ABB Automation Inc.
Substation Automation and Protection Division
Coral Springs, FL. 33065

Instruction Leaflet

41-137.2E

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Supersedes I.L. 41-137.2D, Dated February 1973

Type KRV Directional Overcurrent Relay

(▌)Denotes Change Since Previous Issue.

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.

1.0 APPLICATION

These relays are high speed phase directional overcurrent relays which are used for the protection of transmission lines and feeder circuits.

2.0 CONSTRUCTION AND OPERATION

The Type KRV relay consists of a directional unit (D), an auxiliary switch (CS-1), an instantaneous unit (I), an instantaneous overcurrent unittransformer, and an indicating contactor switch (ICS). The principle component parts of the relay and their location are shown in Figures 1 and 2.

2.1 DIRECTIONAL UNIT (D)

The directional unit is a product induction cylinder type unit operating on the interaction between the polarizing circuit flux and the operating circuit flux.

Mechanically, the directional unit is composed of four basic components; A die-cast aluminum frame, an electromagnet, a moving element assembly, and a molded bridge.

The frame serves as the mounting structure for the magnetic core. The magnetic core which houses the lower pin bearing is secured to the frame by a spring and snap ring. This is an adjustable core which has a .025 inch flat on one side and is held in its adjusted position by the clamping action of two compressed springs. The bearing can be replaced, if necessary, without having to remove the magnetic core from the frame.

The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another; two series-connected operating coils mounted diametrically opposite one another; two magnetic adjusting plugs; upper and lower adjusting plug clips, and two locating pins. The locating pins are used to accurately position the lower pin bearing, which is mounted on the frame, with respect to the upper pin bearing, which is threaded into the bridge. The electromagnet is secured to the frame by four mounting screws.

The moving element assembly consists of a spiral spring, contact carrying member, and an aluminum cylinder assembled to a molded hub which holds the shaft. The shaft has removable top and bottom jewel bearings. The shaft rides between the bottom pin bearing and the upper pin bearing with the cylinder rotating in an air gap formed by the electromagnet and the magnetic core.

The bridge is secured to the electromagnet and frame by two mounting screws. In addition to holding the upper pin bearing, the bridge is used for mounting the adjustable stationary contact housing. The stationary contact housing is held in position by a spring type clamp. The spring adjuster is located on the underside of the bridge and is attached to the moving contact arm by a spiral spring. The spring adjuster is also held in place by a spring type clamp.

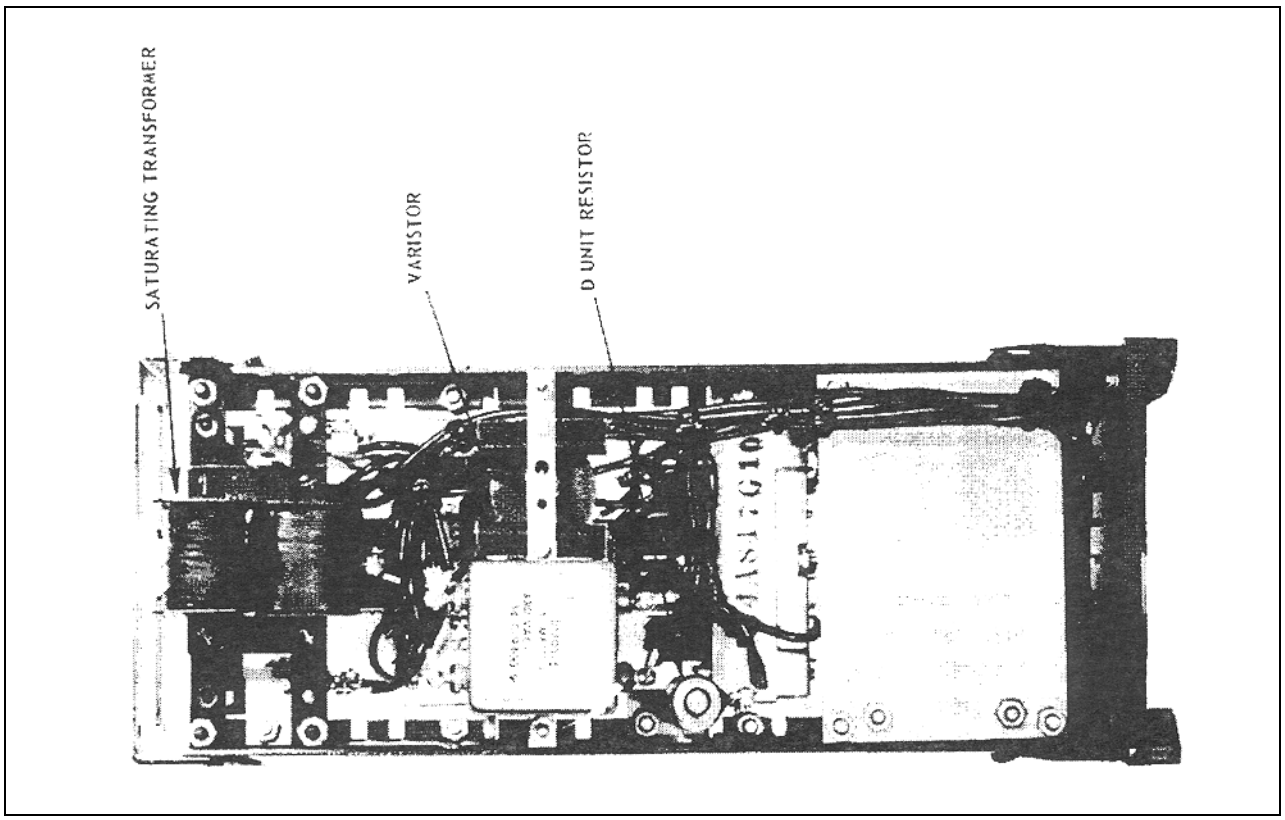


Figure 2. Type KRV Relay Without Case (Rear View)

