INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES HCR AND HCRC DIRECTIONAL OVERCURRENT RELAYS

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

The types HCR and HCRC relays are induction overcurrent relays directionally controlled by a high speed directional element. They are used to disconnect transmission and feeder circuits when the current thru them exceeds a predetermined value in the tripping directions.

The type HCR relay is potential polarized and is used for both phase and ground fault protection. The type HCRC relay is current polarized and used for ground fault protection.

CONSTRUCTION AND OPERATION

The relay consists of a type CO or COH overcurrent element, a type H directional element, auxiliary switches, a contactor switch, and operation indicators, and in some cases an instantaneous trip attachment.

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 thru 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 is obtained by the circuit arrangement shown in Figure 2. 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 inverse and very inverse relays operate on this principle. The definite-time, standard-energy relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper

SUPERSEDES I. L. 41-432 A
* Denotes change from superseded issue.

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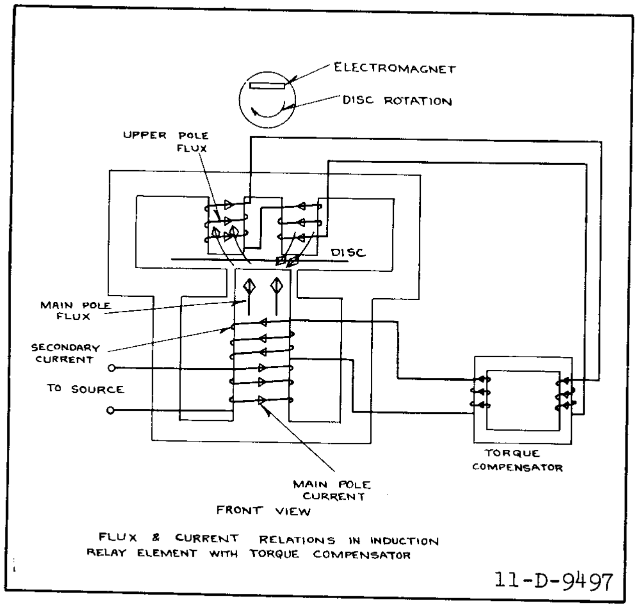


Fig. 1—Flux and Current Relations In the Definite Time Relay With the Torque Compensation.

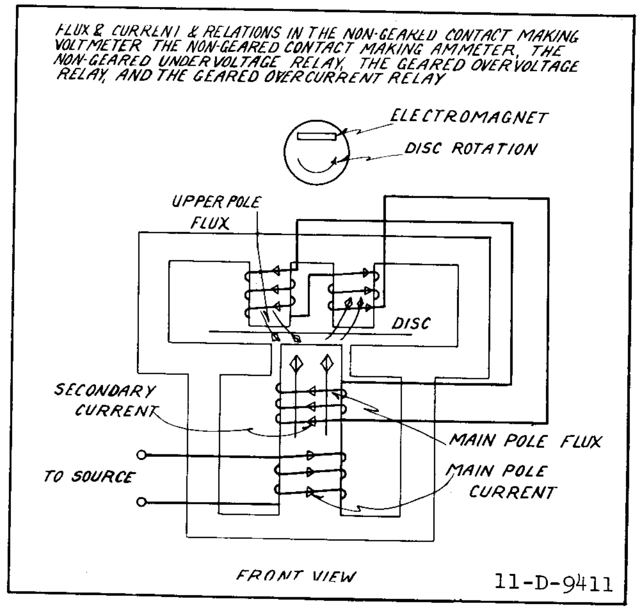


Fig. 2—Flux and Current Relations in the Inverse or Very Inverse Time Relay.

pole coils. This is called the torque compensator and it slows down the disc movement at high currents to such an extent that no gearing is required. (See Figure 1.)

Directional Element

A small voltage transformer causes a large current to flow in a single-turn movable aluminum secondary, which current is substantially in phase with the voltage. The current coils are mounted on a magnetic frame and the current and voltage elements are assembled at right angles to each other with the one-turn voltage loop in the air gaps of the current coil flux path. The interaction of the current and voltage fluxes produces torque and rotates the loop in one of two directions, depending on the direction of power flow. The element has nearly true wattmeter characteristics.

In the type HCRC relay the voltage coil is replaced with a current coil, and the structural details are slightly different.

An Isolantite arm extends from the moving loop and supports a rectangular silver contact which bridges two stationary contacts located on either side of the loop. The stationary contacts are silver hemi-spheres mounted on the lower end of vertically-hanging spring leaves. The contact separation is adjustable by a small screw near the upper end of the rigid stationary contact supporting arm. One of these supporting arms hangs parallel to each of the four stationary contacts. The set screw on the lower end of this arm provides the contact follow adjustment. Two additional screws on the movement frame beneath the current coil iron limit the movement of the one-turn loop.

Contactor Switches

The contactor switch is a small solenoid type d-c switch, the coil of which is connected in the trip circuit. 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. In the single-trip relay, two of these contacts seal around the main relay contact. In the double-trip relays, all three contacts are used to seal in both trip circuits.

The operation of the d-c auxiliary switch is controlled by the directional element which in turn directionally controls the overcurrent

TYPES HCR AND HCRC RELAYS

element. When sufficient power flows in the tripping direction, the auxiliary contactor switch operates to close and seal in the upper pole circuit of the overcurrent element, permitting the disc to rotate. If the direction of power flow reverses, a contact on the directional element shorts the auxiliary contactor switch coil, causing it to drop out. This opens the directional control circuit and allows the overcurrent element to reset.

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.

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 types HCR or HCRC definite minimum time (standard energy) relays are 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 HCR or HCRC inverse, very inverse (low energy) or short time (using type COH overcurrent element) relays are 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 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 semi-circular 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 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 type HCR relay directional element minimum pick-up is 2 volts 10 ampere in-phase. The type HCRC relay directional element minimum pick-up is 3 amperes each winding in phase.

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.

RELAYS IN TYPE FT. CASE

The type FT cases are dust-proof enclosures

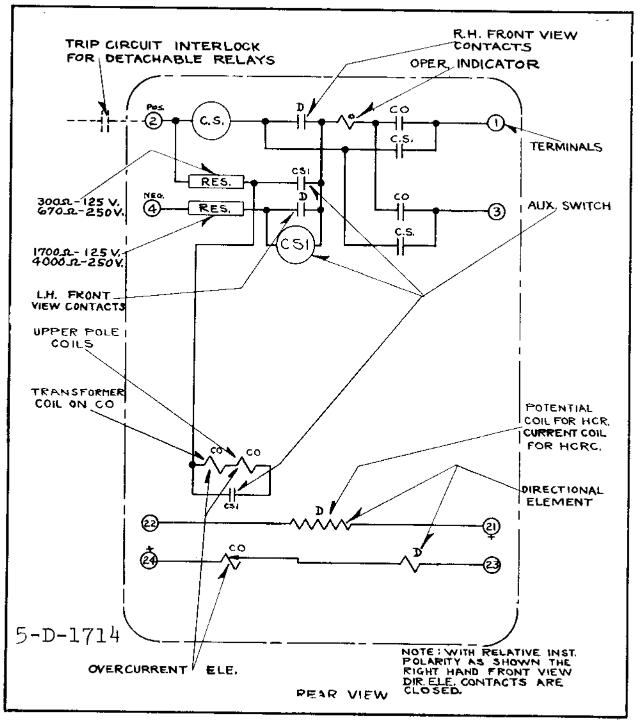


Fig. 3—Internal Schematic Of The Double Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

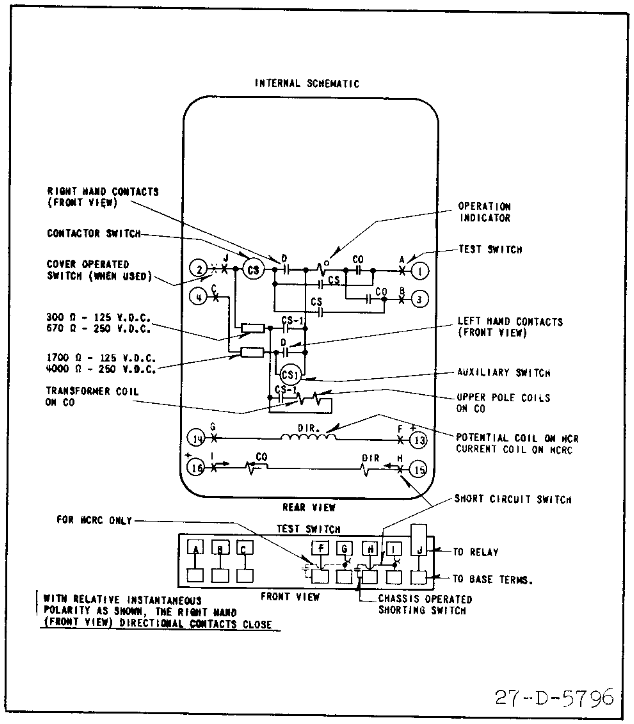


Fig. 4—Internal Schematic Of The Double Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

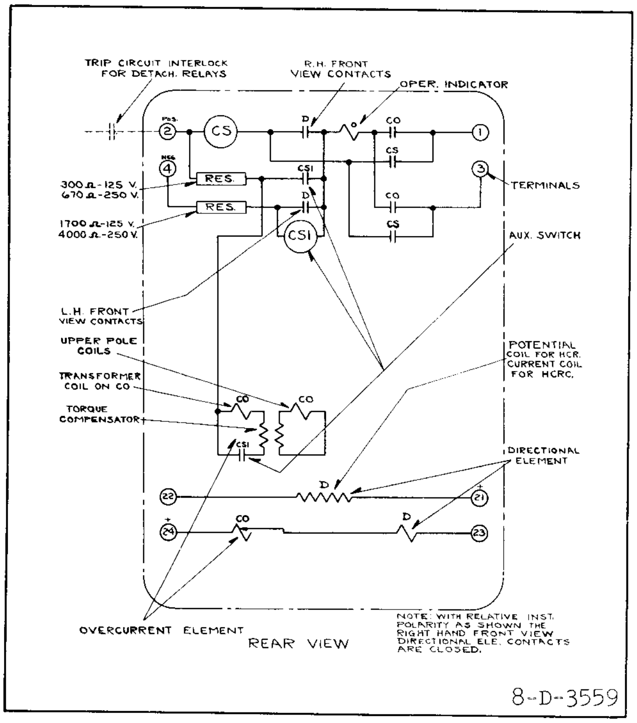


Fig. 5—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

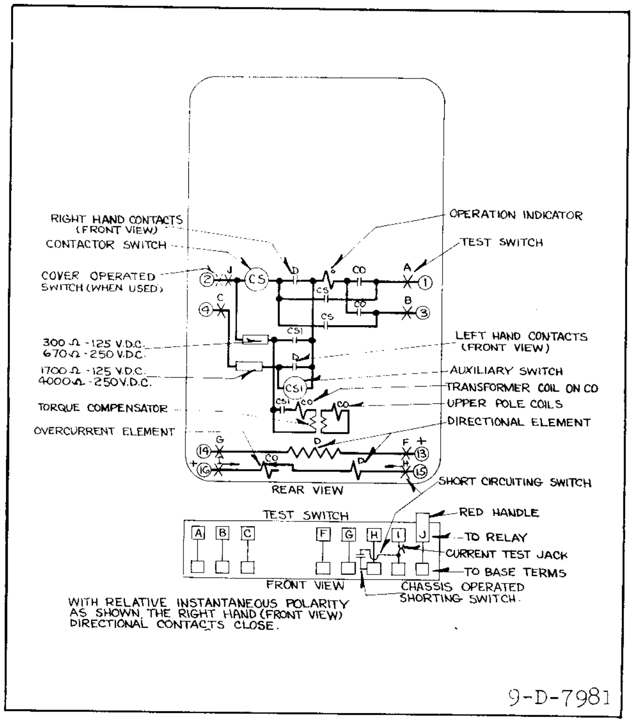


Fig. 6—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

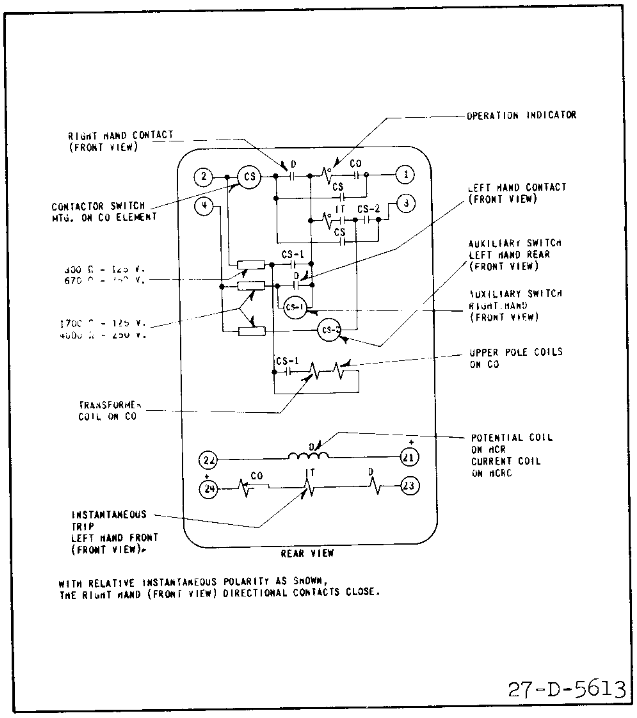


Fig. 7—Internal Schematic Of The Single Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

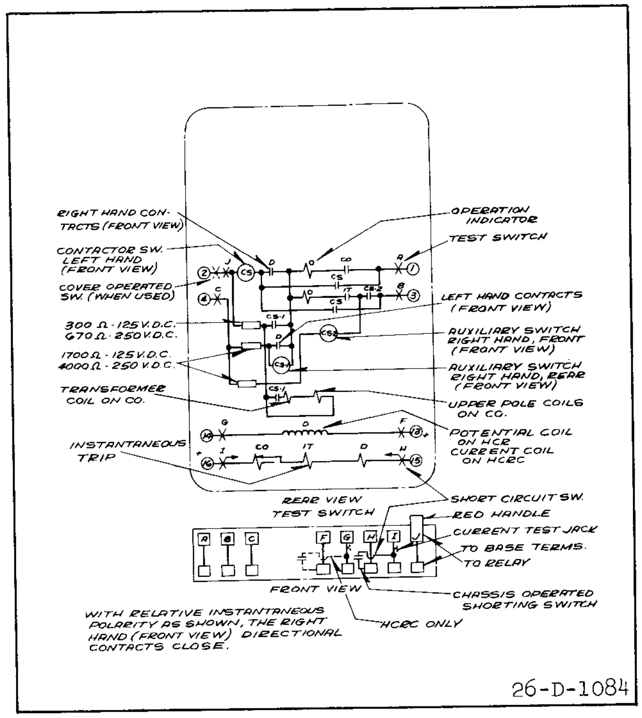


Fig. 8—Internal Schematic Of The Single Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Type FT Case.

