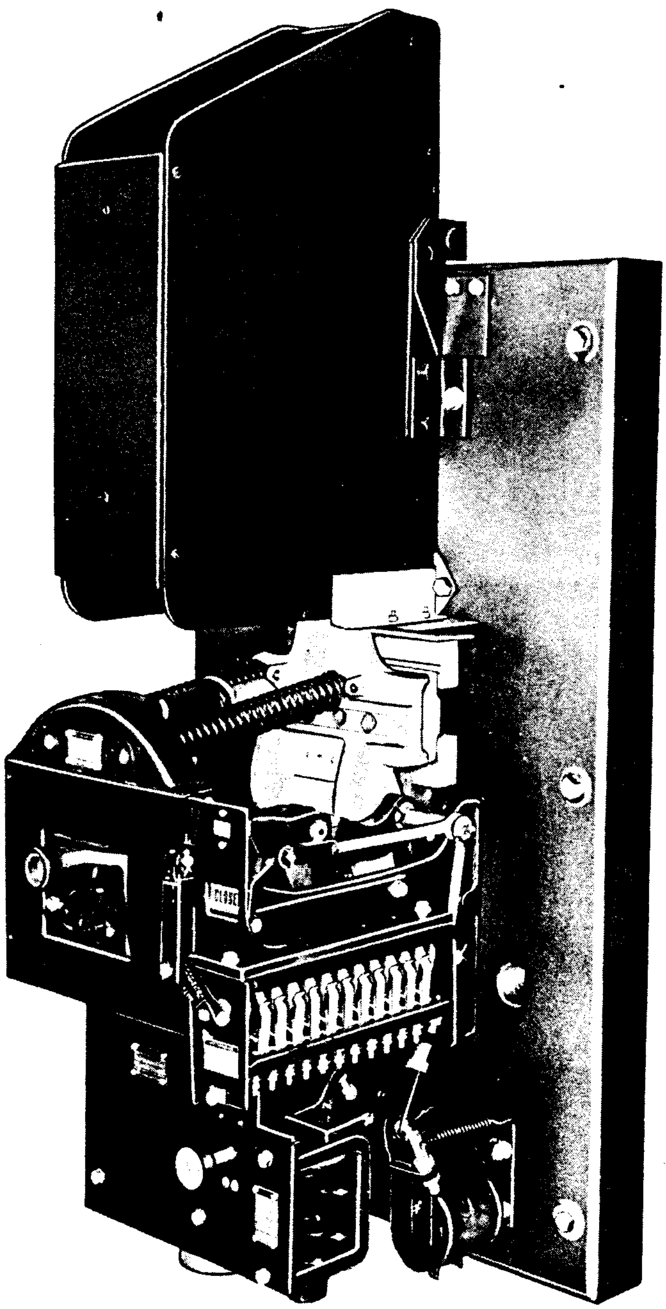
I.B. 35-260-A

INSTRUCTIONS

TYPE DR AIR CIRCUIT BREAKER



SUPERSEDES I.B. 35-260

AUGUST, 1955

WESTINGHOUSE ELECTRIC CORPORATION
EAST PITTSBURGH PLANT • SWITCHGEAR DIVISION • EAST PITTSBURGH, PA.
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RATING OF TYPE DR BREAKERS

The Type DR breaker is a 750V D.C. semi-high speed breaker designed for application on circuits having time-current characteristics which meet the limits established by NEMA for d.c. breakers of the semi-high speed breaker class. Consequently, where the system fault current (determined without the circuit breaker in the circuit) falls between 40000 amperes and 125000 amperes at an instant 0.025 second after the beginning of the fault current transient, the type DR breaker, equipped with instantaneous series overcurrent tripping will limit the magnitude of fault current so that its crest is passed not later than 0.03 second after the beginning of the fault current transient.

However, if the maximum available current is less than 40,000 amperes at an instant 0.025 seconds after initiation of the fault, the time at which the crest of fault current is passed may be greater than the rated 0.03 second.

COMMUNCIATIONS

"When communicating regarding a Product covered by this Instruction Book, replies will be greatly facilitated by citing complete Name Plate Readings of the involved Products. Also, should particular information be desired, please be very careful to clearly and fully state the Problems and Attendant Conditions."

INDEX

LIST OF ILLUSTRATIONS

TYPE DR AIR CIRCUIT BREAKER

PURPOSE

1. The purpose of this instruction book is to acquaint the recipient with the characteristics of the DR Air Circuit Breaker. Complete instructions necessary for installation, operation, and maintenance will be found herein.

PROTECTION FROM DUST

2. Excessive deposits of dust and dirt in the operating parts of a circuit breaker invariably cause binding of shafts, rollers and pins as well as the operating levers. Care should be taken, therefore, to see that accumulation of dirt is prevented and this is particularly true in new installations where the circuit breakers have been installed before the construction work has been completed. In the latter case the breakers should be completely covered by a tarpaulin to prevent plaster and like material from falling on them.

UNPACKING

3. Care should be used in uncrating so that no parts are damaged. All dirt which may have collected on the breaker should be removed. Wipe contact surfaces with a cloth or waste to remove grease used to protect contacts during shipment. A careful inspection should be made to insure none of the parts have been damaged in transit, especially the ceramic plates in the arc chamber.

DESCRIPTION

4. The frontispiece shows a Type DR semi-high speed, single pole, live front, panel mounted, electrically operated, 4,000 ampere, 750 volt d-c. air circuit breaker with auxiliary switch cover removed. Solenoid operating mechanism is mounted on and below the breaker frame. Breaker is mechanically and electrically trip free in all positions.

5. The electrical operating mechanism supplied with DR breakers is of the direct current solenoid type. It is mounted so that the moving core, operating in a vertical plane, acts through a toggle linkage to close the breaker. The necessary tripping devices form a part of the mechanism. Auxiliary switch with contacts from three to eleven in number is mounted on the breaker frame and mechanically connected through links to a pin in the breaker moving contact arm. A cut-off switch, operating with the solenoid core, is supplied to energize a control relay for interruption of the closing coil current. If desired, this control relay may be supplied with fuses and a knife switch for disconnecting the breaker control circuit from the control bus; if so ordered, all this equipment may be mounted on the panel. Terminal blocks for collecting all the circuit breaker control wiring at some convenient point, may also be provided if desired.