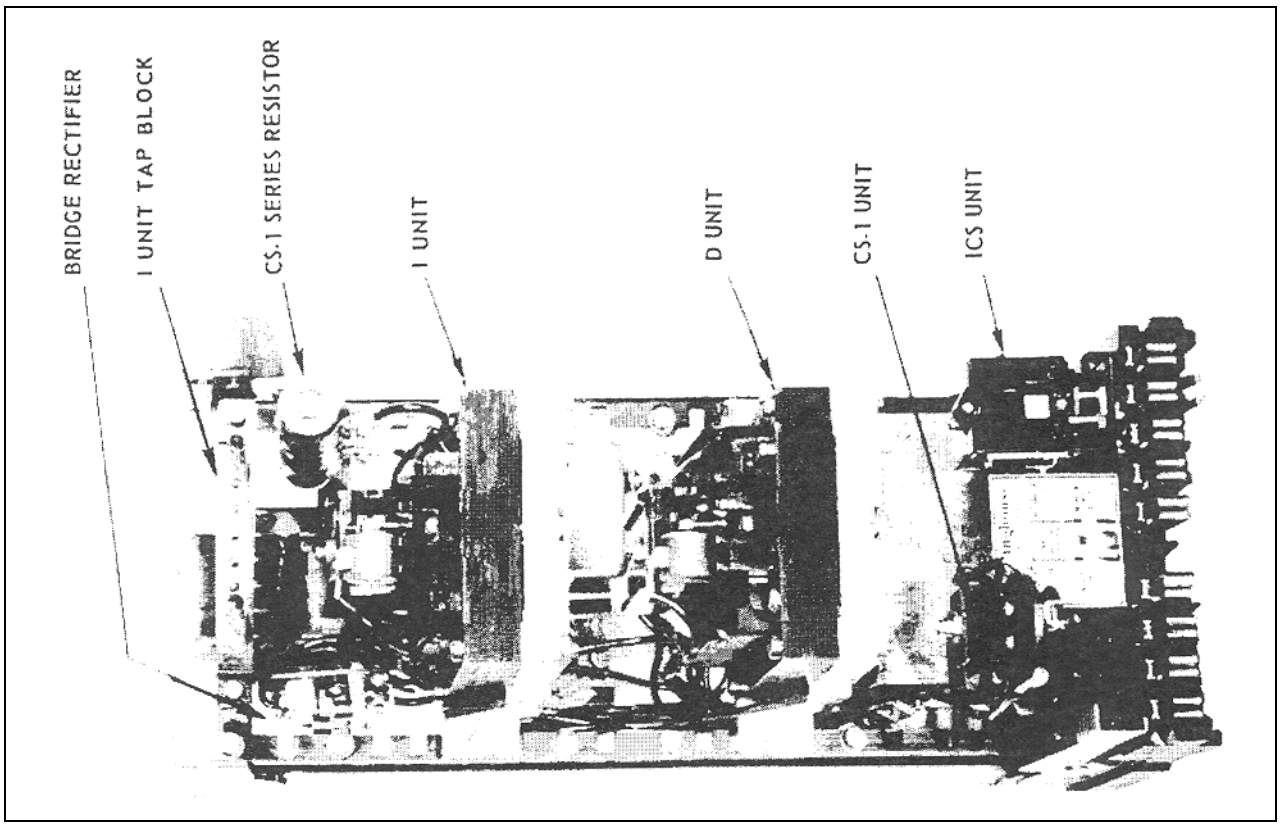


Figure 1. Type KRV Relay Without Case (Front View)

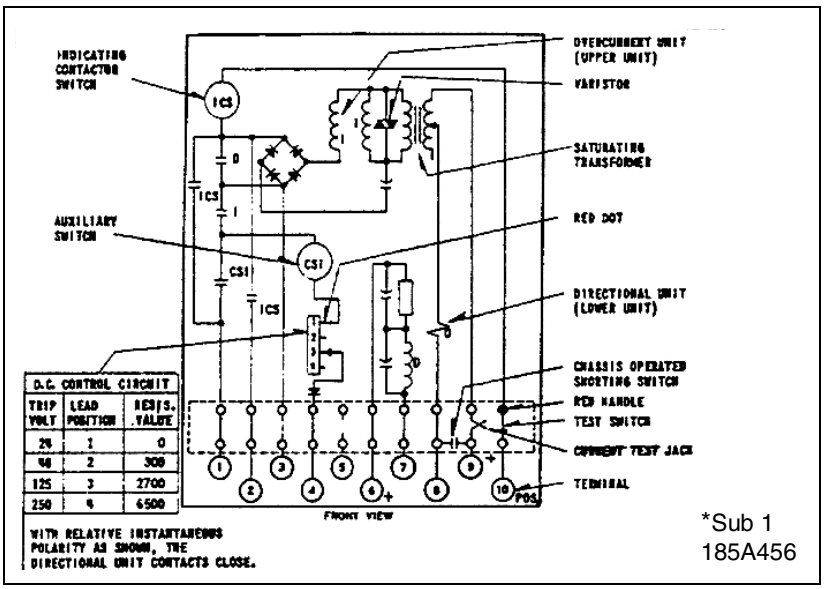


Figure 3. Internal Schematic of the Type KRV Relay in the type FT31 Case.

