Westinghouse

Type CL

Carbon Circuit-Breakers

INSTRUCTION BOOK

INSPECTION AND MAINTENANCE

Do Not Oil Moving Parts

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 intelligent 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 coordination and freedom of all moving parts. The purpose of this Instruction Book on the carbon circuit-breakers, is to provide a guide for those charged with these responsibilities. It is not possible to outline a procedure that will apply in all cases. The frequency and character of inspection will for the most part be a matter of experience. But in general, light monthly inspection, with a thorough inspection semi-annually, should be a minimum. The Corporation will be glad to furnish such additional information as may be needed to amplify or clarify these instructions.

Westinghouse Electric Corporation

East Pittsburgh, Pa.

I. B. 5241-G

Filing No. 35-000

Important

Carbon Circuit-Breaker Maintenance

KEEP MAIN COPPER CONTACTS CLEAN

Copper oxide or sulphide which forms readily on copper contacts in air is a very poor conductor. Consequently unless a circuit-breaker is operated at least once a day the main copper contacts should be carefully cleaned and polished once a month with fine sandpaper in order to prevent overheating of the circuit-breaker. Of course a circuit-breaker which normally carries only a small percentage of its rated current does not require such frequent attention.

In contrast to copper oxide, silver oxide or sulphide is a comparatively good conductor so that circuit-breakers having silver plated main contacts do not require the removal of oxide. As a matter of fact sandpaper should never be applied to silver plated contacts since the useful silver plating would thereby be removed.

(See Pages 4—5)

MAINTAIN PROPER MAIN CONTACT PRESSURE

While it is true that after the main brush contacts have been properly adjusted they will remain so indefinitely, occasional inspections should be made to see that all adjusting screws are tight and if any of these screws are found loose to see that the brush adjustment has not shifted.

(See Page 5)

KEEP CIRCUIT-BREAKERS CLEAN

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. 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 building 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.

Westinghouse

Type CL

Carbon Circuit-Breakers

General

Carbon circuit-breakers come under the general class of air circuit-breakers since air is the medium in which they break an electrical circuit. In the majority of cases they are used on direct-current circuits although there is some demand for their use on low voltage alternating-current circuits such as 220 and 440 volts. On direct-current they are rarely, if ever, applied to circuits of more than 1500 volts and oil circuit-breakers take their place on the higher alternating-current voltages.

Function of a Carbon Circuit-Breaker—A carbon circuit-breaker is a protective device. It is protective in the sense that it is used to open or break an electrical circuit whenever an overload or some other abnormal condition occurs. Fundamentally it is a switch having in addition to the usual main contacts a latch and one or more tripping devices to make it automatic in opening, and arcing contacts to take the arc which necessarily takes place when an electrical circuit is broken.

Since a carbon circuit-breaker is used to open an electrical circuit it must be able to do this, even on severe short circuits, without material damage to its main contacts. Likewise since it normally connects either a generator to a bus, or a bus to its load, it must be able to carry its rated current continuously without overheating.

To protect the main contacts against arcing or pitting, secondary copper contacts and tertiary or carbon contacts are provided. The sequence of operation of these contacts, when the circuit-breaker opens, is shown in Figure 1. It will be seen that the main brush parts contact first, after which the secondary copper contacts open and finally the carbons part. The carbons therefore receive the greatest amount of arcing. However, the secondary contacts also receive some of the arcing and if, after a number of operations, they become slightly roughened, they should be smoothed with fine sandpaper. When badly worn, so that they no longer make good contact, they should be renewed. On severe short circuits even the main brush contacts and stud heads may be pitted slightly in which case they should be carefully smoothed off either with fine sandpaper or a file. The carbons except when broken, usually remain in good condition since they are very refractory and do not roughen very soon under the action of the arc. However, if they do get rough they should be smoothed off until they make good contact since the protection against arcing of the main brush depends upon the good condition and proper sequence of operation of the secondary and tertiary contacts.

If arcing takes place between the main brush and the lower stud head it shows that the flexible shunt connecting the brush to the lower stud is no longer making good connection and should be renewed.

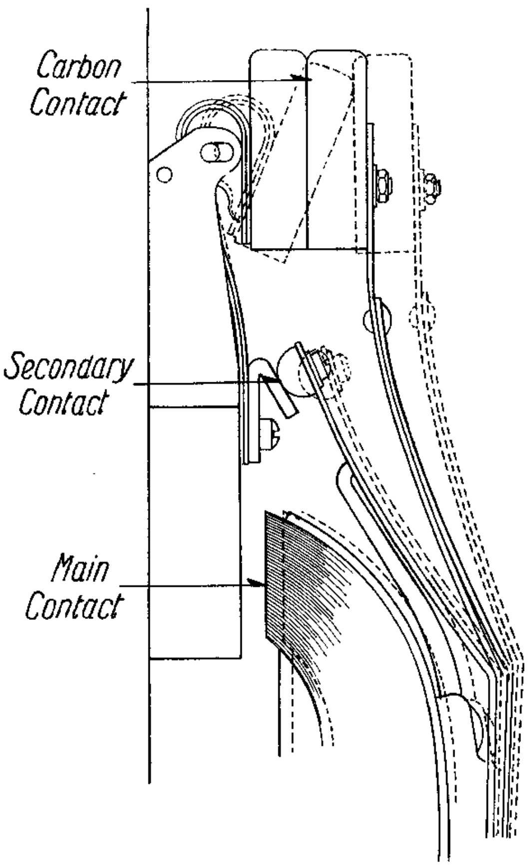


Fig. 1—Outline Showing Sequence of Operation of Type CL Circuit-Breaker Contacts

Care of the Main Contact Brush—Insofar as heating is concerned the main brush is the vital part of the circuit-breaker. When in good condition it should carry rated current at a temperature rise not exceeding 20°C. above 40° ambient temperature. While it is true that overheating may be due to any one of a number of other causes it is due in a large majority of cases to poor condition of the main brush contacts.

Assuming that the current flowing through the brush is no more than its normal rating, abnormal temperature may be due to:

1st.—Insufficient contact pressure.

2nd.—Poor electrical contact between brush and stud head.

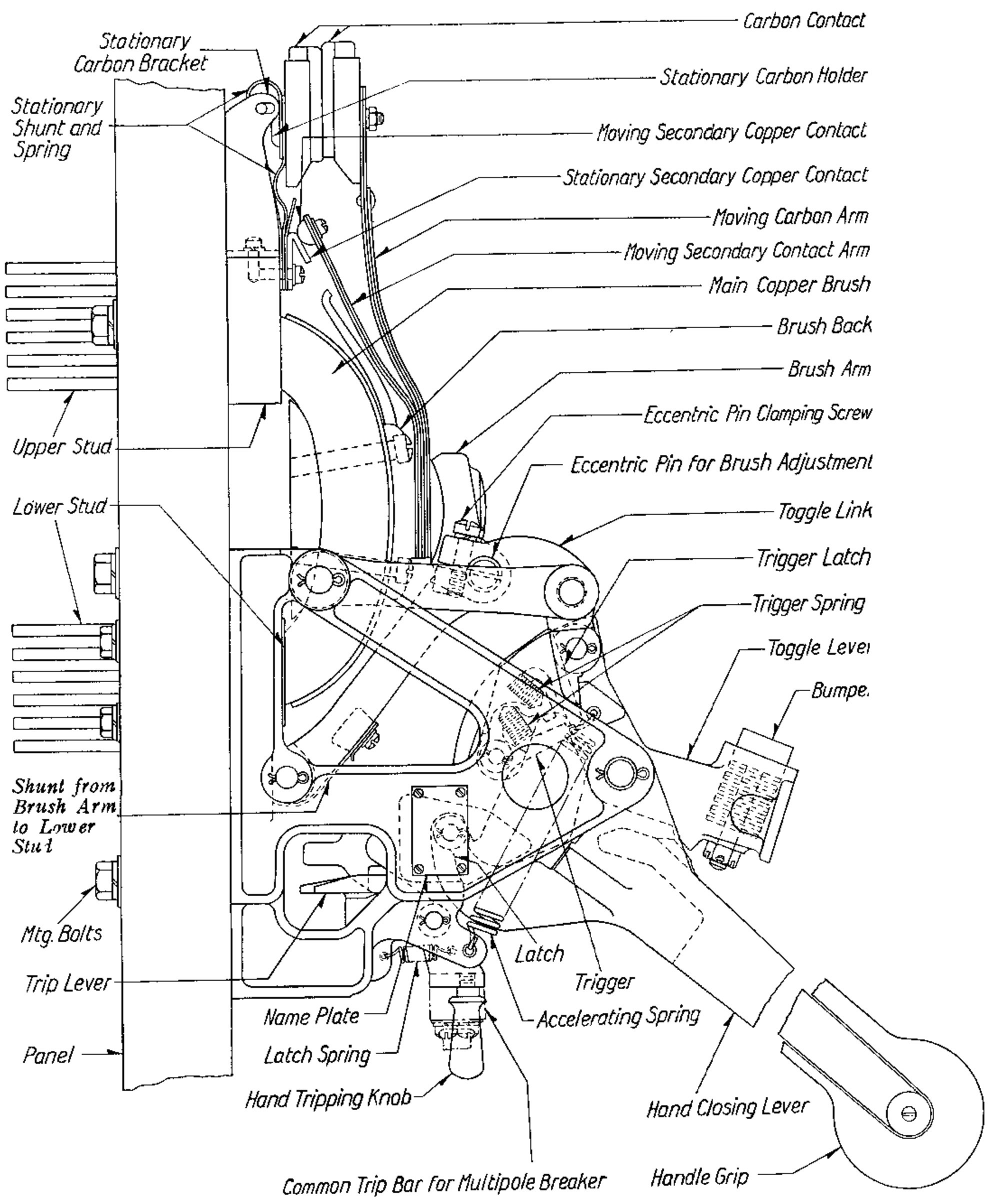


Fig. 2—Outline of a 2400-3000 Amp. D-C., Type CL Trip Free Carbon Circuit-Breaker, Without Overload Trip, Showing the Principal Parts

For the first case an adjustment is provided so that proper contact pressure can be obtained. An eccentric pin in the closing toggle when unclamped and turned by means of a screw driver so as to move the brush closer to the studs will give whatever increased pressure is required. See Figs. 3, 4 and 6.

In the second case poor electrical contact may be due either to copper oxide formation on the contact surface or else to failure of some of the brush laminations to touch the stud head. It should not be considered that when a circuit-breaker stays closed for a long time that it needs no attention. Oxides form just the same and the circuit-breaker should be opened occasionally so that the upper and lower brush contacts and stud heads may be cleaned with fine sandpaper. A good way to hold the sandpaper is shown in Figure 5. To determine whether the brush and stud heads are making good contact, mark the brush contact surfaces with a soft pencil. Place thin pieces of paper under the brush and then close the circuit-breaker. An imprint on the paper of every lamination of the brush indicates good contact. On the other hand, blank spaces here and there will indicate that some of the laminations are not touching. In this case it will be necessary to refit the brush very carefully by means of a file until it makes good contact.