6. The breaker contact assembly will carry normal load currents and draw the arc during the interrupting periods in such a manner that after circuit interruption, the load current can be carried without undue temperature rise. The moving main contacts are self-aligning bridge members to which bars of silver nickel composition are brazed. Silver nickel bars are also brazed to the studs to form the stationary main contacts. In the closed position the silver bars engaged to complete the main current path through the breaker.

7. On opening, the main contact bridges, attached to the moving contact arm, part from the stationary elements first and the arcing (center) bridge second. The lower part of main contact is protected from arcing by a parallel shunt and the upper part is protected by secondary and arcing contacts located above the mains. During the early part of the opening movement a horizontal barrier system isolates the main contacts from gases thrown downward by the arc. The stationary portion of the protective contacts are arranged on a spring-mounted platform which follows the opening contact arm for a short distance. At the lower edge of this platform is the secondary contact surface which continues contact with the secondary contacts on the moving arm until the main contact surfaces are separated a safe distance. Stops then operate to halt the follow-up movement of the lower portion of the platform, thus acting to separate the secondary contact surfaces while the arc-drawing members are still permitted to remain in contact. The arcing contacts part last, consequently the arc is drawn at the extreme upper end of the contact structure.

8. The arc chamber is located immediately above the arcing contacts of the breaker; the insulating sides of the chamber extend downward past the upper contact members to insure a positive transfer of the arc into the chamber. The chamber consists of laterally spaced ceramic plates having V-shaped slots and held together with a moisture and heat resisting cement. An arcing horn is provided at the rear of the chamber. The series of V-shaped slots in these plates form a vented groove or slot extending the full length of the chamber into which the arc is drawn and extinguished, thus interrupting the circuit.

9. A multi-turn coil, located behind the arc-chamber is inserted into the electrical circuit by the transfer of the arc from the arcing contact to the arcing horn which is directly above it. This coil then generates a magnetic flux which is directed across the arc path by magnetic pole faces that are in the sides of the arc chamber. The flux across the gap between the pole faces and through the chamber forces the arc upward into the interrupting slot.

10. The arcing contacts are so arranged that at the instant of parting they form a sharp loop in the current path through the breaker. The magnetic effect of this loop extends the arc upward very rapidly as the contacts open. Due to this upward looping effect, the arc almost immediately impinges against the arcing horn in the chamber directly above the stationary arcing contact so that one terminal of the arc transfers to this horn, the other terminal remaining on the moving arc contact. Transfer of the arc to this horn alters the current path through the breaker to include the multi-turn coil mentioned in the preceding paragraph, this coil is not energized when the breaker is in the closed position. Energizing this coil produces a magnetic circuit which moves the arc upward into the arc chamber.

SAFETY FOR PERSONNEL

11. The installation, operation, and maintenance of circuit breaker equipment requires that certain precautionary measures be taken to prevent accidents. The following represents suggestions of that character.

A. *DO NOT TOUCH A LIVE BREAKER.*

Parts of the circuit breaker attached to the upper stud are at line potential of the circuit to which the circuit breaker is connected. The breaker should be isolated from the circuit by a disconnecting switch before attempting any work on the breaker.

B. Whenever possible the breaker should be in the open position when any work is being done on it. If that is impossible the trigger should be secured in the latched position by inserting a wooden block between the trigger and the frame in such a manner that it is impossible to move the trigger upward to the tripping position. Such a blocking arrangement is also useful when working with the undervoltage attachment.

INSTALLATION

12. The DR air circuit breaker, complete with all attachments, is a self-contained unit, and has been mounted, adjusted and calibrated on its own permanent panel at the factory. It is designed only to be mounted in a vertical position, and all inspections for proper operation must be made with the breaker panel held vertically. Excessive deposits of dust and dirt in the operating parts of a circuit breaker invariably cause binding of shafts, triggers, rollers and pins as well as the operating levers.

It is important that the connecting bus be of sufficient current carrying capacity and that connections to the breaker be joined properly. Obviously heat conducted into a breaker from a hot joint will increase the temperature rise of the breaker. Connecting cables or bus should be well supported and braced so that the breaker studs will not be subjected to unnecessary strain as a result of magnetic forces set up by short circuit currents.

CONTROL SCHEMES

13. Typical control schemes employing a cutoff switch are shown by figures 7 and 8. It will be noted that, with either of these schemes, automatic reciprocation of the closing mechanism (known as pumping) cannot occur should the cutoff switch or breaker mechanism lose its adjustment. The cutoff switch is used to energize a cutoff (Y) relay which in turn opens the operating coil circuit of the contactor (X), causing the contacts "X" to open the closing coil circuit. The "Y" relay remains energized until the control switch is opened and by this means "pumping" is avoided.

ADJUSTMENT OF CONTACT ARM

14. To adjust the contact arm, put the arc chamber in the hinged position (see paragraph 29F) and put the contact arm in a partially closed position. After the bolt which clamps the eccentric pin is loosened the eccentric pin should be turned so that the machined surface of the contact arm should be parallel to and 2 5/8 ± 1/16 from the panel (See Fig. #1) when the breaker is closed. When the contact arm is adjusted to the correct position care should be taken to securely lock the eccentric pin before the breaker is operated again. Before this adjustment should be considered complete inspection should be made by prying each set of contacts gently apart with the aid of a large screw driver or similar tool, being careful not to mar the contact surfaces.

ADJUSTMENT OF CONTACT SEQUENCE

15. IT IS VERY IMPORTANT THAT ADEQUATE SEPARATION BE OBTAINED BETWEEN MAIN CONTACT SURFACES AT THE INSTANT THE SECONDARY CONTACTS PART DURING THE OPENING STROKE OF THE BREAKER. THIS separation should be approximately 5/16" for the outer main contacts and approximately 9/32" for the center main contact.

16. This separation can be obtained by first adjusting the contact arm, as per paragraph 14, then adjusting the nut located at the center of the bridging members. To adjust the nut, remove the locking pin and screw down the nut to a point where it just touches the bridge member with the breaker in the closed position, then back off the nut 1/16" for the outer contacts and 3/32" for the center contacts. (Note: 1/16" corresponds to 5/6 turn of the bridge nut and 3/32" is approximately 1-1/6 turn of the same nut. See Figure 1.) Lock contacts in position after adjustment with the locking pin. *IT SHOULD BE BORNE IN MIND THAT SATISFACTORY PERFORMANCE OF THE BREAKER DEPENDS UPON MAINTAINING THIS IMPORTANT ADJUSTMENT.*

ADJUSTMENT OF ARC CHAMBER

17. Proper alignment of the arc chamber is obtained when the clearance between the arc tip to each side of the ceramic plates is approximately the same. The machined surfaces at the rear of the arc chamber should also be resting on the spring guard of the stationary arc platform and up against the panel. The moving arc tip should not touch the ceramic plates under any circumstances. SEE PARAGRAPH 29-A FOR THE REMOVAL OF THE ARC CHAMBER.

