sustained if any part of the body is struck by the contact arms since they move very rapidly in the opening stroke. Personnel working about the breaker should stay clear of the space in which the contact arms move while the breaker is closed or being closed. Never trip the breaker with the maintenance-closing lever in place. After the breaker has been removed from the shipping crate, place it in a convenient position adjacent to the test cabinet or in front of the metal clad cell in which it will go. Then perform the following sequence of operations to place the breaker in service.

1. Remove tie on hand-trip lever. Breakers are shipped with the contacts closed and a tie on the hand-trip lever to prevent tripping. Take off the tie on the trip lever being careful not to trip the mechanism until all personnel are clear of all moving parts, then trip the breaker.

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FIG. 24. Type 50-DH-150-E/250-E Contact Adjustment

2. Wipe off breaker main and arcing contacts. A light film of grease is applied to the contacts before the breaker is operated at the factory and is normally removed before shipment. Be sure contacts are free of grease or any foreign material before placing in service.

**3. Close breaker by hand.** Place the maintenance closing handle in the closing socket of the mechanism and push down to close the breaker. As the contacts touch near the end of the stroke, the force necessary to latch the breaker increases rapidly.

4. Check contact adjustment. The breaker main contacts are properly adjusted when the overtravel at the bottom of the outside stationary contact fingers is between  $\frac{1}{8}$  and  $\frac{5}{32}$  inch, with the breaker closed and latched. See Fig. 24. This may be measured through the rectangular opening on each side of the finger stop casting. If adjustment is required, it is made by loosening the two locknuts at the lower end of the operating rod; and turning the adjusting stud to lengthen or shorten the operating rod as required. Be sure to tighten the lock nuts after adjusting the contacts.

Trip the breaker, and close it again by hand until the main contact surfaces are separated  $\frac{3}{16}$  inch plus  $\frac{1}{16}$  minus  $\frac{1}{32}$  measured at the inside fingers. The outside fingers will be  $\frac{1}{32}$  plus  $\frac{1}{16}$  minus  $\frac{1}{32}$ . Holding

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#### INSTALLATION.

this position, adjust the contact stop nut located below the moving arcing contact springs until the moving and stationary arcing contacts just touch.

Current is conducted across the hinge through silver contact rings on the inside of the moving contact arms and the outside of the lower contact foot, with the correct pressure being maintained by means of spring cup washers. There should be no need for changing this adjustment unless the moving contact arms have been removed. With the operating rod disconnected from the moving contact arms, open the arms to approximately 45 degrees from the "contact closed" position. Tighten the castle nut on the hinge bolt sufficiently to barely hold the 45° position. Replace the cotter pin, and reconnect the operating rod.

**5. Trip the breaker.** The breaker is tripped both manually and electrically by lifting up on the hand trip assembly on the front of the breaker mechanism panel. Refer to Fig. 7.

**6. Close and trip the breaker.** Close and trip the breaker manually several times to be certain that all parts are functioning properly.

7. Connect test jumper. Connect the test jumper from the test cabinet to the breaker secondary contact block and operate the breaker electrically several times. With some installation, a Test Jumper is furnished instead of a Test Cabinet. This jumper connects between the secondary receptacle in the cell and the secondary plug on the breaker, and allows the breaker to be operated electrically while in front of the cell. Breaker operation should be quick and positive in both closing and tripping.

8. Inspect arc chutes. 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 arc chutes to make certain the vents and slots are open and free from obstructions; and there are no broken parts.

**9. Mount arc chutes.** Mount the arc chutes one at a time in the following manner: (It will be advantageous to begin with the center pole since this arc chute hinge pin must be threaded through one of the outside pole hinge brackets).

(a) Remove the hinge pin from the hinge bracket on the bushing support.

(b) Lift the arc chute into place so that the two parts of the hinge bracket are aligned with the arc chute in the tilted back position. See Fig. 4. Slip the hinge pin into place, and secure with a cotter pin on each end. The arc chutes are balanced so that they will remain in this position.

**Caution:** DO NOT use the molded deflector angles at the top of the arc chutes for lift-

ing as the seal to the ceramic plate will be broken.

(c) Carefully lower the arc chute to the horizontal position while checking the alignment with the moving and stationary contacts. The rear arc horn clip must make good contact with the rear projection of the upper contact foot.

(d) Bolt front arc horn to shunt strap of moving contact bushing.

(e) Make final check by operating breaker slowly by hand to see that there is no interference with movement of the contacts at any point in the travel.

(f) Check the nine pole auxiliary switch contacts to see that the fingers are approximately centered on the rotor segments for both open and closed positions of the breaker.

(g) The plunger of the single pole cutoff switch, located to the right of the nine pole switch, should be fully depressed when the breaker is latched closed.

10. Mount the barrier. When mounting the barrier, the lower rear corners of the outside plates go to the inside of the breaker frame. Two bolts in the lower front corners hold the assembly in place.

11. Prepare levering-in device to move breaker into cell. Breakers are shipped with levering-in device in the position shown in Fig. 18 with the arms pointing toward the breaker front. Before placing the breaker in the cell, the levering-in device roller arms must be pointed to the rear of the breaker and slightly downward as shown in Fig. 17. To put the levers in the position just described, place the crank over the shaft extending through the right front corner of the mechanism panel. Press in on the crank to engage the levering-in device coupling and rotate counterclockwise until the arms come around to the end of the travel against the solid stop. The breaker must be open to engage the levering-in device.

**12. Place breaker in test position.** Position the breaker in the cell and roll it in until it comes up against the solid stop. This is the test position.

**13. Engage secondary contacts.** Place the maintenance closing handle in the secondary contact socket and lift up to engage the secondary contacts, Figs. 20, and 21.

14. Operate breaker electrically. Close and trip the breaker several times electrically from the control switch on the front of the cell to check the control wiring in the cell. If the operation is satisfactory, the breaker may now be levered into the operating position.

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15. Caution: When this breaker is put into the cell and moved in beyond the test position, the high voltage parts 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 the barrier assembled in place, and the shunt strap bolted to the arc chute connection.

16. Lever breaker into cell. To move the breaker to the operating position, the contacts must be open. Place the crank on the levering-in device operating shaft, press in to engage the levering-in device, and rotate the crank clockwise to the end of the travel. At the end of the travel, the handle will come back out and the indicator on the breaker

### PART FIVE

mechanism panel will point to "Operate". The breaker must be all the way in for the interlock to release to permit the contacts to close. Remove the levering-in crank.

17. **Caution:** Do not attempt to close this breaker by hand against an energized circuit. To insure sufficient force and speed, the breaker must be closed electrically, from an adequate power source. (See NEMA Standard SG-6-213).

18. Energize the breaker. Close and secure the cell door. Close the breaker electrically with the control switch on the cell door.

If a test cabinet is not available for checking the breaker electrically before placing it in the cell, it can be checked electrically in the test position in the cell. Observe the caution of Step 15 above and do not go beyond the test position unless the arc chutes and barrier are in place.

