INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CVN VOLTAGE RELAY FOR MARINE SERVICE

CAUTION: Before putting protective relays into service, remove all blocking material inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

The type CVN relay is a single-phase induction-disc type relay operating on voltage. This relay is applied as a voltage fault detector operating in conjunction with other protective relays. The relay is also used as a timing device for various automatic operations. Either geared or non-geared type relays are available. The non-geared relay gives short time operation with quick reset. The geared relay gives longer time of operation with longer reset. The contacts are single-pole, double-throw operating on both over and under voltages. The relay is designed to withstand the 2000 ft. lb. class HI shock test.

CONSTRUCTION AND OPERATION

The relay element is an induction-disc type voltage element. The induction disc is four inches in diameter, mounted on a vertical shaft. A steel bearing pin at the bottom of the shaft is supported by a steel ball bearing. This ball is spring mounted. The upper end of the shaft has a phosphor bronze olive jewel, and this rides on a steel bearing pin, held by a screw mounted on the main movement frame.

The moving contact is a small silver hemispnere fastened on the end of an arm. The other end of this arm is clamped to an insulating shaft geared to the disc shaft. The electrical connection is made from the moving contact thru the arm and a spiral spring. One end of the spring is fastened to the arm, and the other, to a slotted spring adjuster disc which in turn fastens to the moulded insulation block mounted on the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to the moulded block. A small set screw provides adjustment of the contact follow.

Torque is produced to rotate the disc by an electromagnet in the rear of the relay. A permanent damping magnet is mounted in the front. In the non-geared relay the disc rotates only a fraction of a revolution and has graduated perforations in the disc which gives the relay a constant pick-up value regardless of the time lever setting. The lower pole of the electromagnet is energized by voltage. In order to produce torque the upper pole circuit is energized with the voltage induced across a few secondary turns wound on the lower pole as shown in Figure 1.

The permanent magnet is mounted on the movement frame by means of four mounting screws — two at the front and two at the under side of the magnet mounting clamp. Above the two side screws and between the magnet clamp and the movement frame, are two adjusting hex-headed screws. With the mounting screws loose, by means of the hex-head screws the position of the permanent magnet is adjusted so that the disc rides midway in the air gap. The locking nut on the hex-headed screws are screwed down first and then the four mounting screws securely tightened.

The magnetic shunt in the center of the permanent magnet assembly can be rotated up or down to calibrate the timer element. It is locked in place by a small set screw.

Mechanical Balance

The moving element of the Type CVN relay is balanced in the factory. This insures proper operation of the relay in tilted positions up to 45 degrees from the vertical.

SUPERSEDES I.L. 41-284
*Denotes change from superseded issue.

EFFECTIVE AUGUST 1968

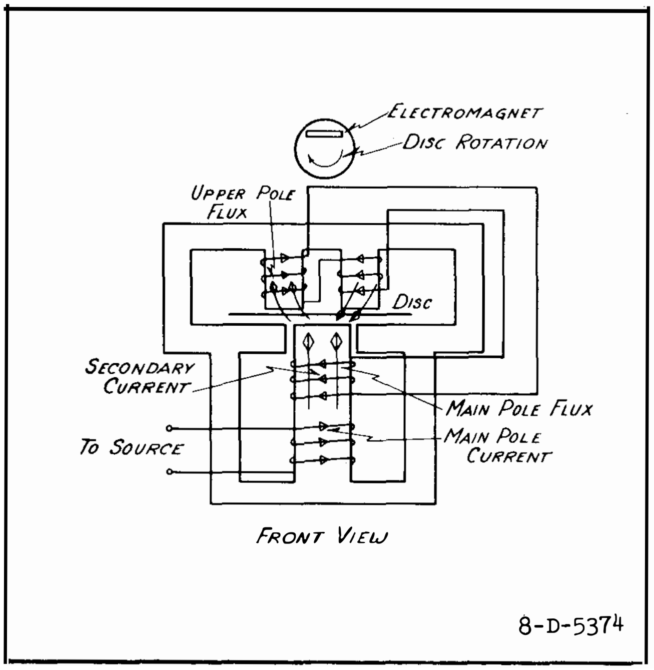


Fig. 1—Flux and Current Relations in a Non-Geared Type Voltage Element. For the Geared Voltage Elements the Upper Pole Connections and Disc Rotation are Reversed.

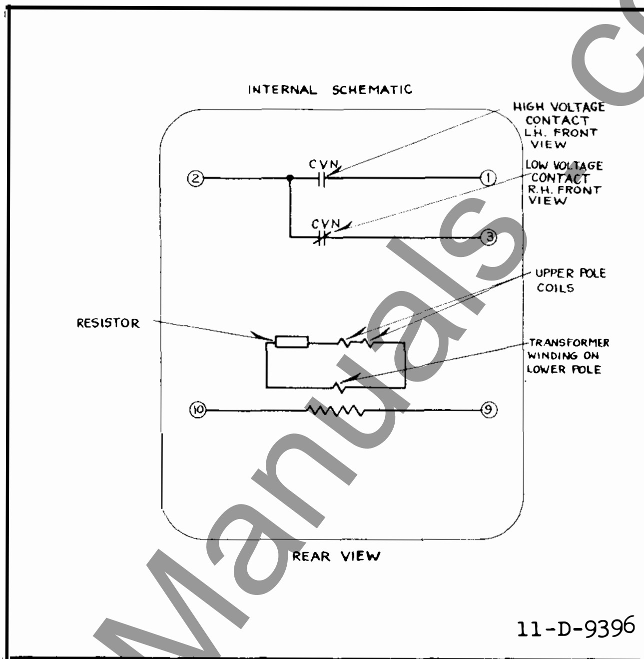


Fig. 2—Internal Schematic of the Single Pole Double Throw Type CVN Relay.

CHARACTERISTICS

The timer element is rated at 115 volts, 60 cycles. The minimum trip value is 80 volts, or 70 percent of rated voltage. The continuous rating is 127 volts, or 110 percent of rated voltage. The characteristic time curves are shown in Figures 3 to 6 for various voltage and time-lever settings.

INSTALLATION

The relays should be mounted on switchboard panels, or their equivalent, in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes at top and bottom of the case flange. One of the mounting screws may be utilized for grounding the relay case. The electrical connections may be made direct to the terminals by means of screws. Typical external connections are shown in Figure 7.

Trip Circuit

The contacts will safely close 30 amperes at 250 volts d-c., and will safely carry this current long enough to trip a breaker. Preferred practice is to use a contact of the energized device, to seal around the relay contacts, and relieve them of further duty.

The time for the contacts to break after operation can be decreased by eliminating the follow. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the moulded support. When this is done, the position of the contact stop on the time level should be shifted so that the moving and stationary contacts just touch when the time lever is set on zero. The stop screw in the time lever scale should be temporarily removed for this adjustment.

Voltage Element Connections

Connect the relay coil directly to the potential transformer. For phase-to-phase operation, either delta or star voltages may be used as desired. For phase-to-ground operation, the broken delta secondary of a grounded star connected potential transformer primary will provide the required residual voltage.

SETTINGS

There is only one setting to be determined. This is the time delay of the voltage element, and it is adjusted by the position of the time lever along the time lever scale. This scale has ten divisions, and Figures 3 to 6 give a curve of time

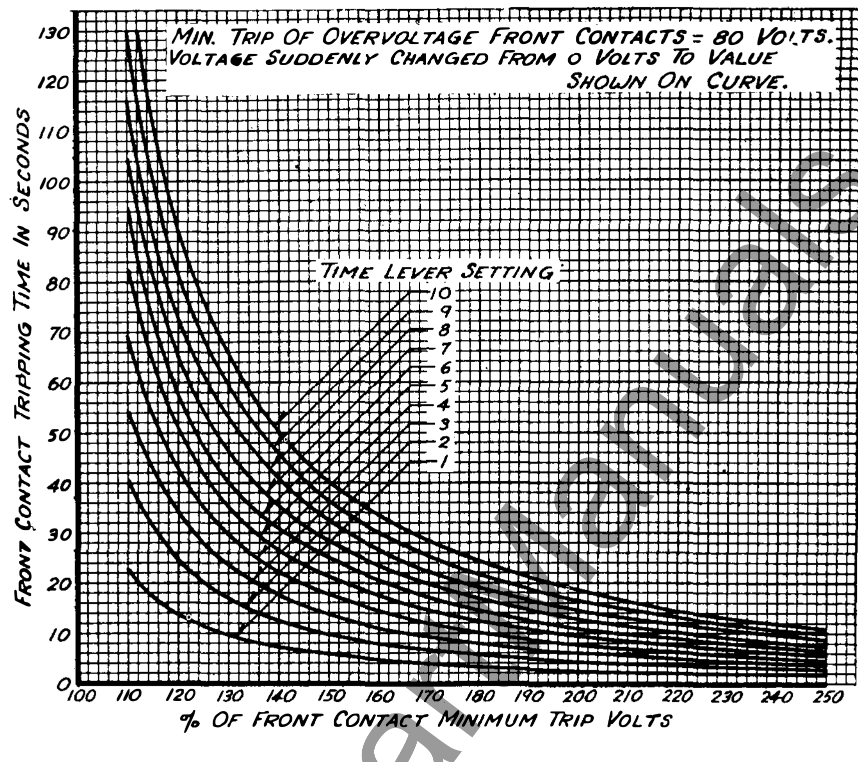


Fig. 3 — Typical Overvoltage Time Curves for the Geared Type CVN Relay.

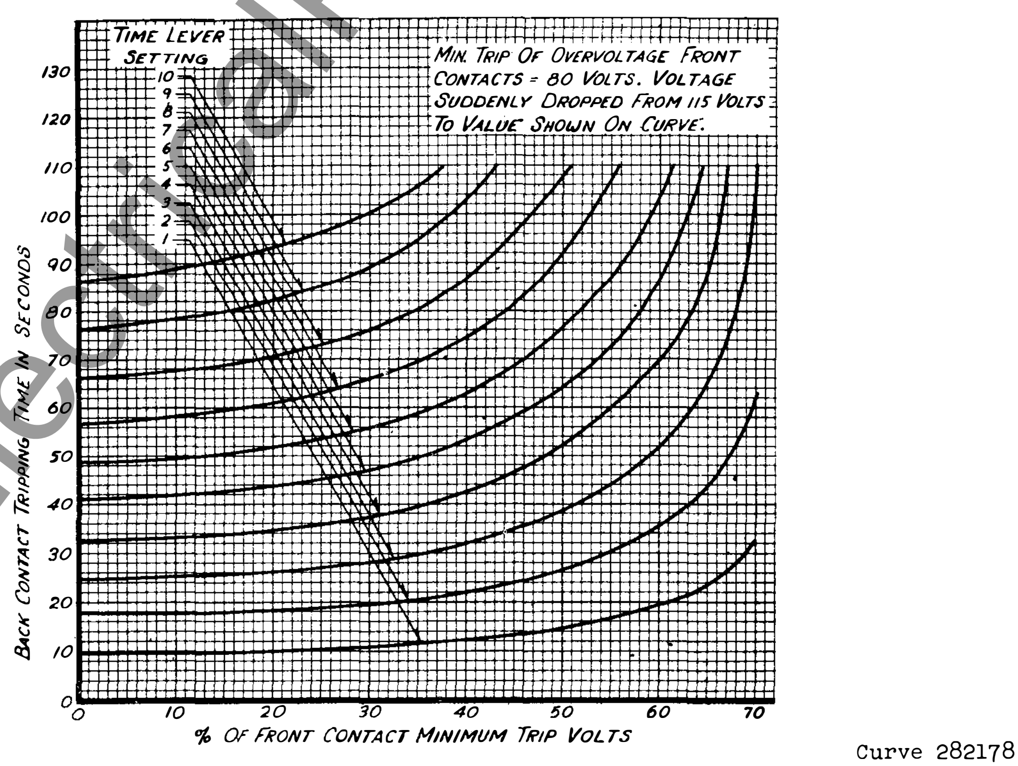
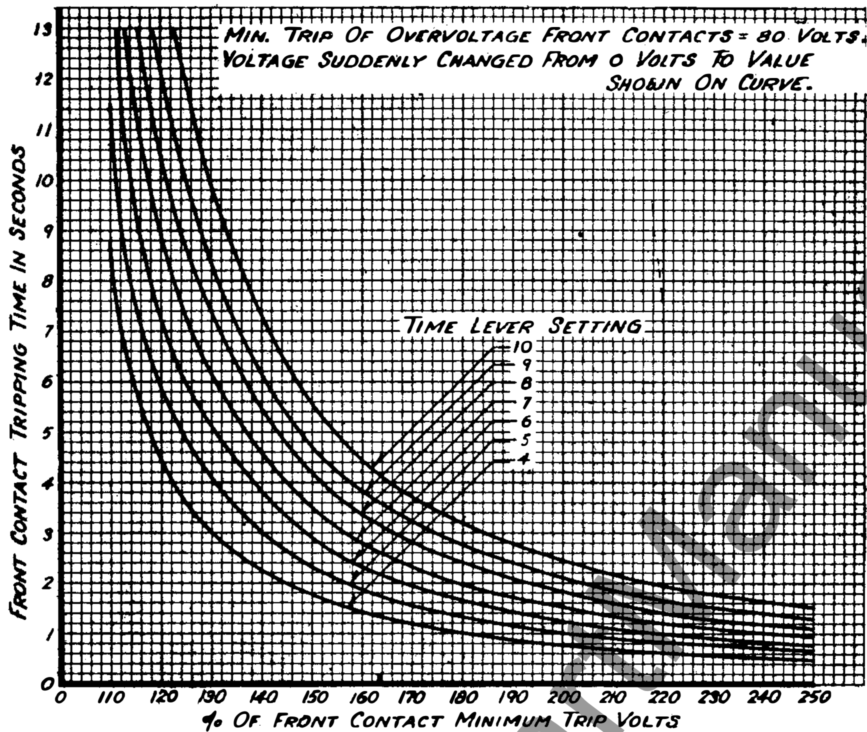
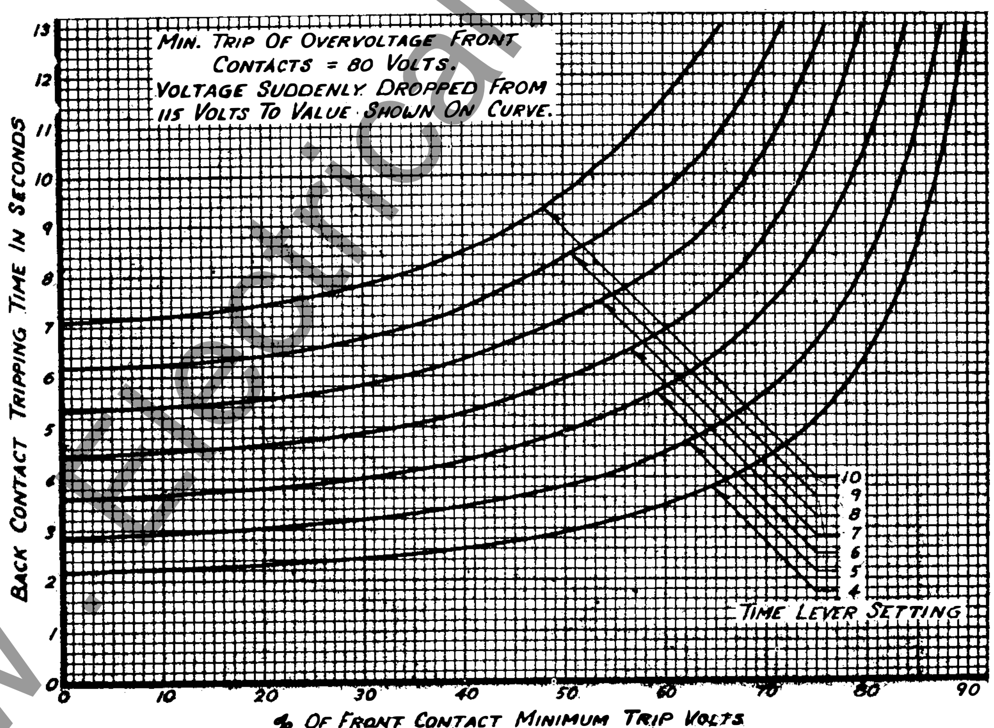


Fig. 4 — Typical Undervoltage Time Curves for the Geared Type CVN Relay.



Curve 282179

Fig. 5—Typical Overvoltage Time Curves for the Non-Geared Type CVN Relay.



Curve 282180

Fig. 6—Typical Undervoltage Time Curves for the Non-Geared Type CVN Relay.

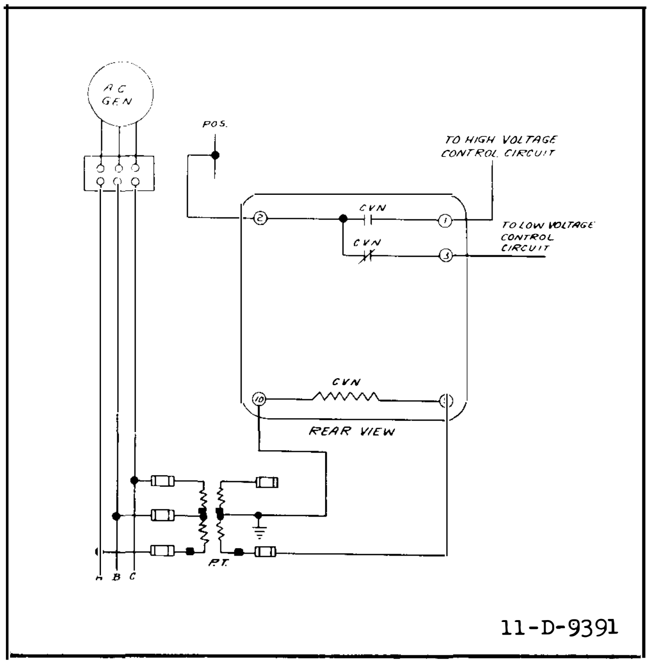


Fig. 7 — External Connections for Type CVN Relay.

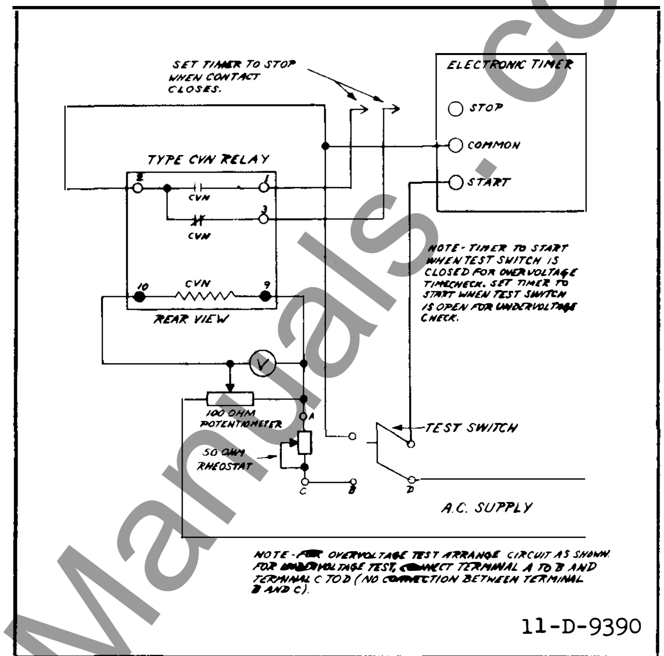


Fig. 8 — Diagram of Test Connections for the Type CVN Relay.

delay vs. lever setting for various impressed voltages. Time is approximately proportional to lever setting.

In order to prevent operation of the relay during shock, the minimum setting of the time lever is limited by a screw in the scale to the #1 time lever setting on the geared relay. The non-geared relay has the stop in the scale to limit the minimum setting to the #4 time lever setting.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after the relay is received by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

NOTE: Since the moving element of the non-geared relay is balanced, no parts in this assembly can be replaced separately. The complete element, including spring, spring adjuster, moving contact, shaft, disc, and lower bearing pinholder must be replaced as a complete unit.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The time of operation can be checked with a timer using the test diagram of Figure 8.

The upper bearing screws of the timer element should be screwed down until there is four to five thousandths inch clearance between the end of the bearing screw and the top of the shaft. The bearing screw should then be locked in place by tightening the locknut.

Voltage Element

Adjust the back stop on the time lever so that the moving contact just touches the stationary contact when the time lever is in the zero position. The stop screw on the time lever scale may be temporarily removed for this purpose. The small adjustment screw on the stationary contact should not be screwed in far enough to limit the follow of the stationary contact.

The spiral spring should have approximately 1¼ turns initial tension with the moving contact in the #10 time lever position. The convolutions of the spring should not touch each other for any position of the moving contacts. Adjust the tension of the spiral spring so that the contacts will just close at 80 volts. Adjust the position of the damping magnet shunt, 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.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

Burdens of the relays at 115 volts, 60 cycles are as follows:

	Volt Amperes	Watts	Power Factor (Current Lagging)
Geared	8.6	4.5	.52
Non-Geared	8.5	4.6	.54

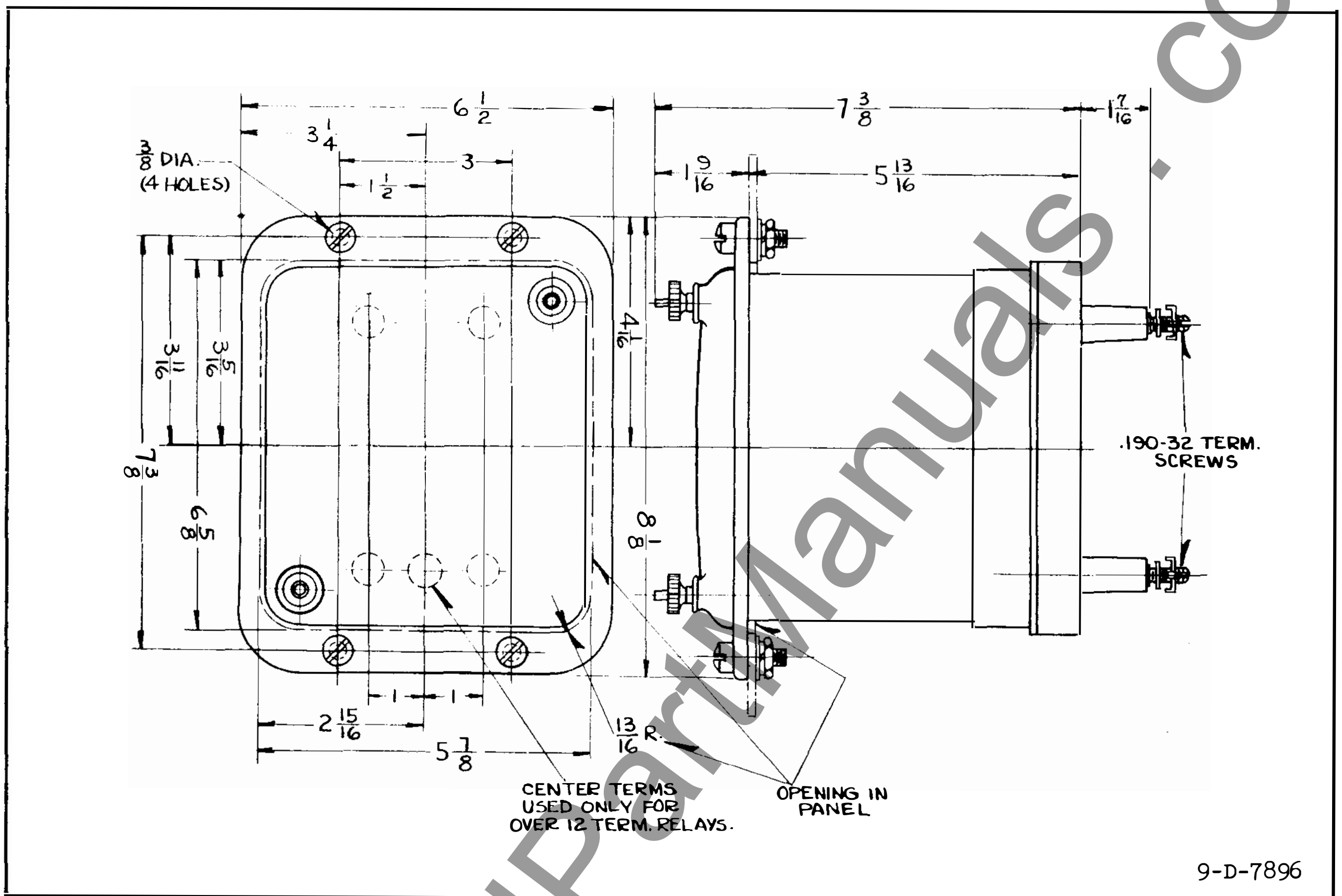


Fig. 9—Outline and Drilling Plan for the Type HI Shockproof Semi-Flush Non-Detachable Case.

WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES CO AND COH OVERCURRENT RELAYS

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker. Where low voltage or no station battery exists, the circuit opening type relay in conjunction with a-c series trip coils can be used to open the breaker.

The inverse time (low-energy) type relay is used in preference to the definite minimum time (standard energy) relay where the requirements necessitate (1) a lower burden on the current transformer, or (2) a more inverse curve for selectivity, or (3) a very low current range as for example, ground protection of transmission systems.

The very-inverse time (low-energy) relay is similar to the inverse relay and is used where a still more inverse curve is desired. The term "low energy" refers to the burden at tap value that is placed on the current transformers and does not refer to the current rating.

The long time (40 second) relay is designed to protect motors against overloads. This can be equipped with an instantaneous attachment that will operate, if a short-circuit occurs in the motor.

The type COH relay finds application for phase and ground protection where a high speed induction type relay is desired. It is sometimes used in differential protective schemes.

The above relays can be supplied with the secondary electromagnet circuit brought out to separate terminals. This variety is known as the type CO or COH Torque Control Relay. Thus the contacts of a separate relay can be used to control the operation of the torque control relay. For example, a three phase directional relay plus suitable auxiliary relays can be used to directionally control three torque control relays.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay

The circuit-closing types CO and COH relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft in the non-geared type relays, or to an auxiliary shaft

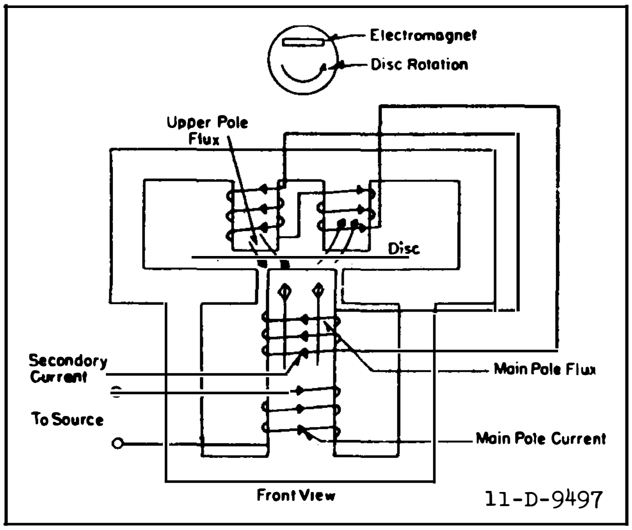


Fig. 1—Flux And Current Relations in The Type COH. Type CO Inverse and Very Inverse Time Relays Without The Torque Compensator.

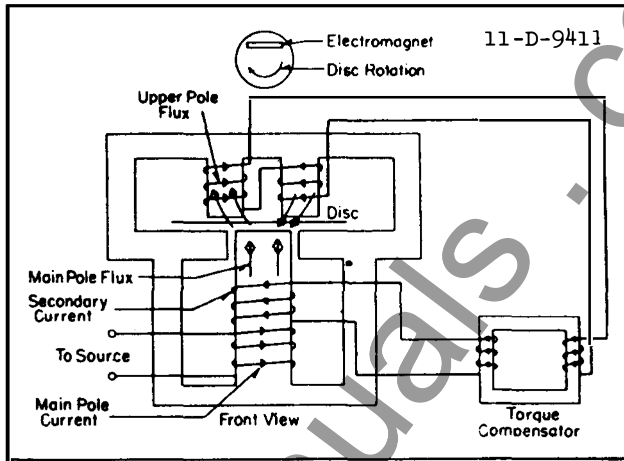


Fig. 2—Flux And Current Relations In The Long Time and Definite Minimum Time Relays With The Torque Compensator.

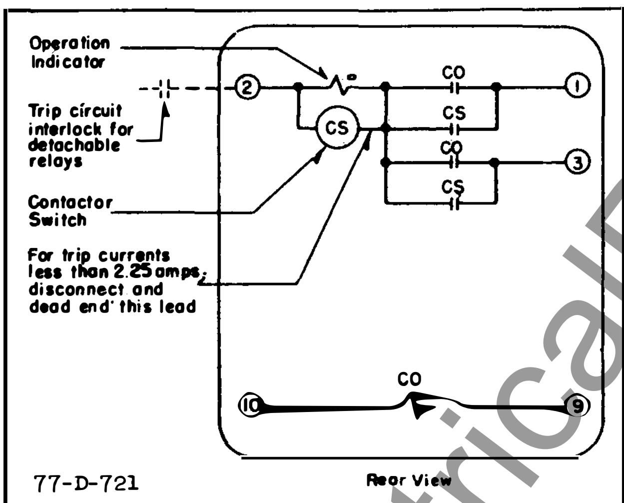


Fig. 3—Internal Schematic Of The Double Trip Circuit Closing Types CO And COH Relays In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

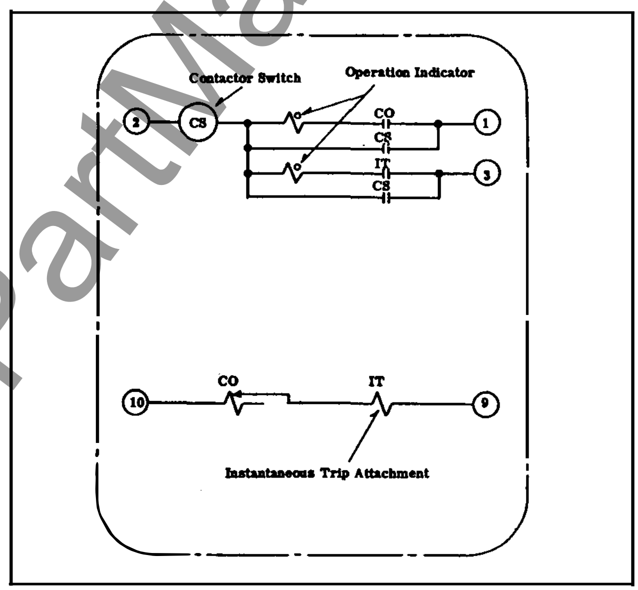


Fig. 4—Internal Schematic Of The Single Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Standard Case.

geared to the disc shaft in the geared type relays. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front. The operating torque of the inverse or very inverse relays is obtained

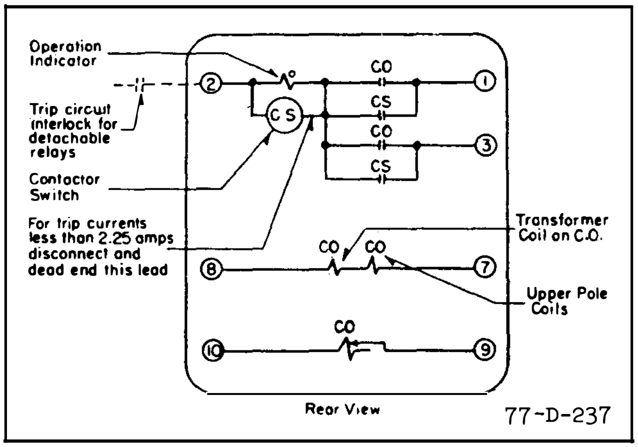


Fig. 5—Internal Schematic Of The Double Trip Circuit Closing Inverse And Very Inverse Types CO And COH Relays With Torque Control Terminals In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

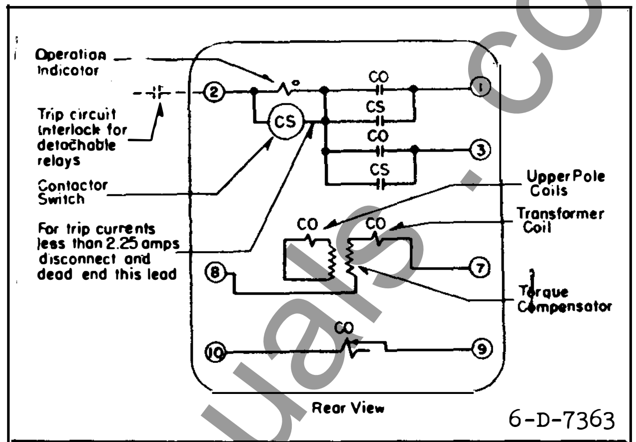


Fig. 6—Internal Schematic Of The Double Trip Circuit Closing Definite Minimum Time Type CO Relay With Torque Control Terminals In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

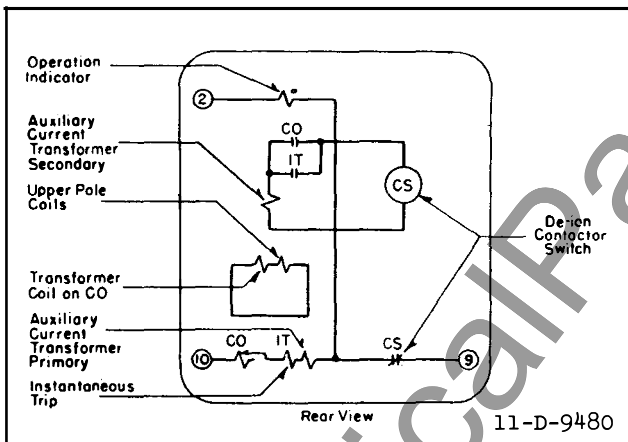


Fig. 7—Internal Schematic Of The Circuit Opening Inverse And Very Inverse Time Type CO Relays With Instantaneous Trip Attachment In The Standard Case.

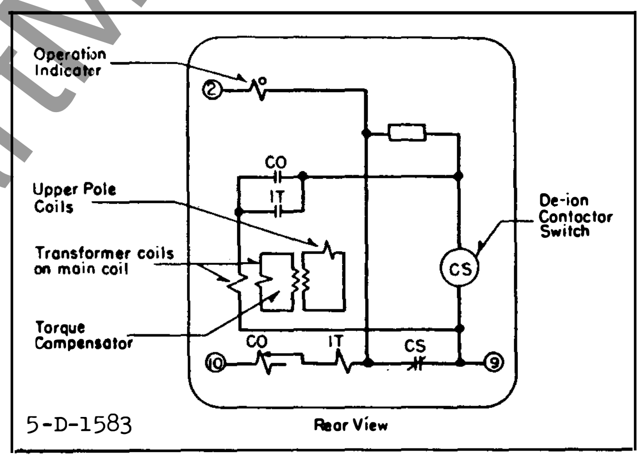


Fig. 8—Internal Schematic Of The Circuit Opening Definite Minimum Time Type CO Relays With Instantaneous Trip Attachment In The Standard Case.

by the circuit arrangement shown in Figure 1. The main pole coil of the relay acts as a transformer and induces a voltage in a secondary coil. Current from this secondary coil flows through the upper pole coils and thus produces torque on the disc by the reaction between the fluxes of the upper and lower poles.

The definite-time relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper pole coils. This is called the torque conpensator and it slows down the disc movement to such an extent that no gearing is required. (See Figure 2).

The long time relay is a geared relay with a torque compensator.

The type COH relay is a non-geared relay without a torque compensator.

Contactor Switch

The d-c. contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid.

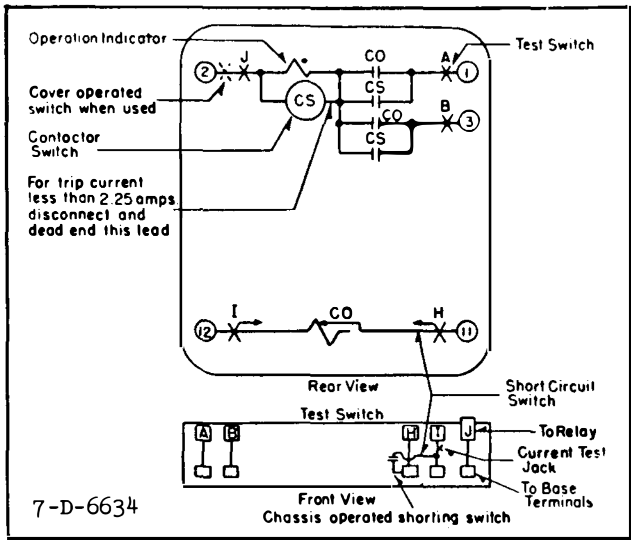


Fig. 9—Internal Schematic Of The Double Trip Circuit Closing Types CO And COH Relays In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

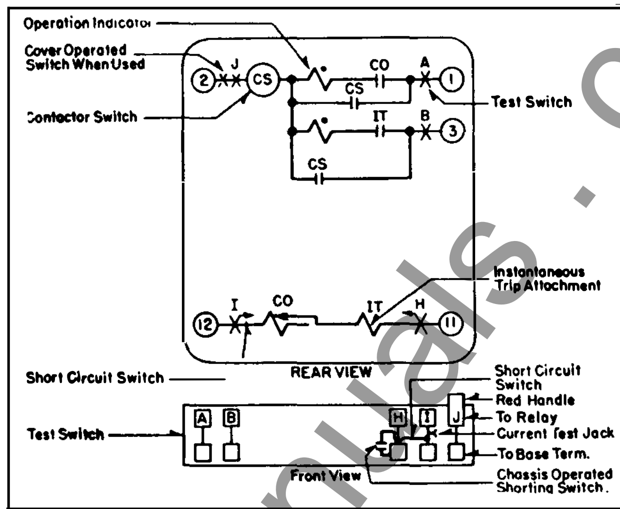


Fig. 10—Internal Schematic Of The Single Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Type FT Case.

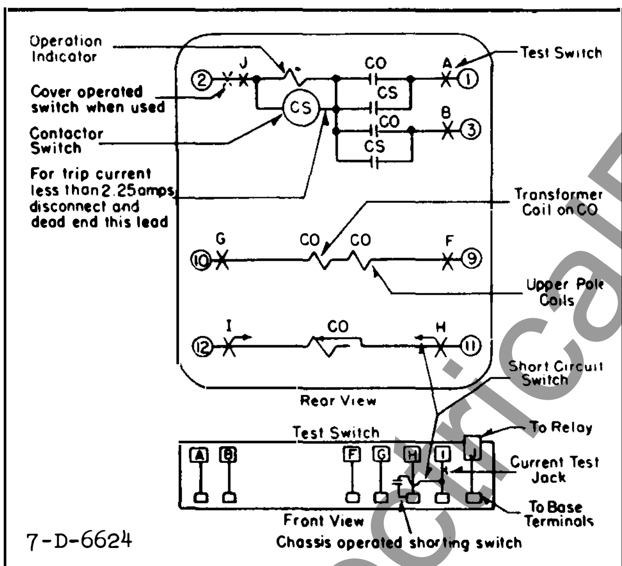


Fig. 11—Internal Schematic Of The Double Trip Circuit Closing Inverse And Very Inverse Types CO And COH Relays With Torque Control Terminals In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

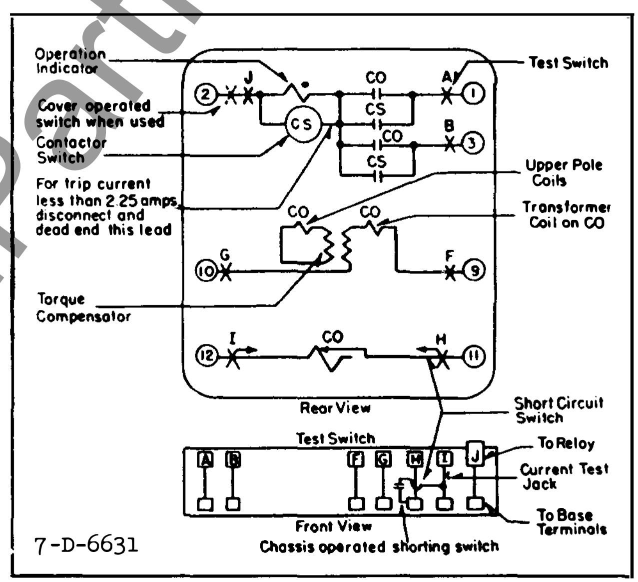


Fig. 12—Internal Schematic Of The Double Trip Circuit Closing Definite Minimum Time Type CO Relay With Torque Control Terminals In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid

coil connected in the trip circuit. When the coil is energized. a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

Instantaneous Lock-Out Attachment (When Supplied)

The lock-out attachment is used to prevent the relay from tripping a circuit breaker when current is too high above its interrupting capacity.

Circuit-Opening Relay

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, an operation indicator and an instantaneous trip attachment where required.

Overcurrent Element

The overcurrent construction and operation is similar to that described for the circuit closing relays.

De-ion Contactor Switch

This switch is a small a-c. solenoid switch whose coil is energized from a few turns on the lower pole of the overcurrent element in the standard-energy type relays, and from a small transformer connected in the main current circuit in the low-energy type relays. Its construction is similar to the d-c. type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

The transformer coil on the lower pole of the overcurrent element and the contactor switch circuits in the standard energy type relays are connected to the main circuits as shown in Figures 8 and 14. When the overcurrent contact closes, the contactor switch operates, and the voltage across the trip coil is impressed on the transformer and contactor switch coils. This voltage acts to seal-in the contactor switch, and to feed energy through the transformer coil to the main overcurrent winding which produces contact closing torque. This arrangement provides a definite minimum pick-up value largely independent of the value of trip coil impedance.

Operation Indicator

The operation indicator is in series with the breaker trip coil. Its construction is as described above.

CHARACTERISTICS

The type CO definite minimum time (standard energy) or long time (40 second) circuit closing relay is available in either of the following current ranges.

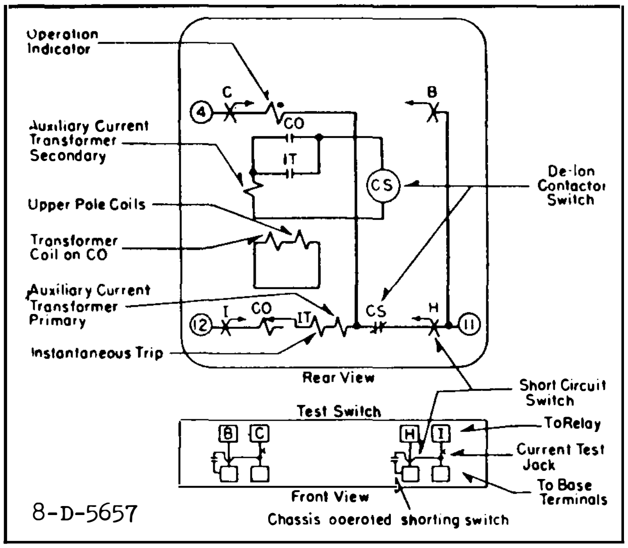


Fig. 13—Internal Schematic Of The Circuit Opening Inverse And Very Inverse Time Type CO Relays With Instantaneous Trip Attachment In The Type FT Case.

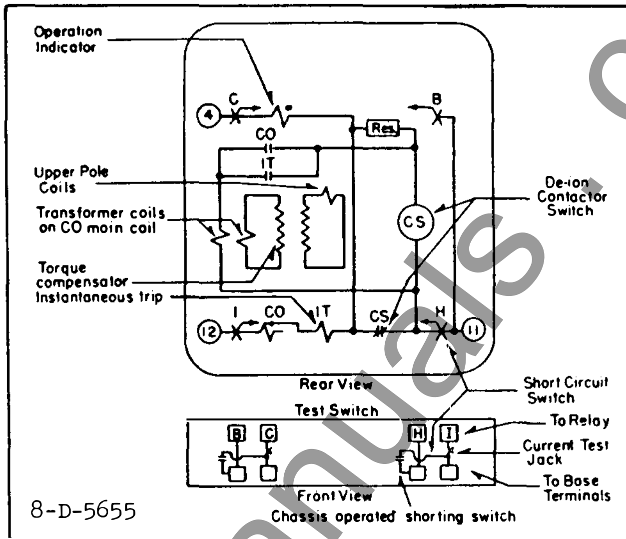


Fig. 14—Internal Schematic Of The Circuit Opening Definite Minimum Time Type CO Relays With Instantaneous Trip Attachment In The Type FT Case.

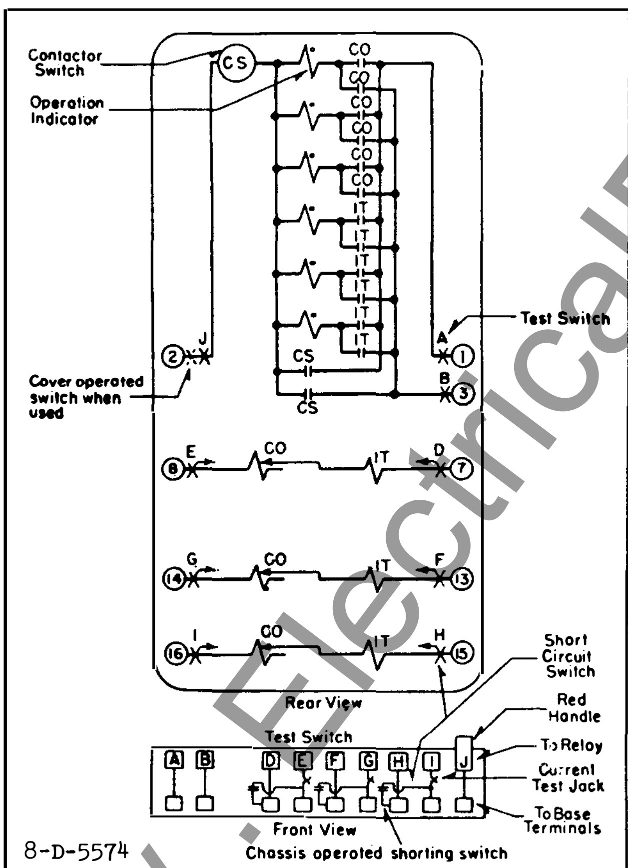


Fig. 15—Internal Schematic Of The Three Element Double Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

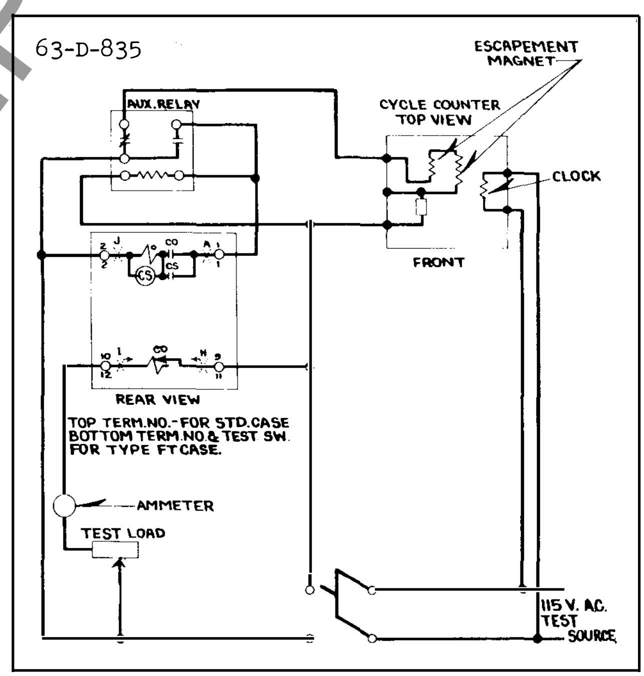


Fig. 16—Diagram Of Test Connections For Circuit Closing Types CO And COH.

2 2.5 3 3.5 4 5 6
4 5 6 8 10 12 15

The type CO inverse, very inverse (low energy) or the type COH circuit closing relay is available in the following current ranges.

0.5 0.6 0.8 1.0 1.5 2.0 2.5
2 2.5 3 3.5 4 5 6
4 5 6 8 10 12 15

The type CO circuit-opening relay is made only in the 4 to 15 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. In addition to the taps. the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 11 divisions.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers. or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The characteristics of the various varieties of type CO and COH relays usually supplied are as shown on page 13.

The burdens and thermal ratings are listed under Energy Requirements.

The instantaneous trip attachment has a 1 to 4 range. Typical ranges are 10-40 or 20-80 but other ranges may be supplied as ordered.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

The instantaneous lock-out attachment has a 3 to 1 range with typical ranges similar to the instantaneous trip attachment.

Trip Circuit

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done. the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit
Resistance of 0.2 ampere Target......2.8 ohms
Resistance of 2.0 ampere Contact Switch...........................0.25 ohms
Resistance of Target and Switch in Parallel.........................0.23 ohms

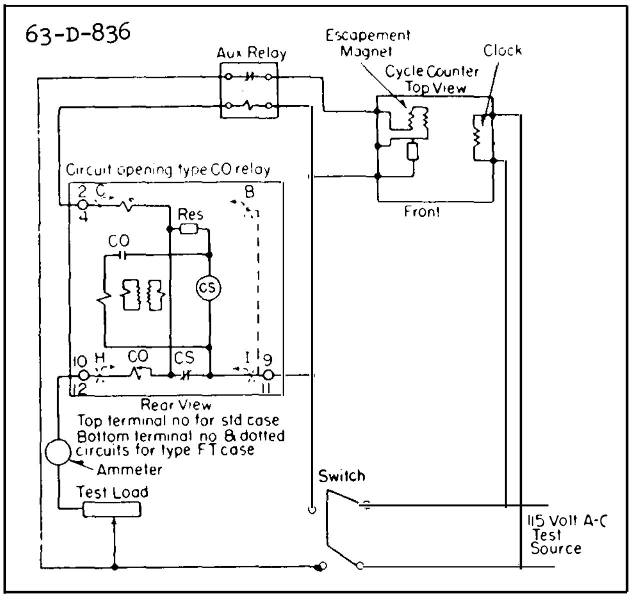


Fig. 17—Diagram Of Test Connection For Circuit Opening Type CO Relay.

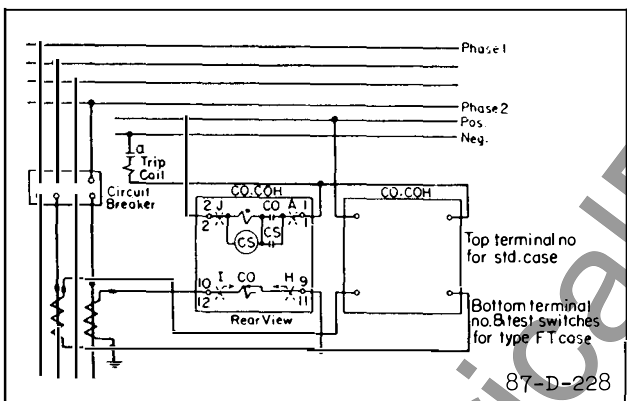


Fig. 19—External Connections Of The Circuit Closing Types CO And COH Relays For Overcurrent Protection On A Two-Phase System.

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target......0.16 ohms
Resistance of 2.0 ampere Contactor Switch...........................0.25 ohms
Resistance of Target and Switch in Series...........................0.41 ohms

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of

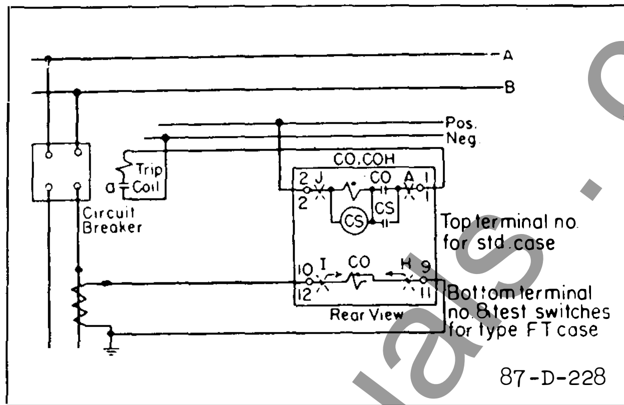


Fig. 18—External Connections Of The Circuit Closing Types CO And COH Relays For Overcurrent Protection On A Single Phase System.

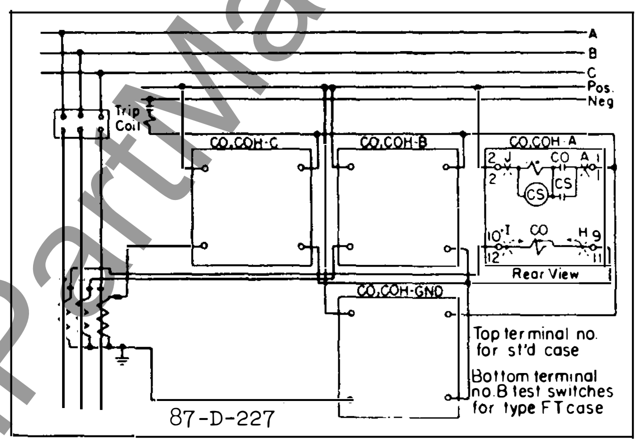


Fig. 20—External Connections Of The Circuit Closing Types CO And COH Relays For Phase And Ground Overcurrent Protection On A Three-Phase System.

the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

Because the circuit-opening relay contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subject to shocks which may jar the contacts

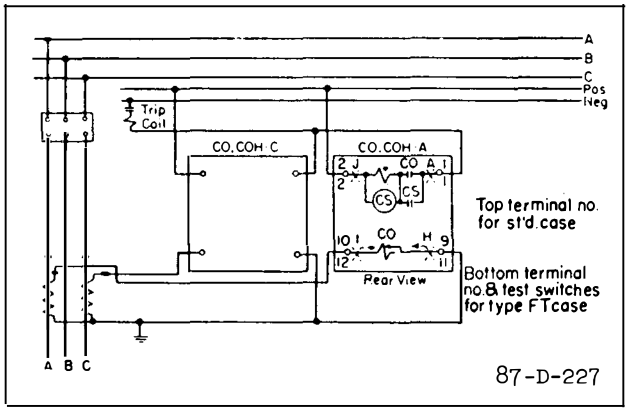


Fig. 21—External Connections Of The Circuit Closing Types CO And COH Relays For Phase Overcurrent Protection On An Ungrounded Three-Phase System.

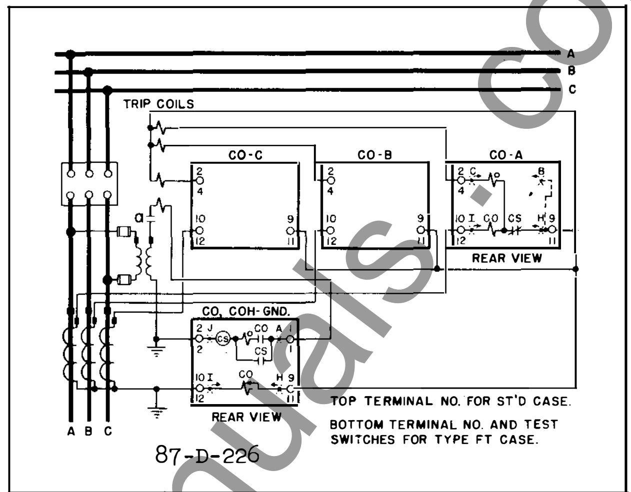


Fig. 22—External Connections Of The Circuit Opening Type CO Relay For Phase Overcurrent Protection And Of The Circuit Closing Types CO And COH Relays For Ground Protection On A Three-Phase System.

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 safeguard so that there is no danger from even an excessive shock unless the current is also heavy.

Typical external connections are shown in Figures 18 to 22. When using the circuit-opening relays for phase protection, ground protection may be secured by using a low-energy circuit-closing relay operating on a-c. voltage trip coil, as shown in Figure 22.

SETTINGS

There are two settings-namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 screwdriver inserted in one of the notches of the plate to which 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.

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 circuits the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, in the new tap and removing the old screw from its original setting.

Time Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figures 23 to 27.

ADJUSTMENTS AND MAINTENANCE

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 shoudl not be used in testing induction-type relays because of the resulting distorted current wave form which produces an error in timing.

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed or the relay taken apart for repairs, the following instructions should be followed in reassembling and setting it.

(Overcurrent Element Circuit-Closing Relays)

Shift the position of the contact stop on the time lever and adjust the 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 tap block. Check the time curve as shown by test with a cycle counter, to be as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field. If the relay has a metal cover, this cover must be in place when making tests.

The relays with torque control terminals will not operate until these terminals are short-circuited either by a jumper or by the external control contacts.

Contactor Switch (Circuit-Closing Relays)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c. have been passed through the coil.

Operation Indicator (Circuit-Closing Relays)

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side

of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current has been applied.

Overcurrent Element (Circuit Opening Relays)

Adjust the relay with the instructions given under "Overcurrent Element (Circuit Closing Relays)" using the test connection of Figure 17 except that for the definite minimum time circuit opening relay the following caution should be observed:

CAUTION When a signal lamp or other voltage operated device is to be connected in series with the relay contacts, disconnect the internal leads of the element from the stationary and moving contacts respectfully and dead end them. Then the lamp or other device can be connected to the stationary and moving contacts.

De-ion Contactor Switch (Circuit Opening Relays)

Adjust the core stop on the top as high as possible without allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32" to 1/16". Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes on the 4 ampere overcurrent tap setting.

In the case of the standard energy circuit opening relay the contactor switch should pick-up and seal itself open at 75% of minimum trip current.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 4 amperes a-c.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut which locks the Micarta disc and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pick-up.

This element will not fit in the round-type case.

Instantaneous Lock-Out Attachment

The position of the bottom of the plunger with reference to the calibrated guide indicates the minimum current required to open the contacts. To change the setting hold the top slotted head of the plunger rod fixed with a screwdriver. Then with a second screwdriver adjust the lower end of the plunger for the current pick-up desired.

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. The nominal range of adjustment is 3 to 1.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

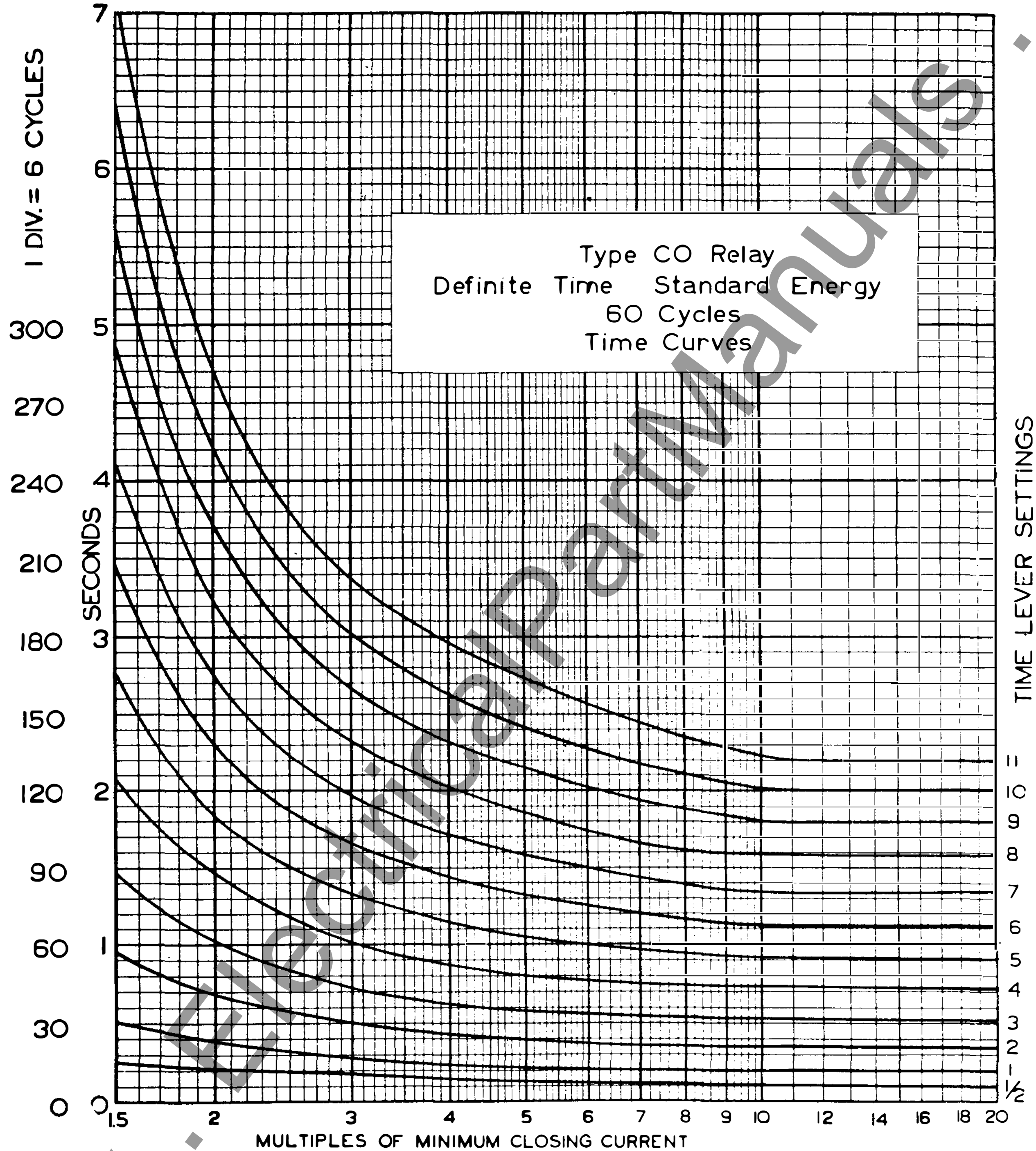


Fig. 23—Typical 60 Cycle Time Curves Of The Definite Minimum Time (Standard Energy) Type CO Relay.

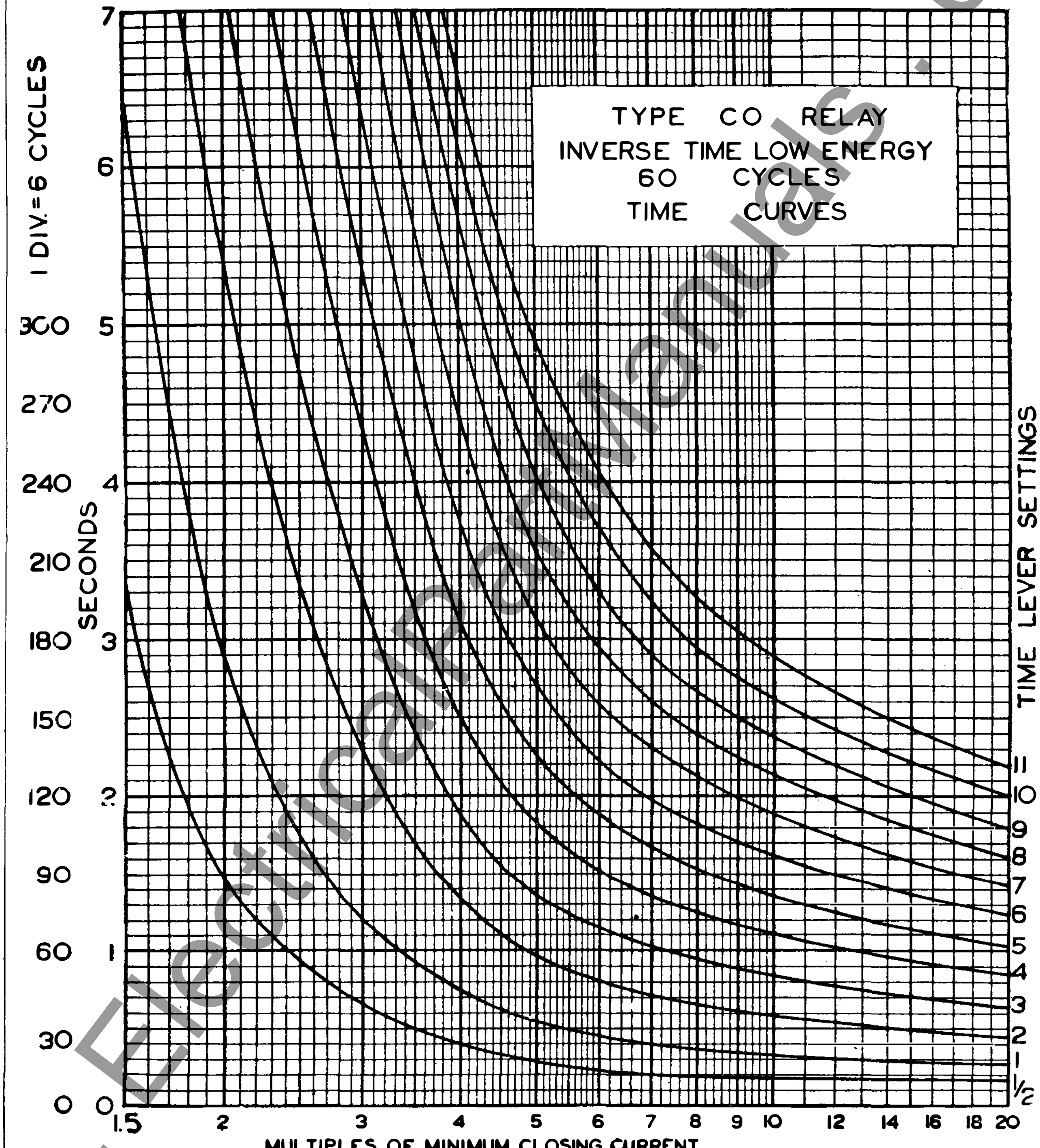


Fig. 24—Typical 60 Cycle Time Curves Of The Inverse Time (Low Energy) Type CO Relay.

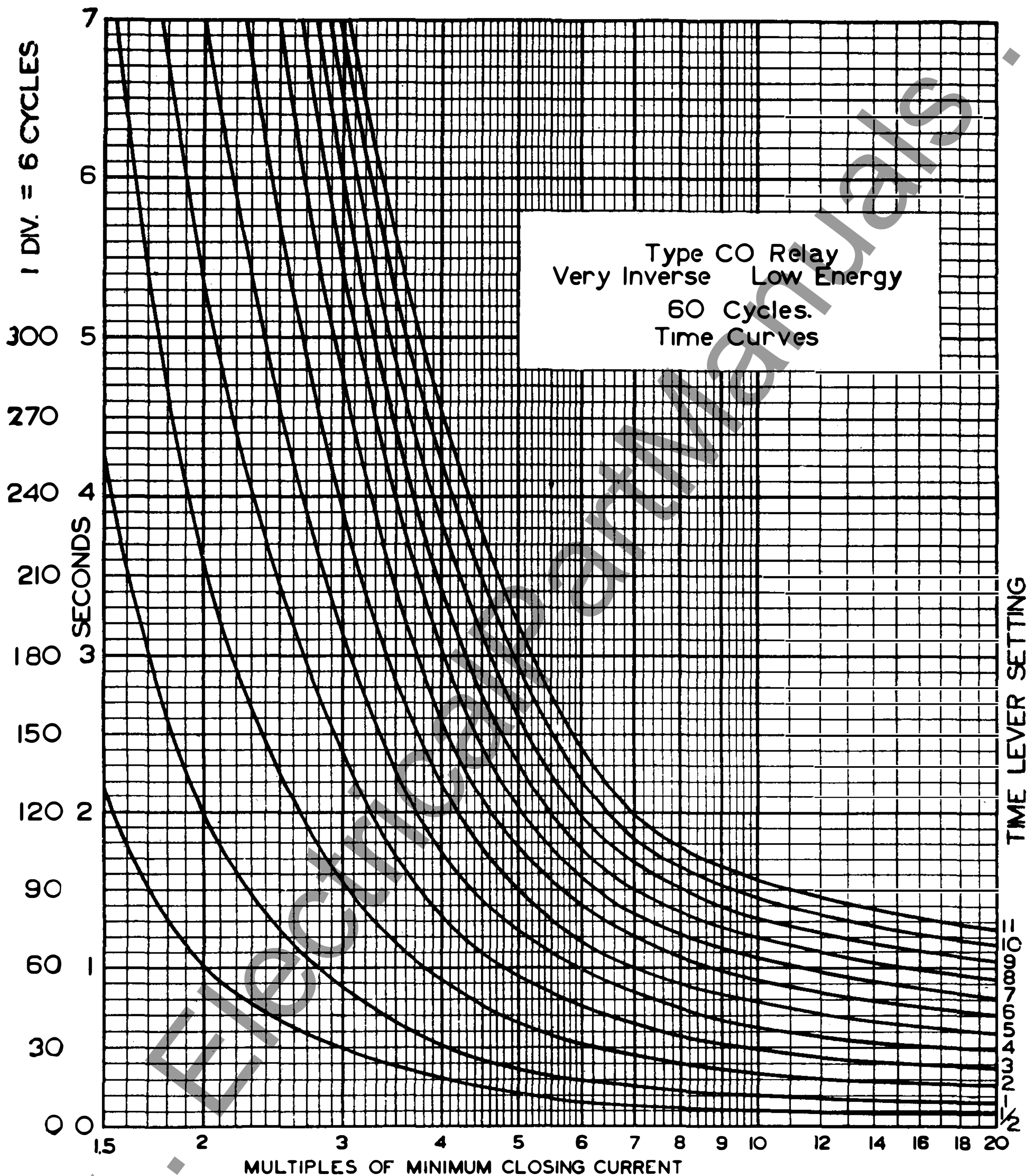


Fig. 25—Typical 60 Cycle Time Curves Of The Very Inverse Time (Low Energy) Type CO Relay.