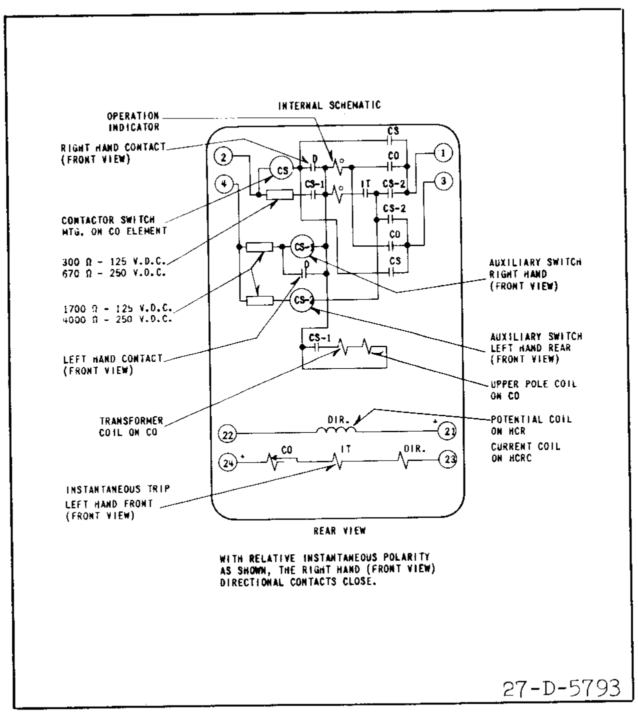


Fig. 9—Internal Schematic Of The Double Trip Inverse, Very Inverse Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

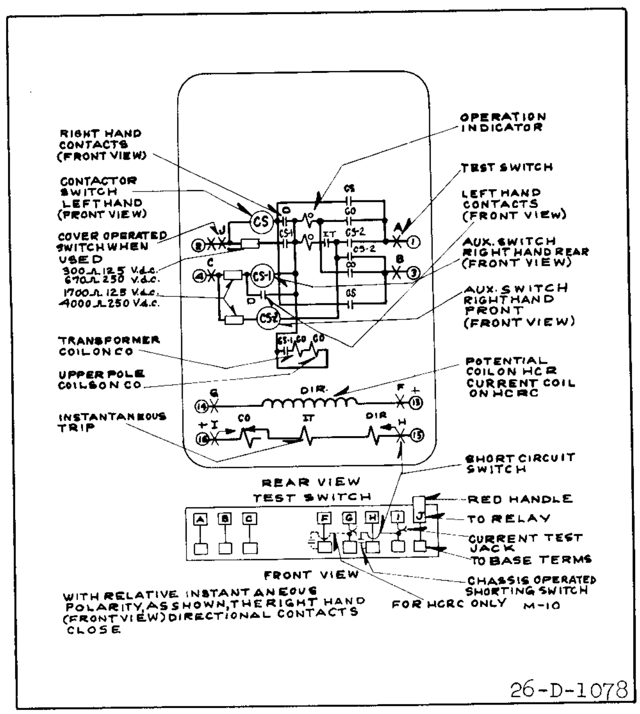


Fig. 10—Internal Schematic Of The Double Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Type FT Case.

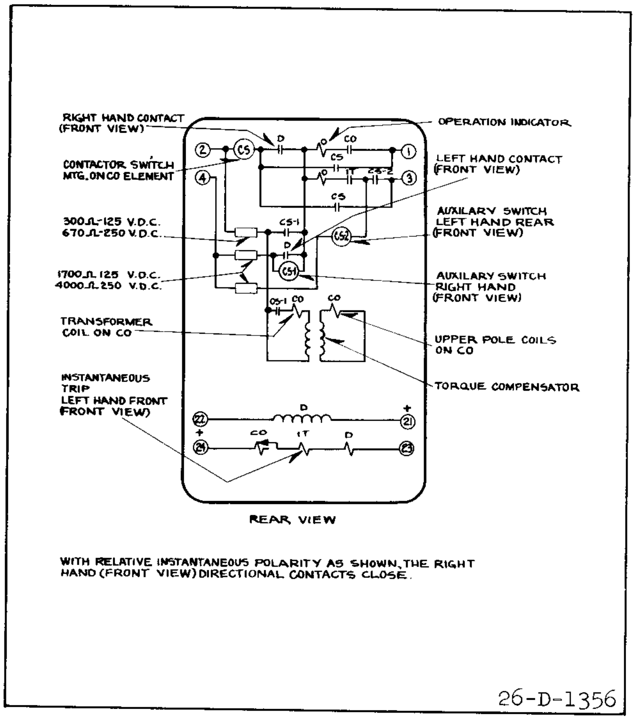


Fig. 11—Internal Schematic Of The Single Trip Definite Minimum Time Type HCR Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

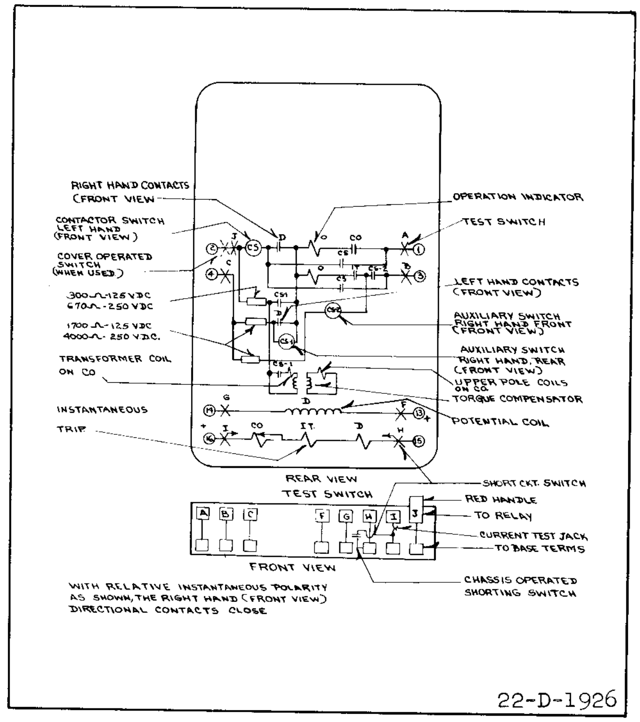


Fig. 12—Internal Schematic Of The Single Trip Definite Minimum Time Type HCR Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Type FT Case.

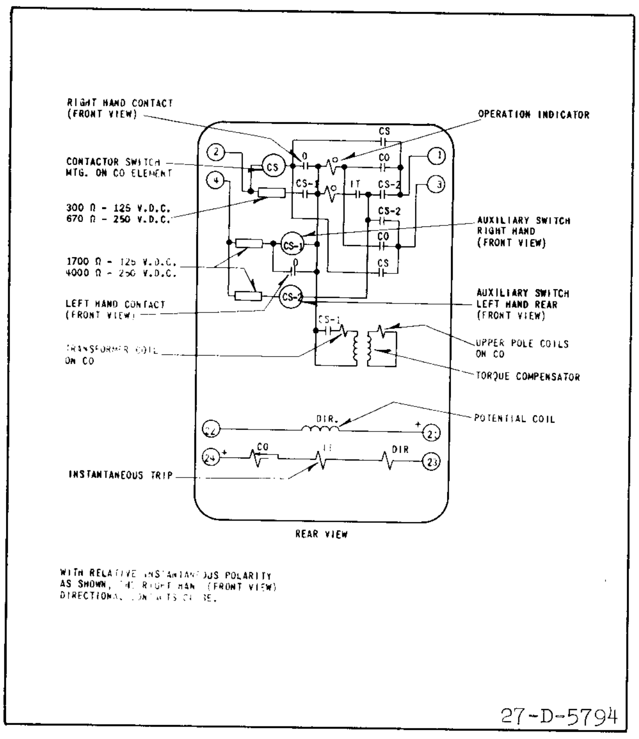


Fig. 13—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay with Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

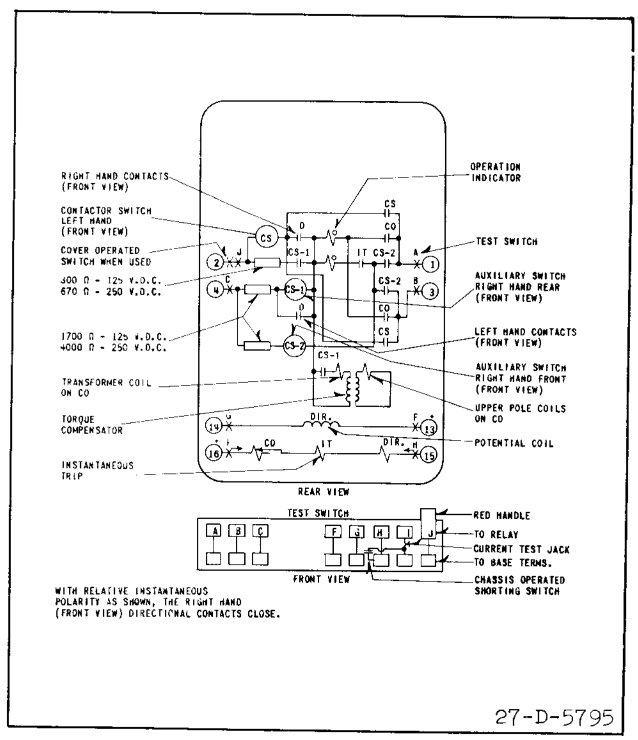


Fig. 14.—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay with Instantaneous Trip and Auxiliary CS-2 Switch In The Type FT Case.

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 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 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 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:

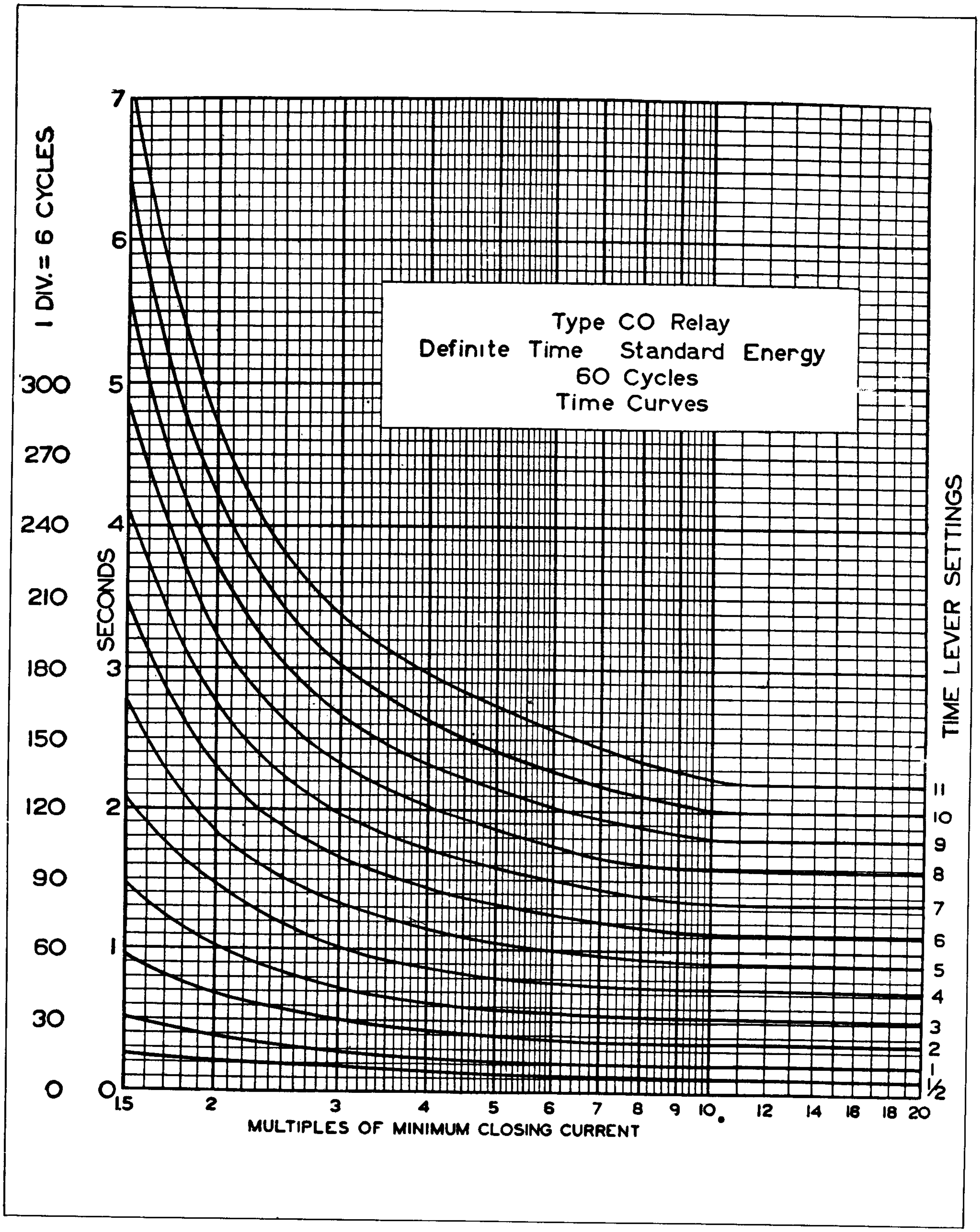


Fig. 15–Typical 60 Cycle Time Curves of the Overcurrent Element of the Definite Minimum Time (Standard Energy) Type HCR and HCRC Relays.

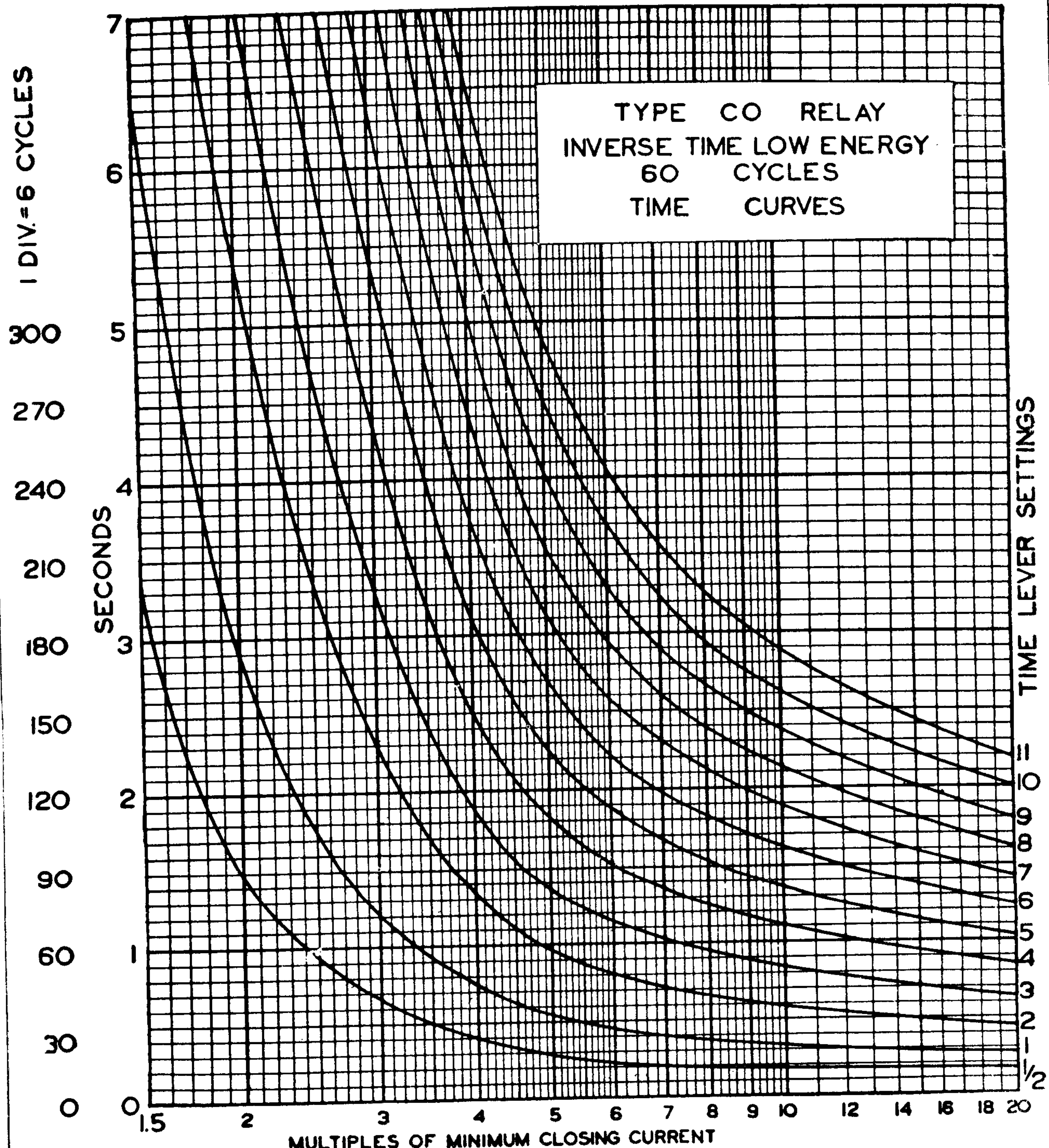


Fig. 16—Typical 60 Cycle Time Curves of the Overcurrent Element of the Inverse Time (Low Energy) Type HCR and HCRC Relays.

