I. L. 1849-C
(Filing No. 41-000)

Westinghouse

Types CO and COA Overcurrent and Types CR, CRA and CRC Directional Overcurrent Relays

Caution

Remove all blocking from relay before placing in service.

Installation

Carefully unpack the relay and remove all dust and packing material with a soft brush or cloth. The cover of the relay should be removed and the interior parts carefully inspected for any damage which might have been done in shipment. This inspection should include a test of the moving parts to see that they have not become misaligned and that there is no friction present. The presence of friction can usually be determined by moving the disc or contactor plunger by hand and letting it return to the normal position. Owing to the importance of proper relay functioning it is a wise precaution before placing relays in service, to check each relay for operating current, time of operation, and polarity. For all type CR relays, the left hand contacts of the directional element, front view, should open when the potential and current applied to the relay are in phase, See Fig. 5.

Mount the relay vertically by means of the two mounting studs. Connections may be made direct to the terminals by means of screws for steel panel mounting or to the terminal studs, furnished with the relay, for slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. Note that the top mounting stud may be utilized as a grounding stud for grounding the metal case.

Connect the relay as shown on the proper diagram in this leaflet, or consult the nearest Sales Office for additional diagrams of connections for cases not covered by this leaflet.

The tripping circuit should not be opened by the relay, but an auxiliary contact on the circuit-breaker should be provided to open the tripping circuit the instant the breaker opens.

This relay is suitable for operating the Westinghouse direct trip attachment for tripping direct from the current transformer and also for operating the transfer relay for the same purpose.

Instructions for Setting

In arriving at the proper setting of the overload element, or relay, two things must be determined.

FIRST—In terms of the secondary circuit of the current transformer, the minimum amperes to trip (tap setting) should be higher than the overload peaks due to service load. Under short circuit conditions, the current will be fixed by the impedance of the circuit to which the relays are connected and the minimum short circuit current will usually be several hundred percent of the tap setting.

SECOND—The time setting for short circuit conditions is determined by consideration of the sequence in which the breakers should trip, the time required for breaker mechanisms to operate etc., as required to give proper selective action throughout the system as a whole.

Current Setting:

The connecting screw on the terminal plate above the scale makes connections to various coil. By placing this on the operating holes, the relay will pick up at the corresponding current value. The various 12 or 15 amperes, or as marked on the contacts terminal plate. 10.

The tripping value of the relay on any tap may be altered by changing the initial tension of the spiral spring. This can be accomplished by turning the spring adjuster by means of a screw driver inserted in one of the notches of the plate to when the outside convolution of the spring is fastened. An adjustment of tripping current approximately 15 percent above or below any tap value, can be secured without materially

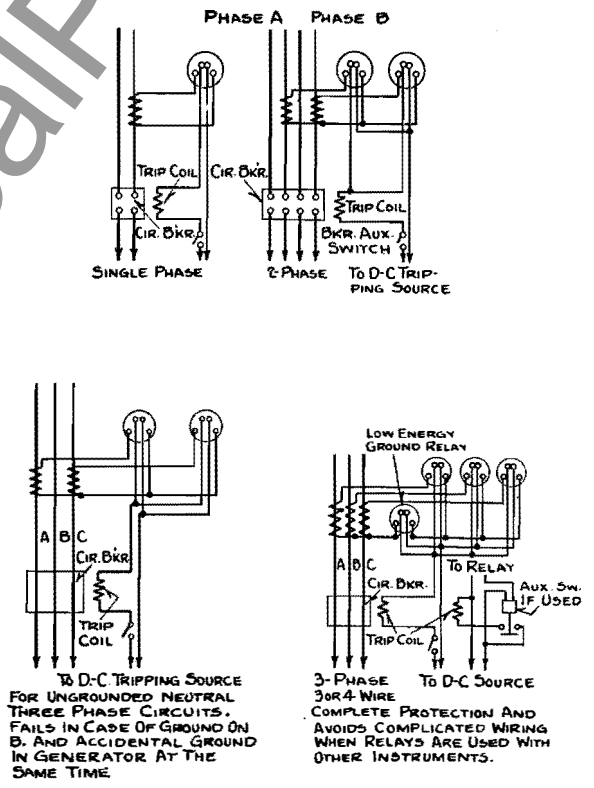

FIG. 1—CONNECTIONS FOR DIFFERENT INSTALLATIONS OF TYPE CO OVERCURRENT RELAYS USING D-C. TRIPPING SOURCE

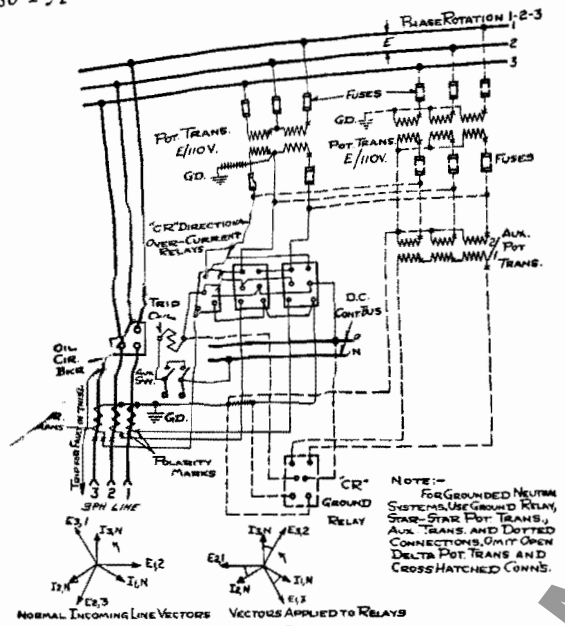

FIG. 2—CONNECTIONS FOR SHORT-CIRCUIT AND GROUND PROTECTION USING TYPE CR RELAYS AND HIGH-TENSION POTENTIAL TRANSFORMERS

affecting the operating characteristics of the relay. By choosing the proper tap, a continuous adjustment of tripping current from 3.4 amperes to 17.5 amperes may be secured. The characteristic time curve will be affected less for any large adjustment if the next higher tap is selected and the initial tension of the spiral spring is decreased to secure the desired tripping value. For example, the relay should be set on the 8 ampere tap with less initial tension in order to secure a 7 ampere tripping value.

Caution

Be sure that the connector screw is turned up tight so as to make a good contact, for the operating current passes through it. Since the overload element is connected directly in the current transformer circuit, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, located on the right hand mounting boss, in the new tap and removing the old screw from its original setting.

Time Adjustments

The index or time lever, limits the motion of the disc and thus varies the time of operation. The latter is proportional to the lever setting, that is, with the lever on the number 5 setting, at 2000 percent load, the relay will operate in one second and similarly on the number 1 setting the time of operation is 0.2 seconds.

The relay has been calibrated from the #10 time lever setting according to the curve engraved on the nameplate. The #11 time setting may be used to secure a time delay approximately 10 per cent longer, that is, to secure a setting of 2.2 seconds for a 2 second relay.

Be sure that the contacts just touch when the time lever is set on zero, otherwise the time will not be proportional to the lever setting.

Operation Indicator

This relay is equipped with a universal operation indicator suitable for all tripping currents above 0.2 amperes. The relay leaves the factory with the operation indicator coil connected in parallel with the contactor switch coil and if the tripping current is more than 2.25 amperes d-c., sufficient current will flow through both coils to cause their operation. The resistance of both coils in parallel is approximately 0.25 ohm.

If the trip current is less than 2.25 amperes there is no necessity for the contactor switch and it should be removed from the trip circuit so that all trip current will pass through the indicator coil. The indicator coil has approximately 2.8 ohms resistance. To disconnect the contactor switch coil, remove the lower lead on the front stationary contact of the contactor switch (See Figure 3) and this lead should be fastened (dead ended) under the small fillister head screw located in the micarta base of the contactor switch (See Figure 4).

Make sure that the indicator receives sufficient current to operate through the trip coil. The trip coil has such a high inductance that the breaker may open and open its pallet switch before the current has built up to its full value. Also, the voltage may be low resulting in a lower trip current. It is advisable to assume that the current through the indicator will be only half of the value calculated from the resistance of the coil and normal control voltage. If the trip circuit does not draw enough current to drop the target when it is set to operate at .2 ampere, more current may be secured by putting a small loading resistor around the trip coil or around the auxiliary relay, if this is used.

Directional Element

The standard single trip and double trip type CR relays are directionally controlled, that is, the directional contacts must close in order for the overcurrent element to operate. The contacts of the latter trip the breaker direct. The single trip 7 terminal stud relay (7th terminal between the directional and overcurrent contacts) and the duo-directional relay cannot be made directional controlled and therefore the contacts of the overcurrent and directional elements are in series in the trip circuit.

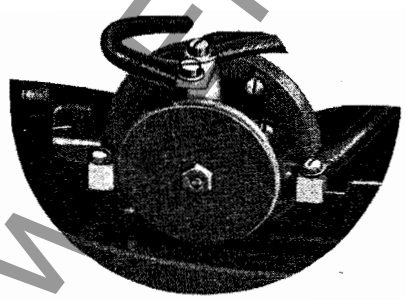

FIG. 3—CONTACTOR SWITCH COIL CONNECTED IN TRIP CIRCUIT. THE TARGET OPERATES ON 2.25 AMPERES OR MORE

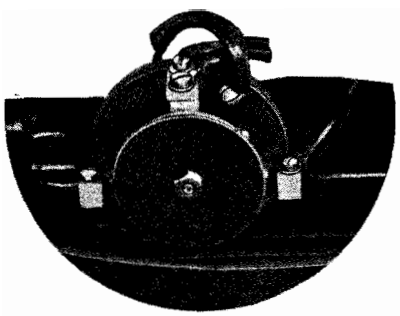

FIG. 4—CONTACTOR SWITCH COIL DISCONNECTED FROM TRIP CIRCUIT. ALL THE CURRENT PASSES THROUGH THE TARGET COIL SO THAT IT WILL OPERATE ON .2 AMPERE OR MORE

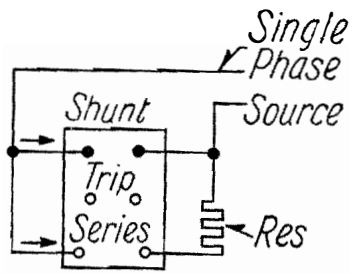

FIG. 5—METHOD OF TESTING POLARITY OF TYPE CR RELAY. THE CONTACTS REMAIN OPEN

The directional element is usually connected to the system in such a manner that the directional contacts close when power flow is away from the station bus All diagrams shown have this polarity.

Checking Connections of the Type CR Relay

All type CR relays, except the ground relays, have wattmeter characteristics for the directional elements and, therefore, the directional element disc will reverse its direction of rotation when the phase relation of the current and voltage becomes 90° or greater. The directional relay must be connected so that this relation will never exceed 90°.

Since the power factor of fault currents may vary over a considerable range, it is necessary that the proper voltage be used on the directional element. Connections should be made so that with unity power factor on the line, the current in the relay directional element will be 30% ahead of the potential supplying the directional element.

The following methods should be used in checking up the correct connections to the directional element of the relay.

Wattmeter Method

With the power flowing in either direction, if the current is lagging, so that the power factor is between 50 and 100 per cent, connect the current coils of a single phase wattmeter in series with the current winding of the relay. Then select a pair of voltage leads which give the highest reading on the wattmeter. The two leads should be connected to the relay potential terminal. Inspect the contact of the directional element, which should be open when the power is flowing towards the bus bars. If the contacts are closed when the current flows toward the bus bars, then the potential leads of the relay should be reversed.

Power Factor Meter Method

A second method is to connect the current coils of a single phase power factor meter in series with the current coils of the relay. A pair of potential leads is then selected which will give 86.6 per cent power factor leading on the power factor meter when the line power factor is 100 per cent. These two leads should be connected to the relay potential terminals. The upper contact should be inspected, as before mentioned in the preceding paragraph and checked for proper direction of operation.

Phase Indicator Method

A third method of checking the proper connections of the relay is by means of the Westinghouse phase indicator. It is a portable instrument built on very much the same principle as a power factor meter but calibrated to read in degrees, and show precisely the phase relation between any current and voltage sources to which it may be connected. Full directions for the use of the portable phase indicator are supplied with the instrument.

Relay for 90° Connection

This relay can be used for the 90° connection, that is, with the current leading the applied potential by 90° when the line power factor is 100%, by installing a suitable external resistor in series with the potential coil. These external resistors can be ordered by style number as follows.

25 Cycle, 115 Volts, 760 ohms, S# 721435
50 Cycle, 115 Volts, 670 ohms, S# 721436
60 Cycle, 115 Volts, 565 ohms, S# 721437

Type CR Ground Relays

The directional element of the type CR relay which is intended for ground protection differs from that of the phase relay by not having true wattmeter characteristics. It develops its maximum torque when the relay current lags about 15 degrees behind the relay voltage. This is essential on systems where the neutral is dead grounded. These relays may be distinguished from

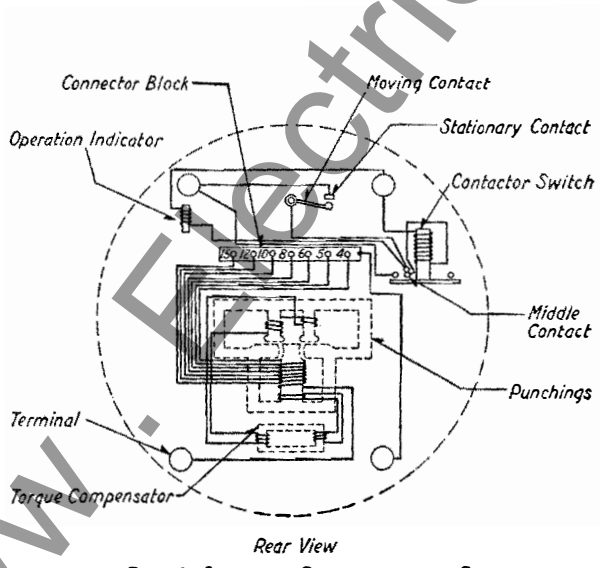

FIG. 6—INTERNAL CONNECTIONS OF SINGLE-TRIP, STANDARD-ENERGY TYPE CO RELAY

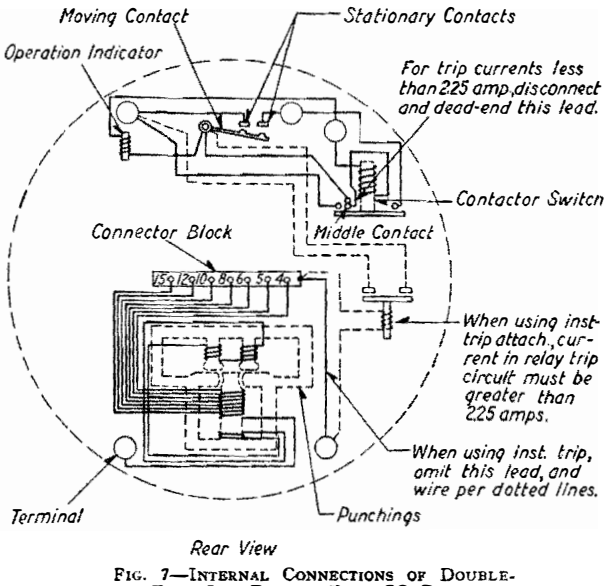

FIG. 7—INTERNAL CONNECTIONS OF DOUBLE-TRIP, LOW-ENERGY TYPE CO RELAY

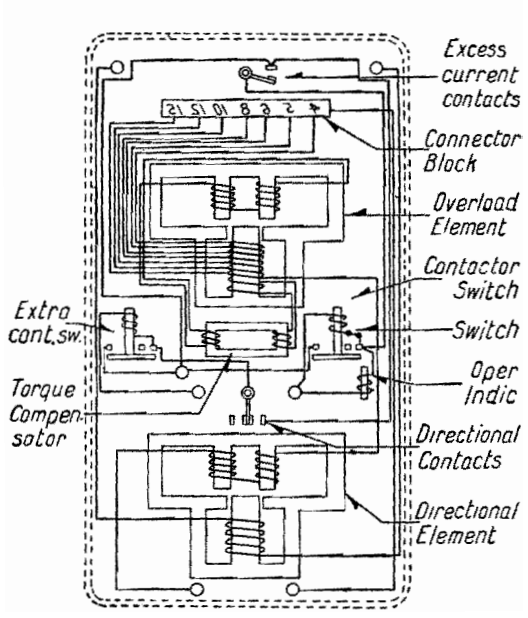

FIG. 8—INTERNAL CONNECTIONS OF STANDARD-ENERGY, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY WITH A TAP CONNECTION BETWEEN THE DIRECTIONAL AND OVERCURRENT CONTACTS—REAR VIEW

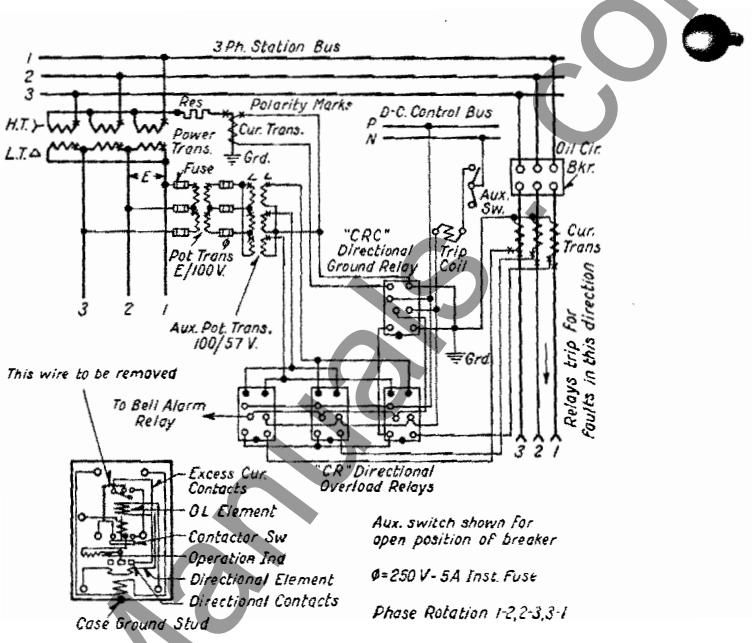

FIG. 10—EXTERNAL CONNECTIONS OF THE TYPE CRC RELAY USED FOR GROUND PROTECTION—REAR VIEW

others because they are of the low energy type and have ratings of .5 to 2.5 or 2 to 6 amperes.

Low Energy Types CO and CR Relays

The low energy type of CO and CR relays are different from the standard ones. Instead of obtaining the definite minimum time feature by means of

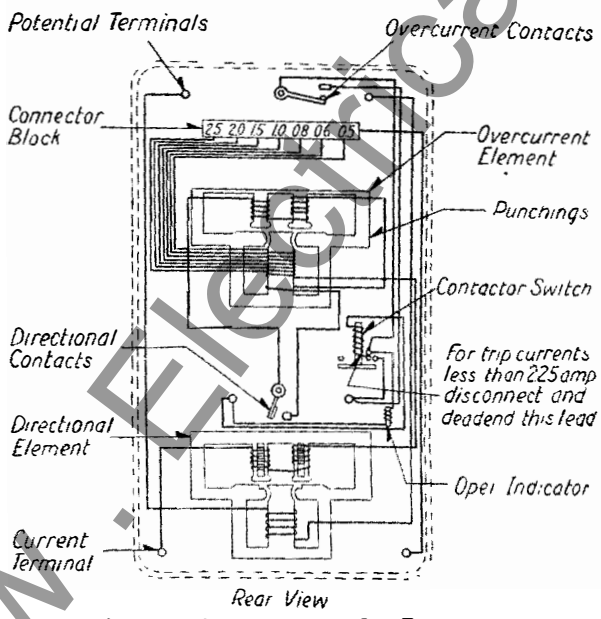

FIG. 9—INTERNAL CONNECTIONS OF LOW-ENERGY, DIRECTIONAL-CONTROL, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY

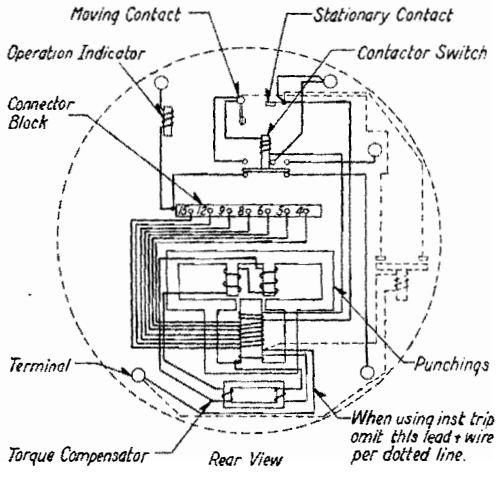

FIG. 11—INTERNAL CONNECTIONS OF CIRCUIT-OPENING TYPE CO RELAY FOR SERIES TRIP CIRCUIT

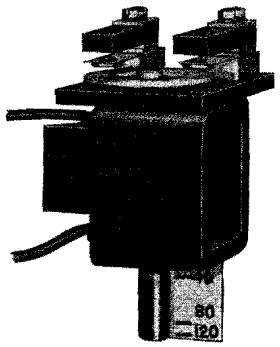

FIG. 12—THE INSTANTANEOUS ATTACHMENT

the torque compensator, a somewhat similar result is obtained by gearing the disc to the shaft which carries the contact arm. This results in a characteristic curve which is somewhat more inverse than the standard curve and also results in much slower resetting time. The term "low energy" refers to the burden which is placed on the current transformers and does not refer to the current rating. All of the small current ranges are of the low energy type and some of the higher current ranges are also made in the low energy type for use on certain current transformers which are incapable of carrying a heavy burden. The low energy and standard relays have the same external appearance and dimensions.

When circuit breakers are instantaneously reclosed, it is necessary to use special quick opening contacts on the low energy type of relay. These contacts differ from the normal ones in being stiff, without any follow, so that they will open quickly.

Very-Inverse Type CO Relay

This relay is similar to the low-energy relay but contains a different electromagnet and has a much more inverse curve. The mechanical arrangement of the parts is similar to the low-energy type, although they are not exact duplicates. The burden on the current transformer is considerably less than that of the low-energy CO relay.

The 40-Second Type CO Relay

This relay is similar in appearance to the low energy relay but consists of a standard energy 4-second relay with a 10 to 1 gear reduction, making the total time 40 seconds on the flat part of the curve. The 25 cycle relay has a resetting time of approximately 90 seconds. It will overheat before tripping from the number 10 position for currents greater than 750% of the tripping value. The 60 cycle relay resets in 120 seconds and will overheat before tripping from the number 10 position for current greater than 1000% of the tripping value.

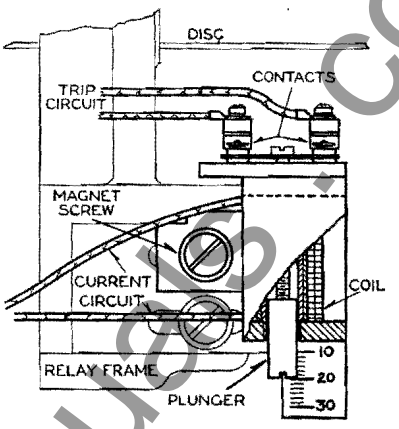

FIG. 14—ADJUSTMENT DETAILS AND METHOD OF MOUNTING THE INSTANTANEOUS ATTACHMENT

This relay is frequently used for motor protection and may require an accurate current setting which can be given by adjusting the spiral spring. The instantaneous attachment mentioned below is useful on this relay to protect against short circuits.

CRC Ground Relay

This is a directional relay quite similar to the CR relay with the same dimensions and internal connections, but the

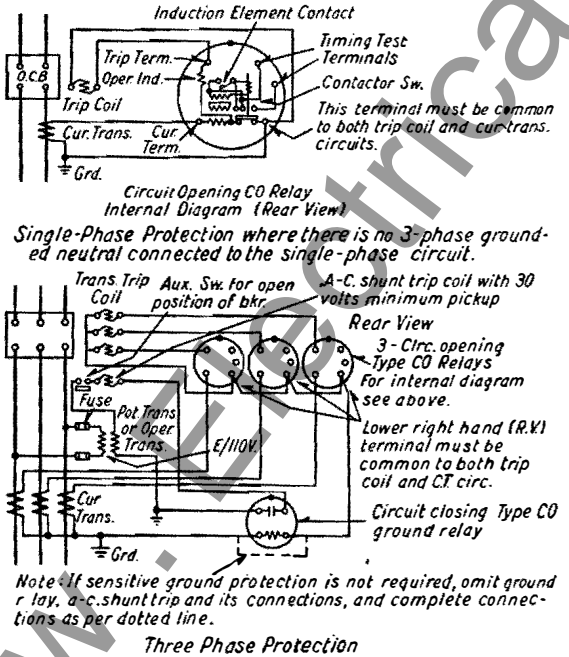

FIG. 13—OVER-CURRENT PROTECTION USING 3 CIRCUIT-OPENING TYPE CO RELAYS FOR LINE PROTECTION AND ONE CIRCUIT-CLOSING GROUND RELAY

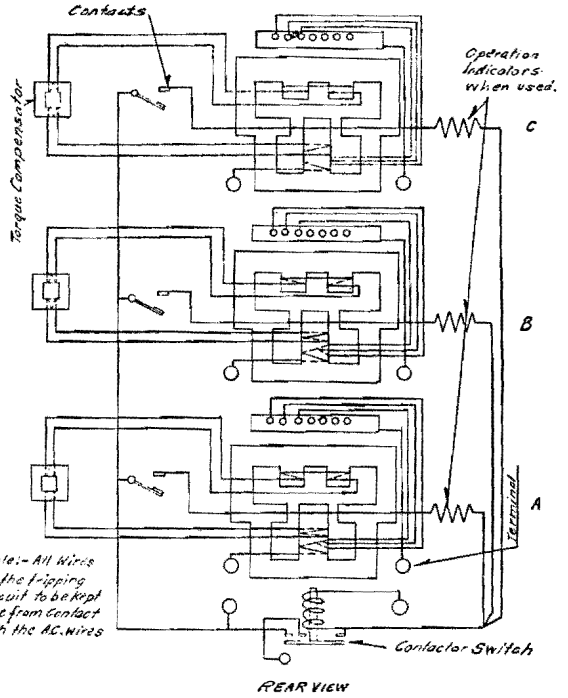

FIG. 15—INTERNAL CONNECTIONS OF THREE ELEMENT TYPE CO AND COA RELAY WITH EXTRA BELL ALARM TERMINAL

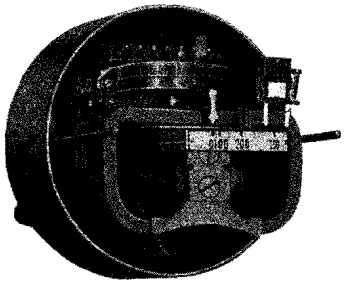

FIG. 16—SINGLE-PHASE TYPE COA RELAY WITH NAMEPLATE REMOVED

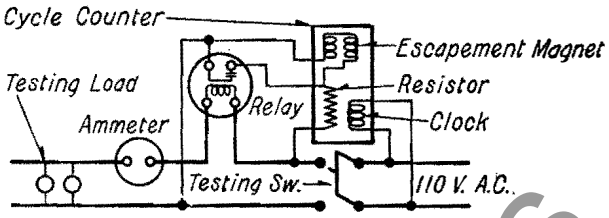

FIG. 18—CONNECTIONS FOR THE USE OF THE CYCLE COUNTER IN TESTING CIRCUIT-CLOSING TIME-LIMIT RELAYS

polarizing coil on the directional element has a 5 ampere winding. This coil is energized by a current transformer placed in the neutral of the power transformers.

All the adjustments and manipulations are the same as for the CR relay.