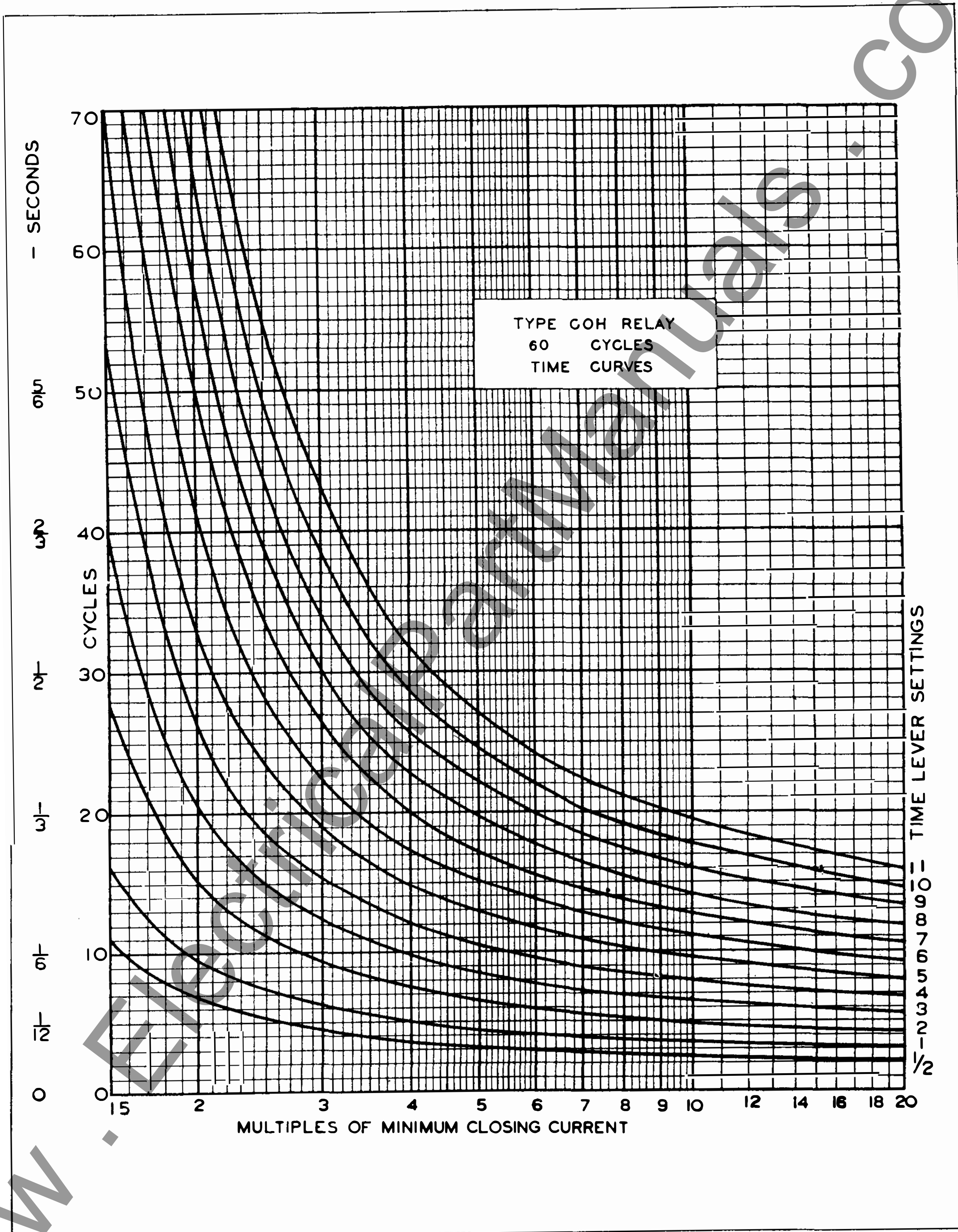


Fig. 26—Typical 60 Cycle Time Curves Of The Type COH Relay.

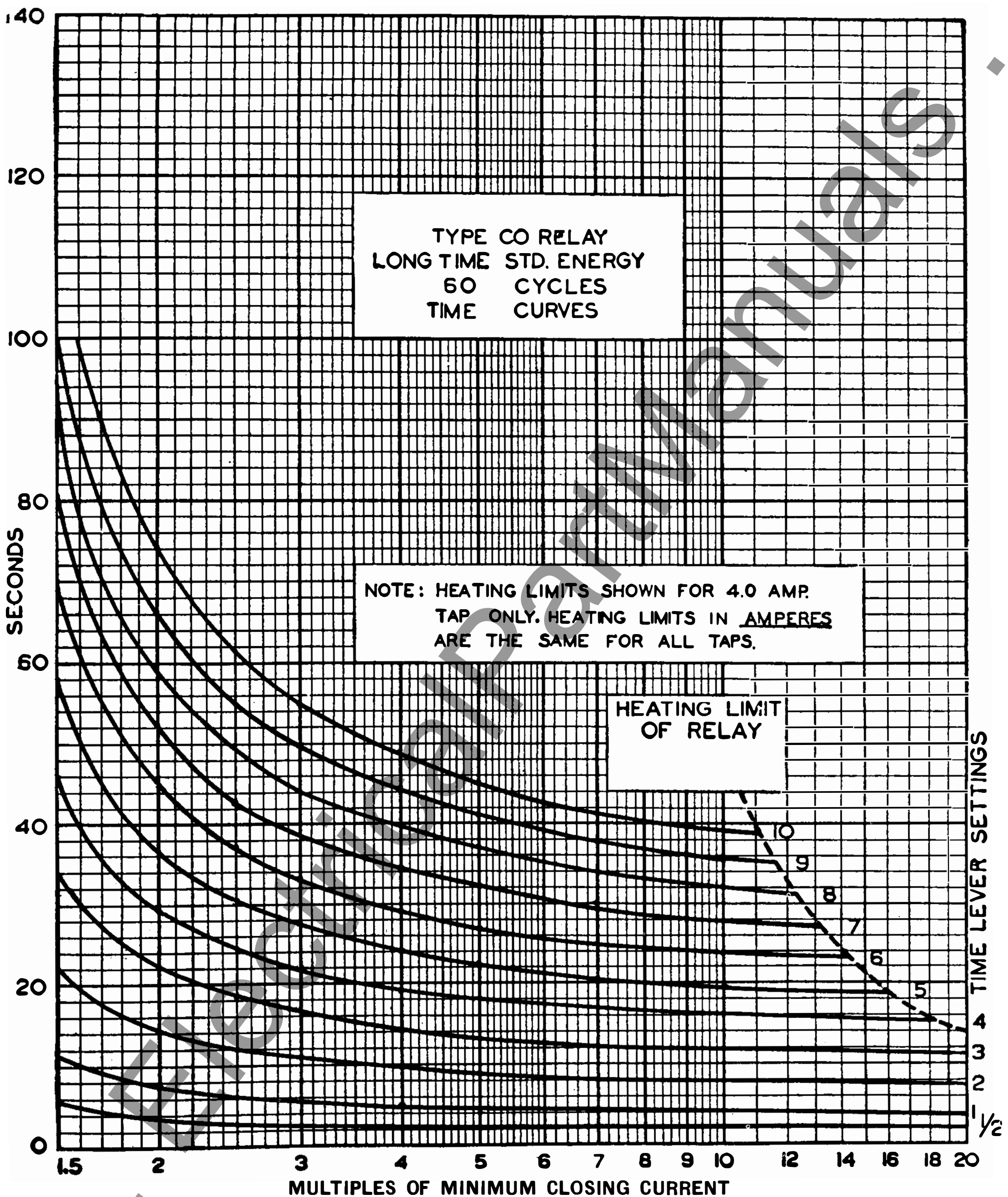


Fig. 27—Typical 60 Cycle Time Curves Of The Long Time (40 Second) Type CO Relay.

ENERGY REQUIREMENTS

The burdens and thermal capacities of the various circuits of the relay are as follows:

DEFINITE MINIMUM TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
2/6	2	108	17	60° lag	4	140
	2.5	68	17	60° lag	5	140
	3	47	17	60° lag	5	140
	3.5	35	17	60° lag	6	140
	4	26	17	60° lag	7	140
	5	17	17	60° lag	8	140
	6	12	17	60° lag	10	140
4/15	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

INVERSE TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	200	2	66° lag	2	70
	0.6	140	2	66° lag	2	70
	0.8	78	2	66° lag	2	70
	1.0	50	2	66° lag	3	70
	1.5	22	2	66° lag	3	70
	2.0	12.5	2	66° lag	4	70
	2.5	8	2	66° lag	5	70
2/6	2	12.4	2	66.4° lag	8	250
	2.5	8	2	66.4° lag	8	250
	3	5.6	2	66.4° lag	8	250
	3.5	4.1	2	66.4° lag	8	250
	4	3.1	2	66.4° lag	9	250
	5	2	2	66.4° lag	9	250
	6	1.3	2	66.4° lag	10	250
4/15	4	3.1	2	66.4° lag	16	250
	5	2	2	66.4° lag	16	250
	6	1.4	2	66.4° lag	16	250
	8	0.8	2	66.4° lag	17	250
	10	0.5	2	66.4° lag	18	250
	12	0.3	2	66.4° lag	19	250
	15	0.2	2	66.4° lag	20	250

VERY INVERSE TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	125	1.25	66.4° lag	2	100
	0.6	87	1.25	66.4° lag	2	100
	0.8	49	1.25	66.4° lag	2	100
	1.0	31	1.25	66.4° lag	3	100
	1.5	14	1.25	66.4° lag	3	100
	2.0	8	1.25	66.4° lag	4	100
	2.5	5	1.25	66.4° lag	5	100
2/6	2	8	1.25	66.4° lag	8	250
	2.5	5	1.25	66.4° lag	8	250
	3	3.5	1.25	66.4° lag	8	250
	3.5	2.5	1.25	66.4° lag	8	250
	4	1.9	1.25	66.4° lag	9	250
	5	1.25	1.25	66.4° lag	9	250
	6	0.9	1.25	66.4° lag	10	250
4/15	4	1.9	1.25	66.4° lag	16	250
	5	1.25	1.25	66.4° lag	16	250
	6	0.9	1.25	66.4° lag	16	250
	8	0.5	1.25	66.4° lag	17	250
	10	0.3	1.25	66.4° lag	18	250
	12	0.2	1.25	66.4° lag	19	250
	15	0.15	1.25	66.4° lag	20	250

*Thermal capacities for other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

LONG TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
4/15	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

SHORT TIME COH RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	400	4	60° lag	2	56
	0.6	280	4	60° lag	2	56
	0.8	156	4	60° lag	2	56
	1.0	100	4	60° lag	3	56
	1.5	44	4	60° lag	3	56
	2.0	25	4	60° lag	4	56
	2.5	16	4	60° lag	5	56
2/6	2	25	4	60° lag	8	250
	2.5	16	4	60° lag	8	250
	3	11	4	60° lag	8	250
	3.5	8	4	60° lag	8	250
	4	6.3	4	60° lag	9	250
	5	4	4	60° lag	9	250
	6	2.8	4	60° lag	10	250
4/15	4	6.3	4	60° lag	16	250
	5	4.0	4	60° lag	16	250
	6	3.0	4	60° lag	16	250
	8	1.6	4	60° lag	17	250
	10	1.0	4	60° lag	18	250
	12	0.7	4	60° lag	19	250
	15	0.4	4	60° lag	20	250

BURDENS AT TAP CURRENT ON 25 AND 50 CYCLES

	25 Cycles V.A.	25 Cycles Power Factor	50 Cycles V.A.	50 Cycles Power Factor
Definite Minimum Time CO...	16	53° lag	17	60° lag
Inverse Time CO.............	2	60° lag	2	60° lag
Very Inverse Time CO........	1.25	60° lag	1.25	66.4° lag
Long Time CO...............	16	53° lag	17	60° lag
Short Time COH............	4	53° lag	4	60° lag

BURDENS FOR SATURATION DATA

Voltage taken with Rectox type voltmeter.

Multiples of Tap Values of Current		1	3	10	20
Definite Time	V.A. Burden	17	100	490	1300
Inverse Time	V.A. Burden	2.0	18.3	136	351
Very Inverse Time	V.A. Burden	1.25	10.75	97	254
COH Time	V.A. Burden	4	37.4	198	506

Characteristics of Types CO and COH Relays

Type	Energy	Time	Approx. #10 Lever Time at 20 x Tap Value	Gearing	Torque Compen-sator	Schematic per Figure No.	Typical 60 Cycle Time Curve per Fig. No.
CO	Std.	Definite Time	2 Sec.	Non-geared	Yes	3,4,6,8,9,10,12,14&15	23
CO	Std.	Definite Time	4 Sec.	Non-geared	Yes	3,4,6,8,9,10,12,14&15	..
CO	Low	Inverse	2 Sec.	Geared	No	3,4,5,7,9,10,11,13&15	24
CO	Low	Inverse	4 Sec.	Geared	Yes	3,4,6,8,9,10,12,14&15	..
CO	Low	Very Inverse	1 + Sec.	Geared	No	3,4,5,7,9,10,11,13&15	25
CO	Std.	Definite Time	40 Sec.	Geared	Yes	3,4,6,8,9,10,12,14&15	27
COH	....	Inverse	18 Cyc.	Non-Geared	No	3,4,5,9,10,11&15	26

Three element relay characteristics are the same as in single element forms.

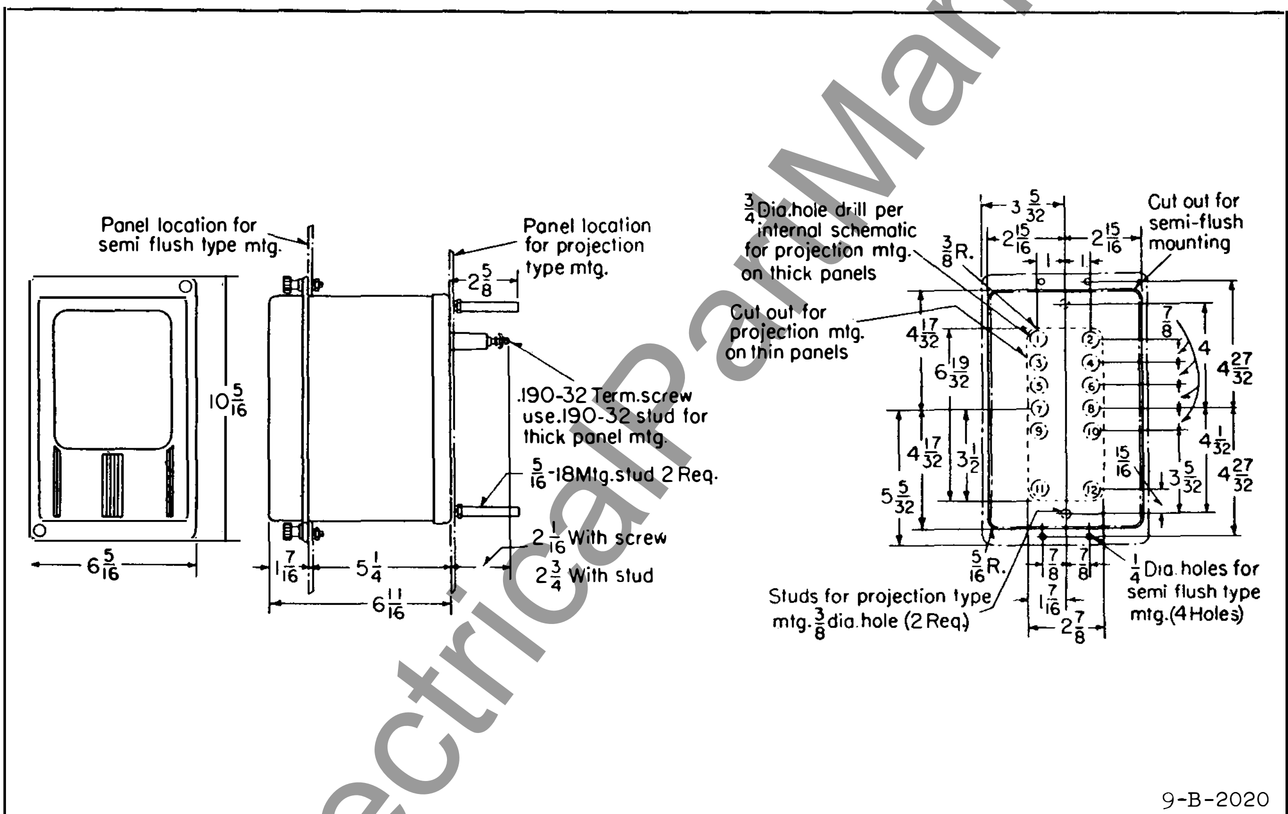


Fig. 28—Outline And Drilling Plan For The Single Element Types CO And COH Relays In The S10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

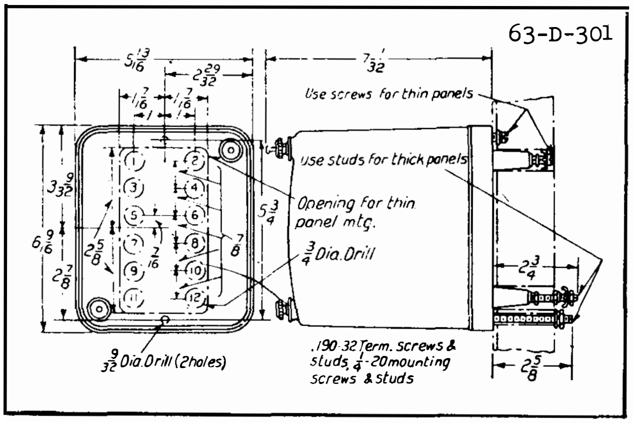


Fig. 29—Outline And Drilling Plan For The Single Element Types CO And COH Relays In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

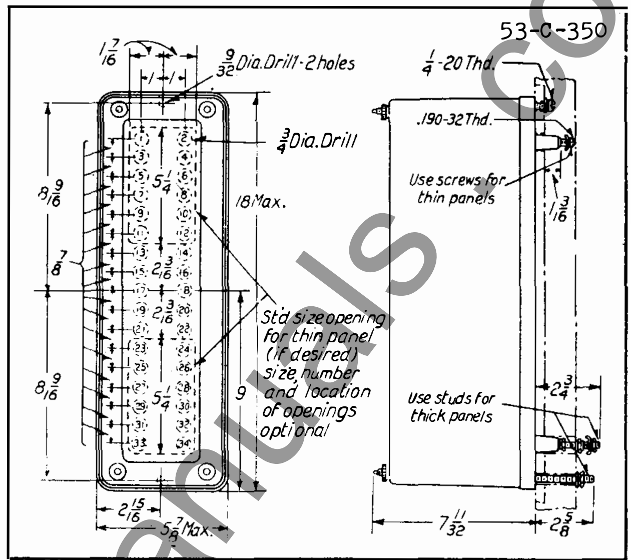


Fig. 30—Outline And Drilling Plan For The Three Element Types CO And COH Relays In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

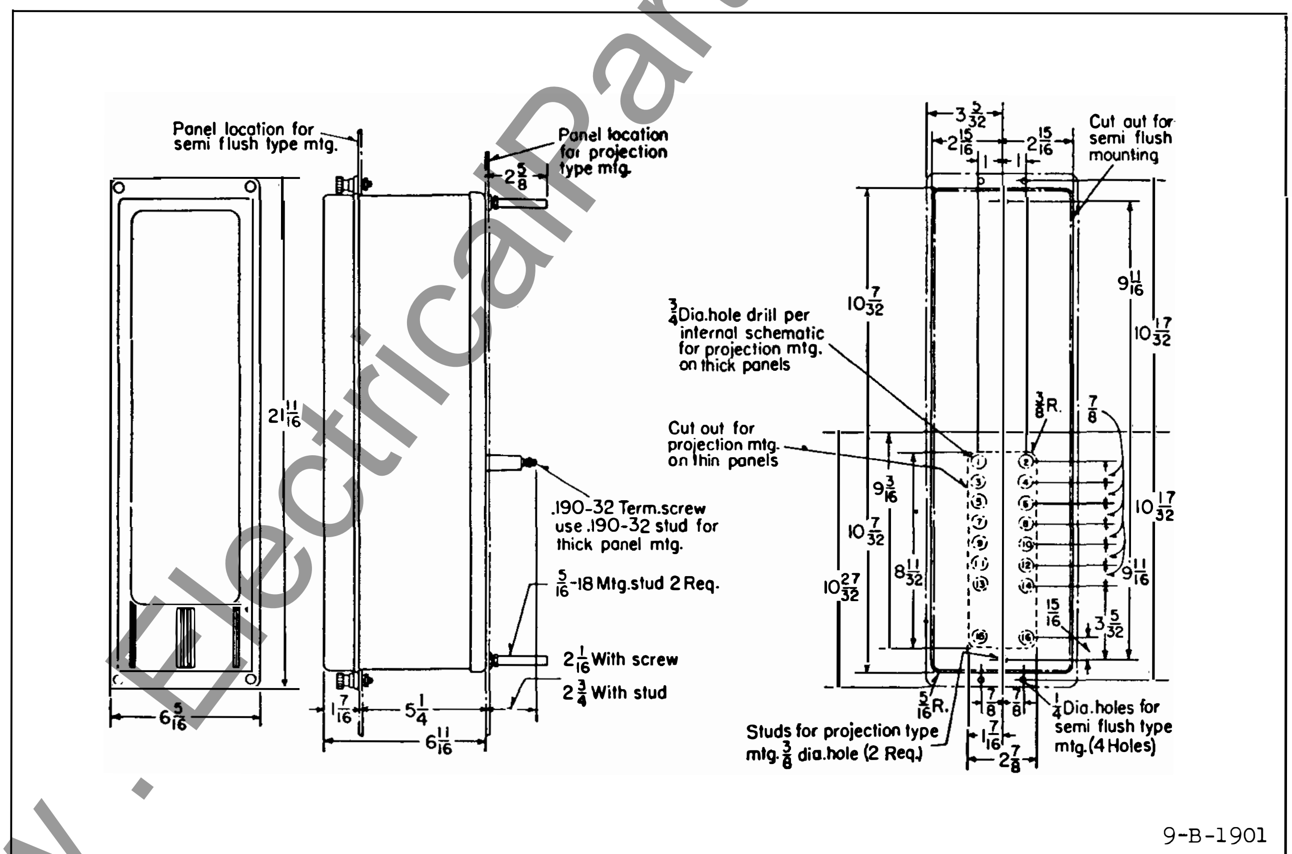


Fig. 31— Outline And Drilling Plan For The Three Element Types CO And COH Relays In The L10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION
METER DIVISION

NEWARK, N.J.
Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO ADJUSTABLE INVERSE TIME OVERCURRENT RELAY

CAUTION

Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker. Where no suitable station battery is available, the circuit opening type relay in conjunction with a-c series trip coils can be used to trip the breaker.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay

The circuit-closing type CO relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment when required.

Circuit-Opening Relay

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, a small transformer to energize the de-ion contactor switch, an operation indicator and an instantaneous trip attachment when required.

OVERCURRENT ELEMENT

Electromagnet

The electromagnet is shown in the schematic diagram of Fig. 1. The main tapped coil produces a flux which splits and returns through the outer legs. A shading coil causes the flux through the left hand leg to lag the main pole flux. The out of phase fluxes thus produced cause a contact closing torque. The tap value adjuster is a single turn shading coil mounted on the right hand leg. It is short circuited through an adjustable length of wire and tends to partially neutralize the effect of the shading coil. The function of the tap value adjuster is fully described under Adjustments. Adjustable magnetic plugs in the magnetic circuit are held in position by means of elastic clinch nuts located on the rear of the electromagnet.

Disc, Shaft and Bearings

The spiral shaped disc is fastened to a vertical shaft supported on the lower end by a pin and end stone type bearing and on the upper end by a pin and olive bearing. The upper and lower disc shaft bearings are removable, and the corresponding upper and lower bearing pins are removable and adjustable. The bottom bearing pin is securely locked in position by means of a set screw and nylon plug, and the top bearing pin by a shoulder nut that holds the time dial in position.

Damping Magnet

The damping magnet is an Alnico 5 permanent magnet with an adjustable keeper. The keeper is locked in position by means of a set screw and nylon plug in the casting that secures the damping magnet to the movement frame.

SUPERSEDES I. L. 41-280.7A
*Denotes change from superseded issue.

EFFECTIVE NOVEMBER 1953

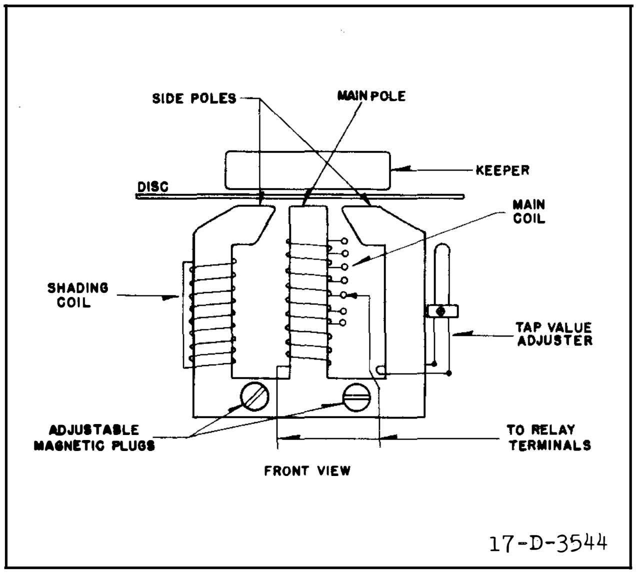


Fig. 1—Schematic Diagram of the Overcurrent Element Electromagnet.

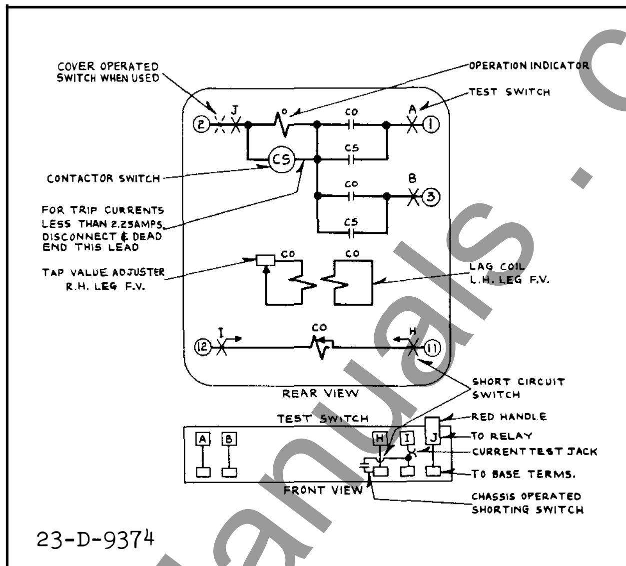


Fig. 2—Internal Schematic of the Double Trip Circuit Closing Relay in the Type FT Case. The Single Trip Relay has Terminal 3 and Associated Circuits Omitted.

Tap Block Assembly

The tap block assembly consists of eight spring loaded tap terminals housed in a moulded tap block, a tap plate secured to the front of the moulded block, and a tap screw. The tap screw engages the tap terminal and pulls the terminal forward to cause a direct metal to metal contact with the tap plate. When the tap screw is removed, the terminal is pushed back by a spring so that it will no longer be in contact with the tap plate. The tap screw is equipped with an insulating nylon sleeve.

Contacts

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

Time Dial

The time dial is a moulded adjustable contact stop with 11 equal scale divisions marked through a 270 degree arc. The time dial is held in position at the top of the disc shaft by means of a star cupped spring washer and a shoulder nut.

An adjustable index pointer is located on the movement frame top bearing mount.

Contactor Switch (Circuit Closing)

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid.

As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain

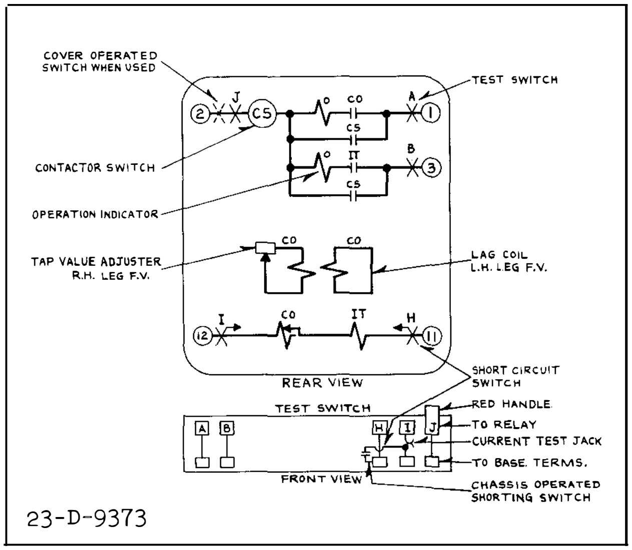


Fig. 3—Internal Schematic of the Single Trip Circuit Closing Relay with Instantaneous Trip Attachment in the Type FT Case.

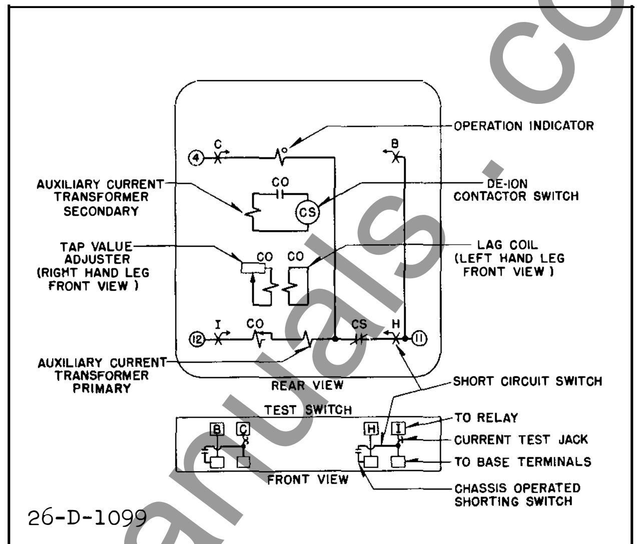


Fig. 4—Internal Schematic of the Circuit Opening Relay in the Type FT Case.

closed until the trip circuit is opened by the auxiliary switch on the breaker.

De-ion Contactor Switch (Circuit Opening)

This switch is a small a-c solenoid switch whose coil is energized from a small transformer connected in the main current circuit. Its construction is similar to the d-c type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator may be reset from outside of the case.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

CHARACTERISTICS

The type CO adjustable inverse time circuit closing relay is available in the following current ranges:

0.5	0.6	0.8	1.0	1.5	2.0	2.5
2	2.5	3	3.5	4	5	6
4	5	6	7	8	10	12

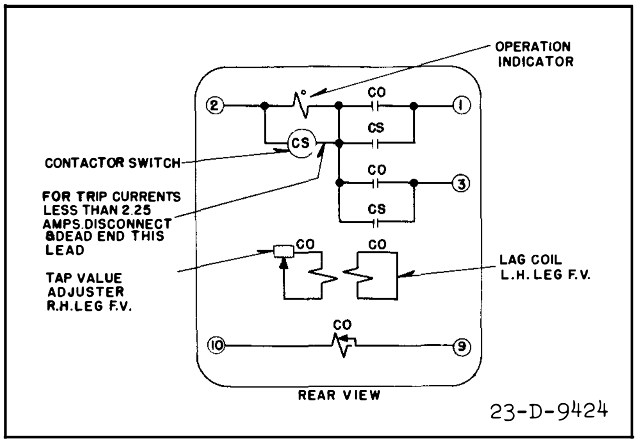


Fig. 5—Internal Schematic of the Double Trip Circuit Closing Relay in the Standard Case. The Single Trip Relay has Terminal 3 and Associated Circuits Omitted.

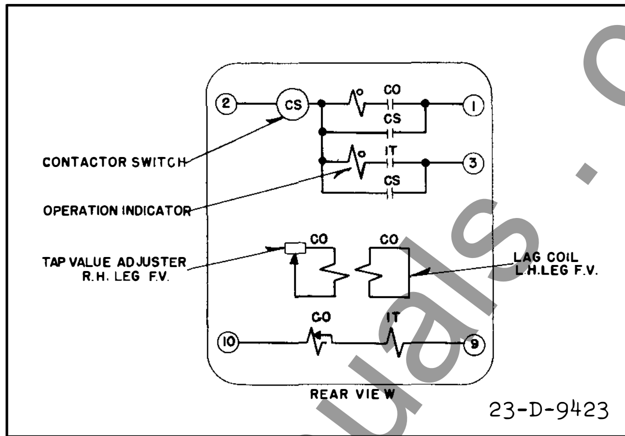


Fig. 6—Internal Schematic of the Single Trip Circuit Closing Relay with Instantaneous Trip Attachment in the Standard Case.

The type CO adjustable inverse time circuit-opening relay is recommended only in the 4 to 12 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. The moving contacts will leave the time dial stop, regardless of the time dial setting, and move to touch the stationary contacts at tap value current.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers, or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The time vs current characteristics for the style calibration of inverse or very inverse are shown in Fig. 10 and Fig. 11 respectively. The term "style calibration" is used as there is no difference between the inverse and very inverse relays except in their calibration. Relays carrying a style number which indicates the inverse calibration may be changed to the very inverse calibration or vice versa through two simple adjustments. This is outlined in detail under Adjustments.

In addition to the one relay covering the inverse or the very inverse curves, the relay may be re-calibrated for a characteristic other than either of these. An example of the spread of adjustments to provide different curve shapes is shown by Fig. 8 wherein all curves are passed through 27 seconds at 2 times minimum trip current. The curves may be passed through a common point other than 27 seconds by adjustment of the damping magnet keeper screw. The range of adjustability indicated at 20 times minimum trip current is obtained by means of the magnetic plugs. The upper limit curve is obtained with the right hand plug "all in" and the left hand plug "all out" (approximately 20 turns of the screw). The lower limit is obtained with the left hand plug "all in" and the right hand plug "all-out". Various adjustments of the plugs partially withdrawn from the magnetic circuit may be used as desired to obtain a curve within the band shown, including the standard or "pattern" curve to which the relay is calibrated at the factory. Thus, one or the other of the plugs will be partially withdrawn in the factory calibration to one or the other of the inverse or very inverse standard curves. Similarly, the factory set position of the damping magnet keeper screw will depend upon the "style calibration".

The burdens and thermal ratings are listed under Energy Requirements. The instantaneous trip attachment has a 1 to 4 ratio. Typical ranges are 10-40 or 20-80, but other ranges are also available.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

Trip Circuit

The main contacts will safely close 30 amperes at 250 V. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d.c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead-ended) under the small filister head screw located in the Micarta base of the contactor switch.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one or 0.2 ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the contact back stop. When this is done, the position of the index pointer should be shifted so that the moving and stationary contacts barely touch when the time dial is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere Target.......2.8 ohms
Resistance of 2.0 ampere Contactor Switch 0.25ohms
Resistance of Target and Switch in Parallel 0.23ohms

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target...... 0.16ohms
Resistance of 0.2 ampere Target...... 2.8 ohms
Resistance of 2.0 ampere Contactor Switch 0.25ohms

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed-knife blades.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. This exposes the relay element and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before opening any of the black handle or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position for test as well as on its back or sides for easy inspection and maintenance.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuits thru the current test jack-jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

TESTING

The relays can be tested in service, in the case but with the external circuits isolated, or out of the case as follows:

Testing In Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above under "Electrical Circuits".

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage. It is recommended that the relay be checked in position as a final check on the calibration.

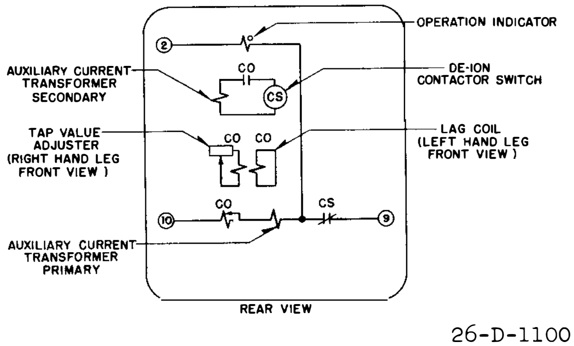


Fig. 7—Internal Schematic of the Circuit Opening Relay in the Standard Case.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

SETTINGS

There are two settings - namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the settings must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

Current Setting

The connector screw on the terminal plate above the time dial 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 4.0 - 5.0 - 6.0 - 7.0 - 8 - 10 - 12 amperes, or as marked on the terminal plate.

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 circuits, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw in the new tap and removing the old screw from its original setting.

Time Dial Setting

The time dial limits the motion of the disc and thus varies the time of operation. The latter decreases with lower time dial settings as shown in the typical time curves.

ADJUSTMENTS AND MAINTENANCE

All relays should be inspected periodically and the time of operation should be checked at least once every six months or at such other time intervals as may be dictated by experience to be suitable to the particular application. 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.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not require readjustment

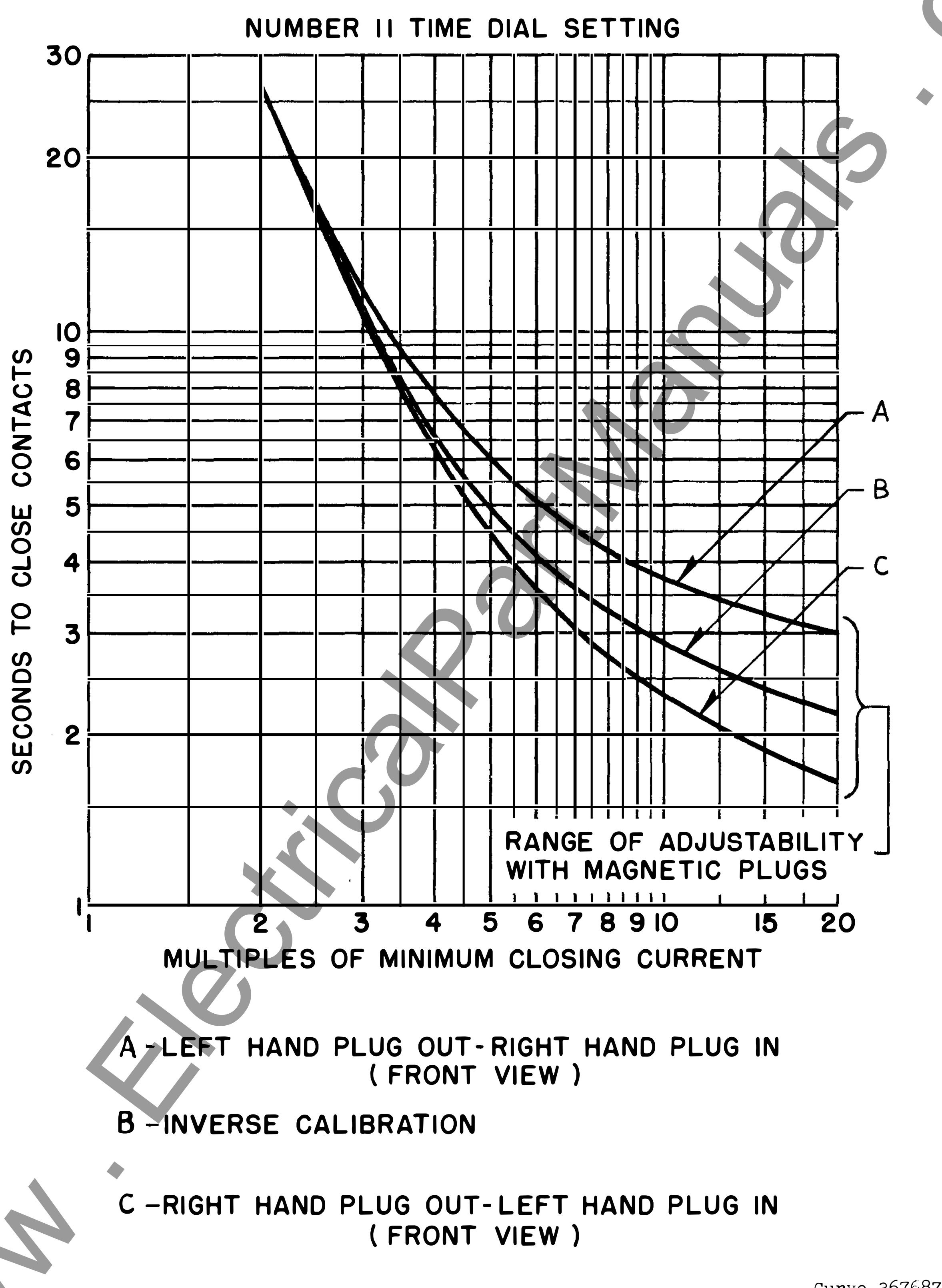


Fig. 8—Example of the Range of Adjustability of the Time Curves by Means of the Adjustable Magnetic Plugs.

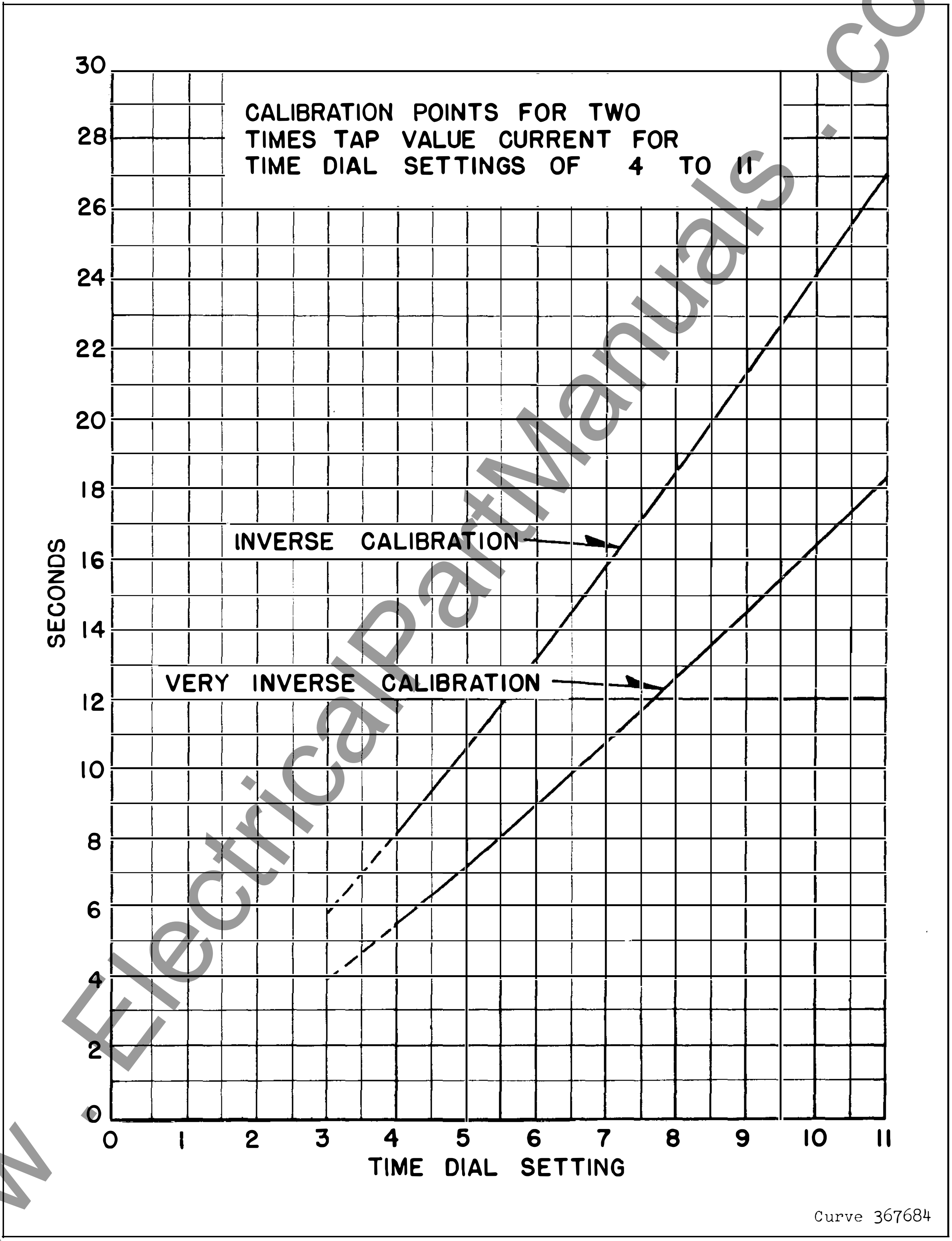


Fig. 9—Time VS Time Dial Setting for Inverse and Very Inverse Calibration at 2 Times Minimum Trip.

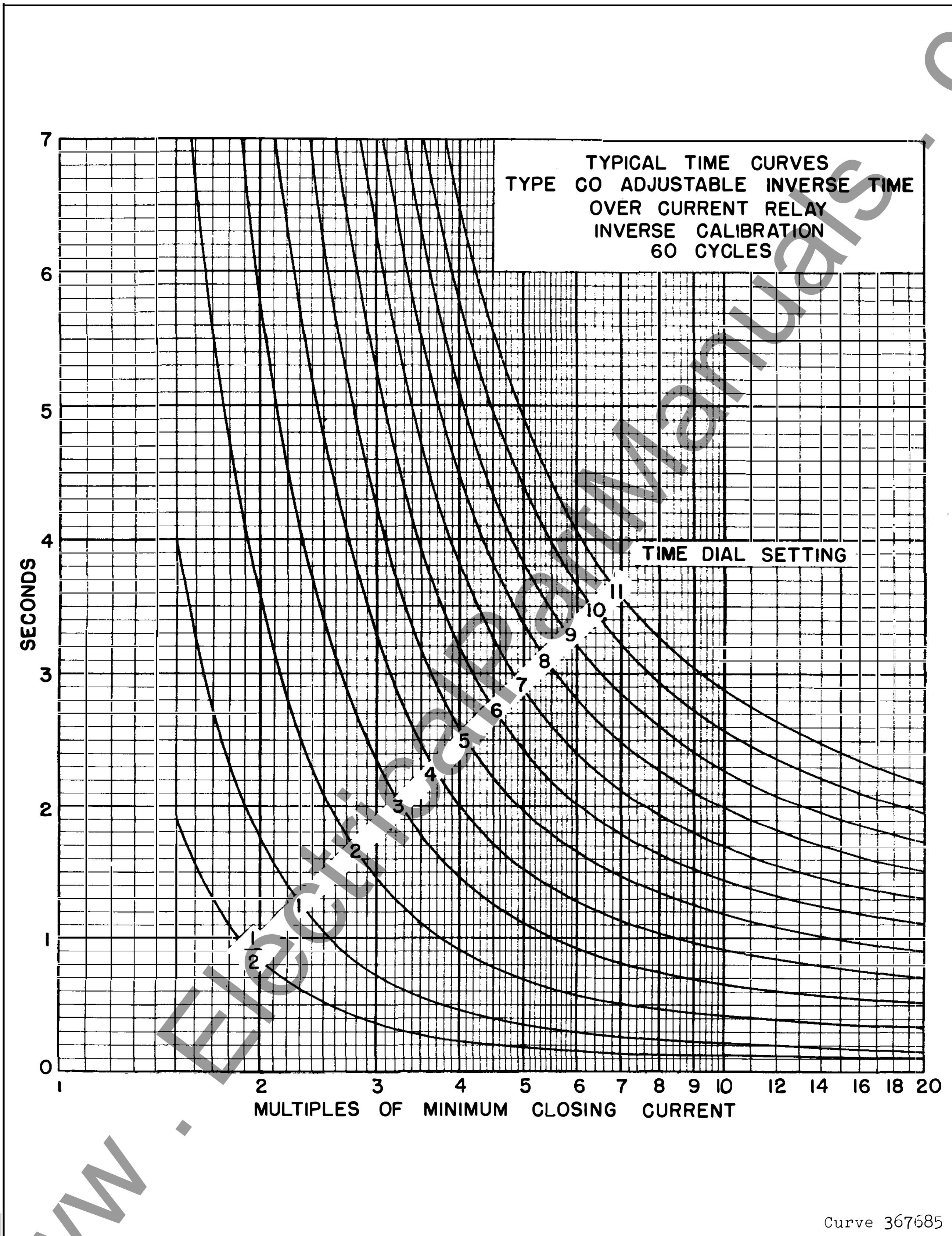


Fig. 10—Typical 60 Cycle Time Curves for the Inverse Calibration.

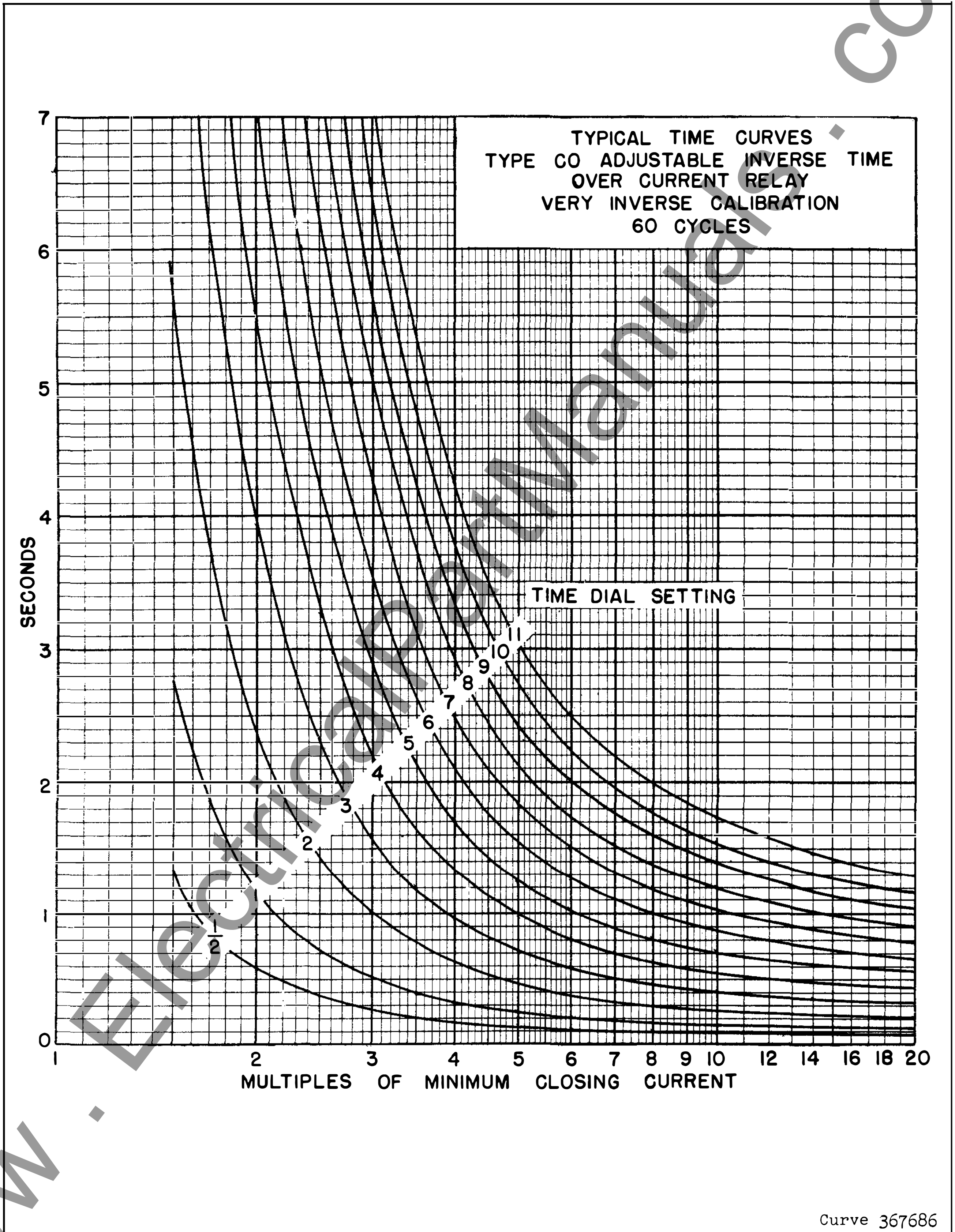
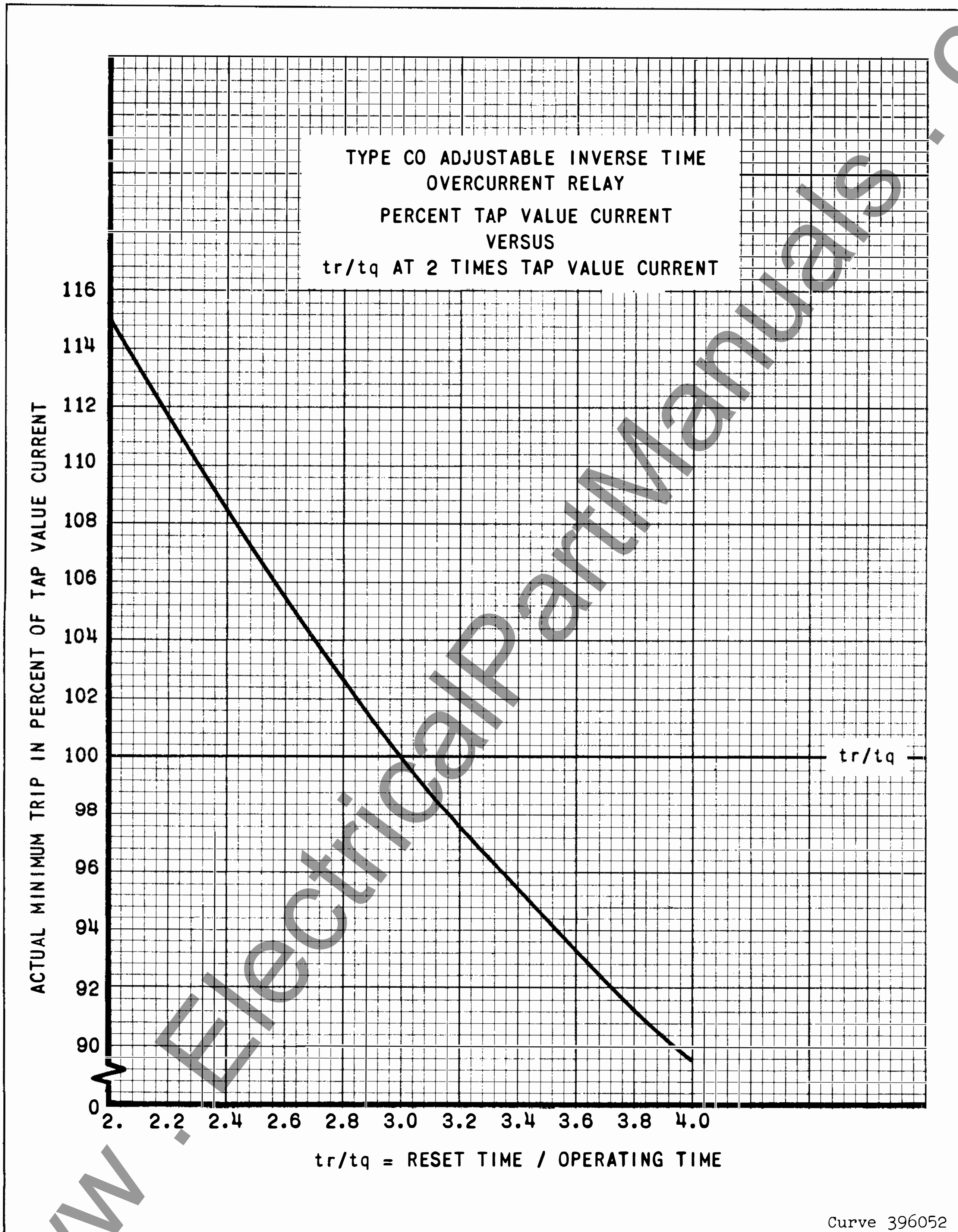


Fig. 11—Typical 60 Cycle Time Curves for the Very Inverse Calibration.



* Fig. 12—Curve For Determining Actual Minimum Trip Current In Percent Of Tap Value Current.

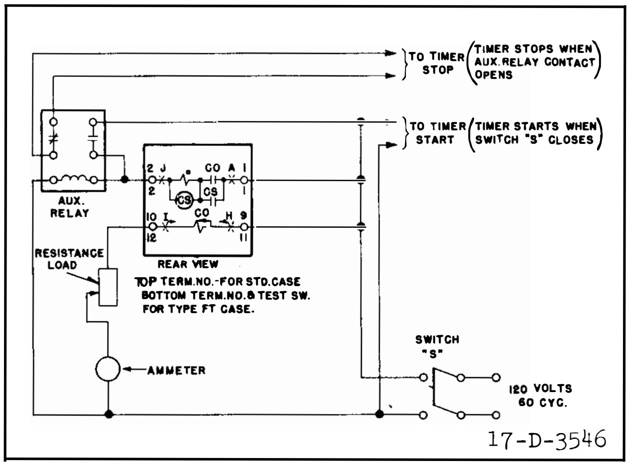


Fig. 13—Diagram Of Test Connections For The Circuit Closing Type CO Relay

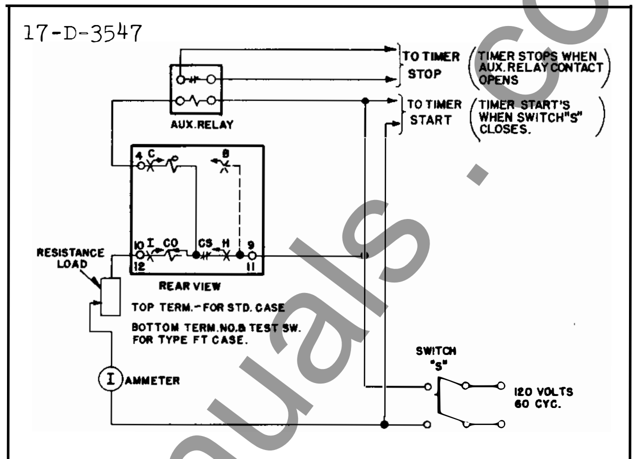


Fig. 14—Diagram Of Test Connections For The Circuit Opening Type CO Relay

after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to change the operating characteristic, such as from inverse to very inverse, the instructions below should be followed.

For relays that are used with circuit breakers that are not instantaneously reclosed, adjust the stationary contact by means of its adjusting screw such that the contact spring is just free of the front spring stop. By means of the time dial, move the moving contacts until they deflect the stationary contacts approximately 1/64 inch. Set the index pointer such that it points to the "O" mark on the time dial. Adjust the stationary contact by means of its adjusting screw until the moving and stationary contacts just touch. This adjustment is to set "O" on the time dial and provide follow for the contacts.

For relays that are used with circuit breakers that are instantaneously reclosed, adjust the stationary contact for quick opening. This is done by screwing in the contact adjusting screw until the stationary contact rests solidly against the contact back stop. By means of the time dial, move the moving contacts until they just touch the stationary contact. Set the index pointer such that it points to the "O" mark on the time dial.

The adjustment of the spring tension and the tap value adjuster are most conveniently made with the damping magnet removed. The reason for this is both adjustments require the balance of two torques which can best be recognized with no damping magnet to retard the motion of the disc.

With the time dial still set on "O", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show. This is an initial rough adjustment. From this preliminary setting, and using minimum tap setting, adjust the spring tension so that the electrical torque balances the spring torque at a fixed value of current at #10-1/2 and #1/2 time dial settings. The best way to do this is to first measure the actual current required to balance the spring torque at the #1/2 and #10-1/2 time dial settings. If less current is required to balance the spring torque at the #10-1/2 position than at the #1/2 position, it is an indication that the spring needs to be wound up more, and vice-versa. All spring convolutions must be free. This setting of the spring will not necessarily be at tap value of current. By winding up or unwinding the spring as required, the current required to move the disc at the extreme limits of its travel (and consequently through the entire range of travel) may be made constant within very close tolerances.

After having balanced the spring torque and the electrical torque as above to match at a

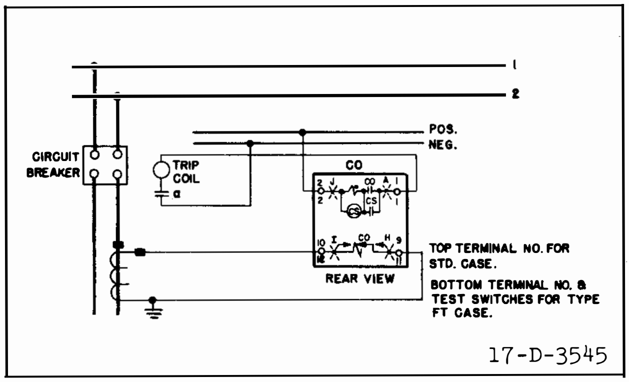


Fig. 15—External Connections of the Circuit Closing Type CO Relay for Overcurrent Protection on a Single Phase System.

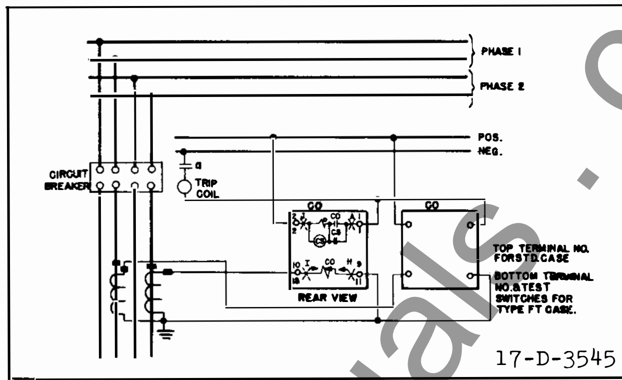


Fig. 16—External Connections of the Circuit Closing Type CO Relay for Overcurrent Protection on a Two-Phase System.

substantially constant value of current, then adjust this constant current value up or down as required to match the tap value current by means of the tap value adjuster located on the right hand leg, front view, of the electromagnet. Moving the slider toward the top decreases minimum trip current and moving the slider toward the bottom increases minimum trip current. The slider must be clamped tight when checking this adjustment.

Time Curve Calibration

After checking the adjustments as outlined above replace the permanent magnet and adjust it to calibrate the relay at 2 times tap value current. This adjustment is made by means of the damping magnet keeper screw. Adjust the keeper screw position such that the relay will operate in the time as defined by the curve of Fig. 9 for inverse or very inverse depending upon the calibration desired. For example, if the inverse calibration is desired, the damping magnet may be adjusted for 27 seconds from the #11 time dial setting. If the very inverse calibration is desired, the adjustment may be made for 18.3 seconds from the #11 time dial setting. Time values somewhat greater than those shown for the inverse calibration and somewhat less that those shown for the very inverse calibration may be obtained if particular problems require them.

The time of operation at 20 times tap value current is adjusted by means of the two adjustable magnetic plugs. Adjust the plug position such that the relay will operate in the time as defined by the current vs time curves of figure 10 or 11 for inverse or very inverse calibration depending upon the characteristic desired for which the 2 times tap value adjustment of time was made. For example, if the inverse calibration is desired, the relay may be calibrated for 2.18 seconds from the #11 time dial position at 20 times minimum trip current by screwing the right hand plug all the way in and adjusting the left hand plug for 2.18 seconds. If the very inverse calibration is desired, screw the left hand plug all the way in and adjust the right hand plug for 1.28 seconds from the #11 time dial position at 20 times minimum trip current.

Curve shapes that are different from the inverse or very inverse may be obtained by adjustable magnetic plugs. An example of this adjustment has been referred to under "Characteristics", and wherein one range of possibilities is shown by Fig. 8.

* Minimum Trip Current

The minimum trip current for a calibrated relay may be checked to an accuracy of $\pm 5\%$ by the use of the following formula:

$$I = \frac{I_2}{\sqrt{1 + t_r/t_2}}$$

where:

I = Actual minimum trip current.

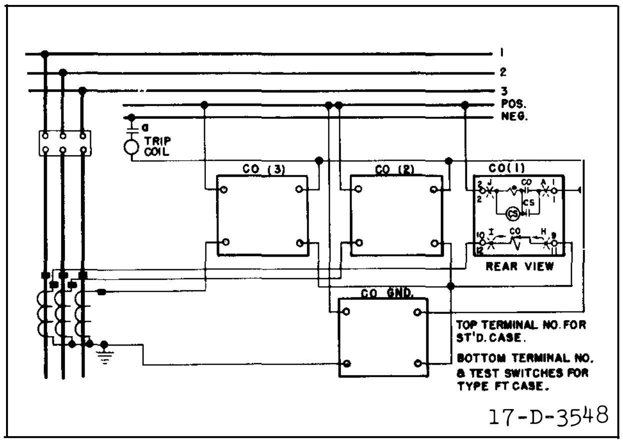


Fig. 17—External Connections of the Circuit Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

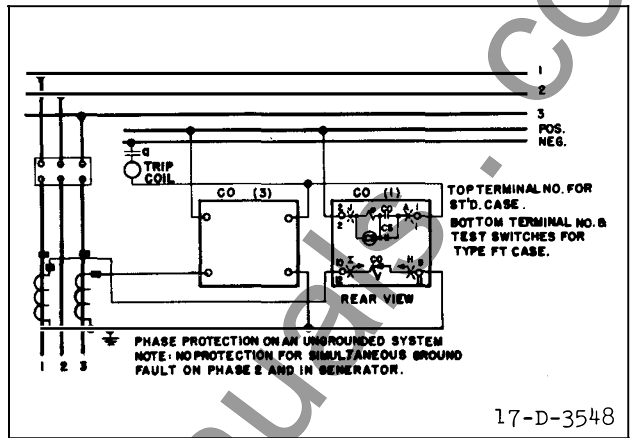


Fig. 18—External Connections of the Circuit Closing Type CO Relay for Phase Overcurrent Protection on an Ungrounded Three-Phase System.

I_2 = Current at a multiple of 2 times the minimum tap setting.

t_2 = Operating time at the #11 time dial setting with I_2 applied.

t_r = Reset time of the relay to the #11 time dial position.

To aid in determining the minimum trip current Fig. 12 has been provided in which a plot has been made of the minimum trip current in percent of tap value current versus values of t_r/t_q.

Example: I_2 = 8 amperes

t_2 = 27 seconds

t_r = 81 seconds

t_r/t_q = 3

I = 100% TAP VALUE CURRENT, Fig. 12.

TRIP CIRCUIT

For Relays with Universal Trip

This combination uses a 2.0 amp. contactor switch and a 0.2 amp. operation indicator connected in parallel. Adjust the contactor switch and indicator as outlined below:

Contactor Switch - Turn the relay up side down. Screw up the core screw until the contact ring starts rotating. Now back off the core until the contact ring stops rotating. Back off the core screw one more turn and lock in place. Adjust the two nuts at the bottom of the switch so that there is 3/32 inch clearance between the moving contact ring and the stationary contacts in the open position. The guide rod may be used as a scale as it has 52 threads per inch, therefore, 5 turns of the nuts will equal approximately 3/32 inch.

Combination Test - Close the main relay contacts and pass 2.25 amps d.c. through the trip circuit. The contactor switch must pick-up. Adjust the operation indicator by moving the flag holder such that the indicator operates

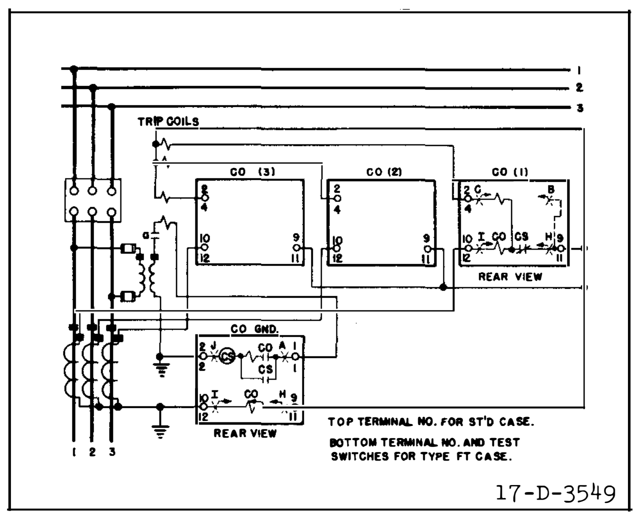


Fig. 19—External Connections of the Circuit Opening Type CO Relay for Phase Overcurrent Protection and of the Circuit Closing Type CO Relay for Ground Protection on a Three-Phase System.

with the application of the 2.25 amps. Pass 30 amps d.c. through the trip circuit. The indicator and contactor switch must not stick in the operated position when the current is interrupted.

For Relays with Series Trip

This combination uses a 2.0 amp. contactor switch and either a 1.0 amp or a 0.2 amp operation indicator connected in series. Adjust the contactor switch and operation indicator as outlined below:

Contactor Switch Adjust the same as above for Contactor Switch.

Operation Indicator Close the main relay contacts and pass 95% of rated indicator current d.c. through the trip circuit. Adjust the operation indicator by moving the flag holder such that the indicator operates with the application of the 95% current.

Combination Test Pass 30 times indicator rating through the trip circuit. The contactor switch and indicator must operate with the application of the current and the contactor switch and indicator must not stick in the operated position when the current is interrupted.

De-ion Contactor Switch
(Circuit - Opening Relays)

Adjust the core stop on the top as high as possible without allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32" to 1/16". Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 2 amperes a.c.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut which locks the Micarta disc and rotating the Micarta disc. The nominal ratio of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pickup.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The 60 cycle burdens and thermal capacities of the various circuits of the relay are as follows:

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle Ø	Volt Amperes △ At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
0.5/2.5	0.5	2	56	72	2.38	21	132	350
	0.6	2.2	56	71	2.38	21	134	365
	0.8	2.5	56	69	2.40	21.1	142	400
	1.0	2.8	56	67	2.42	21.2	150	440
	1.5	3.4	56	62	2.51	22	170	530
	2.0	4.0	56	57	2.65	23.5	200	675
	2.5	4.4	56	53	2.74	24.8	228	800
2/6	2	8	230	70	2.38	21	136	360
	2.5	8.8	230	66	2.40	21.1	142	395
	3	9.7	230	64	2.42	21.5	149	430
	3.5	10.4	230	62	2.48	22	157	470
	4	11.2	230	60	2.53	22.7	164	500
	5	12.5	230	58	2.64	24	180	580
	6	13.7	230	56	2.75	25.2	198	660
4/12	4	16	460	68	2.38	21.3	146	420
	5	18.8	460	63	2.46	21.8	158	480
	6	19.3	460	60	2.54	22.6	172	550
	7	20.8	460	57	2.62	23.6	190	620
	8	22.5	460	54	2.73	24.8	207	700
	10	25	460	48	3.00	27.8	248	850
	12	28	460	45	3.46	31.4	292	1020

*Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.
Ø Degrees current lags voltage at tap value current.
△ Voltages taken with Rectox Type Voltmeter.