ADJUSTMENT OF AUXILIARY SWITCH

18. Rotary type auxiliary switches are sturdily constructed and provide a variety of combinations of opening and closing contacts. Positive operation is obtained through an adjustable operating link which connects the rotor crank to the breaker. Proper setting of the auxiliary switch is obtained by adjusting the length of the rotor crank and the length of the operating link so that the rotor crank pin is at a point 45° above the horizontal when the breaker is closed and at a point 45° below the horizontal when the breaker is in the extreme open position. For normal application the assembled relation between crank and rotor causes the contact segment nearest the crank to close when the breaker closes.

19. Adjustment of the position of the switch arm with respect to the breaker contact arm is obtained by varying the length of the operating link by means of the threaded joint.

ADJUSTMENT OF CLOSING MECHANISM

20. To obtain the maximum closing effort from any particular closing magnet, the air gap between the moving and stationary core sections should be as short as practicable at the point in the closing stroke where the force requirement is greatest. The ideal adjustment, therefore, is obtained when the closing linkage is adjusted to provide only the necessary overtravel of the toggle linkage at the position where the magnet cores come together. Attempts to adjust for an abnormal amount of over-travel may cause the stops in the breaker mechanism to meet and thereby needlessly cause high stress in the breaker parts.

21. Adjustment of the length of the closing linkage is provided by means of a threaded joint on the magnet stem. To readjust the closing linkage loosen the clamping bolt in the rod end and remove the locking key to free the stem. The length of the stem can then be varied by turning the moving core at the bottom. Adjustments of less than one-half of a turn cannot be made because the stem is only slotted in two places 180° apart. After adjustment has been made return locking key to original position and tighten clamping bolt. Check to see that moving core operates cut-off switch after the adjustment has been made.

ADJUSTMENT OF THE CUT-OFF SWITCH

22. Closing coils are designed to remain energized only momentarily, hence to avoid overheating, provision must be made to interrupt the closing coil circuit immediately after the breaker has latched closed. Unless otherwise specified, a small "cutoff" switch having contacts which "make" as the cores of the closing magnet come together is mounted on the breaker frame.

23. Proper adjustment of the cut-off switch requires that its contacts be closed and remain closed when the moving core reaches the end of its closing stroke. Due to the inertia of the moving parts of the breaker, moving core and contactor, it is practical to permit the cut-off switch contacts to touch slightly before the core reaches the end of the stroke.

LOCATING CAUSE OF IMPROPER OPERATION

24. Failure to Trip From Overload May Be Due To:-

A. Improper setting of current calibration.
B. Friction in tripping details as a result of foreign objects or a broken part.
C. Stray-magnetic fields.

25. Failure to Trip By Remote Control May Be Due To:-

A. Open circuit due to loose connection.
B. Burned out trip coil.

26. Overheating Of The Breaker May Be Due To:-

A. Overload
B. Improper adjustment of spring pressure on main contacts. (Refer to adjustment of contact arm and contact sequence.)
C. Poor condition of main contact surfaces.

27. Excess Burning Of Main Contacts May Be Due To:-

A. Poor contact at the secondary contacts due to an obstruction, surface condition, or inadequate spring pressure.

B. High resistance of the secondary contact circuit due to loose joining at the upper or lower shunt.

C. Inadequate lead of main contact over secondary contact. (See adjustment of contact sequence.)

28. Failure Of The Breaker To Stay Closed May Be Due To:-

A. Inadequate over-travel of the toggle linkage to the fully closed position. (See adjustment of closing linkage.)

REMOVAL OF PARTS

29. The following instructions will be helpful if it is necessary to remove parts for inspection or to make replacements.

A. To Remove the Arc Chamber: Trip the breaker and remove the two bolts that holds the arc chamber to the panel. Then pull the arc chamber towards you and lift up and when the arc chamber clears the moving contact arm then lift the arc chamber from the pins. The above procedure should be reversed for mounting the arc chamber on the panel.

B. To Remove the Moving Arcing Contact: The three tap bolts should be removed from the back of the moving contact support. These bolts are made of non-magnetic material and substitution of steel bolts should be avoided.

C. To Remove the Stationary Arcing Contact: Trip the breaker and put the arc chamber in the hinged position. (See paragraph 29F). Then remove the two bolts that holds the stationary arcing contact bracket to the panel.

D. To Remove the Coil from the Closing Magnet: Remove the cover from the front of the assembly. Disconnect wires from the closing coil and the cut-off switch. Remove the locking key on the threaded brass rod by removing the clamping bolt in the rod end. Unscrew brass rod by turning moving core from bottom. The moving core and stem will then slip out. Now the magnet frame can be removed by removing the bolt at each side of the frame. The closing coil is removed after the stationary core is withdrawn.

E. To Remove the Oil Pot of the Inverse-time-limit Overload Attachment:

(1) Loosen knob on the overload dash pot.
(2) Turn dash pot until the index is about 45° off the scale at either the 0 or 100 end.
(3) Remove dash pot by pulling straight downward.
(4) To replace dash pot reverse the above procedure.

F Arc Chamber in the Hinged Position: To put the arc chamber in this position trip the breaker and remove the two bolts that hold the arc chamber to the panel. Then by pulling the arc chamber towards you and lifting up the arc chamber until you can insert a 7 in. or longer 1/2 Dia. bolt or steel rod into the 5/8 Dia. hole in the hinged brackets. Then let the arc chamber rest on the bolt or the steel rod. See Fig. #1. The arc chamber must be bolted to the panel before the breaker is put in service.

SERIES OVERLOAD TRIP ATTACHMENTS

30. Series overload trips are used to trip the circuit breaker whenever the current through the breaker exceeds a predetermined value. This device includes a one turn stationary magnetic circuit mounted around the lower stud of the breaker, and a movable iron armature. The armature is mounted in such a way that as it moves under magnetic attraction to reduce the air gap, it provides the force to trip the breaker latch. The amount of current required to start the armature is a function of air gap length and upon this principle all overload trips for DR breakers are calibrated.