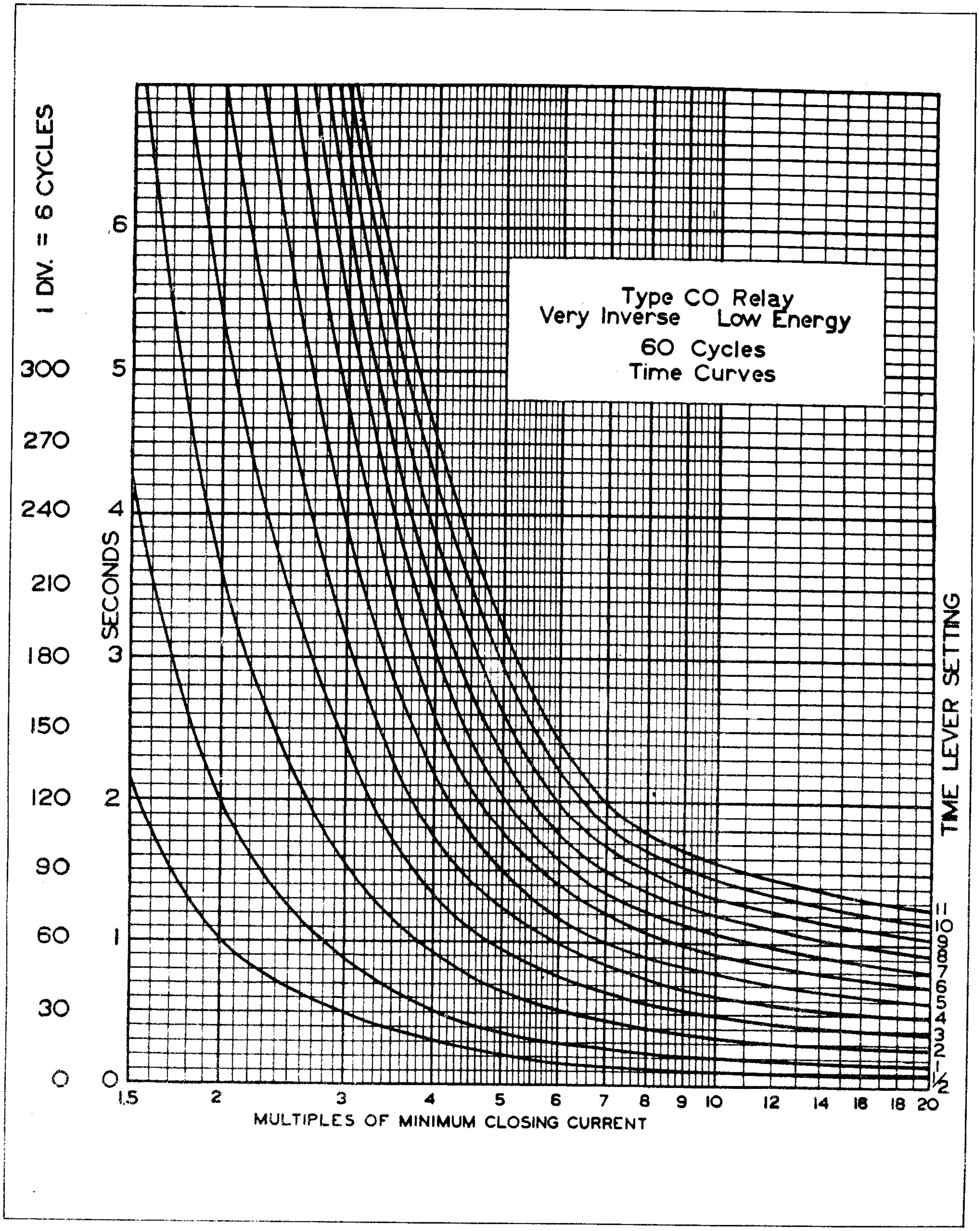


Fig. 17 -Typical 60 Cycle Time Curves of the Overcurrent Element of the Very Inverse (Low Energy) Type HCR and HCRC Relays.

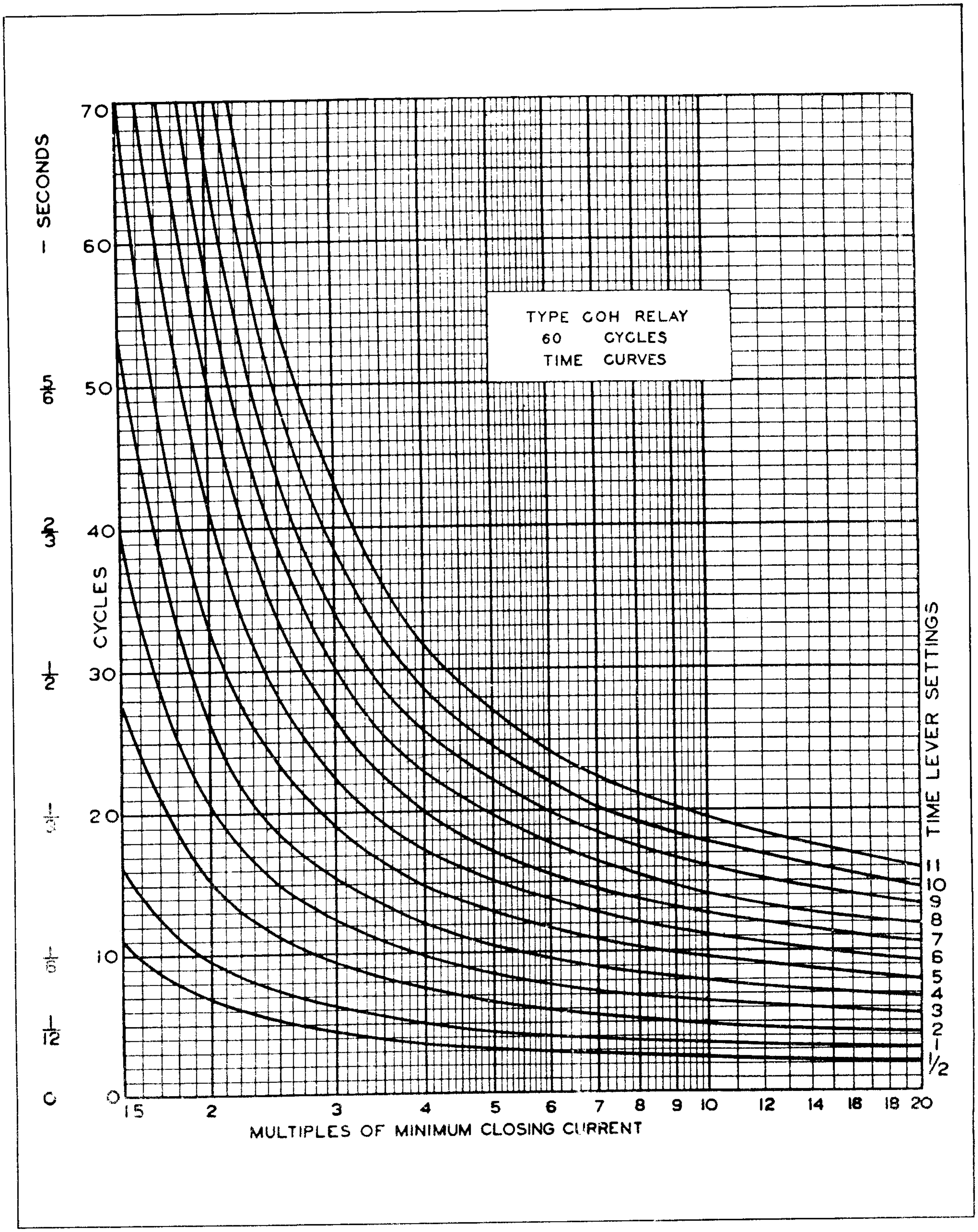


Fig. 18 —Typical 60 Cycle Time Curves of the Overcurrent Element of the Short Time (CON) Type HCR and HCRC Relays.

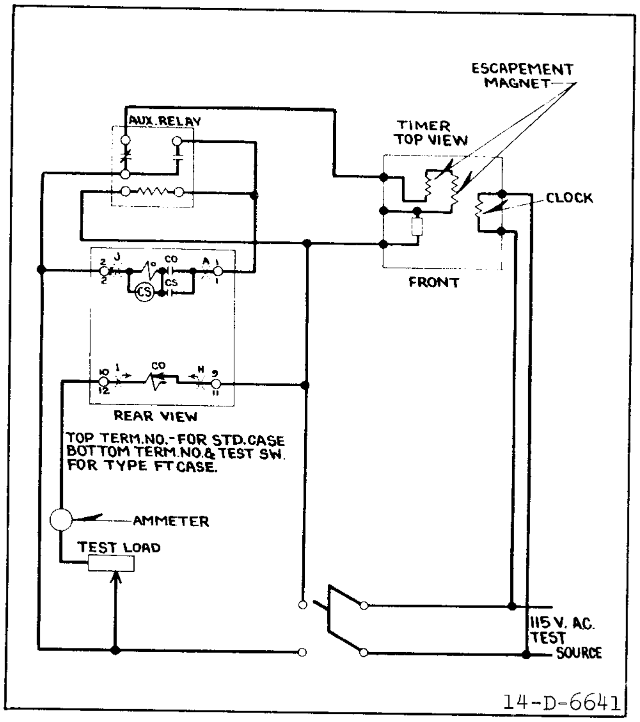


Fig. 19–Diagram of Test Connections of the Overcurrent Element.

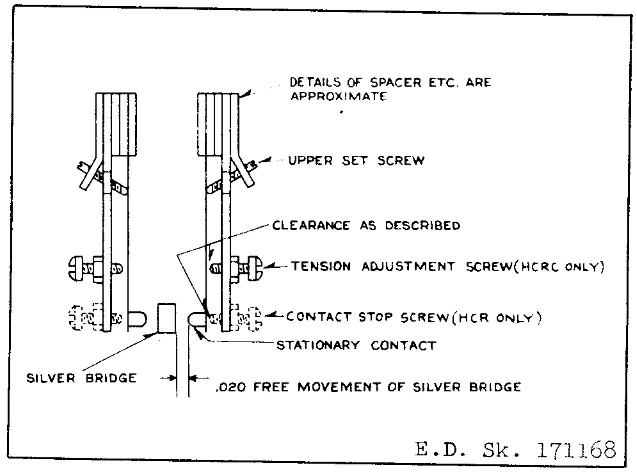


Fig. 20–Front View of the Directional Element Showing Contact Adjustment Details.

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 element 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 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. 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 settings.

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. Typical relay time curves are shown in Figures 15 to 18.

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

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 terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are as shown on the typical time curves. Note that 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.

DIRECTIONAL ELEMENT

Voltage Polarized Relays

Check the free movement of the directional element loop with the relay in a vertical position to see that it is free from friction and properly centered. The loop should assume a vertical position with the contacts open when the element is completely de-energized.

With the loop in the vertical position adjust the front and back stationary contacts for .020 inch separation from the vertical moving contact. Adjust the contact back stop screws to just touch the stationary contacts, then back off 1/4 of a turn to give correct contact follow. Adjust the two stop screws which limit the movement of the loop (these screws are located to the rear of the current coil) so that the loop strikes these stops at the same instant or slightly before the stationary contacts strike their back stop.

Energize the loop with normal potential long enough to bring it up to temperature (about 10 or 15 minutes) and adjust the bearing screws so there is about .010 inch end play. See that the loop does not bind or strike against the iron or coil when pressed against either end jewel.

The minimum pick-up of the element is 10 amperes at 2.0 volts (unity power factor). Apply these values to the element and see that contacts make good contact in the correct direction. Reverse the direction of current to see that the contacts make good contact in the opposite direction.

When the directional element is energized on voltage alone, there may be a small torque which may hold contacts either open or closed. This torque is small and shows up only at high voltages with the entire absence of current. At voltages high enough to make this torque discernible, it will be found that only a fraction of an ampere in the current coils will produce wattmeter torque to insure positive action. This is mentioned because the slight torque shown on voltage alone has no practical effect on the directional element operation.

Current Polarized Relays

As utilized in the type HCRC, the directional element differs from those used in potential polarized relays in two respects. First, a current polarizing winding is used, and second, the stationary contact back stop screws are located and used differently. The essential details of the stationary contact assembly are shown in Figure 20.

The backstop screws located in the rear of the current coil and iron assembly which limit the travel of the loop should be backed out of the way to the point where they give maximum loop movement without allowing the loop to strike on the movement frame, which must be avoided. Adjust the left hand stationary contacts, front view, with the upper set screws to give .005" to .010" clearance between the moving silver contact bridge and the stationary contacts. Adjust the right hand stationary contacts to give approximately .020" clearance between the stationary contacts and the moving contact bridge. The moving contact bridge should make with both bridge contacts at the same instant. The tension adjustment screws are then set to clear the stationary contact leaf spring by approximately 0" to .005". This gives contact wipe, and frictional damping which enable the directional element contacts to operate the CS-1 auxiliary switch satisfactorily at very high torques, which are pulsating. The operation of the contacts should be checked at high, low, and intermediate currents over the expected range of operation to see that a satisfactory adjustment has been made. * The element will operate satisfactorily with 3 amperes, 60 cycles in each winding up to 80 amperes in each winding.

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 done by turning the relay up-side-down or by disconnecting the switch and turning it up-side-down. Then 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 assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn 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" 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.

Auxiliary Contactor Switch

The adjustments for the auxiliary switch CS-1 are the same as for the seal in contactor switch except that the contact separation should be 3/64". The switch should pick up at or below 80 volts applied to the relay d-c terminals. Apply 140 volts d-c to the circuit and see that the contactor drops out when shorted by the left hand directional contacts. For 250 volt d-c relays, the pick up should be 165 volts or less. With 280 volts applied to the circuit the contactor must drop out when shorted by the left-hand directional contacts.

The adjustments for the auxiliary switch CS-2 are the same as for the seal-in contactor switch except that the contact separation should be 3/64". The switch should pick-up at or below 80 volts applied to the relay d-c terminals. For 250 volt d-c relays, the pick-up should be 165 volts or less.

When the CS-2 auxiliary switch is used with a trip coil supervisory indicator lamp, a breaker "a" switch must be connected between terminal 4 of the relay and the negative bus of the trip circuit.

Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c 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 be weakened slightly by stretching to obtain the 1 ampere calibration. The coil resistance is approximately 0.16 ohms.

Instantaneous Trip

The position of the Micarta disc at the

bottom of the element with reference to the calibrated guide indicates the minimum over-current required to operate the element. The disc should be lowered or raised to the proper position by loosening the lock nut which locks the Micarta disc, and rotating the Micarta disc. The nominal range of adjustment is 1 to 4; for example, 10 to 40 amperes, and it has an accuracy within the range 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. The drop-out should be adjusted for about 2/3 of the minimum pick-up. Adjusting the drop-out will slightly effect the value of pick-up.

