



INSTALLATION • OPERATION • MAINTENANCE INSTRUCTIONS

DIRECTIONAL OVERCURRENT RELAYS TYPES: CR, CRC, CRP AND CRD

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

APPLICATION

These induction type directional overcurrent relays are used to disconnect transmission and feeder circuits when current through them in a given direction exceeds a predetermined value.

CONTENTS

This instruction leaflet applies to the following types of relays:

- Type CR Voltage Polarized Phase Relay
- Type CRC Current Polarized Ground Relay
- Type CRP Voltage Polarized Ground Relay
- Type CRD Dual Polarized Ground Relay

CONSTRUCTION AND OPERATION

The various types of relays as outlined in the contents consist of a directional unit or units, an overcurrent unit, an indicating contactor switch unit and an indicating instantaneous trip unit when required. The type CRP and type CRD relays also utilize an internal phase shifting mechanism. The principal component parts of the relay and their locations are shown in Figs. 1, 2, 3 and 4.

A. Overcurrent Unit (CO)

The overcurrent unit operates on the induction principle. A main tapped coil located on the center leg of an "E" type laminated structure produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap cause a contact closing torque.

B. Indicating Contactor Switch Unit (ICS)

The indicating contactor switch is a small d-c operated 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 target is reset from the outside of the case by a push rod located at the bottom of the cover.

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

C. Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated 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 the 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 target is reset from the outside of the case by a push rod located at the bottom of the cover.

A core screw accessible from the top of the switch provides the adjustable pickup range.

D. 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 locking nut. 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

SUPERSEDES I.L. 41-131L

*Denotes change from superseded issue.

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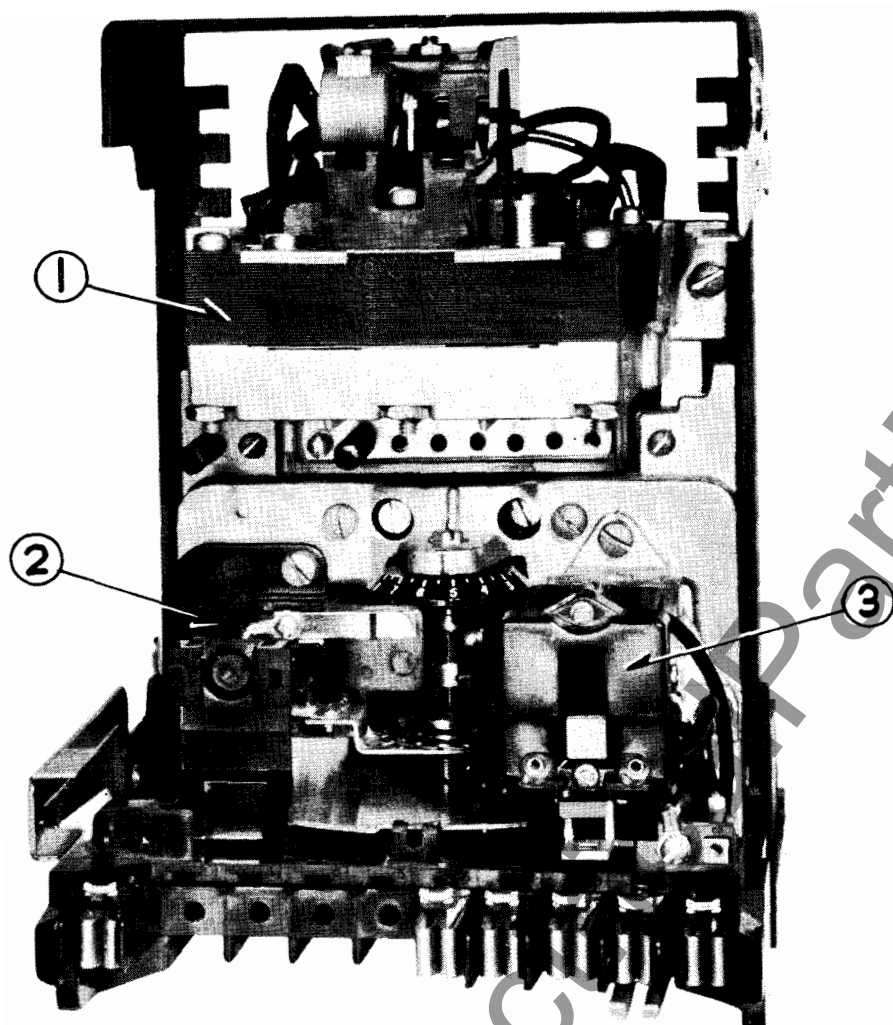


Fig. 1 Type CR Relay Without Case. 1-Directional Unit (D). 2-Overcurrent Unit (CO). 3-Indicating Contactor Switch (ICS).

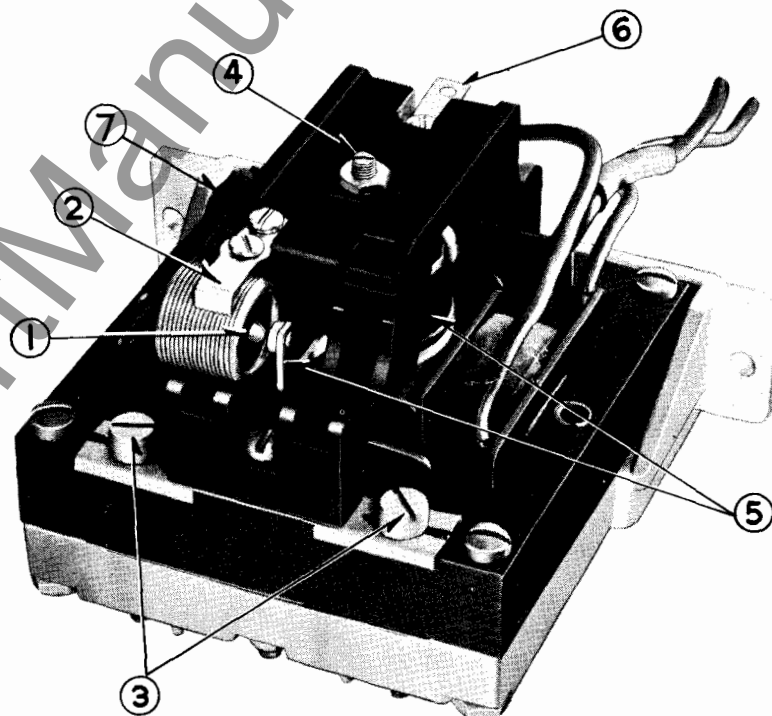


Fig. 2. Directional Unit. 1-Stationary Contact. 2-Stationary Contact pressure spring. 3-Magnetic adjusting plugs. 4-Upper bearing screw. 5-Moving element assembly. 6-Spring adjuster clamp. 7-Current Bias Vane.

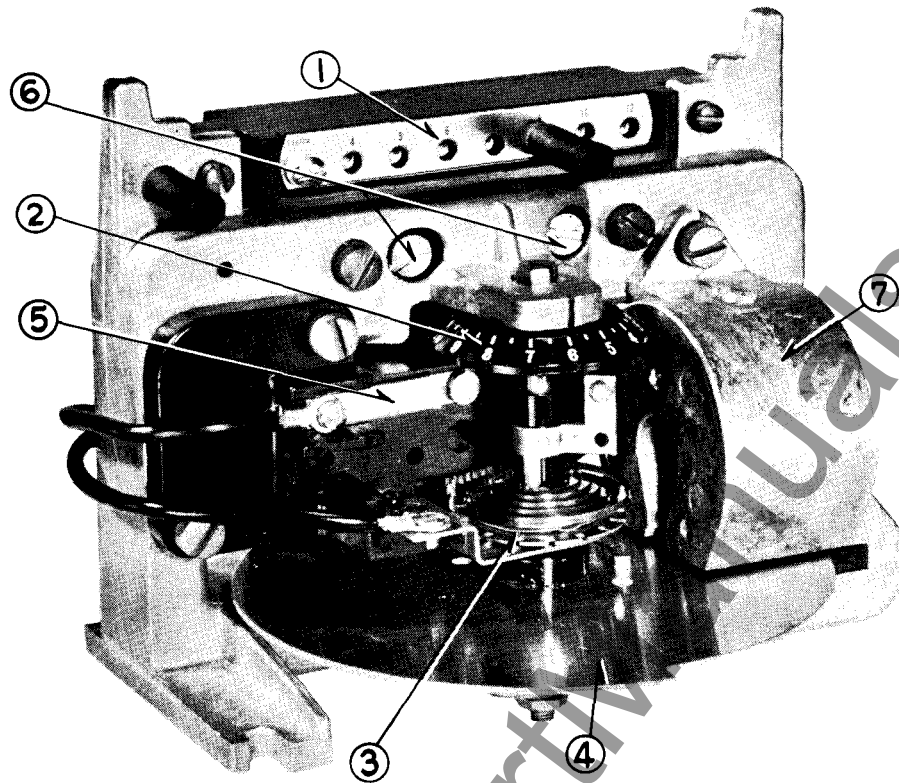


Fig. 3. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

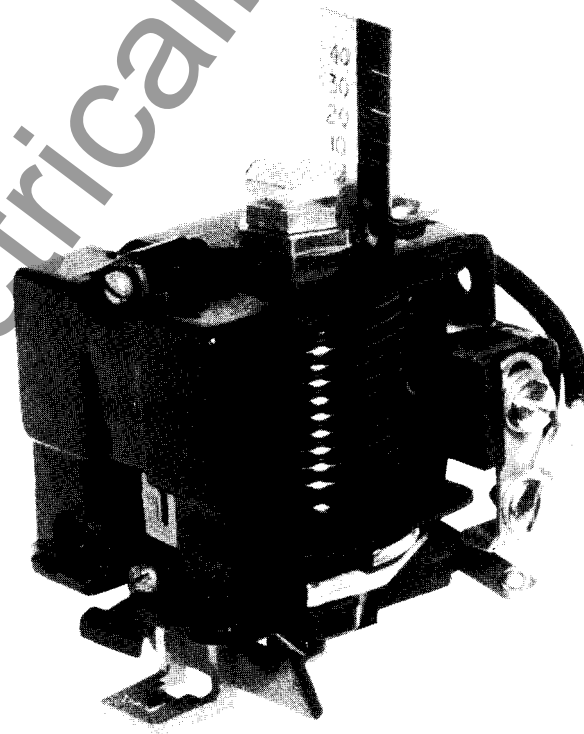


Fig. 4. Indicating Instantaneous Trip Unit (IIT).

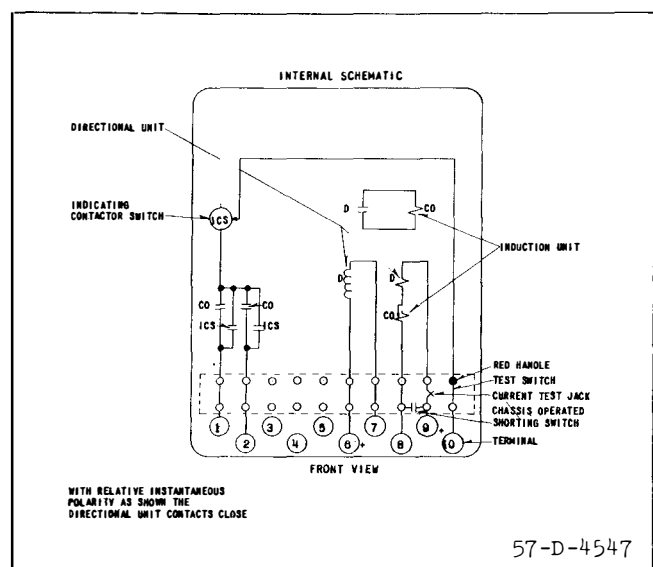


Fig. 5. Internal Schematic of double trip, directional over-current relay type CR in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4549.

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 stops for the moving element contact arm are an integral part of the bridge.

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.

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.

The contacts of the directional unit are connected in series with the shading coil of the over-current unit, thus giving directional control of the overcurrent unit. This arrangement prevents the relay from operating for faults in the non-tripping direction.

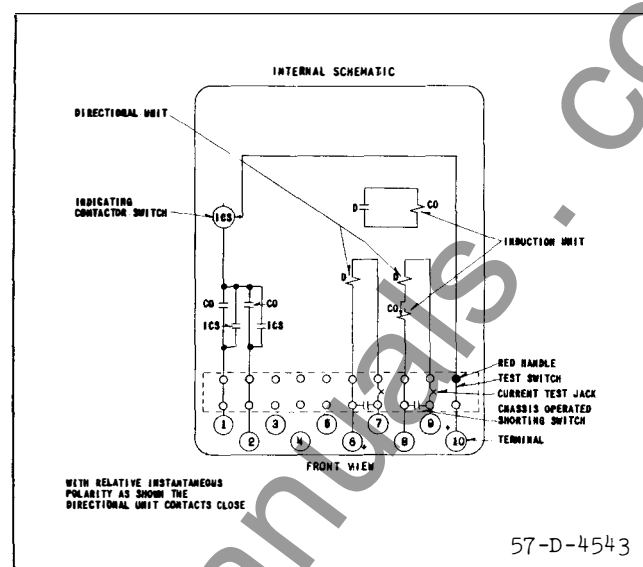


Fig. 6. Internal Schematic of double trip, directional over-current relay type CRC in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4539.

CHARACTERISTICS

The time characteristics of the directional over-current relays are designated by specific numbers as indicated in Table I (e.g. CR-8).

TABLE I

| Time Characteristics | Designation |
|-------------------------|-------------|
| Short Time | 2 |
| Long Time | 5 |
| Definite Time | 6 |
| Moderately Inverse Time | 7 |
| Inverse Time | 8 |
| Very Inverse Time | 9 |
| Extremely Inverse Time | 11 |

The relays are generally available in the following overcurrent unit current ranges:

| Range | Taps |
|-----------|-----------------------------|
| 0.5 — 2.5 | 0.5 0.6 0.8 1.0 1.5 2.0 2.5 |
| 2 — 6 | 2 2.5 3 3.5 4 5 6 |
| 4 — 12 | 4 5 6 7 8 10 12 |

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 13 to 19. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

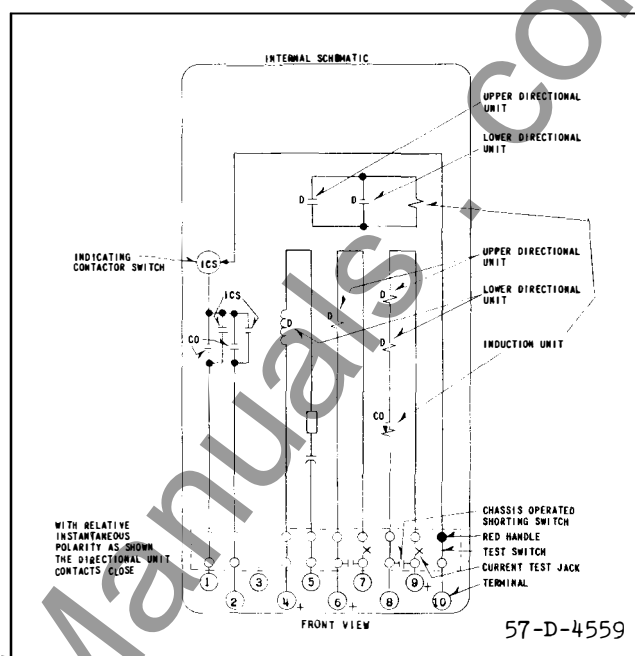
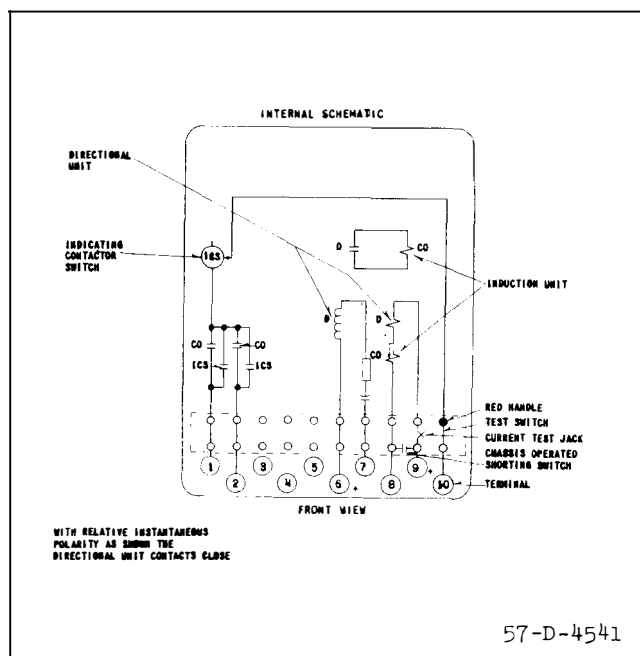


Fig. 7. Internal Schematic of double trip, directional over-current relay type CRP in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4545.

Fig. 8. Internal Schematic of double trip, directional over-current relay type CRD in type FT31 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4561.

Trip Circuit

The main 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.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting of lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

- Indicating Contactor Switch —
- 0.2 amp tap 6.5 ohms d-c resistance
 - 2.0 amp tap 0.15 ohms d-c resistance

Type CR Relay

This voltage polarized type 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 pick-up is 1 volt and 4 amperes at its maximum torque angle for the 4 to 42 ampere range relays and 1 volt and 2 amperes for the 2 to 6 ampere and 0.5 to 2.5 ampere range relays.

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 Fig. 21.

Type CRC Relay

The current polarized type relay is intended for ground fault protection and operates on residual current. See Fig. 23. The type CRC relay has its maximum torque when the operating current leads the polarizing current by approximately 40° . The directional unit minimum pick-up is 0.5 ampere in each winding in phase for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

Type CRP Relay

The voltage polarized relay is intended for ground fault protection and has its maximum torque when the current lags the voltage by approximately 60° . The shifting of the maximum torque angle has been accomplished by the use of an internally mounted phase shifter as illustrated in Fig. 7.

The type CRP relay operates on residual voltage and residual current. See Fig. 22.

The directional unit minimum pick-up is 1 volt and 2 amperes at its maximum torque angle for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

Type CRD Relay

The dual polarized type relay is intended for ground fault protection. The relay can be polarized from a potential source, from a local ground source, or

TYPES CR, CRC, CRP AND CRD RELAYS

from both simultaneously.

The type CRD relay utilizes the directional unit of the type CRC relay in conjunction with the directional unit and phase shifting mechanism of the type CRP relay. The directional contacts are connected in parallel to torque-control a common overcurrent unit. See Fig. 8.

The current-polarized directional unit of the type CRD relay operates on residual voltage and residual current.

potential polarized directional unit of the type CRD relay operates on residual voltage and residual current. See Fig. 24.

For the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays, the minimum pick-up of the current polarized unit is 0.5 ampere in each winding in-phase and the minimum pick-up for the voltage polarized unit is 1 volt and 2 amperes with the current lagging voltage by 60° .

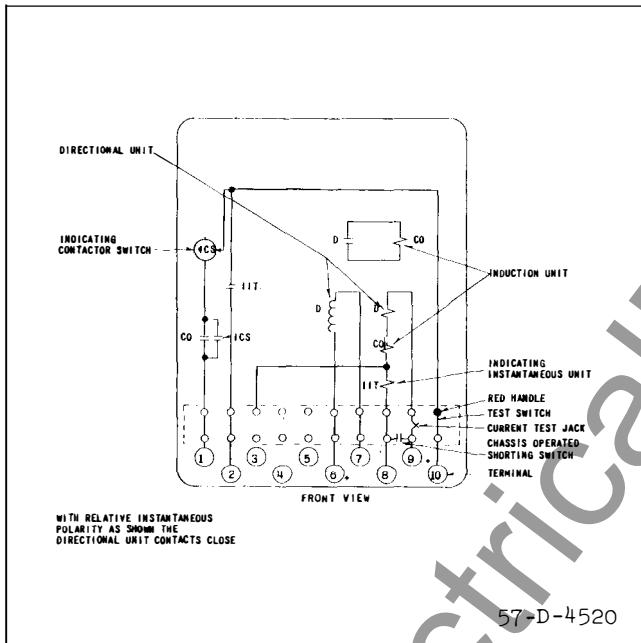


Fig. 9. Internal Schematic of single trip directional control relay Type CR with Indicating Instantaneous Trip Unit, in Type FT21 Case.

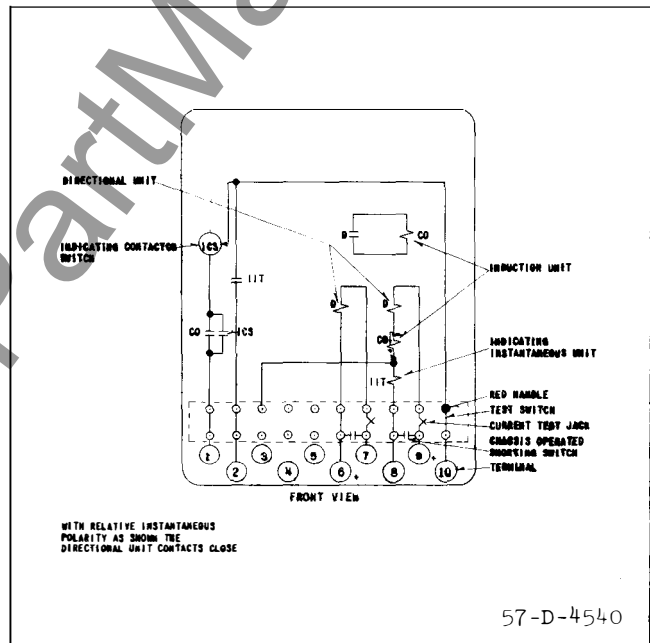


Fig. 10. Internal Schematic of single trip directional control relay Type CRC with Indicating Instantaneous Trip Unit, in Type FT21 Case.

ENERGY REQUIREMENTS

CR-2, CRC-2, CRP-2, CRD-2 OVERCURRENT UNITS

| AMPERE RANGE | TAP | CONTINUOUS RATING (AMPERES) | ONE SECOND RATING † (AMPERES) | POWER FACTOR ANGLE ϕ | VOLT AMPERES †† | | | |
|-----------------|------|-----------------------------------|-------------------------------------|---------------------------------|----------------------------|------------------------------------|-------------------------------------|-------------------------------------|
| | | | | | AT TAP VALUE CURRENT | AT 3 TIMES TAP VALUE CURRENT | AT 10 TIMES TAP VALUE CURRENT | AT 20 TIMES TAP VALUE CURRENT |
| 0.5/2.5 | 0.5 | 0.91 | 28 | 58 | 4.8 | 39.6 | 256 | 790 |
| | 0.6 | 0.96 | 28 | 57 | 4.9 | 39.8 | 270 | 851 |
| | 0.8 | 1.18 | 28 | 53 | 5.0 | 42.7 | 308 | 1024 |
| | 1.0 | 1.37 | 28 | 50 | 5.3 | 45.4 | 348 | 1220 |
| | 1.5 | 1.95 | 28 | 40 | 6.2 | 54.4 | 435 | 1740 |
| | 2.0 | 2.24 | 28 | 36 | 7.2 | 65.4 | 580 | 2280 |
| | 2.5 | 2.50 | 28 | 29 | 7.9 | 73.6 | 700 | 2850 |
| 2/6 | 2.0 | 3.1 | 110 | 59 | 5.04 | 38.7 | 262 | 800 |
| | 2.5 | 4.0 | 110 | 55 | 5.13 | 39.8 | 280 | 920 |
| | 3.0 | 4.4 | 110 | 51 | 5.37 | 42.8 | 312 | 1008 |
| | 3.5 | 4.8 | 110 | 47 | 5.53 | 42.8 | 329 | 1120 |
| | 4.0 | 5.2 | 110 | 45 | 5.72 | 46.0 | 360 | 1216 |
| | 5.0 | 5.6 | 110 | 41 | 5.90 | 50.3 | 420 | 1500 |
| | 6.0 | 6.0 | 110 | 37 | 6.54 | 54.9 | 474 | 1800 |
| 4/12 | 4.0 | 7.3 | 230 | 65 | 4.92 | 39.1 | 268 | 848 |
| | 5.0 | 8.0 | 230 | 50 | 5.20 | 42.0 | 305 | 1020 |
| | 6.0 | 8.8 | 230 | 47 | 5.34 | 44.1 | 330 | 1128 |
| | 7.0 | 9.6 | 230 | 46 | 5.53 | 45.8 | 364 | 1260 |
| | 8.0 | 10.4 | 230 | 43 | 5.86 | 49.9 | 400 | 1408 |
| | 10.0 | 11.2 | 230 | 37 | 6.6 | 55.5 | 470 | 1720 |
| | 12.0 | 12.0 | 230 | 34 | 7.00 | 62.3 | 528 | 2064 |

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

ϕ Degrees current lags voltage at tap value current.

†† Voltages taken with Rectox type voltmeter.