# ADJUSTMENT

#### MECHANISM

The mechanism of the 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 to "C", Fig. 6. 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 trigger handle (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. Remove the barrier from the breaker. This gives easy access to the gap. 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 /32 inch gap, loosen the locknut and adjust the mechanism stop bolt until the cam to roller clearance is within limits. When measuring this, the closing latch should be depressed to be sure the tripping cam is in its normal position. The stop bolt is accessible through the cut-out in the mechanism panel next to the shunt trip. See Fig. 7. The hand closing lever should be out of the socket during this adjustment.

Cut-Off Switch. Operation of this switch must occur at the proper time in the closing stroke. The contact must make positively before the end of motion of the trip free lever so that the current will always be cut off. In the other direction, cut-off must not occur too early in the stroke or the mechanism might fail to complete its closing stroke. Proper action will be obtained when the switch plunger has from  $\frac{1}{32}$  to  $\frac{1}{8}$  inch over travel. In other words between the position where the contacts touch and the position with the breaker closed and latched at rest, there must be  $\frac{1}{32}$  to  $\frac{1}{8}$  inch motion of this switch plunger. Ordinarily no adjustment is required. The resilience provided in the operating arm by the leaf spring prevents damage to the switch on the mechanism over travel. If it should be necessary to change the switch contact time, bend the switch operating arm to get the proper time.

**Latch Check Switch.** The action of this switch may be checked as follows. With the breaker open, raise the trigger (Lift to Trip) arm to end of the travel. Lower it slowly listening for the snap action. Note the position of the arm when the switch snaps closed. The switch should close its contact when the trigger

#### ADJUSTMENT,

arm is in an interval from  $\frac{3}{8}$  to  $\frac{1}{8}$  inch above the normal reset position measuring at the shunt trip plunger centerline. A convenient method of measuring this is to raise and lower the trigger arm by pushing with the trip plunger and making pencil marks on the plunger rod. If the breaker is out of the cell, switch action may be indicated electrically by connecting to contacts number 1 and 2 on the secondary plug. If switch action must be made earlier or later, bend the switch arm near the middle of its length.

**Contacts.** Each time the breaker is operated, a small amount of the contact material is eroded away.

PART SIX

In order to maintain proper pressure as the contacts erode, it is necessary to readjust the contacts from time to time to compensate for wear. The contacts are properly adjusted when the over travel at the bottom of the outside stationary contact fingers is between 1/8 inch minimum and  $\frac{5}{32}$  inch maximum. This may be measured through the rectangular opening on each side of the finger stop casting. Refer to Fig. 24 and Contact Adjustment Paragraph 4 under Installation.

Always tighten all locknuts securely, and then recheck measurements.

### **MAINTENANCE**

The Westinghouse Type DH circuit breakers are designed to have a long life with a minimum of maintenance when operating duty is ordinary or average. However, with the many types of applications of these breakers, the operating duty will vary greatly as to frequency of operation and as to amount and power factor of current interrupted. 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 varying the maintenance practice.

Breakers which operate only a few times per year with light to medium currents being interrupted will require only light routine maintenance. This 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 operations to be sure they are quick, snappy, and positive; and that there is no tendency 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. It is recommended that breakers which remain closed continuously without any automatic operations be given several "exercising" operations and a complete inspection once a year.

With breakers which operate a moderate number of times, say 100 to 1,000 times 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 chutes but leave them clean electrically. On the other hand, frequent operation at low or medium currents (about 1,000 amperes or less) tend 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 adjustment should be checked. Also the interior of the arc chutes should be inspected for cleanliness, degree of erosion, etc.

For breakers which operate very frequently, more maintenance will be required especially when the 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 1,000 operations which ever comes sooner. At inspection, such breakers will need close checking of contacts and mechanism for wear and may need cleaning in the arc chutes and readjustment of the mechanism.

#### CONTACTS

In normal operation the arc will make terminal marks all over the 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 contacts for several cycles.

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Hence a breaker which has had many operations at low currents may be expected to have numerous small burn 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 1/8 inch thickness is gone, the contact should be replaced. This is because the remaining 1/16 inch thickness will be mechanically weak and might suddenly be broken away.

On high fault current operations there may be occasional slight burning on the main contacts. Also after many operations, the 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. In other cases, the surfaces may become glazed or shiny, and this may be corrected by the use of fine sandpaper. 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 the contacts have been worn and dressed off as above, or replaced, contact adjustment should be checked. Refer to the section on Contact Adjustment.

**Moving Contact Assembly.** The moving contact assembly consists of a copper forging to which is brazed the main contact silver alloy inlay, with the arcing contact hinged to the top. To change this contact assembly remove the three bolts which hold the contact between the blades.

The moving arcing contact, springs, and shunt may be separated from the main contact forging by first removing the  $\frac{3}{8}$ -16 hex head bolt located under the arcing contact stop nut. Refer to Fig. 24. One of the snap rings and the  $\frac{5}{16}$  inch diameter arcing contact hinge pin are removed.

If only the main contact is to be replaced, the parts are then reassembled in the reverse order.

To replace the moving arcing contact, the two  $\frac{1}{4}$ -20 hex head bolts are removed at the top of the flexible shunt. For the 50-DH-150-E rating, the  $\frac{3}{8}$  inch diameter pin at the top of the spring eyebolt is driven out. In replacing the new contact, the pin may be started through the eyebolt by prying from the opposite side with a rod of similar diameter to force the spring guide down. For the 50-DH-250-E rating, the two halves of the arcing contact are slipped off the side. If only one half of the contact is changed at a time, the spring pressure will be reduced.

**Caution:** There is considerable spring pressure and the parts will have a tendency to fly apart as the spring guide snaps to the shoulder on the eye-bolt. Do not remove the

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adjusting nut at the bottom of the spring eyebolt.

The arcing contact assembly is then installed on the main contact forging. Make sure all bolts are tight, and the snap rings have been replaced on the hinge pin.

**Stationary Main Contacts.** The stationary main contact is made up of four or six individually sprung fingers held in the upper bushing contact foot for the 1200 ampere and 2000 ampere rating. See Figs. 12, 13, and 14. These are removed by partially closing the breaker with the maintenance closing handle far enough to hold the fingers in place.

**Caution:** Do not latch breaker. Remove the two  $\frac{5}{16}$ —18 hex head bolts from the finger stop. The breaker is allowed to open slowly. The fingers and their springs may be slipped out the side of the contact foot.

A very thin coat of a graphite grease should be placed on the silver plated contact surface between the contact fingers and the contact foot before replacing the fingers. (W) No. 8831-9 is recommended.

In replacing the fingers, the thin strip of insulation must be located between the bottom of the finger springs and the contact foot.

The 1200 ampere rating with four fingers has a spring for each finger. The 2000 ampere rating has two concentric springs resting on a spring seat for each pair of fingers. One side of the spring seat has two ridges. In reassembling, the spring seat must be placed so that each ridge is parallel to the finger and rests on a single finger.

After the fingers are in place, the finger springs are compressed by partially closing the breaker with the maintenance closing handle. This will allow the finger stop to be bolted in place.

