Instructions for Low-Voltage Power Circuit Breakers Types DS-206, DS-416 and DS-532

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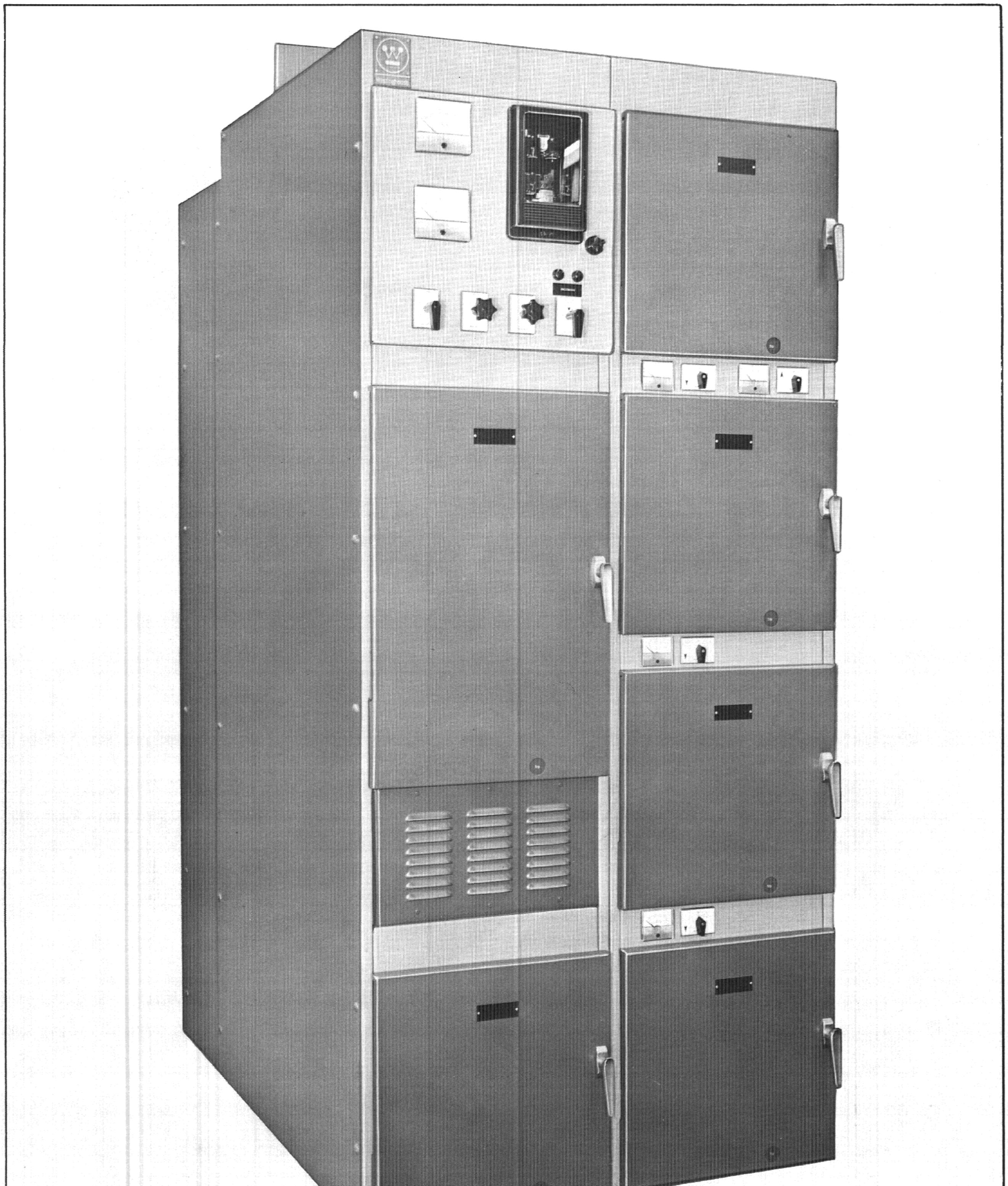

Frontispiece

DSL-206 AND DSL-416
POWER CIRCUIT BREAKERS

The DSL Power Circuit Breakers are similar to DS breakers with the exception that limiters have been added to extend their application to systems having higher short circuit capacities. These limiters are specially designed for use on the DSL breaker, and are not interchangeable with Standard Class L fuses.

BLOWN LIMITER INDICATOR

This device consists of three solenoids, each connected in parallel with one of the limiters. When a limiter is blown, the resulting voltage across the open limiter causes the associated solenoid to operate, tripping the circuit breaker and extending an indicator through the front cover of the circuit breaker. (See Figure 1) The indicator will remain extended and the breaker will be held trip-free until the reset button is pushed. If the device is reset and the breaker reclosed on an energized circuit before the blown limiter is replaced, the breaker will be immediately reopened and held trip free. The solenoids are isolated from the primary circuit voltage by three transformers located above the limiters. (See Figures 2 and 3).

TYPE DSL-206

Figure 2 shows the three limiters in place in the top studs of the breaker. These are easily replaced by removing the single bolt from each end of the limiter.

TYPE DSL-416

As shown in Figure 3, each limiter is held in place by two bolts on each end. Access to each is available from the side of the unit.

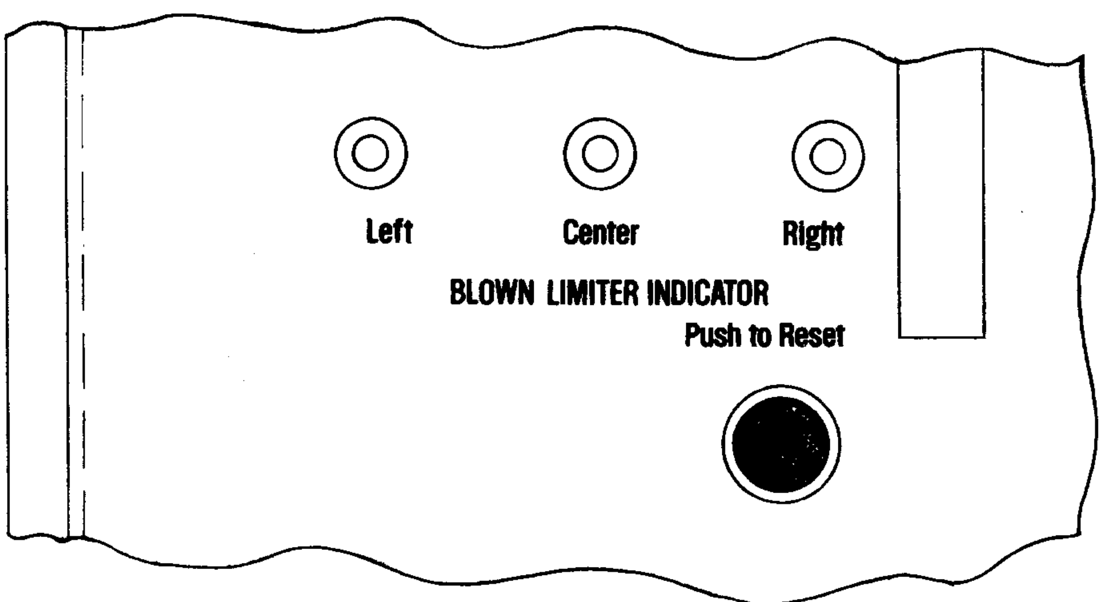

Fig. 1

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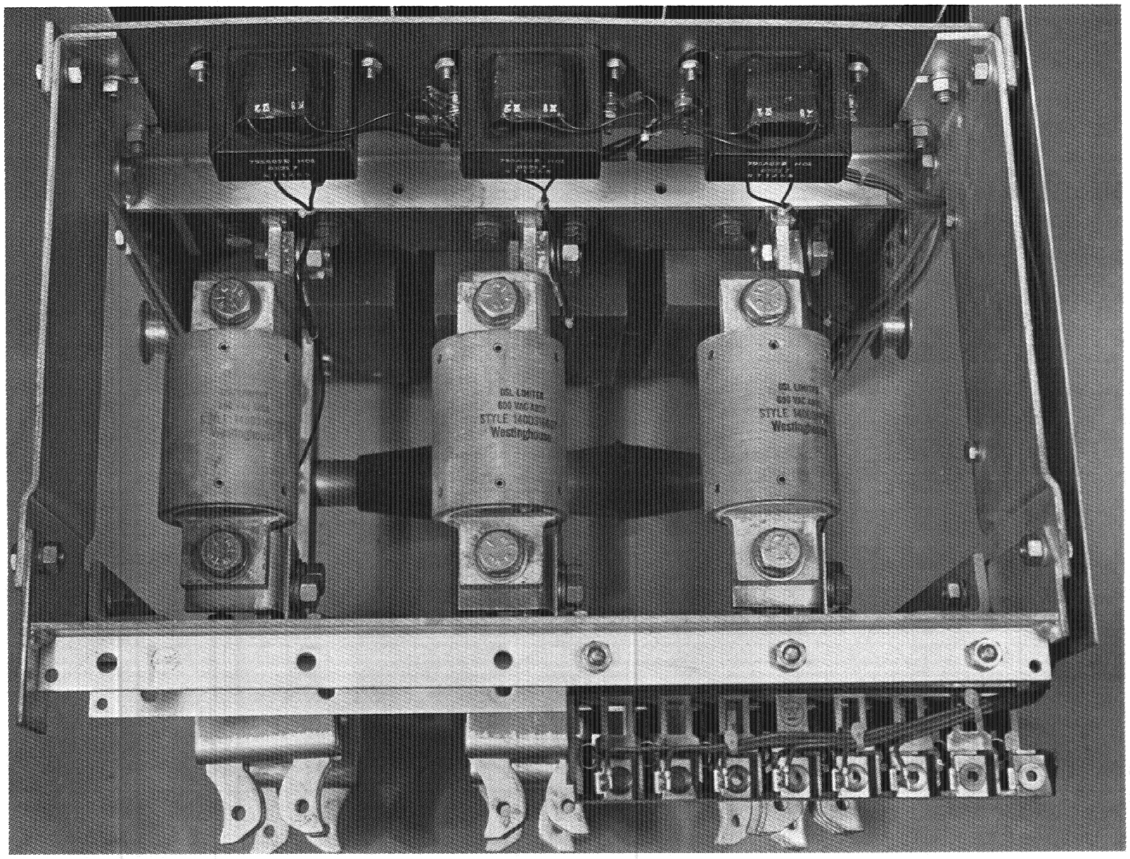

Fig. 2

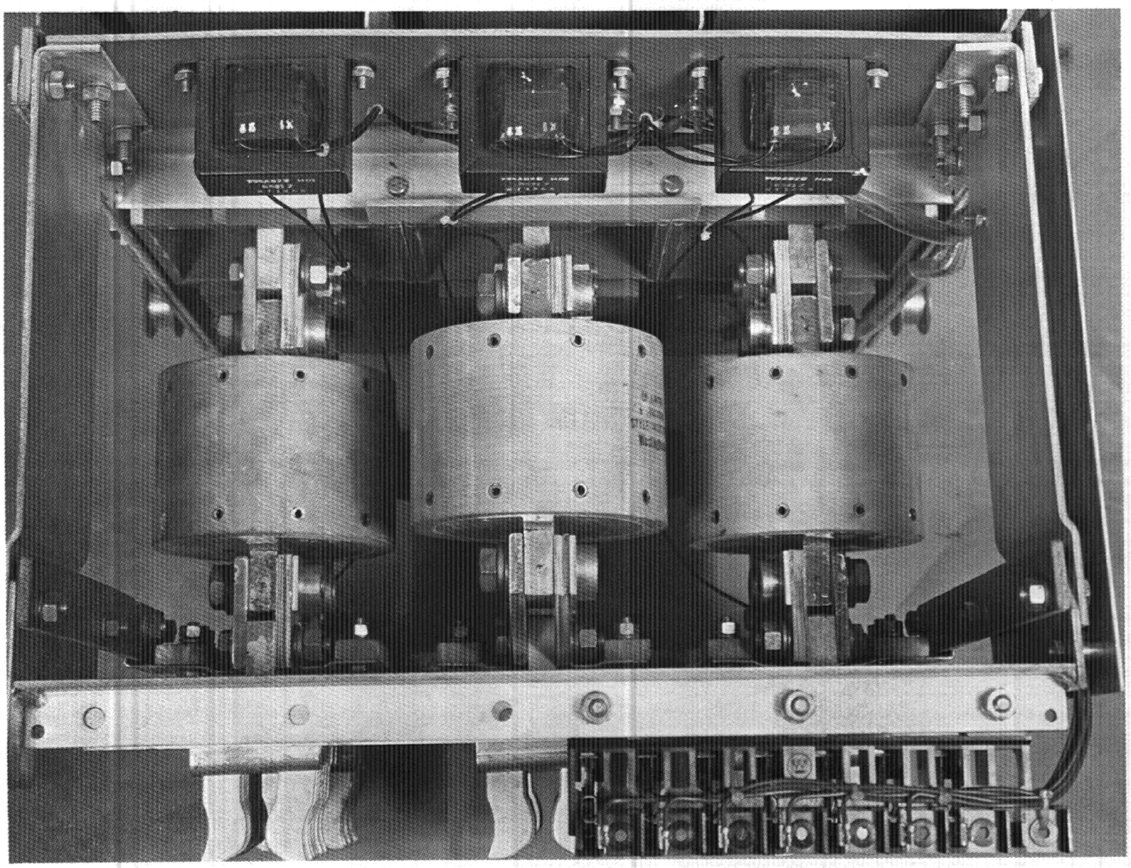

Fig. 3

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Introduction

These instructions cover the description, operation and maintenance of Westinghouse type DS206, DS416 and DS532 Low-Voltage Power Circuit Breakers. These breakers are usually supplied only as part of low voltage metal enclosed switchgear of the four-position drawout type. These instructions apply only to the circuit breaker and its auxiliary drawout details. These have been designed as a completely integrated drawout unit. Ratings covered by these instructions are shown in the rating table on page 27.

If you follow these instructions carefully you will realize the full capabilities of this excellent equipment. Therefore:

PLEASE STUDY THESE INSTRUCTIONS AND UNDERSTAND THEM. STUDY THE BREAKER ITSELF AND OPERATE IT THROUGH "DRY RUNS" AS INSTRUCTED, BEFORE ATTEMPTING TO OPERATE IT ON A LIVE CIRCUIT.

Section 1 - Receiving, Handling, Storage

1.0 HANDLING

The circuit breakers are shipped completely assembled and *inside their respective compartments.* Handling of this equipment is covered in Westinghouse Instruction Book 32-690 for Low-Voltage Metal-Enclosed Switchgear, Type DS.

1.1 STORING

If it is necessary to store the equipment before installation, keep it in a clean dry place, protected from dirt and water and with ample air circulation and heat, if necessary, to prevent condensation. Like all electrical apparatus, these units contain insulation. Although it is of highest quality, it, like all other insulation, must be protected against dirt and moisture.

Section 2 - First Removal of Breaker from Compartment

2.0 GENERAL

To examine and become familiar with the construction and operation of the breaker, it first must be withdrawn from the compartment. There are rails provided which permit the breaker to be rolled out of the compartment so that it can be examined on all sides and operated. First unlatch and open the compartment door.

2.1 SETTING THE RAILS IN FRONT OF THE COMPARTMENT

Refer to Figures 1 and 2. There are two rails for each breaker compartment which, when not in use, are stored on the inside of the compartment in a back-sloping position. Withdraw each rail completely and let it down into a horizontal position, as shown in Figure 2.

The first movement of the breaker toward the front of the compartment must be done with the levering device.

2.2 REMOVING SHIPPING BRACE

Before the circuit breaker element can be withdrawn from its compartment for the first time, a shipping brace must be removed from the lower part of the breaker front panel. This is an angle, painted yellow to facilitate identification. During shipment, the front wheels of the breaker are lifted approximately 1/16 inch above the compartment rails, and the unit is held part way between disconnected and test positions by means of its levering device and the shipping angle.

1. With a screwdriver, remove the two (2) outside .25-20 panhead screws with captive washers from the bottom leg of the yellow angle. Do not discard, as later they will be returned to their tapped holes. Do not remove the center screw.

2. The levering device is now used to release the breaker from the shipping position.

2a. When the breaker is part way between test and disconnected positions, the breaker levering device interlock will hold the shutter down and the trip plate depressed. The hex shaft of the levering device will be exposed and ready to receive the levering crank handle. Insert the crank and turn in a counterclockwise direction and observe the action of the drawout position indicator. The indicator will move down to the "Remove" position at which time the load on the crank handle increases because a stop has been reached.

DO NOT APPLY FORCE ON THE CRANK HANDLE AFTER THE STOP HAS BEEN REACHED AS THE BREAKER IS NOW FREE.

2b. If the breaker is received with the levering device in the fully connected position, this will be shown on the indicator and the shutter over the hex levering shaft will be closed as shown in Figure 3. To lower the shutter, the trip plate must first be pushed in. This double operation can be done with one hand as shown in Figure 4 and then the crank inserted as in Figure 5. Then proceed as outlined in 2a above.

3. When the position indicator shows the levering device to be in the remove position, remove the hand crank. Pull the breaker out onto the extended rails. This will require more effort than normal as the rear wheels are jammed into the cradle hold-down hooks by two lengths of plastic tubing. Refer to illustrations in the stationary structure Instruction Book 32-690 covering shipping braces.

4. Remove the two (2) .25-20 hex head bolts holding the yellow shipping angle to the front panel of the breaker. Care must be exercised to prevent marring the front panel. Two or more flat washers are used between the angle and front panel for shipping. Discard the angle.

5. Immediately replace the two hex head bolts using the lock washer and only one flat washer on each.

6. With the breaker pulled completely to the end of the rails, remove the two (2) six inch long pieces of split plastic tubing that are on the rear of the stationary rails immediately below the hold-down hooks. This tubing is for shipping purposes only and is to be discarded.

7. The stationary secondary disconnecting contacts are covered by a sheet of insulating material during shipment. This must be removed and discarded before the breaker is moved to the test or connected position.

8. Push the breaker back into its compartment, and replace the two (2) .25-20 screws at the front edge of the cradle.

2.3 LIFTING THE BREAKER

If it becomes necessary to lift the breaker off the rails, all lifting should be done only with the accessory lifting adapter. DO NOT ATTEMPT TO LIFT BREAKER WITH ORDINARY CRANE HOOKS, ROPES, CHAINS ETC., AS VITAL PARTS SUCH AS WIRING, BARRIERS AND

ARC CHUTE PARTS MIGHT BE DAMAGED. Figure 6 shows a view of the breaker with the lifting adapter in place. The lifter consists essentially of two sheet steel hooks specially shaped to hook under the top edges of the large openings on each circuit breaker side sheet, and a spreader. Actual lifting may be with a crane, chain block or with the optional lifting mechanism which can be supplied for this switchgear.

Section 3 - Preliminary Examination

3.0 GENERAL

Read these instructions carefully and look at the breaker as it stands out of the compartment before trying to operate it. Refer to Figures 7, 8, and 9.

The complete drawout element includes the circuit breaker itself and its auxiliaries. The circuit breaker consists of three major components:

1. The operating mechanism.
2. The contacts, operated by the mechanism.
3. The arc chutes, which interrupt the arc which always results from opening the breaker under load or short circuit conditions.

The remainder of the drawout element includes the following auxiliary components:

1. Interphase barriers which isolate the arc chutes from each other and from ground.
2. Drawout element frame and rollers.
3. The levering device, for placing the element into its various positions inside the compartment.
4. The main disconnecting contacts, for connecting the breaker to power source and load.
5. The secondary contacts, for connecting the control circuits to the electrical operating parts of the element.
6. The interlocks, which increase the safety of operation.
7. Drawout element position indicator
8. Open-Close indicator.
9. Spring charge indicator.
10. The close bar and trip plate.

Each breaker is equipped with a spring type stored energy closing mechanism. This mechanism closes the circuit breaker contacts with the necessary speed and force, independently of the operator. Basically, the closing springs must first be charged or cocked before the breaker can be closed. The springs are then released by releasing the spring release latch. The breaker is opened by releasing the tripping latch.

3.1 INDEPENDENT MANUAL AND POWER OPERATED BREAKERS

3.1.1 Closing Facilities

On manually operated breakers, the closing springs can be charged only by hand, by means of the spring-charge handle. The actual closing of the breaker is done only by hand-push on the close bar. As optional equipment, the electrical spring release attachment normally supplied only on power-operated breakers can be supplied on manually operated breakers.

On power-operated breakers, the springs are normally charged by an electric motor. Closing may be done electrically by an electro-magnet which lifts the closing spring release latch. Both of these operations can be done by hand if the control power source fails.

3.1.2 Tripping Facilities

The breaker can be tripped open by hand by pushing with the finger on the trip plate on the breaker panel or the trip button on the breaker compartment door (the latter is operative only when the breaker is in the connected position).

The breaker can also be tripped electrically by the following devices:

1. Shunt trip device, optional equipment on manually operated breakers.
2. Actuator, energized from the Amptector® trip unit.

3.2 LEVERING DEVICE

The drawout element has four normal positions in its compartment, determined by the levering device:

1. The remove position, Figure 7.
2. The disconnected position.
3. The test position, Figure 8.
4. The connected position, Figure 9.

The remove position is the first position in the compartment as the element is pushed directly by hand as far as it will go. The disconnected, test, and the connected positions are reached only by means of the levering device. This is hand operated with a removable crank handle. This handle is placed on the levering device worm shaft, which is exposed by depressing the shutter.

Section 4 - Basic Operating Instructions

4.0 GENERAL

The breaker is now ready for trial mechanical operation. Keep the breaker standing on the compartment rails, out in front of the compartment. Examine it externally for any signs of obvious damage or foreign material. When everything appears to be in order, perform the following operations as "dry run" practice. If any malfunctioning is found during these operations, see that it is corrected before further operations or before placing the breaker in service.

4.1 LEVERING DEVICE

Place the crank handle on the hex worm shaft. Rotate the crank clockwise to simulate levering the breaker inward toward the connected position. Watch the movement of the levering device arms. At the start of cranking the arms are horizontal, with rollers toward the rear, Figure 7. As the crank is turned clockwise the levering device arms rotate downward. When they have moved approximately 40^{o} from the horizontal, the shutter will raise until it touches the crank socket. The position indicator will be opposite "Disc" which is the disconnected position wherein the breaker is held in its compartment with both main and secondary contacts disengaged. If the crank is withdrawn, the shutter will close completely, and the breaker may be locked in this position as later described in Section 5.1.8.5 of this instruction book. There is very little movement of the breaker into its compartment between the remove and disconnect positions.

Continued rotation of the crank in the clockwise direction moves the arms downward to the vertical position, and the indicator will show "Test" as in Figure 8. The shutter will rise.

Further clockwise rotation of the crank handle rotates the arms to the connected position. This is 63 degrees from the test position, as shown in Figure 9. When this position is reached, the crank suddenly becomes hard to turn. At this point, stop turning the crank, as the worm shaft bottoms in the tapped hole of the stop nut.

FURTHER TURNING EFFORT IS USELESS. THE BREAKER WILL BE SECURE, EVEN IF THE STOP IS ONLY LIGHTLY TOUCHED. REMEMBER THIS WHEN ACTUALLY LEVERING THE BREAKER INTO THE CONNECTED POSITION.

Rotation of the crank counterclockwise will turn the levering device arms to withdraw the unit from the connected position to the test position and thence to the disconnected and remove positions. Then, when the crank is removed from the worm shaft, the shutter will remain down and the trip plate will remain trapped by the shutter.

Note: **If the breaker is levered out from the test position to the remove position with the closing springs charged, a trip free "closing" operation automatically will be performed but the breaker contacts will not close.**

4.2 CHARGE THE CLOSING SPRINGS

The closing springs must be charged before the breaker can be closed. To manually charge the closing springs, the levering device arms must be rotated away from the remove position to the test position. If charging is attempted in the remove or disconnected positions, the closing cam will rotate past the charged position and go through a trip-free "closing" operation, i.e. without closing the breaker. Having so rotated the arms, manually charge the springs. On manual operated breakers, the springs are charged by a single stroke downward on the spring-charge handle, rotating it about 90^{o} toward you until it suddenly becomes very easy to move and then tends to run away from your hand. At the same time, you will hear a metallic "click!" as the over center closing spring stop is reached. Note that the spring charge indicator now shows "Spring Charged."

On power operated breakers, a short spring-charge handle is included for emergency operation. This works on a ratchet principle, and requires 10 to 12 pumping operations to completely charge the springs. At this point, the same metallic "click" will be heard; and the spring charge indicator will show "Spring Charged." The handle must not be moved beyond this point.

Caution: **Hold breaker to prevent tilting forward when hand charging closing springs with the breaker on the extended rails.**

Note: **Power-operated breakers, when being levered into the compartment, will have the spring-charge motor run and charge the spring automatically as the test position is reached.**

4.3 CLOSE THE BREAKER

The breaker can be closed only when the following conditions are met:

1. The closing springs are charged.

2. The levering arms are in either the test position, Figure 8 or in the connected position, Figure 9.

3. The levering device crank handle has been removed.

Having met these conditions, close the breaker by pushing on the close bar. Note that the breaker position indicator shows "Closed," against a red background. Also that the spring-charge indicator now shows "Spring Discharged."

Some power-operated breakers are interlocked to prevent manual closing from the close bar on the front panel when in the connected position. Crank the levering device to the test position to operate. This interlock is covered by Section 5.1.8.2.

It is possible to recharge the springs immediately after closing the breaker. This results in increased strain on the mechanism, and it is recommended that this be done only if the operating procedure requires this condition.

Note: **If closing is attempted with the levering arms in other than the test or connected positions, with or without the levering crank in place, a trip free "closing" operation is performed but the breaker contacts do not close. This trip free type of operation results in more shock on some parts of the mechanism than normal closing operations. Therefore, this type of operation should be avoided if possible.**

4.4 OPEN THE BREAKER

The breaker can be opened in the following ways:

1. By hand operation of the trip plate.

2. Automatically by overload or short circuit.

3. Breakers equipped for power operation can be tripped electrically by a shunt trip device energized by hand switch or relay. For the present purpose of getting acquainted with the breaker, open it by pushing on the trip plate. Note that the breaker position indicator now shows "open," against a green background.

Note: **On breakers equipped for power operation, when they are in the compartment and in either the test or connected position, the spring-charge motor runs automatically and charges the closing springs as soon as the breaker opens. The closing springs normally remain uncharged while the breaker stands in the closed position.**

Now to become better acquainted with the breaker, charge the closing springs, close and open the breaker several times. Also, place the levering crank handle on the levering device worm shaft and rotate the levering arms to their various positions by turning the levering crank handle.

LEAVE THE LEVERING ARMS HORIZONTAL, WITH ROLLERS TOWARD REAR OF BREAKER, I.E. IN THE REMOVE POSITION.

The breaker is now ready to be put into its various operating positions in the compartment.

4.5 PLACE THE BREAKER IN THE TEST POSITION

Push the breaker into the remove position.

Note that the compartment door can now be closed and fastened. With the compartment door closed, the breaker cannot be operated in any manner. HOWEVER YOU WILL NOTE THAT, WITH THE COMPARTMENT DOOR OPEN, THE FRONT PANEL ASSEMBLY OF THE BREAKER FORMS A STEEL PROTECTIVE SHIELD.

Place crank on the levering device worm shaft. Turn crank clockwise until drawout unit position indicator shows "Test." Remove the levering device crank. The shutter will close over the hex shaft. All manual operations can now be performed. On power operated breakers the spring is charged automatically as the breaker arrives in the test position. The breaker can also be opened with its shunt trip device, and it can be electrically closed with the spring release device.

4.6 PLACE THE BREAKER IN THE CONNECTED POSITION

Press the trip plate and lower the shutter. Place the crank handle on the levering device worm shaft and turn the crank clockwise until the connected position stop is reached, as indicated by sudden increase in load on the crank, as previously described in paragraph 4.1.

NOTE however, that before the stop is thus reached, an increase in load on the crank will be felt after the breaker has moved about an inch. This is caused by the making up of the main disconnecting contacts. The load on the crank will decrease after reaching a peak. The next increase in load is when the stop is reached. DO NOT TRY TO CRANK FURTHER AFTER THE STOP IS

REACHED. TIGHTENING OF THE CRANK DOES NOT HELP KEEP THE BREAKER IN POSITION. WHEN THE CRANK HANDLE IS REMOVED, THE SHUTTER AND THE TRIP PLATE SHOULD SNAP INTO NORMAL POSITION.

4.7 REMOVE THE BREAKER FOR FINAL INSPECTION

Withdraw the breaker from the connected position in the compartment to the end of the extended rails following the reverse procedure described above. Inspect it thoroughly to see that no foreign objects have lodged within it. If any defects were found during these preliminary operations, complete their corrections at once.

4.8 FINAL INSPECTION

MAKE SURE THE THREE (3) ARC CHUTES ARE PROPERLY INSTALLED.

MAKE SURE ALL FOUR (4) INSULATING BARRIERS ARE PROPERLY INSTALLED.

1. With the breaker withdrawn, rotate levering device to connected position before attempting to charge the spring.

2. Close and trip the breaker several times as previously described.

3. Return the levering device to the remove position; i.e., with the roller arms pointing toward the rear as shown in Figure 7.

4. This completes the "dry run."

4.9 AMPTECTOR TRIP SETTINGS

When the breaker is shipped, the calibrating dials of the Amptector trip unit are at the nominal settings. For specific overload tripping characteristics to coordinate with the load or the system, refer to Section 8.1 and Curve No. 1 on page 29 of this instruction book.

4.10 PLACE THE BREAKER IN SERVICE

Lever the breaker into the connected position as previously described, and latch the compartment door.

Section 5 - Description and Explanation of Operation

5.0 GENERAL

The following paragraphs give a general description and explanation of the operation of the breaker.

5.1 THE OPERATING MECHANISM AND HOW IT WORKS

The operating mechanism is of the spring stored energy type. This means that it consists of two major parts:
(1) The stored energy or spring charging mechanism,
(2) The mechanism for closing and opening the breaker. The basic parts of these are combined into one subassembly illustrated in Figures 13, 14, and 15. There are two varieties of mechanisms for the DS line of breakers:

Power-Operated

Manually Operated

5.1.1 Power-Operated Mechanism

In the power-operated version, the mechanism is equipped with a universal-type motor for automatic charging of the closing springs. It is equipped with a spring release device for electrically closing through a control switch or other circuit-making device for remote closing. A shunt trip device is supplied for remote tripping through a control switch, relay, etc. In the absence of control voltage, or whenever desirable, the closing spring can be charged by hand with the emergency charging handle. Hand closing of the breaker can be done by means of the close bar. Hand opening of the breaker can be done by means of the trip plate.

5.1.2 Explanation of Spring-Charging Mechanism for Power-Operated Breakers

Figure 18 is an isometric diagram of the principal parts of a completely power-operated mechanism.

Figure 19 is a front view drawing showing the principal parts of the spring-charging portion of this mechanism. Other parts are omitted for clarity. Figures 20a and 20b show in greater detail the major parts of the spring-charging mechanism in the two basic positions:

Closing springs charged (20a).

Closing springs discharged (20b).

Referring to Figure 19, the basic elements are mounted on the crank shaft (8). This is a straight shaft with four flats machined on it, and a crank arm (11) attached to each end. Each crank arm connects to its closing spring (9) by a formed spring end (10). The rear of the springs anchor to the rear of the mechanism frame. The crank arms (11), motor cutoff switch cam (7), close cam (6) and two drive plates (25) have matching flats; and are thus anchored to the crank shaft. The spring charge indicator (12) ratchet wheel (17), oscillator (30), and emergency charge device (26) do not have internal flats but are mounted on separate bushings and are free to rotate on the crank shaft.

Figure 59 is an exploded view of the crankshaft parts.

Figure 20a is a view looking into the right end of the crankshaft, and shows the position of the components when the springs are charged.

Figure 20b is a partial view with the springs discharged.

The *motor crank shaft assembly* (29), carrying a *roller* for driving the *oscillator,* is pivoted in the right hand mechanism side frame. The *hold pawl* (18) is mounted by means of a pin on the mechanism side frame as shown.

In operation, rotation of the motor crank pushes the oscillator arm counterclockwise to make the oscillator pawl (28) push a tooth in the ratchet wheel (17) and rotate the ratchet wheel slightly more than one tooth in the counterclockwise direction. The holding pawl snaps behind the corresponding advanced tooth, and holds it against the torque of the closing springs while the oscillator arm rotates back clockwise to catch another ratchet tooth. Thus the ratchet wheel is rotated counterclockwise until the ratchet wheel pin (21) engages the two drive plates (25) which in turn rotate the crank shaft and the crank arms in the same direction until the arms are slightly past horizontal dead center. Since the close cam (6) is rigidly mounted on the crank shaft, the same as the drive plates, it has rotated the same amount as the plates. The close cam carries a *stop roller* as shown in Figure 24b. Just after horizontal dead center of the crank arms is reached, the torque of the closing springs starts to rotate the crank, independently of the driving motor. However, the stop roller on the close cam quickly stops the movement of the crank at only a few degrees over center and holds it there by coming against the spring release latch. This is the "spring charged" position. The *motor cut-off switch cam* (7) operates the switch (15) through a lever (13) at this time, and the motor stops.

At the instant that the springs snap over dead center, the lobe of the left hand drive plate raises the pawl lifter (27), and prevents the oscillator pawl (28) from engaging the next tooth in the ratchet wheel. Thus the oscillator is free and renders the exact stopping point of the motor uncritical.

When the spring release latch is moved below the level of the stop roller, as later described, the close cam is free to rotate; and the two closing springs rotate the crank-shaft counterclockwise to close the breaker contacts. They assume the position shown in Figure 20b and the cam as in 24c. During rotation, the drive plates move away from the ratchet wheel pin. The ratchet wheel does not rotate during the closing operation thus preventing excessive wear on the teeth and pawls.

Power-operated breakers are also equipped for emergency hand charging the closing springs. Refer to Figure 21. This operation is similar to that of the motor and oscillator except a separate emergency charge pawl (33) is used to advance the ratchet wheel (17) several teeth on each stroke of the charge handle (34). This device (26) also pivots on the crank shaft.

5.1.2.1 Power Operation

The electrical operation of the spring-charging motor circuit is as follows:

The basic schematic and connection diagrams are shown in Figure 52a and c. Device Y is the anti-pump relay and includes an integral bridge type rectifier when the motor is operated from an AC control circuit. For DC control the rectifier is omitted.

With the breaker open and springs discharged, the motor is energized through the limit switch (LS) and the "b" contact. The green indicating lamp (G) is controlled by a separate "b" contact, and when lit indicates that the breaker is open.

Motor runs and charges the closing springs.

When the springs are fully charged, limit switch (LS) opens in the motor circuit and closes in the spring release coil (SR) circuit.

When the close contact (CS-C) makes, the spring release coil (SR) is energized through the normally closed "Y" contact, the limit switch (LS), and breaker "b" contacts. This releases the latch holding the stop roller on the close cam.

Springs are released to close the breaker. When the breaker closes, the "b" contact opens to cut off spring release coil and motor, and limit switch (LS) contacts reset.

If the close contact (CS-C) is maintained, the "Y" relay will be picked up by the current through the SR coil, and will open its "Y" contact in the SR circuit. This allows only one close operation until the close contact (CS-C) has been reset. The "Y" coil has a very low drop-out voltage.

The standard control utilizes AC control power. For 120 volt equipment, the control power is taken direct from the source through fuses. For 480 and 600 volt operation, a suitable control power transformer is used. The transformer is optional for 240 volt control. If DC operation is desired for the breaker, an optional single full wave rectifier can be furnished. This is shown schematically in Figure 52d.

When the breaker closed, the "a" contact in the shunt trip (SH-TR) coil circuit also closed to complete this trip circuit. The red indicating lamp (R) supervises the shunt trip circuit to show that it is in working order, and indicates that the breaker is closed.

When control power is turned on, any power-operated breaker in the test or connected position with its springs discharged will have its motor energized until the closing springs are charged.

5.1.3 Manual-Operated Mechanisms

On manually operated breakers, the closing spring can be charged *only* by hand, as described in Section 4.2. As usually equipped, the breaker can be closed only by hand, with the close bar. As an optional extra, a closing spring release device can be supplied on these breakers.

Hand opening of the breaker can be done only by means of the trip plate; however a shunt trip device can be supplied as an optional extra.

5.1.4 Explanation of Spring Charging Mechanism for Manually Operated Breakers

Figure 22 is another isometric diagram to illustrate the mechanism in a manually operated breaker. For sake of clarity, the actuator has been omitted.

Figure 23 gives the details of this spring charging device which is located between the mechanism right hand side frame and the right crank arm. A part of this assembly is the manual charge cam which is rigidly fixed to the crank shaft, the same as the main close cam and crank arms.

The other parts are the *front crank assembly* which is pivoted to a bracket fastened to the main frame base, and has a *socket* for the *manual charge handle.* The rear crank is pivoted to the front portion and has a cross-wise pin on the end. A *spring* forces this pin against the cam. Another *spring* holds the front crank assembly in a clockwise direction against a stop, so that the manual spring-charge handle *socket* is normally upright in the unused position.

The manual charge cam is mounted on the crank shaft so that the crank pin hooks behind the hook-shaped surface of the manual charge cam as shown, when the handle is upright and the springs discharged. The springs are fully charged by a 90 degree counterclockwise rotation of the handle. The crank spring then returns the assembly to the handle-upright position. In operation this means a single downward stroke from vertical to approximately the horizontal position. As the "Spring charged" position is reached, the handle becomes effortless to turn and the closing spring crank arms snap over center.

On the Type DS532 mechanism a ratchet wheel and hold pawl are located between the manual spring charging device and the mechanism side frame. See Figure 22. The purpose of these two items is to limit backlash on the crankshaft when the breaker closes.

These two items are not included on the mechanism for the manually charged Types DS206 and DS416 which is shown in Figure 13.

It is possible to manually recharge the closing springs immediately after closing the breaker and before it has been tripped open. This results in the springs loading the associated bearings and latches for long periods. Also an extra close operation, or trip-free operation, will be necessary on levering the breaker to the disconnect and remove positions. Therefore, it is recommended that the springs be charged just prior to the closing of the breaker.