TYPES CR, CRC, CRP AND CRD RELAYS

ENERGY REQUIREMENTS

CR-5, CRC-5, CRP-5, CRD-5, CR-6, CRC-6, CRP-6, CRD-6 OVERCURRENT UNITS

VOLT AMPERES ††

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating † (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|-------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 69 | 3.92 | 20.6 | 103 | 270 |
| | (0.6 | 3.1 | 88 | 68 | 3.96 | 20.7 | 106 | 288 |
| | (0.8 | 3.7 | 88 | 67 | 3.96 | 21 | 114 | 325 |
| | (1.0 | 4.1 | 88 | 66 | 4.07 | 21.4 | 122 | 360 |
| | (1.5 | 5.7 | 88 | 62 | 4.19 | 23.2 | 147 | 462 |
| | (2.0 | 6.8 | 88 | 60 | 4.30 | 24.9 | 168 | 548 |
| | (2.5 | 7.7 | 88 | 58 | 4.37 | 26.2 | 180 | 630 |
| 2/6 | (2 | 8 | 230 | 67 | 3.88 | 21 | 110 | 308 |
| | (2.5 | 8.8 | 230 | 66 | 3.90 | 21.6 | 118 | 342 |
| | (3 | 9.7 | 230 | 64 | 3.93 | 22.1 | 126 | 381 |
| | (3.5 | 10.4 | 230 | 63 | 4.09 | 23.1 | 136 | 417 |
| | (4 | 11.2 | 230 | 62 | 4.12 | 23.5 | 144 | 448 |
| | (5 | 12.5 | 230 | 59 | 4.20 | 24.8 | 162 | 540 |
| | (6 | 13.7 | 230 | 57 | 4.38 | 26.5 | 183 | 624 |
| 4/12 | (4 | 16 | 460 | 65 | 4.00 | 22.4 | 126 | 376 |
| | (5 | 18.8 | 460 | 63 | 4.15 | 23.7 | 143 | 450 |
| | (6 | 19.3 | 460 | 61 | 4.32 | 25.3 | 162 | 531 |
| | (7 | 20.8 | 460 | 59 | 4.35 | 26.4 | 183 | 611 |
| | (8 | 22.5 | 460 | 56 | 4.40 | 27.8 | 204 | 699 |
| | (10 | 25 | 460 | 53 | 4.60 | 30.1 | 247 | 880 |
| | (12 | 28 | 460 | 47 | 4.92 | 35.6 | 288 | 1056 |

CR-7, CRC-7, CRP-7 & CRD-7 OVERCURRENT UNITS

VOLT AMPERES ††

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating † (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|-------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 68 | 3.88 | 20.7 | 103 | 278 |
| | (0.6 | 3.1 | 88 | 67 | 3.93 | 20.9 | 107 | 288 |
| | (0.8 | 3.7 | 88 | 66 | 3.93 | 21.1 | 114 | 320 |
| | (1.0 | 4.1 | 88 | 64 | 4.00 | 21.6 | 122 | 356 |
| | (1.5 | 5.7 | 88 | 61 | 4.08 | 22.9 | 148 | 459 |
| | (2.0 | 6.8 | 88 | 58 | 4.24 | 24.8 | 174 | 552 |
| | (2.5 | 7.7 | 88 | 56 | 4.38 | 25.9 | 185 | 640 |
| 2/6 | (2 | 8 | 230 | 66 | 4.06 | 21.3 | 111 | 306 |
| | (2.5 | 8.8 | 230 | 63 | 4.07 | 21.8 | 120 | 342 |
| | (3 | 9.7 | 230 | 63 | 4.14 | 22.5 | 129 | 366 |
| | (3.5 | 10.4 | 230 | 62 | 4.34 | 23.4 | 141 | 413 |
| | (4 | 11.2 | 230 | 61 | 4.34 | 23.8 | 149 | 448 |
| | (5 | 12.5 | 230 | 59 | 4.40 | 25.2 | 163 | 530 |
| | (6 | 13.7 | 230 | 58 | 4.62 | 27 | 183 | 624 |
| 4/12 | (4 | 16 | 460 | 64 | 4.24 | 22.8 | 129 | 392 |
| | (5 | 18.8 | 460 | 61 | 4.30 | 24.2 | 149 | 460 |
| | (6 | 19.3 | 460 | 60 | 4.62 | 25.9 | 168 | 540 |
| | (7 | 20.8 | 460 | 58 | 4.69 | 27.3 | 187 | 626 |
| | (8 | 22.5 | 460 | 55 | 4.80 | 29.8 | 211 | 688 |
| | (10 | 25 | 460 | 51 | 5.20 | 33 | 260 | 860 |
| | (12 | 28 | 460 | 46 | 5.40 | 37.5 | 308 | 1032 |

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

ϕ Degrees current lags voltage at tap value current.

†† Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS

CR-8, CRC-8, CRP-8 & CRD-8
CR-9, CRC-9, CRP-9 & CRD-9 OVERCURRENT UNITS

| VOLT AMPERES ^{††} | | | | | | | | |
|----------------------------|----------------|------------------|--|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| Ampere Range | Continuous Tap | Rating (Amperes) | One Second Rating [†] (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
| 0.5/2.5 | (0.5 | 2.7 | 88 | 72 | 2.38 | 21 | 132 | 350 |
| | (0.6 | 3.1 | 88 | 71 | 2.38 | 21 | 134 | 365 |
| | (0.8 | 3.7 | 88 | 69 | 2.40 | 21.1 | 142 | 400 |
| | (1.0 | 4.1 | 88 | 67 | 2.42 | 21.2 | 150 | 440 |
| | (1.5 | 5.7 | 88 | 62 | 2.51 | 22 | 170 | 530 |
| | (2.0 | 6.8 | 88 | 57 | 2.65 | 23.5 | 200 | 675 |
| | (2.5 | 7.7 | 88 | 53 | 2.74 | 24.8 | 228 | 800 |
| 2/6 | (2 | 8 | 230 | 70 | 2.38 | 21 | 136 | 360 |
| | (2.5 | 8.8 | 230 | 66 | 2.40 | 21.1 | 142 | 395 |
| | (3 | 9.7 | 230 | 64 | 2.42 | 21.5 | 149 | 430 |
| | (3.5 | 10.4 | 230 | 62 | 2.48 | 22 | 157 | 470 |
| | (4 | 11.2 | 230 | 60 | 2.53 | 22.7 | 164 | 500 |
| | (5 | 12.5 | 230 | 58 | 2.64 | 24 | 180 | 580 |
| | (6 | 13.7 | 230 | 56 | 2.75 | 25.2 | 198 | 660 |
| 4/12 | (4 | 16 | 460 | 68 | 2.38 | 21.3 | 146 | 420 |
| | (5 | 18.8 | 460 | 63 | 2.46 | 21.8 | 158 | 480 |
| | (6 | 19.3 | 460 | 60 | 2.54 | 22.6 | 172 | 550 |
| | (7 | 20.8 | 460 | 57 | 2.62 | 23.6 | 190 | 620 |
| | (8 | 22.5 | 460 | 54 | 2.73 | 24.8 | 207 | 700 |
| | (10 | 25 | 460 | 48 | 3.00 | 27.8 | 248 | 850 |
| | (12 | 28 | 460 | 45 | 3.46 | 31.4 | 292 | 1020 |

CR-11, CRC-11
CRP-11 & CRD-11 OVERCURRENT UNITS

| | | VOLT AMPERES †† | | | | | | |
|--------------|------|-----------------------------|-------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| AMPERE RANGE | TAP | CONTINUOUS RATING (AMPERES) | ONE SECOND RATING † (AMPERES) | POWER FACTOR ANGLE ϕ | AT TAP VALUE CURRENT | AT 3 TIMES TAP VALUE CURRENT | AT 10 TIMES TAP VALUE CURRENT | AT 20 TIMES TAP VALUE CURRENT |
| 0.5/2.5 | 0.5 | 1.7 | 56 | 36 | 0.72 | 6.54 | 71.8 | 250 |
| | 0.6 | 1.9 | 56 | 34 | 0.75 | 6.80 | 75.0 | 267 |
| | 0.8 | 2.2 | 56 | 30 | 0.81 | 7.46 | 84.0 | 298 |
| | 1.0 | 2.5 | 56 | 27 | 0.89 | 8.30 | 93.1 | 330 |
| | 1.5 | 3.0 | 56 | 22 | 1.13 | 10.04 | 115.5 | 411 |
| | 2.0 | 3.5 | 56 | 17 | 1.30 | 11.95 | 136.3 | 502 |
| | 2.5 | 3.8 | 56 | 16 | 1.48 | 13.95 | 160.0 | 610 |
| 2/6 | 2.0 | 7.0 | 230 | 32 | 0.73 | 6.30 | 74.0 | 264 |
| | 2.5 | 7.8 | 230 | 30 | 0.78 | 7.00 | 78.5 | 285 |
| | 3.0 | 8.3 | 230 | 27 | 0.83 | 7.74 | 84.0 | 309 |
| | 3.5 | 9.0 | 230 | 24 | 0.88 | 8.20 | 89.0 | 340 |
| | 4.0 | 10.0 | 230 | 23 | 0.96 | 9.12 | 102.0 | 372 |
| | 5.0 | 11.0 | 230 | 20 | 1.07 | 9.80 | 109.0 | 430 |
| | 6.0 | 12.0 | 230 | 20 | 1.23 | 11.34 | 129.0 | 504 |
| 4/12 | 4.0 | 14 | 460 | 29 | 0.79 | 7.08 | 78.4 | 296 |
| | 5.0 | 16 | 460 | 25 | 0.89 | 8.00 | 90.0 | 340 |
| | 6.0 | 17 | 460 | 22 | 1.02 | 9.18 | 101.4 | 378 |
| | 7.0 | 18 | 460 | 20 | 1.10 | 10.00 | 110.0 | 454 |
| | 8.0 | 20 | 460 | 18 | 1.23 | 11.1 | 124.8 | 480 |
| | 10.0 | 22 | 460 | 17 | 1.32 | 14.9 | 131.6 | 600 |
| | 12.0 | 26 | 460 | 16 | 1.8 | 16.3 | 180.0 | 720 |

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

ϕ Degrees current lags voltage at tap value current.

^{††} Voltages taken with Rectox type voltmeter.

* DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

| Relay Type | Rating | Volt Amperes Δ | Power Factor Angle ϕ |
|------------------|----------------|-----------------------|---------------------------|
| CR | 132* Volts | 11.5 | 58° Lag |
| CRC | 230 ** Amperes | 1.45 | 8° Lag |
| CRP | 208*** Volts | 11.2 | 28° Lead |
| CRD Current Unit | 230** Amperes | 1.45 | 8° Lag |
| CRD Voltage Unit | 208*** Volts | 11.2 | 28° Lead |

ϕ Degrees current leads or lags voltage at 120 volts on voltage polarized units and 5 amperes on current polarized units.

Δ Voltages taken with rectox type voltmeter - Burden of Voltage polarized units taken at 120 volts - Burden of current polarized units taken at 5 amperes.

* Continuous rating.

** One second rating.

*** 30 second rating.

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

| Relay Type | Range Amps | Continuous Rating (Amperes) | One Second Rating† (Amperes) | Power Factor Angle ϕ | At Minimum Tap Value Current | VOLT AMPERES†† | | |
|------------|------------|-----------------------------|------------------------------|---------------------------|------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| | | | | | | At 3 Times Minimum Tap Value Current | At 10 Times Minimum Tap Value Current | At 20 Times Minimum Tap Value Current |
| CR | 2-6 | 10 | 230 | 34.5 | 0.44 | 4.08 | 48.0 | 182.0 |
| | 4-12 | 12 | 280 | 25.0 | 0.53 | 5.0 | 59.2 | 236.0 |
| CRC | 0.5-2.5 | - | 230 | 44.0 | 0.033 | 0.30 | 3.3 | 14.2 |
| | 2-6 | - | 230 | 42.5 | 0.58 | 5.28 | 58.0 | 240.0 |
| CRP | 0.5-2.5 | 10 | 230 | 34.5 | 0.03 | 0.23 | 2.8 | 11.5 |
| | 2-6 | 10 | 230 | 34.5 | 0.44 | 4.08 | 48.0 | 182.0 |
| CRD | 0.5-2.5 | 10 | 230 | 45.0 | 0.07 | 0.59 | 6.6 | 26.0 |
| | 2-6 | 10 | 230 | 45.0 | 1.04 | 9.9 | 106.0 | 420.0 |

ϕ Degrees current lags voltage at tap value current.

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

†† Voltages taken with Rectox type voltmeter.

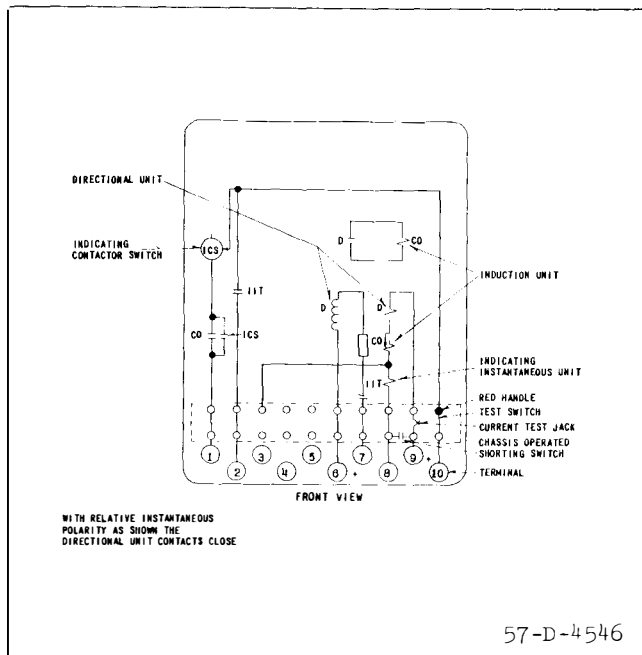


Fig. 11. Internal Schematic of single trip directional control relay Type CRP with Indicating Instantaneous Trip Unit, in Type FT21 Case.

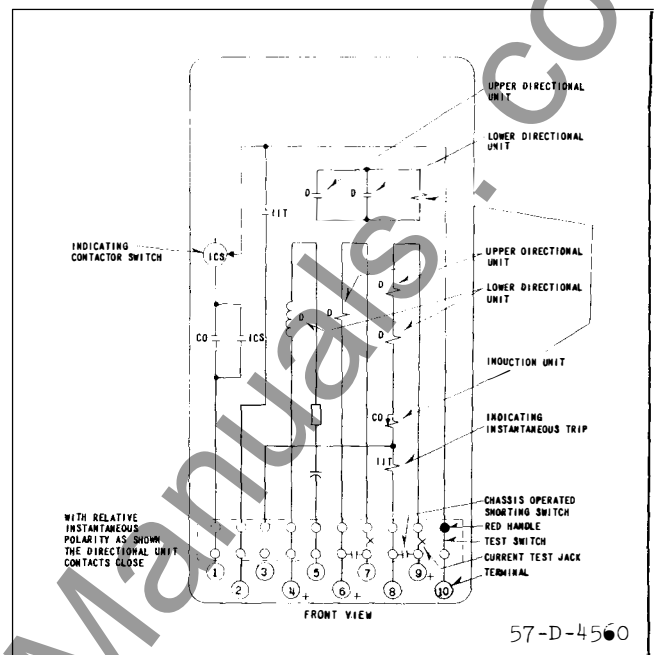


Fig. 12. Internal Schematic of single trip directional control relay Type CRD with Indicating Instantaneous Trip Unit, in Type FT31 Case.

SETTINGS

A. Overcurrent Unit (CO)

The overcurrent unit settings can be defined either by tap settings and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing the screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original

tap position.

Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

B. Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 to 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

C. Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up desired.

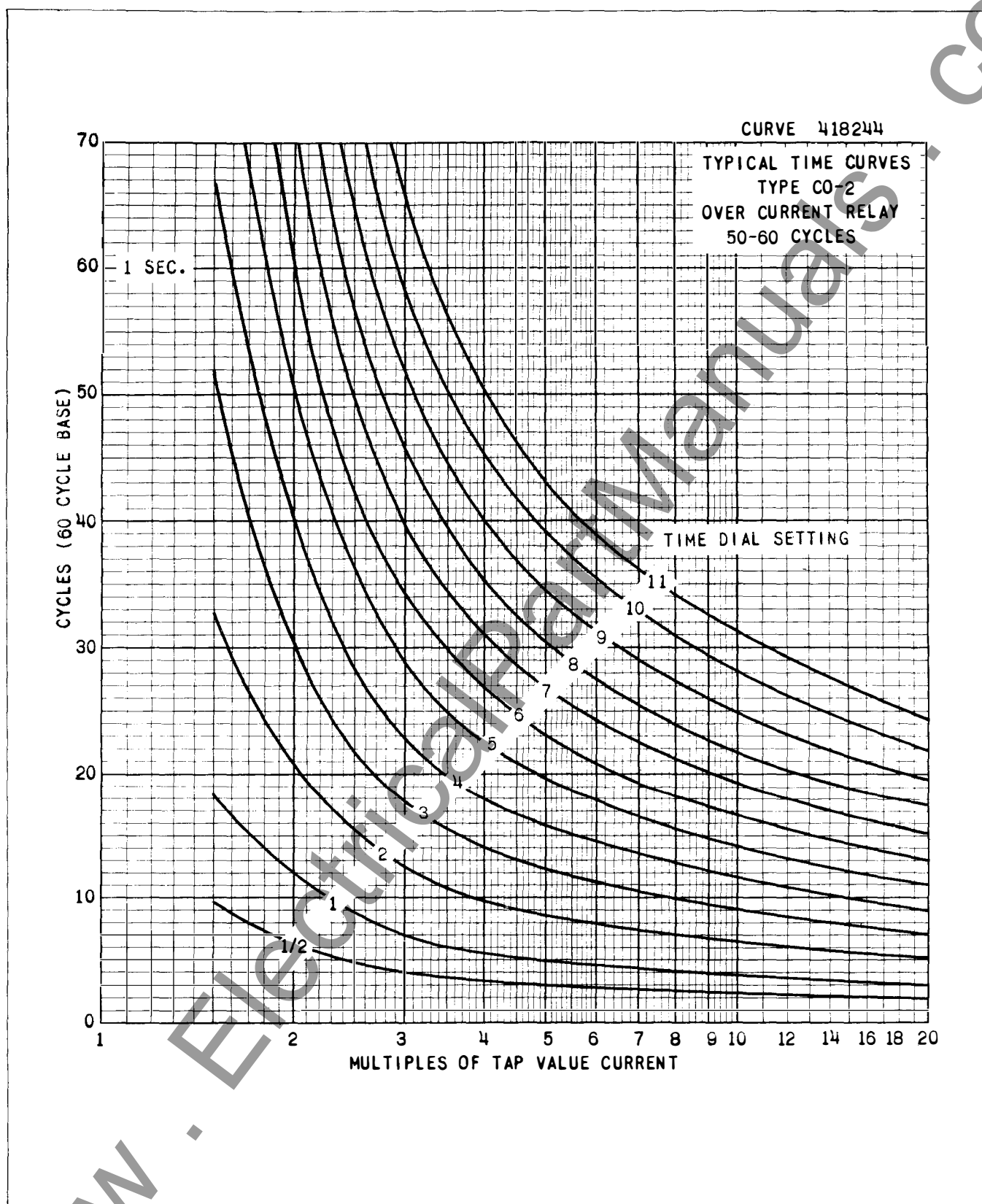


Fig. 13. Typical Time Curves For Relays With CO-2 Units.

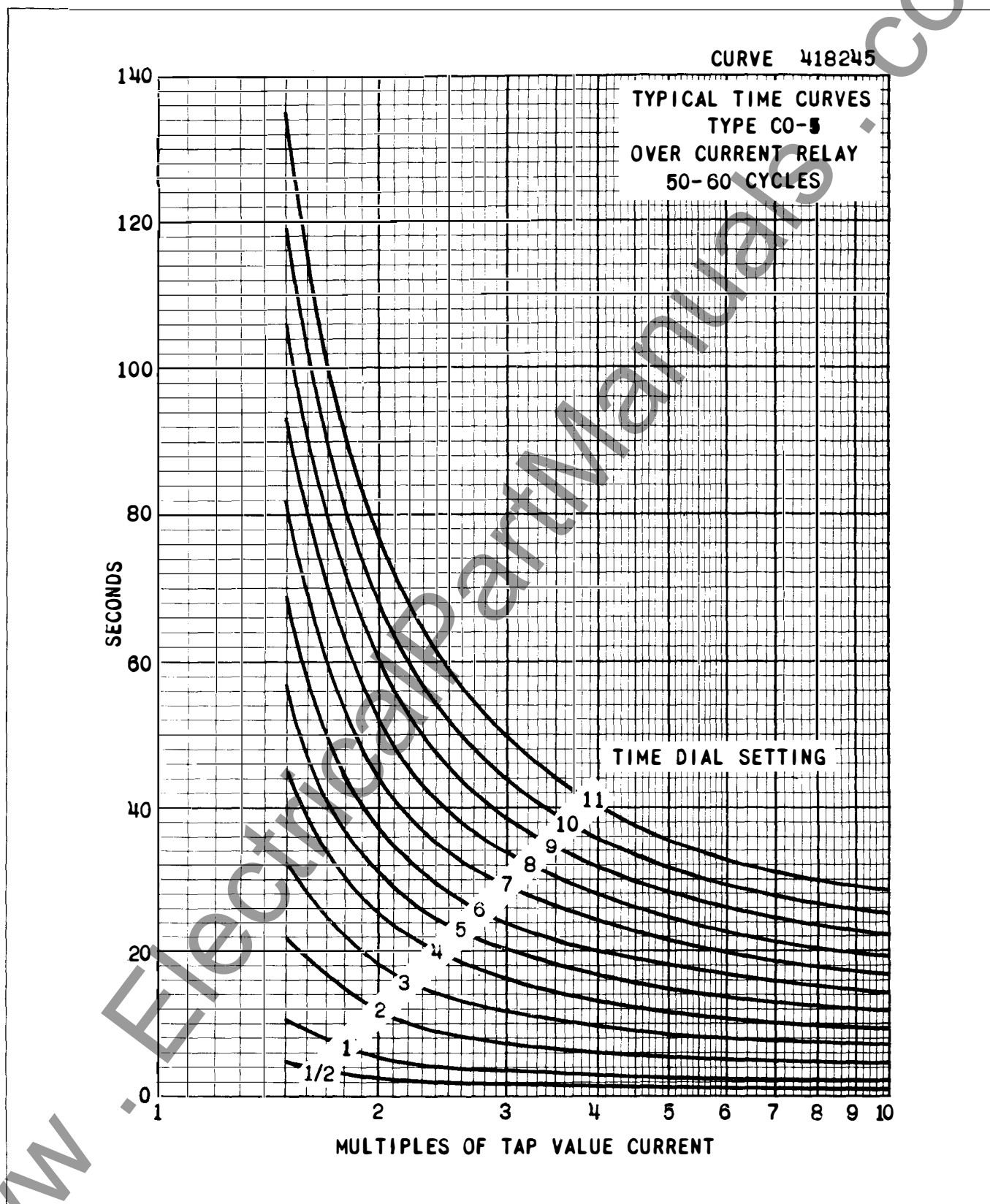


Fig. 14. Typical Time Curves For Relays With CO-5 Units.

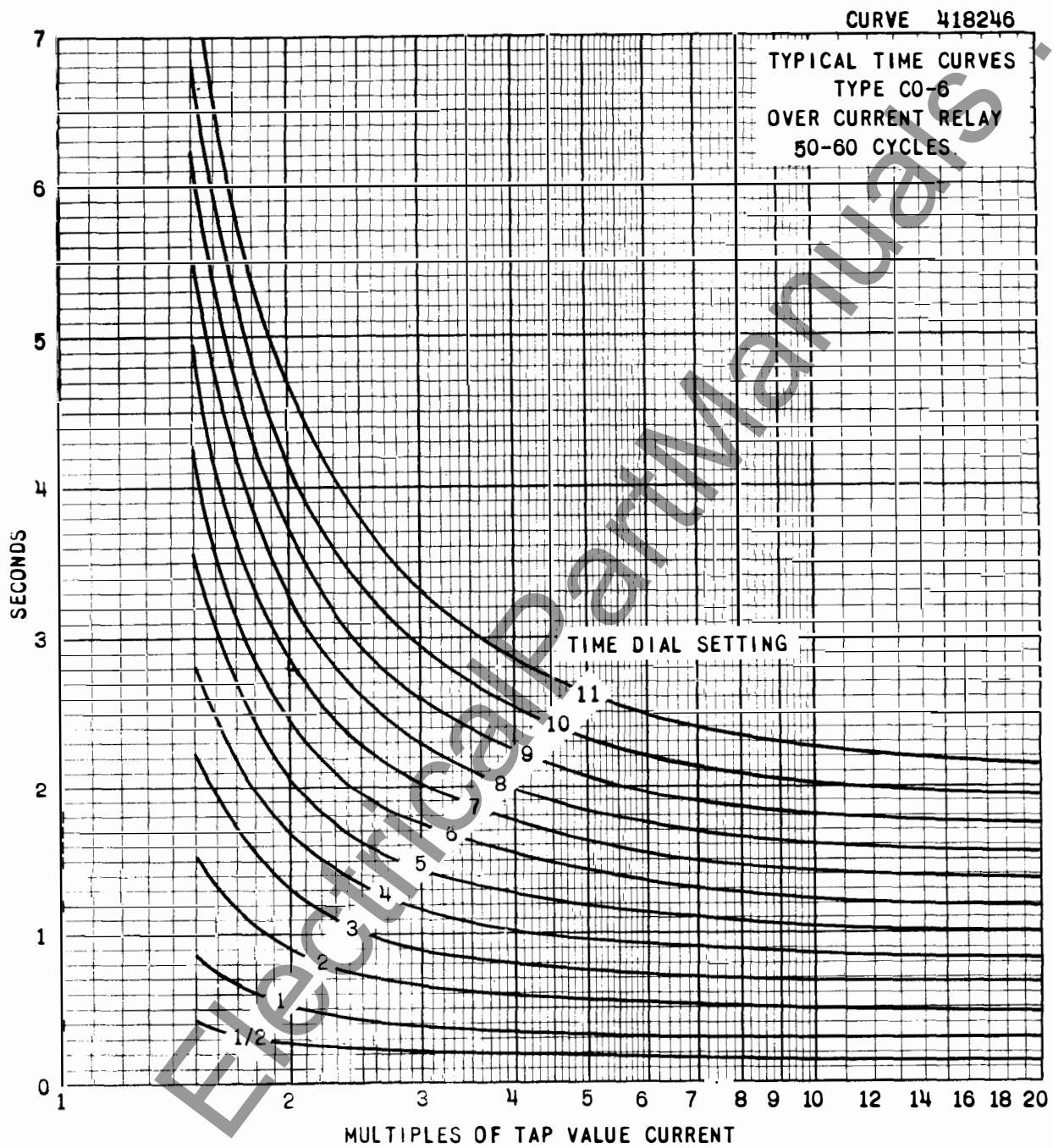


Fig. 15. Typical time curves for relays with CO-6 units.

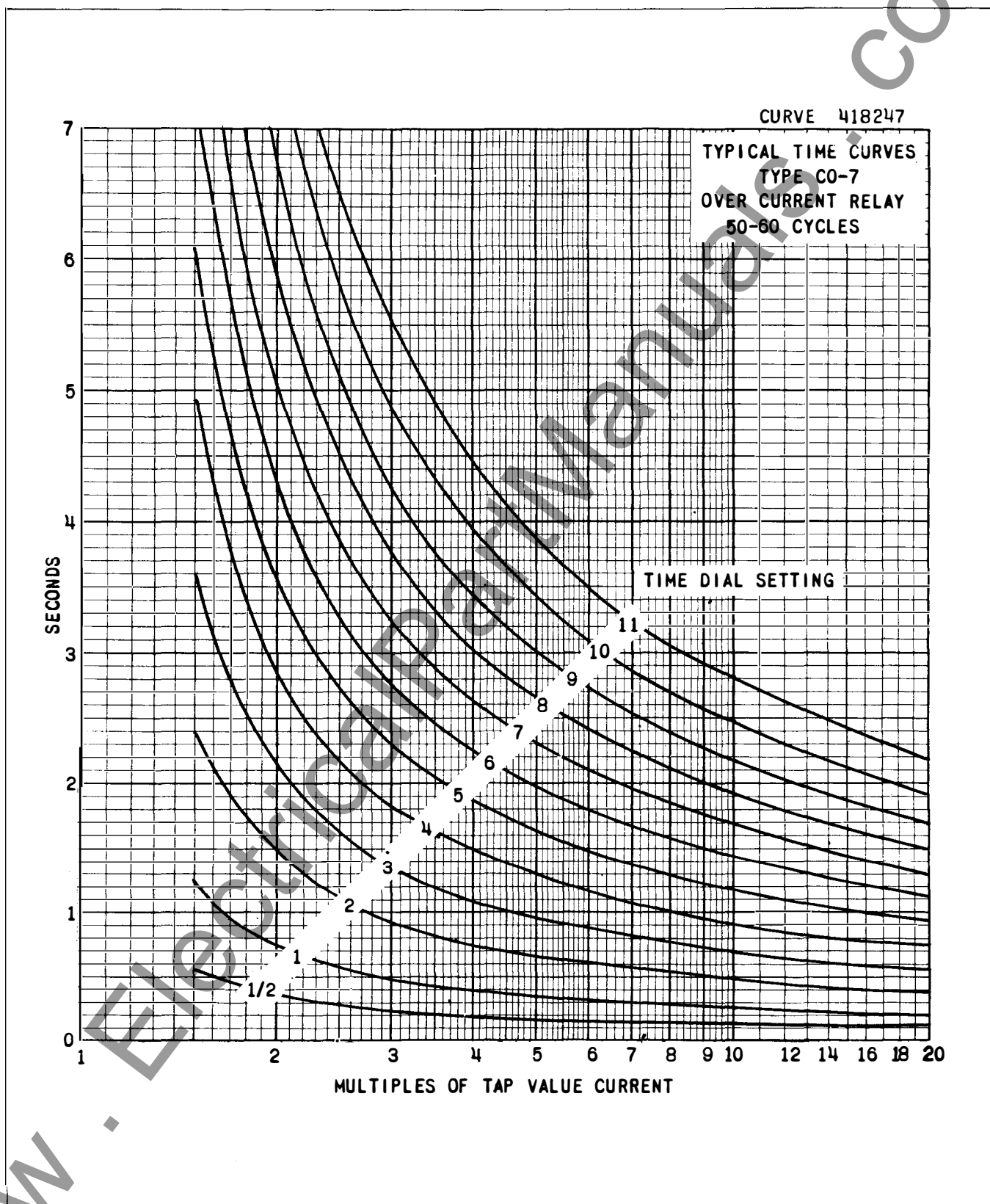


Fig. 16. Typical time curves for relays with CO-7 units.

