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 unit. 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 unit, a type H directional unit, auxiliary switches, a contactor switch, and operation indicators, and an instantaneous trip unit.

Overcurrent Unit

This is an induction-disc type unit 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 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 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.

Directional Unit

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.

NEW INFORMATION

EFFECTIVE SEPTEMBER 1957

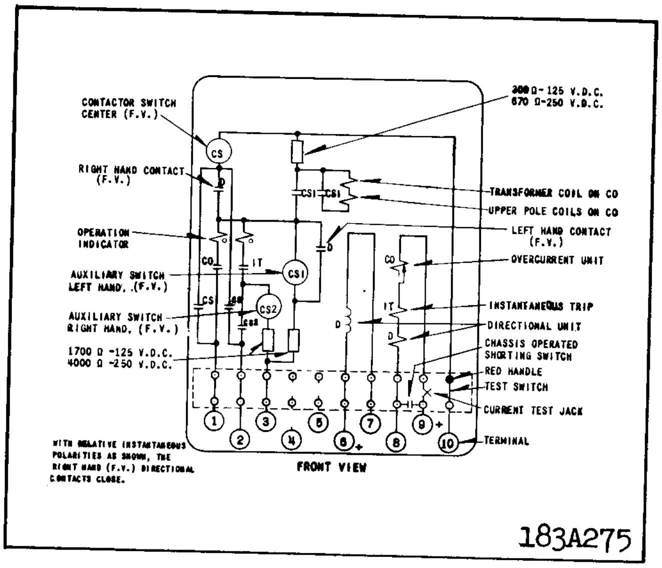

Fig. 1. Internal Schematic of the Type HCR Relay in the FT31 Case.

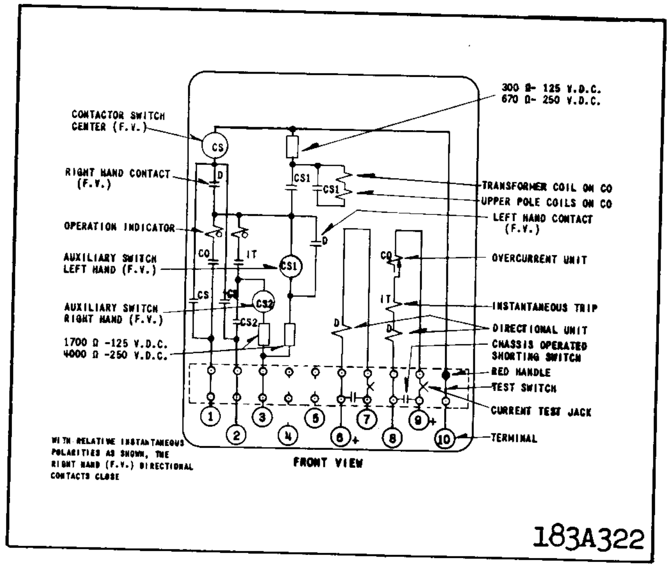

Fig. 2. Internal Schematic of the Type HCRC Relay in the FT31 Case.

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

A ceramic 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 (CS1, CS2, CS)

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.

The operation of the CS1 switch is controlled by the directional unit which in turn directionally controls the overcurrent unit. When sufficient power flows in the tripping direction, the CS1 switch operates to close and seal in the upper pole circuit of the overcurrent unit, permitting the disc to rotate. If the direction of power flow reverses, a contact on the directional units shorts the CS1 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

The instantaneous trip is a small solenoid unit. 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 unit 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 unit.

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.

The instantaneous trip unit 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 unit minimum pick-up is 2 volts 10 ampere in-phase. The type HCRC relay directional unit 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.

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 on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detailed FT case information refer to I.L. 41-076.

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 and 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.