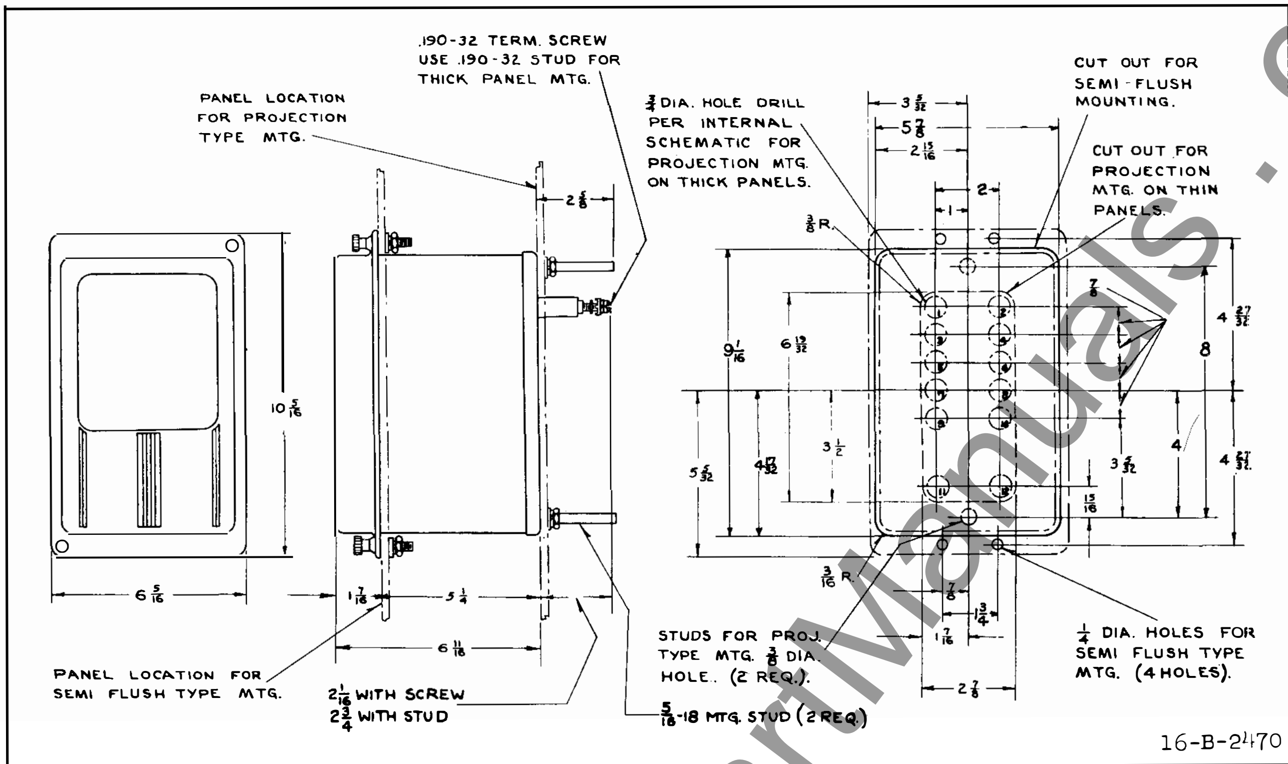


Fig. 20—Outline And Drilling Plan For The Type CO Relay In The S10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

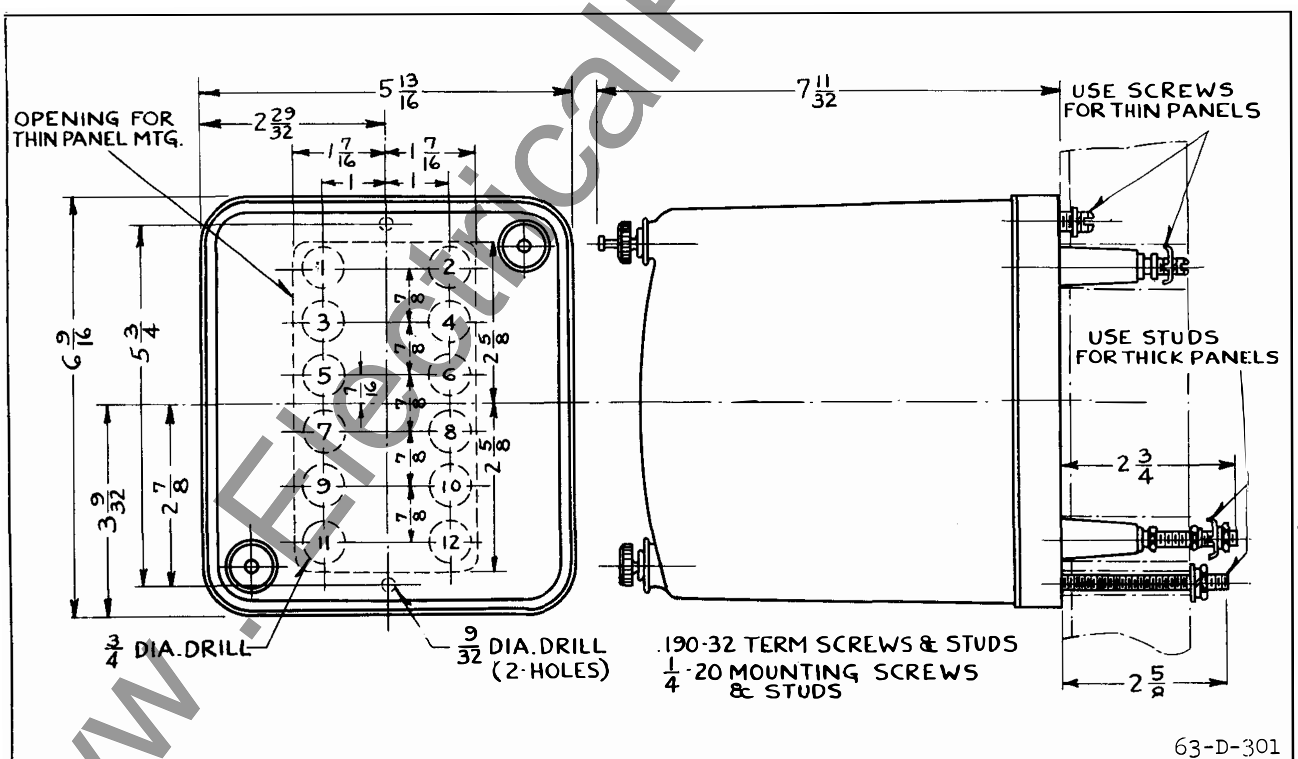


Fig. 21—Outline And Drilling Plan For The Type CO Relay In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

Printed in U. S. A.

WESTINGHOUSE

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO ADJUSTABLE INVERSE TIME OVERCURRENT RELAY

CAUTION

Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker. Where no suitable station battery is available, the circuit opening type relay in conjunction with a-c series trip coils can be used to trip the breaker.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay By 41-280.7B

The circuit-closing type CO relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment when required.

Circuit-Opening Relay See relay Book

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, a small transformer to energize the de-ion contactor switch, an operation indicator and an instantaneous trip attachment when required.

OVERCURRENT ELEMENT

Electromagnet

The electromagnet is shown in the schematic diagram of Fig. 1. The main tapped coil produces a flux which splits and returns through the outer legs. A shading coil causes the flux through the left hand leg to lag the main pole flux. The out of phase fluxes thus produced cause a contact closing torque. The tap value adjuster is a single turn shading coil mounted on the right hand leg. It is short circuited through an adjustable length of wire and tends to partially neutralize the effect of the shading coil. The function of the tap value adjuster is fully described under Adjustments. Adjustable magnetic plugs in the magnetic circuit are held in position by means of elastic clinch nuts located on the rear of the electromagnet.

Disc, Shaft and Bearings

The spiral shaped disc is fastened to a vertical shaft supported on the lower end by a pin and end stone type bearing and on the upper end by a pin and olive bearing. The upper and lower disc shaft bearings are removable, and the corresponding upper and lower bearing pins are removable and adjustable. The bottom bearing pin is securely locked in position by means of a set screw and nylon plug, and the top bearing pin by a shoulder nut that holds the time dial in position.

Damping Magnet

The damping magnet is an Alnico 5 permanent magnet with an adjustable keeper. The keeper is locked in position by means of a set screw and nylon plug in the casting that secures the damping magnet to the movement frame.

SUPERSEDES I. L. 41-280.7
*Denotes change from superseded issue.

EFFECTIVE JULY 1953

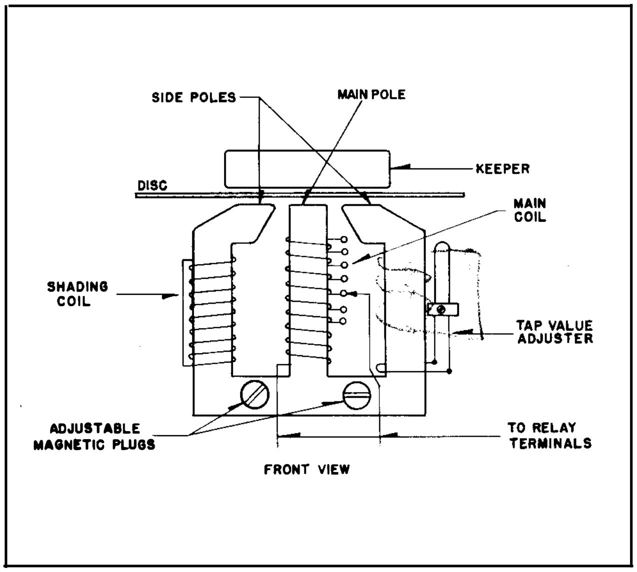


Fig. 1—Schematic Diagram of the Overcurrent Element Electromagnet.

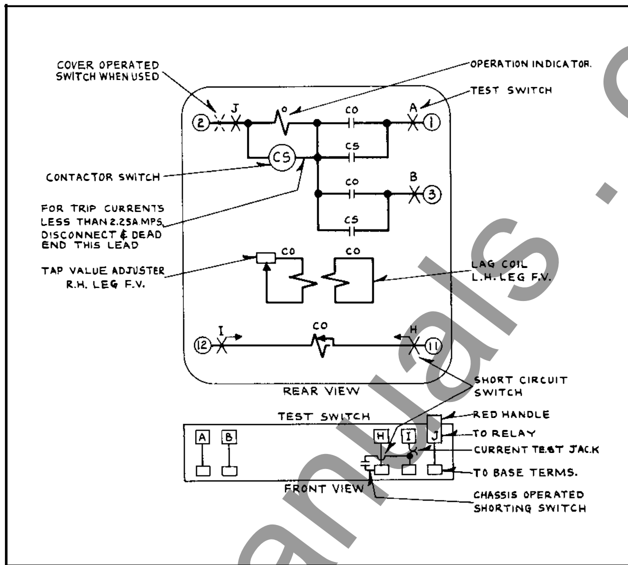


Fig. 2—Internal Schematic of the Double Trip Circuit Closing Relay in the Type FT Case. The Single Trip Relay has Terminal 3 and Associated Circuits Omitted.

Tap Block Assembly

The tap block assembly consists of eight spring loaded tap terminals housed in a moulded tap block, a tap plate secured to the front of the moulded block, and a tap screw. The tap screw engages the tap terminal and pulls the terminal forward to cause a direct metal to metal contact with the tap plate. When the tap screw is removed, the terminal is pushed back by a spring so that it will no longer be in contact with the tap plate. The tap screw is equipped with an insulating nylon sleeve.

Contacts

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

Time Dial

The time dial is a moulded adjustable contact stop with 11 equal scale divisions marked through a 270 degree arc. The time dial is held in position at the top of the disc shaft by means of a star cupped spring washer and a shoulder nut.

An adjustable index pointer is located on the movement frame top bearing mount.

Contactor Switch (Circuit Closing)

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid.

As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain

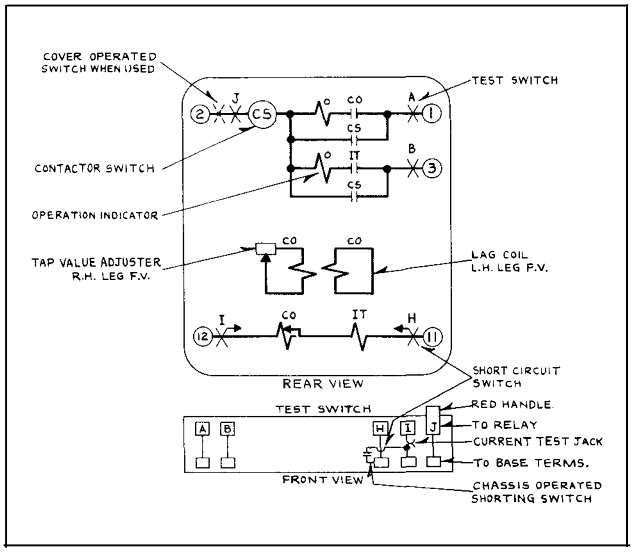


Fig. 3—Internal Schematic of the Single Trip Circuit Closing Relay with Instantaneous Trip Attachment in the Type FT Case.

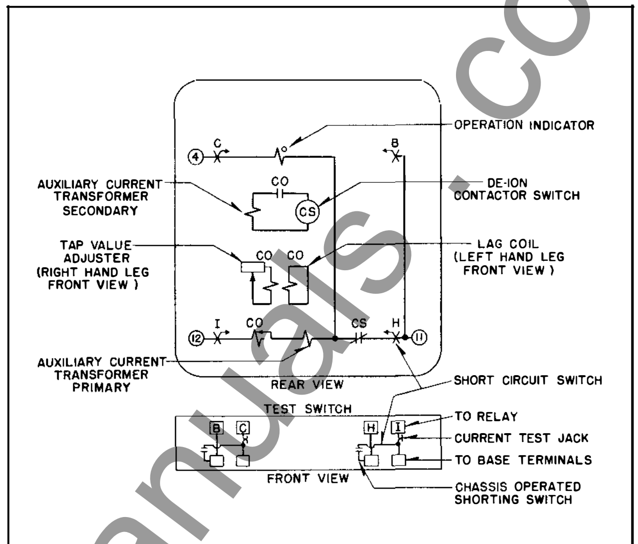


Fig. 4—Internal Schematic of the Circuit Opening Relay in the Type FT Case.

closed until the trip circuit is opened by the auxiliary switch on the breaker.

De-ion Contactor Switch (Circuit Opening)

This switch is a small a-c solenoid switch whose coil is energized from a small transformer connected in the main current circuit. Its construction is similar to the d-c type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator may be reset from outside of the case.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

CHARACTERISTICS

The type CO adjustable inverse time circuit closing relay is available in the following current ranges:

0.5	0.6	0.8	1.0	1.5	2.0	2.5
2	2.5	3	3.5	4	5	6
4	5	6	7	8	10	12

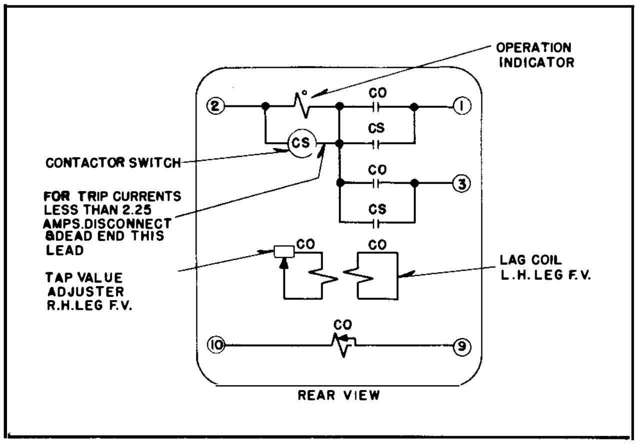


Fig. 5—Internal Schematic of the Double Trip Circuit Closing Relay in the Standard Case. The Single Trip Relay has Terminal 3 and Associated Circuits Omitted.

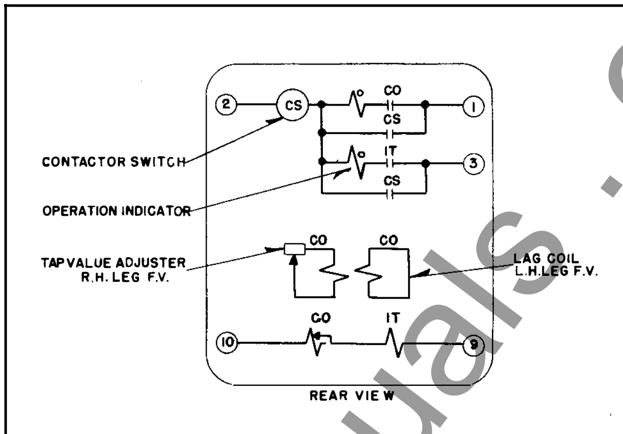


Fig. 6—Internal Schematic of the Single Trip Circuit Closing Relay with Instantaneous Trip Attachment in the Standard Case.

The type CO adjustable inverse time circuit-opening relay is recommended only in the 4 to 12 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. The moving contacts will leave the time dial stop, regardless of the time dial setting, and move to touch the stationary contacts at tap value current.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers, or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The time vs current characteristics for the style calibration of inverse or very inverse are shown in Fig. 10 and Fig. 11 respectively. The term "style calibration" is used as there is no difference between the inverse and very inverse relays except in their calibration. Relays carrying a style number which indicates the inverse calibration may be changed to the very inverse calibration or vice versa through two simple adjustments. This is outlined in detail under Adjustments.

In addition to the one relay covering the inverse or the very inverse curves, the relay may be re-calibrated for a characteristic other than either of these. An example of the spread of adjustments to provide different curve shapes is shown by Fig. 8 wherein all curves are passed through 27 seconds at 2 times minimum trip current. The curves may be passed through a common point other than 27 seconds by adjustment of the damping magnet keeper screw. The range of adjustability indicated at 20 times minimum trip current is obtained by means of the magnetic plugs. The upper limit curve is obtained with the right hand plug "all in" and the left hand plug "all out" (approximately 20 turns of the screw). The lower limit is obtained with the left hand plug "all in" and the right hand plug "all-out". Various adjustments of the plugs partially withdrawn from the magnetic circuit may be used as desired to obtain a curve within the band shown, including the standard or "pattern" curve to which the relay is calibrated at the factory. Thus, one or the other of the plugs will be partially withdrawn in the factory calibration to one or the other of the inverse or very inverse standard curves. Similarly, the factory set position of the damping magnet keeper screw will depend upon the "style calibration".

The burdens and thermal ratings are listed under Energy Requirements. The instantaneous trip attachment has a 1 to 4 ratio. Typical ranges are 10-40 or 20-80, but other ranges are also available.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

Trip Circuit

The main contacts will safely close 30 amperes at 250 V. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d.c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead-ended) under the small filister head screw located in the Micarta base of the contactor switch.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one or 0.2 ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the contact back stop. When this is done, the position of the index pointer should be shifted so that the moving and stationary contacts barely touch when the time dial is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere Target.......2.8 ohms
Resistance of 2.0 ampere Contactor Switch 0.25ohms
Resistance of Target and Switch in Parallel 0.23ohms

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target...... 0.16ohms
Resistance of 0.2 ampere Target...... 2.8 ohms
Resistance of 2.0 ampere Contactor Switch 0.25ohms

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed-knife blades.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. This exposes the relay element and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before opening any of the black handle or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position for test as well as on its back or sides for easy inspection and maintenance.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuits thru the current test jack-jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

TESTING

The relays can be tested in service, in the case but with the external circuits isolated, or out of the case as follows:

Testing In Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above under "Electrical Circuits".

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage. It is recommended that the relay be checked in position as a final check on the calibration.

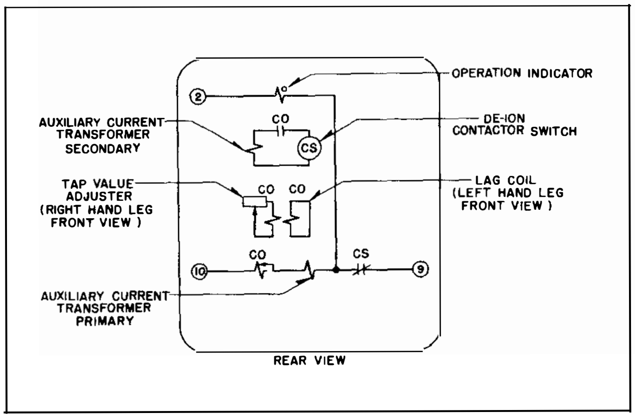


Fig. 7—Internal Schematic of the Circuit Opening Relay in the Standard Case.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

SETTINGS

There are two settings - namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the settings must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

Current Setting

The connector screw on the terminal plate above the time dial 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 4.0 - 5.0 - 6.0 - 7.0 - 8 - 10 - 12 amperes, or as marked on the terminal plate.

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 circuits, the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw in the new tap and removing the old screw from its original setting.

Time Dial Setting

The time dial limits the motion of the disc and thus varies the time of operation. The latter decreases with lower time dial settings as shown in the typical time curves.

ADJUSTMENTS AND MAINTENANCE

All relays should be inspected periodically and the time of operation should be checked at least once every six months or at such other time intervals as may be dictated by experience to be suitable to the particular application. 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.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not require readjustment

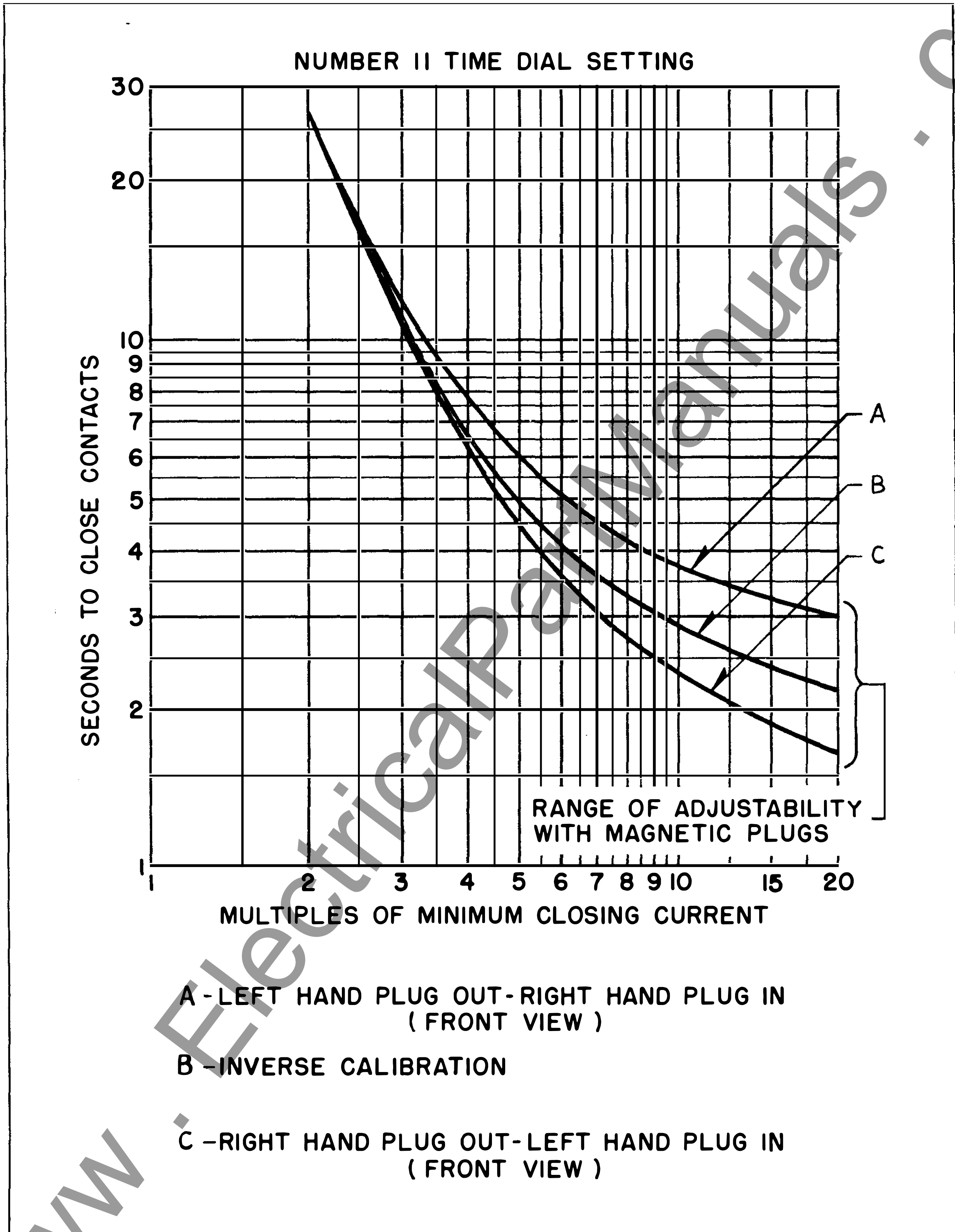


Fig. 8—Example of the Range of Adjustability of the Time Curves by Means of the Adjustable Magnetic Plugs.

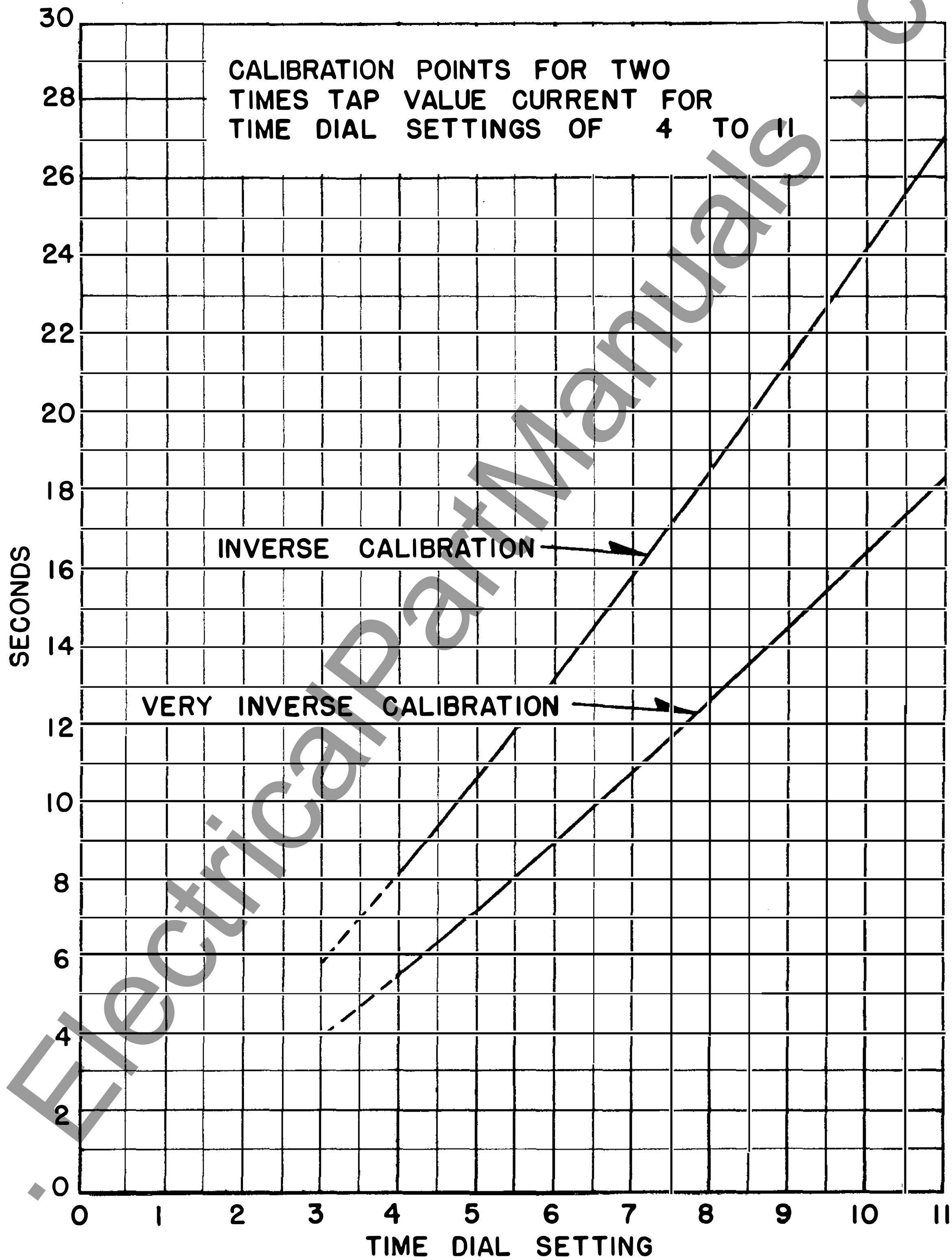


Fig. 9—Time VS Time Dial Setting for Inverse and Very Inverse Calibration at 2 Times Minimum Trip.

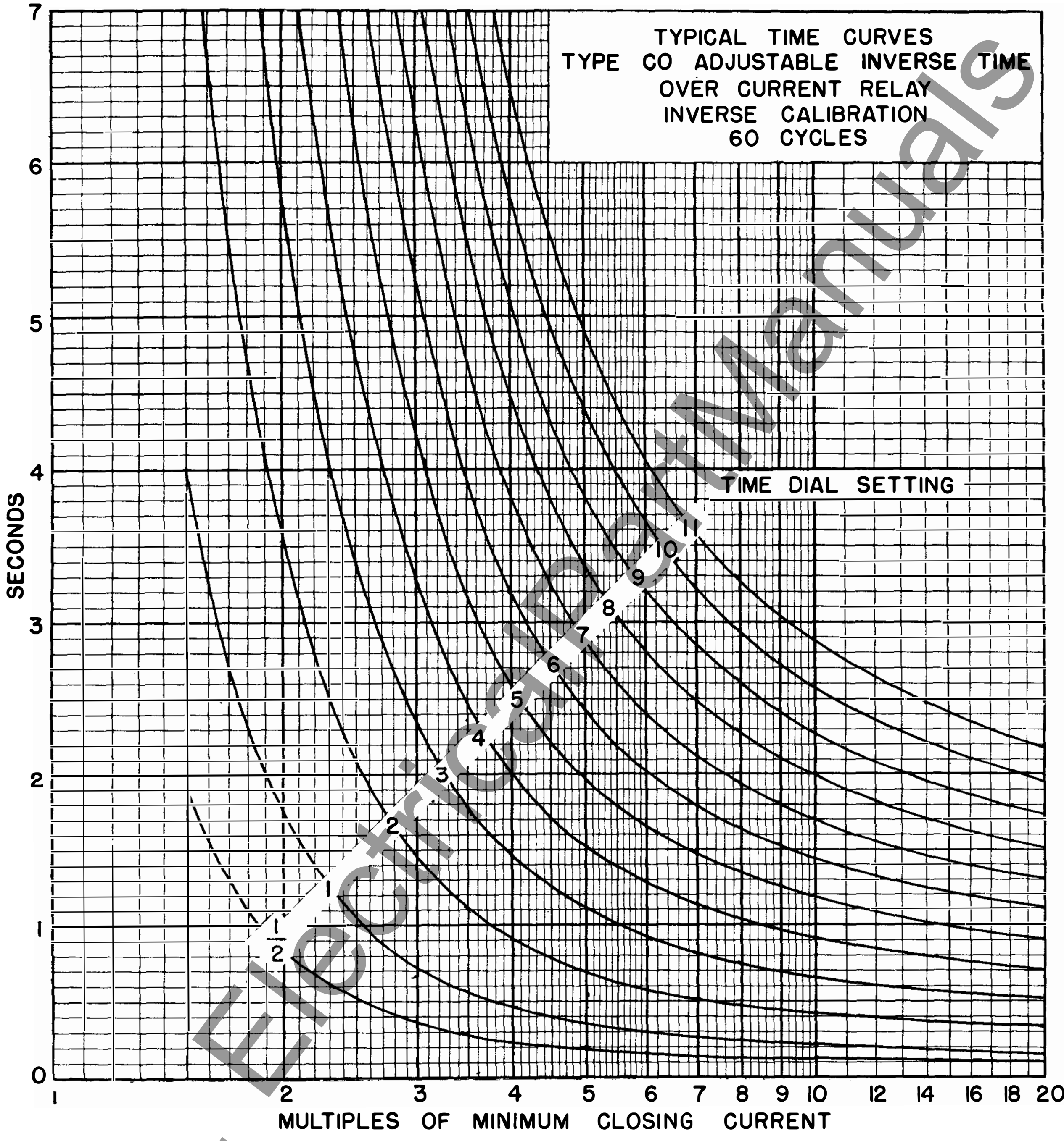


Fig. 10—Typical 60 Cycle Time Curves for the Inverse Calibration.

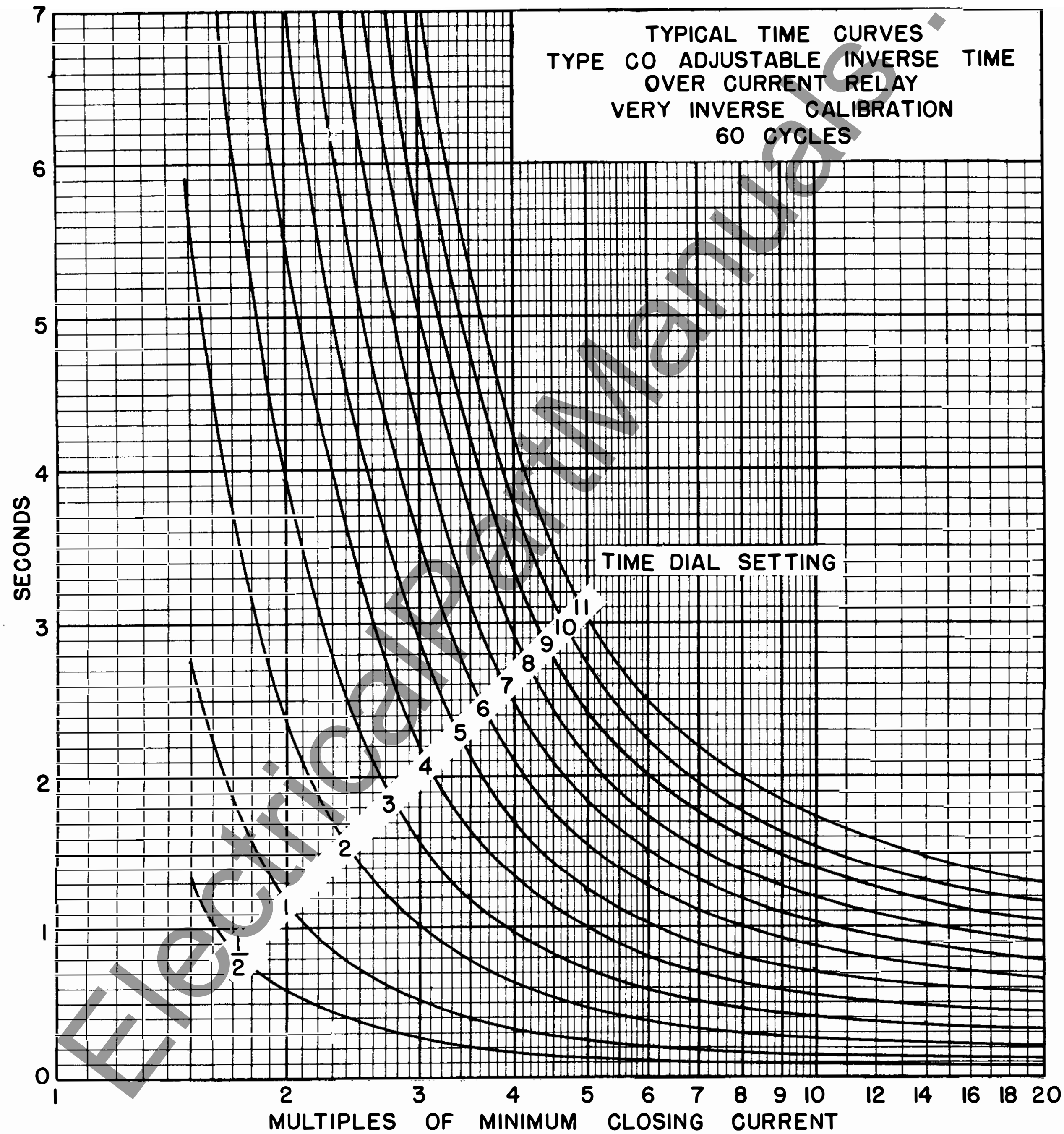


Fig. 11—Typical 60 Cycle Time Curves for the Very Inverse Calibration.

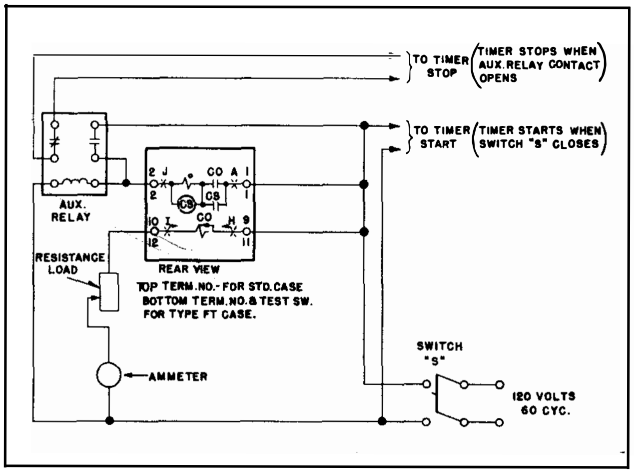


Fig. 12—Diagram of Test Connections for the Circuit Closing Type CO Relay.

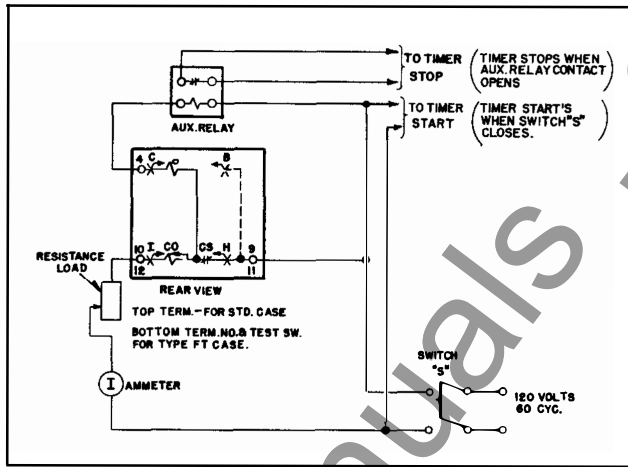


Fig. 13—Diagram of Test Connections for the Circuit Opening Type CO Relay.

after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to change the operating characteristic, such as from inverse to very inverse, the instructions below should be followed.

For relays that are used with circuit breakers that are not instantaneously reclosed, adjust the stationary contact by means of its adjusting screw such that the contact spring is just free of the front spring stop. By means of the time dial, move the moving contacts until they deflect the stationary contacts approximately 1/64 inch. Set the index pointer such that it points to the "0" mark on the time dial. Adjust the stationary contact by means of its adjusting screw until the moving and stationary contacts just touch. This adjustment is to set "0" on the time dial and provide follow for the contacts.

For relays that are used with circuit breakers that are instantaneously reclosed, adjust the stationary contact for quick opening. This is done by screwing in the contact adjusting screw until the stationary contact rests solidly against the contact back stop. By means of the time dial, move the moving contacts until they just touch the stationary contact. Set the index pointer such that it points to the "0" mark on the time dial.

The adjustment of the spring tension and the tap value adjuster are most conveniently made with the damping magnet removed. The reason for this is both adjustments require the balance of two torques which can best be recognized with no damping magnet to retard the motion of the disc.

With the time dial still set on "0", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show. This is an initial rough adjustment. From this preliminary setting, and using minimum tap setting, adjust the spring tension so that the electrical torque balances the spring torque at a fixed value of current at #10-1/2 and #1/2 time dial settings. The best way to do this is to first measure the actual current required to balance the spring torque at the #1/2 and #10-1/2 time dial settings. If less current is required to balance the spring torque at the #10-1/2 position than at the #1/2 position, it is an indication that the spring needs to be wound up more, and vice-versa. All spring convolutions must be free. This setting of the spring will not necessarily be at tap value of current. By winding up or unwinding the spring as required, the current required to move the disc at the extreme limits of its travel (and consequently through the entire range of travel) may be made constant within very close tolerances.

After having balanced the spring torque and the electrical torque as above to match at a

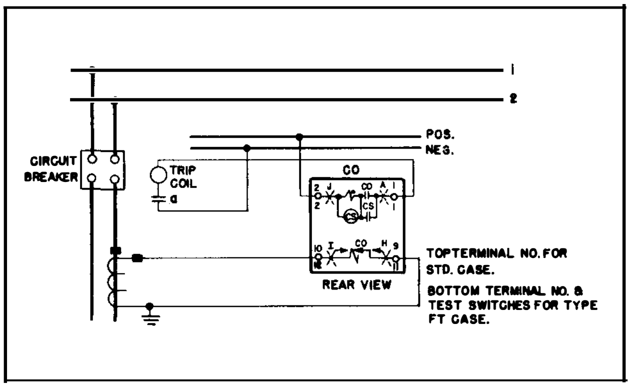


Fig. 14—External Connections of the Circuit Closing Type CO Relay for Overcurrent Protection on a Single Phase System.

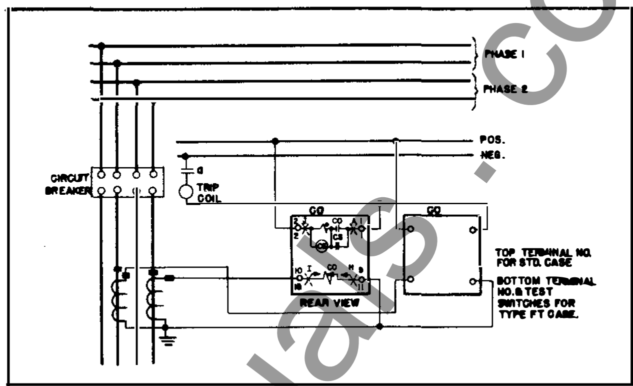


Fig. 15—External Connections of the Circuit Closing Type CO Relay for Overcurrent Protection on a Two-Phase System.

substantially constant value of current, then adjust this constant current value up or down as required to match the tap value current by means of the tap value adjuster located on the right hand leg, front view, of the electromagnet. Moving the slider toward the top decreases minimum trip current and moving the slider toward the bottom increases minimum trip current. The slider must be clamped tight when checking this adjustment.

Time Curve Calibration

After checking the adjustments as outlined above replace the permanent magnet and adjust it to calibrate the relay at 2 times tap value current. This adjustment is made by means of the damping magnet keeper screw. Adjust the keeper screw position such that the relay will operate in the time as defined by the curve of Fig. 9 for inverse or very inverse depending upon the calibration desired. For example, if the inverse calibration is desired, the damping magnet may be adjusted for 27 seconds from the #11 time dial setting. If the very inverse calibration is desired, the adjustment may be made for 18.3 seconds from the #11 time dial setting. Time values somewhat greater than those shown for the inverse calibration and somewhat less that those shown for the very inverse calibration may be obtained if particular problems require them.

The time of operation at 20 times tap value current is adjusted by means of the two adjustable magnetic plugs. Adjust the plug position such that the relay will operate in the time as defined by the current vs time curves of figure 10 or 11 for inverse or very inverse calibration depending upon the characteristic desired for which the 2 times tap value adjustment of time was made. For example, if the inverse calibration is desired, the relay may be calibrated for 2.18 seconds from the #11 time dial position at 20 times minimum trip current by screwing the right hand plug all the way in and adjusting the left hand plug for 2.18 seconds. If the very inverse calibration is desired, screw the left hand plug all the way in and adjust the right hand plug for 1.28 seconds from the #11 time dial position at 20 times minimum trip current.

Curve shapes that are different from the inverse or very inverse may be obtained by adjustable magnetic plugs. An example of this adjustment has been referred to under "Characteristics", and wherein one range of possibilities is shown by Fig. 8.

TRIP CIRCUIT

For Relays with Universal Trip

This combination uses a 2.0 amp. contactor switch and a 0.2 amp. operation indicator connected in parallel. Adjust the contactor switch and indicator as outlined below:

Contactor Switch - Turn the relay up side down. Screw up the core screw until the contact ring starts rotating. Now back off the core until the contact ring stops rotating.

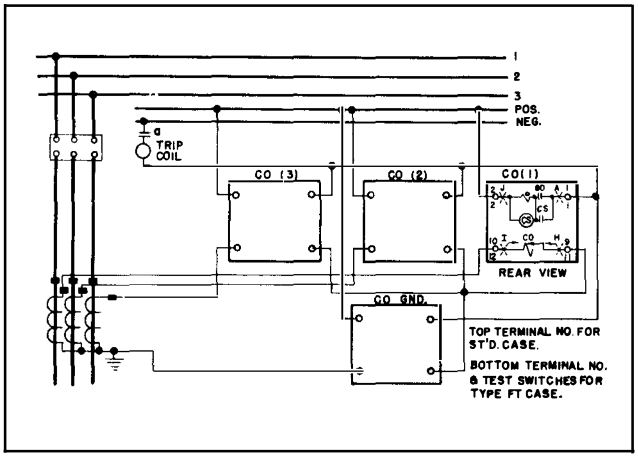


Fig. 16—External Connections of the Circuit Closing Type CO Relay for Phase and Ground Overcurrent Protection on a Three-Phase System.

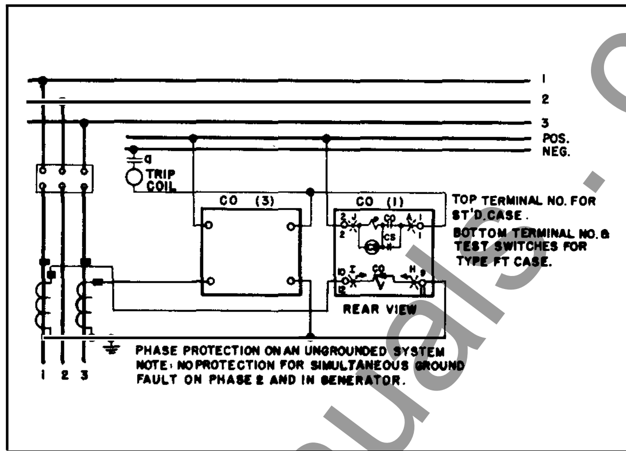


Fig. 17—External Connections of the Circuit Closing Type CO Relay for Phase Overcurrent Protection on an Ungrounded Three-Phase System.

Back off the core screw one more turn and lock in place. Adjust the two nuts at the bottom of the switch so that there is 3/32 inch clearance between the moving contact ring and the stationary contacts in the open position. The guide rod may be used as a scale as it has 32 threads per inch, therefore, 3 turns of the nuts will equal approximately 3/32 inch.

Combination Test - Close the main relay contacts and pass 2.25 amps d.c. through the trip circuit. The contactor switch must pick-up. Adjust the operation indicator by moving the flag holder such that the indicator operates with the application of the 2.25 amps. Pass 30 amps d.c. through the trip circuit. The indicator and contactor switch must not stick in the operated position when the current is interrupted.

For Relays with Series Trip

This combination uses a 2.0 amp. contactor switch and either a 1.0 amp or a 0.2 amp operation indicator connected in series. Adjust the contactor switch and operation indicator as outlined below:

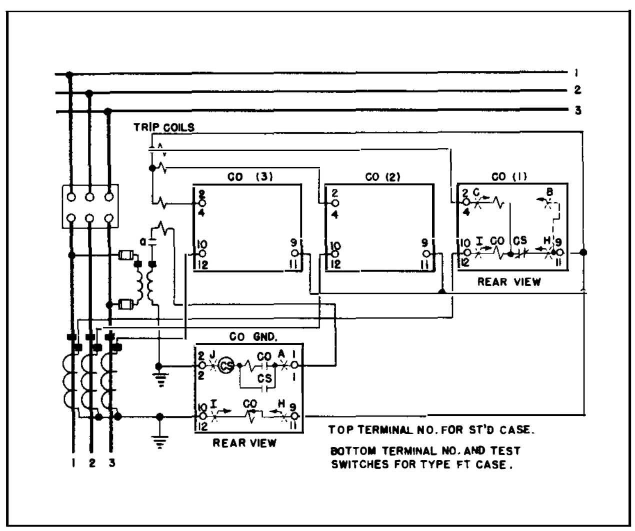
Contactor Switch Adjust the same as above for Contactor Switch.

Operation Indicator Close the main relay contacts and pass 95% of rated indicator current d.c. through the trip circuit. Adjust the operation indicator by moving the flag holder such that the indicator operates with the application of the 95% current.

Combination Test Pass 30 times indicator rating through the trip circuit. The contactor switch and indicator must operate with the application of the current and the contactor switch and indicator must not stick in the operated position when the current is interrupted.

De-ion Contactor Switch
(Circuit - Opening Relays)

Adjust the core stop on the top as high as possible without allowing the insulating bush-



✱ **Fig. 18—External Connections of the Circuit Opening Type CO Relay for Phase Overcurrent Protection and of the Circuit Closing Type CO Relay for Ground Protection on a Three-Phase System.**

ing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32" to 1/16". Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 2 amperes a.c.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut which locks the Micarta disc and rotating the Micarta disc. The nominal ratio of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pickup.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The 60 cycle burdens and thermal capacities of the various circuits of the relay are as follows:

Ampere Range	Tap	Continuous Rating (Amperes)	One Second Rating* (Amperes)	Power Factor Angle∅	Volt Amperes△ At Tap Value Current	At 3 Times Tap Value Current	At 10 Times Tap Value Current	At 20 Times Tap Value Current
0.5/2.5	0.5	2	56	72	2.38	21	132	350
	0.6	2.2	56	71	2.38	21	134	365
	0.8	2.5	56	69	2.40	21.1	142	400
	1.0	2.8	56	67	2.42	21.2	150	440
	1.5	3.4	56	62	2.51	22	170	530
	2.0	4.0	56	57	2.65	23.5	200	675
	2.5	4.4	56	53	2.74	24.8	228	800
2/6	2	8	230	70	2.38	21	136	360
	2.5	8.8	230	66	2.40	21.1	142	395
	3	9.7	230	64	2.42	21.5	149	430
	3.5	10.4	230	62	2.48	22	157	470
	4	11.2	230	60	2.53	22.7	164	500
	5	12.5	230	58	2.64	24	180	580
	6	13.7	230	56	2.75	25.2	198	660
4/12	4	16	460	68	2.38	21.3	146	420
	5	18.8	460	63	2.46	21.8	158	480
	6	19.3	460	60	2.54	22.6	172	550
	7	20.8	460	57	2.62	23.6	190	620
	8	22.5	460	54	2.73	24.8	207	700
	10	25	460	48	3.00	27.8	248	850
	12	28	460	45	3.46	31.4	292	1020

*Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

∅ Degrees current lags voltage at tap value current.

△ Voltages taken with Rectox Type Voltmeter.

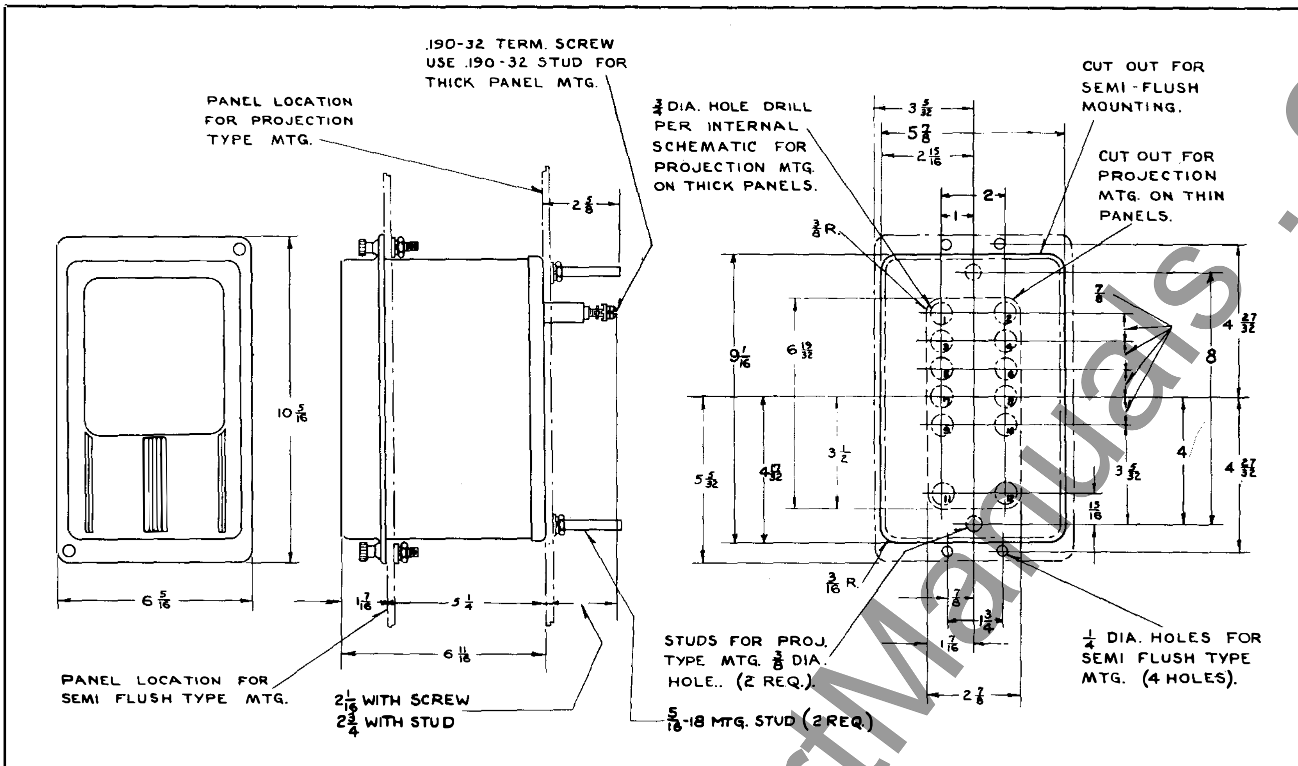


Fig. 19—Outline and Drilling Plan for the Type CO Relay in the S10 Projection or Semi-Flush Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

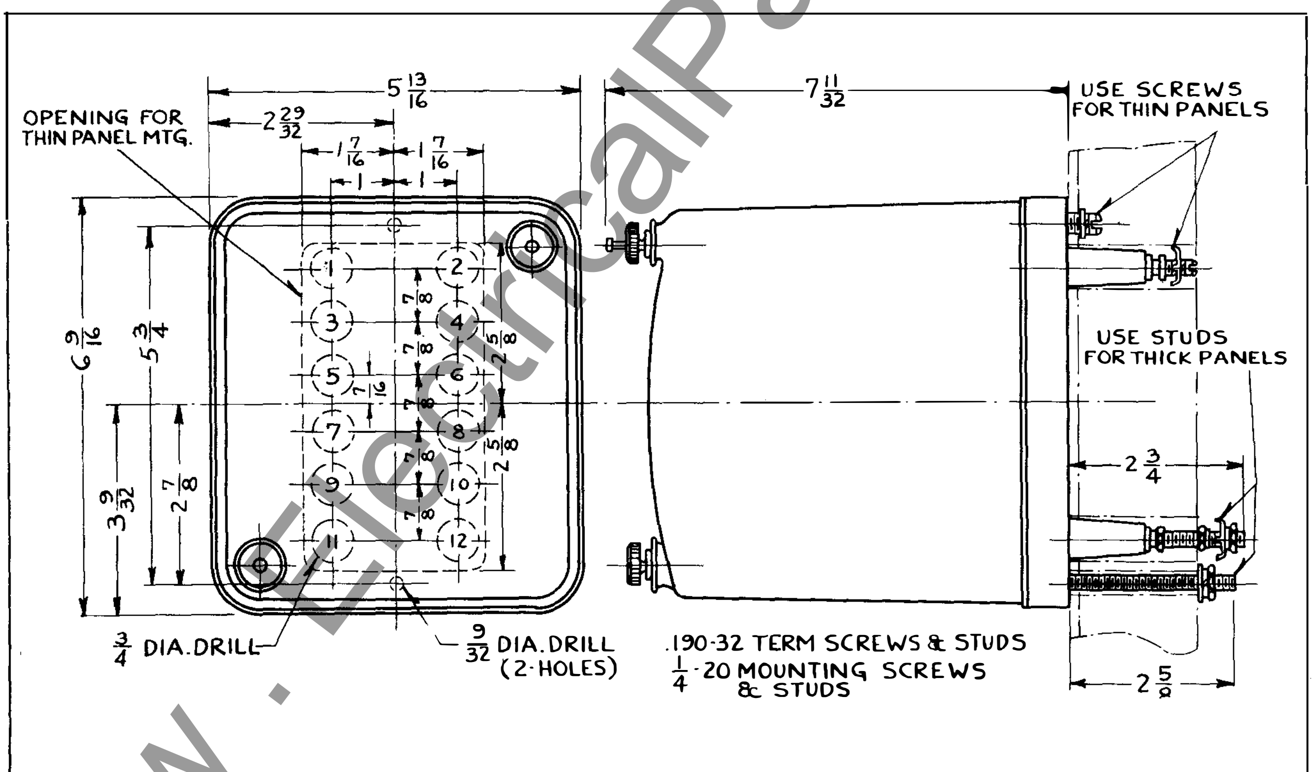


Fig. 20—Outline and Drilling Plan for the Type CO Relay in the Projection Type Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO-4 STEP-TIME OVERCURRENT RELAY

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

The type CO-4 relay is used in applications that require a step-type current vs time characteristics. A typical application is as an overcurrent relay that is to coordinate with Westinghouse type DB circuit breaker or circuit breaker with similar tripping characteristics.

CONSTRUCTION AND OPERATION

The type CO-4 relay consists of an induction disc long time overcurrent element, two instantaneous trip attachments, a timer, operation indicators and contactor switch.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent, The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an auxiliary shaft geared to the disc shaft. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front.

Instantaneous Trip

The instantaneous trip attachments are small solenoid type elements. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

The left hand instantaneous trip (IT-1)

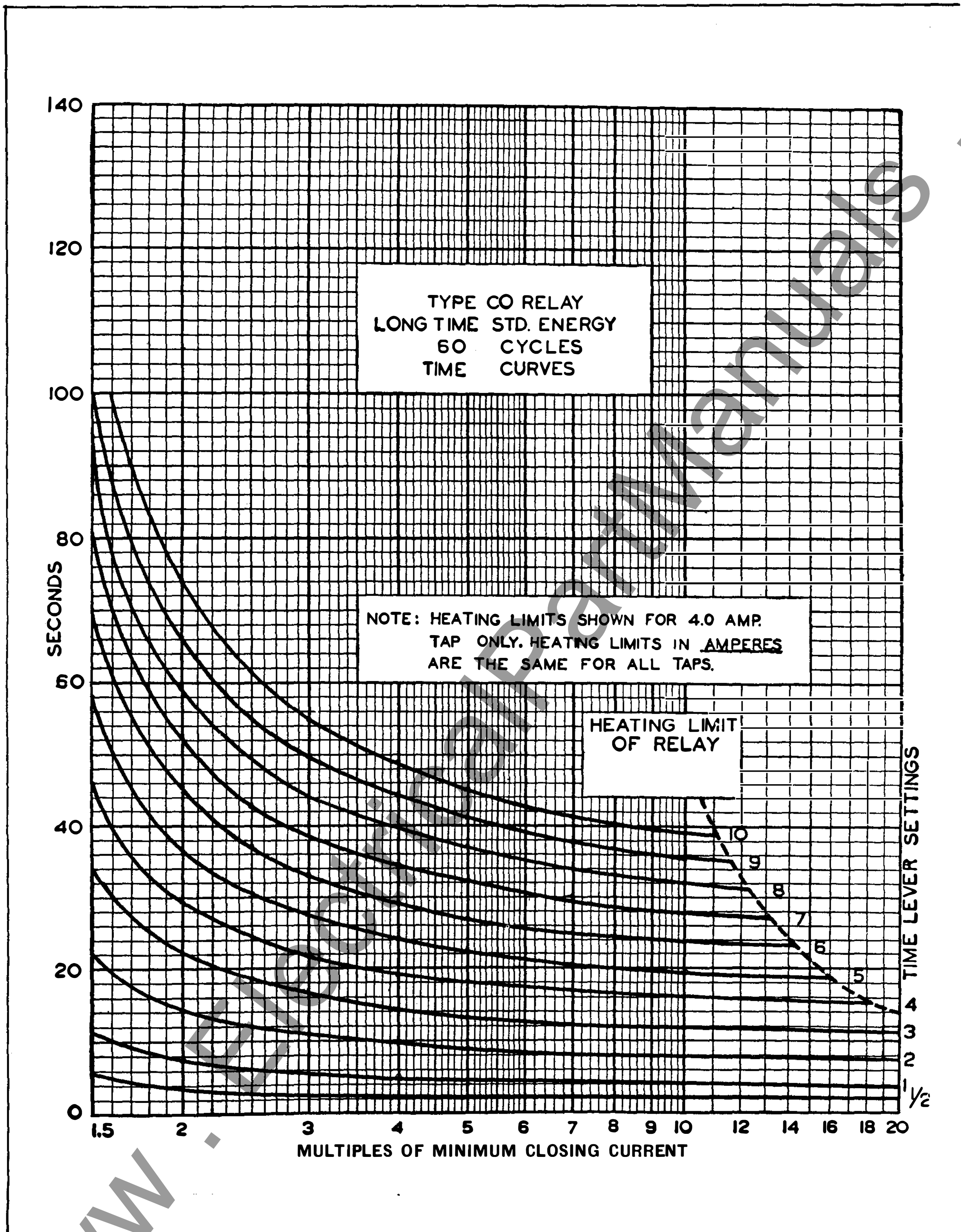


Fig. 1—Typical Time Curves for CO Long Time Element.

contacts are connected in series with a timer motor to allow an adjustable definite time delay after IT-1 pick-up. The right-hand instantaneous trip (IT-2) contacts are connected in the trip circuit to trip instantaneously.

Synchronous Timer

The timer is a small synchronous motor which operates from the current circuit through a saturating transformer, and drives a moving contact arm through a gear train. The contact on the moving arm is a cylindrical silver sleeve, loosely fitted on the moving arm. In making contact, this sleeve strikes two vertically projecting stationary butt contacts to bridge the gap between them. The loose fit of the sleeve permits a positive alignment in bridging these contacts, and, therefore, correct contact action is not greatly dependent on their adjustment. The stationary contacts are mounted on a Micarta insulating block which is adjustable around a semicircular calibrated guide. The maximum time setting of the timer is three seconds.

The synchronous motor has a floating rotor which is in mesh with the gear train only when energized. The rotor falls out instantly when the motor is deenergized, allowing a spring to reset the moving arm.

All tripping contacts are connected in parallel which allows tripping by the CO long time element, IT-1 plus time delay, or IT-2 instantaneously, depending on the relative element settings and current magnitude.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Contactor Switch

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay, and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

CHARACTERISTICS

The typical current ranges of the elements of the type CO-4 relays are as follows:

Long time overcurrent element 4 to 15 amperes with taps at 4-5-6-8-10-12 and 15 amperes.

IT-1 instantaneous element 10 to 40 amperes.

Current range of timer 10 to 100 amperes.

IT-2 instantaneous element 20 to 80 amperes.

The typical operating curves of the Long time element are shown by figure 1.

The typical band curves of the overall operating characteristic of the type CO-4 relay are shown by figure 2.

Trip Circuit

The main contacts will safely close 30 amperes at 250 V. d.c., and the switch contacts will safely carry this current long enough to trip a breaker.

The trip circuit consists of a 2 ampere contactor switch connected in series with the tripping contact and two one ampere operation indicators. One operation indicator indicates tripping that takes place through the Long time CO element or IT-1, plus time delay and the other indicator indicates tripping by means of the IT-2 contacts.

Resistance of the operation indicator is 0.16 ohms and of the contacts switch is 0.25 ohms.

SETTINGS

The settings to be made to obtain an operating characteristic similar to that indicated by the example curve of figure 2 are: tap and time lever position of the CO long time element for the low current, IT-1 pick up and timer contact position for intermediate currents and IT-2 pick up for high currents.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Overcurrent Element (Long Time)

Shift the position of the contact stop on the time lever and adjust the 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 tap block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test are as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field.

Instantaneous Trip Attachment (IT-1 and IT-2)

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately ± 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pick-up.

Synchronous Timer

When testing the synchronous timer, complete the transformer circuit by a jumper around the contacts of the IT-1 element. Test the motor at 10 amperes (or the current indicated by the minimum possible setting of the IT-1 element) thru the current circuit that includes the auxiliary transformer primary. This is the minimum current at which the timer will run in synchronism.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay

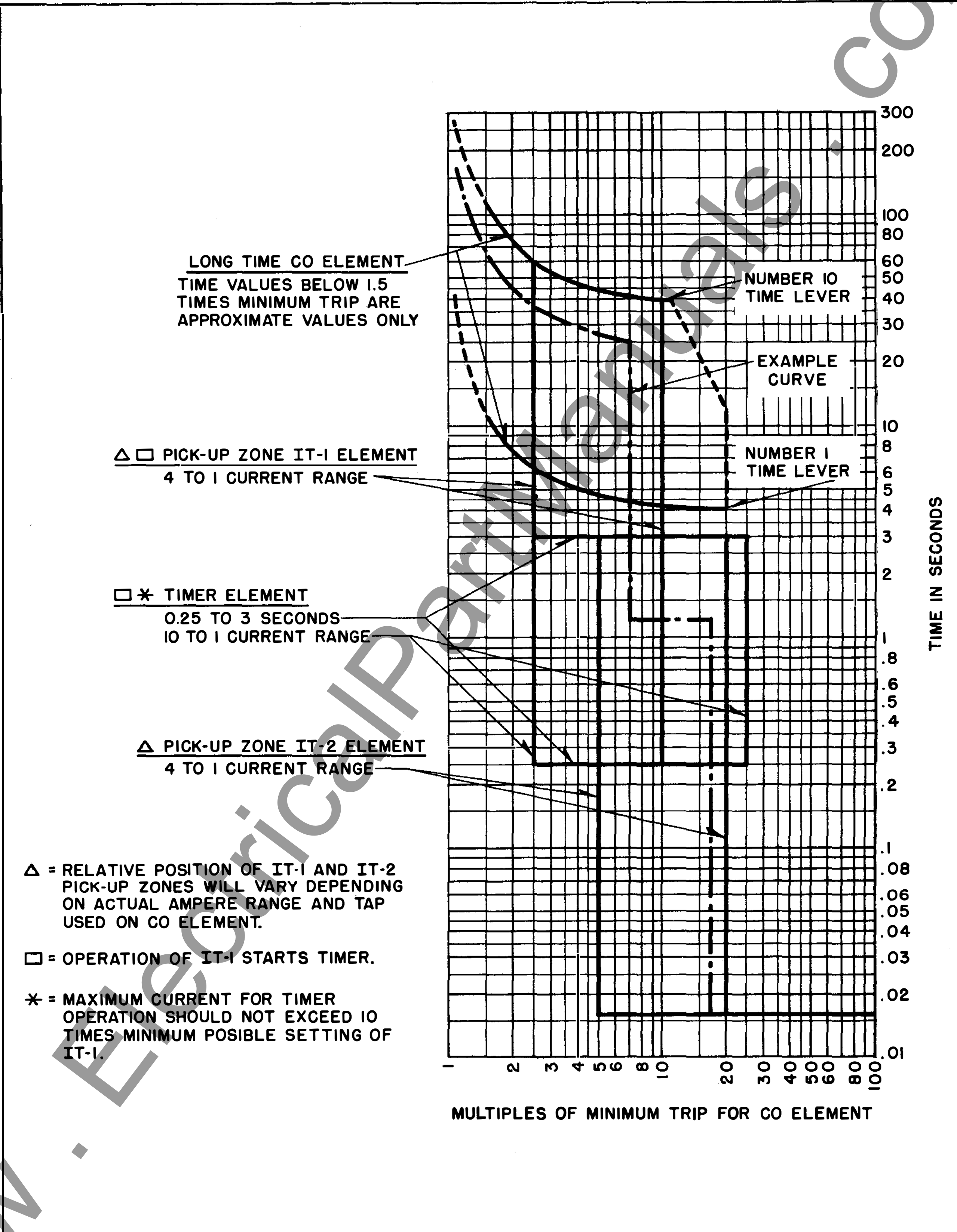


Fig. 2—Typical Current Time Curve Bands for the Type CO-4 Relay.

upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d.c. Test for sticking after 30 amperes d-c have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current has been applied.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete name-plate data.