The above instructions regarding removing oxides with sandpaper, etc., and fitting brushes with a file, apply only to circuit breakers having contacts not silver plated. The contacts of many breakers are silver plated. This plating is only a few thousandths of an inch

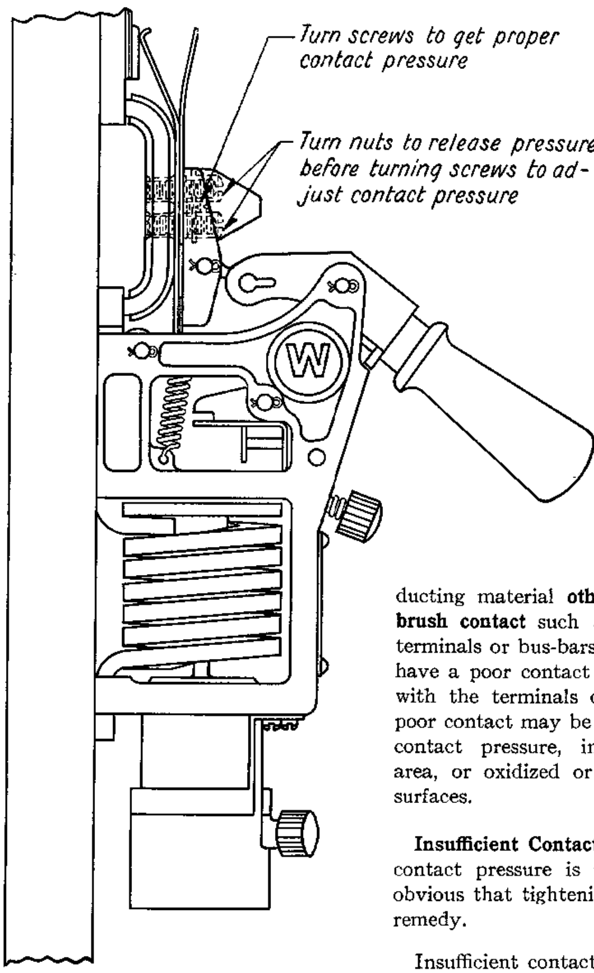


FIG. 3—12½ TO 200 AMPS., CL BREAKERS SHOWING CONTACT ADJUSTMENTS

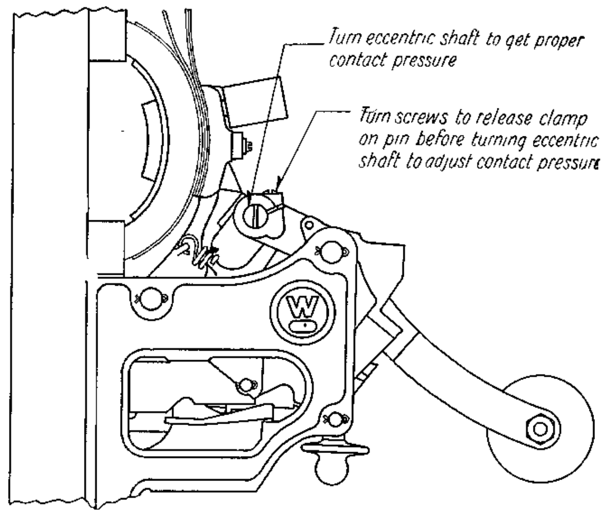


FIG. 4—400 TO 2000 AMPS. D-C., CL BREAKER SHOWING CONTACT ADJUSTMENTS

thick so no scouring or filing should be done except to remove high spots caused by burning.

Silver plated contacts soon turn dark from oxidizing or sulphiding. Since these darkened contacts still have low contact resistance, they should be cleaned only by a cloth moistened with an organic solvent, such as alcohol or naphtha.

As mentioned before overheating may be due to any one or all of a number of causes, other than poor main brush contact. One cause of overheating is the use of insufficient lead capacity or the use of a hot ammeter shunt too near the circuit-breaker. Another cause is defective contact between parts of the conducting material **other than the main brush contact** such as nuts, clamping terminals or bus-bars to the studs may have a poor contact with the studs or with the terminals or bus-bars. This poor contact may be due to insufficient contact pressure, insufficient contact area, or oxidized or corroded contact surfaces.

Insufficient Contact Pressure—If the contact pressure is not enough, it is obvious that tightening the nuts is the remedy.

Insufficient contact area may be due to untrue surfaces on the nuts, studs or bus-bars or terminals, or too small or too few nuts. Contact surfaces that were true when made may become untrue by being battered, raising high spots on the surface. When the amount of battering is small and the surface is plain, the best way is to carefully file off the high spots. If the amount of battering is large, it is best to machine the surface. Where it is the threads on the studs that are battered, they can usually be partially restored by filing away the high spots with a small three cornered file.

Oxdiation and Corrosion—Oxidized and corroded surfaces of threads on studs and nuts may be cleaned by rubbing with a brush, a piece of cloth, or waste dipped in a mixture of water and powdered pumice stone, or some other finely ground scouring material.

Defective Joints—Overheating may be due to a defective soldered joint. It often happens that a soldered joint that was good when made has been partially broken by too great a mechanical load on the joint. The heat then developed has melted the solder causing it to run out of the joint. A soldered joint may be spoiled similarly by an overload, causing the solder to melt and part of it to run out of the joint, rendering it incapable of carrying its rated load thereafter.

Unpacking—When unpacking a circuit-breaker care should be taken to see that all parts are in good condition.

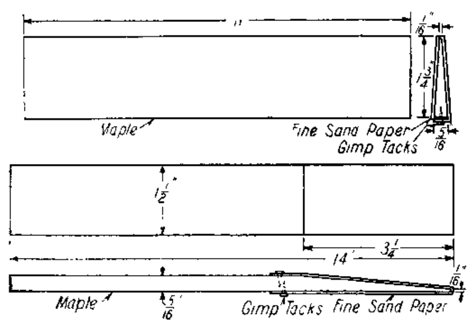


FIG. 5—SANDPAPER HOLDER

ARCING DISTANCE FOR MOUNTING ONE BREAKER ABOVE ANOTHER BREAKER

Breakers below 1200 Amperes without barriers should have 8 inches Clearance between Metallic parts
Breakers below 1200 Amperes with barriers should have 5 inches Clearance between Metallic parts
Breakers above 1200 Amperes without barriers should have 12 inches Clearance between Metallic parts
Breakers above 1200 Amperes with barriers should have 7½ inches Clearance between Metallic parts

INSULATION CLEARANCE

Between live parts and ground

Creeping Distance	Voltage	Striking Distance
1 inch	125	½ inch
1¼ inches	250	¾ inch
2 inches	600	1 inch
2⅛ inches	750	1½ inches

Transferring Circuit-Breakers

A prolific source of trouble with carbon circuit-breakers is the transfer of the breaker from the base on which it was mounted in the factory to a panel of a switchboard. Most carbon circuit-breakers depend on the base to hold some of the parts in proper relation to each other. Type CL carbon circuit-breakers, however, are provided with one piece frames and may, therefore, be moved from one panel to another with much less difficulty than breakers with two piece frames which are held in alignment by the panel. It is, of course, necessary to align one pole with respect to another in order to obtain proper operation of common trip and common closing bars. Each pole unit, however, with its one piece frame retains shaft alignments independently of the panel.

When mounting multipole circuit-breakers it is very important that the pole units be lined up properly with respect to each other, so that the common trip and common closing bars operate freely. To check this, take a shaft as long as the total width of the breaker (not pole unit) and of the same diameter as the handle lever fulcrum shaft and push it through the holes in the frames from which the handle lever fulcrum pins have been removed. This should be done before tightening the frame mounting bolts. See that the shaft turns freely and then tighten the frame mounting bolts. The shaft may then be removed and the breaker assembled with assurance that the pole units will be in proper alignment.

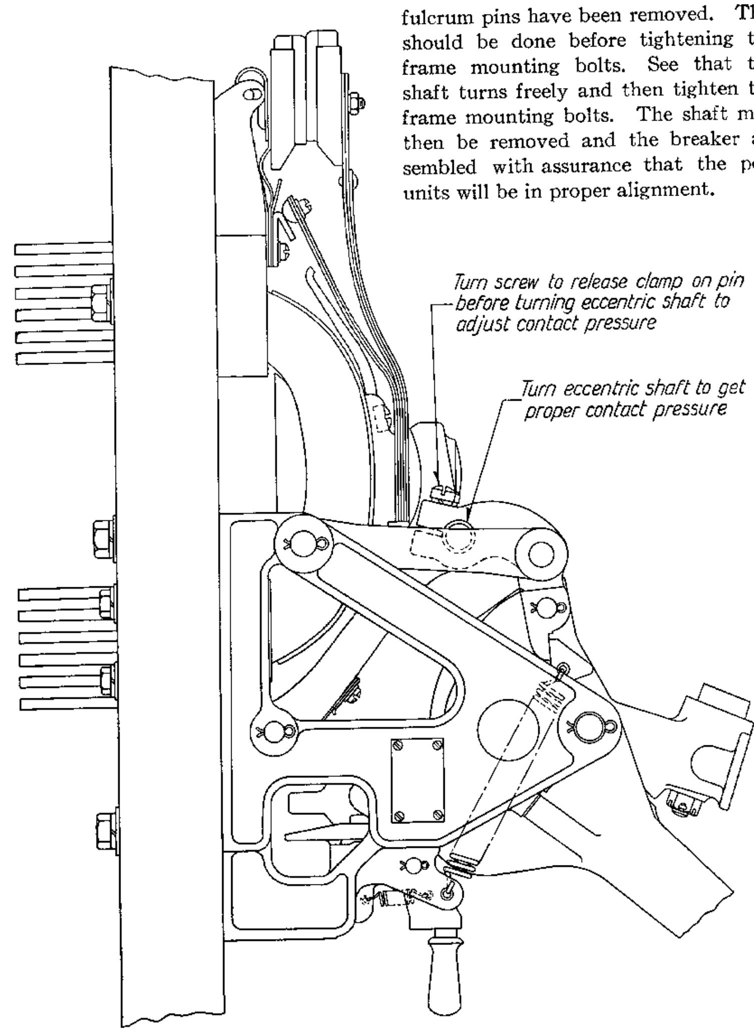


Fig. 6—3000-14000 Amps.,-CL Trip Free Breaker Showing Contact Adjustments

When clamping the upper stud in place, do not clamp so tight as to distort contact surface. Be sure to see that it is in proper relation to the moving parts such as carbon arm, brush and secondary contacts.

When clamping the bottom stud of overload breakers in place, care must be used not to twist coil so as to short out turns or short coil by turn of coil touching frame.

Trip-Free Circuit-Breakers—When an operator closes a non-trip free circuit-breaker by hand, he can hold it closed even though an overload exists on the line. For this reason a knife switch is usually supplied in series with each circuit-breaker. This switch is intended to be opened by the operator after the breaker opens and closed again after the breaker is closed. In this way the breaker is free to open if there is an overload on the line thus giving the desired protection.

In the trip-free circuit-breaker the closing handle is latched to the closing toggle in such a manner that the closing toggle trips free of the closing handle when the breaker is being closed in on an overload. The breaker therefore opens independently of the closing handle and cannot be held closed.

This same trip free feature can be obtained with multi-pole instantaneous trip non-trip-free circuit-breakers by having separate closing handles. After one pole is closed, an attempt to close the other pole, when an overload exists, will trip out the first pole. This scheme works well with two-pole circuit-breakers which protect a single circuit but it is usually necessary to have common closing handles on three-pole circuit-breakers particularly when they are used in protecting three-phase circuits. In the latter case it is of course necessary to have the trip-free pole units in order to get the trip-free feature.