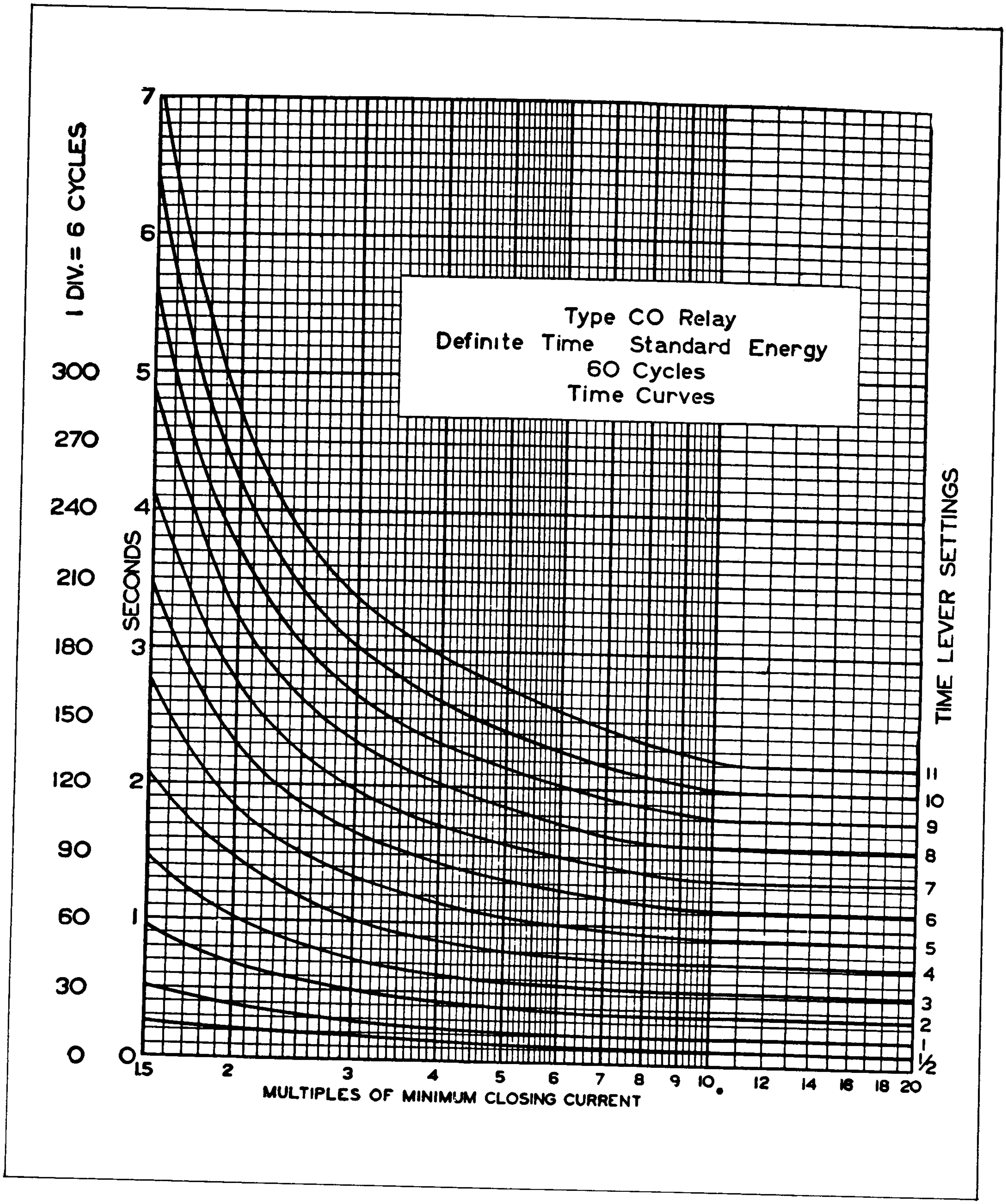

Fig. 3. Typical 60 Cycle Time Curves of the Time-Overcurrent Unit – Definite Minimum Time (Standard Energy).