ENERGY REQUIREMENTS

The burden of each of the instantaneous elements (IT-1 and IT-2) at 5 amperes 60 cycles is as follows:

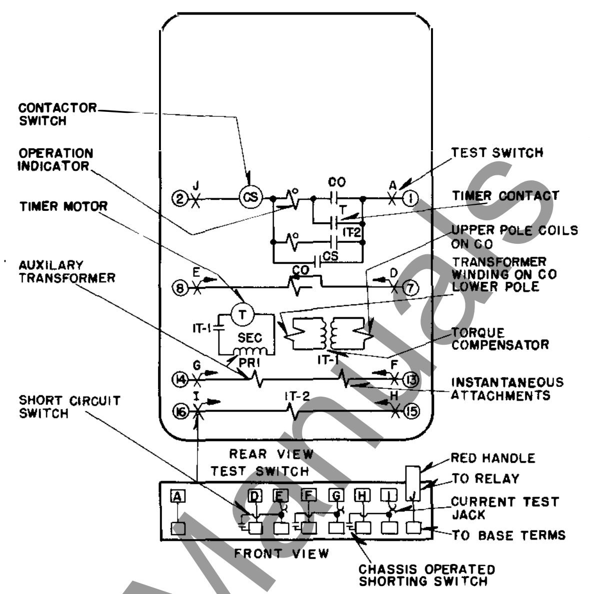


Fig. 3—Internal Schematic of the Type CO-4 Relay in the Type FT Case.

Ampere Range	Voltamperes Min. Setting	P.F. Angle (Lag)
10-40	0.13	26°
20-80	0.03	26°

The saturation data for the long time CO element at 60 cycles is as follows:

Multiples of tap value current	1	3	10	20
V.A. Burden	17	100	490	1300

The burden of the timer and auxiliary transformer at 5 amperes 60 cycles is as follows for IT-1 range of 10 to 40.

IT-1 contact open	0.7 VA at 80° lag.
IT-1 contact close	0.6 VA at 65° lag.

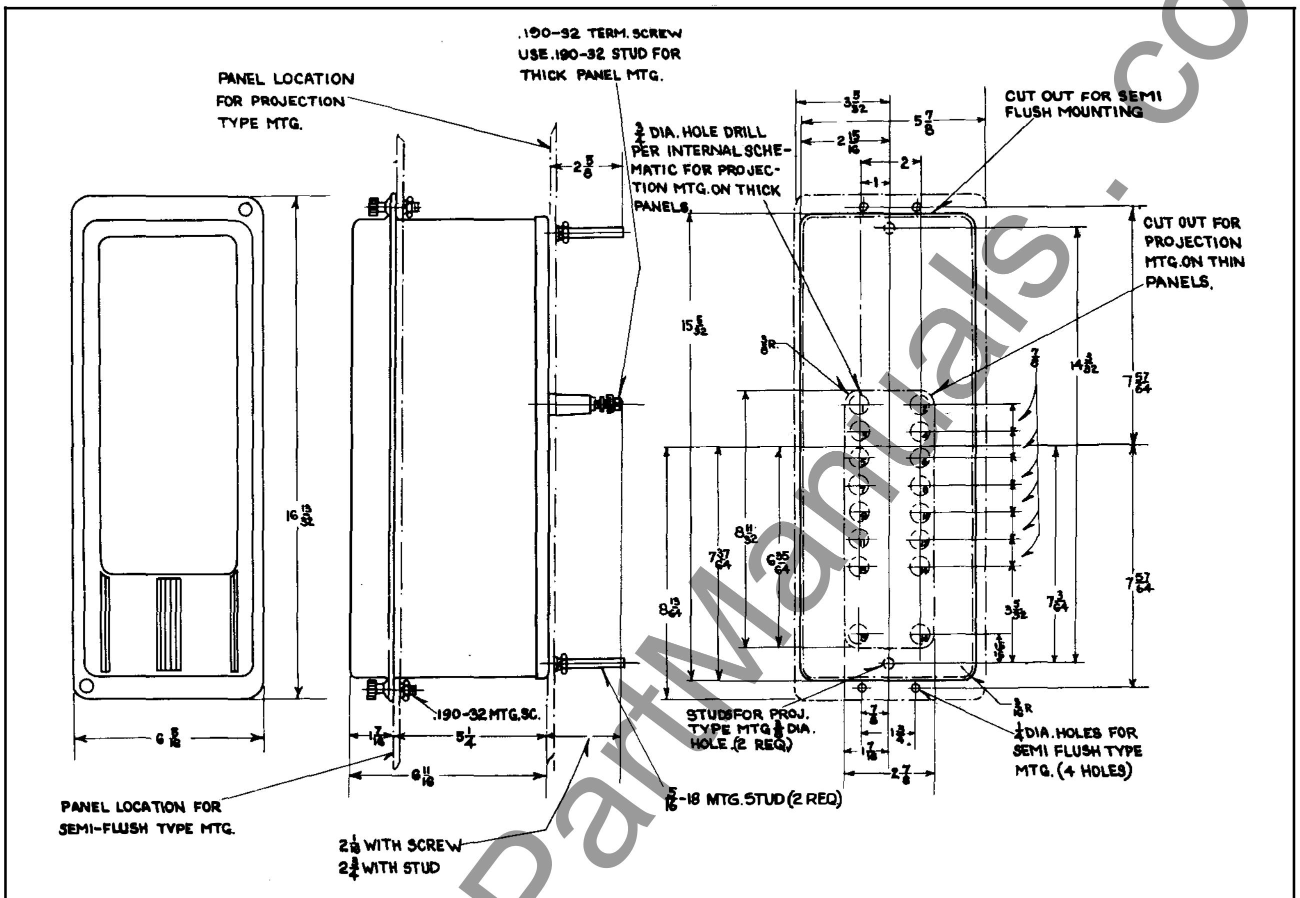


Fig. 4—Outline & Drilling for FT Case. (Reference Only)

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO-4 STEP-TIME OVERCURRENT RELAY

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

The type CO-4 relay is used in applications that require a step-type current vs time characteristics. A typical application is as an overcurrent relay that is to coordinate with Westinghouse type DB circuit breaker or circuit breaker with similar tripping characteristics.

CONSTRUCTION AND OPERATION

The type CO-4 relay consists of an induction disc long time overcurrent element, two instantaneous trip attachments, a timer, operation indicators and contactor switch.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent, The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an auxiliary shaft geared to the disc shaft. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front.

Instantaneous Trip

The instantaneous trip attachments are small solenoid type elements. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

The left hand instantaneous trip (IT-1)

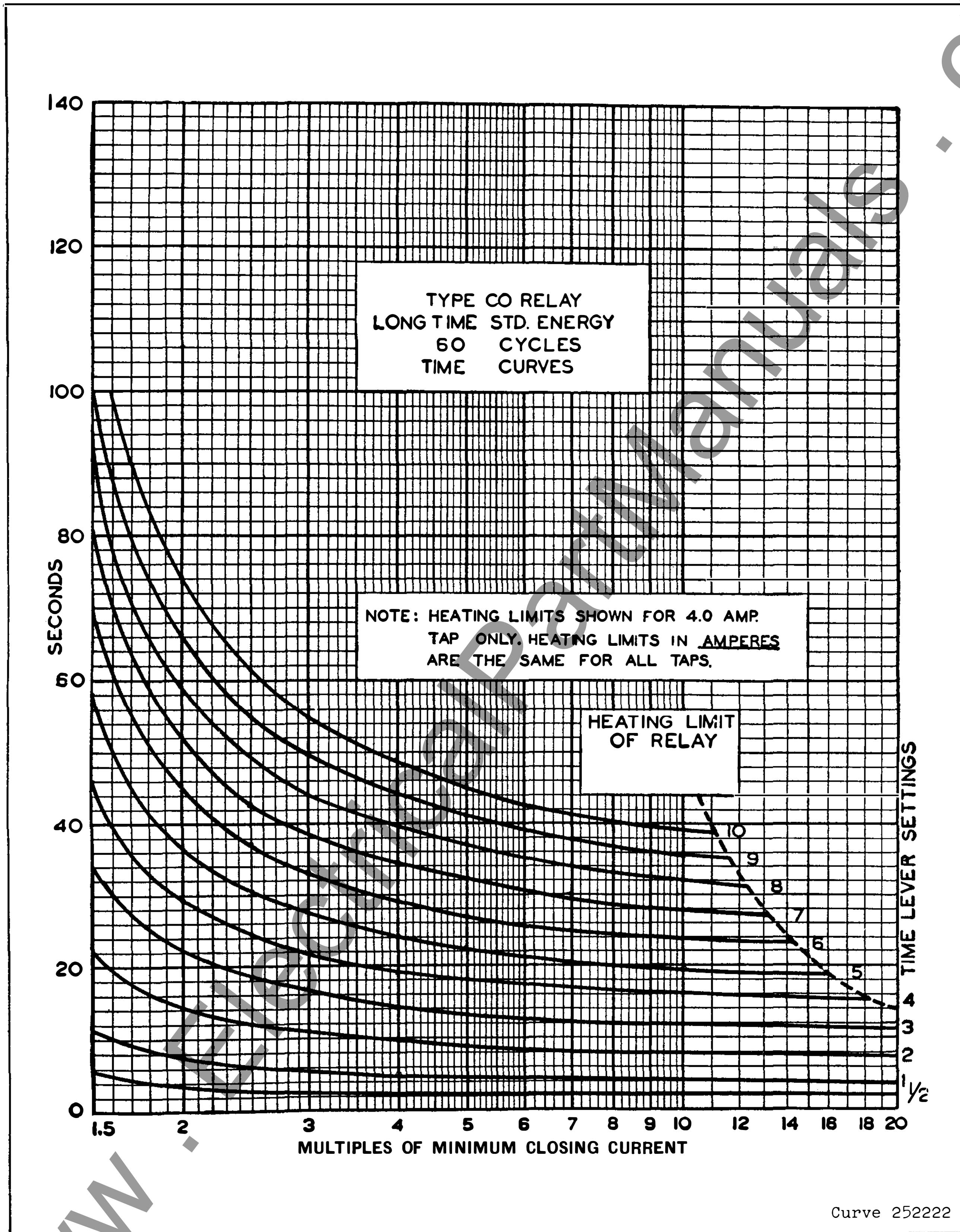

Fig. 1—Typical Time Curves for CO Long Time Element.

contacts are connected in series with a timer motor to allow an adjustable definite time delay after IT-1 pick-up. The right-hand instantaneous trip (IT-2) contacts are connected in the trip circuit to trip instantaneously.

Synchronous Timer

The timer is a small synchronous motor which operates from the current circuit through a saturating transformer, and drives a moving contact arm through a gear train. The contact on the moving arm is a cylindrical silver sleeve, loosely fitted on the moving arm. In making contact, this sleeve strikes two vertically projecting stationary butt contacts to bridge the gap between them. The loose fit of the sleeve permits a positive alignment in bridging these contacts, and, therefore, correct contact action is not greatly dependent on their adjustment. The stationary contacts are mounted on a Micarta insulating block which is adjustable around a semicircular calibrated guide. The maximum time setting of the timer is three seconds.

The synchronous motor has a floating rotor which is in mesh with the gear train only when energized. The rotor falls out instantly when the motor is deenergized, allowing a spring to reset the moving arm.

All tripping contacts are connected in parallel which allows tripping by the CO long time element, IT-1 plus time delay, or IT-2 instantaneously, depending on the relative element settings and current magnitude.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Contactor Switch

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

CHARACTERISTICS

The typical current ranges of the elements of the type CO-4 relays are as follows:

Long time overcurrent element 4 to 15 amperes with taps at 4-5-6-8-10-12 and 15 amperes.

IT-1 instantaneous element 10 to 40 amperes.

Current range of timer 10 to 100 amperes.

IT-2 instantaneous element 20 to 80 amperes.

The typical operating curves of the Long time element are shown by figure 1.

The typical band curves of the overall operating characteristic of the type CO-4 relay are shown by figure 2.

Trip Circuit

The main contacts will safely close 30 amperes at 250 V. d.c., and the switch contacts will safely carry this current long enough to trip a breaker.

The trip circuit consists of a 2 ampere contactor switch connected in series with the tripping contact and two one ampere operation indicators. One operation indicator indicates tripping that takes place through the Long time CO element or IT-1, plus time delay and the other indicator indicates tripping by means of the IT-2 contacts.

Resistance of the operation indicator is 0.16 ohms and of the contacts switch is 0.25 ohms.

SETTINGS

The settings to be made to obtain an operating characteristic similar to that indicated by the example curve of figure 2 are: tap and time lever position of the CO long time element for the low current, IT-1 pick up and timer contact position for intermediate currents and IT-2 pick up for high currents.

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

* All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Overcurrent Element (Long Time)

Shift the position of the contact stop on the time lever and adjust the 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 tap block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test are as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field.

Instantaneous Trip Attachment (IT-1 and IT-2)

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately $\pm$ 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pick-up.

Synchronous Timer

When testing the synchronous timer, complete the transformer circuit by a jumper around the contacts of the IT-1 element. Test the motor at 10 amperes (or the current indicated by the minimum possible setting of the IT-1 element) thru the current circuit that includes the auxiliary transformer primary. This is the minimum current at which the timer will run in synchronism.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay

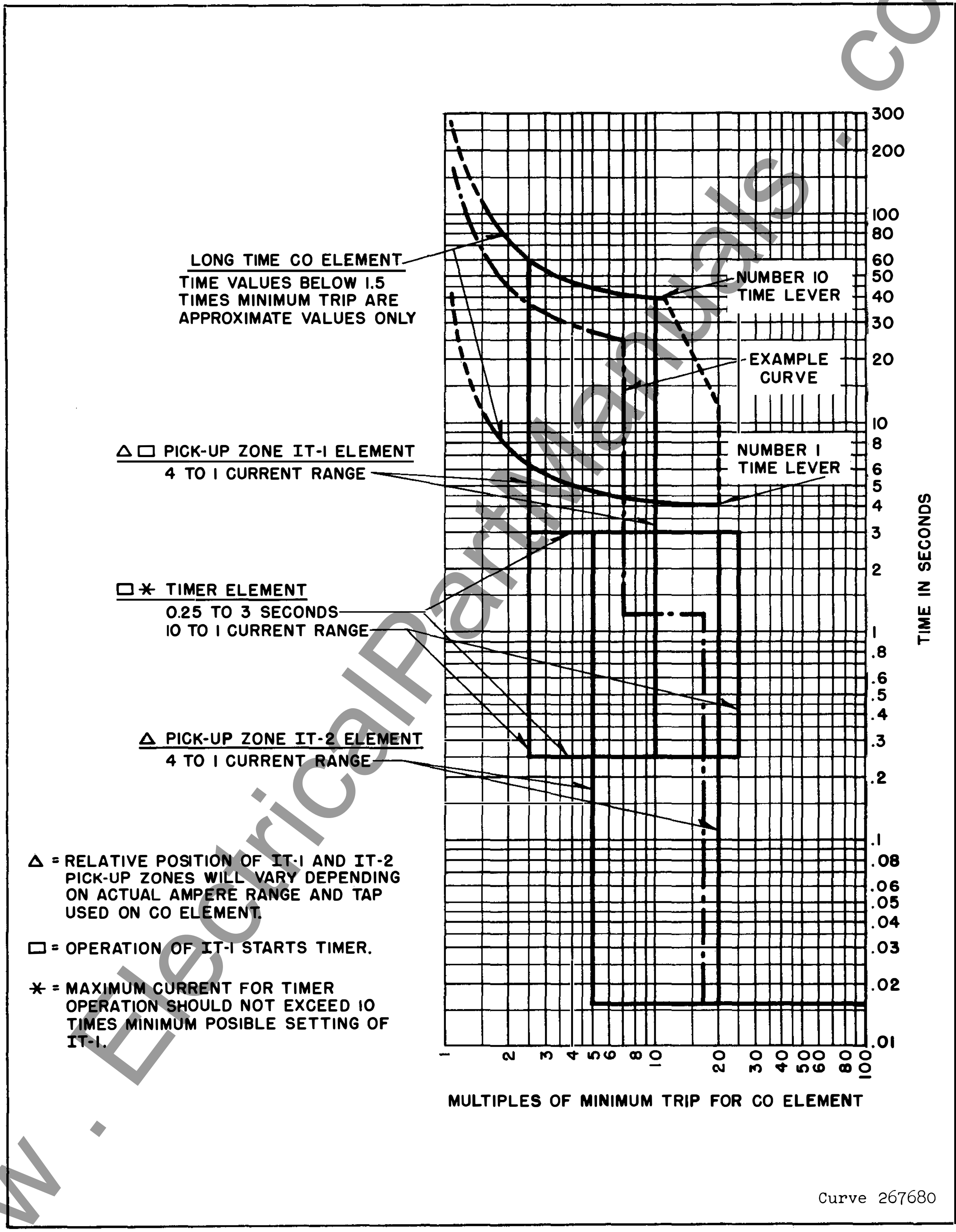

Fig. 2—Typical Current Time Curve Bands for the Type CO-4 Relay.

upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d.c. Test for sticking after 30 amperes d-c have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current has been applied.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete name-plate data.

ENERGY REQUIREMENTS

The burden of each of the instantaneous elements (IT-1 and IT-2) at 5 amperes 60 cycles is as follows:

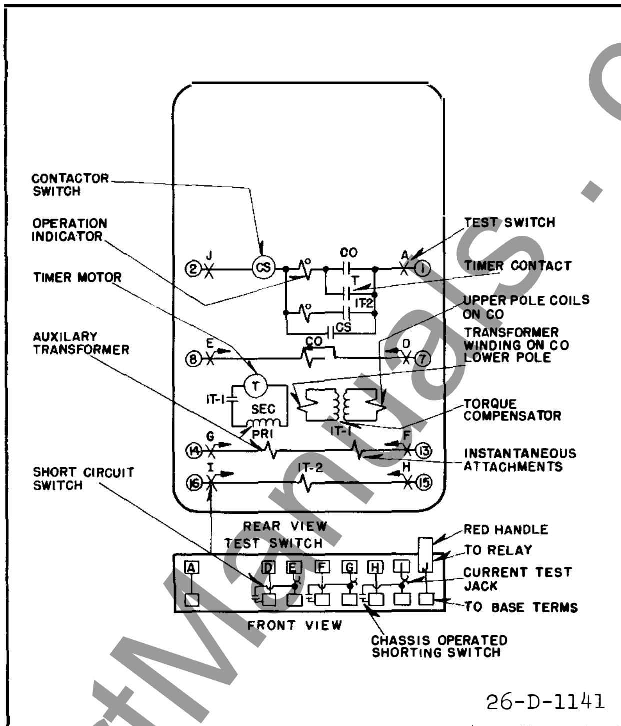

Fig. 3—Internal Schematic of the Type CO-4 Relay in the Type FT Case.

Ampere Range	Voltamperes Min. Setting	P.F. Angle (Lag)
10-40	0.13	26°
20-80	0.03	26°

The saturation data for the long time CO element at 60 cycles is as follows:

Multiples of tap value current	1	3	10	20
V.A. Burden	17	100	490	1300

The burden of the timer and auxiliary transformer at 5 amperes 60 cycles is as follows for IT-1 range of 10 to 40.

IT-1 contact open	0.7 VA at 80° lag.
IT-1 contact close	0.6 VA at 65° lag.

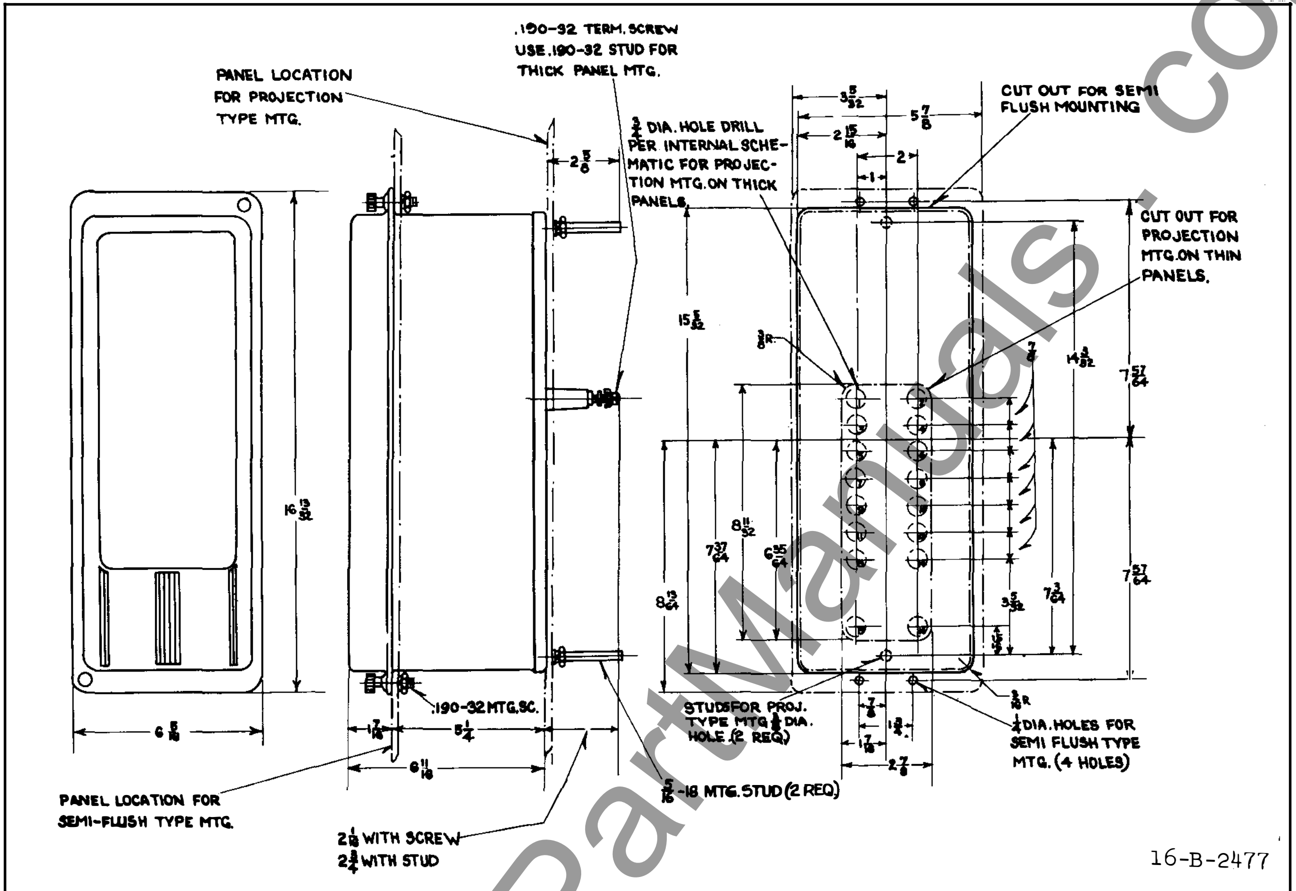

Fig. 4—Outline & Drilling for FT Case. (Reference Only)

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CO-10 OVERCURRENT RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value for a specific length of time.

The type CO-10 relay current vs time characteristic make it particularly suitable for applications that require the coordination between fuses and relays, also as an overcurrent relay for distribution circuits.

CONSTRUCTION AND OPERATION

The type CO-10 relay consists of an overcurrent element, and operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contacts is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft.

The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front.

Contactor Switch

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid

*SUPERSEDES I. L. 41-280.5B
*Denotes change from superseded issue.

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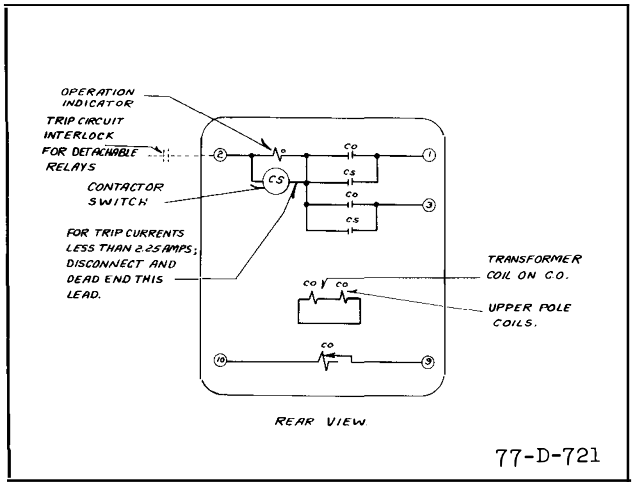

Fig. 1—Internal Schematic Of The Double Trip Circuit Closing Type CO-10 Relays In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

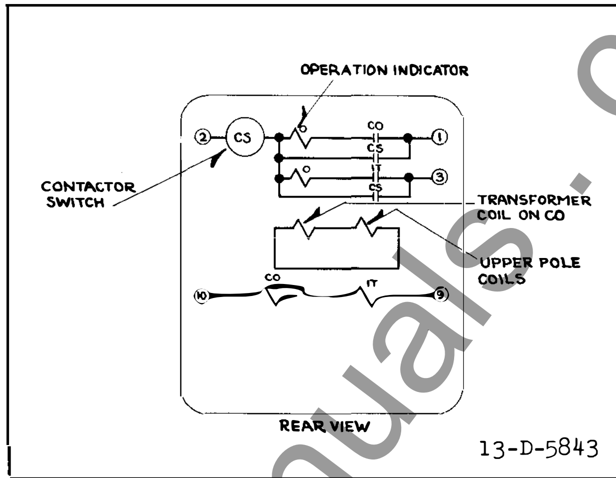

Fig. 2—Internal Schematic Of The Single Trip Circuit Closing Type CO-10 Relays With Instantaneous Trip Attachment In The Standard Case.

coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid switch whose coil is connected in the main current circuit. It functions to energize the breaker trip coil instantaneously and independently of power direction when the fault current is exceptionally heavy.

A cylindrical plunger rides up and down on a vertical guide rod in the center of a solenoid core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger thru a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contacts remain stationary. Thus a-c vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws in the bottom of the guide rod and is locked in place by a small nut. Its position determines the pick-up current of the element.

CHARACTERISTICS

The type CO-10 relay is available in the following current ranges:

.5 - .6 - .8 - 1.0 - 1.5 - 2.0 - 2.5

2.0 - 2.5 - 3.0 - 3.6 - 4.0 - 5.2 - 6.0

4.0 - 5.2 - 6.0 - 7.2 - 8 - 9 -12

The tap value is the minimum current required to just close the relay contacts. In addition to the taps, the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 11 division.

Trip Circuit

The main contacts will safely close 30 amperes at 250 v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the

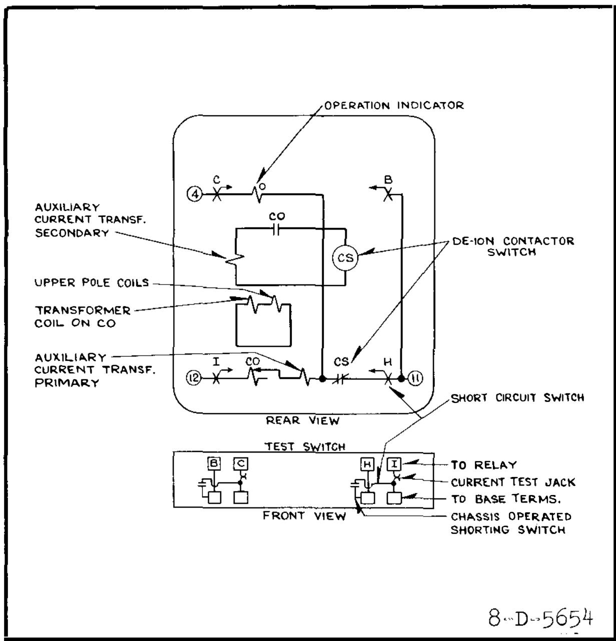

Fig. 3—Internal Schematic Of The Single Trip Circuit Opening Type CO-10 Relay In The Type FT Case.

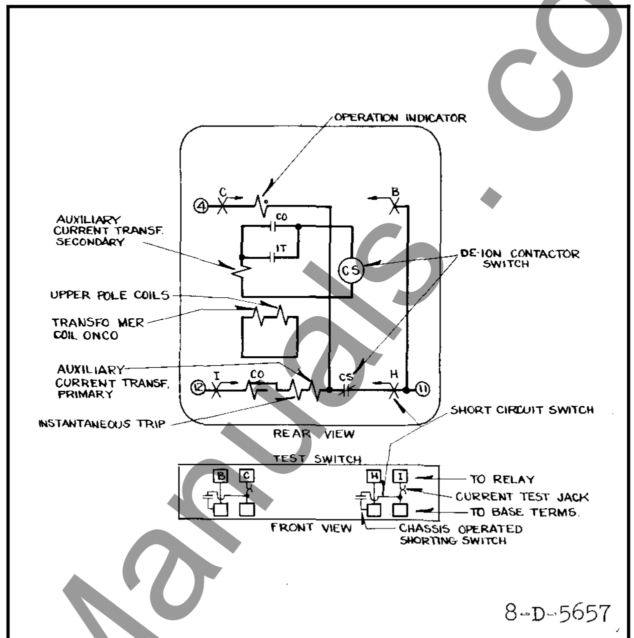

Fig. 4—Internal Schematic Of The Single Trip Circuit Opening Type CO-10 Relay With Instantaneous Trip Attachment In The Type FT Case.

coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay With Quick-Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done, the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere target.......2.8 ohms
Resistance of 2.0 ampere Contactor Switch..... 0.25 ohm
Resistance of Target and Switch in Parallel... 0.23 ohm

Trip Circuit With Instantaneous Trip

Resistance of 1.0 ampere target.......0.16 ohm
Resistance of 2.0 ampere Contactor Switch..... 0.25 ohm
Resistance of Target and Switch in Series..... 0.41 ohm

* INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of

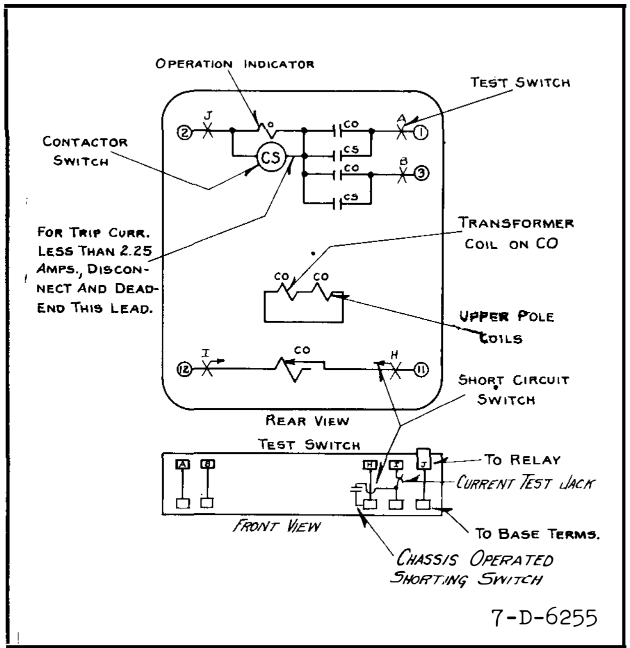

Fig. 5—Internal Schematic Of The Double Trip Circuit Closing Type CO-10 Relays In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

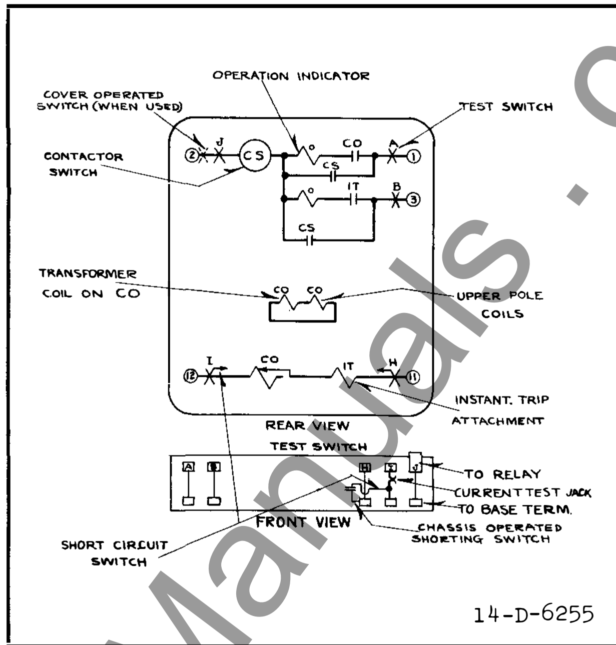

Fig. 6—Internal Schematic Of The Single Trip Circuit Closing Type CO-10 Relays With Instantaneous Trip Attachment In The Type FT Case.

the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

SETTINGS

There are two settings - namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 4.0 - 5.2 - 6.0 - 7.2 8 - 9 - 12 amperes, or as marked on the terminal plate.

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 circuits 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 Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figure.5.

ADJUSTMENTS AND MAINTENANCE

All relays should be inspected periodically and the time of operation should be checked at least once every six months. 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.

* All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

Overcurrent Element

Shift the position of the contact stop on the time lever and adjust the 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 tap block. Shift the position of the damping magnets so that the time characteristics of the relay, are as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The adjustment of spring tension has a great effect on the time curve for values, below 1.5 times minimum trip. Therefore slight changes of spring tension is an adjustment that may be used when recalibrating a type CO-10 relay. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c as supplied gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current have been applied.

Instantaneous Trip Attachement

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the

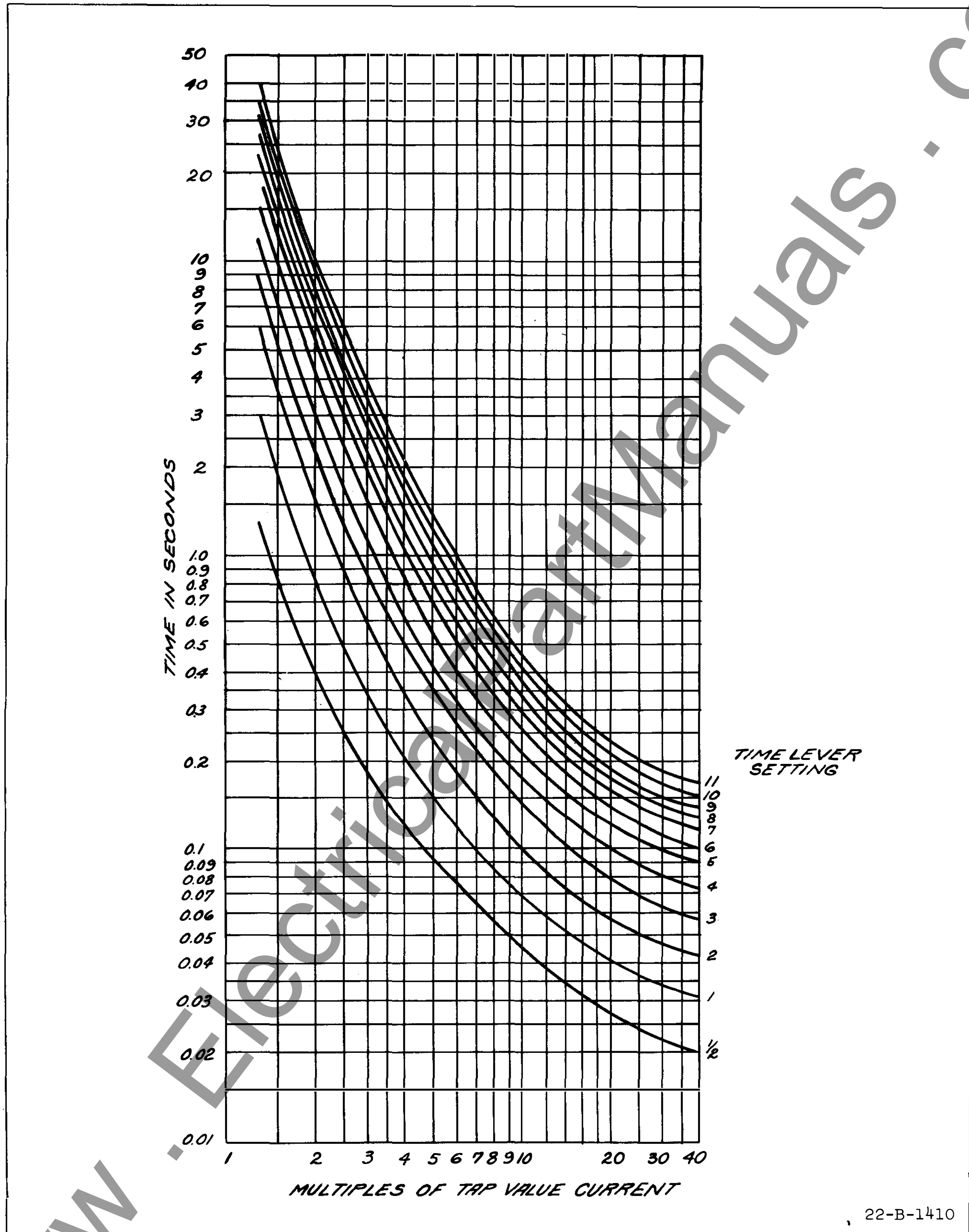

Fig. 7—Typical 60 Cycle Time Curve For The Type CO-10 Relay.

limits of approximately plus or minus 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch and after the final adjustment is made, the core screw should be securely locked in place with the locknut. It should be adjusted for about 2/3 of the minimum pick-up.

BURDEN

The burden of the type CO-10 relay is very low and ranges from 0.30 volt amps to 0.5 volt amps at 65 degrees current lagging the voltage for tap value current.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete name-plate data.

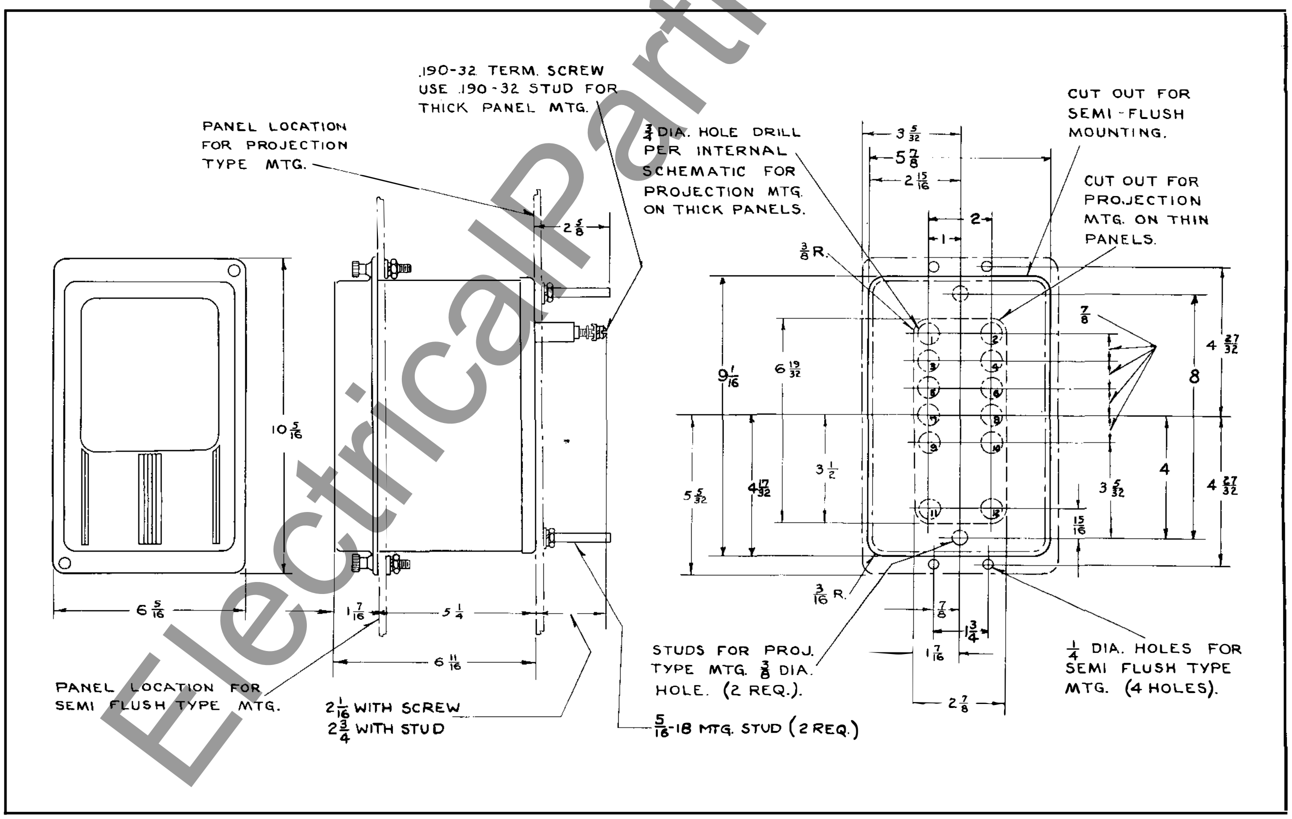

Fig. 8—Outline And Drilling Plan For The Type CO-10 Relay In The S10 Projection Or Semi-Flush Type FT Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

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INSTRUCTIONS

TYPE COI OVERCURRENT RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value for a specific length of time.

The relay can be supplied with the upper pole circuit brought out to separate terminals. This variety is known as the type COI Torque Control Relay. Thus the contacts of a separate relay can be used to control the operation of the torque control relay. For example, a three phase directional relay can be used to directionally control three torque control relays.

CONSTRUCTION AND OPERATION

The type COI relay consists of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

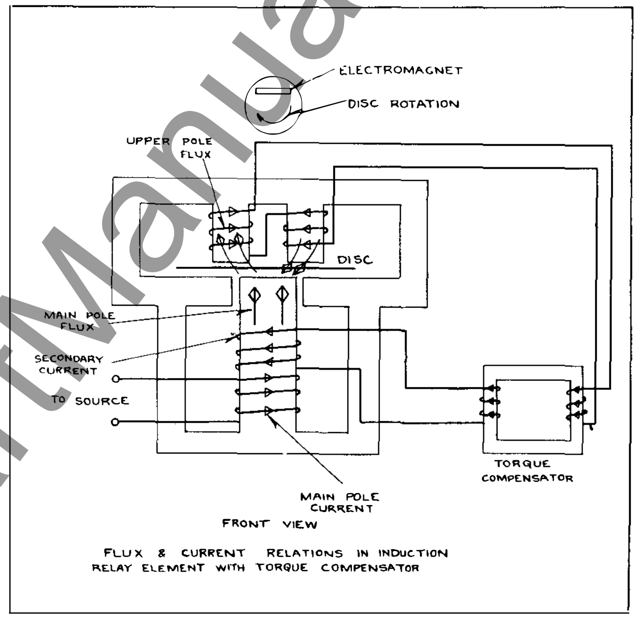

Fig. 1—Flux and Current Relations in the Type COI Relay.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft.

The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent

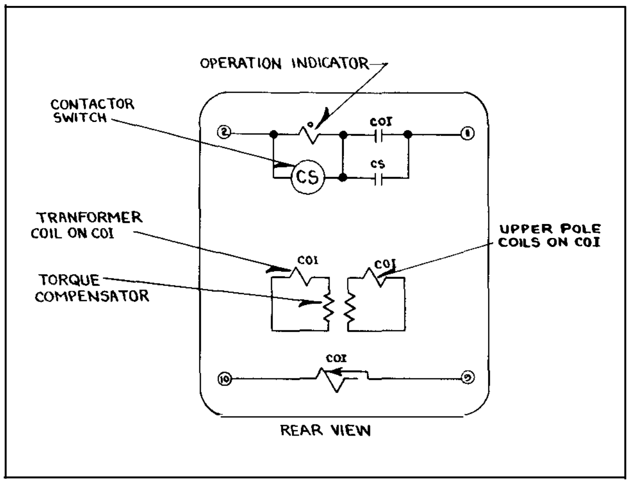

Fig. 2—Internal Schematic of the Single Trip Type COI Relay in the Standard Case.

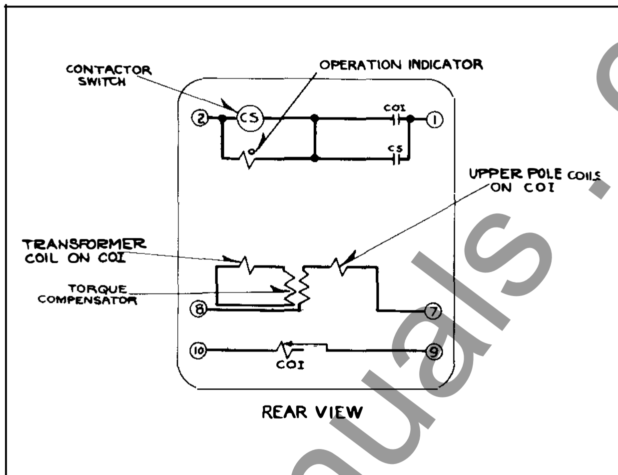

Fig. 3—Internal Schematic of the Single Trip Type COI Relay With External Torque Control Terminals in the Standard Case.

magnet in the front. The operating torque is obtained by the circuit arrangement shown in figure 1. The main pole coil of the relay acts as a transformer and induces a voltage in a secondary coil. Current from this secondary coil flows through the primary of a small saturating transformer. The secondary current from this transformer flows through the upper pole coils and thus produces torque on the disc by the reaction between the fluxes of the upper and lower poles.

The small saturating transformer slows down the disc movement to such an extent that no gearing is required to obtain the inverse time characteristic.

Contactor Switch

The d-c contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid switch whose coil is connected in the main current circuit. It functions to energize the breaker trip coil instantaneously and independently of power direction when the fault current is exceptionally heavy.

A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger thru a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contacts remain stationary. Thus a-c vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is

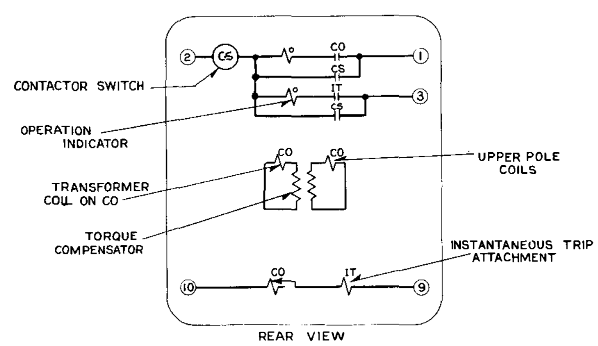

Fig. 4—Internal Schematic of the Single Trip Type COI Relay With Instantaneous Trip in the Standard Case. The Relay With External Torque Control Has Terminals 7 and 8 Per Figure 3.

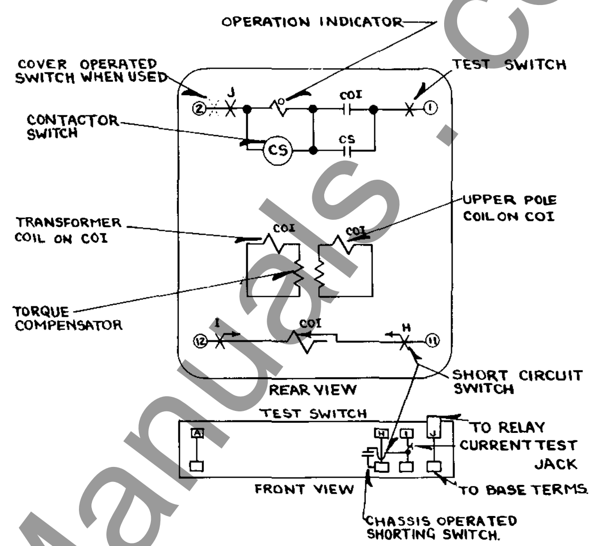

Fig. 5—Internal Schematic of the Single Trip Type COI Relay in the Type FT Case.

locked in place by a small nut. Its position determines the pick-up current of the element.

CHARACTERISTICS

The type COI relay is available in either of the following current ranges:

2 - 2.5 - 3 - 3.5 - 4 - 5 - 6
4 - 5 - 6 - 8 - 10 - 12 - 15

The tap value is the minimum current required to just close the relay contacts. In addition to the taps, the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 11 divisions.

The instantaneous lock-out attachment has a 3 to 1 range with typical ranges similar to the instantaneous trip attachment.

Trip Circuit

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it

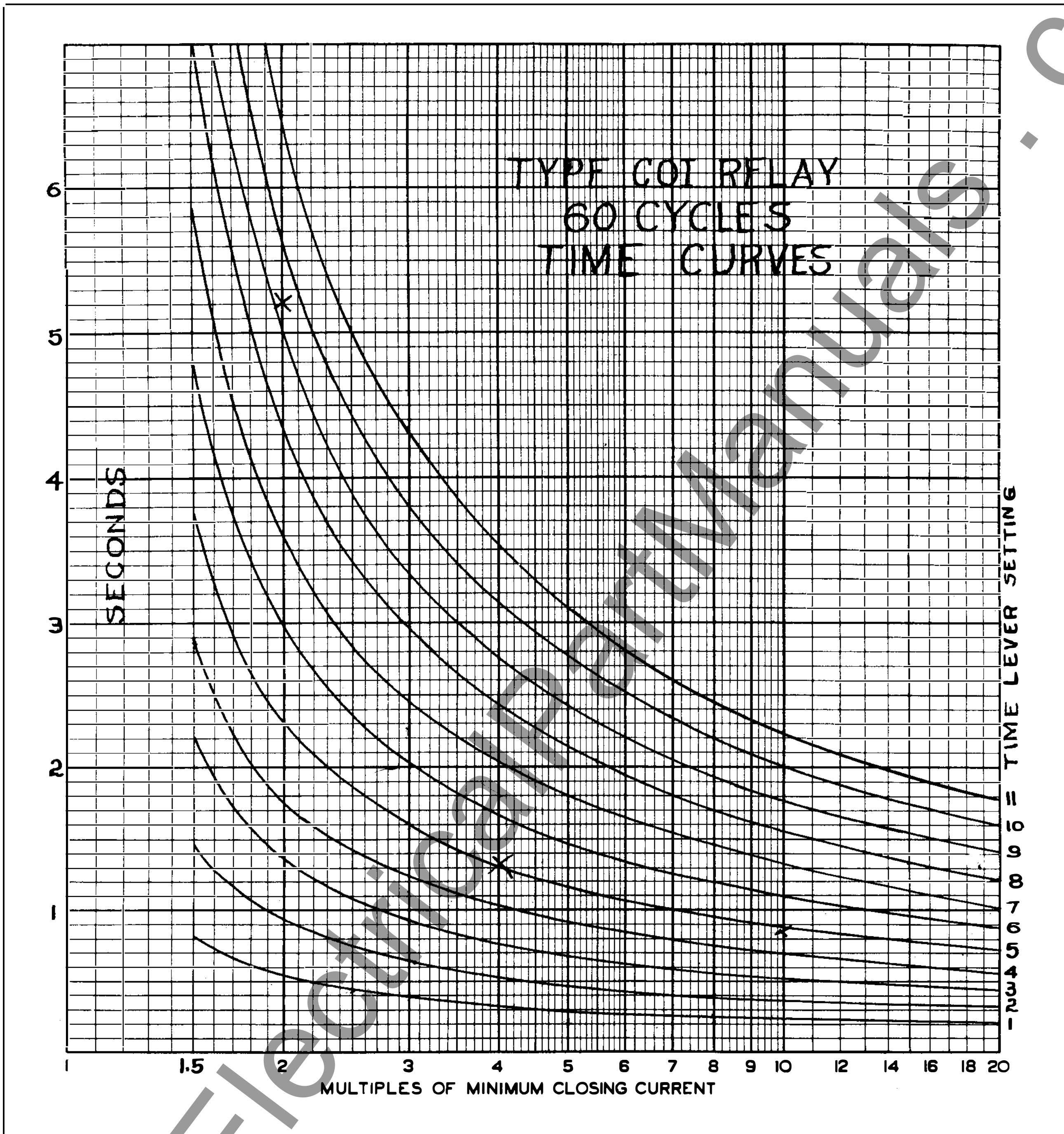

Fig. 6—Typical 60 Cycle Time Curves for the Type COI Relay.

is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done, the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere Target..... 2.8 ohms

Resistance of 2.0 ampere Contactor Switch............................... 0.25 ohm

Resistance of Target and Switch on Parallel............................ 0.23 ohm

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target..... 0.16 ohm

Resistance of 2.0 ampere Contactor Switch............................... 0.25 ohm

Resistance of Target and Switch in Series................................ 0.41 ohm

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

Removing Chassis:

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before opening any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position for test as well as on its back or sides for easy inspection and maintenance.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and

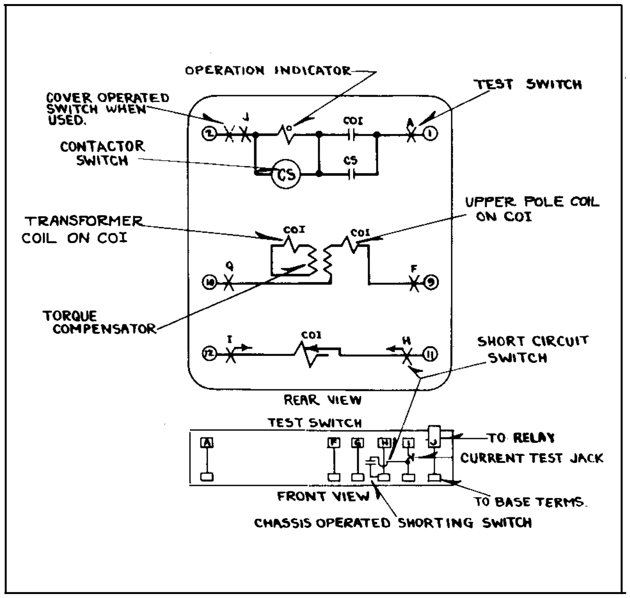

Fig. 7—Internal Schematic of the Single Trip Type COI Relay With External Torque Control Terminals in the Type FT Case.

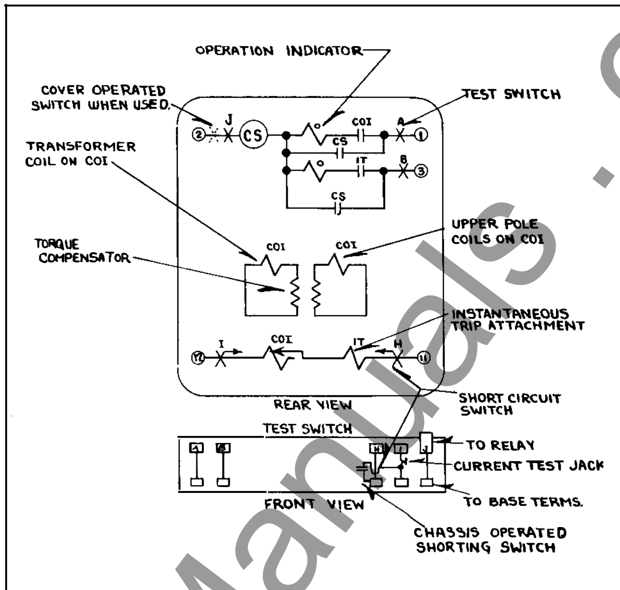

Fig. 8—Internal Schematic of the Single Trip Type COI Relay With Instantaneous Trip in the Type FT Case. The Relay With External Torque Control Has Terminals 9 and 10 Per Figure 7.

bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

Testing in Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing in Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above under "Electrical Circuits".

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage. It is recommended that the relay be checked in position as a final check on the calibration.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

SETTINGS

There are two settings - namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 which 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 affecting the operating characteristics of the relay. For example, on the 4 to 15 amp. 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 circuits 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 Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figure 6.

ADJUSTMENTS AND MAINTENANCE

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.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

Overcurrent Element

Shift the position of the contact stop on the time lever and adjust the contacts so that they barely touch when the time lever is set on zero.

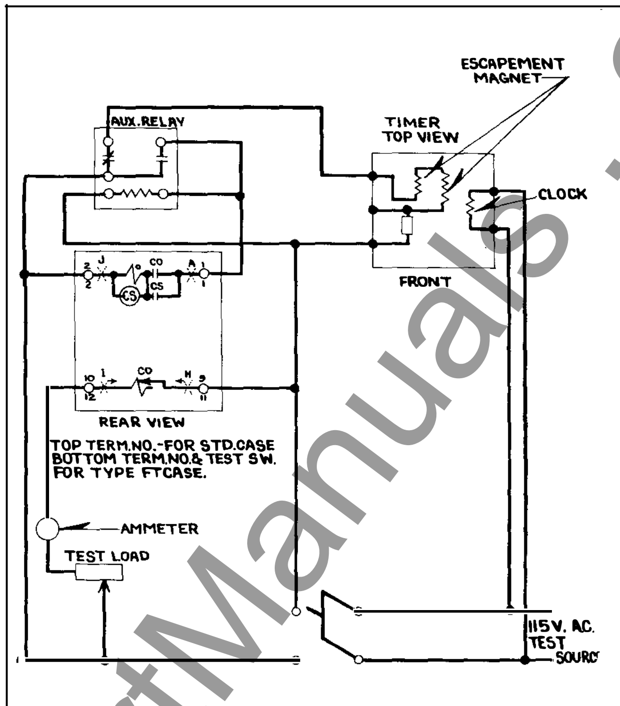

Fig. 9—Diagram of Test Connections for the Type COI Relay.

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 tap 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 as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field. If the relay has a metal cover, this cover must be in place when making tests.

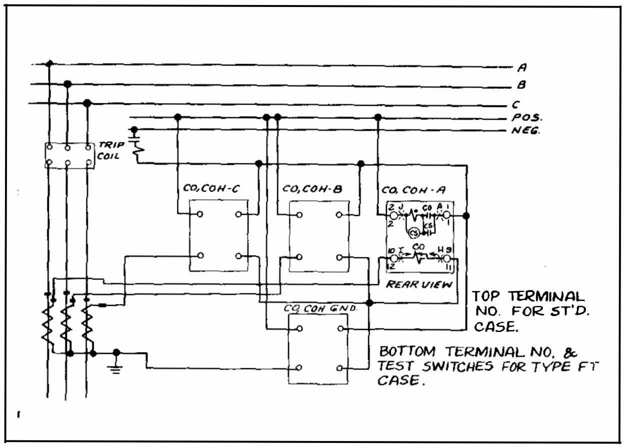

Fig. 10—External Connections of the Type COI Relay for Phase and Ground Overcurrent Protection of a Three Phase System.

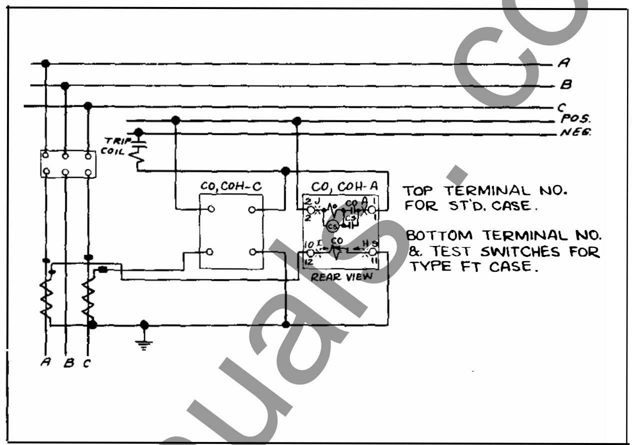

Fig. 11—External Connections of the Type COI Relay for Phase Overcurrent Protection of an Ungrounded Three Phase System.

The relays with torque control terminals will not operate until these terminals are short-circuited either by a jumper or by the external control contacts.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c as supplied gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current has been applied.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately ± 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pick-up.

Instantaneous Lock-Out Attachment

The position of the bottom of the plunger with reference to the calibrated guide indicates the minimum current required to open the contacts. To change the setting hold the top slotted head of the plunger rod fixed with a screwdriver. Then with a second screwdriver adjust the lower end of the plunger for the current pick-up desired.

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. The nominal range of adjustment is 3 to 1.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

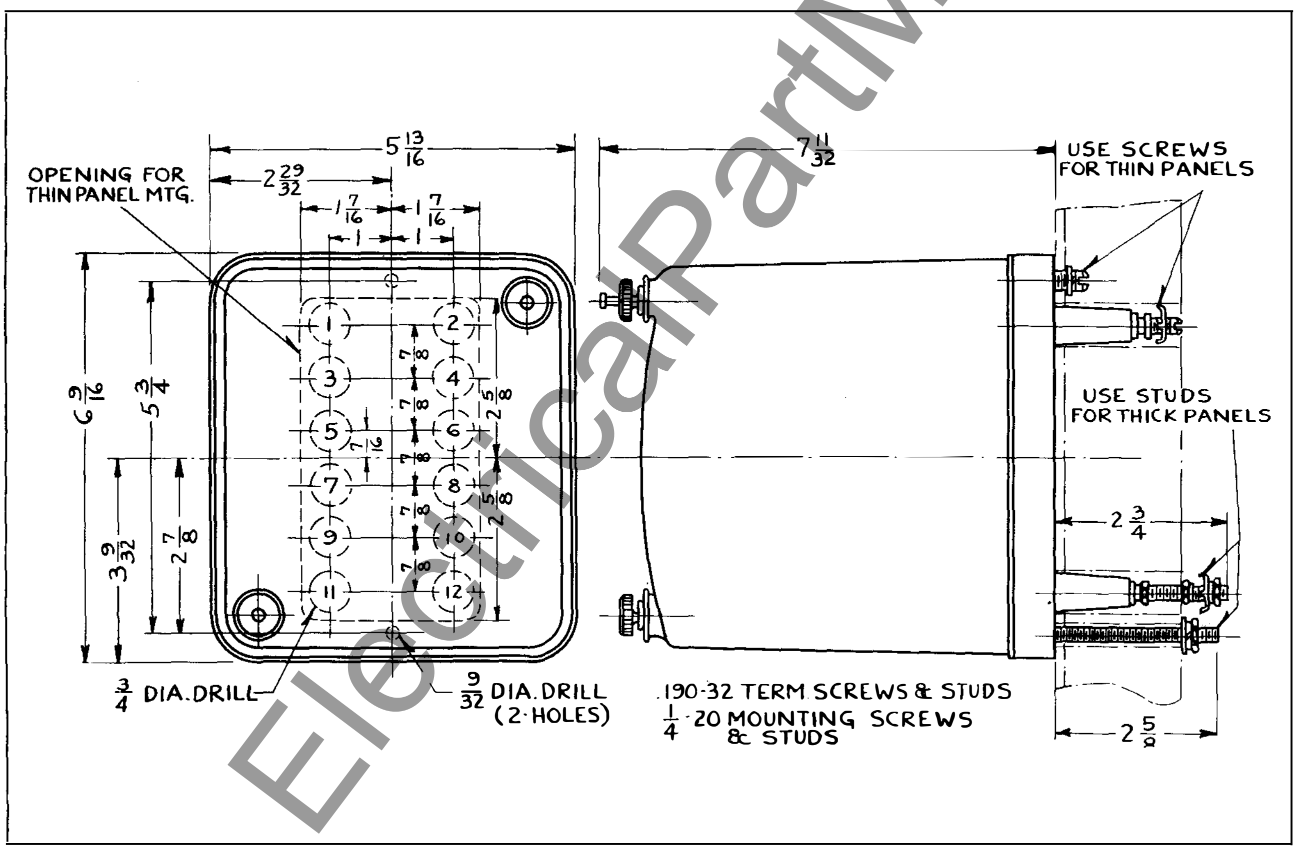

Fig. 12—Outline and Drilling Plan for the Standard Case Relay. See The Internal Schematics for the Terminals Supplied. For Reference Only.

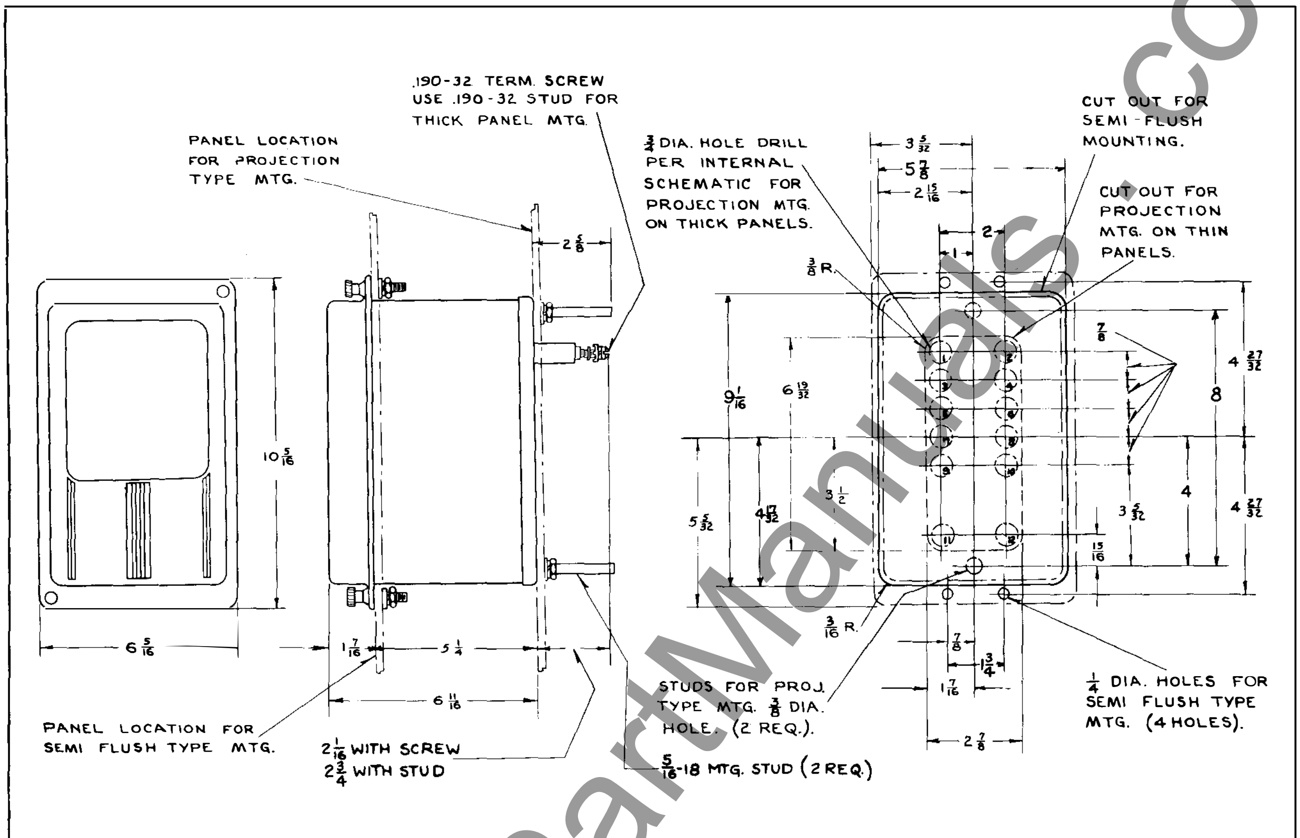

Fig. 13—Outline & Drilling Plan for the S10 Semi-flush or Projection Type FT Flexitest Case. See the Internal Schematics For The Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

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Westinghouse

Types CO and COH Overcurrent Relays

INSTRUCTIONS

CAUTION

Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker. Where low voltage or no station battery exists, the circuit opening type relay in conjunction with a-c series trip coils can be used to open the breaker.

The inverse time (low-energy) type relay is used in preference to the definite minimum time (standard energy) relay where the requirements necessitate (1) a lower burden on the current transformer, or (2) a more inverse curve for selectivity, or (3) a very low current range as for example, ground protection of transmission systems.

The very-inverse time (low-energy) relay is similar to the inverse relay and is used where a still more inverse curve is desired. The term "low energy" refers to the burden at tap value that is placed on the current transformers and does not refer to the current rating.

The long time (40 second) relay is designed to protect motors against overloads. This can be equipped with an instantaneous attachment that will operate, if a short-circuit occurs in the motor.

The type COH relay finds application for phase and ground protection where a high speed induction type relay is desired. It is sometimes used in differential protective schemes.

The above relays can be supplied with the secondary electromagnet circuit brought out to separate terminals. This variety is known as the type CO or COH Torque Control Relay. Thus the contacts of a separate relay can be used to control the operation of the torque control relay. For example, a three phase directional relay can be used to directionally control three torque control relays.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay

The circuit-closing types CO and COH relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft in the non-geared type relays, or to an auxiliary shaft geared to the disc shaft in the geared type relays. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front. The operating torque of the inverse or very inverse relays is obtained by the circuit arrangement shown in Figure 1. The main pole coil of the relay acts as a transformer and induces a voltage in a secondary coil. Current from this secondary coil flows through the upper pole coils and thus produces torque on the disk by the reaction between the fluxes of the upper and lower poles.

The definite-time relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper pole coils. This is called the torque compensator and it slows down the disk movement to such an extent that no gearing is required. (See Figure 2).

The long time relay is a geared relay with a torque compensator.

The type COH relay is a non-geared relay without a torque compensator.

Contactor Switch

The d-c. contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

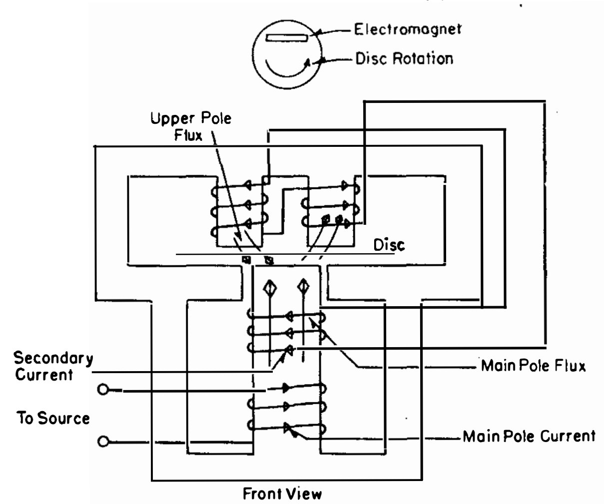

FIGURE 1—FLUX AND CURRENT RELATIONS IN THE INVERSE OR VERY INVERSE TIME RELAYS WITHOUT THE TORQUE COMPENSATOR.