With the contacts closed, the electrical connection is made through the stationary contact housing clamp, to the moving contact, through the spiral spring out to the spring adjuster clamp.

2.2 INSTANTANEOUS OVERCURRENT UNIT (I)

The instantaneous overcurrent unit is similar in construction to the directional unit. The time phase relationship of the two air gap fluxes necessary for the development of torque is achieved by means of a capacitor connected in series with one pair of pole windings.

2.3 INSTANTANEOUS OVERCURRENT UNIT TRANSFORMER

This transformer is of the saturating type for limiting the energy to the instantaneous overcurrent unit at higher values of fault current and to reduce C.T. burden. The primary winding is tapped and these taps are brought out to a tap block for ease in changing the pick-up of the instantaneous overcurrent unit. The use of a tapped transformer provides approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

Across the secondary is connected a non-linear resistor known as a varistor. The effect of the varistor is to reduce the voltage peaks applied to the overcurrent unit and phase shifting capacitor.

2.4 AUXILIARY SWITCH (CS-1)

The auxiliary switch is a small solenoid type d.c switch. A cylindrical plunger, with a silver disc mounted on its lower end, moves in the core of the solenoid. As the plunger travels upward, the disc bridges the silver stationary contacts. A tapped resistor is used to enable one to use the contactor switch on a 24,48, 125 or 250 volt d.c. system connected per Figure 6. The operation of the CS-1 switch is controlled by the directional unit (D) and the I contact. It's function is to insure coordination between the directional contact (D) and the I contact to prevent tripping on reversed faults (where the directional contact was closed on load).

2.5 INDICATING CONTACTOR SWITCH UNIT (ICS)

The dc indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop.

The front spring, in addition to holding thetarget, provides restraint for the armature and thus controls the pickup value of the switch.

3.0 CHARACTERISTICS

The relays are available in the following current ranges:

Instantaneous Overcurrent Unit (I)

Range	Taps				
0.5 - 2 Amps	0.5	0.75	1.0	1.25	1.5	2.0
1 - 4	1.0	1.5	2.0	2.5	3.0	4.0
2 - 8	2.0	3.0	4.0	5.0	6.0	8.0
4 - 16	4.0	6.0	8.0	9.0	12	16
10- 40	10	15	20	24	30	40
20 - 80	20	30	40	48	60	80

The tap value is the minimum current required to just close the relay contacts.

The time vs. current characteristics for the instantaneous overcurrent unit is shown in Figure 4.

The time vs. current characteristics for the directional unit is shown in Figure 5.

3.1 TRIP CIRCUIT

The relay contacts will safely close 30 amperes at 250 volts d.c and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

3.2 TRIP CIRCUIT CONSTANTS

The indicating contactor switch has a pickup of approximately 1 ampere. Its dc resistance of 0.1 ohms.

3.3 AUXILIARY SWITCH (CS-1)

The auxiliary switch has a dc resistance of 1165 ohms. Its operating time is approximately 1/2 cycle.

3.4 CYLINDER UNIT CONTACTS

The moving contact assembly has been factory adjusted for low contact bounce performance and should not be changed.

The set screw in each stationary contact has been shop adjusted for optimum follow and this adjustment should not be disturbed.

3.5 DIRECTIONAL UNIT

The KRV relay is intended for phase fault protection and the directional unit has its maximum torque when the current leads the voltage by approximately 30°. The directional unit minimum pickup at its maximum torque angle is shown in Table 1.

The directional unit should be connected using the current in one-phase wire and the potential across the other two phase wires. This connection is commonly referred to as the 90° connection. When utilizing the 90° connection the maximum torque of the relay occurs when the fault current lags its 100% P.F. position by approximately 60°. See Figure 7.

TABLE 1

RELAY RANGE	DIR. UNIT PICKUP
0.5 to 2 Amps	1.2 Volts and 2 Amps
1 - 4	1.2 Volts and 2 Amps
2 - 8	1.2 Volts and 2 Amps
4 - 16	1.2 Volts and 4 Amps
10 - 40	1.2 Volts and 8 Amps
20 - 80	1.2 Volts and 8 Amps

4.0 SETTINGS

Instantaneous Overcurrent Unit (I)

The only setting required is the pickup current setting which is made by means of the connector screw located on the tap plate. By placing the connector screw in the desired tap, the relay will just close its contacts at the tap value current.

⚠ CAUTION

Since the tap block screw carries operating current, be sure that the screws are turned tight.