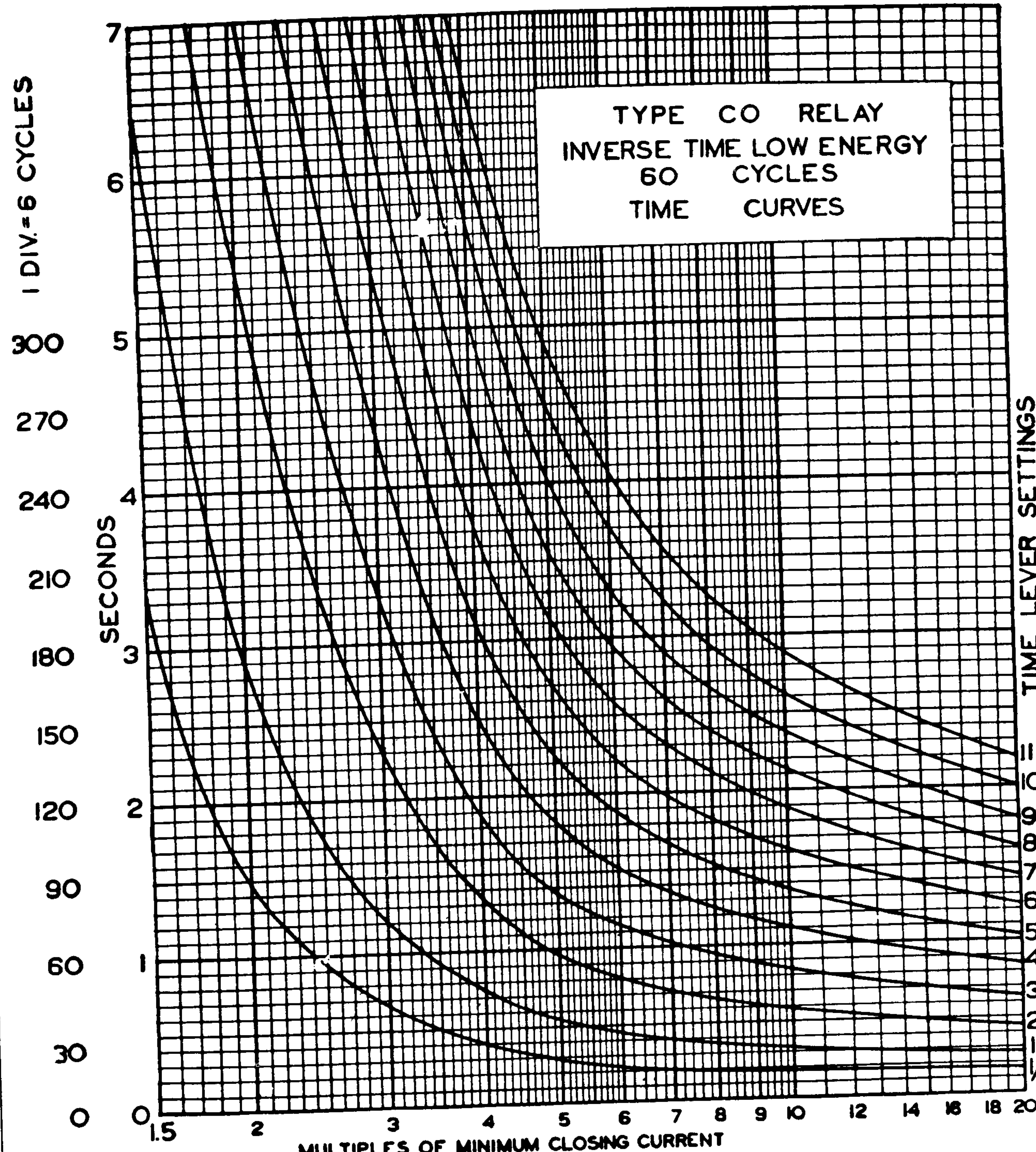

Fig. 4. Typical 60 Cycle Time Curves of the Time-Overcurrent Unit – Inverse Time (Low Energy).

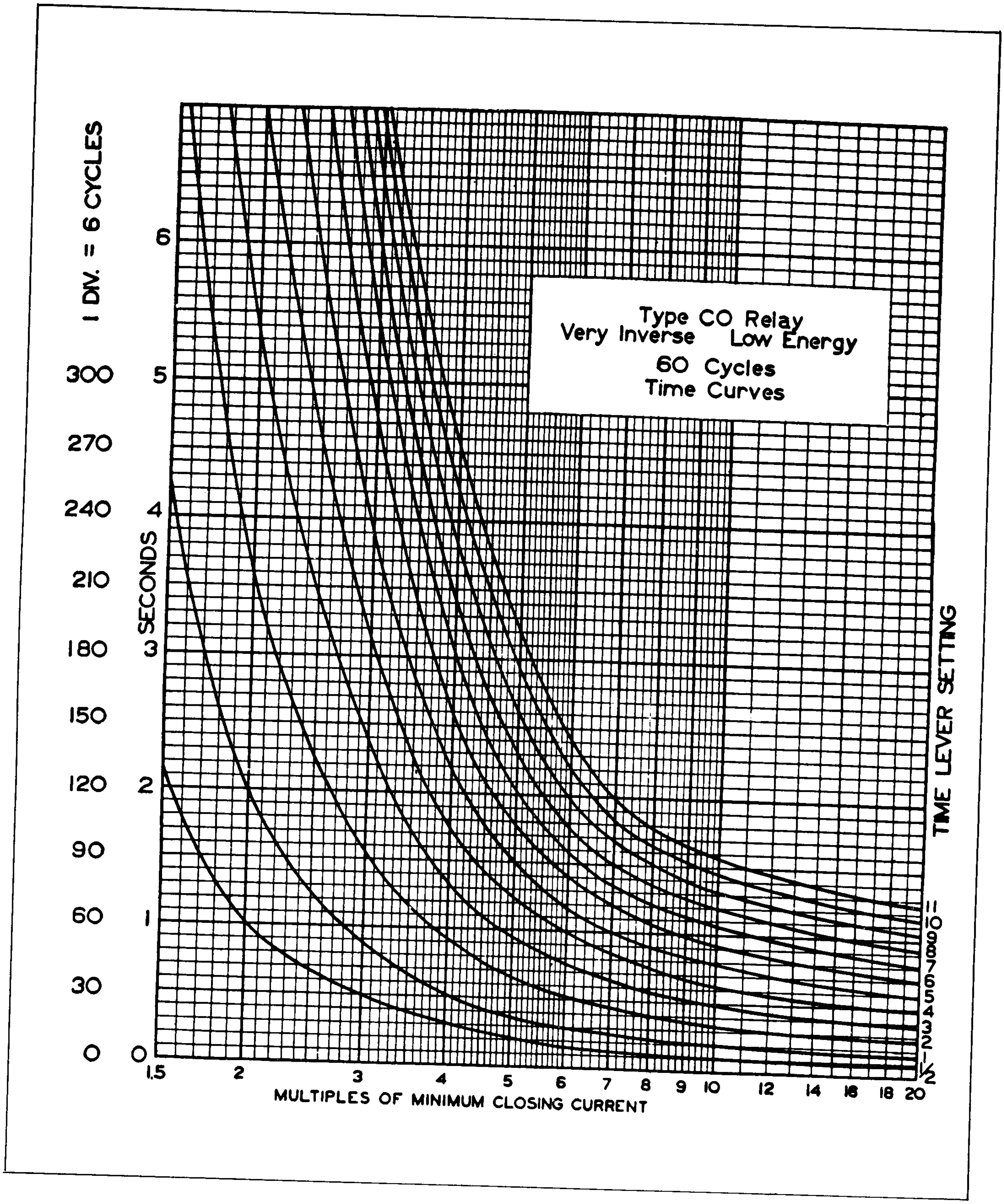

Fig. 5. Typical 60 Cycle Time Curves of the Time-Overcurrent Unit – Very Inverse Time (Low Energy).