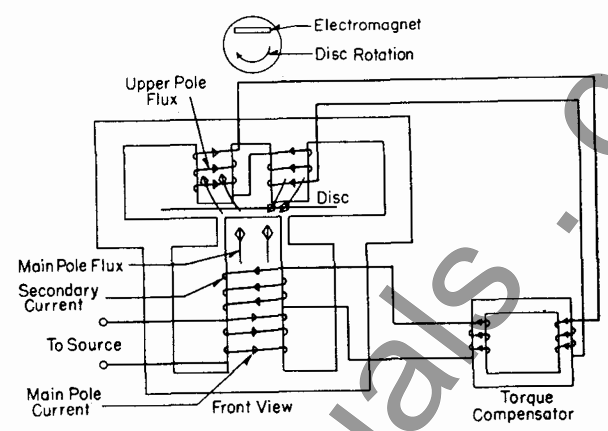

FIGURE 2—FLUX AND CURRENT RELATIONS IN THE DEFINITE MINIMUM TIME RELAYS WITH THE TORQUE COMPENSATOR.

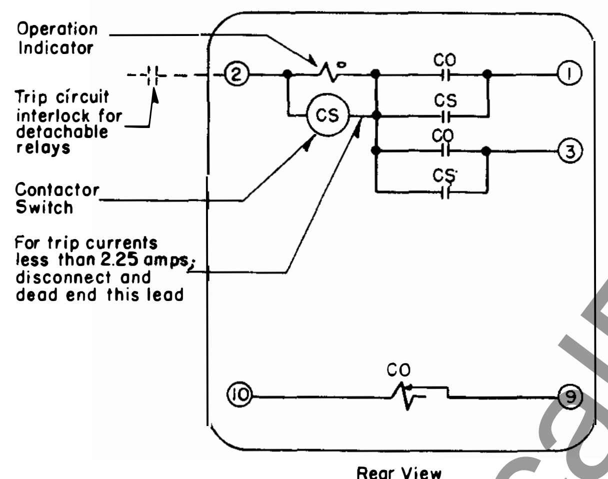

FIGURE 3—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

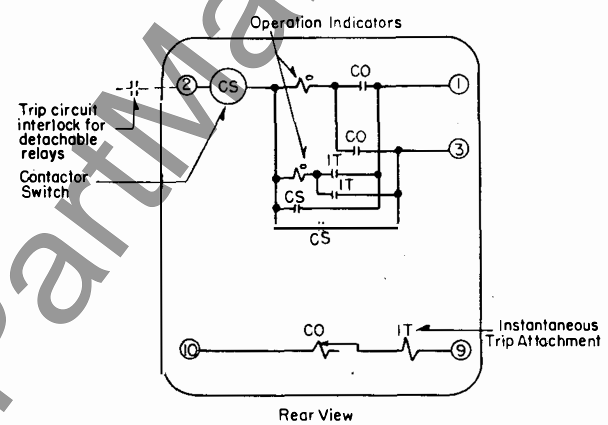

FIGURE 4—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

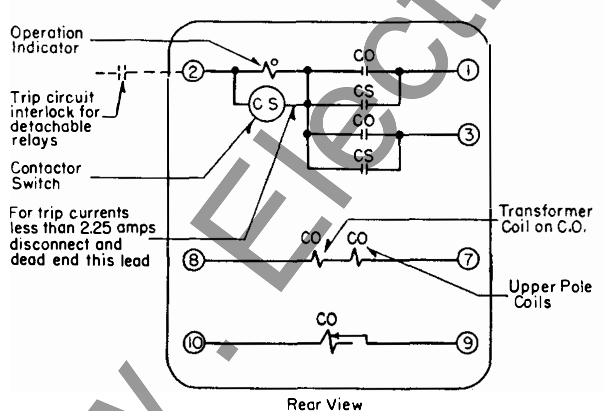

FIGURE 5—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING INVERSE AND VERY INVERSE TYPES CO AND COH RELAYS WITH TORQUE CONTROL TERMINALS IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

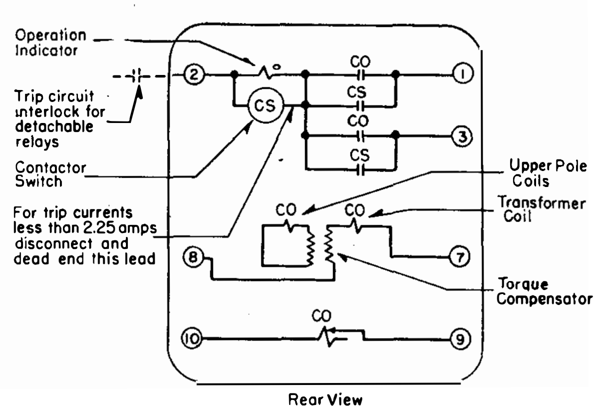

FIGURE 6—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING DEFINITE MINIMUM TIME TYPE CO RELAY WITH TORQUE CONTROL TERMINALS IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

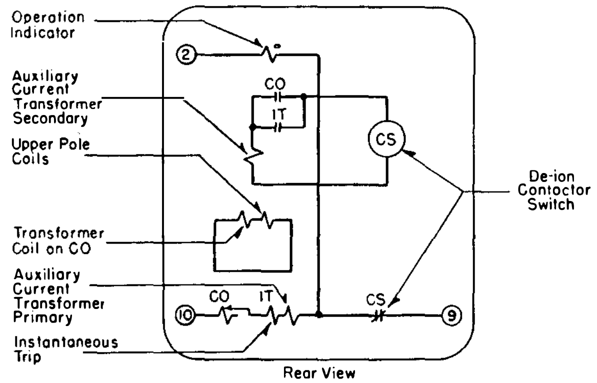

FIGURE 7—INTERNAL SCHEMATIC OF THE CIRCUIT OPENING INVERSE AND VERY INVERSE TIME TYPE CO RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE STANDARD CASE.

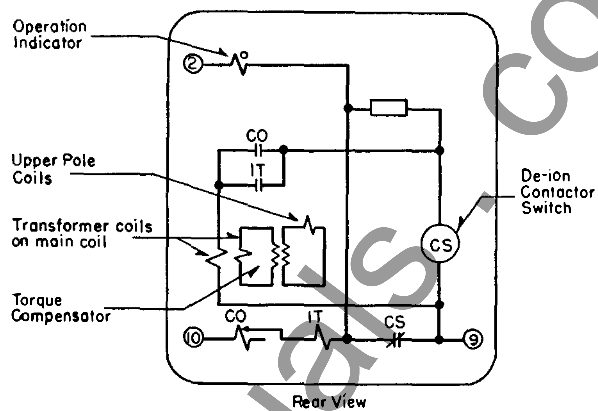

FIGURE 8—INTERNAL SCHEMATIC OF THE CIRCUIT OPENING DEFINITE MINIMUM TIME TYPE CO RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE STANDARD CASE.

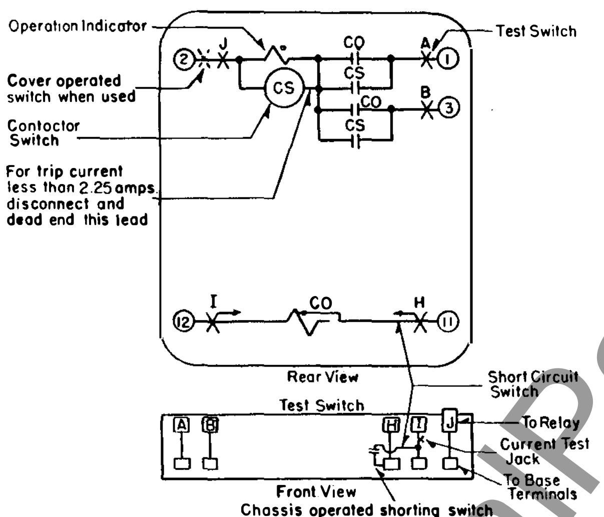

FIGURE 9—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

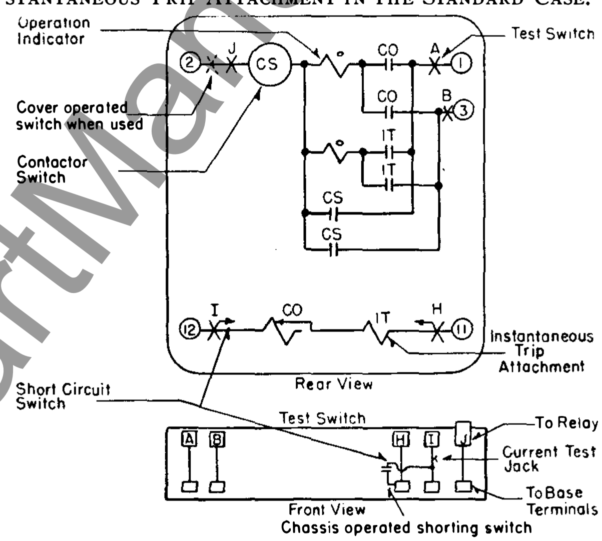

FIGURE 10—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

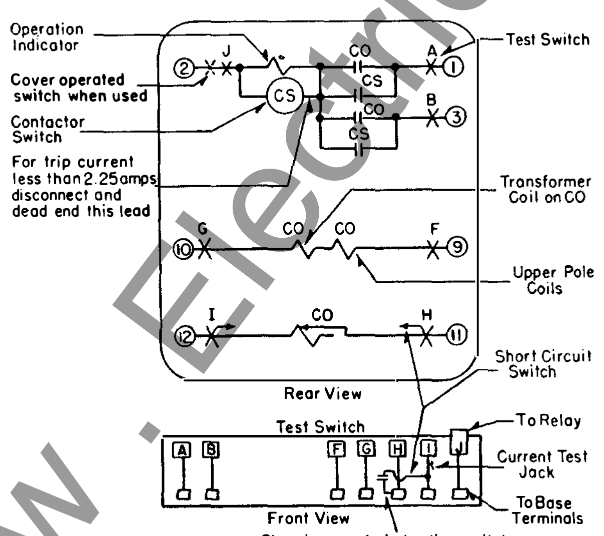

FIGURE 11—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING INVERSE AND VERY INVERSE TYPES CO AND COH RELAYS WITH TORQUE CONTROL TERMINALS IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

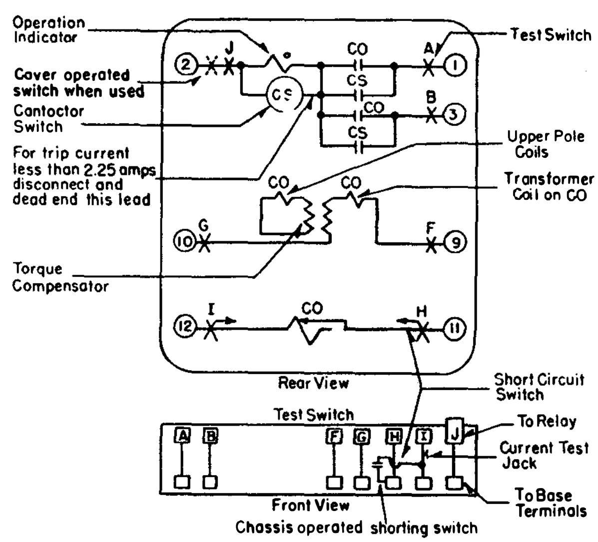

FIGURE 12—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING DEFINITE MINIMUM TIME TYPE CO RELAY WITH TORQUE CONTROL TERMINALS IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc is fastened to the bottom of the guide rod by two small nuts. Its position determines the pick-up current of the element.

Instantaneous Lock-Out Attachment (When Supplied)

The lock-out attachment is used to prevent the relay from tripping a circuit breaker when the current is too high—above its interrupting capacity.

CIRCUIT-OPENING RELAY

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, an operation indicator and an instantaneous trip attachment where required.

Overcurrent Element

The overcurrent construction and operation is similar to that described for the circuit closing relays.

De-ion Contactor Switch

This switch is a small a-c. solenoid switch whose coil is energized from a few turns on the lower pole of the overcurrent element in the standard-energy type relays, and from a small transformer connected in the main current circuit in the low-energy type relays. Its construction is similar to the d-c. type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

The transformer coil on the lower pole of the overcurrent element and the contactor switch circuits in the standard energy type relays are connected to the main circuits as shown in Figures 8 and 14. When the overcurrent contact closes, the contactor switch operates, and the voltage across the trip coil is impressed on the transformer and contactor switch coils. This voltage acts to seal-in the contactor switch, and to feed energy through the transformer coil to the main overcurrent winding which produces contact closing torque. This arrangement provides a definite minimum pick-up value largely independent of the value of trip coil impedance.

Operation Indicator

The operation indicator is in series with the breaker trip coil. Its construction is as described above.

CHARACTERISTICS

The type CO definite minimum time (standard energy) or long time (40 second) circuit closing relay is available in either of the following current ranges.

2	2.5	3	3.5	4	5	6
4	5	6	8	10	12	15

The type CO inverse, very inverse (low energy) or the type COH circuit closing relay is available in the following current ranges.

0.5	0.6	0.8	1.0	1.5	2.0	2.5
2	2.5	3	3.5	4	5	6
4	5	6	8	10	12	15

The type CO circuit-opening relay is made only in the 4 to 15 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. In addition to the taps, the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 10 divisions.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers, or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The characteristics of the various varieties of type CO and COH relays usually supplied are as shown on page 6.

The burdens and thermal ratings are listed under Energy Requirements.

The instantaneous trip attachment has a 4 to 1 range. Typical ranges are 10-40 or 20-80 but other ranges may be supplied as ordered.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

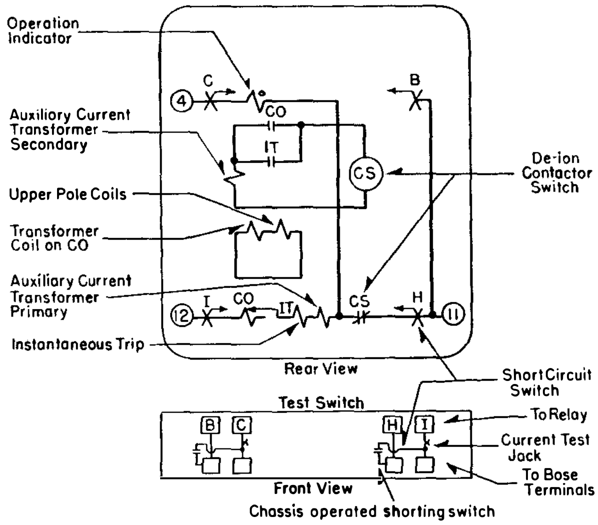

Figure 13—Internal Schematic of the Circuit Opening Inverse and Very Inverse Time Type CO Relays with Instantaneous Trip Attachment in the Type FT Case.

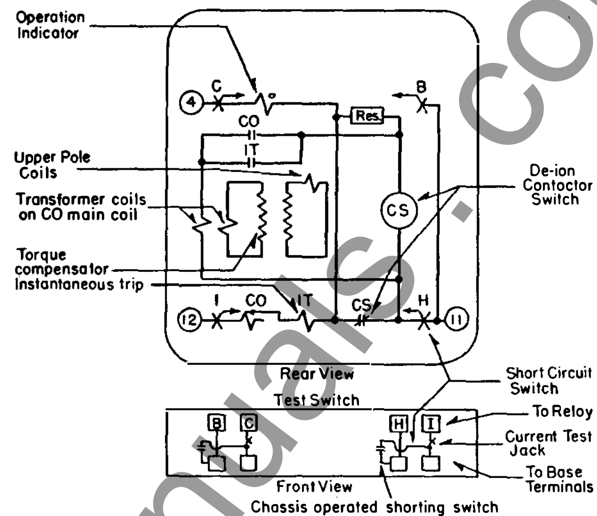

Figure 14—Internal Schematic of the Circuit Opening Definite Minimum Time Type CO Relays with Instantaneous Trip Attachment in the Type FT Case.

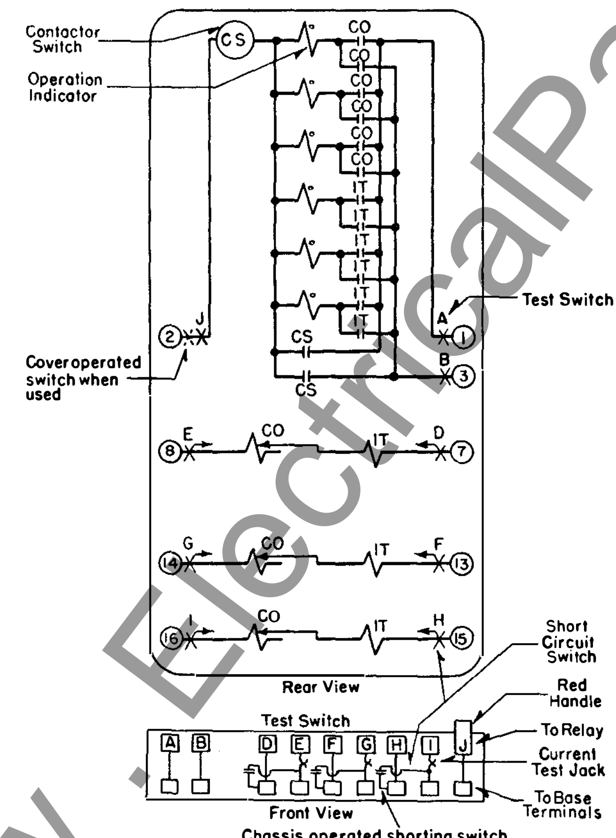

Figure 15—Internal Schematic of the Three Element Double Trip Circuit Closing Types CO and COH Relays with Instantaneous Trip Attachment in the Type FT Case. The Single Trip Relays have Terminal 3 and associated circuits omitted.

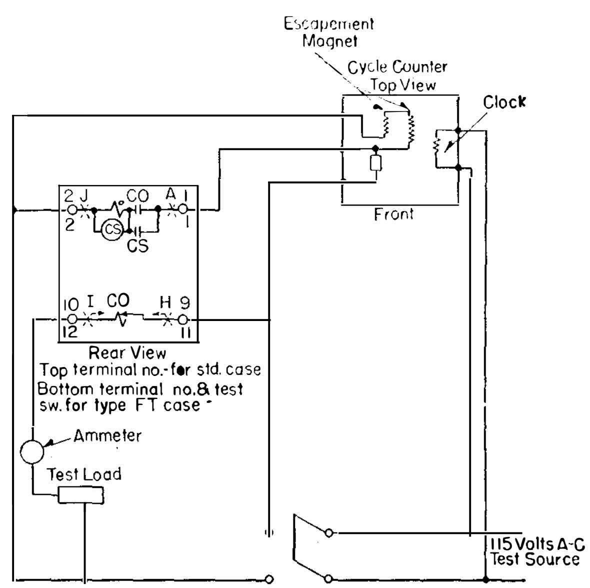

Figure 16—Diagram of Test Connections for Circuit Closing Types CO and COH.

Characteristics of CO and COH Relays

Type	Energy	Time	Approx. #10 Lever Time at 20 x Tap Value	Gearing	Torque Compensator	Schematic per Figure No.	Typical 60 Cycle Time Curve per Figure No.
CO	Std.	Definite Time	2 Sec.	Non-geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	23
CO	Std.	Definite Time	4 Sec.	Non-geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	..
CO	Low	Inverse	2 Sec.	Geared	No	3, 4, 5, 7, 9, 10, 11, 13 & 15	24
CO	Low	Inverse	4 Sec.	Geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	..
CO	Low	Very Inverse	1+ Sec.	Geared	No	3, 4, 5, 7, 9, 10, 11, 13 & 15	25
CO	Std.	Definite Time	40 Sec.	Geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	27
COH	....	Inverse	18 Cyc.	Non-Geared	No	3, 4, 5, 9, 10, 11 & 15	26

Three element relay characteristics are the same as in single element forms.

The instantaneous lock-out attachment has a 3 to 1 range with typical ranges similar to the instantaneous trip attachment.

Trip Circuit

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done, the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere Target	2.8 ohms
Resistance of 2.0 ampere Contact Switch	0.25 ohms
Resistance of Target and Switch in Parallel	0.23 ohms

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target	0.16 ohms
Resistance of 2.0 ampere Contactor Switch	0.25 ohms
Resistance of Target and Switch in Series	0.41 ohms

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

Removing Chassis:—To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches **first** before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits:—Each terminal in the base connects through a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surfaces of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately $\frac{1}{32}''$ thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

Testing:—The relays can be tested in service, in the circuits isolated or out of the case as follows:

Testing In Service—The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current through the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out through holes in the back of the insulated handle.

Voltage between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing In Case:—With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits."

Testing Out of Case:—With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values of some relays by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

Because the circuit-opening relay contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subject 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 safeguard so that there there is no danger from even an excessive shock unless the current is also heavy.

Typical external connections are shown in Figures 18 to 22. When using the circuit-opening relays for phase protection, ground protection may be secured by using a low-energy circuit-closing relay operating on a-c. voltage trip coil, as shown in Figure 22.

SETTINGS

There are two settings—namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

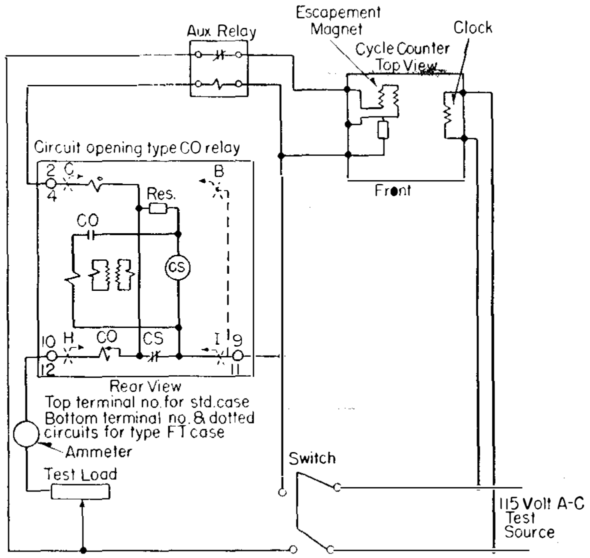

FIGURE 17—DIAGRAM OF TEST CONNECTION FOR CIRCUIT OPENING TYPE CO RELAY.

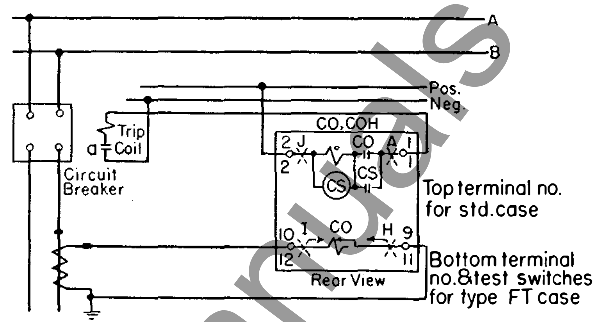

FIGURE 18—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR OVERCURRENT PROTECTION ON A SINGLE PHASE SYSTEM.

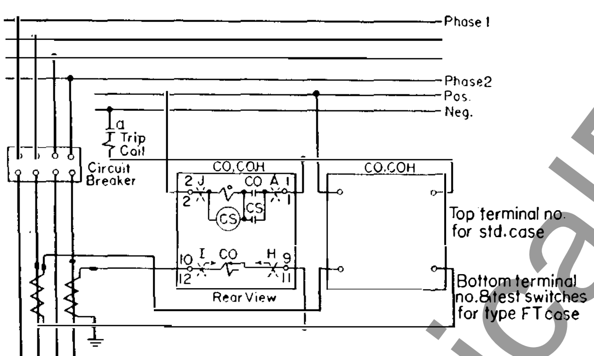

FIGURE 19—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR OVERCURRENT PROTECTION ON A TWO-PHASE SYSTEM.

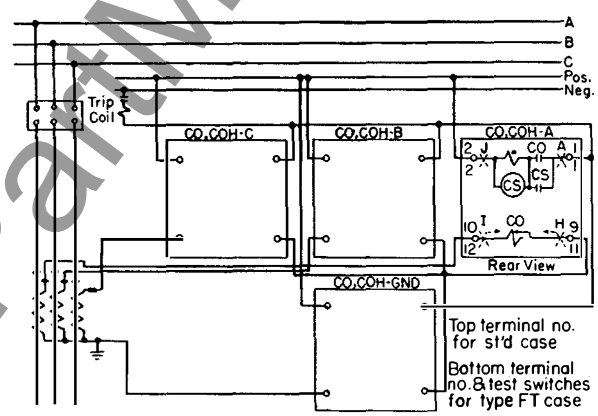

FIGURE 20—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR PHASE AND GROUND OVERCURRENT PROTECTION ON A THREE-PHASE SYSTEM.

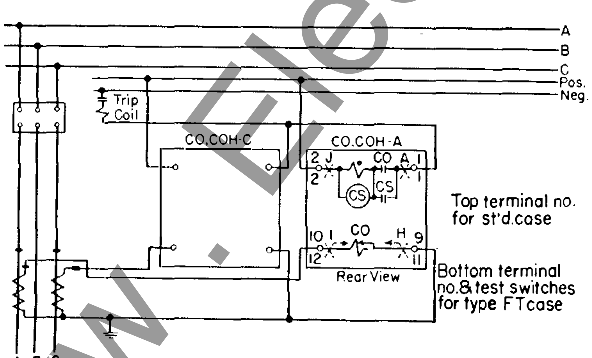

FIGURE 21—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR PHASE OVERCURRENT PROTECTION ON AN UNDERGROUND THREE-PHASE SYSTEM.

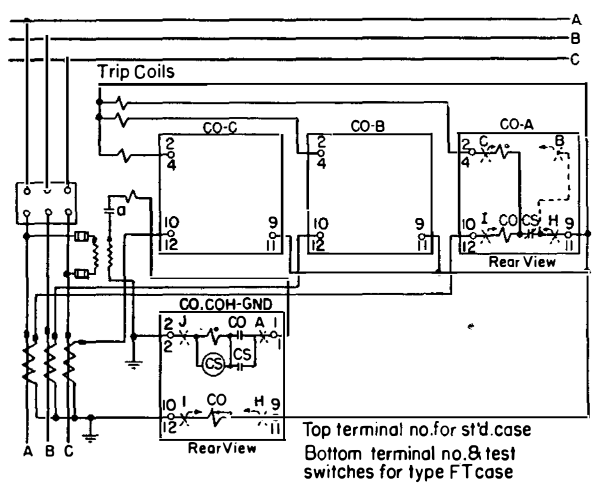

FIGURE 22—EXTERNAL CONNECTIONS OF THE CIRCUIT OPENING TYPE CO RELAY FOR PHASE OVERCURRENT PROTECTION AND OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR GROUND PROTECTION ON A THREE-PHASE SYSTEM.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 screwdriver inserted in one of the notches of the plate to which 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 affecting the operating characteristics of the relay. For example, on the 4 to 15 amp. 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 Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figures 23 to 27.

ADJUSTMENTS AND MAINTENANCE

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.

All contacts should be periodically cleaned with a fine file. S# 1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed or the relay taken apart for repairs, the following instructions should be followed in reassembling and setting it.

(Overcurrent Element Circuit-Closing Relays)

Shift the position of the contact stop on the time lever and adjust the 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 tap 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 as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operating condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field. If the relay has a metal cover, this cover must be in place when making tests.

The relays with torque control terminals will not operate until these terminals are short-circuited either by a jumper or by the external control contacts.

Contactor Switch (Circuit-Closing Relays)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the point where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for $\frac{3}{32}$ inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c. have been passed through the coil.

Operation Indicator (Circuit-Closing Relays)

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. If the two helical springs which reset the armature are replaced by new springs, they should

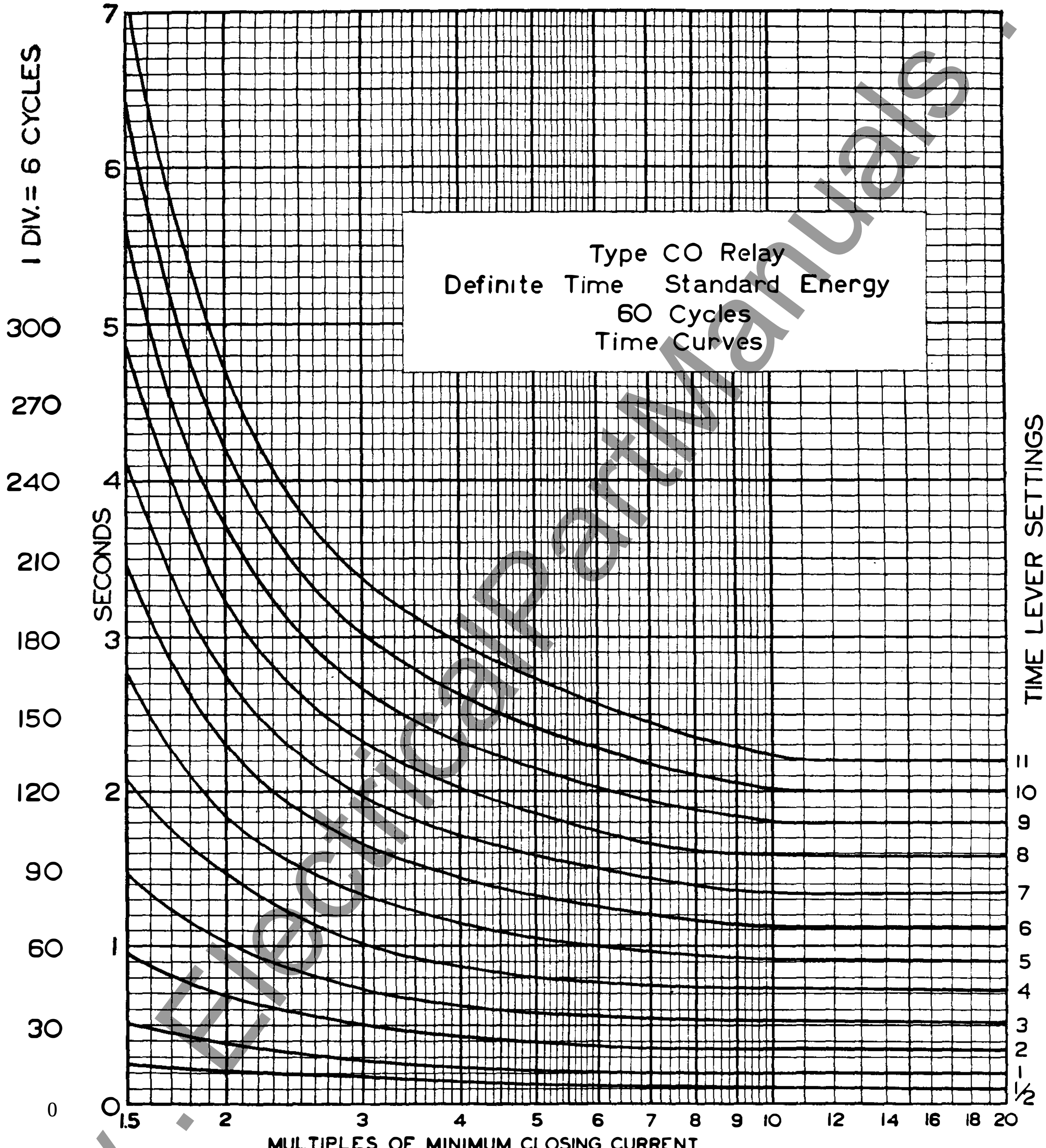

FIGURE 23—TYPICAL 60 CYCLE TIME CURVES OF THE DEFINITE MINIMUM TIME (STANDARD ENERGY) TYPE CO RELAY

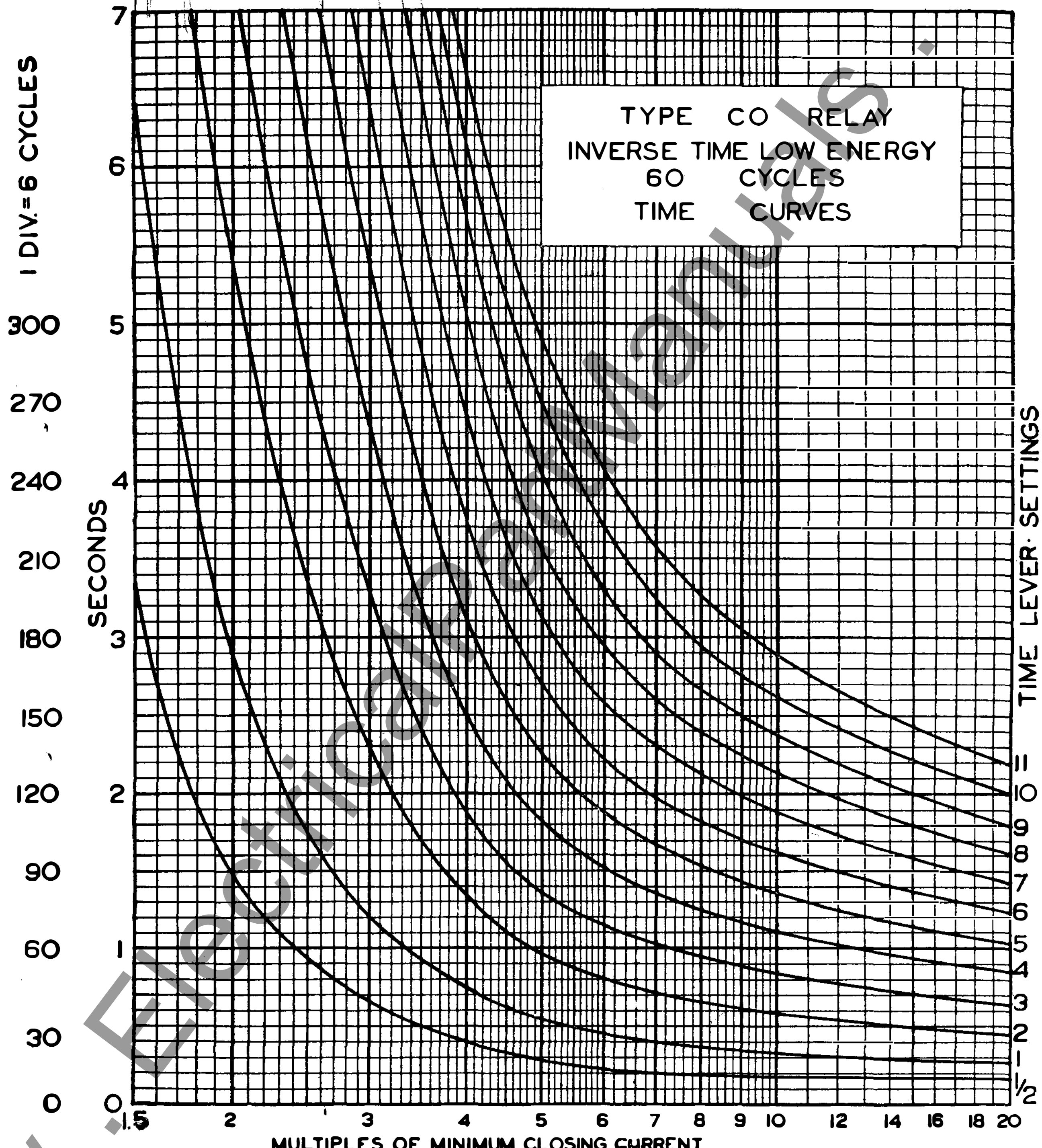

FIGURE 24—TYPICAL 60 CYCLE TIME CURVES OF THE INVERSE TIME (LOW ENERGY) TYPE CO RELAY.

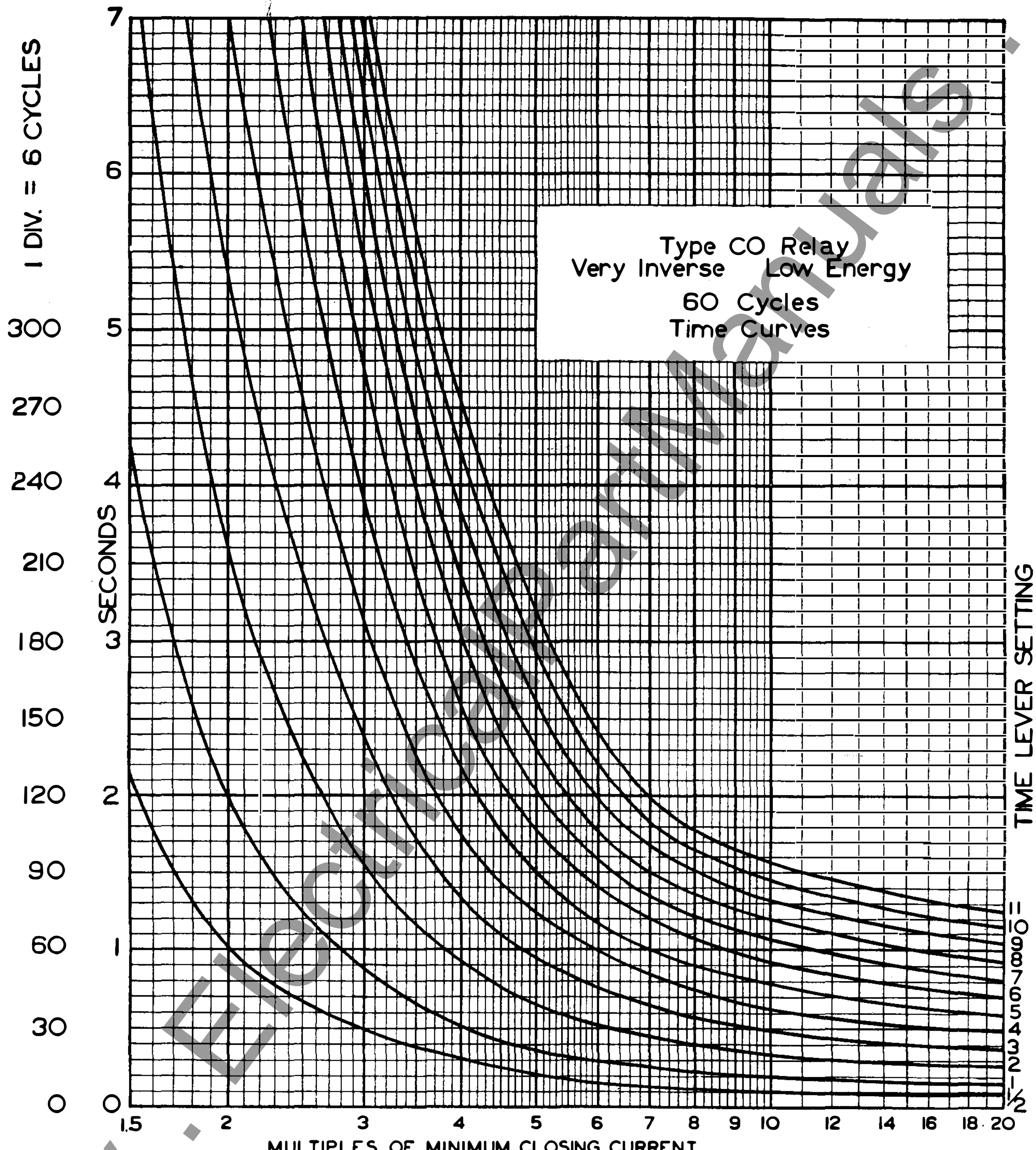

FIGURE 25—TYPICAL 60 CYCLE TIME CURVES OF THE VERY INVERSE TIME (LOW ENERGY) TYPE CO RELAY.

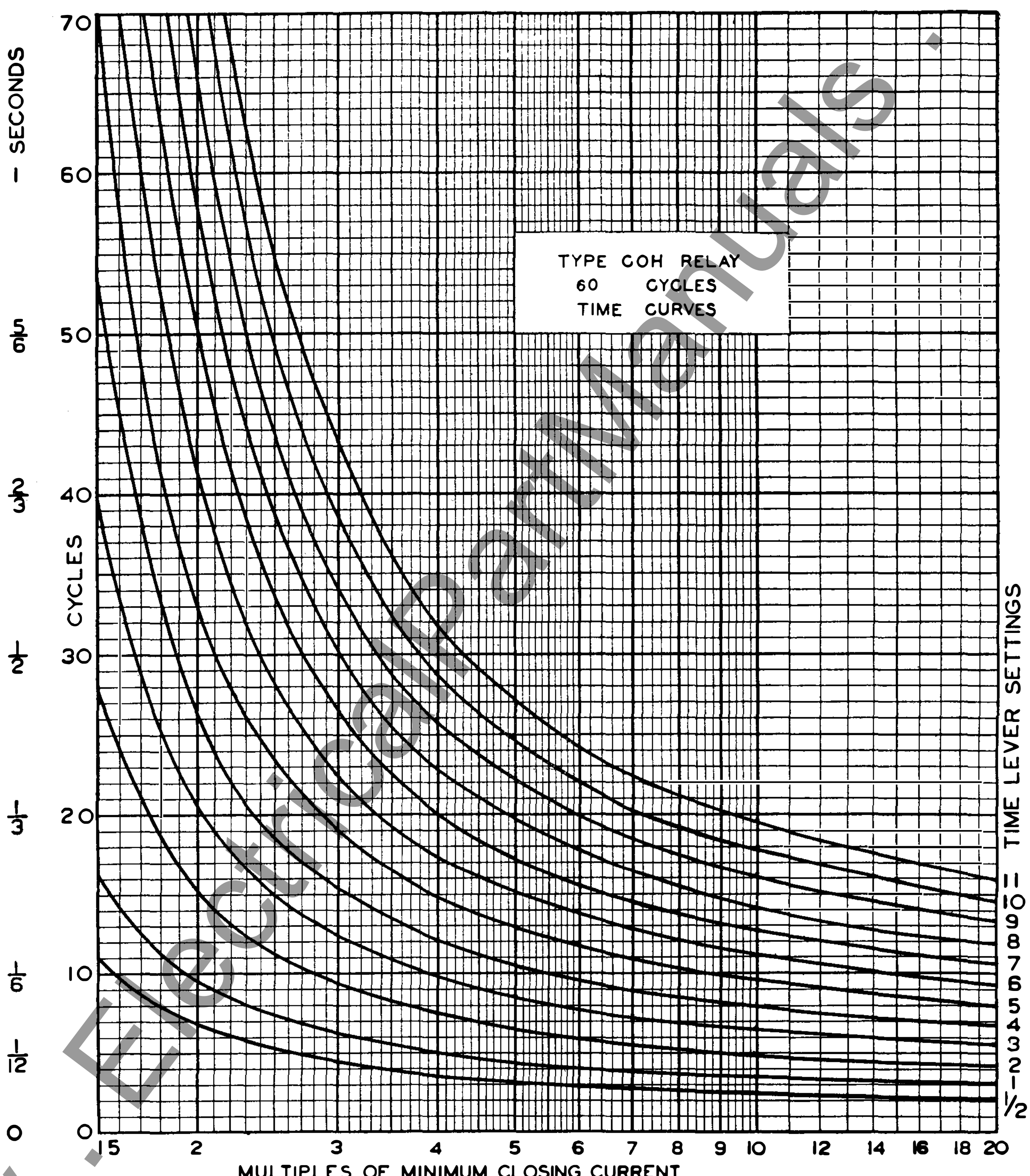

FIGURE 26—TYPICAL 60 CYCLE TIME CURVES OF THE TYPE COH RELAY.

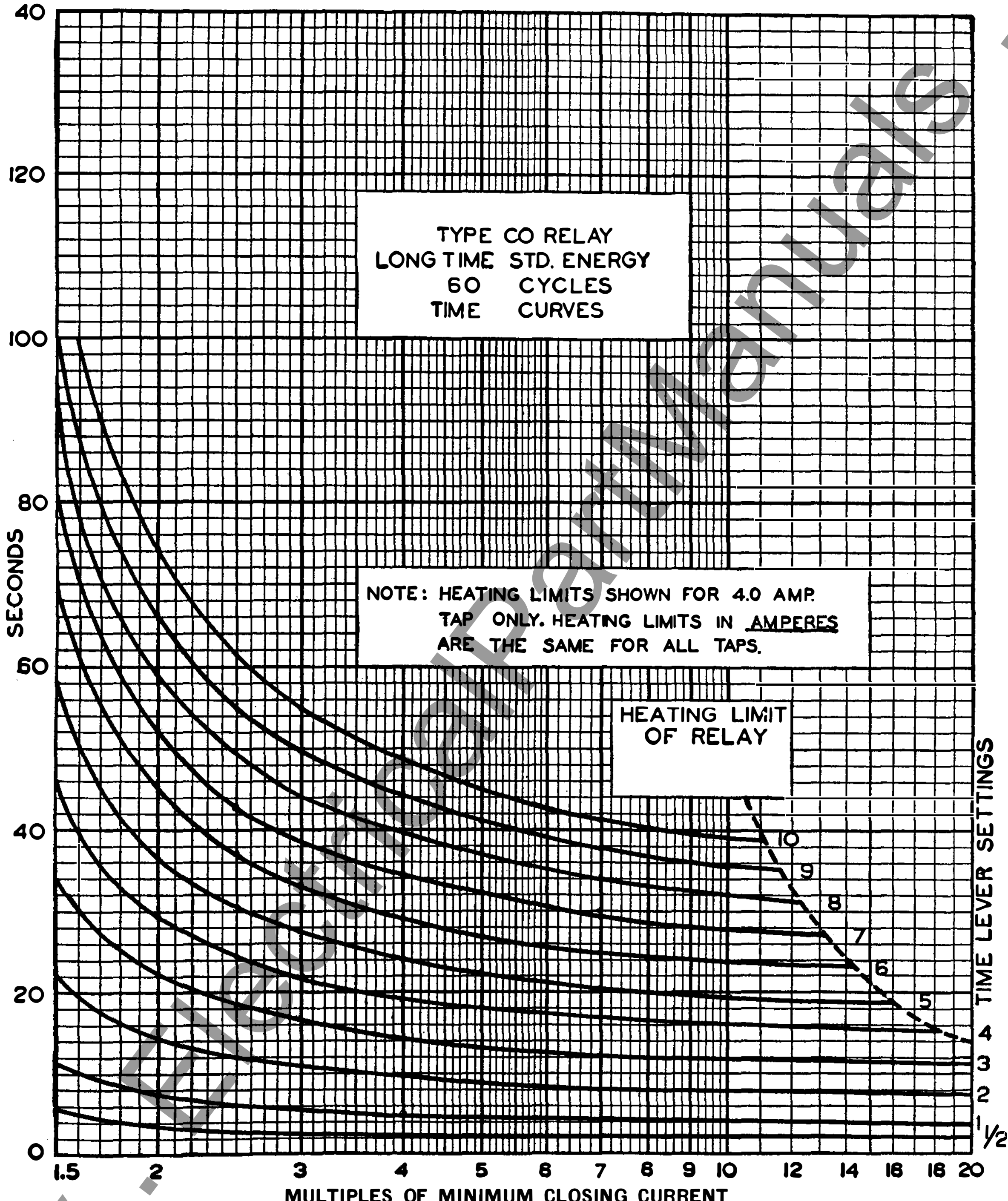

FIGURE 27—TYPICAL 60 CYCLE TIME CURVES OF THE LONG TIME (40 SECOND) TYPE CO RELAY.

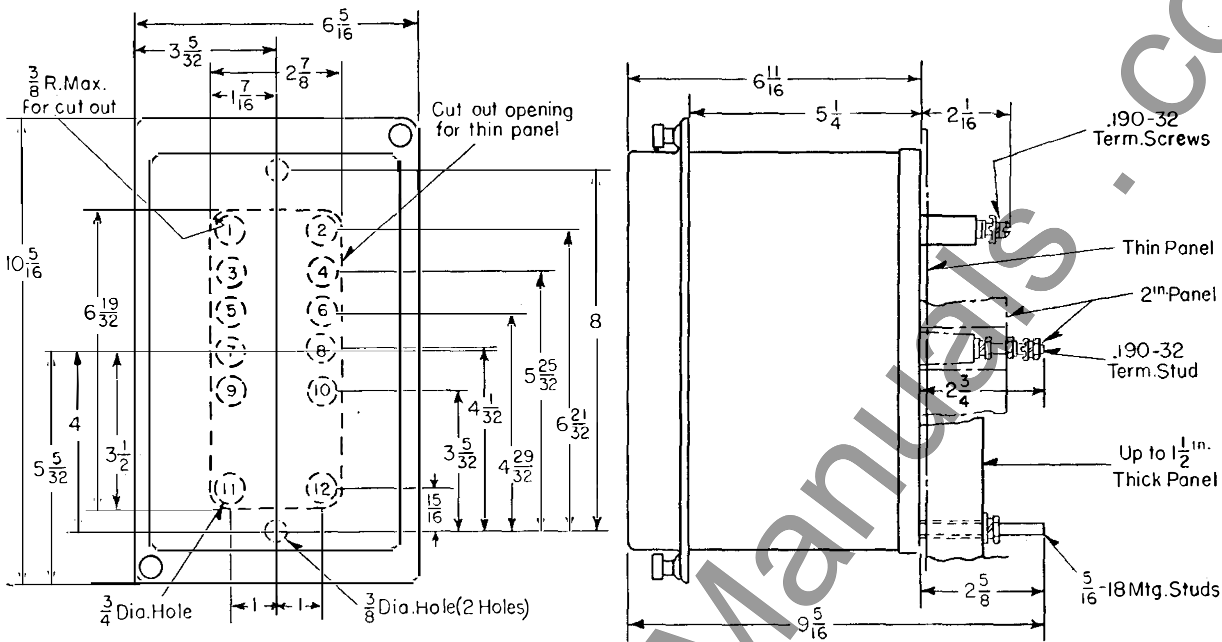

FIGURE 28—OUTLINE AND DRILLING PLAN FOR THE SINGLE ELEMENT TYPES CO AND COH RELAYS IN THE S10 PROJECTION TYPE FT FLEXITEST CASE. SEE THE INTERNAL SCHEMATICS FOR THE TERMINALS SUPPLIED. FOR REFERENCE ONLY.

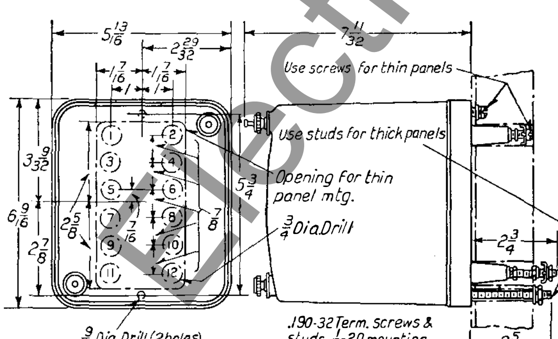

FIGURE 29—OUTLINE AND DRILLING PLAN FOR THE SINGLE ELEMENT TYPES CO AND COH RELAYS IN THE PROJECTION TYPE STANDARD CASE. SEE THE INTERNAL SCHEMATICS FOR THE TERMINALS SUPPLIED. FOR REFERENCE ONLY.

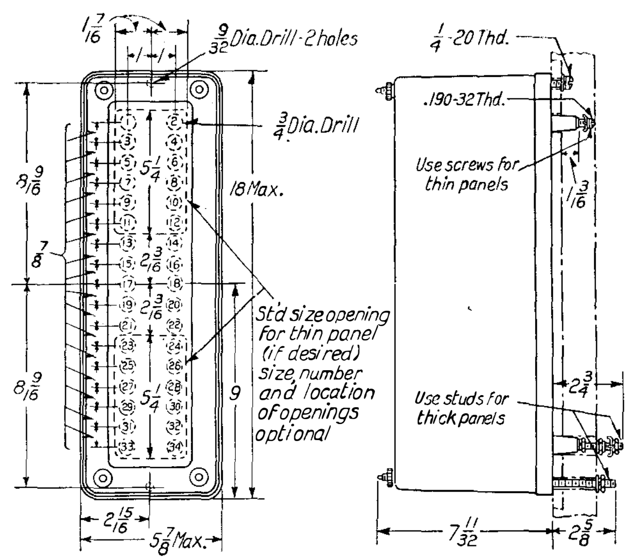

FIGURE 30—OUTLINE AND DRILLING PLAN FOR THE THREE ELEMENT TYPES CO AND COH RELAYS IN THE PROJECTION TYPE STANDARD CASE. SEE THE INTERNAL SCHEMATICS FOR THE TERMINALS SUPPLIED. FOR REFERENCE ONLY.

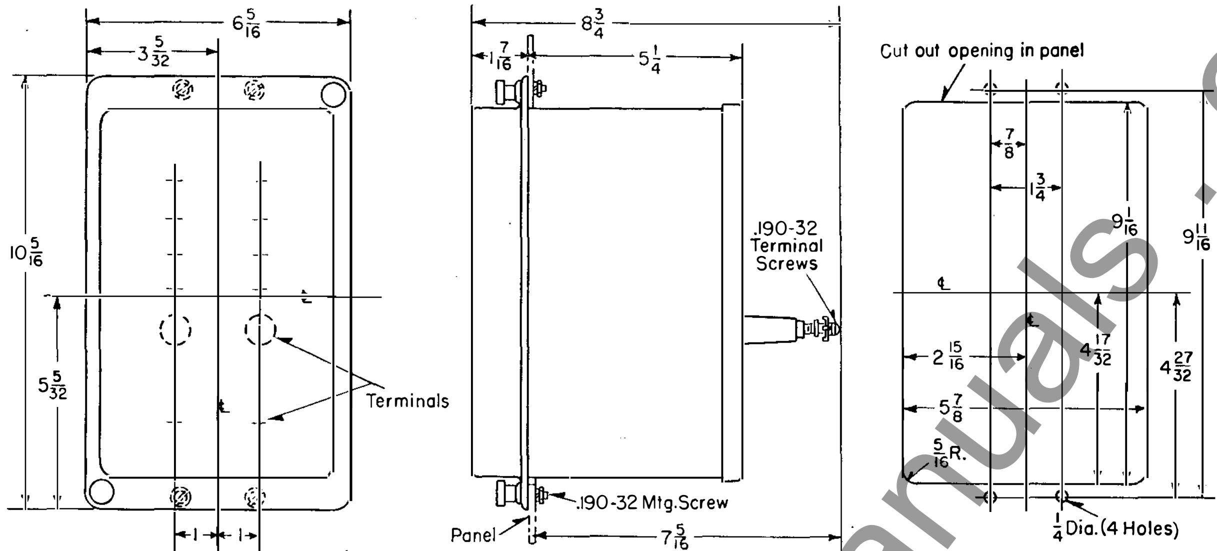

Figure 31—Outline and Drilling Plan for the Single Element Types CO and COH Relays in the S10 Semi-flush Type FT Flexitest Case. For Reference Only.

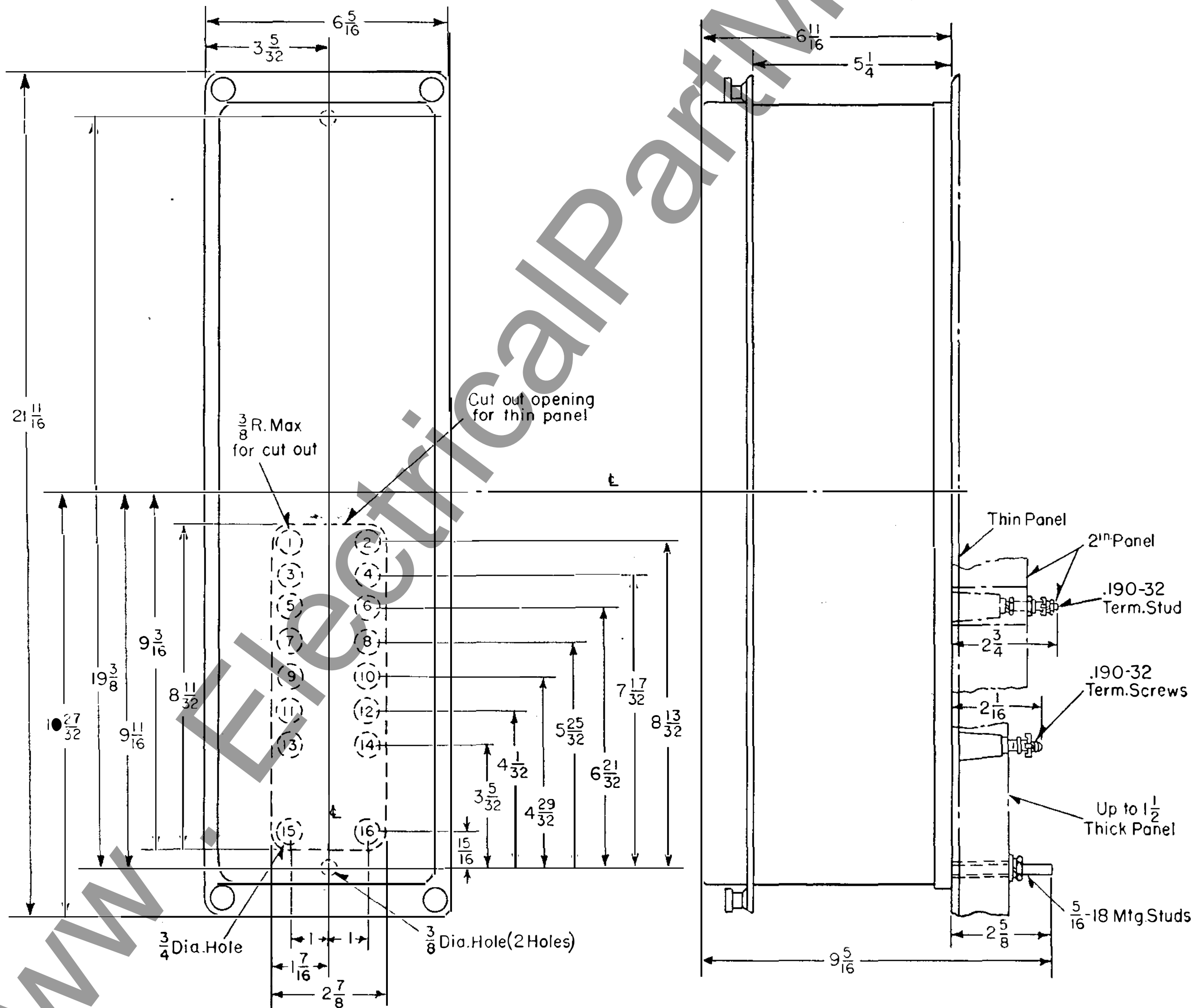

Figure 32—Outline and Drilling Plan for the Three Element Types CO and COH Relays in the L10 Projection Type FT Flexitest case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

be weakened slightly by stretching to obtain the 0.2 or 1.0 ampere calibration. Test for sticking after 10 times rated pick-up current has been applied.

Overcurrent Element (Circuit Opening Relays)

Adjust the relay with the instructions given under "Overcurrent Element (Circuit Closing Relays)" using the test connection of Figure 17 except that for the definite minimum time circuit opening relay the following caution should be observed:

CAUTION—When a signal lamp or other voltage operated device is to be connected in series with the relay contacts, disconnect the internal leads of the element from the stationary and moving contacts respectfully and dead end them. Then the lamp or other device can be connected to the stationary and moving contacts.

De-ion Contactor Switch (Circuit Opening Relays)

Adjust the core stop on the top as high as possible without allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32″ to 1/16″. Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes on the 4 ampere overcurrent tap setting.

In the case of the standard energy circuit opening relay the contactor switch should pick-up and seal itself open at 75% of minimum trip current.

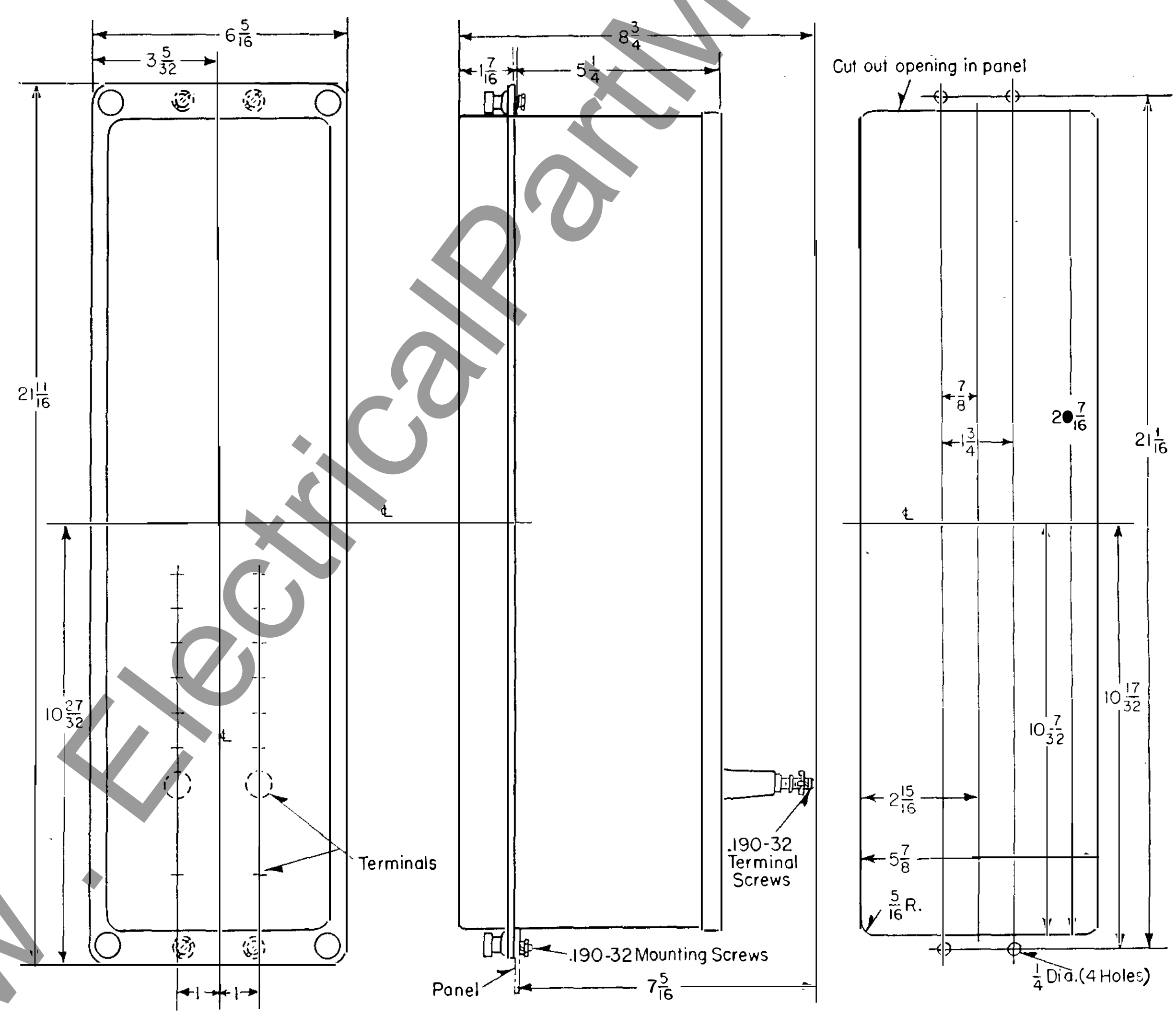

Figure 33—Outline and Drilling Plan for the Three Element Types CO and COH Relays in the L10 Semi-flush Type Flexitest Case. For Reference Only.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 4 amperes a-c.

Instantaneous Trip Attachment

The position of the Micarta disk at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disk should be lowered or raised to the proper position by means of the two nuts on either side of the disk. The nominal range of adjustment is 1 to 4, for example 10 to 40 amperes, and it has an accuracy of about 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about ⅔ of the minimum pick-up.

This element will not fit in the round-type case.

Instantaneous Lock-out Attachment

The position of the bottom of the plunger with reference to the calibrated guide indicates the minimum current required to open the contacts. To change the setting hold the top slotted head of the plunger rod fixed with a screwdriver. Then with a second screwdriver adjust the lower end of the plunger for the current pick-up desired.

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. The nominal range of adjustment is 3 to 1.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The burdens and thermal capacities of the various circuits of the relay are as follows:

Definite Minimum Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	2	108	17	60° lag	4	140
	2.5	68	17	60° lag	5	140
	3	47	17	60° lag	5	140
2/6	3.5	35	17	60° lag	6	140
	4	26	17	60° lag	7	140
	5	17	17	60° lag	8	140
	6	12	17	60° lag	10	140
	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
4/15	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

Inverse Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	0.5	200	2	66° lag	2	70
	0.6	140	2	66° lag	2	70
	0.8	78	2	66° lag	2	70
0.5/2.5	1.0	50	2	66° lag	3	70
	1.5	22	2	66° lag	3	70
	2.0	12.5	2	66° lag	4	70
	2.5	8	2	66° lag	5	70
	2	12.4	2	66.4° lag	8	250
	2.5	8	2	66.4° lag	8	250
	3	5.6	2	66.4° lag	8	250
2/6	3.5	4.1	2	66.4° lag	8	250
	4	3.1	2	66.4° lag	9	250
	5	2	2	66.4° lag	9	250
	6	1.3	2	66.4° lag	10	250
	4	3.1	2	66.4° lag	16	250
	5	2	2	66.4° lag	16	250
	6	1.4	2	66.4° lag	16	250
4/15	8	0.8	2	66.4° lag	17	250
	10	0.5	2	66.4° lag	18	250
	12	0.3	2	66.4° lag	19	250
	15	0.2	2	66.4° lag	20	250

Very Inverse Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	0.5	125	1.25	66.4° lag	2	100
	0.6	87	1.25	66.4° lag	2	100
	0.8	49	1.25	66.4° lag	2	100
0.5/2.5	1.0	31	1.25	66.4° lag	3	100
	1.5	14	1.25	66.4° lag	3	100
	2.0	8	1.25	66.4° lag	4	100
	2.5	5	1.25	66.4° lag	5	100
	2	8	1.25	66.4° lag	8	250
	2.5	5	1.25	66.4° lag	8	250
	3	3.5	1.25	66.4° lag	8	250
2/6	3.5	2.5	1.25	66.4° lag	8	250
	4	1.9	1.25	66.4° lag	9	250
	5	1.25	1.25	66.4° lag	9	250
	6	0.9	1.25	66.4° lag	10	250
	4	1.9	1.25	66.4° lag	16	250
	5	1.25	1.25	66.4° lag	16	250
	6	0.9	1.25	66.4° lag	16	250
4/15	8	0.5	1.25	66.4° lag	17	250
	10	0.3	1.25	66.4° lag	18	250
	12	0.2	1.25	66.4° lag	19	250
	15	0.15	1.25	66.4° lag	20	250

Long Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
4/15	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

Short Time COH Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	0.5	400	4	60° lag	2	56
	0.6	280	4	60° lag	2	56
	0.8	156	4	60° lag	2	56
0.5/2.5	1.0	100	4	60° lag	3	56
	1.5	44	4	60° lag	3	56
	2.0	25	4	60° lag	4	56
	2.5	16	4	60° lag	5	56
	2	25.0	4	60° lag	8	250
	2.5	16	4	60° lag	8	250
	3	11	4	60° lag	8	250
2/6	3.5	8.2	4	60° lag	8	250
	4	6.3	4	60° lag	9	250
	5	4.0	4	60° lag	9	250
	6	3.0	4	60° lag	10	250
	4	6.3	4	60° lag	16	250
	5	4.0	4	60° lag	16	250
	6	3.0	4	60° lag	16	250
4/15	8	1.6	4	60° lag	17	250
	10	1.0	4	60° lag	18	250
	12	0.7	4	60° lag	19	250
	15	0.4	4	60° lag	20	250

Burdens at Tap Current on 25 and 50 Cycles

	25 Cycles		50 Cycles	
	V.A.	Power Factor	V.A.	Power Factor
Definite Minimum Time CO	16	53° lag	17	60° lag
Inverse Time CO	2	60° lag	2	60° lag
Very Inverse Time CO	1.25	60° lag	1.25	66.4° lag
Long Time CO	16	53° lag	17	60° lag
Short Time COH	4	53° lag	4	60° lag

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES CO AND COH OVERCURRENT RELAYS

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker. Where low voltage or no station battery exists, the circuit opening type relay in conjunction with a-c series trip coils can be used to open the breaker.

The inverse time (low-energy) type relay is used in preference to the definite minimum time (standard energy) relay where the requirements necessitate (1) a lower burden on the current transformer, or (2) a more inverse curve for selectivity, or (3) a very low current range as for example, ground protection of transmission systems.

The very-inverse time (low-energy) relay is similar to the inverse relay and is used where a still more inverse curve is desired. The term "low energy" refers to the burden at tap value that is placed on the current transformers and does not refer to the current rating.

The long time (40 second) relay is designed to protect motors against overloads. This can be equipped with an instantaneous attachment that will operate, if a short-circuit occurs in the motor.

The type COH relay finds application for phase and ground protection where a high speed induction type relay is desired. It is sometimes used in differential protective schemes.

The above relays can be supplied with the secondary electromagnet circuit brought out to separate terminals. This variety is known as the type CO or COH Torque Control Relay. Thus the contacts of a separate relay can be used to control the operation of the torque control relay. For example, a three phase directional relay plus suitable auxiliary relays can be used to directionally control three torque control relays.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay

The circuit-closing types CO and COH relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft in the nongeared type relays, or to an auxiliary shaft

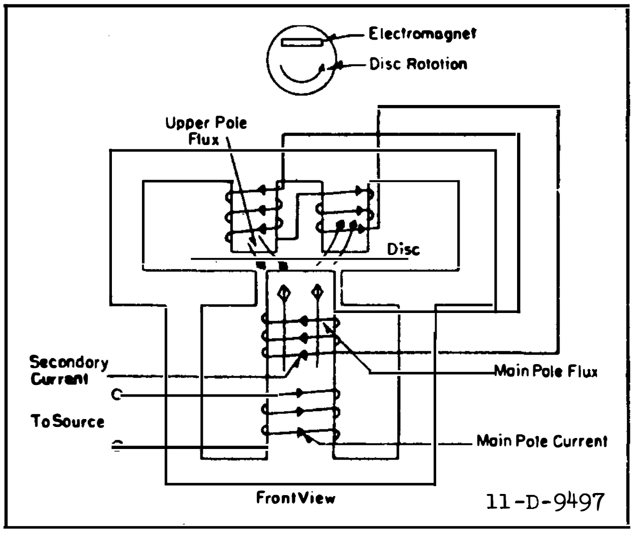

Fig. 1—Flux And Current Relations in The Type COH, Type CO Inverse and Very Inverse Time Relays Without The Torque Compensator.