Stationary Arcing Contacts. These contacts are easily replaced by removing the one, or two  $3/_8$ —16 hex head bolts at the top of the contact foot. The new contact is then bolted in place.

#### **ARC CHUTES**

The insulation 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 chutes 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

#### MAINTENANCE,

shields. These are the ceramic liners in the lower end of the chute where the arc is drawn.

The arc chutes should be inspected each time the contacts are inspected. Remove any residue, 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 the following:

1. Broken or Cracked Ceramic Parts. Small pieces broken from the ceramics, or small cracks are not important. But large breaks and particularly cracks extending from the inverted V slot in the interrupter plates out to the edge of the plate or to the top may interfere with top 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 a ceramic part in the arc chutes, the surface of the ceramic will be melted slightly. When solidified again, the surface will have a glazed whitish appearance. At low and medium current, 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  $\frac{1}{6}$  inch) has been eroded to twice its original size, (about  $\frac{1}{8}$  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 which 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 which may be removed by wiping with cloths free of grease or metallic particles. Third, very tightly adhering deposits from the arc gases on the ceramic arc shields near the contacts. These deposits from the metal vapors boiled out of the contacts and arc horns, may accumulate to a harmful amount only in breakers which receive many operations at low or medium interrupted currents.

4. Cleaning Arc Shields. Cleaning methods for the first two types of dirt are obvious as mentioned above. Particular attention should be paid to any dirt on the glass polyester or Redarta surfaces exposed to the arc below the ceramic arc shield. Wipe clean if possible. If wiping will not remove the dirt, clean with sand paper to remove all traces of carbon or metallic deposit. On breakers which receive 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 dirt can be removed only by rubbing with coarse sand paper or other nonconducting abrasive paper.

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. The arc chutes should withstand 15 KV, 60 cycle for one minute between the front and rear arc horns. Also the dirty surface of the ceramic near the contacts should withstand approximately 10 KV per inch when test prods are placed directly on the ceramic surface. When test voltage is applied, there should be no luminous display in the black deposits.

#### **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: (1) Remove loose dust and dirt with a compressed air stream. (2) Wipe off latch and roller surfaces. (3) With maintenance 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 any evidence of stickiness or excessive friction. (4) Holding trigger up, move maintenance 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 maintenance closing lever is removed slowly.

Lubrication. In general, lubricants are not in wide spread use on circuit breakers. Yet the gains from the use of certain choice lubricants only follows principles of good mechanical practice. For many operating parts, lubricants can be avoided. In certain other parts, the use of special lubricant is desirable and beneficial—PROVIDED IT IS DONE CAREFULLY. This means applying it in small quantities to avoid drippings and accumulation. Experience will dictate the amount required. Those breakers having only a few operations per year, will perform best with the moving surfaces of the mechanism clean and only a very light film of lubrication. While those breakers having many operations per day will require more lubrication to prevent excessive wear.

If any excessive friction or binding is discovered on inspection, relieve it either by adding lubricant 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 a few cases, after long service, the accumulation of dried or oxidized lubricant may make it necessary to disas-

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semble parts and clean them. Carbon tetrachloride is a good solvent for this.

Apply a small amount of a 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, the auxiliary switch, the puffer diaphragm, nor the rubber bumpers. Soft petrolatum may be used on the drawout connectors both primary and secondary.

For the closing magnet core use graphite grease (W) No. 8831-9. Apply a small quantity all around the core when the breaker is in the open position, and close and open the breaker several times to work in the grease.

The silver plated contact surfaces on the hinge of the moving contact arms should be lubricated with graphite grease (W) No. 8831-9.

When the stationary main contact fingers are replaced, the knuckle joint between the fingers and the contact foot should have a light film of graphite grease (W) No. 8831-9.

The rollers and pins on the hand trip assembly, Item 32 on Fig. 27, should receive a very small quantity of a molybdenum lubricant (W) No. 8577-2.

The levering-in device rollers and shutter rollers should also receive molybdenum lubricant (W) No. 8577-2. The levering-in shaft bearings and worm gear should receive (W) Material No. 5435-1.

Any good grade of grease can be used for the breaker wheel bearings.

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 all oil be omitted, and the steel parts in the mechanism be lubricated by rubbing with (W) Molkolube Powder, 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 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. 6C. If readjustment is necessary, see explanation under Mechanism Adjustments. To permit the closing latch to move up to its holding position, the shaft at the lower end of the non-trip free lever must overtravel the latch surface slightly. With the breaker closed, look through the slot in the panel with a flashlight at the closing latch and shaft; and energize the close coil for one or two seconds several times.

The overtravel should be approximately  $V_{32}$  minimum to  $V_{32}$  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. This will change the position of the stationary core with respect to the latching points in the mechanism frame.

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.

### PUFFER

The puffer diaphragm is made of long lasting, wide temperature range material, and should never require replacement unless through accidental puncturing. If replacement is necessary, proceed as follows. Refer to Figs. 19 and 28.

**1.** Remove ground contact.

**2.** Remove two <sup>3</sup>/<sub>4</sub>—10 castle nuts from clamping plate. The right castle nut will be captive until the right hand puffer rod is lowered.

**3.** Remove the links to the 9-pole auxiliary switch and the operation counter. Remove two drive pins from the front of the levering-in device shaft, and slip off the indicator collar.

**4.** After removing the four  $\frac{3}{8}$ —16 bolts from the mechanism front panel, the panel may be swung to the side without disturbing any wiring.

**5.** Remove the 1/2 inch diameter pin between the bottom of the right hand puffer rod and the trip free lever of the mechanism. The rod will then move forward to clear the levering-in gear housing.

**6.** Remove twenty 1/4—20 clamping ring screws. With the levering-in device arms pointing to the rear, two of the screws may be reached through the openings in the side frame.

**7.** Remove the clamping ring, and the diaphragm and clamping plates.

**8.** Remove the two bolts which hold the diaphragm between the clamping plates.

**9.** Place the new diaphragm in the same position as the one removed, and replace the two bolts and locknuts. Do not overtighten so as to crush the diaphragm.

**10.** Place this assembly in the cavity of the puffer casting, and return the clamping ring which may be held in place with several screws.

**11.** Replace the two castle nuts, but do not tighten until the pin has been replaced in the bottom of the right hand puffer rod.

**12.** After moderate tightening, secure the two castle nuts with cotter pins. Replace the twenty

clamping rings screws being careful to not crush the diaphragm.

**13.** Replace the cotter pins in the puffer rod pin, and return the front panel and links.

#### **PUFFER NOZZLE**

The puffer nozzle is molded directly to the puffer tube. The tube passes through the lower bushing foot and into the puffer casting. It can be changed by removing the bolt from the clip at the base of the tube where it passes through the breaker frame. When replacing the tube, be sure the clip is in the notch in the tube before tightening the bolt.

#### **Auxiliary Switch**

The contact fingers and rotor segments of the nine pole auxiliary switch may be inspected when the breaker main barrier and the insulating angle cover on the switch frame are removed. Refer to Fig. 29.