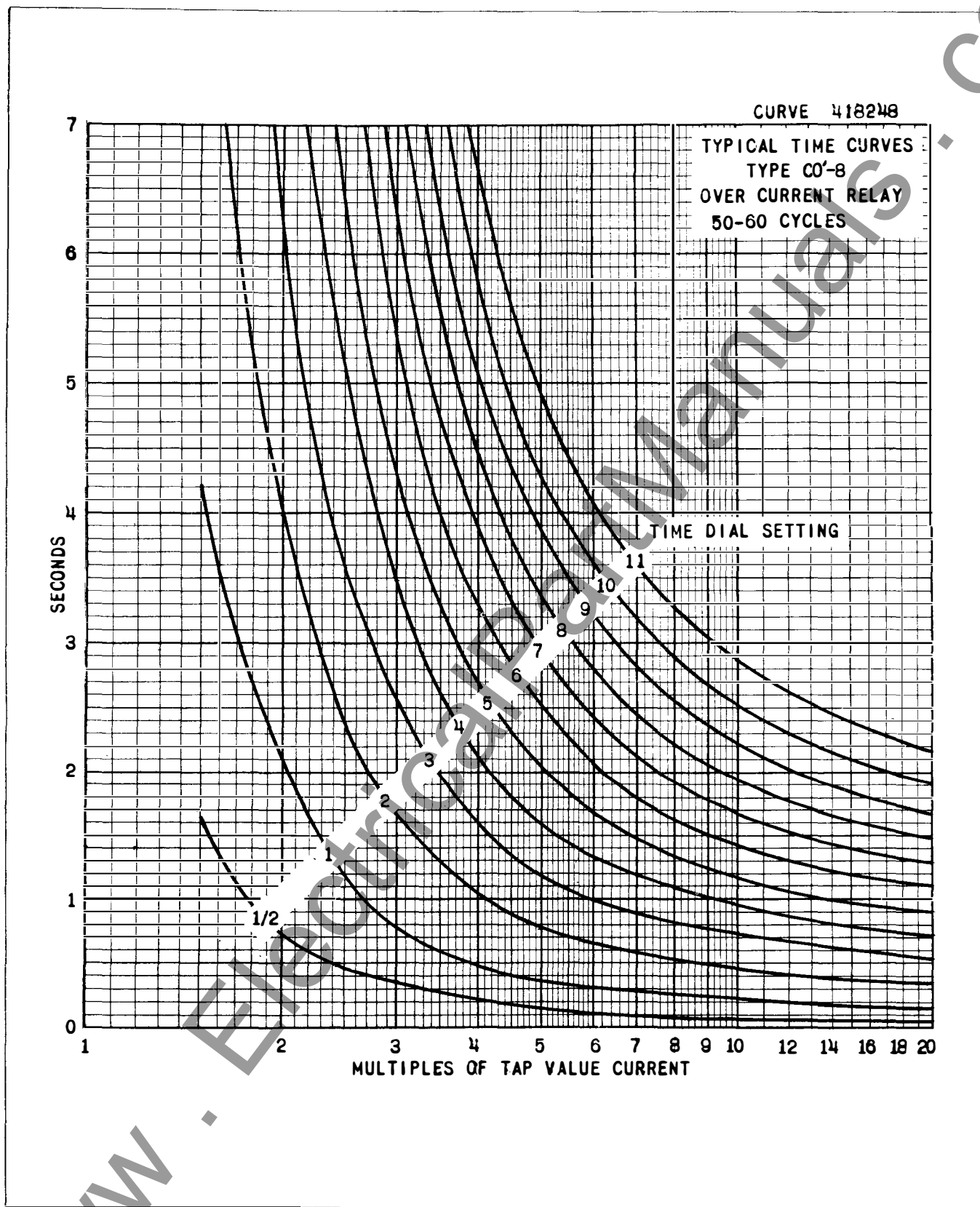


Fig. 17. Typical time curves for relays with CO-8 units.

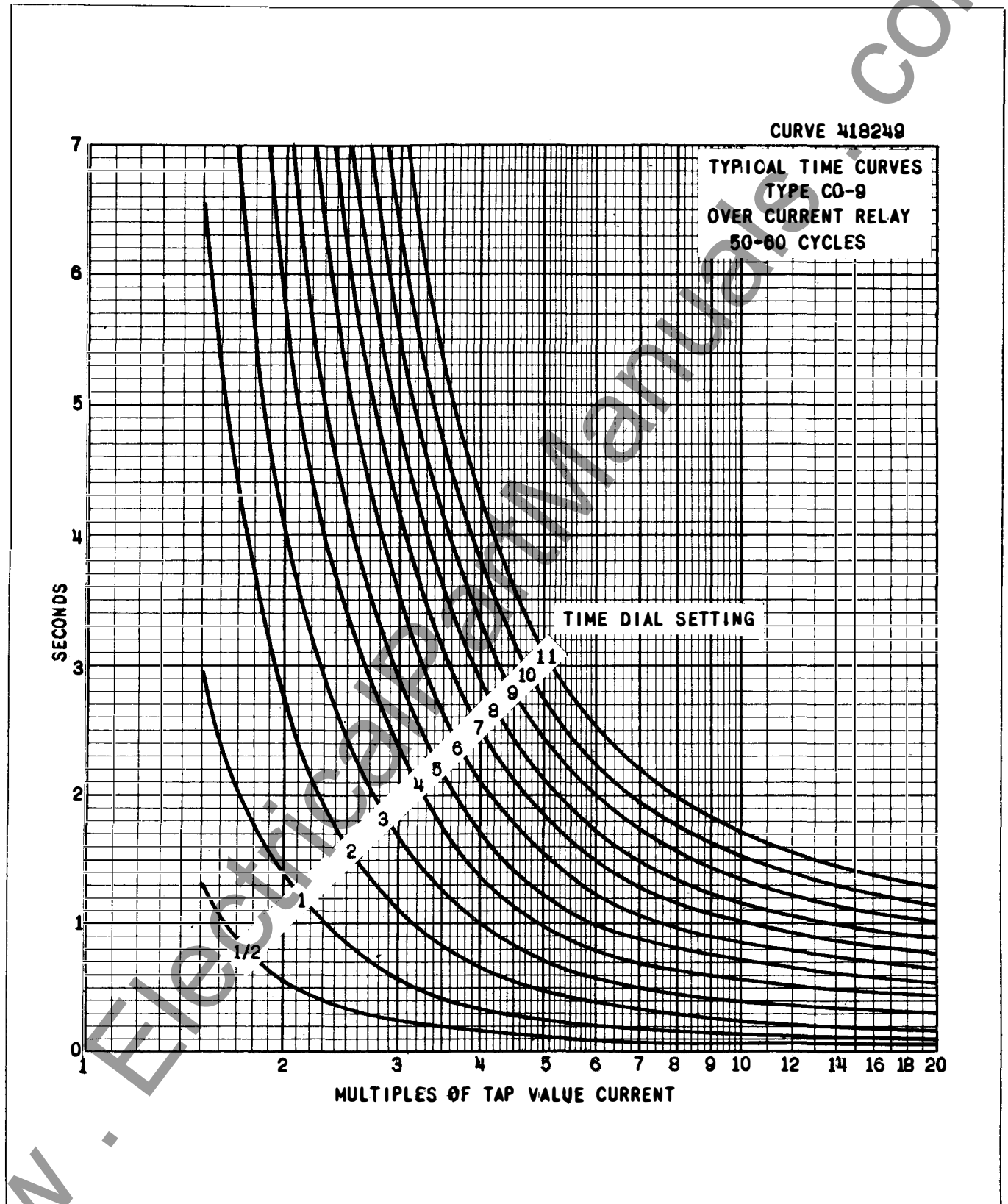


Fig. 18. Typical time curves for relays with CO-9 units.

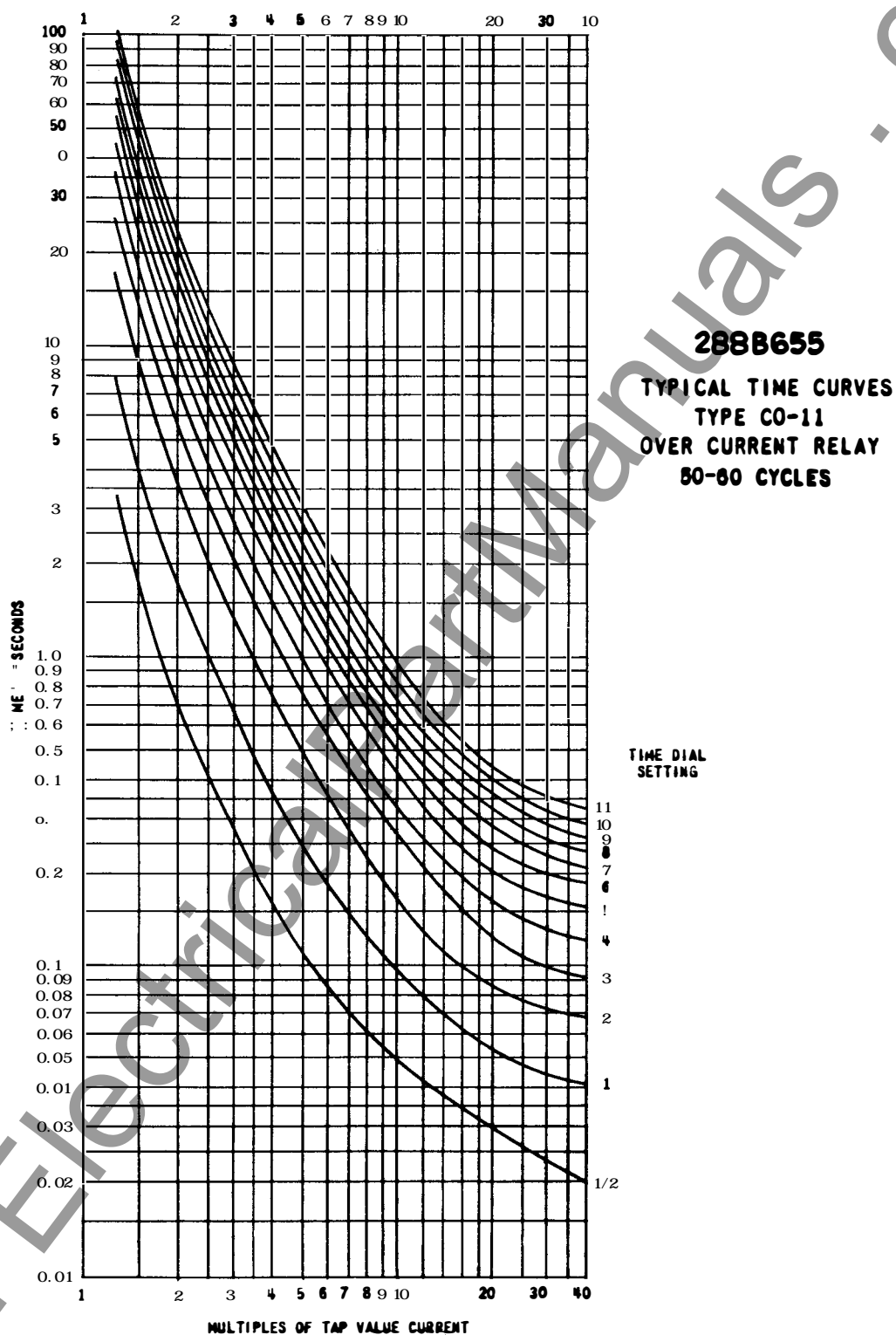


Fig. 19. Typical time curves for relays with CO-11 units.

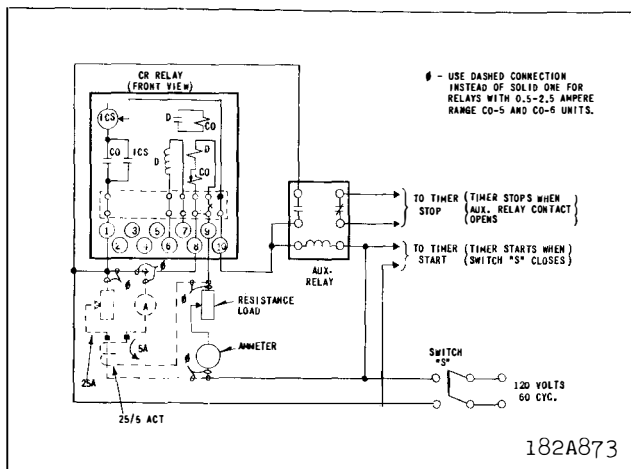


Fig. 20. Diagram of test connections of the overcurrent unit.

The nameplate data will furnish the actual current range that may be obtained from IIT unit.

D. Directional Unit (D)

No setting is required.

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 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 directly to the terminals by means of screws for steel panel mounting or to 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 studs and then turning the proper nut with a wrench.

The external a-c connections of the directional overcurrent relays are shown in Figs. 21 to 24.

ADJUSTMENTS 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

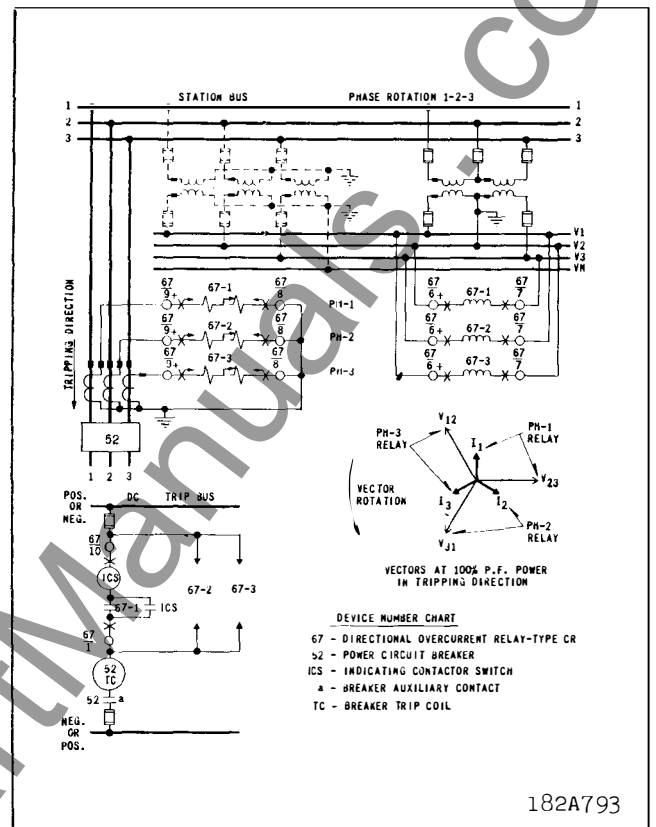


Fig. 21. External Schematic of the type CR Relay for phase fault protection.

Acceptance Check

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

A. Overcurrent Unit (CO)

The directional unit contacts must be in the closed position when checking the operation of the overcurrent unit.

1. Contact

- By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right

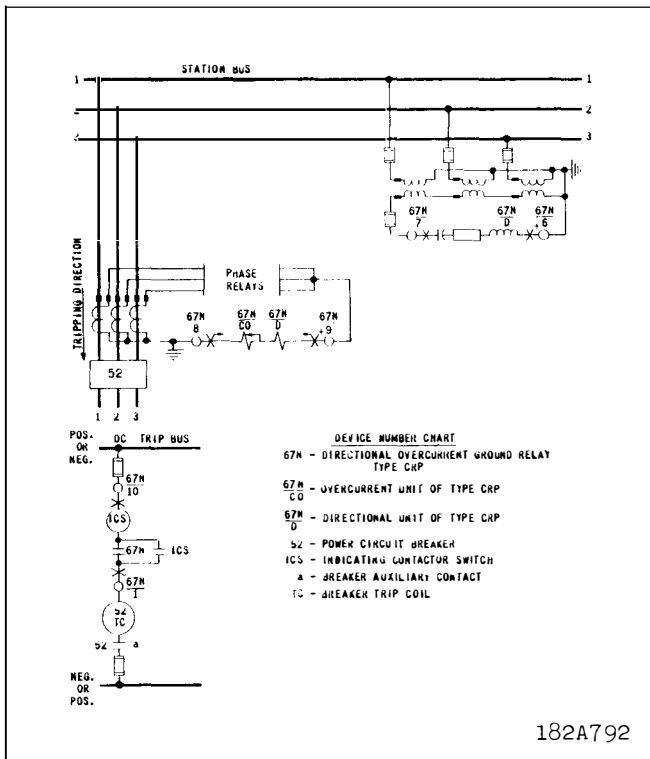


Fig. 22. External Schematic of the type CRP Relay for ground fault protection.

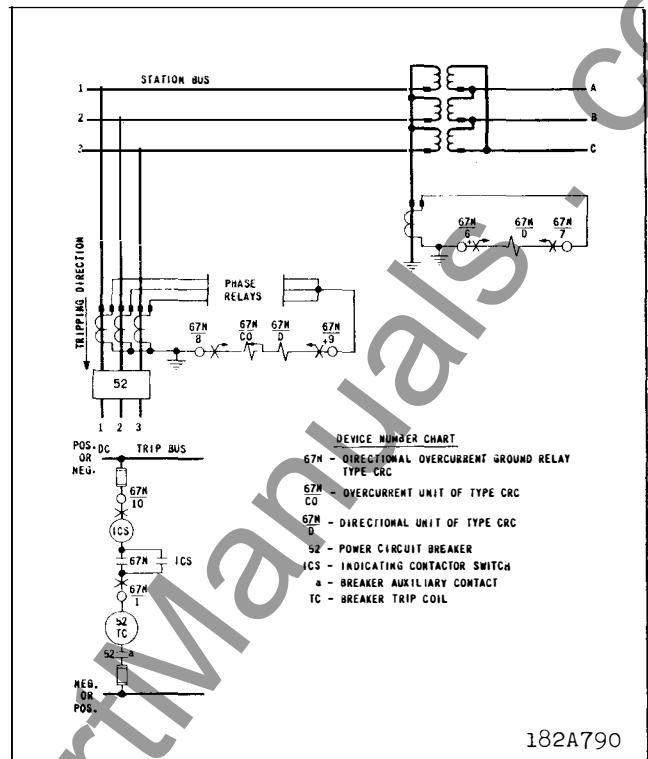


Fig. 23. External Schematic of the type CRC Relay for ground fault protection.

of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current — Set the time dial to position 6. Alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.

3. Time Curve — Table 2 shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table 2 (e.g. for the CR-8, 2 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table 2 plus or minus 5 percent.

For type CR-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary

because of the steepness of the slope of the time-current characteristic (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

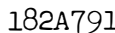
B. Indicating Contactor Switch (ICS) — Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

* C. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from IIT unit.



D. Directional Unit (D)

3. Spurious Torque Adjustments – There should be no spurious closing torques when the operating circuits are energized per Table 4 with the polarizing circuits short-circuited for the voltage polarized units and open-circuited for the current polarized units.

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

All contacts should be periodically cleaned. 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

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").

1. Contact

2. Minimum Trip Current – The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the

TABLE 2
TIME CURVE CALIBRATION DATA – 50 AND 60 CYCLES FOR
OVERCURRENT UNIT

| Relay Type | Time Dial Position | Permanent Magnet Adjustment | | Electromagnet Plug Adjustment | |
|------------|--------------------|----------------------------------|--------------------------|----------------------------------|--------------------------|
| | | Current (Multiples of Tap Value) | Operating Time (Seconds) | Current (Multiples of Tap Value) | Operating Time (Seconds) |
| 2 | 6 | 3 | 0.57 | 20 | 0.22 |
| 5 | 6 | 2 | 37.80 | 10 | 14.30 |
| 6 | 6 | 2 | 2.46 | 20 | 1.19 |
| 7 | 6 | 2 | 4.27 | 20 | 1.11 |
| 8 | 6 | 2 | 13.35 | 20 | 1.11 |
| 9 | 6 | 2 | 8.87 | 20 | 0.65 |
| 11 | 6 | 2 | 11.27 | 20 | 0.24 Δ |

Δ For 50 cycle Co-11 Relay, 20 times operating Time Limits are 0.24 + 10%; - 5%

damping magnet removed.

With the time dial set on "0", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. Time Curve Calibration - Install the permanent magnet.

Apply the indicated current per Table 2 for the permanent magnet adjustment (e.g. CR-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table 2.

For type CR-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has been completed.

Apply the indicated current per Table 2 for the electromagnet plug adjustment (e.g. CR-8, 20 times

tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table 2. (Withdrawing the left-hand plug, front view, increases the operating time and withdrawing the right-hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

B. Indicating Contactor Switch – Unit (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The indicator target should drop freely.

C. Indicating Instantaneous Trip Unit (IIT)

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a normal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The indicator target should drop freely.

D. Directional Unit (D)

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 directional unit is made as follows:

With the moving contact in the normally-opened position, i.e. against the right stop on bridge, screw in the stationary contact until both contacts just close as indicated by a neon lamp in the contact circuit. Then, screw the stationary contact away from the moving contact 3/4 of a turn. 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.

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

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

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.

The spring is to be adjusted such that the contacts will close as indicated by a neon lamp in the contact circuit when energized with the required current and voltage as shown in Table 3. This table indicates that the spring can be adjusted when the

phase angle relationship between the operating circuit and the polarizing circuit is at the maximum torque angle or when the circuit relationship has the operating and polarizing circuits in phase. It is recommended that a single phase (in phase relationship) set-up be used as a matter of ease and convenience.

4. The magnetic plugs 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 in the following manner:

a) Voltage circuit terminals on the voltage polarized relays (CR, CRP and CRD voltage polarized unit) are short-circuited.

b) The polarizing circuit of the current polarized relays (CRC and CRD current polarized unit) are open-circuited.

Upon completion of either "a" or "b", current is applied to the operating circuit terminals as per Table 4.

Plug adjustment is then made per table 4 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment.

The magnetic plug adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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.

TABLE 3
DIRECTIONAL UNIT SENSITIVITY

| Relay Type | Rating | Values for Min. Pick-Up † | | Phase Angle Relationship |
|--------------------|--------------------|---------------------------|---------|--------------------------|
| | | Volts ††† | Amperes | |
| CR | 0.5 - 2.5 2 - 6 | 1 | 2.0 | I leading V by 30° †† |
| | | 1 | 2.3 | I in-phase with V |
| | 4-12 | 1 | 4.0 | I leading V by 30° †† |
| | | 1 | 4.6 | I in-phase with V |
| CRP | 0.5-2.5 | 1 | 2.0 | I lagging V by 60° †† |
| CRD(Voltage Unit) | 2-6 | 1 | 4.0 | I in-phase with V |
| CRC | 0.5-2.5 | | | |
| CRD (Current Unit) | 2-6 | | 0.5 | In-phase |

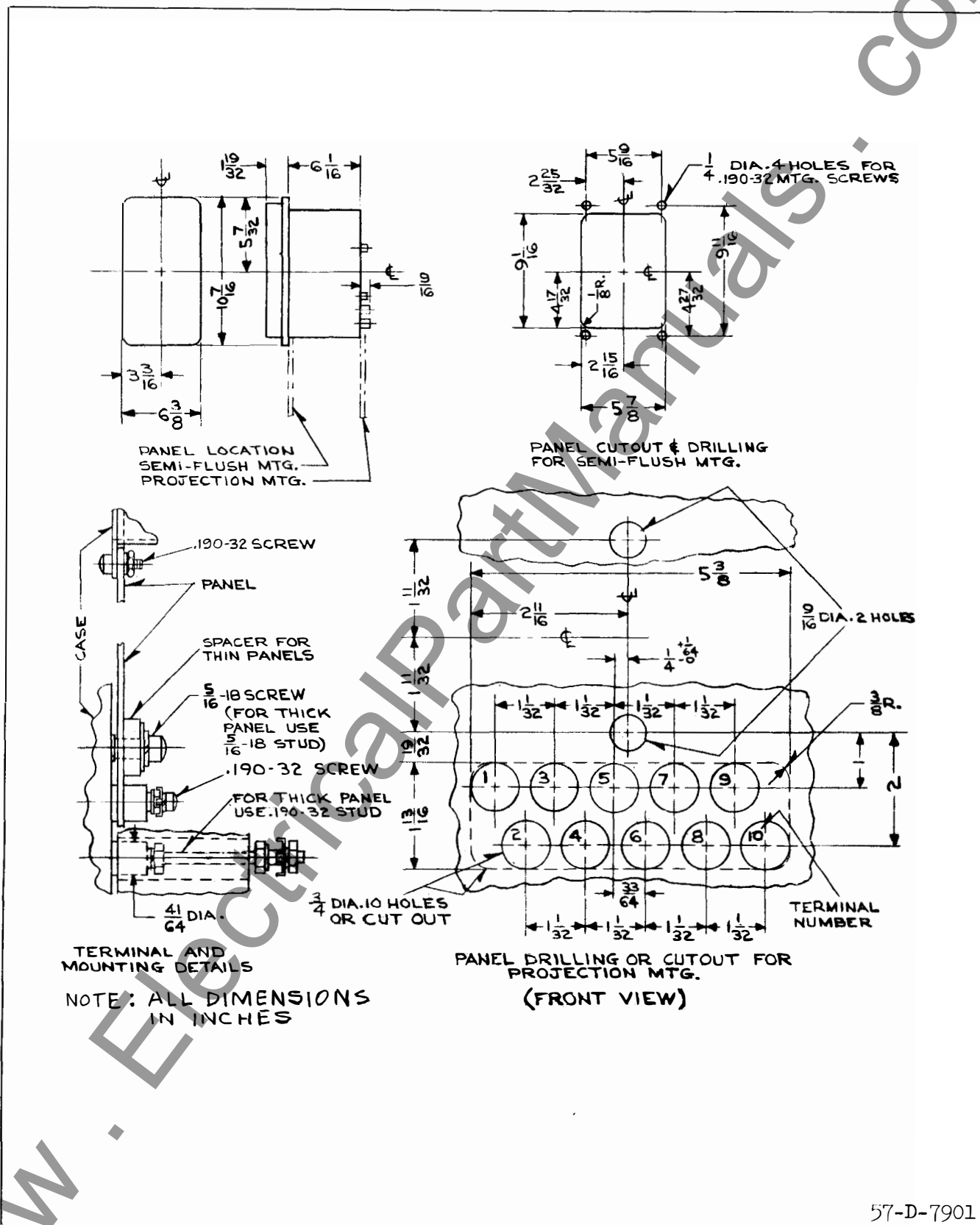
† The energization quantities are input quantities at the relay terminals.

