Westinghouse

Type CL

Carbon Circuit-Breakers

INSTRUCTION BOOK

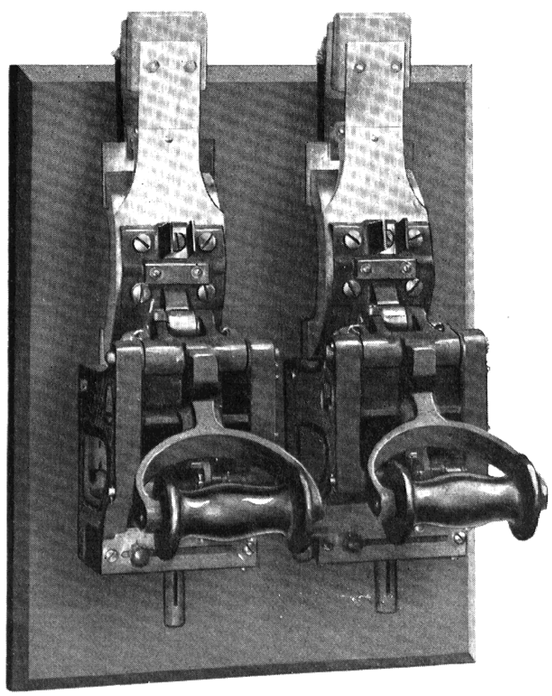

Fig. 1—250 V., D-C., 2000 Amp., 2 Coil, Plain Overload, Type CL Carbon Circuit-Breaker, Separate Closing Handles, Common Trip

Westinghouse Electric & Manufacturing Company

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I. B. 5241-B

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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.

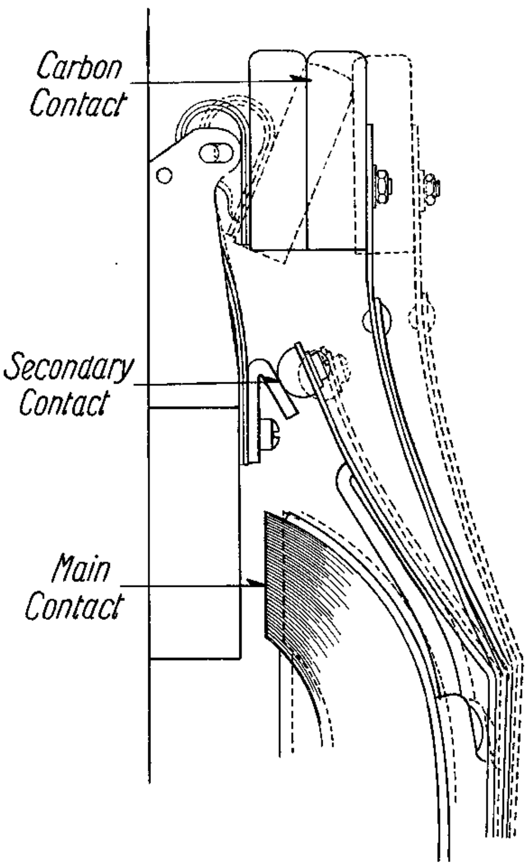


Fig. 2—Outline Showing Sequence of Operation of Type CL Circuit-Breaker Contacts

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 2. 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