The rotor moves approximately 90 degrees starting from a position  $22\frac{1}{2}$  degrees below the horizontal when the breaker is closed. This is adjusted by loosening the  $\frac{1}{4}$ —20 locknut at the end of the operating lever and moving the serrated plate. The "V" tip of the stationary contact finger should be near the center of the contact segment when that stage is closed. Check "a" contacts with the breaker closed, and "b" contacts with the breaker open.

Normal operation is sufficient to keep the contacts clean. If the contacts do require cleaning, a very fine file should be used; and care taken not to remove more material than necessary.

### PART SEVEN

Any burned segments and contact fingers should be replaced. The rotor is removed from the switch by loosening the operating lever and removing the end plates. The rotor is dismantled by removing the 1/4—20 clamping bolt and end clamp. Refer to Fig. 29.

In reassembling, care must be taken that the insulating spacers are placed on the rotor shaft in the correct order. The various widths are given in Fig. 29 with the  $7_{32}$  and  $15_{32}$  spacers starting at the third position and alternating to the end of the rotor.

### INSULATION

Flame retardent, glass-mat polyester insulating materials are used in high voltage air circuit breakers for bushing ties, 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 Redarta, which has a long established record for insulation and mechanical dependability.

Insulation maintenance consists primarily in keeping the surfaces of the material clean. This can be done by wiping the surfaces with cloths free of grease or metallic particles each time the breaker is removed from the cell for inspection.

In case there is any tightly adhering dirt which will not come off by wiping, it can be removed with Westinghouse solvent No. 1609-1 or -2.

# PARTS IDENTIFICATION

Detailed parts identification for the breaker are shown on the various figures throughout this book. Figure 3 shows the major components of the breaker. Figures 6 and 27 shows the mechanism linkage. Figure 7 shows the various components mounted on the mechanism front panel. Figure 25 shows the parts for the moving contact assembly, while Fig. 26 shows the parts for the stationary contact assembly. Figure 28 shows the parts in the puffer assembly. **Renewal Parts.** A list of renewal parts recommended to be kept in stock will be furnished upon request. When ordering renewal parts, always specify the part name and style identification from the renewal parts data. If this is not available, identify the part by name from a particular figure in this instruction book, include the I.B. number. Also, always supply full information from the stamped nameplate on the front of the breaker along with the order.



#### PARTS IDENTIFICATION.

#### 50-DH-150 &-250 AIR CIRCUIT BREAKERS

I.B. 32-251-3

- 1. Moving Contact Assembly-Com-
- plete 2. Spacing Washers 3. Operating Rod Upper Pin

- Cotter Pins
   Left Hand Moving Contact Arm
   Hinge Spring Washers
- 7. Operating Nou 8. Adjusting Stud 9. Rod End

- Hot End
   Lockwashers
   Locknut, Right Hand Thread
   Locknut, Left Hand Thread
   Moving Arcing Contact Spring, Outer
- Moving Arcing Contact Spring,

1

38

Inner

4.

14

20 19 15

- 15. Eyebolt
- 16. Úpper Spring Guide
- 17. Spacer
- 18. Arcing Contact Adjusting Nut
- 19. Shunt Bolts
- 20. Lockwashers
- 21. Shunt Clip
- 22. Arcing Contact Shunt
- 23. Lockwasher
- 24. Shunt Bolt
- 25. Shunt Guide

- 26. Moving Arcing Contact 27. Truarc Rings
- Iftuere innec.
   Pin
   Moving Main Contact
   Nuts
   Lockwashers
   Main Contact Bolts
   Hinge Bolt
   Hinge Snacer

- 34. Hinge Spacer 35. Castelated Nut 36. Cotter Pin 37. Right Hand Moving Contact Arm 38. Bushing, Stud, and Lower Foot Assembly





- Arcing Contact Bolt
   Stationary Arcing Contact
   Finger Stop Casting
   Lockwashers
   Bolts

- FIG. 26. Type 50-DH-150-E, 1200 Ampere Stationary Contact Assembly



PARTS IDENTIFICATION\_

50-DH-150 &-250 AIR CIRCUIT BREAKERS

I.B. 32-251-3



- 1. Mechanism Frame 2. Solenoid Back Plat Solenoid Back Plate
- 3. Back Plate Bolts
- Bolt Locking Clips
- Back Plate Shim Washer
   Core Guide Tube
   Solenoid Coil

- 8. Moving Core
- 9. Stationary Core 10. Stationary Core Shim Washer 11. Stationary Core Bolts
- 12. Lockwashers 13. Closing Link Pin
- Pin Bracket
   Closing Link
- 16. Trip Free Lever
   17. Contact Position Indicator
- 18. Indicator Bolt
- 19. Latching Pin
   20. Operating Arm for Cutoff Switch

- Operating Arm Screws
   Link Assembly
   Spacers for Closing Link
   Lower Trip Free Links 22C. Cam Links 22D. Washers

  - 22E. Pin Joining Upper and Lower
    - Trip Free Links
- 22F. Pin Joining Cam and Cam Link
  22G. Tripping Cam
  22H. Upper Trip Free Link
  22I. Cam Stop Rollers
  23. Pin for Upper Trip Free Link
- Rubber Stop Bumpers
- 24. 25.
- Closing Latch
- 26. Retrieving Spring 27. Non-Trip Free Lever 28. Washers
- 29. Bushing
- 30. Operating Center Pin

FIG. 27. Mechanism Assembly

- 31. Mechanism Stop Bolt and Locknut 32. Hand Trip Assembly
- - 32A. Bracket
  - 32B. Bracket Locating Bolt and Lockwasher
  - 32C. Bracket Mounting Bolts and
  - Lockwashers 32D. Trigger and Roller Lever Pins 32E. Trigger Roller Pin 32F. Trigger Roller

  - 32G. Roller Lever

  - 32H. Truarc Rings 32I. Roller Lever Spring
  - 32J. Trigger Spring

  - 32K. Cam Roller Pin 32L. Trigger Spring Guide
  - 32M. Cam Roller
  - 32N. Trigger





	MEMORANDUM
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#### WESTINGHOUSE ELECTRIC CORPORATION

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### EAST PITTSBURGH PLANT

SUPERSEDES I.B. 32-251-1 ®Trade-Mark Printed in U.S.A. EAST PITTSBURGH, PA. DECEMBER, 1956

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#### I.B. 32-251-14 AIR CIRCUIT BREAKER

# DESCRIPTION

The Type 50-DH-75 air circuit breaker is a 3-pole, 1200 ampere, electrically operated, horizontal drawout unit for metal clad switchgear. The breaker is designed to operate on a-c circuits of 2300 to 4160 volts nominal, and 4760 volts maximum. The interrupting rating is 75,000 KVA in the 4160 volt range, and 50,000 KVA at 2300 volts. This corresponds to 10,400 amperes interrupting rating at 4160 volts, and 12,500 amperes at 2300 volts. For other rating information refer to the Westinghouse Descriptive Bulletin 32-251.