†† Maximum torque angle.

††† For relays rated 240 volt, apply 2 volt.

TABLE 4
DIRECTIONAL UNIT CALIBRATION

| Relay Rating | Current Amperes | Both Plugs In Condition | Adjustment |
|----------------------|--------------------|--|--|
| 0.5 to 2.5 2 to 6 | 40 | Spurious Torque In Contact Closing Direction (Left Front View) | Right (Front-View) Plug Screwed Out Until Spurious Torque is Reversed |
| 4 to 12 | 80 | | |
| 0.5 to 2.5 2 to 6 | 40 | Spurious Torque In Contact Opening Direction (Right Front View) (Contacts remain open) | Left (Front View) Plug Screwed Out Until Spurious Torque is in Contact Closing Direction, Then the plug is screwed in until spurious torque is reversed. |
| 4 to 12 | 80 | | |



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Fig. 25. Outline and Drilling Plan for the Type CR, CRC and CRP Relays in the type FT21 Case.

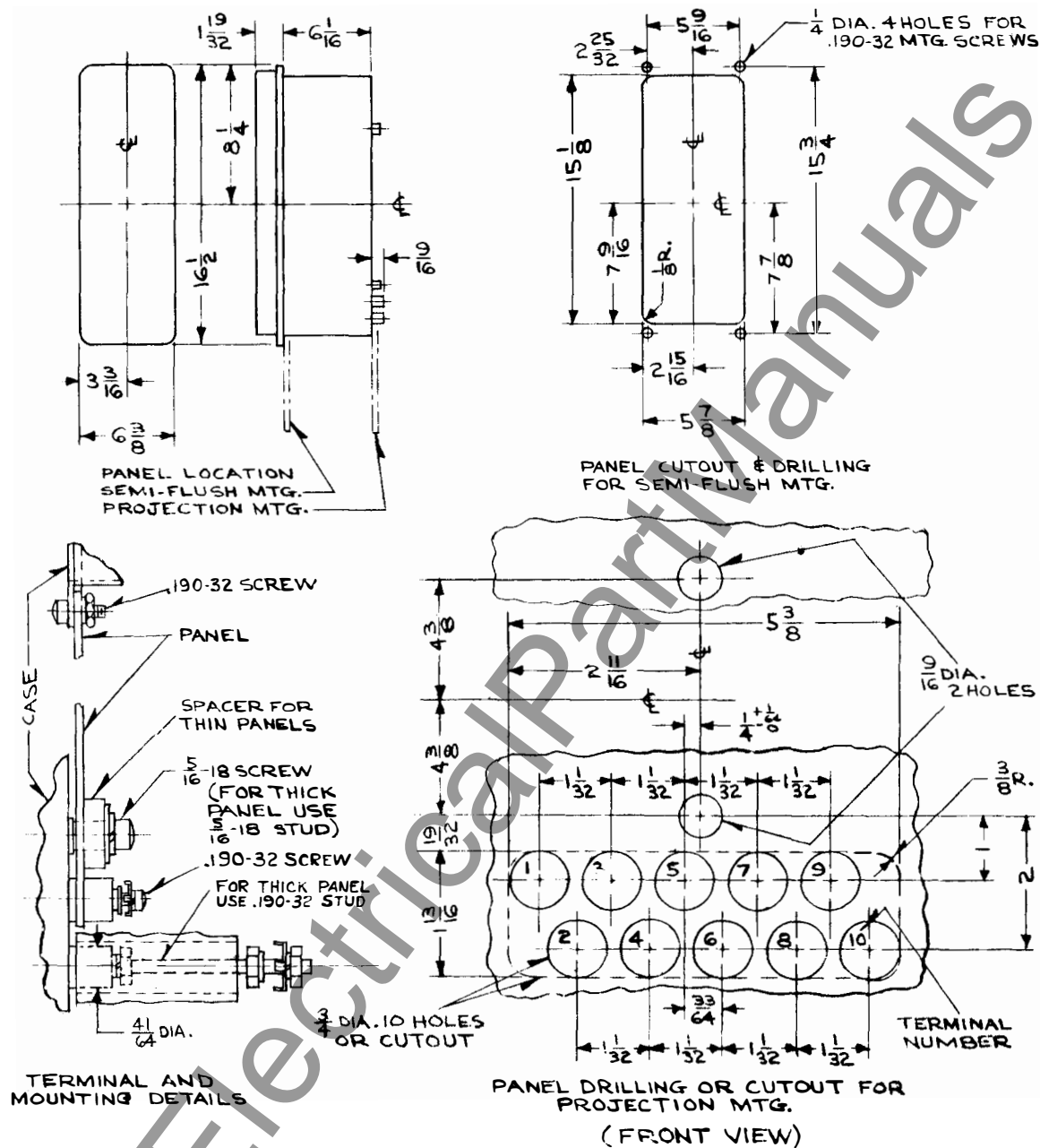


Fig. 26. Outline and Drilling Plan for the Type CRD Relay in the Type FT31 Case.

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INSTALLATION • OPERATION • MAINTENANCE I N S T R U C T I O N S

DIRECTIONAL OVERCURRENT RELAYS TYPES: CR, CRC, CRP AND CRD

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

APPLICATION

These induction type directional overcurrent relays are used to disconnect transmission and feeder circuits when current through them in a given direction exceeds a predetermined value.

CONTENTS

This instruction leaflet applies to the following types of relays:

- Type CR Voltage Polarized Phase Relay
- Type CRC Current Polarized Ground Relay
- Type CRP Voltage Polarized Ground Relay
- Type CRD Dual Polarized Ground Relay

CONSTRUCTION AND OPERATION

The various types of relays as outlined in the contents consist of a directional unit or units, an overcurrent unit, an indicating contactor switch unit and an indicating instantaneous trip unit when required. The type CRP and type CRD relays also utilize an internal phase-shifting mechanism. The principal component parts of the relay and their locations are shown in Figs. 1, 2, 3 and 4.

A. Overcurrent Unit (CO)

The overcurrent unit operates on the induction principle. A main tapped coil located on the center leg of an "E" type laminated structure produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap cause a contact closing torque.

B. Indicating Contactor Switch Unit (ICS)

The indicating contactor switch is a small d-c operated 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 target is reset from the outside of the case by a push rod located at the bottom of the cover.

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

C. Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated 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 the 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 target is reset from the outside of the case by a push rod located at the bottom of the cover.

A core screw accessible from the top of the switch provides the adjustable pickup range.

D. 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 locking nut. 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

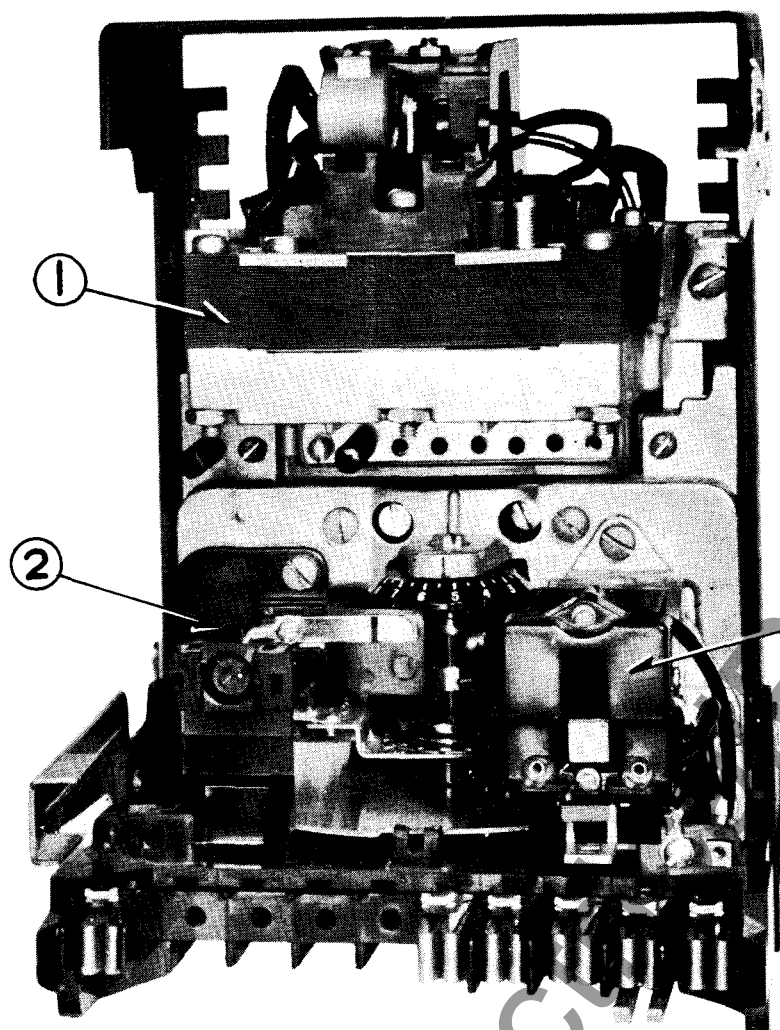


Fig. 1 Type CR Relay Without Case. 1-Directional Unit (D). 2-Overcurrent Unit (CO). 3-Indicating Contactor Switch (ICS).

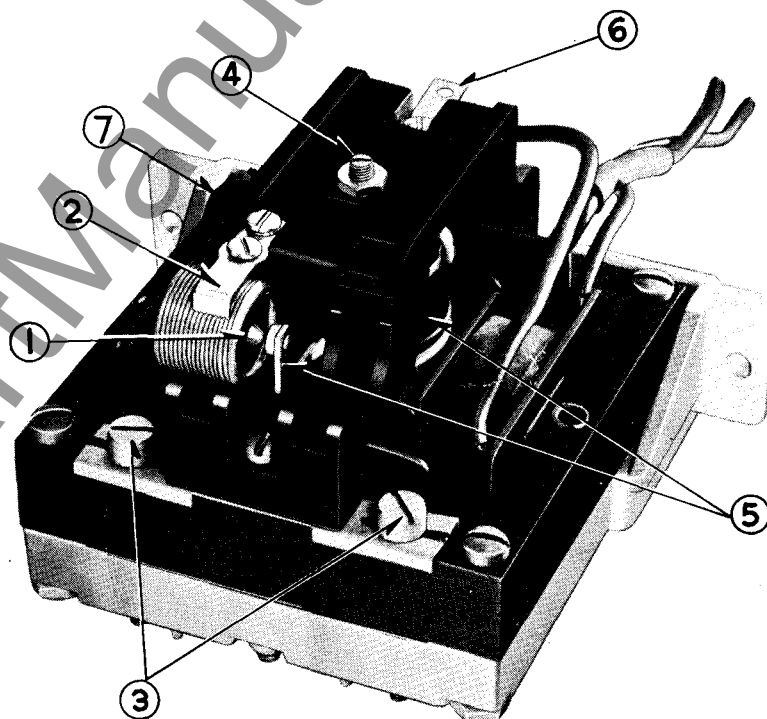


Fig. 2. Directional Unit. 1-Stationary Contact. 2-Stationary Contact pressure spring. 3-Magnetic adjusting plugs. 4-Upper bearing screw. 5-Moving element assembly. 6-Spring adjuster clamp. 7-Current Bias Vane.

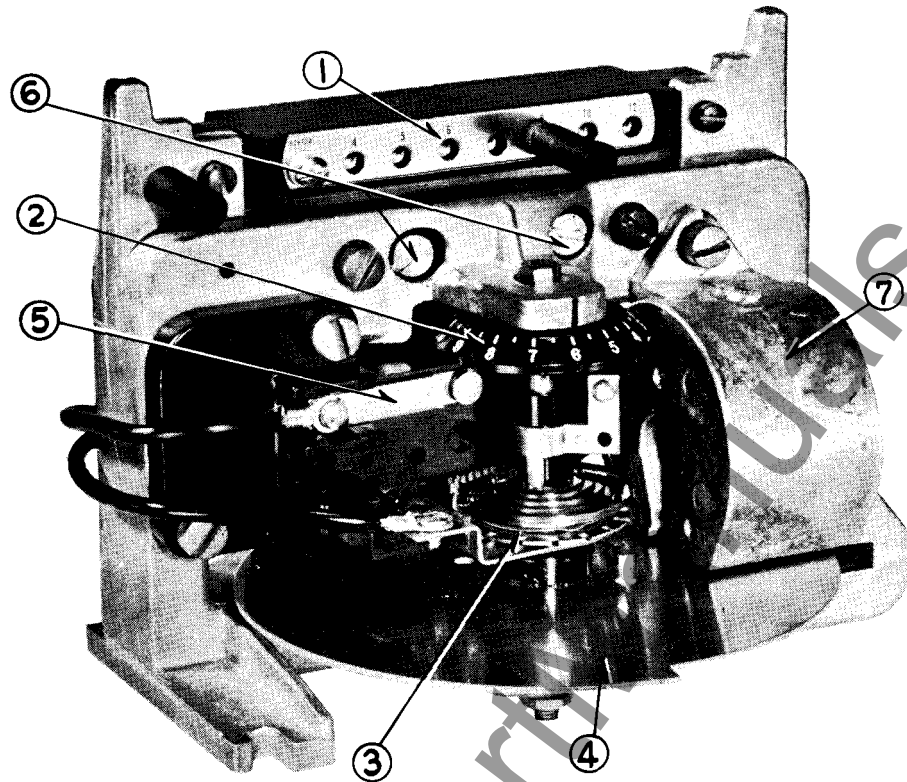


Fig. 3. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.

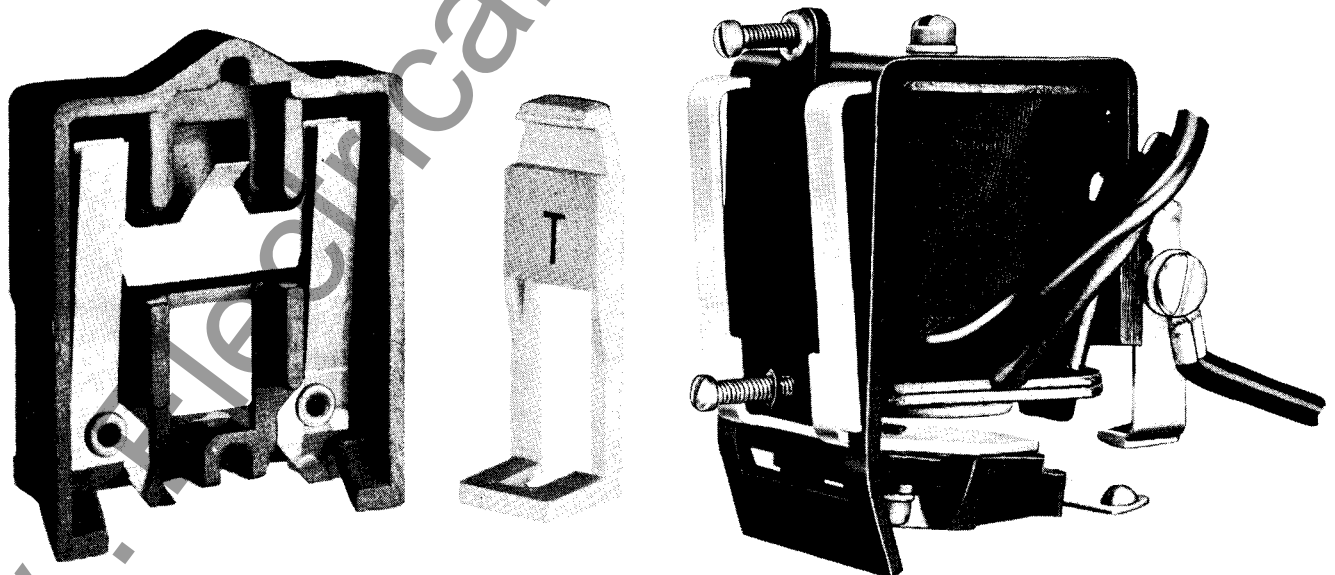


Fig. 4. Indicating Contactor Switch (ICS).

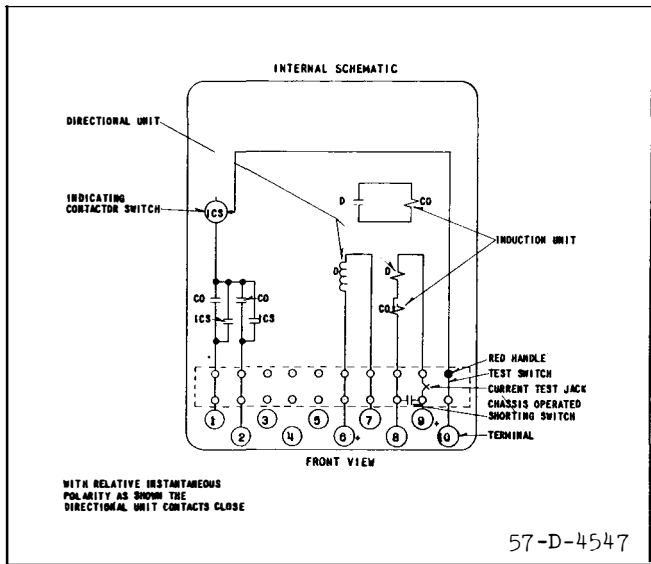


Fig. 5. Internal Schematic of double trip, directional over-current relay type CR in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted.

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 stops for the moving element contact arm are an integral part of the bridge.

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.

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.

The contacts of the directional unit are connected in series with the shading coil of the over-current unit, thus giving directional control of the overcurrent unit. This arrangement prevents the relay from operating for faults in the non-tripping direction.

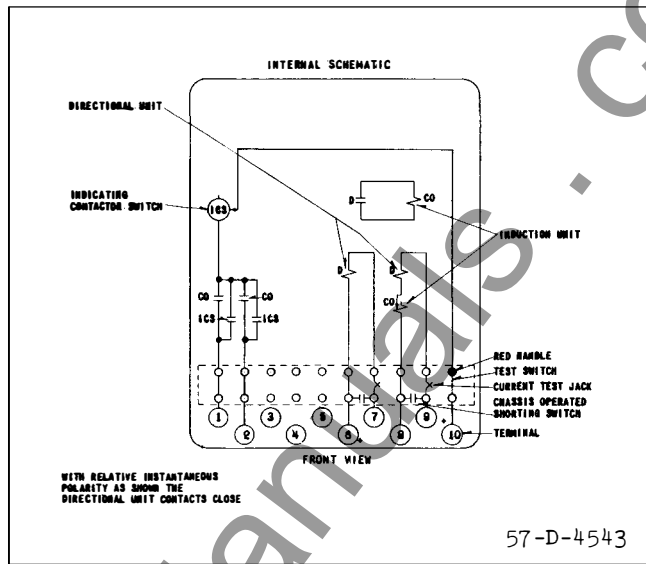


Fig. 6. Internal Schematic of double trip, directional over-current relay type CRC in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted.

CHARACTERISTICS

The time characteristics of the directional over-current relays are designated by specific numbers as indicated in Table I (e.g. CR-8).

TABLE I

| Time Characteristics | Designation |
|-------------------------|-------------|
| Short Time | 2 |
| Long Time | 5 |
| Definite Time | 6 |
| Moderately Inverse Time | 7 |
| Inverse Time | 8 |
| Very Inverse Time | 9 |
| Extremely Inverse Time | 11 |

The relays are generally available in the following overcurrent unit current ranges:

| Range | Taps |
|-----------|-----------------------------|
| 0.5 — 2.5 | 0.5 0.6 0.8 1.0 1.5 2.0 2.5 |
| 2 — 6 | 2 2.5 3 3.5 4 5 6 |
| 4 — 12 | 4 5 6 7 8 10 12 |

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 13 to 19. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

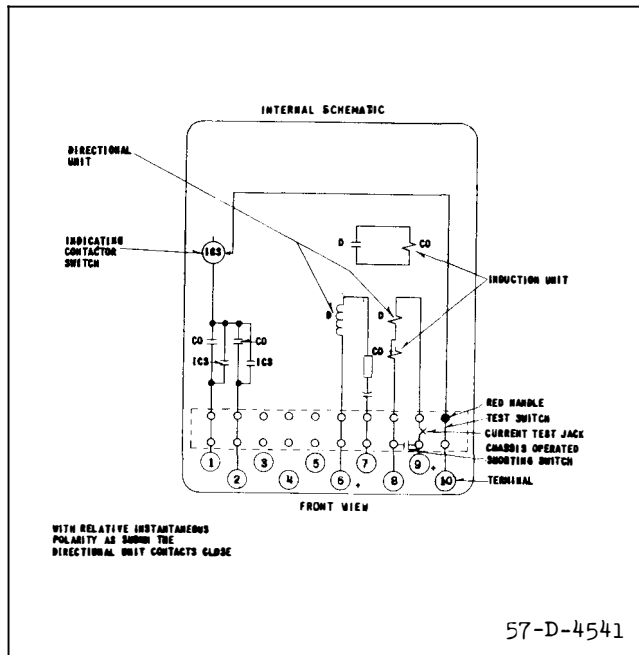


Fig. 7. Internal Schematic of double trip, directional over-current relay type CRP in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted.

Trip Circuit

The main 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.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting of lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

Indicating Contactor Switch —
0.2 amp tap 6.5 ohms d-c resistance
2.0 amp tap 0.15 ohms d-c resistance

Type CR Relay

This voltage polarized type 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 pick-up is 1 volt and 4 amperes at its maximum torque angle for the 4 to 12 ampere range relays and 1 volt and 2 amperes for the 2 to 6 ampere and 0.5 to 2.5 ampere range relays.

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

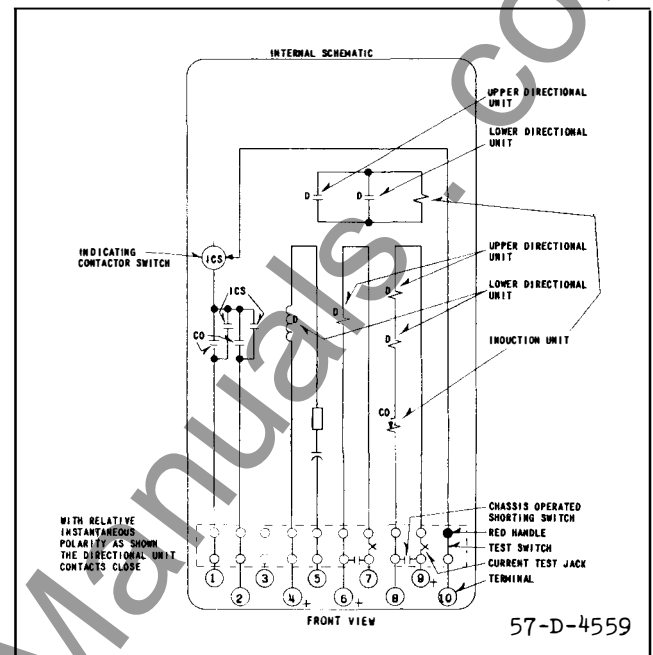


Fig. 8. Internal Schematic of double trip, directional over-current relay type CRD in type FT31 Case. For the single trip relay the circuits associated with terminal 2 are omitted.

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 Fig. 21.

Type CRC Relay

The current polarized type relay is intended for ground fault protection and operates on residual current. See Fig. 23. The type CRC relay has its maximum torque when the operating current leads the polarizing current by approximately 40° . The directional unit minimum pick-up is 0.5 ampere in each winding in phase for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

Type CRP Relay

The voltage polarized relay is intended for ground fault protection and has its maximum torque when the current lags the voltage by approximately 60° . The shifting of the maximum torque angle has been accomplished by the use of an internally mounted phase shifter as illustrated in Fig. 7.

The type CRP relay operates on residual voltage and residual current. See Fig. 22.

The directional unit minimum pick-up is 1 volt and 2 amperes at its maximum torque angle for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

Type CRD Relay

The dual polarized type relay is intended for ground fault protection. The relay can be polarized from a potential source, from a local ground source, or

TYPES CR, CRC, CRP AND CRD RELAYS

from both simultaneously.

The type CRD relay utilizes the directional unit of the type CRC relay in conjunction with the directional unit and phase shifting mechanism of the type CRP relay. The directional contacts are connected in parallel to torque-control a common overcurrent unit. See Fig. 8.

The current-polarized directional unit of the type CRD relay operates on residual currents while the

potential polarized directional unit of the type CRD relay operates on residual voltage and residual current. See Fig. 24.

For the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays, the minimum pick-up of the current polarized unit is 0.5 ampere in each winding in-phase and the minimum pick-up for the voltage polarized unit is 1 volt and 2 amperes with the current lagging voltage by 60° .

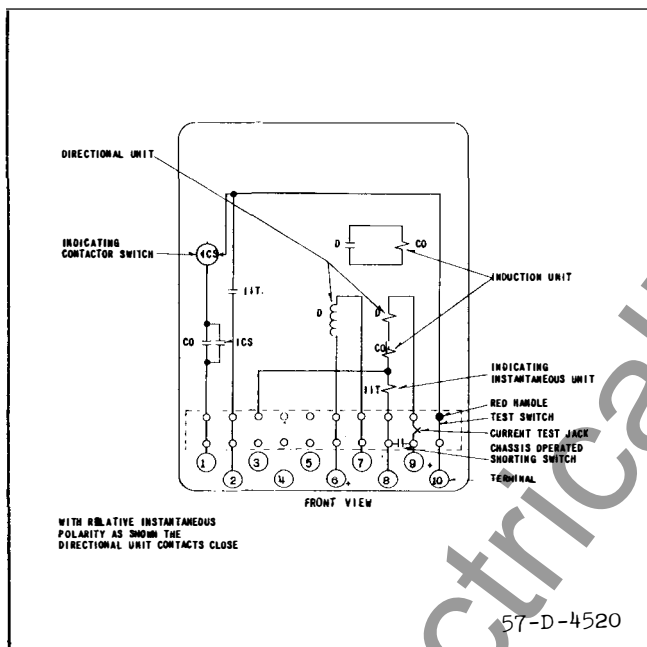


Fig. 9. Internal Schematic of single trip directional control relay Type CR with Indicating Instantaneous Trip Unit, in Type FT21 Case.