Circuit Opening Relays

The conventional method of tripping circuit breakers is by means of current from a storage battery and a relay which closes its contacts to complete the circuit through the trip coil. Where it is desired to eliminate the battery, the breaker may be tripped by current from the current transformers if circuit opening relays are used. As shown in Fig. 11 the operation of the relay connects the circuit breaker trip coil in series with the current circuit. The internal diagram shows that when the main relay contacts close they pull up the contactor which is energized from a secondary coil on the main pole. When the contactor is lifted, it opens the short circuit around the trip coil and allows the current to flow through the coil.

It should be observed that the contacts break the full short circuit current and they may be seriously burned. It is therefore important that the contacts be frequently inspected and kept clean and smooth. With frequent maintenance, the contacts may safely open circuits of 50 amperes. If the current is small, the relay may give satisfactory service with inspection periods as seldom as once a year. It should be borne in mind that these contacts carry the current continuously and if they become bad, they will begin to overheat and finally burn open the current transformer circuit.

Because these contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subjected to shocks which may jar the contacts open and thereby allow current to flow through the trip coil.

Trouble of this kind can be avoided by preventing jars to the switchboard and also by setting the trip coil high enough so that it will not operate on normal load current. This is an extra safe-guard so that there is no danger from even an excessive shock unless the current is also heavy.

The circuit opening relay is made only in the 4 to 15 ampere range. Lower ranges are not desirable because the burden of low range trip coils is too heavy on the current transformer. One trip coil is required for each relay.

If ground relay protection is required, the low range ground relay may be of the circuit closing type and operate an a-c. voltage trip coil. See Fig. 13.

The circuit opening feature is provided only in the Type CO Relay.

Instantaneous Attachment

The instantaneous attachment has its contacts in parallel with the main contacts of the CO or CR relay. Its purpose is to make the time of operation of the relay instantaneous after a predetermined current is exceeded. The device is usually built to operate at a high value, a common style being adjustable between 40 and 120 amperes. The marking is accurate to within ± 25%. The current setting is made by raising or lowering the plunger. The design of the 25 cycle relay is somewhat different from that shown in the illustration and has a piece of felt under the contacts to damp out the vibrations.

The instantaneous attachment is usually applied to the relay while it is being manufactured but it can be attached to any of the old induction type relays. No special mounting arrangements are required—it fits under one of the screws holding the permanent magnets. (See Fig. 14).

Lock-Out Attachment

Sometimes it is desired to prevent a relay from tripping a circuit breaker

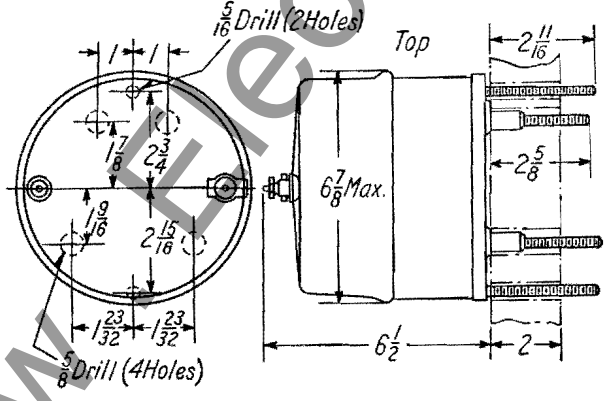

FIG. 17—SINGLE-TRIP STANDARD AND LOW-ENERGY CIRCUIT-CLOSING TYPE CO RELAY, THE TYPE COA RELAY IS 6¾-INCH DEEP INSTEAD OF 6½-INCH

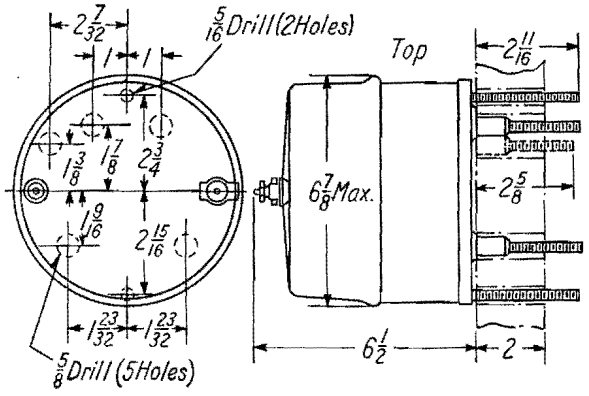

FIG. 19—DOUBLE-TRIP STANDARD AND LOW-ENERGY TYPE CO RELAY, ALSO THE CIRCUIT-OPENING TYPE CO FOR SERIES TRIP. THE TYPE COA RELAY IS 6¾-INCH DEEP INSTEAD OF 6½-INCH

when the current is too high—above its interrupting capacity. For this purpose the lockout attachment is provided. It is similar to the instantaneous attachment in appearance and method of adjusting but its contacts are in series with the main contacts and are normally closed. These contacts must be given special care because they are in series with the main tripping circuit and may prevent proper relay operation if they become dirty.

Three Element Type CO Relay

The CO relay, both standard and low energy type, is sometimes furnished with 3 elements in a single case. The outside dimensions of this case are shown in Fig. 20, but the number of terminals varies with the particular style of relays. Similarly Fig. 15 shows a typical diagram of internal connections with three operation indicators.

This 3-element relay is frequently supplied with the ammeter attachments mentioned in the following section.

Types COA and CRA Relays

These relays are standard type CO or CR with a self-contained ammeter scale. This ammeter operates on the induction principle and consists of an aluminum vane which swings in the same air gap as does the main disc. It, therefore, not only indicates the value of the current but supervises the entire current circuit and assures the operator that current is flowing through the relay coils. The entire scale moves and the reading is indicated by a fixed pointer. A small aluminum vane swings above the permanent magnet and sufficient flux is robbed from the magnet to damp the movements of the ammeter.

The current reading depends upon the tap setting of the relay and this setting should, therefore, be determined before the scale is marked so that it may be properly marked in amperes. Some relays are marked in percent so that any tap value may be used without inconvenience.

The ammeter attachment cannot be put on existing relays. It does not change the diagram of internal connections nor does it change the drilling plan of the various relays which may contain it. On the single element type CO relay it increases the depth from the front of the board by ¼ inch.

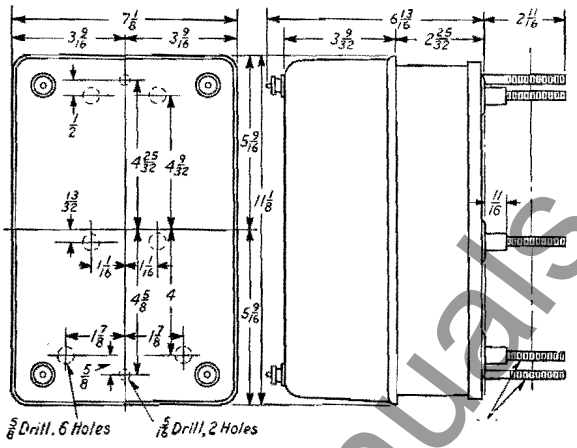

FIG. 21—TYPES CR, CRA AND CRC SINGLE-TRIP CIRCUIT, SIX-TERMINAL RELAYS

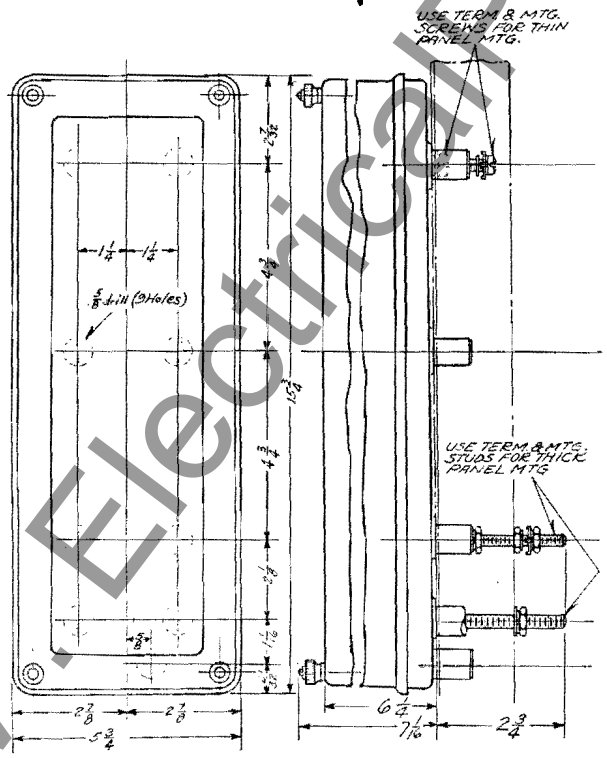

FIG. 20—THREE ELEMENT TYPE CO OR COA RELAY WITH EXTRA ALARM TERMINAL. FOR RELAY WITHOUT ALARM CIRCUIT OMIT THE BOTTOM TERMINAL

Testing Relays

All relays should be inspected periodically and the time of operation should be checked at least once every six months. For this purpose, a cycle counter should be employed because of its convenience and accuracy. Phantom loads should not be used in testing induction type relays because of the resulting distorted current wave form which produces an error in timing.

For the directionally controlled relays, the time of operation is the time for the directional and overcurrent elements to operate, since the former must close contacts before the disc on the latter can start to rotate. The time of operation of the directional element depends upon the applied voltage, current and the phase angle between the two, but will be a matter of a few cycles for nearly all faults. Therefore, the relay has been calibrated at the factory with the directional contacts blocked closed.

Caution

The position of the torque compensator on the overload element is adjustable but this is primarily a factory adjustment and the location of the torque compensator should not be changed in the field.

Readjusting Relays

Overload Element

If the factory adjustment has been disturbed, proceed as follows to make readjustment. By shifting the position of the contact stop on the time lever, adjust contacts so that they barely touch when the time lever is set on zero.

Adjust the tension of the spiral spring so that the relay will close its contacts at its rated current, as shown by the position of the screw on the terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are the same as shown on the calibration curve.

Directional Element

The tension of the spiral spring on the directional element should be just sufficient to return the disc to the stop and thus hold the contacts in the open position.

In many applications there is no objection to having the contacts closed when the relay is de-energized. This can be changed by shifting the spring adjuster but the tension on the spring should never be enough to prevent the contacts from taking their proper position, either open or closed, during time of short circuit when the forces acting on the disc are small.

There is an adjustable magnetic vane on each side of the upper pair of poles, which is intended to balance the current circuit. The normal adjustment is to remove all potential from the voltage coil and apply heavy current to the current coils. The balancing vanes are then adjusted till there is no pronounced torque in either direction. This same adjustment may be used to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker even though the potential may be absolutely zero.

The upper bearing screw should be screwed down until there is only two or three thousandths clearance between it and the shaft and then securely locked in position with the lock nut.

The contact opening on the directionally controlled relays should be $\frac{1}{32}$" in order to reduce the time of operation of the directional element to a minimum. No harm will result if the directional contacts rebound closed momentarily after a fault is cleared, because the overcurrent contacts will be in the open position.

The contact opening on relays which are not directionally controlled should be $\frac{3}{32}$".

Contactor Switch

The stationary core is adjustable so that it may be moved up sufficiently to keep the plunger from striking against it. This is important because, if the plunger strikes against the core, it is likely to stick due to residual magnetism.

Double Trip Circuit

If this relay has two stationary contacts on the overload element, it may be used for tripping two circuit-breakers simultaneously, or for any purpose where it is desired to have two circuits closed at the same time by the relay and yet have them independent when the relay is not operated. Double contacts on the relay are necessary so that either breaker may be opened independently of the other for ordinary switching operation and allowing both to be tripped if both are closed when trouble occurs.

The double trip type CO relay may be used for tripping one breaker and energizing a bell alarm circuit. The directionally controlled double trip type CR relay may also be used in this manner.

Renewal Parts

Repairing

Repair work can be most satisfactorily accomplished at our Works. However, interchangeable renewal parts can be furnished to customers who are equipped for doing repair work.

Ordering Instructions

When ordering renewal parts, give the nameplate reading and the name of the part wanted.

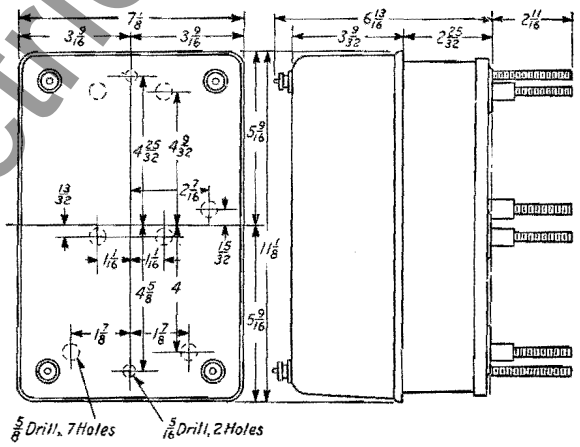

FIG. 22—TYPES CR, CRA AND CRC SEVEN-TERMINAL RELAYS. THIS COVERS THE DOUBLE-TRIP, CIRCUIT-CLOSING OR THE SINGLE-TRIP, DUO-DIRECTIONAL, OR THE SINGLE-TRIP WITH AN EXTRA TAP BETWEEN THE DIRECTIONAL AND THE OVER-CURRENT ELEMENTS.

Westinghouse Electric & Manufacturing Company
Newark, N. J.

Printed in U. S. A. (Rep. 9-37)

I. L. 1849-C
(Filing No. 41-000)

Westinghouse

Types CO and COA Overcurrent and Types CR, CRA and CRC Directional Overcurrent Relays

Caution

Remove all blocking from relay before placing in service.

Installation

Carefully unpack the relay and remove all dust and packing material with a soft brush or cloth. The cover of the relay should be removed and the interior parts carefully inspected for any damage which might have been done in shipment. This inspection should include a test of the moving parts to see that they have not become misaligned and that there is no friction present. The presence of friction can usually be determined by moving the disc or contactor plunger by hand and letting it return to the normal position. Owing to the importance of proper relay functioning it is a wise precaution before placing relays in service, to check each relay for operating current, time of operation, and polarity. For all type CR relays, the left hand contacts of the directional element, front view, should open when the potential and current applied to the relay are in phase, See Fig. 5.

Mount the relay vertically by means of the two mounting studs. Connections may be made direct to the terminals by means of screws for steel panel mounting or to the terminal studs, furnished with the relay, for slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. Note that the top mounting stud may be utilized as a grounding stud for grounding the metal case.

Connect the relay as shown on the proper diagram in this leaflet, or consult the nearest Sales Office for additional diagrams of connections for cases not covered by this leaflet.

The tripping circuit should not be opened by the relay, but an auxiliary contact on the circuit-breaker should be provided to open the tripping circuit the instant the breaker opens.

This relay is suitable for operating the Westinghouse direct trip attachment for tripping direct from the current transformer and also for operating the transfer relay for the same purpose.

Instructions for Setting

In arriving at the proper setting of the overload element, or relay, two things must be determined.

FIRST—In terms of the secondary circuit of the current transformer, the minimum amperes to trip (tap setting) should be higher than the overload peaks due to service load. Under short circuit conditions, the current will be fixed by the impedance of the circuit to which the relays are connected and the minimum short circuit current will usually be several hundred percent of the tap setting.

SECOND—The time setting for short circuit conditions is determined by consideration of the sequence in which the breakers should trip, the time required for breaker mechanisms to operate etc., as required to give proper selective action throughout the system as a whole.

Current Setting:

The connector screw on the terminal plate above the time scale makes connections to various turns on the operating coil. By placing this screw in the various holes, the relay will just close contacts at the corresponding current, 4-5-6-8-10-12 or 15 amperes, or as marked on the terminal plate.

The tripping value of the relay on any tap may be altered by changing the initial tension of the spiral spring. This can be accomplished by turning the spring adjuster by means of a screw driver inserted in one of the notches of the plate to when the outside convolution of the spring is fastened. An adjustment of tripping current approximately 15 percent above or below any tap value, can be secured without materially

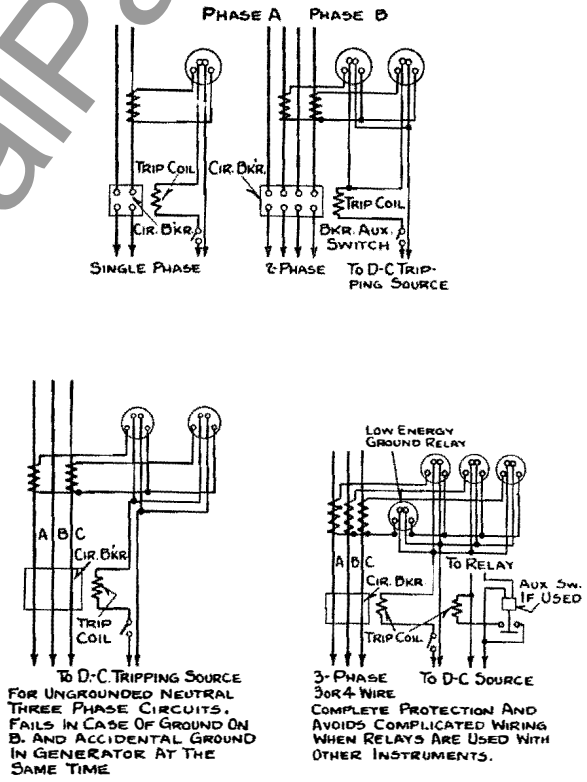

FIG. 1—CONNECTIONS FOR DIFFERENT INSTALLATIONS OF TYPE CO OVERCURRENT RELAYS USING D-C. TRIPPING SOURCE

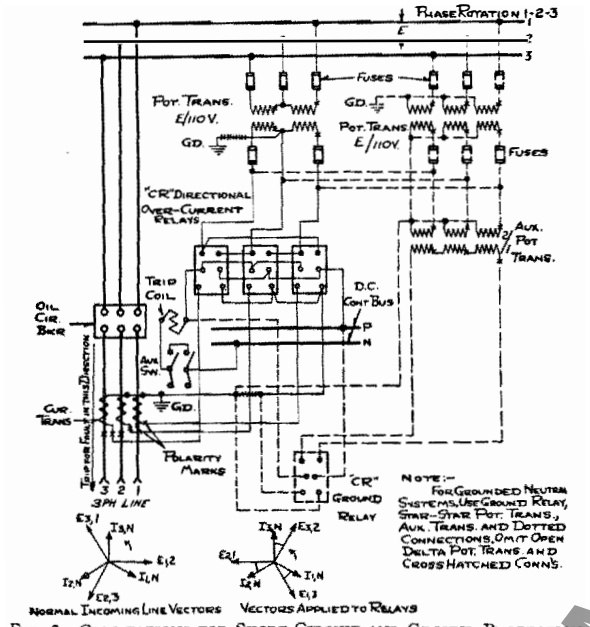

FIG. 2—CONNECTIONS FOR SHORT-CIRCUIT AND GROUND PROTECTION USING TYPE CR RELAYS AND HIGH-TENSION POTENTIAL TRANSFORMERS

affecting the operating characteristics of the relay. By choosing the proper tap, a continuous adjustment of tripping current from 3.4 amperes to 17.5 amperes may be secured. The characteristic time curve will be affected less for any large adjustment if the next higher tap is selected and the initial tension of the spiral spring is decreased to secure the desired tripping value. For example, the relay should be set on the 8 ampere tap with less initial tension in order to secure a 7 ampere tripping value.

Caution

Be sure that the connector screw is turned up tight so as to make a good contact, for the operating current passes through it. Since the overload element is connected directly in the current transformer circuit, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, located on the right hand mounting boss, in the new tap and removing the old screw from its original setting.

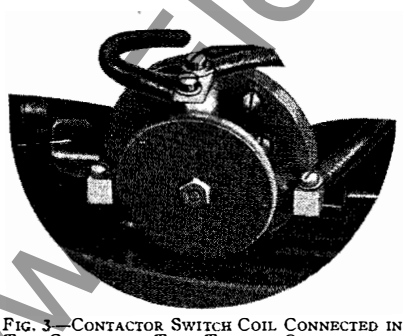

FIG. 3—CONTACTOR SWITCH COIL CONNECTED IN TRIP CIRCUIT. THE TARGET OPERATES ON 2.25 AMPERES OR MORE

Time Adjustments

The index or time lever, limits the motion of the disc and thus varies the time of operation. The latter is proportional to the lever setting, that is, with the lever on the number 5 setting, at 2000 percent load, the relay will operate in one second and similarly on the number 1 setting the time of operation is 0.2 seconds.

The relay has been calibrated from the #10 time lever setting according to the curve engraved on the nameplate. The #11 time setting may be used to secure a time delay approximately 10 per cent longer, that is, to secure a setting of 2.2 seconds for a 2 second relay.

Be sure that the contacts just touch when the time lever is set on zero, otherwise the time will not be proportional to the lever setting.

Operation Indicator

This relay is equipped with a universal operation indicator suitable for all tripping currents above 0.2 amperes. The relay leaves the factory with the operation indicator coil connected in parallel with the contactor switch coil and if the tripping current is more than 2.25 amperes d-c., sufficient current will flow through both coils to cause their operation. The resistance of both coils in parallel is approximately 0.25 ohm.

If the trip current is less than 2.25 amperes there is no necessity for the contactor switch and it should be removed from the trip circuit so that all trip current will pass through the indicator coil. The indicator coil has approximately 2.8 ohms resistance. To disconnect the contactor switch coil, remove the lower lead on the front stationary contact of the contactor switch (See Figure 3) and this lead should be fastened (dead ended) under the small fillister head screw located in the micarta base of the contactor switch (See Figure 4).

Make sure that the indicator receives sufficient current to operate through the trip coil. The trip coil has such a high inductance that the breaker may open and open its pallet switch before the current has built up to its full value. Also, the voltage may be low resulting in a lower trip current. It is advisable to assume that the current through the indicator will be only half of the value calculated from the resistance of the coil and normal control voltage. If the trip circuit does not draw enough current to drop the target when it is set to operate at .2 ampere, more current may be secured by putting a small loading resistor around the trip coil or around the auxiliary relay, if this is used.

Directional Element

The standard single trip and double trip type CR relays are directionally controlled, that is, the directional contacts must close in order for the overcurrent element to operate. The contacts of the latter trip the breaker direct. The single trip 7 terminal stud relay (7th terminal between the directional and overcurrent contacts) and the duo-directional relay cannot be made directional controlled and therefore the contacts of the overcurrent and directional elements are in series in the trip circuit.

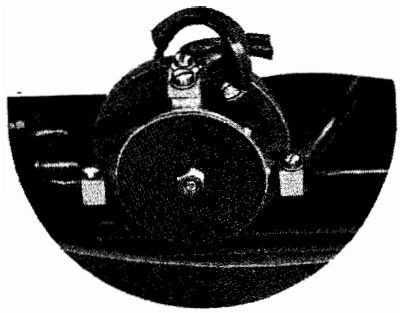

FIG. 4—CONTACTOR SWITCH COIL DISCONNECTED FROM TRIP CIRCUIT. ALL THE CURRENT PASSES THROUGH THE TARGET COIL SO THAT IT WILL OPERATE ON .2 AMPERE OR MORE

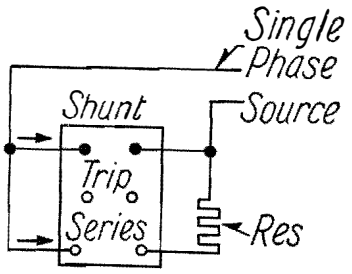

FIG. 5—METHOD OF TESTING POLARITY OF TYPE CR RELAY. THE CONTACTS REMAIN OPEN

The directional element is usually connected to the system in such a manner that the directional contacts close when power flow is away from the station bus All diagrams shown have this polarity.

Checking Connections of the Type CR Relay

All type CR relays, except the ground relays, have wattmeter characteristics for the directional elements and, therefore, the directional element disc will reverse its direction of rotation when the phase relation of the current and voltage becomes 90° or greater. The directional relay must be connected so that this relation will never exceed 90°.

Since the power factor of fault currents may vary over a considerable range, it is necessary that the proper voltage be used on the directional element. Connections should be made so that with unity power factor on the line, the current in the relay directional element will be 30% ahead of the potential supplying the directional element.

The following methods should be used in checking up the correct connections to the directional element of the relay.

Wattmeter Method

With the power flowing in either direction, if the current is lagging, so that the power factor is between 50 and 100 per cent, connect the current coils of a single phase wattmeter in series with the current winding of the relay. Then select a pair of voltage leads which give the highest reading on the wattmeter. The two leads should be connected to the relay potential terminal. Inspect the contact of the directional element, which should be open when the power is flowing towards the bus bars. If the contacts are closed when the current flows toward the bus bars, then the potential leads of the relay should be reversed.

Power Factor Meter Method

A second method is to connect the current coils of a single phase power factor meter in series with the current coils of the relay. A pair of potential leads is then selected which will give 86.6 per cent power factor leading on the power factor meter when the line power factor is 100 per cent. These two leads should be connected to the relay potential terminals. The upper contact should be inspected, as before mentioned in the preceding paragraph and checked for proper direction of operation.

Phase Indicator Method

A third method of checking the proper connections of the relay is by means of the Westinghouse phase indicator. It is a portable instrument built on very much the same principle as a power factor meter but calibrated to read in degrees, and show precisely the phase relation between any current and voltage sources to which it may be connected. Full directions for the use of the portable phase indicator are supplied with the instrument.

Relay for 90° Connection

This relay can be used for the 90° connection, that is, with the current leading the applied potential by 90° when the line power factor is 100%, by installing a suitable external resistor in series with the potential coil. These external resistors can be ordered by style number as follows.