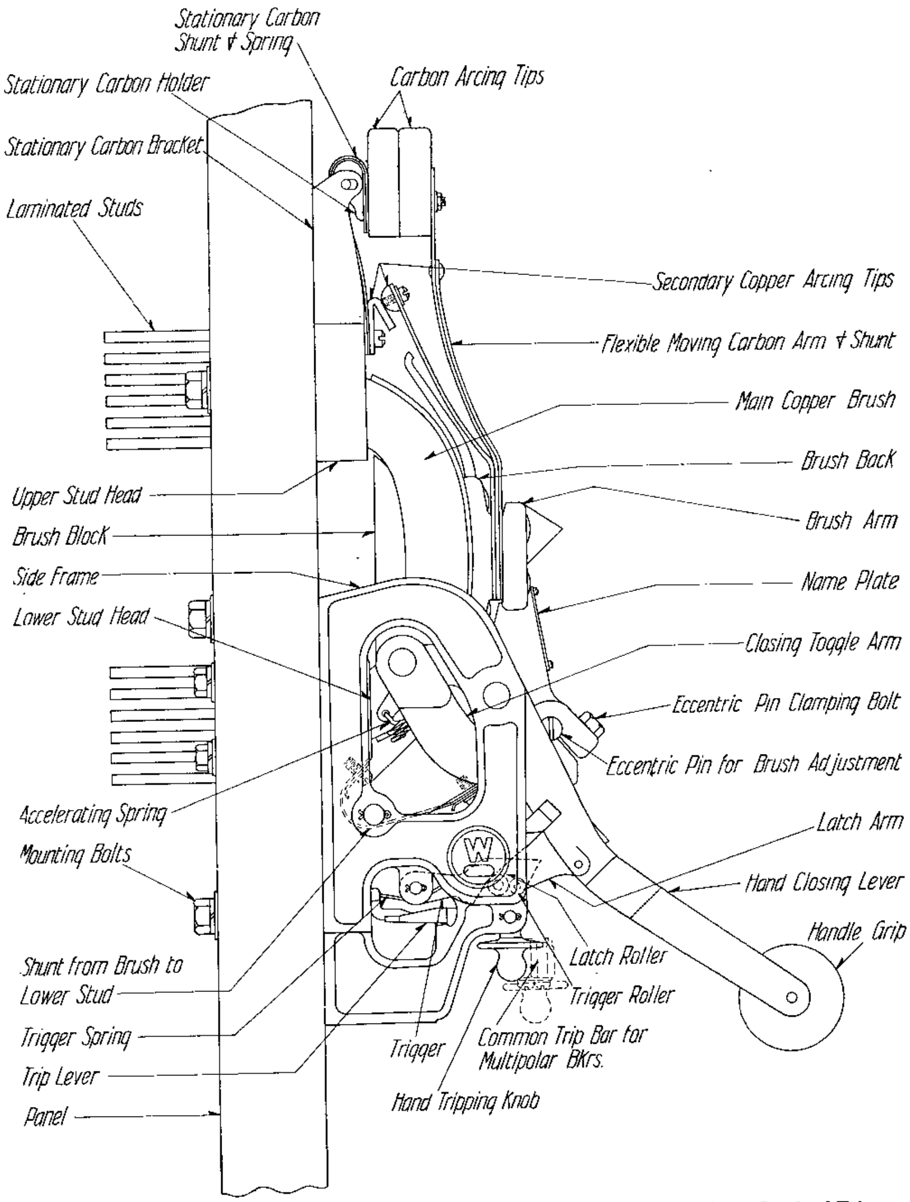


Fig. 3—Outline of a 3000-4000 Amp. Type CL Carbon Circuit-Breaker, Without Overload Trip, Showing the Principle Parts

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.

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

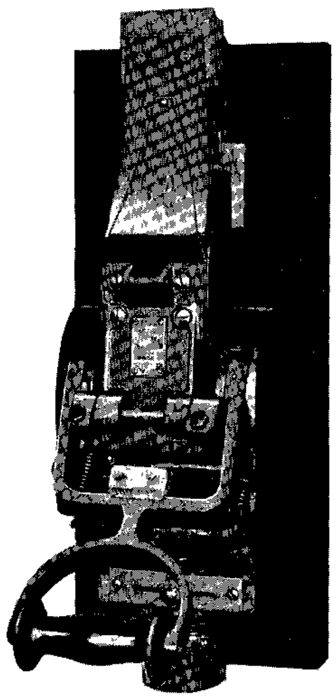


Fig. 4—3000-4000 Amp. D-C., Type CL Carbon Circuit-Breaker with Inverse-Time-Limit Overload Attachments

temperature rise not exceeding 30°C. above 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.

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 Figure 3.

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.

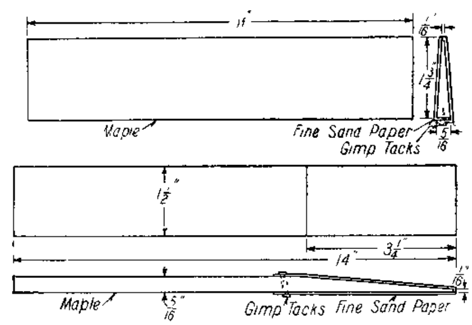


Fig. 5—Sand Paper Holder

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.

Oxidation 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 soldered to melt and part of it to run out of the joint, rendering it incapable of carrying its rated load thereafter.

Unpacking and Installing—When unpacking a circuit-breaker care should be taken to see that all parts are in good condition. If the circuit-breaker is mounted on a wood base it should be lined up properly when transferred to its final and permanent base. The attachments particularly should be adjusted with respect to the circuit-breaker so that they operate in the best possible manner. (See Attachments). The type CL line of carbon circuit-breakers, in this respect, is easy to transfer from one panel to another since the side frames are in one piece and when once fitted at the factory need no further adjusting. Consequently, when transferring a pole unit, the best way to do is to take out the side frame mounting bolts and lower stud bolts or clamp nuts and remove the entire unit, except the upper stud, without disassembling. In multipole circuit-breakers, however, it is necessary to line up one pole with respect to the other in order to get proper operation of the common closing and common trip bars. The trip bar in particular should work without binding or undue friction and when operated by any one pole should trip all of the other poles of the circuit-breaker.

TRIPPING DEVICES AND ATTACHMENTS

Overload Trip (Plain) See Figure 6—The overload 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 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 type CL carbon circuit-breakers are calibrated for overload. The standard range of calibration is 80% to 160% of the normal 30°C. rating of the circuit-breaker. The five main points, 80%-100%-120%-140%-160% are stamped on a suitable scale plate. The means of adjusting the air gap are shown in Figure 6. 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