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 and thermal capacities of the overcurrent elements are as shown on the following pages:

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)
0.5/2.5	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

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	25.0	4	60° lag	8	250
	2.5	16	4	60° lag	8	250
	3	11	4	60° lag	8	250
	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
4/15	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

DIRECTIONAL ELEMENT SERIES COIL

Rating	V.A. at 5 Amperes	Power Factor	One Second Rating (Amperes)
5	3.5	45° lag	140

DIRECTIONAL ELEMENT POTENTIAL POLARIZING COIL, ALONE

Rating	V.A. at 115 Volts	Power Factor
115 V	9	28° lag

DIRECTIONAL ELEMENT CURRENT POLARIZING COIL

Rating	V.A. at 5 Amperes	Power Factor	One Second Rating (Amperes)
5	1.1	*10° lag	140

DIRECTIONAL ELEMENT WITH 60° PHASE SHIFTER

Rating	V.A. at 115 Volts	Power Factor
115 V	8.9	24° lag

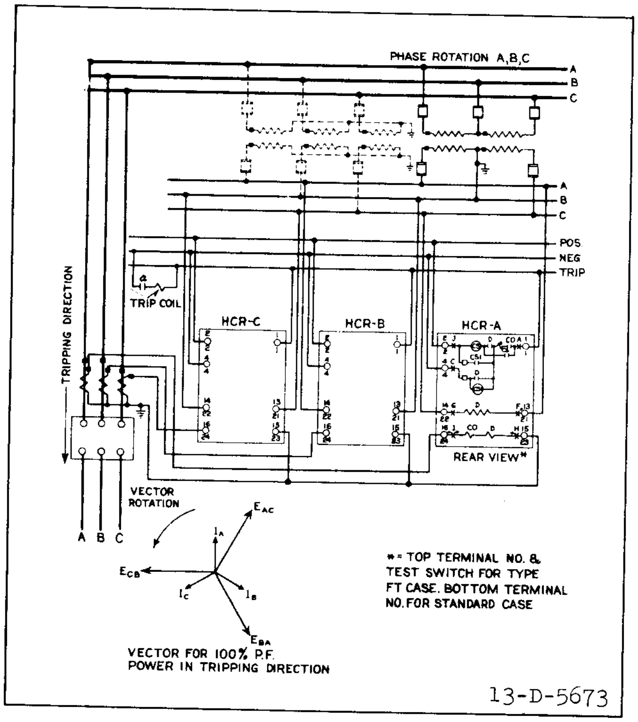


Fig. 21–External Connections of the Type HCR Relay For Phase Fault Protection.

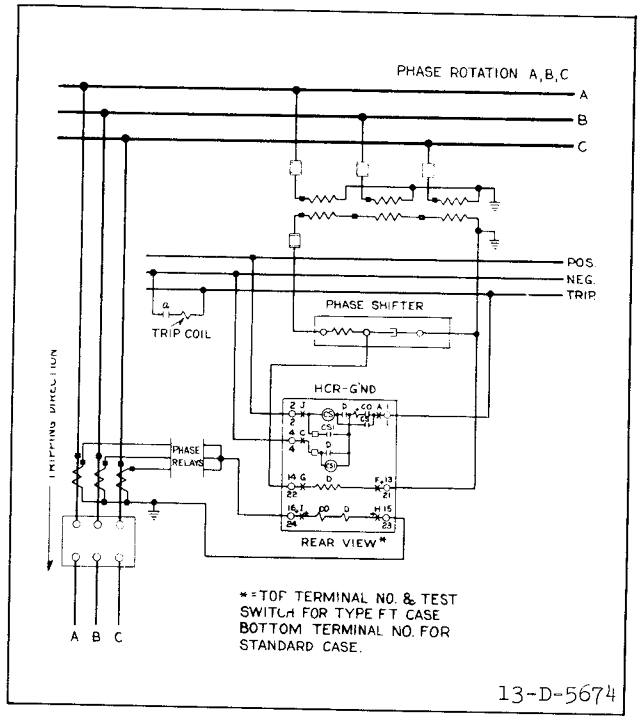


Fig. 22–External Connections of the Type HCR Relay For Ground Fault Protection.

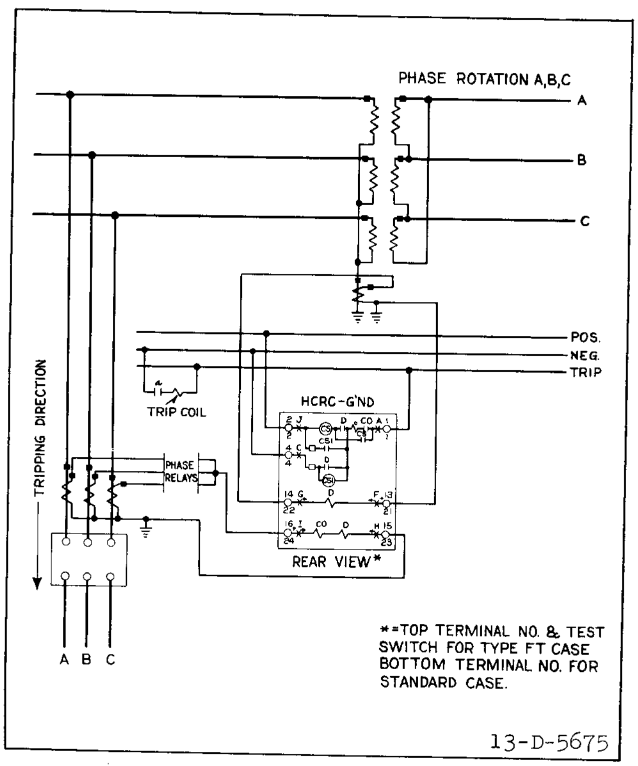


Fig. 23-External Connections of the Type HCRC Relay For Ground Fault Protection.

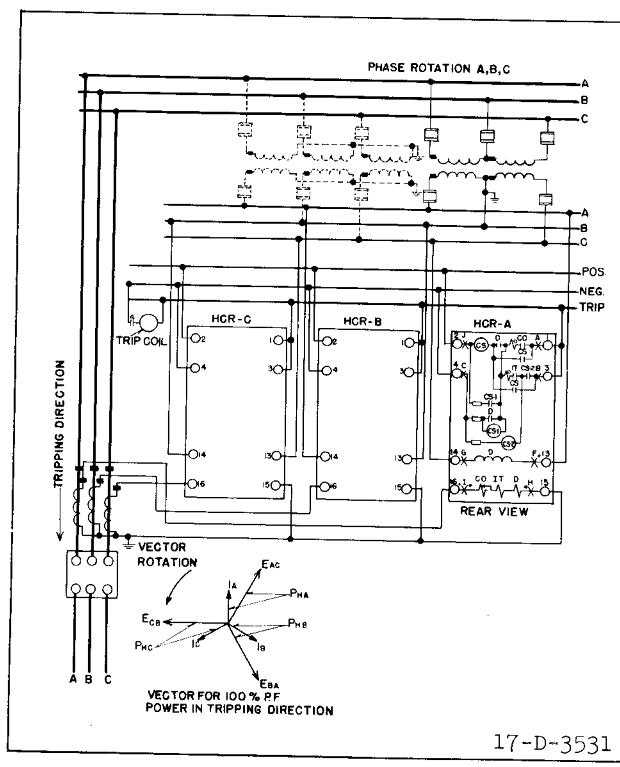
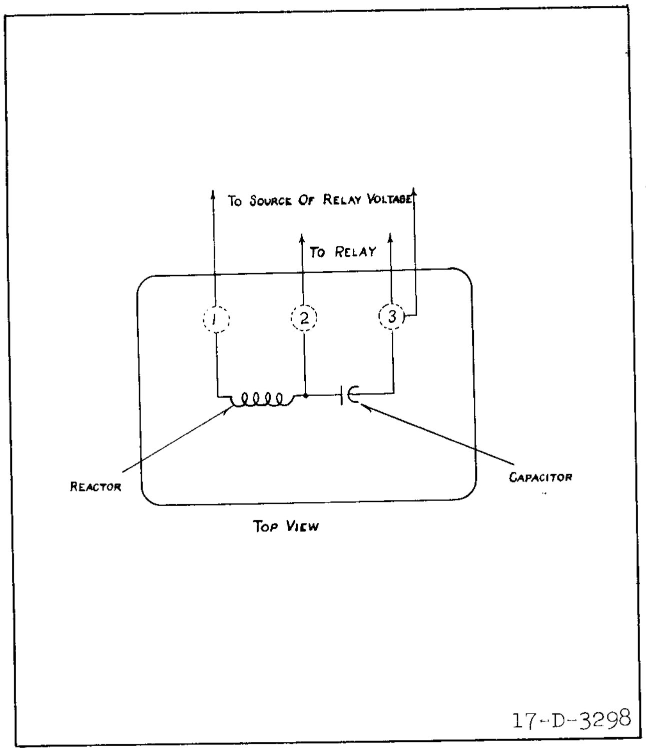


Fig. 24—External Connections Of The Type HCR Relay With Instantaneous Trip For Phase Fault Protection.

TYPES HCR AND HCRC RELAYS



✱ Fig. 25—External Phase Shifter For Type HCR Directional Element

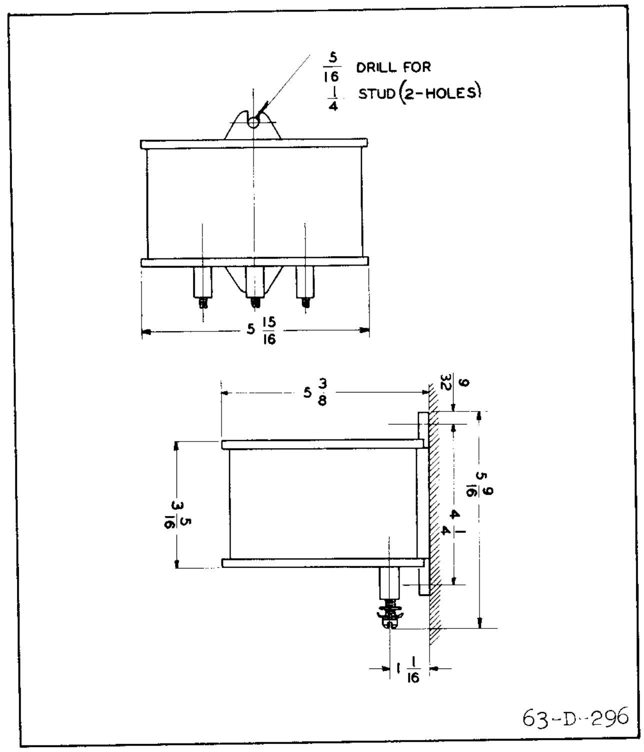


Fig. 26-Outline and Drilling Plan of the External Phase Shifter for the Type HCR Relay When Used For Ground Protection. For Reference Only.

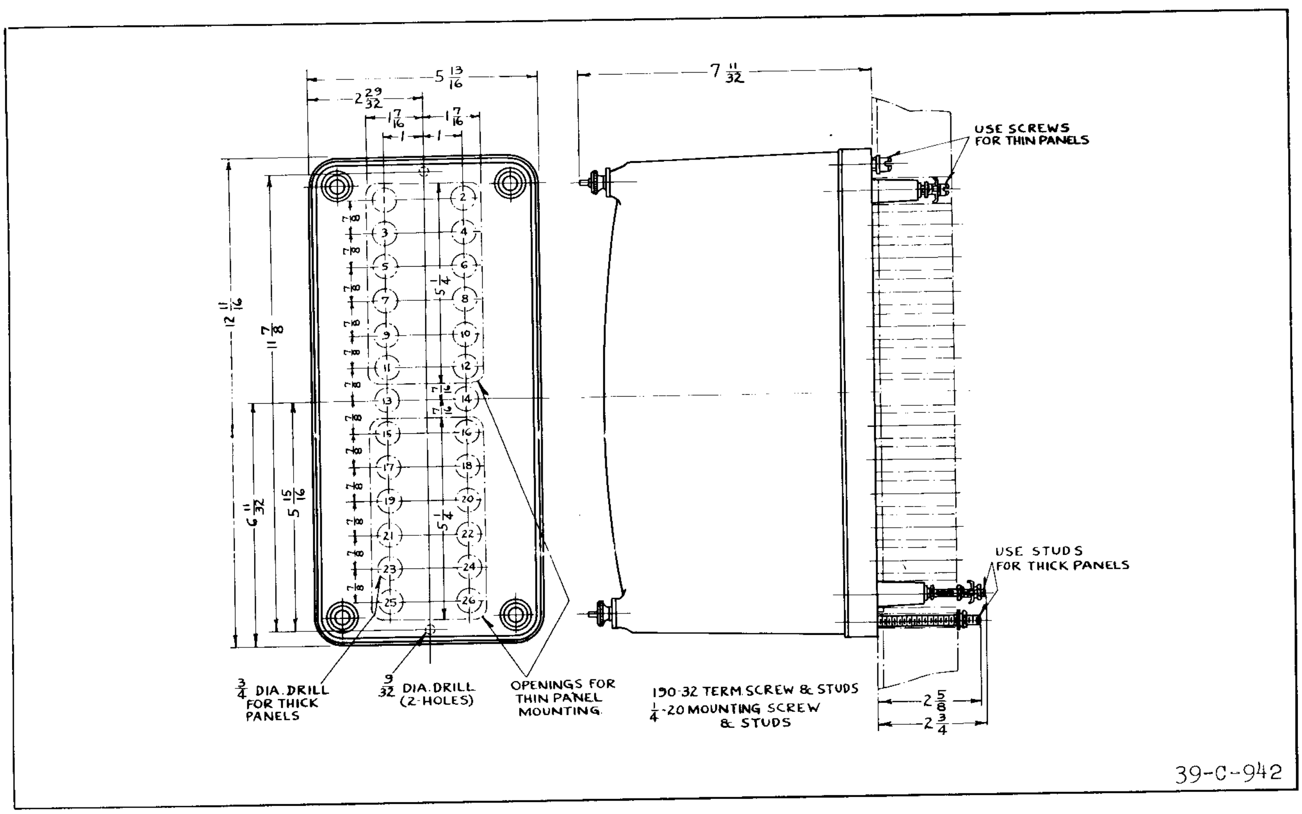


Fig. 27-Outline and Drilling Plan For the Projection Type Standard Case. See the Internal Schematics For the Terminals Supplied. For Reference Only.

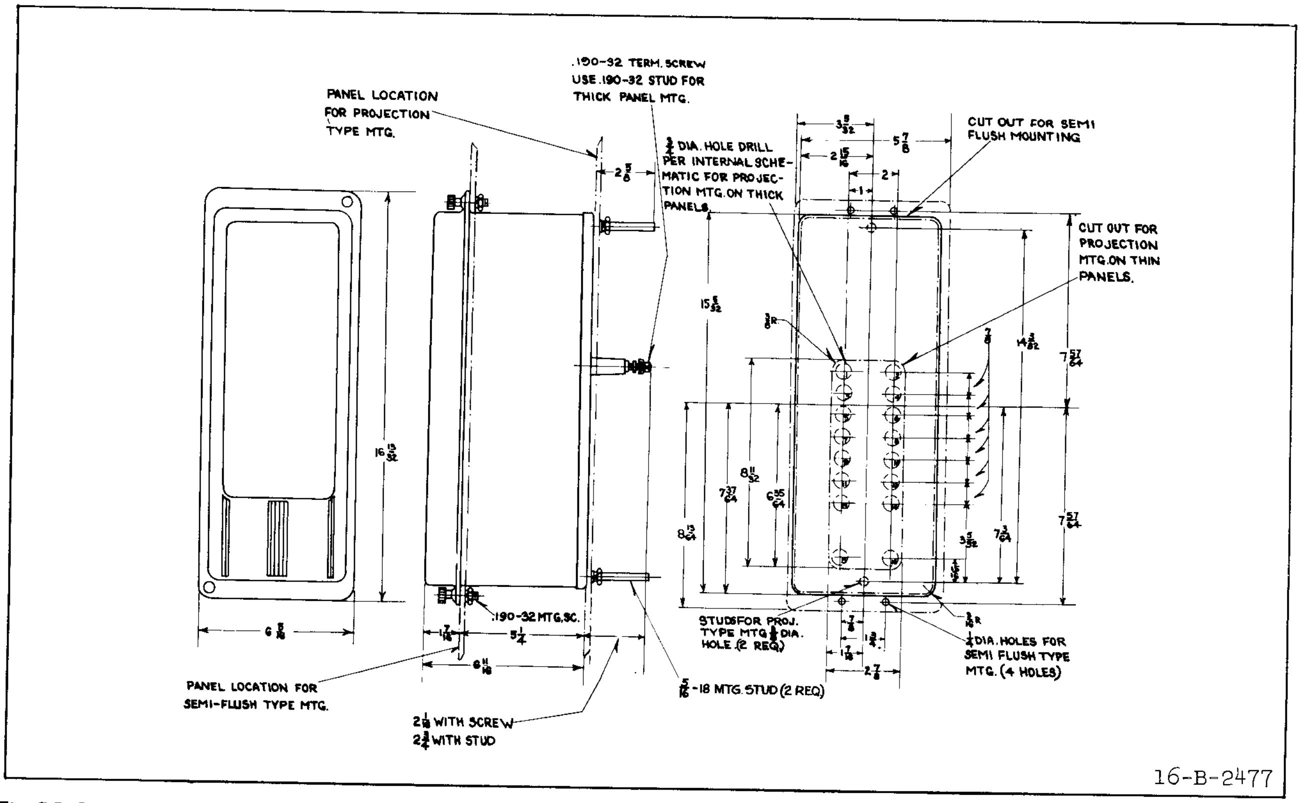


Fig.28-Outline and Drilling Plan for the M10 Projection or Semi-Flush Type FT Flexitest Case. See the Internal Schematics For The Terminals Supplied. For Reference Only.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES HCR AND HCRC DIRECTIONAL OVERCURRENT RELAYS

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

The types HCR and HCRC relays are induction overcurrent relays directionally controlled by a high speed directional element. They are used to disconnect transmission and feeder circuits when the current thru them exceeds a predetermined value in the tripping directions.