25 Cycle, 115 Volts, 760 ohms, S# 721435
50 Cycle, 115 Volts, 670 ohms, S# 721436
60 Cycle, 115 Volts, 565 ohms, S# 721437

Type CR Ground Relays

The directional element of the type CR relay which is intended for ground protection differs from that of the phase relay by not having true wattmeter characteristics. It develops its maximum torque when the relay current lags about 15 degrees behind the relay voltage. This is essential on systems where the neutral is dead grounded. These relays may be distinguished from

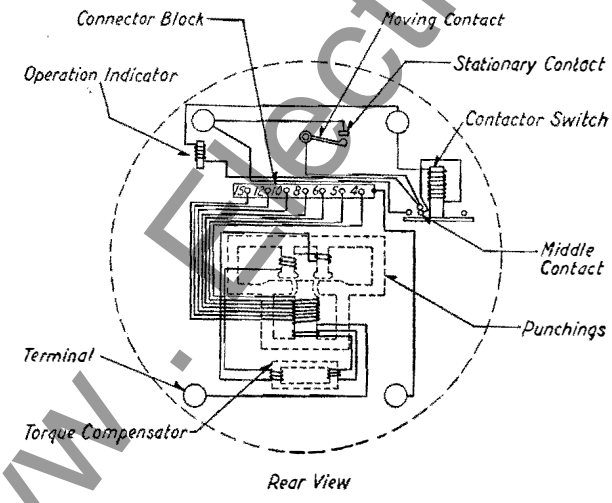

FIG. 6—INTERNAL CONNECTIONS OF SINGLE-TRIP, STANDARD-ENERGY TYPE CO RELAY

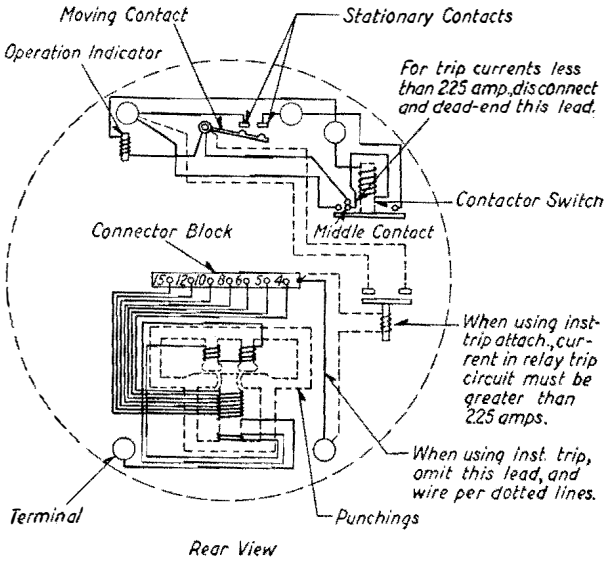

FIG. 7—INTERNAL CONNECTIONS OF DOUBLE-TRIP, LOW-ENERGY TYPE CO RELAY

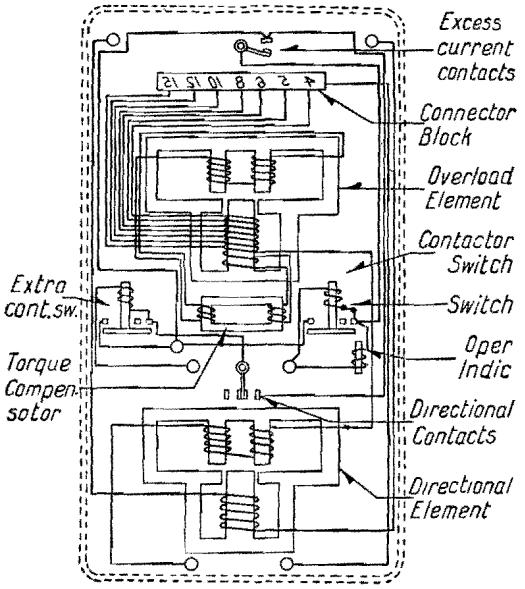

FIG. 8—INTERNAL CONNECTIONS OF STANDARD-ENERGY, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY WITH A TAP CONNECTION BETWEEN THE DIRECTIONAL AND OVERCURRENT CONTACTS—REAR VIEW

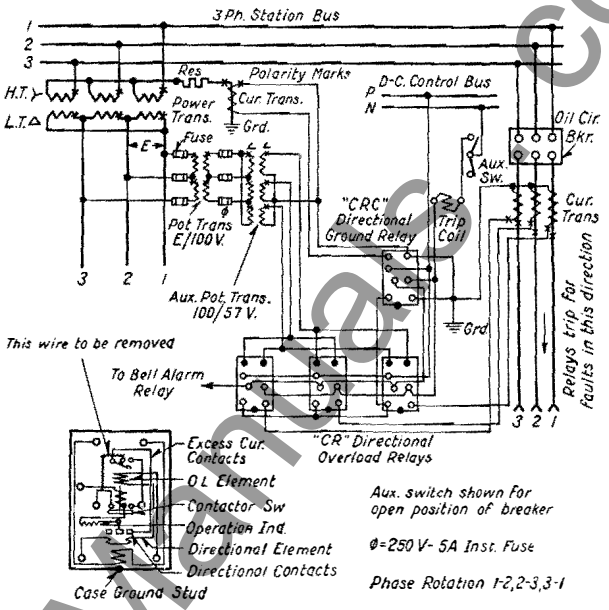

FIG. 10—EXTERNAL CONNECTIONS OF THE TYPE CRC RELAY USED FOR GROUND PROTECTION—REAR VIEW

others because they are of the low energy type and have ratings of .5 to 2.5 or 2 to 6 amperes.

Low Energy Types CO and CR Relays

The low energy type of CO and CR relays are different from the standard ones. Instead of obtaining the definite minimum time feature by means of

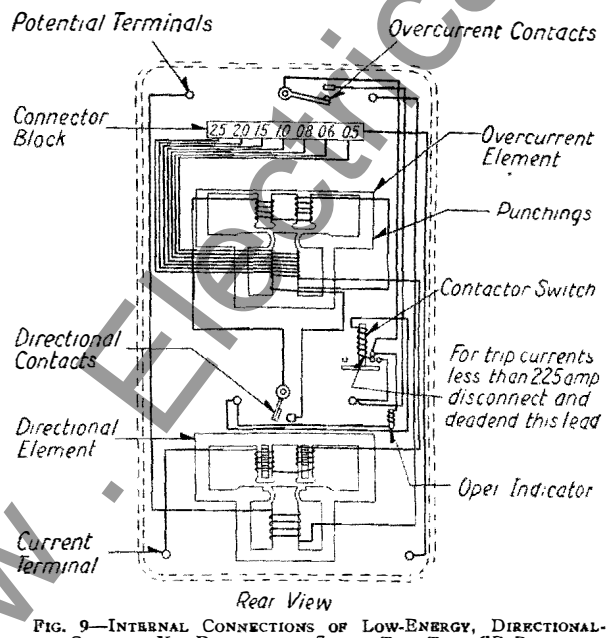

FIG. 9—INTERNAL CONNECTIONS OF LOW-ENERGY, DIRECTIONAL-CONTROL, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY

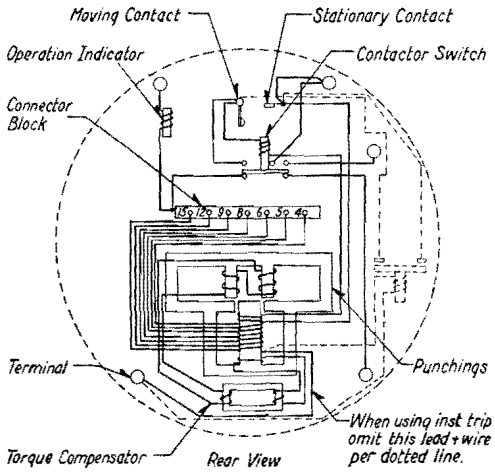

FIG. 11—INTERNAL CONNECTIONS OF CIRCUIT-OPENING TYPE CO RELAY FOR SERIES TRIP CIRCUIT

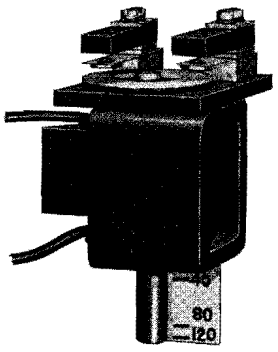

FIG. 12—THE INSTANTANEOUS ATTACHMENT

the torque compensator, a somewhat similar result is obtained by gearing the disc to the shaft which carries the contact arm. This results in a characteristic curve which is somewhat more inverse than the standard curve and also results in much slower resetting time. The term "low energy" refers to the burden which is placed on the current transformers and does not refer to the current rating. All of the small current ranges are of the low energy type and some of the higher current ranges are also made in the low energy type for use on certain current transformers which are incapable of carrying a heavy burden. The low energy and standard relays have the same external appearance and dimensions.

When circuit breakers are instantaneously reclosed, it is necessary to use special quick opening contacts on the low energy type of relay. These contacts differ from the normal ones in being stiff, without any follow, so that they will open quickly.

Very-Inverse Type CO Relay

This relay is similar to the low-energy relay but contains a different electromagnet and has a much more inverse curve. The mechanical arrangement of the parts is similar to the low-energy type, although they are not exact duplicates. The burden on the current transformer is considerably less than that of the low-energy CO relay.

The 40-Second Type CO Relay

This relay is similar in appearance to the low energy relay but consists of a standard energy 4-second relay with a 10 to 1 gear reduction, making the total time 40 seconds on the flat part of the curve. The 25 cycle relay has a resetting time of approximately 90 seconds. It will overheat before tripping from the number 10 position for currents greater than 750% of the tripping value. The 60 cycle relay resets in 120 seconds and will overheat before tripping from the number 10 position for current greater than 1000% of the tripping value.

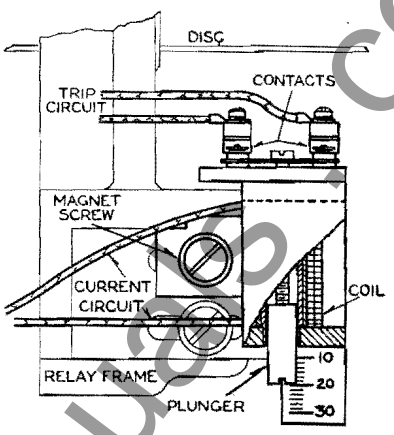

FIG. 14—ADJUSTMENT DETAILS AND METHOD OF MOUNTING THE INSTANTANEOUS ATTACHMENT

This relay is frequently used for motor protection and may require an accurate current setting which can be given by adjusting the spiral spring. The instantaneous attachment mentioned below is useful on this relay to protect against short circuits.

CRC Ground Relay

This is a directional relay quite similar to the CR relay with the same dimensions and internal connections, but the

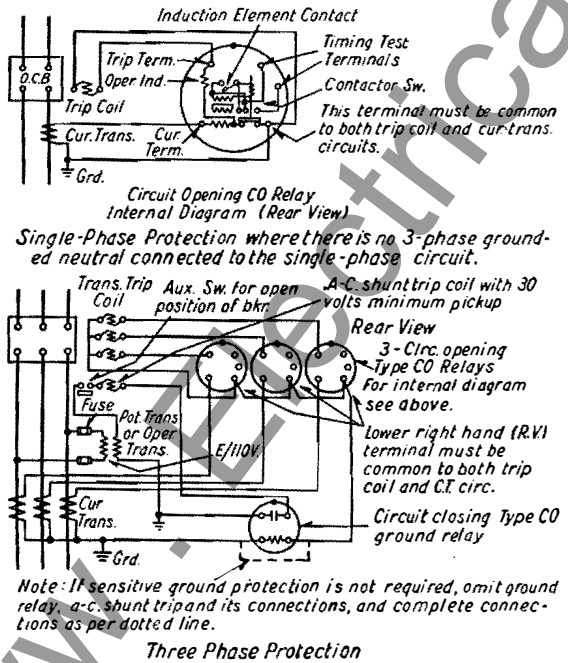

FIG. 13—OVER-CURRENT PROTECTION USING 3 CIRCUIT-OPENING TYPE CO RELAYS FOR LINE PROTECTION AND ONE CIRCUIT-CLOSING GROUND RELAY

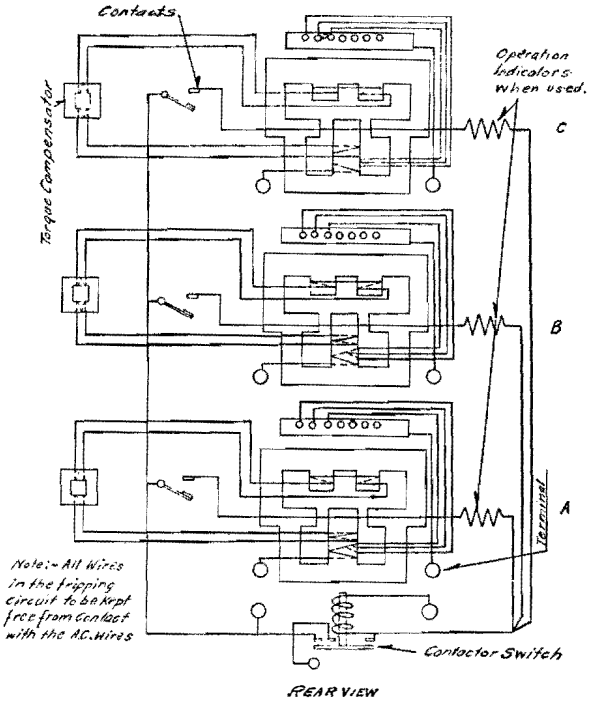

FIG. 15—INTERNAL CONNECTIONS OF THREE ELEMENT TYPE CO AND COA RELAY WITH EXTRA BELL ALARM TERMINAL

Caution

The position of the torque compensator on the overload element is adjustable but this is primarily a factory adjustment and the location of the torque compensator should not be changed in the field.

Readjusting Relays

Overload Element

If the factory adjustment has been disturbed, proceed as follows to make readjustment. By shifting the position of the contact stop on the time lever, adjust contacts so that they barely touch when the time lever is set on zero.

Adjust the tension of the spiral spring so that the relay will close its contacts at its rated current, as shown by the position of the screw on the terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are the same as shown on the calibration curve.

Directional Element

The tension of the spiral spring on the directional element should be just sufficient to return the disc to the stop and thus hold the contacts in the open position.

In many applications there is no objection to having the contacts closed when the relay is de-energized. This can be changed by shifting the spring adjuster but the tension on the spring should never be enough to prevent the contacts from taking their proper position, either open or closed, during time of short circuit when the forces acting on the disc are small.

There is an adjustable magnetic vane on each side of the upper pair of poles, which is intended to balance the current circuit. The normal adjustment is to remove all potential from the voltage coil and apply heavy current to the current coils. The balancing vanes are then adjusted till there is no pronounced torque in either direction. This same adjustment may be used to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker even though the potential may be absolutely zero.

The upper bearing screw should be screwed down until there is only two or three thousandths clearance between it and the shaft and then securely locked in position with the lock nut.

The contact opening on the directionally controlled relays should be $\frac{1}{32}$" in order to reduce the time of operation of the directional element to a minimum. No harm will result if the directional contacts rebound closed momentarily after a fault is cleared, because the overcurrent contacts will be in the open position.

The contact opening on relays which are not directionally controlled should be $\frac{3}{32}$".

Contactor Switch

The stationary core is adjustable so that it may be moved up sufficiently to keep the plunger from striking against it. This is important because, if the plunger strikes against the core, it is likely to stick due to residual magnetism.

Double Trip Circuit

If this relay has two stationary contacts on the overload element, it may be used for tripping two circuit-breakers simultaneously, or for any purpose where it is desired to have two circuits closed at the same time by the relay and yet have them independent when the relay is not operated. Double contacts on the relay are necessary so that either breaker may be opened independently of the other for ordinary switching operation and allowing both to be tripped if both are closed when trouble occurs.

The double trip type CO relay may be used for tripping one breaker and energizing a bell alarm circuit. The directionally controlled double trip type CR relay may also be used in this manner.

Renewal Parts

Repairing

Repair work can be most satisfactorily accomplished at our Works. However, interchangeable renewal parts can be furnished to customers who are equipped for doing repair work.

Ordering Instructions

When ordering renewal parts, give the nameplate reading and the name of the part wanted.

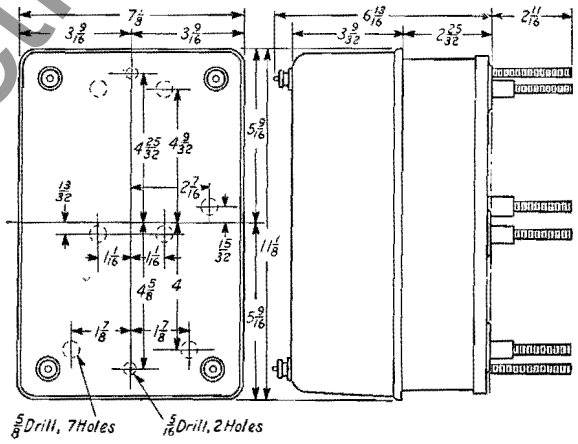

FIG. 22—TYPES CR, CRA AND CRC SEVEN-TERMINAL RELAYS. THIS COVERS THE DOUBLE-TRIP, CIRCUIT-CLOSING OR THE SINGLE-TRIP, DUO-DIRECTIONAL, OR THE SINGLE-TRIP WITH AN EXTRA TAP BETWEEN THE DIRECTIONAL AND THE OVER-CURRENT ELEMENTS.

Westinghouse Electric & Manufacturing Company
Newark, N. J.

Printed in U. S. A. (Rep. 9-37)

I. L. 1849-C
(Filing No. 41-000)

Westinghouse

Types CO and COA Overcurrent and Types CR, CRA and CRC Directional Overcurrent Relays

Caution

Remove all blocking from relay before placing in service.

Installation

Carefully unpack the relay and remove all dust and packing material with a soft brush or cloth. The cover of the relay should be removed and the interior parts carefully inspected for any damage which might have been done in shipment. This inspection should include a test of the moving parts to see that they have not become misaligned and that there is no friction present. The presence of friction can usually be determined by moving the disc or contactor plunger by hand and letting it return to the normal position. Owing to the importance of proper relay functioning it is a wise precaution before placing relays in service, to check each relay for operating current, time of operation, and polarity. For all type CR relays, the left hand contacts of the directional element, front view, should open when the potential and current applied to the relay are in phase, See Fig. 5.

Mount the relay vertically by means of the two mounting studs. Connections may be made direct to the terminals by means of screws for steel panel mounting or to the terminal studs, furnished with the relay, for slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. Note that the top mounting stud may be utilized as a grounding stud for grounding the metal case.

Connect the relay as shown on the proper diagram in this leaflet, or consult the nearest Sales Office for additional diagrams of connections for cases not covered by this leaflet.

The tripping circuit should not be opened by the relay, but an auxiliary contact on the circuit-breaker should be provided to open the tripping circuit the instant the breaker opens.

This relay is suitable for operating the Westinghouse direct trip attachment for tripping direct from the current transformer and also for operating the transfer relay for the same purpose.

Instructions for Setting

In arriving at the proper setting of the overload element, or relay, two things must be determined.

FIRST—In terms of the secondary circuit of the current transformer, the minimum amperes to trip (tap setting) should be higher than the overload peaks due to service load. Under short circuit conditions, the current will be fixed by the impedance of the circuit to which the relays are connected and the minimum short circuit current will usually be several hundred percent of the tap setting.

SECOND—The time setting for short circuit conditions is determined by consideration of the sequence in which the breakers should trip, the time required for breaker mechanisms to operate etc., as required to give proper selective action throughout the system as a whole.

Current Setting:

The connector screw on the terminal plate above the time scale makes connections to various turns on the operating coil. By placing this screw in the various holes, the relay will just close contacts at the corresponding current, 4-5-6-8-10-12 or 15 amperes, or as marked on the terminal plate.

The tripping value of the relay on any tap may be altered by changing the initial tension of the spiral spring. This can be accomplished by turning the spring adjuster by means of a screw driver inserted in one of the notches of the plate to when the outside convolution of the spring is fastened. An adjustment of tripping current approximately 15 percent above or below any tap value, can be secured without materially

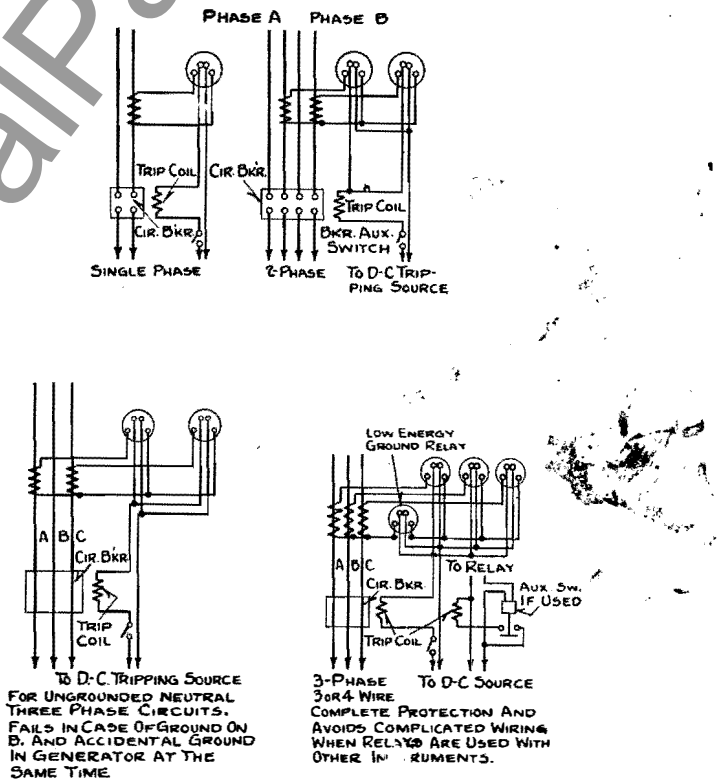

FIG. 1—CONNECTIONS FOR DIFFERENT INSTALLATIONS OF TYPE CO OVERCURRENT RELAYS USING D-C. TRIPPING SOURCE

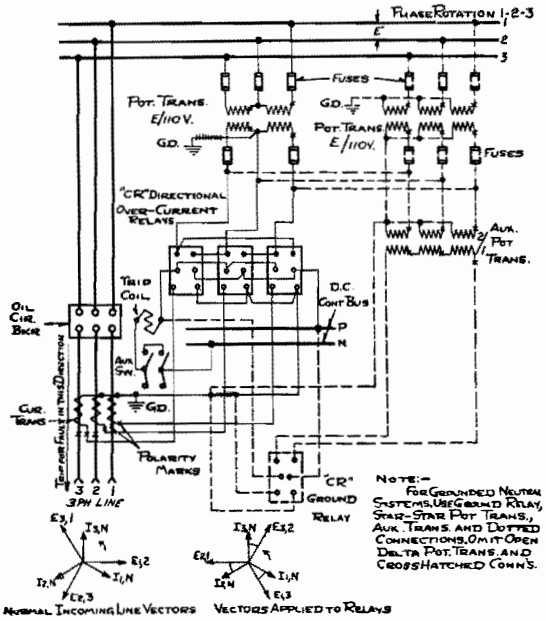

FIG. 2—CONNECTIONS FOR SHORT-CIRCUIT AND GROUND PROTECTION USING TYPE CR RELAYS AND HIGH-TENSION POTENTIAL TRANSFORMERS

affecting the operating characteristics of the relay. By choosing the proper tap, a continuous adjustment of tripping current from 3.4 amperes to 17.5 amperes may be secured. The characteristic time curve will be affected less for any large adjustment if the next higher tap is selected and the initial tension of the spiral spring is decreased to secure the desired tripping value. For example, the relay should be set on the 8 ampere tap with less initial tension in order to secure a 7 ampere tripping value.

Caution

Be sure that the connector screw is turned up tight so as to make a good contact, for the operating current passes through it. Since the overload element is connected directly in the current transformer circuit, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, located on the right hand mounting boss, in the new tap and removing the old screw from its original setting.

Time Adjustments

The index or time lever, limits the motion of the disc and thus varies the time of operation. The latter is proportional to the lever setting, that is, with the lever on the number 5 setting, at 2000 percent load, the relay will operate in one second and similarly on the number 1 setting the time of operation is 0.2 seconds.

The relay has been calibrated from the # 10 time lever setting according to the curve engraved on the nameplate. The # 11 time setting may be used to secure a time delay approximately 10 per cent longer, that is, to secure a setting of 2.2 seconds for a 2 second relay.

Be sure that the contacts just touch when the time lever is set on zero, otherwise the time will not be proportional to the lever setting.

Operation Indicator

This relay is equipped with a universal operation indicator suitable for all tripping currents above 0.2 amperes. The relay leaves the factory with the operation indicator coil connected in parallel with the contactor switch coil and if the tripping current is more than 2.25 amperes d-c., sufficient current will flow through both coils to cause their operation. The resistance of both coils in parallel is approximately 0.25 ohm.

If the trip current is less than 2.25 amperes there is no necessity for the contactor switch and it should be removed from the trip circuit so that all trip current will pass through the indicator coil. The indicator coil has approximately 2.8 ohms resistance. To disconnect the contactor switch coil, remove the lower lead on the front stationary contact of the contactor switch (See Figure 3) and this lead should be fastened (dead ended) under the small fillister head screw located in the micarta base of the contactor switch (See Figure 4).

Make sure that the indicator receives sufficient current to operate through the trip coil. The trip coil has such a high inductance that the breaker may open and open its pallet switch before the current has built up to its full value. Also, the voltage may be low resulting in a lower trip current. It is advisable to assume that the current through the indicator will be only half of the value calculated from the resistance of the coil and normal control voltage. If the trip circuit does not draw enough current to drop the target when it is set to operate at .2 ampere, more current may be secured by putting a small loading resistor around the trip coil or around the auxiliary relay, if this is used.

Directional Element

The standard single trip and double trip type CR relays are directionally controlled, that is, the directional contacts must close in order for the overcurrent element to operate. The contacts of the latter trip the breaker direct. The single trip 7 terminal stud relay (7th terminal between the directional and overcurrent contacts) and the duo-directional relay cannot be made directional controlled and therefore the contacts of the overcurrent and directional elements are in series in the trip circuit.

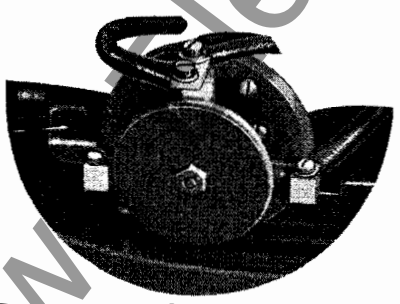

FIG. 3—CONTACTOR SWITCH COIL CONNECTED IN TRIP CIRCUIT. THE TARGET OPERATES ON 2.25 AMPERES OR MORE

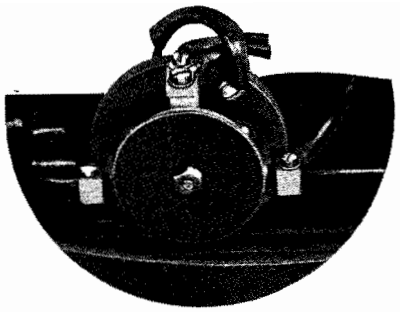

FIG. 4—CONTACTOR SWITCH COIL DISCONNECTED FROM TRIP CIRCUIT. ALL THE CURRENT PASSES THROUGH THE TARGET COIL SO THAT IT WILL OPERATE ON .2 AMPERE OR MORE

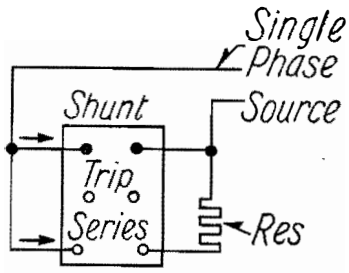

FIG. 5—METHOD OF TESTING POLARITY OF TYPE CR RELAY. THE CONTACTS REMAIN OPEN

The directional element is usually connected to the system in such a manner that the directional contacts close when power flow is away from the station bus All diagrams shown have this polarity.

Checking Connections of the Type CR Relay

All type CR relays, except the ground relays, have wattmeter characteristics for the directional elements and, therefore, the directional element disc will reverse its direction of rotation when the phase relation of the current and voltage becomes 90° or greater. The directional relay must be connected so that this relation will never exceed 90°.

Since the power factor of fault currents may vary over a considerable range, it is necessary that the proper voltage be used on the directional element. Connections should be made so that with unity power factor on the line, the current in the relay directional element will be 30% ahead of the potential supplying the directional element.

The following methods should be used in checking up the correct connections to the directional element of the relay.

Wattmeter Method

With the power flowing in either direction, if the current is lagging, so that the power factor is between 50 and 100 per cent, connect the current coils of a single phase wattmeter in series with the current winding of the relay. Then select a pair of voltage leads which give the highest reading on the wattmeter. The two leads should be connected to the relay potential terminal. Inspect the contact of the directional element, which should be open when the power is flowing towards the bus bars. If the contacts are closed when the current flows toward the bus bars, then the potential leads of the relay should be reversed.

Power Factor Meter Method

A second method is to connect the current coils of a single phase power factor meter in series with the current coils of the relay. A pair of potential leads is then selected which will give 86.6 per cent power factor leading on the power factor meter when the line power factor is 100 per cent. These two leads should be connected to the relay potential terminals. The upper contact should be inspected, as before mentioned in the preceding paragraph and checked for proper direction of operation.

Phase Indicator Method

A third method of checking the proper connections of the relay is by means of the Westinghouse phase indicator. It is a portable instrument built on very much the same principle as a power factor meter but calibrated to read in degrees, and show precisely the phase relation between any current and voltage sources to which it may be connected. Full directions for the use of the portable phase indicator are supplied with the instrument.

Relay for 90° Connection

This relay can be used for the 90° connection, that is, with the current leading the applied potential by 90° when the line power factor is 100%, by installing a suitable external resistor in series with the potential coil. These external resistors can be ordered by style number as follows.