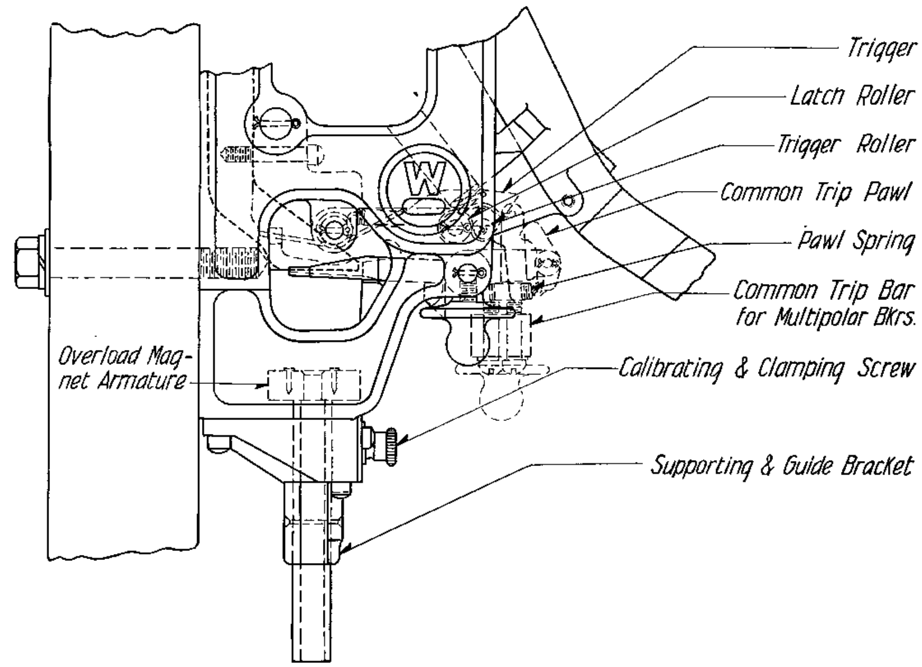


Fig. 6—Plain Overload Trip Attachment

alternating-current except in the smaller sizes of 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.

Trip-Free Circuit-Breakers—When an operator closes a plain overload single-pole 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. However, there are occasions when due to space limitations and installation costs, trip-free circuit-breakers are required.

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-polar plain overload 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 special trip-free pole units in order to get the trip free feature.

Inverse-Time-Limit Attachment (Figure 7) The plain overload trip device will trip a circuit-breaker on practically any overload impulse

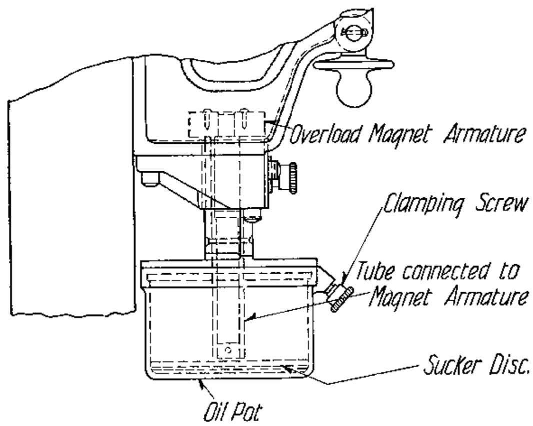


Fig. 7—Inverse-Time-Limit Overload Attachment

above its setting unless this impulse lasts only an extremely short time. There are times, however, especially in starting a motor, when the tripping of a circuit-breaker on short time overloads is undesirable. For cases of this kind inverse-time-limit attachments are provided.

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 containing 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.

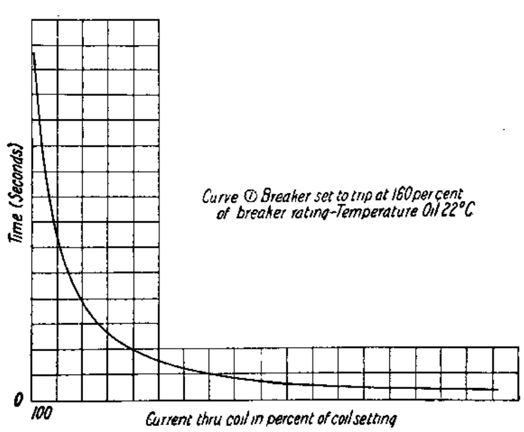


Fig. 8—Characteristic Curves of Inverse-Time-Limit Device

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 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 cause all high spots should be removed with a scraper.

Undervoltage Release Attachment (Figure 9) 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 50% 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.

Hand Rest—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 not be cut out of circuit when the breaker opens else 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 A-C. mechanisms the coils of which must be cut out of circuit when the breaker opens. For this service an adjustable leverage is provided which is actuated by the closing motion of the circuit-breaker to reset the undervoltage mechanism. This reset should be adjusted so that when the breaker is being closed 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 spring. To make this adjustment, release the clamping screw (see Figure 9) and turn the eccentric pin slightly by means of a screw driver. Then reclamp by means of the clamping screw.

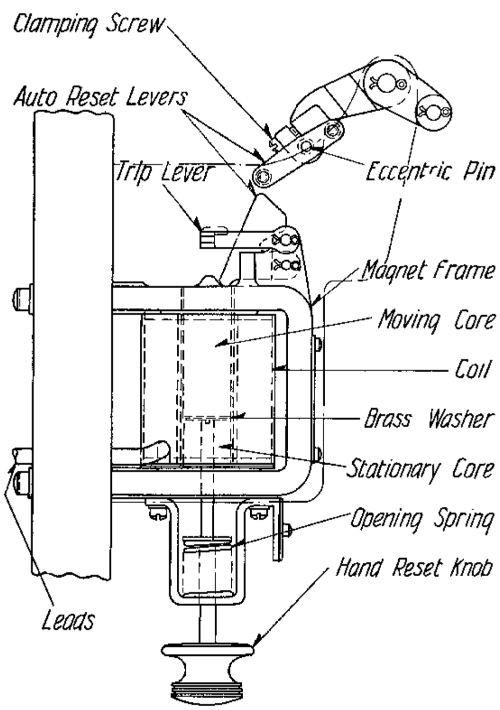


Fig. 9—Undervoltage Release Attachment

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 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.