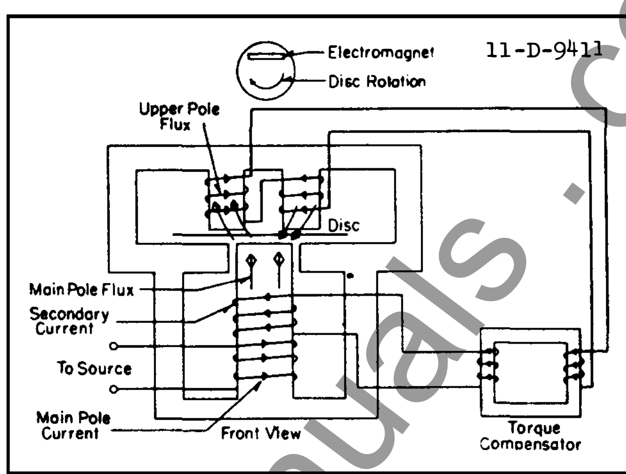

Fig. 2—Flux And Current Relations In The Long Time and Definite Minimum Time Relays With The Torque Compensator.

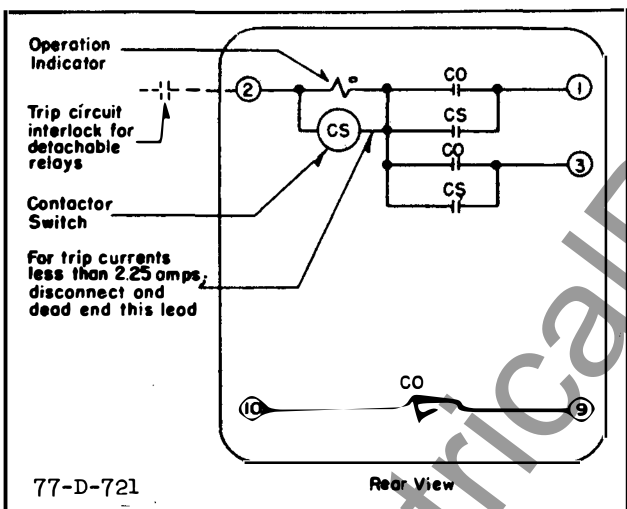

Fig. 3—Internal Schematic Of The Double Trip Circuit Closing Types CO And COH Relays In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

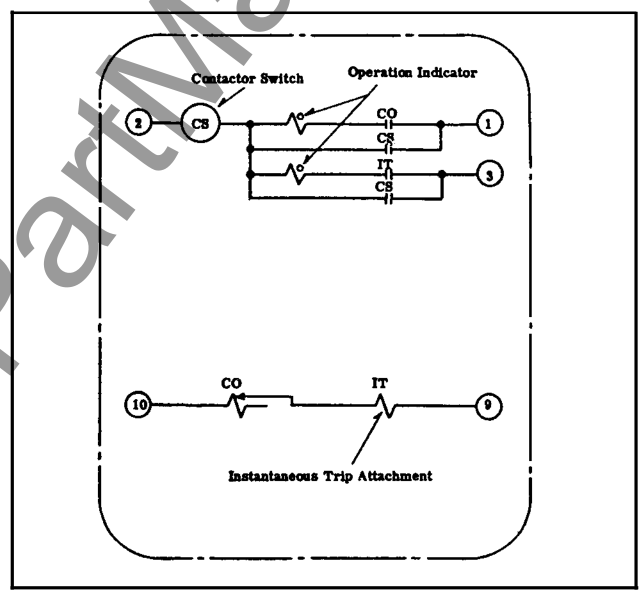

Fig. 4—Internal Schematic Of The Single Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Standard Case.

geared to the disc shaft in the geared type relays. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front. The operating torque of the inverse or very inverse relays is obtained

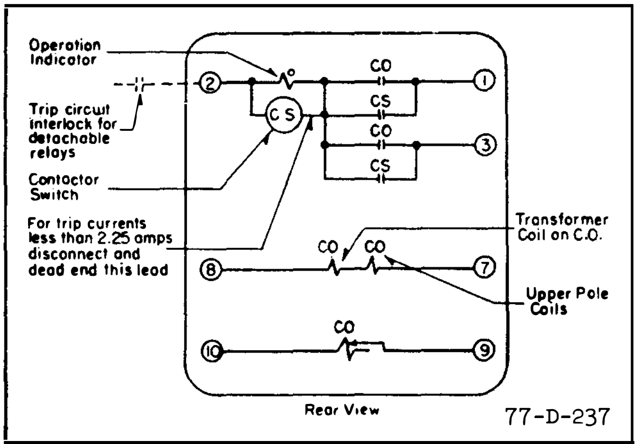

Fig. 5—Internal Schematic Of The Double Trip Circuit Closing Inverse And Very Inverse Types CO And COH Relays With Torque Control Terminals In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

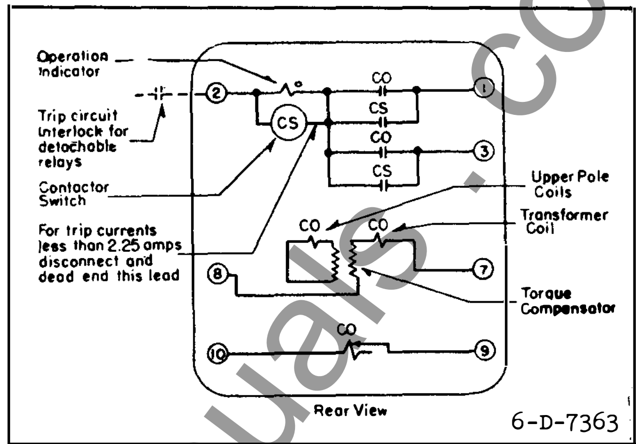

Fig. 6—Internal Schematic Of The Double Trip Circuit Closing Definite Minimum Time Type CO Relay With Torque Control Terminals In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

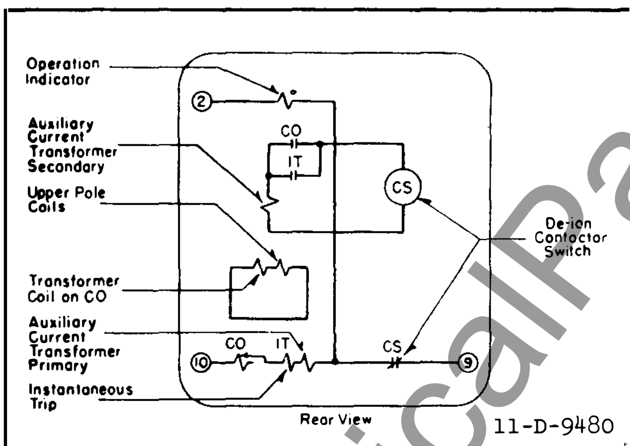

Fig. 7—Internal Schematic Of The Circuit Opening Inverse And Very Inverse Time Type CO Relays With Instantaneous Trip Attachment In The Standard Case.

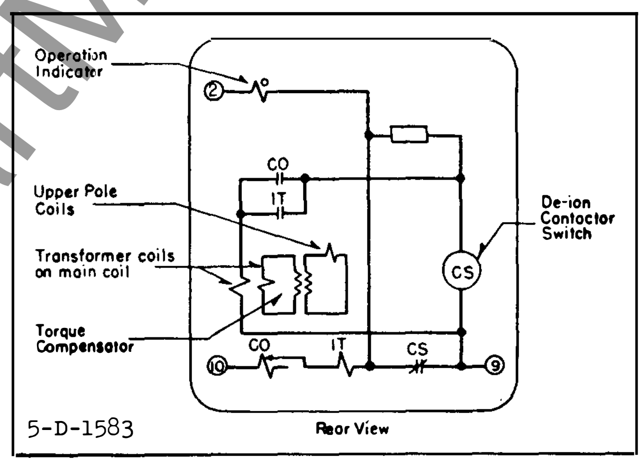

Fig. 8—Internal Schematic Of The Circuit Opening Definite Minimum Time Type CO Relays With Instantaneous Trip Attachment In The Standard Case.

by the circuit arrangement shown in Figure 1. The main pole coil of the relay acts as a transformer and induces a voltage in a secondary coil. Current from this secondary coil flows through the upper pole coils and thus produces torque on the disc by the reaction between the fluxes of the upper and lower poles.

The definite-time relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper pole coils. This is called the torque conpensator and it slows down the disc movement to such an extent that no gearing is required. (See Figure 2).

The long time relay is a geared relay with a torque compensator.

The type COH relay is a non-geared relay without a torque compensator.

Contactor Switch

The d-c. contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid.

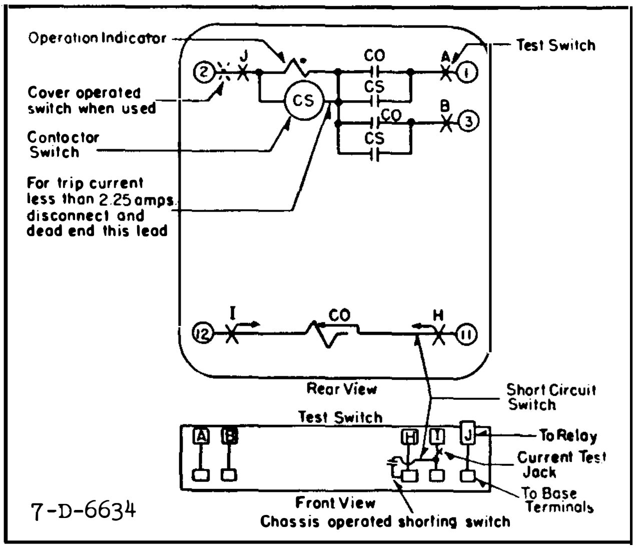

Fig. 9—Internal Schematic Of The Double Trip Circuit Closing Types CO And COH Relays In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

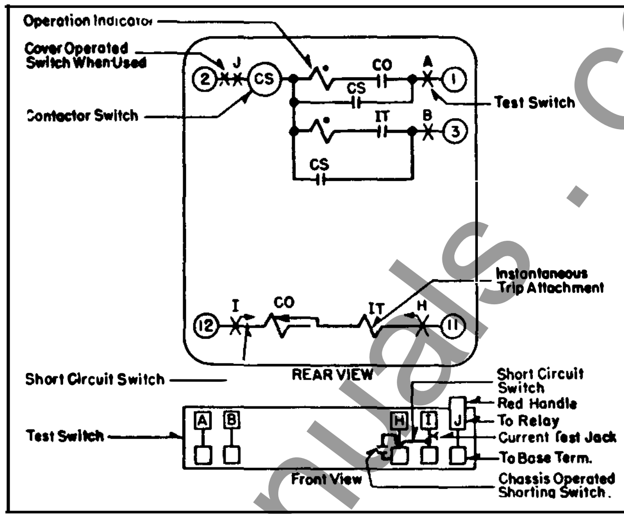

Fig. 10—Internal Schematic Of The Single Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Type FT Case.

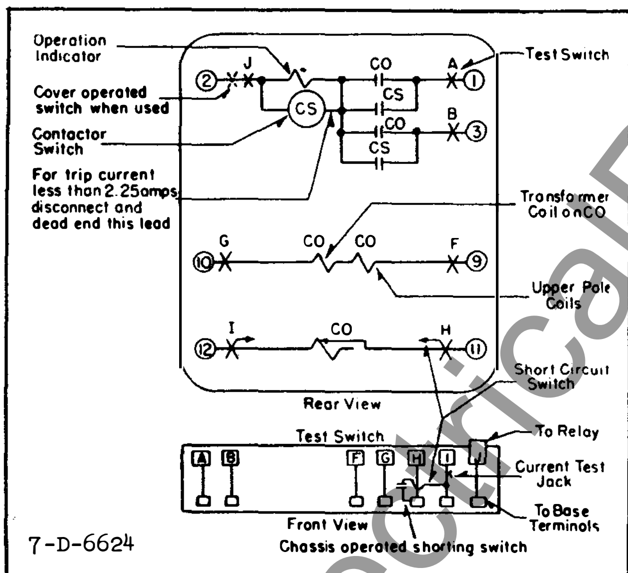

Fig. 11—Internal Schematic Of The Double Trip Circuit Closing Inverse And Very Inverse Types CO And COH Relays With Torque Control Terminals In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

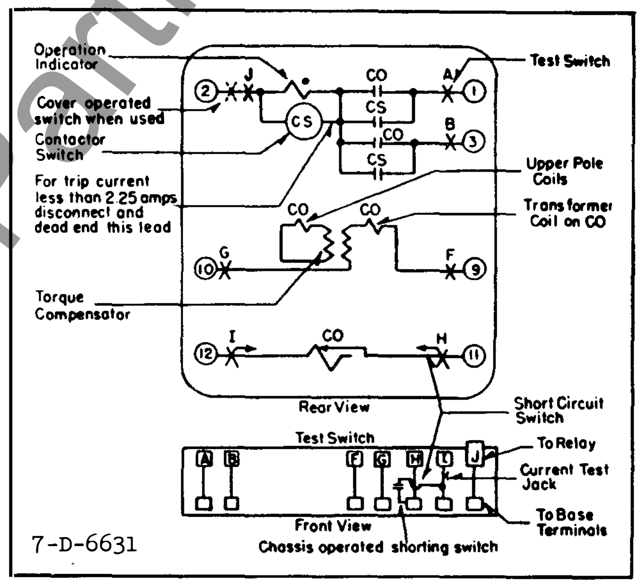

Fig. 12—Internal Schematic Of The Double Trip Circuit Closing Definite Minimum Time Type CO Relay With Torque Control Terminals In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

As the plunger travels upward. the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid

coil connected in the trip circuit. When the coil is energized. a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

Instantaneous Lock-Out Attachment (When Supplied)

The lock-out attachment is used to prevent the relay from tripping a circuit breaker when current is too high-above its interrupting capacity.

Circuit-Opening Relay

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, an operation indicator and an instantaneous trip attachment where required.

Overcurrent Element

The overcurrent construction and operation is similar to that described for the circuit closing relays.

De-ion Contactor Switch

This switch is a small a-c. solenoid switch whose coil is energized from a few turns on the lower pole of the overcurrent element in the standard-energy type relays, and from a small transformer connected in the main current circuit in the low-energy type relays. Its construction is similar to the d-c. type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

The transformer coil on the lower pole of the overcurrent element and the contactor switch circuits in the standard energy type relays are connected to the main circuits as shown in Figures 8 and 14. When the overcurrent contact closes, the contactor switch operates, and the voltage across the trip coil is impressed on the transformer and contactor switch coils. This voltage acts to seal-in the contactor switch, and to feed energy through the transformer coil to the main overcurrent winding which produces contact closing torque. This arrangement provides a definite minimum pick-up value largely independent of the value of trip coil impedance.

Operation Indicator

The operation indicator is in series with the breaker trip coil. Its construction is as described above.

CHARACTERISTICS

The type CO definite minimum time (standard energy) or long time (40 second) circuit closing relay is available in either of the following current ranges.

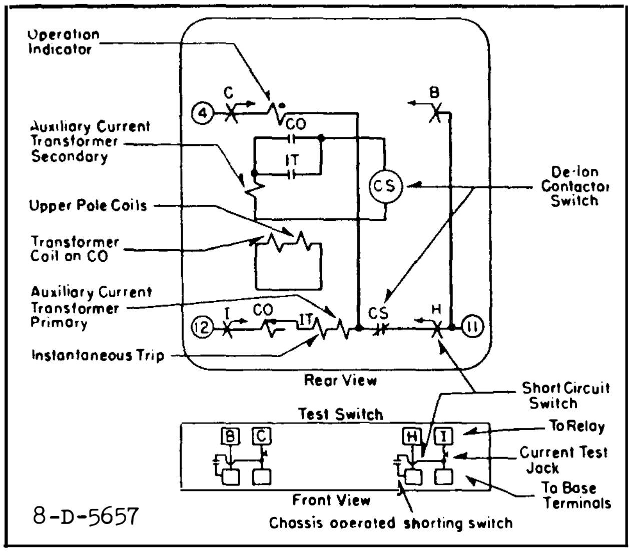

Fig. 13—Internal Schematic Of The Circuit Opening Inverse And Very Inverse Time Type CO Relays With Instantaneous Trip Attachment In The Type FT Case.

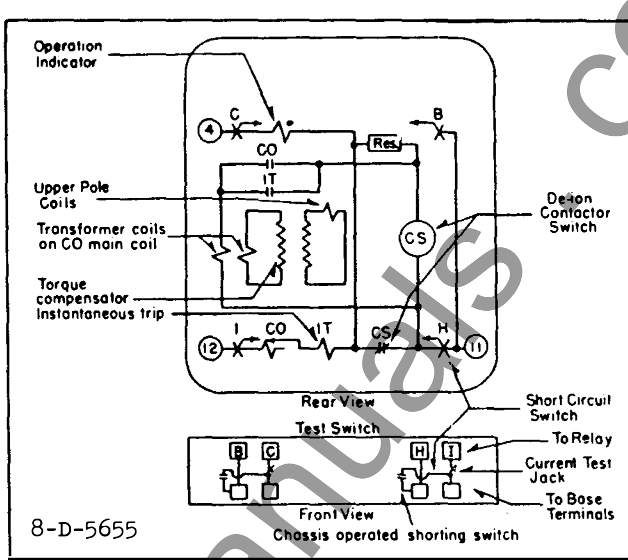

Fig. 14—Internal Schematic Of The Circuit Opening Definite Minimum Time Type CO Relays With Instantaneous Trip Attachment In The Type FT Case.

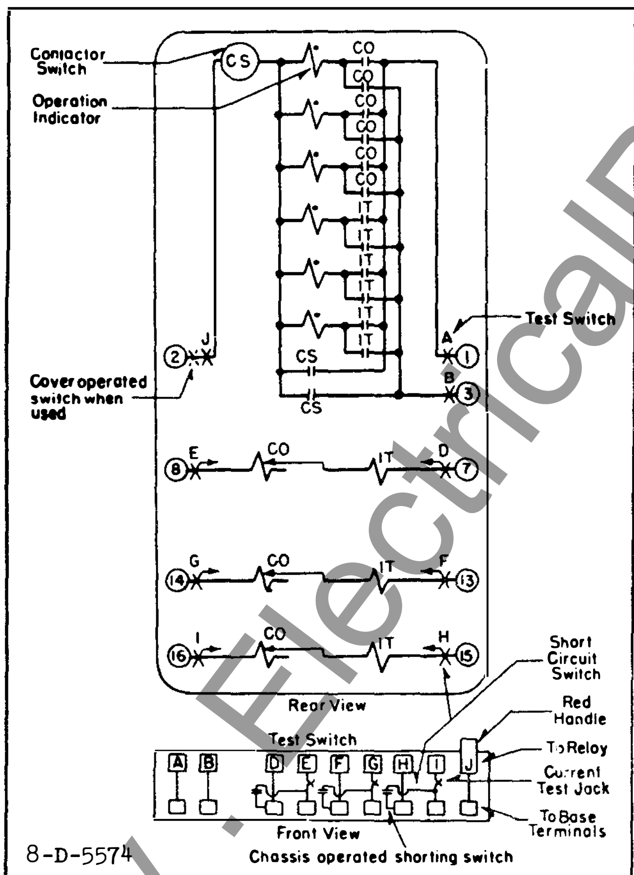

Fig. 15—Internal Schematic Of The Three Element Double Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

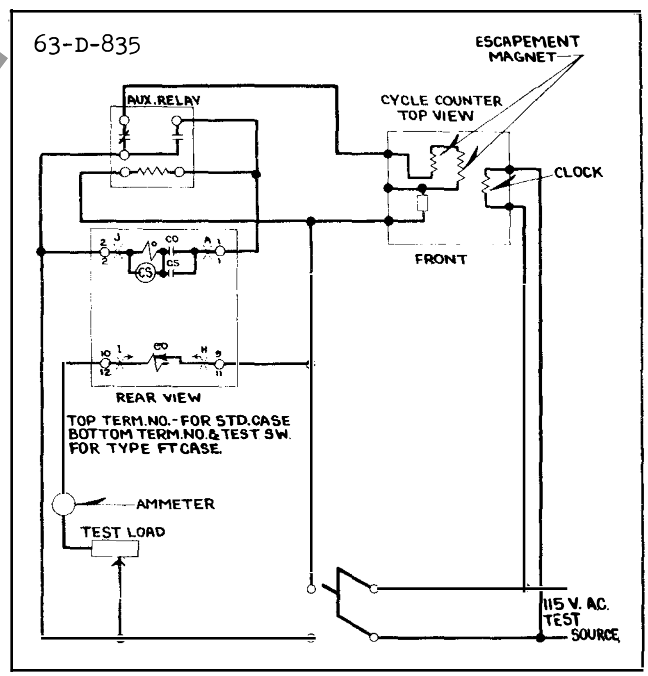

Fig. 16—Diagram Of Test Connections For Circuit Closing Types CO And COH.

2 2.5 3 3.5 4 5 6
4 5 6 8 10 12 15

The type CO inverse, very inverse (low energy) or the type COH circuit closing relay is available in the following current ranges.

0.5 0.6 0.8 1.0 1.5 2.0 2.5
2 2.5 3 3.5 4 5 6
4 5 6 8 10 12 15

The type CO circuit-opening relay is made only in the 4 to 15 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. In addition to the taps, the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 11 divisions.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers, or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The characteristics of the various varieties of type CO and COH relays usually supplied are as shown on page 13.

The burdens and thermal ratings are listed under Energy Requirements.

The instantaneous trip attachment has a 1 to 4 range. Typical ranges are 10-40 or 20-80 but other ranges may be supplied as ordered.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

The instantaneous lock-out attachment has a 3 to 1 range with typical ranges similar to the instantaneous trip attachment.

Trip Circuit

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done, the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere Target......2.8 ohms
Resistance of 2.0 ampere Contact Switch............................0.25 ohms
Resistance of Target and Switch in Parallel..........................0.23 ohms

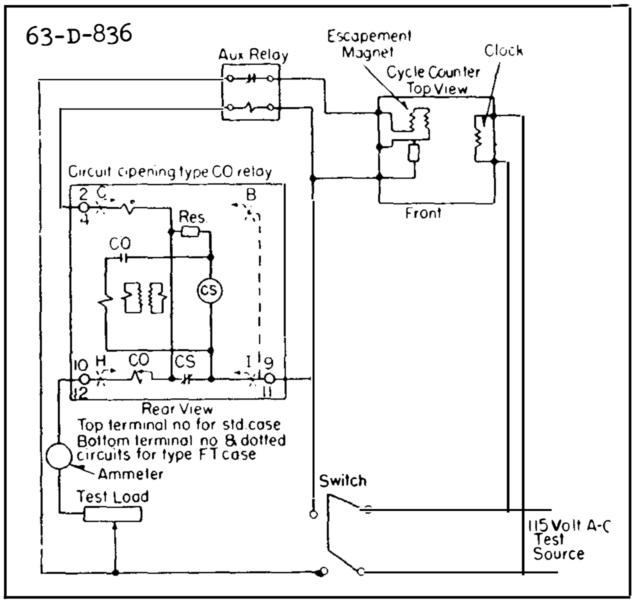

Fig. 17—Diagram Of Test Connection For Circuit Opening Type CO Relay.

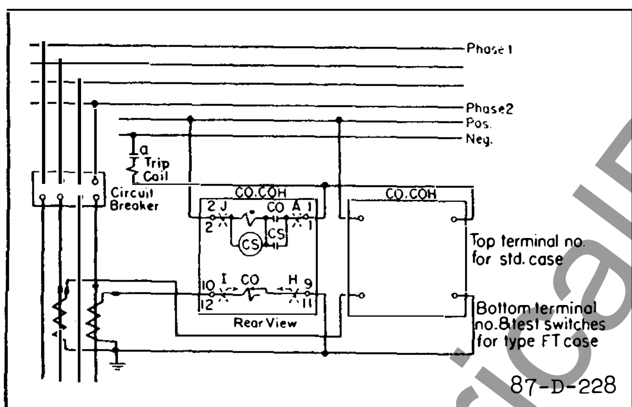

Fig. 19—External Connections Of The Circuit Closing Types CO And COH Relays For Overcurrent Protection On A Two-Phase System.

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target......0.16 ohms
Resistance of 2.0 ampere Contactor
Switch............................0.25 ohms
Resistance of Target and Switch in
Series............................0.41 ohms

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of

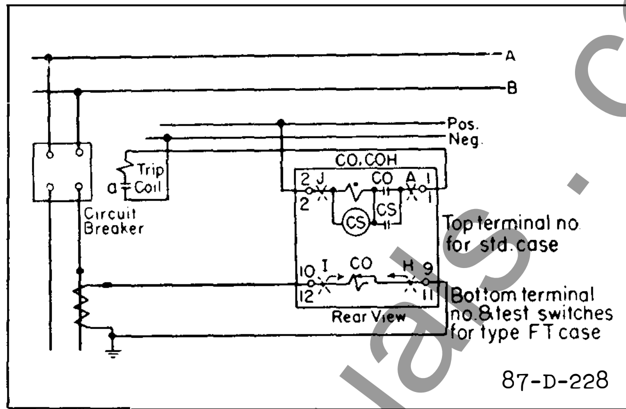

Fig. 18—External Connections Of The Circuit Closing Types CO And COH Relays For Overcurrent Protection On A Single Phase System.

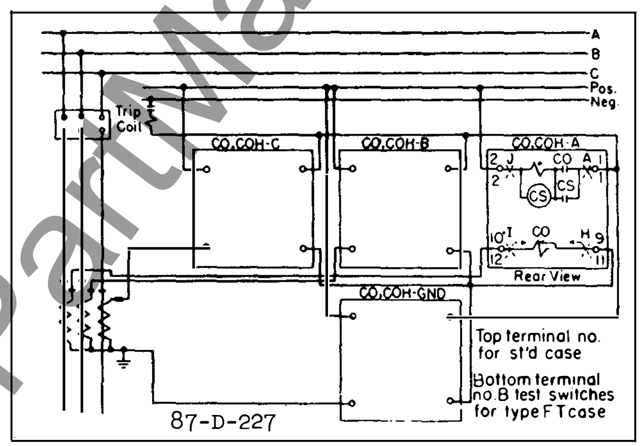

Fig. 20—External Connections Of The Circuit Closing Types CO And COH Relays For Phase And Ground Overcurrent Protection On A Three-Phase System.

the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

Because the circuit-opening relay contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subject to shocks which may jar the contacts

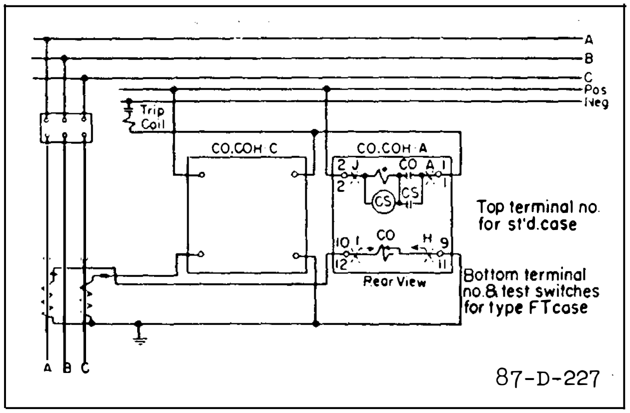

Fig. 21—External Connections Of The Circuit Closing Types CO And COH Relays For Phase Overcurrent Protection On An Ungrounded Three-Phase System.

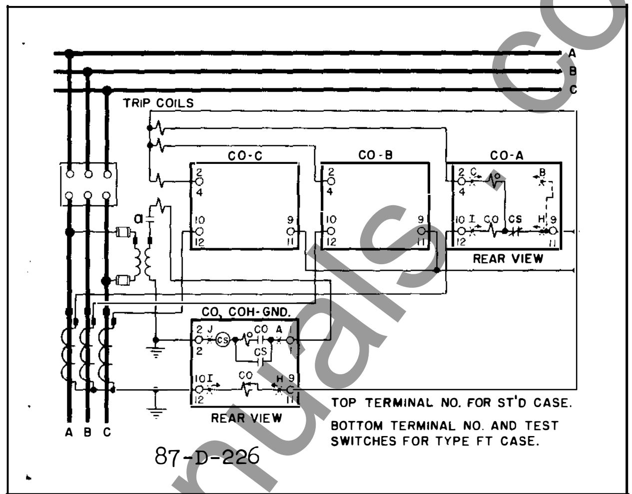

Fig. 22—External Connections Of The Circuit Opening Type CO Relay For Phase Overcurrent Protection And Of The Circuit Closing Types CO And COH Relays For Ground Protection On A Three-Phase System.

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 safeguard so that there is no danger from even an excessive shock unless the current is also heavy.

Typical external connections are shown in Figures 18 to 22. When using the circuit-opening relays for phase protection, ground protection may be secured by using a low-energy circuit-closing relay operating on a-c. voltage trip coil, as shown in Figure 22.

SETTINGS

There are two settings-namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 screwdriver inserted in one of the notches of the plate to which 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.

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 circuits the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, in the new tap and removing the old screw from its original setting.

Time Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figures 23 to 27.

ADJUSTMENTS AND MAINTENANCE

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 shoudl not be used in testing induction-type relays because of the resulting distorted current wave form which produces an error in timing.

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed or the relay taken apart for repairs, the following instructions should be followed in reassembling and setting it.

(Overcurrent Element Circuit-Closing Relays)

Shift the position of the contact stop on the time lever and adjust the 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 tap block. Check the time curve as shown by test with a cycle counter, to be as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable. influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field. If the relay has a metal cover, this cover must be in place when making tests.

The relays with torque control terminals will not operate until these terminals are short-circuited either by a jumper or by the external control contacts.

Contactor Switch (Circuit-Closing Relays)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up. and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c. have been passed through the coil.

Operation Indicator (Circuit-Closing Relays)

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side

of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current has been applied.

Overcurrent Element (Circuit Opening Relays)

Adjust the relay with the instructions given under "Overcurrent Element (Circuit Closing Relays)" using the test connection of Figure 17 except that for the definite minimum time circuit opening relay the following caution should be observed:

CAUTION When a signal lamp or other voltage operated device is to be connected in series with the relay contacts, disconnect the internal leads of the element from the stationary and moving contacts respectfully and dead end them. Then the lamp or other device can be connected to the stationary and moving contacts.

De-ion Contactor Switch (Circuit Opening Relays)

Adjust the core stop on the top as high as possible without allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32" to 1/16". Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes on the 4 ampere overcurrent tap setting.

In the case of the standard energy circuit opening relay the contactor switch should pick-up and seal itself open at 75% of minimum trip current.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 4 amperes a-c.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut which locks the Micarta disc and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pick-up.

This element will not fit in the round-type case.

Instantaneous Lock-Out Attachment

The position of the bottom of the plunger with reference to the calibrated guide indicates the minimum current required to open the contacts. To change the setting hold the top slotted head of the plunger rod fixed with a screwdriver. Then with a second screwdriver adjust the lower end of the plunger for the current pick-up desired.

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. The nominal range of adjustment is 3 to 1.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

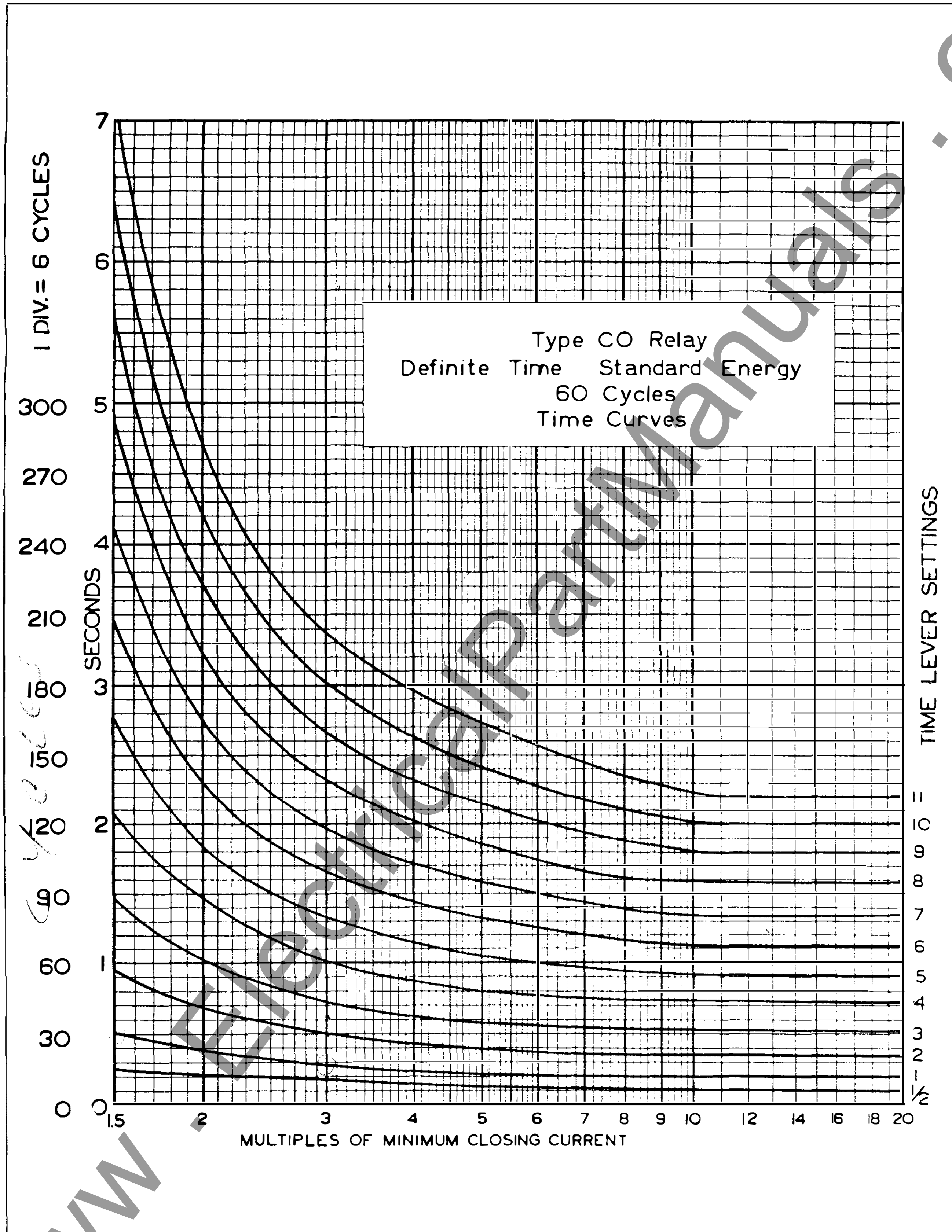

Fig. 23—Typical 60 Cycle Time Curves Of The Definite Minimum Time (Standard Energy) Type CO Relay.

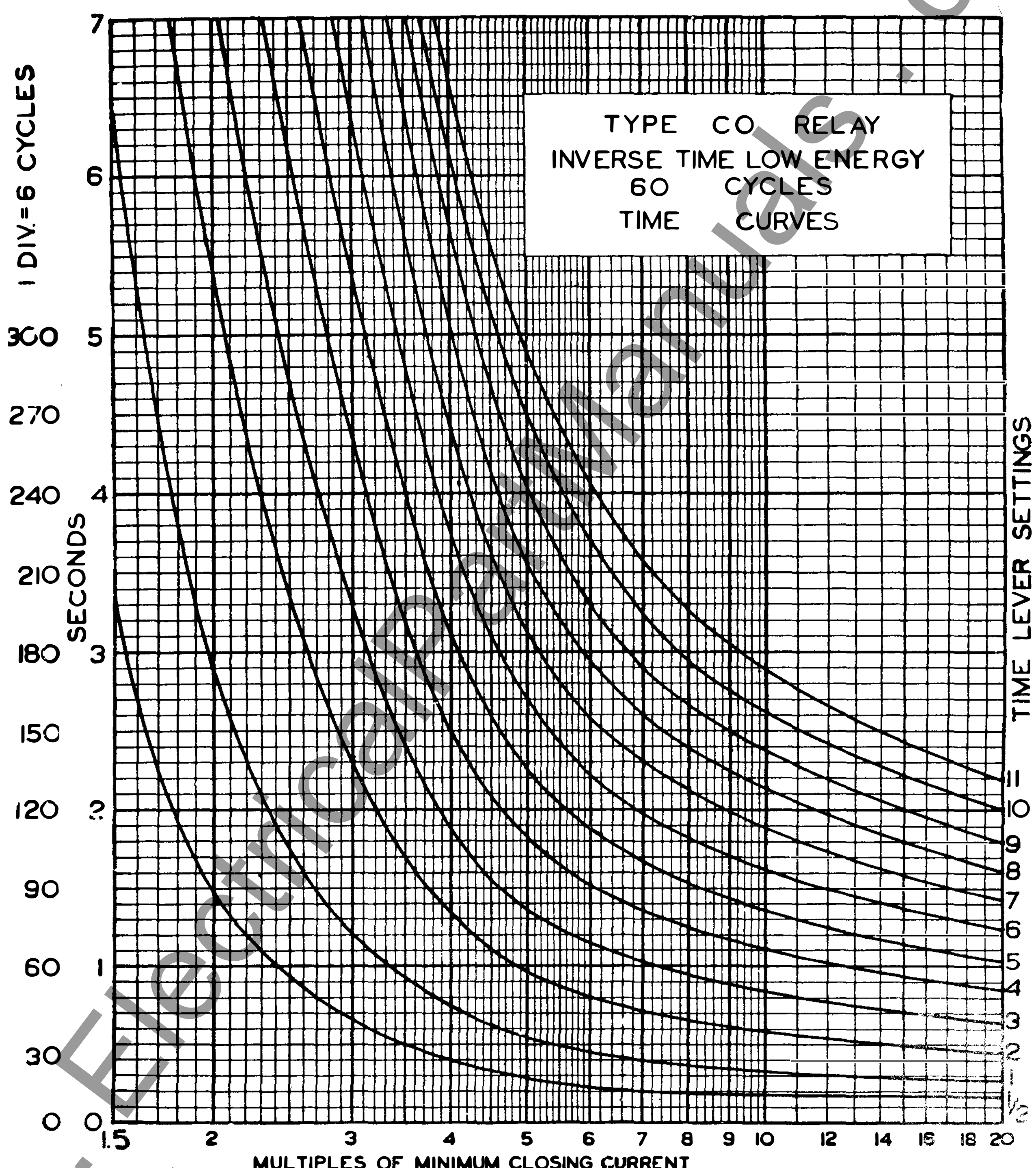

Fig. 24—Typical 60 Cycle Time Curves Of The Inverse Time (Low Energy) Type CO Relay.

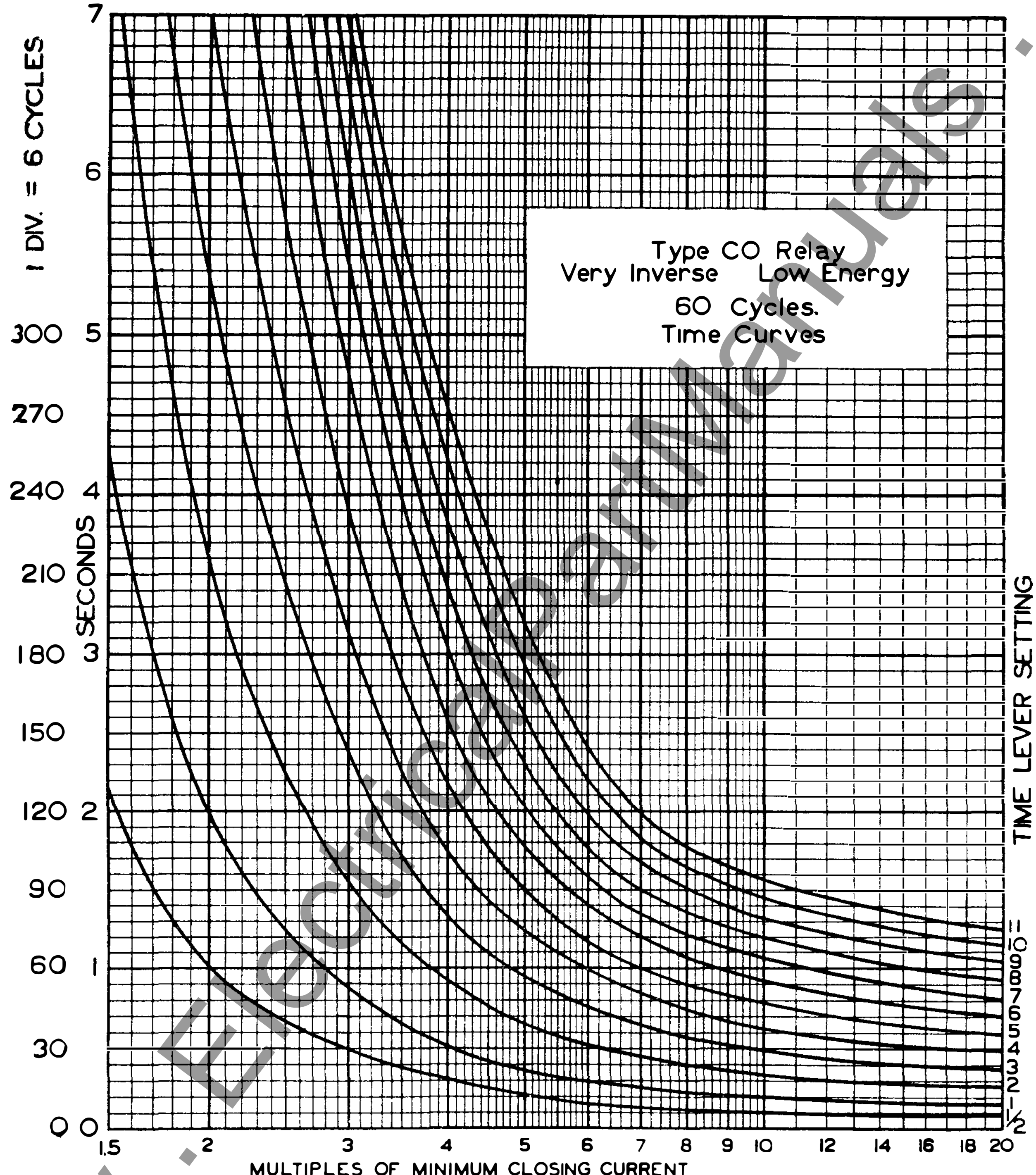

Fig. 25—Typical 60 Cycle Time Curves Of The Very Inverse Time (Low Energy) Type CO Relay.

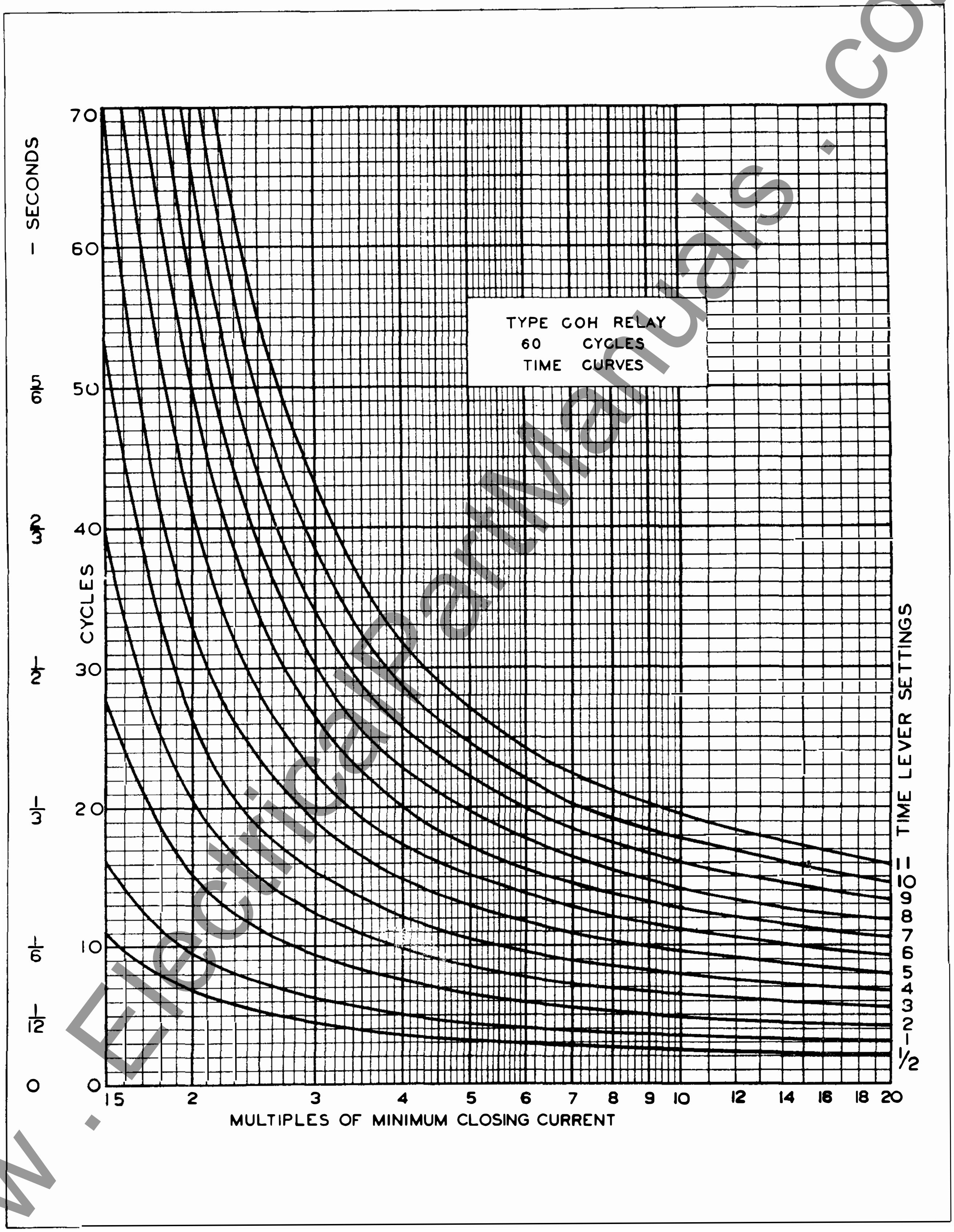

Fig. 26—Typical 60 Cycle Time Curves Of The Type COH Relay.

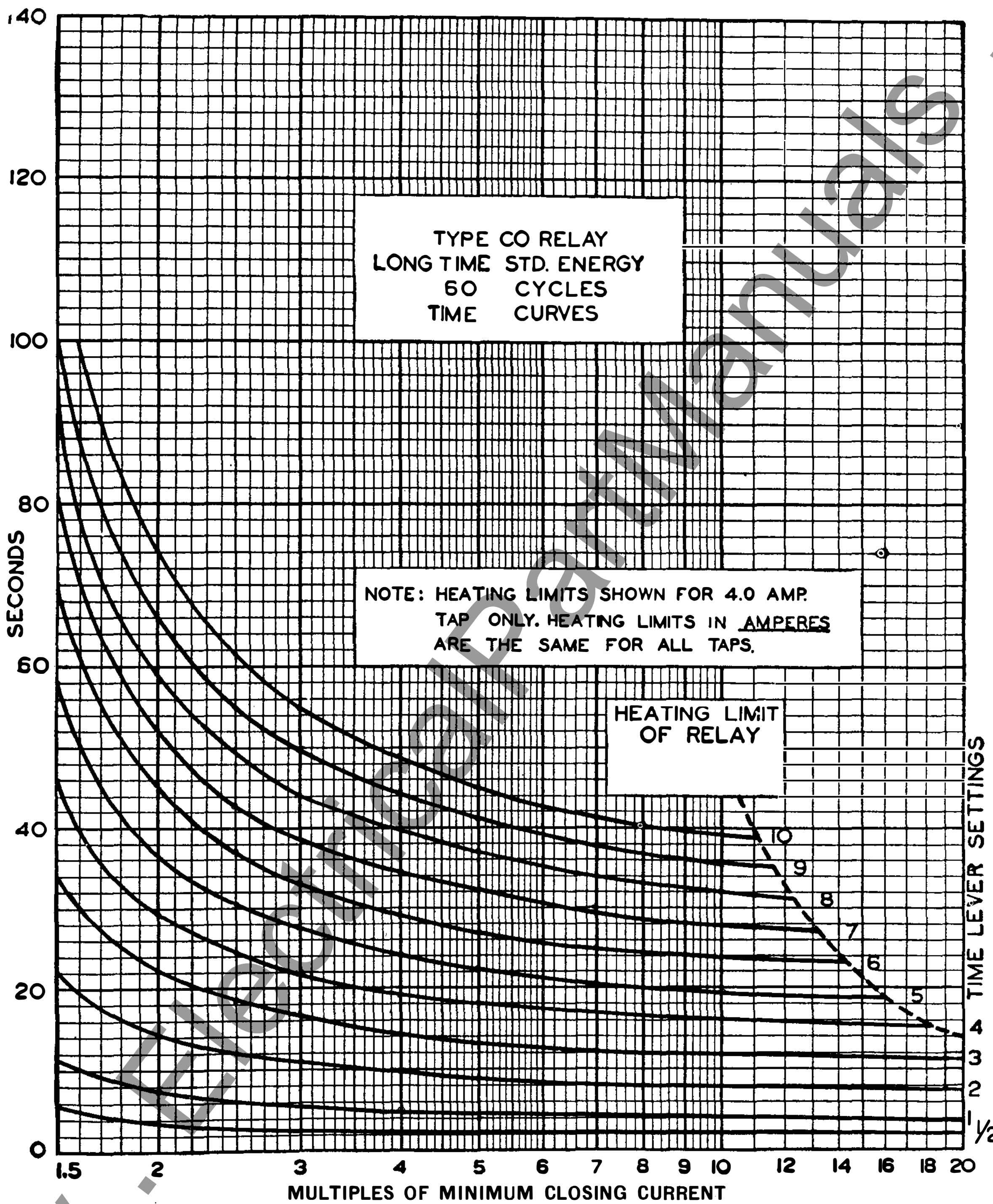

Fig. 27—Typical 60 Cycle Time Curves Of The Long Time (40 Second) Type CO Relay.

ENERGY REQUIREMENTS

The burdens and thermal capacities of the various circuits of the relay are as follows:

DEFINITE MINIMUM TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
2/6	2	108	17	60° lag	4	140
	2.5	68	17	60° lag	5	140
	3	47	17	60° lag	5	140
	3.5	35	17	60° lag	6	140
	4	26	17	60° lag	7	140
	5	17	17	60° lag	8	140
	6	12	17	60° lag	10	140
4/15	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

INVERSE TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	200	2	66° lag	2	70
	0.6	140	2	66° lag	2	70
	0.8	78	2	66° lag	2	70
	1.0	50	2	66° lag	3	70
	1.5	22	2	66° lag	3	70
	2.0	12.5	2	66° lag	4	70
	2.5	8	2	66° lag	5	70
2/6	2	12.4	2	66.4° lag	8	250
	2.5	8	2	66.4° lag	8	250
	3	5.6	2	66.4° lag	8	250
	3.5	4.1	2	66.4° lag	8	250
	4	3.1	2	66.4° lag	9	250
	5	2	2	66.4° lag	9	250
	6	1.3	2	66.4° lag	10	250
4/15	4	3.1	2	66.4° lag	16	250
	5	2	2	66.4° lag	16	250
	6	1.4	2	66.4° lag	16	250
	8	0.8	2	66.4° lag	17	250
	10	0.5	2	66.4° lag	18	250
	12	0.3	2	66.4° lag	19	250
	15	0.2	2	66.4° lag	20	250

VERY INVERSE TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	125	1.25	66.4° lag	2	100
	0.6	87	1.25	66.4° lag	2	100
	0.8	49	1.25	66.4° lag	2	100
	1.0	31	1.25	66.4° lag	3	100
	1.5	14	1.25	66.4° lag	3	100
	2.0	8	1.25	66.4° lag	4	100
	2.5	5	1.25	66.4° lag	5	100
2/6	2	8	1.25	66.4° lag	8	250
	2.5	5	1.25	66.4° lag	8	250
	3	3.5	1.25	66.4° lag	8	250
	3.5	2.5	1.25	66.4° lag	8	250
	4	1.9	1.25	66.4° lag	9	250
	5	1.25	1.25	66.4° lag	9	250
	6	0.9	1.25	66.4° lag	10	250
4/15	4	1.9	1.25	66.4° lag	16	250
	5	1.25	1.25	66.4° lag	16	250
	6	0.9	1.25	66.4° lag	16	250
	8	0.5	1.25	66.4° lag	17	250
	10	0.3	1.25	66.4° lag	18	250
	12	0.2	1.25	66.4° lag	19	250
	15	0.15	1.25	66.4° lag	20	250

*Thermal capacities for other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

LONG TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
4/15	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

SHORT TIME COH RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	400	4	60° lag	2	56
	0.6	280	4	60° lag	2	56
	0.8	156	4	60° lag	2	56
	1.0	100	4	60° lag	3	56
	1.5	44	4	60° lag	3	56
	2.0	25	4	60° lag	4	56
	2.5	16	4	60° lag	5	56
2/6	2	25	4	60° lag	8	250
	2.5	16	4	60° lag	8	250
	3	11	4	60° lag	8	250
	3.5	8	4	60° lag	8	250
	4	6.3	4	60° lag	9	250
	5	4	4	60° lag	9	250
	6	2.8	4	60° lag	10	250
4/15	4	6.3	4	60° lag	16	250
	5	4.0	4	60° lag	16	250
	6	3.0	4	60° lag	16	250
	8	1.6	4	60° lag	17	250
	10	1.0	4	60° lag	18	250
	12	0.7	4	60° lag	19	250
	15	0.4	4	60° lag	20	250

BURDENS AT TAP CURRENT ON 25 AND 50 CYCLES

	25 Cycles V.A.	25 Cycles Power Factor	50 Cycles V.A.	50 Cycles Power Factor
Definite Minimum Time CO...	16	53° lag	17	60° lag
Inverse Time CO.............	2	60° lag	2	60° lag
Very Inverse Time CO........	1.25	60° lag	1.25	66.4° lag
Long Time CO...............	16	53° lag	17	60° lag
Short Time COH.............	4	53° lag	4	60° lag

BURDENS FOR SATURATION DATA

Voltage taken with Rectox type voltmeter.

Multiples of Tap Values of Current		1	3	10	20
Definite Time	V.A. Burden	17	100	490	1300
Inverse Time	V.A. Burden	2.0	18.3	136	351
Very Inverse Time	V.A. Burden	1.25	10.75	97	254
COH Time	V.A. Burden	4	37.4	198	506

Characteristics of Types CO and COH Relays

Type	Energy	Time	Approx. #10 Lever Time at 20 x Tap Value	Gearing	Torque Compen-sator	Schematic per Figure No.	Typical 60 Cycle Time Curve per Fig. No.
CO	Std.	Definite Time	2 Sec.	Non-geared	Yes	3,4,6,8,9,10,12,14&15	23
CO	Std.	Definite Time	4 Sec.	Non-geared	Yes	3,4,6,8,9,10,12,14&15	..
CO	Low	Inverse	2 Sec.	Geared	No	3,4,5,7,9,10,11,13&15	24
CO	Low	Inverse	4 Sec.	Geared	Yes	3,4,6,8,9,10,12,14&15	..
CO	Low	Very Inverse	1 + Sec.	Geared	No	3,4,5,7,9,10,11,13&15	25
CO	Std.	Definite Time	40 Sec.	Geared	Yes	3,4,6,8,9,10,12,14&15	27
COH	....	Inverse	18 Cyc.	Non-Geared	No	3,4,5,9,10,11&15	26

Three element relay characteristics are the same as in single element forms.

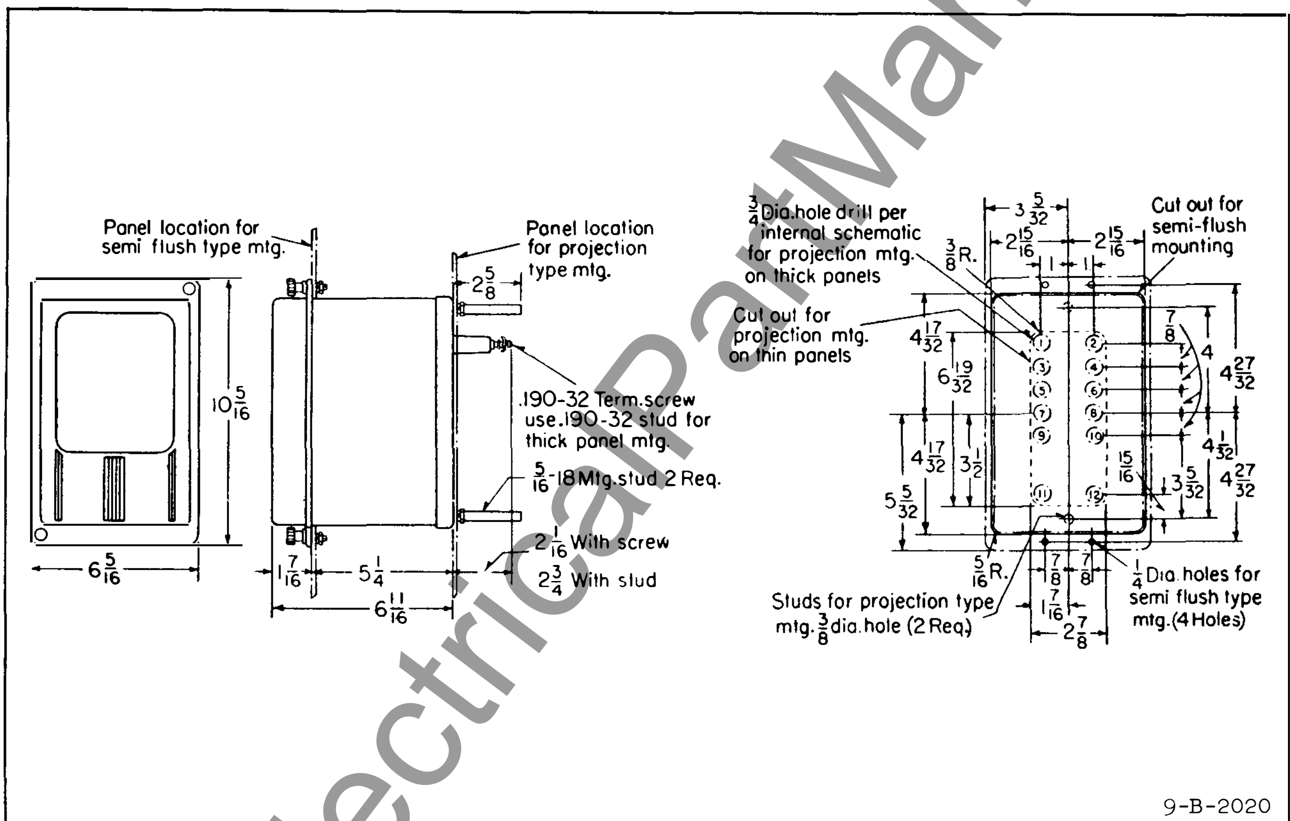

Fig. 28—Outline And Drilling Plan For The Single Element Types CO And COH Relays In The S10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

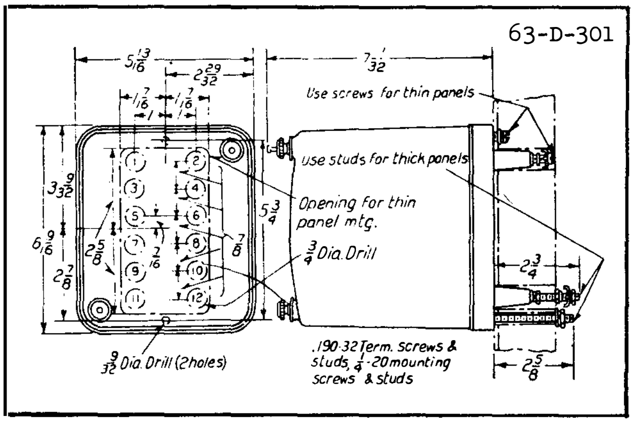

Fig. 29—Outline And Drilling Plan For The Single Element Types CO And COH Relays In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

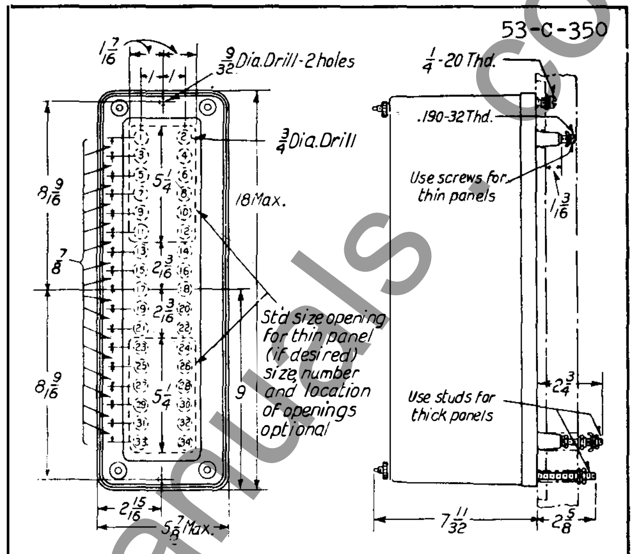

Fig. 30—Outline And Drilling Plan For The Three Element Types CO And COH Relays In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

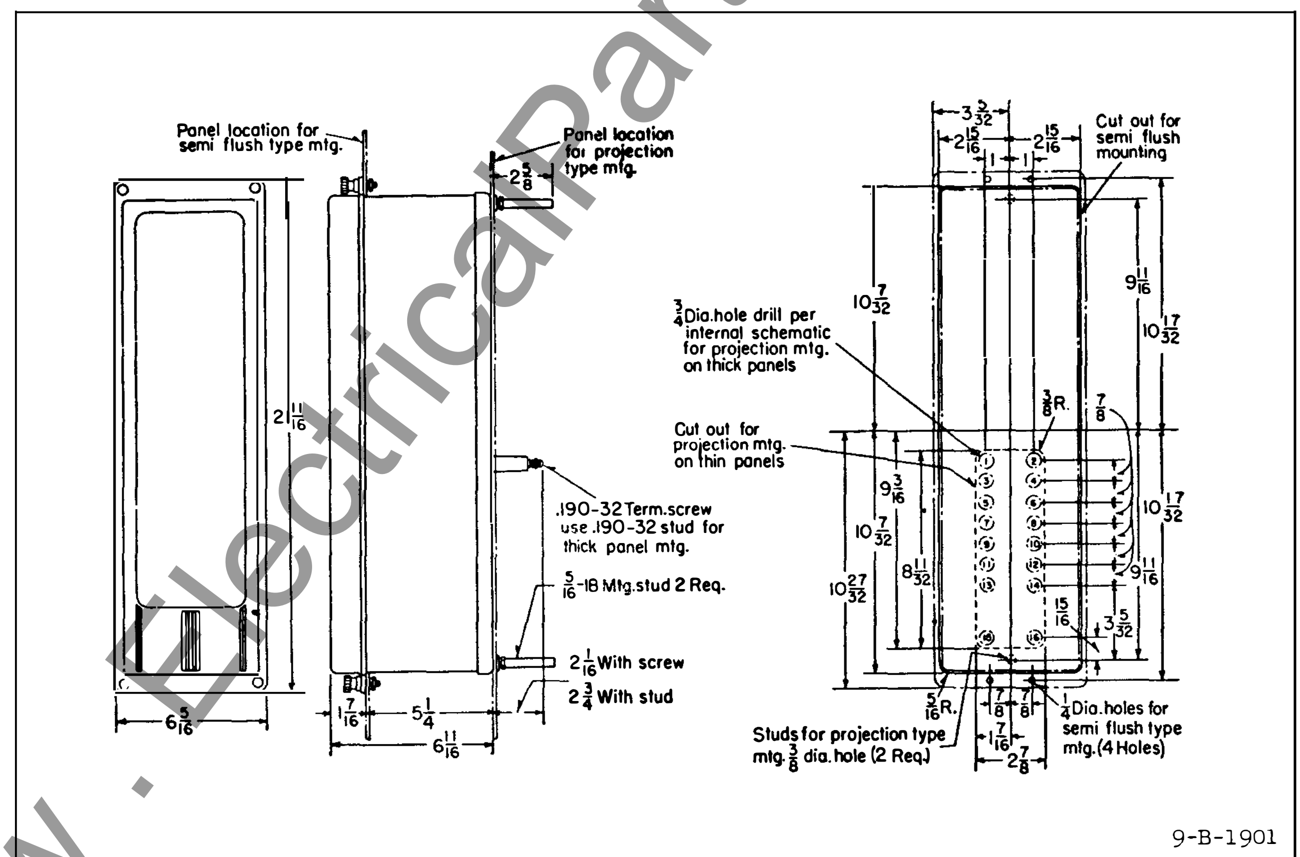

Fig. 31— Outline And Drilling Plan For The Three Element Types CO And COH Relays In The L10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION
METER DIVISION

NEWARK, N.J.
Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES CO AND COH OVERCURRENT RELAYS

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available. the circuit closing type relays are normally used to trip the circuit breaker. Where low voltage or no station battery exists, the circuit opening type relay in conjunction with a-c series trip coils can be used to open the breaker.

The inverse time (low-energy) type relay is used in preference to the definite minimum time (standard energy) relay where the requirements necessitate (1) a lower burden on the current transformer, or (2) a more inverse curve for selectivity, or (3) a very low current range as for example, ground protection of transmission systems.

The very-inverse time (low-energy) relay is similar to the inverse relay and is used where a still more inverse curve is desired. The term "low energy" refers to the burden at tap value that is placed on the current transformers and does not refer to the current rating.

The long time (40 second) relay is designed to protect motors against overloads. This can be equipped with an instantaneous attachment that will operate, if a short-circuit occurs in the motor.

The type COH relay finds application for phase and ground protection where a high speed induction type relay is desired. It is sometimes used in differential protective schemes.

The above relays can be supplied with the secondary electromagnet circuit brought out to separate terminals. This variety is known as the type CO or COH Torque Control Relay. Thus the contacts of a separate relay can be used to control the operation of the torque control relay. For example, a three phase directional relay plus suitable auxiliary relays can be used to directionally control three torque control relays.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay

The circuit-closing types CO and COH relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft in the non-geared type relays, or to an auxiliary shaft

SUPERSEDES I.L. 41-280 H

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*Denotes change from superseded issue

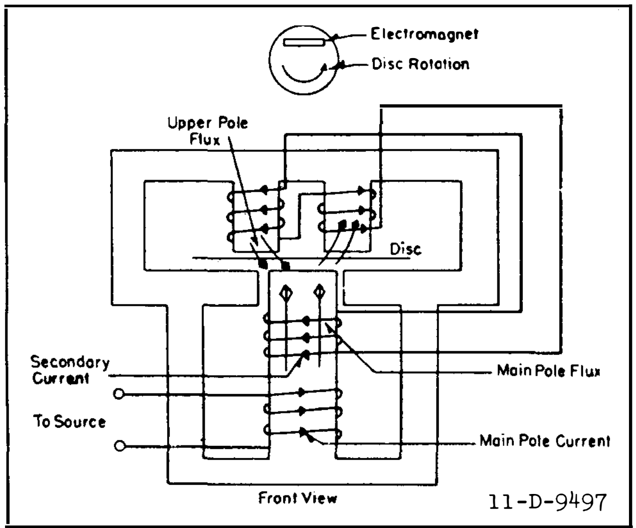

Fig. 1—Flux And Current Relations in The Type OOH, Type CO Inverse and Very Inverse Time Relays Without The Torque Compensator.

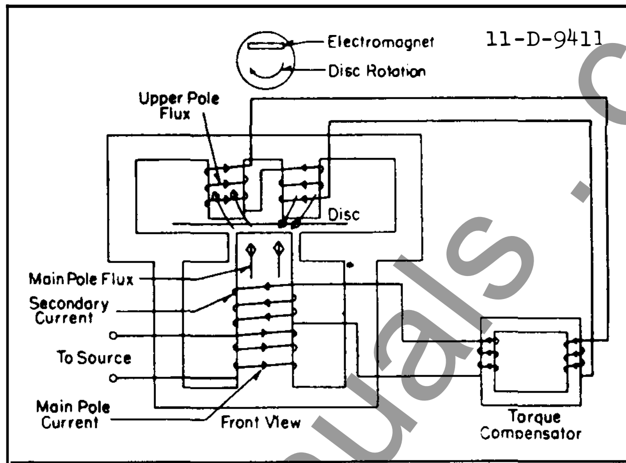

Fig. 2—Flux And Current Relations In The Long Time and Definite Minimum Time Relays With The Torque Compensator.