25 Cycle, 115 Volts, 760 ohms, S# 721435
50 Cycle, 115 Volts, 670 ohms, S# 721436
60 Cycle, 115 Volts, 565 ohms, S# 721437

Type CR Ground Relays

The directional element of the type CR relay which is intended for ground protection differs from that of the phase relay by not having true wattmeter characteristics. It develops its maximum torque when the relay current lags about 15 degrees behind the relay voltage. This is essential on systems where the neutral is dead grounded. These relays may be distinguished from

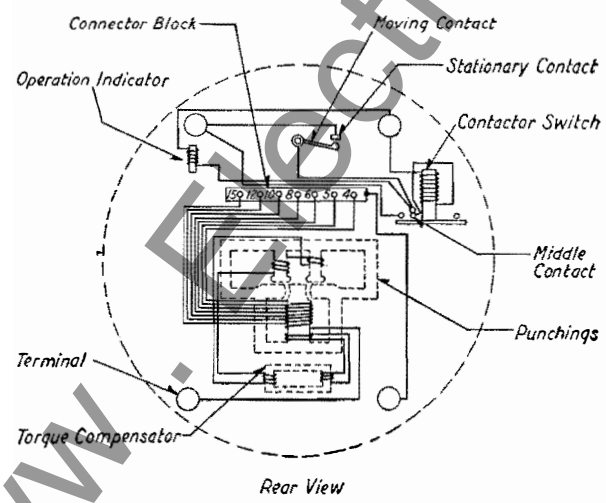

FIG. 6—INTERNAL CONNECTIONS OF SINGLE-TRIP, STANDARD-ENERGY TYPE CO RELAY

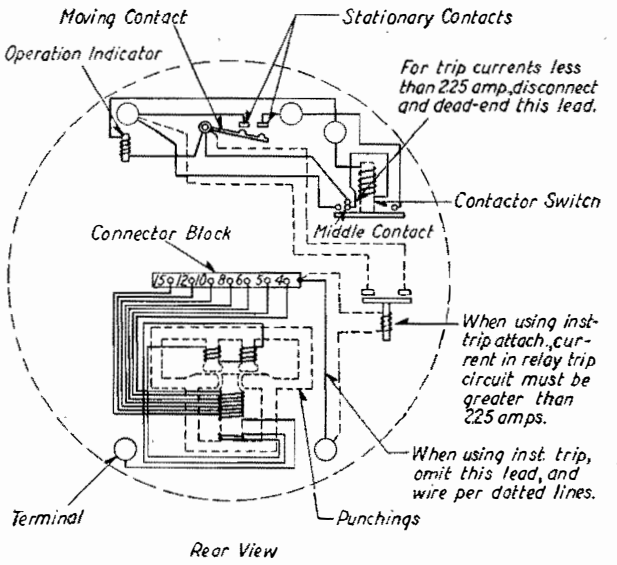

FIG. 7—INTERNAL CONNECTIONS OF DOUBLE-TRIP, LOW-ENERGY TYPE CO RELAY

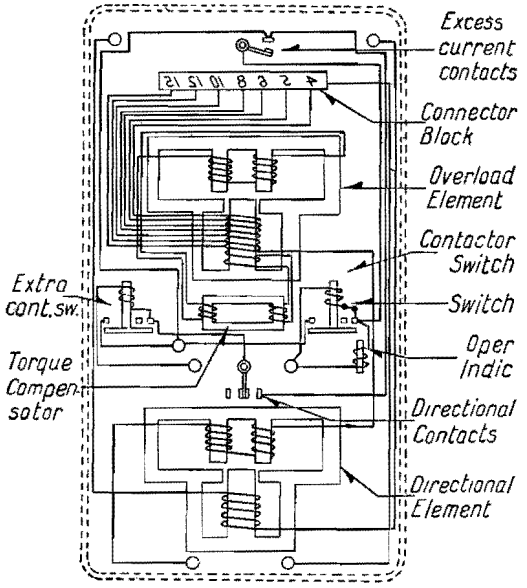

FIG. 8—INTERNAL CONNECTIONS OF STANDARD-ENERGY, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY WITH A TAP CONNECTION BETWEEN THE DIRECTIONAL AND OVERCURRENT CONTACTS—REAR VIEW

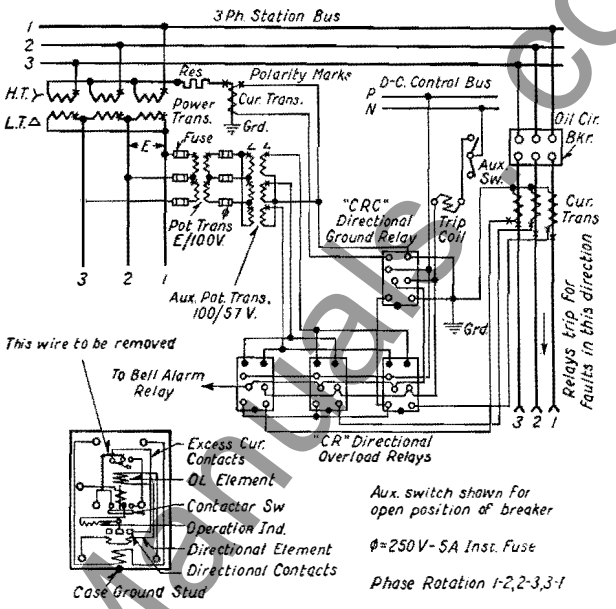

FIG. 10—EXTERNAL CONNECTIONS OF THE TYPE CRC RELAY USED FOR GROUND PROTECTION—REAR VIEW

others because they are of the low energy type and have ratings of .5 to 2.5 or 2 to 6 amperes.

Low Energy Types CO and CR Relays

The low energy type of CO and CR relays are different from the standard ones. Instead of obtaining the definite minimum time feature by means of

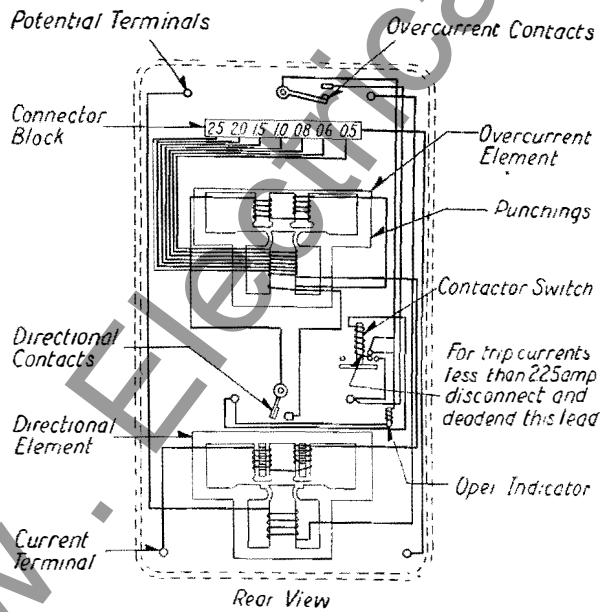

FIG. 9—INTERNAL CONNECTIONS OF LOW-ENERGY, DIRECTIONAL-CONTROL, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY

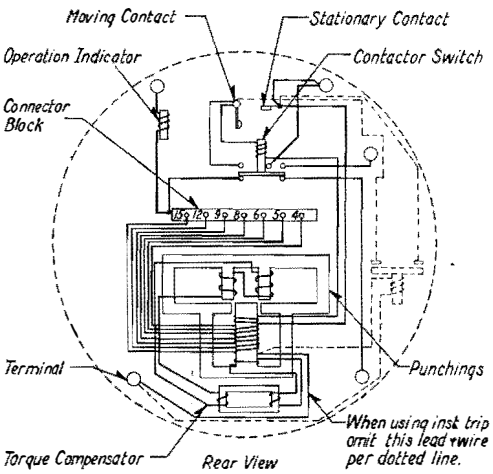

FIG. 11—INTERNAL CONNECTIONS OF CIRCUIT-OPENING TYPE CO RELAY FOR SERIES TRIP CIRCUIT

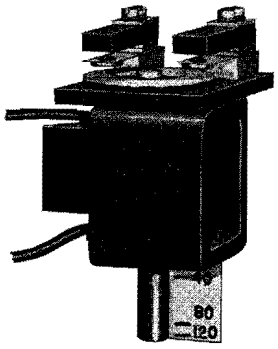

FIG. 12—THE INSTANTANEOUS ATTACHMENT

the torque compensator, a somewhat similar result is obtained by gearing the disc to the shaft which carries the contact arm. This results in a characteristic curve which is somewhat more inverse than the standard curve and also results in much slower resetting time. The term "low energy" refers to the burden which is placed on the current transformers and does not refer to the current rating. All of the small current ranges are of the low energy type and some of the higher current ranges are also made in the low energy type for use on certain current transformers which are incapable of carrying a heavy burden. The low energy and standard relays have the same external appearance and dimensions.

When circuit breakers are instantaneously reclosed, it is necessary to use special quick opening contacts on the low energy type of relay. These contacts differ from the normal ones in being stiff, without any follow, so that they will open quickly.

Very-Inverse Type CO Relay

This relay is similar to the low-energy relay but contains a different electromagnet and has a much more inverse curve. The mechanical arrangement of the parts is similar to the low-energy type, although they are not exact duplicates. The burden on the current transformer is considerably less than that of the low-energy CO relay.

The 40-Second Type CO Relay

This relay is similar in appearance to the low energy relay but consists of a standard energy 4-second relay with a 10 to 1 gear reduction, making the total time 40 seconds on the flat part of the curve. The 25 cycle relay has a resetting time of approximately 90 seconds. It will overheat before tripping from the number 10 position for currents greater than 750% of the tripping value. The 60 cycle relay resets in 120 seconds and will overheat before tripping from the number 10 position for current greater than 1000% of the tripping value.

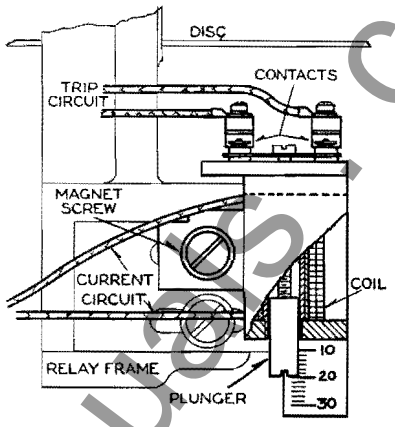

FIG. 14—ADJUSTMENT DETAILS AND METHOD OF MOUNTING THE INSTANTANEOUS ATTACHMENT

This relay is frequently used for motor protection and may require an accurate current setting which can be given by adjusting the spiral spring. The instantaneous attachment mentioned below is useful on this relay to protect against short circuits.

CRC Ground Relay

This is a directional relay quite similar to the CR relay with the same dimensions and internal connections, but the

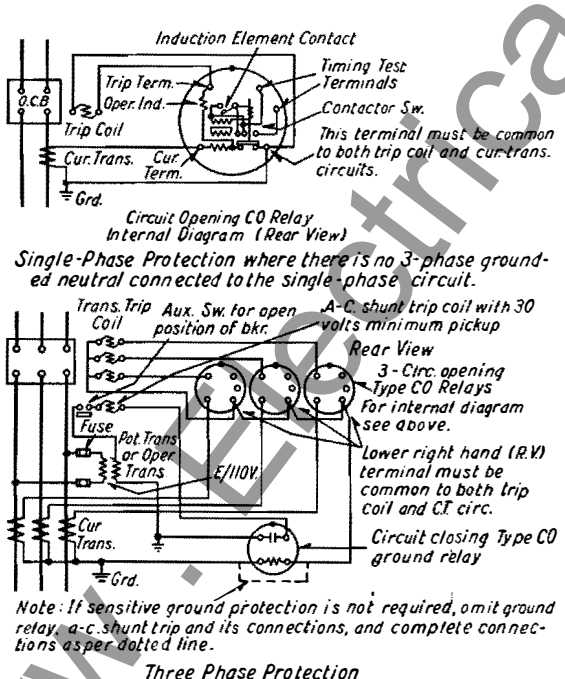

FIG. 13—OVER-CURRENT PROTECTION USING 3 CIRCUIT-OPENING TYPE CO RELAYS FOR LINE PROTECTION AND ONE CIRCUIT-CLOSING GROUND RELAY

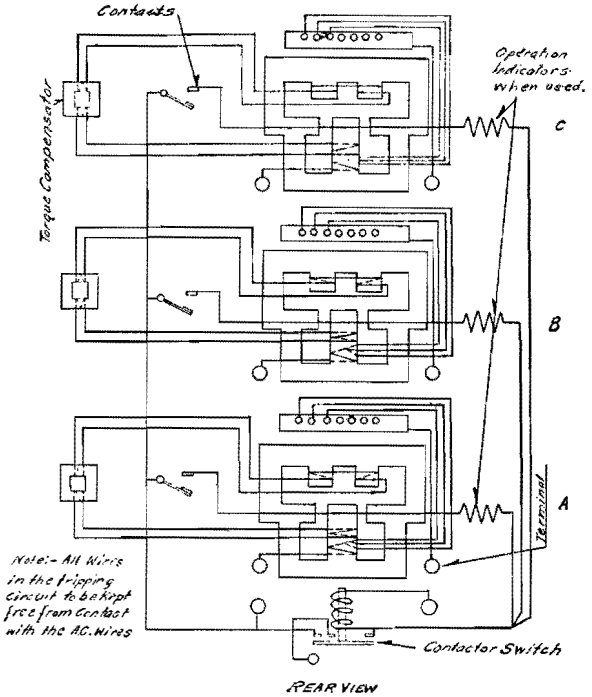

FIG. 15—INTERNAL CONNECTIONS OF THREE ELEMENT TYPE CO AND COA RELAY WITH EXTRA BELL ALARM TERMINAL

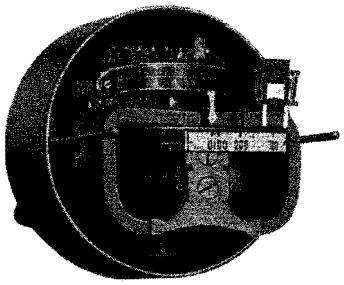

FIG. 16—SINGLE-PHASE TYPE COA RELAY WITH NAMEPLATE REMOVED

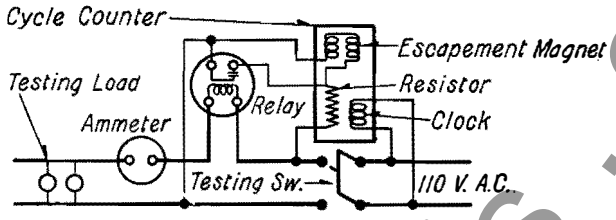

FIG. 18—CONNECTIONS FOR THE USE OF THE CYCLE COUNTER IN TESTING CIRCUIT-CLOSING TIME-LIMIT RELAYS

polarizing coil on the directional element has a 5 ampere winding. This coil is energized by a current transformer placed in the neutral of the power transformers.

All the adjustments and manipulations are the same as for the CR relay.

Circuit Opening Relays

The conventional method of tripping circuit breakers is by means of current from a storage battery and a relay which closes its contacts to complete the circuit through the trip coil. Where it is desired to eliminate the battery, the breaker may be tripped by current from the current transformers if circuit opening relays are used. As shown in Fig. 11 the operation of the relay connects the circuit breaker trip coil in series with the current circuit. The internal diagram shows that when the main relay contacts close they pull up the contactor which is energized from a secondary coil on the main pole. When the contactor is lifted, it opens the short circuit around the trip coil and allows the current to flow through the coil.

It should be observed that the contacts break the full short circuit current and they may be seriously burned. It is therefore important that the contacts be frequently inspected and kept clean and smooth. With frequent maintenance, the contacts may safely open circuits of 50 amperes. If the current is small, the relay may give satisfactory service with inspection periods as seldom as once a year. It should be borne in mind that these contacts carry the current continuously and if they become bad, they will begin to overheat and finally burn open the current transformer circuit.

Because these contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subjected to shocks which may jar the contacts open and thereby allow current to flow through the trip coil.

Trouble of this kind can be avoided by preventing jars to the switchboard and also by setting the trip coil high enough so that it will not operate on normal load current. This is an extra safe-guard so that there is no danger from even an excessive shock unless the current is also heavy.

The circuit opening relay is made only in the 4 to 15 ampere range. Lower ranges are not desirable because the burden of low range trip coils is too heavy on the current transformer. One trip coil is required for each relay.

If ground relay protection is required, the low range ground relay may be of the circuit closing type and operate an a-c. voltage trip coil. See Fig. 13.

The circuit opening feature is provided only in the Type CO Relay.

Instantaneous Attachment

The instantaneous attachment has its contacts in parallel with the main contacts of the CO or CR relay. Its purpose is to make the time of operation of the relay instantaneous after a predetermined current is exceeded. The device is usually built to operate at a high value, a common style being adjustable between 40 and 120 amperes. The marking is accurate to within ± 25%. The current setting is made by raising or lowering the plunger. The design of the 25 cycle relay is somewhat different from that shown in the illustration and has a piece of felt under the contacts to damp out the vibrations.

The instantaneous attachment is usually applied to the relay while it is being manufactured but it can be attached to any of the old induction type relays. No special mounting arrangements are required—it fits under one of the screws holding the permanent magnets. (See Fig. 14).

Lock-Out Attachment

Sometimes it is desired to prevent a relay from tripping a circuit breaker

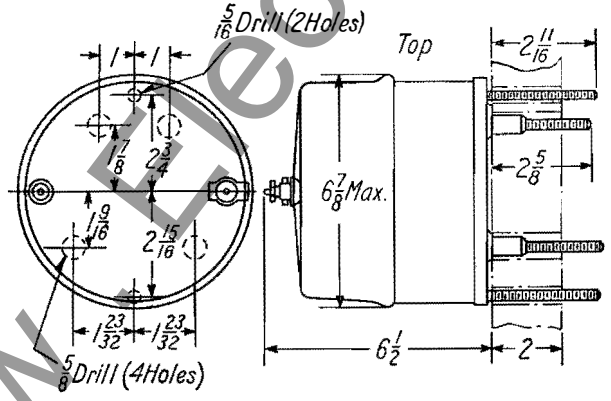

FIG. 17—SINGLE-TRIP STANDARD AND LOW-ENERGY CIRCUIT-CLOSING TYPE CO RELAY. THE TYPE COA RELAY IS 6 23/32-INCH DEEP INSTEAD OF 6 1/2-INCH

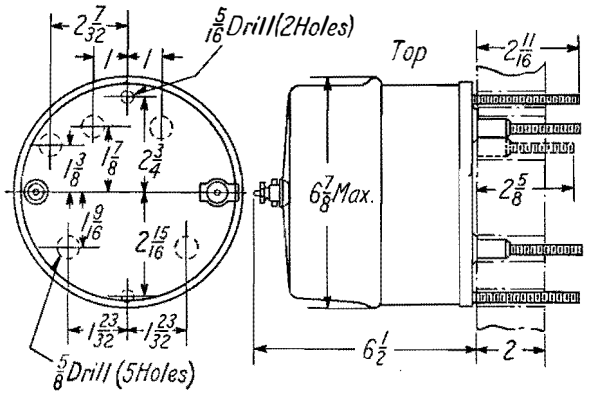

FIG. 19—DOUBLE-TRIP STANDARD AND LOW-ENERGY TYPE CO RELAY, ALSO THE CIRCUIT-OPENING TYPE CO FOR SERIES TRIP. THE TYPE COA RELAY IS 6 23/32-INCH DEEP INSTEAD OF 6 1/2-INCH

when the current is too high—above its interrupting capacity. For this purpose the lockout attachment is provided. It is similar to the instantaneous attachment in appearance and method of adjusting but its contacts are in series with the main contacts and are normally closed. These contacts must be given special care because they are in series with the main tripping circuit and may prevent proper relay operation if they become dirty.

Three Element Type CO Relay

The CO relay, both standard and low energy type, is sometimes furnished with 3 elements in a single case. The outside dimensions of this case are shown in Fig. 20, but the number of terminals varies with the particular style of relays. Similarly Fig. 15 shows a typical diagram of internal connections with three operation indicators.

This 3-element relay is frequently supplied with the ammeter attachments mentioned in the following section.

Types COA and CRA Relays

These relays are standard type CO or CR with a self-contained ammeter scale. This ammeter operates on the induction principle and consists of an aluminum vane which swings in the same air gap as does the main disc. It, therefore, not only indicates the value of the current but supervises the entire current circuit and assures the operator that current is flowing through the relay coils. The entire scale moves and the reading is indicated by a fixed pointer. A small aluminum vane swings above the permanent magnet and sufficient flux is robbed from the magnet to damp the movements of the ammeter.

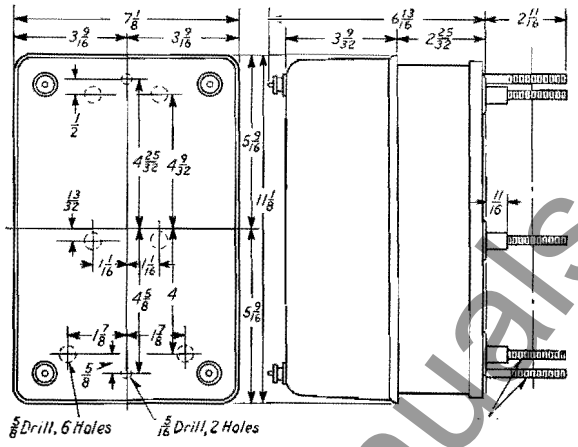

FIG. 21—TYPES CR, CRA AND CRC SINGLE-TRIP CIRCUIT, SIX-TERMINAL RELAYS

The current reading depends upon the tap setting of the relay and this setting should, therefore, be determined before the scale is marked so that it may be properly marked in amperes. Some relays are marked in percent so that any tap value may be used without inconvenience.

The ammeter attachment cannot be put on existing relays. It does not change the diagram of internal connections nor does it change the drilling plan of the various relays which may contain it. On the single element type CO relay it increases the depth from the front of the board by ¼ inch.

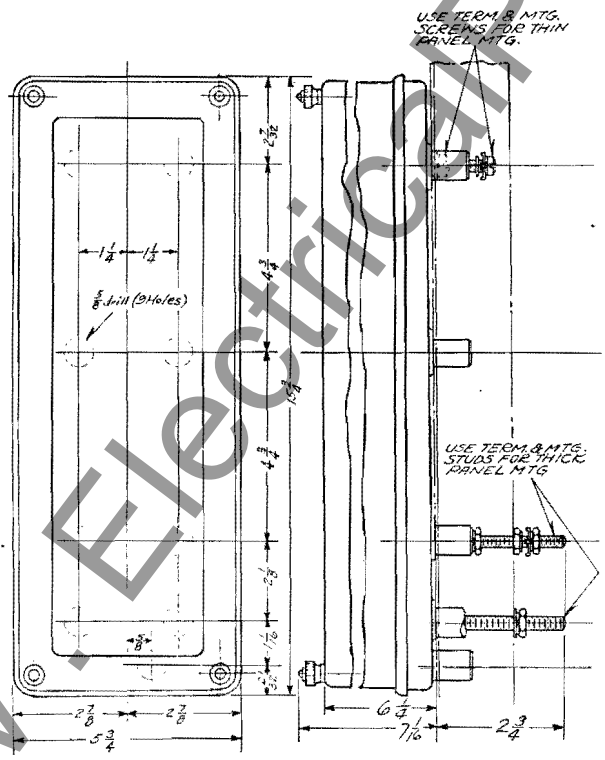

FIG. 20—THREE ELEMENT TYPE CO OR COA RELAY WITH EXTRA ALARM TERMINAL. FOR RELAY WITHOUT ALARM CIRCUIT OMIT THE BOTTOM TERMINAL

Testing Relays

All relays should be inspected periodically and the time of operation should be checked at least once every six months. For this purpose, a cycle counter should be employed because of its convenience and accuracy. Phantom loads should not be used in testing induction type relays because of the resulting distorted current wave form which produces an error in timing.

For the directionally controlled relays, the time of operation is the time for the directional and overcurrent elements to operate, since the former must close contacts before the disc on the latter can start to rotate. The time of operation of the directional element depends upon the applied voltage, current and the phase angle between the two, but will be a matter of a few cycles for nearly all faults. Therefore, the relay has been calibrated at the factory with the directional contacts blocked closed.

Caution

The position of the torque compensator on the overload element is adjustable but this is primarily a factory adjustment and the location of the torque compensator should not be changed in the field.

Readjusting Relays

Overload Element

If the factory adjustment has been disturbed, proceed as follows to make readjustment. By shifting the position of the contact stop on the time lever, adjust contacts so that they barely touch when the time lever is set on zero.

Adjust the tension of the spiral spring so that the relay will close its contacts at its rated current, as shown by the position of the screw on the terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are the same as shown on the calibration curve.

Directional Element

The tension of the spiral spring on the directional element should be just sufficient to return the disc to the stop and thus hold the contacts in the open position.

In many applications there is no objection to having the contacts closed when the relay is de-energized. This can be changed by shifting the spring adjuster but the tension on the spring should never be enough to prevent the contacts from taking their proper position, either open or closed, during time of short circuit when the forces acting on the disc are small.

There is an adjustable magnetic vane on each side of the upper pair of poles, which is intended to balance the current circuit. The normal adjustment is to remove all potential from the voltage coil and apply heavy current to the current coils. The balancing vanes are then adjusted till there is no pronounced torque in either direction. This same adjustment may be used to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker even though the potential may be absolutely zero.

The upper bearing screw should be screwed down until there is only two or three thousandths clearance between it and the shaft and then securely locked in position with the lock nut.

The contact opening on the directionally controlled relays should be $\frac{1}{32}$" in order to reduce the time of operation of the directional element to a minimum. No harm will result if the directional contacts rebound closed momentarily after a fault is cleared, because the overcurrent contacts will be in the open position.

The contact opening on relays which are not directionally controlled should be $\frac{3}{32}$".

Contactor Switch

The stationary core is adjustable so that it may be moved up sufficiently to keep the plunger from striking against it. This is important because, if the plunger strikes against the core, it is likely to stick due to residual magnetism.

Double Trip Circuit

If this relay has two stationary contacts on the overload element, it may be used for tripping two circuit-breakers simultaneously, or for any purpose where it is desired to have two circuits closed at the same time by the relay and yet have them independent when the relay is not operated. Double contacts on the relay are necessary so that either breaker may be opened independently of the other for ordinary switching operation and allowing both to be tripped if both are closed when trouble occurs.

The double trip type CO relay may be used for tripping one breaker and energizing a bell alarm circuit. The directionally controlled double trip type CR relay may also be used in this manner.

Renewal Parts

Repairing

Repair work can be most satisfactorily accomplished at our Works. However, interchangeable renewal parts can be furnished to customers who are equipped for doing repair work.

Ordering Instructions

When ordering renewal parts, give the nameplate reading and the name of the part wanted.

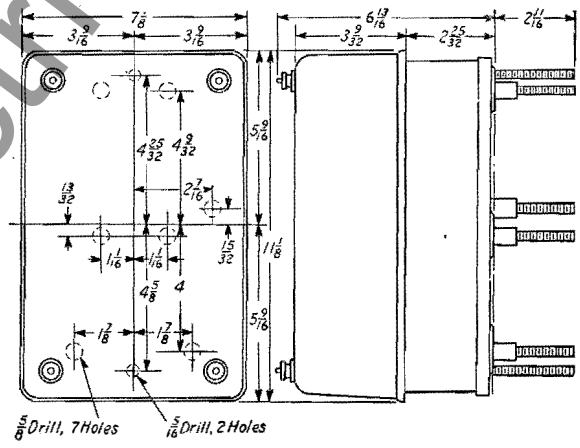

FIG. 22—TYPES CR, CRA AND CRC SEVEN-TERMINAL RELAYS. THIS COVERS THE DOUBLE-TRIP, CIRCUIT-CLOSING OR THE SINGLE-TRIP, DUO-DIRECTIONAL, OR THE SINGLE-TRIP WITH AN EXTRA TAP BETWEEN THE DIRECTIONAL AND THE OVER-CURRENT ELEMENTS.