5.1.5 Circuit Breaker Closing Mechanism

This mechanism is of the general variety of mechanically trip-free mechanisms. This means that the breaker can be opened or tripped free from the closing mechanism at any point in its closing stroke. It also means that if the trip latch is held in the "trip" position while the spring release latch is released, the closing springs will make a trip-free operation but the breaker contacts will not close or move appreciably toward the closed position.

Based on this construction, the breaker close and trip linkage can have four steady state conditions. The arrangements of the basic close and trip linkage for these four conditions are shown in Figures 24a, 24b, 24c, and 24d as follows:

Figure 24a Breaker Open, Springs Discharged, Trip Latch Not Reset.

Figure 24b Breaker Open, Springs Charged, Trip Latch Reset.

Figure 24c Breaker Closed, Springs Discharged.

Figure 24d Breaker Closed, Springs Charged.

The angular position of the close cam in Figure 24a corresponds to the angular position of the drive plates and closing spring crank arms shown in Figure 20b. The trip latch is in the tripped position and it will reset to the latched position at the end of the spring charging stroke. The closing springs are charged by counterclockwise rotation of the ratchet and drive plates until the close cam stop roller meets the spring release latch, as shown in Figure 24b.

Note in Figure 24b also that the lower end of the main drive link, with the main roller, has swung upward and toward the left, pushing the trip latch constraining link so as to rotate the trip latch back to the reset position. This occurs at the same time that the spring charge is complete and just before the close cam stop roller strikes the spring release latch. The position of the cam in Figure 24b corresponds to the position of the drive plates in Figure 20a spring charged, breaker open.

The breaker is now ready to be closed. Closing is started by counterclockwise rotation of the spring release latch. Refer again to Figure 24b. This removes the hold on the close cam stop roller, and allows the force of the closing springs to rotate the close cam counterclockwise and close the breaker. The linkage is then in the position shown in Figure 24c. The close cam has rotated about 180 degrees. This rotation will vary, depending on closing load. In a trip free operation the rotation is considerably more than 180 degrees because there is no load to absorb the energy stored in the closing springs. The energy goes back into partially recharging the springs as the cam rotates more than 180 degrees. On closing against a fault, the rotation is very little more than 180 degrees.

The spring release latch can be rotated by two methods:

1. By the spring release device on power-operated breakers, as shown in Figures 18 and 32b.

2. By the close bar, through the linkage shown in Figure 32b.

5.1.6 Circuit Breaker Tripping or Opening Mechanism

Referring to Figure 24c showing the breaker in the closed position, the breaker is tripped open by counterclockwise rotation of the trip shaft. The trip shaft extends across the left hand part of the breaker, from the left hand mechanism side sheet to the left hand breaker side sheet; and can be rotated by several devices as later described.

Rotation of the trip shaft accomplishes breaker opening as follows: Staying with Figure 24c, the opening spring, (not shown) produces a clockwise twisting force or torque on the *pole shaft*, which is in the direction to open the breaker contacts. This is transmitted by the *center pole lever* downward through the *main drive link* to the *main roller*. The main drive link at the *main roller* is connected to the *trip latch* by the *roller constraining link*. The downward force on the *main drive link* results in a pulling force on the *roller constraining link*. This force tends to rotate the *trip latch* counterclockwise, but the *trip latch* is kept from rotating by overlap of the latch surface of the trip shaft. A very small rotation of the trip shaft thus releases the trip latch to rotate counterclockwise to the position shown in Figure 24a. The enlarged views of the trip shaft and trip latch tip in Figure 24e show in detail the rotation of the trip shaft for release of the trip latch. Thus the entire linkage collapses under the force of the opening spring and comes to rest with the breaker open, as in Figure 24a. Note that the trip latch is still in the released position, i.e., not reset.

If the breaker stands open with springs charged as in 24b, and if the trip shaft is held in the rotated or trip position, an attempt to close will result in a trip-free operation. This is so because, with the trip shaft in the trip position, there is no restraint on the trip latch, so no force is applied to the main link to close the breaker.

Although certain interlocking operations may or will result in this trip-free type of operation, it causes some extra shock on the mechanism parts. Therefore trip-free operations should be avoided.

The trip shaft can be rotated to trip the breaker in the following ways:

1. By hand push on the trip plate. As shown in Figure 28, this item has a tab which pushes against a pin on the trip shaft which applies a direct rotating force on the shaft in the tripping direction.

2. By shunt trip device, as shown in Figure 25. The armature of the clapper type electro magnet pushes on a lever on the trip shaft to rotate it in the tripping direction.

3. By action of the actuator, as shown in Figure 26. A downward pull by the trip plunger pulls on a lever from the trip shaft to rotate it in the tripping direction.

4. By action of the trip plate on the front of the breaker compartment door (providing the breaker is in the connected position.) A flap on the breaker compartment hinged door, operating through a sliding link and lever fastened to the cradle move the compartment trip lever extending from the bottom of the drawout unit. Refer to Figures 12 and 27.

5. An undervoltage trip device is available as an accessory, and will directly operate the trip shaft. This is shown in Figure 64, and its operation is covered in Section 8.3.1.

5.1.6.1 Miscellaneous Details

Figure 27 shows a bottom view of the breaker drawout unit. Visible in this picture are details as follows:

1. The Interference Interlock.

This is a Z-section of steel turned so as to prevent placing a DS206 breaker in a DS416 compartment or vice-versa. The section on the breaker moves under a corresponding section on the compartment floor if the two are correctly matched. If incorrectly matched the breaker section is blocked by the compartment floor section and the breaker cannot enter.

This also has a stabilizing effect in holding the breakers down as they are levered in or out of the compartment. It is not required on the DS532 breaker compartment as the smaller breakers would be blocked by the levering device arms on the DS532 cradle.

2. Ground Contact.

This contact engages a corresponding contact on the compartment floor and provides positive grounding of the breaker frame.

3. Motor Cut-Off Switch.

On power-operated breakers this *switch* disconnects the motor when the charging of the closing springs is complete. It is operated by a *cam* shown in Figures 16 and 19, which also operates the *spring charge indicator*.

5.1.7 Mechanical Interlocking, Description and Explanation of Operation

To increase safety to personnel and the circuits to which the breaker is connected, the complete unit is equipped with automatic mechanical interlocking. This interlocking is effective in various ways in the four breaker positions:

1. The remove position.
2. The disconnected position.
3. The test position.
4. The connected position.

In addition there is an interference interlock described in Section 5.1.6.1.

This mechanical interlock system serves basic purposes as follows:

1. In the remove position it prevents the breaker from being closed or opened and prevents the closing springs from being charged or remaining charged. The levering device shutter is held open.

2. In the disconnected position it prevents the breaker from being withdrawn from its compartment.

3. In the test position it permits all normal no-load operations of the breaker with the primary disconnect contacts separated.

4. In the connected position it prevents the disconnecting or withdrawal of a closed breaker. This prevents the drawing of dangerous, destructive arcs on the disconnecting contacts if the circuit is loaded.

5. While moving the breaker in either direction between the test position and the connected position or the disconnected position; or while standing in any intermediate position, it prevents the closing of the breaker. Therefore it prevents the connecting of a closed breaker to the power circuits. This prevents arcing on the disconnecting contacts as would occur in going into contact with a load on the circuit.

Here are the detailed interlocking conditions which exist in each of the four breaker positions:

1. The Remove Position

This is the position of the breaker when nearest the front of its compartment, and is where the breaker must be placed when it is installed after having been completely outside of the compartment.

Or, it is the farthest point in the compartment to which the breaker can be withdrawn without opening the outer door after having been in the connected position.

The conditions about the breaker in this, *the remove position*, are as follows:

A. The breaker is open.

B. The breaker cannot be closed either electrically or by hand.

C. The closing springs are discharged. If an attempt is made to charge the springs, a trip free operation will result.

D. The breaker can be withdrawn from the compartment by direct pull.

E. The levering device arms are in a horizontal position with their rollers pointing toward the rear. See Figure 7.

2. The Disconnected Position

In this position the breaker has moved only a fraction of an inch into its compartment and will be shown by the position indicator.

The conditions about the breaker in this, the disconnected position, are as follows:

A. The breaker is open.

B. The breaker will be held in its compartment as the levering rollers have lowered into the slots in the cradle arms.

C. The shutter will close over the levering device hex shaft.

D. The shutter may be locked closed and the breaker held trip-free by a padlock as described in Section 5.1.8.5, thus locking it in the compartment.

E. Both primary and secondary disconnecting contacts are separated.

3. The Test Position

This is the position of the breaker when at a point in between the disconnected position and the connected position, as shown by the *draw-out position indicator.* In this position the main disconnecting contacts are separated enough to permit safe operation of the breaker. However, the secondary contacts are made up.

The conditions about the breaker in this, the *test position* are as follows:

A. The breaker must arrive in this position from either direction with its contacts open. Its closing springs may be either charged or discharged when coming from the connected position.

B. When the levering crank handle is removed, it is possible to close and trip the breaker by hand or electrically.

C. Just before the breaker arrives in the test position from the disconnected position, the secondary contacts make up and the spring-charge motor automatically runs and charges the closing springs on power-operated breakers.

D. The breaker can be closed by hand, or electrically, after the springs are charged as in paragraph C above.

E. The breaker can be tripped open by hand, or electrically through the shunt trip device.

F. The trip plate on the hinged compartment door will not trip the breaker.

G. The breaker must be open before further levering can be done.

H. The overload tripping characteristics can be visually checked or changed, and the settings checked with the optional Test Kit.

4. The Connected Position

This is the position in which both primary and secondary disconnecting contacts on the breaker are engaged with their stationary counterparts in the compartment.

It is the farthest position from the front of the compartment into which the breaker can be levered, as (1) shown by the drawout position indicator, and (2) when the mechanical stop is felt as a sudden increase in load on the levering crank handle.

Note: **When levering in from the test position, an increase in load on the crank handle will be felt as the main disconnecting contacts are engaged. As cranking is continued, the load will decrease some and then suddenly increase as the final connected position stop is reached.**

The conditions about the breaker in this, the *connected position,* are as follows:

All conditions about the breaker are the same as for the Test Position, described under A through E. It is not advisable to attempt to check trip settings with the Test Kit or by any other method in this position.

The trip plate on the hinged compartment door will be operative, and will trip the breaker when this door is closed.

In addition to the above interlocks, the interference interlock described in Section 5.1.6.1 prevents a breaker of the wrong frame size from being placed in a compartment.

5.1.8 Detailed Explanation of Mechanical Interlock System

That part of the interlock system which prevents closing of the breaker while being driven in either direction by the levering device, or while it is standing in any intermediate position between "Test" and "Connected" or "Disconnected," is shown in Figure 28a and b. Figure 28a shows the shutter and trip plate for normal operation, such as in Disconnected, Test, or Connected positions. The breaker can be closed and tripped open by all available devices in the latter two positions except the trip plate on the hinged compartment door.

In Figure 28a, the shutter prevents pushing the levering device crank handle onto the worm shaft. If the shutter alone is pushed downward, it will rotate slightly about its pivot pin and its lower projection (See Figure 28a) strikes the hook on the trip plate, and the worm shaft will not be cleared. So it is necessary to push the trip plate in, which moves the hook back out of the way of the shutter lower projection. This permits the shutter to be pushed downward to clear the worm shaft for the levering device crank handle, as shown in Figure 28b.

Note that pushing the trip plate in also pushes the trip shaft pin so as to rotate the trip shaft counterclockwise, thus tripping the breaker open. If closing is attempted with the linkage as in Figure 28b, a trip free operation will be made.

Movement of the shutter also is controlled by the interlock cam, mounted on the levering device shaft to the left of the worm gear. The interlock cam has a fixed relation to the levering device arms. Figure 30a, b, c, and d show the relation between the shutter, interlock cam and levering device arms for the four basic positions of the drawout unit in the compartment.

Figure 30a shows the connected position. The *cam* is in a position to allow free travel of the *shutter interlock pin.*

Therefore the shutter can be pushed downward, but only after pushing in the trip plate as in Figure 28. This trips the breaker and therefore prevents levering out with the breaker closed.

Figure 30b shows the test position. Note that the cam has rotated first so as to block the shutter interlock pin. This prevents the shutter returning to its closed position and releasing the trip plate if the levering device crank handle is removed. Thus, if a closing operation is tried during this part of the travel, a trip-free operation occurs and the breaker contacts do not close. Note that this is true for either direction of breaker travel so that no load is made or broken at the disconnecting contacts.

When the breaker gets to the test position, a slot in the interlock cam allows free movement of the shutter interlock pin, and the shutter returns to closed position when the crank is removed. The levering device arms are almost vertically downward.

Figure 30c shows the disconnected position. Here also the cam rotates so as to block the shutter interlock pin while the breaker is between positions thus holding the shutter open. When the exact position, as shown on the indicator, is reached, the shutter will close when the crank is removed. The levering arms will be approximately 40° below the horizontal.

Figure 30d shows the remove position. Here the interlock cam stops with the shutter interlock pin blocked. Thus the shutter stays down and the breaker stays tripped when the crank handle is removed. The breaker is held trip-free, so it cannot be closed. Also, by another interlock described later, the close-release latch cannot be released.

5.1.8.1 Spring Discharge Interlock

1. The purpose of this interlock is to operate the close-release latch as the breaker arrives in the disconnected position. This causes a trip-free operation of the closing mechanism because it occurs while the levering device crank handle is necessarily still on the worm shaft, and the closing springs are charged if the breaker is electrically operated. This is because the crank handle is still being used to move the breaker in the final part of its travel to the disconnected position. Thus, the trip plate is still pushed in and consequently the breaker is trip free.

2. Figure 31a, b, c and d shows the essential parts of the spring discharge interlock. A and b show the levering device in the remove position. The *Interlock Plate* has two *horizontal pins* extending from it, as shown in a, b, c and d. The upper one is designated arbitrarily as *Pin A* and is darkened to distinguish it from *Pin B.* In levering the breaker out to the remove position as shown in a and b the *levering shaft* has turned counterclockwise until the levering device arms are horizontal to the rear. As it rotates, the close bar cam has been rotated counterclockwise by Pin B, to the "close" position. This releases the spring release latch through the linkage shown in Figure 32, which results in a trip free operation of the breaker if the closing springs are charged. This happens because the levering device crank has the Trip plate held in the "Trip Position." If the breaker is manually operated, levering out can be stopped at the test position. Remove the levering device crank handle and (1) Close the breaker and (2) Trip the breaker. This will discharge the springs so that, when the "Disconnected" position is reached, there will not be a trip free operation. The Close bar will merely be pulled into the "Close" position.

5.1.8.2 Connected Breaker Manual Close Interlock

The purpose of this Interlock is to make possible a choice between being able to close the breaker by hand-push on the Close bar and not being able to, with the breaker in the "Connected" position. Some consider it undesirable to do so. Referring to Figure 31a, the *Interlock Plate Assembly* is keyed loosely to the *levering device shaft* by a *drive pin* as shown. If the interlock *screw* is omitted, the *interlock plate* can be rotated freely on the *shaft* about 10 degrees. This is because the *"wide" slot* is considerably wider than the *drive pin.* If the interlock screw is in place in the "narrow" slot, the *Interlock Plate* has practically no play and is forced to rotate exactly as much as the levering device shaft rotates.

Figure 31c shows the standard arrangement, without the *interlock screw,* with the *levering device arms* in the "Connected" position. Note that there is a *clearance* between the back of *the hook and Pin A.* This permits the *close bar* to be pushed to the "close" position and close the breaker.

In Figure 31d, all parts are in the same position as in Figure 31c, except that the interlock screw has been placed in the "narrow slot". This arrangement is shown in Figure 12. This forces the *interlock plate* to rotate about 10 degrees further than in Figure 31c, so that there is almost no clearance between *Pin A* and the *back of the hook.* Consequently the *Close* bar cannot be pushed to the "Close" position. However, the breaker can be remote-closed by applying control voltage to the shunt close coil through a control switch or other circuit-making device.

Section 6 - Circuit Breaker Pole Units, Description and Operation

6.0 GENERAL

Figures 34, 35, and 36 show the three pole assembly for the types DS206, DS416, and DS532 respectively. The DS206 has the three poles mounted on a single molded base of high strength insulating material, with the contact parts and sensors mounted on it. Figures 37 and 38 show front and rear views of the assembly.

The DS416 and DS532 differ in that each of the three poles are mounted on individual insulating bases, and all three poles held in accurate alignment by a welded steel frame. Front and rear views of each are shown in Figures 39 and 40 for the DS416, and Figures 41 and 42 for the DS532.

6.1 MOVING CONTACT SUB-ASSEMBLIES

The moving contact members of all ratings consist of blades hinged at the bottom to the lower main terminal through controlled pressure rotating contacts and with main and arcing contacts at the upper end. The arcing contacts of all of the three ratings shown are the same design. The number of blades, the size of the main terminals and the number of fingers in the main disconnecting contacts vary with the rating. The DS206 has two moving blades, the DS416, four moving blades and the DS532, eight moving blades. On the DS206 and DS416 the main contact member, i.e. which makes actual contact with the stationary contacts, is a horizontal member to which all blades are connected. On the DS532 there are two sets of contacting surfaces, one vertically above the other, for making contact with two corresponding rows of stationary contact fingers. The arcing contact assembly is bolted to the top of the main moving contact blade assembly. This has the arcing contact tips, of arc resisting metallic composition, permanently fastened near the upper end of the assembly. The moving contact blade assembly is operated by a strong and rigid insulating link.

6.2 STATIONARY CONTACT SUB-ASSEMBLIES

The stationary contact sub-assemblies of the DS206, DS416, and DS532 may be seen in Figures 37, 39 and 41. All main contacts, i.e. those which carry the main continuous load current, are of the butt type composed of a multiplicity of fingers. Each finger is hinged at the upper end under controlled pressure. Compression springs at the lower end apply predetermined pressure against the moving main contact in closing, and standing in the closed position. These springs are visible in the photograph of the DS206 only. With this construction, the pressure on the main contact surfaces is increased during the carrying and opening of high short circuit currents because the magnetic field of the current pushes the lower end of the finger toward the moving contact. Hinging the finger at the top thus results in what is sometimes called a "blow-on" action. This greatly increases the capability of the entire contact assembly to withstand the high fault currents associated with these breaker ratings.

The stationary arcing contacts are similar for all ratings and consist of two parallel fingers, one on each side of the stationary terminal member. They are pushed toward each other by compression springs and have arc resisting tips. The moving arcing contact thus wedges the stationary contact fingers apart as the breaker closes.

The parallel action of the magnetic fields of the currents in each arcing contact finger causes the fingers to be attracted toward each other when closing against fault currents. This results in a "blow-on" action on the arcing contacts.

Figures 43, 44 and 45 show the side view of the combined moving and stationary contact sub-assemblies of the DS206, DS416 and DS532 respectively. This shows the proper relationships, clearances and contact deflections of the various parts.

Section 7-Arc Chute

7.0 GENERAL

Figure 46 is a close-up view of a breaker with one insulating barrier removed to show the arc chute in place on the pole unit. The same design of arc chute is used on the DS416 and DS532 assemblies with a slightly smaller one on the DS206. The arc chute fits well down over the arcing contacts so that the arc is confined inside the chute at all times and for all values of current. In the arc chute, immediately above the arcing contacts, are spaced crosswise vertical steel splitter plates having an inverted "V" notch to attract the arc and interrupt it essentially by cooling.

The DS206 arc chute is shown in Figure 47. The larger arc chute for the DS416 and DS532 is shown in Figure 48. In addition to the steel plates, the larger arc chute includes sheets of hard arc-resisting plastic. These plastic plates produce turbulence in the exhaust gases above the steel plates and prevent electrical breakdown over the top of the arc chute or to ground.

WARNING: **ALL ARC CHUTES AND BARRIERS MUST BE IN PLACE BEFORE RETURNING BREAKER TO COMPARTMENT.**

Section 8 - Circuit Breaker Automatic Tripping System

8.0 GENERAL

The circuit breaker is tripped on overload and short circuit conditions by combined action of three components:

1. The sensors.

2. The Amptector® solid state trip unit.

3. The Actuator.

Schematically this may be represented as shown in Figure 49. This provides a very flexible system covering a wide range of tripping characteristics. Not only is the Amptector trip unit adjustable but the sensors are available over a wide range of current ratings.

The automatic overload and short circuit tripping characteristics for a specific breaker rating, as determined by the sensor rating, are determined by the settings of the Amptector solid state trip unit. This unit also supplies a pulse of tripping current to the actuator. Thus all tripping functions are performed by secondary control circuitry, with no mechanical or direct magnetic action between the primary current and the mechanical tripping parts of the breaker.

8.1 THE AMPTECTOR TRIP UNIT CHARACTERISTIC SETTINGS

As shown in Figure 3 the Amptector trip unit is at the top front of the breaker. Figure 50 shows a close-up of the front of the Amptector trip unit. There can be a total of six adjustable controls, with screwdriver adjustment. These are for setting the following characteristics:

1. Long-delay current pick-up.

2. Long-delay.

3. Short-delay current pick-up.

4. Short-delay.

5. Instantaneous current pick-up.

6. Ground current time, with non-adjustable current pick-up.

Note: **The term "pick-up" as used here means the magnitude of current at which the Amptector trip unit timing function begins.**

Figure 51 is the Amptector trip unit with front cover removed, showing all of the calibration marks on the dials. The ranges of current settings in multiples of sensor rating and time delay are as follows:

1. Long-delay pick-up .5 to 1.25 X sensor rating.

2. Long-delay 4 to 36 seconds, at 6 X rating.

Over these ranges tripping will always occur within the time band shown on Curve No. 1, page 29. The bottom of the band is called the resettable delay. If the overload subsides in less than the resettable delay time, resetting of the Amptector trip unit will occur within a few cycles after the load drops to less than 90% of the pick-up setting.

3. Short-delay pick-up 4 to 10 X sensor rating

4. Short delay .18 seconds to .50 seconds or 11 to 30 cycles at 60 Hz, at 2.5 X pick-up setting.

Over these ranges tripping will always occur at or before the time value shown on Curve No. 1, page 29. Although the time adjustment is continuous, three time bands are recommended and are marked as follows:

	Minimum	Intermediate	Maximum
Trip at	.18 Sec. 11 Cycles	.33 Sec. 20 Cycles	.50 Sec. 30 Cycles
Resettable Delay	.068 Sec. 4.1 Cycles	.20 Sec. 12 Cycles	.37 Sec. 22 Cycles

Above and near each of the three time markings on the short delay dial is a black dot that marks the exact setting for that particular time value. These dials are individually calibrated for each Amptector trip unit, and the exact time will be obtained when the black dot, rather than the numeral, is aligned with the vertical mark on the front cover.

5. Instantaneous Pick-up 4 to 12 X sensor rating

6. Ground Current

Pick-up is not adjustable

Ground Tripping Delay .22 to .50 Seconds
13 to 30 Cycles at 60 Hz.

The ground current tripping delay dial is also individually calibrated, and three black dots will locate the exact position for each of the three time bands.

Any one of six combinations of three pick-up ranges and the three time ranges listed above may be used. These combinations, with corresponding Amptector trip unit model numbers are as follows:

	Amptector Trip Unit Model
1. Long Delay Instantaneous	LI
2. Long Delay Instantaneous Ground	LIG
3. Long Delay Short Delay Ground	LSG
4. Long Delay Short Delay Instantaneous Ground	LSIG
5. Long Delay Short Delay	LS
6. Long Delay Short Delay Instantaneous	LSI

Each Amptector trip unit has a terminal block equipped with test plug terminals accessible on the front of the circuit breaker front panel. This permits convenient field checking of calibrations and operation with an external power supply. A specially designed power supply test kit, with plugs to match the Amptector trip unit test plug terminals is available; and its operation is described in Section 8.3.5 of this instruction book.

Figure 52 shows a typical standard wiring diagram, which includes the Amptector trip unit terminal block. The following table explains the markings of the terminals:

A	Sensor phase terminal
B	Sensor phase terminal
C	Sensor phase terminal
N	Sensor Neutral
G	Ground
OP	Output positive*
ON	Output negative*
DN	Test point
DS	Test point
TP	Test point
OSS	Over current switch signal to accessory unit.

*To Actuator Coil. THIS COIL HAS A POLARITY MARKING ON THE POSITIVE LEAD WHICH MUST BE OBSERVED.

8.1.1 Ground Protection

When the Amptector trip unit includes ground current protection, the type of connection to the circuit must be considered. If the system neutral is grounded but the neutral *is not* carried with the phase conductors, the Amptector trip unit has all of the equipment necessary for sensitive ground protection.

If the system neutral is grounded and a neutral conductor *is* carried with the phase conductors, it is necessary to order an additional sensor, duplicate of the sensors on the breaker. This is for the purpose of cancelling out any residual current in the phase conductors. This sensor must be mounted separately and must be located on the neutral conductor at the point where the neutral conductor connects to the neutral bus.

The Amptector trip unit ground element may be energized from an external ground current source rather than from internally developed ground current. Such an external source could be a ring type transformer through which all the load current conductors would have to pass. In the case of a three-phase four-wire circuit all three phase conductors and the neutral conductors would have to pass through the transformer. The sensitivity of the ground element for this kind of arrangement would depend on the ratio of the transformer used.

8.1.2 Servicing of Amptector Trip Unit

The Amptector trip unit is the intelligence of the overcurrent protection provided by the breaker. It is a device that has many solid-state components. Since the only moving parts are the adjustments, the Amptector trip unit will give long, trouble-free service. All components and connections, including the printed circuit board itself, are coated to give effective environmental protection.

In changing the Amptector trip unit settings, the dials should be moved only by means of a small screw driver inserted through the round hole in the faceplate directly below the calibration window. The shafts must never be rotated by applying torque directly to the dial as it has only a friction fit on the shaft.

If it is suspected that the dial has moved on its shaft, it may be checked by means of rotating the shaft counterclockwise to the limit of travel. A black dot at the end of the calibration should lineup with the index mark on the faceplate. See asterisk (*) on Figure 51.

If there is any reason to suspect that the Amptector trip unit is not operating correctly IT SHOULD NOT BE TAMPERED WITH; SINCE TAMPERING COULD RESULT IN LOSS OF VITAL OVERCURRENT PROTECTION.

Note: **Warranty on the Amptector trip unit will be void if there is any evidence of tampering.**

A specially designed tester is available for checking Amptector trip unit operation without using primary current. The tester can be plugged into any convenience outlet; and will pass enough current to check any pickup calibration. Time delay calibrations can also be checked. Place breaker in "Disconnected Position" before performing Amptector trip unit check.

Special handling and test equipment are required to service solid-state devices. If use of the tester shows that an Amptector trip unit is not operating correctly, it is strongly recommended that a spare Amptector trip unit be used; and the questionable unit be returned to the factory for service.

8.1.3 Actuator

The actuator receives a tripping pulse from the Amptector trip unit, and produces a mechanical force to trip the breaker. Refer to Figures 11, 26, and 60 for location and details. The actuator is made up of a permanent magnet, a disc held by the magnet, a rod acted on by a spring, a lever for tripping the breaker, and a lever for mechanically resetting the actuator. The magnet cannot pull and reset the disc against the force of the spring acting on the rod, but can overcome the spring force when the disc is in contact with the magnet. A tripping pulse from the Amptector trip unit counteracts the effect of the permanent magnet, allowing the spring to separate the disc from the magnet and move the rod to actuate the trip shaft lever. The trip shaft lever then rotates the trip shaft and trips the breaker. As the breaker opens, the left pole unit lever pin strikes the spring finger attached to the reset lever; this furnishes the assistance required to move the disc so as to close the air gap between it and the permanent magnet against the spring force. The device is reset when the disc is in contact with the magnet. If the disc is not fully reset, the trip shaft lever will hold the breaker mechanism in the trip free condition; and the breaker cannot be reclosed.

The actuator must be replaced if it will not stay reset when the plunger has been moved to the top of its travel.

8.2 SENSORS

The three sensors are located at the rear of the breaker on the lower studs, and directly behind the main disconnecting contacts. Refer to Figure 9. They produce an output proportional to the load current and furnish the Amptector trip unit with the intelligence and energy to trip the breaker when preselected conditions of current magnitude and duration are exceeded.

The continuous current rating for any frame size breaker can be changed simply by changing the sensors. The wide range of long-delay current pick-up available on the Amptector trip unit makes one set of sensors suitable for a number of current ratings. The Amptector trip unit setting controls are standard, and are usable with any standard sensors. If sensors are changed because of changing load conditions etc., it is only necessary to readjust the Amptector trip unit controls to the new desired values.

8.2.1 Sensor Ratings

Standard available sensor ratings are listed in Table 1.

8.3 OPTIONAL ACCESSORIES

In addition to the Amptector trip unit to provide standard breaker overload protection, the following optional accessories are available for special applications

8.3.1 Undervoltage Trip Attachment

The undervoltage trip shown in Figure 64 is an electromechanical device that trips the circuit breaker when the voltage on its coil falls to between 30 and 60 percent of normal. The standard unit trips instantaneously. Also it is

TABLE 1 RATING TABLE

Breaker Type	Frame* Size Amps	Sensor Ratings Amps	Trip Range Amps	Ac Voltage Rating	Inst. S.C. Interr. Rating Sym. Amps	Selective S.C. Rating Sym. Amps
DS206	600	100 150 200 300 400 600*	50 - 125 75 - 187 100 - 250 150 - 375 200 - 500 300 - 600*	600	22,000	22,000
				480	30,000	30,000
				240	42,000	30,000
DS416	1600	100 150 200 300 400 600 800 1200 1600*	50 - 125 75 - 187 100 - 250 150 - 375 200 - 500 300 - 750 400 - 1000 600 - 1500 800 - 1600*	600	42,000	42,000
				480	50,000	50,000
				240	65,000	50,000
DS532	3200	2400 3200	1200 - 3000 1600 - 3200*	600	50,000	50,000
				480	50,000	50,000
				240	65,000	50,000

*Maximum continuous current rating for breaker. Amptector trip unit Long Delay Pick-up should not be set above 100% when using sensor rating equal to frame size.

available with non-adjustable time delay of approximately four seconds.

In operation, a moving core is normally held magnetically against a stationary core and a spring. This is linked to a latch carrying two rollers, one of which restrains the main tripping lever of this assembly.

When the coil voltage is reduced sufficiently, the torsion spring overcomes the magnetic attraction between the two cores; and the moving core travels upward. This in turn rotates the latch in a clockwise direction so that one of its rollers moves from beneath the tail of the main tripping lever. A torsion spring (not visible in Figure 64) around the pivot pin of the tripping lever then rotates it in a clockwise direction, causing a projection on the left side of this lever to strike a pin in the breaker mechanism trip shaft, and rotate the latter in a counterclockwise direction to trip the breaker.

As the breaker opens, an arm on the pole unit shaft strikes a vertical leg (Reset arm) of the undervoltage tripping lever and rotates it counterclockwise against its torsion spring. Another arm on the tripping lever resets the roller latch and the moving core. A slight amount of overtravel on the trip latch insures positive resetting under all conditions.

Always connect the undervoltage coil on the line side of the breaker unless the attachment is equipped with a time delay device. In this case, the time delay will delay tripping of the breaker long enough to permit energization of the undervoltage coil from the load side. Do not use an auxiliary switch contact in this circuit.

8.3.2 Overcurrent Trip Switch

This device is available as an optional accessory on either manually operated or power-operated breakers of all ratings. Its function is to provide a signal to indicate that the breaker has tripped open by action of the Amptector trip unit due to phase or ground overcurrent. Normal tripping by the trip plate, shunt trip device, undervoltage trip device, etc. does not cause it to operate. It is mounted on and operates from the trip actuator of the breaker.

Three contact arrangements are available: (1) two normally open, (2) two normally closed, or (3) one normally open and one normally closed contact. These are independently wired to secondary disconnect contacts at the rear of the breaker unit.

The device is latch-type and must be manually reset by means of a pushbutton on the breaker front panel. Also available is an electric reset for remote operation.

8.3.3 High Load Switch

This is a self-resetting solid state device which picks up on an overload condition at a lower pick-up value than the breaker overload trip setting of the Amptector trip unit. Its function is to give advance notice of an overload condition before the breaker trips.

The pick-up point is adjustable from 60% to 100% of the Amptector trip long delay pick-up setting. The non-adjustable time delay of 60 seconds requires that the pick-up current be maintained for that interval to cause the relay contact to operate. If the load current falls below the pick-up point, the timing resets in about a second. The relay has one normally open and one normally closed contact with a common connection. Its built-in power supply requires a reliable source of either 120 or 240 volts AC.

Since this is a solid state device, no maintenance will be required; and the same cautions apply as previously stated for the Amptector trip unit. Warranty will be void if there is any evidence of tampering.

8.3.4 Auxiliary Switches

As shown in Figure 12, there may be from one to three auxiliary switches located to the right of the Amptector trip unit. These contacts will carry 15 amperes continuously and are insulated for 240 volts AC or DC. On power-operated breakers, one auxiliary switch is required for breaker control circuits.

8.3.5 Amptector Trip Unit Tester

8.3.5.1 General

The Amptector trip unit tester consists of an external power supply, current measuring device, and a precision timer for field checking the operation of the unit. These three functions have been combined into a single portable device housed in a convenient carrying case. It is powered from a standard 120 volt, single phase, 60 Hz outlet; and will furnish the high secondary currents to the input of the Amptector unit to simulate primary fault conditions on the circuit breaker.

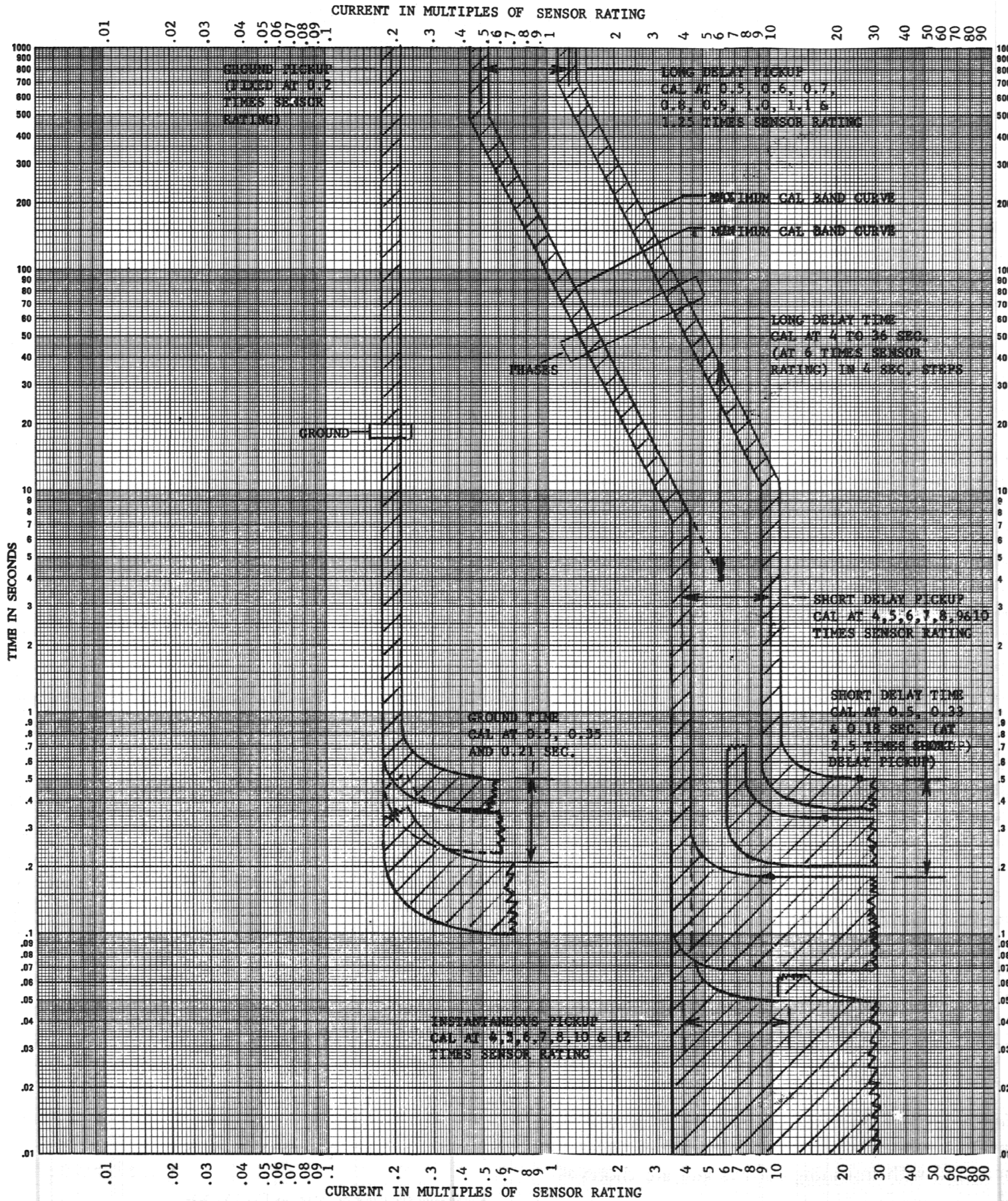
8.3.5.2 Description

A long flexible cable terminated by an 11 prong polarized plug connects to the test terminals of the Amptector trip unit. A second cable connects to the source of input power. Figure 67 shows the tester and operating controls. The ammeter is dual range and controlled by the "Hi-Lo" switch. In the low range it reads 0-8 amps, while the high range covers 0-80 amps. The timer reads in seconds with the right hand digit (white) in tenths of seconds. An external ammeter may be connected in the output circuit through the terminals designated for this purpose, and the shorting link removed.

Caution: **When using the tester, the breaker must not be in the connected position. It may be in either the test or disconnected position, or removed from its compartment.**

8.3.5.3 Operation

The complete testing and calibration of the Amptector trip unit by means of the tester is covered by the instruction sheet included with the tester.