The type HCR relay is potential polarized and is used for both phase and ground fault protection. The type HCRC relay is current polarized and used for ground fault protection.

CONSTRUCTION AND OPERATION

The relay consists of a type CO or COH overcurrent element, a type H directional element, an auxiliary switch, a contactor switch, and operation indicators, and in some cases an instantaneous trip attachment.

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 thru 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 is obtained by the circuit arrangement shown in Figure 2. 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 inverse and very inverse relays operate on this principle. The definite-time, standard-energy relay obtains its flat characteristic curve because of a small saturating transformer that is interposed between the secondary coil and the upper

SUPERSEDES I. L. 41-432
✱ Denotes change from superseded issue.

EFFECTIVE DECEMBER 1953

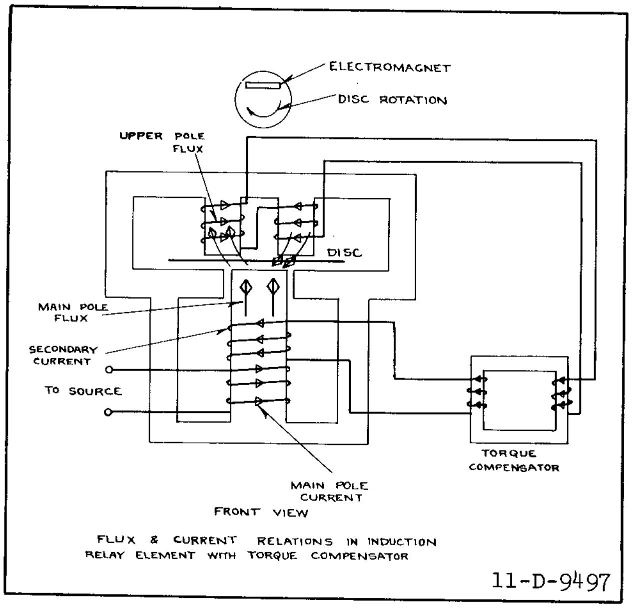


Fig. 1—Flux and Current Relations In the Definite Time Relay With the Torque Compensation.

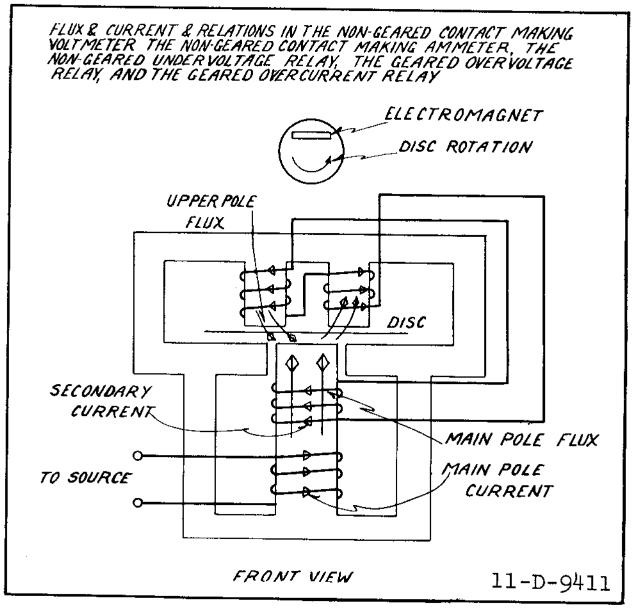


Fig. 2—Flux and Current Relations in the Inverse or Very Inverse Time Relay.

pole coils. This is called the torque compensator and it slows down the disc movement at high currents to such an extent that no gearing is required. (See Figure 1.)

Directional Element

A small voltage transformer causes a large current to flow in a single-turn movable aluminum secondary, which current is substantially in phase with the voltage. The current coils are mounted on a magnetic frame and the current and voltage elements are assembled at right angles to each other with the one-turn voltage loop in the air gaps of the current coil flux path. The interaction of the current and voltage fluxes produces torque and rotates the loop in one of two directions, depending on the direction of power flow. The element has nearly true wattmeter characteristics.

In the type HCRC relay the voltage coil is replaced with a current coil, and the structural details are slightly different.

An Isolantite arm extends from the moving loop and supports a rectangular silver contact which bridges two stationary contacts located on either side of the loop. The stationary contacts are silver hemi-spheres mounted on the lower end of vertically-hanging spring leaves. The contact separation is adjustable by a small screw near the upper end of the rigid stationary contact supporting arm. One of these supporting arms hangs parallel to each of the four stationary contacts. The set screw on the lower end of this arm provides the contact follow adjustment. Two additional screws on the movement frame beneath the current coil iron limit the movement of the one-turn loop.

Contactor Switches

The contactor switch is a small solenoid type d-c switch, the coil of which is connected in the trip circuit. 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. In the single-trip relay, two of these contacts seal around the main relay contact. In the double-trip relays, all three contacts are used to seal in both trip circuits.

The operation of the d-c auxiliary switch is controlled by the directional element which in turn directionally controls the overcurrent element. When sufficient power flows in the tripping direction, the auxiliary contactor switch operates to close and seal in the upper pole circuit of the overcurrent element, permitting the disc to rotate. If the direction of power flow reverses, a contact on the directional element shorts the auxiliary contactor switch coil, causing it to drop out. This opens the directional control circuit and allows the overcurrent element to reset.

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.

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 types HCR or HCRC definite minimum time (standard energy) relays are 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 HCR or HCRC inverse, very inverse (low energy) or short time (using type COH overcurrent element) relays are 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 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 semi-circular 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 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 type HCR relay directional element minimum pick-up is 2 volts 10 ampere in-phase. The type HCRC relay directional element minimum pick-up is 3 amperes each winding in phase.

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.

RELAYS IN TYPE FT. CASE

The type FT cases are dust-proof enclosures

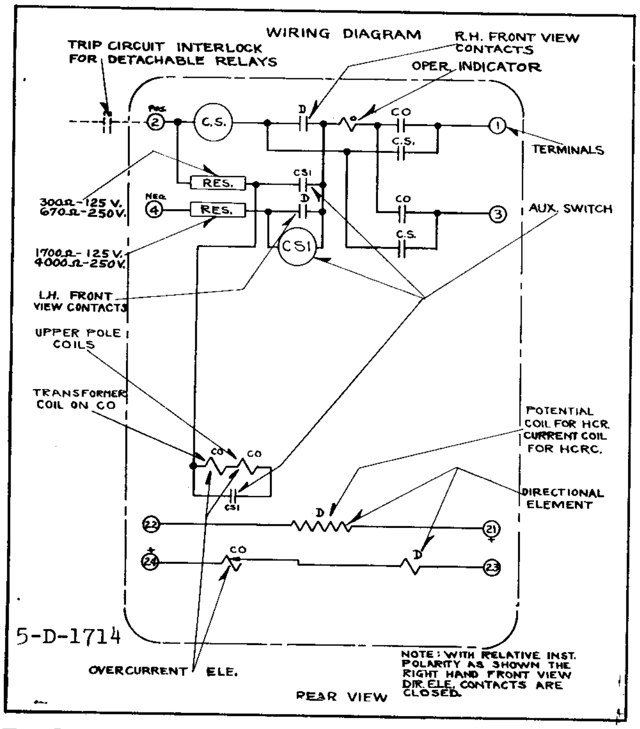


Fig. 3—Internal Schematic Of The Double Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

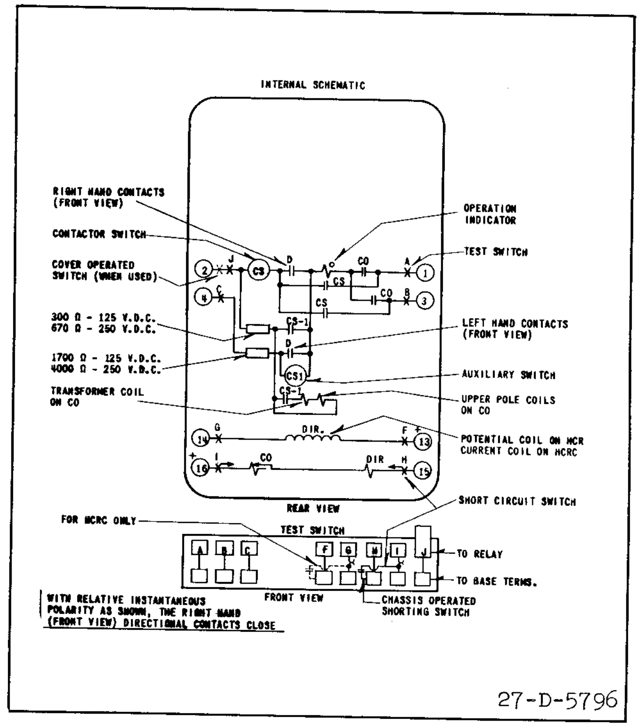


Fig. 4—Internal Schematic Of The Double Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

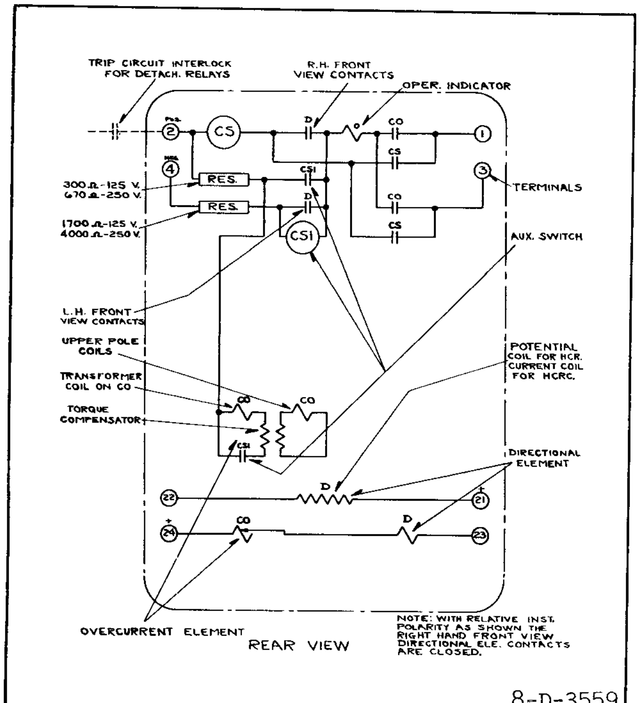


Fig. 5—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay In The Standard Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

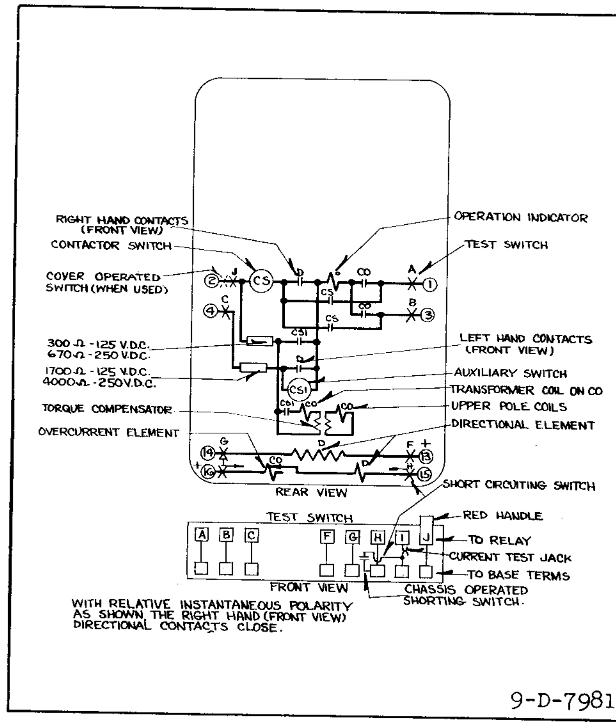


Fig. 6—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay In The Type FT Case. The Single Trip Relays Have Terminal 3 And Associated Circuits Omitted.

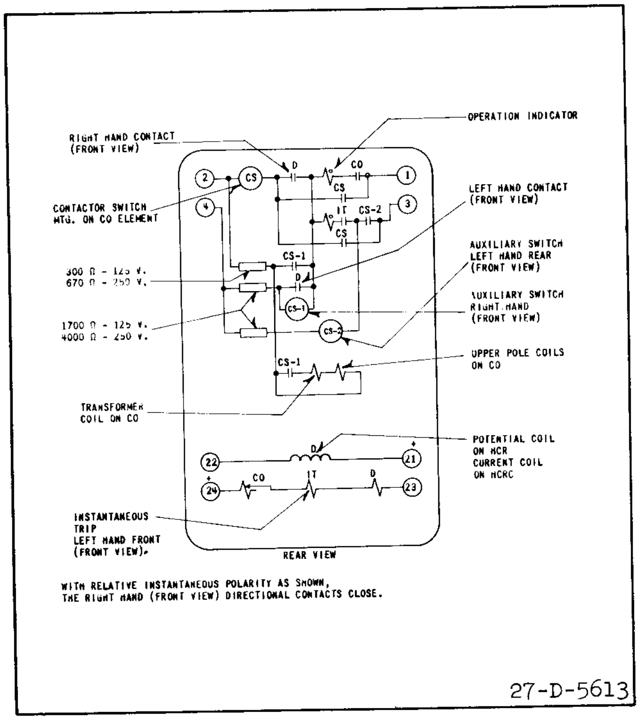


Fig. 7—Internal Schematic Of The Single Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

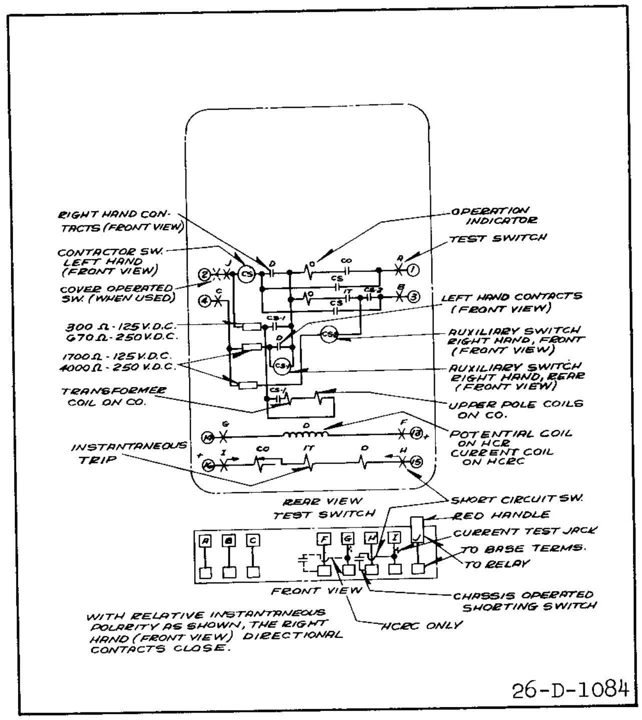


Fig. 8—Internal Schematic Of The Single Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Type FT Case.