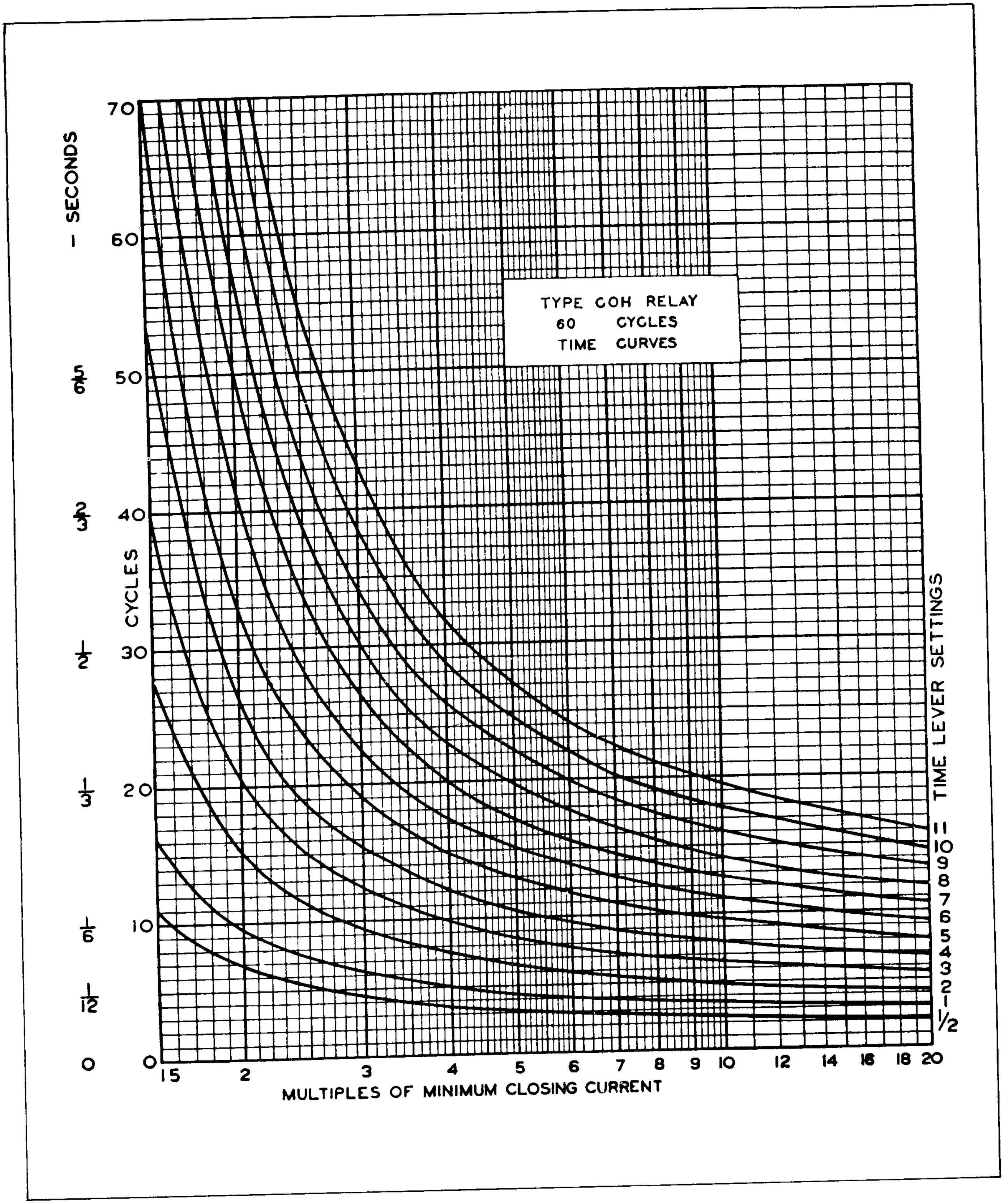

Fig. 6. Typical 60 Cycle Time Curves of the Time-Overcurrent Unit – Short Time (COH).

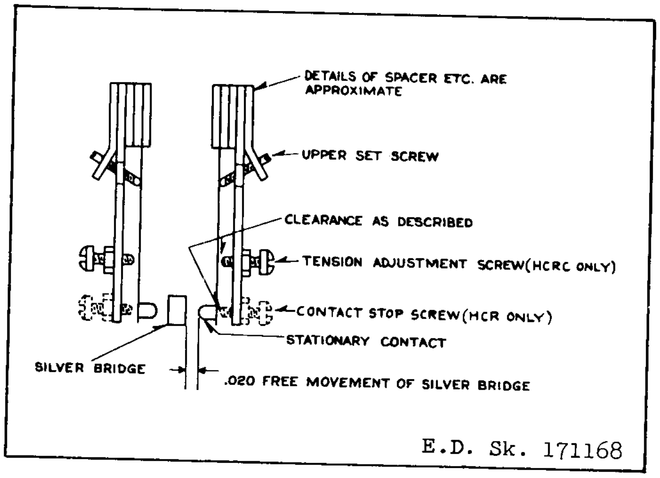

Fig. 7. Front View of Directional Unit Showing Contact Adjustment Details.