CURRENT IN MULTIPLES OF SENSOR RATING
TIME IN SECONDS
GROUND PICKUP (FIXED AT 0.2 TIMES SENSOR RATING)
LONG DELAY PICKUP CAL AT 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1 & 1.25 TIMES SENSOR RATING
MAXIMUM CAL BAND CURVE
MINIMUM CAL BAND CURVE
LONG DELAY TIME CAL AT 4 TO 36 SEC. (AT 6 TIMES SENSOR RATING) IN 4 SEC. STEPS
PHASES
GROUND
SHORT DELAY PICKUP CAL AT 4,5,6,7,8,9&10 TIMES SENSOR RATING
SHORT DELAY TIME CAL AT 0.5, 0.33 & 0.18 SEC. (AT 2.5 TIMES SHORT DELAY PICKUP)
GROUND TIME CAL AT 0.5, 0.35 AND 0.21 SEC.
INSTANTANEOUS PICKUP CAL AT 4,5,6,7,8,10 & 12 TIMES SENSOR RATING

Curve No. 1

Section 9 - Inspection and Maintenance

9.0 GENERAL

Type DS circuit breakers are "top of the line" equipment. This means they are manufactured under a high degree of quality control, of the best available materials and with a high degree of tooling for accuracy and interchangeability of parts. Design tests show them to have durability considerably beyond minimum standards requirements. All of these factors give the DS line of breakers high reliability. However, because of the variability of application conditions and the great dependence placed upon these breakers for protection and the assurance of service continuity, inspection and maintenance checks on them should be made on regular schedules.

Since maintenance of these breakers will consist mainly in keeping them clean, the frequency of maintenance will depend to some extent on the cleanliness of the surroundings. If there is much dust, lint or other foreign matter present obviously more frequent maintenance will be required.

9.1 WHEN TO INSPECT

Industry standards for this type of equipment recommend a general inspection and lubrication after the number of operations listed in Section 9.3.1 of this instruction book. This should also be conducted at the end of the first six months of service if the number of operations has not been reached.

After the first inspection, inspect at least once a year. If these recommended inspections show no maintenance requirements, the period may be extended to a more economical point. Conversely, if the recommended inspection shows, for instance, heavy accumulations of dirt or other foreign matter that might cause mechanical, insulation or other electrical damage, the inspection and maintenance interval should be decreased.

When a breaker opens a heavy fault, at or near its rating, give it a visual inspection withdrawn from the compartment and with insulating barriers and arc chutes removed.

9.1.2 What To Inspect

First withdraw the breaker from the compartment. Remove barriers. Remove arc chutes. If there is a deposit of dust, blow clean with compressed air, if available. Wipe accessible areas with a clean dry cloth. Inspect contacts.

Note: **Switching and fault interruptions and the making of motor inrush currents will cause some pitting of the breaker contact parts. A large accumulation of operations will give the contacts, especially the arcing contacts, a mottled, dirty, eroded appearance. This appearance is the normal result of arc burning and in itself is no cause for concern.**

DS206

Inspect the contact system as follows:

Remove the four insulating barriers and the three arc chutes to expose the contacts.

Close the circuit breaker and adjust the contacts as shown in Figure 43. The two self-locking nuts on the threaded stud of the insulating link should be adjusted until the front faces of the stationary main contact fingers are parallel to the center section of the main contact. These nuts must be tight on the link pivot block.

Dimension A (Figure 43) must be a minimum of .020 inch between both stationary arcing contacts and their center section when the breaker is closed. If this dimension cannot be maintained, the arcing contacts, both moving and stationary, must be replaced.

At the notch on the bottom of the stationary main contact finger, dimension X must equal or be greater than dimension Y. Also if dimension B will not accept a .250 diameter rod the main contacts should be examined. If either moving or stationary main contact tip is less than .03 inch in thickness, it should be replaced.

When the breaker is open, the gap between the stationary arcing contacts should be .42 ± .08 inch. This also applies to the other ratings.

DS416

Inspect the contact system as follows:

Proceed similar to above for DS206.

Close the circuit breaker and adjust the contacts as described in Section 9.2.3.

Dimension A (Figure 44) must exceed .020 in. If this dimension cannot be maintained the arcing contacts must be replaced.

If Dimension B will not accept a 1/4" rod, the main contacts should be examined closely. If the main contact tips are less than 1/32" in thickness, the main contacts should be replaced.

Where sufficient main contact material remains and dimension B exceeds 3/16" (3/16" diameter rod), the contact system can be deemed satisfactory.

When dimension B is 3/16" or less, the main contact system must be replaced.

DS532

In addition to the above:

The lower main fixed contacts should be inspected to ensure that they have adequate contact pressure. This is determined by pin "X" being free to slide in the contact cage. (See Figure 45.)

9.1.3 Replacement of Contacts

DS206

Both moving main and arcing contacts are held between the two moving arms by two bolts with self-locking nuts. Removal of the two bolts permits the replacement of the moving contacts. These bolts must be securely tightened after replacement.

The fixed arcing contacts are held by a single bolt passing through the contacts and their pressure springs. On reassembly the self-locking nut is tightened so that a dimension of 3.12 inches is obtained between the inside surfaces of the flat washers on the spring ends with the breaker open.

To replace the stationary contacts, the disconnect fingers on the rear are removed and then the two bolts holding the upper contact assembly to the molded base. Withdraw the contact assembly from the front. This should be replaced with a new contact assembly. Make sure that all bolts are securely tightened. Close the circuit breaker and check all contact dimensions as described in Section 9.1.2.

DS416 and DS532

The moving arcing and main contacts are secured to the moving contact assembly by two bolts. Removal of these bolts permits the replacement of the moving contacts.

To change the fixed arcing and main contacts, the fixed contact assembly must first be removed from the pole unit.

Remove the disconnect fingers, remove the screws holding the contact assembly to the pole unit base and withdraw the contact assembly.

Obtain a new or reconditioned assembly and reassemble in the pole unit, with the holding screws finger tight. Close circuit breaker and check the dimensions A (Figures 44 & 45); they should be approximately equal. If not, trip breaker and adjust fixed contact system until alignment is obtained. Tighten screws and contacts as described in 9.2.3.

9.1.4 Arc Chutes

The V-shaped slots in the arc chutes will undergo slow erosion with arc interruptions. Switching operations will give them a pitted, mottled and sooty appearance. This is normal. Heavy fault interruptions will cause greater arc erosion.

When the steel splitter plates have about 1/4 inch of material eroded away at the top of the V-shaped slots, they should be replaced. This can be determined by comparing a plate near the center with a plate near the end. The insulating plates should be replaced at the same time. This can be done easily by removing the top retaining strips, removing the worn plates and replacing with new ones.

The throat of the insulating arc chute enclosure will become eroded and sooted with operations. These areas should be sanded with sandpaper and the enclosure blown out with air or brushed out, before installing new splitter plates. Occasionally the whole arc chute may need replacing, depending upon the severity of duty.

9.1.5 General Inspection

Look over all visible parts possible for missing pin retainers, loose nuts, bolts or screws, bent, worn or damaged parts. Make appropriate corrections to anything found out of order.

After any inspection make sure all parts are properly installed on the breaker, especially arc chutes and all four barriers.

9.2 FACTORY ADJUSTMENTS (Required for Major Overhaul Only)

The Type DS circuit breakers are designed and built with very few adjustable parts. The operating parts and frame mounting parts are accurately tool made for automatically accurate assembly relationships. The parts are made of material that are affected to the minimum by repeated operations and normally encountered atmospheric temperature and dirt conditions.

There are a few adjustments, made at the factory and subjected to quality control inspection and test. These factory settings normally can be expected to hold for the life of the breaker.

Factory settings are adjustments which should only be necessary when parts are reassembled after dismantling. These are described in Sections 9.2.1 and 9.2.2.

Maintenance adjustments should be made as indicated on maintenance inspections and are described in Section 9.2.3.

9.2.1 Trip Latch Overlap

Figure 25a shows a composite view of the shunt trip lever and the trip latch, as described in Section 5.1.6. The angular position of the trip shaft latch surface is adjustable in relation to the trip latch surface by means of a screw located in the top of the actuator frame. (Figure 25b.)

Proper adjustment procedure is as follows:

Close the breaker.

Slowly rotate adjusting screw clockwise until the breaker trips. This is "no overlap" position.

Rotate adjusting screw 3-1/2 turns in a counterclockwise direction.

9.2.2 Breaker Open Position Stop

Proper Adjustment Procedure is as follows:

Refer to Figure 53.

With the breaker open, loosen the open position stop bolt nuts so that the eccentric cylinders can be turned by hand but will stay put.

Rotate the cylinders to obtain a clearance of approximately .005 in. between the cylinders and the stop levers. Tighten nuts on bolts.

9.2.3 Moving Contact Adjustment

The contact assemblies are adjustable for the amount of engagement only. The lead of the arcing contacts over the main contacts is fixed. The correct engagement of the contacts is achieved when the vertical faces of the main fixed contacts and the fixed contact cage are parallel. For the DS206 this is obtained by the adjusting nuts located on the insulating link stud above and below the pivot block. Refer to Figure 37. These nuts are self-locking, and must be tight when the adjustment is complete.

The moving pole of the DS416 is adjusted by rotating the insulating link after the lock nut has been loosened. Refer to Figure 39. This link has right hand threads on one end and left hand threads on the other. Tighten the locknut securely after the adjustment has been completed.

The DS532 has two adjusting studs on each pole, and both must be moved together to retain the parallelism. Refer to Figure 41. A spring type locking clip holds the adjustment from moving.

Check contact system as described in Section 9.1.2.

9.2.4 Levering Mechanism

The complete levering mechanism is shown in detail in Figure 17. If the traveling stop nut on the rear of the worm shaft has been removed, it must be replaced in the exact position with respect to the worm gear position for proper interlock operation. This is achieved when the threaded worm shaft bottoms in the stop nut and the interlock cam is in the connected position shown in Figure 30a. The shutter interlock pin will then drop to its normal position beneath the lobe of the cam. The retaining clamp ring also operates the position indicator and may be slipped in its groove in the stop nut. The stop nut is prevented from rotating by having a "flat" against the bottom of the breaker horizontal front pan.

When reassembling, care must be exercised to insure that the two guide spacers are located in the slots of the front pan. This allows this mechanism to float.

9.3 LUBRICATION

In general, the circuit breaker requires only moderate lubrication at regular intervals. The use of a special lubricant is required in a few places, and must be applied with care. Only small quantities are needed. All excess must be removed with a clean cloth to prevent any accumulation of dust or dirt. Avoid any lubricant on insulation or other electrical parts. Care must be taken to prevent any of the molybdenum lubricant reaching any current carrying contact surface.

9.3.1 Frequency

Type DS206 Breaker after 1750 operations.
Type DS416 Breaker after 500 operations.
Type DS532 Breaker after 250 operations.

9.3.2 Location and Lubricant

Refer to Figures 65 and 66. The numbered references below correspond to those on the above figures.

A mixture of alcohol and molybdenum disulphide should be placed on the following surfaces. Oil base lubricants are generally avoided to prevent the accumulation of dust and dirt which will cause wear and binding in the mechanism.

1. The spring-charge indicator bearing on the left side of the crank shaft.

2. The cam surface operating the cut-off switch link.

3. The pins on both ends of the constraining link.

4. The pins on both ends of the main drive link.

5. The curved surface of the trip latch.

6. Trip latch bearings - both side frames.

7. Both sides of oscillator plate where it pivots on the crank shaft.

8. The surface of the main close cam.

9. The trip shaft notch and both end bearings - Refer to Figure 61.

10. A molybdenum grease should be used at the main spring pins on each end of the crankshaft.

Note: All parts of the levering mechanism, Figure 17 have sufficient lubrication, and should not require any further attention.

Section 10 - Parts Identification

Figures 55 through 63, show all major sub assemblies and their detail parts, for easy and quick parts identification. In inquiring about or ordering parts, refer to these figures for verification of exact part in question.

Section 11 - Renewal Parts

List of renewal parts by name, recommended to be kept in stock, are included in this section and are referred to the figures showing them. When ordering renewal parts, always specify the part name and style number, if known, from the Renewal Parts Data, not included in this book. If the style number is not known, use the Figure number, name, and item number if given, together with the instruction book number, from this section of the instruction book. Also always supply the complete information from the nameplate on the front of the breaker chassis panel.

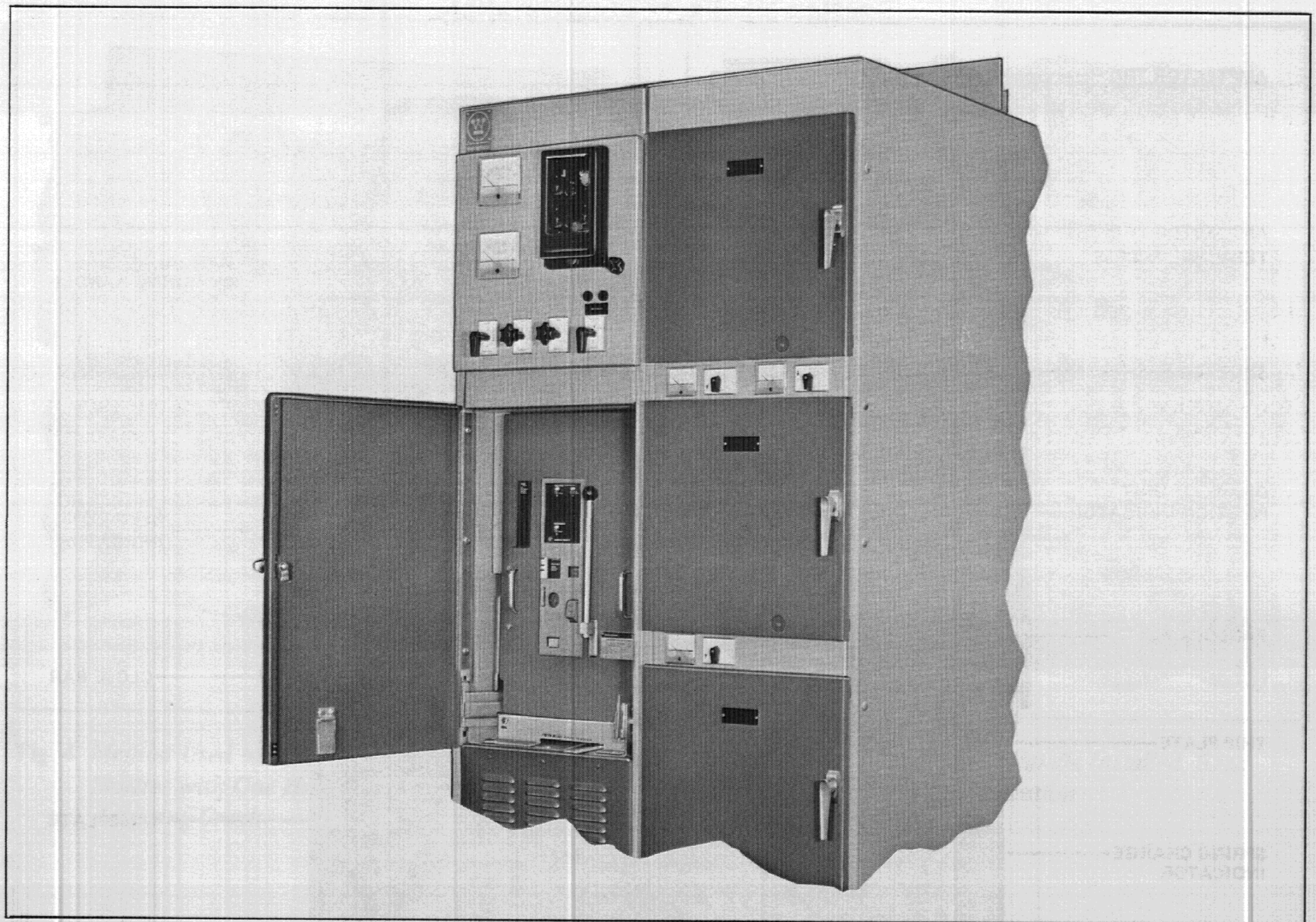


Fig. 1 *The Type DS Low Voltage Power Circuit Breaker is Shipped Inside Its Own Compartment*

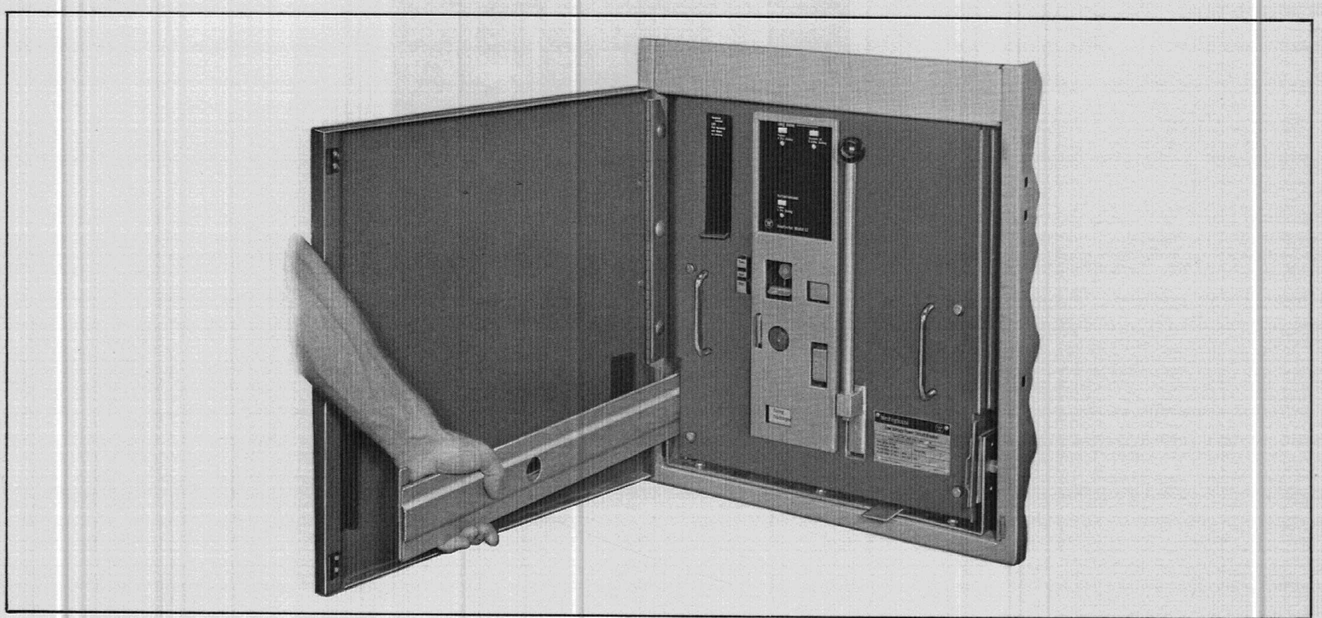


Fig. 2 *Rails are Stowed away in the Compartment. Withdraw as Shown*

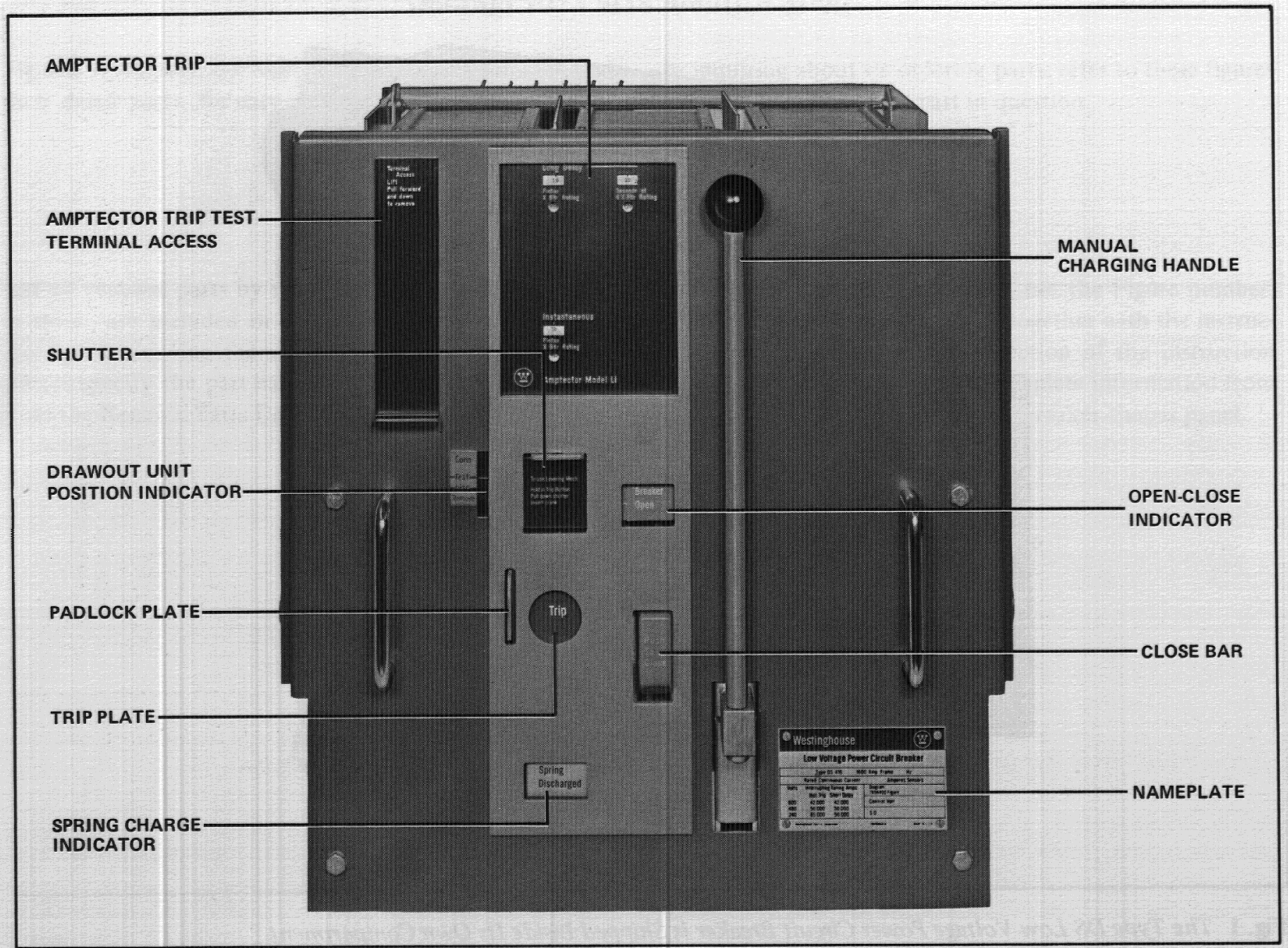


Fig. 3 *View Showing Controls on the Panel*

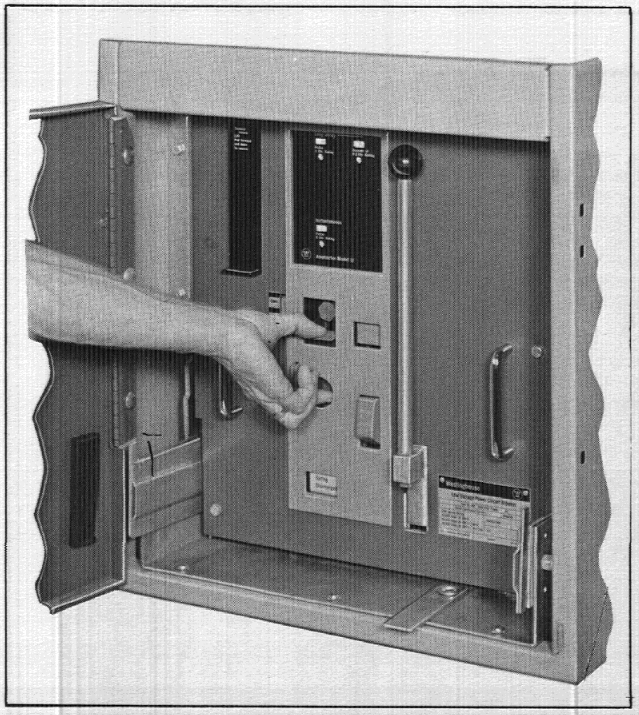


Fig. 4 *Method Used to Press Trip Plate and Lower Shutter with One Hand, Preparatory to Inserting Crank*

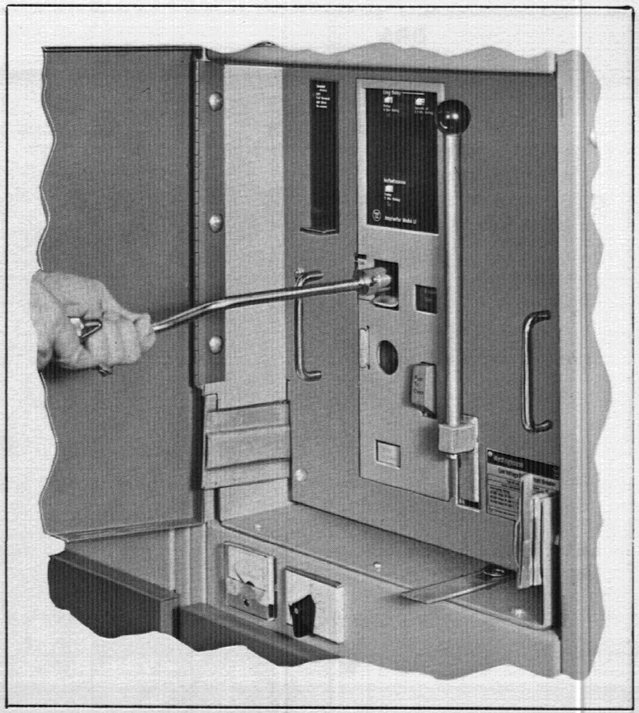


Fig. 5 *Levering Device Crank Handle Installed. Read Section 2.2 on this Operation*