31. The tripping magnet is used at its best efficiency when adjusted so that, of the total travel of the armature, that part used to move the breaker trigger should be just long enough to trip the trigger free of the toggle latch. With this adjustment the maximum amount of armature travel is used to obtain momentum for tripping the breaker.

32. Each overload trip unit is calibrated on the breaker at the factory. Powerful stray magnetic fields affect the calibration points to some extent on large breakers. Where the bus arrangement of the switchboard is known, the breakers are calibrated at the factory with the same arrangement.

33. All the overload trip devices reset themselves automatically. That is, after tripping, they automatically return to their original position.

I - Instantaneous Trip

34. Instantaneous trip attachments are designed to be calibrated on currents close to the breaker rating. The standard range of calibration is 100% to 200% of the normal 30° C. rating of the breaker. Unless otherwise specified, the five main points 100%, 125%, 150%, 175% and 200% are stamped on the scale plate.

II - Inverse Time Limit

35. The Inverse-time-limit attachment consists of a tripping device with the addition of a time delay device which prevents tripping on a relatively small overload which lasts but a short time.

36. The time delay feature is obtained by the sucker action between a smooth surface metal disc which is attached to the overload armature and which normally rests on the smooth bottom surface of a pot containing a small quantity of oil (approximately 1/8" deep). The resulting sucker action retards the starting of the overload armature, the time of delay being approximately inverse to the magnitude of the overload.

37. A limited variation in the time delay can be obtained by turning the pot which varies the amount of surface in contact between the sucker and pot. Further variation can be obtained by using oils of different viscosities.

38. The overload trip device is calibrated without oil in the pot. The calibration range and scale markings for the standard Inverse-time-limit attachment is the same as for the Instantaneous Trip Attachment.

39. To insure reliable performance of the time delay device, it is important that oil in the pot be kept clean. A single particle of dirt between the sucker surfaces may greatly reduce the time delay. To remove imperfections in the sucker surfaces due to bruising or other causes, it is suggested that all high spots be removed with a scraper. A paper washer is placed between the sucker surfaces to protect them during shipment. This washer should be removed when placing the breaker in service and before oil is placed in the pot.

40. For instructions on removing the oil pot of the Inverse-time-limit attachment, see paragraph 29-E.

SHUNT TRIP ATTACHMENT

41. The shunt trip attachment is designed to trip the breaker when the trip coil is energized by an auxiliary circuit, thus providing for remote control and various interlocking arrangements. Shunt trip coils are designed to remain energized only momentarily, hence provisions should be made to interrupt the shunt trip circuit immediately after the breaker has been tripped. It is common practice to obtain this result by means of an auxiliary switch having contacts which open as the breaker opens.

LOW VOLTAGE TRIP ATTACHMENT

42. The low voltage attachment is mounted on the panel to the left of the breaker and operates to trip the breaker if the control voltage drops below a predetermined value.

43. The important elements of this device function as follows:- When energized at rated voltage, magnetic force holds the armature to the stationary core against the action of the stressed tripping spring. If the applied voltage decreases to a value at which the magnetic attraction for the armature is less than the force exerted by the tripping spring, the armature "drops out" and the breaker is tripped by energy from the tripping spring. The armature is reset mechanically through links attached to the breaker.

44. To adjust for drop-out at a given voltage, apply rated voltage and close breaker then reduce voltage to the desired drop-out value and adjust screw to the position which causes the armature to drop-out. This setting should be checked by repeating the above procedure. For normal applications this device is adjusted to drop-out at 30% to 60% of the rated voltage.

REVERSE CURRENT TRIP ATTACHMENT

45. The reverse current trip attachment is used to trip the breaker when the direction of current flow through the breaker is reversed.

46. The reverse current trip mechanism consists of a stationary magnet energized by a series current coil and movable armature energized by a polarizing coil. When the series coil current is flowing in the normal direction the armature tends to rotate in one direction but is restrained by a stop. When the series current reverses, the armature is rotated in the opposite direction against a spring to trip the breaker. This adjustment is set at the minimum trip value which is approximately 250 amperes.

47. The reverse current armature is reset after a tripping operation by opening the polarizing coil circuit. This can be accomplished by wiring the polarizing coil through an auxiliary switch on the breaker.

LUBRICATION

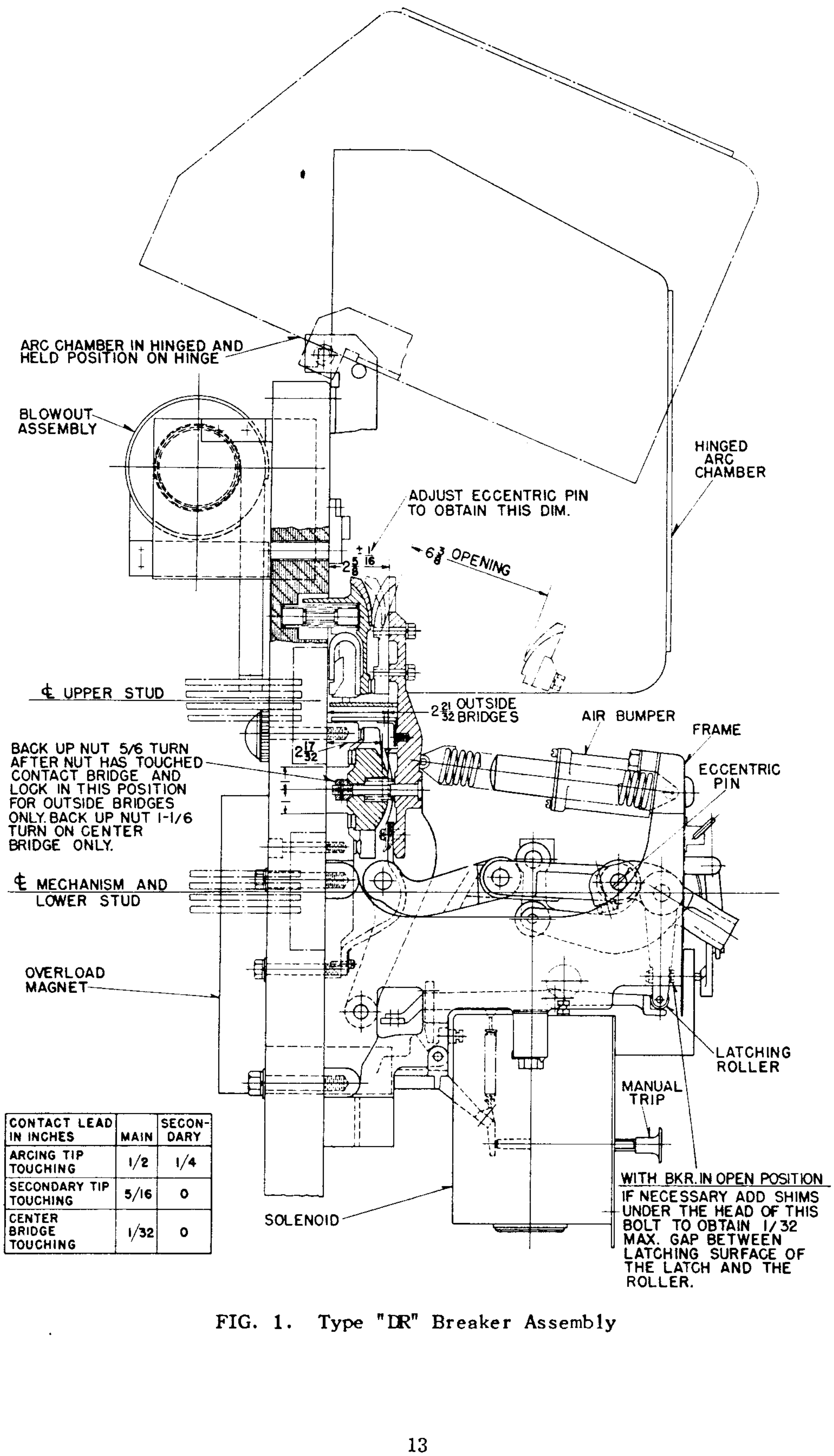
48. Lubrication of the mechanism as applied at the factory should be sufficient for years of service. It should be remembered that oily surfaces promote the accumulation of dirt and for that reason contact surfaces should be kept free from oil or grease. It is recommended that no lubricants be applied to the breaker.