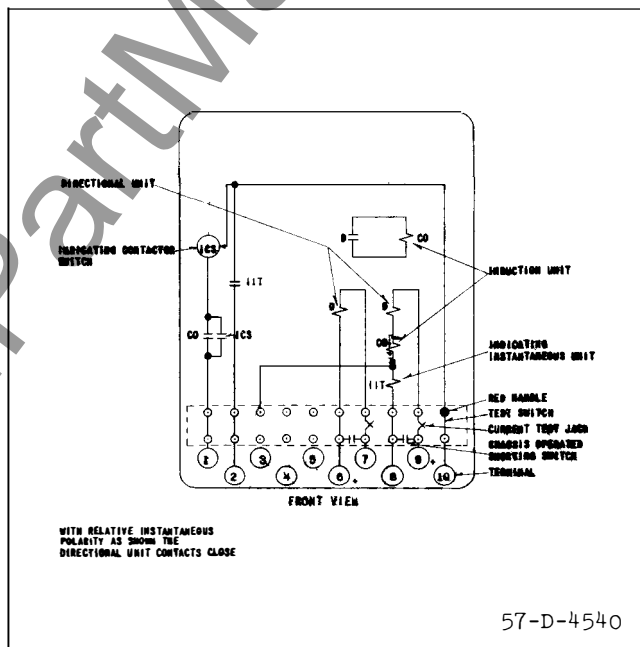


Fig. 10. Internal Schematic of single trip directional control relay Type CRC with Indicating Instantaneous Trip Unit, in Type FT21 Case.

ENERGY REQUIREMENTS

CR-2, CRC-2, CRP-2, CRD-2 OVERCURRENT UNITS

| AMPERE RANGE | TAP | CONTINUOUS RATING (AMPERES) | ONE SECOND RATING* (AMPERES) | POWER FACTOR ANGLE ϕ | VOLT AMPERES** | | | |
|-----------------|------|-----------------------------------|------------------------------------|---------------------------------|----------------------------|------------------------------------|-------------------------------------|-------------------------------------|
| | | | | | AT TAP VALUE CURRENT | AT 3 TIMES TAP VALUE CURRENT | AT 10 TIMES TAP VALUE CURRENT | AT 20 TIMES TAP VALUE CURRENT |
| 0.5/2.5 | 0.5 | 0.91 | 28 | 58 | 4.8 | 39.6 | 256 | 790 |
| | 0.6 | 0.96 | 28 | 57 | 4.9 | 39.8 | 270 | 851 |
| | 0.8 | 1.18 | 28 | 53 | 5.0 | 42.7 | 308 | 1024 |
| | 1.0 | 1.37 | 28 | 50 | 5.3 | 45.4 | 348 | 1220 |
| | 1.5 | 1.95 | 28 | 40 | 6.2 | 54.4 | 435 | 1740 |
| | 2.0 | 2.24 | 28 | 36 | 7.2 | 65.4 | 580 | 2280 |
| | 2.5 | 2.50 | 28 | 29 | 7.9 | 73.6 | 700 | 2850 |
| 2/6 | 2.0 | 3.1 | 110 | 59 | 5.04 | 38.7 | 262 | 800 |
| | 2.5 | 4.0 | 110 | 55 | 5.13 | 39.8 | 280 | 920 |
| | 3.0 | 4.4 | 110 | 51 | 5.37 | 42.8 | 312 | 1008 |
| | 3.5 | 4.8 | 110 | 47 | 5.53 | 42.8 | 329 | 1120 |
| | 4.0 | 5.2 | 110 | 45 | 5.72 | 46.0 | 360 | 1216 |
| | 5.0 | 5.6 | 110 | 41 | 5.90 | 50.3 | 420 | 1500 |
| | 6.0 | 6.0 | 110 | 37 | 6.54 | 54.9 | 474 | 1800 |
| 4/12 | 4.0 | 7.3 | 230 | 65 | 4.92 | 39.1 | 268 | 848 |
| | 5.0 | 8.0 | 230 | 50 | 5.20 | 42.0 | 305 | 1020 |
| | 6.0 | 8.8 | 230 | 47 | 5.34 | 44.1 | 330 | 1128 |
| | 7.0 | 9.6 | 230 | 46 | 5.53 | 45.8 | 364 | 1260 |
| | 8.0 | 10.4 | 230 | 43 | 5.86 | 49.9 | 400 | 1408 |
| | 10.0 | 11.2 | 230 | 37 | 6.6 | 55.5 | 470 | 1720 |
| | 12.0 | 12.0 | 230 | 34 | 7.00 | 62.3 | 528 | 2064 |

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

ϕ Degrees current lags voltage at tap value current.

** Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS

**CR-5, CRC-5, CRP-5, CRD-5,
CR-6, CRC-6, CRP-6, CRD-6 OVERCURRENT UNITS**

VOLT AMPERES**

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating * (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|-------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 69 | 3.92 | 20.6 | 103 | 270 |
| | (0.6 | 3.1 | 88 | 68 | 3.96 | 20.7 | 106 | 288 |
| | (0.8 | 3.7 | 88 | 67 | 3.96 | 21 | 114 | 325 |
| | (1.0 | 4.1 | 88 | 66 | 4.07 | 21.4 | 122 | 360 |
| | (1.5 | 5.7 | 88 | 62 | 4.19 | 23.2 | 147 | 462 |
| | (2.0 | 6.8 | 88 | 60 | 4.30 | 24.9 | 168 | 548 |
| | (2.5 | 7.7 | 88 | 58 | 4.37 | 26.2 | 180 | 630 |
| 2/6 | (2 | 8 | 230 | 67 | 3.88 | 21 | 110 | 308 |
| | (2.5 | 8.8 | 230 | 66 | 3.90 | 21.6 | 118 | 342 |
| | (3 | 9.7 | 230 | 64 | 3.93 | 22.1 | 126 | 381 |
| | (3.5 | 10.4 | 230 | 63 | 4.09 | 23.1 | 136 | 417 |
| | (4 | 11.2 | 230 | 62 | 4.12 | 23.5 | 144 | 448 |
| | (5 | 12.5 | 230 | 59 | 4.20 | 24.8 | 162 | 540 |
| | (6 | 13.7 | 230 | 57 | 4.38 | 26.5 | 183 | 624 |
| 4/12 | (4 | 16 | 460 | 65 | 4.00 | 22.4 | 126 | 376 |
| | (5 | 18.8 | 460 | 63 | 4.15 | 23.7 | 143 | 450 |
| | (6 | 19.3 | 460 | 61 | 4.32 | 25.3 | 162 | 531 |
| | (7 | 20.8 | 460 | 59 | 4.35 | 26.4 | 183 | 611 |
| | (8 | 22.5 | 460 | 56 | 4.40 | 27.8 | 204 | 699 |
| | (10 | 25 | 460 | 53 | 4.60 | 30.1 | 247 | 880 |
| | (12 | 28 | 460 | 47 | 4.92 | 35.6 | 288 | 1056 |

CR-7, CRC-7, CRP-7 & CRD-7 OVERCURRENT UNITS

VOLT AMPERES**

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating* (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 68 | 3.88 | 20.7 | 103 | 278 |
| | (0.6 | 3.1 | 88 | 67 | 3.93 | 20.9 | 107 | 288 |
| | (0.8 | 3.7 | 88 | 66 | 3.93 | 21.1 | 114 | 320 |
| | (1.0 | 4.1 | 88 | 64 | 4.00 | 21.6 | 122 | 356 |
| | (1.5 | 5.7 | 88 | 61 | 4.08 | 22.9 | 148 | 459 |
| | (2.0 | 6.8 | 88 | 58 | 4.24 | 24.8 | 174 | 552 |
| | (2.5 | 7.7 | 88 | 56 | 4.38 | 25.9 | 185 | 640 |
| 2/6 | (2 | 8 | 230 | 66 | 4.06 | 21.3 | 111 | 306 |
| | (2.5 | 8.8 | 230 | 63 | 4.07 | 21.8 | 120 | 342 |
| | (3 | 9.7 | 230 | 63 | 4.14 | 22.5 | 129 | 366 |
| | (3.5 | 10.4 | 230 | 62 | 4.34 | 23.4 | 141 | 413 |
| | (4 | 11.2 | 230 | 61 | 4.34 | 23.8 | 149 | 448 |
| | (5 | 12.5 | 230 | 59 | 4.40 | 25.2 | 163 | 530 |
| | (6 | 13.7 | 230 | 58 | 4.62 | 27 | 183 | 624 |
| 4/12 | (4 | 16 | 460 | 64 | 4.24 | 22.8 | 129 | 392 |
| | (5 | 18.8 | 460 | 61 | 4.30 | 24.2 | 149 | 460 |
| | (6 | 19.3 | 460 | 60 | 4.62 | 25.9 | 168 | 540 |
| | (7 | 20.8 | 460 | 58 | 4.69 | 27.3 | 187 | 626 |
| | (8 | 22.5 | 460 | 55 | 4.80 | 29.8 | 211 | 688 |
| | (10 | 25 | 460 | 51 | 5.20 | 33 | 260 | 860 |
| | (12 | 28 | 460 | 46 | 5.40 | 37.5 | 308 | 1032 |

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

ϕ Degrees current lags voltage at tap value current.

** Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS

CR-8, CRC-8, CRP-8 & CRD-8
CR-9, CRC-9, CRP-9 & CRD-9 OVERCURRENT UNITS

VOLT AMPERES**

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating* (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 72 | 2.38 | 21 | 132 | 350 |
| | (0.6 | 3.1 | 88 | 71 | 2.38 | 21 | 134 | 365 |
| | (0.8 | 3.7 | 88 | 69 | 2.40 | 21.1 | 142 | 400 |
| | (1.0 | 4.1 | 88 | 67 | 2.42 | 21.2 | 150 | 440 |
| | (1.5 | 5.7 | 88 | 62 | 2.51 | 22 | 170 | 530 |
| | (2.0 | 6.8 | 88 | 57 | 2.65 | 23.5 | 200 | 675 |
| | (2.5 | 7.7 | 88 | 53 | 2.74 | 24.8 | 228 | 800 |
| 2/6 | (2 | 8 | 230 | 70 | 2.38 | 21 | 136 | 360 |
| | (2.5 | 8.8 | 230 | 66 | 2.40 | 21.1 | 142 | 395 |
| | (3 | 9.7 | 230 | 64 | 2.42 | 21.5 | 149 | 430 |
| | (3.5 | 10.4 | 230 | 62 | 2.48 | 22 | 157 | 470 |
| | (4 | 11.2 | 230 | 60 | 2.53 | 22.7 | 164 | 500 |
| | (5 | 12.5 | 230 | 58 | 2.64 | 24 | 180 | 580 |
| | (6 | 13.7 | 230 | 56 | 2.75 | 25.2 | 198 | 660 |
| 4/12 | (4 | 16 | 460 | 68 | 2.38 | 21.3 | 146 | 420 |
| | (5 | 18.8 | 460 | 63 | 2.46 | 21.8 | 168 | 480 |
| | (6 | 19.3 | 460 | 60 | 2.54 | 22.6 | 172 | 550 |
| | (7 | 20.8 | 460 | 57 | 2.62 | 23.6 | 190 | 620 |
| | (8 | 22.5 | 460 | 54 | 2.73 | 24.8 | 207 | 700 |
| | (10 | 25 | 460 | 48 | 3.00 | 27.8 | 248 | 850 |
| | (12 | 28 | 460 | 45 | 3.46 | 31.4 | 292 | 1020 |

CR-11, CRC-11
CRP-11 & CRD-11 OVERCURRENT UNITS

VOLT AMPERES**

| AMPERE RANGE | TAP | CONTINUOUS RATING (AMPERES) | ONE SECOND RATING* (AMPERES) | POWER FACTOR ANGLE ϕ | AT TAP VALUE CURRENT | AT 3 TIMES TAP VALUE CURRENT | AT 10 TIMES TAP VALUE CURRENT | AT 20 TIMES TAP VALUE CURRENT |
|--------------|------|-----------------------------|------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | 0.5 | 1.7 | 56 | 36 | 0.72 | 6.54 | 71.8 | 250 |
| | 0.6 | 1.9 | 56 | 34 | 0.75 | 6.80 | 75.0 | 267 |
| | 0.8 | 2.2 | 56 | 30 | 0.81 | 7.46 | 84.0 | 298 |
| | 1.0 | 2.5 | 56 | 27 | 0.89 | 8.30 | 93.1 | 330 |
| | 1.5 | 3.0 | 56 | 22 | 1.13 | 10.04 | 115.5 | 411 |
| | 2.0 | 3.5 | 56 | 17 | 1.30 | 11.95 | 136.3 | 502 |
| | 2.5 | 3.8 | 56 | 16 | 1.48 | 13.95 | 160.0 | 610 |
| 2/6 | 2.0 | 7.0 | 230 | 32 | 0.73 | 6.30 | 74.0 | 264 |
| | 2.5 | 7.8 | 230 | 30 | 0.78 | 7.00 | 78.5 | 285 |
| | 3.0 | 8.3 | 230 | 27 | 0.83 | 7.74 | 84.0 | 309 |
| | 3.5 | 9.0 | 230 | 24 | 0.88 | 8.20 | 89.0 | 340 |
| | 4.0 | 10.0 | 230 | 23 | 0.96 | 9.12 | 102.0 | 372 |
| | 5.0 | 11.0 | 230 | 20 | 1.07 | 9.80 | 109.0 | 430 |
| | 6.0 | 12.0 | 230 | 20 | 1.23 | 11.34 | 129.0 | 504 |
| 4/12 | 4.0 | 14 | 460 | 29 | 0.79 | 7.08 | 78.4 | 296 |
| | 5.0 | 16 | 460 | 25 | 0.89 | 8.00 | 90.0 | 340 |
| | 6.0 | 17 | 460 | 22 | 1.02 | 9.18 | 101.4 | 378 |
| | 7.0 | 18 | 460 | 20 | 1.10 | 10.00 | 110.0 | 454 |
| | 8.0 | 20 | 460 | 18 | 1.23 | 11.1 | 124.8 | 480 |
| | 10.0 | 22 | 460 | 17 | 1.32 | 14.9 | 131.6 | 600 |
| | 12.0 | 26 | 460 | 16 | 1.8 | 16.3 | 180.0 | 720 |

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

ϕ Degrees current lags voltage at tap value current.

** Voltages taken with Rectox type voltmeter.

DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

| Relay Type | Rating | Volt Amperes Δ | Power Factor Angle ϕ |
|------------------|---------------|-----------------------|---------------------------|
| CR | 132* Volts | 11.5 | 58° Lag |
| CRC | 230** Amperes | 1.45 | 8° Lag |
| CRP | 208*** Volts | 11.2 | 28° Lead |
| CRD Current Unit | 230** Amperes | 1.45 | 8° Lag |
| CRD Voltage Unit | 208*** Volts | 11.2 | 28° Lead |

ϕ Degrees current leads or lags voltage at 120 volts on voltage polarized units and 5 amperes on current polarized units.

Δ Voltages taken with rectox type voltmeter - Burden of Voltage polarized units taken at 120 volts - Burden of current polarized units taken at 5 amperes.

* Continuous rating.

** One second rating.

*** 30 second rating.

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

| Relay Type | Range Amps | Continuous Rating (Amperes) | One Second Rating* (Amperes) | Power Factor Angle ϕ | VOLT AMPERES** | | | |
|------------|------------|-----------------------------|------------------------------|---------------------------|------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| | | | | | At Minimum Tap Value Current | At 3 Times Minimum Tap Value Current | At 10 Times Minimum Tap Value Current | At 20 Times Minimum Tap Value Current |
| CR | 2-6 | 10 | 230 | 34.5 | 0.44 | 4.08 | 48.0 | 182.0 |
| | 4-12 | 12 | 280 | 25.0 | 0.53 | 5.0 | 59.2 | 236.0 |
| CRC | 0.5-2.5 | - | 230 | 44.0 | 0.033 | 0.30 | 3.3 | 14.2 |
| | 2-6 | - | 230 | 42.5 | 0.58 | 5.28 | 58.0 | 240.0 |
| CRP | 0.5-2.5 | 10 | 230 | 34.5 | 0.03 | 0.23 | 2.8 | 11.5 |
| | 2-6 | 10 | 230 | 34.5 | 0.44 | 4.08 | 48.0 | 182.0 |
| CRD | 0.5-2.5 | 10 | 230 | 45.0 | 0.07 | 0.59 | 6.6 | 26.0 |
| | 2-6 | 10 | 230 | 45.0 | 1.04 | 9.9 | 106.0 | 420.0 |

ϕ Degrees current lags voltage at tap value current.

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

** Voltages taken with Rectox type voltmeter.

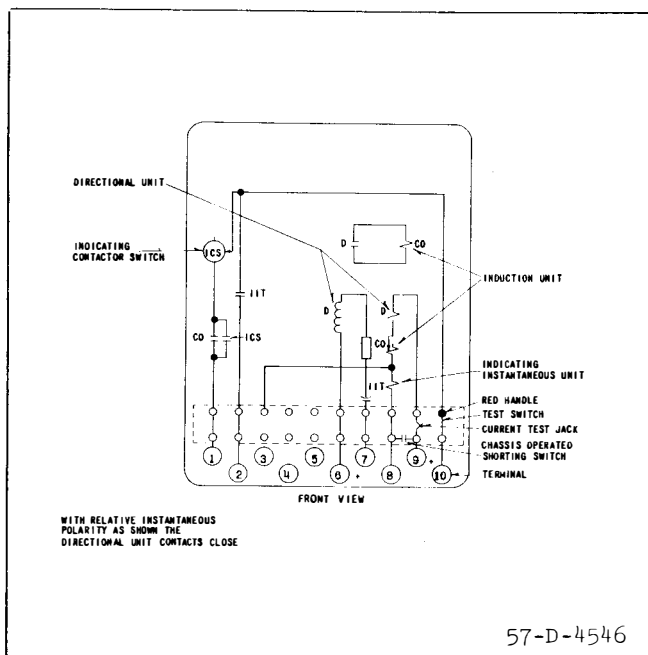


Fig. 11. Internal Schematic of single trip directional control relay Type CRP with Indicating Instantaneous Trip Unit, in Type FT21 Case.

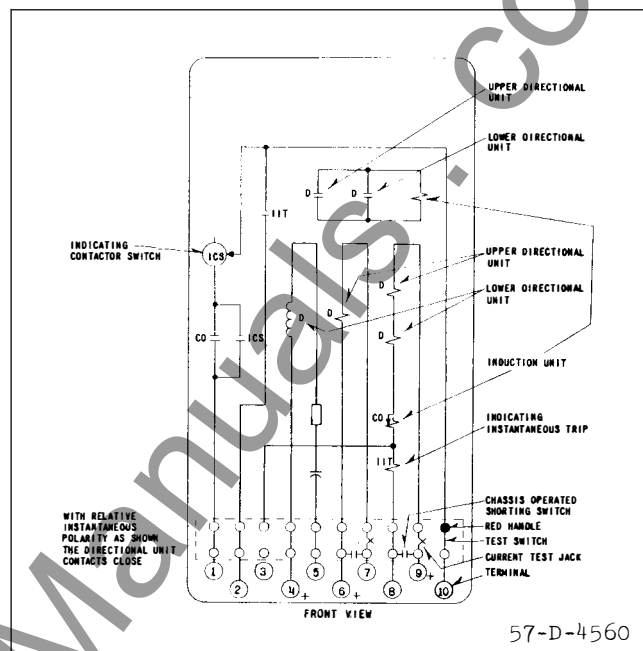


Fig. 12. Internal Schematic of single trip directional control relay Type CRD with Indicating Instantaneous Trip Unit, in Type FT31 Case.

SETTINGS

A. Overcurrent Unit (CO)

The overcurrent unit settings can be defined either by tap settings and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing the screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original

tap position.

Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

B. Indicating Contactor Switch (ICS)

* The only setting required on the ICS unit is the selection of the 0.2 to 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

C. Indicating Instantaneous Trip (IIT)

The core screw must be adjusted to the value of pick-up desired.

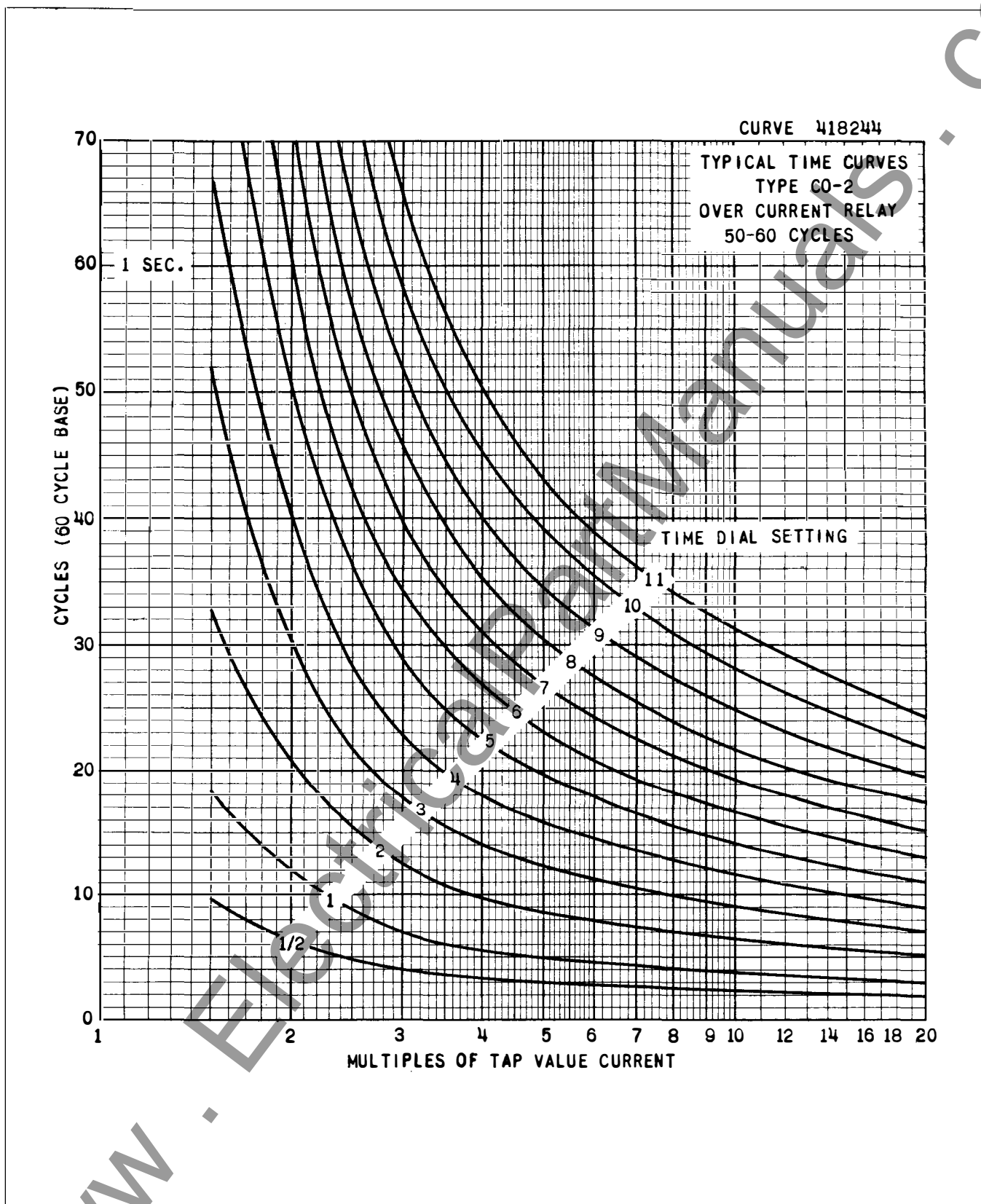


Fig. 13. Typical Time Curves For Relays With CO-2 Units.

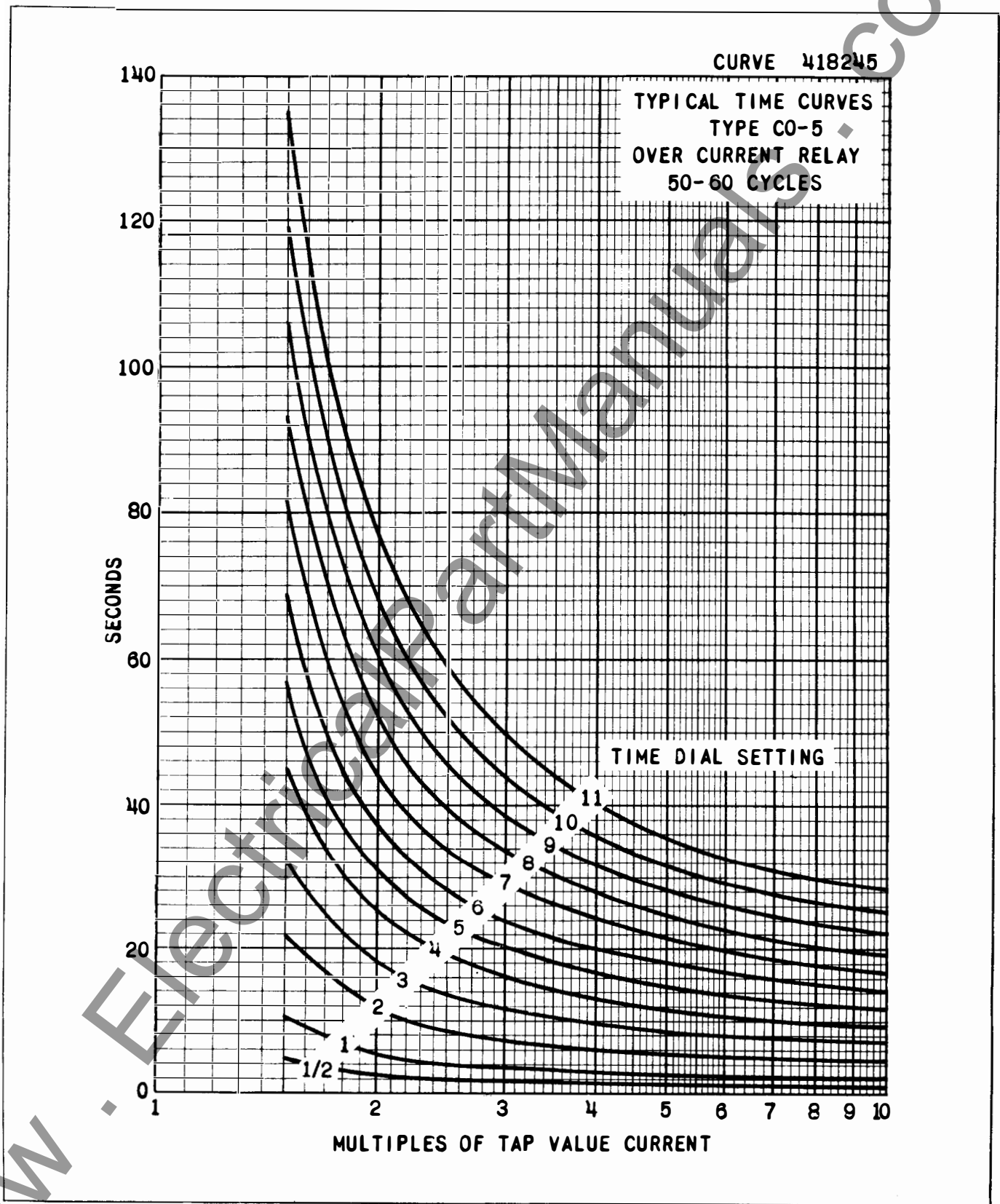


Fig. 14. Typical Time Curves For Relays With CO-5 Units.