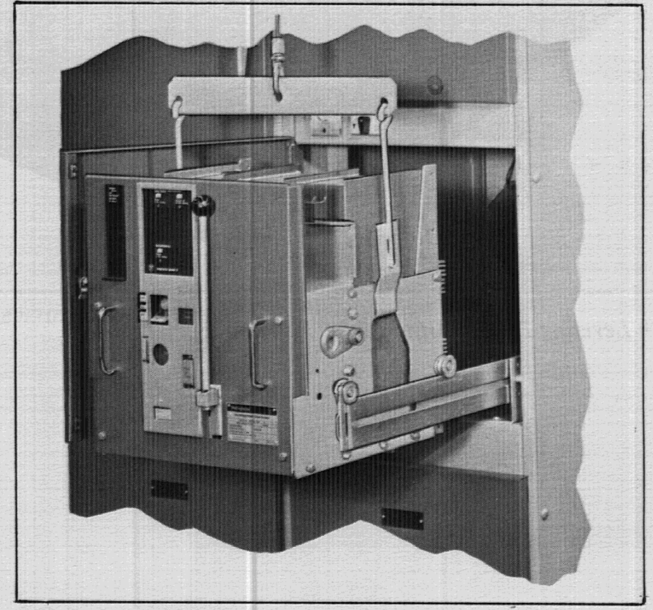


Fig. 6 *Use of Breaker Lifting Adapter*

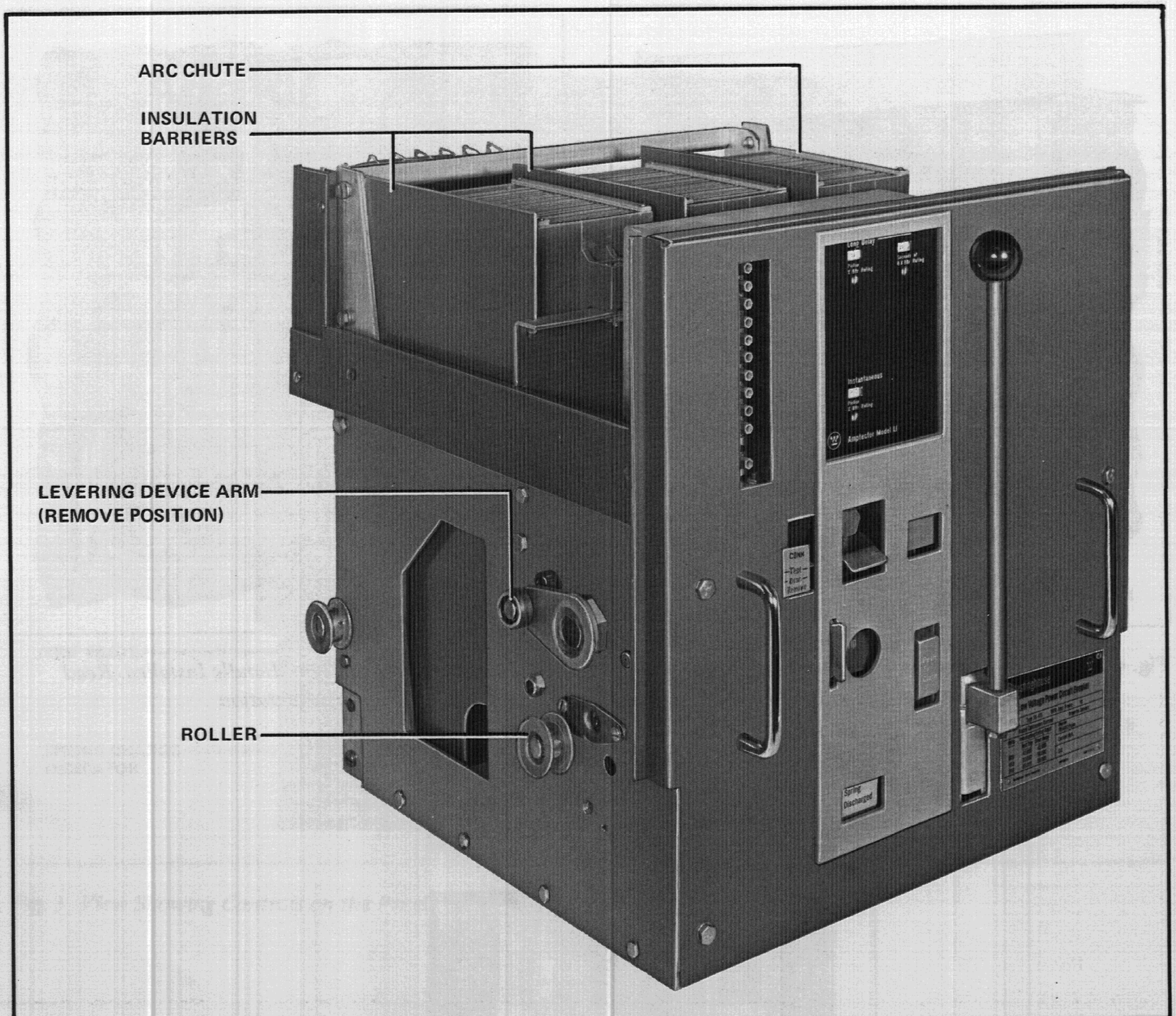


Fig. 7 *Left Side of Breaker with Levering Device Arm in Disc. Position*

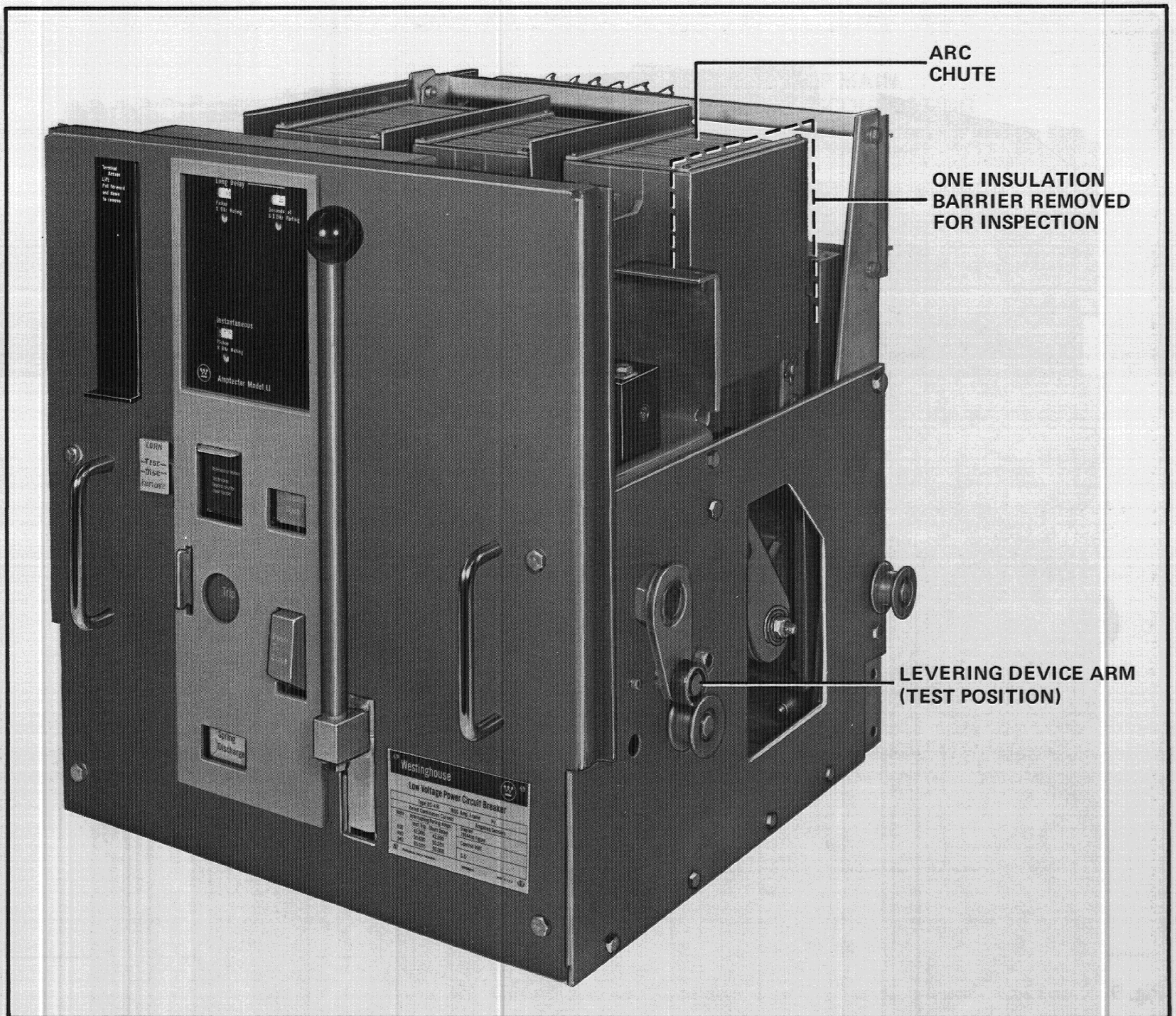


Fig. 8 *Right Side Showing Levering Device Arm in Test Position*

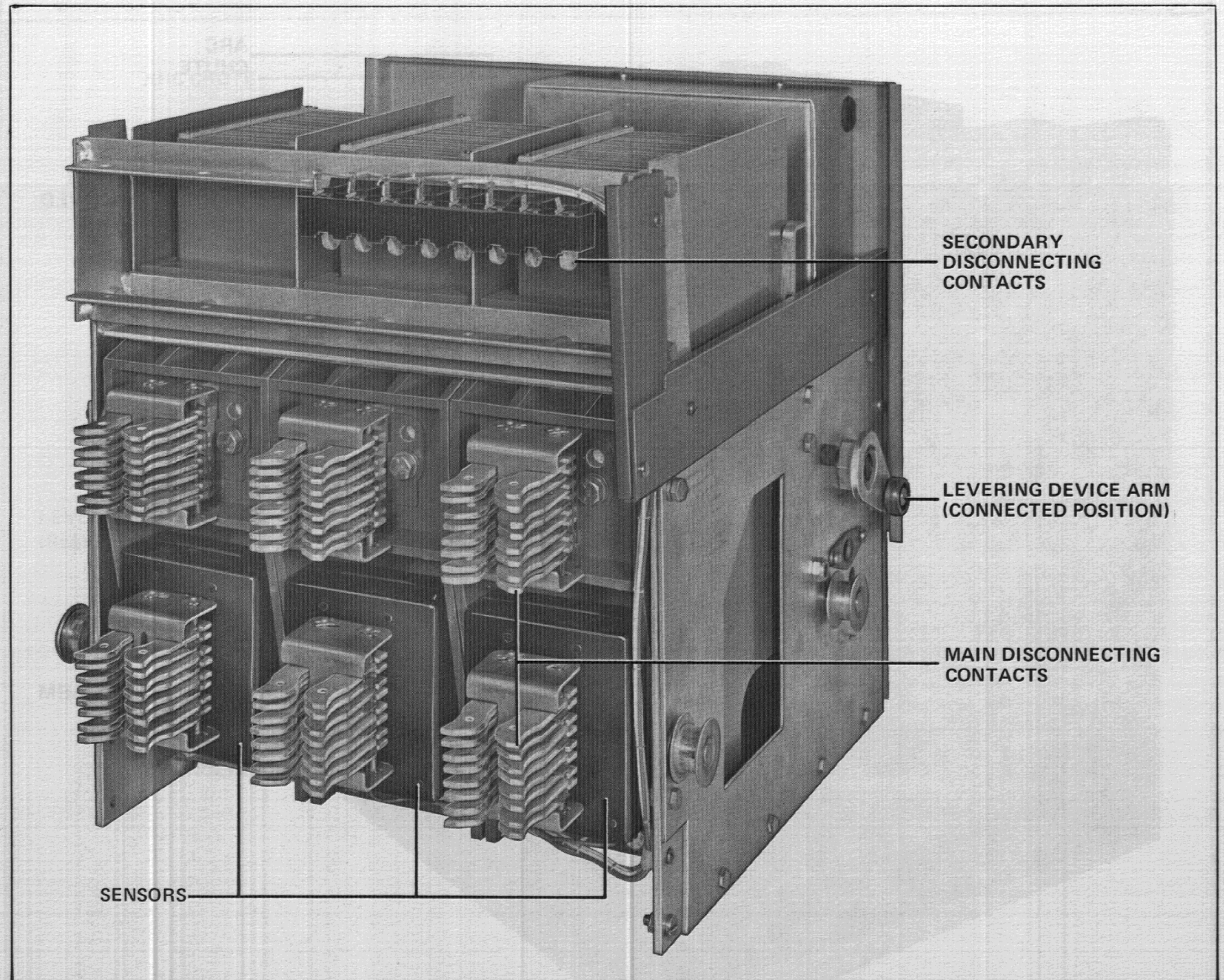


Fig. 9 *Rear View Showing Levering Device Arm in Connected Position*

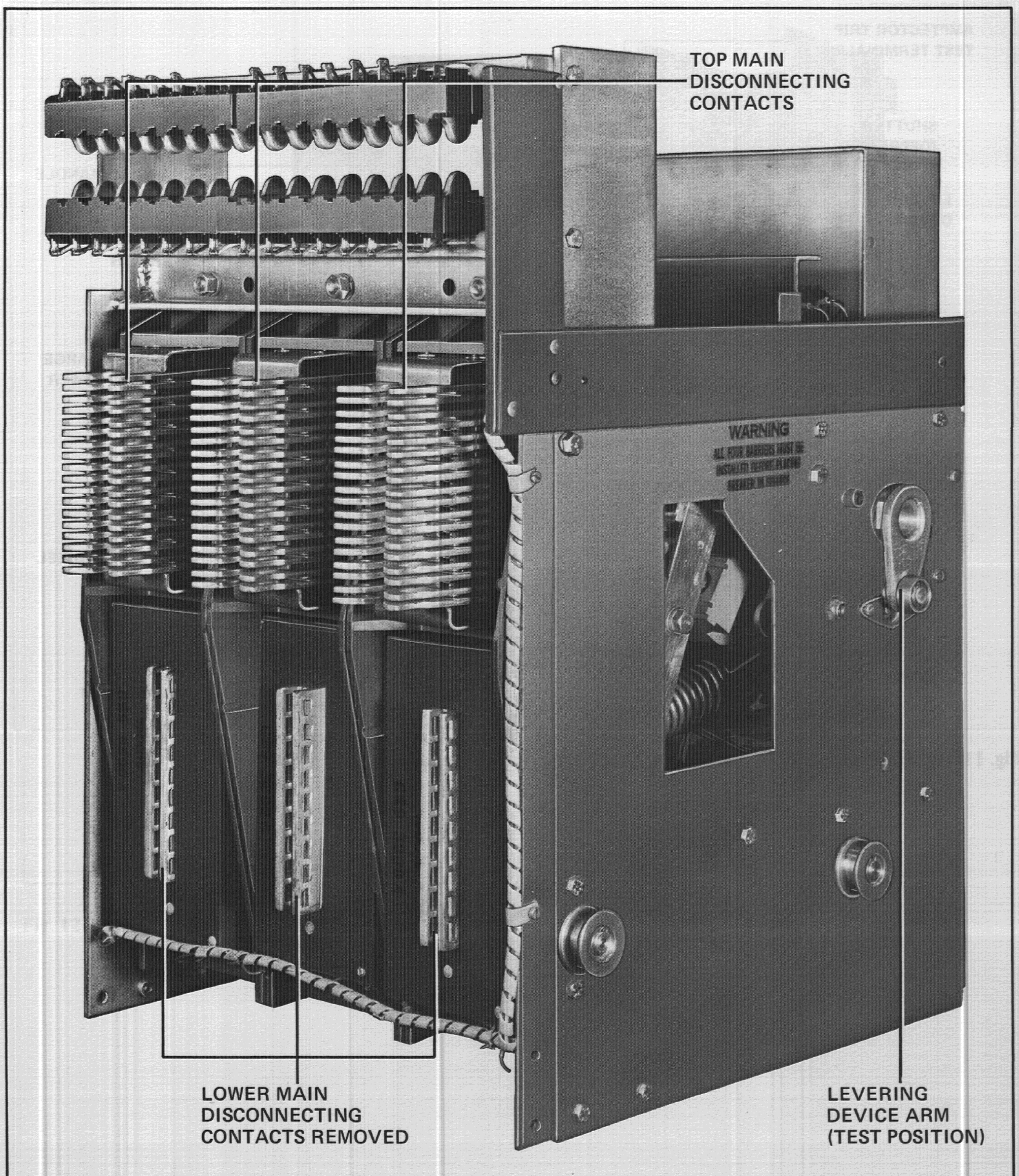


Fig. 10 *DS-532 Breaker Rear View*

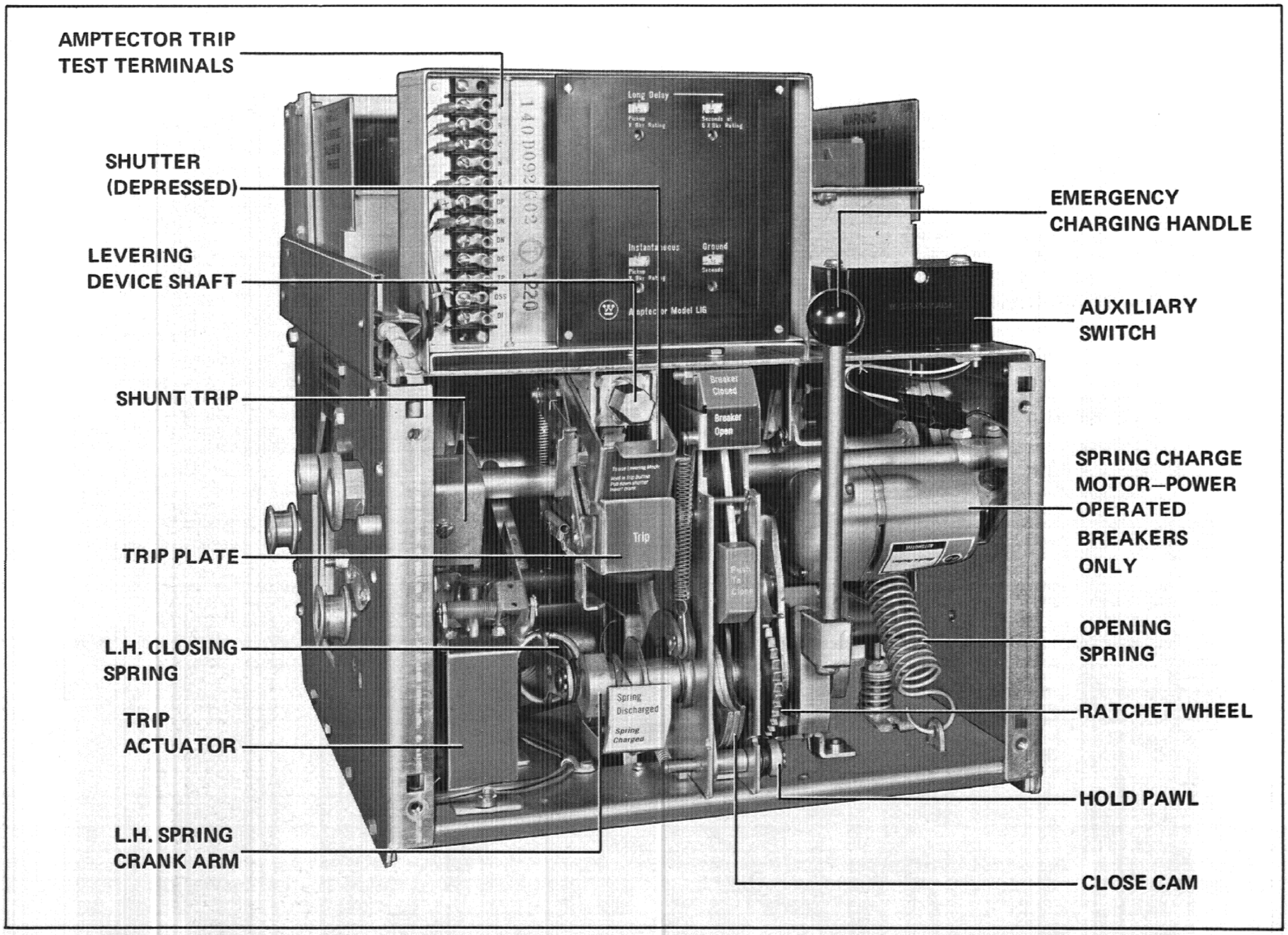


Fig. 11 *DS-416 Breaker with Front Panel Removed (The DS-206 is Similar)*

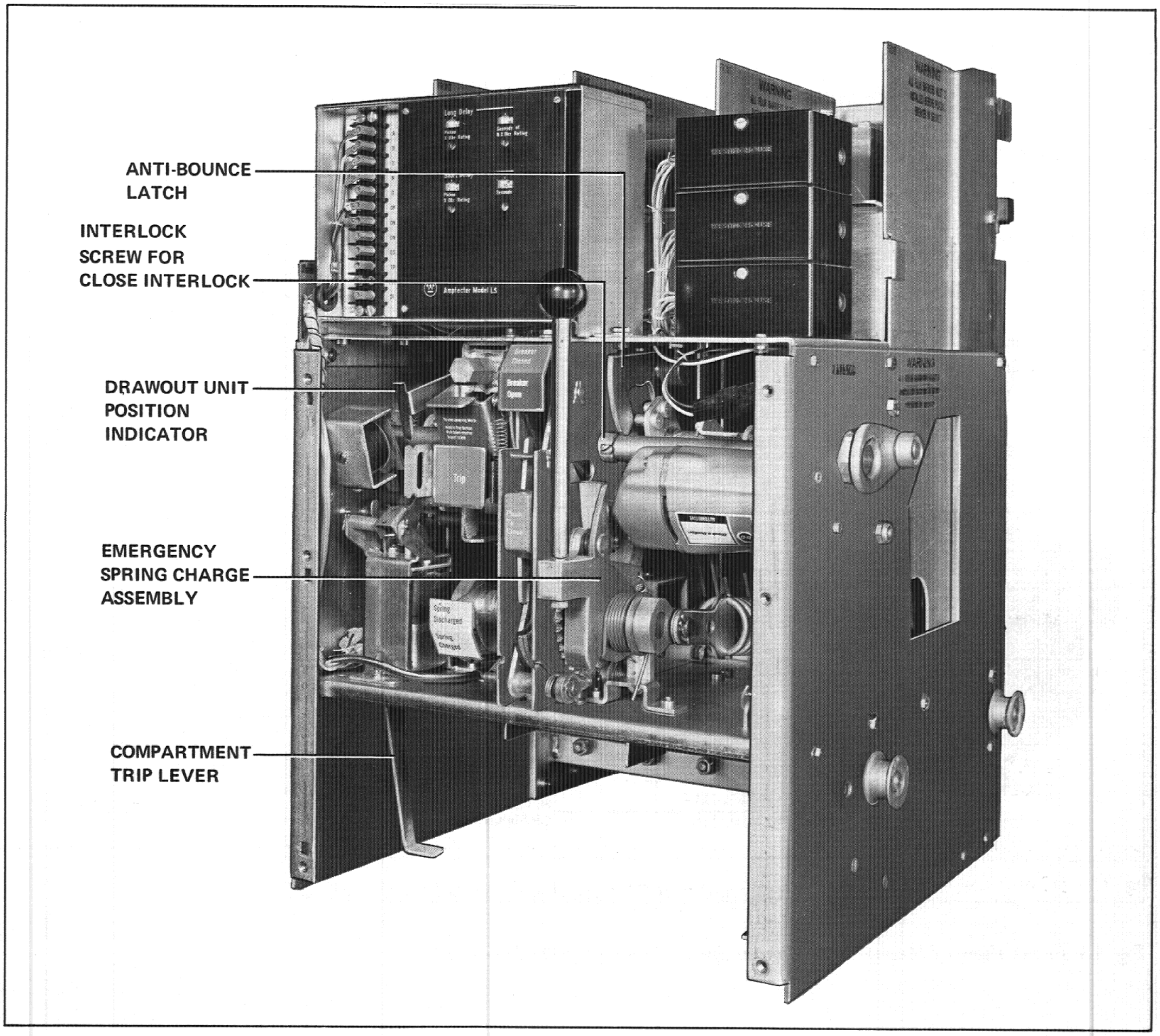


Fig. 12 *DS-532 Breaker with Front Panel Removed*

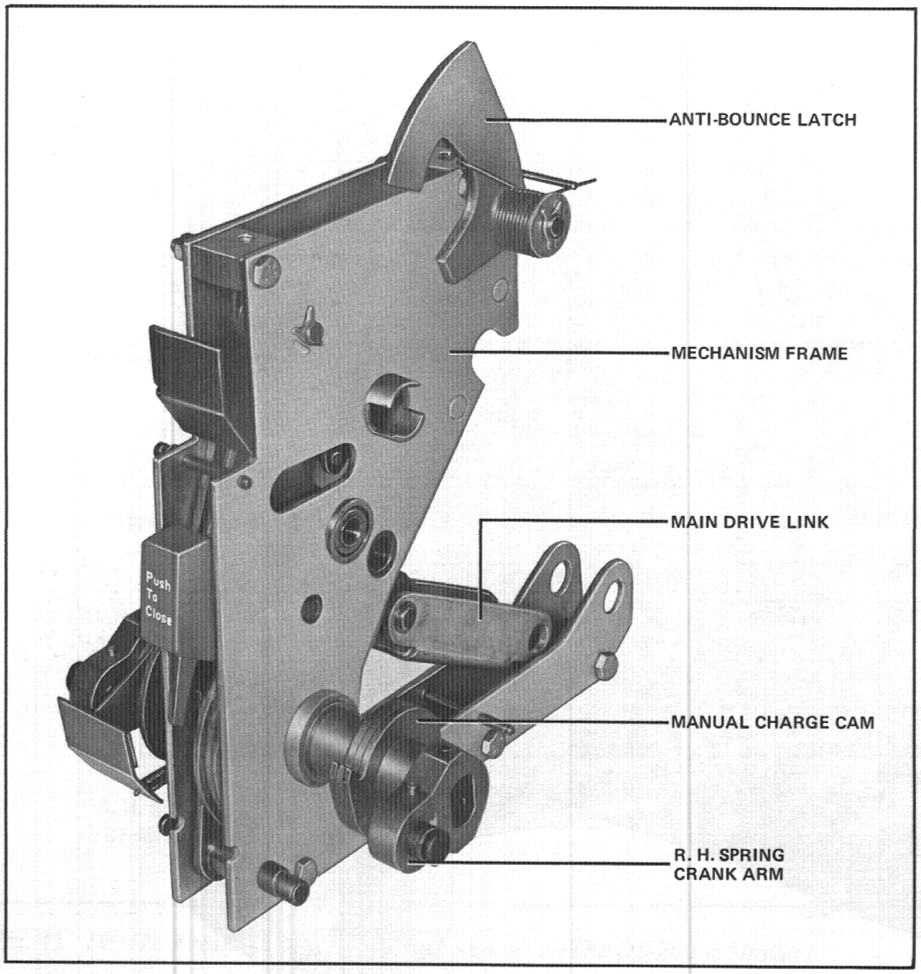


Fig. 13 *Front View of Mechanism (Manual Spring Charge for DS-206 and DS-416)*

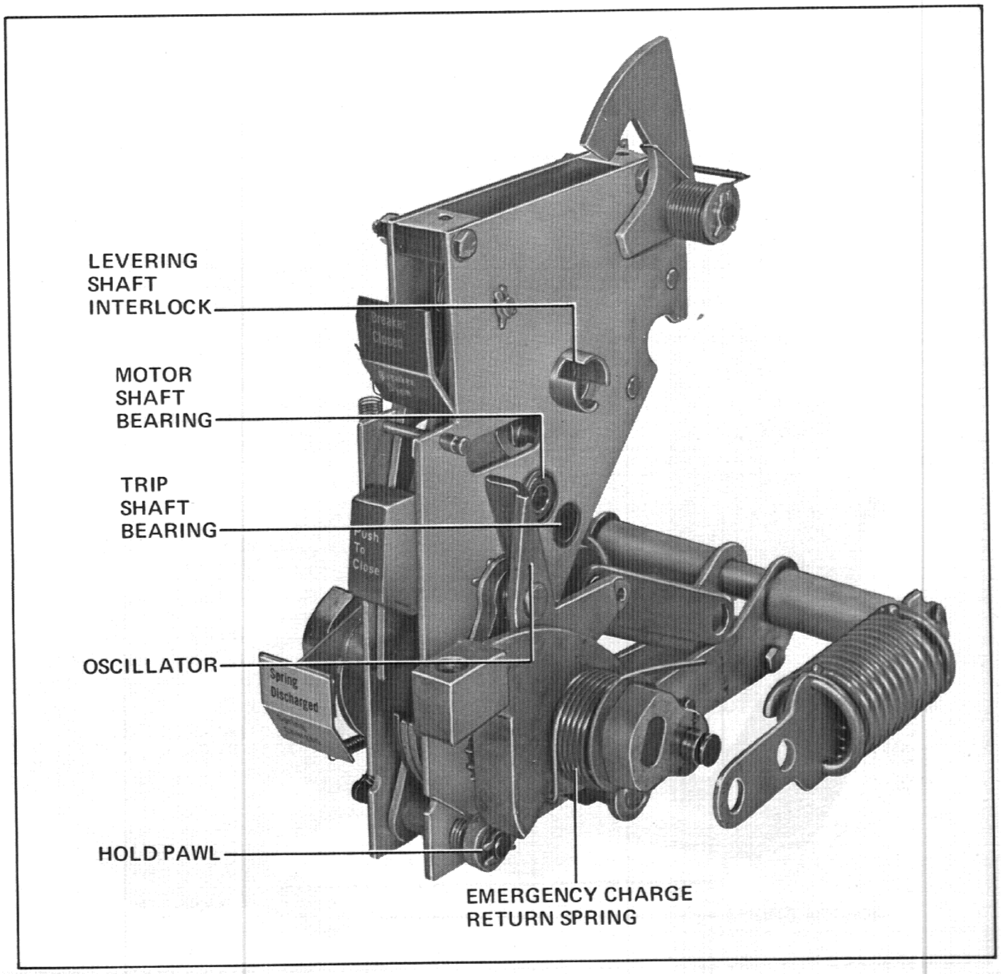


Fig. 14 *Front View of Mechanism (Power-Operated Spring-Charge)*

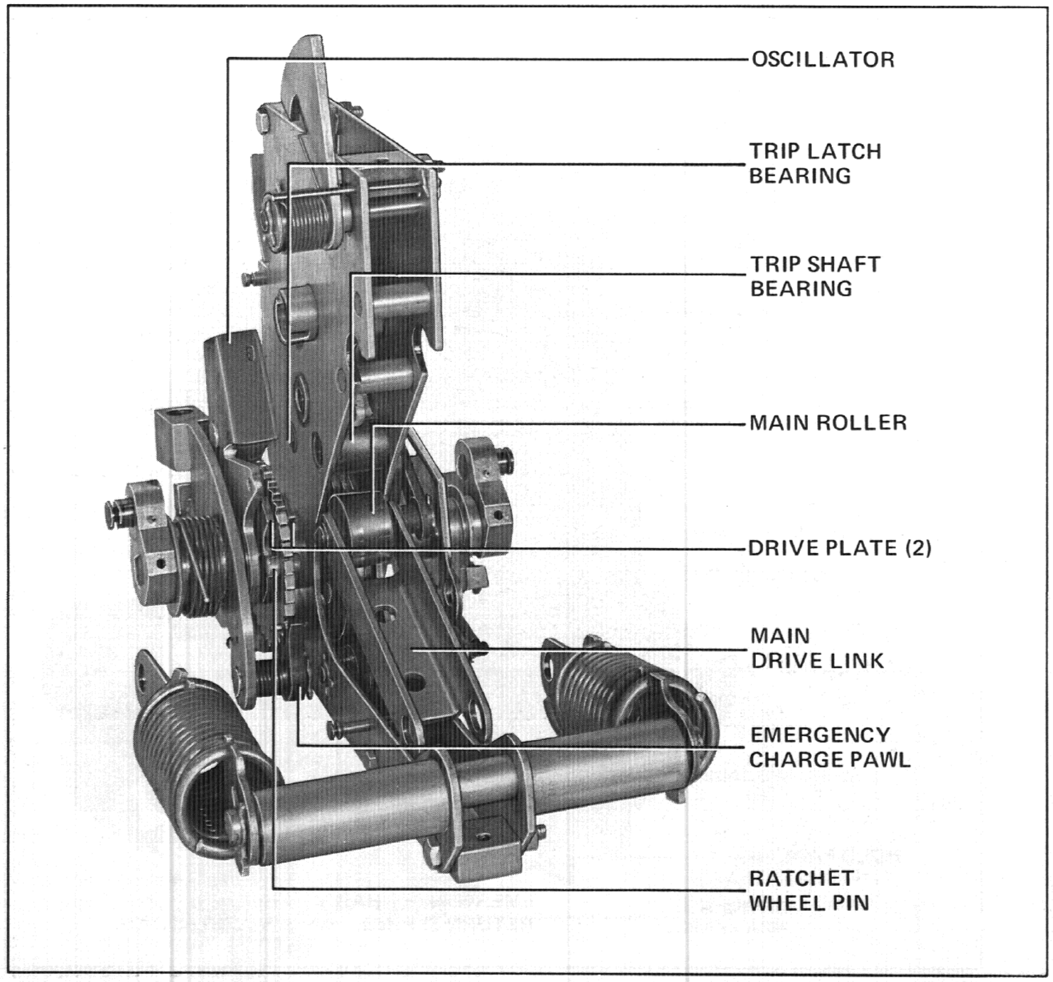


Fig. 15 *Rear of Power-Operated Mechanism*

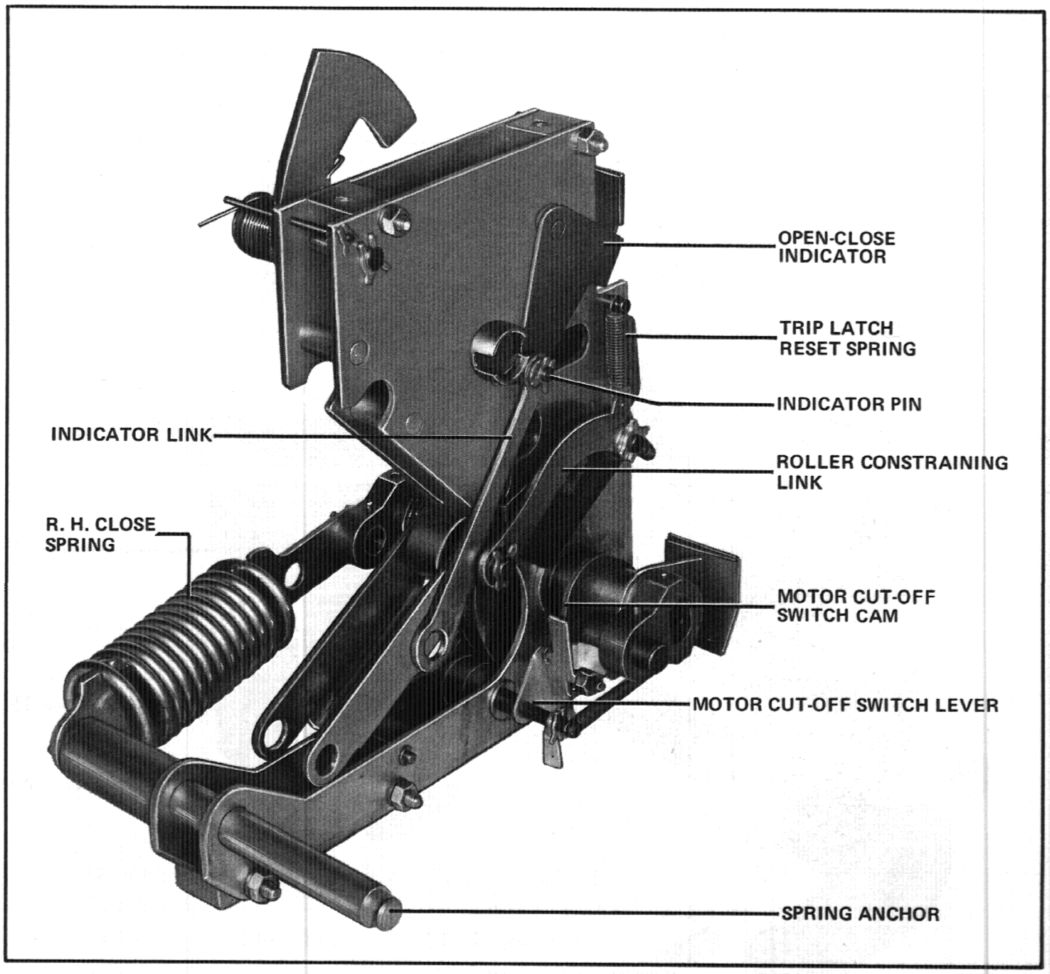


Fig. 16 *Rear View of Mechanism (Left Close Spring Removed)*

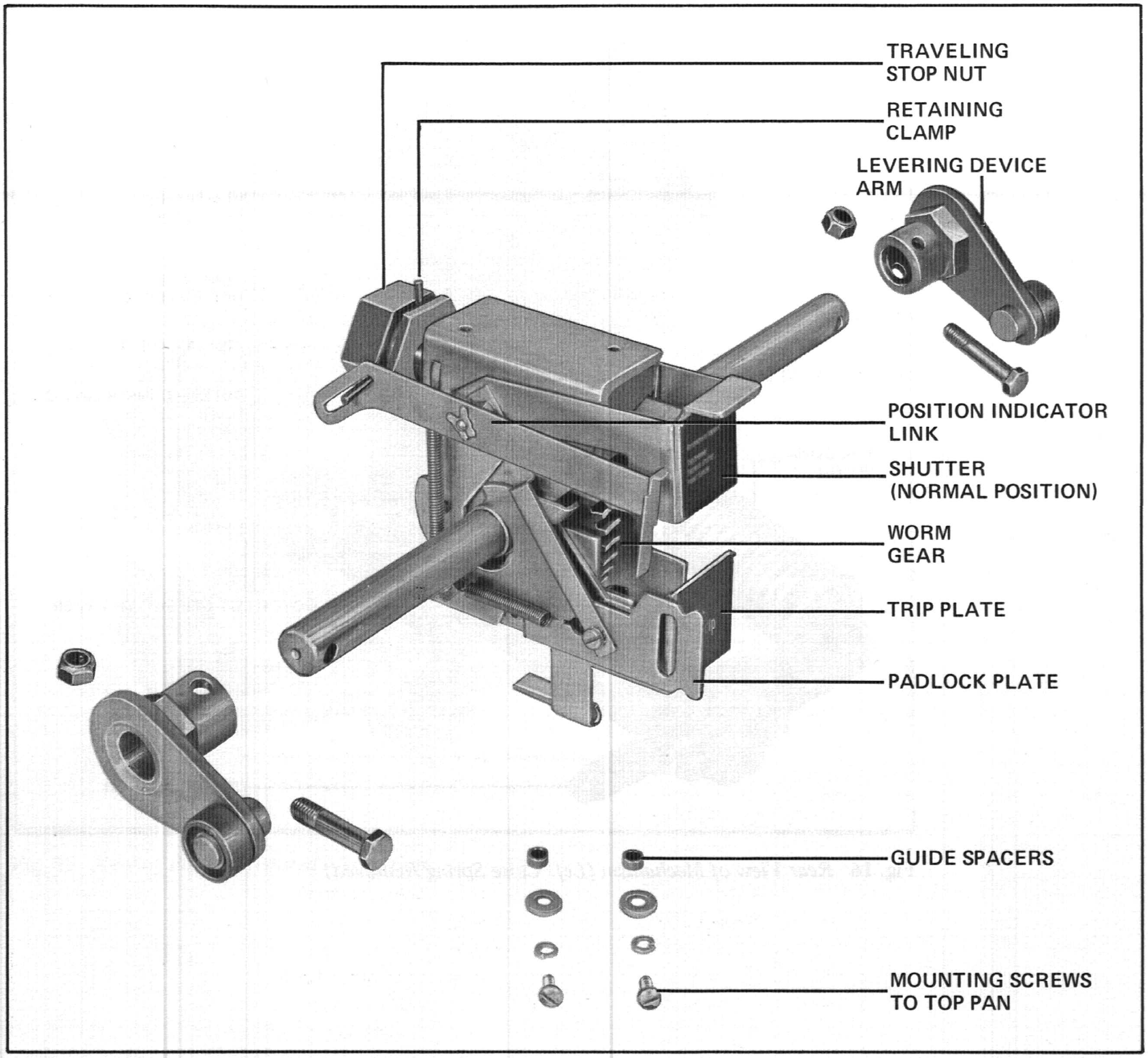
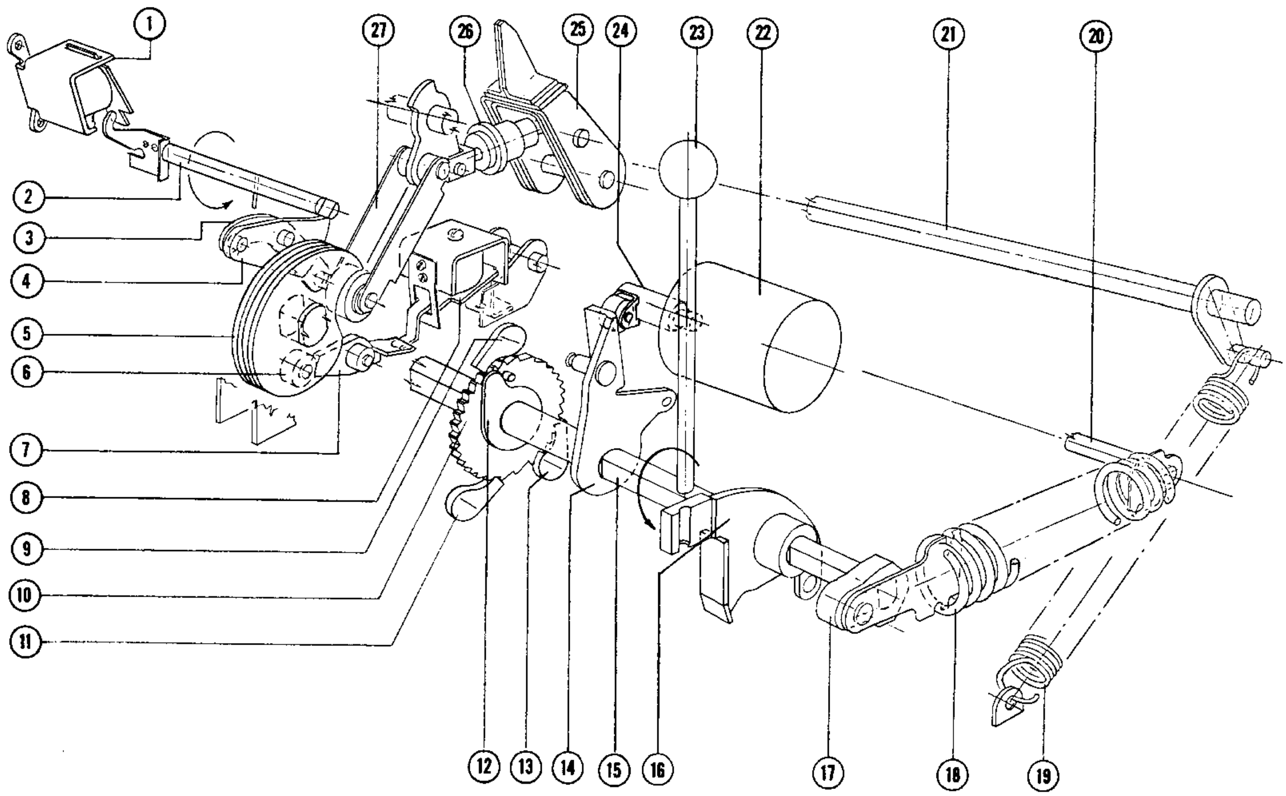
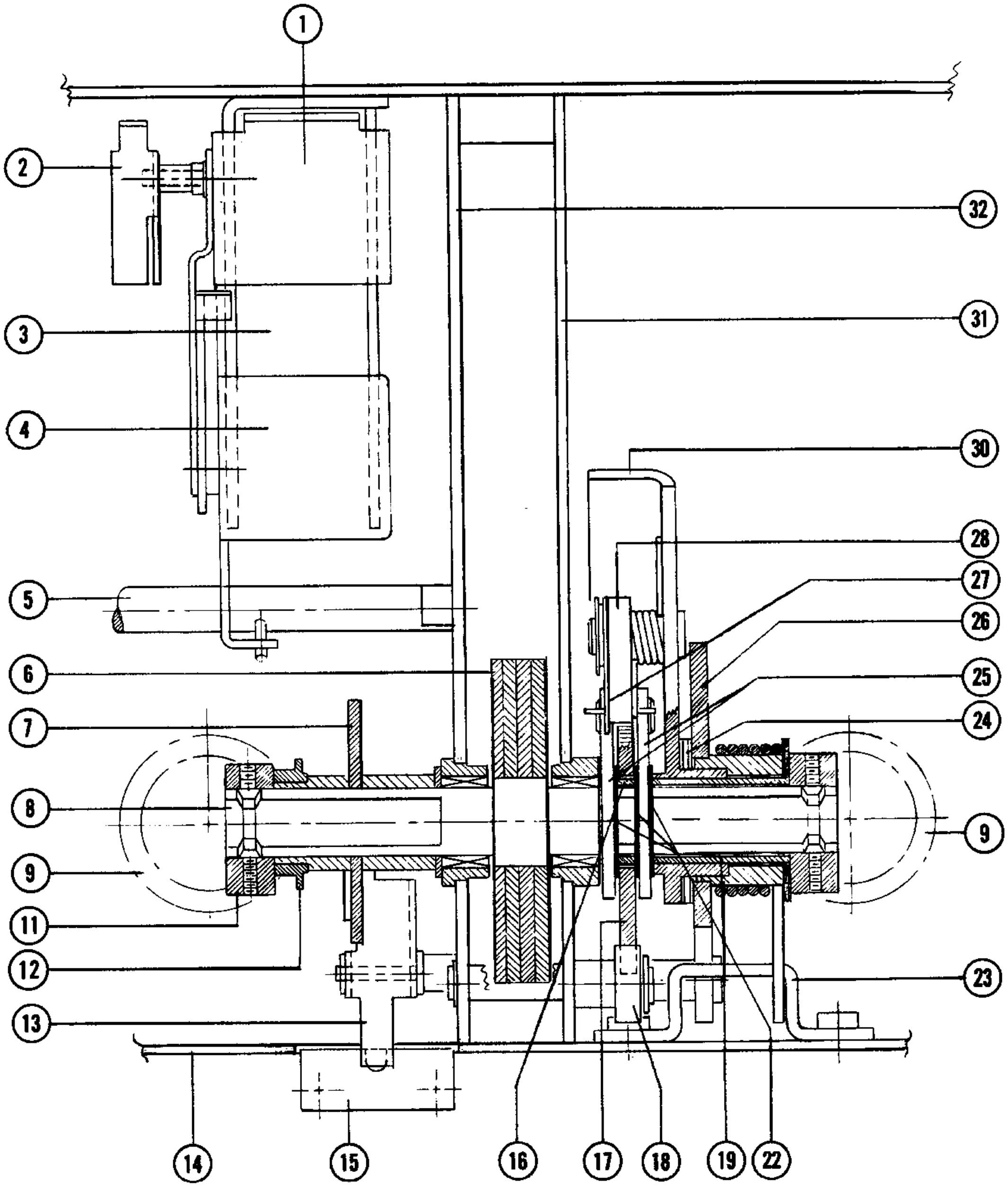


Fig. 17 *Levering Mechanism*



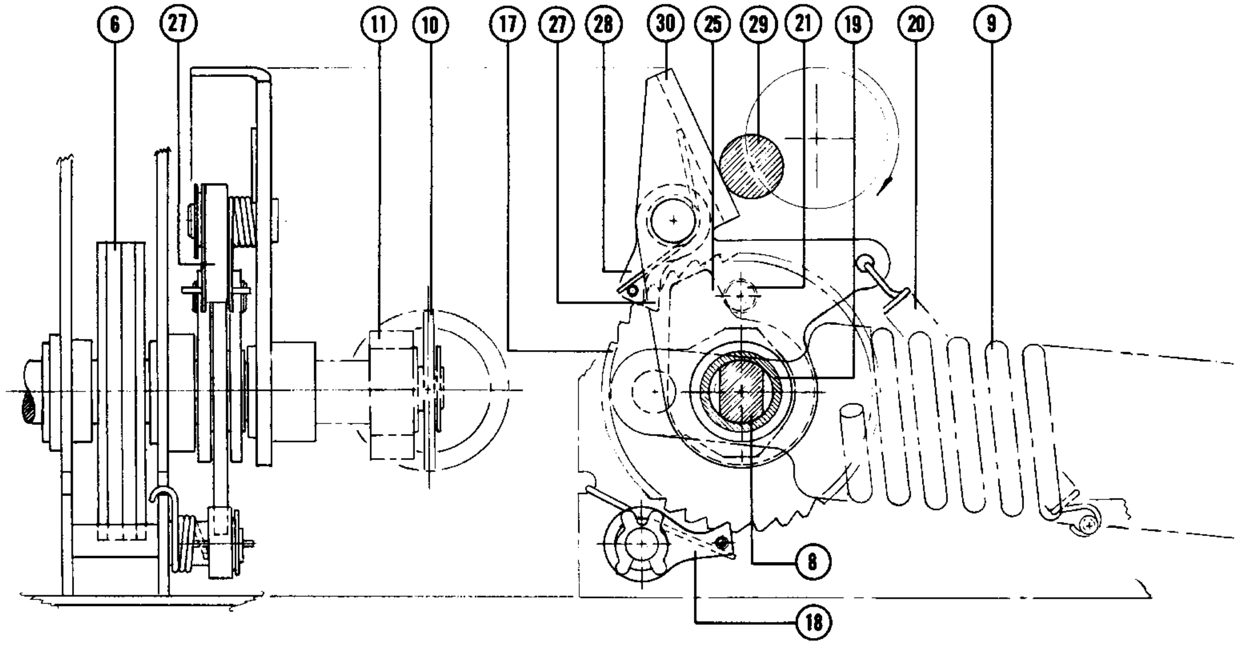
1. Shunt Trip Device
2. Trip Shaft
3. Roller Constraining Link
4. Trip Latch
5. Close Cam
6. Stop Roller
7. Spring Release Latch
8. Spring Release Device
9. Oscillator Pawl
10. Ratchet Wheel
11. Hold Pawl
12. Drive Plate
13. Emergency Charge Pawl
14. Oscillator
15. Crank Shaft
16. Emergency Charge Device
17. Crank Arm
18. Closing Spring
19. Opening Spring
20. Closing Spring Anchor
21. Pole Shaft
22. Motor
23. Emergency Charge Handle
24. Motor Crank and Handle
25. Moving Contact Assembly
26. Insulating Link
27. Main Drive Link

Fig. 18 *Arrangement of the Principal Parts of a Completely Power Operated Mechanism. The Close Spring is Shown in the Charged Position*



1. Shutter
2. Levering Device Indicator
3. Levering Mechanism
4. Trip Plate
5. Trip Shaft
6. Close Cam
7. Motor Cut-Off Switch Cam
8. Crank Shaft
9. Closing Spring
11. Crank Arm
12. Spring Charge Indicator
13. Motor Cut-Off Switch Lever
14. Draw Out Unit Base
15. Motor Cut-Off Switch
16. Ratchet Bushing
17. Ratchet Wheel
18. Hold Pawl
19. Oscillator Bushing
22. Spacers (3)
23. Stop Bracket
24. Thrust Bearing and Races
25. Drive Plates (2)
26. Emergency Charge Device
27. Pawl Lifter
28. Oscillator Pawl
30. Oscillator
31. Mechanism Side Frame, Right Hand
32. Mechanism Side Frame, Left Hand

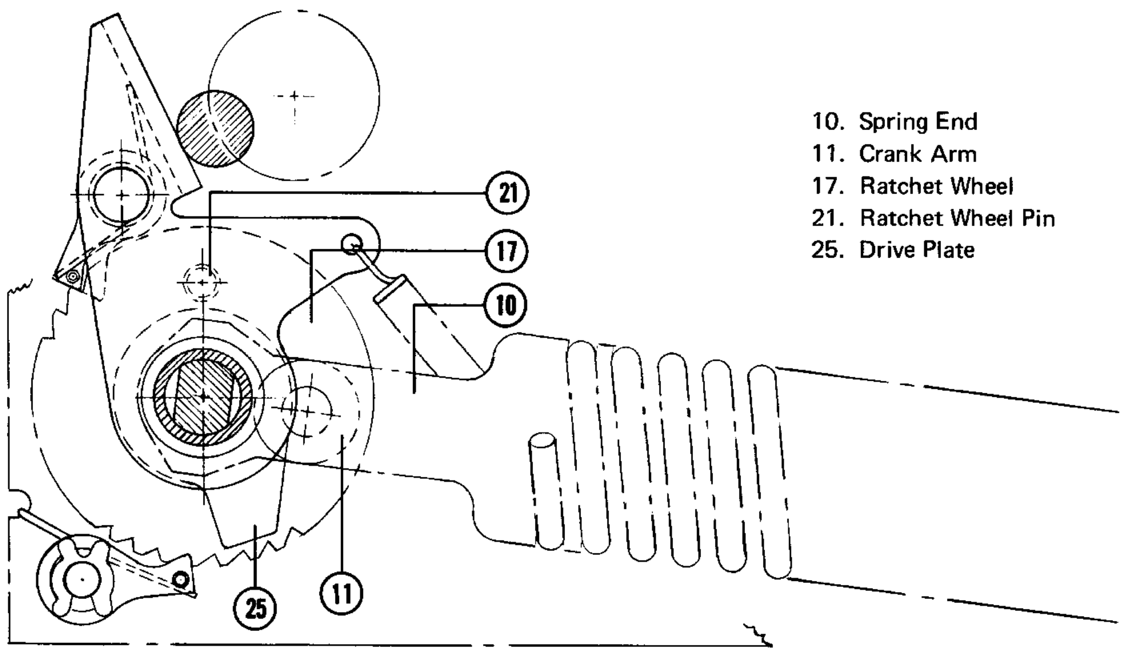
Fig. 19 *Front View Showing Major Parts of the Crank Shaft Assembly. Some Parts are Omitted for Clarity*



a) Spring Charged

Note: Main cam position for this crank shaft position is shown in Fig. 24a.