Westinghouse Electric & Manufacturing Company
Newark, N. J.

Printed in U. S. A. (Rep. 9-37)

I. L. 1849-C
(Filing No. 41-000)

Westinghouse

Types CO and COA Overcurrent and Types CR, CRA and CRC Directional Overcurrent Relays

Caution

Remove all blocking from relay before placing in service.

Installation

Carefully unpack the relay and remove all dust and packing material with a soft brush or cloth. The cover of the relay should be removed and the interior parts carefully inspected for any damage which might have been done in shipment. This inspection should include a test of the moving parts to see that they have not become misaligned and that there is no friction present. The presence of friction can usually be determined by moving the disc or contactor plunger by hand and letting it return to the normal position. Owing to the importance of proper relay functioning it is a wise precaution before placing relays in service, to check each relay for operating current, time of operation, and polarity. For all type CR relays, the left hand contacts of the directional element, front view, should open when the potential and current applied to the relay are in phase, See Fig. 5.

Mount the relay vertically by means of the two mounting studs. Connections may be made direct to the terminals by means of screws for steel panel mounting or to the terminal studs, furnished with the relay, for slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. Note that the top mounting stud may be utilized as a grounding stud for grounding the metal case.

Connect the relay as shown on the proper diagram in this leaflet, or consult the nearest Sales Office for additional diagrams of connections for cases not covered by this leaflet.

The tripping circuit should not be opened by the relay, but an auxiliary contact on the circuit-breaker should be provided to open the tripping circuit the instant the breaker opens.

This relay is suitable for operating the Westinghouse direct trip attachment for tripping direct from the current transformer and also for operating the transfer relay for the same purpose.

Instructions for Setting

In arriving at the proper setting of the overload element, or relay, two things must be determined.

FIRST—In terms of the secondary circuit of the current transformer, the minimum amperes to trip (tap setting) should be higher than the overload peaks due to service load. Under short circuit conditions, the current will be fixed by the impedance of the circuit to which the relays are connected and the minimum short circuit current will usually be several hundred percent of the tap setting.

SECOND—The time setting for short circuit conditions is determined by consideration of the sequence in which the breakers should trip, the time required for breaker mechanisms to operate etc., as required to give proper selective action throughout the system as a whole.

Current Setting:

The connector screw on the terminal plate above the time scale makes connections to various turns on the operating coil. By placing this screw in the various holes, the relay will just close contacts at the corresponding current, 4-5-6-8-10-12 or 15 amperes, or as marked on the terminal plate.

The tripping value of the relay on any tap may be altered by changing the initial tension of the spiral spring. This can be accomplished by turning the spring adjuster by means of a screw driver inserted in one of the notches of the plate to when the outside convolution of the spring is fastened. An adjustment of tripping current approximately 15 percent above or below any tap value, can be secured without materially

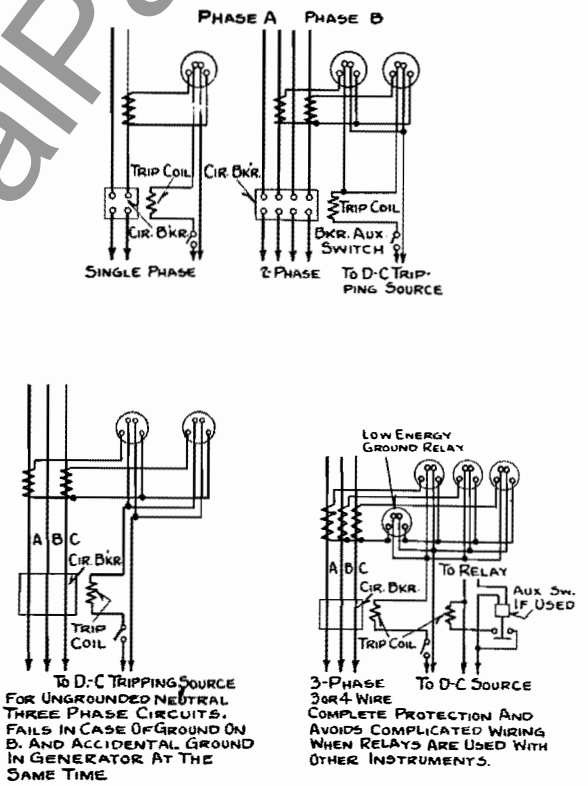

FIG. 1—CONNECTIONS FOR DIFFERENT INSTALLATIONS OF TYPE CO OVERCURRENT RELAYS USING D-C. TRIPPING SOURCE

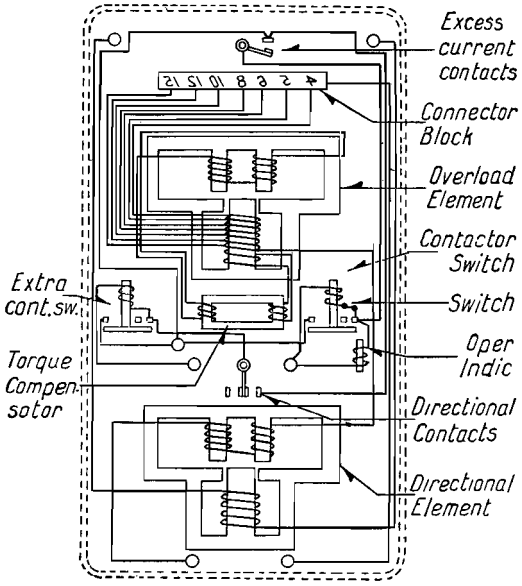

FIG. 8—INTERNAL CONNECTIONS OF STANDARD-ENERGY, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY WITH A TAP CONNECTION BETWEEN THE DIRECTIONAL AND OVERCURRENT CONTACTS—REAR VIEW

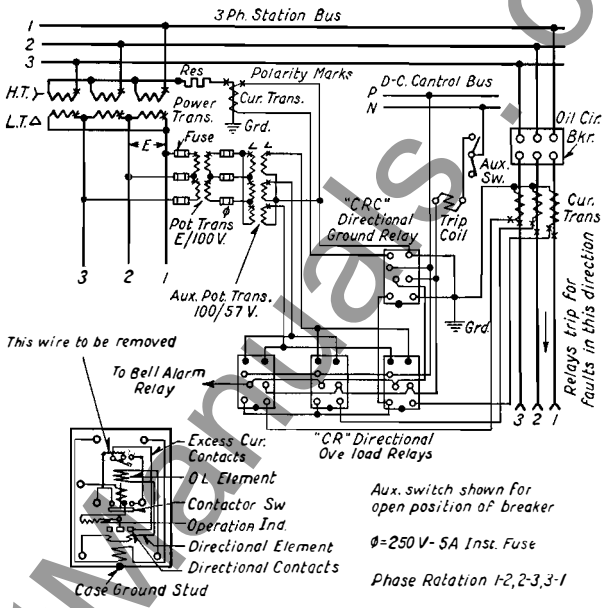

FIG. 10—EXTERNAL CONNECTIONS OF THE TYPE CRC RELAY USED FOR GROUND PROTECTION—REAR VIEW

others because they are of the low energy type and have ratings of .5 to 2.5 or 2 to 6 amperes.

Low Energy Types CO and CR Relays

The low energy type of CO and CR relays are different from the standard ones. Instead of obtaining the definite minimum time feature by means of

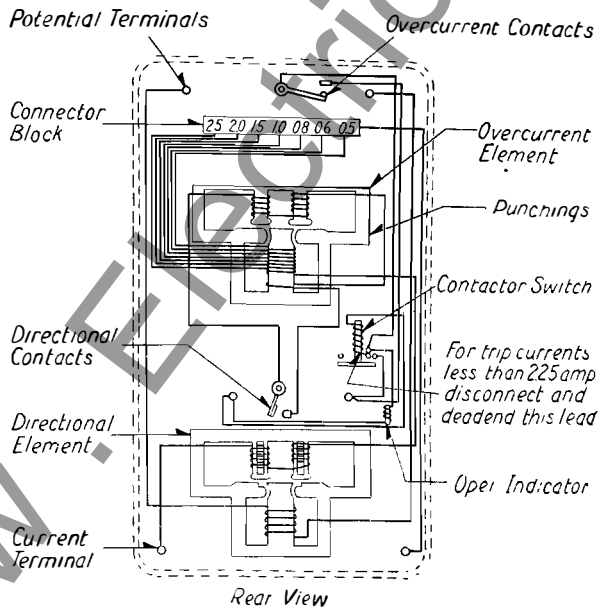

FIG. 9—INTERNAL CONNECTIONS OF LOW-ENERGY, DIRECTIONAL-CONTROL, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY

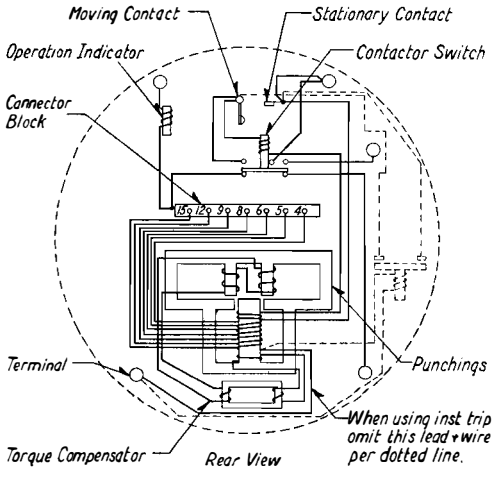

FIG. 11—INTERNAL CONNECTIONS OF CIRCUIT-OPENING TYPE CO RELAY FOR SERIES TRIP CIRCUIT

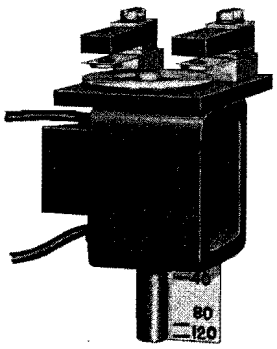

FIG. 12—THE INSTANTANEOUS ATTACHMENT

the torque compensator, a somewhat similar result is obtained by gearing the disc to the shaft which carries the contact arm. This results in a characteristic curve which is somewhat more inverse than the standard curve and also results in much slower resetting time. The term "low energy" refers to the burden which is placed on the current transformers and does not refer to the current rating. All of the small current ranges are of the low energy type and some of the higher current ranges are also made in the low energy type for use on certain current transformers which are incapable of carrying a heavy burden. The low energy and standard relays have the same external appearance and dimensions.

When circuit breakers are instantaneously reclosed, it is necessary to use special quick opening contacts on the low energy type of relay. These contacts differ from the normal ones in being stiff, without any follow, so that they will open quickly.

Very-Inverse Type CO Relay

This relay is similar to the low-energy relay but contains a different electromagnet and has a much more inverse curve. The mechanical arrangement of the parts is similar to the low-energy type, although they are not exact duplicates. The burden on the current transformer is considerably less than that of the low-energy CO relay.

The 40-Second Type CO Relay

This relay is similar in appearance to the low energy relay but consists of a standard energy 4-second relay with a 10 to 1 gear reduction, making the total time 40 seconds on the flat part of the curve. The 25 cycle relay has a resetting time of approximately 90 seconds. It will overheat before tripping from the number 10 position for currents greater than 750% of the tripping value. The 60 cycle relay resets in 120 seconds and will overheat before tripping from the number 10 position for current greater than 1000% of the tripping value.

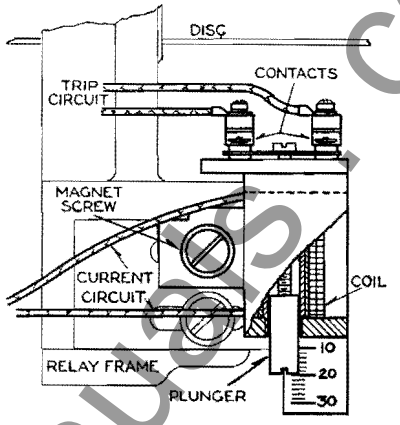

FIG. 14—ADJUSTMENT DETAILS AND METHOD OF MOUNTING THE INSTANTANEOUS ATTACHMENT

This relay is frequently used for motor protection and may require an accurate current setting which can be given by adjusting the spiral spring. The instantaneous attachment mentioned below is useful on this relay to protect against short circuits.

CRC Ground Relay

This is a directional relay quite similar to the CR relay with the same dimensions and internal connections, but the

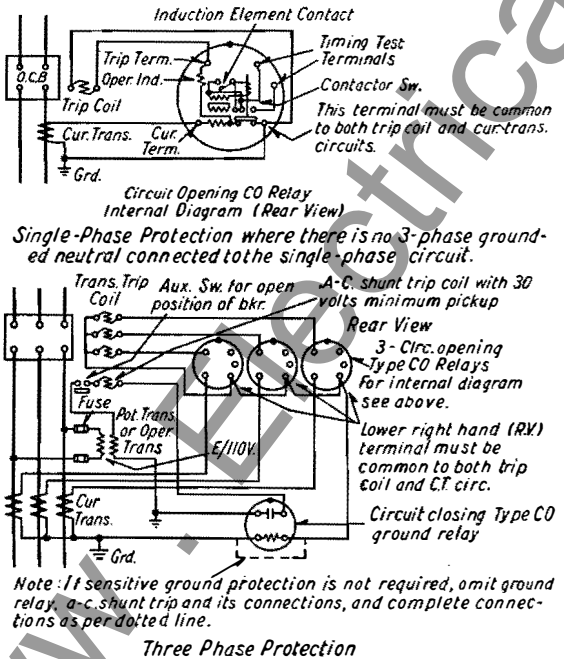

FIG. 13—OVER-CURRENT PROTECTION USING 3 CIRCUIT-OPENING TYPE CO RELAYS FOR LINE PROTECTION AND ONE CIRCUIT-CLOSING GROUND RELAY

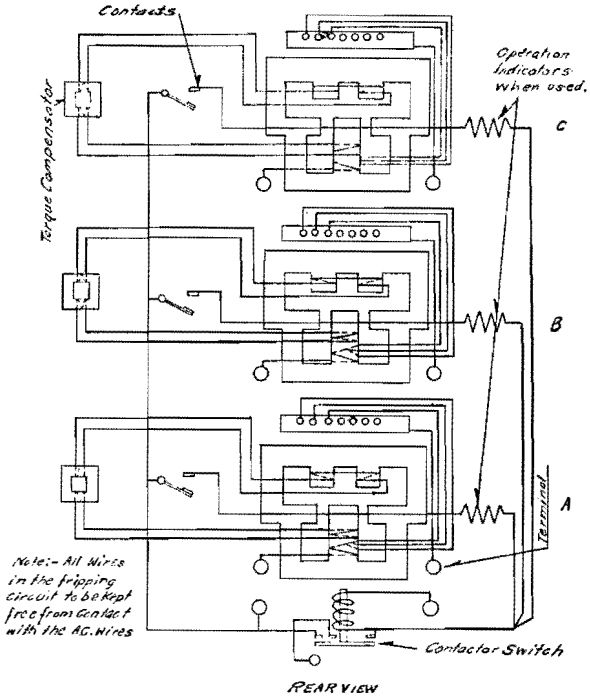

FIG. 15—INTERNAL CONNECTIONS OF THREE ELEMENT TYPE CO AND COA RELAY WITH EXTRA BELL ALARM TERMINAL

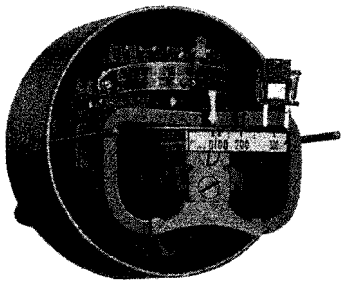

FIG. 16—SINGLE-PHASE TYPE COA RELAY WITH NAMEPLATE REMOVED

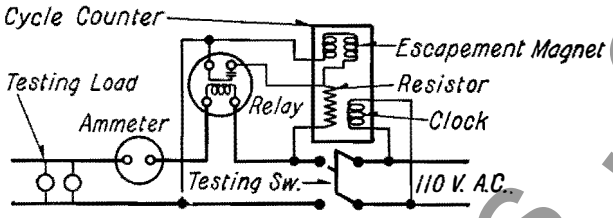

FIG. 18—CONNECTIONS FOR THE USE OF THE CYCLE COUNTER IN TESTING CIRCUIT-CLOSING TIME-LIMIT RELAYS

polarizing coil on the directional element has a 5 ampere winding. This coil is energized by a current transformer placed in the neutral of the power transformers.

All the adjustments and manipulations are the same as for the CR relay.

Circuit Opening Relays

The conventional method of tripping circuit breakers is by means of current from a storage battery and a relay which closes its contacts to complete the circuit through the trip coil. Where it is desired to eliminate the battery, the breaker may be tripped by current from the current transformers if circuit opening relays are used. As shown in Fig. 11 the operation of the relay connects the circuit breaker trip coil in series with the current circuit. The internal diagram shows that when the main relay contacts close they pull up the contactor which is energized from a secondary coil on the main pole. When the contactor is lifted, it opens the short circuit around the trip coil and allows the current to flow through the coil.

It should be observed that the contacts break the full short circuit current and they may be seriously burned. It is therefore important that the contacts be frequently inspected and kept clean and smooth. With frequent maintenance, the contacts may safely open circuits of 50 amperes. If the current is small, the relay may give satisfactory service with inspection periods as seldom as once a year. It should be borne in mind that these contacts carry the current continuously and if they become bad, they will begin to overheat and finally burn open the current transformer circuit.

Because these contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subjected to shocks which may jar the contacts open and thereby allow current to flow through the trip coil.

Trouble of this kind can be avoided by preventing jars to the switchboard and also by setting the trip coil high enough so that it will not operate on normal load current. This is an extra safe-guard so that there is no danger from even an excessive shock unless the current is also heavy.

The circuit opening relay is made only in the 4 to 15 ampere range. Lower ranges are not desirable because the burden of low range trip coils is too heavy on the current transformer. One trip coil is required for each relay.

If ground relay protection is required, the low range ground relay may be of the circuit closing type and operate an a-c. voltage trip coil. See Fig. 13.

The circuit opening feature is provided only in the Type CO Relay.

Instantaneous Attachment

The instantaneous attachment has its contacts in parallel with the main contacts of the CO or CR relay. Its purpose is to make the time of operation of the relay instantaneous after a predetermined current is exceeded. The device is usually built to operate at a high value, a common style being adjustable between 40 and 120 amperes. The marking is accurate to within ± 25%. The current setting is made by raising or lowering the plunger. The design of the 25 cycle relay is somewhat different from that shown in the illustration and has a piece of felt under the contacts to damp out the vibrations.

The instantaneous attachment is usually applied to the relay while it is being manufactured but it can be attached to any of the old induction type relays. No special mounting arrangements are required—it fits under one of the screws holding the permanent magnets. (See Fig. 14).

Lock-Out Attachment

Sometimes it is desired to prevent a relay from tripping a circuit breaker

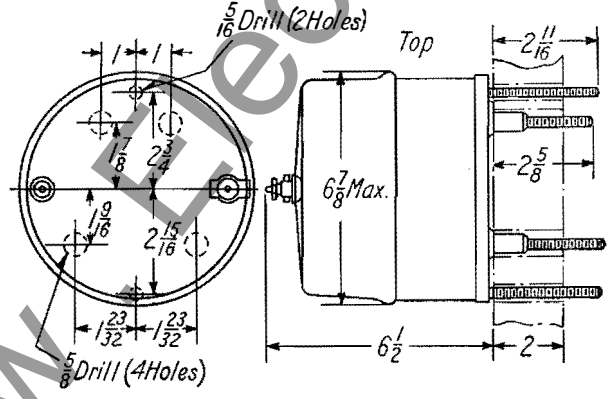

FIG. 17—SINGLE-TRIP STANDARD AND LOW-ENERGY CIRCUIT-CLOSING TYPE CO RELAY. THE TYPE COA RELAY IS 6¾-INCH DEEP INSTEAD OF 6½-INCH

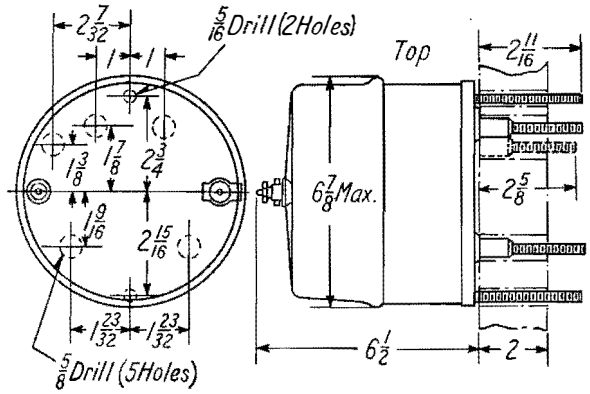

FIG. 19—DOUBLE-TRIP STANDARD AND LOW-ENERGY TYPE CO RELAY, ALSO THE CIRCUIT-OPENING TYPE CO FOR SERIES TRIP. THE TYPE COA RELAY IS 6¾-INCH DEEP INSTEAD OF 6½-INCH

when the current is too high—above its interrupting capacity. For this purpose the lockout attachment is provided. It is similar to the instantaneous attachment in appearance and method of adjusting but its contacts are in series with the main contacts and are normally closed. These contacts must be given special care because they are in series with the main tripping circuit and may prevent proper relay operation if they become dirty.

Three Element Type CO Relay

The CO relay, both standard and low energy type, is sometimes furnished with 3 elements in a single case. The outside dimensions of this case are shown in Fig. 20, but the number of terminals varies with the particular style of relays. Similarly Fig. 15 shows a typical diagram of internal connections with three operation indicators.

This 3-element relay is frequently supplied with the ammeter attachments mentioned in the following section.

Types COA and CRA Relays

These relays are standard type CO or CR with a self-contained ammeter scale. This ammeter operates on the induction principle and consists of an aluminum vane which swings in the same air gap as does the main disc. It, therefore, not only indicates the value of the current but supervises the entire current circuit and assures the operator that current is flowing through the relay coils. The entire scale moves and the reading is indicated by a fixed pointer. A small aluminum vane swings above the permanent magnet and sufficient flux is robbed from the magnet to damp the movements of the ammeter.

The current reading depends upon the tap setting of the relay and this setting should, therefore, be determined before the scale is marked so that it may be properly marked in amperes. Some relays are marked in percent so that any tap value may be used without inconvenience.

The ammeter attachment cannot be put on existing relays. It does not change the diagram of internal connections nor does it change the drilling plan of the various relays which may contain it. On the single element type CO relay it increases the depth from the front of the board by ¼ inch.

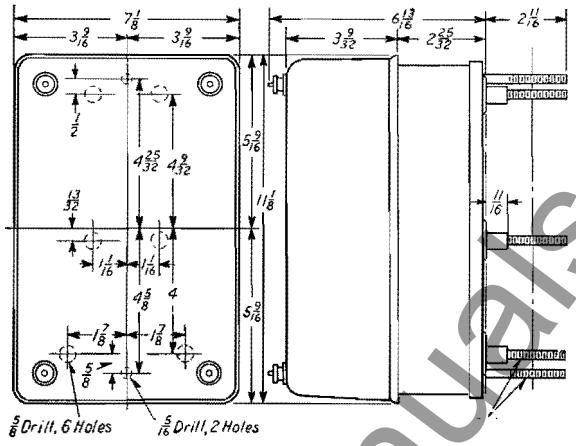

FIG. 21—TYPES CR, CRA AND CRC SINGLE-TRIP CIRCUIT, SIX-TERMINAL RELAYS

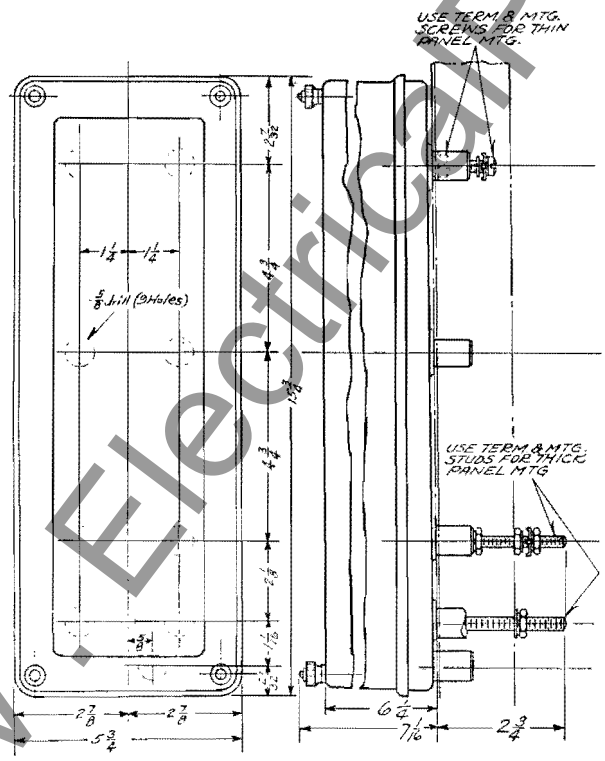

FIG. 20—THREE ELEMENT TYPE CO OR COA RELAY WITH EXTRA ALARM TERMINAL. FOR RELAY WITHOUT ALARM CIRCUIT OMIT THE BOTTOM TERMINAL

Testing Relays

All relays should be inspected periodically and the time of operation should be checked at least once every six months. For this purpose, a cycle counter should be employed because of its convenience and accuracy. Phantom loads should not be used in testing induction type relays because of the resulting distorted current wave form which produces an error in timing.

For the directionally controlled relays, the time of operation is the time for the directional and overcurrent elements to operate, since the former must close contacts before the disc on the latter can start to rotate. The time of operation of the directional element depends upon the applied voltage, current and the phase angle between the two, but will be a matter of a few cycles for nearly all faults. Therefore, the relay has been calibrated at the factory with the directional contacts blocked closed.

Caution

The position of the torque compensator on the overload element is adjustable but this is primarily a factory adjustment and the location of the torque compensator should not be changed in the field.

Readjusting Relays

Overload Element

If the factory adjustment has been disturbed, proceed as follows to make readjustment. By shifting the position of the contact stop on the time lever, adjust contacts so that they barely touch when the time lever is set on zero.

Adjust the tension of the spiral spring so that the relay will close its contacts at its rated current, as shown by the position of the screw on the terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are the same as shown on the calibration curve.

Directional Element

The tension of the spiral spring on the directional element should be just sufficient to return the disc to the stop and thus hold the contacts in the open position.

In many applications there is no objection to having the contacts closed when the relay is de-energized. This can be changed by shifting the spring adjuster but the tension on the spring should never be enough to prevent the contacts from taking their proper position, either open or closed, during time of short circuit when the forces acting on the disc are small.

There is an adjustable magnetic vane on each side of the upper pair of poles, which is intended to balance the current circuit. The normal adjustment is to remove all potential from the voltage coil and apply heavy current to the current coils. The balancing vanes are then adjusted till there is no pronounced torque in either direction. This same adjustment may be used to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker even though the potential may be absolutely zero.

The upper bearing screw should be screwed down until there is only two or three thousandths clearance between it and the shaft and then securely locked in position with the lock nut.

The contact opening on the directionally controlled relays should be $\frac{1}{32}$" in order to reduce the time of operation of the directional element to a minimum. No harm will result if the directional contacts rebound closed momentarily after a fault is cleared, because the overcurrent contacts will be in the open position.

The contact opening on relays which are not directionally controlled should be $\frac{3}{32}$".

Contactor Switch

The stationary core is adjustable so that it may be moved up sufficiently to keep the plunger from striking against it. This is important because, if the plunger strikes against the core, it is likely to stick due to residual magnetism.

Double Trip Circuit

If this relay has two stationary contacts on the overload element, it may be used for tripping two circuit-breakers simultaneously, or for any purpose where it is desired to have two circuits closed at the same time by the relay and yet have them independent when the relay is not operated. Double contacts on the relay are necessary so that either breaker may be opened independently of the other for ordinary switching operation and allowing both to be tripped if both are closed when trouble occurs.