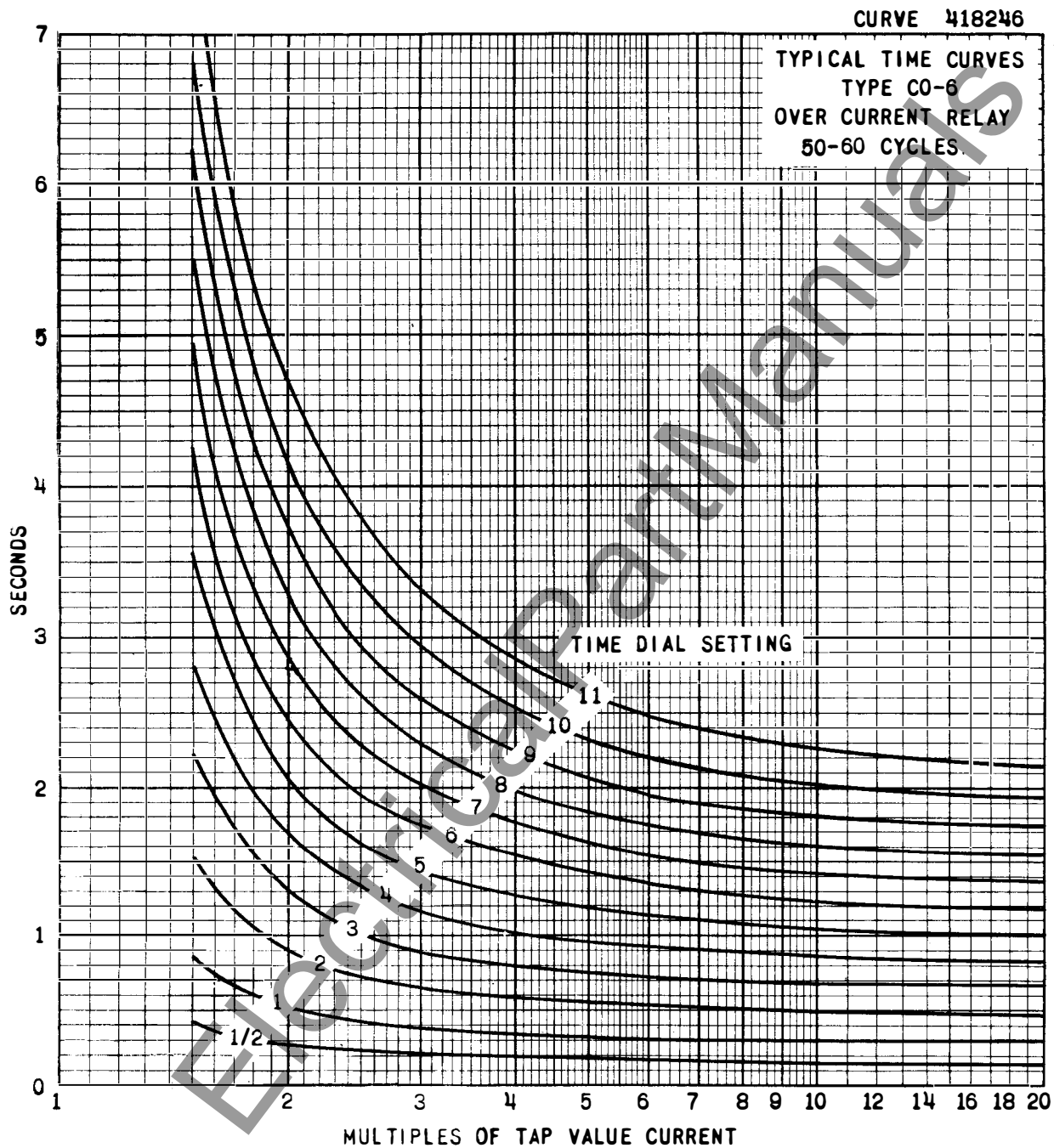


Fig. 15. Typical time curves for relays with CO-6 units.

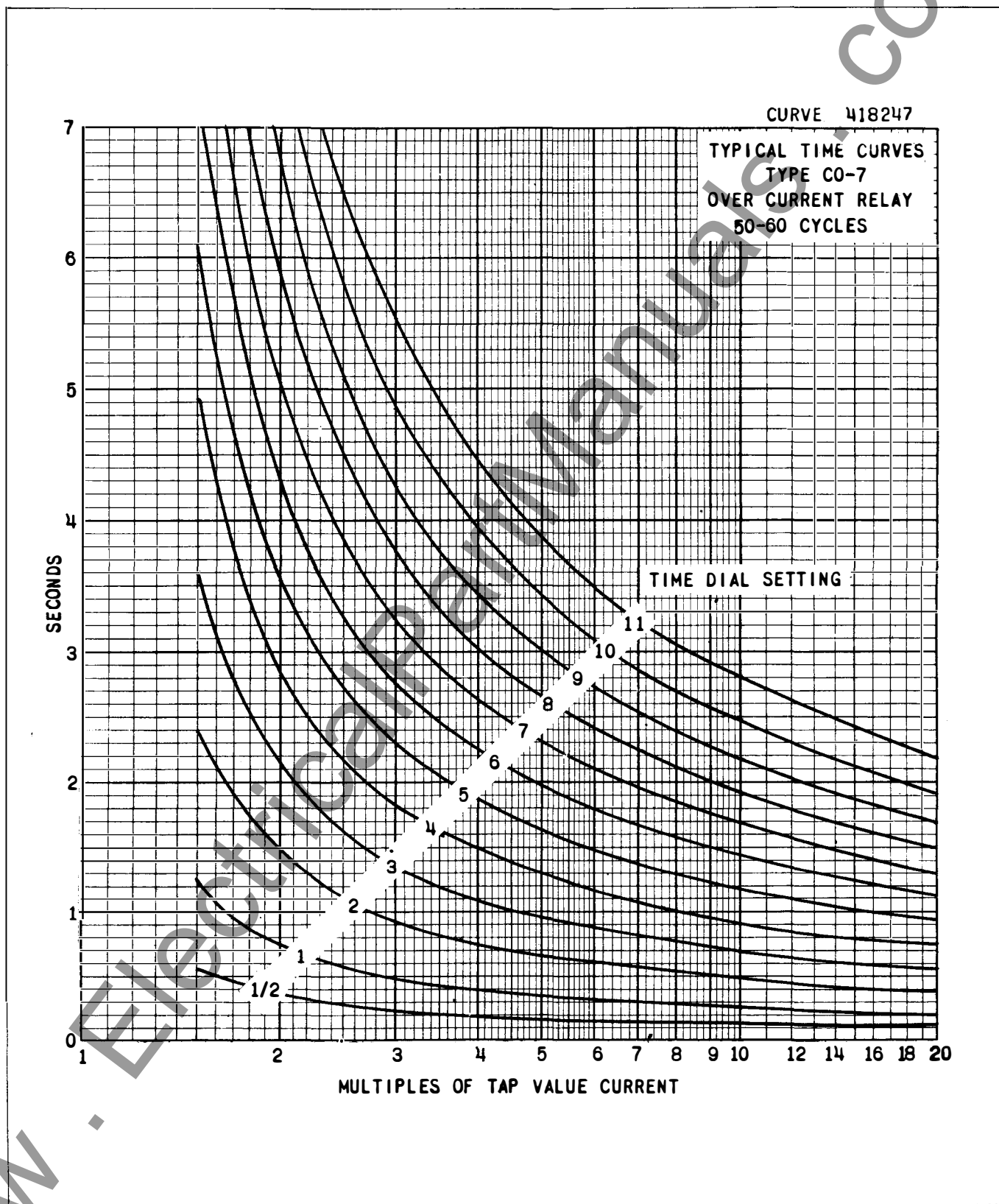


Fig. 16. Typical time curves for relays with CO-7 units.

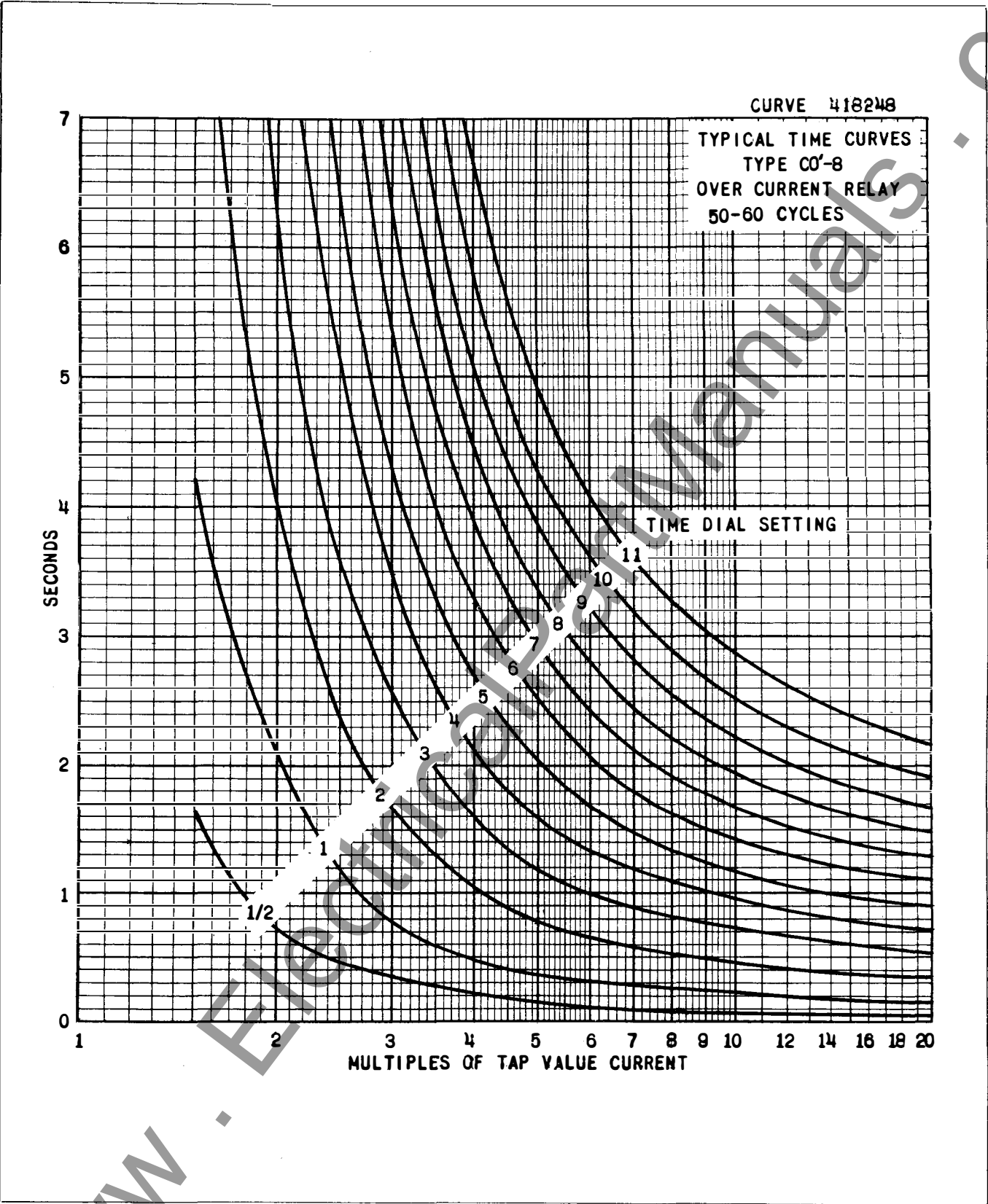


Fig. 17. Typical time curves for relays with CO-8 units.

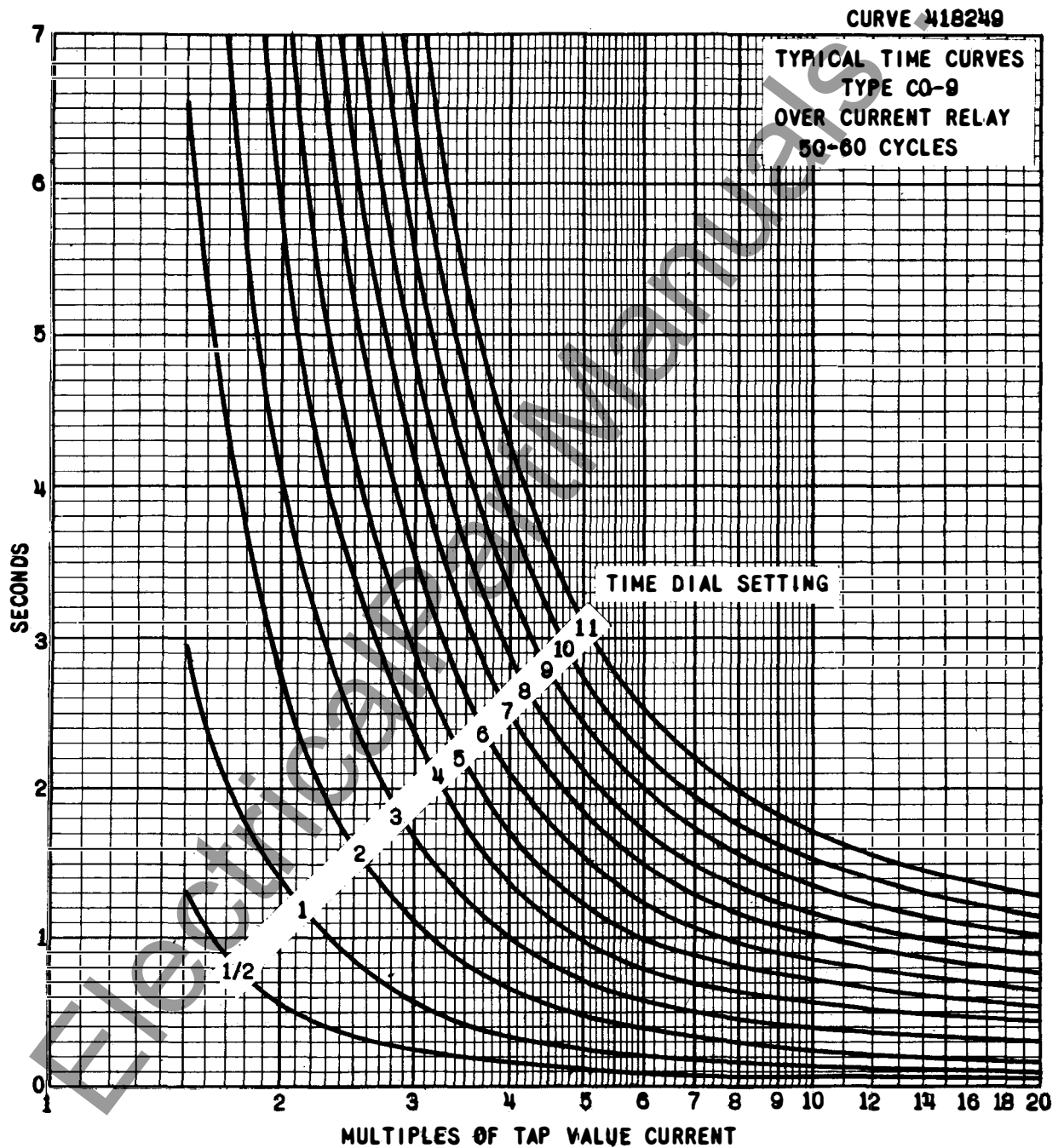


Fig. 18. Typical time curves for relays with CO-9 units.

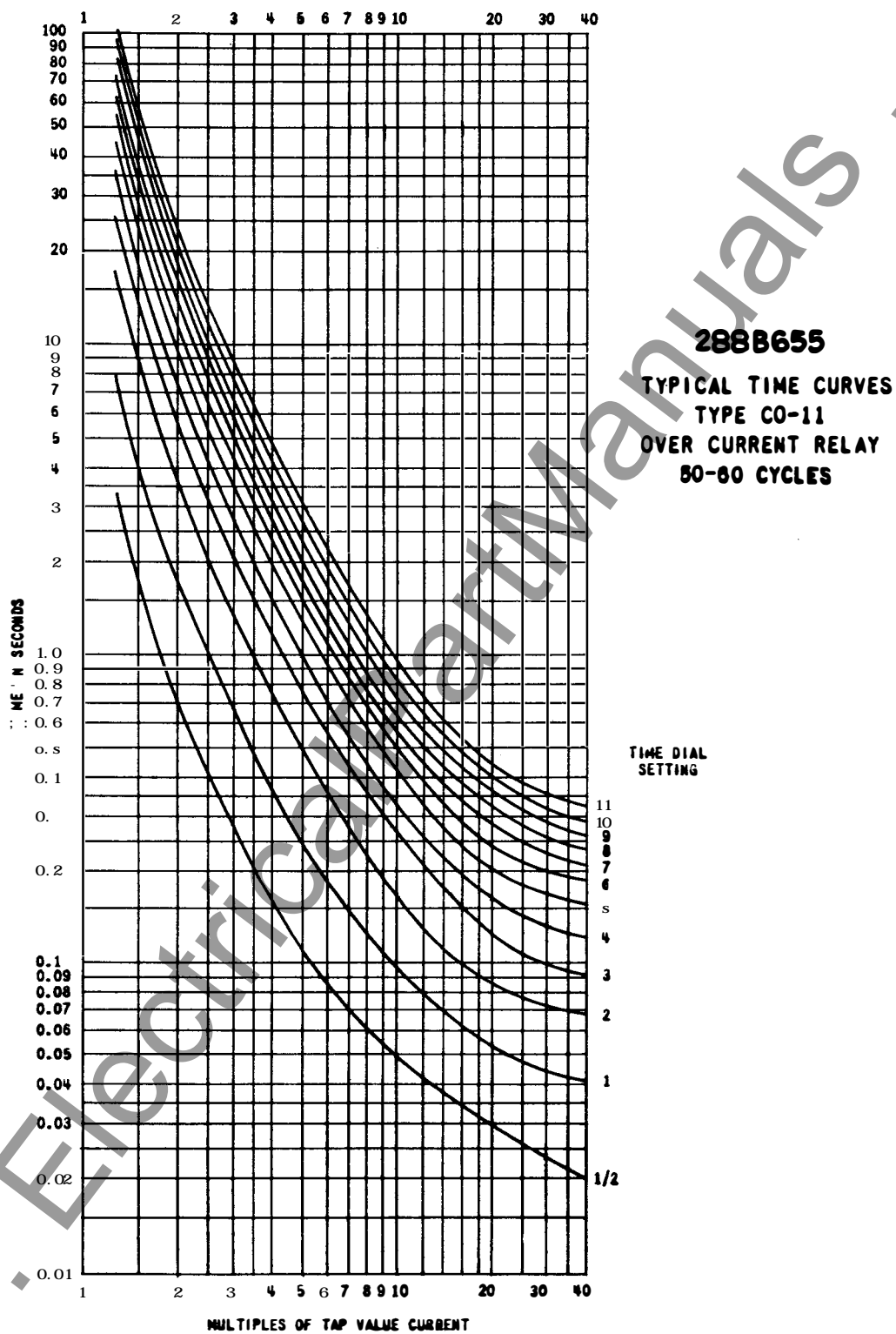


Fig. 19. Typical time curves for relays with CO-11 units.

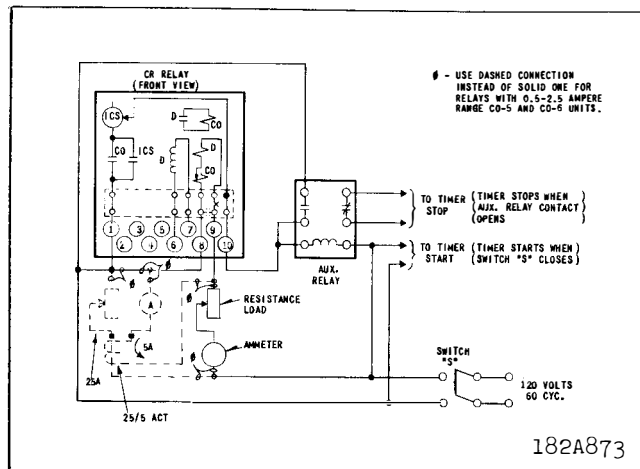


Fig. 20. Diagram of test connections of the overcurrent unit.

The nameplate data will furnish the actual current range that may be obtained from IIT unit.

D. Directional Unit (D)

No setting is required.

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 type F'T projection case or by means of the four mounting holes on the flange for the semi-flush type F'T case. Either of the studs 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 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 studs and then turning the proper nut with a wrench.

The external a-c connections of the directional overcurrent relays are shown in Figs. 21 to 24.

ADJUSTMENTS 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

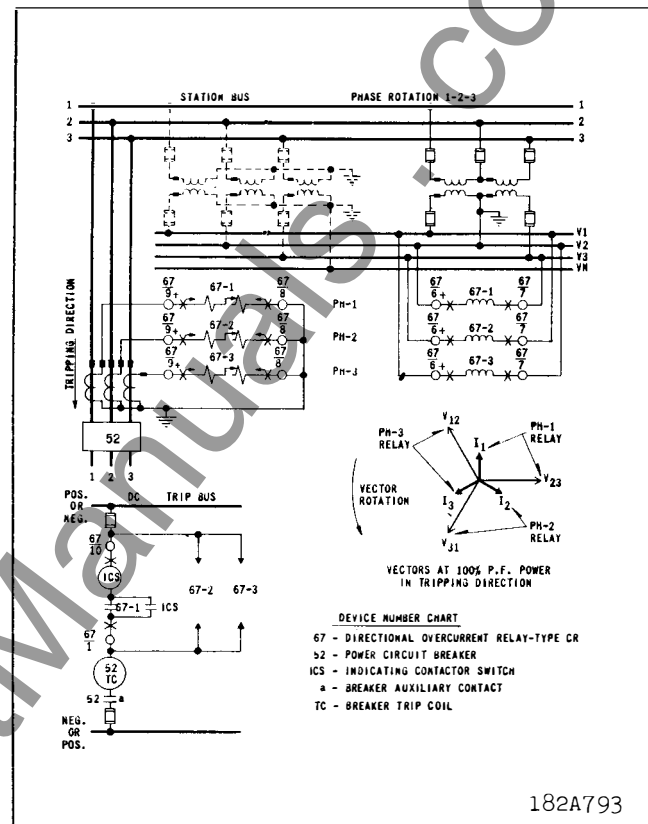


Fig. 21. External Schematic of the type CR Relay for phase fault protection.

Acceptance Check

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

A. Overcurrent Unit (CO)

The directional unit contacts must be in the closed position when checking the operation of the overcurrent unit.

1. Contact

- By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right

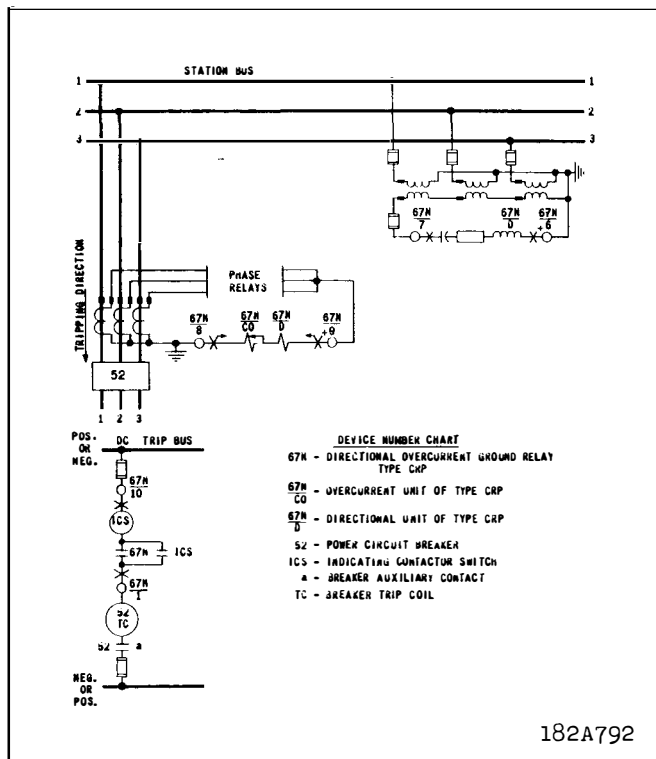


Fig. 22. External Schematic of the type CRP Relay for ground fault protection.

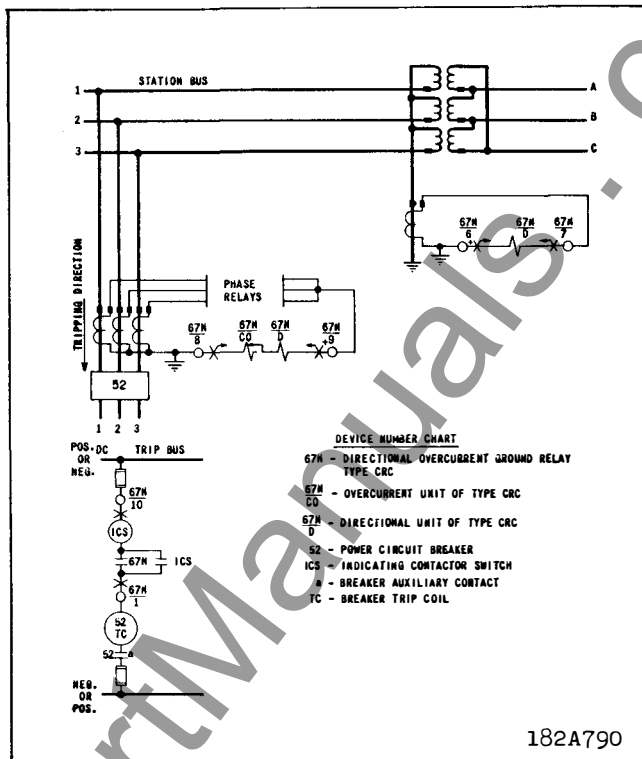


Fig. 23. External Schematic of the type CRC Relay for ground fault protection.

of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current — Set the time dial to position 6. Alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.

3. Time Curve — Table 2 shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table 2 (e.g. for the CR-8, 2 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table 2 plus or minus 5 percent.

For type CR-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring

instrument deviation) will change the nominal operating time by approximately 4%.

B. Indicating Contactor Switch (ICS) — Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

C. Indicating Instantaneous Trip Unit (IIT) — The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The bridging moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the IIT. The indicator target should drop freely.