MAINTENANCE

49. It would be difficult to over-emphasize the importance of adequate care of all protective devices. To assure proper functioning, they should be the subject of periodical, systematic and intellegent inspection. Even the smallest details of required maintenance should not be neglected if costly failures of equipment and service are to be avoided. Maintenance must include occasional checks on calibration as well as on the co-ordination and freedom of all moving parts. The frequency and character of inspection will for the most part be a matter of experience. In general, light monthly inspection, with a thorough inspection semiannually, should be a minimum. The Company will be glad to furnish such additional information as may be needed to amplify or clarify these instructions.

RENEWAL PARTS

50. When ordering renewal parts, specify the name of the part desired. Give the breaker type, amperes, volts and Stock Order Number (S.O. No.) as found engraved on the breaker nameplate.



CONTACT LEAD IN INCHES	MAIN	SECONDARY
ARCING TIP TOUCHING	1/2	1/4
SECONDARY TIP TOUCHING	5/16	0
CENTER BRIDGE TOUCHING	1/32	0

FIG. 1. Type "DR" Breaker Assembly

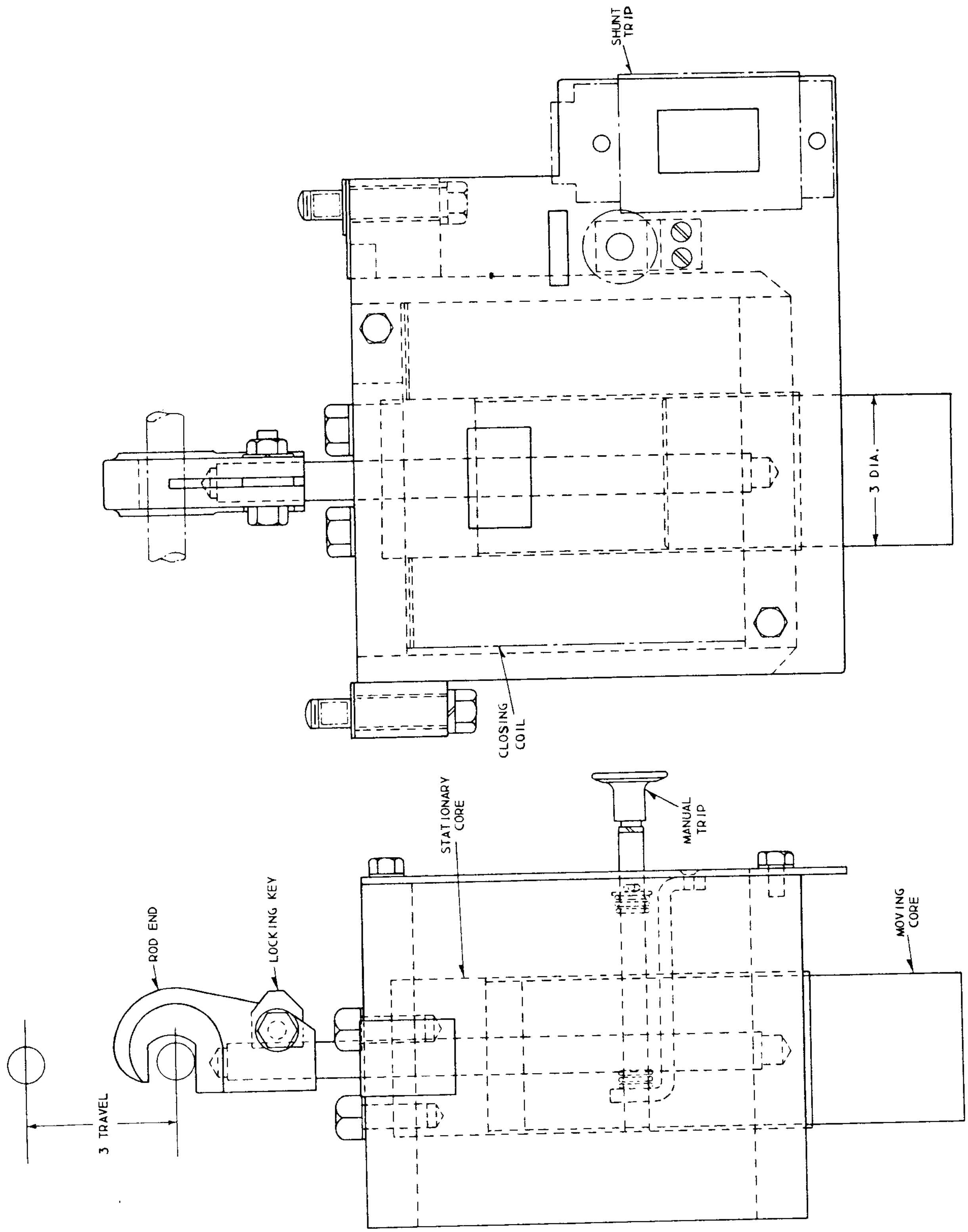


FIG. 2. Closing Solenoid

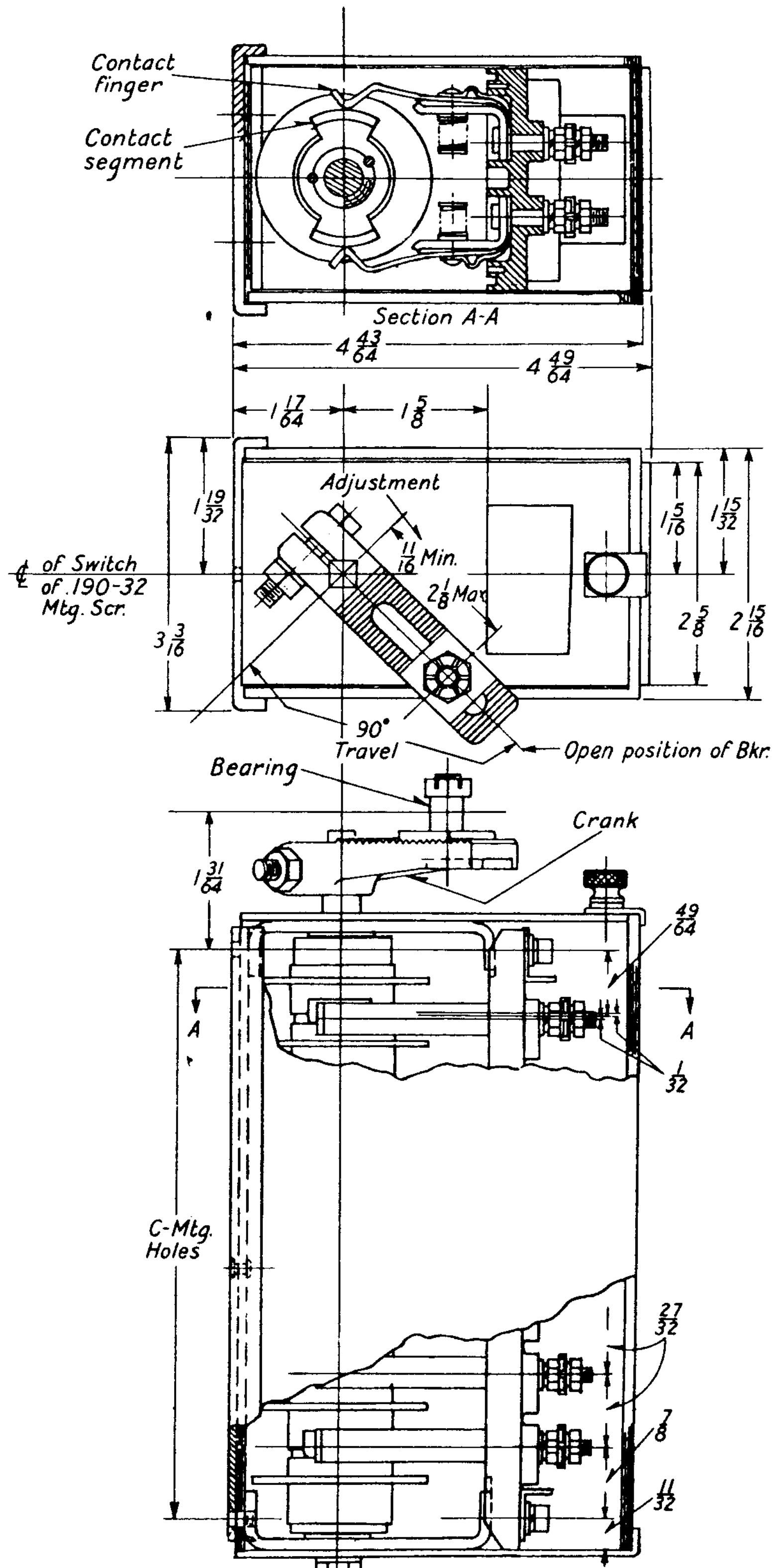


FIG. 3. Auxiliary Switch

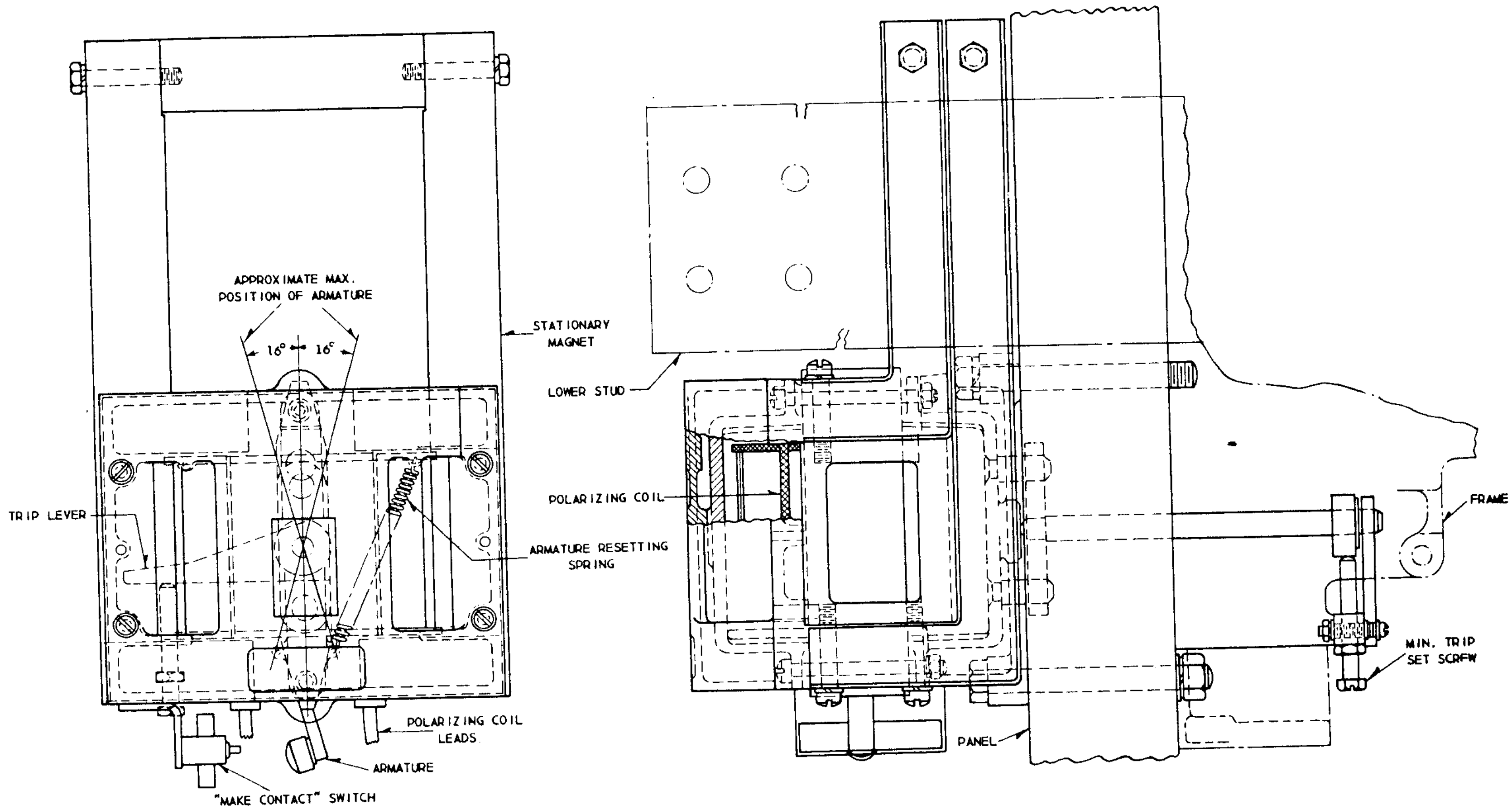


FIG. 4. Reverse Current Trip Attachment

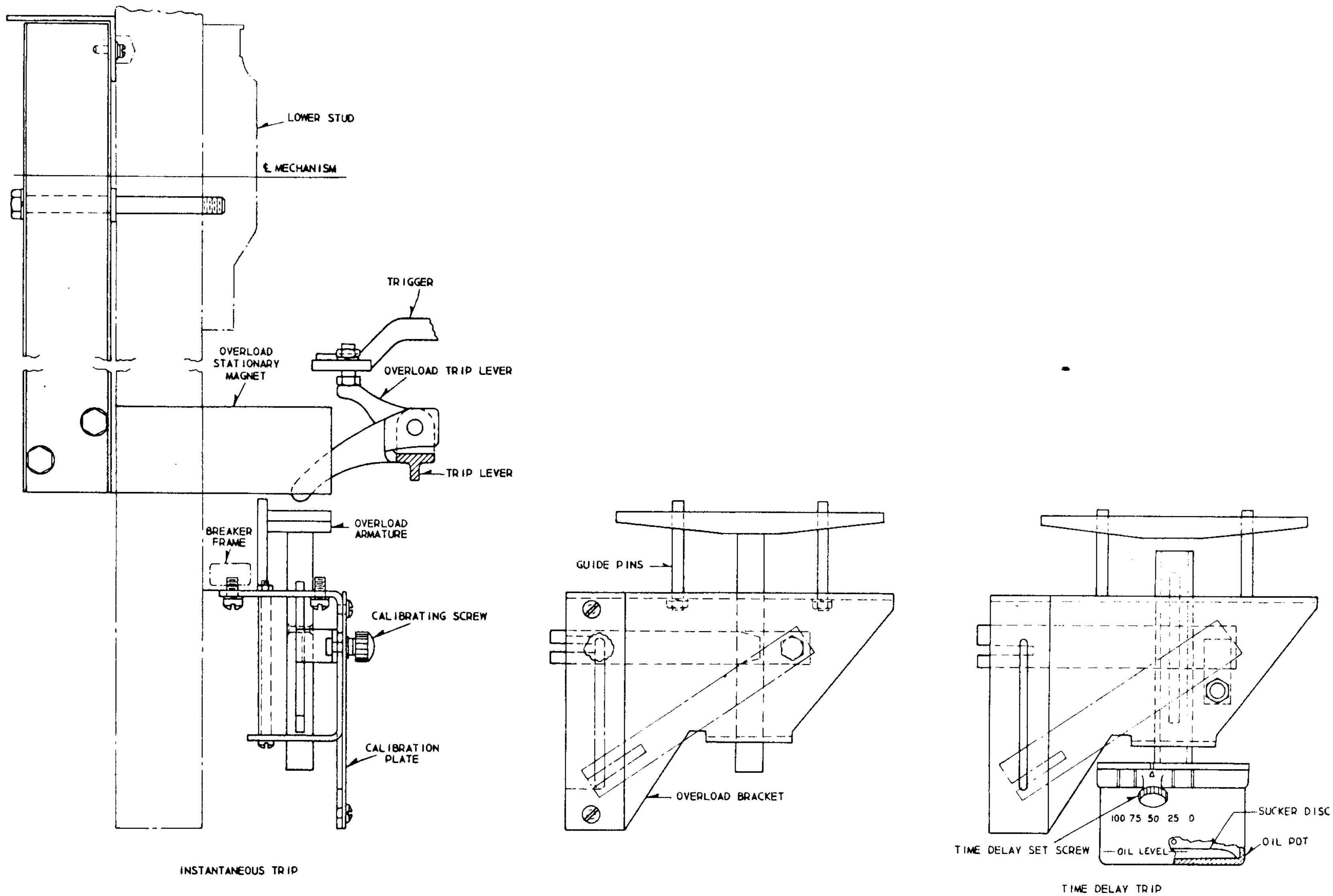


FIG. 5. Overload Trip Attachments

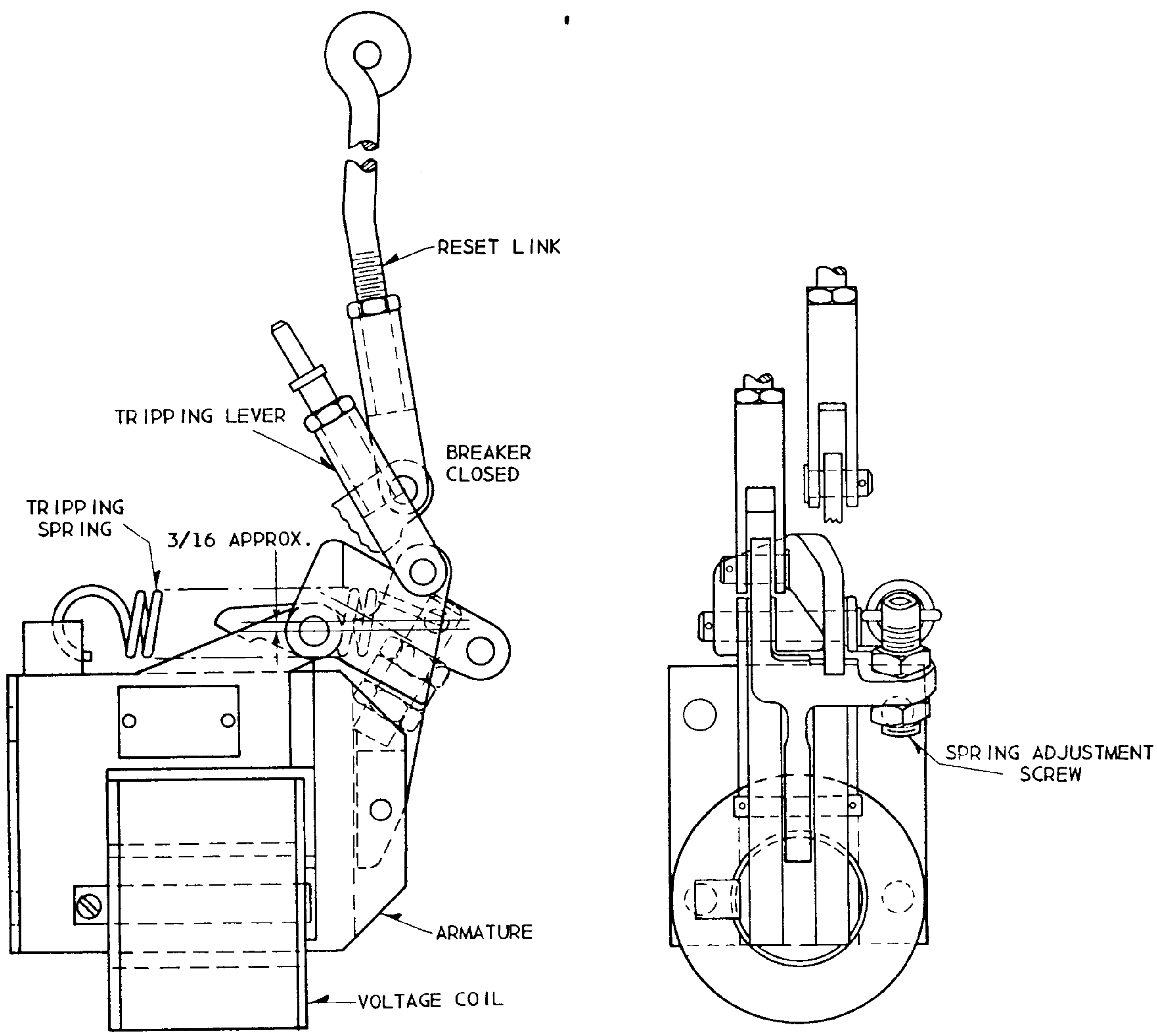


FIG. 6. Low Voltage Trip Attachment

DIAGRAM INFORMATION

TYPE DR AIR CIRCUIT BREAKER CONTROL SCHEMES

Auxiliary Shown for Open Breaker
Relay Contacts Shown for De-energized Relay

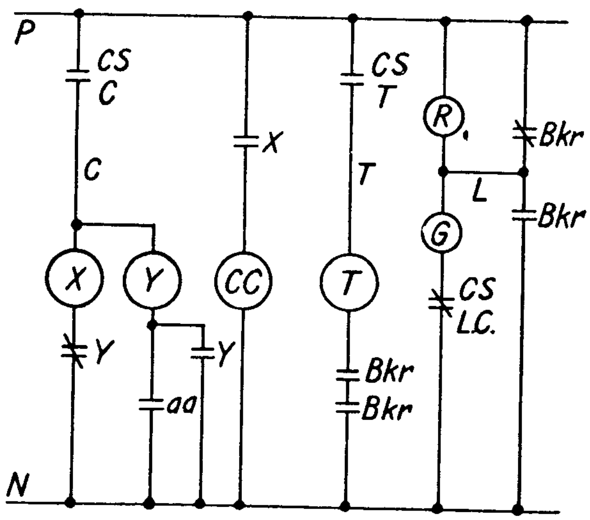