In order to avoid opening current transformer circuits when changing taps under load, start with RED handles FIRST and open all switchblades. Chassis operating shorting switches on the case will short the secondary of the current transformer. Taps may then be changed with the relay either inside or outside the case.Then reclose all switchblades making sure the RED handles are closed LAST.

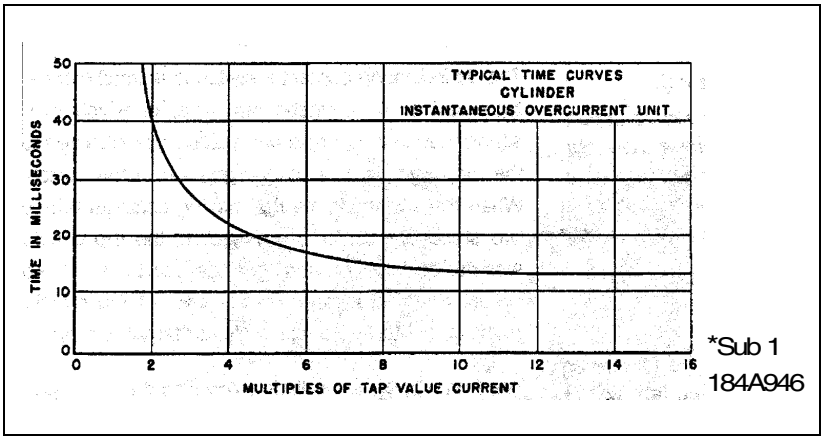


Figure 4. Typical Time Curve of the Instantaneous Overcurrent Unit.

4.1 DIRECTIONAL UNITS (D)

No setting is required.

4.2 INDICATING CONTACTOR SWITCH UNIT (ICS)

No setting is required.

4.3 AUXILIARY SWITCH (CS-1)

No setting required on the CS-1 unit except for the selection of the required 24, 48, 125 or 250 voltage on the tapped resistor. This connection can be made by referring to Figure 6.

5.0 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 projection mounting or by means of the four mounting holes on the flange for the semi-flush mounting. Either the 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 detail information on the FT Case refer to I.L. 41-076.

The external connections of the directional overcurrent relay is shown in Figure 5.

6.0 ADJUSTMENT AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay, no customer adjustments, other than those covered under “SETTINGS”, should be required.

6.1 ACCEPTANCE CHECK

The following check is recommended to insure that the relay is in proper working order;

6.2 INSTANTANEOUS OVERCURRENT UNIT (I)

1. Contact Gap - The gap between the stationary and moving contacts with the relay in the deenergized position should be approximately .020".
2. Minimum Trip Current - The D contacts should be blocked closed when checking the pickup of the overcurrent unit.

The pickup of the overcurrent unit can be checked by inserting the tap screw in the descried tap hole and applying rated tap value current. The contact should close within ±5% of tap value current.

6.3 DIRECTIONAL UNIT (D)

1. Contact Gap - The gap between the stationary contact and moving contact with the relay in the deenergized position should be approximately .020".
2. Sensitivity - The directional unit should pick up at its maximum torque angle (current leading the voltage by 30°) when energized with the value of current and voltage shown in Table 1.
3. Spurious Torque Adjustments - There should be no spurious closing torques when the operating circuits are energized per Table 2 with the polarizing circuit short circuited.

6.4 INDICATING CONTACTOR SWITCH (ICS)

Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should be between 1 and 1.2 amperes. The indicator target should drop freely.

The contact gap should be approximately 5/64” between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously. The third moving contact should make at approximately the same time.

7.0 ROUTINE MAINTENANCE

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

All contacts should be periodically cleaned. A contact burnisher #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.

7.1 CALIBRATION

Use the following procedure for calibrating the relay if the relay has been taken apart for repairs or the adjustments have been disturbed. This procedure should not be used unless it is apparent that the relay is not in proper working order. (See “Acceptance Check”).

7.2 INSTANTANEOUS OVERCURRENT UNIT (I)

1. The upper pin bearing should be screwed down until there is approximately .025" clearance between it and the top of shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut. The lower bearing position is fixed and cannot be adjusted
2. The contact gap adjustment for the overcurrent unit is made with the moving contact in the reset position, i.e., against the right side of the bridge.