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 low lever settings. Typical relay time curves are shown in Figures 3 to 6.

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 consumer. 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 Unit

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 tests 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.

Directional Element

Voltage Polarized Relays

Check the free movement of the directional unit 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 unit 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

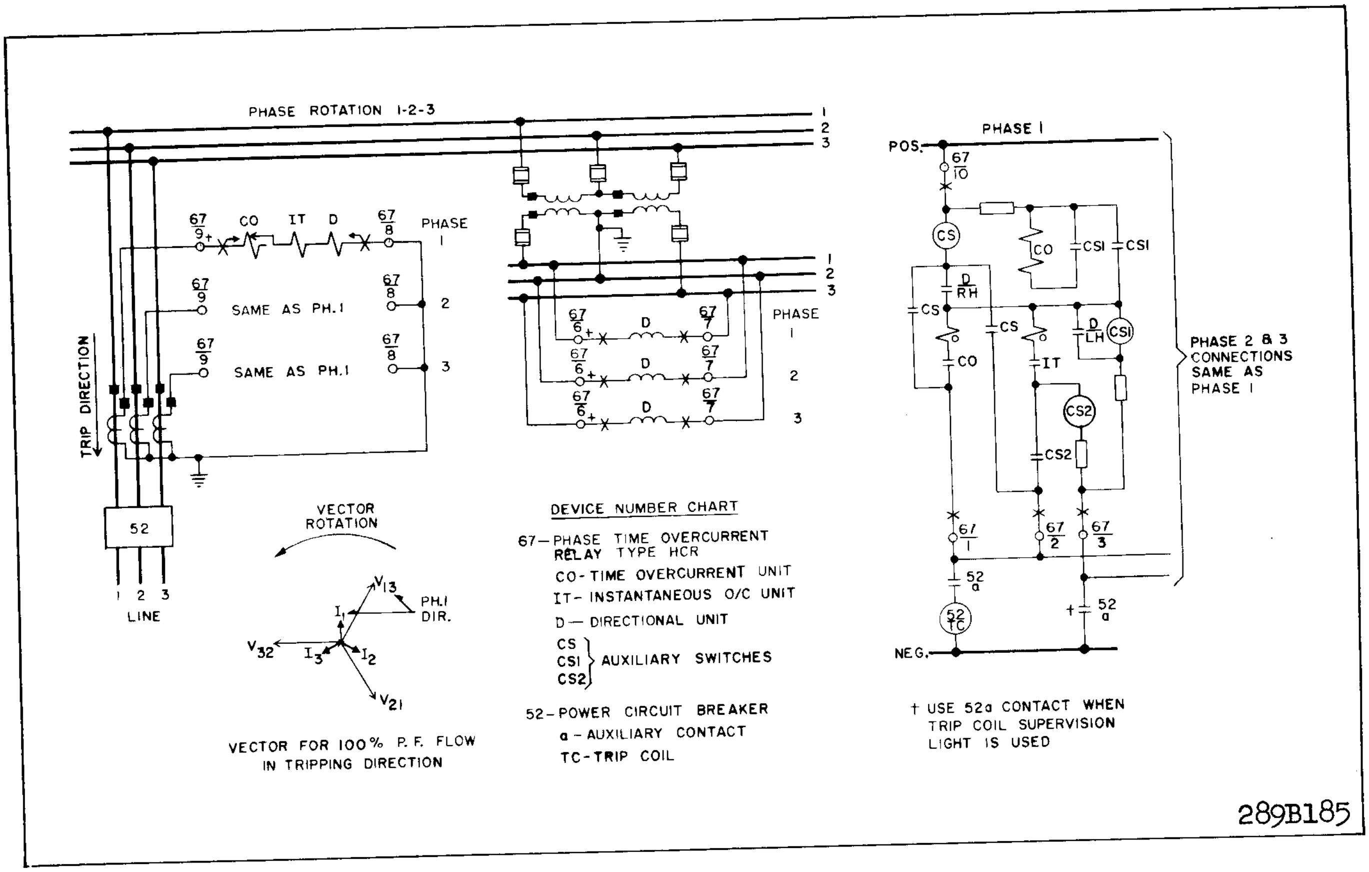

Fig. 8. External Schematic of the HCR Relay for Phase Fault Protection.

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 unit 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 unit 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 unit operation.

Current Polarized Relays

As utilized in the type HCRC, the directional unit 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 7.