The double trip type CO relay may be used for tripping one breaker and energizing a bell alarm circuit. The directionally controlled double trip type CR relay may also be used in this manner.

Renewal Parts

Repairing

Repair work can be most satisfactorily accomplished at our Works. However, interchangeable renewal parts can be furnished to customers who are equipped for doing repair work.

Ordering Instructions

When ordering renewal parts, give the nameplate reading and the name of the part wanted.

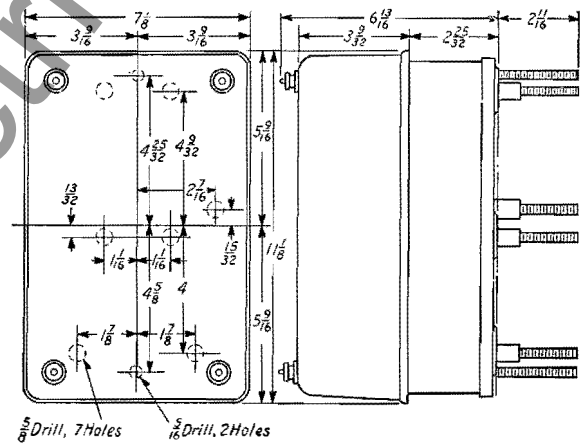

FIG. 22—TYPES CR, CRA AND CRC SEVEN-TERMINAL RELAYS. THIS COVERS THE DOUBLE-TRIP, CIRCUIT-CLOSING OR THE SINGLE-TRIP, DUO-DIRECTIONAL, OR THE SINGLE-TRIP WITH AN EXTRA TAP BETWEEN THE DIRECTIONAL AND THE OVER-CURRENT ELEMENTS.

Westinghouse Electric & Manufacturing Company
Newark, N. J.

Printed in U. S. A. (Rep. 9-37)

I. L. 1849-C
(Filing No. 41-000)

Westinghouse

Types CO and COA Overcurrent and Types CR, CRA and CRC Directional Overcurrent Relays

Caution

Remove all blocking from relay before placing in service.

Installation

Carefully unpack the relay and remove all dust and packing material with a soft brush or cloth. The cover of the relay should be removed and the interior parts carefully inspected for any damage which might have been done in shipment. This inspection should include a test of the moving parts to see that they have not become misaligned and that there is no friction present. The presence of friction can usually be determined by moving the disc or contactor plunger by hand and letting it return to the normal position. Owing to the importance of proper relay functioning it is a wise precaution before placing relays in service, to check each relay for operating current, time of operation, and polarity. For all type CR relays, the left hand contacts of the directional element, front view, should open when the potential and current applied to the relay are in phase, See Fig. 5.

Mount the relay vertically by means of the two mounting studs. Connections may be made direct to the terminals by means of screws for steel panel mounting or to the terminal studs, furnished with the relay, for slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. Note that the top mounting stud may be utilized as a grounding stud for grounding the metal case.

Connect the relay as shown on the proper diagram in this leaflet, or consult the nearest Sales Office for additional diagrams of connections for cases not covered by this leaflet.

The tripping circuit should not be opened by the relay, but an auxiliary contact on the circuit-breaker should be provided to open the tripping circuit the instant the breaker opens.

This relay is suitable for operating the Westinghouse direct trip attachment for tripping direct from the current transformer and also for operating the transfer relay for the same purpose.

Instructions for Setting

In arriving at the proper setting of the overload element, or relay, two things must be determined.

FIRST—In terms of the secondary circuit of the current transformer, the minimum amperes to trip (tap setting) should be higher than the overload peaks due to service load. Under short circuit conditions, the current will be fixed by the impedance of the circuit to which the relays are connected and the minimum short circuit current will usually be several hundred percent of the tap setting.

SECOND—The time setting for short circuit conditions is determined by consideration of the sequence in which the breakers should trip, the time required for breaker mechanisms to operate etc., as required to give proper selective action throughout the system as a whole.

Current Setting:

The connector screw on the terminal plate above the time scale makes connections to various turns on the operating coil. By placing this screw in the various holes, the relay will just close contacts at the corresponding current, 4-5-6-8-10-12 or 15 amperes, or as marked on the terminal plate.

The tripping value of the relay on any tap may be altered by changing the initial tension of the spiral spring. This can be accomplished by turning the spring adjuster by means of a screw driver inserted in one of the notches of the plate to when the outside convolution of the spring is fastened. An adjustment of tripping current approximately 15 percent above or below any tap value, can be secured without materially

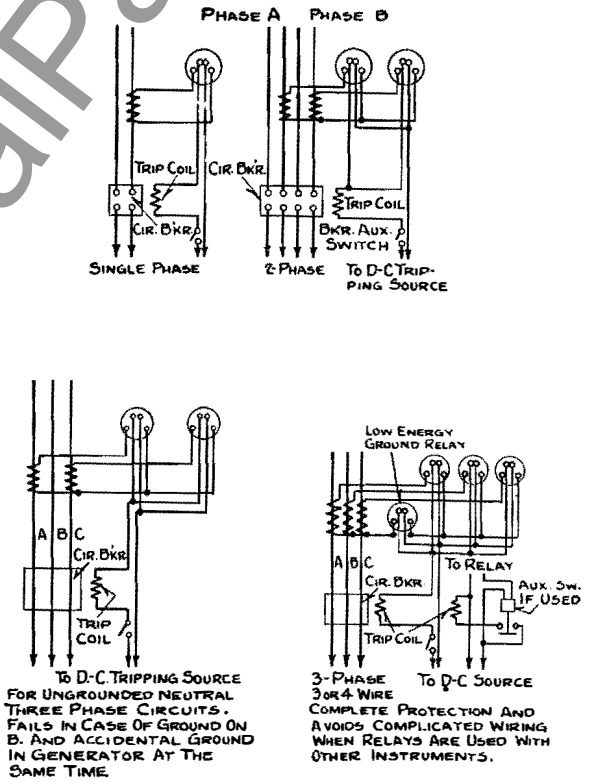

FIG. 1—CONNECTIONS FOR DIFFERENT INSTALLATIONS OF TYPE CO OVERCURRENT RELAYS USING D-C. TRIPPING SOURCE

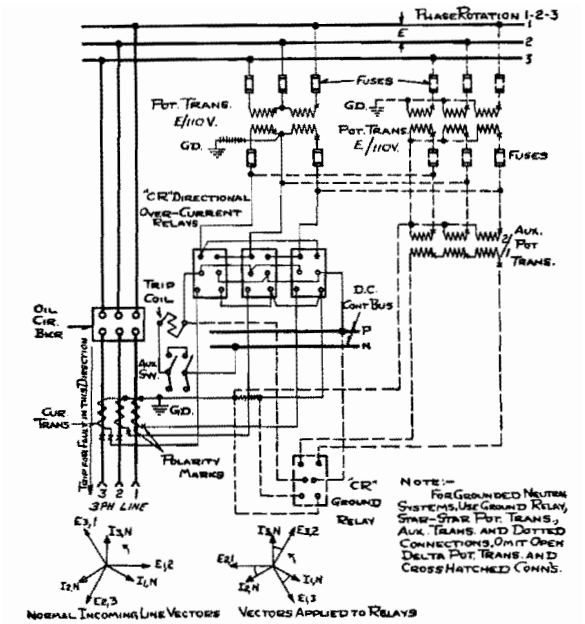

FIG. 2—CONNECTIONS FOR SHORT-CIRCUIT AND GROUND PROTECTION USING TYPE CR RELAYS AND HIGH-TENSION POTENTIAL TRANSFORMERS

affecting the operating characteristics of the relay. By choosing the proper tap, a continuous adjustment of tripping current from 3.4 amperes to 17.5 amperes may be secured. The characteristic time curve will be affected less for any large adjustment if the next higher tap is selected and the initial tension of the spiral spring is decreased to secure the desired tripping value. For example, the relay should be set on the 8 ampere tap with less initial tension in order to secure a 7 ampere tripping value.

Caution

Be sure that the connector screw is turned up tight so as to make a good contact, for the operating current passes through it. Since the overload element is connected directly in the current transformer circuit, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, located on the right hand mounting boss, in the new tap and removing the old screw from its original setting.

Time Adjustments

The index or time lever, limits the motion of the disc and thus varies the time of operation. The latter is proportional to the lever setting, that is, with the lever on the number 5 setting, at 2000 percent load, the relay will operate in one second and similarly on the number 1 setting the time of operation is 0.2 seconds.

The relay has been calibrated from the #10 time lever setting according to the curve engraved on the nameplate. The #11 time setting may be used to secure a time delay approximately 10 per cent longer, that is, to secure a setting of 2.2 seconds for a 2 second relay.

Be sure that the contacts just touch when the time lever is set on zero, otherwise the timewill not be proportional to the lever setting.

Operation Indicator

This relay is equipped with a universal operation indicator suitable for all tripping currents above 0.2 amperes. The relay leaves the factory with the operation indicator coil connected in parallel with the contactor switch coil and if the tripping current is more than 2.25 amperes d-c., sufficient current will flow through both coils to cause their operation. The resistance of both coils in parallel is approximately 0.25 ohm.

If the trip current is less than 2.25 amperes there is no necessity for the contactor switch and it should be removed from the trip circuit so that all trip current will pass through the indicator coil. The indicator coil has approximately 2.8 ohms resistance. To disconnect the contactor switch coil, remove the lower lead on the front stationary contact of the contactor switch (See Figure 3) and this lead should be fastened (dead ended) under the small fillister head screw located in the micarta base of the contactor switch (See Figure 4).

Make sure that the indicator receives sufficient current to operate through the trip coil. The trip coil has such a high inductance that the breaker may open and open its pallet switch before the current has built up to its full value. Also, the voltage may be low resulting in a lower trip current. It is advisable to assume that the current through the indicator will be only half of the value calculated from the resistance of the coil and normal control voltage. If the trip circuit does not draw enough current to drop the target when it is set to operate at .2 ampere, more current may be secured by putting a small loading resistor around the trip coil or around the auxiliary relay, if this is used.

Directional Element

The standard single trip and double trip type CR relays are directionally controlled, that is, the directional contacts must close in order for the overcurrent element to operate. The contacts of the latter trip the breaker direct. The single trip 7 terminal stud relay (7th terminal between the directional and overcurrent contacts) and the duo-directional relay cannot be made directional controlled and therefore the contacts of the overcurrent and directional elements are in series in the trip circuit.

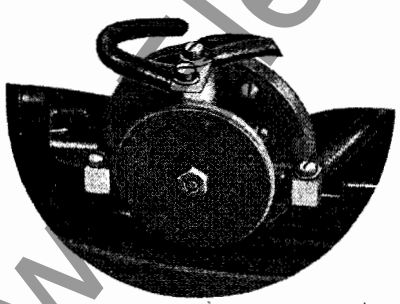

FIG. 3—CONTACTOR SWITCH COIL CONNECTED IN TRIP CIRCUIT. THE TARGET OPERATES ON 2.25 AMPERES OR MORE

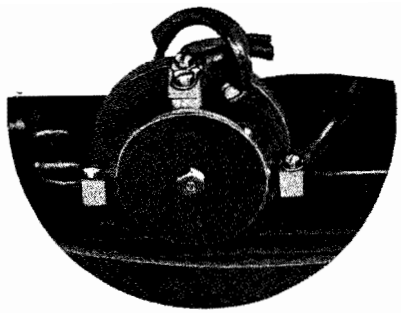

FIG. 4—CONTACTOR SWITCH COIL DISCONNECTED FROM TRIP CIRCUIT. ALL THE CURRENT PASSES THROUGH THE TARGET COIL SO THAT IT WILL OPERATE ON .2 AMPERE OR MORE

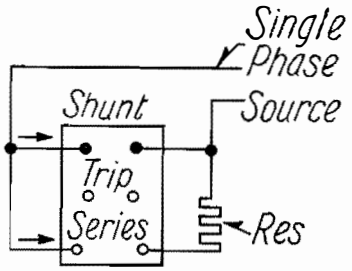

FIG. 5—METHOD OF TESTING POLARITY OF TYPE CR RELAY. THE CONTACTS REMAIN OPEN

The directional element is usually connected to the system in such a manner that the directional contacts close when power flow is away from the station bus All diagrams shown have this polarity.

Checking Connections of the Type CR Relay

All type CR relays, except the ground relays, have wattmeter characteristics for the directional elements and, therefore, the directional element disc will reverse its direction of rotation when the phase relation of the current and voltage becomes 90° or greater. The directional relay must be connected so that this relation will never exceed 90°.

Since the power factor of fault currents may vary over a considerable range, it is necessary that the proper voltage be used on the directional element. Connections should be made so that with unity power factor on the line, the current in the relay directional element will be 30% ahead of the potential supplying the directional element.

The following methods should be used in checking up the correct connections to the directional element of the relay.

Wattmeter Method

With the power flowing in either direction, if the current is lagging, so that the power factor is between 50 and 100 per cent, connect the current coils of a single phase wattmeter in series with the current winding of the relay. Then select a pair of voltage leads which give the highest reading on the wattmeter. The two leads should be connected to the relay potential terminal. Inspect the contact of the directional element, which should be open when the power is flowing towards the bus bars. If the contacts are closed when the current flows toward the bus bars, then the potential leads of the relay should be reversed.

Power Factor Meter Method

A second method is to connect the current coils of a single phase power factor meter in series with the current coils of the relay. A pair of potential leads is then selected which will give 86.6 per cent power factor leading on the power factor meter when the line power factor is 100 per cent. These two leads should be connected to the relay potential terminals. The upper contact should be inspected, as before mentioned in the preceding paragraph and checked for proper direction of operation.

Phase Indicator Method

A third method of checking the proper connections of the relay is by means of the Westinghouse phase indicator. It is a portable instrument built on very much the same principle as a power factor meter but calibrated to read in degrees, and show precisely the phase relation between any current and voltage sources to which it may be connected. Full directions for the use of the portable phase indicator are supplied with the instrument.

Relay for 90° Connection

This relay can be used for the 90° connection, that is, with the current leading the applied potential by 90° when the line power factor is 100%, by installing a suitable external resistor in series with the potential coil. These external resistors can be ordered by style number as follows.

25 Cycle, 115 Volts, 760 ohms, S# 721435
50 Cycle, 115 Volts, 670 ohms, S# 721436
60 Cycle, 115 Volts, 565 ohms, S# 721437

Type CR Ground Relays

The directional element of the type CR relay which is intended for ground protection differs from that of the phase relay by not having true wattmeter characteristics. It develops its maximum torque when the relay current lags about 15 degrees behind the relay voltage. This is essential on systems where the neutral is dead grounded. These relays may be distinguished from

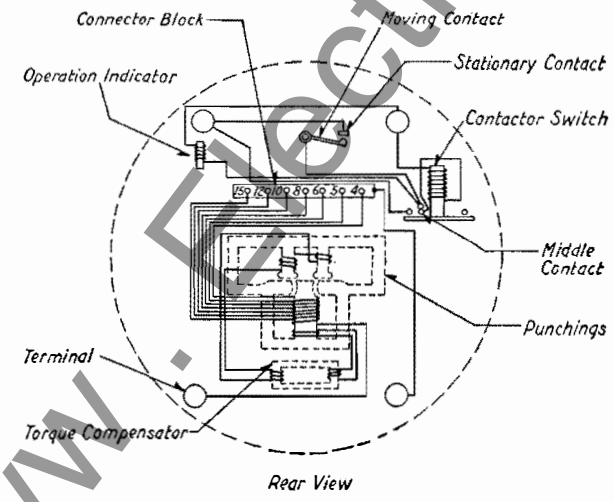

FIG. 6—INTERNAL CONNECTIONS OF SINGLE-TRIP, STANDARD-ENERGY TYPE CO RELAY

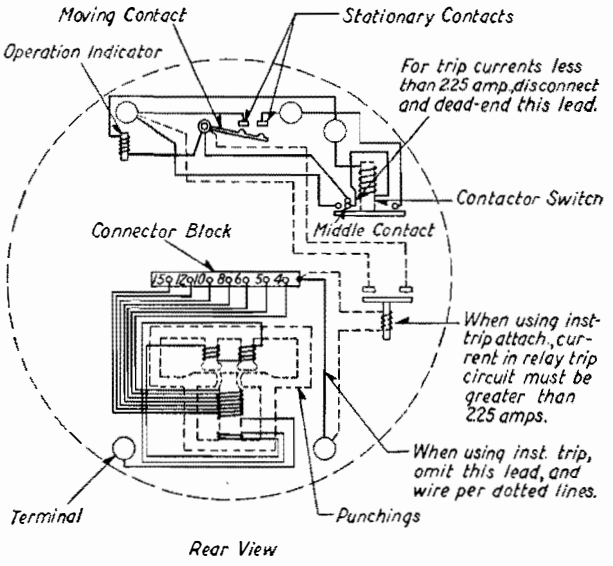

FIG. 7—INTERNAL CONNECTIONS OF DOUBLE-TRIP, LOW-ENERGY TYPE CO RELAY

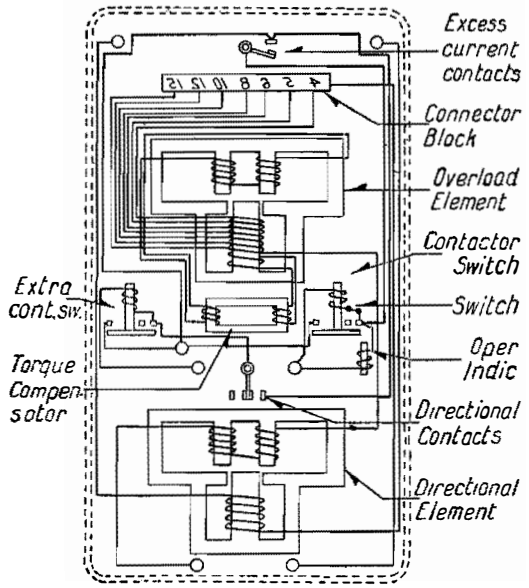

FIG. 8—INTERNAL CONNECTIONS OF STANDARD-ENERGY, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY WITH A TAP CONNECTION BETWEEN THE DIRECTIONAL AND OVERCURRENT CONTACTS—REAR VIEW

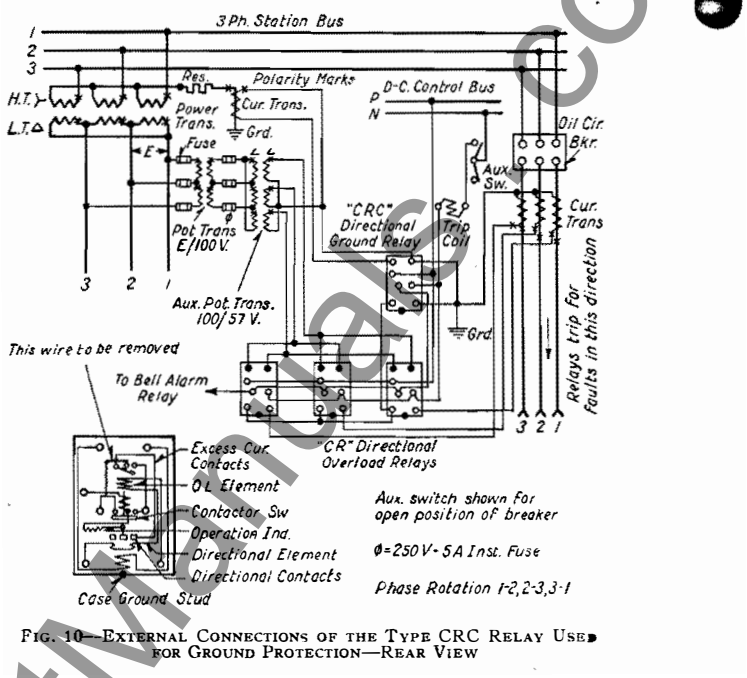

FIG. 10—EXTERNAL CONNECTIONS OF THE TYPE CRC RELAY USED FOR GROUND PROTECTION—REAR VIEW

others because they are of the low energy type and have ratings of .5 to 2.5 or 2 to 6 amperes.

Low Energy Types CO and CR Relays

The low energy type of CO and CR relays are different from the standard ones. Instead of obtaining the definite minimum time feature by means of

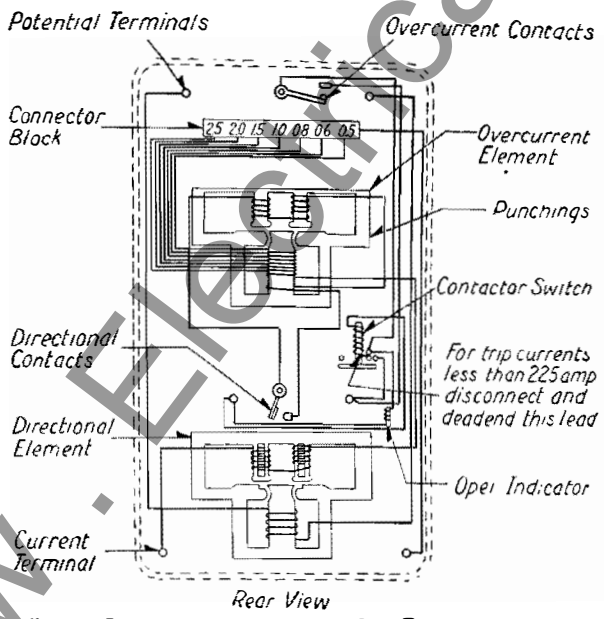

FIG. 9—INTERNAL CONNECTIONS OF LOW-ENERGY, DIRECTIONAL-CONTROL, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY

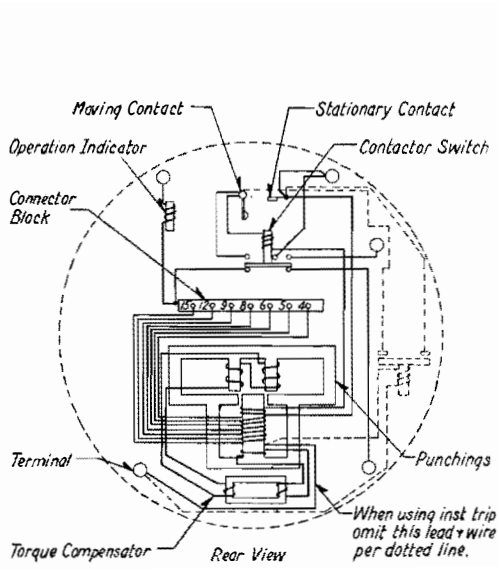

FIG. 11—INTERNAL CONNECTIONS OF CIRCUIT-OPENING TYPE CO RELAY FOR SERIES TRIP CIRCUIT

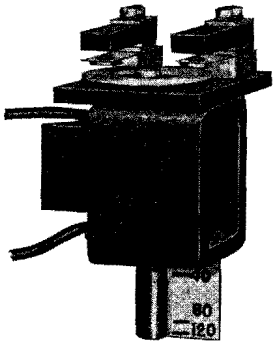

FIG. 12—THE INSTANTANEOUS ATTACHMENT

the torque compensator, a somewhat similar result is obtained by gearing the disc to the shaft which carries the contact arm. This results in a characteristic curve which is somewhat more inverse than the standard curve and also results in much slower resetting time. The term "low energy" refers to the burden which is placed on the current transformers and does not refer to the current rating. All of the small current ranges are of the low energy type and some of the higher current ranges are also made in the low energy type for use on certain current transformers which are incapable of carrying a heavy burden. The low energy and standard relays have the same external appearance and dimensions.

When circuit breakers are instantaneously reclosed, it is necessary to use special quick opening contacts on the low energy type of relay. These contacts differ from the normal ones in being stiff, without any follow, so that they will open quickly.

Very-Inverse Type CO Relay

This relay is similar to the low-energy relay but contains a different electromagnet and has a much more inverse curve. The mechanical arrangement of the parts is similar to the low-energy type, although they are not exact duplicates. The burden on the current transformer is considerably less than that of the low-energy CO relay.

The 40-Second Type CO Relay

This relay is similar in appearance to the low energy relay but consists of a standard energy 4-second relay with a 10 to 1 gear reduction, making the total time 40 seconds on the flat part of the curve. The 25 cycle relay has a resetting time of approximately 90 seconds. It will overheat before tripping from the number 10 position for currents greater than 750% of the tripping value. The 60 cycle relay resets in 120 seconds and will overheat before tripping from the number 10 position for current greater than 1000% of the tripping value.

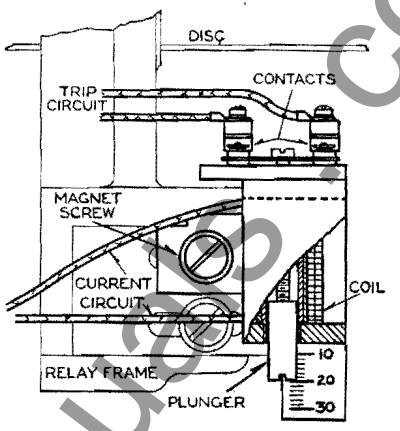

FIG. 14—ADJUSTMENT DETAILS AND METHOD OF MOUNTING THE INSTANTANEOUS ATTACHMENT

This relay is frequently used for motor protection and may require an accurate current setting which can be given by adjusting the spiral spring. The instantaneous attachment mentioned below is useful on this relay to protect against short circuits.

CRC Ground Relay

This is a directional relay quite similar to the CR relay with the same dimensions and internal connections, but the

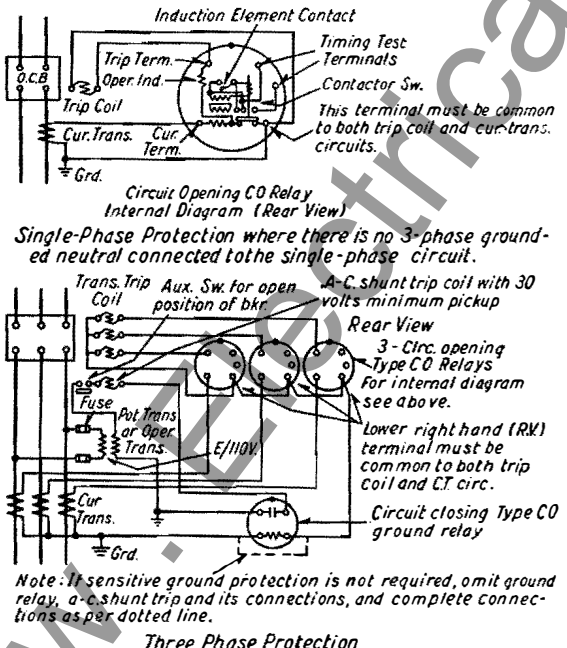

FIG. 13—OVER-CURRENT PROTECTION USING 3 CIRCUIT-OPENING TYPE CO RELAYS FOR LINE PROTECTION AND ONE CIRCUIT-CLOSING GROUND RELAY

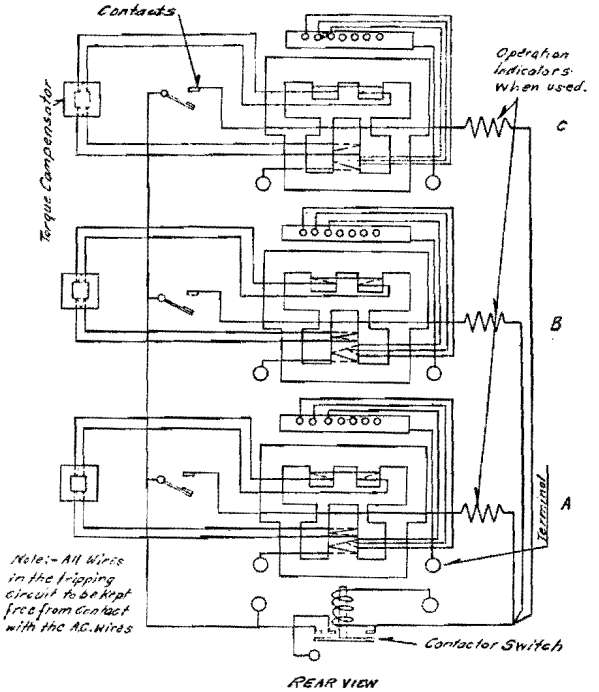

FIG. 15—INTERNAL CONNECTIONS OF THREE ELEMENT TYPE CO AND COA RELAY WITH EXTRA BELL ALARM TERMINAL

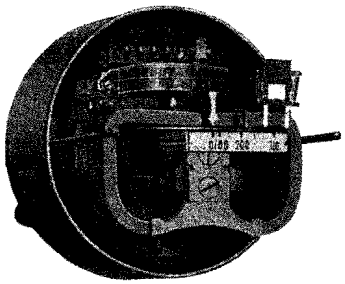

FIG. 16—SINGLE-PHASE TYPE COA RELAY WITH NAMEPLATE REMOVED

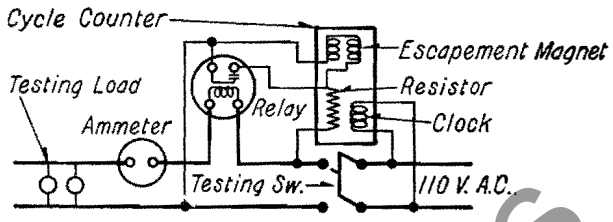

FIG. 18—CONNECTIONS FOR THE USE OF THE CYCLE COUNTER IN TESTING CIRCUIT-CLOSING TIME-LIMIT RELAYS

polarizing coil on the directional element has a 5 ampere winding. This coil is energized by a current transformer placed in the neutral of the power transformers.