Tripping Devices and Attachments

Instantaneous Trip (See Figure 7)—The instantaneous trip device is used to trip a circuit-breaker whenever the current in the circuit which the breaker protects exceeds a certain predetermined safe value. It consists of a coil in series with the line, the ampere turns of which act on a magnetic circuit consisting of a stationary portion and a movable iron armature. When the ampere turns of the series coil are great enough or in other words when the current through the series coil reaches a certain value the magnet armature is attracted to the stationary portion and this movement serves to trip the breaker latch. The instantaneous trip device will trip the circuit-breaker on any overload above its setting. The amount of current required in the series coil of a given overload trip device to cause it to trip the breaker is necessarily dependent upon the air gap between the movable armature and the stationary magnet. Various tripping points can be obtained by varying this gap and it is by this means that all CL carbon circuit-breakers are calibrated for overload. The standard range of calibration is 100% to 200% of the normal current rating of the circuit-breaker. The five main points, 100%, 125%, 150%, 175%, 200% are stamped on a suitable scale plate. The means of adjusting the air gap are shown in Figure 7. Of the total travel of the overload magnet armature, that part used to move the breaker trigger, should be just enough to trip the trigger free of the latch lever. When so adjusted the maximum amount of the armature travel is being used to obtain momentum for tripping the breaker and the magnet is being used at its best efficiency. This applies to any automatic tripping device.

It sometimes happens that even though the current flowing is very much less than the overload setting of the circuit-breaker, the breaker will trip out. Unless the breaker is tripped open due to some excessive vibration or shock the trouble can invariably be traced to some other attachment such as an undervoltage release or auxiliary relay. (See Undervoltage Release Attachment). It rarely, if ever, is due to faulty operation of the overload trip. Powerful stray magnetic fields do affect the calibration points to some extent on the larger breakers and where the bus arrangement of the switchboard is known the breakers are calibrated at the factory with this same arrangement. By this means the effect of the stray fields due to the bus-bars is taken into account.

For direct-current service the overload magnet is solid. Any attempt to use this on alternating-current except in the 12.5 to 800 ampere breakers, will result in overheating of the circuit-breaker since the eddy currents set up in the magnet will make it very hot. Laminated magnets are always provided in circuit-breakers above 800 amperes in capacity. Even then, due to the eddy currents set up in the copper conducting parts, breakers above 800 amperes in capacity must have an A-C. rating materially less than their D-C. rating; this difference increasing with increased capacity.

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

Inverse-Time-Limit Attachment (Figure 10)—The inverse-time-limit attachment will not trip breaker on short time overloads. This attachment is calibrated without oil in pot. With current flowing through breaker same as calibration setting the inverse-time-limit attachment with oil in pot will not trip breaker.

The inverse-time-limit attachment used on type CL breaker is of the sucker type. The sucker which is a smooth surfaced metal disc is attached to the overload armature and normally rests on the smooth bottom surface of a pot coning a small quantity of oil (approximately ⅛" deep). The resulting sucker action retards the starting of movement of the overload armature and unless the overload which occurs is very heavy, a considerable time will elapse before the armature can move.

For breakers above 400 amperes in capacity, the amount of surface in contact between the sucker and pot can be varied, thus providing variation in time limit. Further variation can be

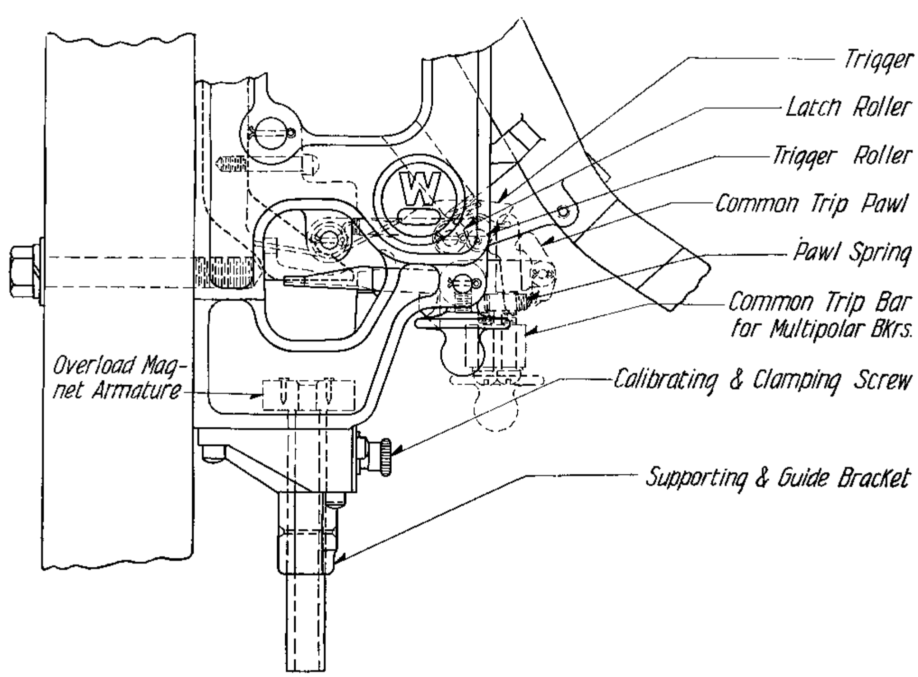


FIG. 7—INSTANTANEOUS TRIP ATTACHMENT

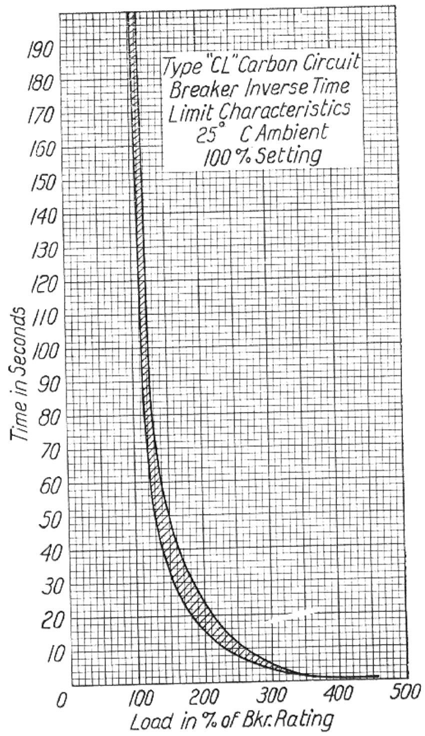


FIG. 8—CHARACTERISTIC CURVES OF INVERSE-TIME-LIMIT DEVICE

75% Setting will be Approximately 75% of readings.
50% Setting will be Approximately 50% of readings.
25% Setting will be Approximately 25% of readings.
0% Setting will be Approximately 2% of readings.

obtained by using oils of different viscosities.

To keep the inverse time limit in good working order it is necessary that the oil be kept clean. A single particle of dirt between the two contact surfaces will sometimes greatly reduce the time lag. If imperfections appear in the contact surfaces due to bruising or other causes all high spots should be removed with a scraper.

Care Should be Taken not to Interchange Overload Details

Removing or Replacing Oil Dash Pot, on 600 and 800 Ampere Breakers

1. Loosen both knobs on the overload dash pot.
2. Place both knobs straight to the left hand side of the breaker, facing the breaker.
3. Turn both knobs in unison to the extreme right, looking at the bottom of the oil pot, and continue the lower knob to the right unit it hits the panel.
4. Then, holding the lower knob against the panel, turn the upper knob to left until the two knobs are 180° apart.
5. Pull the lower portion, onto which the lower knob is attached, downward approximately ¼″.
6. Turn the upper knob to extreme right as far as possible and then turn the lower knob to the left until it is directly beneath the upper knob.
7. Remove the lower oil pot by pulling straight downward.
8. To replace the dashpot it is merely necessary to reverse the above procedure.

Undervoltage Release Attachment (Figure 11)—This is a device for use in automatically tripping a circuit-breaker when the supply voltage drops to a predetermined value. The mechanism consists of a solenoid type of magnet, the movable core of which is held to the stationary core against a strong spring. When rated voltage is applied to the coil of the magnet, sufficient current flows through it to hold the movable core against the resistance of the spring but when the voltage drops to less than 60% of normal the pull of the magnet is no longer great enough and the spring propels the movable core upwards thus tripping the breaker.

For use on direct-current the magnet is made of solid iron but for alternating-current service the iron parts are laminated.

In the direct-current undervoltage mechanisms a thin brass washer is placed between the movable and stationary cores. It is evident that the voltage at which the undervoltage mechanism releases may be varied by putting in washers of different thickness, since the length of the air gap and consequently the strength of the pull between the cores, depends upon the thickness of the

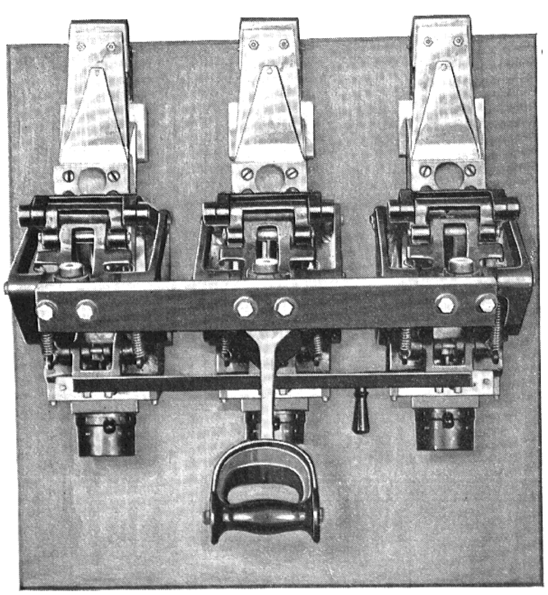


FIG. 9—3000 AMPS., D-C., 3-POLE, TYPE CL TRIP-FREE CARBON CIRCUIT-BREAKER WITH INVERSE-TIME OVERLOAD ATTACHMENTS

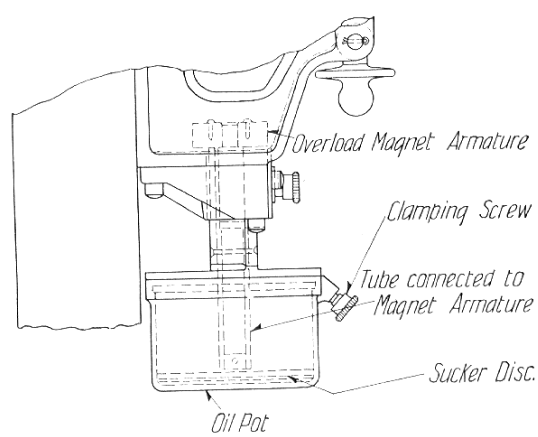


FIG. 10—INVERSE-TIME-LIMIT OVERLOAD ATTACHMENT

intervening washer. This adjustment while probably not so convenient as some, is very simple and effective. It is in addition to that obtainable by changing the movable core spring pressure and also by changing the resistance supplied in series with the coil. The last two methods have their limitations, however, since the spring pressure cannot be reduced below that value required to trip the breaker and too great a reduction in the resistance in series with the coil will allow a current to flow which is greater than the coil capacity.