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 10)–The shunt trip attachment is for use in tripping a circuit-breaker by means of a push button from some

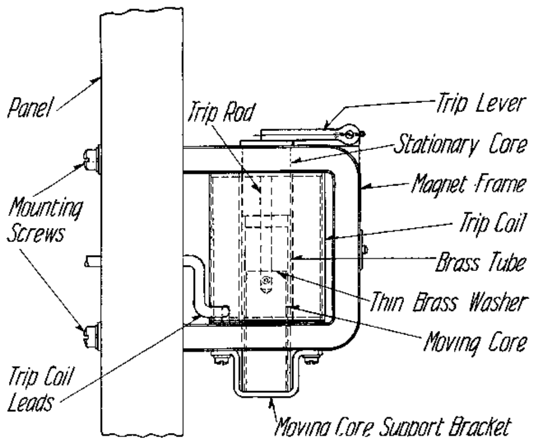


Fig. 10—Shunt Trip Attachment

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 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 11)—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.

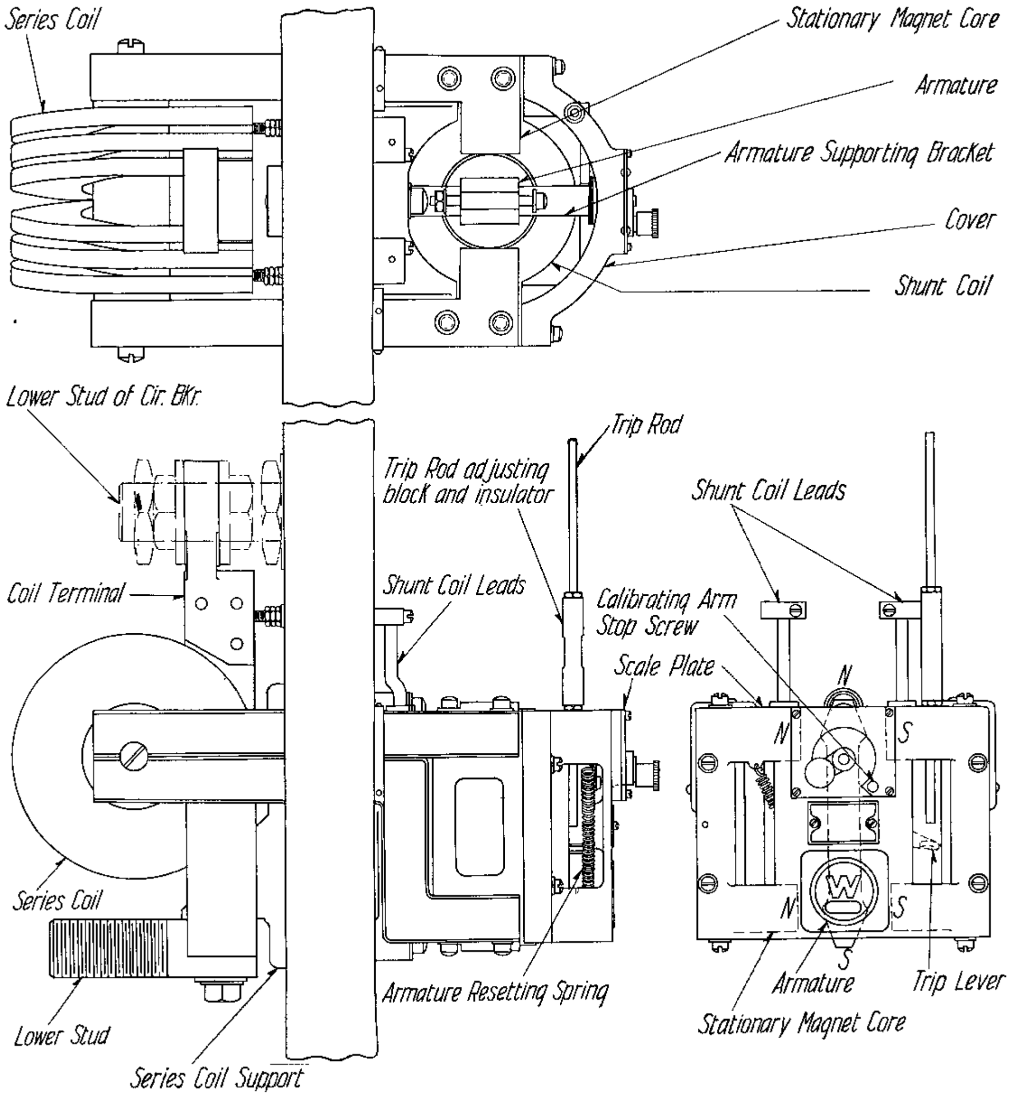


Fig. 11—Reverse-Current Trip Mechanism

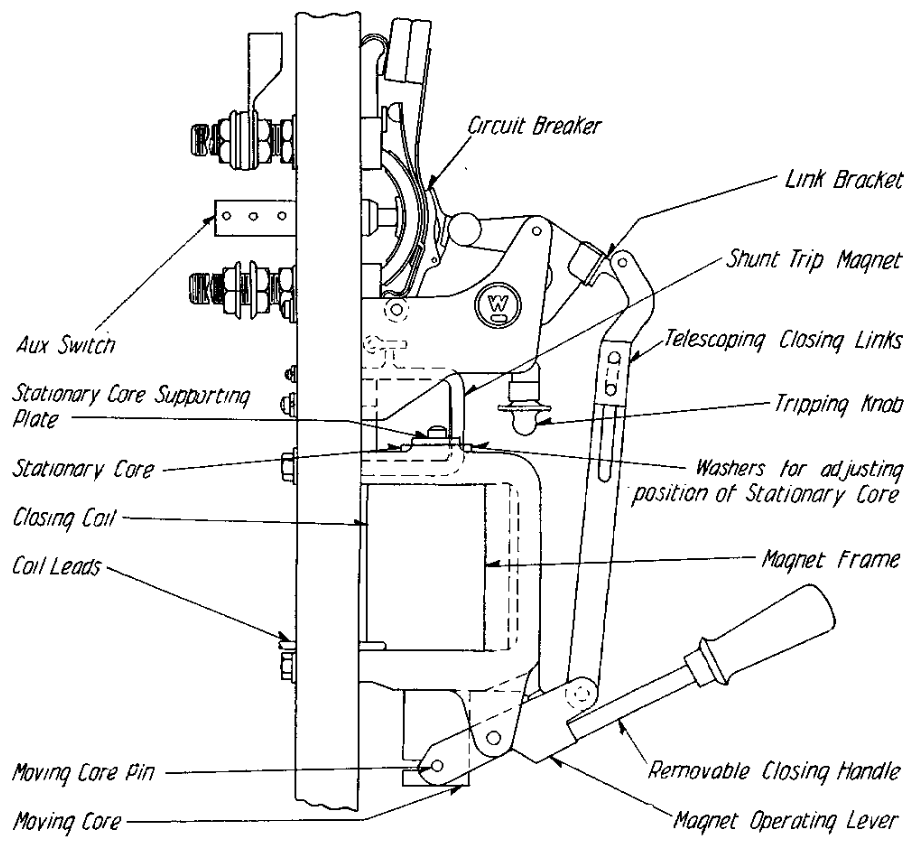


Fig. 12—Solenoid Closing Mechanism

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 12)—Circuit-breakers for electrical remote control are equipped with our standard closing solenoid and shunt 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 