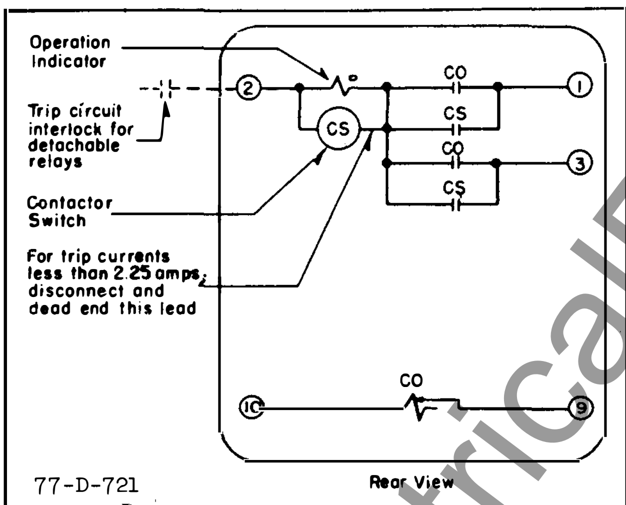

Fig. 3—Internal Schematic Of The Double Trip Circuit Closing Types CO And COH Relays In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

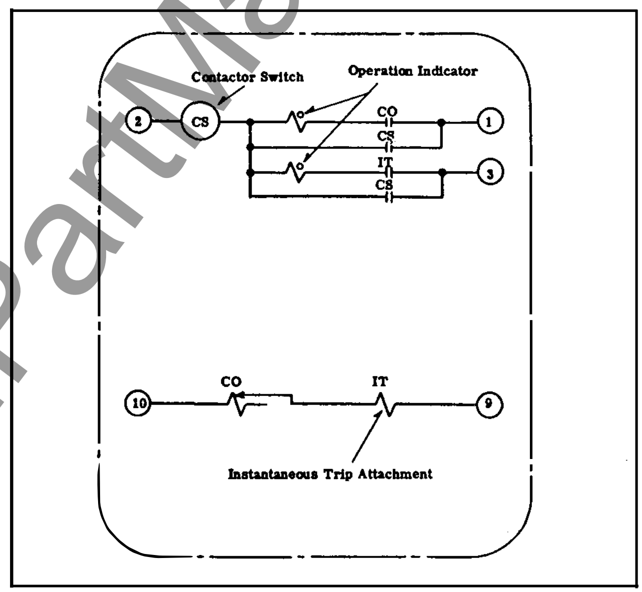

Fig. 4—Internal Schematic Of The Single Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Standard Case.

geared to the disc shaft in the geared type relays. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front. The operating torque of the inverse or very inverse relays is obtained

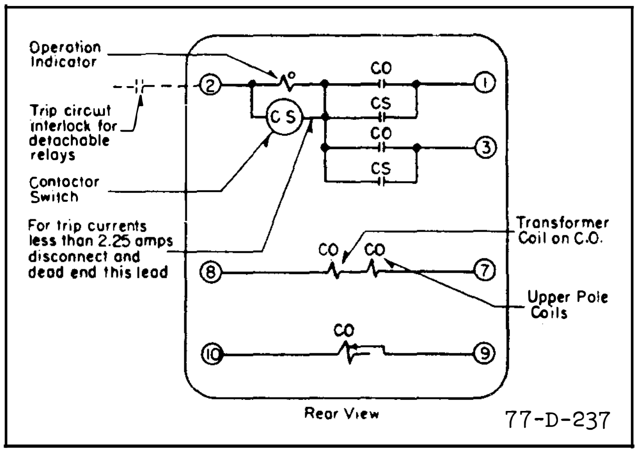

Fig. 5—Internal Schematic Of The Double Trip Circuit Closing Inverse And Very Inverse Types CO And COH Relays With Torque Control Terminals In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

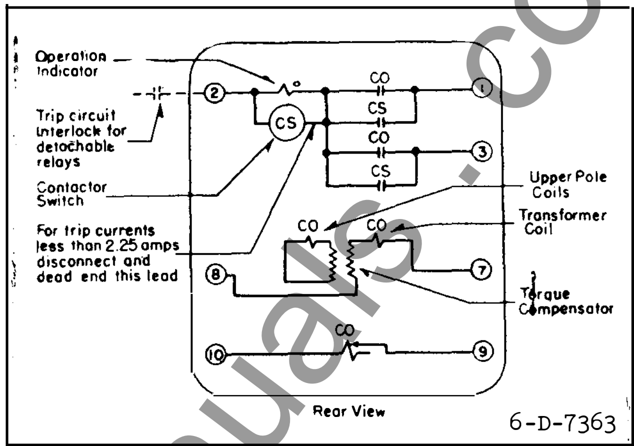

Fig. 6—Internal Schematic Of The Double Trip Circuit Closing Definite Minimum Time Type CO Relay With Torque Control Terminals In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

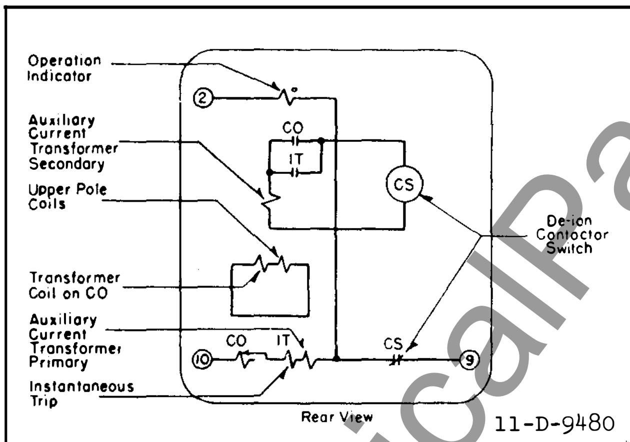

Fig. 7—Internal Schematic Of The Circuit Opening Inverse And Very Inverse Time Type CO Relays With Instantaneous Trip Attachment In The Standard Case.

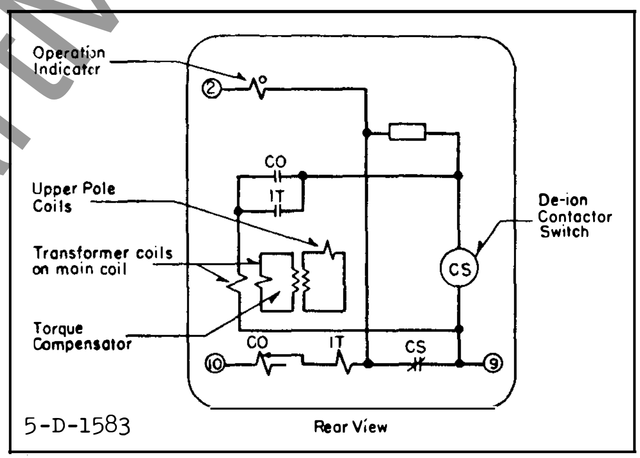

Fig. 8—Internal Schematic Of The Circuit Opening Definite Minimum Time Type CO Relays With Instantaneous Trip Attachment In The Standard Case.

by the circuit arrangement shown in Figure 1. The main pole coil of the relay acts as a transformer and induces a voltage in a secondary coil. Current from this secondary coil flows through the upper pole coils and thus produces torque on the disc by the reaction between the fluxes of the upper and lower poles.

The definite-time relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper pole coils. This is called the torque compensator and it slows down the disc movement to such an extent that no gearing is required. (See Figure 2).

The long time relay is a geared relay with a torque compensator.

The type COH relay is a non-geared relay without a torque compensator.

Contactor Switch

The d-c. contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid.

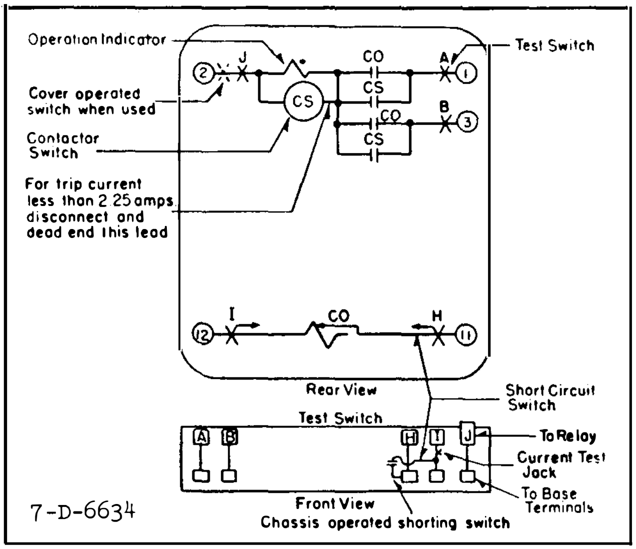

Fig. 9—Internal Schematic Of The Double Trip Circuit Closing Types CO And COH Relays In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

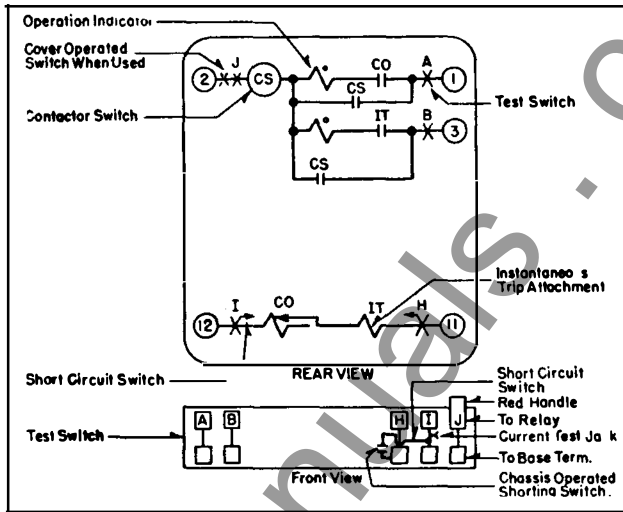

Fig. 10—Internal Schematic Of The Single Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Type FT Case.

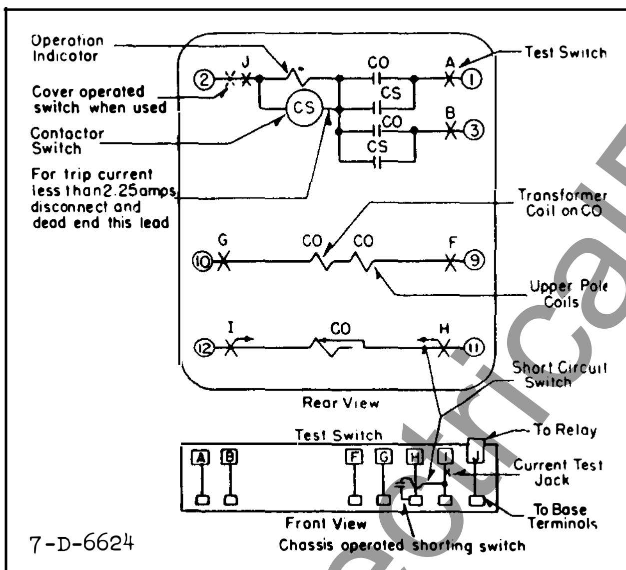

Fig. 11—Internal Schematic Of The Double Trip Circuit Closing Inverse And Very Inverse Types CO And COH Relays With Torque Control Terminals In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

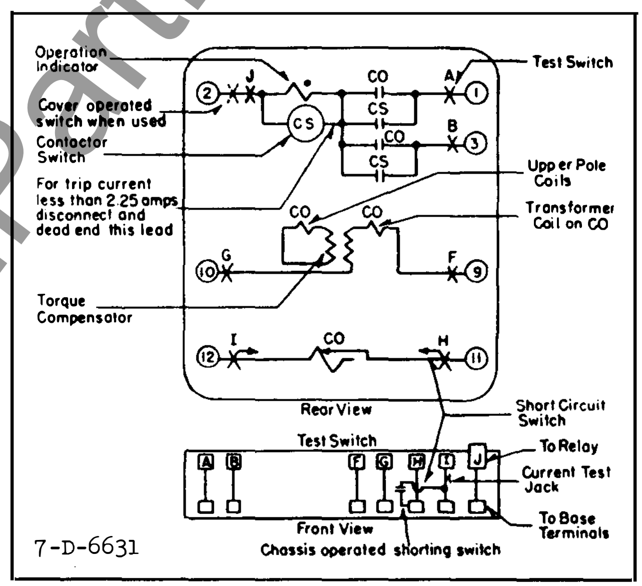

Fig. 12—Internal Schematic Of The Double Trip Circuit Closing Definite Minimum Time Type CO Relay With Torque Control Terminals In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

As the plunger travels upward. the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid

coil connected in the trip circuit. When the coil is energized. a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

Instantaneous Lock-Out Attachment (When Supplied)

The lock-out attachment is used to prevent the relay from tripping a circuit breaker when current is too high above its interrupting capacity.

Circuit-Opening Relay

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, an operation indicator and an instantaneous trip attachment where required.

Overcurrent Element

The overcurrent construction and operation is similar to that described for the circuit closing relays.

De-ion Contactor Switch

This switch is a small a-c. solenoid switch whose coil is energized from a few turns on the lower pole of the overcurrent element in the standard-energy type relays, and from a small transformer connected in the main current circuit in the low-energy type relays. Its construction is similar to the d-c. type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

The transformer coil on the lower pole of the overcurrent element and the contactor switch circuits in the standard energy type relays are connected to the main circuits as shown in Figures 8 and 14. When the overcurrent contact closes, the contactor switch operates, and the voltage across the trip coil is impressed on the transformer and contactor switch coils. This voltage acts to seal-in the contactor switch, and to feed energy through the transformer coil to the main overcurrent winding which produces contact closing torque. This arrangement provides a definite minimum pick-up value largely independent of the value of trip coil impedance.

Operation Indicator

The operation indicator is in series with the breaker trip coil. Its construction is as described above.

CHARACTERISTICS

The type CO definite minimum time (standard energy) or long time (40 second) circuit closing relay is available in either of the following current ranges.

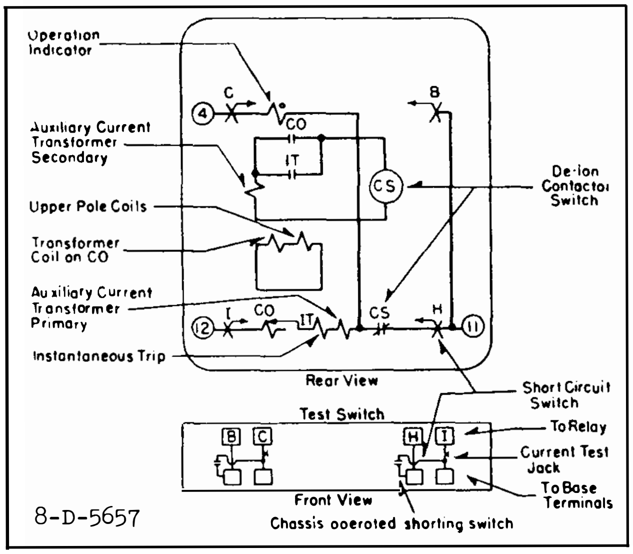

Fig. 13—Internal Schematic Of The Circuit Opening Inverse And Very Inverse Time Type CO Relays With Instantaneous Trip Attachment In The Type FT Case.

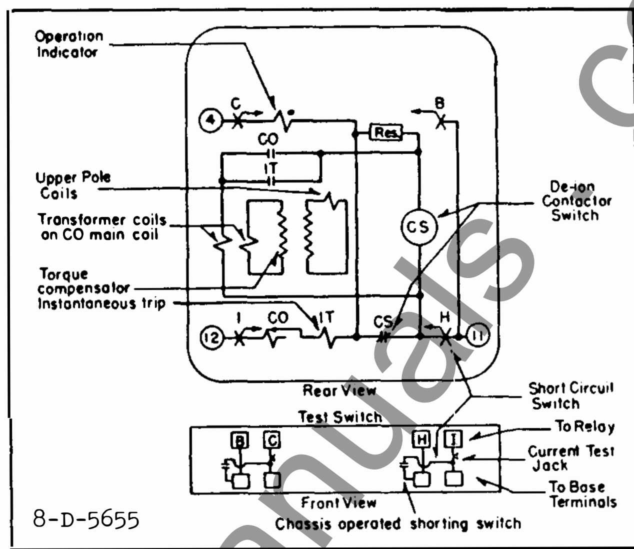

Fig. 14—Internal Schematic Of The Circuit Opening Definite Minimum Time Type CO Relays With Instantaneous Trip Attachment In The Type FT Case.

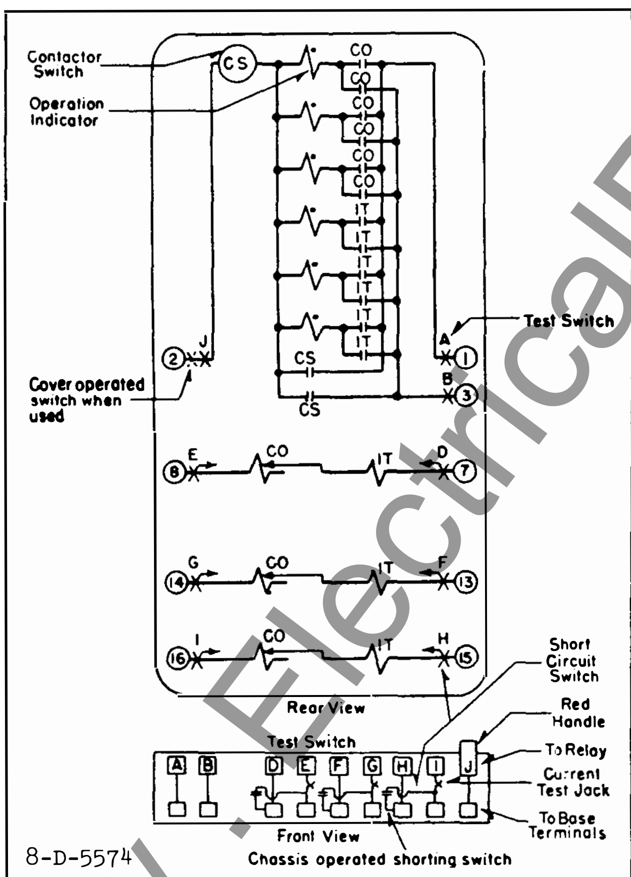

Fig. 15—Internal Schematic Of The Three Element Double Trip Circuit Closing Types CO And COH Relays With Instantaneous Trip Attachment In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

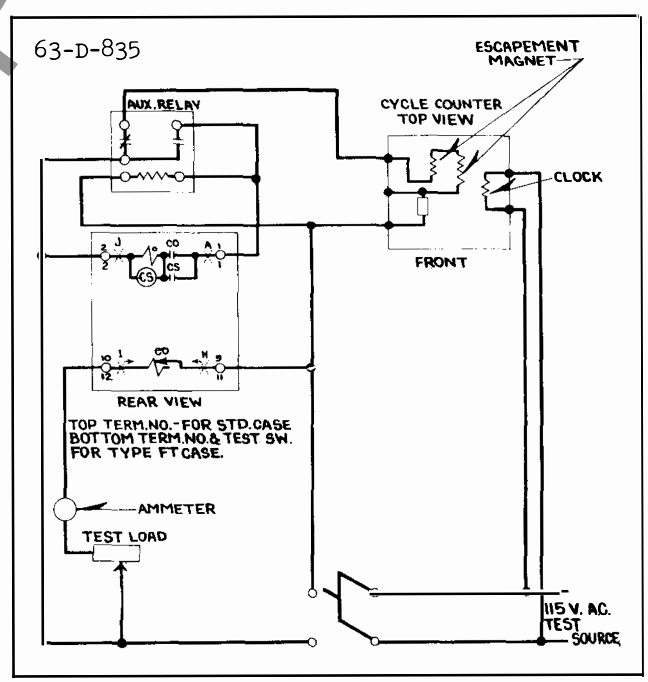

Fig. 16—Diagram Of Test Connections For Circuit Closing Types CO And COH.

2 2.5 3 3.5 4 5 6
4 5 6 8 10 12 15

The type CO inverse, very inverse (low energy) or the type COH circuit closing relay is available in the following current ranges.

0.5 0.6 0.8 1.0 1.5 2.0 2.5
2 2.5 3 3.5 4 5 6
4 5 6 8 10 12 15

The type CO circuit-opening relay is made only in the 4 to 15 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. In addition to the taps, the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 11 divisions.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers, or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The characteristics of the various varieties of type CO and COH relays usually supplied are as shown on page 13.

The burdens and thermal ratings are listed under Energy Requirements.

The instantaneous trip attachment has a 1 to 4 range. Typical ranges are 10-40 or 20-80 but other ranges may be supplied as ordered.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

The instantaneous lock-out attachment has a 3 to 1 range with typical ranges similar to the instantaneous trip attachment.

Trip Circuit

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done, the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit
Resistance of 0.2 ampere Target......2.8 ohms
Resistance of 2.0 ampere Contact Switch...........................0.25 ohms
Resistance of Target and Switch in Parallel.........................0.23 ohms

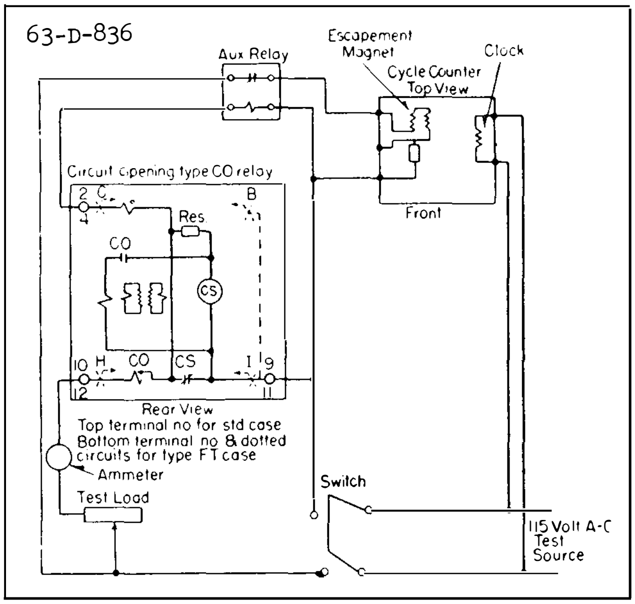

Fig. 17—Diagram Of Test Connection For Circuit Opening Type CO Relay.

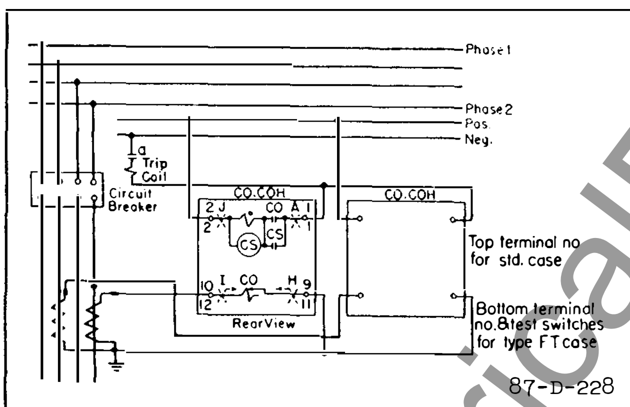

Fig. 19—External Connections Of The Circuit Closing Types CO And COH Relays For Overcurrent Protection On A Two-Phase System.

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target......0.16 ohms
Resistance of 2.0 ampere Contactor
Switch.............................0.25 ohms
Resistance of Target and Switch in
Series.............................0.41 ohms

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of

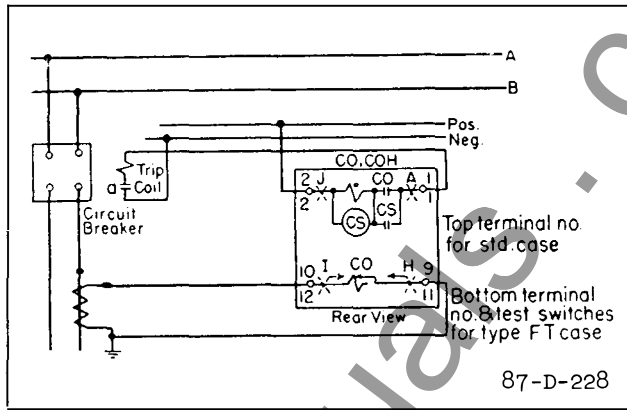

Fig. 18—External Connections Of The Circuit Closing Types CO And COH Relays For Overcurrent Protection On A Single Phase System.

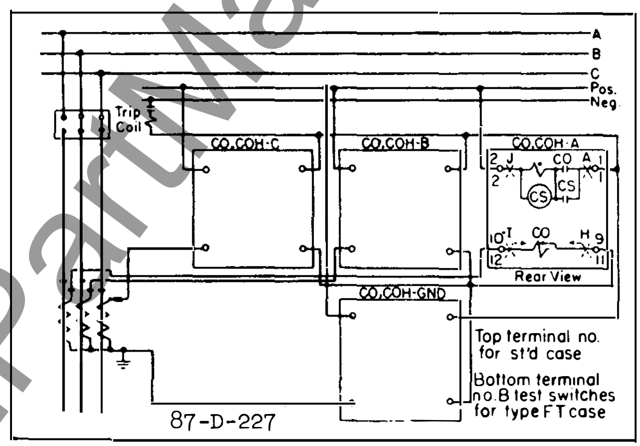

Fig. 20—External Connections Of The Circuit Closing Types CO And COH Relays For Phase And Ground Overcurrent Protection On A Three-Phase System.

the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

Because the circuit-opening relay contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subject to shocks which may jar the contacts

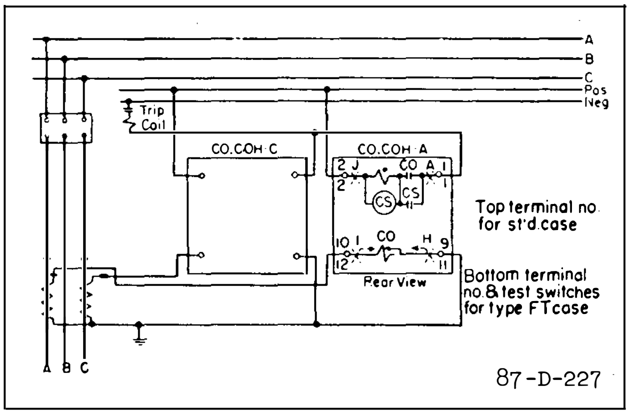

Fig. 21—External Connections Of The Circuit Closing Types CO And COH Relays For Phase Overcurrent Protection On An Ungrounded Three-Phase System.

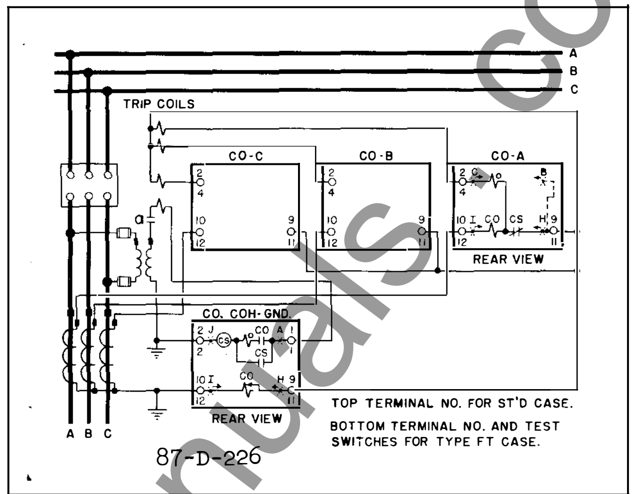

Fig. 22—External Connections Of The Circuit Opening Type CO Relay For Phase Overcurrent Protection And Of The Circuit Closing Types CO And COH Relays For Ground Protection On A Three-Phase System.

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 safeguard so that there is no danger from even an excessive shock unless the current is also heavy.

Typical external connections are shown in Figures 18 to 22. When using the circuit-opening relays for phase protection, ground protection may be secured by using a low-energy circuit-closing relay operating on a-c. voltage trip coil, as shown in Figure 22.

SETTINGS

There are two settings-namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 screwdriver inserted in one of the notches of the plate to which 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.

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 circuits the latter should be short-circuited before changing the connector screw. This can be done conveniently by inserting the extra connector screw, in the new tap and removing the old screw from its original setting.

Time Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figures 23 to 27.

ADJUSTMENTS AND MAINTENANCE

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 shoudl not be used in testing induction-type relays because of the resulting distorted current wave form which produces an error in timing.

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed or the relay taken apart for repairs, the following instructions should be followed in reassembling and setting it.

(Overcurrent Element Circuit-Closing Relays)

Shift the position of the contact stop on the time lever and adjust the 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 tap block. Check the time curve as shown by test with a cycle counter, to be as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operation condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field. If the relay has a metal cover, this cover must be in place when making tests.

The relays with torque control terminals will not operate until these terminals are short-circuited either by a jumper or by the external control contacts.

Contactor Switch (Circuit-Closing Relays)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked-up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c. have been passed through the coil.

Operation Indicator (Circuit-Closing Relays)

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side

of the assembly, and moving the bracket forward or backward. Test for sticking after 10 times rated pick-up current has been applied.

Overcurrent Element (Circuit Opening Relays)

Adjust the relay with the instructions given under "Overcurrent Element (Circuit Closing Relays)" using the test connection of Figure 17 except that for the definite minimum time circuit opening relay the following caution should be observed:

CAUTION When a signal lamp or other voltage operated device is to be connected in series with the relay contacts, disconnect the internal leads of the element from the stationary and moving contacts respectfully and dead end them. Then the lamp or other device can be connected to the stationary and moving contacts.

De-ion Contactor Switch (Circuit Opening Relays)

Adjust the core stop on the top as high as possible without, allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by 1/32" to 1/16". Adjust the contact gap spacing to slightly less than 1/16 of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes on the 4 ampere overcurrent tap setting.

In the case of the standard energy circuit opening relay the contactor switch should pick-up and seal itself open at 75% of minimum trip current.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 4 amperes a-c.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disc should be lowered or raised to the proper position by loosening the locknut which locks the Micarta disc and rotating the Micarta disc. The nominal range of adjustments is 1 to 4, for example 10 to 40 amperes, and it has an accuracy within the limits of approximately 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about 2/3 of the minimum pick-up.

This element will not fit in the round-type case.

Instantaneous Lock-Out Attachment

The position of the bottom of the plunger with reference to the calibrated guide indicates the minimum current required to open the contacts. To change the setting hold the top slotted head of the plunger rod fixed with a screwdriver. Then with a second screwdriver adjust the lower end of the plunger for the current pick-up desired.

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. The nominal range of adjustment is 3 to 1.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

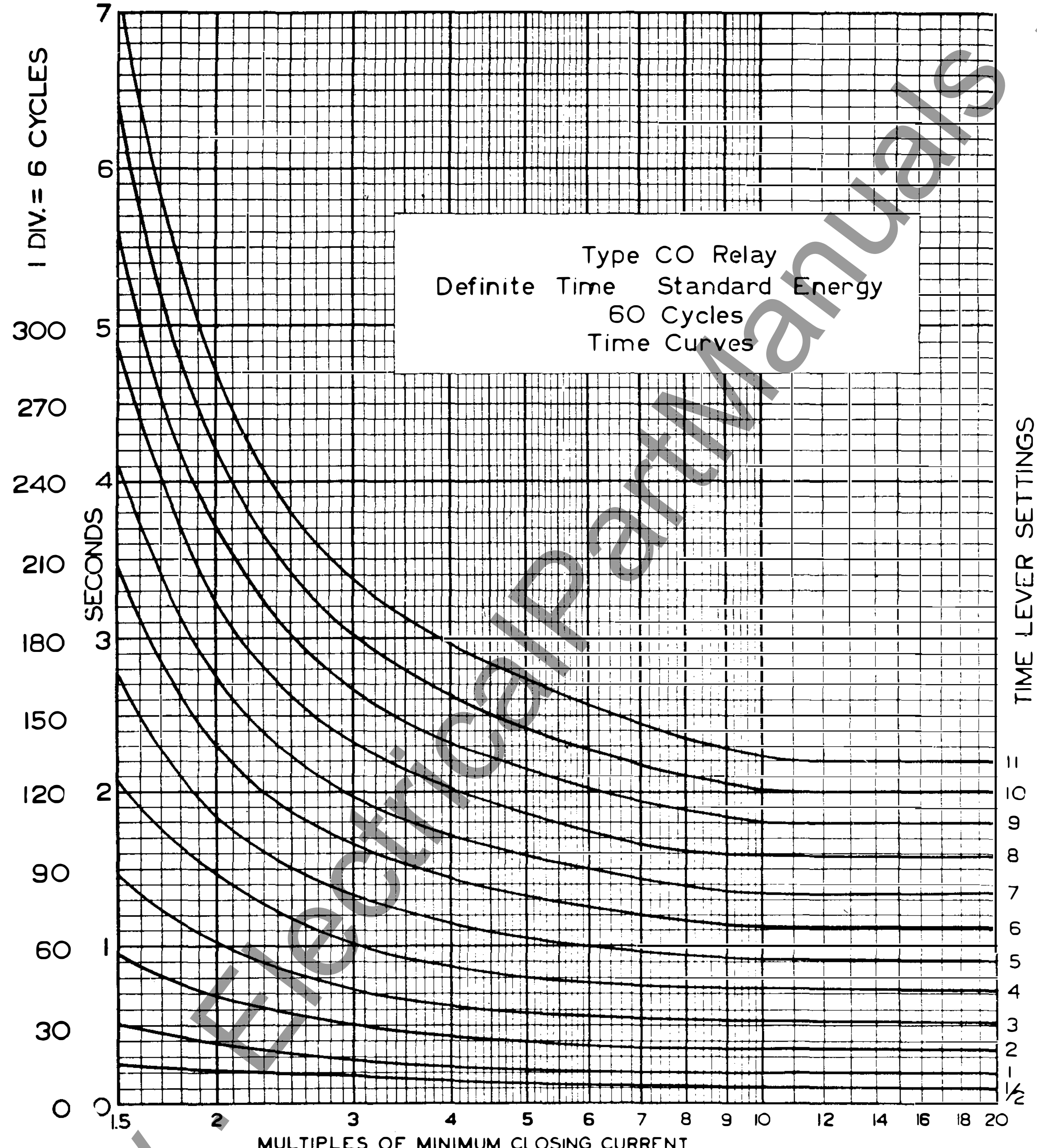

Fig. 23—Typical 60 Cycle Time Curves Of The Definite Minimum Time (Standard Energy) Type CO Relay.

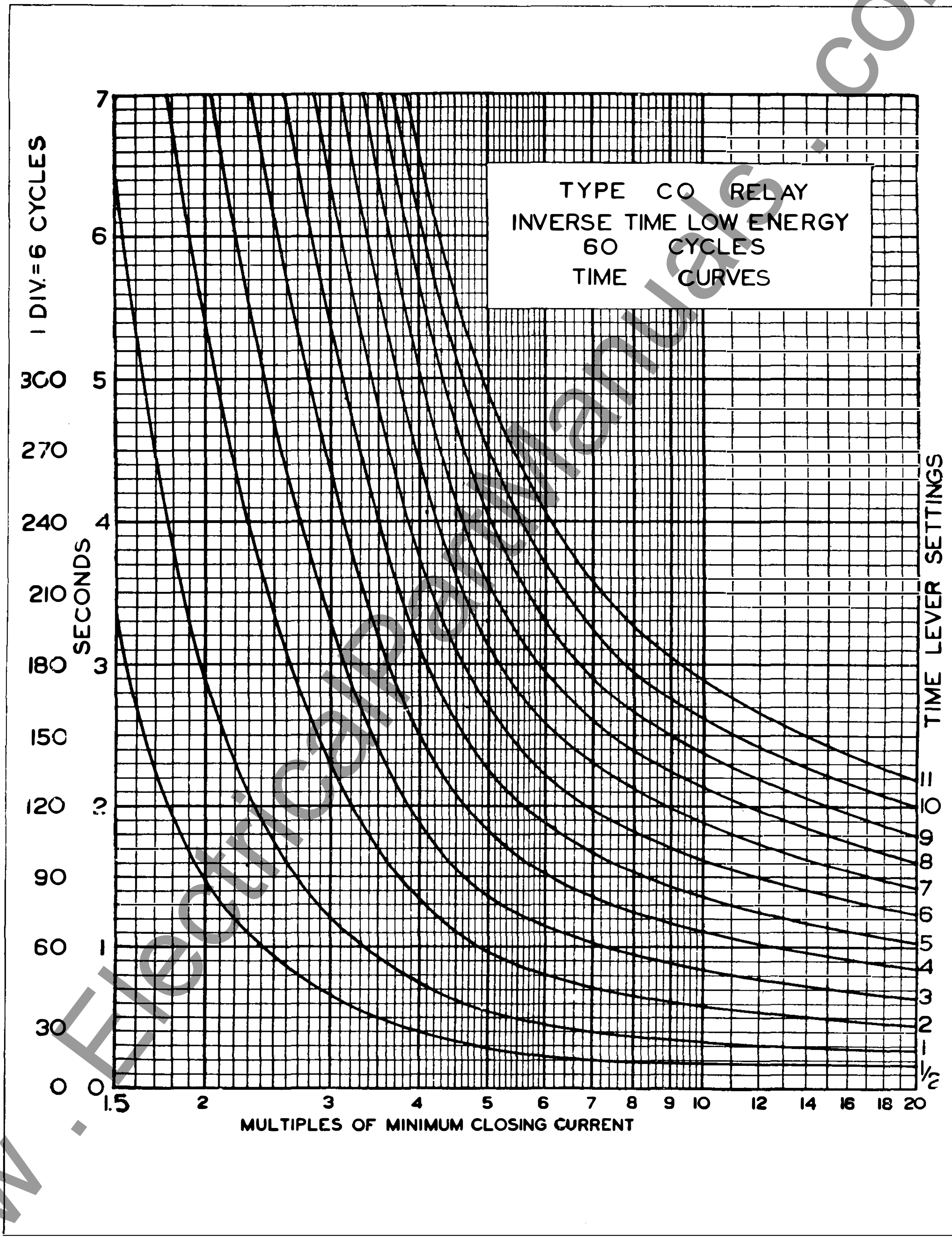

Fig. 24—Typical 60 Cycle Time Curves Of The Inverse Time (Low Energy) Type CO Relay.

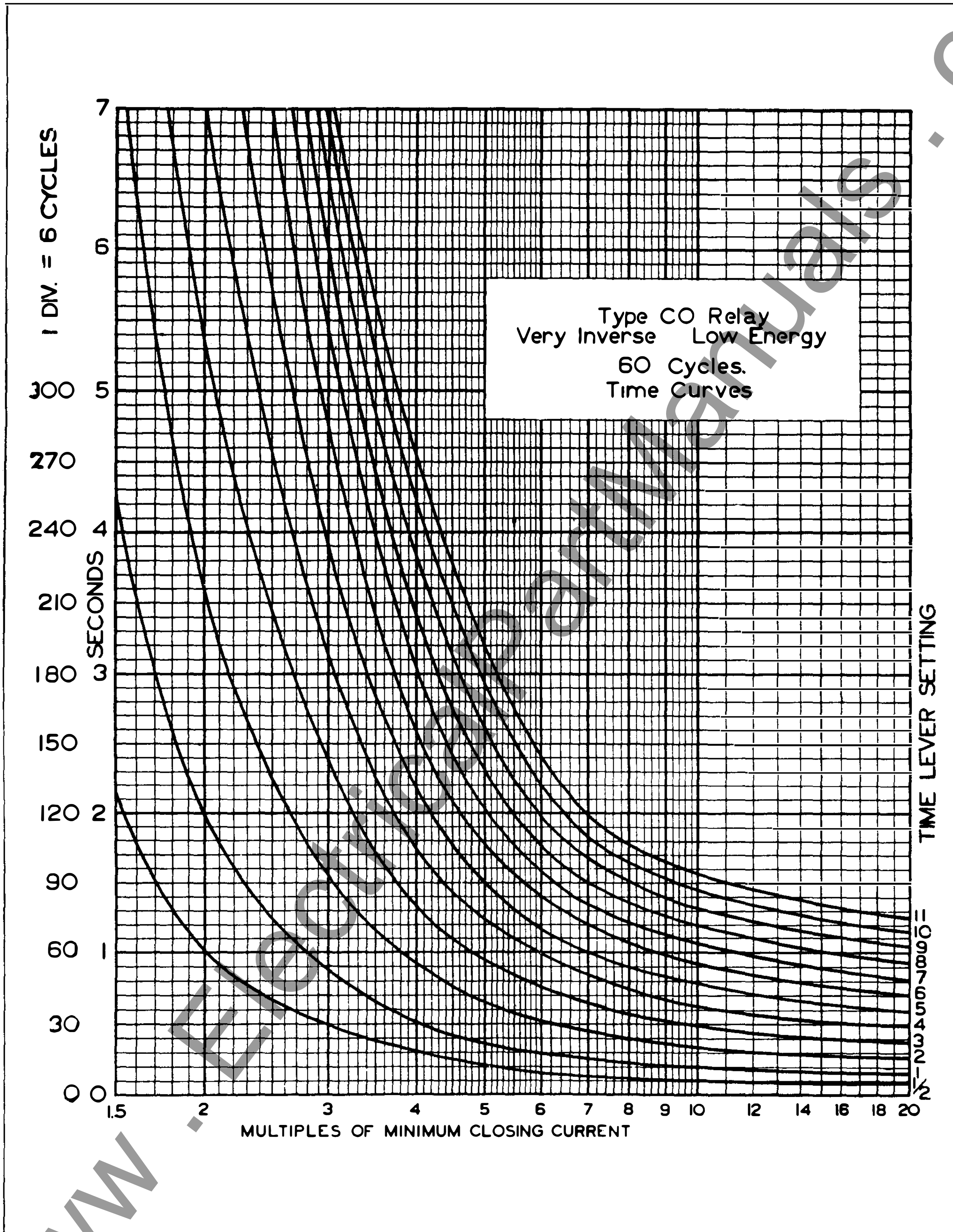

Fig. 25—Typical 60 Cycle Time Curves Of The Very Inverse Time (Low Energy) Type CO Relay.

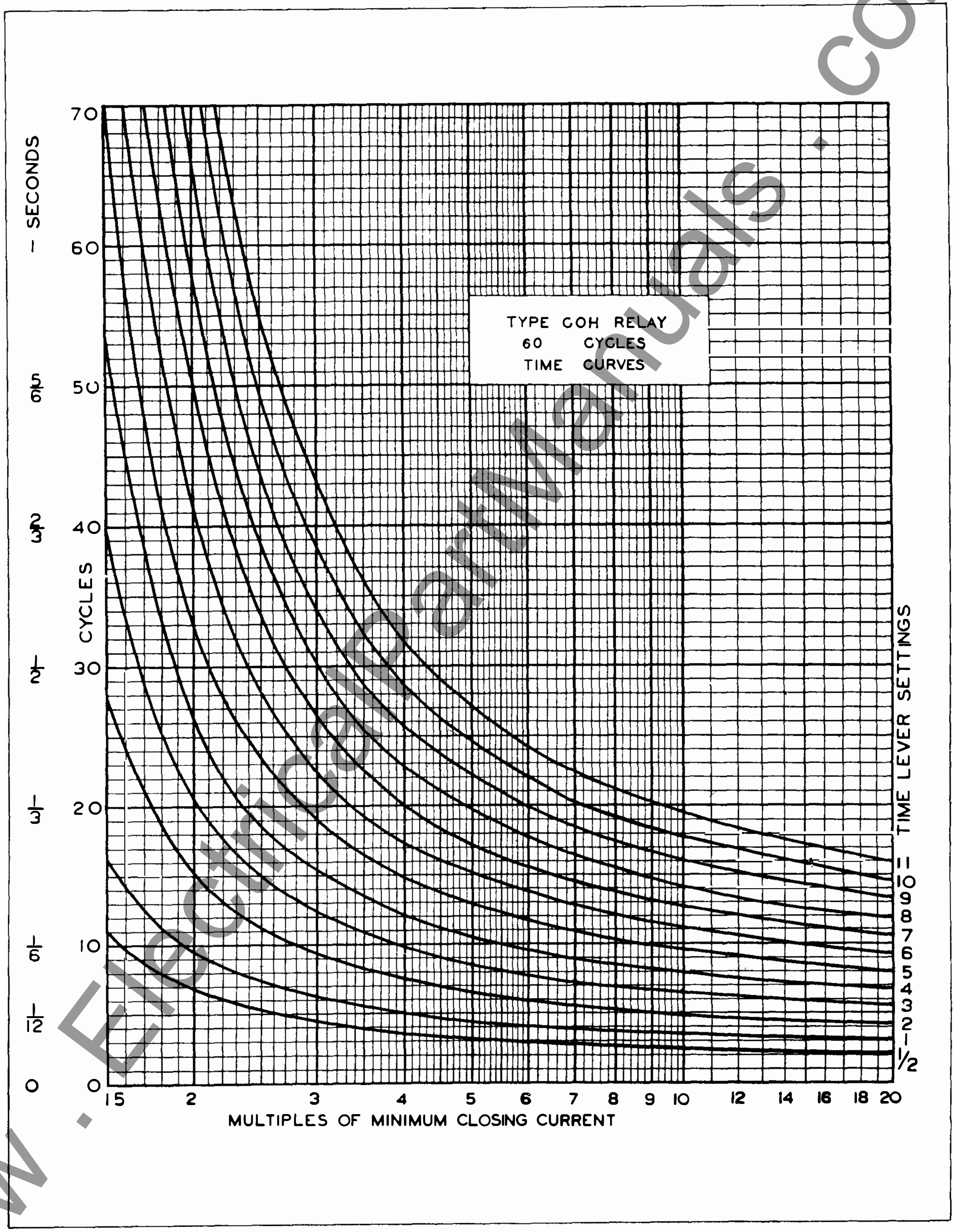

Fig. 26—Typical 60 Cycle Time Curves Of The Type COH Relay.

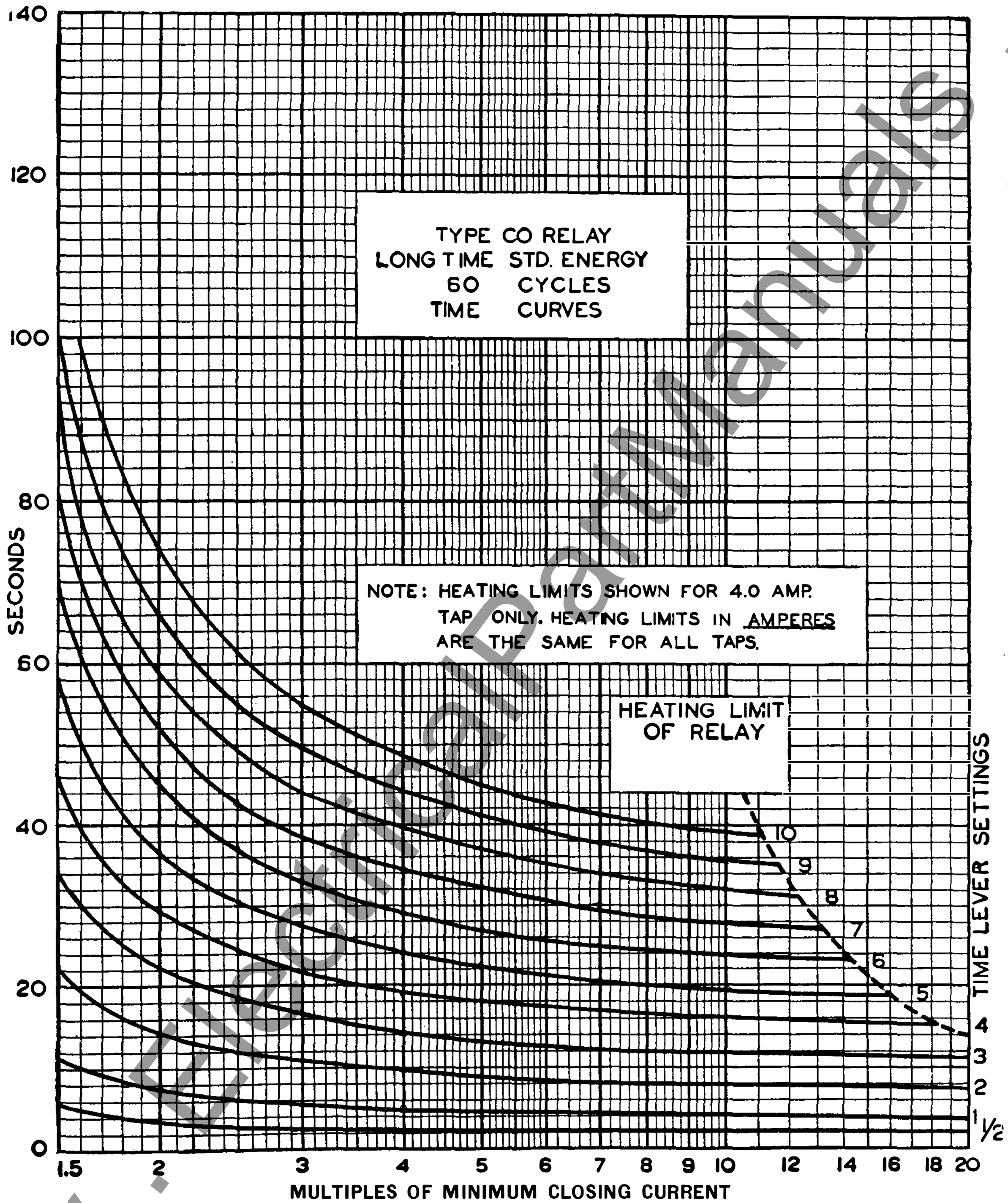

Fig. 27—Typical 60 Cycle Time Curves Of The Long Time (40 Second) Type CO Relay.

ENERGY REQUIREMENTS

The burdens and thermal capacities of the various circuits of the relay are as follows:

DEFINITE MINIMUM TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
2/6	2	108	17	60° lag	4	140
	2.5	68	17	60° lag	5	140
	3	47	17	60° lag	5	140
	3.5	35	17	60° lag	6	140
	4	26	17	60° lag	7	140
	5	17	17	60° lag	8	140
	6	12	17	60° lag	10	140
4/15	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

INVERSE TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	200	2	66° lag	2	70
	0.6	140	2	66° lag	2	70
	0.8	78	2	66° lag	2	70
	1.0	50	2	66° lag	3	70
	1.5	22	2	66° lag	3	70
	2.0	12.5	2	66° lag	4	70
	2.5	8	2	66° lag	5	70
2/6	2	12.4	2	66.4° lag	8	250
	2.5	8	2	66.4° lag	8	250
	3	5.6	2	66.4° lag	8	250
	3.5	4.1	2	66.4° lag	8	250
	4	3.1	2	66.4° lag	9	250
	5	2	2	66.4° lag	9	250
	6	1.3	2	66.4° lag	10	250
4/15	4	3.1	2	66.4° lag	16	250
	5	2	2	66.4° lag	16	250
	6	1.4	2	66.4° lag	16	250
	8	0.8	2	66.4° lag	17	250
	10	0.5	2	66.4° lag	18	250
	12	0.3	2	66.4° lag	19	250
	15	0.2	2	66.4° lag	20	250

VERY INVERSE TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	125	1.25	66.4° lag	2	100
	0.6	87	1.25	66.4° lag	2	100
	0.8	49	1.25	66.4° lag	2	100
	1.0	31	1.25	66.4° lag	3	100
	1.5	14	1.25	66.4° lag	3	100
	2.0	8	1.25	66.4° lag	4	100
	2.5	5	1.25	66.4° lag	5	100
2/6	2	8	1.25	66.4° lag	8	250
	2.5	5	1.25	66.4° lag	8	250
	3	3.5	1.25	66.4° lag	8	250
	3.5	2.5	1.25	66.4° lag	8	250
	4	1.9	1.25	66.4° lag	9	250
	5	1.25	1.25	66.4° lag	9	250
	6	0.9	1.25	66.4° lag	10	250
4/15	4	1.9	1.25	66.4° lag	16	250
	5	1.25	1.25	66.4° lag	16	250
	6	0.9	1.25	66.4° lag	16	250
	8	0.5	1.25	66.4° lag	17	250
	10	0.3	1.25	66.4° lag	18	250
	12	0.2	1.25	66.4° lag	19	250
	15	0.15	1.25	66.4° lag	20	250

*Thermal capacities for other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

LONG TIME CO RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
4/15	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

SHORT TIME COH RELAYS AT 60 CYCLES

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One* Second Rating (Amperes)
0.5/2.5	0.5	400	4	60° lag	2	56
	0.6	280	4	60° lag	2	56
	0.8	156	4	60° lag	2	56
	1.0	100	4	60° lag	3	56
	1.5	44	4	60° lag	3	56
	2.0	25	4	60° lag	4	56
	2.5	16	4	60° lag	5	56
2/6	2	25	4	60° lag	8	250
	2.5	16	4	60° lag	8	250
	3	11	4	60° lag	8	250
	3.5	8	4	60° lag	8	250
	4	6.3	4	60° lag	9	250
	5	4	4	60° lag	9	250
	6	2.8	4	60° lag	10	250
4/15	4	6.3	4	60° lag	16	250
	5	4.0	4	60° lag	16	250
	6	3.0	4	60° lag	16	250
	8	1.6	4	60° lag	17	250
	10	1.0	4	60° lag	18	250
	12	0.7	4	60° lag	19	250
	15	0.4	4	60° lag	20	250

BURDENS AT TAP CURRENT ON 25 AND 50 CYCLES

	25 Cycles V.A.	25 Cycles Power Factor	50 Cycles V.A.	50 Cycles Power Factor
Definite Minimum Time CO...	16	53° lag	17	60° lag
Inverse Time CO.............	2	60° lag	2	60° lag
Very Inverse Time CO........	1.25	60° lag	1.25	66.4° lag
Long Time CO...............	16	53° lag	17	60° lag
Short Time COH.............	4	53° lag	4	60° lag

BURDENS FOR SATURATION DATA

Voltage taken with Rectox type voltmeter.

Multiples of Tap Values of Current		1	3	10	20
Definite Time	V.A. Burden	17	100	490	1300
Inverse Time	V.A. Burden	2.0	18.3	136	351
Very Inverse Time	V.A. Burden	1.25	10.75	97	254
COH Time	V.A. Burden	4	37.4	198	506

Characteristics of Types CO and COH Relays

Type	Energy	Time	Approx. #10 Lever Time at 20 x Tap Value	Gearing	Torque Compensator	Schematic per Figure No.	Typical 60 Cycle Time Curve per Fig. No.
CO	Std.	Definite Time	2 Sec.	Non-geared	Yes	3,4,6,8,9,10,12,14&15	23
CO	Std.	Definite Time	4 Sec.	Non-geared	Yes	3,4,6,8,9,10,12,14&15	..
CO	Low	Inverse	2 Sec.	Geared	No	3,4,5,7,9,10,11,13&15	24
CO	Low	Inverse	4 Sec.	Geared	Yes	3,4,6,8,9,10,12,14&15	..
CO	Low	Very Inverse	1 + Sec.	Geared	No	3,4,5,7,9,10,11,13&15	25
CO	Std.	Definite Time	40 Sec.	Geared	Yes	3,4,6,8,9,10,12,14&15	27
COH	....	Inverse	18 Cyc.	Non-Geared	No	3,4,5,9,10,11&15	26

Three element relay characteristics are the same as in single element forms.

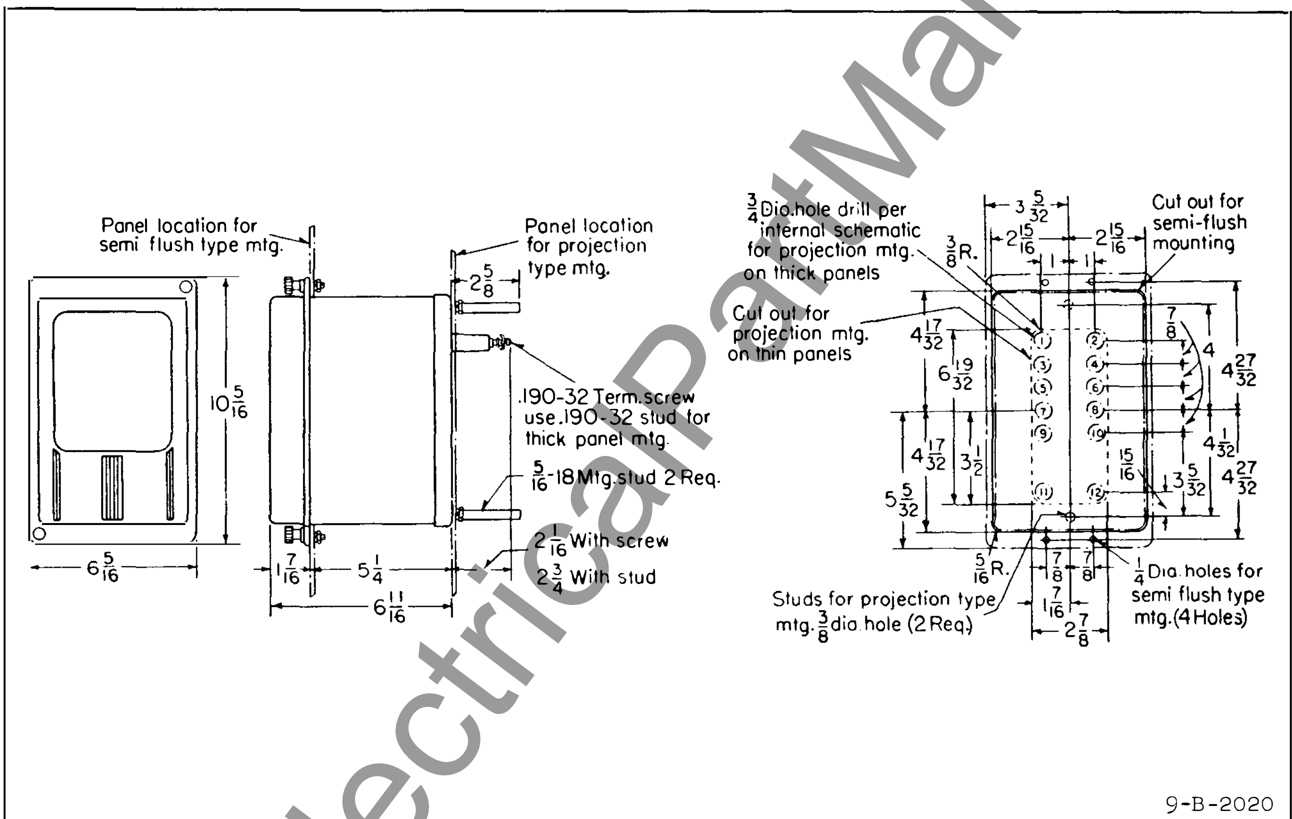

Fig. 28—Outline And Drilling Plan For The Single Element Types CO And COH Relays In The S10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

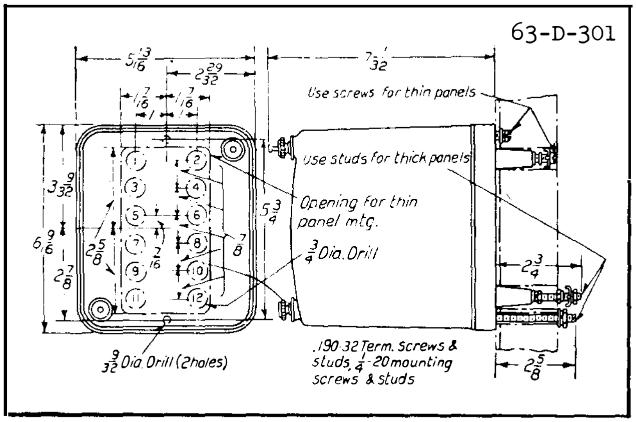

Fig. 29—Outline And Drilling Plan For The Single Element Types CO And COH Relays In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

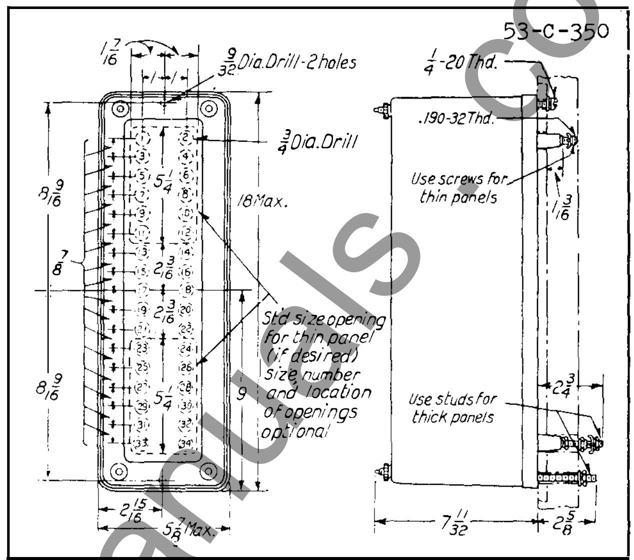

Fig. 30—Outline And Drilling Plan For The Three Element Types CO And COH Relays In The Projection Type Standard Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

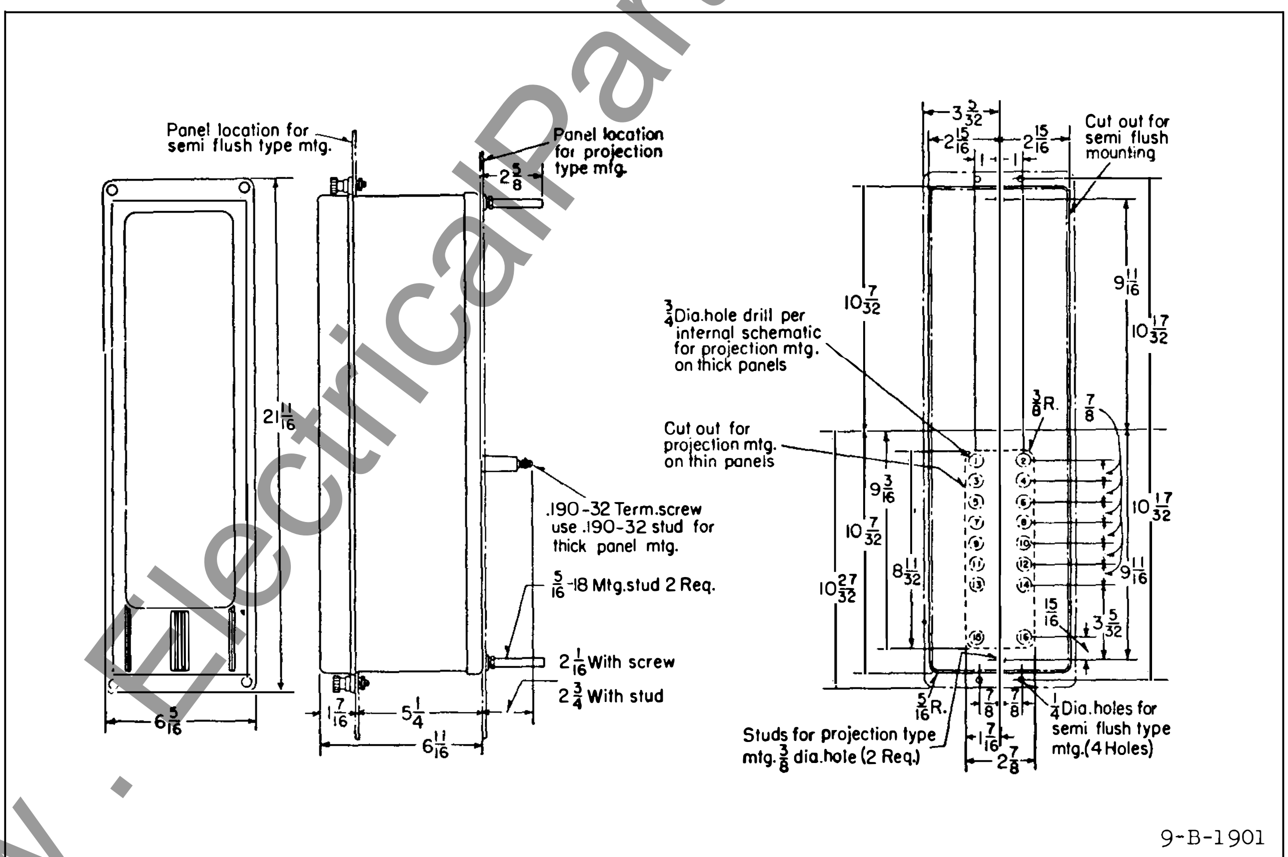

Fig. 31—Outline And Drilling Plan For The Three Element Types CO And COH Relays In The L10 Projection Or Semi-Flush Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION

NEWARK, N.J.

Printed in U.S.A.

Westinghouse

Types CO and COH Overcurrent Relays

INSTRUCTIONS

CAUTION

Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment. Make sure that all moving parts operate freely. Inspect the contacts to see that they are clean and can close properly. Operate the relay to check the settings and electrical connections.

APPLICATION

These induction-overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker. Where low voltage or no station battery exists, the circuit opening type relay in conjunction with a-c series trip coils can be used to open the breaker.

The inverse time (low-energy) type relay is used in preference to the definite minimum time (standard energy) relay where the requirements necessitate (1) a lower burden on the current transformer, or (2) a more inverse curve for selectivity, or (3) a very low current range as for example, ground protection of transmission systems.

The very-inverse time (low-energy) relay is similar to the inverse relay and is used where a still more inverse curve is desired. The term "low energy" refers to the burden at tap value that is placed on the current transformers and does not refer to the current rating.

The long time (40 second) relay is designed to protect motors against overloads. This can be equipped with an instantaneous attachment that will operate, if a short-circuit occurs in the motor.

The type COH relay finds application for phase and ground protection where a high speed induction type relay is desired. It is sometimes used in differential protective schemes.

The above relays can be supplied with the secondary electromagnet circuit brought out to separate terminals. This variety is known as the type CO or COH Torque Control Relay. Thus the contacts of a separate relay can be used to control the operation of the torque control relay. For example, a three phase directional relay can be used to directionally control three torque control relays.

CONSTRUCTION AND OPERATION

Circuit-Closing Relay

The circuit-closing types CO and COH relays consist of an overcurrent element, an operation indicator, a contactor switch, and an instantaneous trip attachment where required.

Overcurrent Element

This element is an induction-disc type element operating on overcurrent. The induction disc is a thin four-inch diameter, aluminum disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft in the non-geared type relays, or to an auxiliary shaft geared to the disc shaft in the geared type relays. The electrical connection is made from the moving contact through the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the Micarta block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in the front. The operating torque of the inverse or very inverse relays is obtained by the circuit arrangement shown in Figure 1. The main pole coil of the relay acts as a transformer and induces a voltage in a secondary coil. Current from this secondary coil flows through the upper pole coils and thus produces torque on the disk by the reaction between the fluxes of the upper and lower poles.

The definite-time relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper pole coils. This is called the torque compensator and it slows down the disk movement to such an extent that no gearing is required. (See Figure 2).

The long time relay is a geared relay with a torque compensator.

The type COH relay is a non-geared relay without a torque compensator.

Contactor Switch

The d-c. contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts.

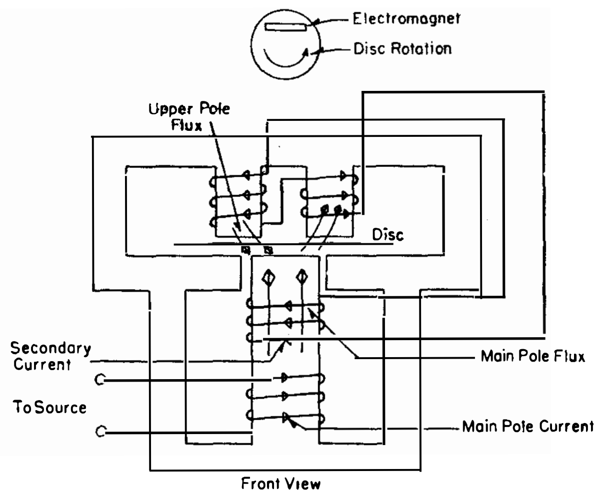

FIGURE 1—FLUX AND CURRENT RELATIONS IN THE INVERSE OR VERY INVERSE TIME RELAYS WITHOUT THE TORQUE COMPENSATOR.

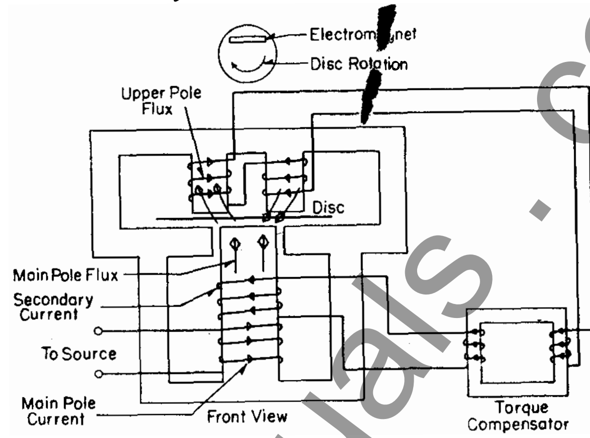

FIGURE 2—FLUX AND CURRENT RELATIONS IN THE DEFINITE MINIMUM TIME RELAYS WITH THE TORQUE COMPENSATOR.