In the alternating-current undervoltage mechanisms no washer is placed between the movable and stationary cores and so the only adjustment available for a given coil and resistance is in the spring pressure. Unless the coil impedance is only a small portion of the combined coil and resistor impedance the coil should be cut out of circuit when the mechanism is in the tripped position. This follows because the coil impedance is considerably less for open gap than for closed gap between the cores and sufficient current would flow to burn out the coil. In this case an automatic reset attachment should be used.

Hand Reset—After this mechanism trips, the magnetic force set up between the movable and stationary cores by re-establishment of normal voltage, is insufficient to pull the movable core downward against the spring. Hence, when automatic operation is not required a knob is provided for resetting this device by hand. It should be noted, however, that the coil should be cut out of circuit when the breaker opens. The breaker will have to be reclosed, before the undervoltage mechanism can be reset.

Automatic Reset—There are occasions, however, when automatic reset is required, particularly for remote control apparatus and for electric operated breakers. For this service a link and reset spring are provided which are actuated by the opening motion of the circuit-breaker to reset the undervoltage mechanism. This reset should be checked so that when the breaker opens the undervoltage moving core is pushed down until it almost touches the stationary core. Then if normal voltage is on the coil its ampere turns will be sufficient to hold the movable core against the tripping spring.

All Continuous Voltage Coils—For coils that are in circuit continuously it is important that the voltage across the coils shall never be more than 5% greater than rated voltage for any appreciable length of time. An excessive voltage will cause overheating of the coil and subsequent breakdown or short circuit.

Shunt Trip Attachment (Figure 12)—The shunt trip attachment is for use in tripping a circuit-breaker by means of a push button from some distant point or is sometimes used with circuit closing relays for tripping the breaker.

The shunt trip magnet is of the solenoid type, the movable core of which is pulled towards the stationary core when the shunt coil is energized. Movement of this core trips the circuit-breaker and the coil is immediately cut out of circuit by an auxiliary contact on the circuit-breaker when the latter opens. This is necessary since the shunt trip coil is short time rated and would soon burn out if the voltage were applied for any length of time.

The total movement of the trip magnet core or that part which is used

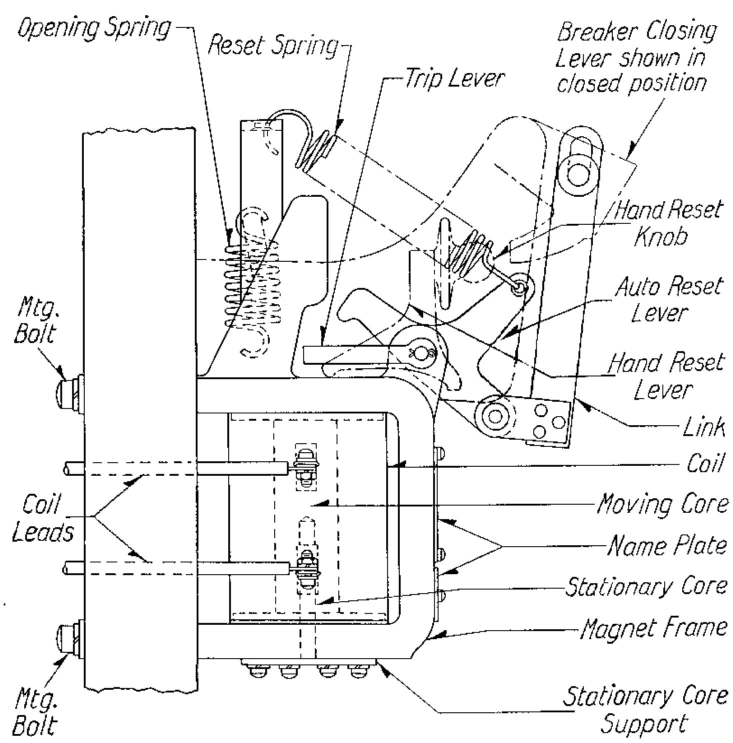


FIG. 11—UNDERVOLTAGE RELEASE ATTACHMENT

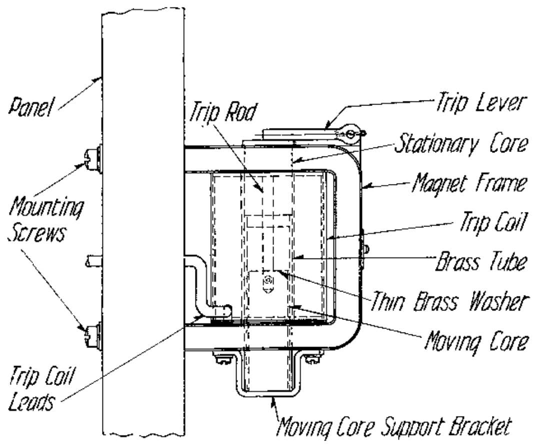


Fig. 12—Shunt Trip Attachment

to move the trigger of the breaker should be just enough to trip this trigger free of the latch lever. This adjustment should be taken care of when mounting the attachment on the panel.

A brass washer is placed between the movable and stationary cores to prevent "freezing". This permits the moving core to return to its normal position after the coil is de-energized and it is then ready to again perform its tripping function. Absence of this brass washer will permit sufficient residual magnetism to hold the movable core against the stationary core, even after the coil is de-energized, and it will then be impossible to trip the breaker open by means of the shunt trip until the movable core is forcibly retrieved, or until the residual magnetism disappears and the core drops back of its own accord.

The standard range of coil voltage over which the shunt trip mechanism operates is 56% to 112% of normal rated coil voltage.

Reverse-Current Trip (Figure 13)—This device is used to protect a circuit against reversal of power or reversal of current.

The reverse-current mechanism consists of a stationary magnet energized by a series coil and a movable iron armature energized by a shunt coil, or vice versa. For a given shunt coil voltage the armature acts in a way similar to a permanent magnet. This armature is pivoted midway between two pairs of poles on the series magnet and will be attracted to one pair or the other depending upon the relation of shunt and series ampere turns. When the series current is flowing in the normal direction the armature is attracted to one pair of poles against an adjustable cam. When the current reverses; the shunt coil current still remaining the same in direction; the armature is attracted to the other pair of poles and if the reversal of current is as large or larger than the setting, the armature will move over and trip the breaker. The amount of current reversal required depends upon the air gap relation between the stationary and armature poles. This relation may be varied by means of an adjustable cam. The standard calibration range of 5%-10%-15%-20%-25% of normal breaker rating marked on the scale plate is obtained in this way.

It is evident that voltage must be applied to the shunt coil in one particular direction. When the coil is incorrectly connected the reverse-current attachment will trip the breaker open when current flows in the normal direction. In this case the leads should be reversed.

The armature of this device is retrieved by means of a light spring after tripping. However, the shunt coil must be cut out of circuit to accomplish this, when the breaker opens. This is done by means of an auxiliary switch on the breaker.

Two screws, one at each end of the calibration scale, prevent moving the calibrating cam beyond its range.

Solenoid Closing Mechanism (Figure 14)—Circuit-breakers for electrical remote control are equipped with our standard closing solenoid and shnut trip attachments. The closing solenoid coils have a short time rating and in order to avoid burning them out must be cut out of circuit as soon as the breaker is closed and latched. This is ordinarily done by means of a hesitating switch, control drum switch and a small contactor which is connected in series with the closing coil. When the control drum switch is turned to the "on" position, the contactor closes and energizes the closing coil. After the breaker is closed the operator cuts off the closing coil by allowing the control drum switch to return to neutral position. This releases the contactor, which in turn opens the closing coil circuit. Telescoping closing links are provided with non-trip free breakers, which permit the closing magnet mechanism to retrieve by gravity after the breaker is closed.

Trip free breaker links do not retrieve when breaker closes, springs are provided to retrieve links when breaker opens.

The closing coil is designed so as to close the breaker on which it is applied over a range of 72% to 104% of normal rated coil voltage. Voltages much higher than 104% should not be applied since the resulting slamming action of the breaker will tend to break the carbons.

When transferring a solenoid operated breaker from one panel to another, care should be taken to see that the stationary core of the closing magnet is adjusted so as to give a slight overtravel on the breaker latch when the breaker is closed electrically. This adjustment may be made by adding or removing washers under the supporting plate of the stationary core. See Figure 14.

Field-Discharge Attachment (Figure 15)—Field-discharge circuit-breakers are used to protect the shunt fields of large separately excited generators. The standard arrangement consists of a single-pole or two-pole, non-trip free hand or solenoid operated carbon circuit-breaker without overload trip but equipped with shunt-trip, auxiliary switch and field-discharge attachments.

The field-discharge attachment, when the breaker opens, connects a resistor across the generator shunt field and thus discharges whatever voltage may have been induced in this winding when it was disconnected by the breaker from its normal voltage supply. If this were not done, the excessive voltage induced in the field winding would break down its insulation.

The type CL field-discharge attachment is nothing more than a knife switch operated by the circuit-breaker. It is not connected directly to the circuit-breaker by a rigid member, but is equipped with a ratchet device which permits a certain amount of lost motion between the two. The links connecting the breaker to this ratchet device are adjustable and care should be taken when transferring this attachment from one panel to another, to make such adjustment on these links as to give the following operation.

When the circuit-breaker is opening, the discharge switch should make contact an instant before the carbons part.

When the circuit-breaker is being closed the discharge switch should part contact before the carbons touch.