Figure 1 shows a Type 50-DH-75 breaker completely assembled. Figure 2 shows the same breaker with the front barrier and the center pole shield removed; and one arc chute tilted back. This also shows the combined arrangement of the blowout magnet and the arc chute, the contacts, the insulated operating rods, and the solenoid operating mechanism. These parts are supported on the chassis having flanged wheels for guiding it into the metal-clad cell. At the front of the chassis is the levering-indevice for engaging the breaker into and out of the cell. The levering-in device is also interlocked with the solenoid mechanism to prevent the breaker being placed into or out of the cell with the breaker contacts in the closed position. The chassis also contains the secondary control cable contacts, auxiliary switch, puffer assembly, and shunt trip assembly for the standard breaker. Special breakers may include undervoltage and current transformer tripping devices.

The center pole insulating shield is slipped into place and the dead front barrier is placed on the breaker before it is rolled into the cell. The front barrier is of one-eighth inch steel to form a grounded barrier between the personnel and the live parts of the breaker when placed in the cell cubicle.

# **RECEIVING HANDLING AND STORING**

#### RECEIVING

All Type 50-DH-75 breakers are given operating tests at the factory, after which they are carefully inspected and prepared for shipment by shippers experienced in the proper handling and packing of the electrical equipment. The breaker is shipped in a single crate as a completely assembled package including the required number of manual operating handles as required by the order. The center insulating barrier is removed from the center pole to facilitate packing. After unpacking, the barrier should be placed over the center pole arc chute until it rests on the pole unit base. After the equipment has been unpacked, make a careful inspection for any damage which may have occured in transit. If the apparatus has been damaged, file a claim immediately with the carrier and notify the nearest Westinghouse Sales Office.



Completely Assembled



FIG. 2. Type 50-DH-75 Breaker with Front Barrier and Center Pole Barrier Removed

#### AIR CIRCUIT BREAKER

I.B. 32-251-1

#### HANDLING

Remove the crating and packing carefully to avoid damage from rough handling of crow bars or other tools. Use a nail puller for the uncrating but first remove the  $\frac{1}{2}$  inch bolt which fastens both sides of the breaker to the crate cross members. Care must be used in handling the assembly since the arc chute splitter plates are made of ceramic material which may break with rough handling.

The base of the crate may be used as a skid for moving the breaker, or the breaker may be lifted with slings placed 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 breaker may be moved about on its own wheels.

If it is necessary to lift the breaker after it is uncrated, four lifting holes are provided in the frame for this purpose. Use a spreader to prevent the cable from distorting the pole unit channel bases.

The approximate weight of a complete three pole breaker is 500 pounds. The arc chutes each weigh 40 pounds, the front steel barrier weighs 30 pounds, and the breaker without the arc chutes and barrier weighs approximately 350 pounds.

#### STORING

Since the breaker is shipped completely assembled, it should be stored in a dry place, sufficiently warm to prevent condensation and absorption of moisture. The assembly should be protected from the accumulation of dust by placing a protective covering of paper or other sheltering material to properly protect the insulating surfaces. Before placing the stored units in service, a careful check should be made of the cleanliness of the insulating surfaces, and any foreign materials that may have accumulated in the arc chute proper should be removed. Stored units subjected to abnormal conditions should pass a potential test of approximately 15,000 volts for one minute between live parts and ground.

Store all components for this breaker in a clean dry place. During the storage period, keep them in a sufficiently warm atmosphere to prevent moisture condensation.

# **INSTALLATION**

#### INSTALLATION

With the exception of the center pole shield, this breaker is shipped completely assembled and adjusted. No adjustment should be required and none should be made unless it appears necessary to do so.

**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 the breaker is closed or is being closed. If the breaker has been closed by hand, always remove the hand closing lever before tripping the breaker.

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

1. After the breaker is unpacked and the shipping ties and braces removed, disconnect the front arc horn bolt and tilt each arc chute back as shown in Figure 2. Then close the breaker carefully by hand using the 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. 2. With the breaker in the closed position, check the contacts to make certain that the adjustments have not been disturbed. The main contact overtravel should not be less than the 1/8 inch as illustrated in Figure 3B. Trip the breaker, and close it again by hand until the arcing contacts just touch. The main contact surfaces should be separated by 3/8 plus or minus 1/32 as illustrated in Figure 3A. If adjustments are required, they should be made as described in Figure 3.

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 breaker is placed in service, inspect all contacts to see that they are dry and free of any oil or grease.

**3.** Before placing the breaker in service, play a stream of dry compressed air through the arc chutes from each end to remove any dust or foreign matter. Then examine the arc chutes to make certain that the vents end slots are open and free from foreign material.

**4.** Return the arc chute to the normal position, connect the copper strap connection at the front tightly. Next replace the center pole insulating



FIG. 3. Pole Unit Assembly

barrier, and then the front steel barrier if it has been removed.

**5.** Make a final check by operating the breaker slowly by hand to see that there is no interference in the free movement of the moving contact.

**6.** The breaker is now ready to be operated electrically. Each breaker should be closed and tripped electrically several times before being connected to the high voltage. These operations may be made at the *test position* in the cell or by other test facilities that may be available. The hand closing lever must always be removed from the socket before operating the breaker electrically. If the electrical operation is fast and positive on the closing and opening operations, the breaker is now ready to be levered-in to the operating position.

**Caution:** Do not attempt to close the breaker by hand against an energized circuit. To insure sufficient closing force and speed, the breaker should be closed electrically from an adequate power source. See NEMA Standard SG 4-510.

When the breaker is placed into the cell and moved beyond the test position, the high voltage parts of the breaker will be energized. The front steel barrier should always be assembled on the breaker, for then personnel will be protected from contacting the live parts. The breaker should never be placed into an energized cell structure beyond the test position without first having the breaker completely assembled with the arc chutes, the center phase insulating barrier, and the front steel barrier.

# **OPERATION**



The general arrangement of the breaker parts is shown in Figures 3 and 4. The solenoid coil is arranged to exert an upward force on the mechanically trip-free linkage. This linkage, in turn, exerts an upward force on the pole unit operating rods which move to close the breaker. The moving contact arms contain the main contacts and arcing contacts. On opening, main contacts first separate apart followed after a short travel, by the opening of the arc contacts. On closing, they touch in the reverse order. The arc contacts touch first followed by the closing of the main contacts. At the terminal ends of the bushing are clusters of finger contacts for engaging the power circuit contacts in the cell. Located directly above the arcing contacts are the arc chute assemblies.

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The breaker is tripped manually by pushing the "Push To Trip" button at the front of the breaker mechanism, or tripped electrically by energizing the trip coil with the control source of power.

# **OPERATING MECHANISM**

The operating mechanism with its trip-free linkage is shown in Figure 4. The vertical lift action of the closing solenoid core is transmitted to the pole unit push rods through a system of links directly connected to the solenoid. The lever system consists of four major links; the first link, the second link, the third link, and the closing lever. These members are arranged as shown in the Figure 4 and are held to form a rigid member by the tension link and the cam. The cam is held in the fixed position by the tripping latch.