6. Close Cam
8. Crank Shaft
9. Closing Spring
10. Spring End
11. Crank Arm
17. Ratchet Wheel
18. Hold Pawl
19. Oscillator Bushing
20. Oscillator Spring
21. Ratchet Wheel Pin
25. Drive Plate
27. Pawl Lifter
28. Oscillator Pawl
29. Motor Crank Roller
30. Oscillator



10. Spring End
11. Crank Arm
17. Ratchet Wheel
21. Ratchet Wheel Pin
25. Drive Plate

b) Spring Discharged

Fig. 20 *Power-Operated Spring-Charge Details*

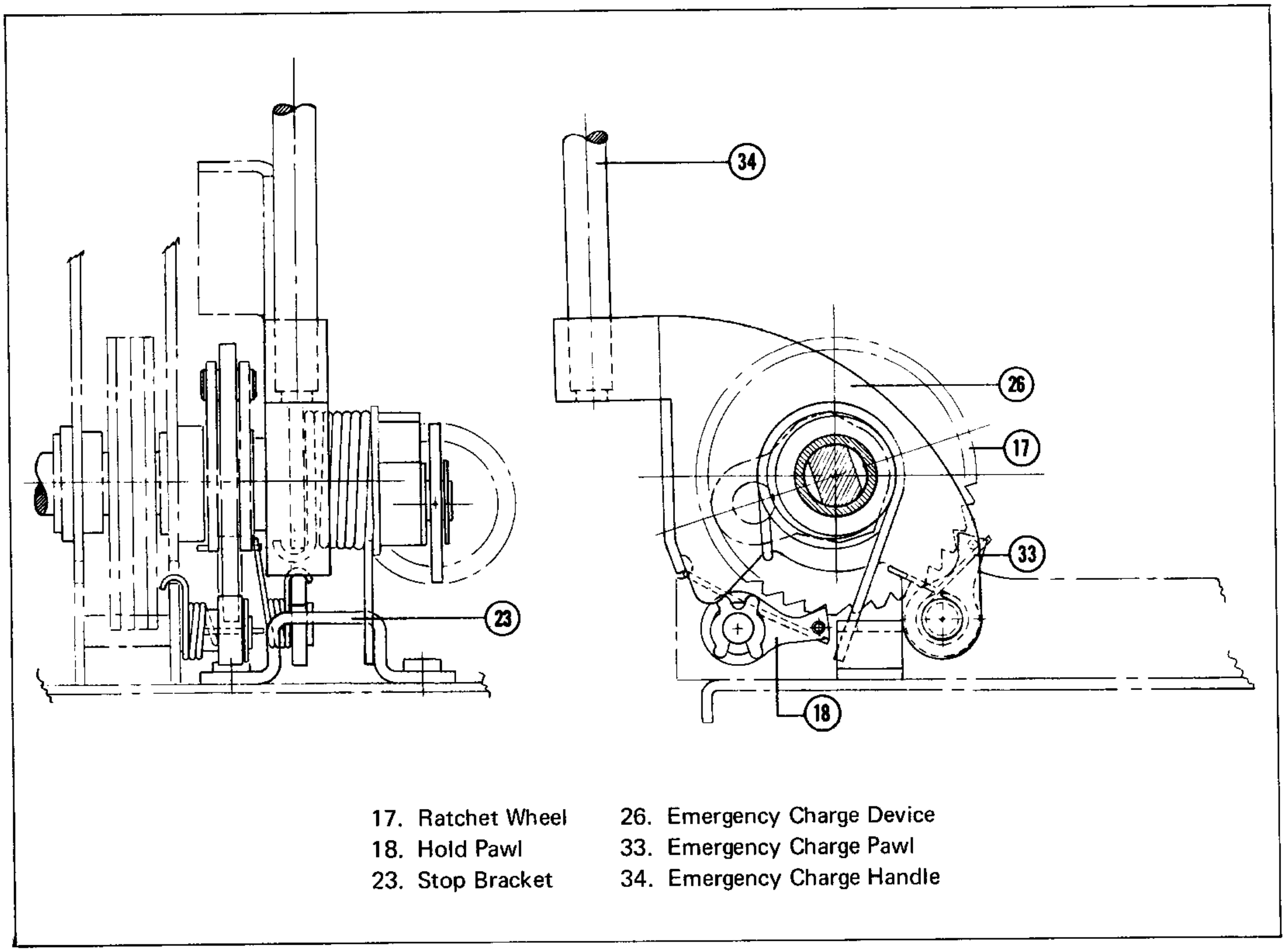
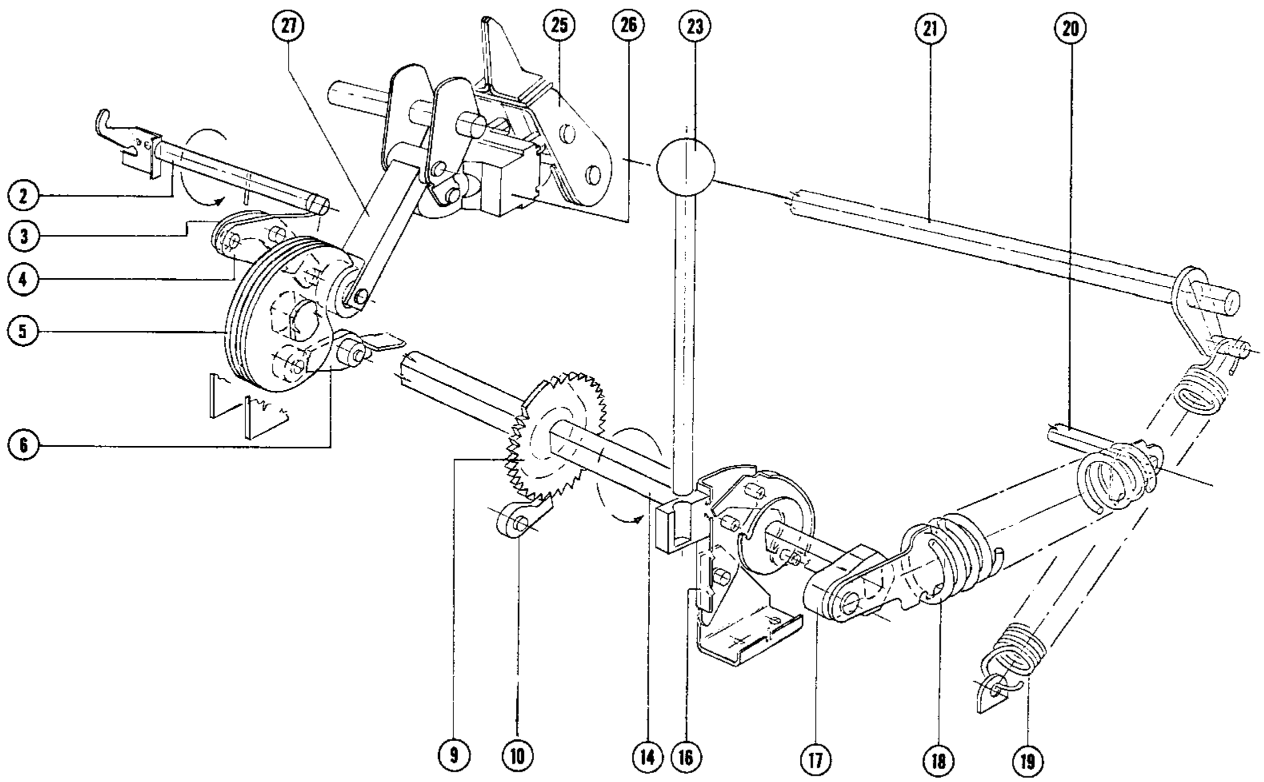


Fig. 21 *Emergency Spring-Charge on Power Operated Mechanism*



2.	Trip Shaft	17.	Crank Arm
3.	Roller Constraining Link	18.	Closing Spring
4.	Trip Shaft	19.	Opening Spring
5.	Close Cam	20.	Closing Spring Anchor
6.	Spring Release Latch	21.	Pole Shaft
9.	Ratchet Wheel	23.	Manual Charge Handle
10.	Hold Pawl	25.	Moving Contact Assembly
14.	Crank Shaft	26.	Insulating Link
16.	Manual Charge Device	27.	Main Drive Link

Fig. 22 *Principal Parts in a Manually Charged Spring Operated Mechanism. Type DS-532 Shown*

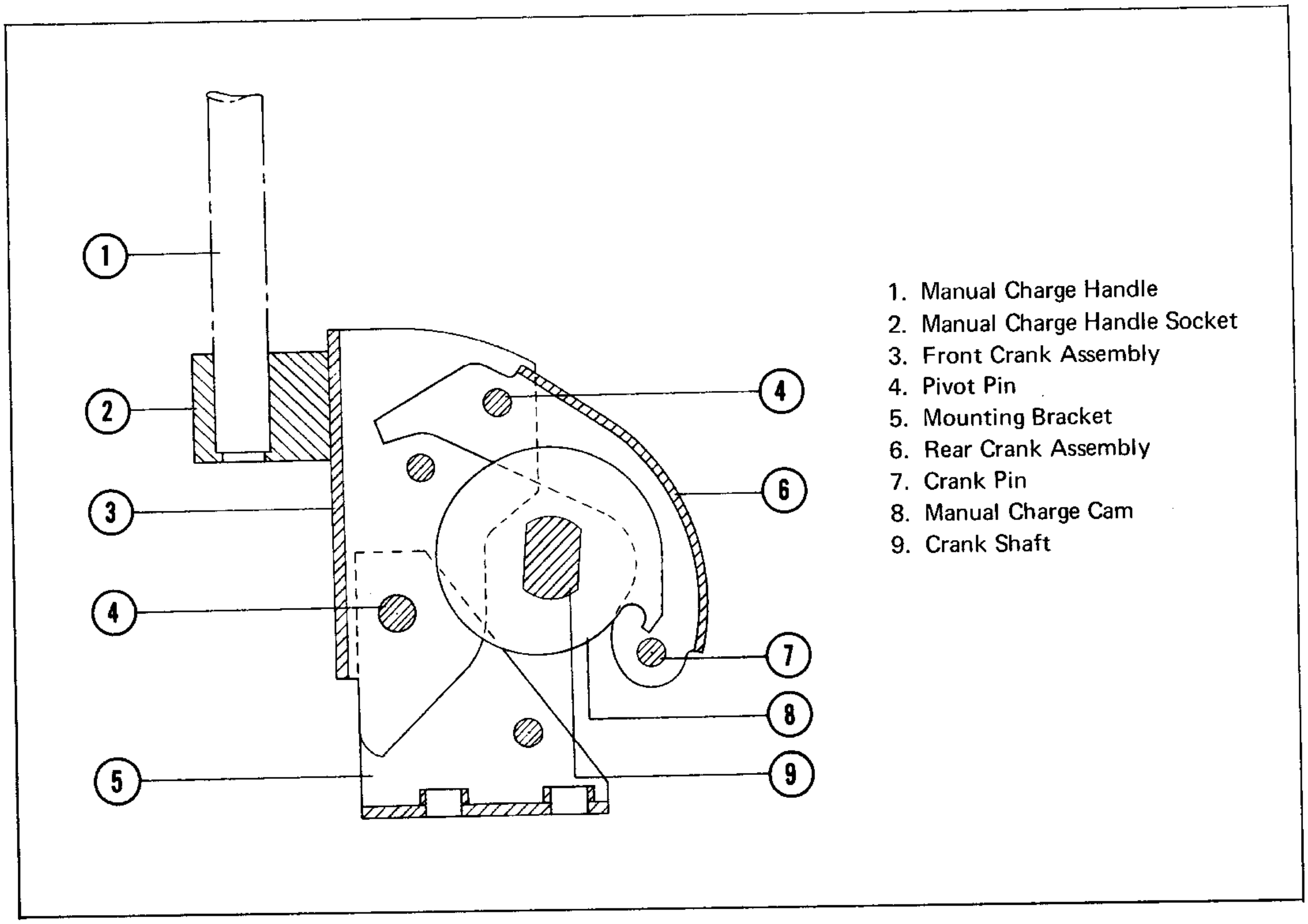


Fig. 23 *Spring-Charging Mechanism on Manual Operated Breakers*

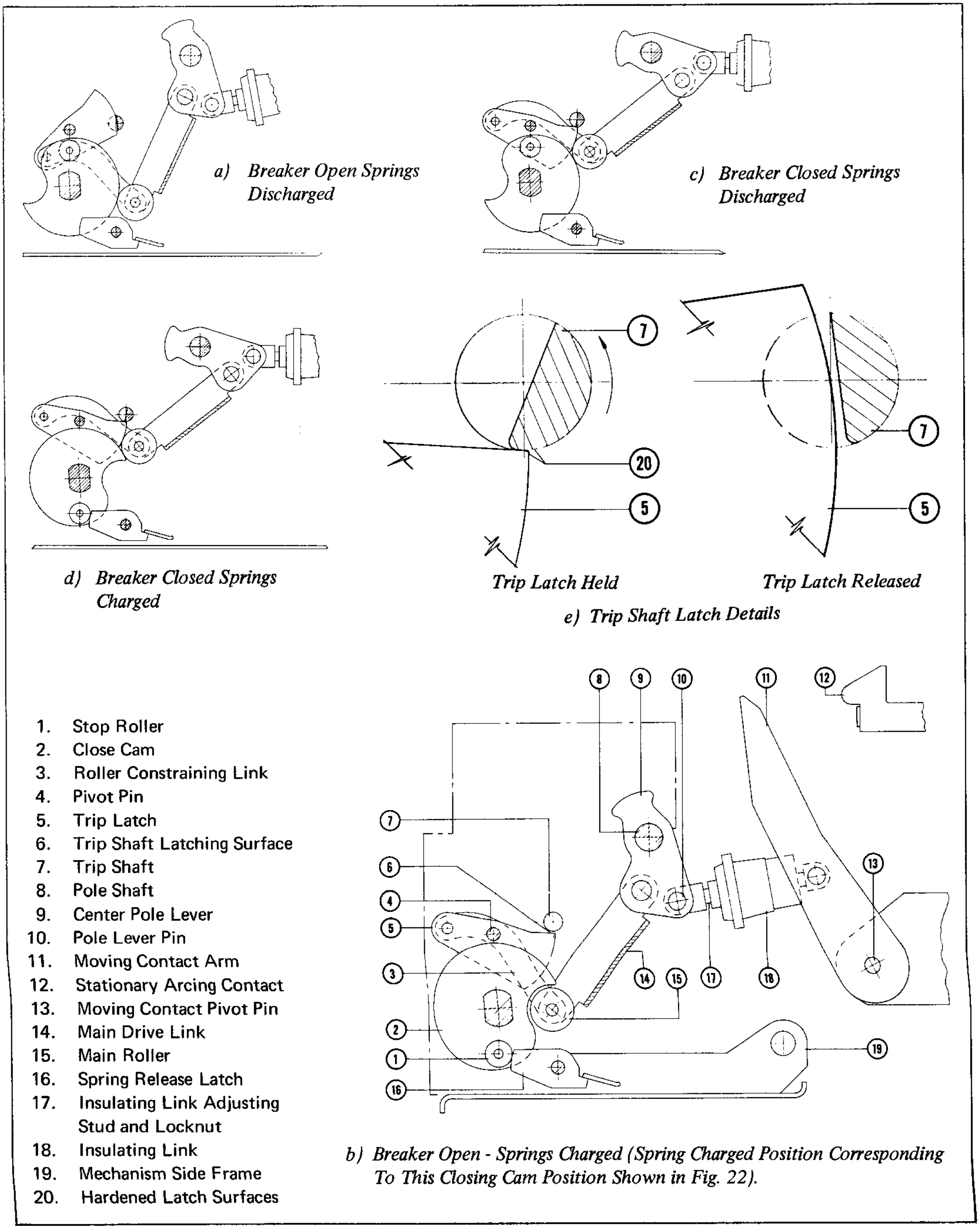


Fig. 24 *These Sketches Show the Four Basic Positions of Breaker and Linkage with Enlarged View of Trip Shaft and Latch*

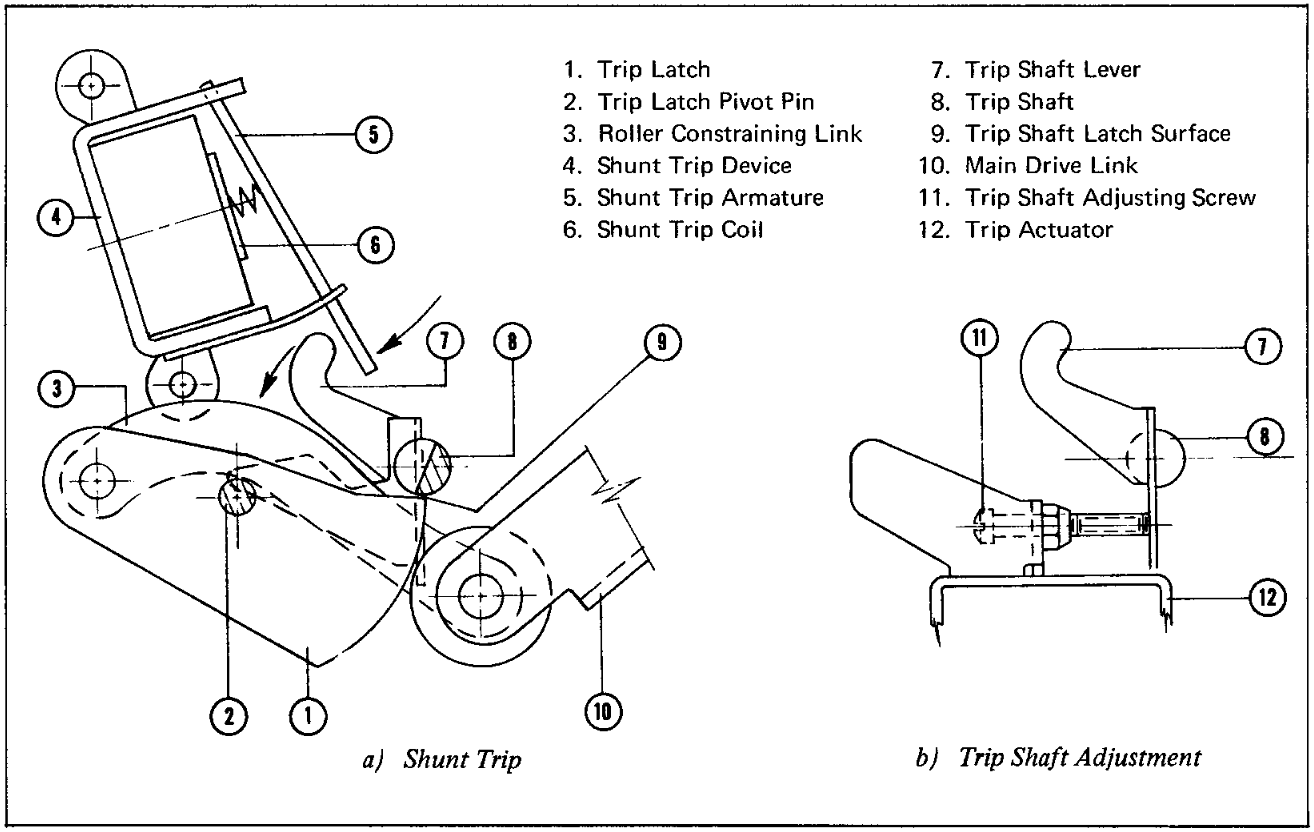


Fig. 25 – *Shunt Trip Details Showing Trip Shaft Adjustment*

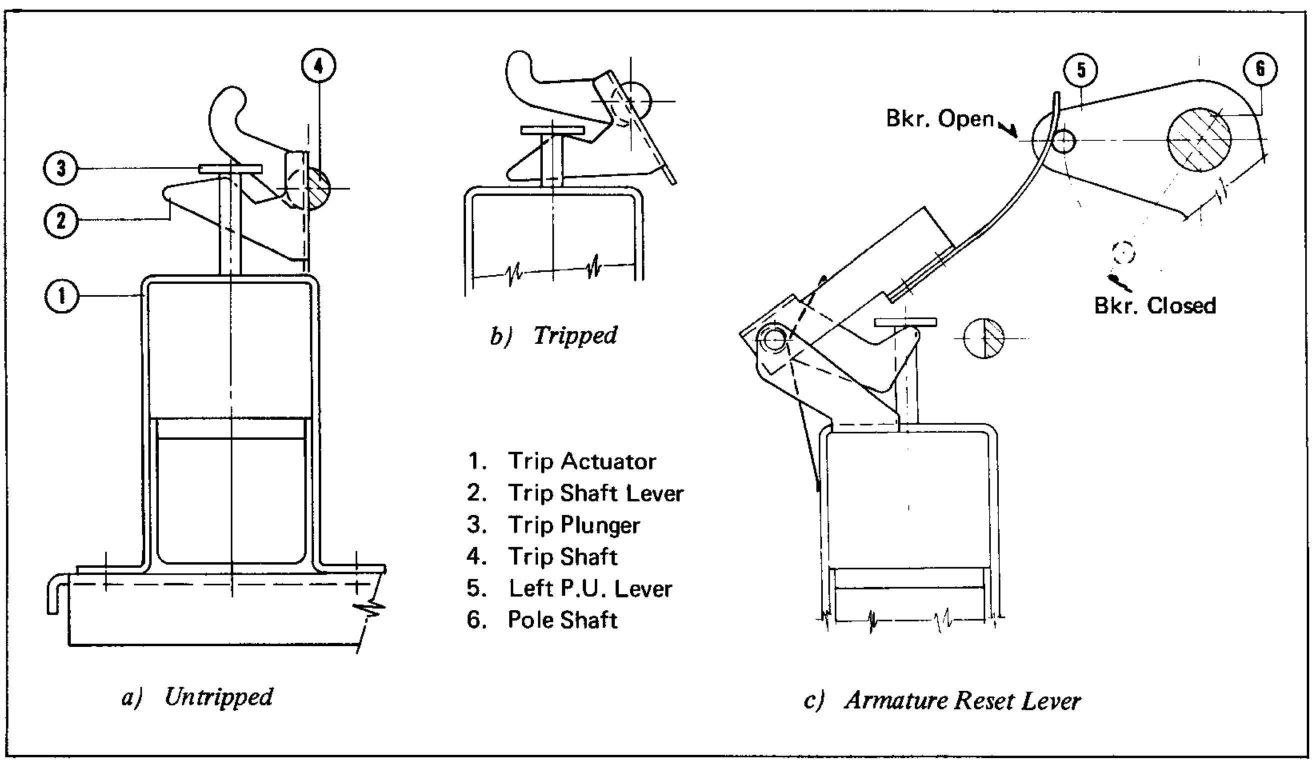


Fig. 26 *Actuator*

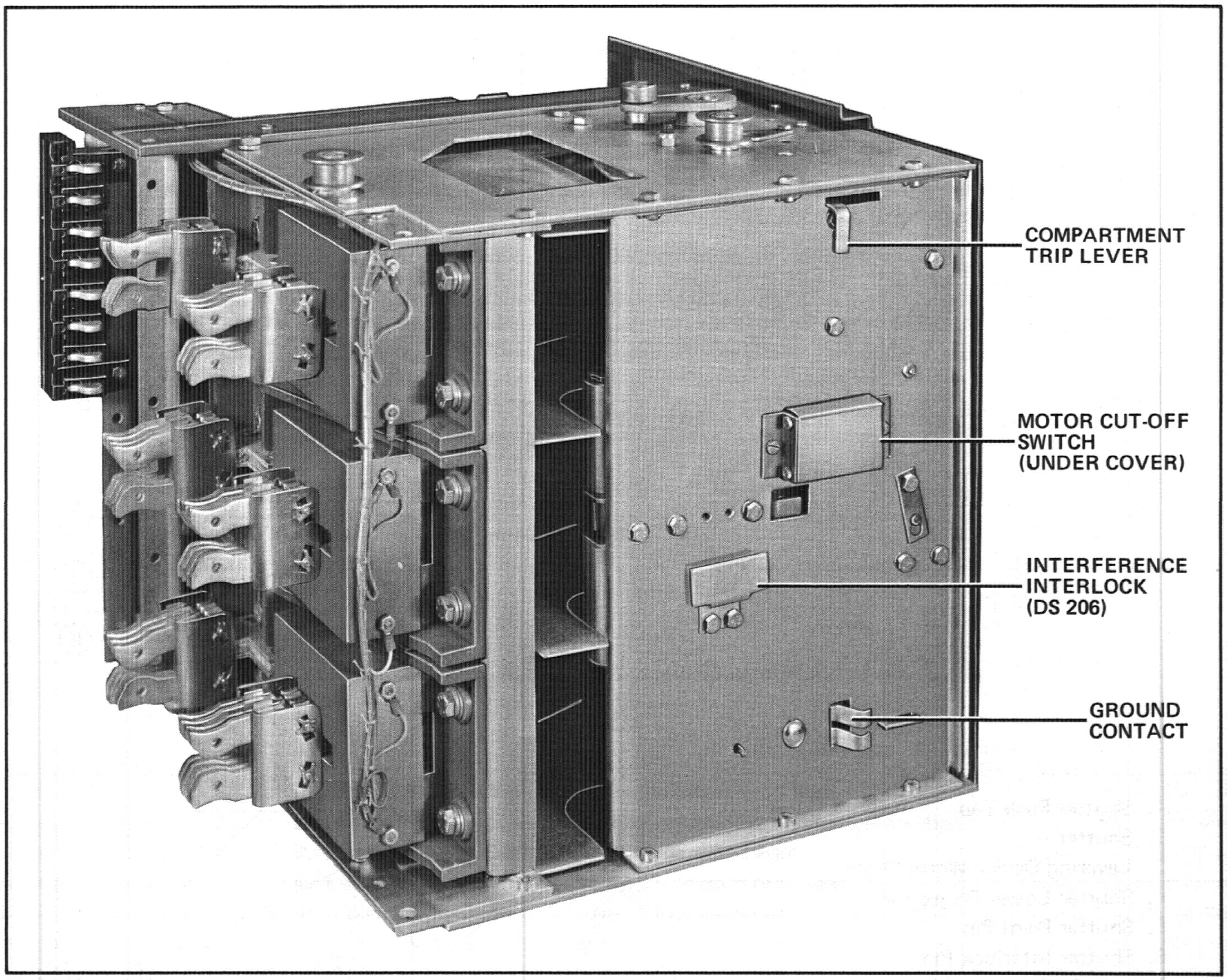
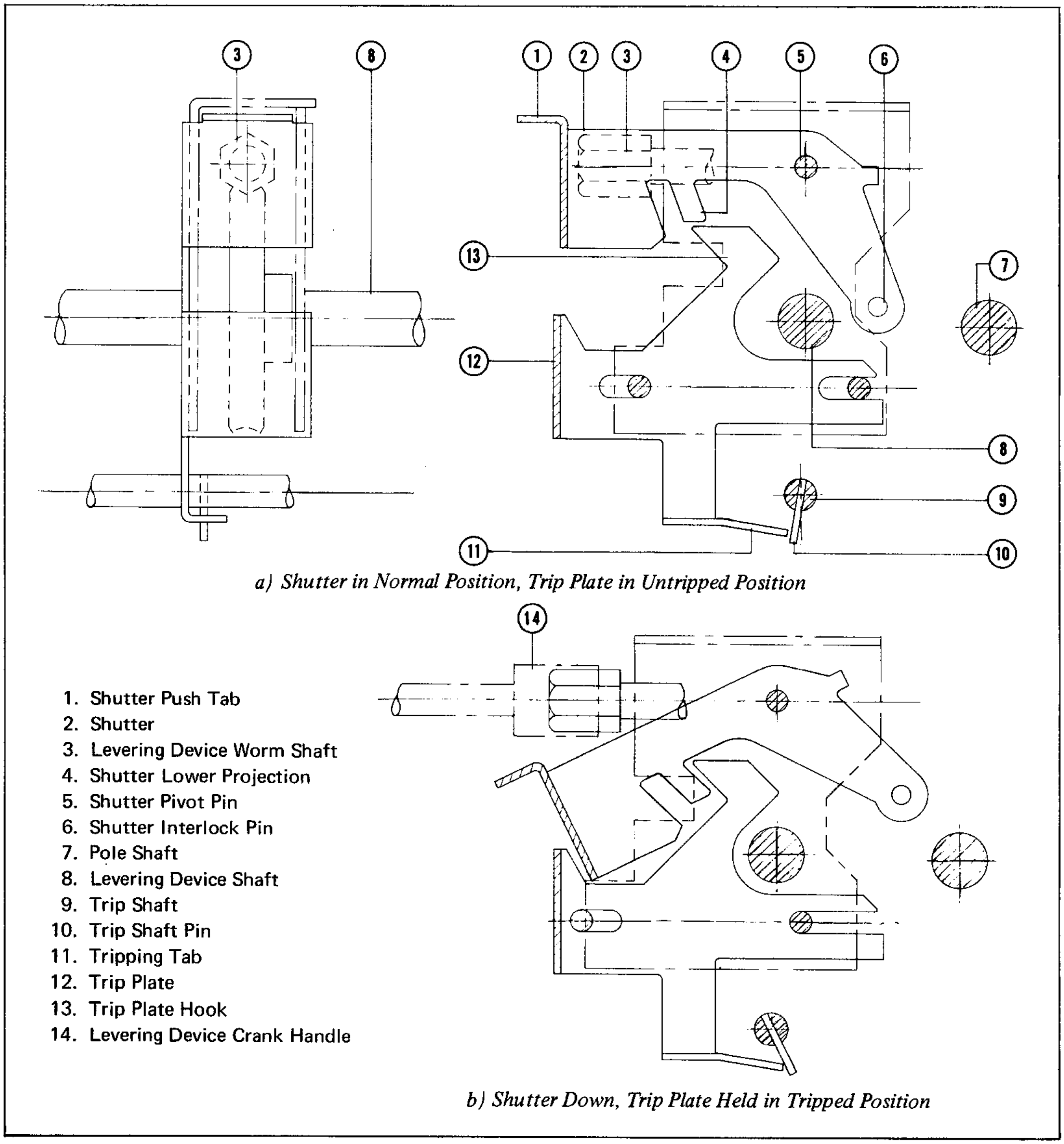


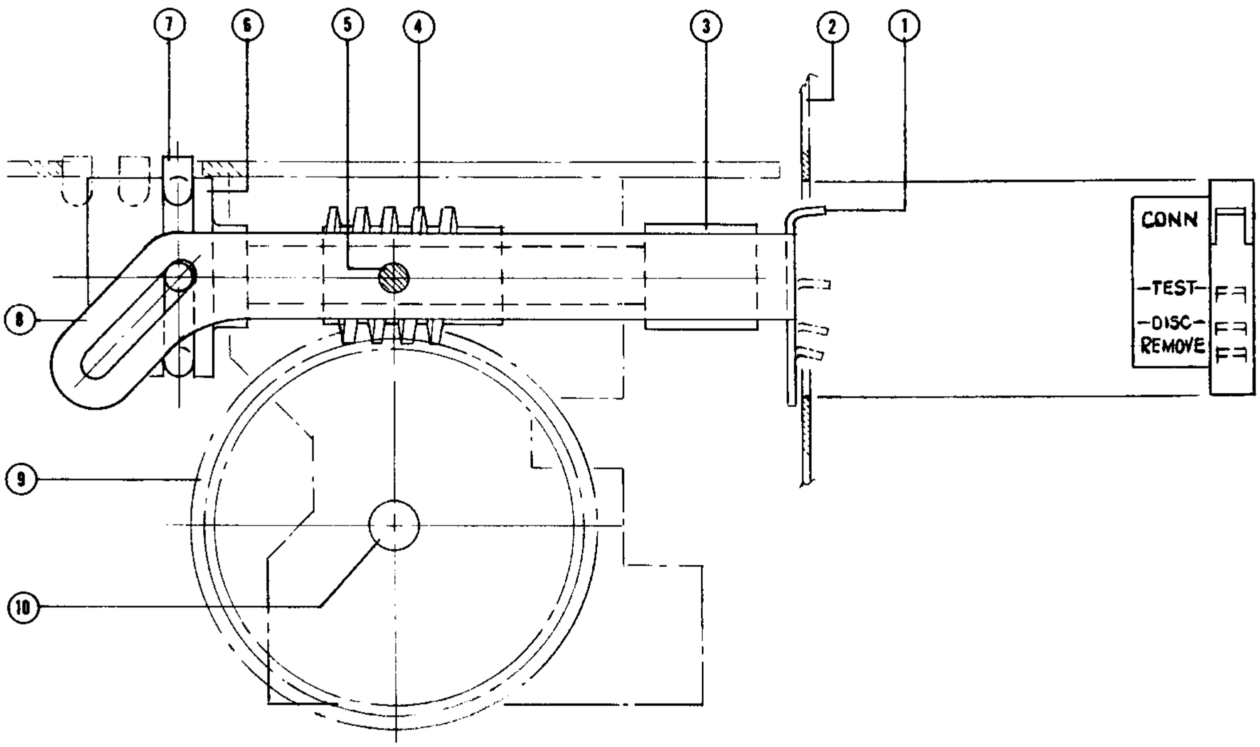
Fig. 27 *Bottom View of Breaker Unit Showing Interference Interlock, Motor Cut-off Switch and Other Details not Visible from Above*



a) Shutter in Normal Position, Trip Plate in Untripped Position

b) Shutter Down, Trip Plate Held in Tripped Position

Fig. 28 *Relation of Shutter, Trip Plate, and Trip Shaft*



1. Indicator Index Tab
2. Front Panel
3. Levering Worm Shaft
4. Levering Worm
5. Indicator Pivot Pin
6. Traveling Stop Nut
7. Traveling Nut Retaining Clamp
8. Indicator Lever
9. Levering Worm Gear
10. Levering Shaft