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 which permit the closing magnet to retrieve by gravity after the breaker is closed.

The closing coil is designed so as to close the breaker on which it is applied over a range of 72% to 112% of normal rated coil voltage. Voltages much higher than 112% 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 12).

Field-Discharge Attachment (**Figure 13**)—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, hand or solenoid operated carbon circuit-breaker without

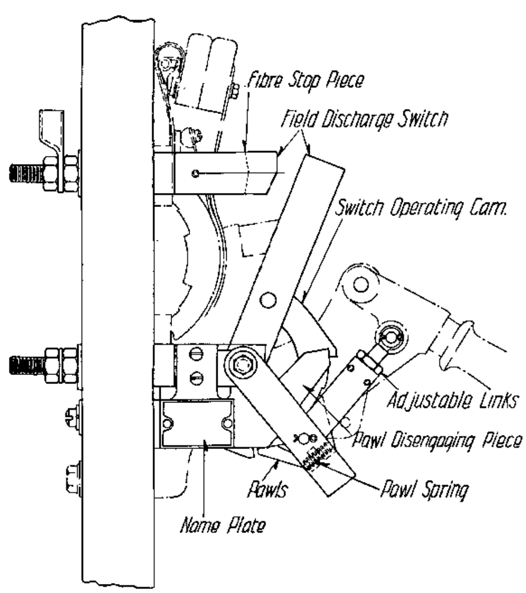


Fig. 13—Field-Discharge Attachment

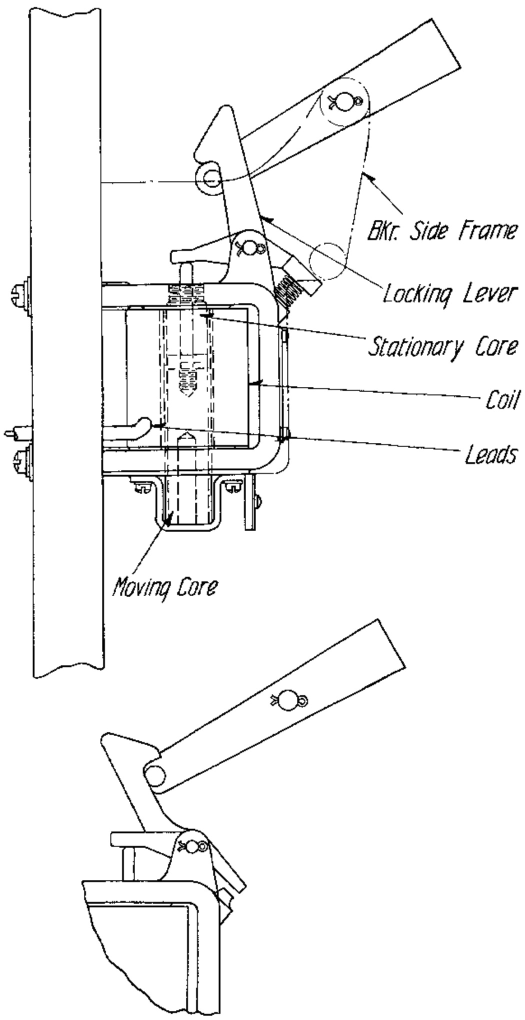


Fig. 14—Electric Lockout Attachment

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 voltages induced in the field winding would break down its insulation.