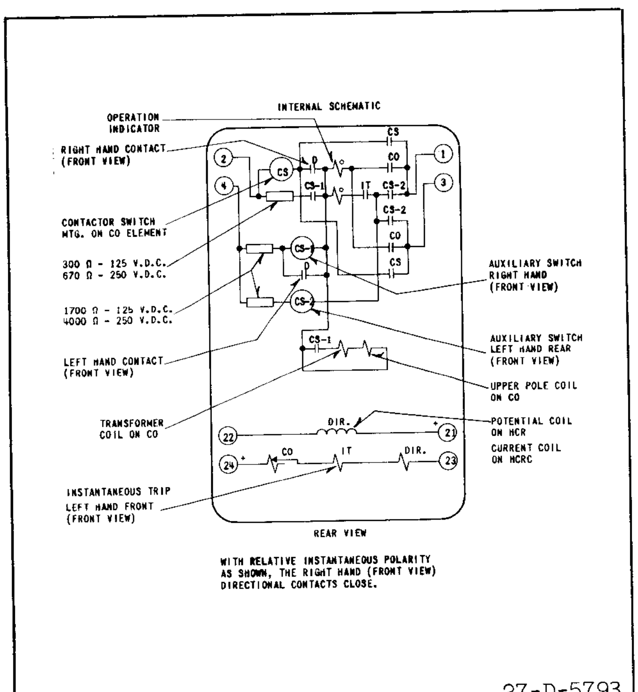


Fig. 9—Internal Schematic Of The Double Trip Inverse, Very Inverse Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

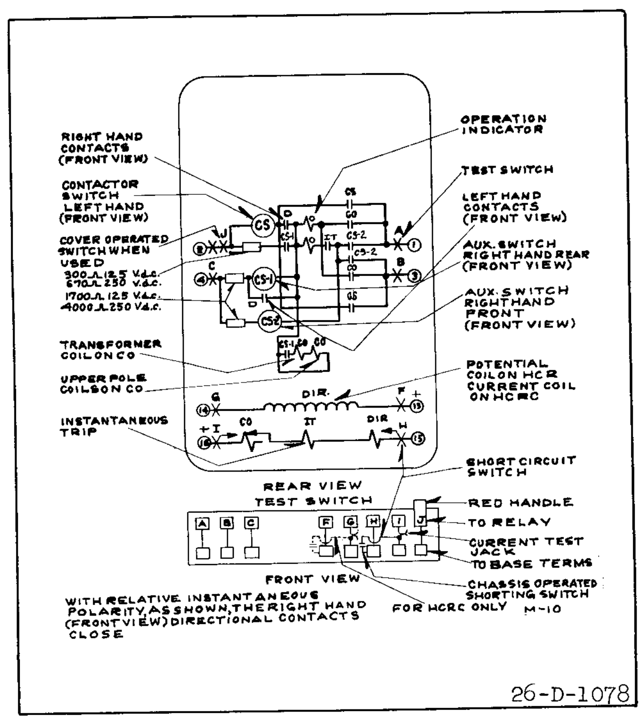


Fig. 10—Internal Schematic Of The Double Trip Inverse, Very Inverse, Or Short Time Type HCR Or HCRC Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Type FT Case.

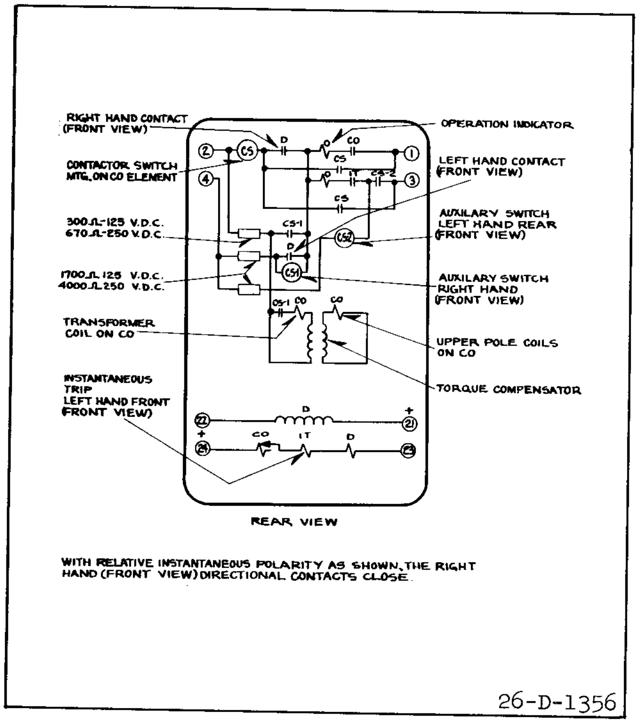


Fig. 11—Internal Schematic Of The Single Trip Definite Minimum Time Type HCR Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

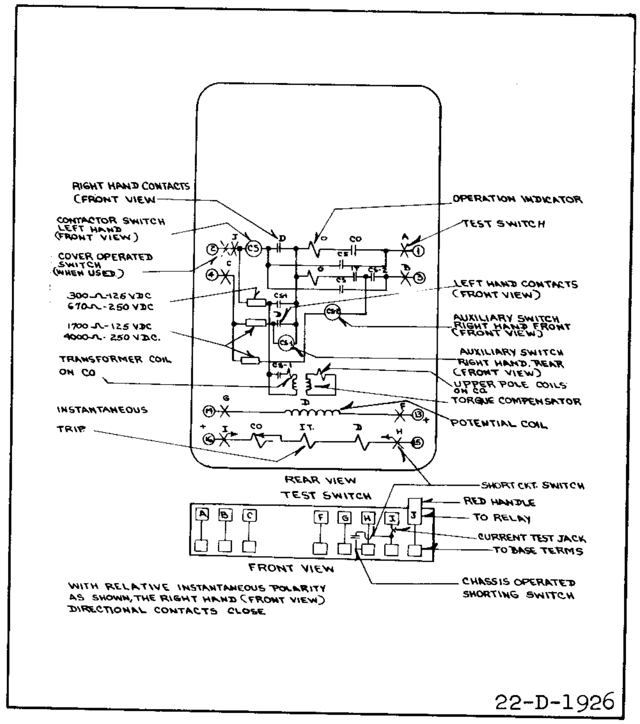


Fig. 12—Internal Schematic Of The Single Trip Definite Minimum Time Type HCR Relay With Instantaneous Trip And Auxiliary CS-2 Switch In The Type FT Case.

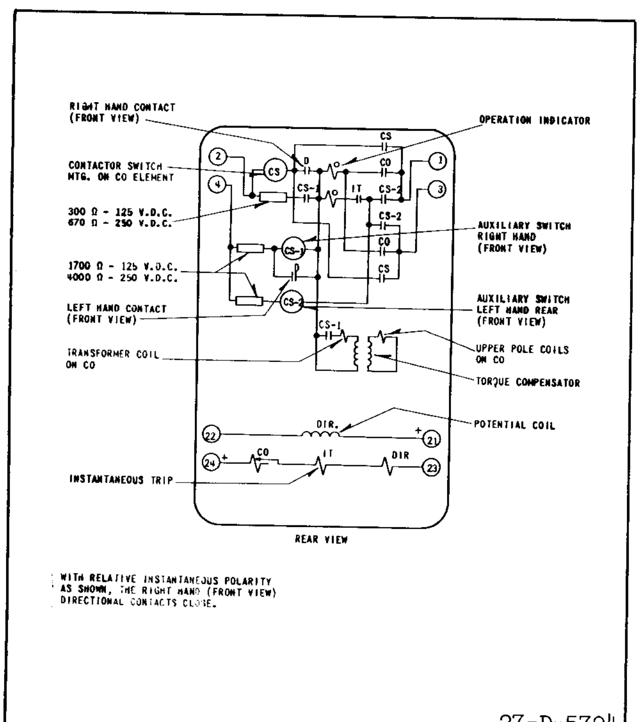


Fig. 13—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay with Instantaneous Trip And Auxiliary CS-2 Switch In The Standard Case.

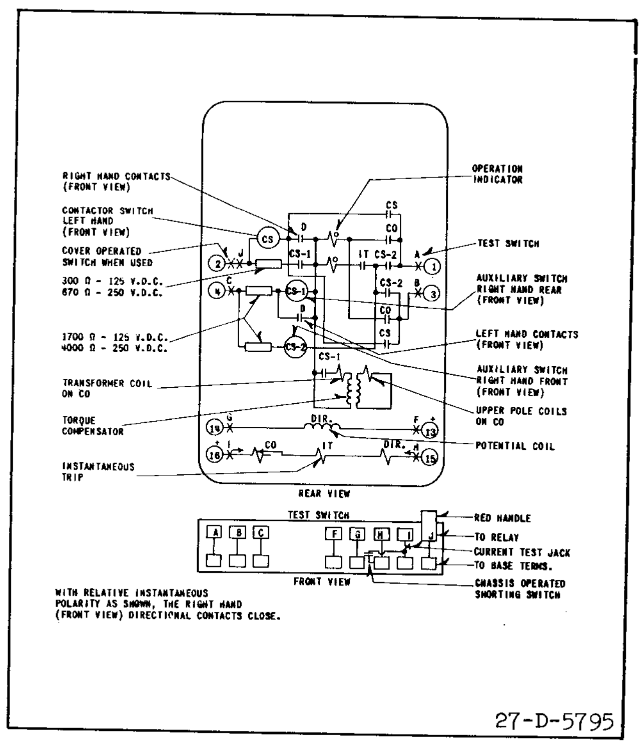


Fig. 14.—Internal Schematic Of The Double Trip Definite Minimum Time Type HCR Relay with Instantaneous Trip and Auxiliary CS-2 Switch In The Type FT Case.

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 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 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 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:

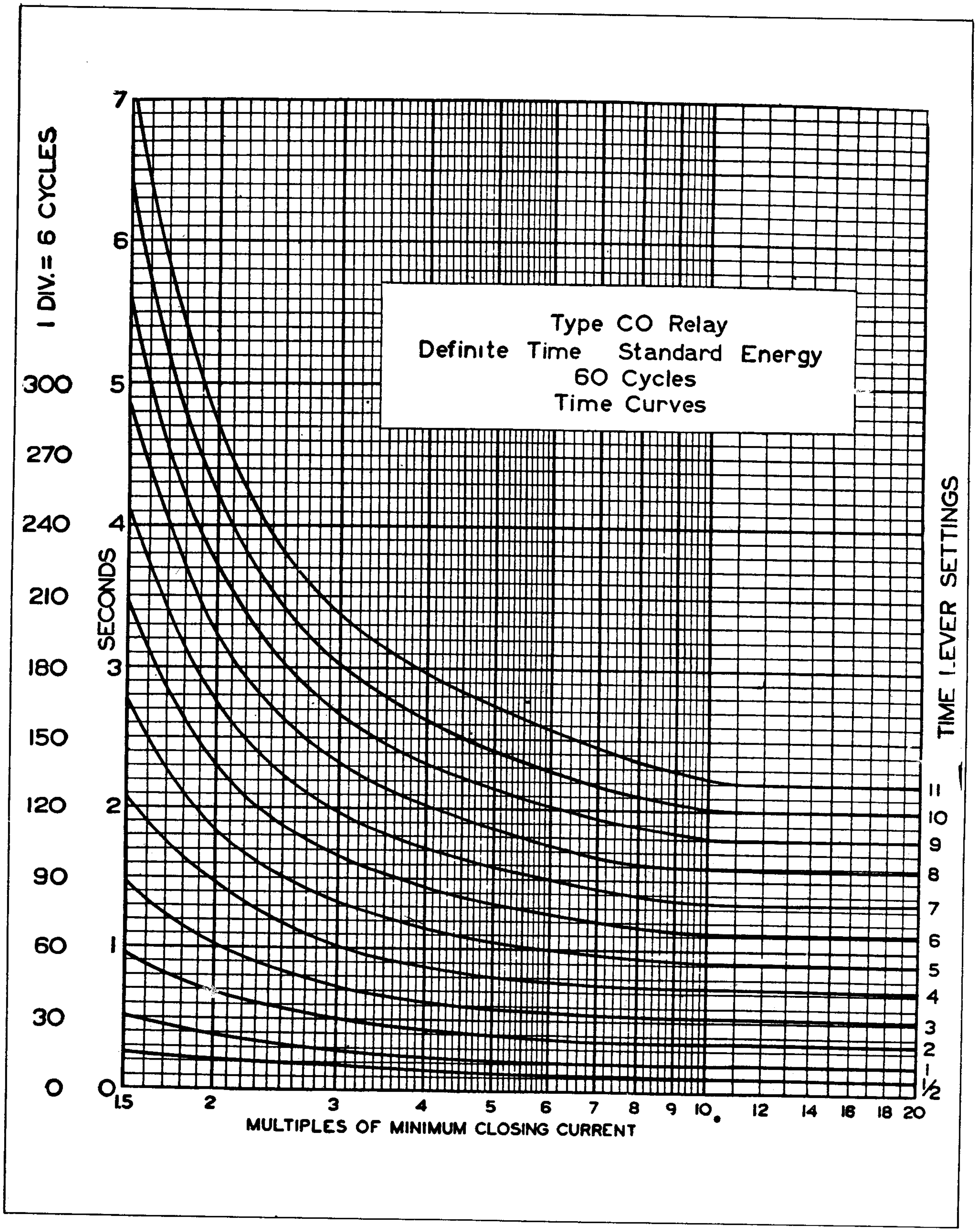


Fig. 15–Typical 60 Cycle Time Curves of the Overcurrent Element of the Definite Minimum Time (Standard Energy) Type HCR and HCRC Relays.

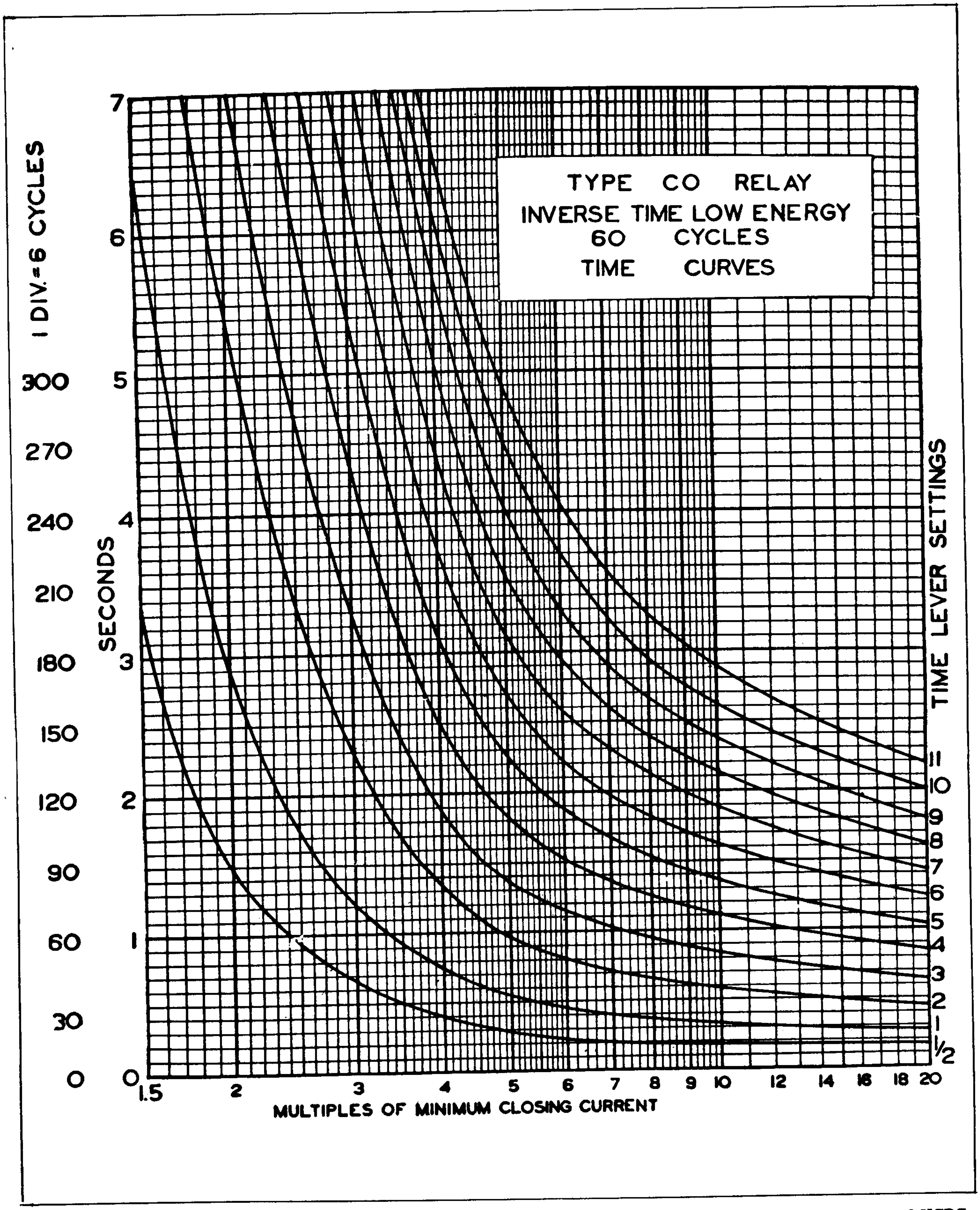


Fig. 16–Typical 60 Cycle Time Curves of the Overcurrent Element of the Inverse Time (Low Energy) Type HCR and HCRC Relays.