Fig. 29 *Drawout Unit Position Indicator*

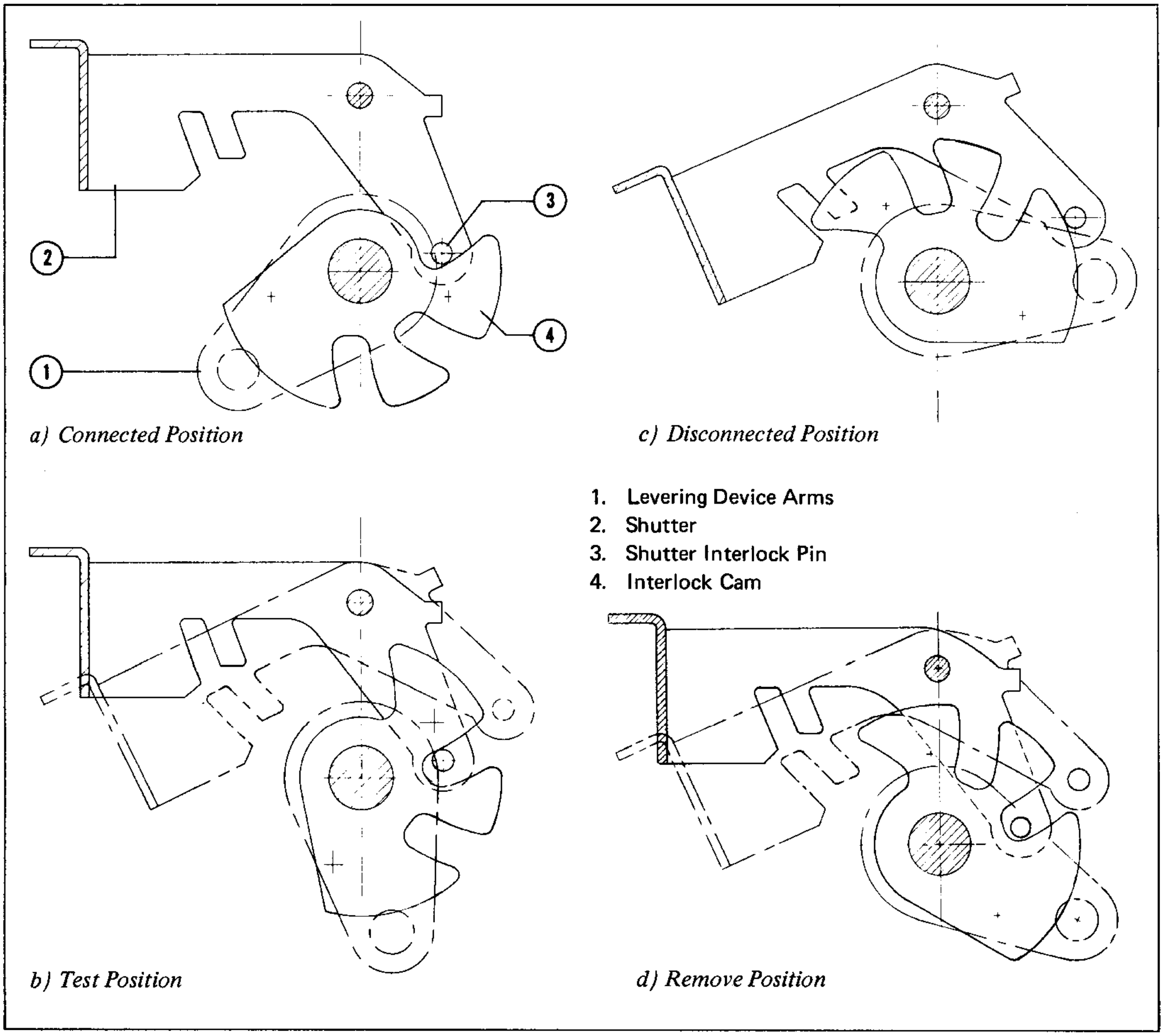
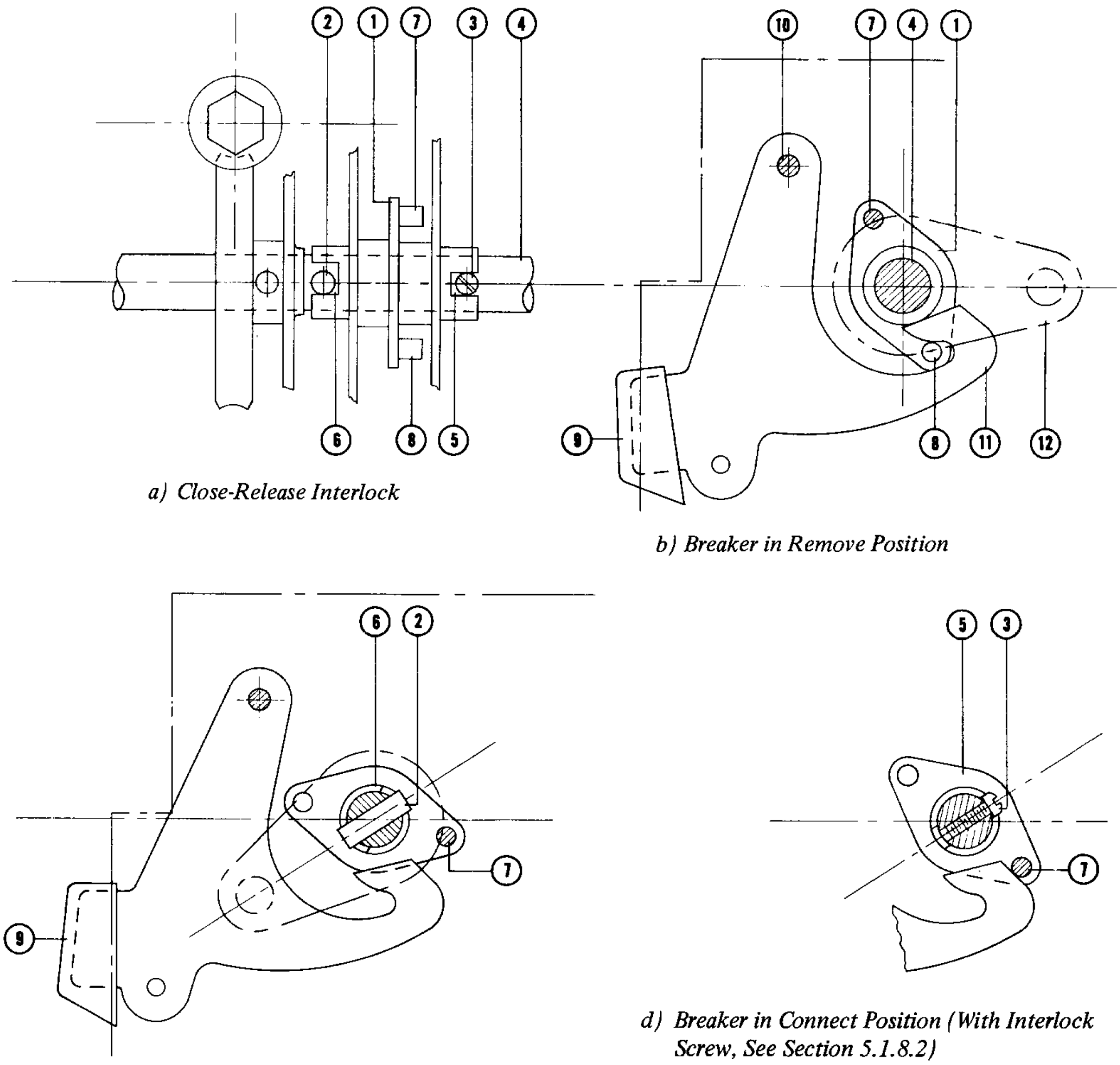


Fig. 30 *Relation of Shutter, Interlock Cam and Levering Device Arms*



a) *Close-Release Interlock*

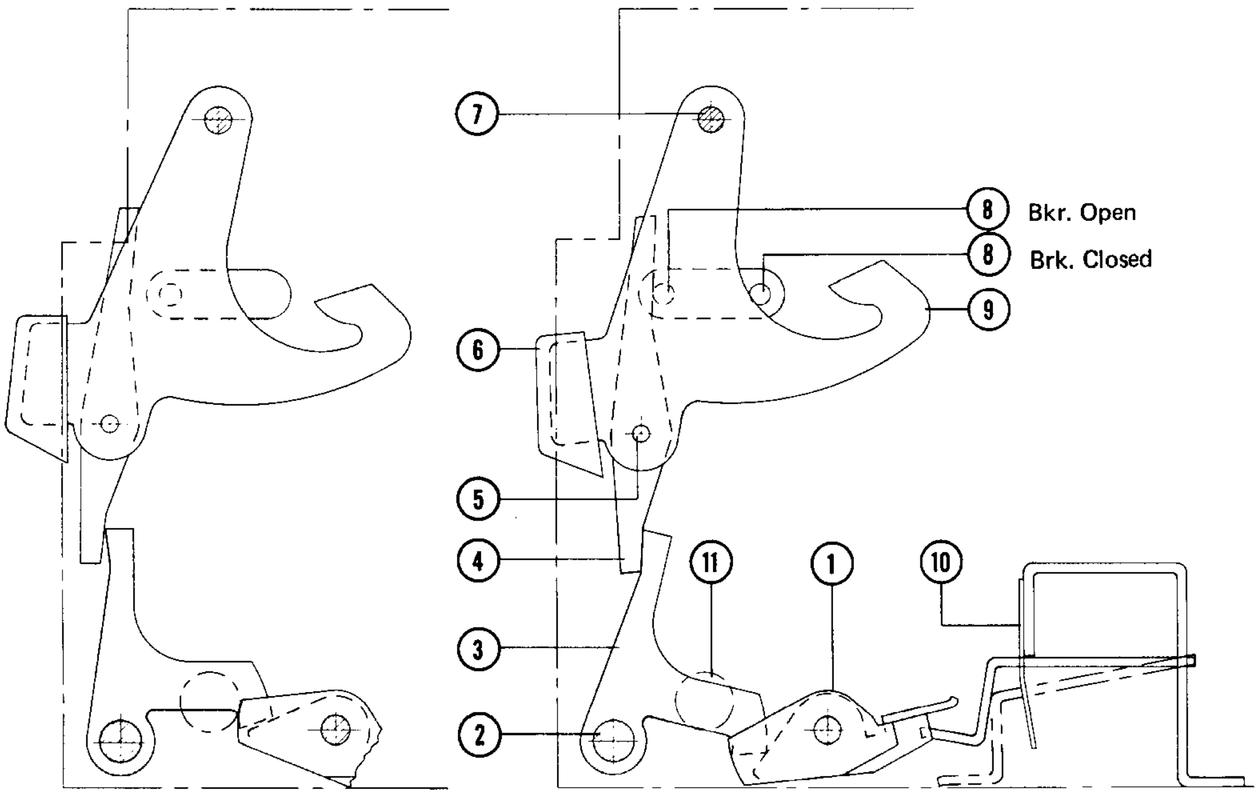
b) *Breaker in Remove Position*

c) *Breaker in Connect Position (Without Interlock Screw, See Section 5.1.8.2)*

d) *Breaker in Connect Position (With Interlock Screw, See Section 5.1.8.2)*

1. Interlock Plate Assembly
2. Drive Pin
3. Interlock Screw
4. Levering Device Shaft
5. Narrow Slot
6. Wide Slot
7. Pin "A"
8. Pin "B"
9. Close Bar
10. Close Bar Pivot
11. Close Bar Cam
12. Levering Device Arm

Fig. 31 *Close-Release Interlock to Discharge Springs on Levering Out of Compartment*



a) Close Bar (Normal Position)

b) Close Bar (Released Position)

1. Spring Release Latch
2. Bell Crank Pivot Pin
3. Bell Crank
4. Spring Release Latch Link
5. Spring Release Latch Link Pin
6. Close Bar
7. Close Bar Pivot Pin
8. Open-Close Indicator Pin
9. Close Bar Cam
10. Spring Release Device
11. Closing Cam Stop Roller

Fig. 32 *Close Interlock to Prevent Efforts to Close a Breaker that is Already Closed*

1. Padlock Plate Notch
2. Padlock Plate
3. Trip Plate
4. Front Panel
5. Shutter
6. Levering Device Worm Shaft
7. Projection on Shutter
8. Bent Tab on Padlock Plate
9. Projection on Trip Plate
10. Padlock Interlock Lever
11. Pin on Padlock Interlock Lever
12. Trip Shaft

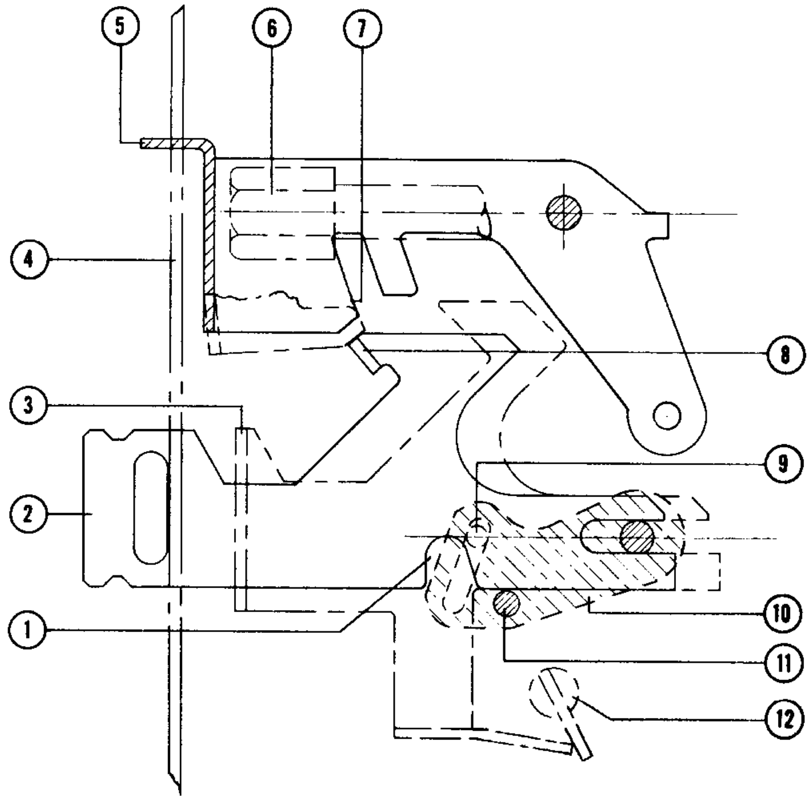
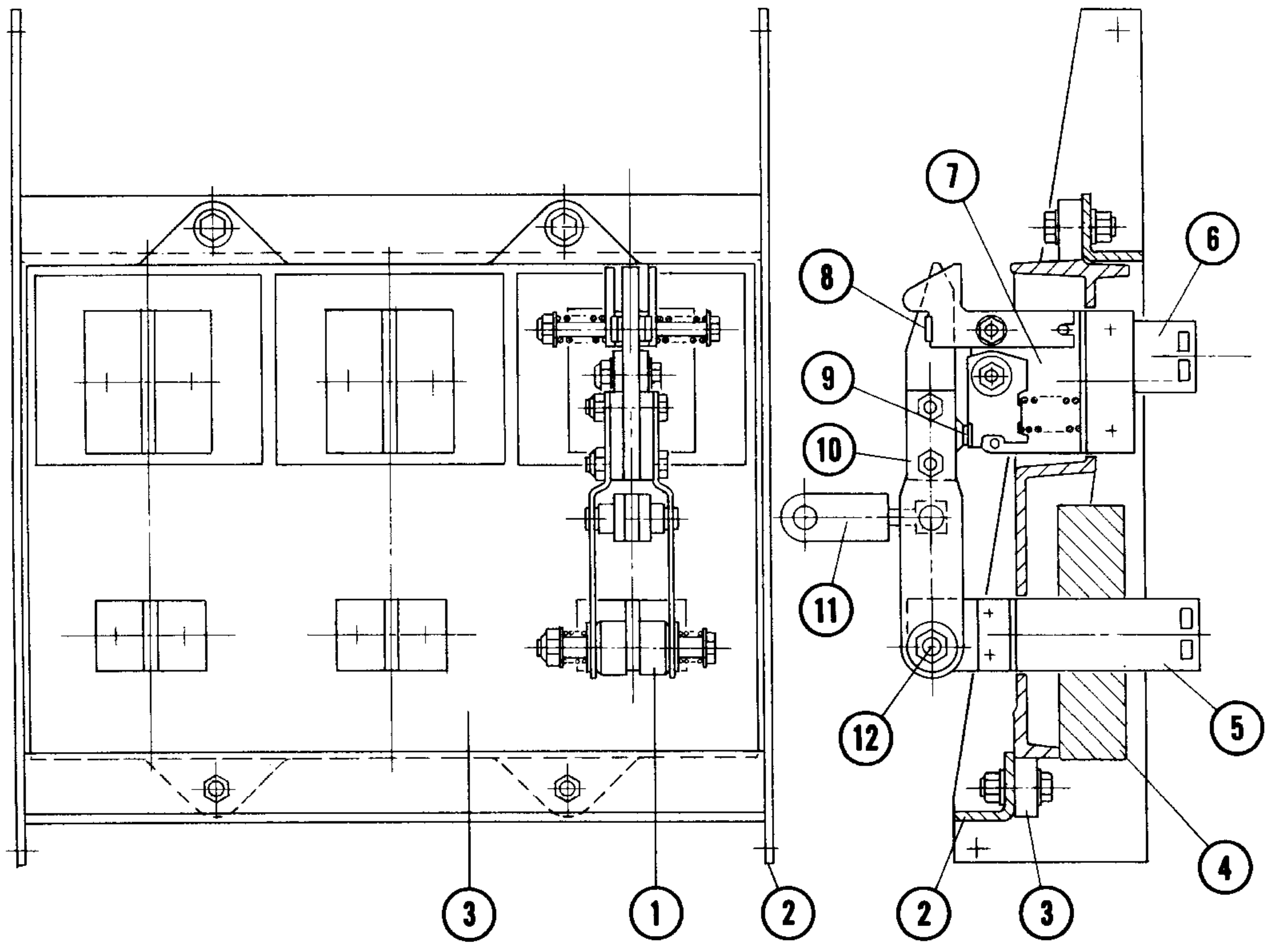
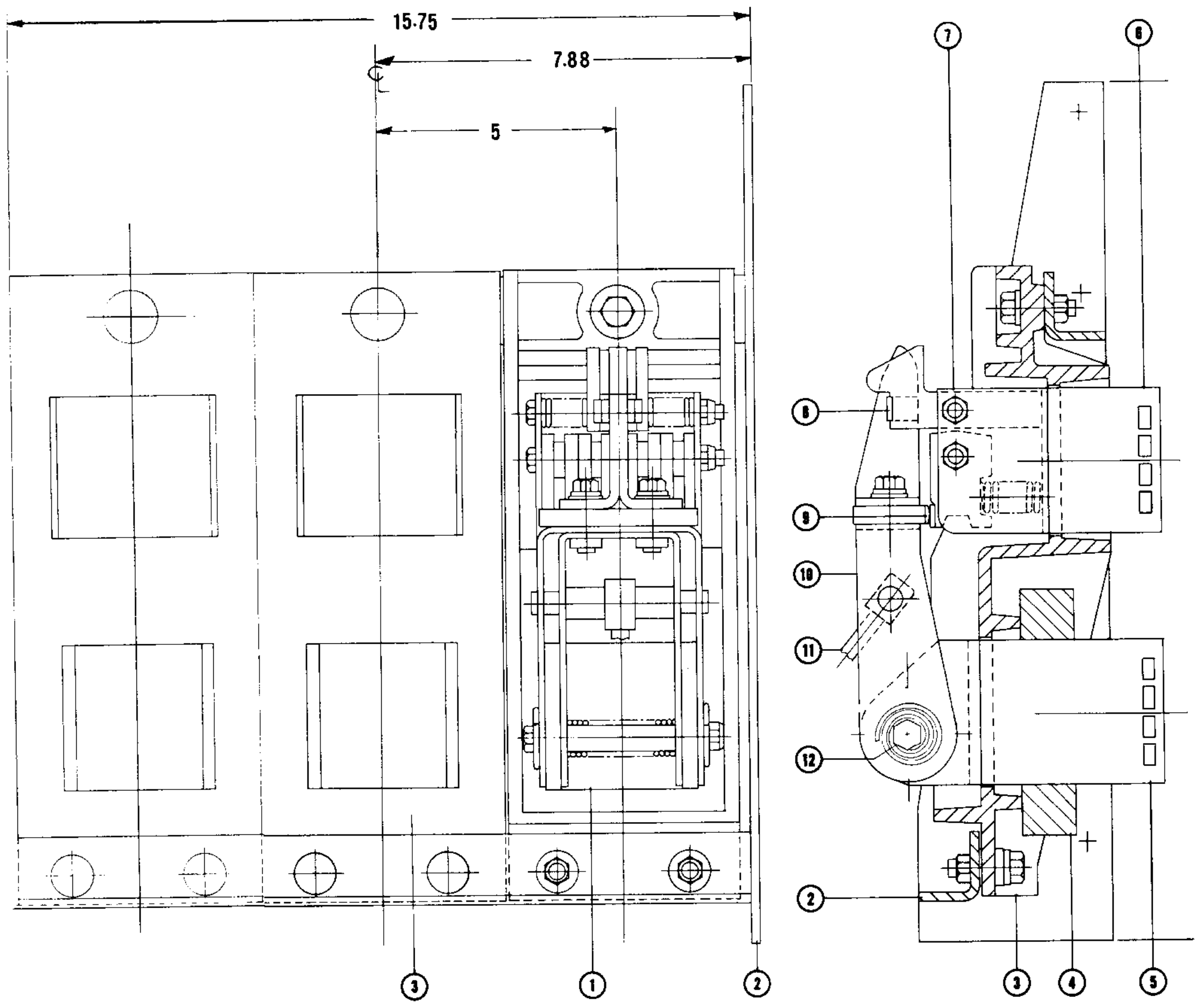


Fig. 33 *Padlock Device - Locked Trip Free and Shutter Raised*



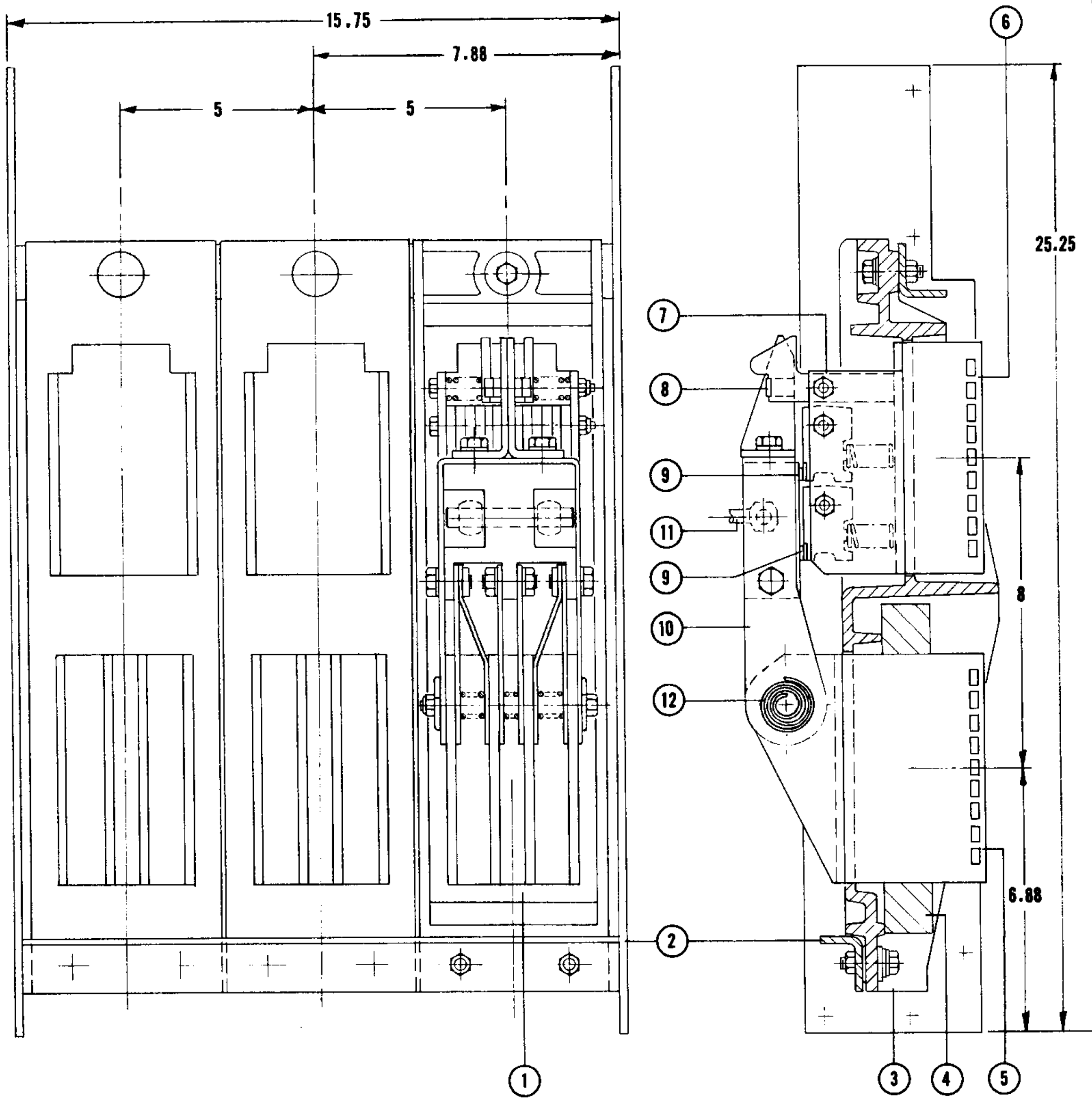
1. Pole Units - One Pole Only Shown
2. Rigid Welded Frame
3. Molded 3-Pole Base
4. Sensor
5. Lower Main Terminal
6. Upper Main Terminal
7. Stationary Contact Assembly
8. Arcing Contact
9. Main Contact
10. Moving Contact Assembly
11. Insulating Link Rod End
12. Moving Contact Pivot

Fig. 34 — *Three Pole Assembly of DS-206 Pole Units on Frame*



1. Individual Single Pole Unit
2. Rigid Welded Frame
3. Molded Pole Base
4. Sensor
5. Lower Main Terminal
6. Upper Main Terminal
7. Stationary Contact Assy.
8. Arcing Contact
9. Main Contact
10. Moving Contact Assy.
11. Insulating Link Rod End
12. Moving Contact Pivot

Fig. 35 *Three-Pole Assembly of DS-416 Pole Unit on Frame*



1. Single Pole Unit
2. Rigid Welded Frame
3. Molded Pole Base
4. Sensor
5. Lower Main Terminal
6. Upper Main Terminal
7. Stationary Contact Assembly
8. Arcing Contact
9. Main Contacts
10. Moving Contact Assembly
11. Insulating Link Rod Ends
12. Moving Contact Pivot