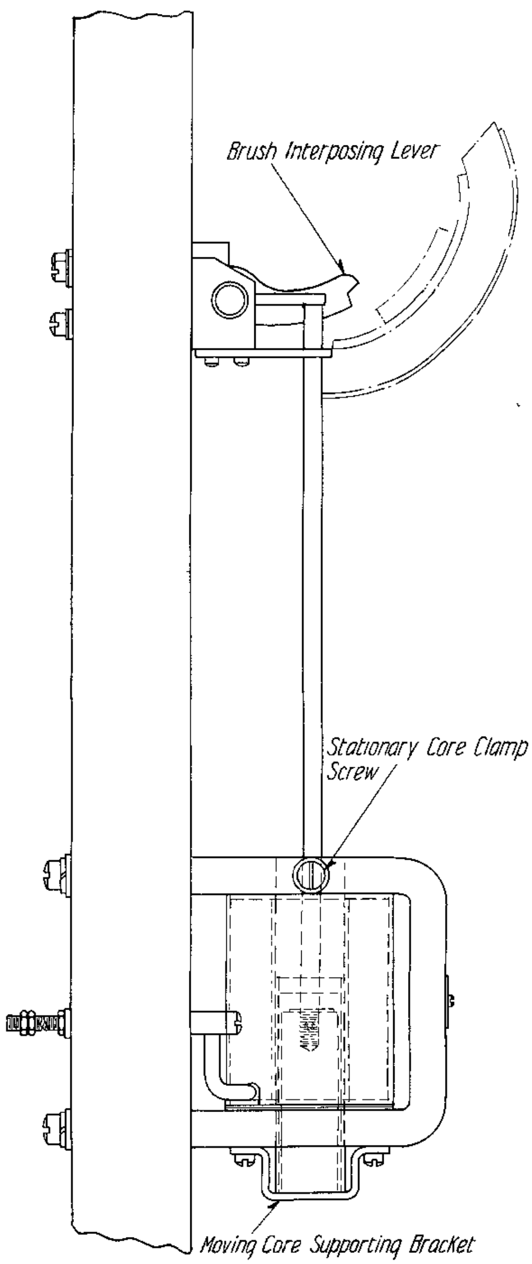


Fig. 15—Electric Lockout Attachment, Arranged to Lockout when Coil is De-Energized

The type CL field-discharge attachment is nothing more nor less 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.

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 14 and 15) 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.

Auxiliary Switches (Figures 16 and 17)–Auxiliary switches are used for signal lamp purposes' shunt trip cutouts, electrical interlocking and similar applications. They may be S.P.D.T. and D.P.D.T. and are mounted as a rule, directly under the circuit-breaker brush. A push rod extending through the panel operates the switch when the circuit-breaker is open or closed.

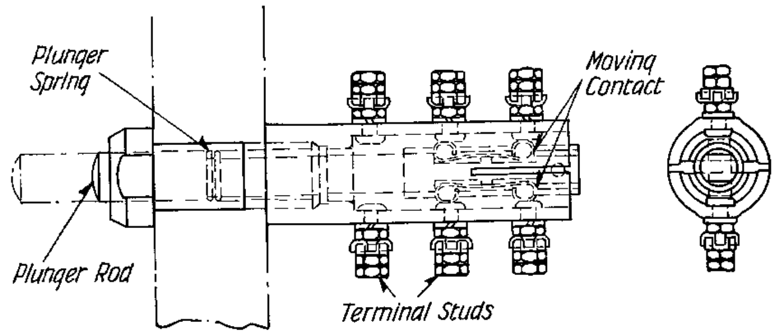


Fig. 16—2 P., D. T. Auxiliary Switch

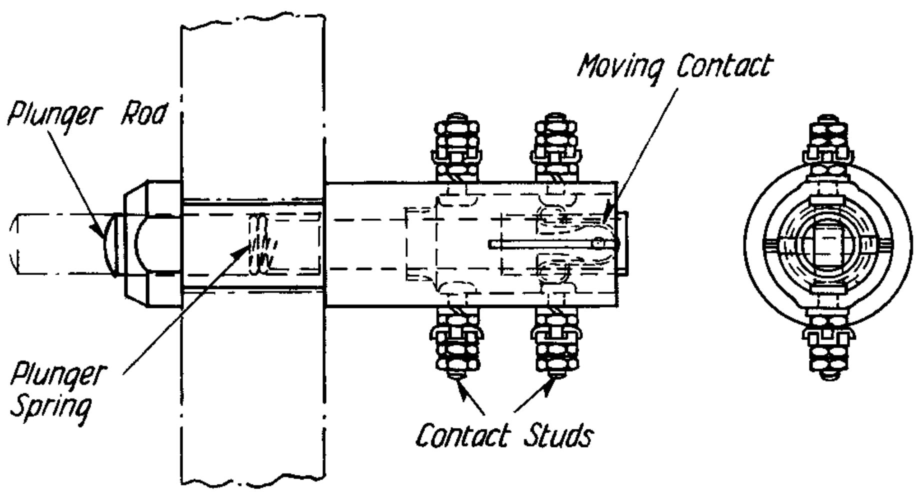


Fig. 17—S. T., D. T. Auxiliary Switch

These switches should be inspected occasionally to see that their contact springs are in good working condition.