When the closing solenoid is energized, it pushes on the junction of the first and second toggle links causing the closing lever to rotate about its fixed center. The closing lever then exerts an upward force on the push rods through the moving contacts to close the breaker. The breaker is then held in this position by the tripping latch and the pawl.

The breaker is tripped electrically or manually by rotating thetripping bar which disengages the primary latch. This allows the roller latch assembly to release the tripping latch which in turn releases the tripping cam so that it is free to rotate. Without the restraining force of the cam and the tension link, the major links 2 and 3 collapse under the combined pushing force of the contact springs, and the accelerating springs which are assembled over the puffer push rods. Included in the operating mechanism is the position indicator. It gives a direct visual indication that the breaker contacts are either in the open or closed position.

#### PUFFER ASSEMBLY

Directly behind the mechanism is a puffer arrangement that supplies a jet of air to each set of contacts through an insulating tube and nozzle. Since the blowout force of small currents is very light, the jet of air is released at the instant the breaker is tripped. The arrangement is illustrated in Figure 5, and should require no maintenance. The diaphragm is connected to the operating mechanism through the two operating rods, which also contain accelerating springs that help accelerate the contacts to the open position. To remove the puffer tube and nozzle, the set screw should first be loosened and the nozzle tube may then be drawn from the top side of the breaker. The diaphram is made of long lasting wide temperature range material and should never require replacement unless through accidental puncturing. If replacement is necessary, remove the clamping ring and the bolted clamp plate. Add the new diaphragm in a relaxed position without gasket cement, then tighten the bolts around the clamp uniformly with moderate uniform pressure.

#### **MECHANISM MOUNTING PLATE**

The mechanism mounting plate is located between the truck side frames. On it are mounted the operating mechanism, closing solenoid, and the following auxiliary devices included as standard on all breakers:



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**Shunt Trip Magnet.** This device is used to trip the breaker electrically. It may be equipped with a coil for direct current or alternating current or capacitor tripping power source.

**Cut-Off Switch.** This switch controls the power to the closing solenoid which is cut off after the breaker reaches the closed position.

**Latch Check Switch.** The latch check switch is mounted directly above the shunt trip assembly. It is connected to the secondary contact block, in accordance with the wiring diagram supplied with the apparatus. If the breaker is used for automatic reclosing duty, it is necessary to arrange the electrical control so that the closing circuit will not be established until the breaker has completely re-set after the tripping operation. This sequence is controlled by the latch check switch. The switch remains closed at all times except from the instant the primary latch is tripped and until the linkage has completely reset. During this short period of time, the latch check switch circuit is open and prevents the closing circuit from being established.

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

The following devices may also be mounted on the breaker as specified by the Customer's requirements:

**Undervoltage Trip Attachment.** The device is illustrated in Figure 5.1, and it is located at the right side of the closing mechanism mounting plate This is a magnetically held device which when deenergized will trip the breaker using the force stored in a spring during the breaker's previous opening stroke. For instantaneous release, the holding magnet coil may be directly connected to a d-c control source, or it may be supplied with a low voltage d-c obtained from an a-c control voltage through a

#### **OPERATING MECHANISM\_**

small transformer and rectox assembly mounted in the cell structure. For time delay release on tripping, an undervoltage time delay attachment Figure 5.2, is mounted on the undervoltage trip assembly. This is an air dash-pot device, and the controlled flow of air through a needle valve gives the required time delay. The attachment does not have a quick reset feature, and therefore, approximately 1 minute should be allowed between operations to permit complete resetting.







**Three Coil Trip Attachment.** The three coil current trip attachment, when supplied, mounts at the rear of the mechanism mounting plate and is used in addition to the shunt trip magnet. It is designed to accommodate three instantaneous current transformer trip assemblies. The calibration on each of the current trip coils is engraved with the values of current required to trip the breaker.



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#### **ARC CHUTE**

The arc chute on the 50-DH-75 air circuit breaker consists of a blowout magnet and coil assembly, two side plates of insulating refractory material, and two arc horns all housed in a rectangular Micarta<sup>®</sup> jacket illustrated in Figure 7. The arc chute is hinged to the pole unit, and when it is in the normal position, its lower end completely surrounds the contact structure.

The blowout magnet and coil assembly with its arc horns is located in the center of the arc chute. To either side of the blowout magnet and coil assembly are the main ceramic interrupter stacks. These stacks are made of zircon refractory material with an inverted V shape slot molded into them. The slots in the plates are off-set so that when the plates are stacked with the slots alternating from one side to the other, the arc must take a wavy path as it moves up into the arc chute, thus increasing the length of the arc.

Inside the front and rear of the arc chute are the two metallic arc horns to which the arc transfers from the arc contacts. The front arc horn is connected electrically to the moving contact, and the rear arc horn to the stationary contact assembly.

Directly below the blowout magnet and coil assembly is the transfer stack. The purpose of the transfer stack is to interrupt the small part of the arc between the center arc horns, thus inserting the blowout coil in the circuit.

The action of the breaker in interrupting an arc is also shown in Figure 6. When the arcing contacts separate, the arc is drawn between them as indicated by position 1. The arc expands rapidly from this position under the influence of magnetic forces and the thermal effects of the air currents. This causes the arc to pass through the transfer stacks where the short portion between the center arc horns is interrupted putting the blowout coil in series with the arc.

When current starts to flow in the blowout coil, the magnetic field is established and the arc is driven very rapidly up into the slots of the refractory plates. Successive positions of the arc are also shown in the figure. As the arc moves to the closed ends of the slots it is restricted, lengthened, cooled, and subject to a strong magnetically induced blast of gas. All of these actions result in rapid deionization of the arc space, and for the arc to maintain itself it must continually ionize fresh gas. At current zero the formation of new ionization momentarily ceases but the de-ionization continues so that

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the dielectric strength is established in the arc space and the circuit is interrupted.

#### LEVERING-IN DEVICE

To move the breaker in or out of the cell against the resistance of the contact fingers, a leveringin mechanism is provided on the breaker. This consists of a shaft across the front of the breaker that has an interlocking operating casting, and a moving arm at each end. (See Figure 6). Each lever has a roller which engages a slot on the side wall of the cell. The operating handle is inserted in the casting openings provided for the lever and pushed downward in three strokes which in turn moves the engaging levers that draw the breaker into the cell.

Before the breaker is advanced into the cell, the levers on either side of the breaker must be at their extreme rear downward position as shown in Figure 1. When the breaker is levered into the cell operating position, the levers take the position illustrated in Figure 6. With the levers in the rear downward position, the breaker is ready to be advanced into the cell. When the breaker is being advanced into the cell, the rollers on these arms strike a vertical slot in the cell which stops the advancing movement of the breaker.

**This Is The Test Position.** The breaker may be now operated electrically in this position by first engaging the control wiring contact block with the mating block in the cell structure. Figure 6 shows the manual closing handle in the control wiring socket. A 66 degree downward stroke of the handle engages the control circuits. The breaker may now be closed and tripped electrically.