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

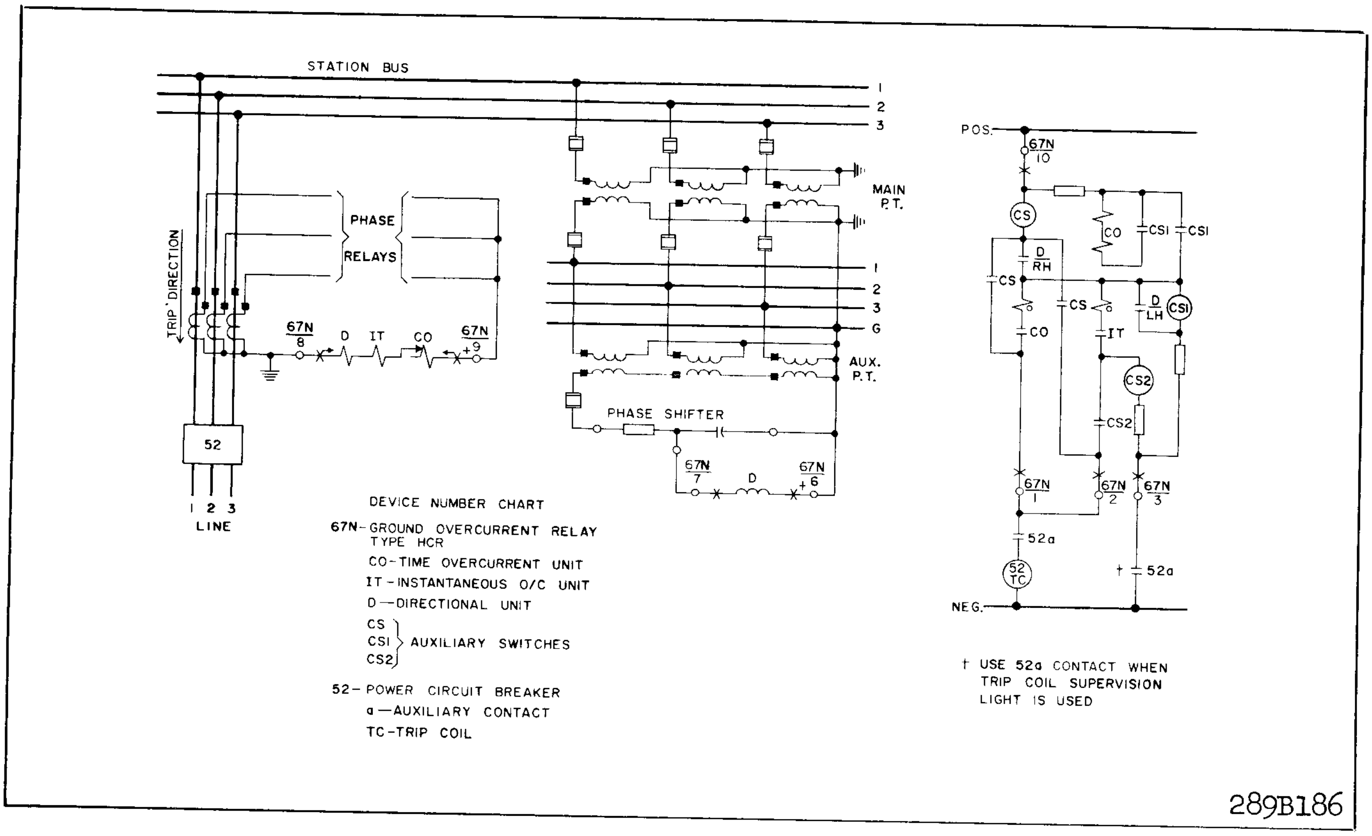

Fig. 9. ***External Schematic of the HCR Relay for Ground Fault Protection.***

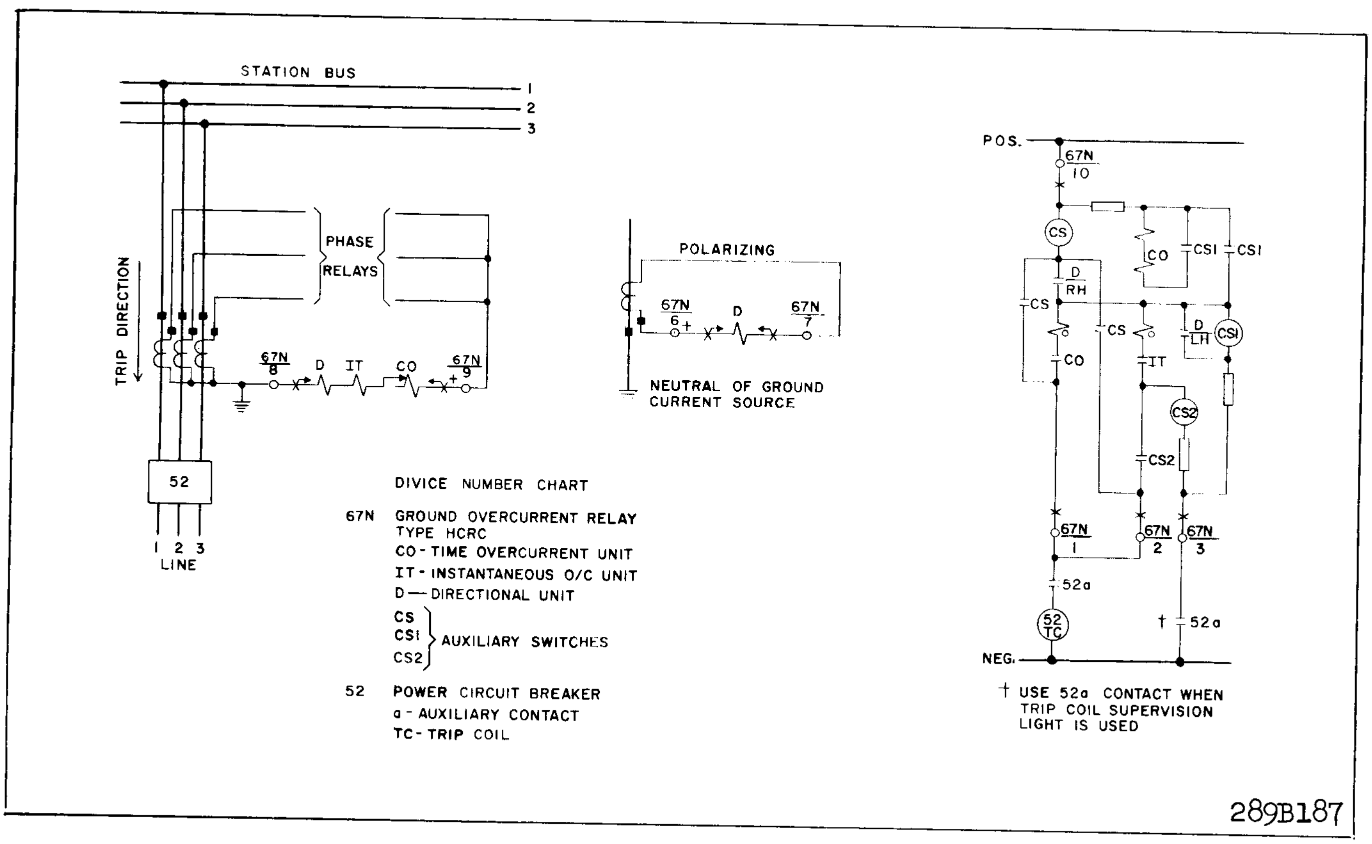

Fig. 10. ***External Schematic of the HCRC Relay for Ground Fault Protection.***