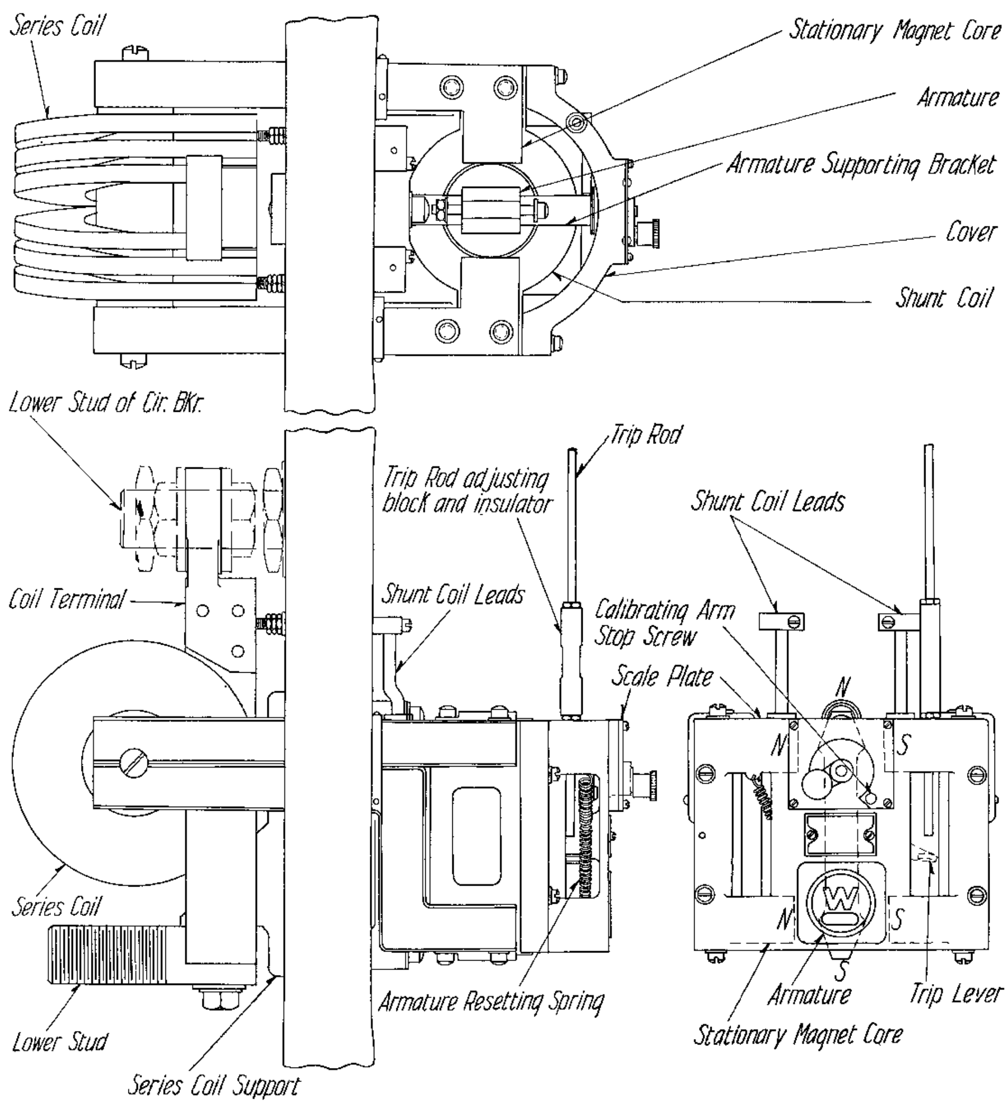


FIG. 13—REVERSE-CURRENT TRIP MECHANISM

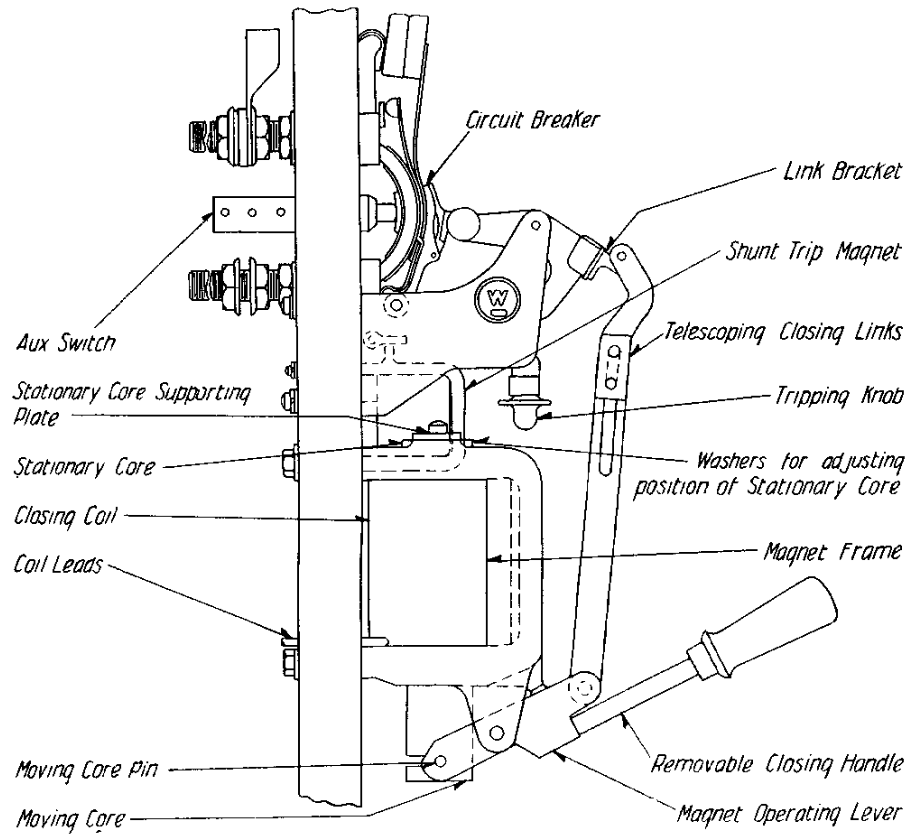


FIG. 14—SOLENOID CLOSING MECHANISM FOR NON-TRIP FREE BREAKERS

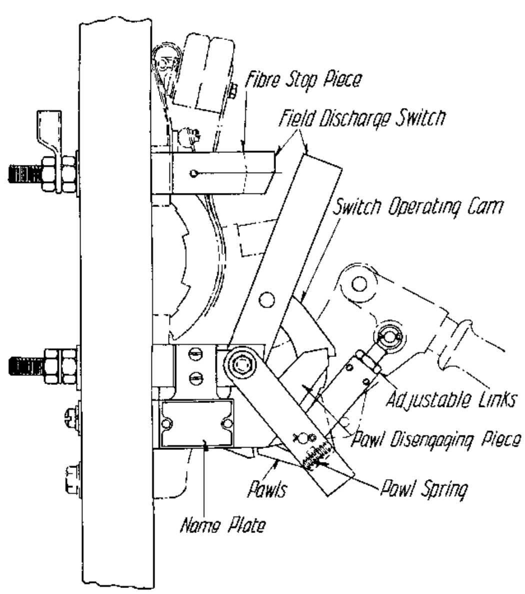


FIG. 15—FIELD-DISCHARGE-ATTACHMENT

Make these adjustments by **slowly opening** and **closing** the circuit-breaker by hand.

Care should be exercised in closing the breaker so the sequence of operation of the field switch is not destroyed. If the breaker is partially closed and allowed to open, the failure of the spring pawl to latch on the switch ratchet will disrupt the sequence of operation and the breaker must be closed and opened again to establish the correct relationship.

Electric Lockout (Figures 16 and 17) There are times when it is desired to lock a breaker in the open position when certain conditions exist. For this purpose a lockout attachment is provided which either latches the breaker open, or else interposes an arm which opposes the movement of the brush. Depending upon requirements the coil may lock the breaker open when energized, or it may be so arranged as to lock the breaker open when de-energized.

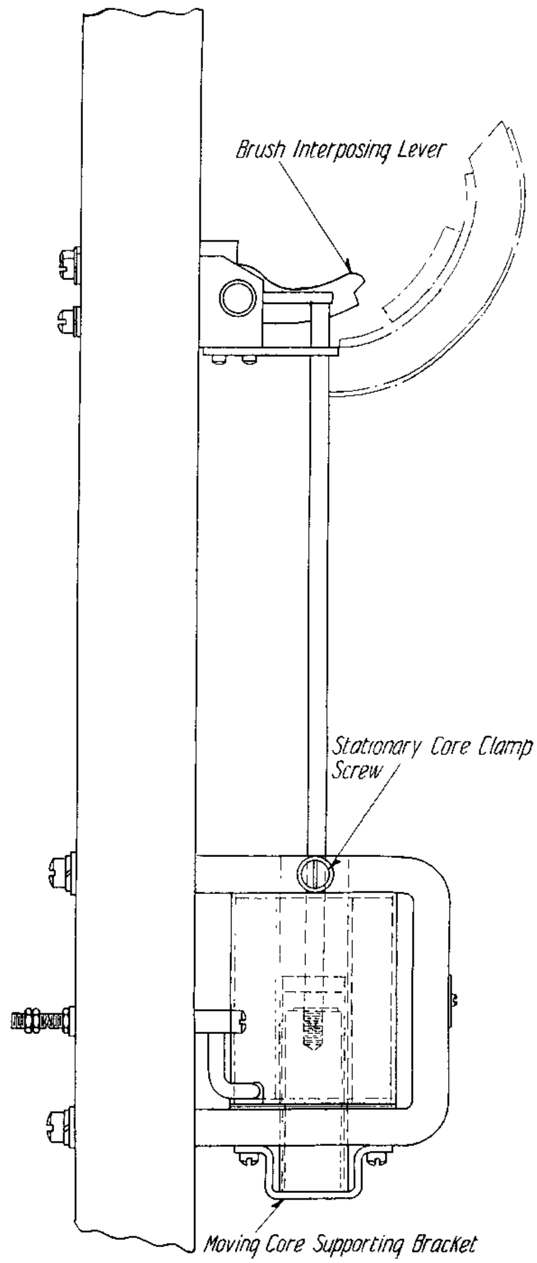


Fig. 16—Electric Lockout Attachment, Arranged to Lockout When Coil is De-Energized

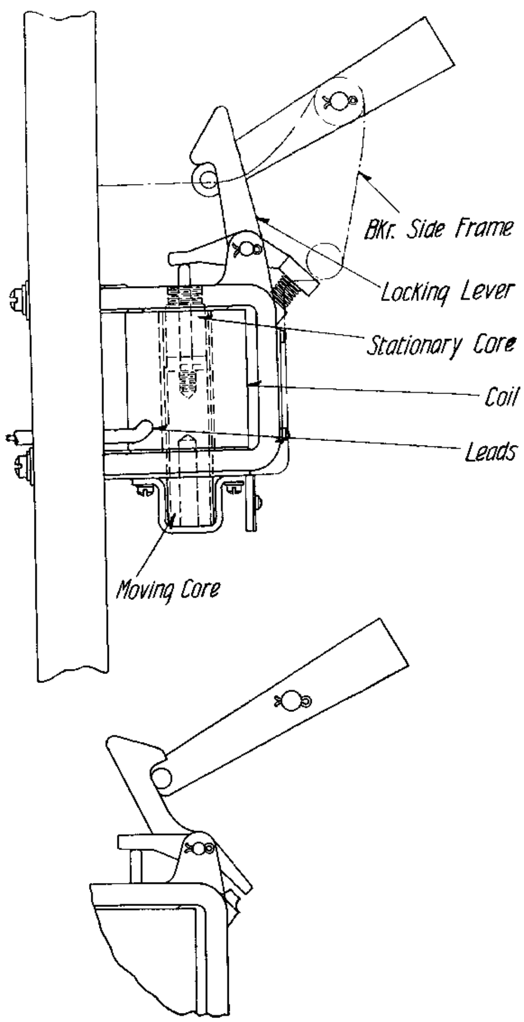


FIG. 17—ELECTRIC LOCKOUT ATTACHMENT

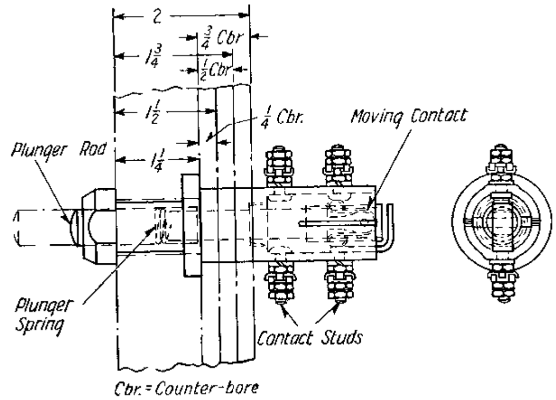


FIG. 18—S.P., D.T. AUXILIARY SWITCH

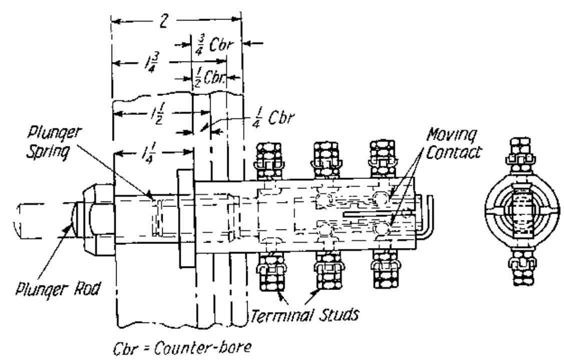


FIG. 19—D.P., D.T. AUXILIARY SWITCH

Auxiliary Switches (Figures 18-19 and 20)—Auxiliary switches are used for signal lamp purposes, shunt trip cut outs, electrical interlocking and similar applications.