To move the breaker from the "test" position to the "In" or "Operating" position, first the breaker contacts must be in the open position or it will not move. Then insert the small end of the operating handle into the holes of the levering-in casting, and press downward through an arc of approximately 60°. Re-insert the handle in the next advancing hole to appear in the rotation of the casting, and repeat the downward stroke. A total of three strokes engages the breaker to the operating position. The indicating line on the side of the lever-in drive casting shows when the breaker is completely in the cell by lining up with the "in" line on the barrier identifying plate.

To move the breaker from the "in" to the "out" position, repeat the operations in reverse. Three upward strokes of the operating lever are required to free the breaker from the cell.

#### OPERATING MECHANISM.

**Mechanical Interlock.** The breaker is equipped with a mechanical interlock which engages the levering-in shaft and connects to the closing lever of the mechanism. This prevents the breaker from being levered into or out of the cell with the breaker contacts in the closed position. It also prevents the contacts from closing at any intermediate position between the limits of the "in" and "out" position.

**Secondary Contacts.** The control circuit is arranged for drawout connection by means of an 18 point secondary contact block which plugs into a mating block in the cell. The secondary contact block is mounted on a movable bracket on the lower left side of the breaker frame. The sliding bracket permits the plug-in connections to be extended to the rear of the breaker so that control circuits may be connected and the breaker operated electrically in the cell test position described above. To engage the secondary control contacts when the breaker is in the test position, insert the small end of the closing handle into the socket on the secondary contact slide and with a downward pressure to release the latch, the handle is pushed downward to the end of its travel. This movement connects the breaker control wiring to the cell control wiring block and the breaker can now be operated electrically in the *test position*.



# **MECHANISM ADJUSTMENTS**

**Mechanism.** The operating mechanism, illustrated in Figure 4, consists of a series of non-ferrous links and is non-adjustable. Excessive friction can cause the breaker to fail to close by not permitting the links to move freely to the resetting position. The action of the links can be checked by first inserting the manual closing handle, push the tripping button down, and then move the handle through the closing stroke. The linkage system should move, and then retrieve freely without sticking. The latch should then reset to the normal position. If excessive friction is present, several carefully placed drops of liquid molybdenum lubricant No. M-8577-2 can be applied to the links and pins to eliminate this friction.

**Cut-Off Switch.** This switch is operated by a spring-like plate fastened to the bottom of the solenoid moving core. This plate operates to close the switch at the proper time during the closing stroke. The switch contacts must make before the end of the solenoid closing stroke so that the closing coil current will always be cut-off after the closing sequence is completed. This is necessary to prevent any damage to the closed coil. The cut-off must not operate too early in the stroke or the mechanism will fail to complete the closing cycle. Proper action will be obtained when the switch pushbutton has a  $\frac{1}{32}$  to  $\frac{1}{8}$  inch of overtravel. Ordinarily no adjustment is required. The spring-like action of the pushing plate prevents any damage to the switch on overtravel. Should it be necessary to change the switch operating position, bend the plate slightly to obtain the right switch cut-off action.

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**Latch Check Switch.** The latch check switch is mounted on a bracket adjacent to the shunt trip coil. It is mechanically operated by the tripping bar, and the switch operating arm is adjusted by bending the arm slightly so that the contacts are made just as the latch slips over the mechanism trigger. If the switch makes contact too early, the mechanism will fail to latch close. Bend the operating arm to secure the correct switch action.

**Operation Counter.** The operation counter is connected to the mechanism operating lever with a flexible link, and records each breaker operation. The operation counter operating arm can be moved to a position to obtain the required operating stroke action. Any excessive travel is taken up by the flexible connecting link without placing undue force on the operation counter assembly.



Westinghouse Type DH air circuit breakers are designed to give good life with a minimum of maintenance when the duty is ordinary or moderate. However, the duty will vary greatly with the frequency of operation, and the amount and power factor of the current and faults interrupted, with the many types of application of the 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 the breaker is performing. The following remarks are intended as a general guide. Experience on a particular application may show a need for a different maintenance schedule and practice.

Breakers which operate only a few times a year in the light to medium current range of interruption, will require only light routine maintenance The maintenance should consist of a general inspection for mechanical soundness, and a cleaning of any accumulated dust or dirt particularly on primary insulation surfaces, and a few exercising operations. When making these exercising operations, observe the mechanical motions to make certain that they are quickly responsive, snappy, and positive in action with no tendency of any part to stick or hesitate. If there is any stickiness or sluggish motion, operate the breaker slowly by hand to locate the source of friction, and apply a few drops of the lubricant recommended. It is also recommended that breakers which remain closed continuously without any automatic operations, be tried for proper operation at least one every six months.

For breakers which operate a moderate number of times, say 100 to 1,000 operations per year, mechanical stickiness is unlikely to develop and there will be no need for exercising operations. However, on inspection, more attention should be paid to cleanliness of the interrupter interior, especially if there is a wide range of current interruptions. Large current arcs glaze the ceramic surfaces inside the arc chute, but leave them electrically clean. On the other hand, frequent operation at low or medium currents (about 1,000 amperes or less) tends to cause the accumulation of soot and condensed metal vapor 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 under the subject "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 adjustments should be checked. Also the interior of the arc chutes should be inspected for cleanliness, degree of erosion, and other irregularities. Minor pit marks on the arc horns are natural, and some wasting of these surfaces is normal and of no concern as long as these parts remain mechanically and electrically stable.

For breakers, which operate frequently such as those on motor starting, and other frequent switching operations, more maintenance will be required, especially when the breaker interrupts large currents as well as the ordinary load currents. Until experience has been acquired on such applications, inspection should be scheduled at least every month. At inspection, such breakers will need close checking of the contact adjustment and the mechanism wear and the adjustment if necessary. Arc chutes will also need cleaning.

#### ARC CHUTES

The insulating parts of the arc chutes 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 voltage across the breaker. The ability to withstand this voltage depends on the care given to this insulation.

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

The arc chutes should be removed periodically for a thorough inspection. Remove any residue or arc product dirt with a clean dry cloth or by light



rubdown with sandpaper. Do not use a wire brush or emery cloth for this purpose because of the possibility of embedding conducting particles in the ceramic material. If possible, apply 10,000 to 15,000 volts across the arc chute, or the breaker terminals, for one minute to check the condition of the arc chute. The arc chute should withstand this test without any evidence of flashing over.

When inspecting the arc chute look for the following:

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

**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 white appearance. At low or medium current, this effect is very slight. However, large current arcs repeated many times may boil away appreciable amounts of the ceramic material. When the width of the narrowest point of the slot has been worn to twice its original size (or about  $\frac{1}{8}$  of an inch), the ceramic stack should be replaced.

**Dirt in the Arc Chute.** In service, the arc chute will become dirty from three causes. First, dust deposited from the air can be readily blown out of the arc 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 a clean dry cloth. Third, some deposits from the arc gases 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 horns may accumulate to a harmful amount in breakers which get many operations at low or medium interrupted currents.