ENERGY REQUIREMENTS

BURDEN DATA OF OPERATING CURRENT CIRCUIT - 60 HERTZ

AMPERE RANGE	TAP	VA AT TAP VALUE††	P.F. ANGLEø	VA AT 5 AMPS.††	P.F. ANGLEø
0.5-2	.5	0.40	36.8°	26.10	42.3°
	.75	0.45	35.3	16.70	36.9
	1.0	0.53	34.1	12.10	33.9
	1.25	0.62	33.1	9.43	33.1
	1.5	0.73	32.3	7.94	31.6
	2.0	0.96	32.1	6.06	31.1
1-4	1.0	0.53	31.1°	12.50	31.2°
	1.5	0.72	29.1	7.99	28.2
	2.0	0.96	28.7	6.09	27.8
	2.5	1.25	28.7	5.04	28.1
	3.0	1.63	29.6	4.57	28.9
	4.0	2.55	30.1	3.99	30.0
2-8	2	1.55	38.3°	9.54	37.6°
	3	2.26	35.5	6.25	34.8
	4	3.20	33.2	4.98	33.1
	5	4.39	32.8	4.40	32.7
	6	5.78	32.4	4.05	32.1
	8	9.31	31.8	3.62	32.4
4-16	4	2.05	42.8°	3.24	42.0°
	6	2.94	38.5	2.03	38.0
	8	4.09	35.7	1.59	35.7
	9	4.77	34.8	1.46	35.5
	12	7.30	33.3	1.24	34.3
	16	11.50	32.0	1.11	34.2
10-40	10	2.50	29.0°	.63	29.0°
	15	4.20	25.0	.47	25.0
	20	6.30	22.0	.40	22.0
	24	8.20	21.0	.35	21.0
	30	11.0	19.0	.31	19.0
	40	18.0	19.0	.28	19.0
20-80	20	10.0	32.0°	.60	32.0°
	30	17.0	28.0	.45	28.0
	40	25.0	24.0	.38	24.0
	48	32.0	23.0	.34	23.0
	60	45.0	22.0	.30	22.0
	80	70.0	21.0	.27	21.0

ϕ *Degrees current lags voltage.*

†† *Voltages taken with Rectox type voltmeter.*

RATINGS OF DIRECTIONAL AND OVERCURRENT UNITS

	OVERCURRENT UNIT		DIRECTIONAL UNIT	
RANGE	CONTINUOUS RATING	ONE SECOND RATING	CONTINUOUS RATING	ONE SECOND RATING
0.5-2 Amps	5	100	8	200
1-4	8	140	8	200
2-8	8	140	8	200
4-16	10	200	10	280
10-40	10	200	10	280
20-80	10	200	10	280

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

DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

The burden at 120V, 60 hertz, is 12.5 volt-amperes at 15 degrees. (Current leading voltage).

Move in the left-hand stationary contact until it just touches the moving contact then back off the stationary contact 2/3 of one turn for a gap of approximately .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring adjuster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments. Before applying current block close the contacts of the D unit.

   Insert the tap screw in the minimum tap setting and adjust the spring such that the contacts will close as indicated by a neon lamp in the contact circuit when energized with the required current. The pick up of the overcurrent unit with the tap screw in any other tap should be within ± 5% of tap value.

   If adjustment of pick-up current in between tap settings is desired insert the tap screw in the next lowest tap setting and adjust the spring as described. It should be noted that this adjustment results in a slightly different time characteristic curve and burden.

7.3 DIRECTIONAL UNIT (D)

The directional unit is the lower cylinder unit.

1. The upper bearing screw should be screwed down until there is approximately .025" clearance between it and the top of the shaft bearing. The upper pin bearing should then be securely locked in position with the lock nut.

2. Contact gap adjustment for the directional unit is made with the moving contact in the reset position, i.e., against the right side of the bridge. Advance the right hand stationary contact until the contacts just close.

   Move in the left-hand stationary contact until it just touches the moving contact. Then back off the stationary contact 2/3 of one turn for a contact gap of .020". The clamp holding the stationary contact housing need not be loosened for the adjustment since the clamp utilizes a spring-type action in holding the stationary contact in position.

3. Insert tap screw of overcurrent unit in highest tap. The sensitivity adjustment is made by varying the tension of the spiral spring attached to the moving element assembly. The spring is adjusted by placing a screwdriver or similar tool into one of the notches located on the periphery of the spring ad-

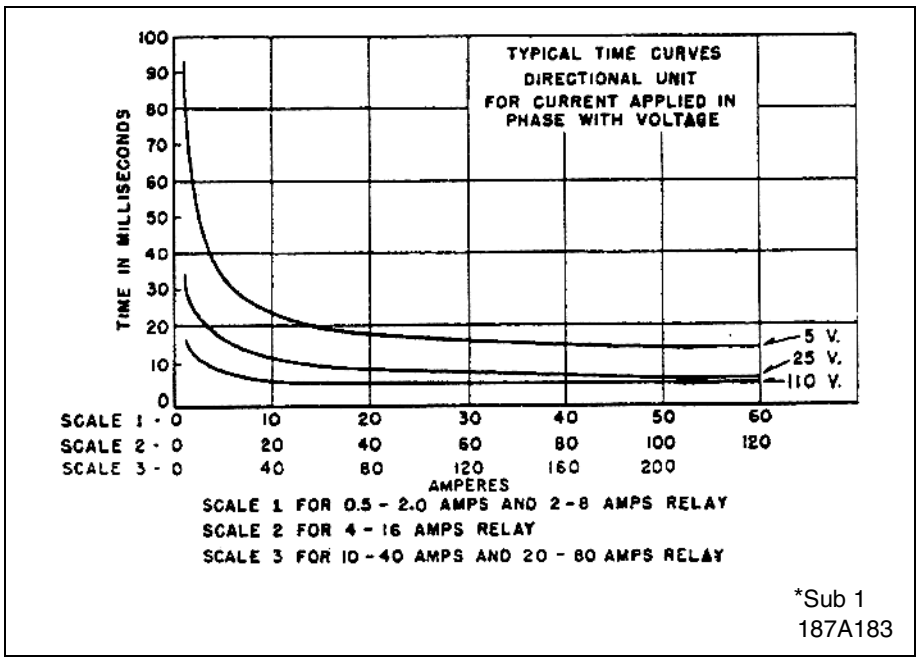


Figure 5. Typical Time Curves of the Directional Unit.

juster and rotating it. The spring adjuster is located on the underside of the bridge and is held in place by a spring type clamp that does not have to be loosened prior to making the necessary adjustments.