Plunger type are either S.P.D.T. or D.P.D.T. and are mounted as a rule

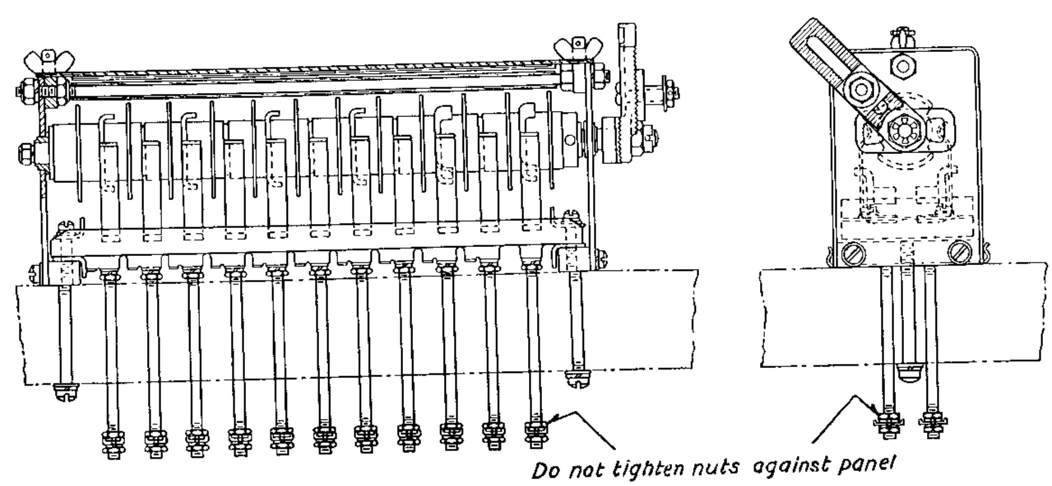


FIG. 20—TYPE W ROTARY SWITCH

directly under the circuit-breaker brush. A push rod extending through the panel operates the switch when the circuit-breaker is open or closed. Rotary type switches are simple and positive in operation and are mounted on front of panel. The switch is connected to an operating link by means of a crank on the end of a rotor. The operating link should be adjusted so that with breaker open the center of the moving break contact should be making contact with stationary contact and with breaker closed the center of the moving make contact should make contact with stationary contact. These switches should be inspected occasionally to see that the contact springs are in good working condition.

Bell Alarm When Breaker Trips From Overload (Fig. 21)—By the ringing of a bell or by a signal lamp, this device is used to indicate which breaker tripped from overload.

It consists of two auxiliary switches connected in series, a shoulder pin screwed to the breaker closing lever that operates the link and latch, by the opening or closing of the breaker. A trip knob and rod for breaking the circuit of the bell alarm. Rod should be adjusted so that the auxiliary switch makes contact when the breaker is closed and breaks the contact when the trip knob is pushed towards the panel and the latch engages the metal sleeve on the switch plunger.

Link should be adjusted to release the latch when closing breaker and to engage the latch when trip knob trips the breaker.

When breaker trips from overload the auxiliary switch under brush completes circuit for bell alarm, (see diagram for connections). To stop bell from ringing push the trip knob towards the panel until latch engages metal sleeve on the switch plunger.

Hesitating Switch (Fig. 22)—Hesitating switches are used in the solenoid circuit to cut off the closing current just before the breaker latches.

These switches are operated from the solenoid operating lever for trip free breakers and the breaker closing lever for the non-trip free breakers. They should be adjusted so that the contact breaks, just as the breaker latches and should have available overtravel at each end of the stroke.

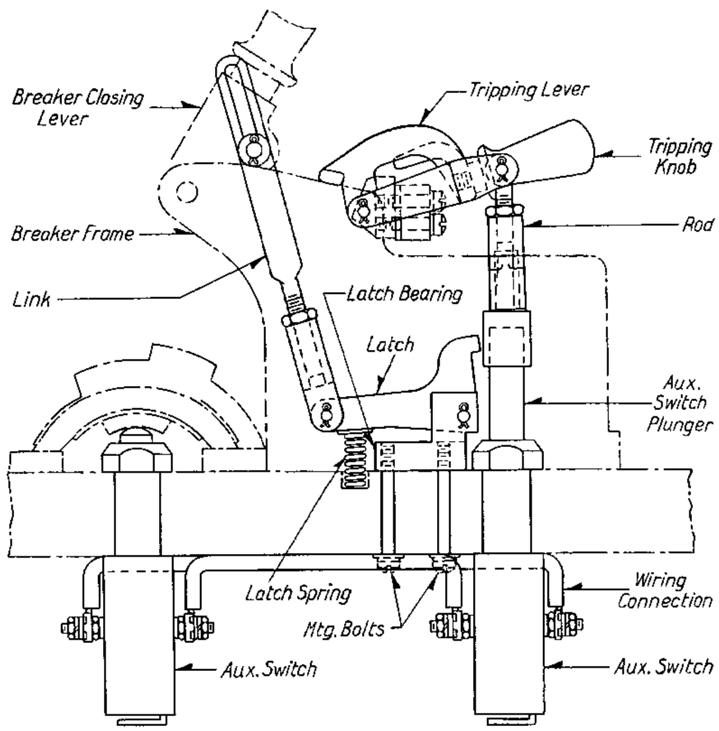


Fig. 21—Bell Alarm when Breaker Trips from Overload

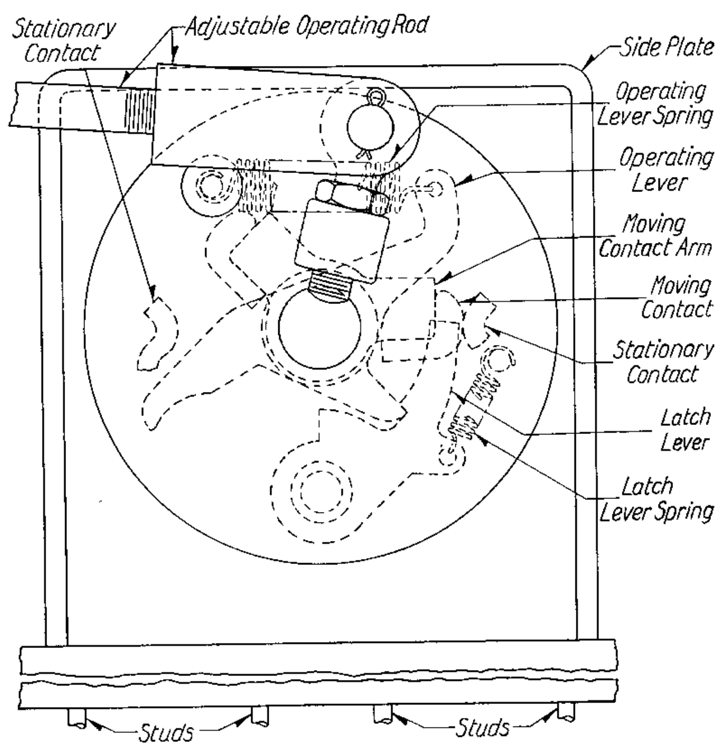


Fig. 22—Hesitating Switch

DIAGRAM INFORMATION

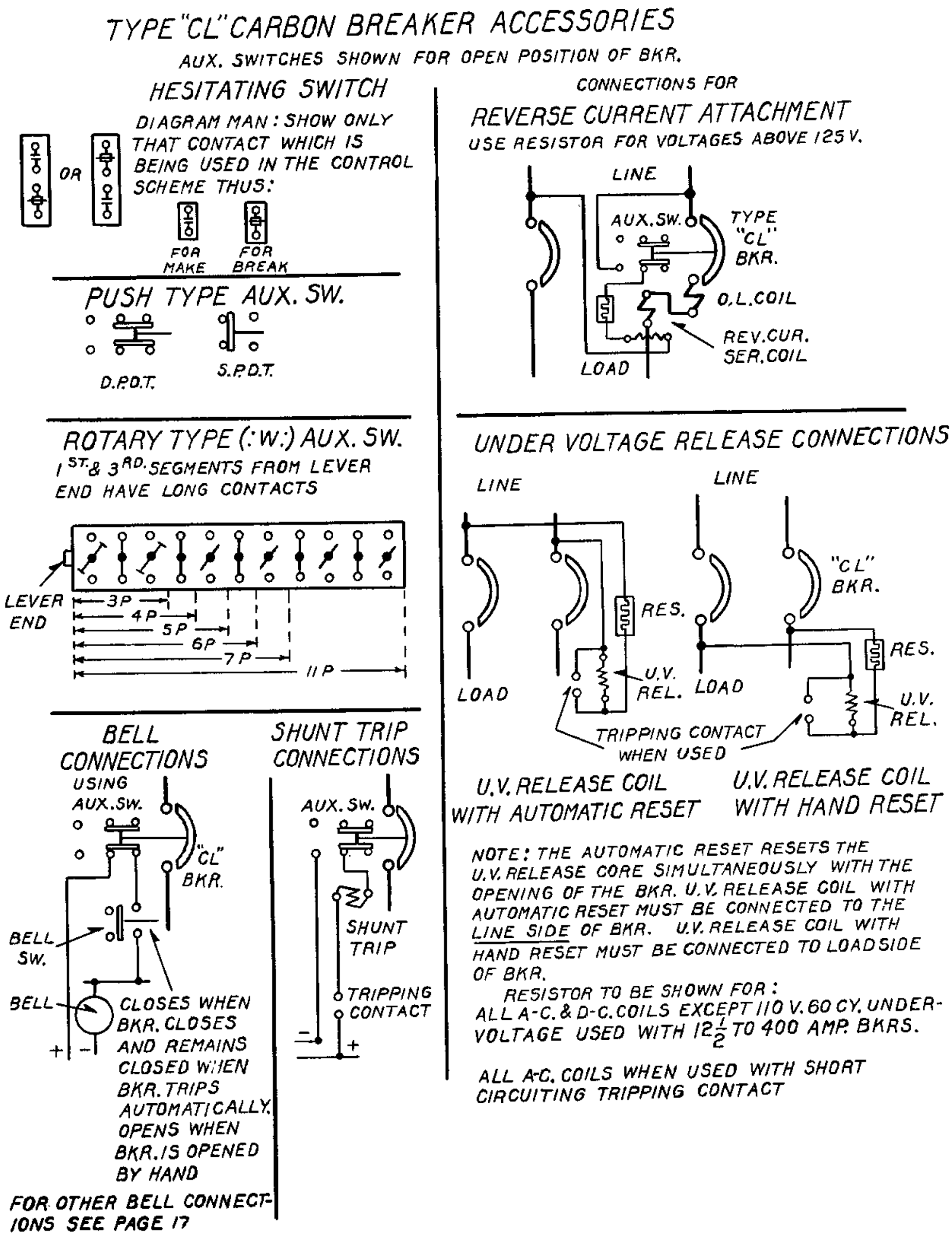
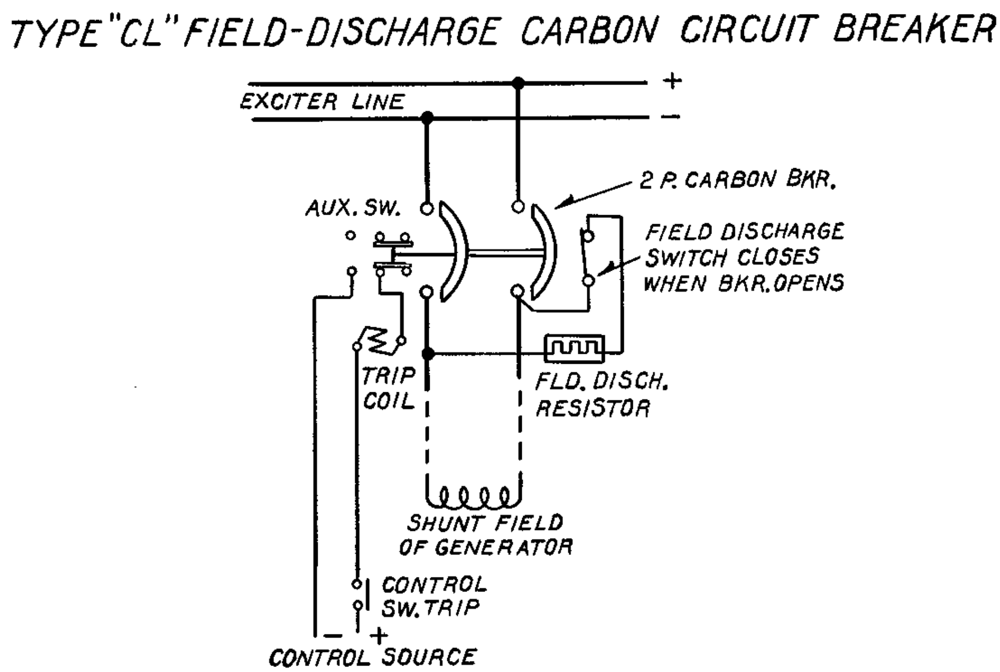