FIG. 7. D-C. Control, X-Control Relay, Y-Cut-off Relay, Breaker Auxiliary Switch, Cut-off Switch (aa)

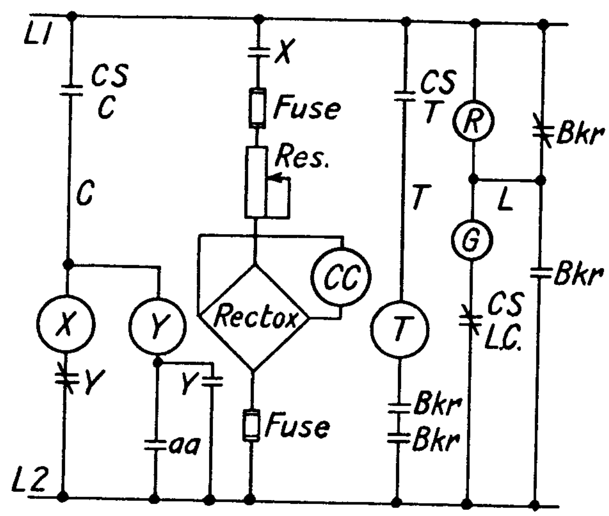


FIG. 8. A-C. Control, X-Control Relay, Y-Cut-off Relay, Breaker Auxiliary Switch, Cut-off Switch (aa)

LEGEND

CS - Control Switch; C-Close; T-Trip;

L.C. - Lamp Cutout

CC - Breaker Closing Coil

T - Breaker Trip Coil

X - Control Relay Y - Cutoff Relay

 - Contact or Auxiliary Switch Closed when Device Is Energized or Closed

 - Contact or Auxiliary Switch Open when Device Is Energized or Closed

 aa - Contact Closes when Breaker or Mechanism Is in Operated Position