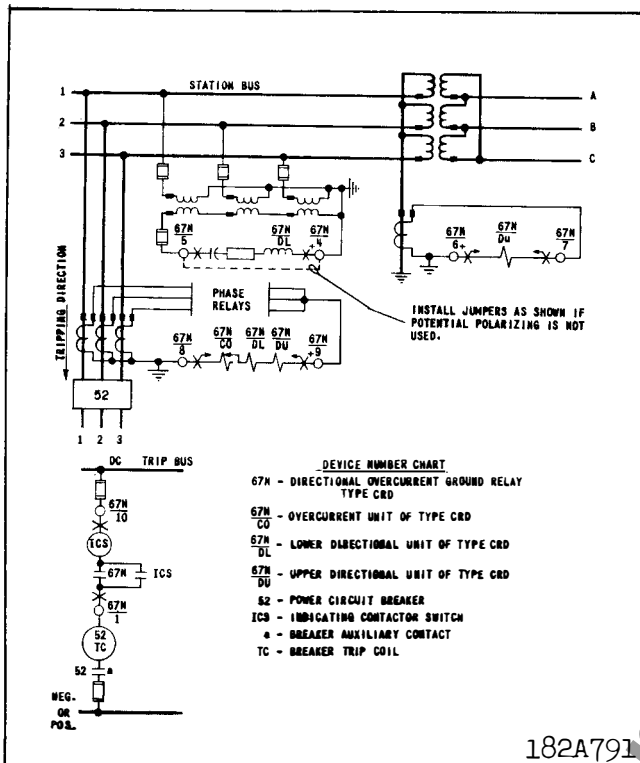


Fig. 24. External Schematic of the type CRD Relay for ground fault protection.

D. Directional Unit (D)

1. Contact Gap — The gap between the stationary contact and moving contact with the relay in a de-energized position should be approximately .020".

2. Sensitivity — The respective directional units should trip with value of energization and phase angle relationships as indicated in Table 3.

3. Spurious Torque Adjustments — There should be no spurious closing torques when the operating circuits are energized per Table 4 with the polarizing circuits short-circuited for the voltage polarized units and open-circuited for the current polarized units.

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass sec-

ondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 20 as these relays are affected by a distorted wave form. With this connection the 25/5 ampere current transformers should be worked well below the knee of the saturation (i.e., use 10L50 or better).

All contacts should be periodically cleaned. 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

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").

A. Overcurrent Unit (CO)

1. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current — The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the

TABLE 2
TIME CURVE CALIBRATION DATA – 50 AND 60 CYCLES FOR
OVERCURRENT UNIT

| Relay Type | Time Dial Position | Permanent Magnet Adjustment | | Electromagnet Plug Adjustment | |
|------------|--------------------|----------------------------------|--------------------------|----------------------------------|--------------------------|
| | | Current (Multiples of Tap Value) | Operating Time (Seconds) | Current (Multiples of Tap Value) | Operating Time (Seconds) |
| 2 | 6 | 3 | 0.57 | 20 | 0.22 |
| 5 | 6 | 2 | 37.80 | 10 | 14.30 |
| 6 | 6 | 2 | 2.46 | 20 | 1.19 |
| 7 | 6 | 2 | 4.27 | 20 | 1.11 |
| 8 | 6 | 2 | 13.35 | 20 | 1.11 |
| 9 | 6 | 2 | 8.87 | 20 | 0.65 |
| 11 | 6 | 2 | 11.27 | 20 | 0.24 Δ |

Δ For 50 cycle Co-11 Relay, 20 times operating Time Limits are 0.24 + 10%; - 5%

damping magnet removed.

With the time dial set on "0", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. Time Curve Calibration - Install the permanent magnet.

Apply the indicated current per Table 2 for the permanent magnet adjustment (e.g. CR-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table 2.

For type CR-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has been completed.

Apply the indicated current per Table 2 for the electromagnet plug adjustment (e.g. CR-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table 2. (Withdrawing the left-hand plug, front view, increases the operating time and withdrawing the right-hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

B. Indicating Contactor Switch – Unit (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The indicator target should drop freely.

C. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from IIT unit.

D. Directional Unit (D)

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 directional unit is made as follows:

With the moving contact in the normally-opened

position, i.e. against the right stop on bridge, screw in the stationary contact until both contacts just close as indicated by a neon lamp in the contact circuit. Then, screw the stationary contact away from the moving contact $3/4$ of a turn. 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.

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

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

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.

The spring is to be adjusted such that the contacts will close as indicated by a neon lamp in the contact circuit when energized with the required current and voltage as shown in Table 3. This table indicates that the spring can be adjusted when the phase angle relationship between the operating circuit and the polarizing circuit is at the maximum torque angle or when the circuit relationship has the operating and polarizing circuits in phase. It is recom-

mended that a single phase (in phase relationship) set-up be used as a matter of ease and convenience.

4. The magnetic plugs 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 in the following manner:

a) Voltage circuit terminals on the voltage polarized relays (CR, CRP and CRD voltage polarized unit) are short-circuited.

b) The polarizing circuit of the current polarized relays (CRC and CRD current polarized unit) are open-circuited.

Upon completion of either "a" or "b", current is applied to the operating circuit terminals as per Table 4.

Plug adjustment is then made per table 4 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment.

The magnetic plug adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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.

TABLE 3
DIRECTIONAL UNIT SENSITIVITY

| Relay Type | Rating | Values for Min. Pick-Up* | | Phase Angle Relationship |
|--------------------|----------------------|--------------------------|---------|--------------------------------|
| | | Volts | Amperes | |
| CR | * 0.5 - 2.5 2 - 6 | 1 | 2.0 | I leading V by 30° ** |
| | | 1 | 2.3 | I in-phase with V |
| | 4-12 | 1 | 4.0 | I leading V by 30° ** |
| | | 1 | 4.6 | I in-phase with V |
| CRP | 0.5-2.5 | 1 | 2.0 | I lagging V by 60° ** |
| CRD(Voltage Unit) | 2-6 | 1 | 4.0 | I in-phase with V |
| CRC | 0.5-2.5 | | | |
| CRD (Current Unit) | 2-6 | | 0.5 | In-phase |

* The energization quantities are input quantities at the relay terminals.

** Maximum torque angle.

TABLE 4
DIRECTIONAL UNIT CALIBRATION

| Relay Rating | Current Amperes | Both Plugs In Condition | Adjustment |
|----------------------|--------------------|--|--|
| 0.5 to 2.5 2 to 6 | 40 | Spurious Torque In Contact Closing Direction (Left Front View) | Right (Front-View) Plug Screwed Out Until Spurious Torque is Reversed |
| 4 to 12 | 80 | | |
| 0.5 to 2.5 2 to 6 | 40 | Spurious Torque In Contact Opening Direction (Right Front View) (Contacts remain open) | Left (Front View) Plug Screwed Out Until Spurious Torque is in Contact Closing Direction, Then the plug is screwed in until spurious torque is reversed. |
| 4 to 12 | 80 | | |

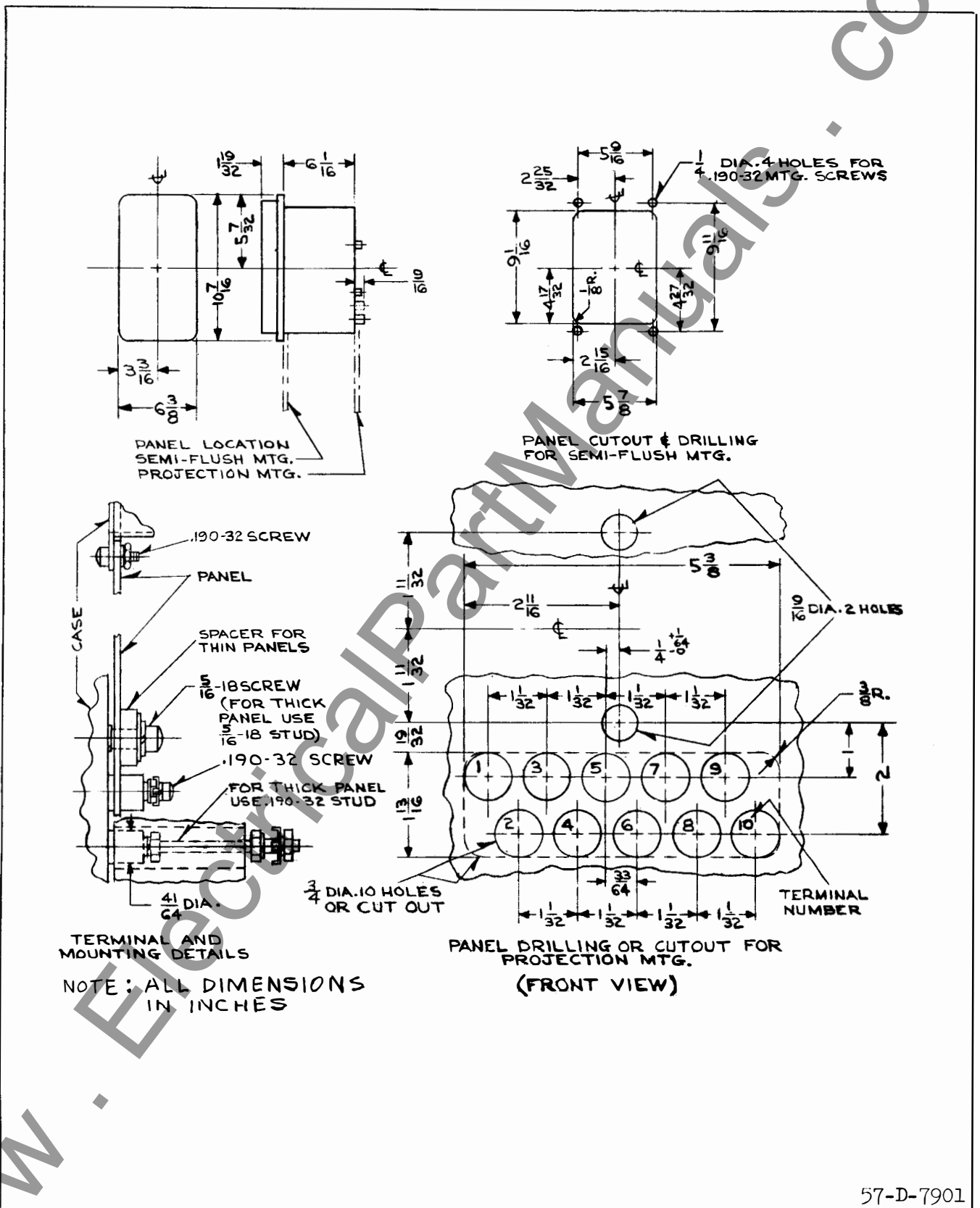
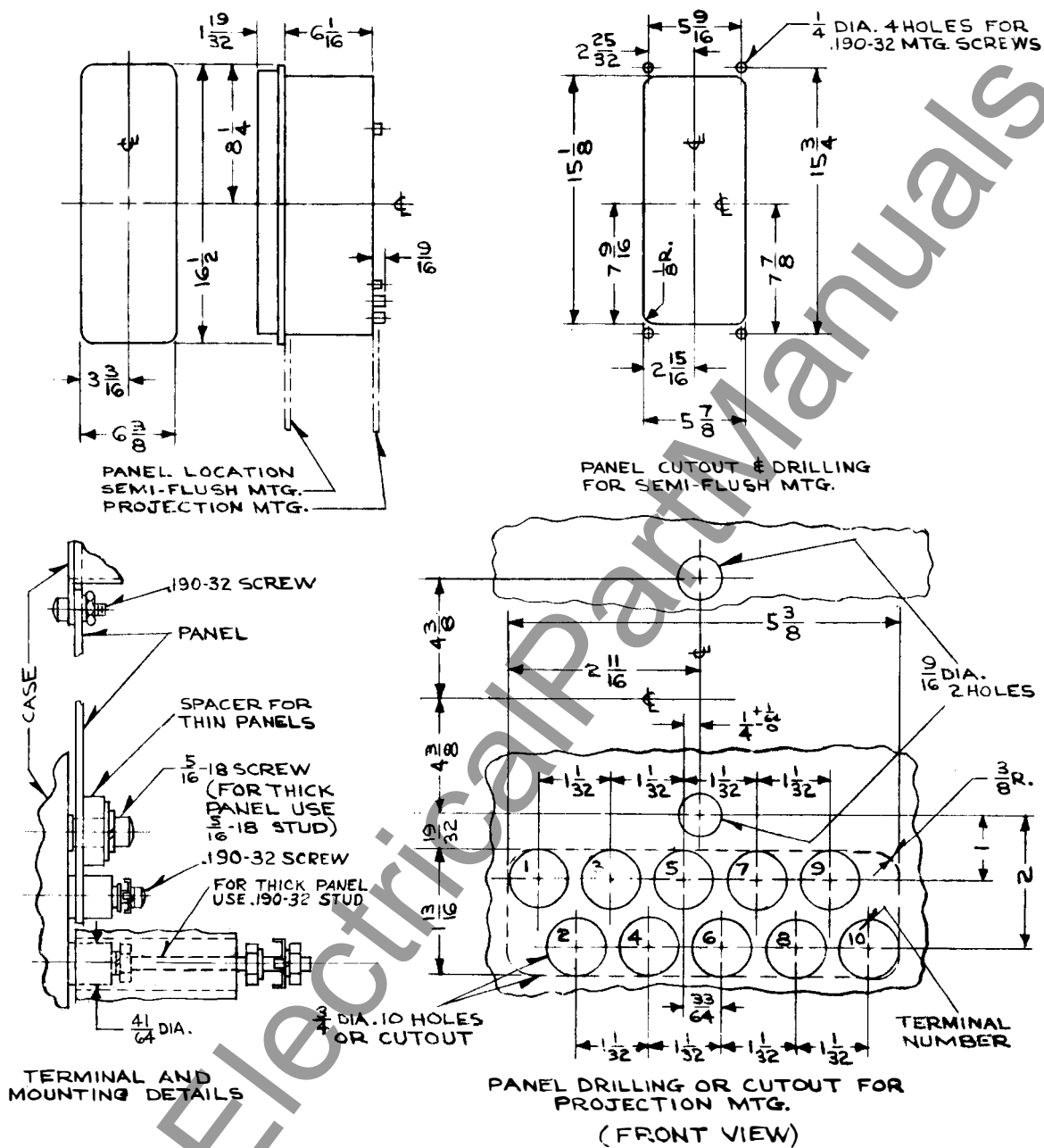


Fig. 25. Outline and Drilling Plan for the Type CR, CRC and CRP Relays in the type FT21 Case.



57-D-7902

Fig. 26. Outline and Drilling Plan for the Type CRD Relay in the Type FT31 Case.

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WESTINGHOUSE ELECTRIC CORPORATION
RELAY-INSTRUMENT DIVISION

NEWARK, N. J.

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INSTALLATION • OPERATION • MAINTENANCE INSTRUCTIONS

DIRECTIONAL OVERCURRENT RELAYS TYPES: CR, CRC, CRP AND CRD

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

APPLICATION

These induction type directional overcurrent relays are used to disconnect transmission and feeder circuits when current through them in a given direction exceeds a predetermined value.

CONTENTS

This instruction leaflet applies to the following types of relays:

- Type CR Voltage Polarized Phase Relay
- Type CRC Current Polarized Ground Relay
- Type CRP Voltage Polarized Ground Relay
- Type CRD Dual Polarized Ground Relay

CONSTRUCTION AND OPERATION

The various types of relays as outlined in the contents consist of a directional unit or units, an overcurrent unit, an indicating contactor switch unit and an indicating instantaneous trip unit when required. The type CRP and type CRD relays also utilize an internal phase shifting mechanism. The principal component parts of the relay and their locations are shown in Figs. 1, 2, 3 and 4.

A. Overcurrent Unit (CO)

The overcurrent unit operates on the induction principle. A main tapped coil located on the center leg of an "E" type laminated structure produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap cause a contact closing torque.

B. Indicating Contactor Switch Unit (ICS)

The indicating contactor switch is a small d-c operated 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 target is reset from the outside of the case by a push rod located at the bottom of the cover.

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

C. Indicating Instantaneous Trip Unit (IIT)

The instantaneous trip unit is a small a-c operated 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 the 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 target is reset from the outside of the case by a push rod located at the bottom of the cover.

A core screw accessible from the top of the switch provides the adjustable pickup range.

D. 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 locking nut. 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 another; two series-connected operating coils mounted diametrically opposite one another; two main adjusting plugs; upper and lower adjusting clips, and two locating pins. The locating pin is used to accurately position the lower pin bearing which is mounted on the frame, with respect to

SUPERSEDES I.L. 41-131M, dated February 1973

* Denotes change from superseded issue

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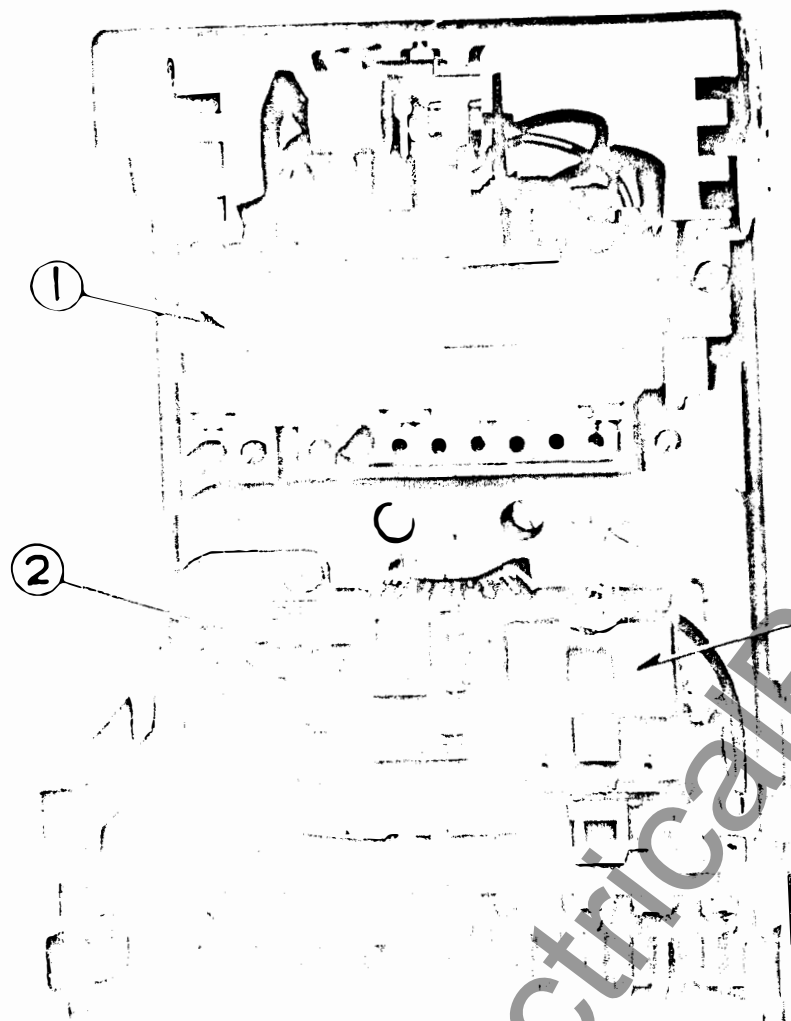


Fig. 1 Type CR Relay Without Case. 1-Directional Unit (D). 2-Overcurrent Unit (CO). 3-Indicating Contactor Switch (ICS).

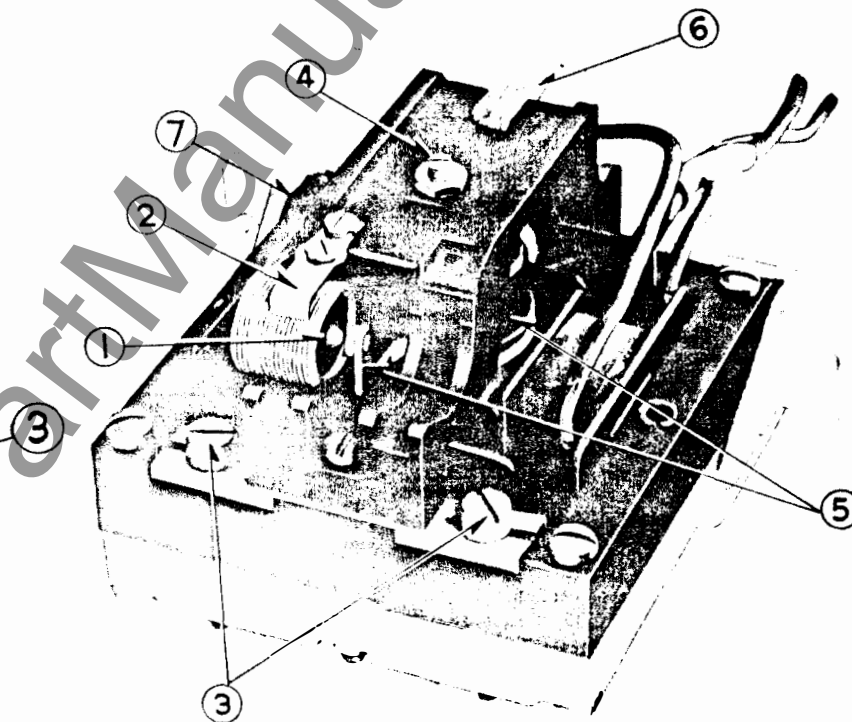


Fig. 2. Directional Unit. 1-Stationary Contact. 2-Stationary Contact pressure spring. 3-Magnetic adjusting plugs. 4-Upper bearing screw. 5-Moving element assembly. 6-Spring adjuster clamp. 7-Current Bias Vane.

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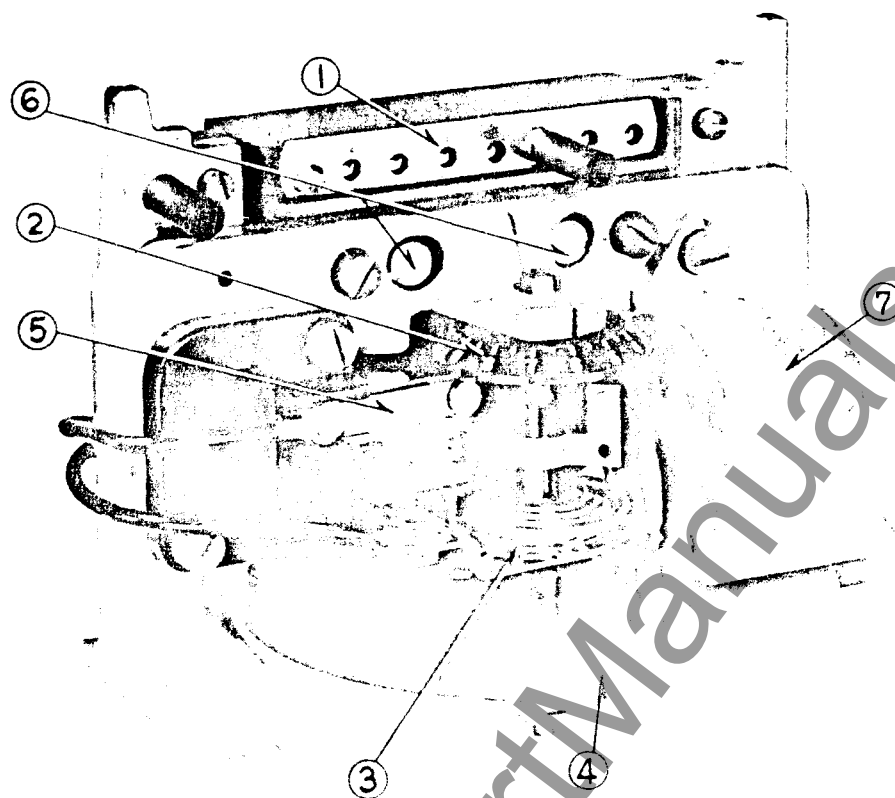


Fig. 3. Time Overcurrent Unit (Front View). 1-Tap Block. 2-Time Dial. 3-Control Spring Assembly. 4-Disc. 5-Stationary Contact Assembly. 6-Magnetic Plugs. 7-Permanent Magnet.



Fig. 4. Indicating Instantaneous Trip Unit (IIT).

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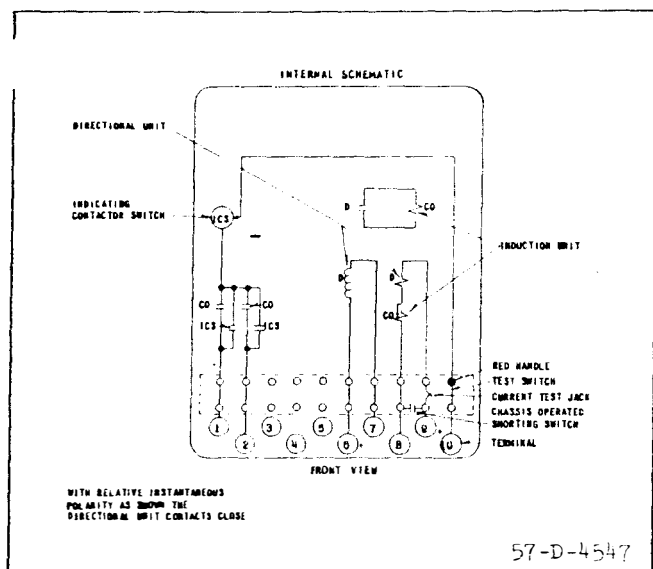


Fig. 5. Internal Schematic of double trip, directional over-current relay type CR in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4549.

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 stops for the moving element contact arm are an integral part of the bridge.

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.

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.

The contacts of the directional unit are connected in series with the shading coil of the over-current unit, thus giving directional control of the overcurrent unit. This arrangement prevents the relay from operating for faults in the non-tripping direction.

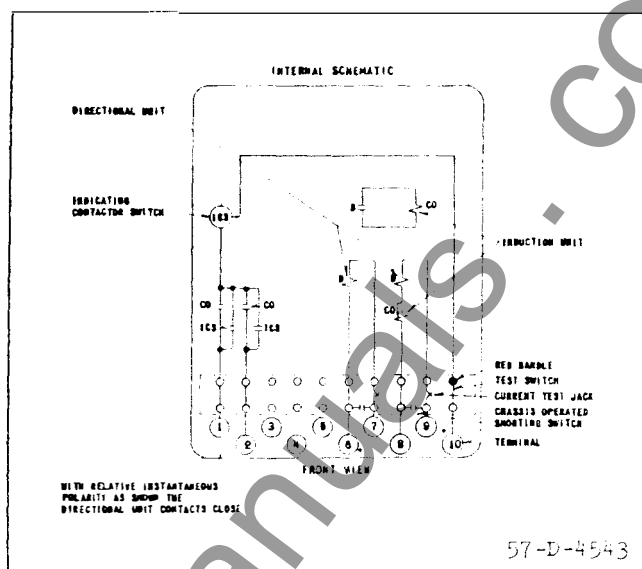


Fig. 6. Internal Schematic of double trip, directional over-current relay type CRC in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4539.

CHARACTERISTICS

The time characteristics of the directional over-current relays are designated by specific numbers as indicated in Table I (e.g. CR-8).

TABLE I

| Time Characteristics | Designation |
|-------------------------|-------------|
| Short Time | 2 |
| Long Time | 5 |
| Definite Time | 6 |
| Moderately Inverse Time | 7 |
| Inverse Time | 8 |
| Very Inverse Time | 9 |
| Extremely Inverse Time | 11 |

The relays are generally available in the following overcurrent unit current ranges:

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

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

The time vs. current characteristics are shown in Figs. 13 to 19. These characteristics give the contact closing time for the various time dial settings when the indicated multiples of tap value current are applied to the relay.