**Cleaning the Arc Shields.** Cleaning methods for the first two types of dirt are mentioned above. Particular attention should be exercised also to any dirt on the Micarta surfaces exposed to the arc below the ceramic arc shields. Wipe these surfaces clean. If wiping will not remove the dirt, rub with a light grade of sandpaper and refinish carefully with a smooth light coat of red enamel No. 672, or its equivalent. On breakers clearing many operations

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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 with a coarse sandpaper rub down. Doing this by hand inside the arc chute is slow and tedious. It is more convenient to remove the ceramic shields from the arc chute, and clean them with a power driven sander. Wipe off the sanded surface with a clean dry cloth.

The ceramic arc shields may appear to be dirty and yet have sufficient insulation strength. This can be checked by applying 15,000, 60 cycles for one minute across the arc chute applied between the front and rear arc horns. Also the dirty surface of the ceramic near the contacts should be able to withstand 10,000 volts per inch when test prods are touched directly on the ceramic surface. When the test voltage is applied, there should be no luminous display in the black deposit. If, after wiping and cleaning, or sanding down with sandpaper, the ceramic will not withstand this test, the ceramic shields should be replaced with new ones. When replacing the arc shields wipe off the Micarta surfaces sanding the surfaces down lightly if necessary, and refinish with a thin smooth coat of No. 672 enamel.

After an arc chute has been serviced, apply the voltage test outlined above. When assembling the arc chute on the breaker, be sure to tightly bolt the front arc horn connection to the connection strap from the lower bushing terminal.

#### CONTACTS

In normal operation, the arc will make terminal marks all over the arcing contact with some melting blisters. High current arcs will erode contact material more rapidly, but high current arcs move upward very guickly off of the contacts. Low current arcs move slower and their terminals may hop around the arcing contacts for several cycles. Therefore, a breaker which has had many operations at low currents, may be expected to have numerous small blisters and pock marks all over the metal parts supporting the arc contacts. When inspecting the arcing contacts the important condition to be observed is the extent of the erosion of the contact material. When half of the 1/8 inch thick arc tip material has gone, the contact should be replaced. This is necessary because the  $\frac{1}{16}$  inch material remaining will be mechanically weakened and might be broken away suddenly during any of the interruptions.

On high fault current operations there may be occasional slight burning on the main contacts. Also after many operations, main contacts will sometimes become roughened. A fine flat file should be used lightly on the main contact surfaces, 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 a high contact pressure.

After the contacts have been worn and dressed off as above, contact adjustments should be checked. (See Figure 3.) Some re-adjusting will involve changing position of the rods at the lower end of the insulating operating rod so as to lengthen or shorten the rod. Some mechanics may prefer to do this adjusting on the operating rod with the breaker in the closed position. If this is done the danger in this practice should be understood and safety precautions taken.

The energy stored in the contact and opening springs can very easily lead to severe personal injury if breaker is accidentally tripped while head or hands are near the moving parts. Therefore a safety block or guard should be put on the breaker to stop the contact arms early in the opening stroke in the event of accidental tripping.

Ordinarily the only adjustment required will be the compensation for the normal wear of the arcing tips. Each pull rod is fastened to a common cross bar attached to the mechanism through a half inch bolt which can be loosened to either lengthen or shorten the length of the pull rod. When the breaker is closed manually it is important that the stationary contacts have the adjustment clearance as indicated on Figure 3 and the pull rod lengths should be adjusted to obtain these dimensions. The compensation for the adjustment of the arcing contacts can be realized by simply retarding the arcing tip adjustment nut until the contact separation is obtained as illustrated in Figure 3. The bolts and nuts should then be securely locked and re-checked again for proper contact sequence and 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

#### **MAINTENANCE-**

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:



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**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 inflammable 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 infra-red 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.

#### **PARTS IDENTIFICATION AND RENEWAL**

Detailed parts identification for the pole unit assemblies is shown in the illustration of Figure 8.



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Detailed parts identification for the moving contact assembly are shown in Figure 9. Detailed parts identification for the arc chute assembly are shown in Figure 10.

Pole Unit. The change of parts for the pole unit, and moving contacts is relatively easy, requiring only that the parts that are fastened together be bolted securely, and that parts requiring free movement be checked to see that the parts move freely as required. Alignment and adjustment of the contacts should always be checked for proper operation after replacements are made.

Arc Chute. Servicing the arc chute would most generally involve some of the items shown in Figure 10. The interrupter stacks, of which there are two, can be removed and replaced by simply removing the retaining fibre pieces at the top of the arc chute, and then pushing each ceramic section towards the top of the jacket. The new ones can then be slipped back in place. The two side arc

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shields can be removed by unfastening the side assembly screws. The arc shields should then slip out easily. After a new arc shield has been placed, the screws should be tightened just to take up the loose motion and then cut the excess length of threads with a pair of side cutters. This will flare the threads and prevent the bolt from loosening (this step is important).

The small transfer stack is available as a cemented unit, and should be replaced with a completely new assembly. This can be done by first removing the arc shields, which will permit the assembly to drop out.

The front and rear arc horns will seldom require replacing as long as they remain mechanically intact. Small blisters or arc marks on the surfaces of the metal horns are unimportant. The supporting asbestos composition plates should be replaced if they are broken, or if the surfaces are worn enough to break through to endanger the micarta jacket inside surfaces.

The blowout magnet assembly will rarely be changed, except for the replacement of the center arc horns. The center arc horns will exhibit some blistering and wearing of the curved bottom ends. As long as the curved ends remain mechanically intact, there will be no need for replacement.

When servicing of the blowout magnet becomes necessary, a certain procedure must be followed so that the whole assembly can be removed from the jacket. First, the entire stack will have to be dismantled. The jacket sides will then have to be expanded enough to allow the whole magnet assembly to be drawn out from the top. The reason for this is that the center arc horns have a 3/16 projecting end at each side that trap the whole assembly into the arc chute jacket opening. Several wooden wedges should be driven at each side of the magnet until the assembly can be pulled out. The wedges should be held in place until the serviced assembly is re-assembled in place.

Precautions should be taken to see that the bolted connections of the blowout coils are tightly secured before returning the assembly into the arc chute jacket.

Other parts such as the closing coil, trip coil, and control devices can be identified for the particular breaker by reporting the breaker nameplate data, or referring to renewal parts data sheets.

**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.

· WESTIN	GHOUSE ·
METAL CLAD	SWITCHGEAR
DE-ION AIR CIF	RCUIT BREAKER H
STYLE OR SO	DATE OF MANUFACTURE
SERIAL	BREAKER UNIT & CODE
RATED KV	WILL FIT HOUSING CODE
MAX DESIGN KV	TYPE MECHANISM
AMPERES	CLOSING VOLTAGE
CYCLES	TRIPPING VOLTAGE
PATENTS 2442199 2243038	2276968 2243040 2242905 2177014
• WESTINGHOUSE NP54068-C	ELECTRIC CORP. MADE IN U.S.A.

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