Fig. 36 *Three-Pole Assembly of DS-532 Pole Units on Frame*

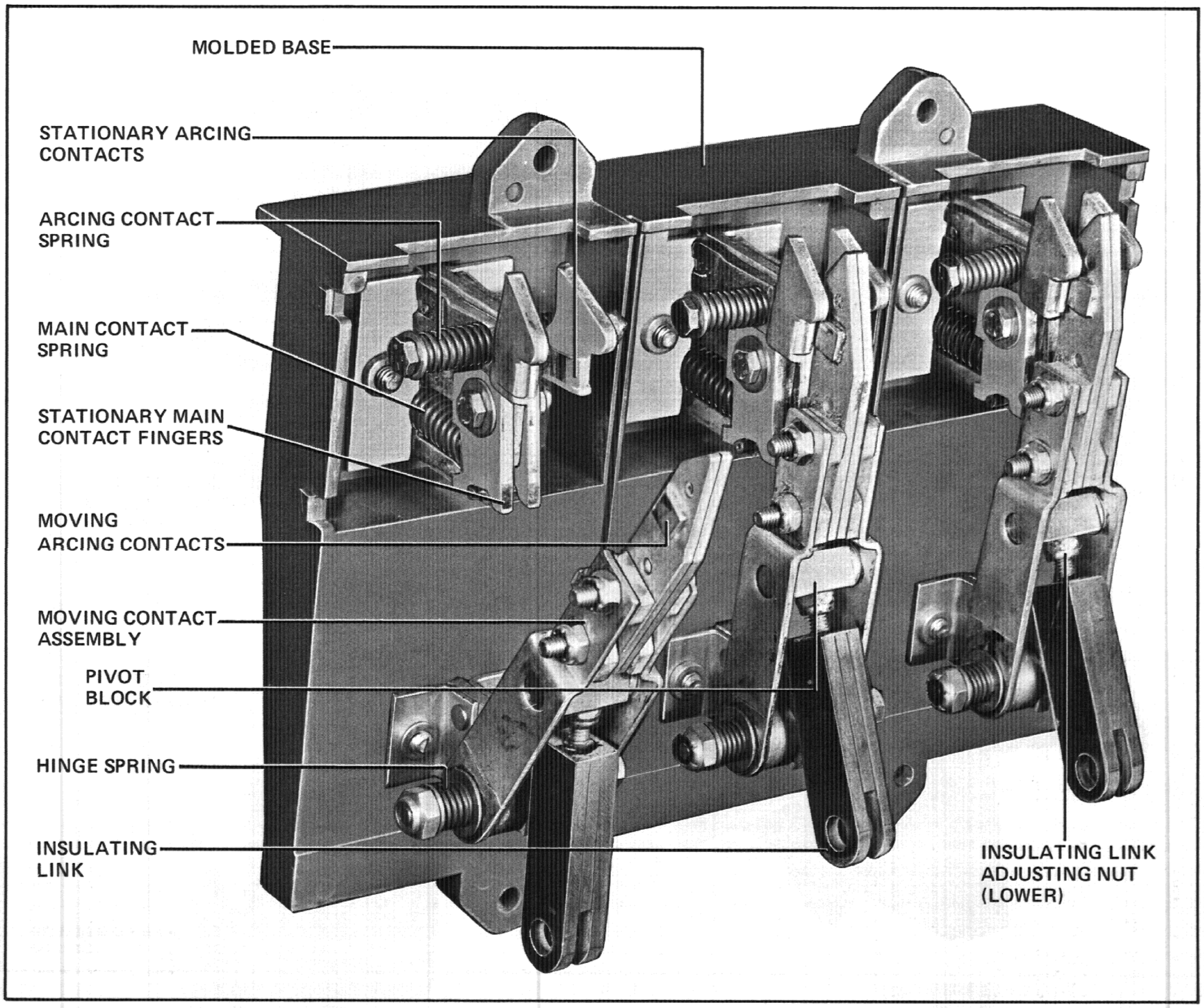


Fig. 37 *Type DS-206 Pole Unit Assembly - Front View*

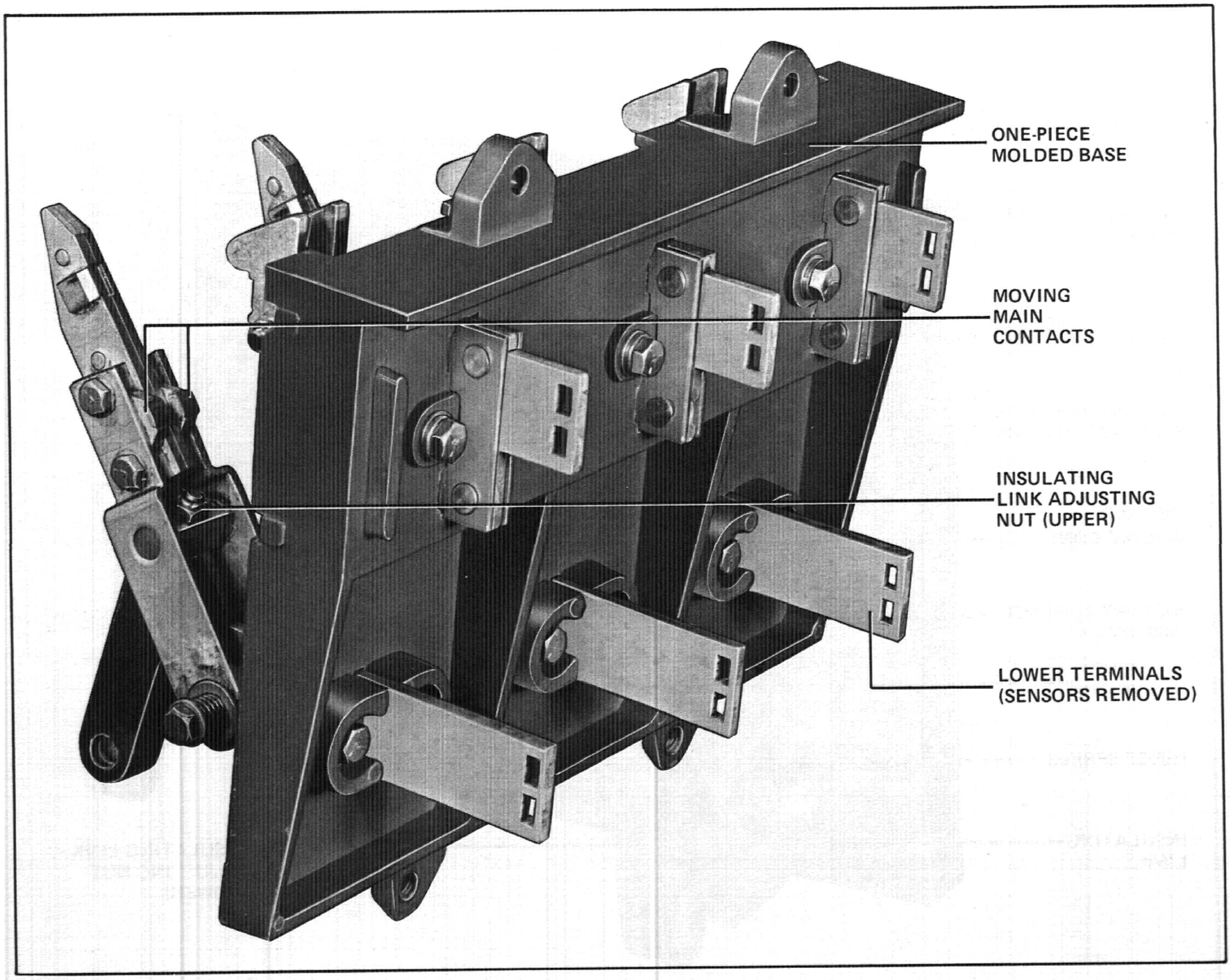


Fig. 38 *Type DS-206 Pole Unit Assembly - Rear View*

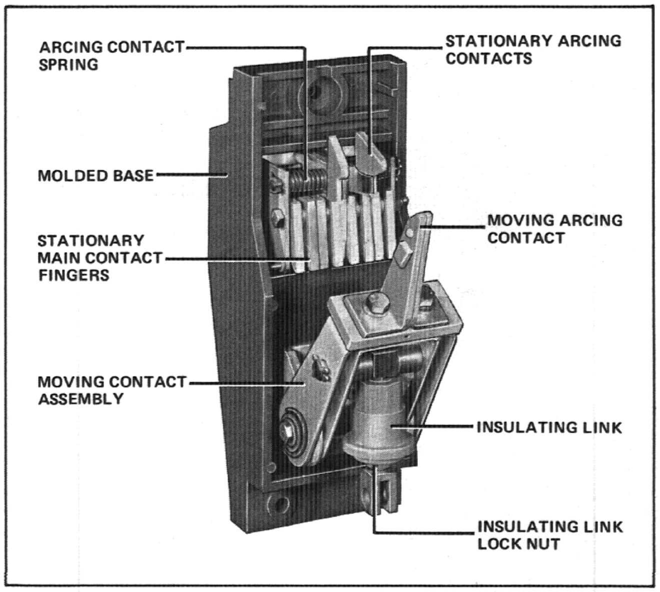


Fig. 39 *Type DS-416 Pole Unit Assembly - Front View*

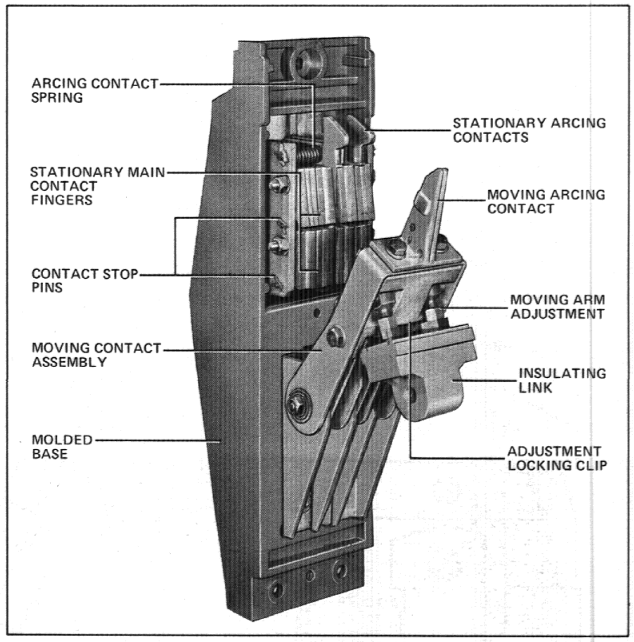


Fig. 41 *Type DS-532 Pole Unit Assembly - Front View*

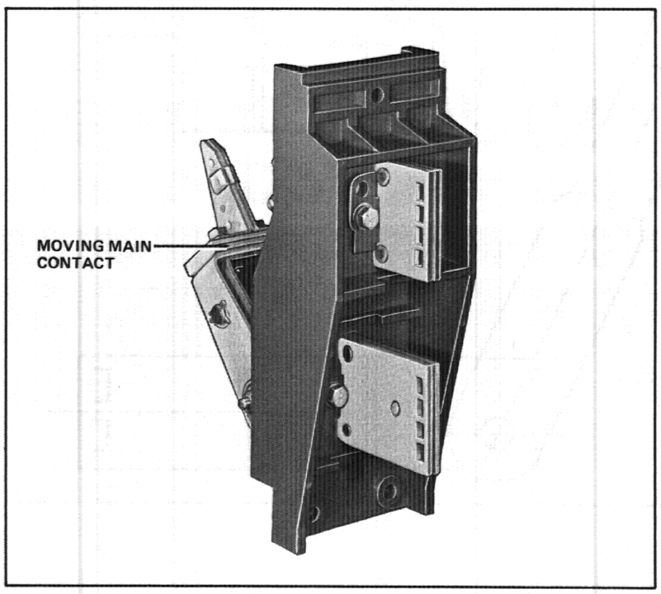


Fig. 40 *Type DS-416 Pole Unit Assembly - Rear View*

Fig. 42 *Type DS-532 Pole Unit Assembly - Rear View*

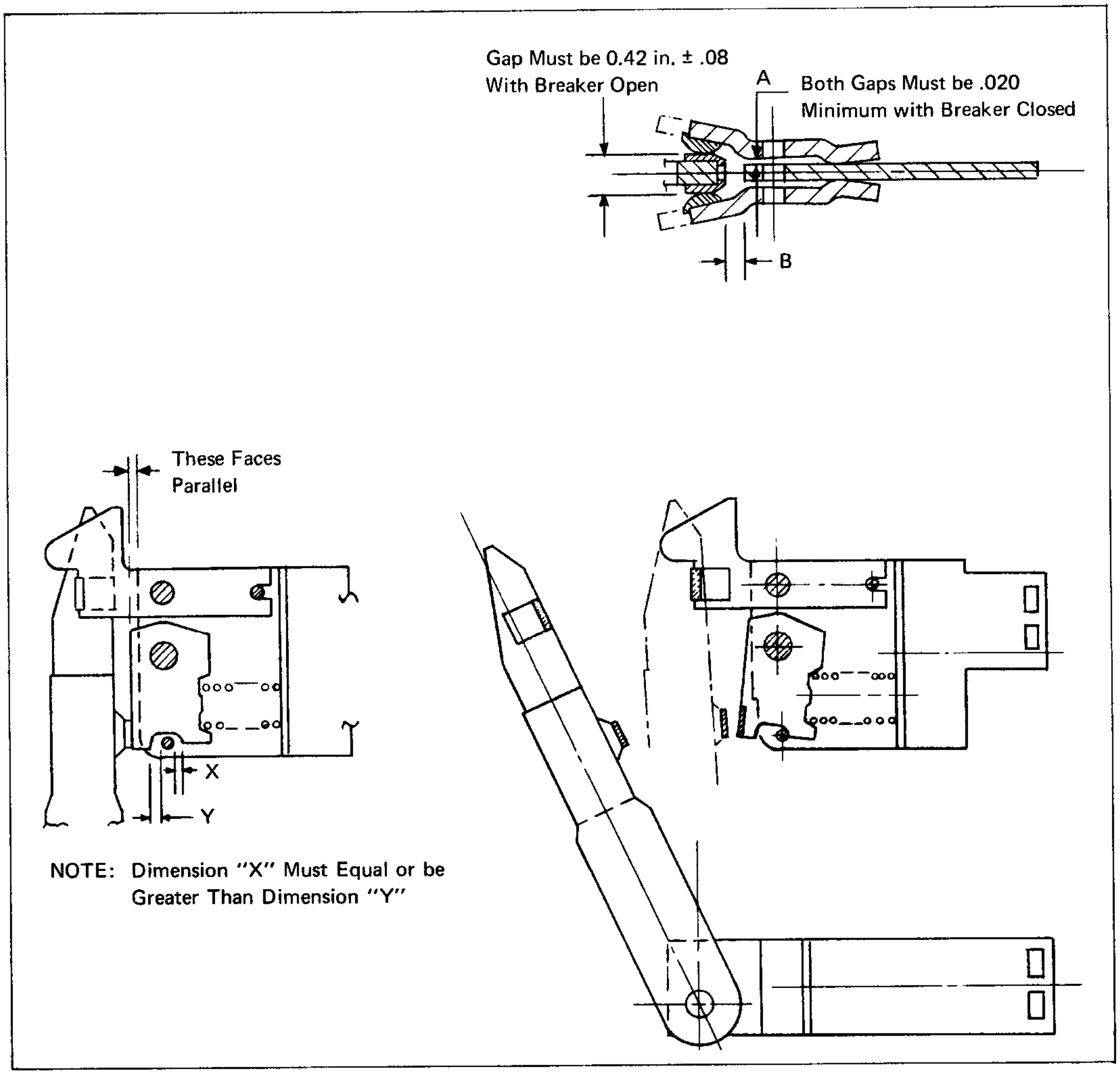


Fig. 43 – *Contacts and their Adjustment, DS-206 Breaker*

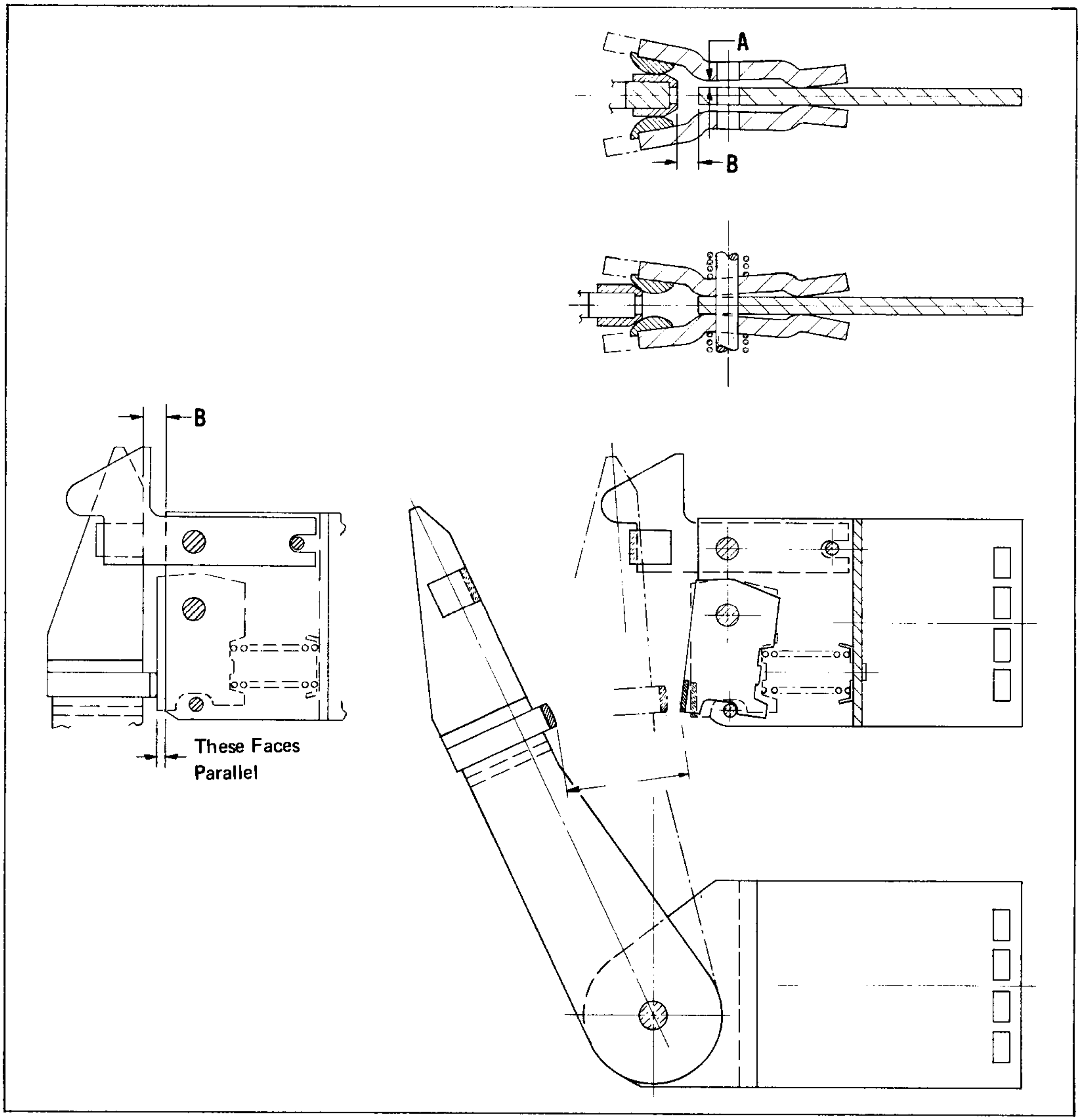


Fig. 44 *Contacts and their Adjustment, DS-416 Breaker*

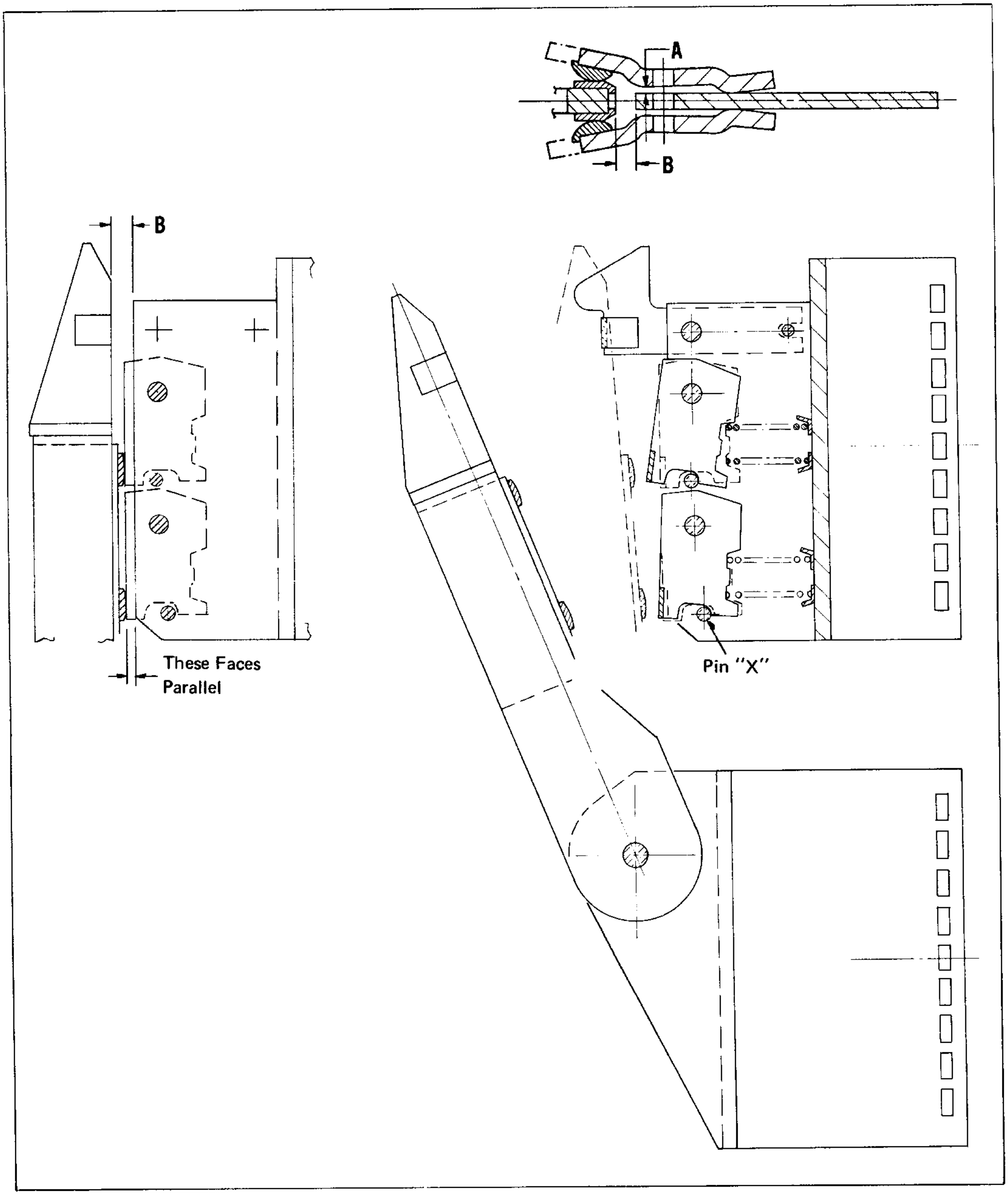


Fig. 45 *Contacts and their Adjustment, DS-532 Breaker*

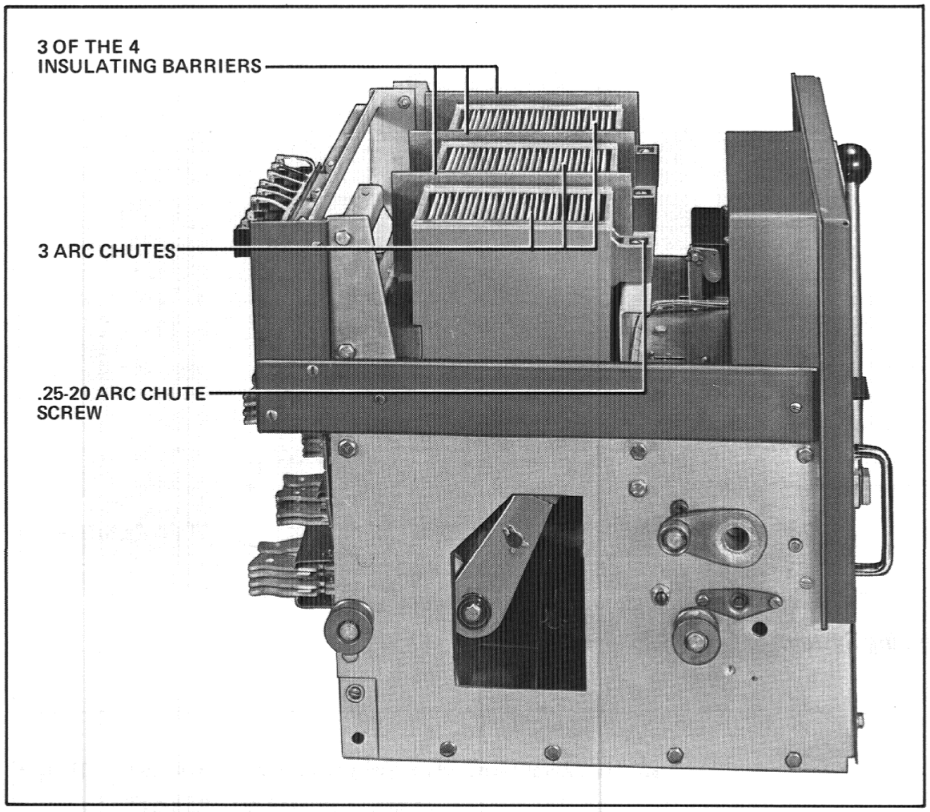


Fig. 46 *Breaker with Barrier Removed to Show Mounting of Arc Chutes*

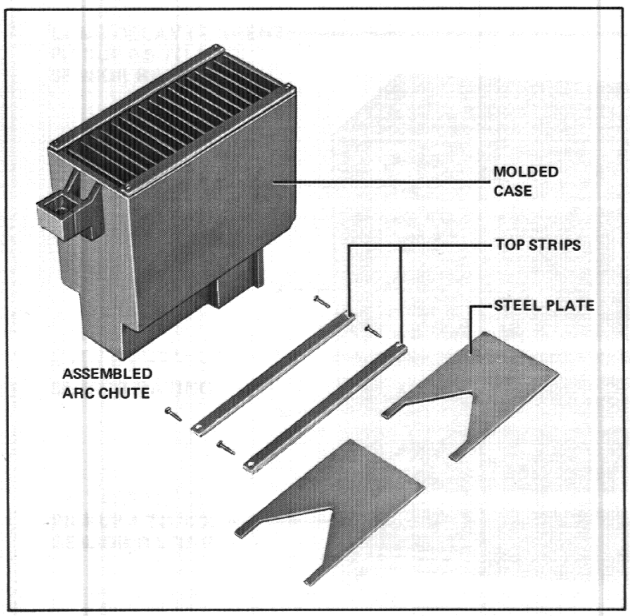


Fig. 47 *DS-206 Arc Chute with Details*

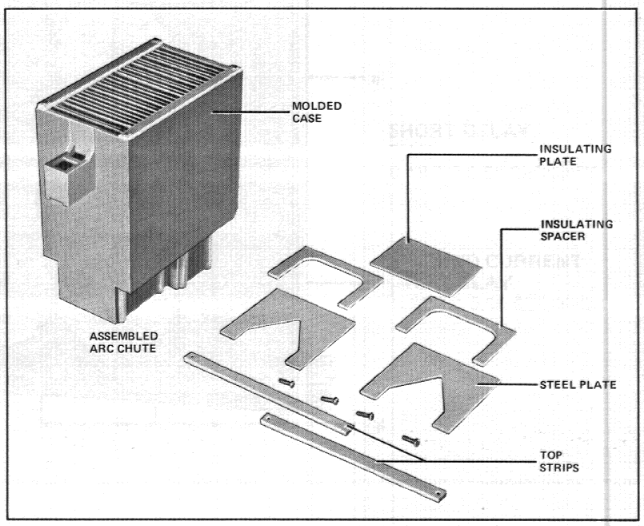


Fig. 48 *DS-416 and DS-532 Arc Chute with Details*

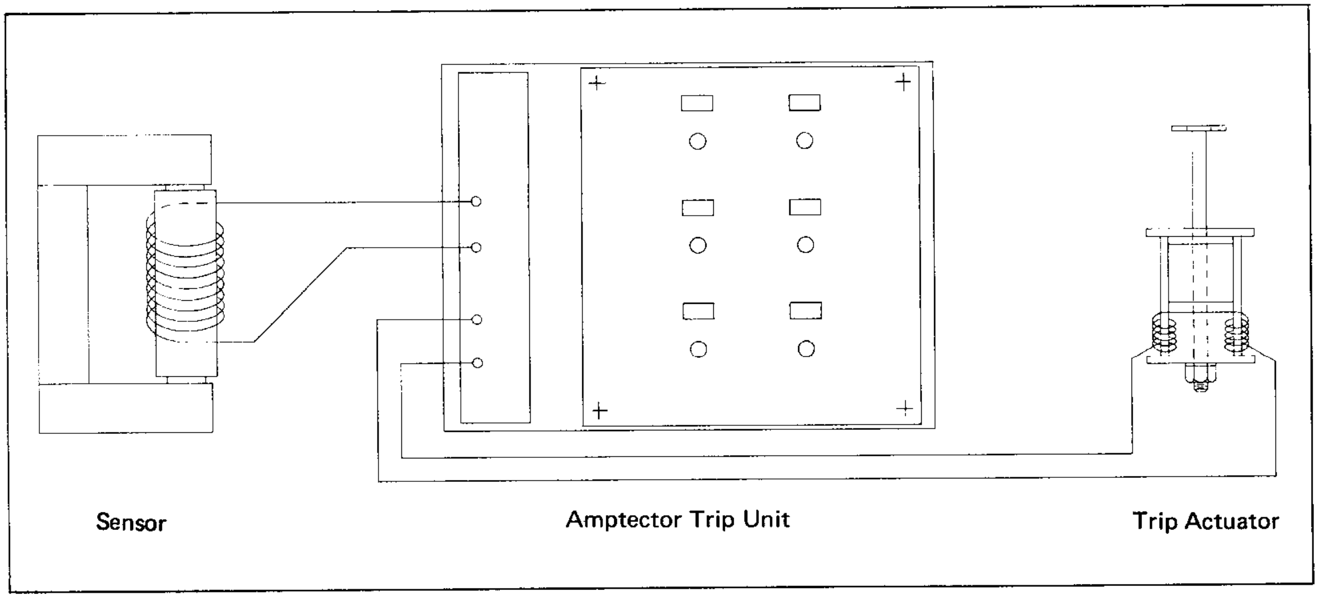


Fig. 49 *Schematic Illustration of Tripping System*

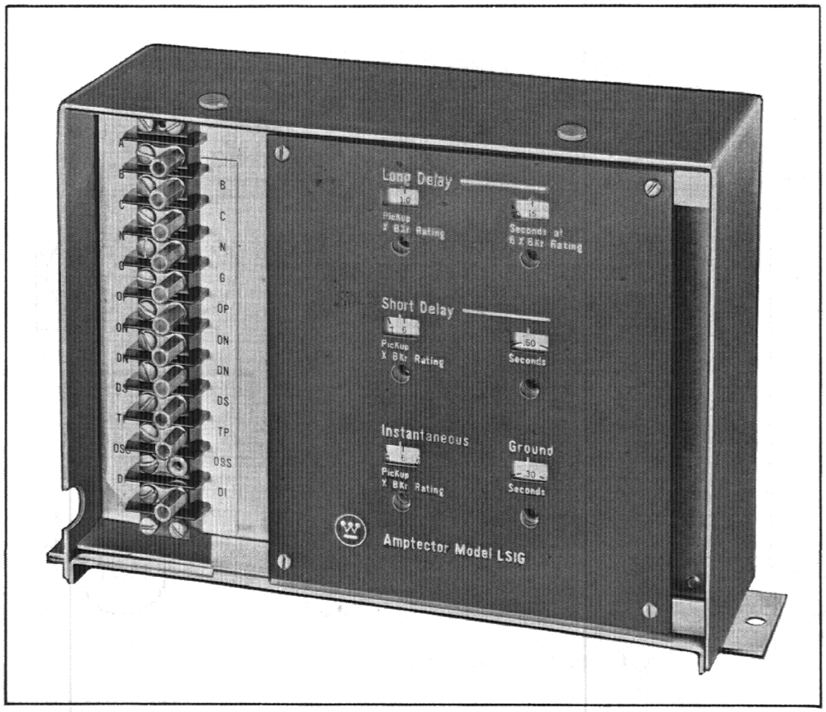
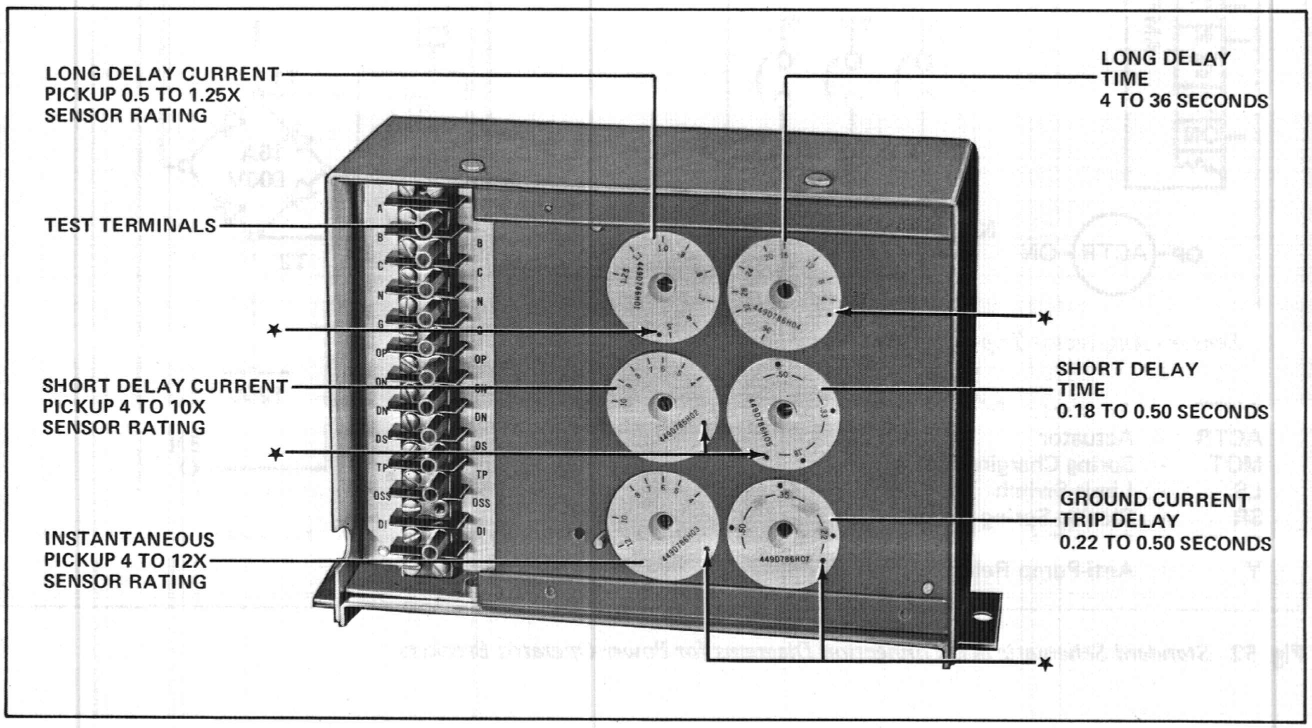
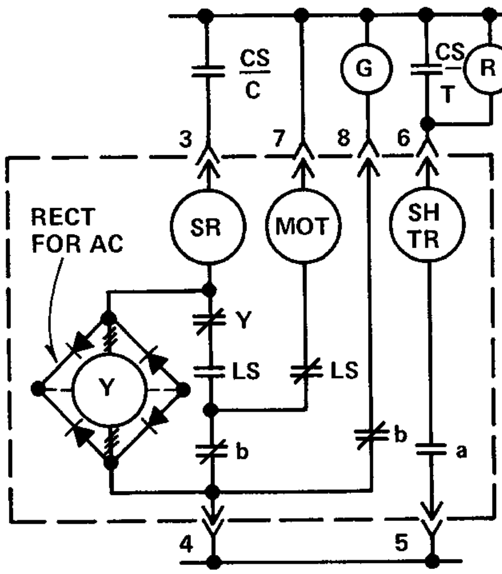


Fig. 50 *The Amptector Trip Unit is the Intelligence of the Type DS Air Circuit Breaker*

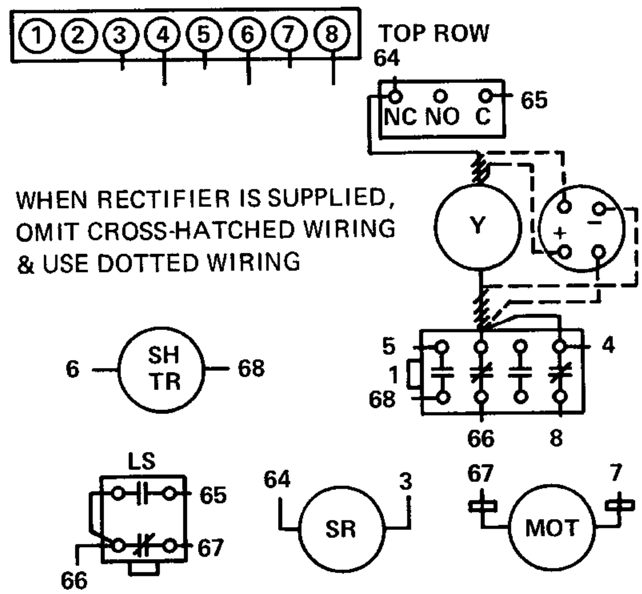


★ See Section 8.1 of Text for Explanation

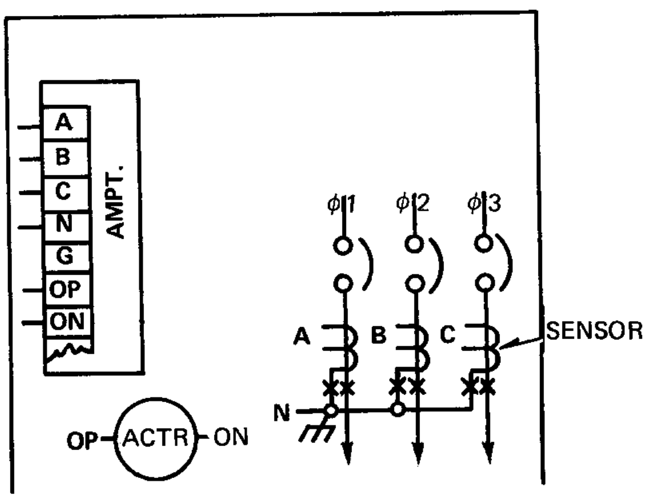
Fig. 51 *Close-up of Amptector Trip Unit with Front Cover Removed Showing all Markings on Dials*



a. Schematic

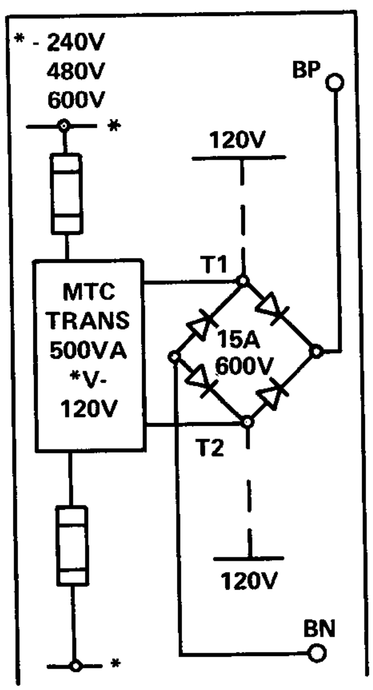


c. Connection Diagram



b. Sensor - Amptector Trip-Actuator Connections

AMPT - Amptector Trip
ACTR - Actuator
MOT - Spring Charging Motor
LS - Limit Switch
SR - Closing Spring Release
SH TR - Shunt Trip
Y - Anti-Pump Relay



d. Optional AC Power supply. Located in stationary unit; one set per assembly.

Fig. 52 *Standard Schematic and Connection Diagrams for Power-Operated Breakers*

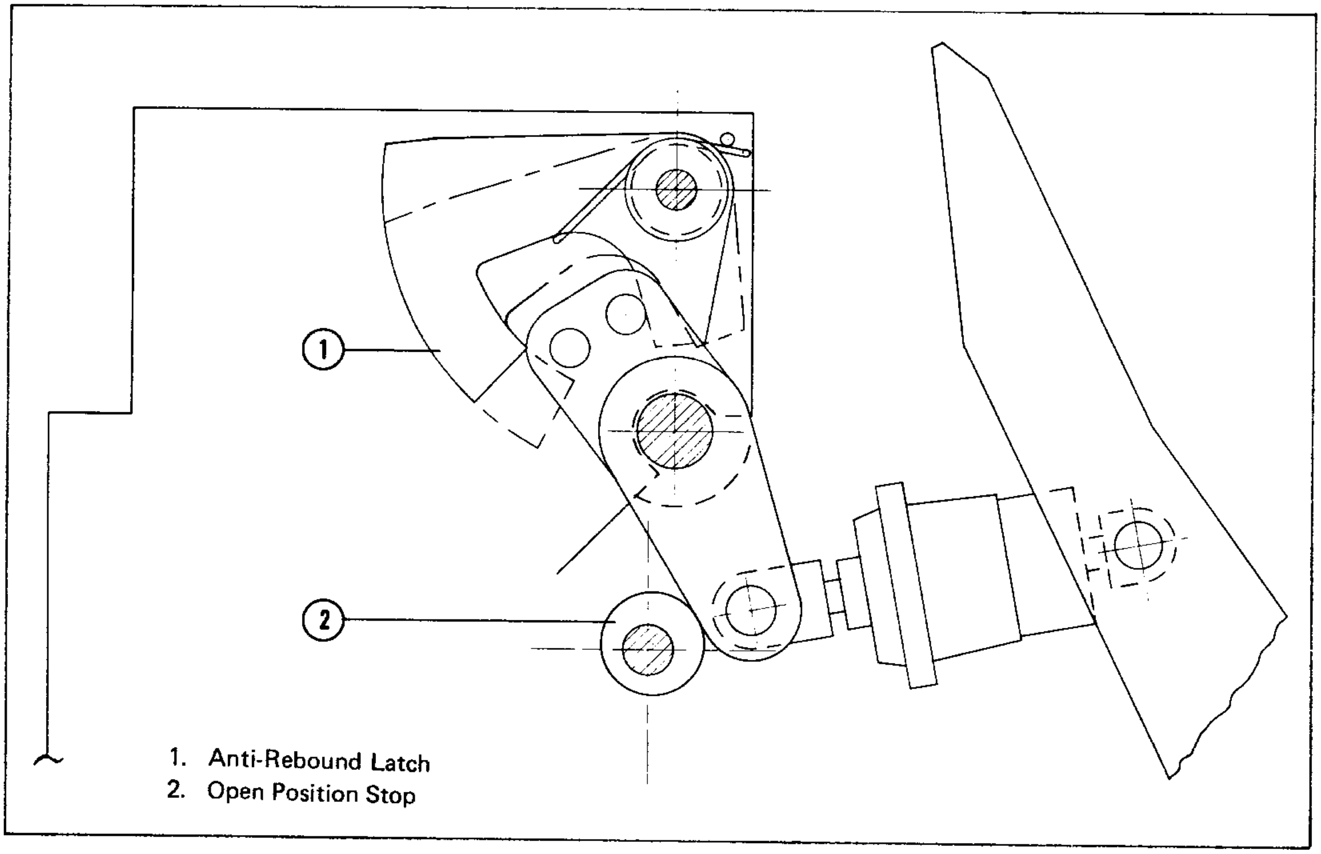


Fig. 53 *Open Position Stop and Anti-Rebound Latch*

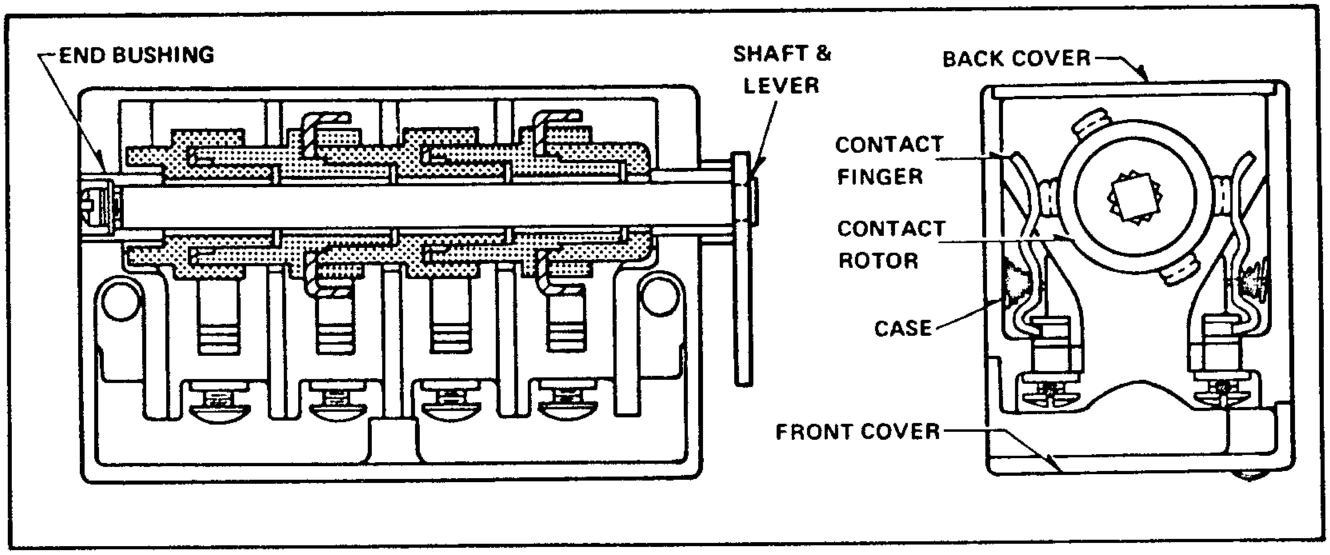
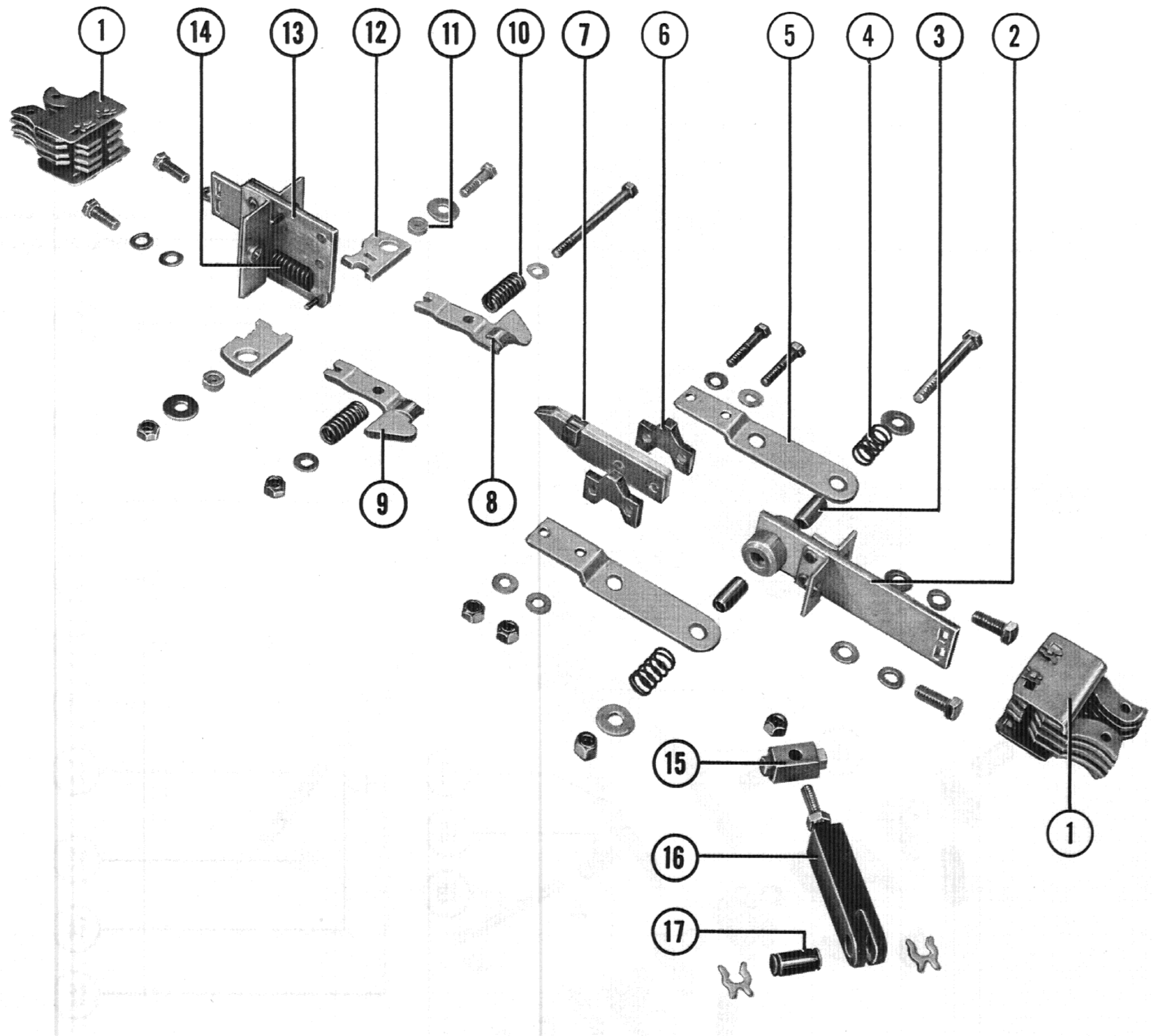