All the adjustments and manipulations are the same as for the CR relay.

Circuit Opening Relays

The conventional method of tripping circuit breakers is by means of current from a storage battery and a relay which closes its contacts to complete the circuit through the trip coil. Where it is desired to eliminate the battery, the breaker may be tripped by current from the current transformers if circuit opening relays are used. As shown in Fig. 11 the operation of the relay connects the circuit breaker trip coil in series with the current circuit. The internal diagram shows that when the main relay contacts close they pull up the contactor which is energized from a secondary coil on the main pole. When the contactor is lifted, it opens the short circuit around the trip coil and allows the current to flow through the coil.

It should be observed that the contacts break the full short circuit current and they may be seriously burned. It is therefore important that the contacts be frequently inspected and kept clean and smooth. With frequent maintenance, the contacts may safely open circuits of 50 amperes. If the current is small, the relay may give satisfactory service with inspection periods as seldom as once a year. It should be borne in mind that these contacts carry the current continuously and if they become bad, they will begin to overheat and finally burn open the current transformer circuit.

Because these contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subjected to shocks which may jar the contacts open and thereby allow current to flow through the trip coil.

Trouble of this kind can be avoided by preventing jars to the switchboard and also by setting the trip coil high enough so that it will not operate on normal load current. This is an extra safe-guard so that there is no danger from even an excessive shock unless the current is also heavy.

The circuit opening relay is made only in the 4 to 15 ampere range. Lower ranges are not desirable because the burden of low range trip coils is too heavy on the current transformer. One trip coil is required for each relay.

If ground relay protection is required, the low range ground relay may be of the circuit closing type and operate an a-c. voltage trip coil. See Fig. 13.

The circuit opening feature is provided only in the Type CO Relay.

Instantaneous Attachment

The instantaneous attachment has its contacts in parallel with the main contacts of the CO or CR relay. Its purpose is to make the time of operation of the relay instantaneous after a predetermined current is exceeded. The device is usually built to operate at a high value, a common style being adjustable between 40 and 120 amperes. The marking is accurate to within ± 25%. The current setting is made by raising or lowering the plunger. The design of the 25 cycle relay is somewhat different from that shown in the illustration and has a piece of felt under the contacts to damp out the vibrations.

The instantaneous attachment is usually applied to the relay while it is being manufactured but it can be attached to any of the old induction type relays. No special mounting arrangements are required—it fits under one of the screws holding the permanent magnets. (See Fig. 14).

Lock-Out Attachment

Sometimes it is desired to prevent a relay from tripping a circuit breaker

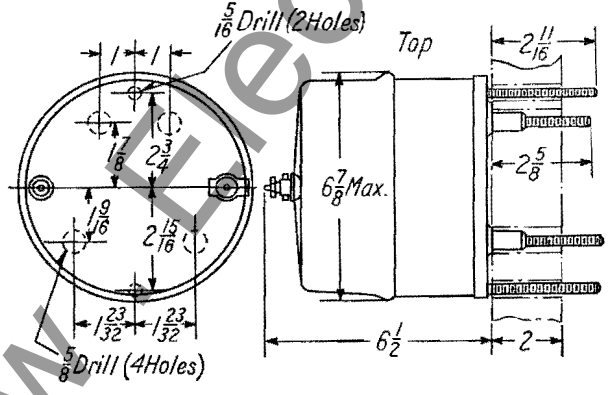

FIG. 17—SINGLE-TRIP STANDARD AND LOW-ENERGY CIRCUIT-CLOSING TYPE CO RELAY. THE TYPE COA RELAY IS 6 11/16-INCH DEEP INSTEAD OF 6 1/2-INCH

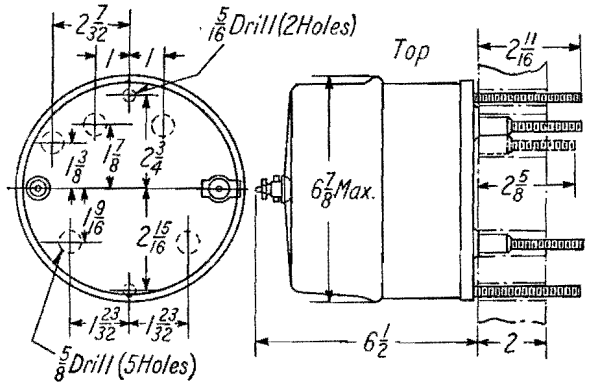

FIG. 19—DOUBLE-TRIP STANDARD AND LOW-ENERGY TYPE CO RELAY, ALSO THE CIRCUIT-OPENING TYPE CO FOR SERIES TRIP. THE TYPE COA RELAY IS 6 11/16-INCH DEEP INSTEAD OF 6 1/2-INCH

when the current is too high—above its interrupting capacity. For this purpose the lockout attachment is provided. It is similar to the instantaneous attachment in appearance and method of adjusting but its contacts are in series with the main contacts and are normally closed. These contacts must be given special care because they are in series with the main tripping circuit and may prevent proper relay operation if they become dirty.

Three Element Type CO Relay

The CO relay, both standard and low energy type, is sometimes furnished with 3 elements in a single case. The outside dimensions of this case are shown in Fig. 20, but the number of terminals varies with the particular style of relays. Similarly Fig. 15 shows a typical diagram of internal connections with three operation indicators.

This 3-element relay is frequently supplied with the ammeter attachments mentioned in the following section.

Types COA and CRA Relays

These relays are standard type CO or CR with a self-contained ammeter scale. This ammeter operates on the induction principle and consists of an aluminum vane which swings in the same air gap as does the main disc. It, therefore, not only indicates the value of the current but supervises the entire current circuit and assures the operator that current is flowing through the relay coils. The entire scale moves and the reading is indicated by a fixed pointer. A small aluminum vane swings above the permanent magnet and sufficient flux is robbed from the magnet to damp the movements of the ammeter.

The current reading depends upon the tap setting of the relay and this setting should, therefore, be determined before the scale is marked so that it may be properly marked in amperes. Some relays are marked in percent so that any tap value may be used without inconvenience.

The ammeter attachment cannot be put on existing relays. It does not change the diagram of internal connections nor does it change the drilling plan of the various relays which may contain it. On the single element type CO relay it increases the depth from the front of the board by ¼ inch.

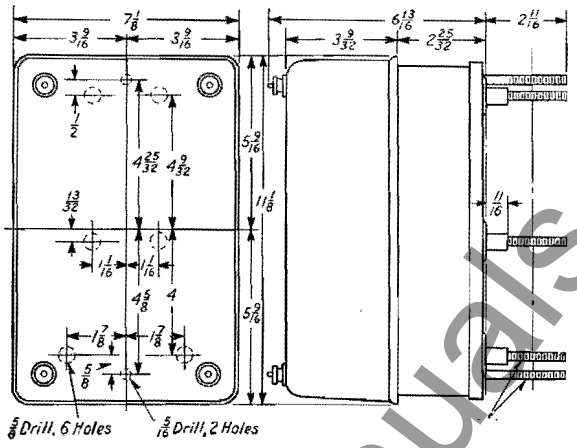

FIG. 21—TYPES CR, CRA AND CRC SINGLE-TRIP CIRCUIT, SIX-TERMINAL RELAYS

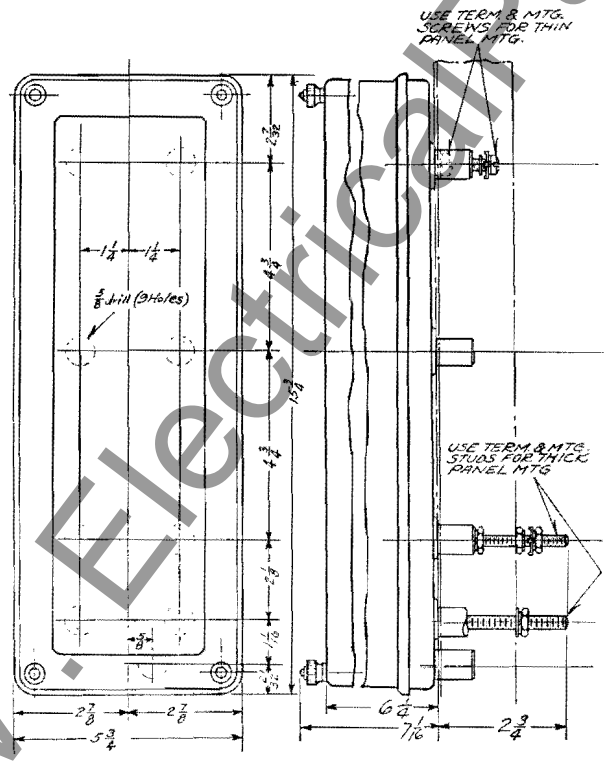

FIG. 20—THREE ELEMENT TYPE CO OR COA RELAY WITH EXTRA ALARM TERMINAL. FOR RELAY WITHOUT ALARM CIRCUIT OMIT THE BOTTOM TERMINAL

Testing Relays

All relays should be inspected periodically and the time of operation should be checked at least once every six months. For this purpose, a cycle counter should be employed because of its convenience and accuracy. Phantom loads should not be used in testing induction type relays because of the resulting distorted current wave form which produces an error in timing.

For the directionally controlled relays, the time of operation is the time for the directional and overcurrent elements to operate, since the former must close contacts before the disc on the latter can start to rotate. The time of operation of the directional element depends upon the applied voltage, current and the phase angle between the two, but will be a matter of a few cycles for nearly all faults. Therefore, the relay has been calibrated at the factory with the directional contacts blocked closed.

Caution

The position of the torque compensator on the overload element is adjustable but this is primarily a factory adjustment and the location of the torque compensator should not be changed in the field.

Readjusting Relays

Overload Element

If the factory adjustment has been disturbed, proceed as follows to make readjustment. By shifting the position of the contact stop on the time lever, adjust contacts so that they barely touch when the time lever is set on zero.

Adjust the tension of the spiral spring so that the relay will close its contacts at its rated current, as shown by the position of the screw on the terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are the same as shown on the calibration curve.

Directional Element

The tension of the spiral spring on the directional element should be just sufficient to return the disc to the stop and thus hold the contacts in the open position.

In many applications there is no objection to having the contacts closed when the relay is de-energized. This can be changed by shifting the spring adjuster but the tension on the spring should never be enough to prevent the contacts from taking their proper position, either open or closed, during time of short circuit when the forces acting on the disc are small.

There is an adjustable magnetic vane on each side of the upper pair of poles, which is intended to balance the current circuit. The normal adjustment is to remove all potential from the voltage coil and apply heavy current to the current coils. The balancing vanes are then adjusted till there is no pronounced torque in either direction. This same adjustment may be used to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker even though the potential may be absolutely zero.

The upper bearing screw should be screwed down until there is only two or three thousandths clearance between it and the shaft and then securely locked in position with the lock nut.

The contact opening on the directionally controlled relays should be $\frac{1}{32}$" in order to reduce the time of operation of the directional element to a minimum. No harm will result if the directional contacts rebound closed momentarily after a fault is cleared, because the overcurrent contacts will be in the open position.

The contact opening on relays which are not directionally controlled should be $\frac{3}{32}$".

Contactor Switch

The stationary core is adjustable so that it may be moved up sufficiently to keep the plunger from striking against it. This is important because, if the plunger strikes against the core, it is likely to stick due to residual magnetism.

Double Trip Circuit

If this relay has two stationary contacts on the overload element, it may be used for tripping two circuit-breakers simultaneously, or for any purpose where it is desired to have two circuits closed at the same time by the relay and yet have them independent when the relay is not operated. Double contacts on the relay are necessary so that either breaker may be opened independently of the other for ordinary switching operation and allowing both to be tripped if both are closed when trouble occurs.

The double trip type CO relay may be used for tripping one breaker and energizing a bell alarm circuit. The directionally controlled double trip type CR relay may also be used in this manner.

Renewal Parts

Repairing

Repair work can be most satisfactorily accomplished at our Works. However, interchangeable renewal parts can be furnished to customers who are equipped for doing repair work.

Ordering Instructions

When ordering renewal parts, give the nameplate reading and the name of the part wanted.

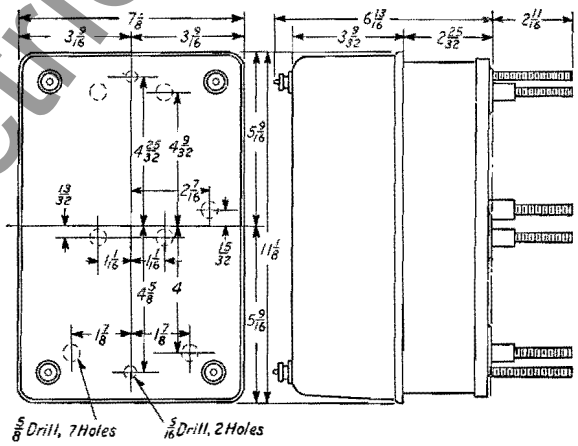

FIG. 22—TYPES CR, CRA AND CRC SEVEN-TERMINAL RELAYS. THIS COVERS THE DOUBLE-TRIP, CIRCUIT-CLOSING OR THE SINGLE-TRIP, DUO-DIRECTIONAL, OR THE SINGLE-TRIP WITH AN EXTRA TAP BETWEEN THE DIRECTIONAL AND THE OVER-CURRENT ELEMENTS.

Westinghouse Electric & Manufacturing Company
Newark, N. J.

Printed in U. S. A. (Rep. 9-37)

I. L. 1849-C
(Filing No. 41-000)

Westinghouse

Types CO and COA Overcurrent and Types CR, CRA and CRC Directional Overcurrent Relays

Caution

Remove all blocking from relay before placing in service.

Installation

Carefully unpack the relay and remove all dust and packing material with a soft brush or cloth. The cover of the relay should be removed and the interior parts carefully inspected for any damage which might have been done in shipment. This inspection should include a test of the moving parts to see that they have not become misaligned and that there is no friction present. The presence of friction can usually be determined by moving the disc or contactor plunger by hand and letting it return to the normal position. Owing to the importance of proper relay functioning it is a wise precaution before placing relays in service, to check each relay for operating current, time of operation, and polarity. For all type CR relays, the left hand contacts of the directional element, front view, should open when the potential and current applied to the relay are in phase, See Fig. 5.

Mount the relay vertically by means of the two mounting studs. Connections may be made direct to the terminals by means of screws for steel panel mounting or to the terminal studs, furnished with the relay, for slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench. Note that the top mounting stud may be utilized as a grounding stud for grounding the metal case.

Connect the relay as shown on the proper diagram in this leaflet, or consult the nearest Sales Office for additional diagrams of connections for cases not covered by this leaflet.

The tripping circuit should not be opened by the relay, but an auxiliary contact on the circuit-breaker should be provided to open the tripping circuit the instant the breaker opens.

This relay is suitable for operating the Westinghouse direct trip attachment for tripping direct from the current transformer and also for operating the transfer relay for the same purpose.

Instructions for Setting

In arriving at the proper setting of the overload element, or relay, two things must be determined.

FIRST—In terms of the secondary circuit of the current transformer, the minimum amperes to trip (tap setting) should be higher than the overload peaks due to service load. Under short circuit conditions, the current will be fixed by the impedance of the circuit to which the relays are connected and the minimum short circuit current will usually be several hundred percent of the tap setting.

SECOND—The time setting for short circuit conditions is determined by consideration of the sequence in which the breakers should trip, the time required for breaker mechanisms to operate etc., as required to give proper selective action throughout the system as a whole.

Current Setting:

The connector screw on the terminal plate above the time scale makes connections to various turns on the operating coil. By placing this screw in the various holes, the relay will just close contacts at the corresponding current, 4-5-6-8-10-12 or 15 amperes, or as marked on the terminal plate.

The tripping value of the relay on any tap may be altered by changing the initial tension of the spiral spring. This can be accomplished by turning the spring adjuster by means of a screw driver inserted in one of the notches of the plate to when the outside convolution of the spring is fastened. An adjustment of tripping current approximately 15 percent above or below any tap value, can be secured without materially

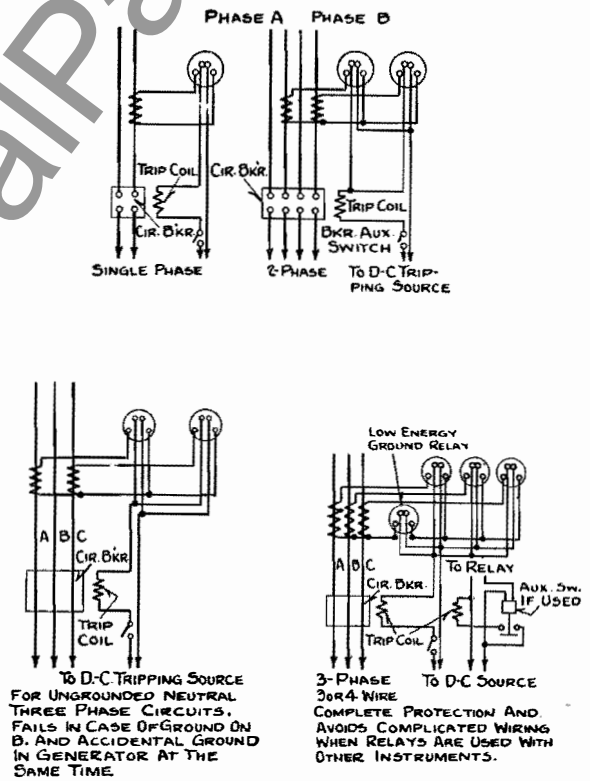

FIG. 1—CONNECTIONS FOR DIFFERENT INSTALLATIONS OF TYPE CO OVERCURRENT RELAYS USING D-C. TRIPPING SOURCE

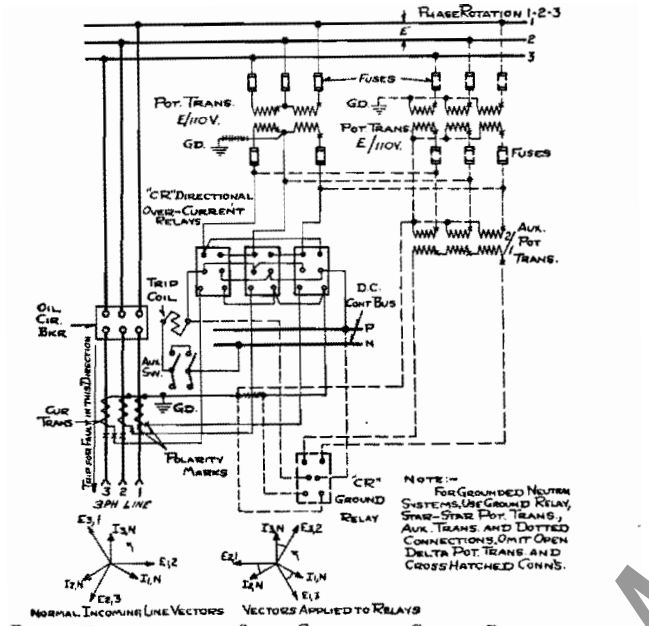

FIG. 2—CONNECTIONS FOR SHORT-CIRCUIT AND GROUND PROTECTION USING TYPE CR RELAYS AND HIGH-TENSION POTENTIAL TRANSFORMERS

affecting the operating characteristics of the relay. By choosing the proper tap, a continuous adjustment of tripping current from 3.4 amperes to 17.5 amperes may be secured. The characteristic time curve will be affected less for any large adjustment if the next higher tap is selected and the initial tension of the spiral spring is decreased to secure the desired tripping value. For example, the relay should be set on the 8 ampere tap with less initial tension in order to secure a 7 ampere tripping value.

Caution

Be sure that the connector screw is turned up tight so as to make a good contact, for the operating current passes through it. Since the overload element is connected directly in the current transformer circuit, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, located on the right hand mounting boss, in the new tap and removing the old screw from its original setting.

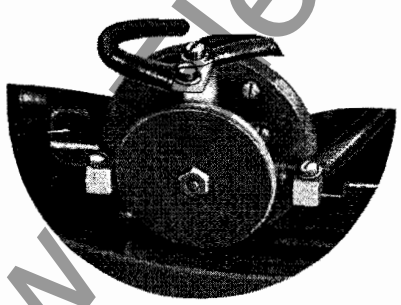

FIG. 3—CONTACTOR SWITCH COIL CONNECTED IN TRIP CIRCUIT. THE TARGET OPERATES ON 2.25 AMPERES OR MORE

Time Adjustments

The index or time lever, limits the motion of the disc and thus varies the time of operation. The latter is proportional to the lever setting, that is, with the lever on the number 5 setting, at 2000 percent load, the relay will operate in one second and similarly on the number 1 setting the time of operation is 0.2 seconds.

The relay has been calibrated from the #10 time lever setting according to the curve engraved on the nameplate. The #11 time setting may be used to secure a time delay approximately 10 per cent longer, that is, to secure a setting of 2.2 seconds for a 2 second relay.

Be sure that the contacts just touch when the time lever is set on zero, otherwise the time will not be proportional to the lever setting.

Operation Indicator

This relay is equipped with a universal operation indicator suitable for all tripping currents above 0.2 amperes. The relay leaves the factory with the operation indicator coil connected in parallel with the contactor switch coil and if the tripping current is more than 2.25 amperes d-c., sufficient current will flow through both coils to cause their operation. The resistance of both coils in parallel is approximately 0.25 ohm.

If the trip current is less than 2.25 amperes there is no necessity for the contactor switch and it should be removed from the trip circuit so that all trip current will pass through the indicator coil. The indicator coil has approximately 2.8 ohms resistance. To disconnect the contactor switch coil, remove the lower lead on the front stationary contact of the contactor switch (See Figure 3) and this lead should be fastened (dead ended) under the small fillister head screw located in the micarta base of the contactor switch (See Figure 4).

Make sure that the indicator receives sufficient current to operate through the trip coil. The trip coil has such a high inductance that the breaker may open and open its pallet switch before the current has built up to its full value. Also, the voltage may be low resulting in a lower trip current. It is advisable to assume that the current through the indicator will be only half of the value calculated from the resistance of the coil and normal control voltage. If the trip circuit does not draw enough current to drop the target when it is set to operate at .2 ampere, more current may be secured by putting a small loading resistor around the trip coil or around the auxiliary relay, if this is used.

Directional Element

The standard single trip and double trip type CR relays are directionally controlled, that is, the directional contacts must close in order for the overcurrent element to operate. The contacts of the latter trip the breaker direct. The single trip 7 terminal stud relay (7th terminal between the directional and overcurrent contacts) and the duo-directional relay cannot be made directional controlled and therefore the contacts of the overcurrent and directional elements are in series in the trip circuit.

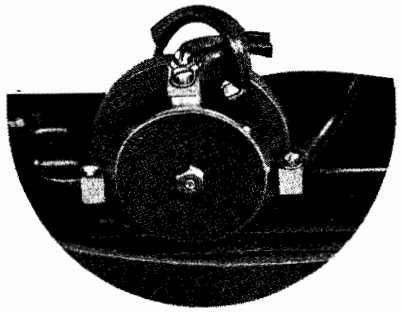

FIG. 4—CONTACTOR SWITCH COIL DISCONNECTED FROM TRIP CIRCUIT. ALL THE CURRENT PASSES THROUGH THE TARGET COIL SO THAT IT WILL OPERATE ON .2 AMPERE OR MORE

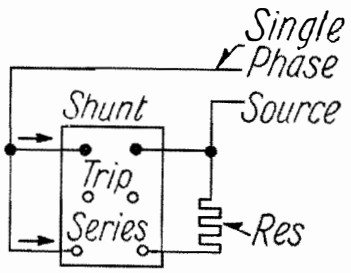

FIG. 5—METHOD OF TESTING POLARITY OF TYPE CR RELAY. THE CONTACTS REMAIN OPEN

The directional element is usually connected to the system in such a manner that the directional contacts close when power flow is away from the station bus All diagrams shown have this polarity.

Checking Connections of the Type CR Relay

All type CR relays, except the ground relays, have wattmeter characteristics for the directional elements and, therefore, the directional element disc will reverse its direction of rotation when the phase relation of the current and voltage becomes 90° or greater. The directional relay must be connected so that this relation will never exceed 90°.

Since the power factor of fault currents may vary over a considerable range, it is necessary that the proper voltage be used on the directional element. Connections should be made so that with unity power factor on the line, the current in the relay directional element will be 30° ahead of the potential supplying the directional element.

The following methods should be used in checking up the correct connections to the directional element of the relay.

Wattmeter Method

With the power flowing in either direction, if the current is lagging, so that the power factor is between 50 and 100 per cent, connect the current coils of a single phase wattmeter in series with the current winding of the relay. Then select a pair of voltage leads which give the highest reading on the wattmeter. The two leads should be connected to the relay potential terminal. Inspect the contact of the directional element, which should be open when the power is flowing towards the bus bars. If the contacts are closed when the current flows toward the bus bars, then the potential leads of the relay should be reversed.

Power Factor Meter Method

A second method is to connect the current coils of a single phase power factor meter in series with the current coils of the relay. A pair of potential leads is then selected which will give 86.6 per cent power factor leading on the power factor meter when the line power factor is 100 percent. These two leads should be connected to the relay potential terminals. The upper contact should be inspected, as before mentioned in the preceding paragraph and checked for proper direction of operation.

Phase Indicator Method

A third method of checking the proper connections of the relay is by means of the Westinghouse phase indicator. It is a portable instrument built on very much the same principle as a power factor meter but calibrated to read in degrees, and show precisely the phase relation between any current and voltage sources to which it may be connected. Full directions for the use of the portable phase indicator are supplied with the instrument.

Relay for 90° Connection

This relay can be used for the 90° connection, that is, with the current leading the applied potential by 90° when the line power factor is 100%, by installing a suitable external resistor in series with the potential coil. These external resistors can be ordered by style number as follows.