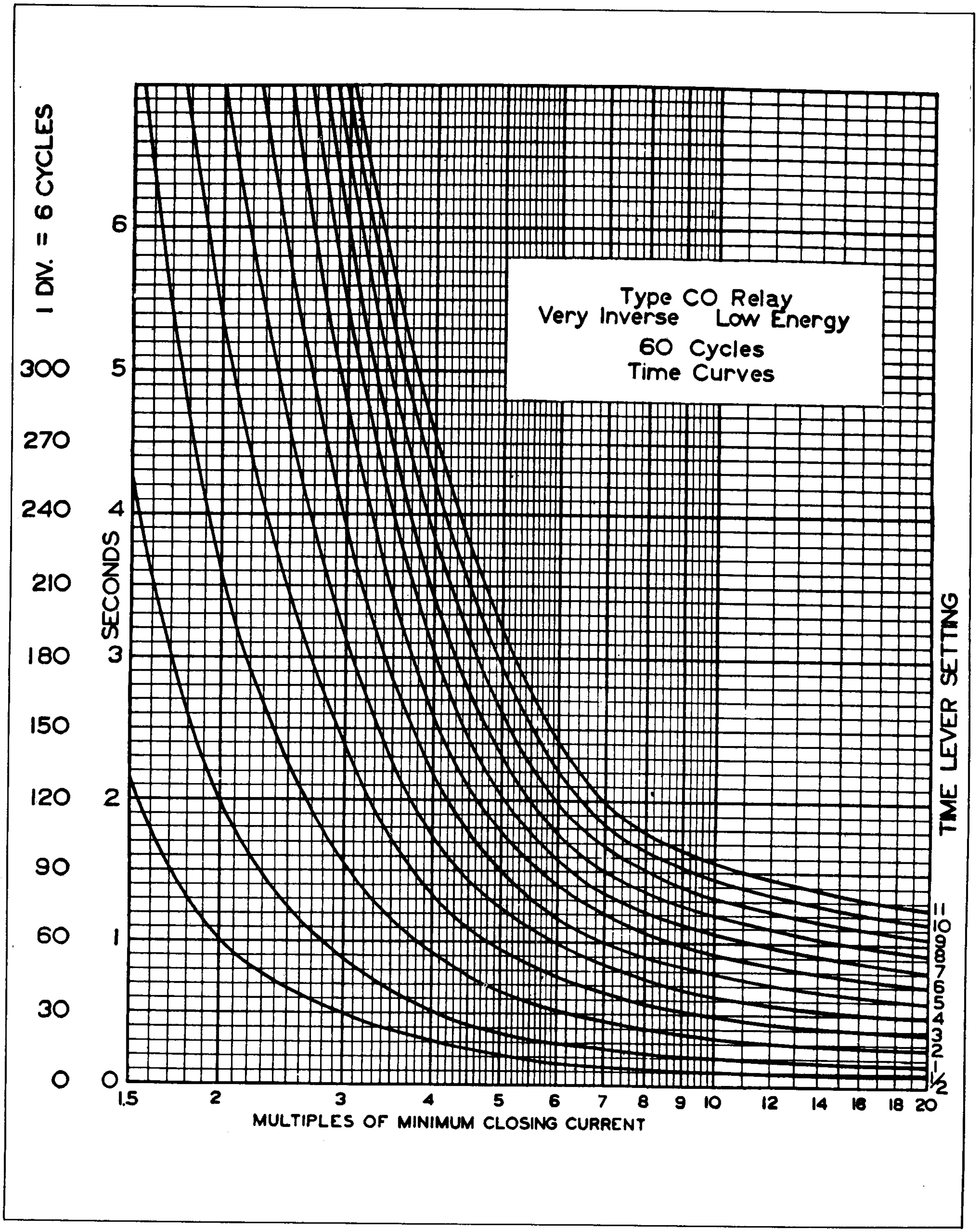


Fig. 17 -Typical 60 Cycle Time Curves of the Overcurrent Element of the Very Inverse (Low Energy) Type HCR and HCRC Relays.

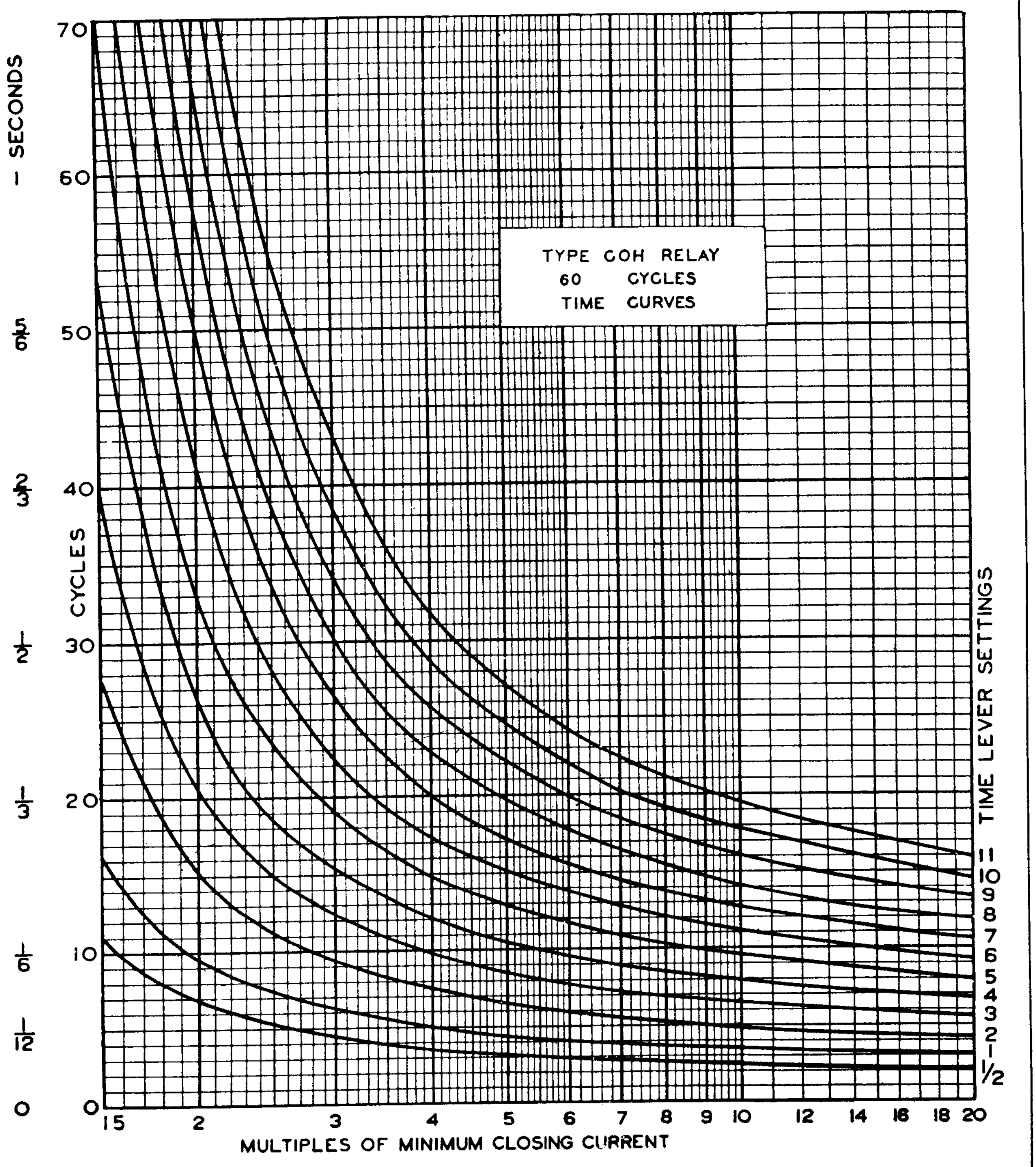


Fig. 18 —Typical 60 Cycle Time Curves of the Overcurrent Element of the Short Time (CON) Type HCR and HCRC Relays.

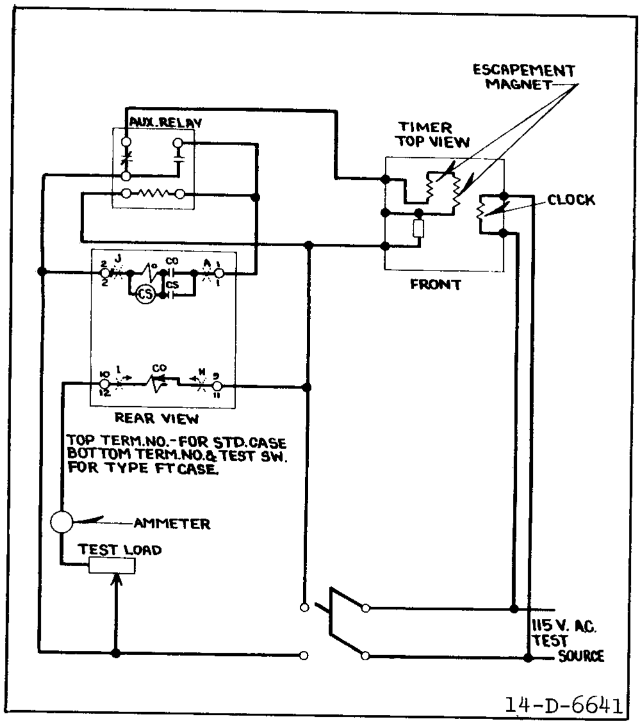


Fig. 19–Diagram of Test Connections of the Overcurrent Element.

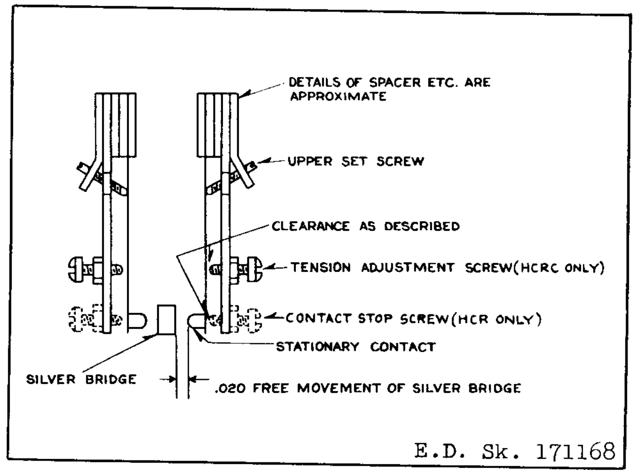


Fig. 20–Front View of the Directional Element Showing Contact Adjustment Details.

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 element 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 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. 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 settings.

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. Typical relay time curves are shown in Figures 15 to 18.

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

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 terminal block. Shift the position of the damping magnets so that the time characteristics of the relay, as shown by test with a cycle counter, are as shown on the typical time curves. Note that 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.

DIRECTIONAL ELEMENT

Voltage Polarized Relays

Check the free movement of the directional element loop with the relay in a vertical position to see that it is free from friction and properly centered. The loop should assume a vertical position with the contacts open when the element is completely de-energized.

With the loop in the vertical position adjust the front and back stationary contacts for .020 inch separation from the vertical moving contact. Adjust the contact back stop screws to just touch the stationary contacts, then back off 1/4 of a turn to give correct contact follow. Adjust the two stop screws which limit the movement of the loop (these screws are located to the rear of the current coil) so that the loop strikes these stops at the same instant or slightly before the stationary contacts strike their back stop.

Energize the loop with normal potential long enough to bring it up to temperature (about 10 or 15 minutes) and adjust the bearing screws so there is about .010 inch end play. See that the loop does not bind or strike against the iron or coil when pressed against either end jewel.

The minimum pick-up of the element is 10 amperes at 2.0 volts (unity power factor). Apply these values to the element and see that contacts make good contact in the correct direction. Reverse the direction of current to see that the contacts make good contact in the opposite direction.

When the directional element is energized on voltage alone, there may be a small torque which may hold contacts either open or closed. This torque is small and shows up only at high voltages with the entire absence of current. At voltages high enough to make this torque discernible, it will be found that only a fraction of an ampere in the current coils will produce wattmeter torque to insure positive action. This is mentioned because the slight torque shown on voltage alone has no practical effect on the directional element operation.

Current Polarized Relays

As utilized in the type HCRC, the directional element differs from those used in potential polarized relays in two respects. First, a current polarizing winding is used, and second, the stationary contact back stop screws are located and used differently. The essential details of the stationary contact assembly are shown in Figure 20.

The backstop screws located in the rear of the current coil and iron assembly which limit the travel of the loop should be backed out of the way to the point where they give maximum loop movement without allowing the loop to strike on the movement frame, which must be avoided. Adjust the left hand stationary contacts, front view, with the upper set screws to give .005" to .010" clearance between the moving silver contact bridge and the stationary contacts. Adjust the right hand stationary contacts to give approximately .020" clearance between the stationary contacts and the moving contact bridge. The moving contact bridge should make with both bridge contacts at the same instant. The tension adjustment screws are then set to clear the stationary contact leaf spring by approximately 0" to .005". This gives contact wipe, and frictional damping which enable the directional element contacts to operate the CS-1 auxiliary switch satisfactorily at very high torques, which are pulsating. The operation of the contacts should be checked at high, low, and intermediate currents over the expected range of operation to see that a satisfactory adjustment has been made. The element for the 2-6 ampere and 4-15 ampere relay current ranges will operate satisfactorily with 3 amperes, 60 cycles in each winding up to 80 amperes in each winding. The relay element for the 0.5 to 2.5 ampere range will operate satisfactorily with 0.5 amperes, 60 cycles up to 14 amperes in each winding.

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 done by turning the relay up-side-down or by disconnecting the switch and turning it up-side-down. Then 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 assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn 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" 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.

Auxiliary Contactor Switch

The adjustments for the auxiliary switch CS-1 are the same as for the seal in contactor switch except that the contact separation should be 3/64". The switch should pick up at or below 80 volts applied to the relay d-c terminals. Apply 140 volts d-c to the circuit and see that the contactor drops out when shorted by the left hand directional contacts. For 250 volt d-c relays, the pick up should be 165 volts or less. With 280 volts applied to the circuit the contactor must drop out when shorted by the left-hand directional contacts.