Fig. 54 *Auxiliary Switch Construction Details*



1. Main Disconnecting Contact Cluster
2. Hinge Contact
3. Hinge Bearing Tube
4. Hinge Spring
5. Moving Arm
6. Moving Main Contact
7. Moving Arcing Contact
8. Stationary Arcing Contact - Right Hand
9. Stationary Arcing Contact - Left Hand
10. Stationary Arcing Contact Spring
11. Contact Spacer
12. Stationary Main Contact Finger
13. Stationary Contact Assembly
14. Main Contact Spring
15. Link Pivot Block
16. Insulating Link
17. Pole Lever Pin

Fig. 55 *Moving and Stationary Contact Details DS-206*

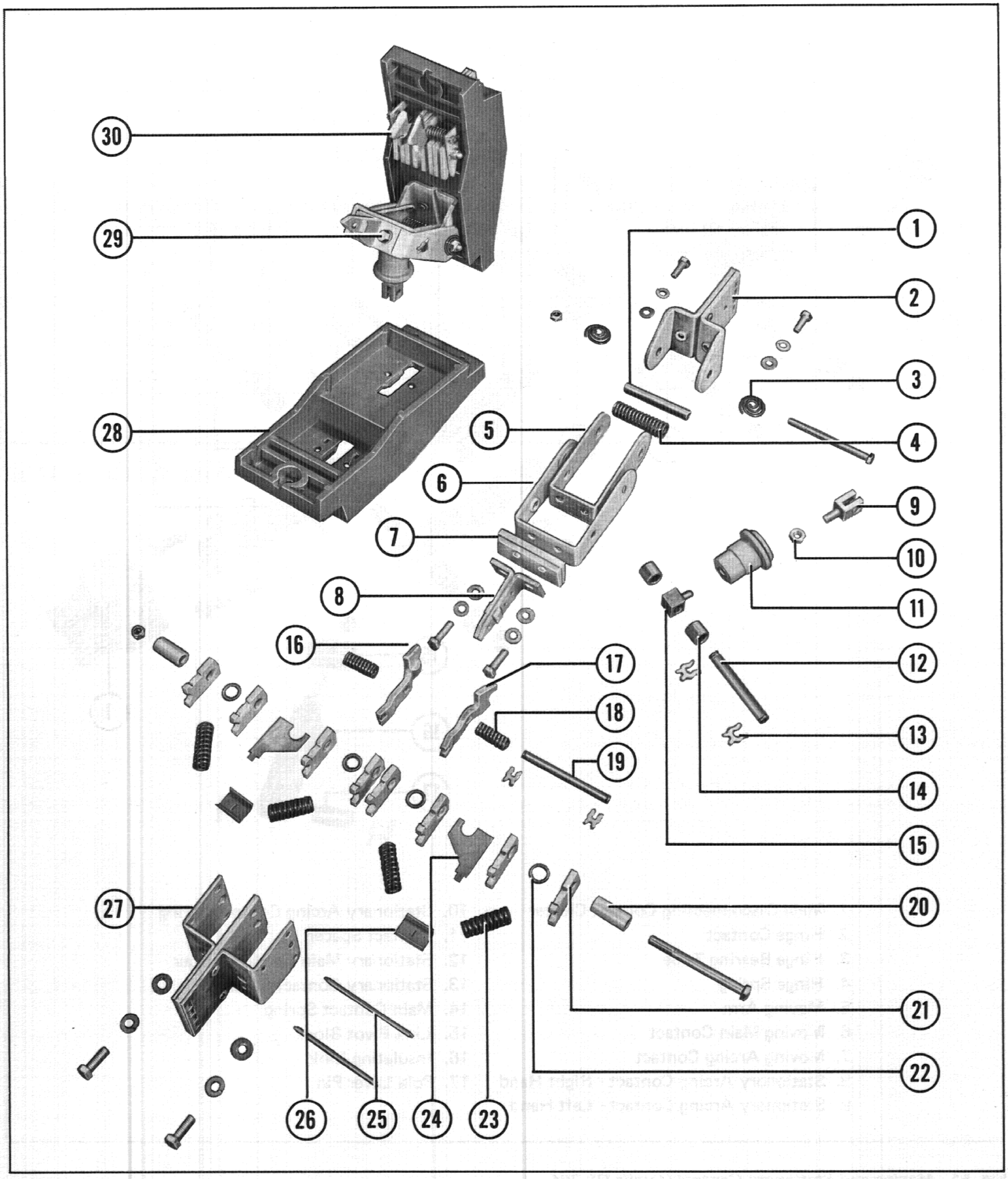


Fig. 56 *Moving and Stationary Contact Details DS-416 (See Next Page for Legend)*

Legend for Figure 56

1. Hinge Bearing Tube
2. Hinge Assembly
3. Spring Washer
4. Hinge Spring
5. Moving Arm - Inner
6. Moving Arm - Outer
7. Moving Main Contact
8. Moving Arcing Contact
9. Clevis
10. Insulating Link Lock Nut
11. Insulating Link
12. Operating Link Upper Pin
13. Retainer
14. Spacer
15. Rod End
16. Stationary Arcing Contact - Right Hand
17. Stationary Arcing Contact - Left Hand
18. Stationary Arcing Contact Spring
19. Arcing Contact Retaining Pin
20. Bearing Tube
21. Main Contact Fingers
22. Contact Spacer
23. Contact Spring
24. Spring Guide
25. Pin
26. Spring Seat
27. Stationary Contact Cage
28. Base Mold
29. Moving Contact Assembly
30. Stationary Contact Assembly

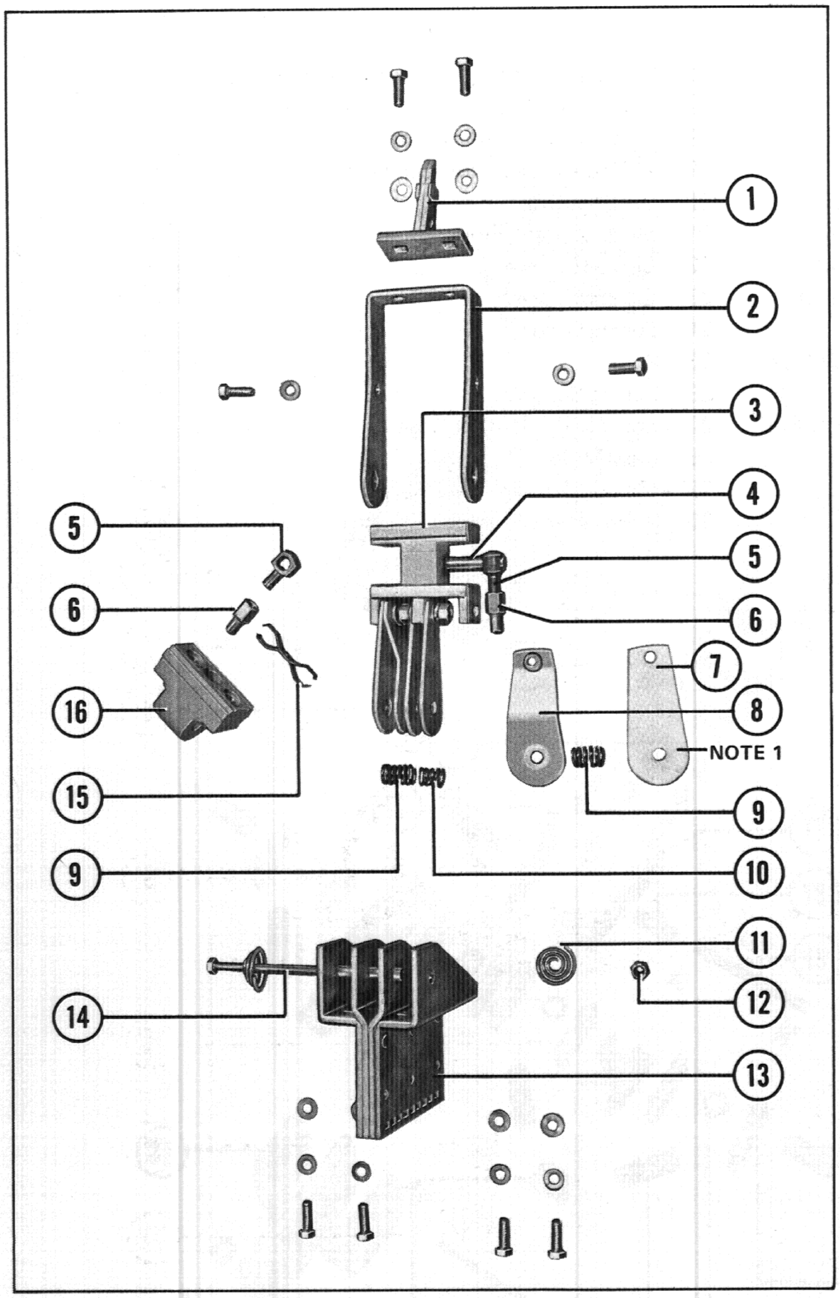
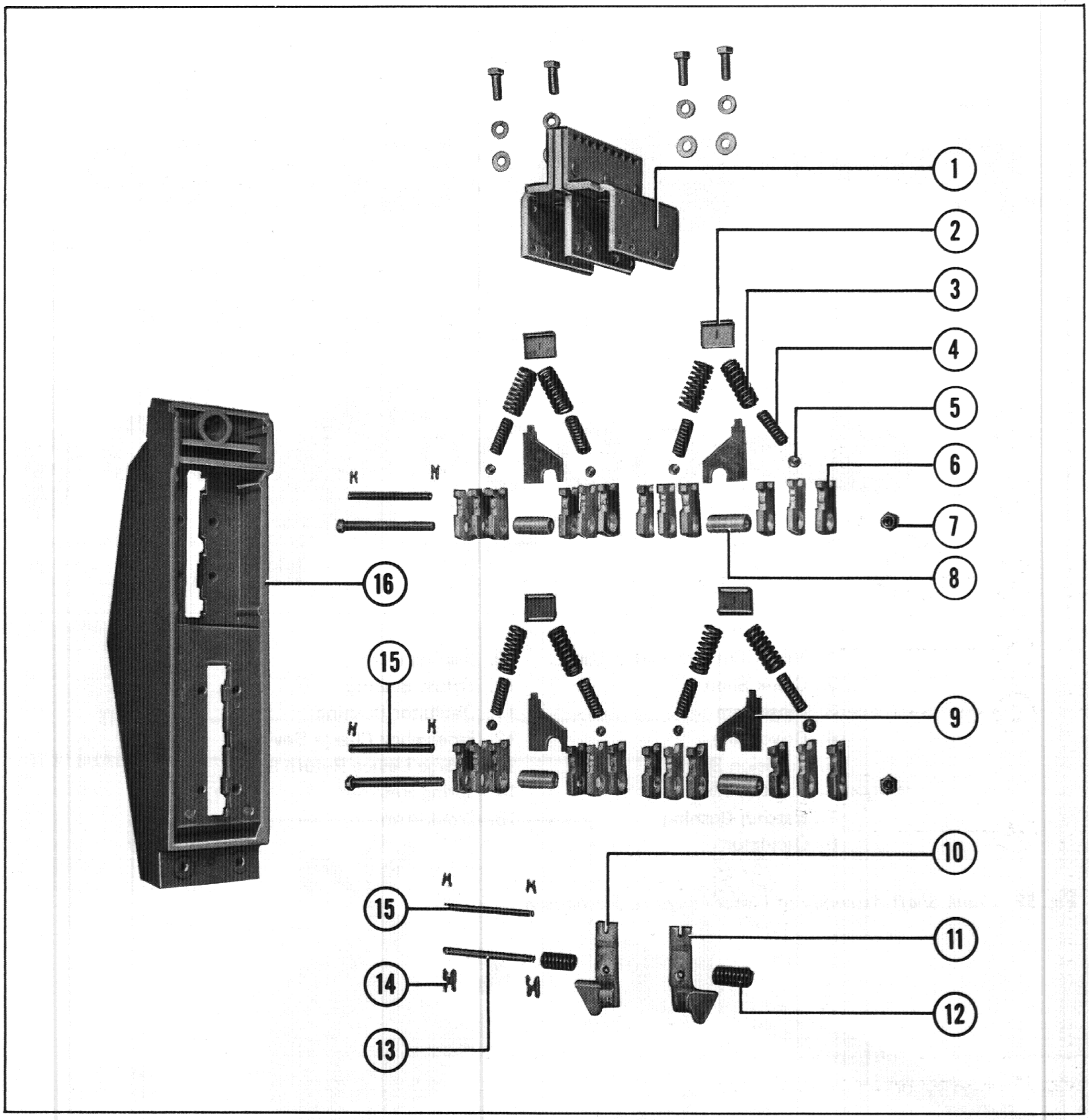


Fig. 57 *Moving Contact Details DS-532*

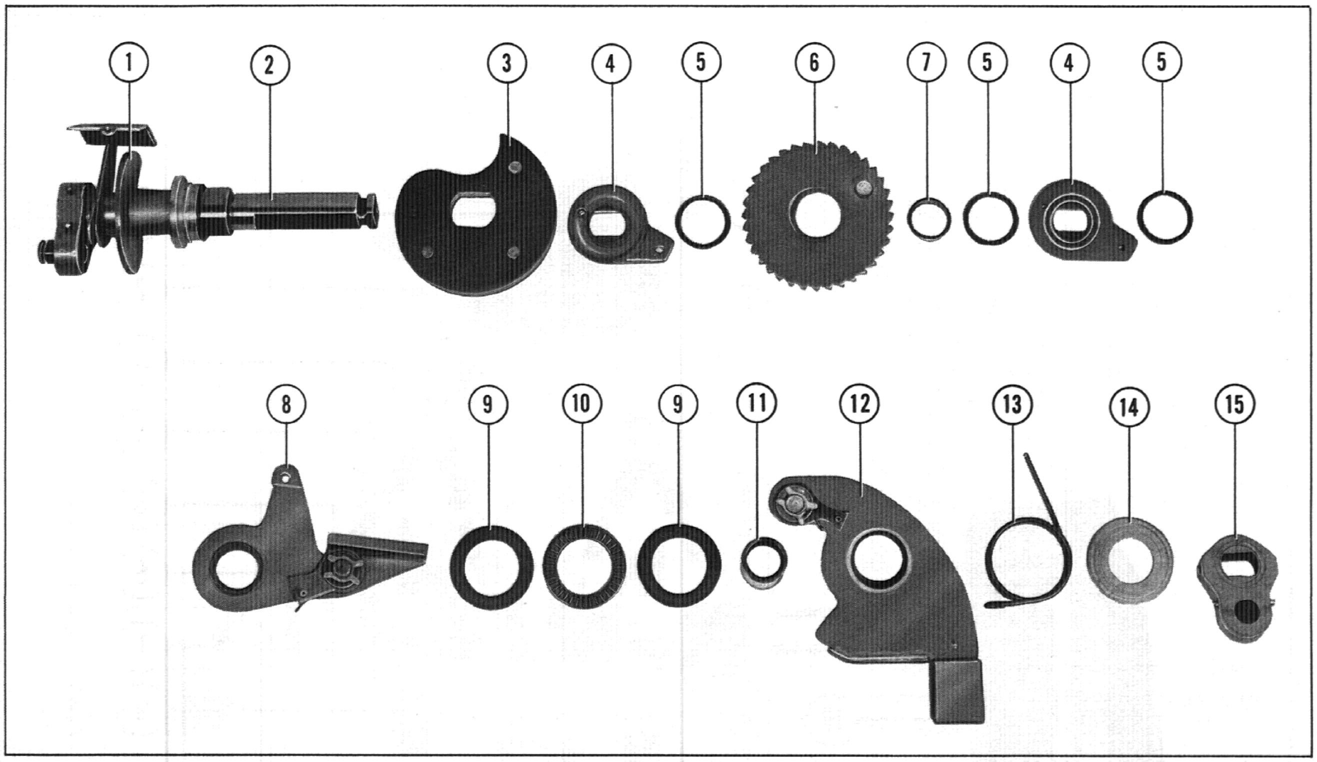
1. Arcing Contact
2. Moving Arm - Outer Link
3. Main Contact
4. Operating Link - Upper Pin
5. Rod End
6. Adjusting Nut
7. Moving Arm - Inner Links - Straight
8. Moving Arm - Inner Links - Offset
9. Hinge Springs - Outer
10. Hinge Spring - Center
11. Spring Washer
12. Locking Nut
13. Hinge Assembly
14. Hinge Bearing Tube
15. Adjustment Locking Clip
16. Insulating Link

Note 1 - Raised bearing surface on each arm must be in contact with stationary hinge surface.



1. Stationary Contact Cage
2. Spring Seat
3. Contact Spring - Outer
4. Contact Spring - Inner
5. Spring Button
6. Main Contact Fingers
7. Locking Nut
8. Bearing Tube
9. Spring Guide
10. Arcing Contact - Left Hand
11. Arcing Contact - Right Hand
12. Arcing Contact Spring
13. Arcing Contact Retaining Pin
14. Retainer
15. Pin
16. Base Mold

Fig. 58 *Stationary Contact Details DS-532*



1. Motor Cut-Off Switch Cam
2. Crank Shaft
3. Close Cam
4. Drive Plate
5. Precision Spacer
6. Ratchet Wheel
7. Ratchet Bushing
8. Oscillator
9. Bearing Race
10. Thrust Bearing
11. Oscillator Bushing
12. Emergency Charge Device
13. Charge Device Return Spring
14. Spring Retainer
15. Crank Arm

Fig. 59 *Crank Shaft Assembly of Power-Operated Mechanism*

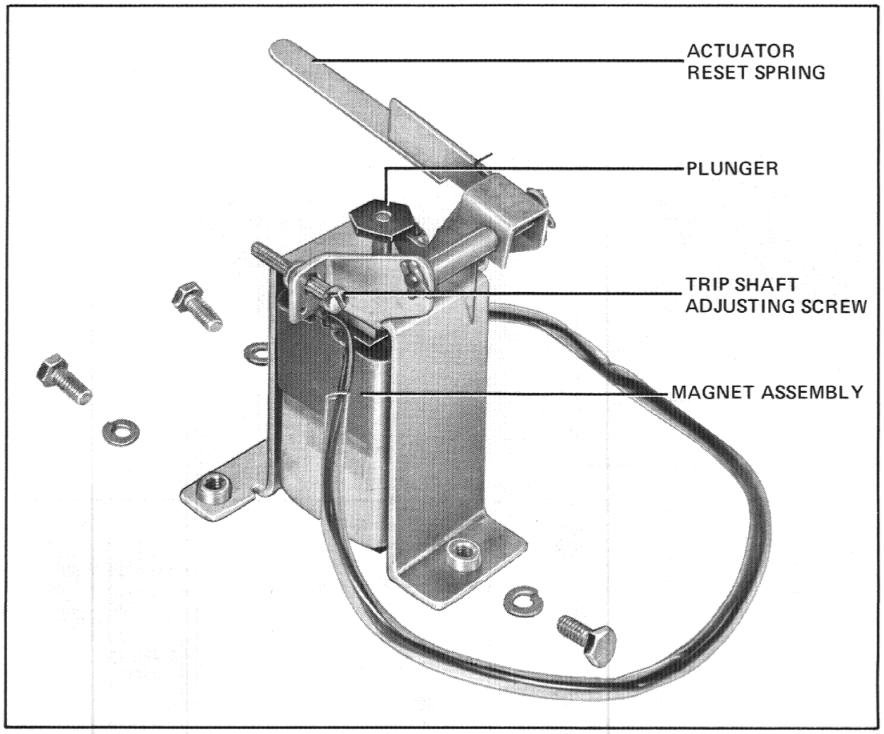


Fig. 60 *Trip Actuator*

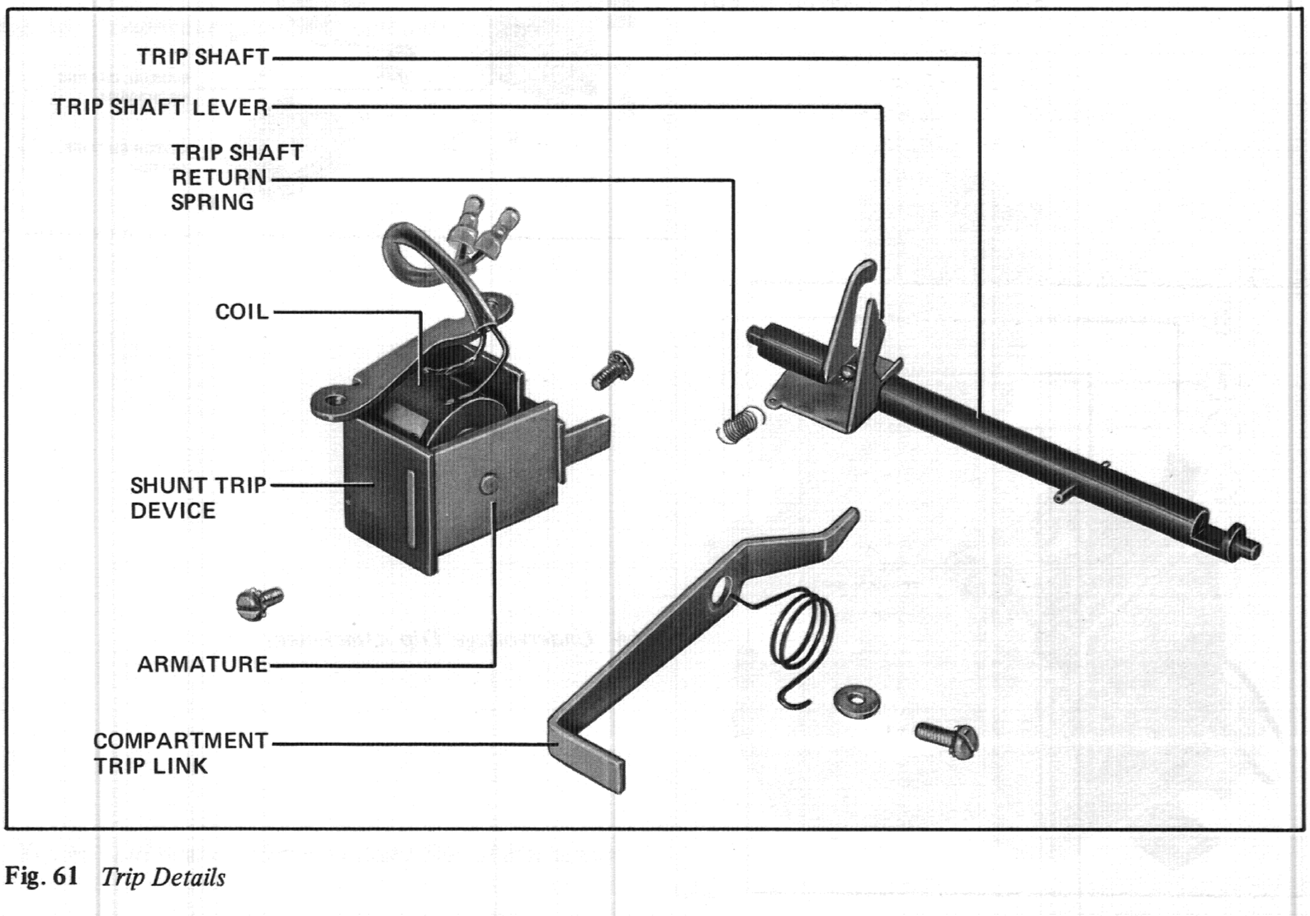


Fig. 61 *Trip Details*

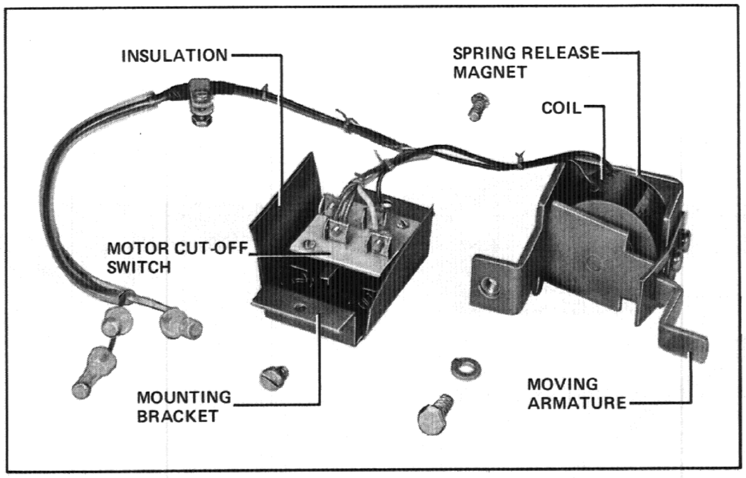


Fig. 62 *Spring-Release Details*

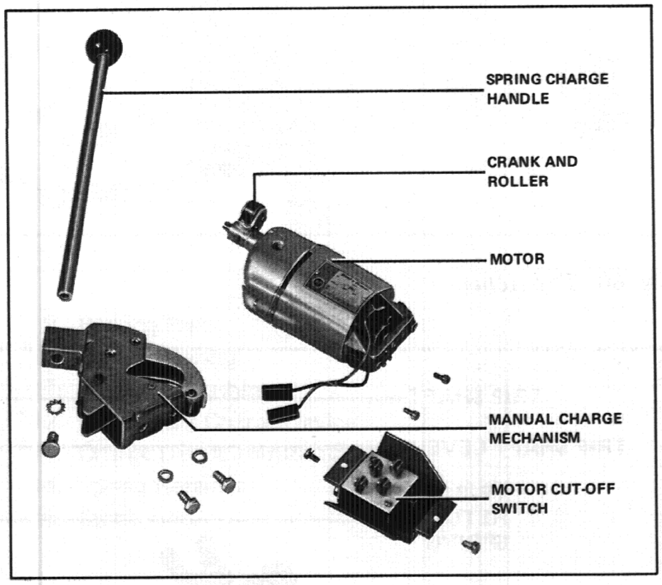


Fig. 63 *Spring-Charging Details*

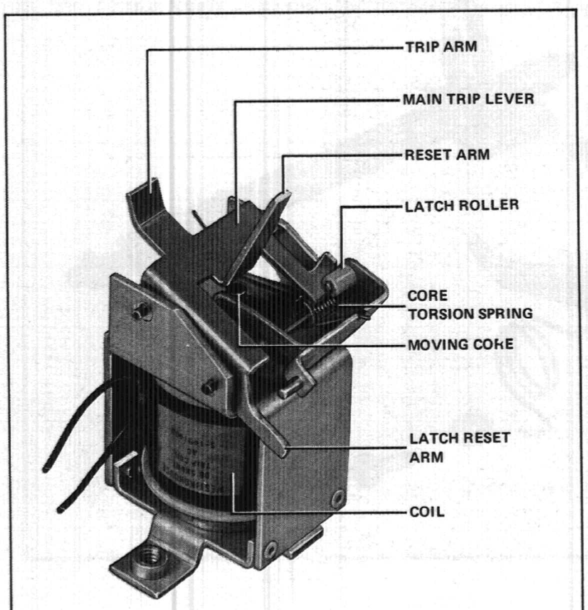


Fig. 64 *Undervoltage Trip Attachment*

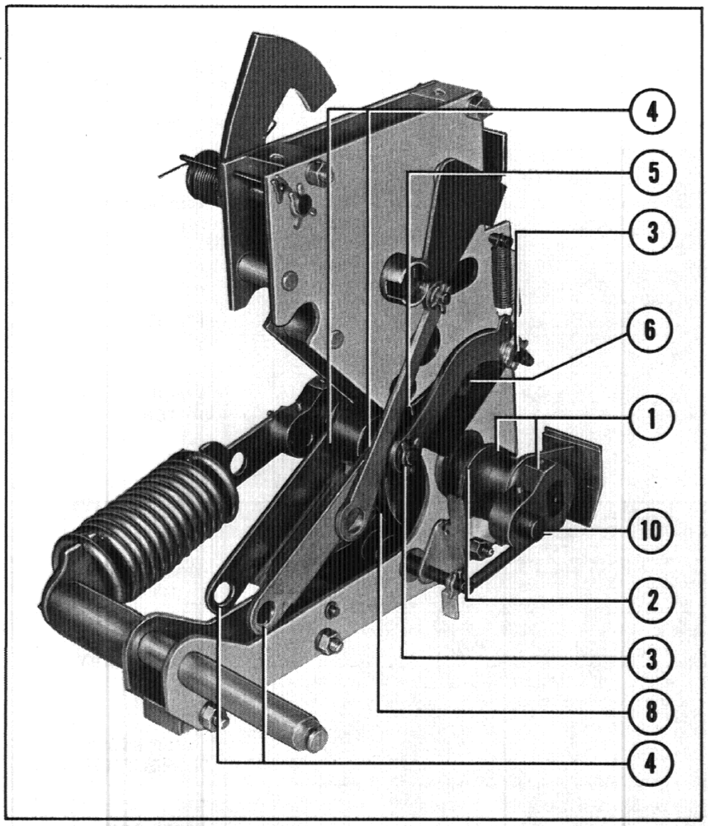


Fig. 65 *Lubrication Points on Left Side of Mechanism*

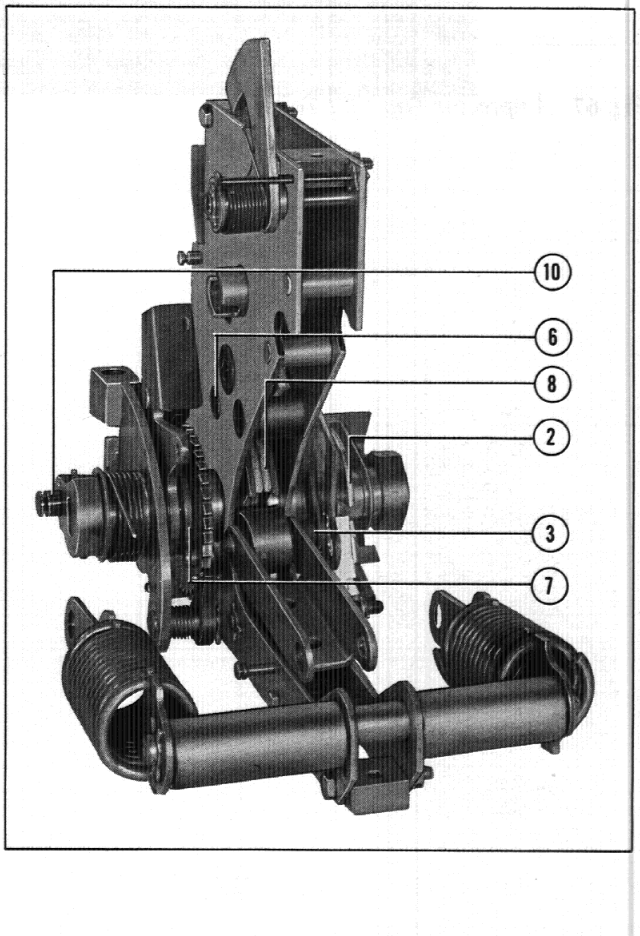


Fig. 66 *Lubrication Points on Right Side of Mechanism*

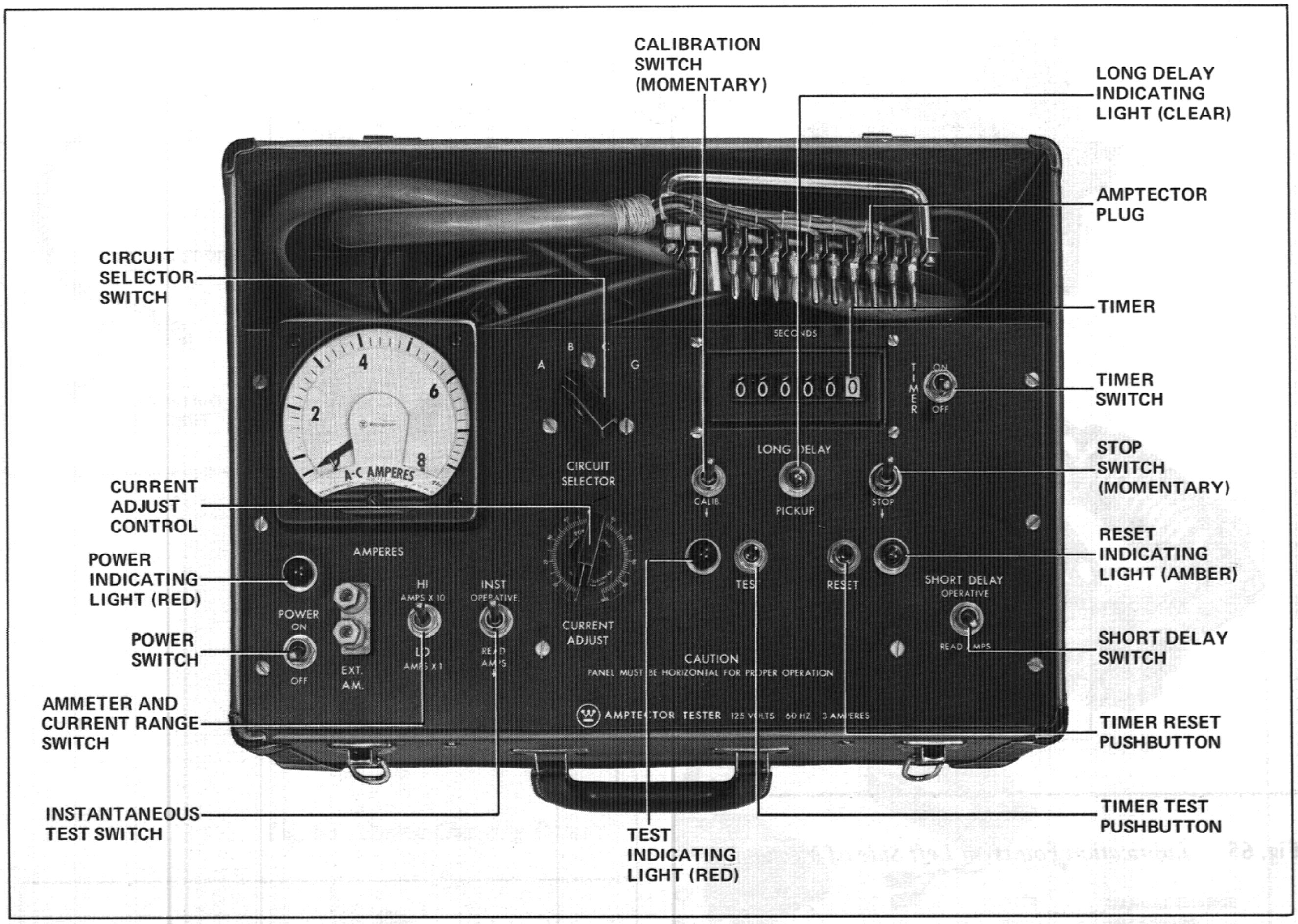


Fig. 67 *Amptector Trip Unit Tester*

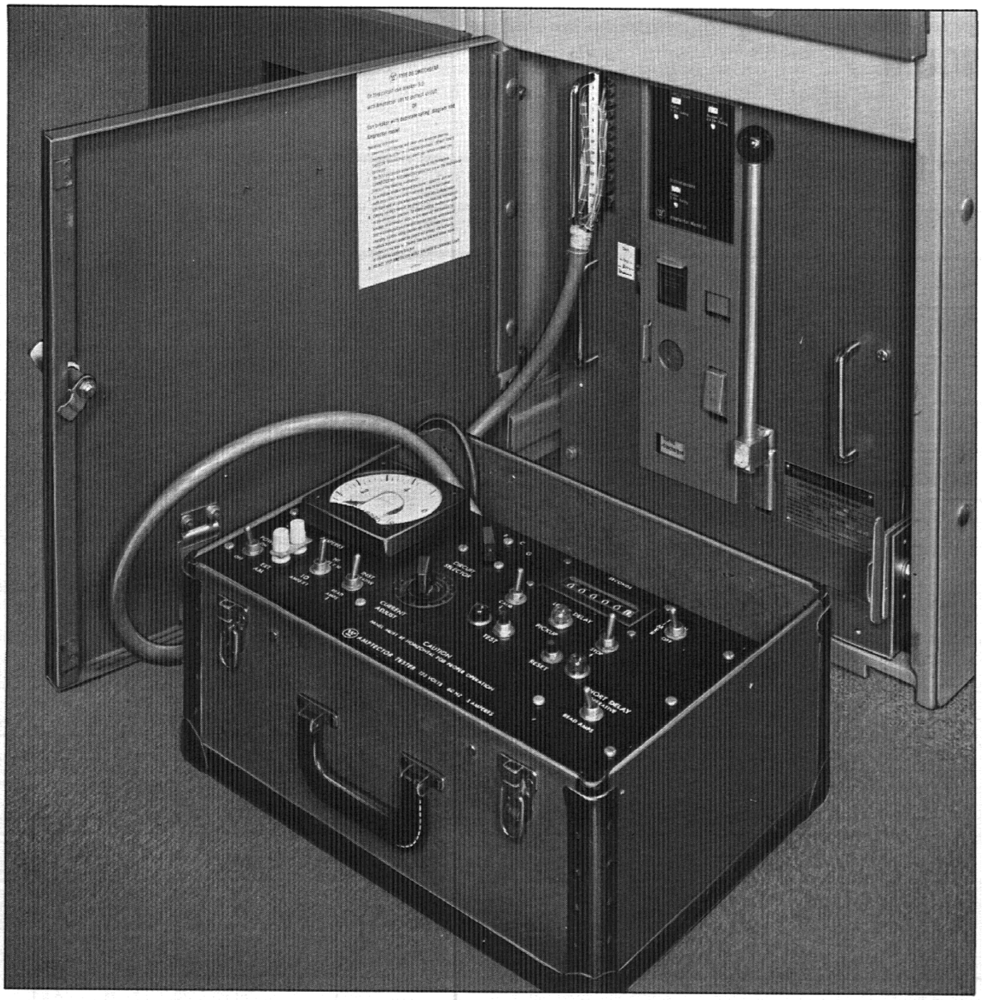


Fig. 68 *Test Unit in Operation*