The spring is to be adjusted such that the contacts will close when the unit is energized at its maximum torque angle (current leading the voltage by 30°) with the value of current and voltage shown in Table 1.

4. The magnetic plugs and core are used to reverse any unwanted spurious torques that may be present when the relay is energized on current alone.

   The reversing of the spurious torques is accomplished by using the adjusting plugs and core in the following manner:

   a. Apply 120 volts ac to terminals 6 and 7 relay should remain open. If the contacts are closed, adjust the core until contacts stay open.

   b. Insert the tap screw in the highest value of the cylinder overcurrent unit.

   c. Short circuit the voltage terminals (6 and 7).

   d. Apply current as per Table II, adjusting only the plugs for spurious torque.

7.4 AUXILIARY SWITCH (CS-1)

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 upside-down. Then screw the core screw up until the moving core starts rotating. Now back off the core screw until the moving core stops rotating. This indicates the points when 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 3/64” by means of the two small nuts on either side of the Micarta disc.

Connect lead (A) to proper terminal per Figure 6. Block directional unit (D) and I contacts close and energize trip circuit with rated voltage. Contacts of auxiliary switch (CS-1) should make as indicated by a neon lamp in the contact circuit.

7.5 INDICATING CONTACTOR SWITCH (ICS)

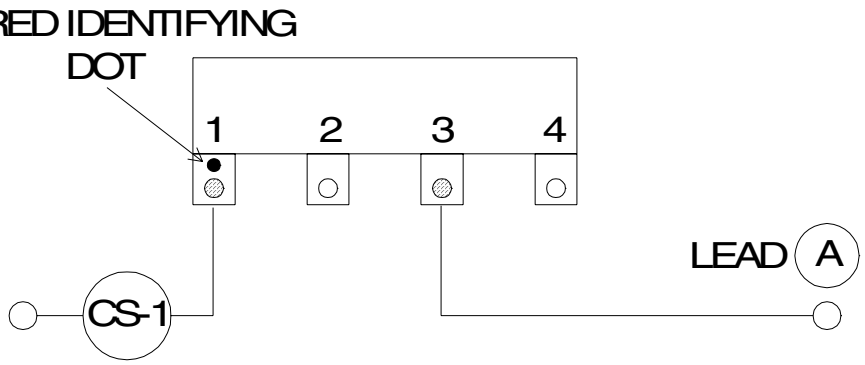
Adjust the contact gap for approximately 5/64” (-1/64”, +0).

Close the main relay contacts and check to see that the relay picks up and the target drops between 1 and 1.2 amperes dc.

7.6 BRIDGE RECTIFIER AND BLOCKING DIODE

These diodes are silicon diodes type IN1225. If it is suspected that one or more are defective they can be checked for reverse leakage by applying 80% or less of rated diode voltage (700 VDC). The leakage current should be less than 0.5 MA. Voltage should be increased gradually.

If any of the diodes are open circuited, then either the CS1 switch or the I unit will become inoperative.



POSITION LEAD A	RATED dc VOLTAGE	RESISTOR RESISTANCE
1	24	0
2	48	300
3	125	2700
4	250	6500

NOTE: Relays are shipped on the 125 V Tap

Figure 6. Selection of Proper Voltage Top for Auxiliary Switch (CS-1) Operation.