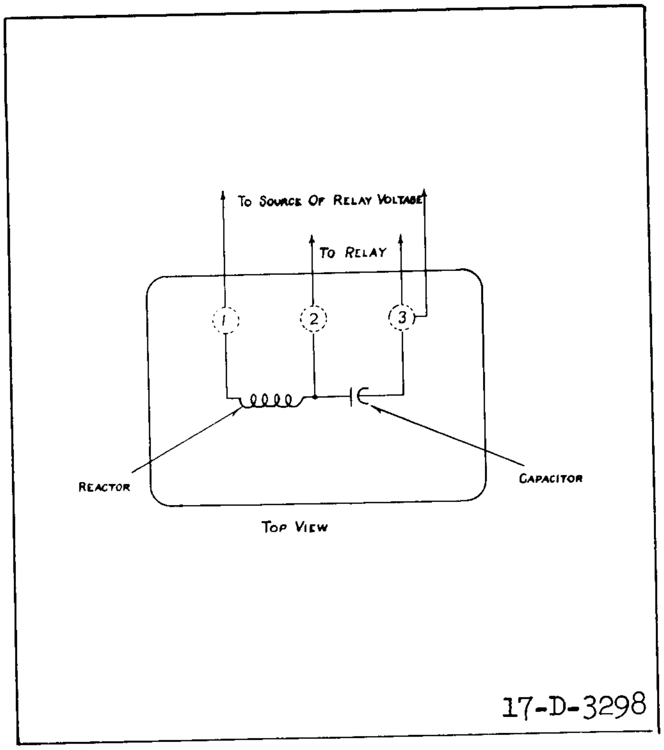

Fig. 11. Schematic of External Phase Shifter for HCR Relay When Used for Ground Fault Protection.

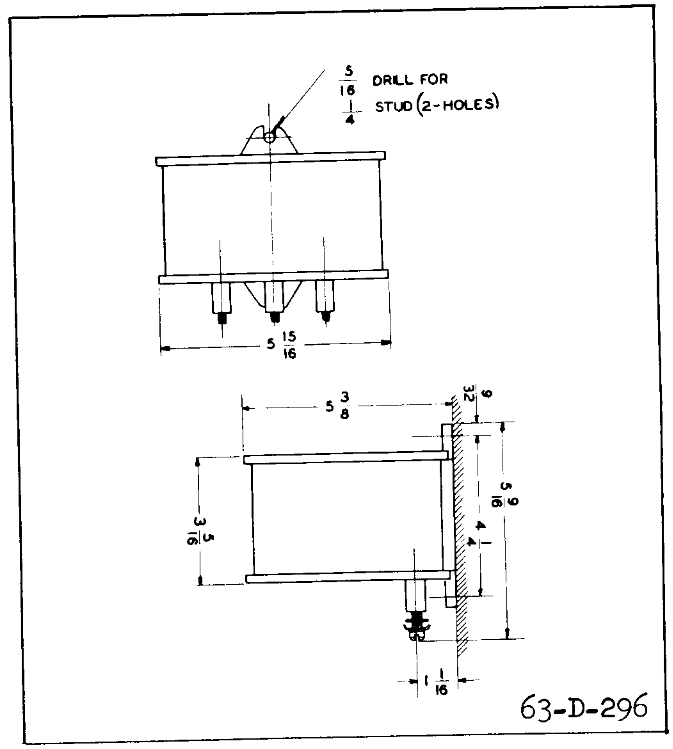

Fig. 12. Outline and Drilling Plan for External Phase Shifter Used With HCR for Ground Fault Protection.