RENEWAL PARTS

When ordering renewal parts, specify the name of the part wanted as shown in the illustrations in this book, give the style or stock order number of the circuit-breaker, for example: One closing lever for Type CL Circuit-Breaker, S.O. 43B675, as shown in Instruction Book No. 5241-B. The style or stock order number of the circuit-breaker will be found stamped on nameplate.

WIRING DIAGRAMS

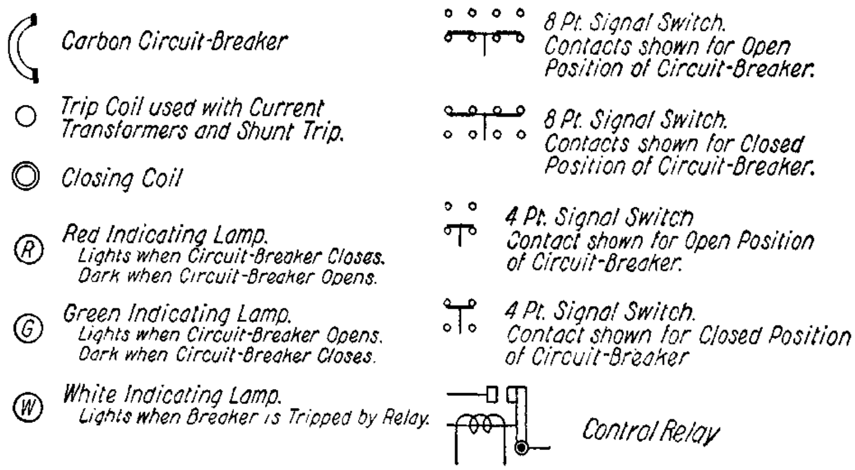


Fig. 18—Symbols Used on Wiring Diagrams

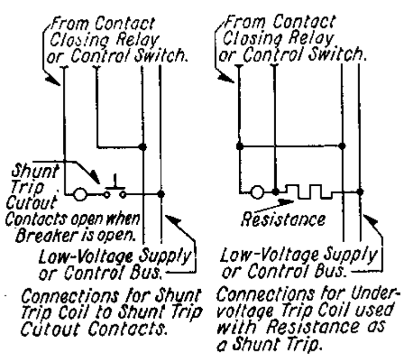


Fig. 19

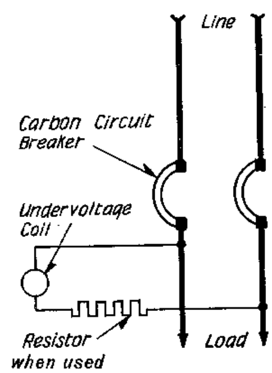


Fig. 20—Connections for undervoltage release coil on "load side" of breaker. For automatic reset only A-C. or D-C. with or without resistor.

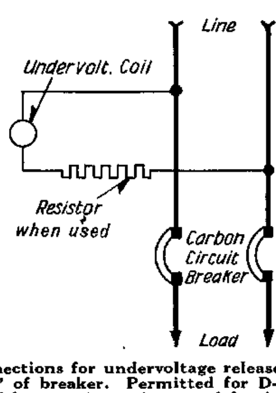


Fig. 21—Connections for undervoltage release coil on "line side" of breaker. Permitted for D-C. Coils with or without series resistor and for A-C. Coils with resistors only.