25 Cycle, 115 Volts, 760 ohms, S# 721435
50 Cycle, 115 Volts, 670 ohms, S# 721436
60 Cycle, 115 Volts, 565 ohms, S# 721437

Type CR Ground Relays

The directional element of the type CR relay which is intended for ground protection differs from that of the phase relay by not having true wattmeter characteristics. It develops its maximum torque when the relay current lags about 15 degrees behind the relay voltage. This is essential on systems where the neutral is dead grounded. These relays may be distinguished from

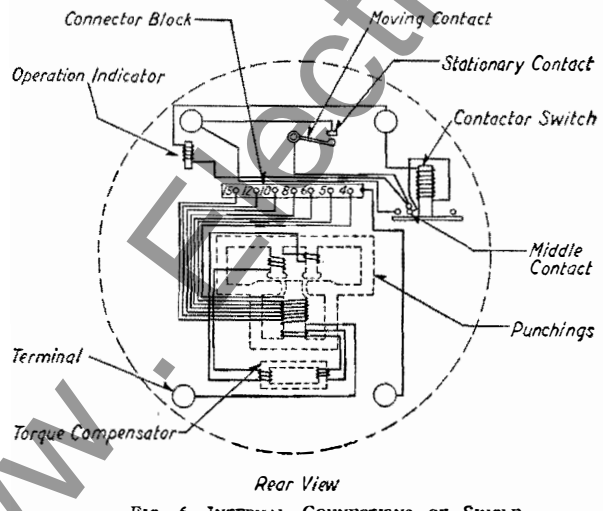

FIG. 6—INTERNAL CONNECTIONS OF SINGLE-TRIP, STANDARD-ENERGY TYPE CO RELAY

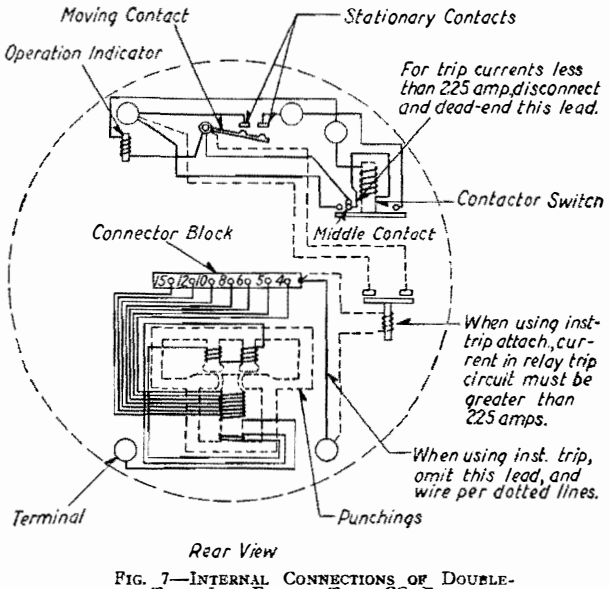

FIG. 7—INTERNAL CONNECTIONS OF DOUBLE-TRIP, LOW-ENERGY TYPE CO RELAY

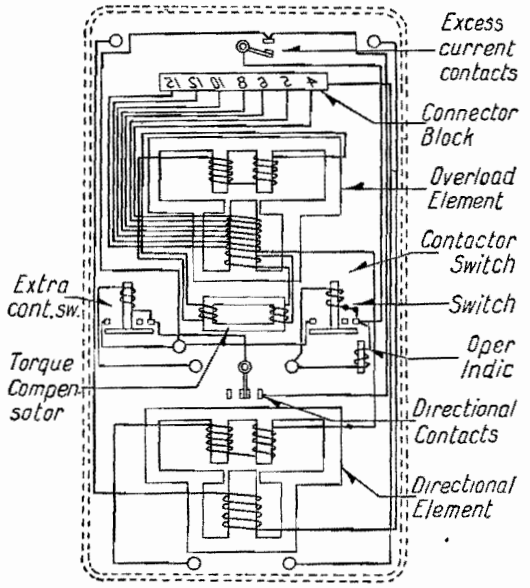

FIG. 8—INTERNAL CONNECTIONS OF STANDARD-ENERGY, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY WITH A TAP CONNECTION BETWEEN THE DIRECTIONAL AND OVERCURRENT CONTACTS—REAR VIEW

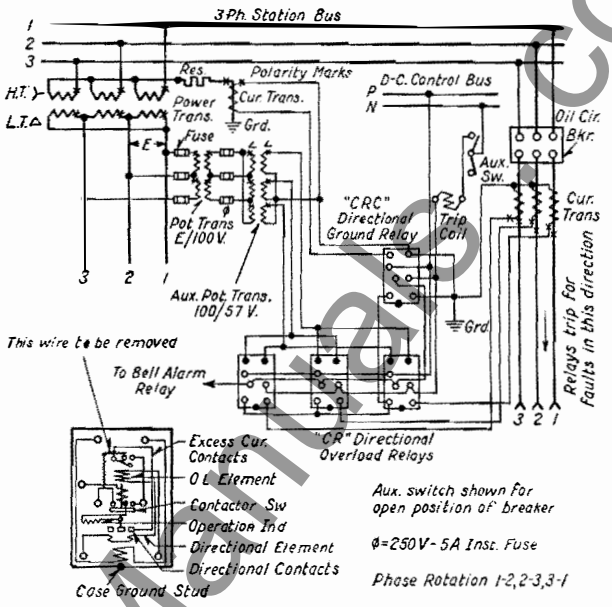

FIG. 10—EXTERNAL CONNECTIONS OF THE TYPE CRC RELAY USED FOR GROUND PROTECTION—REAR VIEW

others because they are of the low energy type and have ratings of .5 to 2.5 or 2 to 6 amperes.

Low Energy Types CO and CR Relays

The low energy type of CO and CR relays are different from the standard ones. Instead of obtaining the definite minimum time feature by means of

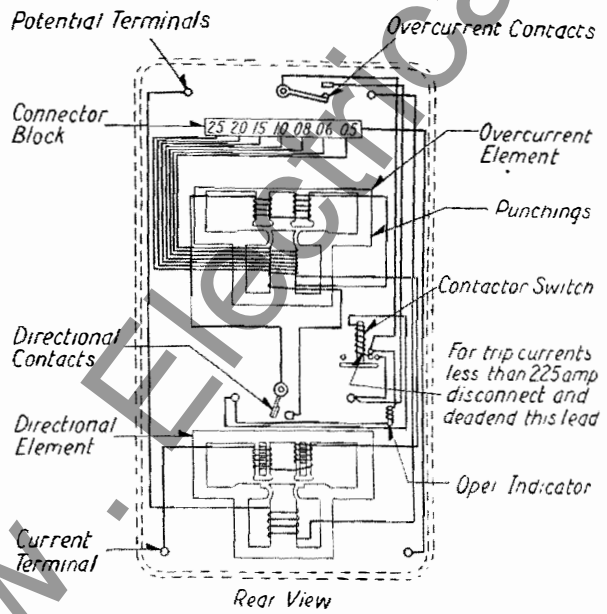

FIG. 9—INTERNAL CONNECTIONS OF LOW-ENERGY, DIRECTIONAL-CONTROL, UNI-DIRECTIONAL, SINGLE-TRIP TYPE CR RELAY

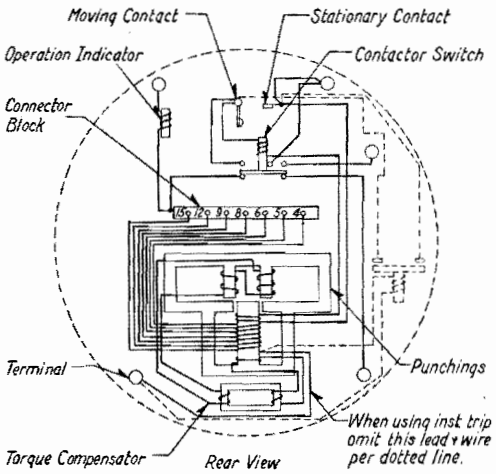

FIG. 11—INTERNAL CONNECTIONS OF CIRCUIT-OPENING TYPE CO RELAY FOR SERIES TRIP CIRCUIT

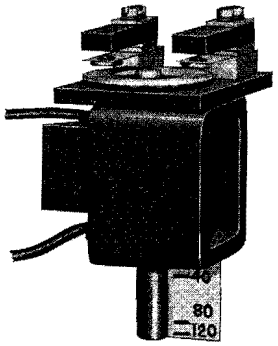

FIG. 12—THE INSTANTANEOUS ATTACHMENT

the torque compensator, a somewhat similar result is obtained by gearing the disc to the shaft which carries the contact arm. This results in a characteristic curve which is somewhat more inverse than the standard curve and also results in much slower resetting time. The term "low energy" refers to the burden which is placed on the current transformers and does not refer to the current rating. All of the small current ranges are of the low energy type and some of the higher current ranges are also made in the low energy type for use on certain current transformers which are incapable of carrying a heavy burden. The low energy and standard relays have the same external appearance and dimensions.

When circuit breakers are instantaneously reclosed, it is necessary to use special quick opening contacts on the low energy type of relay. These contacts differ from the normal ones in being stiff, without any follow, so that they will open quickly.

Very-Inverse Type CO Relay

This relay is similar to the low-energy relay but contains a different electromagnet and has a much more inverse curve. The mechanical arrangement of the parts is similar to the low-energy type, although they are not exact duplicates. The burden on the current transformer is considerably less than that of the low-energy CO relay.

The 40-Second Type CO Relay

This relay is similar in appearance to the low energy relay but consists of a standard energy 4-second relay with a 10 to 1 gear reduction, making the total time 40 seconds on the flat part of the curve. The 25 cycle relay has a resetting time of approximately 90 seconds. It will overheat before tripping from the number 10 position for currents greater than 750% of the tripping value. The 60 cycle relay resets in 120 seconds and will overheat before tripping from the number 10 position for current greater than 1000% of the tripping value.

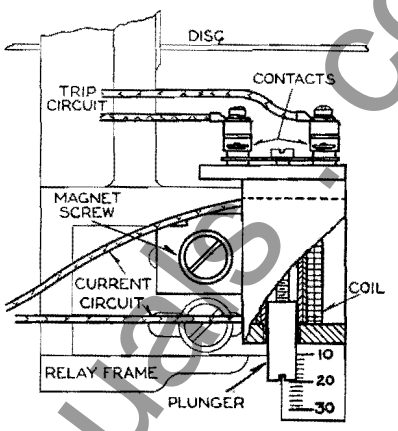

FIG. 14—ADJUSTMENT DETAILS AND METHOD OF MOUNTING THE INSTANTANEOUS ATTACHMENT

This relay is frequently used for motor protection and may require an accurate current setting which can be given by adjusting the spiral spring. The instantaneous attachment mentioned below is useful on this relay to protect against short circuits.

CRC Ground Relay

This is a directional relay quite similar to the CR relay with the same dimensions and internal connections, but the

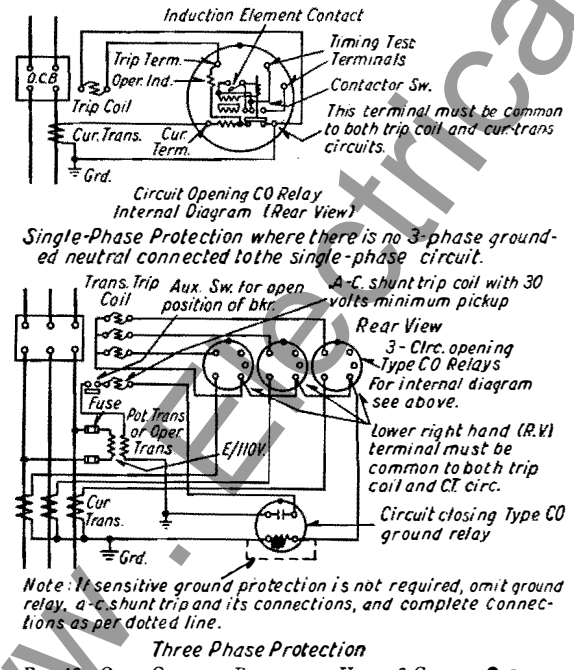

FIG. 13—OVER-CURRENT PROTECTION USING 3 CIRCUIT-OPENING TYPE CO RELAYS FOR LINE PROTECTION AND ONE CIRCUIT-CLOSING GROUND RELAY

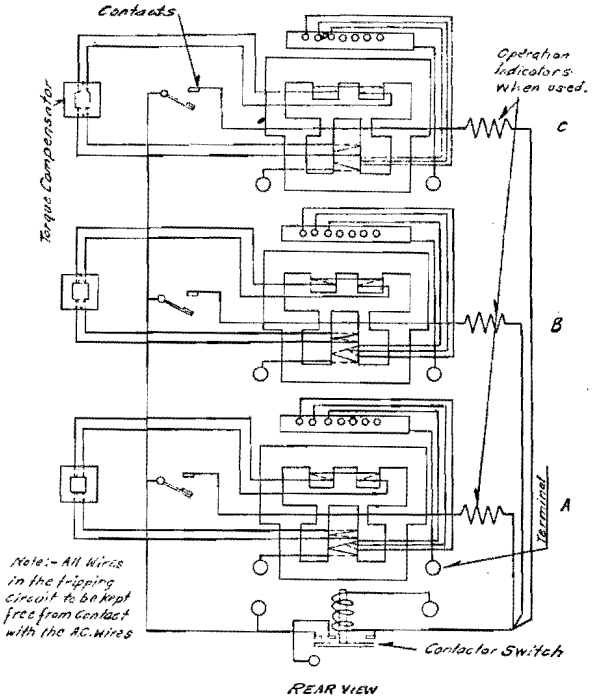

FIG. 15—INTERNAL CONNECTIONS OF THREE ELEMENT TYPE CO AND COA RELAY WITH EXTRA BELL ALARM TERMINAL

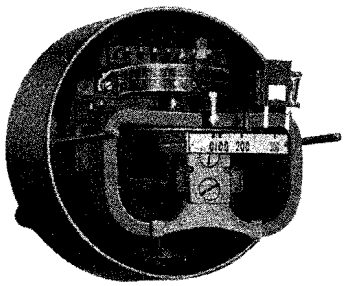

FIG. 16—SINGLE-PHASE TYPE COA RELAY WITH NAMEPLATE REMOVED

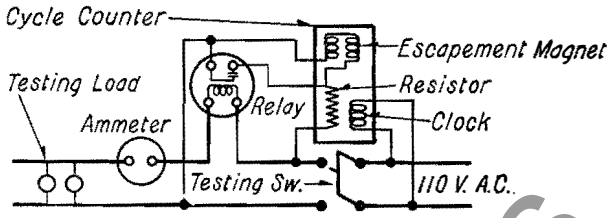

FIG. 18—CONNECTIONS FOR THE USE OF THE CYCLE COUNTER IN TESTING CIRCUIT-CLOSING TIME-LIMIT RELAYS

polarizing coil on the directional element has a 5 ampere winding. This coil is energized by a current transformer placed in the neutral of the power transformers.

All the adjustments and manipulations are the same as for the CR relay.

Circuit Opening Relays

The conventional method of tripping circuit breakers is by means of current from a storage battery and a relay which closes its contacts to complete the circuit through the trip coil. Where it is desired to eliminate the battery, the breaker may be tripped by current from the current transformers if circuit opening relays are used. As shown in Fig. 11 the operation of the relay connects the circuit breaker trip coil in series with the current circuit. The internal diagram shows that when the main relay contacts close they pull up the contactor which is energized from a secondary coil on the main pole. When the contactor is lifted, it opens the short circuit around the trip coil and allows the current to flow through the coil.

It should be observed that the contacts break the full short circuit current and they may be seriously burned. It is therefore important that the contacts be frequently inspected and kept clean and smooth. With frequent maintenance, the contacts may safely open circuits of 50 amperes. If the current is small, the relay may give satisfactory service with inspection periods as seldom as once a year. It should be borne in mind that these contacts carry the current continuously and if they become bad, they will begin to overheat and finally burn open the current transformer circuit.

Because these contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subjected to shocks which may jar the contacts open and thereby allow current to flow through the trip coil.

Trouble of this kind can be avoided by preventing jars to the switchboard and also by setting the trip coil high enough so that it will not operate on normal load current. This is an extra safe-guard so that there is no danger from even an excessive shock unless the current is also heavy.

The circuit opening relay is made only in the 4 to 15 ampere range. Lower ranges are not desirable because the burden of low range trip coils is too heavy on the current transformer. One trip coil is required for each relay.

If ground relay protection is required, the low range ground relay may be of the circuit closing type and operate an a-c. voltage trip coil. See Fig. 13.

The circuit opening feature is provided only in the Type CO Relay.

Instantaneous Attachment

The instantaneous attachment has its contacts in parallel with the main contacts of the CO or CR relay. Its purpose is to make the time of operation of the relay instantaneous after a predetermined current is exceeded. The device is usually built to operate at a high value, a common style being adjustable between 40 and 120 amperes. The marking is accurate to within ± 25%. The current setting is made by raising or lowering the plunger. The design of the 25 cycle relay is somewhat different from that shown in the illustration and has a piece of felt under the contacts to damp out the vibrations.

The instantaneous attachment is usually applied to the relay while it is being manufactured but it can be attached to any of the old induction type relays. No special mounting arrangements are required—it fits under one of the screws holding the permanent magnets. (See Fig. 14).

Lock-Out Attachment

Sometimes it is desired to prevent a relay from tripping a circuit breaker

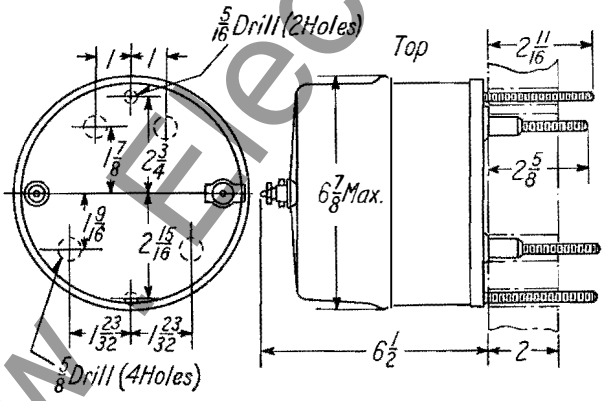

FIG. 17—SINGLE-TRIP STANDARD AND LOW-ENERGY CIRCUIT-CLOSING TYPE CO RELAY. THE TYPE COA RELAY IS 6 3/4-INCH DEEP INSTEAD OF 6 1/2-INCH

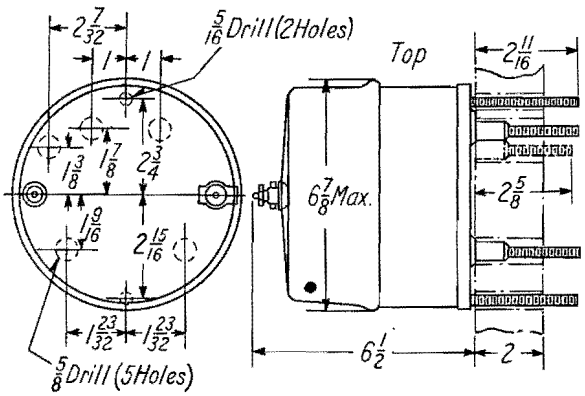

FIG. 19—DOUBLE-TRIP STANDARD AND LOW-ENERGY TYPE CO RELAY. ALSO THE CIRCUIT-OPENING TYPE CO FOR SERIES TRIP. THE TYPE COA RELAY IS 6 3/4-INCH DEEP INSTEAD OF 6 1/2-INCH

when the current is too high—above its interrupting capacity. For this purpose the lockout attachment is provided. It is similar to the instantaneous attachment in appearance and method of adjusting but its contacts are in series with the main contacts and are normally closed. These contacts must be given special care because they are in series with the main tripping circuit and may prevent proper relay operation if they become dirty.

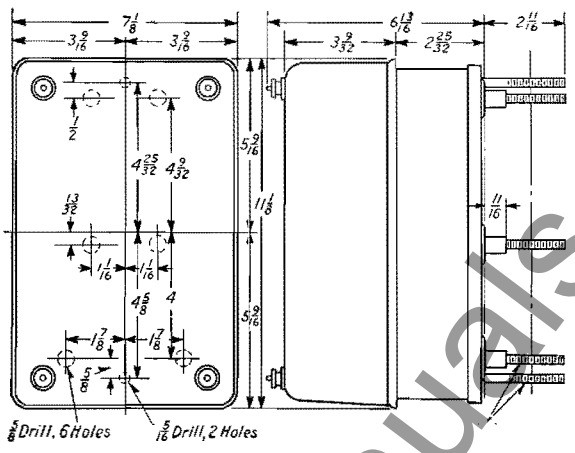

FIG. 21—TYPES CR, CRA AND CRC SINGLE-TRIP CIRCUIT, SIX-TERMINAL RELAYS

Three Element Type CO Relay

The CO relay, both standard and low energy type, is sometimes furnished with 3 elements in a single case. The outside dimensions of this case are shown in Fig. 20, but the number of terminals varies with the particular style of relays. Similarly Fig. 15 shows a typical diagram of internal connections with three operation indicators.

This 3-element relay is frequently supplied with the ammeter attachments mentioned in the following section.

Types COA and CRA Relays

These relays are standard type CO or CR with a self-contained ammeter scale. This ammeter operates on the induction principle and consists of an aluminum vane which swings in the same air gap as does the main disc. It, therefore, not only indicates the value of the current but supervises the entire current circuit and assures the operator that current is flowing through the relay coils. The entire scale moves and the reading is indicated by a fixed pointer. A small aluminum vane swings above the permanent magnet and sufficient flux is robbed from the magnet to damp the movements of the ammeter.

The current reading depends upon the tap setting of the relay and this setting should, therefore, be determined before the scale is marked so that it may be properly marked in amperes. Some relays are marked in percent so that any tap value may be used without inconvenience.

The ammeter attachment cannot be put on existing relays. It does not change the diagram of internal connections nor does it change the drilling plan of the various relays which may contain it. On the single element type CO relay it increases the depth from the front of the board by ¼ inch.

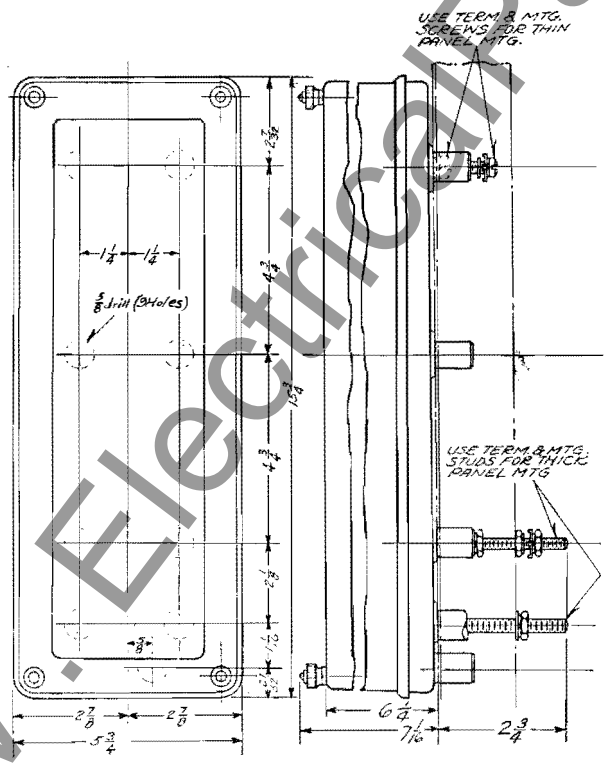

FIG. 20—THREE ELEMENT TYPE CO OR COA RELAY WITH EXTRA ALARM TERMINAL. FOR RELAY WITHOUT ALARM CIRCUIT OMIT THE BOTTOM TERMINAL

Testing Relays

All relays should be inspected periodically and the time of operation should be checked at least once every six months. For this purpose, a cycle counter should be employed because of its convenience and accuracy. Phantom loads should not be used in testing induction type relays because of the resulting distorted current wave form which produces an error in timing.

For the directionally controlled relays, the time of operation is the time for the directional and overcurrent elements to operate, since the former must close contacts before the disc on the latter can start to rotate. The time of operation of the directional element depends upon the applied voltage, current and the phase angle between the two, but will be a matter of a few cycles for nearly all faults. Therefore, the relay has been calibrated at the factory with the directional contacts blocked closed.

Caution

The position of the torque compensator on the overload element is adjustable but this is primarily a factory adjustment and the location of the torque compensator should not be changed in the field.

Readjusting Relays

Overload Element

If the factory adjustment has been disturbed, proceed as follows to make readjustment. By shifting the position of the contact stop on the time lever, adjust contacts so that they barely touch when the time lever is set on zero.

Adjust the tension of the spiral spring so that the relay will close its contacts at its rated current, as shown by the position of the screw on the terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are the same as shown on the calibration curve.

Directional Element

The tension of the spiral spring on the directional element should be just sufficient to return the disc to the stop and thus hold the contacts in the open position.

In many applications there is no objection to having the contacts closed when the relay is de-energized. This can be changed by shifting the spring adjuster but the tension on the spring should never be enough to prevent the contacts from taking their proper position, either open or closed, during time of short circuit when the forces acting on the disc are small.

There is an adjustable magnetic vane on each side of the upper pair of poles, which is intended to balance the current circuit. The normal adjustment is to remove all potential from the voltage coil and apply heavy current to the current coils. The balancing vanes are then adjusted till there is no pronounced torque in either direction. This same adjustment may be used to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker even though the potential may be absolutely zero.

The upper bearing screw should be screwed down until there is only two or three thousandths clearance between it and the shaft and then securely locked in position with the lock nut.

The contact opening on the directionally controlled relays should be $\frac{1}{32}$" in order to reduce the time of operation of the directional element to a minimum. No harm will result if the directional contacts rebound closed momentarily after a fault is cleared, because the overcurrent contacts will be in the open position.

The contact opening on relays which are not directionally controlled should be $\frac{3}{32}$".

Contactor Switch

The stationary core is adjustable so that it may be moved up sufficiently to keep the plunger from striking against it. This is important because, if the plunger strikes against the core, it is likely to stick due to residual magnetism.

Double Trip Circuit

If this relay has two stationary contacts on the overload element, it may be used for tripping two circuit-breakers simultaneously, or for any purpose where it is desired to have two circuits closed at the same time by the relay and yet have them independent when the relay is not operated. Double contacts on the relay are necessary so that either breaker may be opened independently of the other for ordinary switching operation and allowing both to be tripped if both are closed when trouble occurs.

The double trip type CO relay may be used for tripping one breaker and energizing a bell alarm circuit. The directionally controlled double trip type CR relay may also be used in this manner.

Renewal Parts

Repairing

Repair work can be most satisfactorily accomplished at our Works. However, interchangeable renewal parts can be furnished to customers who are equipped for doing repair work.

Ordering Instructions

When ordering renewal parts, give the nameplate reading and the name of the part wanted.

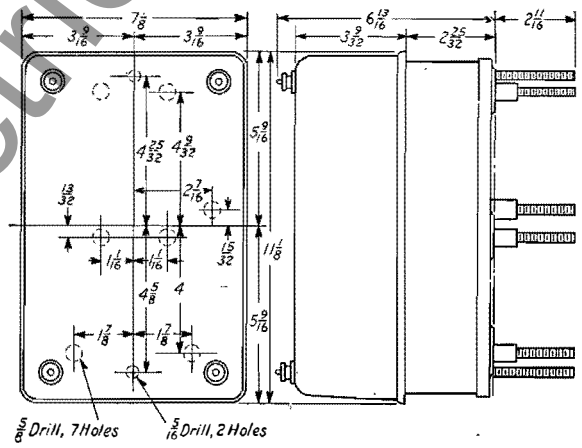

FIG. 22—TYPES CR, CRA AND CRC SEVEN-TERMINAL RELAYS. THIS COVERS THE DOUBLE-TRIP, CIRCUIT-CLOSING OR THE SINGLE-TRIP, DUO-DIRECTIONAL, OR THE SINGLE-TRIP WITH AN EXTRA TAP BETWEEN THE DIRECTIONAL AND THE OVER-CURRENT ELEMENTS.

Westinghouse Electric & Manufacturing Company
Newark, N. J.

Printed in U. S. A. (Rep. 9-37)