DIAGRAM INFORMATION—Continued



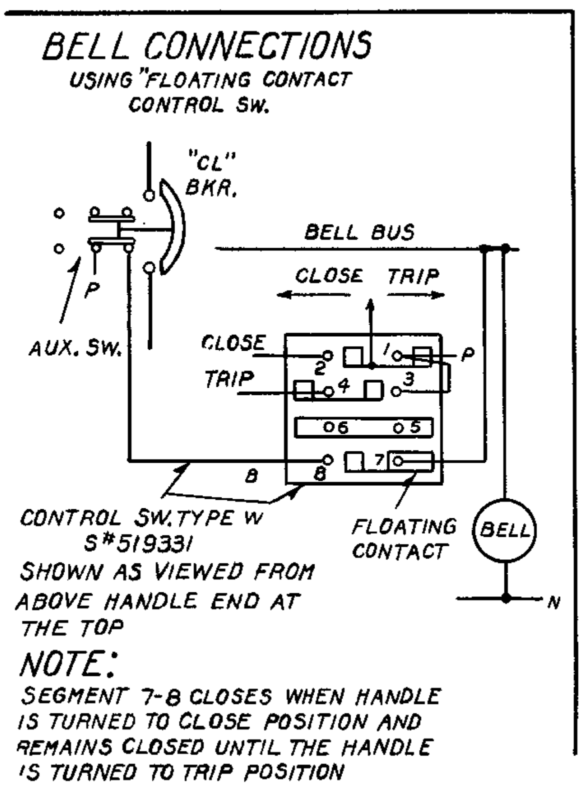


DIAGRAM INFORMATION—Continued

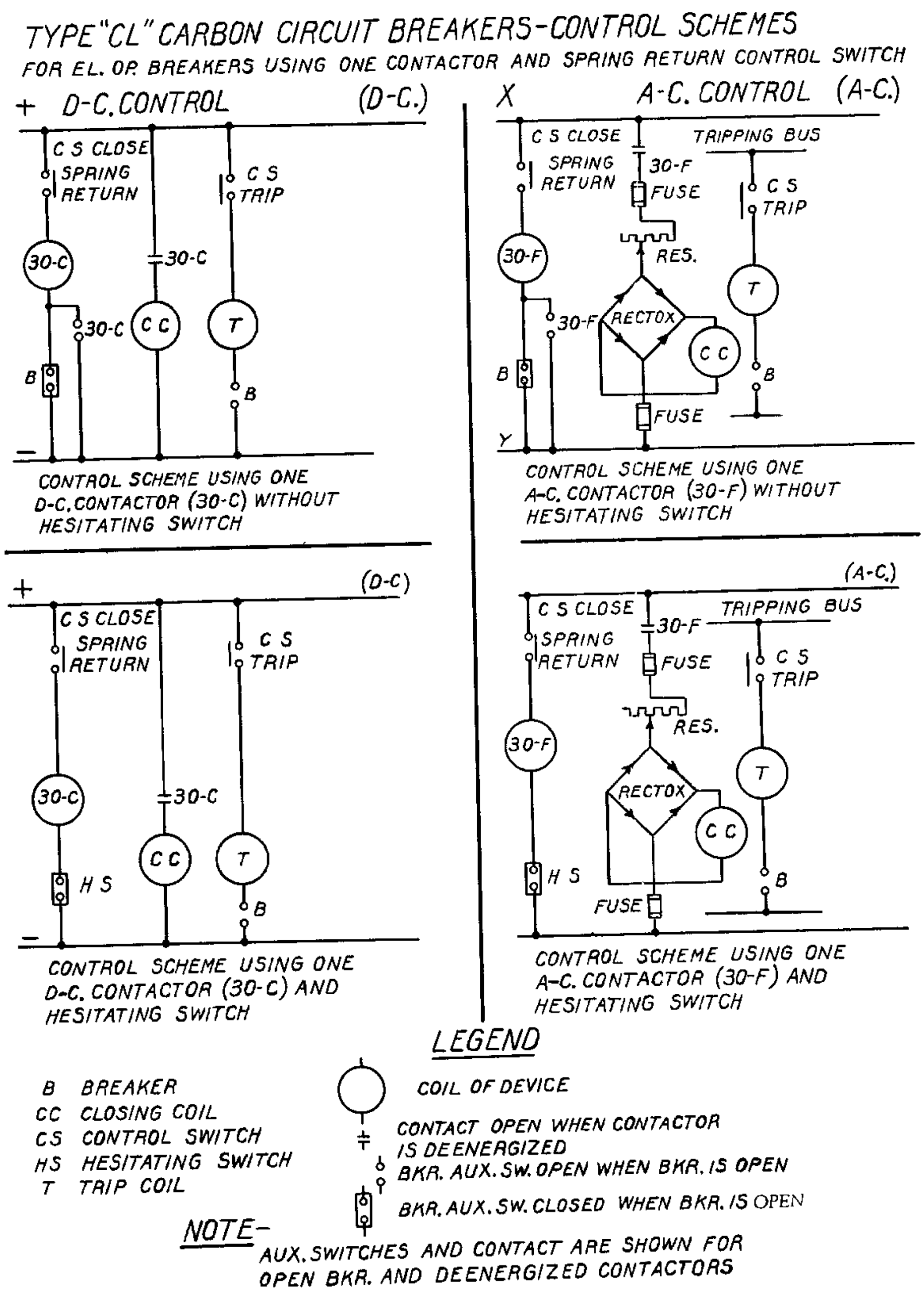
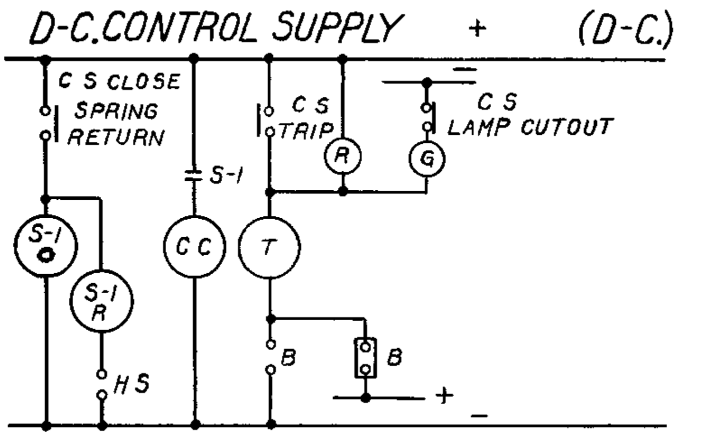


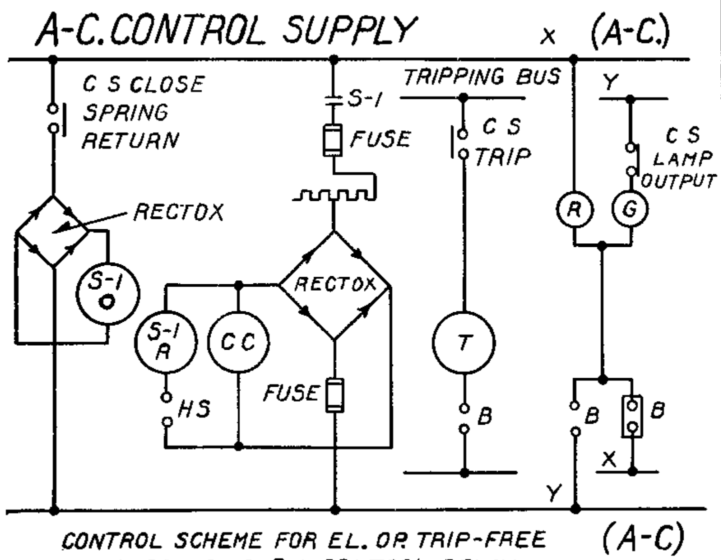
DIAGRAM INFORMATION—Continued

TYPE "CL" CARBON CIRCUIT BREAKERS

CONTROL SCHEMES FOR EL. OP. TRIP-FREE BREAKERS USING S-I RELAYS CANNOT BE USED WHERE THE CLOSE CONTACT IS OF STAY-PUT TYPE



CONTROL SCHEME FOR EL. OP. TRIP-FREE BREAKER USING S-I CONTROL RELAY ON D-C. SUPPLY



CONTROL SCHEME FOR EL. OR TRIP-FREE BREAKER USING S-I CONTROL RELAY ON A-C SUPPLY

LEGEND

B BREAKER
CC CLOSING COIL
CS CONTROL SWITCH
HS HESITATING SWITCH CONNECTED TO MECH.
S-I.O S-I CONTROL REL. OPER. COIL
S-I.R S-I CONTROL REL. RELEASE COIL
T TRIP COIL