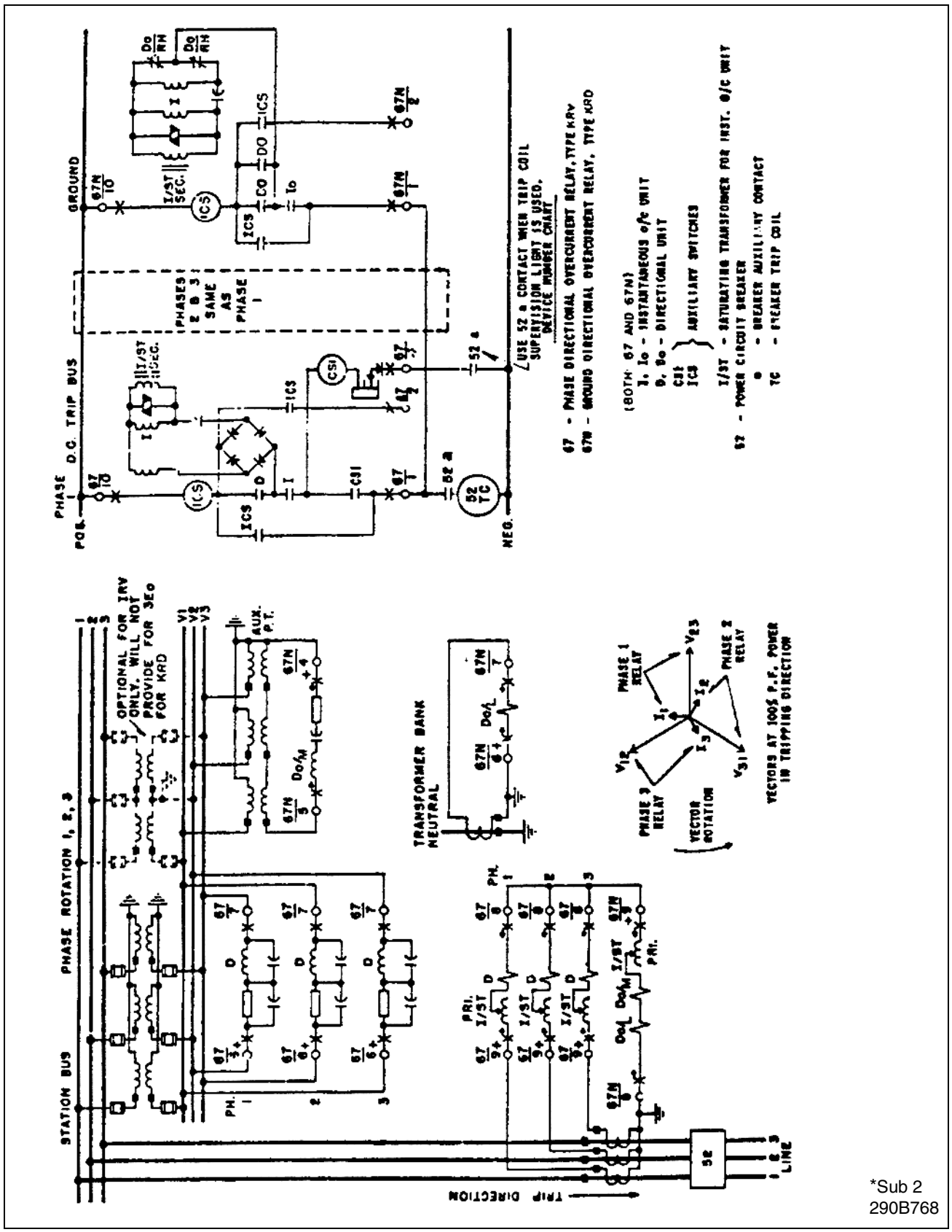


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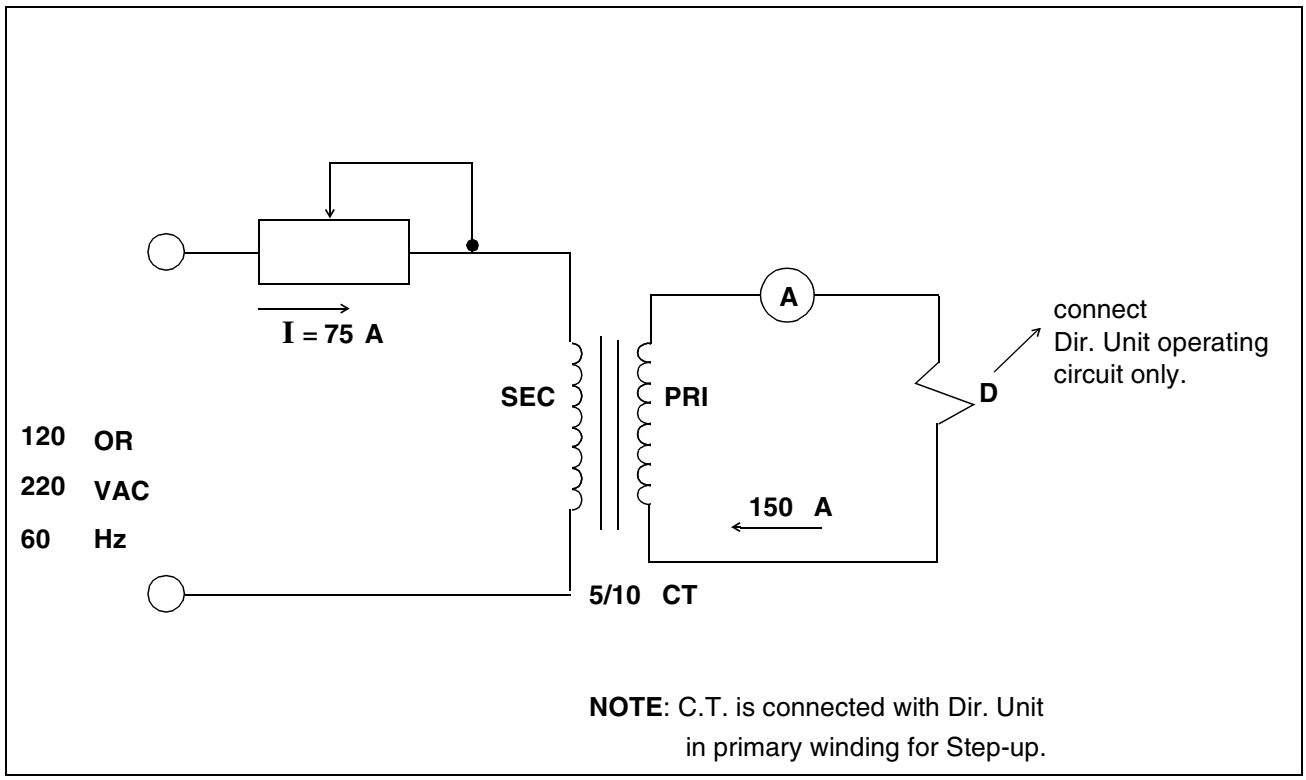
Figure 7. External Schematic of the KRV Relay for Phase Protection and the KRD Relay for Ground Protection.