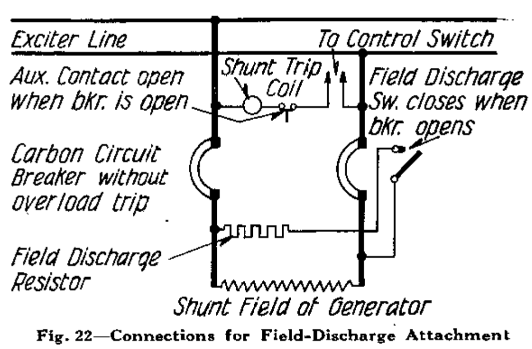


Fig. 22—Connections for Field-Discharge Attachment

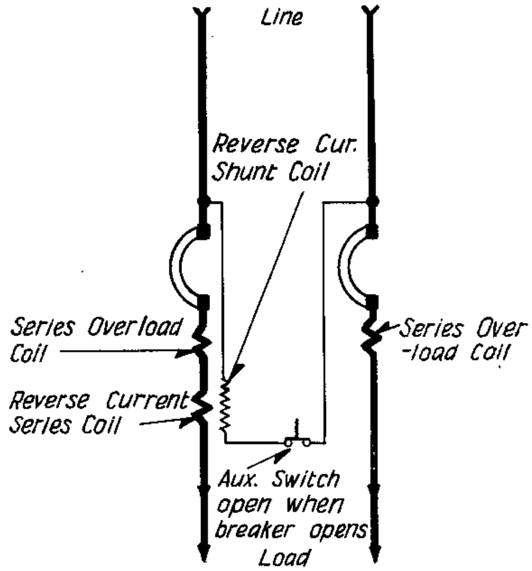
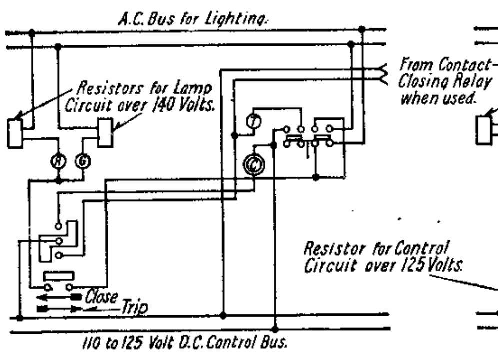


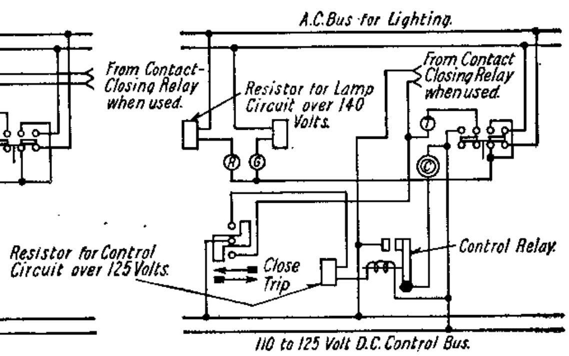
Fig. 23—Connections for Reverse-Current Trip Attachment—All Capacities

Note—Figs. 24 to 30 are Wiring Diagrams for Solenoid-Operated Circuit-Breakers



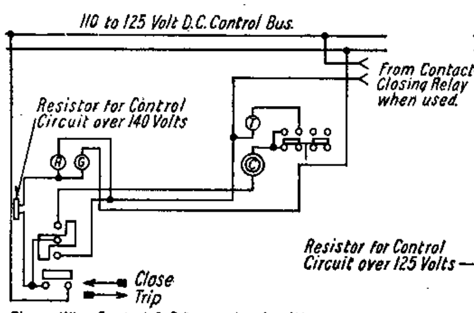
Three-Wire Control, Lamp Cutout Contacts, Separate Lighting Circuit.

Fig. 24



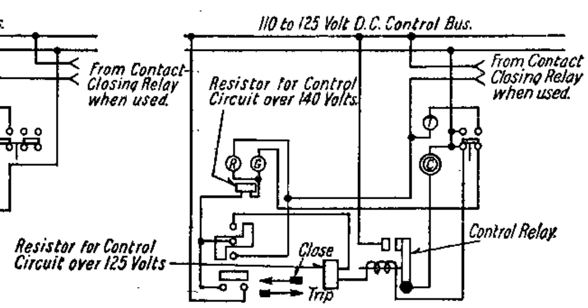
Three-Wire Control, Control Relay Separate Lighting Circuit.

Fig. 25



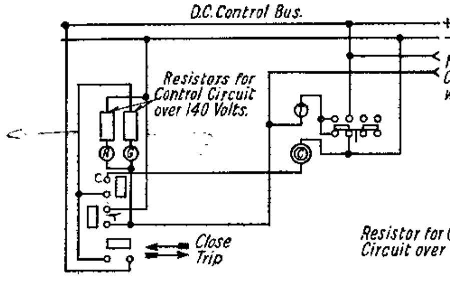
Three-Wire Control, D.C. Lamp circuit with Lamp Cutout Contacts.

Fig. 26



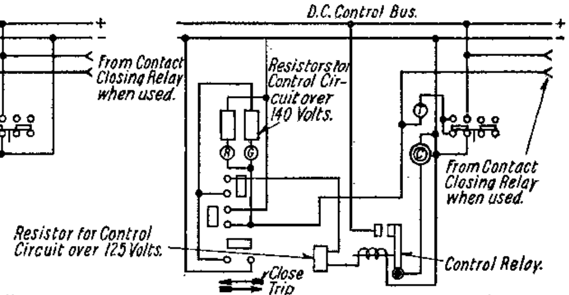
Three Wire Control, D.C. Lamp Circuit Control Relay.

Fig. 27



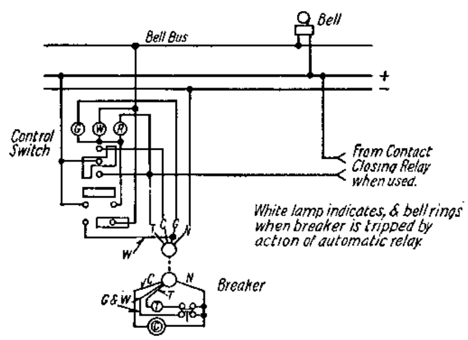
Two-Wire Control with Two-Lamp Controller.

Fig. 28



Two-Wire Control, Two-Lamp Controller with Control Relay.

Fig. 29



Four-Wire Control – Three-Lamp & Bell Alarm Controller.

Fig. 30