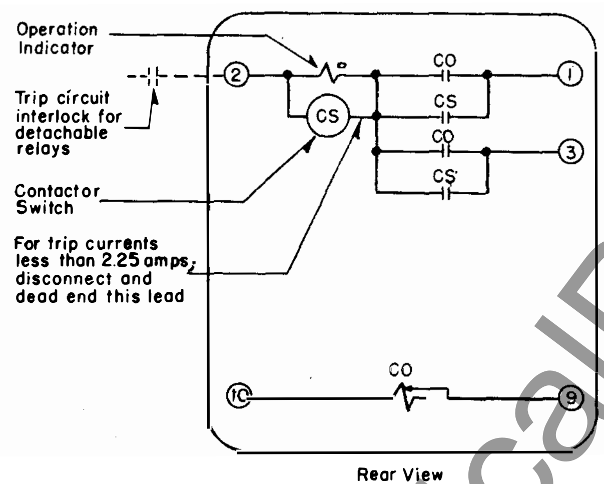

FIGURE 3—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

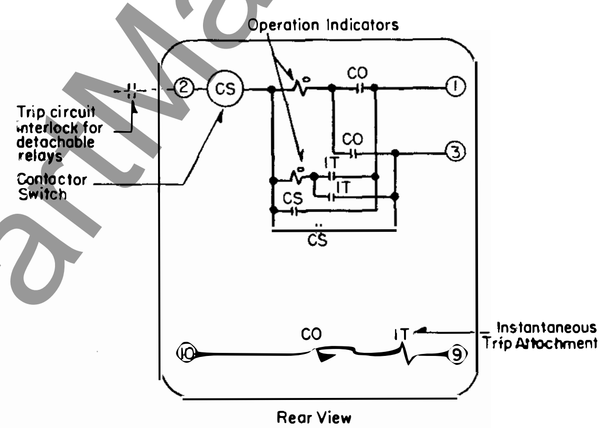

FIGURE 4—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

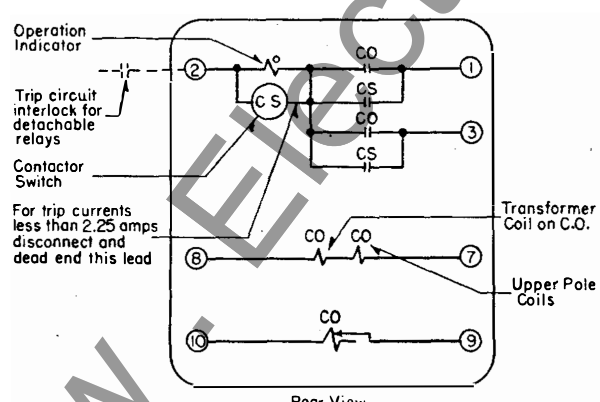

FIGURE 5—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING INVERSE AND VERY INVERSE TYPES CO AND COH RELAYS WITH TORQUE CONTROL TERMINALS IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

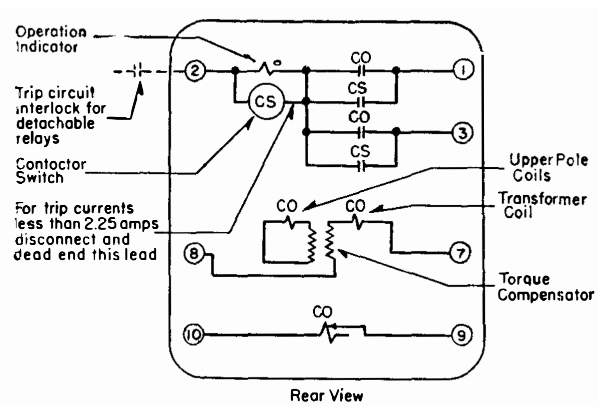

FIGURE 6—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING DEFINITE MINIMUM TIME TYPE CO RELAY WITH TORQUE CONTROL TERMINALS IN THE STANDARD CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

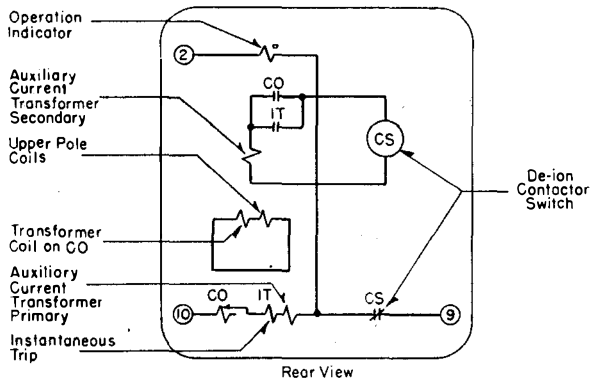

FIGURE 7—INTERNAL SCHEMATIC OF THE CIRCUIT OPENING INVERSE AND VERY INVERSE TIME TYPE CO RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE STANDARD CASE.

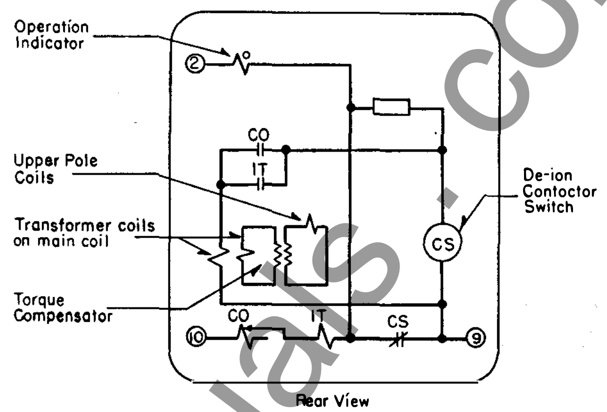

FIGURE 8—INTERNAL SCHEMATIC OF THE CIRCUIT OPENING DEFINITE MINIMUM TIME TYPE CO RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE STANDARD CASE.

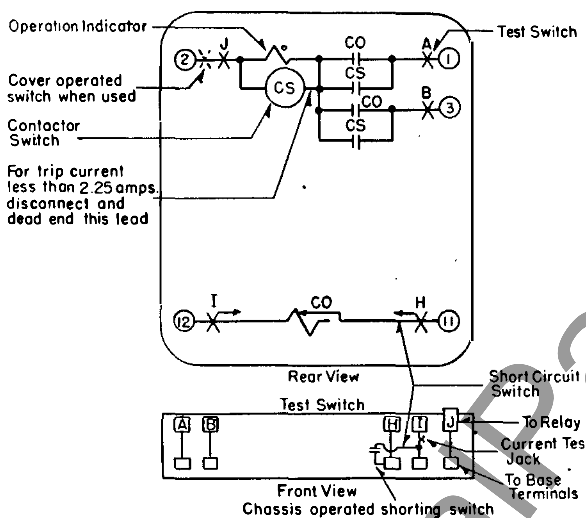

FIGURE 9—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

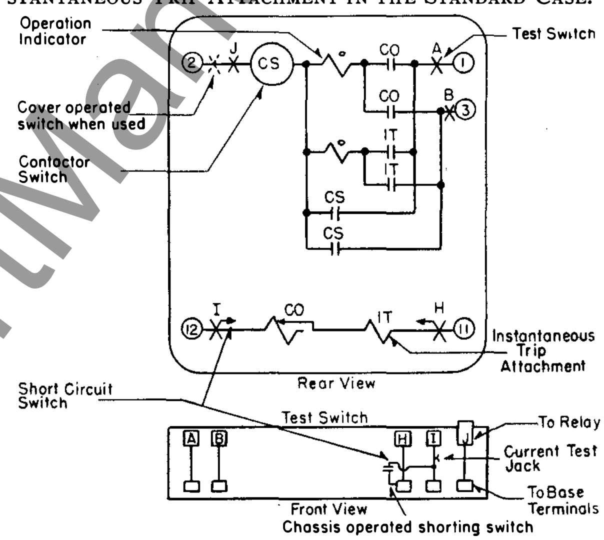

FIGURE 10—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

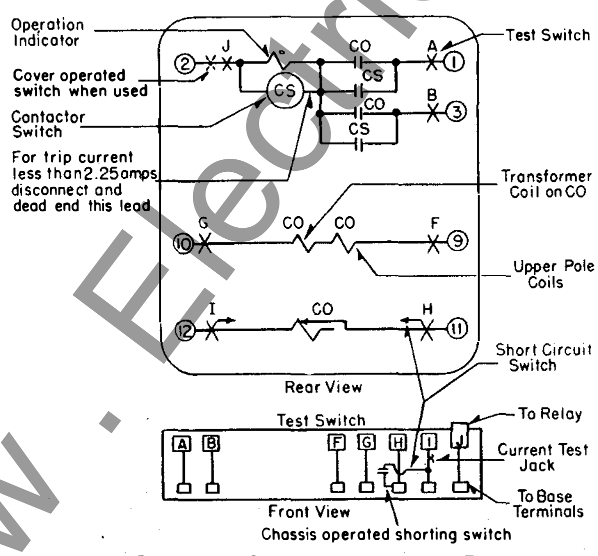

FIGURE 11—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING INVERSE AND VERY INVERSE TYPES CO AND COH RELAYS WITH TORQUE CONTROL TERMINALS IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

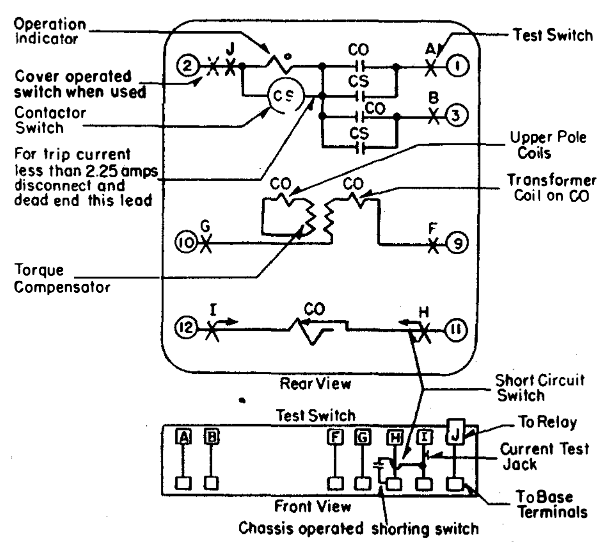

FIGURE 12—INTERNAL SCHEMATIC OF THE DOUBLE TRIP CIRCUIT CLOSING DEFINITE MINIMUM TIME TYPE CO RELAY WITH TORQUE CONTROL TERMINALS IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c. vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc is fastened to the bottom of the guide rod by two small nuts. Its position determines the pick-up current of the element.

Instantaneous Lock-Out Attachment (When Supplied)

The lock-out attachment is used to prevent the relay from tripping a circuit breaker when the current is too high—above its interrupting capacity.

CIRCUIT-OPENING RELAY

The circuit-opening type CO Relay consists of an overcurrent element, a de-ion contactor switch, an operation indicator and an instantaneous trip attachment where required.

Overcurrent Element

The overcurrent construction and operation is similar to that described for the circuit closing relays.

De-ion Contactor Switch

This switch is a small a-c. solenoid switch whose coil is energized from a few turns on the lower pole of the overcurrent element in the standard-energy type relays, and from a small transformer connected in the main current circuit in the low-energy type relays. Its construction is similar to the d-c. type switch except that the plunger operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame at the other end.

The overcurrent element contacts are in the contactor switch coil circuit and when they close, the solenoid plunger moves upward to open the de-ion contacts which normally short circuit the trip coil. These contacts are able to transfer the heavy current due to a short circuit and permit this current to energize the breaker trip coil.

The transformer coil on the lower pole of the overcurrent element and the contactor switch circuits in the standard energy type relays are connected to the main circuits as shown in Figures 8 and 14. When the overcurrent contact closes, the contactor switch operates, and the voltage across the trip coil is impressed on the transformer and contactor switch coils. This voltage acts to seal-in the contactor switch, and to feed energy through the transformer coil to the main overcurrent winding which produces contact closing torque. This arrangement provides a definite minimum pick-up value largely independent of the value of trip coil impedance.

Operation Indicator

The operation indicator is in series with the breaker trip coil. Its construction is as described above.

CHARACTERISTICS

The type CO definite minimum time (standard energy) or long time (40 second) circuit closing relay is available in either of the following current ranges.

2	2.5	3	3.5	4	5	6
4	5	6	8	10	12	15

The type CO inverse, very inverse (low energy) or the type COH circuit closing relay is available in the following current ranges.

0.5	0.6	0.8	1.0	1.5	2.0	2.5
2	2.5	3	3.5	4	5	6
4	5	6	8	10	12	15

The type CO circuit-opening relay is made only in the 4 to 15 ampere range. A lower range is not desirable because the burden of a low-range trip coil is too heavy on the current transformer. One trip coil is required for each relay.

The tap value is the minimum current required to just close the relay contacts. In addition to the taps, the initial position of the moving contact is adjustable around a semicircular lever scale calibrated in 10 divisions.

These relays may have either single or double circuit closing contacts for tripping either one or two breakers, or may have circuit-opening contacts for tripping the breakers by current from the current transformers.

The characteristics of the various varieties of type CO and COH relays usually supplied are as shown on page 6.

The burdens and thermal ratings are listed under Energy Requirements.

The instantaneous trip attachment has a 4 to 1 range. Typical ranges are 10-40 or 20-80 but other ranges may be supplied as ordered.

The De-ion contactor switch on the circuit opening relays has a minimum pick-up of 4 amperes a-c.

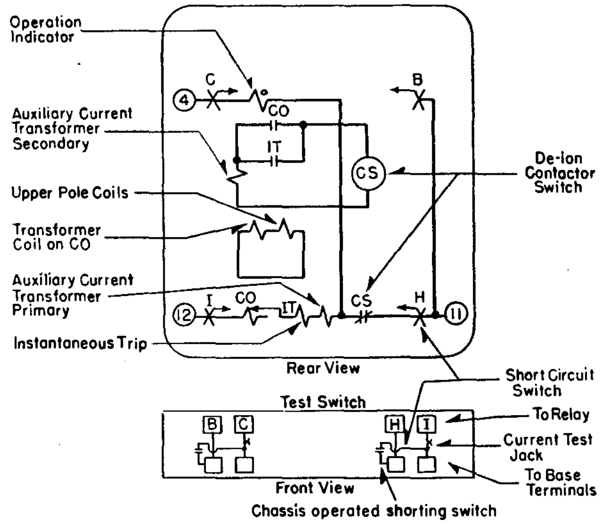

FIGURE 13—INTERNAL SCHEMATIC OF THE CIRCUIT OPENING INVERSE AND VERY INVERSE TIME TYPE CO RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE TYPE FT CASE.

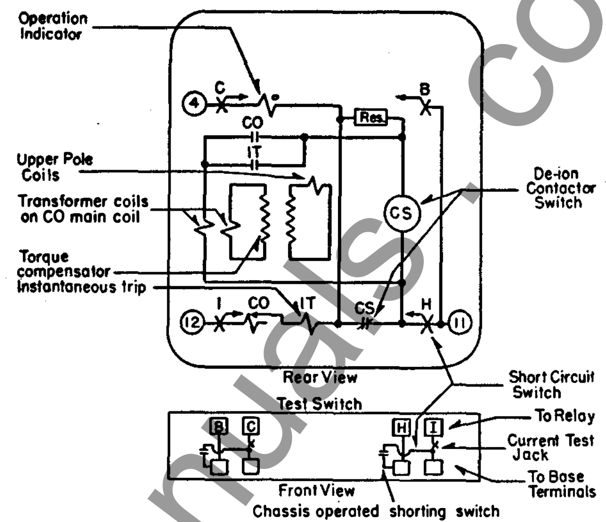

FIGURE 14—INTERNAL SCHEMATIC OF THE CIRCUIT OPENING DEFINITE MINIMUM TIME TYPE CO RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE TYPE FT CASE.

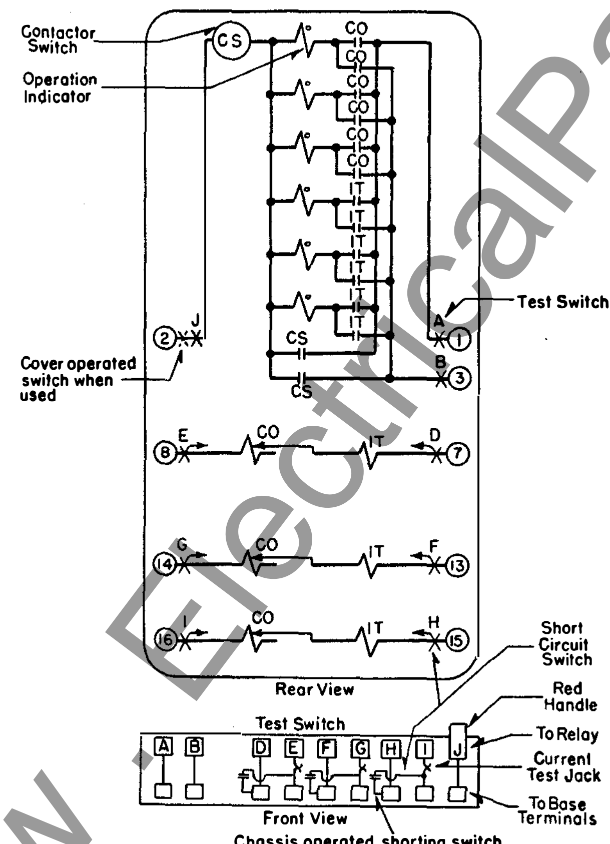

FIGURE 15—INTERNAL SCHEMATIC OF THE THREE ELEMENT DOUBLE TRIP CIRCUIT CLOSING TYPES CO AND COH RELAYS WITH INSTANTANEOUS TRIP ATTACHMENT IN THE TYPE FT CASE. THE SINGLE TRIP RELAYS HAVE TERMINAL 3 AND ASSOCIATED CIRCUITS OMITTED.

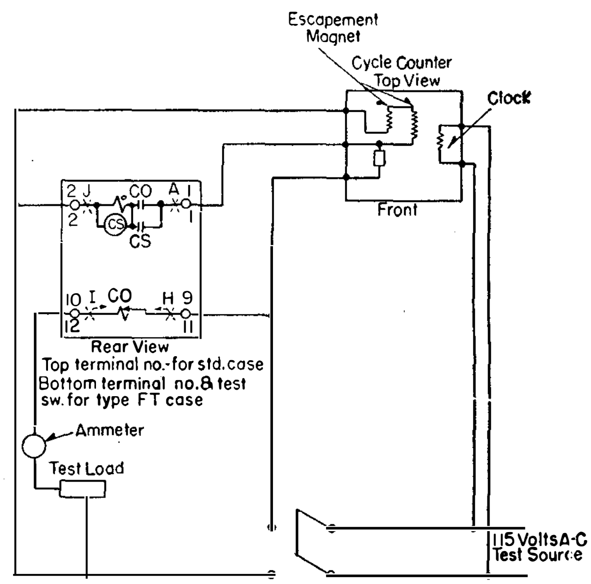

FIGURE 16—DIAGRAM OF TEST CONNECTIONS FOR CIRCUIT CLOSING TYPES CO AND COH.

Characteristics of CO and COH Relays

Type	Energy	Time	Approx. #10 Lever Time at 20 x Tap Value	Gearing	Torque Compensator	Schematic per Figure No.	Typical 60 Cycle Time Curve per Figure No.
CO	Std.	Definite Time	2 Sec.	Non-geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	23
CO	Std.	Definite Time	4 Sec.	Non-geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	..
CO	Low	Inverse	2 Sec.	Geared	No	3, 4, 5, 7, 9, 10, 11, 13 & 15	24
CO	Low	Inverse	4 Sec.	Geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	..
CO	Low	Very Inverse	1+ Sec.	Geared	No	3, 4, 5, 7, 9, 10, 11, 13 & 15	25
CO	Std.	Definite Time	40 Sec.	Geared	Yes	3, 4, 6, 8, 9, 10, 12, 14 & 15	27
COH	....	Inverse	18 Cyc.	Non-Geared	No	3, 4, 5, 9, 10, 11 & 15	26

Three element relay characteristics are the same as in single element forms.

The instantaneous lock-out attachment has a 3 to 1 range with typical ranges similar to the instantaneous trip attachment.

Trip Circuit

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

The relay without the instantaneous trip attachment is shipped with the operation indicator and the contactor switch connected in parallel. This circuit is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filisterhead screw located in the Micarta base of the contactor switch. For the Flexitest relays, the coil is disconnected by removing the coil lead at the spring adjuster and dead-ending it under a screw at the top of the Micarta support.

The relay with the instantaneous trip attachment has a two ampere contactor switch in series with a one ampere operation indicator in each trip path.

Relay with Quick Opening Contacts

When the relays are used with circuit breakers that are instantaneously reclosed, it is necessary to arrange the relay contacts to be quick opening. This is done by screwing in the small set screw on the stationary contact assembly until the contact rivet rests solidly on the Micarta support. When this is done, the position of the contact stop on the time lever should be shifted so that the moving and stationary contacts barely touch when the time lever is set on zero.

CONTACT CIRCUIT CONSTANTS

Universal Trip Circuit

Resistance of 0.2 ampere Target........2.8 ohms
Resistance of 2.0 ampere Contact Switch. 0.25 ohms
Resistance of Target and Switch in Parallel..........................0.23 ohms

Trip Circuit with Instantaneous Trip

Resistance of 1.0 ampere Target........0.16 ohms
Resistance of 2.0 ampere Contactor Switch...........................0.25 ohms
Resistance of Target and Switch in Series 0.41 ohms

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

Removing Chassis:—To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches **first** before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits:—Each terminal in the base connects through a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surfaces of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately $\frac{1}{32}''$ thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

Testing:—The relays can be tested in service, in the circuits isolated or out of the case as follows:

Testing In Service—The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current through the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out through holes in the back of the insulated handle.

Voltage between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

Testing In Case:—With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits."

Testing Out of Case:—With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values of some relays by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

Because the circuit-opening relay contacts short circuit the trip coil, it is important that the relay be mounted where it will not be subject 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 safeguard so that there there is no danger from even an excessive shock unless the current is also heavy.

Typical external connections are shown in Figures 18 to 22. When using the circuit-opening relays for phase protection, ground protection may be secured by using a low-energy circuit-closing relay operating on a-c. voltage trip coil, as shown in Figure 22.

SETTINGS

There are two settings—namely the current value at which the relay closes its contacts and the time required to close them. When the relay is to be used to protect equipment against overload, the setting must be determined by the nature of the load, the magnitude of the peaks and the frequency of their occurrence.

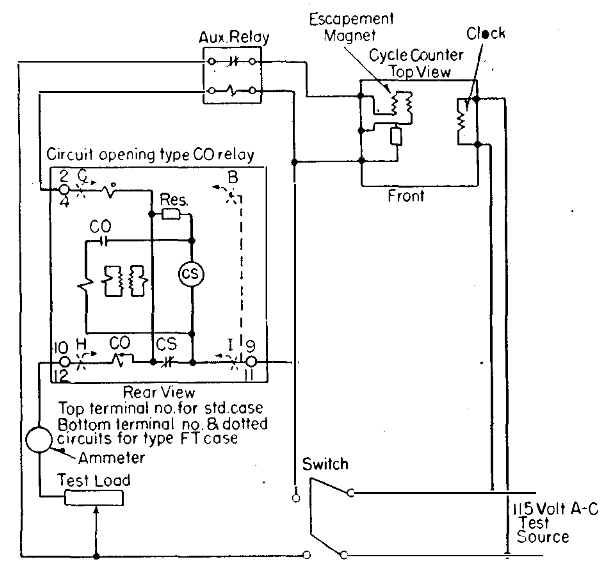

FIGURE 17—DIAGRAM OF TEST CONNECTION FOR CIRCUIT OPENING TYPE CO RELAY.

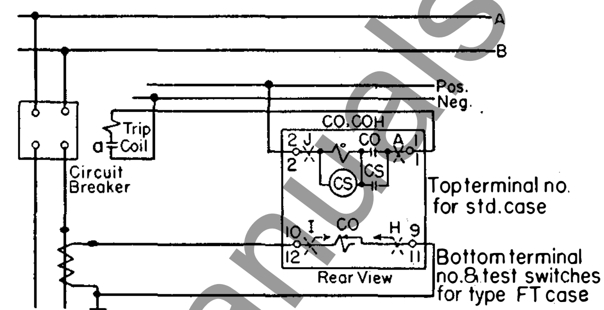

FIGURE 18—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR OVERCURRENT PROTECTION ON A SINGLE PHASE SYSTEM.

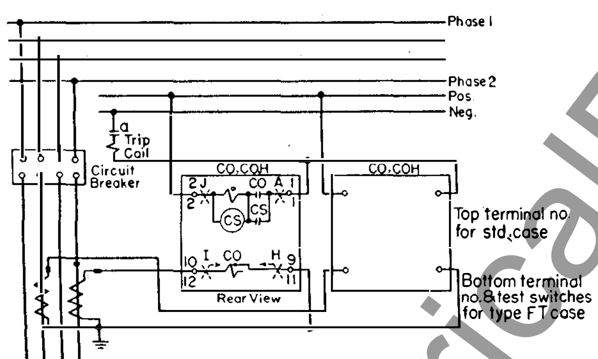

FIGURE 19—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR OVERCURRENT PROTECTION ON A TWO-PHASE SYSTEM.

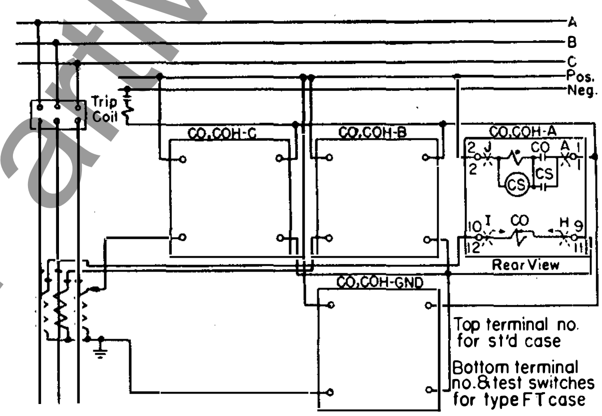

FIGURE 20—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR PHASE AND GROUND OVERCURRENT PROTECTION ON A THREE-PHASE SYSTEM.

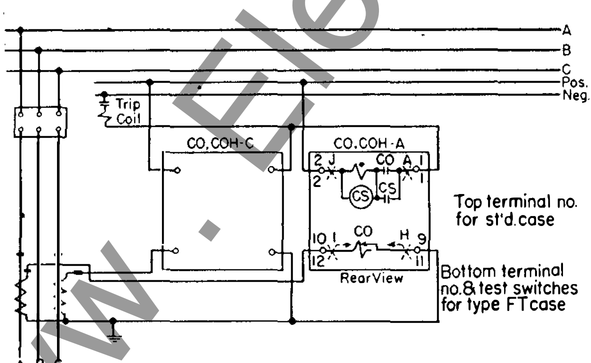

FIGURE 21—EXTERNAL CONNECTIONS OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR PHASE OVERCURRENT PROTECTION ON AN UNDERGROUND THREE-PHASE SYSTEM.

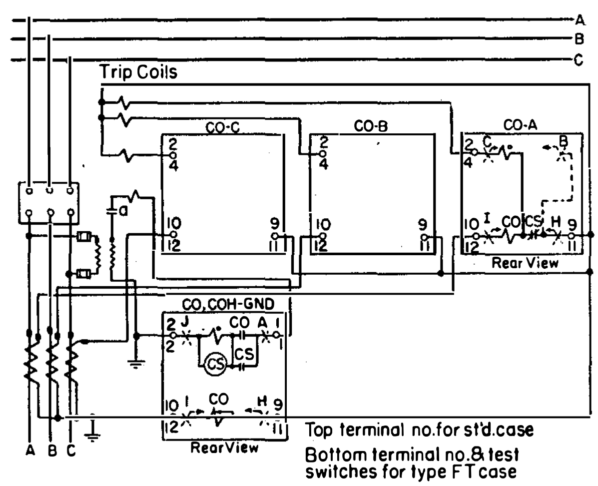

FIGURE 22—EXTERNAL CONNECTIONS OF THE CIRCUIT OPENING TYPE CO RELAY FOR PHASE OVERCURRENT PROTECTION AND OF THE CIRCUIT CLOSING TYPES CO AND COH RELAYS FOR GROUND PROTECTION ON A THREE-PHASE SYSTEM.

For sectionalizing transmission systems the current and time setting must be determined by calculation, due consideration being given to the time required for circuit breakers to open so that proper selective action can be obtained throughout the system.

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 screwdriver inserted in one of the notches of the plate to which 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 affecting the operating characteristics of the relay. For example, on the 4 to 15 amp. 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 Lever Setting

The index or time lever limits the motion of the disc and thus varies the time of operation. The latter decreases with lower lever settings as shown in the typical time curves of Figures 23 to 27.

ADJUSTMENTS AND MAINTENANCE

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.

All contacts should be periodically cleaned with a fine file. S# 1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed or the relay taken apart for repairs, the following instructions should be followed in reassembling and setting it.

(Overcurrent Element Circuit-Closing Relays)

Shift the position of the contact stop on the time lever and adjust the 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 tap 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 as shown on the typical time curves. In the factory the relay is tested from the No. 10 lever position. The calibration is intended to be on the basis of the cool or normal operating condition inasmuch as overloads are of short duration. When checking a number of points on the time curves, it will be necessary to cool the relay coils between points particularly after operating at high currents. An air hose may be used for this purpose.

The position of the torque compensator on the overload element is adjustable, influencing the shape of the curve. This is a factory adjustment and the location of the torque compensator should not be changed in the field. If the relay has a metal cover, this cover must be in place when making tests.

The relays with torque control terminals will not operate until these terminals are short-circuited either by a jumper or by the external control contacts.

Contactor Switch (Circuit-Closing Relays)

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be most conveniently done by disconnecting the switch and turning it or the relay upside-down. Screw up the core screw until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the point where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for $\frac{3}{32}$ inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c. have been passed through the coil.

Operation Indicator (Circuit-Closing Relays)

Adjust the indicator to operate at 0.2 or 1.0 ampere d-c. as supplied gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. If the two helical springs which reset the armature are replaced by new springs, they should

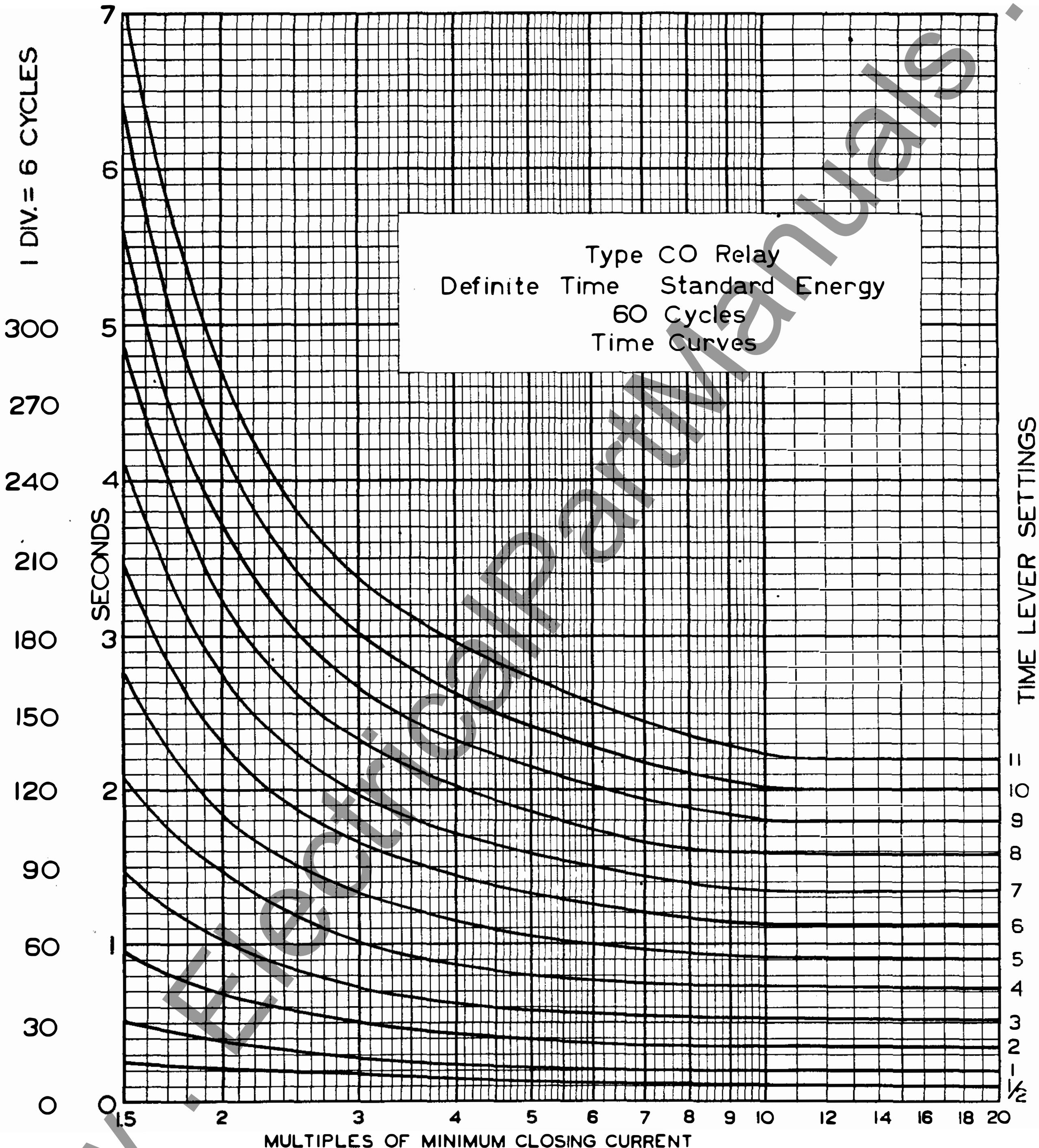

FIGURE 23—TYPICAL 60 CYCLE TIME CURVES OF THE DEFINITE MINIMUM TIME (STANDARD ENERGY) TYPE CO RELAY.

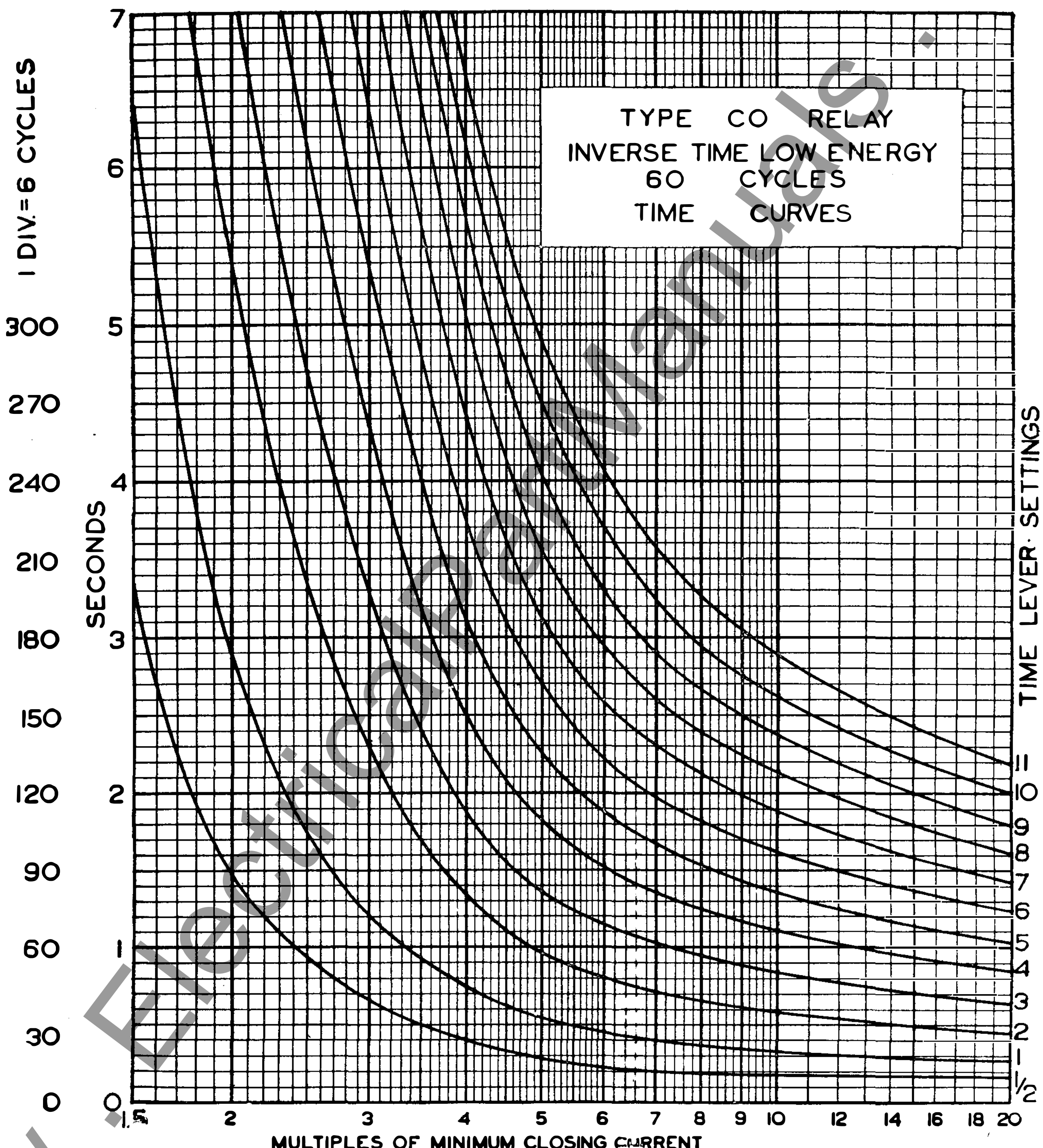

FIGURE 24—TYPICAL 60 CYCLE TIME CURVES OF THE INVERSE TIME (LOW ENERGY) TYPE CO RELAY.

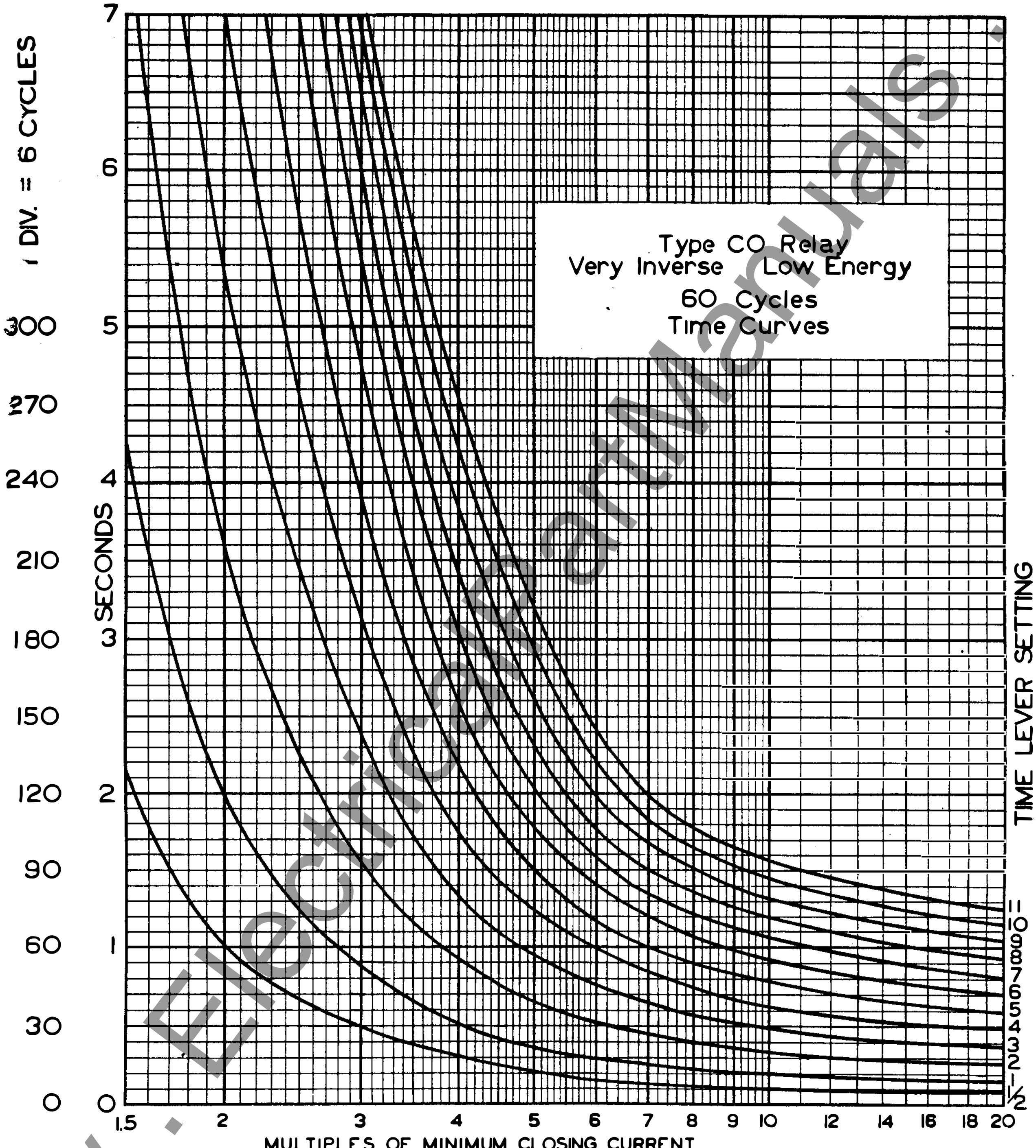

FIGURE 25—TYPICAL 60 CYCLE TIME CURVES OF THE VERY INVERSE TIME (LOW ENERGY) TYPE CO RELAY.

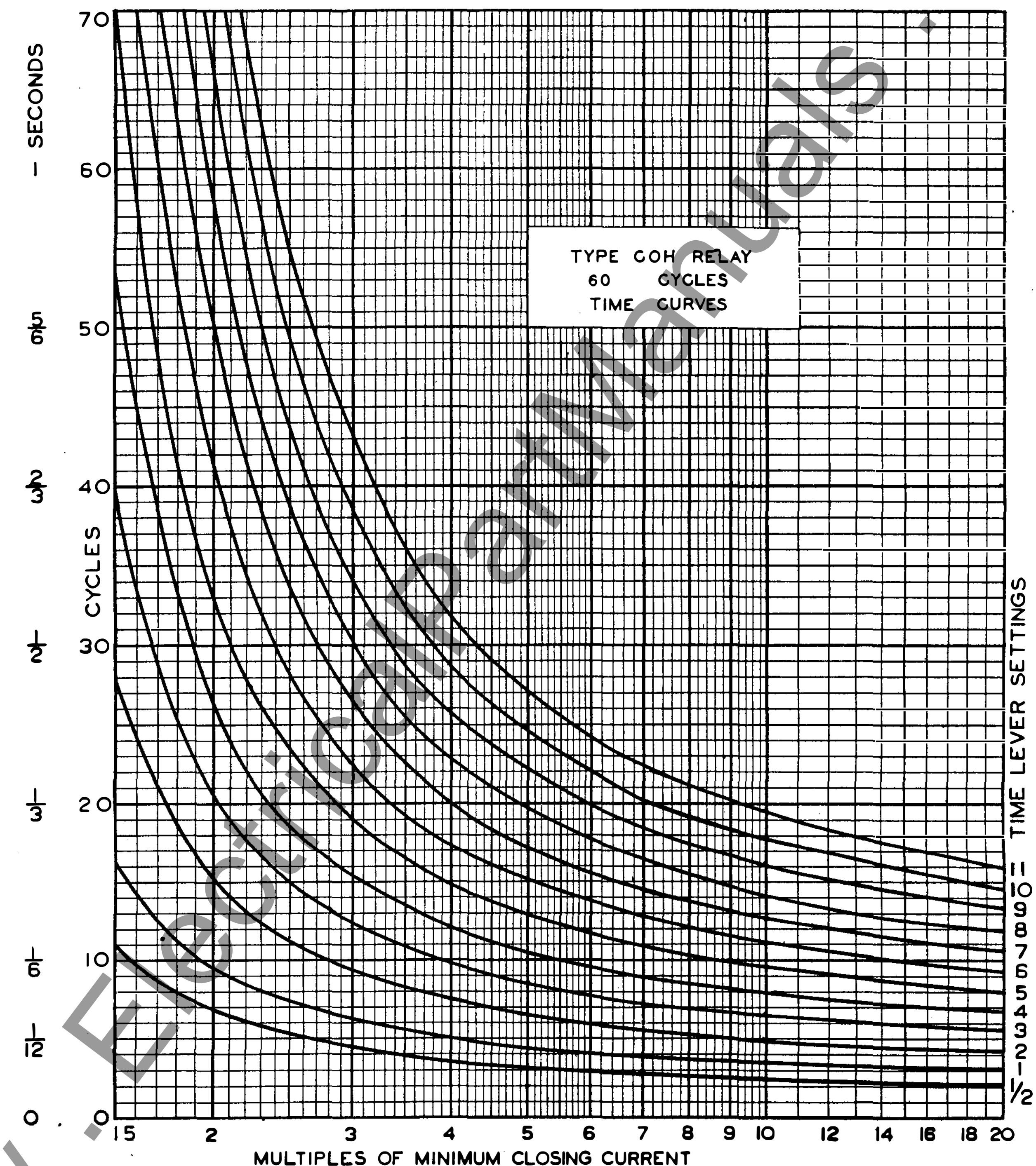

FIGURE 26—TYPICAL 60 CYCLE TIME CURVES OF THE TYPE COH RELAY.

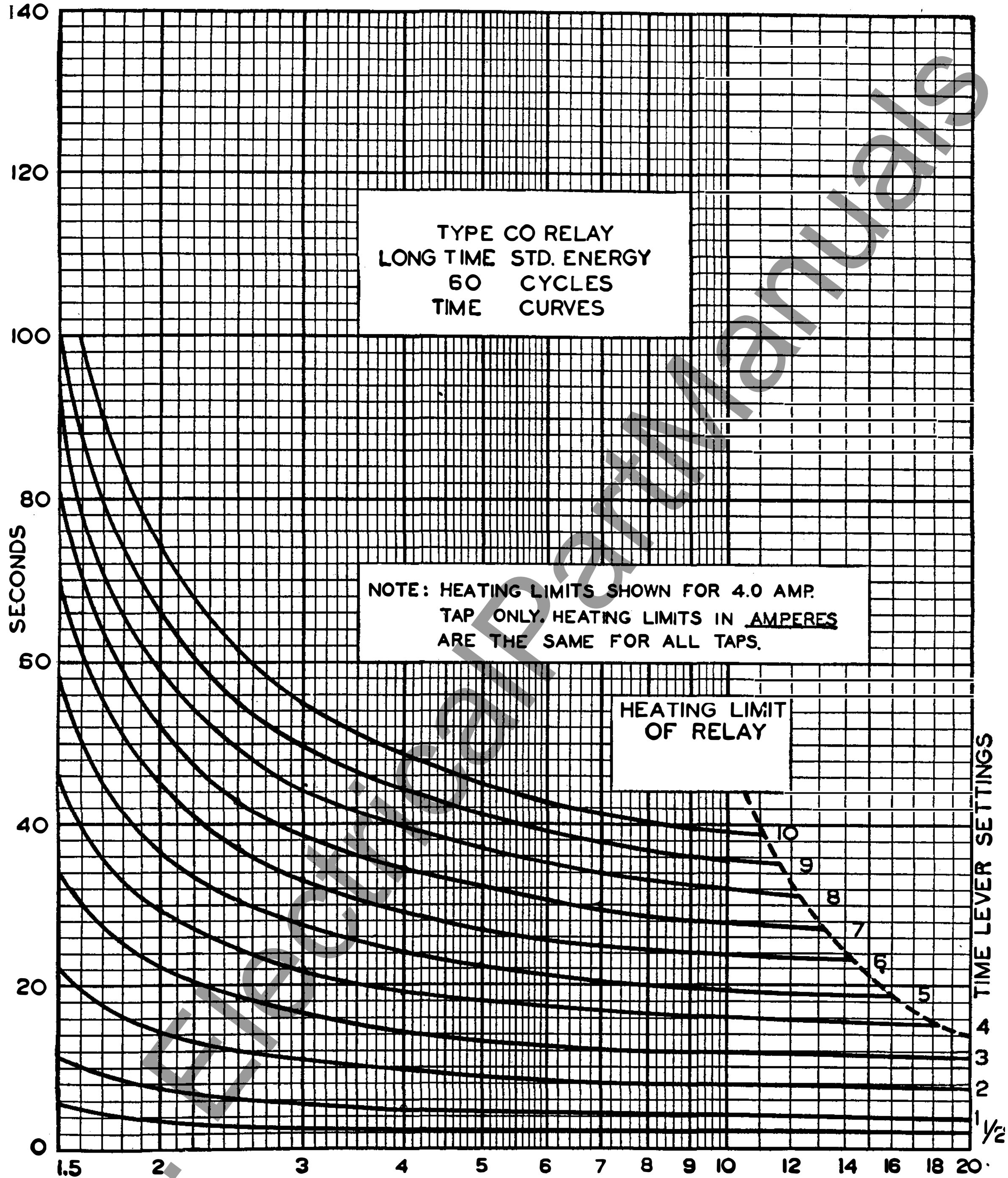

FIGURE 27—TYPICAL 60 CYCLE TIME CURVES OF THE LONG TIME (40 SECOND) TYPE CO RELAY.

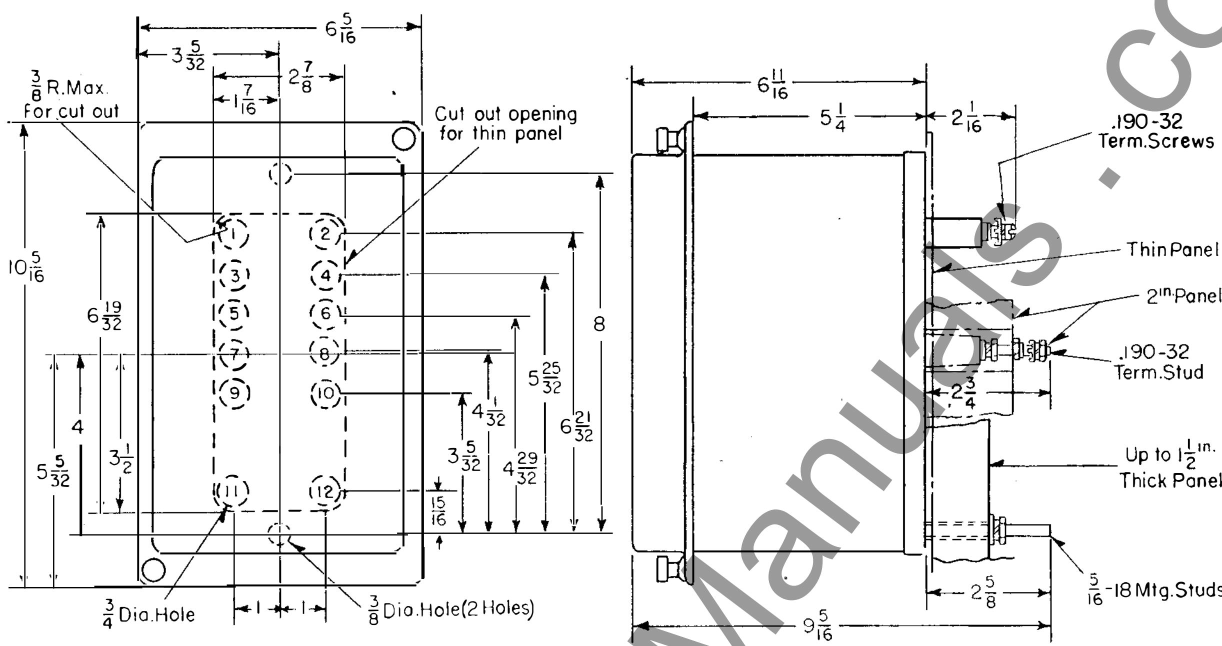

Figure 28—Outline and Drilling Plan for the Single Element Types CO and COH Relays in the S10 Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

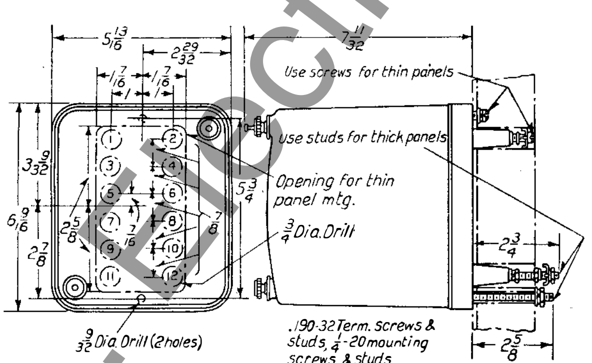

Figure 29—Outline and Drilling Plan for the Single Element Types CO and COH Relays in the Projection Type Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

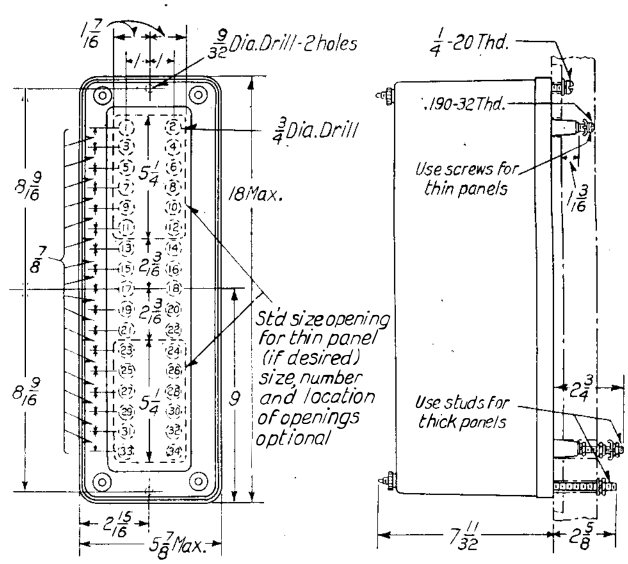

Figure 30—Outline and Drilling Plan for the Three Element Types CO and COH Relays in the Projection Type Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

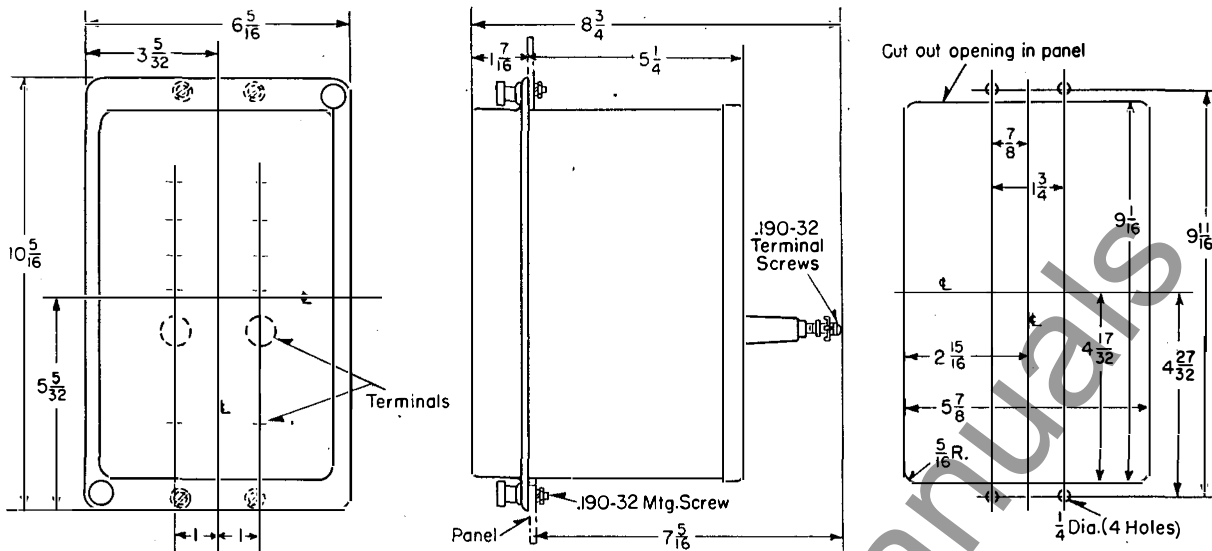

FIGURE 31—OUTLINE AND DRILLING PLAN FOR THE SINGLE ELEMENT TYPES CO AND COH RELAYS IN THE S10 SEMI-FLUSH TYPE FT FLEXITEST CASE. FOR REFERENCE ONLY.

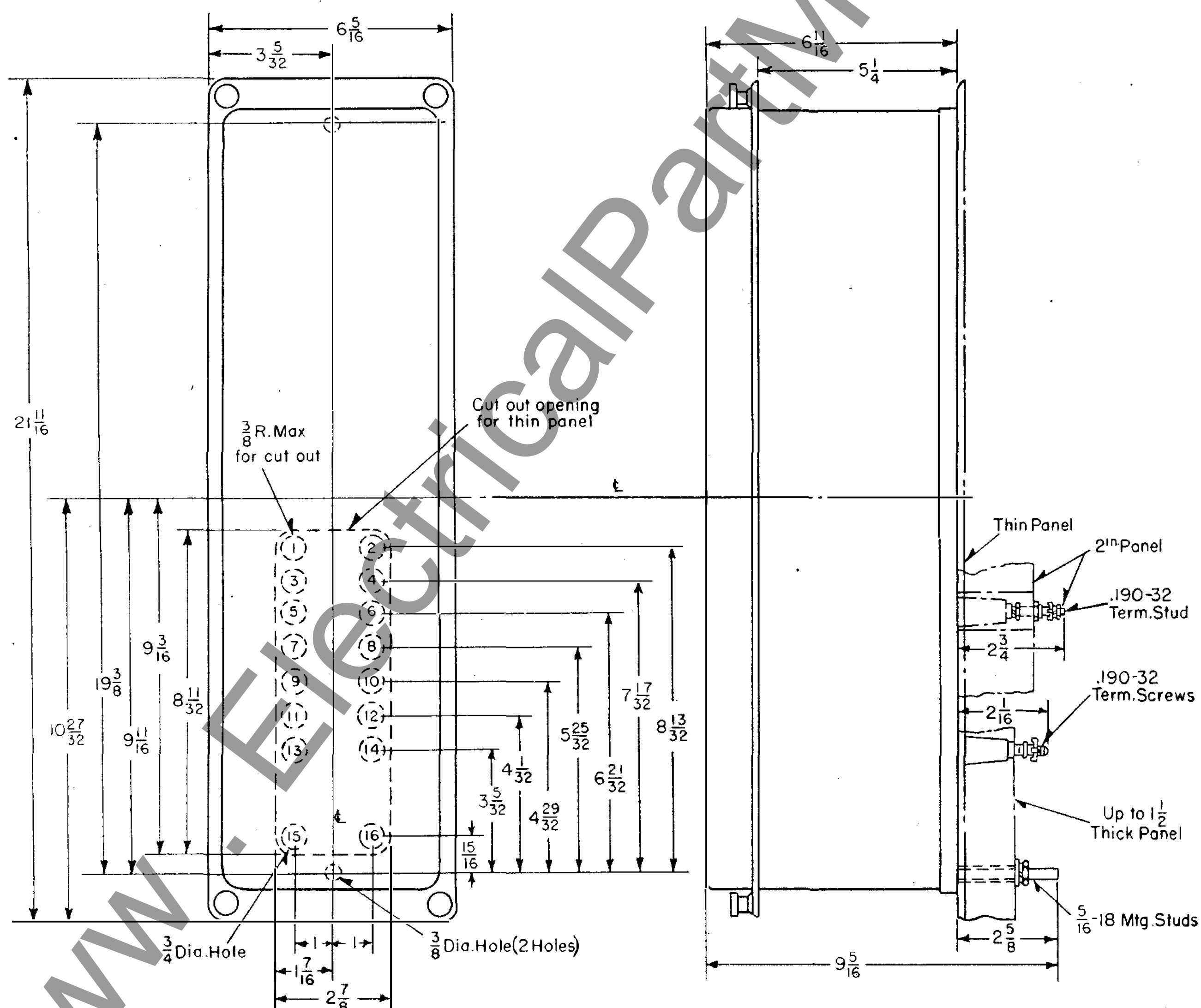

FIGURE 32—OUTLINE AND DRILLING PLAN FOR THE THREE ELEMENT TYPES CO AND COH RELAYS IN THE L10 PROJECTION TYPE FT FLEXITEST CASE. SEE THE INTERNAL SCHEMATICS FOR THE TERMINALS SUPPLIED. FOR REFERENCE ONLY.

be weakened slightly by stretching to obtain the 0.2 or 1.0 ampere calibration. Test for sticking after 10 times rated pick-up current has been applied.

Overcurrent Element (Circuit Opening Relays)

Adjust the relay with the instructions given under "Overcurrent Element (Circuit Closing Relays)" using the test connection of Figure 17 except that for the definite minimum time circuit opening relay the following caution should be observed:

CAUTION—When a signal lamp or other voltage operated device is to be connected in series with the relay contacts, disconnect the internal leads of the element from the stationary and moving contacts respectfully and dead end them. Then the lamp or other device can be connected to the stationary and moving contacts.

De-ion Contactor Switch (Circuit Opening Relays)

Adjust the core stop on the top as high as possible without allowing the insulating bushing at the bottom of the plunger to touch the Micarta angle. The contact will be separated from the Micarta angle by $\frac{1}{32}''$ to $\frac{1}{16}''$. Adjust the contact gap spacing to slightly less than $\frac{1}{16}$ of an inch. Bend down the contact springs so that a firm contact is made but not so strong that the minimum pick-up value cannot be obtained. The spring tension should be about 15 grams.

Hold the relay contacts closed and with an auxiliary relay coil connected across terminals to simulate the circuit breaker trip coil, note that the contactor switch picks up on less than 4 amperes on the 4 ampere overcurrent tap setting.

In the case of the standard energy circuit opening relay the contactor switch should pick-up and seal itself open at 75% of minimum trip current.

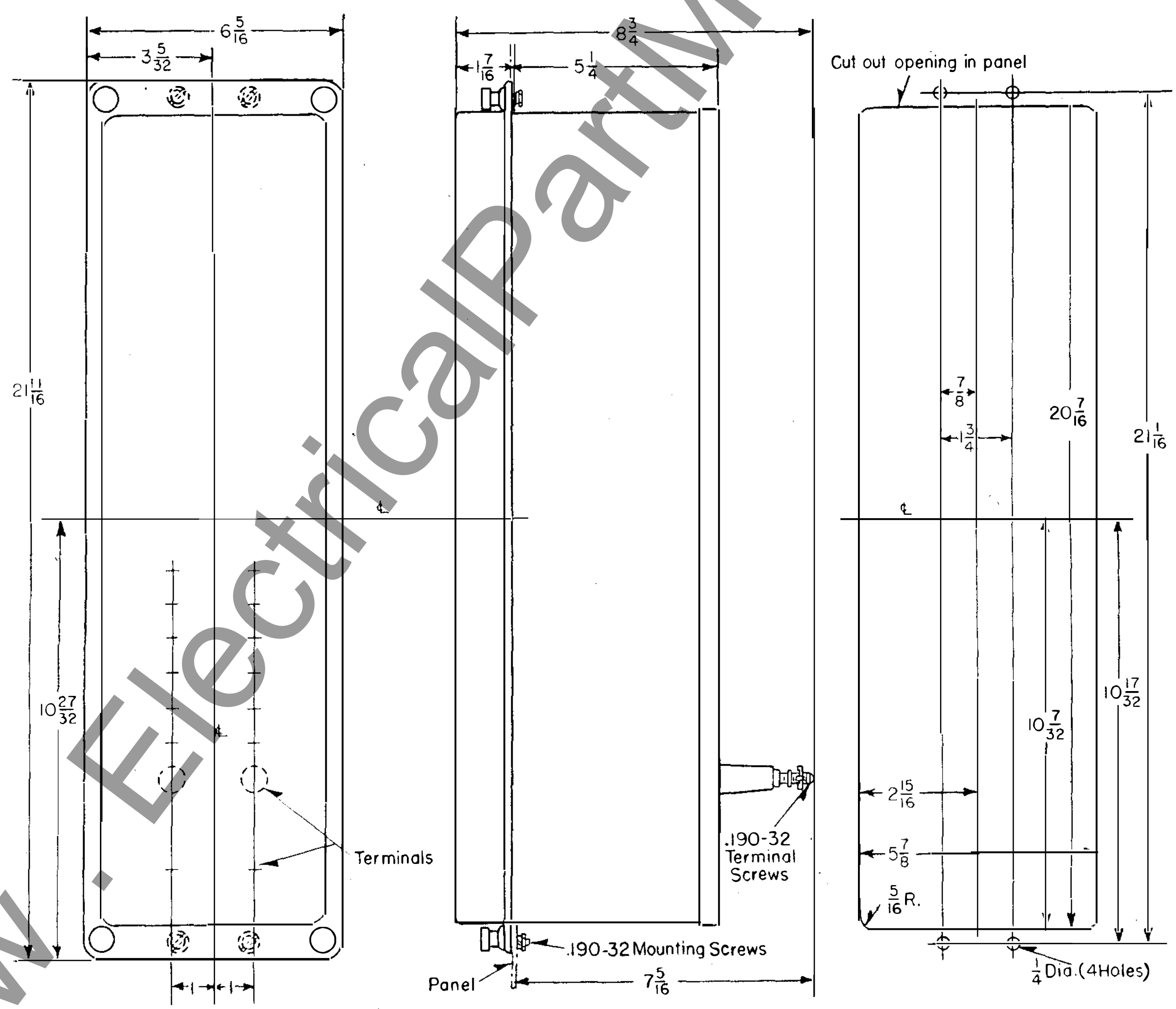

FIGURE 33—OUTLINE AND DRILLING PLAN FOR THE THREE ELEMENT TYPES CO AND COH RELAYS IN THE L10 SEMI-FLUSH TYPE FLEXITEST CASE. FOR REFERENCE ONLY.

Operation Indicator (Circuit Opening Relays)

Adjust the indicator similar to that described for the circuit closing relay except to operate at 4 amperes a-c.

Instantaneous Trip Attachment

The position of the Micarta disk at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. This disk should be lowered or raised to the proper position by means of the two nuts on either side of the disk. The nominal range of adjustment is 1 to 4, for example 10 to 40 amperes, and it has an accuracy of about 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. It should be adjusted for about ⅔ of the minimum pick-up.

This element will not fit in the round-type case.

Instantaneous Lock-out Attachment

The position of the bottom of the plunger with reference to the calibrated guide indicates the minimum current required to open the contacts. To change the setting hold the top slotted head of the plunger rod fixed with a screwdriver. Then with a second screwdriver adjust the lower end of the plunger for the current pick-up desired.

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. The nominal range of adjustment is 3 to 1.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The burdens and thermal capacities of the various circuits of the relay are as follows:

Definite Minimum Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	2	108	17	60° lag	4	140
	2.5	68	17	60° lag	5	140
	3	47	17	60° lag	5	140
2/6	3.5	35	17	60° lag	6	140
	4	26	17	60° lag	7	140
	5	17	17	60° lag	8	140
	6	12	17	60° lag	10	140
	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
4/15	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

Inverse Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	0.5	200	2	66° lag	2	70
	0.6	140	2	66° lag	2	70
	0.8	78	2	66° lag	2	70
0.5/2.5	1.0	50	2	66° lag	3	70
	1.5	22	2	66° lag	3	70
	2.0	12.5	2	66° lag	4	70
	2.5	8	2	66° lag	5	70
	2	12.4	2	66.4° lag	8	250
	2.5	8	2	66.4° lag	8	250
	3	5.6	2	66.4° lag	8	250
2/6	3.5	4.1	2	66.4° lag	8	250
	4	3.1	2	66.4° lag	9	250
	5	2	2	66.4° lag	9	250
	6	1.3	2	66.4° lag	10	250
	4	3.1	2	66.4° lag	16	250
	5	2	2	66.4° lag	16	250
	6	1.4	2	66.4° lag	16	250
4/15	8	0.8	2	66.4° lag	17	250
	10	0.5	2	66.4° lag	18	250
	12	0.3	2	66.4° lag	19	250
	15	0.2	2	66.4° lag	20	250

Very Inverse Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	0.5	125	1.25	66.4° lag	2	100
	0.6	87	1.25	66.4° lag	2	100
	0.8	49	1.25	66.4° lag	2	100
0.5/2.5	1.0	31	1.25	66.4° lag	3	100
	1.5	14	1.25	66.4° lag	3	100
	2.0	8	1.25	66.4° lag	4	100
	2.5	5	1.25	66.4° lag	5	100
	2	8	1.25	66.4° lag	8	250
	2.5	5	1.25	66.4° lag	8	250
	3	3.5	1.25	66.4° lag	8	250
2/6	3.5	2.5	1.25	66.4° lag	8	250
	4	1.9	1.25	66.4° lag	9	250
	5	1.25	1.25	66.4° lag	9	250
	6	0.9	1.25	66.4° lag	10	250
	4	1.9	1.25	66.4° lag	16	250
	5	1.25	1.25	66.4° lag	16	250
	6	0.9	1.25	66.4° lag	16	250
4/15	8	0.5	1.25	66.4° lag	17	250
	10	0.3	1.25	66.4° lag	18	250
	12	0.2	1.25	66.4° lag	19	250
	15	0.15	1.25	66.4° lag	20	250

Long Time CO Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	4	26	17	60° lag	8	250
	5	17	17	60° lag	8	250
	6	12	17	60° lag	9	250
4/15	8	6.5	17	60° lag	10	250
	10	4.5	17	60° lag	12	250
	12	3	17	60° lag	13	250
	15	2	17	60° lag	15	250

Short Time COH Relays at 60 Cycles

Ampere Range	Tap	V.A. at 5 Amperes	V.A. at Tap Current	Power Factor	Continuous Rating (Amperes)	One Second Rating (Amperes)
	0.5	400	4	60° lag	2	56
	0.6	280	4	60° lag	2	56
	0.8	156	4	60° lag	2	56
0.5/2.5	1.0	100	4	60° lag	3	56
	1.5	44	4	60° lag	3	56
	2.0	25	4	60° lag	4	56
	2.5	16	4	60° lag	5	56
	2	25.0	4	60° lag	8	250
	2.5	16	4	60° lag	8	250
	3	11	4	60° lag	8	250
2/6	3.5	8.2	4	60° lag	8	250
	4	6.3	4	60° lag	9	250
	5	4.0	4	60° lag	9	250
	6	3.0	4	60° lag	10	250
	4	6.3	4	60° lag	16	250
	5	4.0	4	60° lag	16	250
	6	3.0	4	60° lag	16	250
4/15	8	1.6	4	60° lag	17	250
	10	1.0	4	60° lag	18	250
	12	0.7	4	60° lag	19	250
	15	0.4	4	60° lag	20	250

Burdens at Tap Current on 25 and 50 Cycles

	25 Cycles		50 Cycles	
	V.A.	Power Factor	V.A.	Power Factor
Definite Minimum Time CO	16	53° lag	17	60° lag
Inverse Time CO	2	60° lag	2	60° lag
Very Inverse Time CO	1.25	60° lag	1.25	66.4° lag
Long Time CO	16	53° lag	17	60° lag
Short Time COH	4	53° lag	4	60° lag

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