RELAY	CURRENT	* ADJUST	ADJUSTMENT	† CHECK POINTS
15 - 2 1 - 4 2 - 8	50 Amps.	Magnetic Plugs	If spurious torque is in contact closing dir. (left front) view, screw our r. mag. plug until dir. of spurious torque is reversed. If spurious torque is in contact opening dir., screw out left plug until torque is reversed. Then screw in for slight opening torque.	80, 50 and 20 Amps.
4 - 16	100			
10 - 40 20 - 80	150 Δ			120, 75 and 30 Amps.

* *Plugs should be fully in prior to core adjustment.*

† *Slight re-adjustment may be necessary of core or plugs, if contact closes at these check points.*

Δ *150 Amps. may be obtained by using a 10/5 CT as shown below.*



NOTE: C.T. is connected with Dir. Unit in primary winding for Step-up.

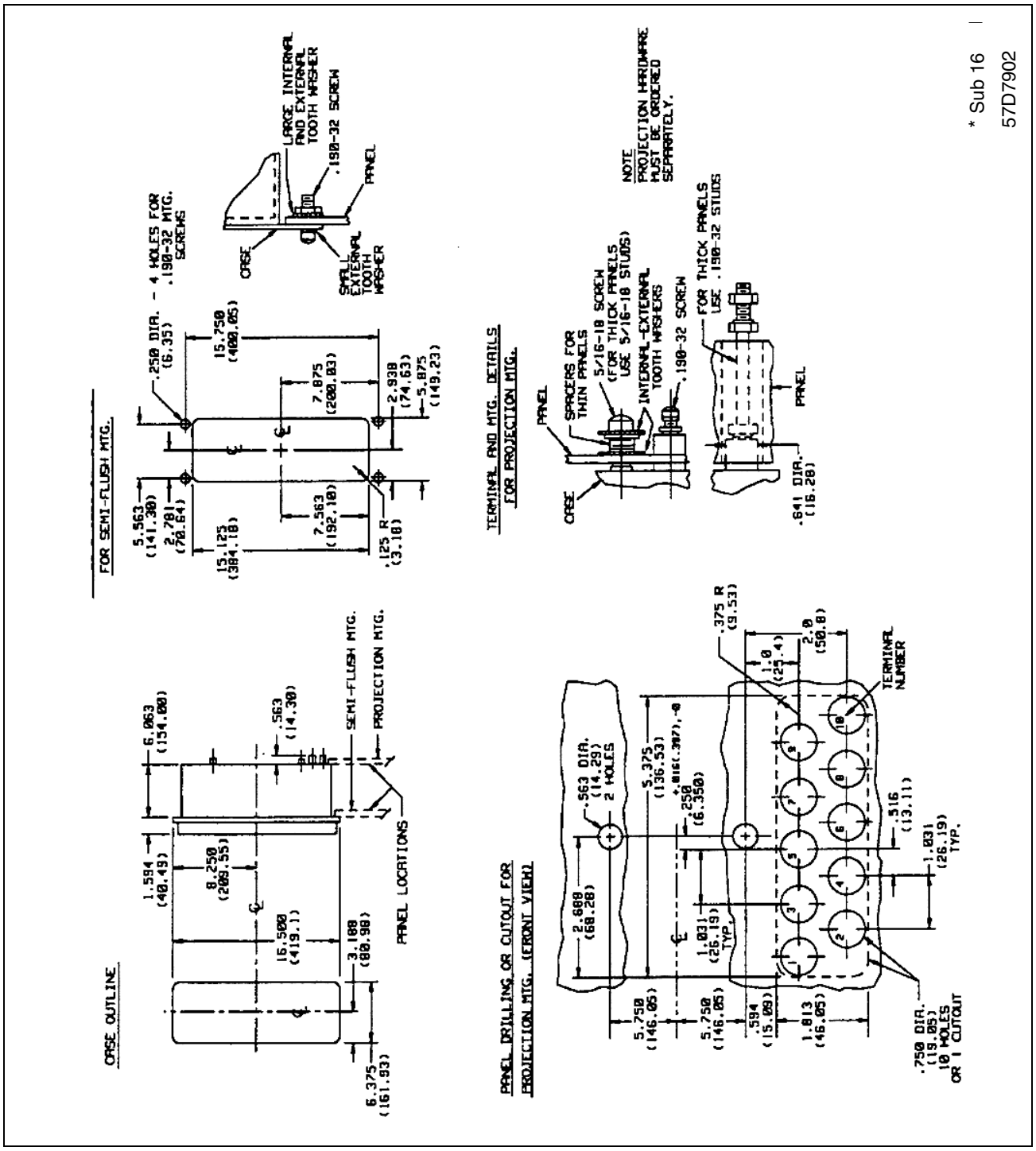


Figure 8. Outline and Drilling Plan for the Type KRV Relay in the Type FT31 Case.

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