The adjustments for the auxiliary switch CS-2 are the same as for the seal-in contactor switch except that the contact separation should be 3/64". The switch should pick-up at or below 80 volts applied to the relay d-c terminals. For 250 volt d-c relays, the pick-up should be 165 volts or less.

When the CS-2 auxiliary switch is used with a trip coil supervisory indicator lamp, a breaker "a" switch must be connected between terminal 4 of the relay and the negative bus of the trip circuit.

Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c 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 be weakened slightly by stretching to obtain the 1 ampere calibration. The coil resistance is approximately 0.16 ohms.

Instantaneous Trip

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum over-current required to operate the element. The disc should be lowered or raised to the proper position by loosening the lock nut which locks the Micarta disc, and rotating the Micarta disc. The nominal range of adjustment is 1 to 4; for example, 10 to 40 amperes, and it has an accuracy within the range 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. The drop-out should be adjusted for about 2/3 of the minimum pick-up. Adjusting the drop-out will slightly effect the value of pick-up.

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 and thermal capacities of the overcurrent elements are as shown on the following pages:

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	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

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

DIRECTIONAL ELEMENT SERIES COIL

Rating	V.A. at 5 Amperes	Power Factor	One Second Rating (Amperes)
5	3.5	45° lag	140

DIRECTIONAL ELEMENT POTENTIAL POLARIZING COIL, ALONE

Rating	V.A. at 115 Volts	Power Factor
115 V	9	28° lag

DIRECTIONAL ELEMENT CURRENT POLARIZING COIL

Rating	V.A. at 5 Amperes	Power Factor	One Second Rating (Amperes)
5	1.1	78° lag	140

DIRECTIONAL ELEMENT WITH 60° PHASE SHIFTER

Rating	V.A. at 115 Volts	Power Factor
115 V	8.9	24° lag

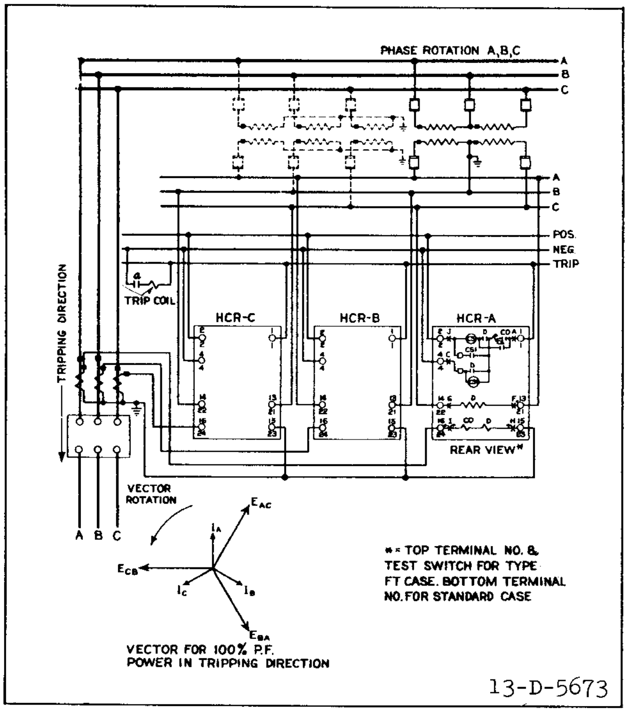


Fig. 21–External Connections of the Type HCR Relay For Phase Fault Protection.

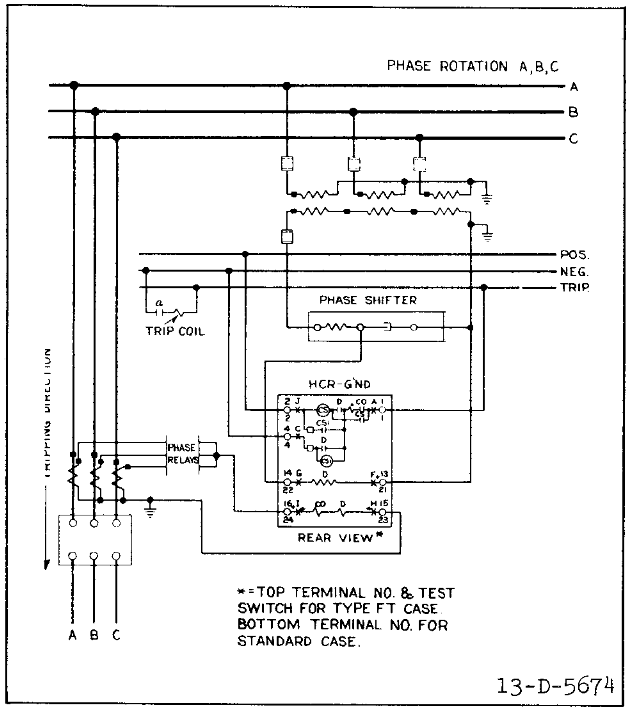


Fig. 22–External Connections of the Type HCR Relay For Ground Fault Protection.

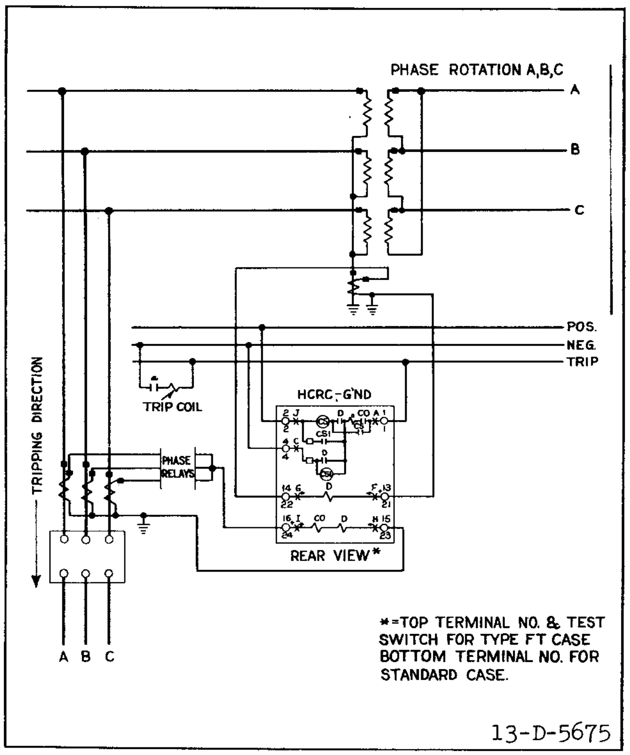


Fig. 23-External Connections of the Type HCRC Relay For Ground Fault Protection.

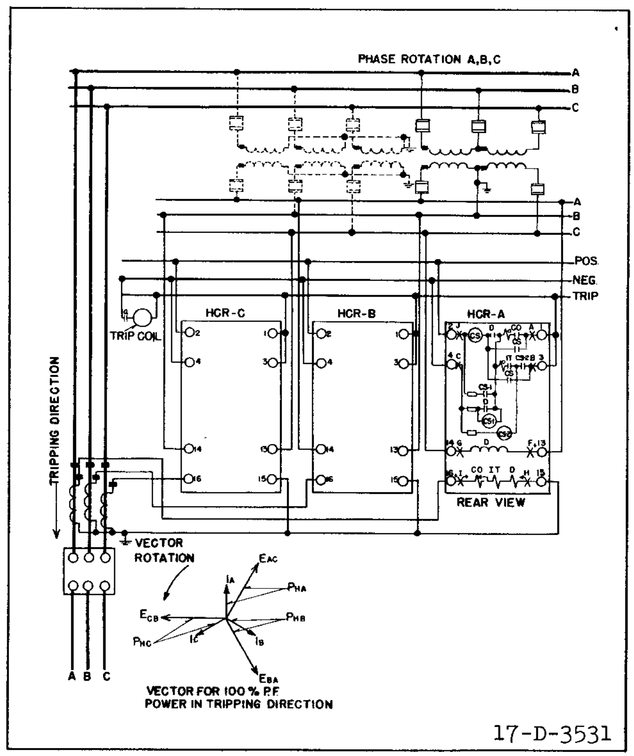
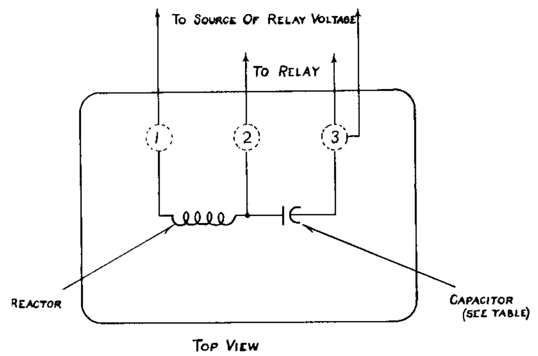


Fig. 24—External Connections Of The Type HCR Relay With Instantaneous Trip For Phase Fault Protection.



Capacitor Values

Line	Degrees Shift	Type Relay	Freq. Cycles	MFD.
1	45	HRP	60	0.75
2	60	HRP	60	1.00
3	70	HRP	50	1.80
4	60	HCR	60	1.50
5	85	HZ-1	25	1.50

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Fig. 25—External Phase Shifter For Type HCR Directional Element (Delete Info. On Capacitor).

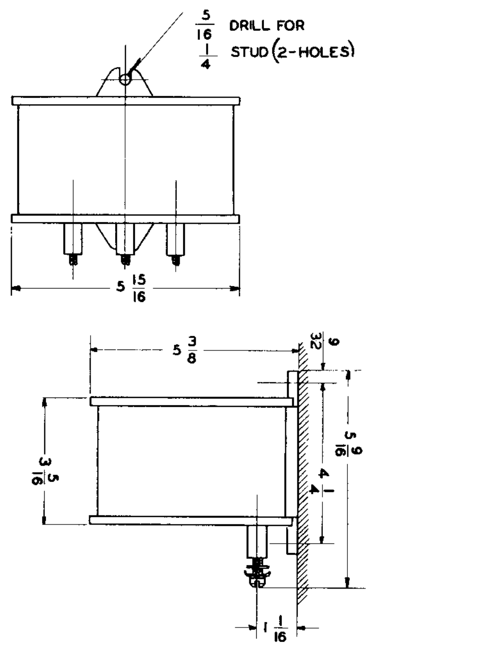

Fig. 26-Outline and Drilling Plan of the External Phase Shifter for the Type HCR Relay When Used For Ground Protection. For Reference Only.

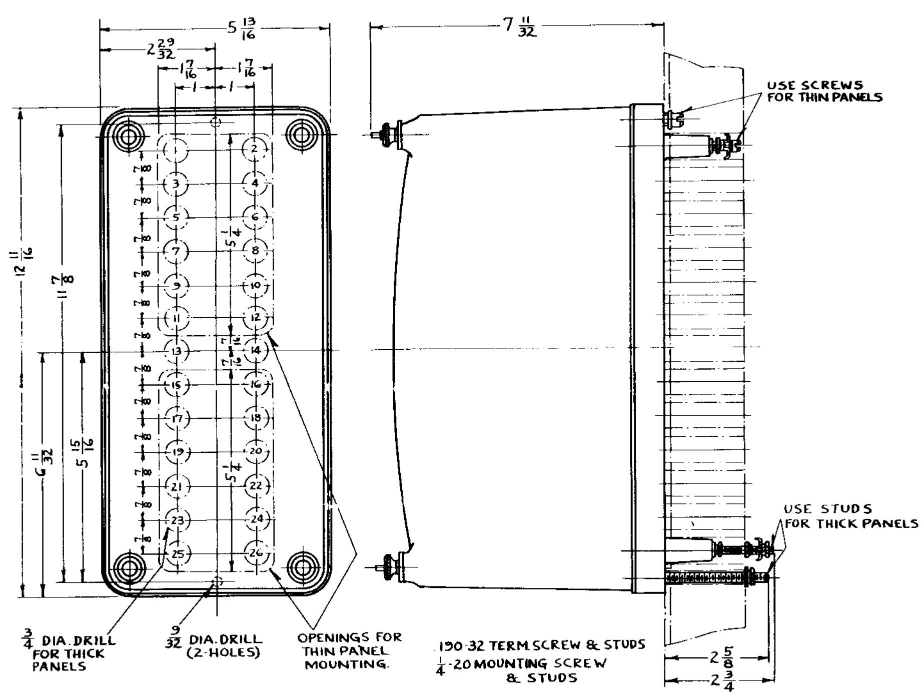

Fig. 27-Outline and Drilling Plan For the Projection Type Standard Case. See the Internal Schematics For the Terminals Supplied. For Reference Only.

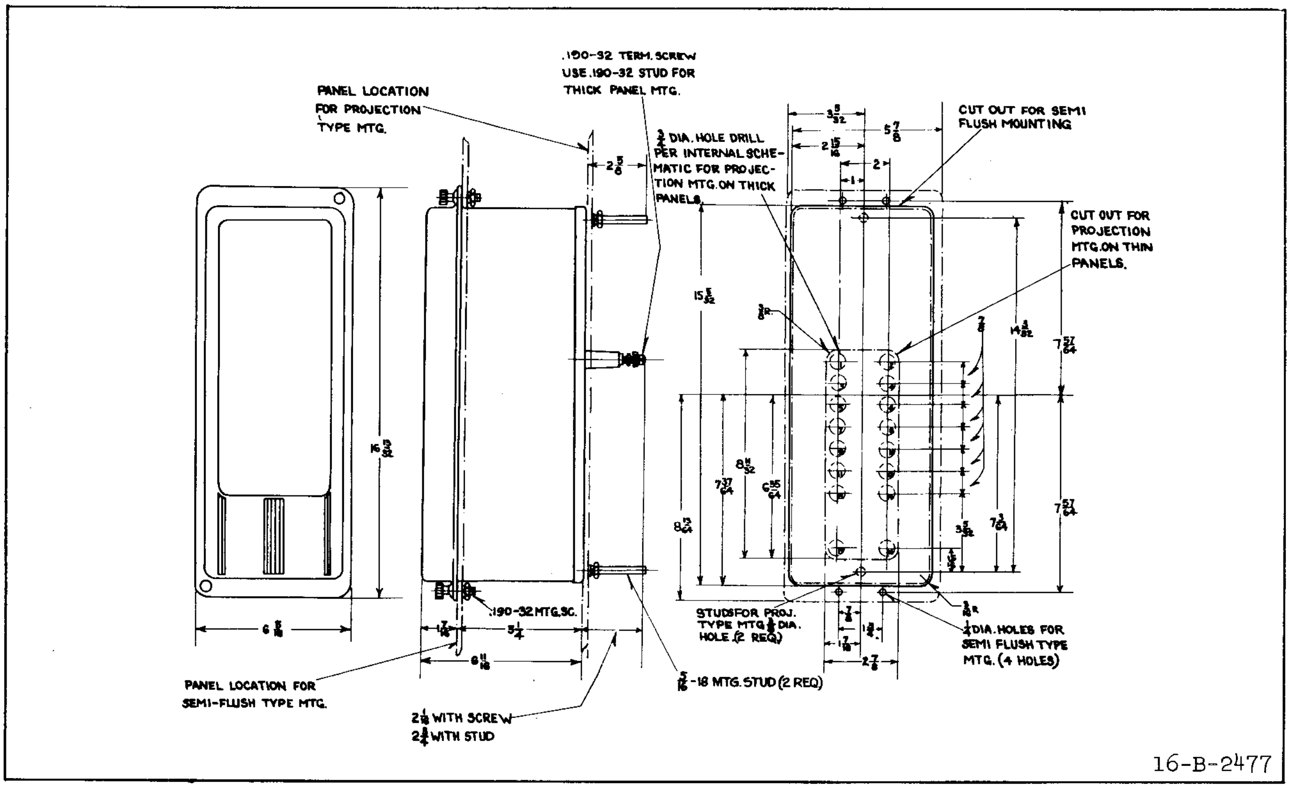

Fig.28-Outline and Drilling Plan for the M10 Projection or Semi-Flush Type FT Flexitest Case. See the Internal Schematics For The Terminals Supplied. For Reference Only.

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