COIL OF DEVICE

CONTACT OPEN WHEN RELAY IS DEENERGIZED

BKR. AUX. SW. OPEN WHEN BKR. IS OPEN

BKR. AUX. SW. CLOSED WHEN BKR. IS OPENED

NOTE

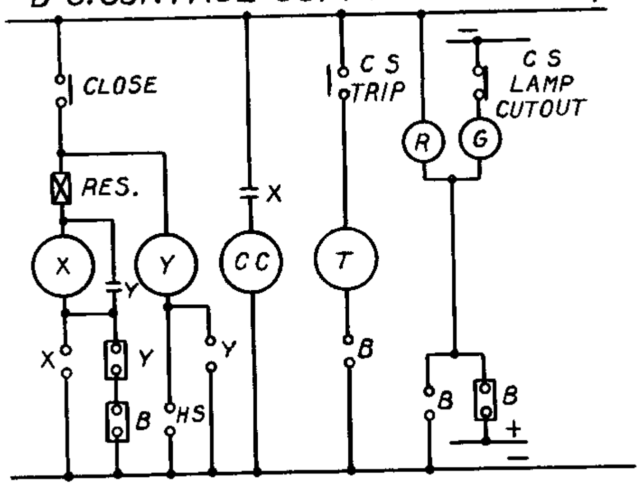
AUX. SWITCHES AND RELAY CONTACTS ARE SHOWN FOR OPEN BKR. AND DEENERGIZED RELAY

DIAGRAM INFORMATION—Continued

TYPE "CL" CARBON CIRCUIT BREAKERS CONTROL SCHEMES

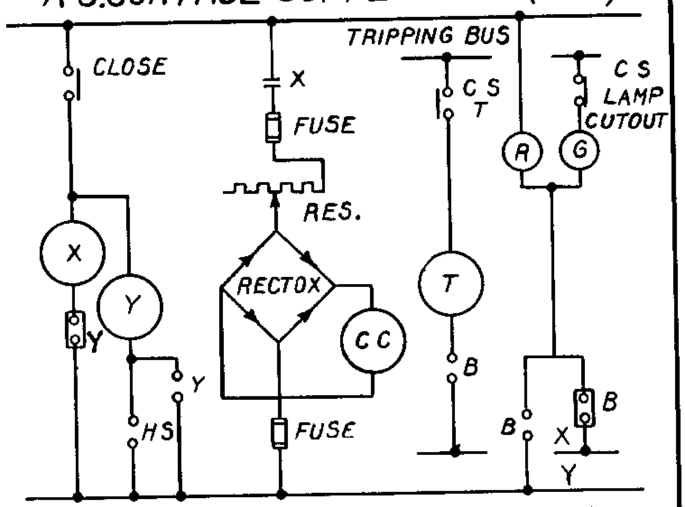
FOR EL. OP. TRIP FREE BREAKERS USING X-Y CONTACTORS. TO BE USED WHERE THE "CLOSE" CONTACT IS OF STAY-PUT TYPE OR SPRING RETURN

D-C. CONTROL SUPPLY + (D-C.)



CONTROL SCHEME FOR EL. OP. TRIP-FREE BREAKER USING X-Y CONTROL RELAYS ON D-C. SUPPLY

A-C. CONTROL SUPPLY (A-C.)



CONTROL SCHEME FOR EL. OP. TRIP-FREE BREAKER USING TWO A-C. CONTACTORS (X-Y) ON A-C. SUPPLY

LEGEND

- B BREAKER
- CC CLOSING COIL
- CS CONTROL SWITCH
- HS HESITATING SWITCH CONNECTED TO ELECTRIC MECHANISM
- T TRIP COIL
- X CONTROL RELAY
- Y AUX. CONTROL RELAY

COIL OF DEVICE

CONTACT OPEN WHEN CONTACTOR IS DEENERGIZED

BKR. AUX. SW. OPEN WHEN BKR. IS OPEN

BKR. AUX. SW. CLOSED WHEN BKR. IS OPEN

NOTE

AUX. SWITCHES AND RELAY CONTACTS ARE SHOWN FOR OPEN BKR. AND DEENERGIZED RELAY

Renewal Parts Data

Recommended Stock of Renewal Parts

TYPE CL CARBON CIRCUIT-BREAKER POLE UNIT

12.5 to 16,000 Amperes—250 to 600 Volts—D-C.—20°C.—Single Pole

The following is a list of the Renewal Parts and the quantities of each that we recommend should be stocked by the user of this apparatus to minimize interrupted operation caused by breakdowns. The parts recommended are those most subject to wear in normal operation or those subject to damage or breakage due to possible abnormal conditions. This list of Renewal Parts is given only as a guide. When continuous operation is a primary consideration, additional insurance against shut-downs is desirable. Under such conditions more renewal parts should be carried, the amount depending upon the severity of the service and the time required to secure replacements.

FOR ILLUSTRATION OF PARTS SEE FIGURE 2, PAGE 4.

Breaker Pole Units in use up to and including.............	1	5	Style Number of Part																					
Name of Part	Recommended for Stock		No. Per Pole Unit	12.5 to 200 Amperes	No. Per Pole Unit	300/400 Amperes	No. Per Pole Unit	600/800 Amperes	No. Per Pole Unit	600-800* Amperes	No. Per Pole Unit	1000 to 2400 Amperes	No. Per Pole Unit	1000 to 2400* Amperes	No. Per Pole Unit	3000 to 5000 Amperes	No. Per Pole Unit	6000 Amperes	No. Per Pole Unit	8000 Amperes	No. Per Pole Unit	10000 Amperes	No. Per Pole Unit	16000 Amperes
Breaker Pole Unit Complete	0	0	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†
Moving Carbon Arm Complete	0	0	1	687483	1	687481	1	766025	1	766025	1	†	1	†	1	†	1	†	3	†	4	†	..	......
Moving Carbon Arm Complete—R.H.	0	0	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	3	695441
Moving Carbon Arm Complete—L.H.	0	0	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	3	695442
Carbon Contact—Moving	1 set	2 sets	1	550971	1	550971	1	550972	1	550972	1	494569	1	494569	1	483717	2	494569	3	483717	4	483717	6	483717
Moving Secondary Contact Arm Complete	0	0	1	553054	1	389536	1	766026	1	766026	1	†	1	†	1	†	1	†	3	†	4	†	..	......
Moving Secondary Contact Arm Complete—R.H.	0	0	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	3	711961
Moving Secondary Contact Arm Complete—L.H.	0	0	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	..	......	3	711962
Secondary Copper Contact—Moving	1 set	2 sets	..	......	1	379297	1	387527	1	387527	1	382077	1	382077	2	383217	2	382077	6	383217	8	383217	12	383217
Main Copper Brush	0	0	1	323277	1	385597	1	385609	1	385609	‡	†	‡	†	2	†	2	†	3	422821	4	422821	6	422821
Shunt from Brush Arm to Lower Stud	0	..	..	......	..	......	..	......	..	......	1	662603	1	662603	1	483725	2	483727	3	483727	4	483727	6	483727
Stationary Carbon Holder Complete	0	..	1	687480	1	687480	1	687478	1	707737	1	684790	1	833506	1	710808	2	833687	3	†	4	†	6	845099
Shunt and Spring	0	..	1	591811	1	591811	1	687479	1	707739	1	653886	1	833507	1	710809	20	685366	3	†	4	†	6	845100
Carbon Contact—Stationary	1 set	2 sets	1	550971	1	550971	1	550972	1	550972	1	494569	1	494569	1	483717	2	494569	3	483717	4	483717	6	483717
Secondary Copper Contact—Stationary	1 set	2 sets	1	379294	1	379294	1	387522	1	707738	1	382140	1	686434	1	383205	1	383204	3	383205	4	383205	6	383205
Accelerating Spring	0	..	1	323231	2	379314	2	387539	2	666090	2	382083	2	685263	2	†	2	†	2	†	2	†	2	711960
Bumper	0	..	1	323221	1	379299	1	387531	1	387531	1	382084	1	382084	1	†	1	†	1	†	2	†	2	780443
Upper Stud	0	..	1	323265	1	379317	1	387553	1	707745	1	†	1	†	1	†	1	†	1	†	2	†	3	†
Lower Stud	0	..	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	2	†	3	†
Trigger	0	..	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	†	1	711954
Trigger Latch	0	..	..	......	..	......	..	......	..	......	..	......	1	†	1	†	1	†	1	†	1	†	1	711955
Trigger Spring	0	..	1	†	1	†	1	†	1	†	1	†	2	†	2	†	2	†	2	†	2	†	2	711959
Latch	0	..	..	......	1	†	..	......	1	†	1	†	..	......	..	......	..	......	1	†	1	†	1	711953
Latch Spring	0	..	..	......	1	†	..	......	1	†	1	†	..	......	..	......	..	......	1	†	1	†	1	685270
Trip Lever	0	..	1	†	1	379306	1	387546	1	685268	1	382092	1	685255	1	†	1	†	1	†	1	†	1	†
Hand Tripping Knob	0	..	1	188260	1	†	1	†	1	†	1	†	1	†	1	†	1	44939	1	†	1	†	1	767603

Parts indented are included in the part under which they are indented.

†Style Numbers of these Parts vary with different Ratings and Characteristics of Pole Units. If identification of these Parts are desired, Recommendations for Stocking Renewal Parts will be supplied for your complete Breaker. Give the complete name plate reading with your request to the nearest Sales Office of the Company.

*For Breaker Pole Units built after January, 1931. ‡Required 1 for 1000/1200 and 2 for 1600 to 2400 Amperes.

ORDERING INSTRUCTIONS

When ordering Renewal Parts, always specify the name of the part wanted as shown on the illustrations in this Instruction Book, giving Shop Order Number, and the type of Circuit-Breaker as shown on the nameplate. For example:

One Main Copper Brush, 2400 Amperes, for Type CL Carbon Circuit Breaker, S.O. 5F327, shown in Figure 2, Page 4.

To avoid delays and misunderstandings, note carefully the following points:

1. Send all correspondence and orders to the nearest Sales Office of the Company.
2. State whether shipment is to be made by freight, express or parcel post. In the absence of instructions, goods will be shipped at our discretion. Parcel post shipments will be insured only on request. All shipments are at purchaser's risk.
3. Small orders should be combined so as to amount to a value of at least $1.00 net. Where the total of the sale is less than this, the material will be invoiced at $1.00.

CONVERSION TABLE

Amperes at 30° C. Rise.			Amperes at 20° C. Rise		
D-C.	25 Cycles	60 Cycles	D-C.	25 Cycles	60 Cycles
12.5 to 800	12.5 to 800	12.5 to 800	12.5 to 800	12.5 to 800	12.5 to 800
1200	1200	1000	1000	1000	....
1600	1500	1200	1200	1200	1000
2000	1800	1600	1600	1500	1200
2400	2200	2000	2000	1800	1600
3000	2750	2400	2400	2200	2000
4000	3500	3000	3000	2750	2400
6000	*5000	*4000	4000/5000	*4000	*3000
8000	*6500	*5000	6000	*5000	*4000
10000	*8000	*6000	8000	*6500	*5000
16000	....	....	10000	*8000	*6000
20000	....	....	16000	....	*8000

*With Transformer Trip Coils.

INDEX

WESTINGHOUSE

I. B. 5241-G
Filing No. 35-000

Printed in U.S.A.
(Rev. 8-46)