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 unit contacts to operate the CS1 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 unit 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 (CS1 & CS2)

The adjustments for the auxiliary switch CS-1 are the same as for the CS 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 CS 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 pickup should be 165 volts or less.

When the CS2 auxiliary switch is used with a trip coil supervisory indicator lamp, a breaker "a" switch must be connected between terminal 3 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 Unit

The position of the Micarta disc at the bottom of the unit with reference to the calibrated guide indicates the minimum overcurrent 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 accurate 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 nameplate data.

ENERGY REQUIREMENTS

The burden and thermal capacities of the overcurrent elements are 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	10° lag	140

DIRECTIONAL ELEMENT WITH 60° PHASE SHIFTER

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

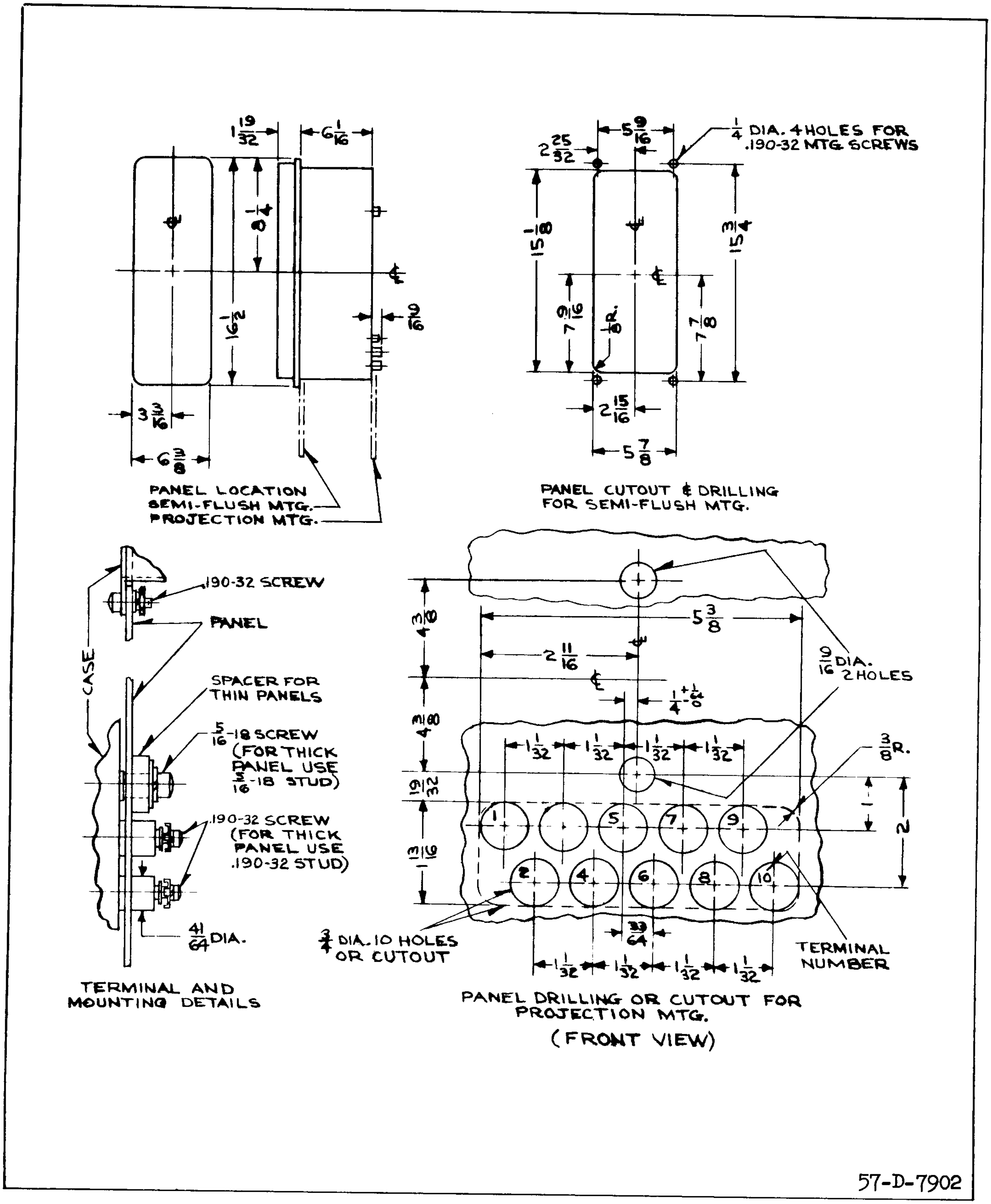

Fig. 13. Outline and Drilling Plan for the HCR and HCRC Relays in the FT31 Case.

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METER DIVISION • **NEWARK, N.J.**

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