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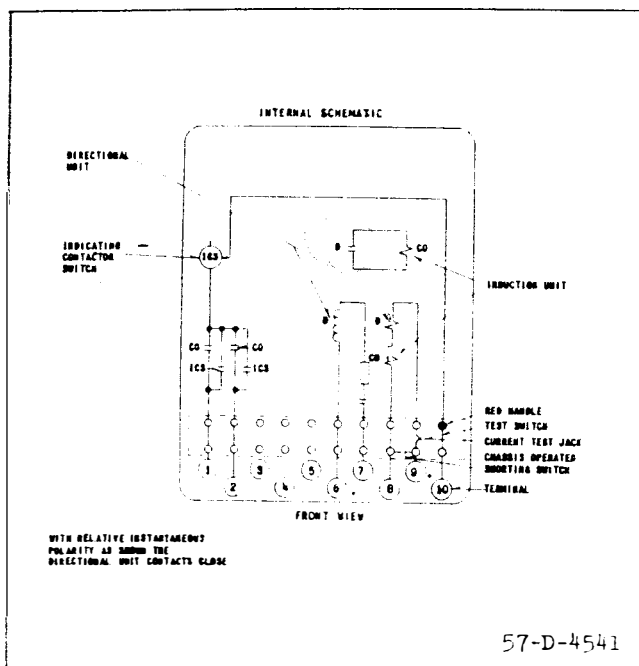


Fig. 7. Internal Schematic of double trip, directional over-current relay type CRP in type FT21 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4545.

Trip Circuit

The main 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.

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts d-c, and will carry this current long enough to trip a breaker.

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting of lead located in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

Indicating Contactor Switch –
0.2 amp tap 6.5 ohms d-c resistance
2.0 amp tap 0.15 ohms d-c resistance

Type CR Relay

This voltage polarized type 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 pick-up is 1 volt and 4 amperes at its maximum torque angle for the 4 to 12 ampere range relays and 1 volt and 2 amperes for the 2 to 6 ampere and 0.5 to 2.5 ampere range relays.

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

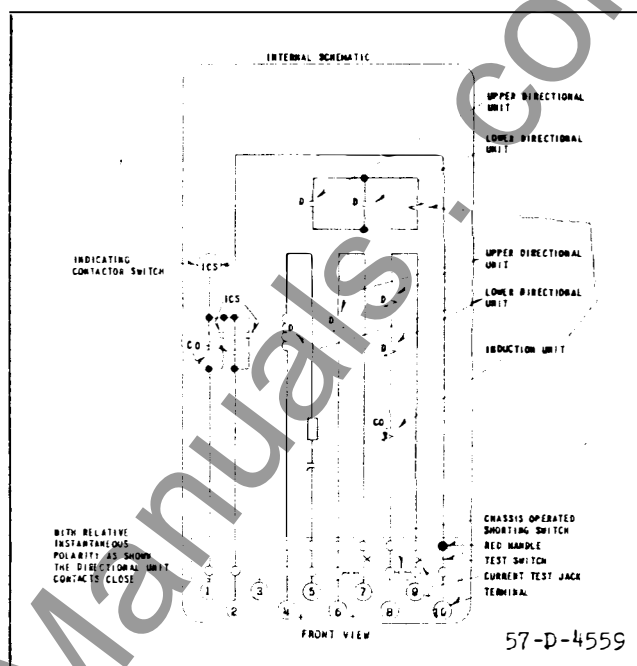


Fig. 8. Internal Schematic of double trip, directional over-current relay type CRD in type FT31 Case. For the single trip relay the circuits associated with terminal 2 are omitted, 57D4561.

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 Fig. 21.

Type CRC Relay

The current polarized type relay is intended for ground fault protection and operates on residual current. See Fig. 23. The type CRC relay has its maximum torque when the operating current leads the polarizing current by approximately 40° . The directional unit minimum pick-up is 0.5 ampere in each winding in phase for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

Type CRP Relay

The voltage polarized relay is intended for ground fault protection and has its maximum torque when the current lags the voltage by approximately 60° . The shifting of the maximum torque angle has been accomplished by the use of an internally mounted phase shifter as illustrated in Fig. 7.

The type CRP relay operates on residual voltage and residual current. See Fig. 22.

The directional unit minimum pick-up is 1 volt and 2 amperes at its maximum torque angle for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

Type CRD Relay

The dual polarized type relay is intended for ground fault protection. The relay can be polarized from a potential source, from a local ground source, or

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TYPES CR, CRC, CRP AND CRD RELAYS

from both simultaneously.

The type CRD relay utilizes the directional unit of the type CRC relay in conjunction with the directional unit and phase shifting mechanism of the type CRP relay. The directional contacts are connected in parallel to torque-control a common overcurrent unit. See Fig. 8.

The current-polarized directional unit of the type CRD relay operates on residual currents while the

potential polarized directional unit of the type CRD relay operates on residual voltage and residual current. See Fig. 24.

For the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays, the minimum pick-up of the current polarized unit is 0.5 ampere in each winding in-phase and the minimum pick-up for the voltage polarized unit is 1 volt and 2 amperes with the current lagging voltage by 60° .

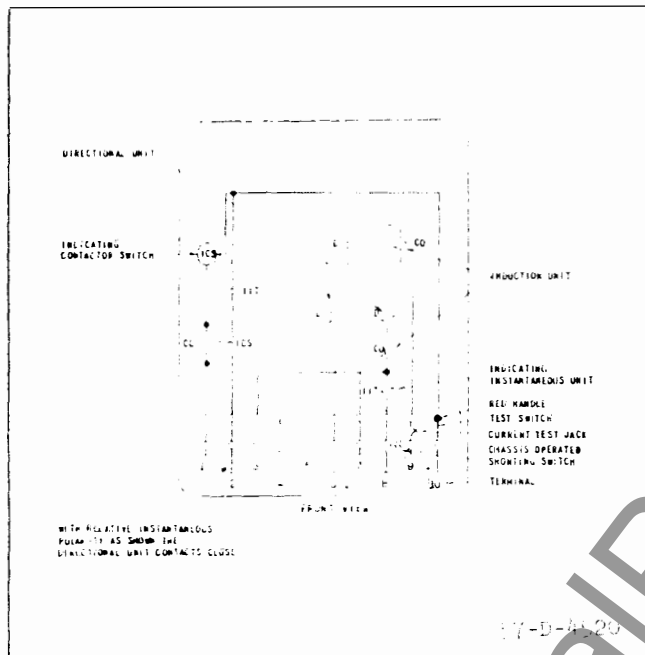


Fig. 9. Internal Schematic of single trip directional control relay Type CR with Indicating Instantaneous Trip Unit, in Type FT21 Case.

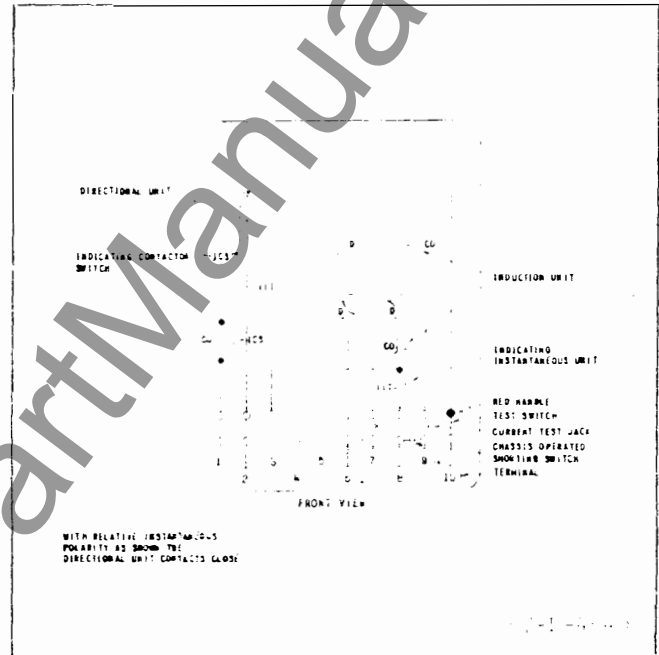
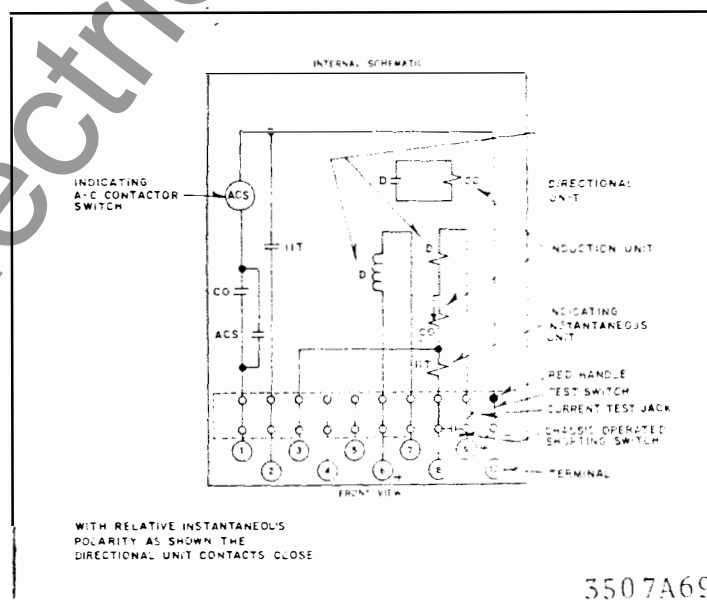


Fig. 10. Internal Schematic of single trip directional control relay Type CRC with Indicating Instantaneous Trip Unit, in Type FT21 Case.



* Fig. 10A. Internal Schematic of single trip directional control relay Type CR with Indicating Instantaneous Trip Unit and AC Shunt Trip in FT21 Case.

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ENERGY REQUIREMENTS

CR-2, CRC-2, CRP-2, CRD-2 OVERCURRENT UNITS

| AMPERE RANGE | TAP | CONTINUOUS RATING (AMPERES) | ONE SECOND RATING † (AMPERES) | POWER FACTOR ANGLE δ | VOLT AMPERES †† | | | |
|-----------------|------|-----------------------------------|-------------------------------------|----------------------------|----------------------------|------------------------------------|-------------------------------------|-------------------------------------|
| | | | | | AT TAP VALUE CURRENT | AT 3 TIMES TAP VALUE CURRENT | AT 10 TIMES TAP VALUE CURRENT | AT 20 TIMES TAP VALUE CURRENT |
| 0.5/2.5 | 0.5 | 0.91 | 28 | 56 | 4.8 | 39.6 | 256 | 790 |
| | 0.6 | 0.96 | 28 | 57 | 4.9 | 39.8 | 270 | 851 |
| | 0.8 | 1.18 | 28 | 53 | 5.0 | 42.7 | 308 | 1024 |
| | 1.0 | 1.37 | 28 | 50 | 5.3 | 45.4 | 348 | 1226 |
| | 1.5 | 1.95 | 28 | 40 | 6.2 | 54.4 | 435 | 1740 |
| | 2.0 | 2.24 | 28 | 36 | 7.2 | 65.4 | 580 | 2286 |
| | 2.5 | 2.50 | 28 | 29 | 7.9 | 73.6 | 700 | 2856 |
| 2/6 | 2.0 | 3.1 | 110 | 59 | 5.64 | 38.7 | 262 | 806 |
| | 2.5 | 4.0 | 110 | 55 | 5.13 | 39.8 | 280 | 926 |
| | 3.0 | 4.4 | 110 | 51 | 5.37 | 42.8 | 312 | 1008 |
| | 3.5 | 4.8 | 110 | 47 | 5.53 | 42.8 | 329 | 1120 |
| | 4.0 | 5.2 | 110 | 45 | 5.72 | 46.0 | 360 | 1216 |
| | 5.0 | 5.6 | 110 | 41 | 5.90 | 50.3 | 420 | 1500 |
| | 6.0 | 6.0 | 110 | 37 | 6.54 | 54.9 | 474 | 1800 |
| 4/12 | 4.0 | 7.3 | 230 | 65 | 4.92 | 39.1 | 268 | 848 |
| | 5.0 | 8.0 | 230 | 50 | 5.20 | 42.0 | 305 | 1020 |
| | 6.0 | 8.8 | 230 | 47 | 5.34 | 44.1 | 330 | 1128 |
| | 7.0 | 9.6 | 230 | 46 | 5.53 | 45.8 | 364 | 1260 |
| | 8.0 | 10.4 | 230 | 43 | 5.86 | 49.9 | 400 | 1408 |
| | 10.0 | 11.2 | 230 | 37 | 6.6 | 55.5 | 470 | 1720 |
| | 12.0 | 12.0 | 230 | 34 | 7.00 | 62.3 | 528 | 2064 |

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

δ Degrees current lags voltage at tap value current.

†† Voltages taken with Krohn type voltmeter.

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ENERGY REQUIREMENTS

CR-5, CRC-5, CRP-5, CRD-5,
CR-6, CRC-6, CRP-6, CRD-6 OVERCURRENT UNITS

VOLT AMPERES††

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating† (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 69 | 3.92 | 20.6 | 103 | 270 |
| | (0.6 | 3.1 | 88 | 68 | 3.96 | 20.7 | 106 | 288 |
| | (0.8 | 3.7 | 88 | 67 | 3.96 | 21 | 114 | 325 |
| | (1.0 | 4.1 | 88 | 66 | 4.07 | 21.4 | 122 | 360 |
| | (1.5 | 5.7 | 88 | 62 | 4.19 | 23.2 | 147 | 462 |
| | (2.0 | 6.8 | 88 | 60 | 4.30 | 24.9 | 168 | 548 |
| | (2.5 | 7.7 | 88 | 58 | 4.37 | 26.2 | 180 | 630 |
| | (2 | 8 | 230 | 67 | 3.88 | 21 | 110 | 308 |
| 2/6 | (2.5 | 8.8 | 230 | 66 | 3.90 | 21.6 | 118 | 342 |
| | (3 | 9.7 | 230 | 64 | 3.93 | 22.1 | 126 | 381 |
| | (3.5 | 10.4 | 230 | 63 | 4.09 | 23.1 | 136 | 417 |
| | (4 | 11.2 | 230 | 62 | 4.12 | 23.5 | 144 | 448 |
| | (5 | 12.5 | 230 | 59 | 4.20 | 24.8 | 162 | 540 |
| | (6 | 13.7 | 230 | 57 | 4.38 | 26.5 | 183 | 624 |
| | (4 | 16 | 460 | 65 | 4.00 | 22.4 | 126 | 376 |
| | (5 | 18.6 | 460 | 63 | 4.15 | 23.7 | 143 | 450 |
| 4/12 | (6 | 19.3 | 460 | 61 | 4.32 | 25.3 | 162 | 531 |
| | (7 | 20.8 | 460 | 59 | 4.35 | 26.4 | 183 | 611 |
| | (8 | 22.5 | 460 | 56 | 4.40 | 27.8 | 204 | 699 |
| | (10 | 25 | 460 | 53 | 4.60 | 30.1 | 247 | 880 |
| | (12 | 28 | 460 | 47 | 4.92 | 35.6 | 288 | 1056 |

CR-7, CRC-7, CRP-7 & CRD-7 OVERCURRENT UNITS

VOLT AMPERES††

| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating† (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
|--------------|-------|-----------------------------|------------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 0.5/2.5 | (0.5 | 2.7 | 88 | 68 | 3.88 | 20.7 | 103 | 278 |
| | (0.6 | 3.1 | 88 | 67 | 3.93 | 20.9 | 107 | 288 |
| | (0.8 | 3.7 | 88 | 66 | 3.93 | 21.1 | 114 | 320 |
| | (1.0 | 4.1 | 88 | 64 | 4.00 | 21.6 | 122 | 356 |
| | (1.5 | 5.7 | 88 | 61 | 4.08 | 22.9 | 148 | 459 |
| | (2.0 | 6.8 | 88 | 58 | 4.24 | 24.8 | 174 | 552 |
| | (2.5 | 7.7 | 88 | 56 | 4.38 | 25.9 | 185 | 640 |
| | (2 | 8 | 230 | 66 | 4.06 | 21.3 | 111 | 306 |
| 2/6 | (2.5 | 8.8 | 230 | 63 | 4.07 | 21.8 | 120 | 342 |
| | (3 | 9.7 | 230 | 63 | 4.14 | 22.5 | 129 | 366 |
| | (3.5 | 10.4 | 230 | 62 | 4.34 | 23.4 | 141 | 413 |
| | (4 | 11.2 | 230 | 61 | 4.34 | 23.8 | 149 | 448 |
| | (5 | 12.5 | 230 | 59 | 4.40 | 25.2 | 163 | 530 |
| | (6 | 13.7 | 230 | 58 | 4.62 | 27 | 183 | 624 |
| | (4 | 16 | 460 | 64 | 4.24 | 22.8 | 129 | 392 |
| | (5 | 18.6 | 460 | 61 | 4.30 | 24.2 | 149 | 460 |
| 4/12 | (6 | 19.3 | 460 | 60 | 4.62 | 25.9 | 168 | 540 |
| | (7 | 20.8 | 460 | 56 | 4.69 | 27.3 | 187 | 626 |
| | (8 | 22.5 | 460 | 55 | 4.80 | 29.8 | 211 | 688 |
| | (10 | 25 | 460 | 51 | 5.20 | 33 | 260 | 860 |
| | (12 | 28 | 460 | 46 | 5.40 | 37.5 | 308 | 1032 |

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

ϕ Degrees current lags voltage at tap value current.

†† Voltages taken with Rectox type voltmeter.

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ENERGY REQUIREMENTS

CR-8, CRC-8, CRP-8 & CRD-8
CR-9, CRC-9, CRP-9 & CRD-9 OVERCURRENT UNITS

| | | VOLT AMPERES ^{††} | | | | | | |
|--------------|-------|-----------------------------|--|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| Ampere Range | Tap | Continuous Rating (Amperes) | One Second Rating [†] (Amperes) | Power Factor Angle ϕ | At Tap Value Current | At 3 Times Tap Value Current | At 10 Times Tap Value Current | At 20 Times Tap Value Current |
| 0.5/2.5 | (0.5 | 2.7 | 88 | 72 | 2.38 | 21 | 132 | 350 |
| | (0.6 | 3.1 | 88 | 71 | 2.38 | 21 | 134 | 365 |
| | (0.8 | 3.7 | 88 | 69 | 2.40 | 21.1 | 142 | 400 |
| | (1.0 | 4.1 | 88 | 67 | 2.42 | 21.2 | 150 | 440 |
| | (1.5 | 5.7 | 88 | 62 | 2.51 | 22 | 170 | 530 |
| | (2.0 | 6.8 | 88 | 57 | 2.65 | 23.5 | 200 | 675 |
| 2/6 | (2.5 | 7.7 | 88 | 53 | 2.74 | 24.8 | 228 | 800 |
| | (2 | 8 | 230 | 70 | 2.38 | 21 | 136 | 360 |
| | (2.5 | 8.8 | 230 | 66 | 2.40 | 21.1 | 142 | 395 |
| | (3 | 9.7 | 230 | 64 | 2.42 | 21.5 | 149 | 430 |
| | (3.5 | 10.4 | 230 | 62 | 2.48 | 22 | 157 | 470 |
| | (4 | 11.2 | 230 | 60 | 2.53 | 22.7 | 164 | 500 |
| 4/12 | (5 | 12.5 | 230 | 58 | 2.64 | 24 | 180 | 580 |
| | (6 | 13.7 | 230 | 56 | 2.75 | 25.2 | 198 | 660 |
| | (4 | 16 | 460 | 68 | 2.38 | 21.3 | 146 | 420 |
| | (5 | 18.8 | 460 | 63 | 2.46 | 21.8 | 158 | 480 |
| | (6 | 19.3 | 460 | 60 | 2.54 | 22.6 | 172 | 550 |
| | (7 | 20.8 | 460 | 57 | 2.62 | 23.6 | 190 | 620 |
| | (8 | 22.5 | 460 | 54 | 2.73 | 24.8 | 207 | 700 |
| | (10 | 25 | 460 | 48 | 3.00 | 27.8 | 248 | 850 |
| | (12 | 28 | 460 | 45 | 3.46 | 31.4 | 292 | 1020 |

CR-11, CRC-11
CRP-11 & CRD-11 OVERCURRENT UNITS

| | | VOLT AMPERES ^{††} | | | | | | |
|--------------|------|-----------------------------|--|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| AMPERE RANGE | TAP | CONTINUOUS RATING (AMPERES) | ONE SECOND RATING [†] (AMPERES) | POWER FACTOR ANGLE ϕ | AT TAP VALUE CURRENT | AT 3 TIMES TAP VALUE CURRENT | AT 10 TIMES TAP VALUE CURRENT | AT 20 TIMES TAP VALUE CURRENT |
| 0.5/2.5 | 0.5 | 1.7 | 56 | 36 | 0.72 | 6.54 | 71.8 | 250 |
| | 0.6 | 1.9 | 56 | 34 | 0.75 | 6.80 | 75.0 | 267 |
| | 0.8 | 2.2 | 56 | 30 | 0.81 | 7.46 | 84.0 | 298 |
| | 1.0 | 2.5 | 56 | 27 | 0.89 | 8.30 | 93.1 | 330 |
| | 1.5 | 3.0 | 56 | 22 | 1.13 | 10.04 | 115.5 | 411 |
| | 2.0 | 3.5 | 56 | 17 | 1.30 | 11.95 | 136.3 | 502 |
| 2/6 | 2.5 | 3.8 | 56 | 16 | 1.48 | 13.95 | 160.0 | 610 |
| | 2.0 | 7.0 | 230 | 32 | 0.73 | 6.30 | 74.0 | 264 |
| | 2.5 | 7.8 | 230 | 30 | 0.78 | 7.00 | 78.5 | 285 |
| | 3.0 | 8.3 | 230 | 27 | 0.83 | 7.74 | 84.0 | 309 |
| | 3.5 | 9.0 | 230 | 24 | 0.88 | 8.20 | 89.0 | 340 |
| | 4.0 | 10.0 | 230 | 23 | 0.96 | 9.12 | 102.0 | 372 |
| 4/12 | 5.0 | 11.0 | 230 | 20 | 1.07 | 9.80 | 109.0 | 430 |
| | 6.0 | 12.0 | 230 | 20 | 1.23 | 11.34 | 129.0 | 504 |
| | 4.0 | 14 | 460 | 29 | 0.79 | 7.05 | 78.4 | 296 |
| | 5.0 | 16 | 460 | 25 | 0.89 | 8.00 | 90.0 | 340 |
| | 6.0 | 17 | 460 | 22 | 1.02 | 9.18 | 101.4 | 378 |
| | 7.0 | 18 | 460 | 20 | 1.10 | 10.00 | 110.0 | 454 |
| | 8.0 | 20 | 460 | 18 | 1.23 | 11.1 | 124.8 | 480 |
| | 10.0 | 22 | 460 | 17 | 1.32 | 14.9 | 131.6 | 600 |
| | 12.0 | 26 | 460 | 16 | 1.8 | 16.3 | 180.0 | 720 |

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

ϕ Degrees current lags voltage at tap value current.

^{††} Voltages taken with Rectox type voltmeter.

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DIRECTIONAL UNIT POLARIZING CIRCUIT BURDEN

| Relay Type | Rating | Volt Amperes Δ | Power Factor Angle ϕ |
|------------------|---------------|-----------------------|---------------------------|
| CR | 132* Volts | 11.5 | 58° Lag |
| CRC | 230** Amperes | 1.45 | 8° Lag |
| CRP | 208*** Volts | 11.2 | 28° Lead |
| CRD Current Unit | 230** Amperes | 1.45 | 8° Lag |
| CRD Voltage Unit | 208*** Volts | 11.2 | 28° Lead |

ϕ Degrees current leads or lags voltage at 120 volts on voltage polarized units and 5 amperes on current polarized units.

Δ Voltages taken with rectox type voltmeter - Burden of Voltage polarized units taken at 120 volts - Burden of current polarized units taken at 5 amperes.

* Continuous rating.

** One second rating.

*** 30 second rating.

DIRECTIONAL UNIT OPERATING CIRCUIT BURDEN

| Relay Type | Range Amps | Continuous Rating (Amperes) | One Second Rating† (Amperes) | Power Factor Angle ϕ | VOLT AMPERES†† | | | |
|------------|------------|-----------------------------|------------------------------|---------------------------|------------------------------|--------------------------------------|---------------------------------------|---------------------------------------|
| | | | | | At Minimum Tap Value Current | At 3 Times Minimum Tap Value Current | At 10 Times Minimum Tap Value Current | At 20 Times Minimum Tap Value Current |
| CR | 2-6 | 10 | 230 | 34.5 | 0.44 | 4.08 | 48.0 | 182.0 |
| | 4-12 | 12 | 280 | 25.0 | 0.53 | 5.0 | 59.2 | 236.0 |
| CRC | 0.5-2.5 | - | 230 | 44.0 | 0.033 | 0.30 | 3.3 | 14.2 |
| | 2-6 | - | 230 | 42.5 | 0.58 | 5.28 | 58.0 | 240.0 |
| CRP | 0.5-2.5 | 10 | 230 | 34.5 | 0.03 | 0.23 | 2.8 | 11.5 |
| | 2-6 | 10 | 230 | 34.5 | 0.44 | 4.08 | 48.0 | 182.0 |
| CRD | 0.5-2.5 | 10 | 230 | 45.0 | 0.07 | 0.59 | 6.6 | 26.0 |
| | 2-6 | 10 | 230 | 45.0 | 1.04 | 9.9 | 106.0 | 420.0 |

ϕ Degrees current lags voltage at tap value current.

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

†† Voltages taken with Rectox type voltmeter.

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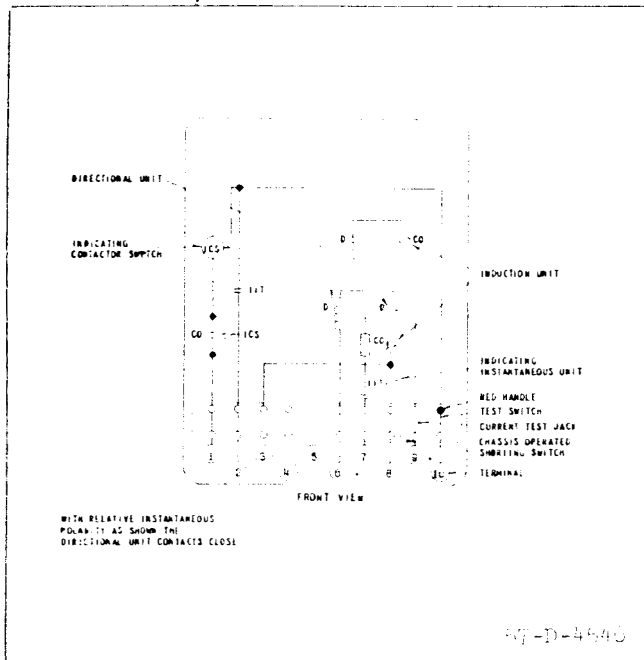


Fig. 11. Internal Schematic of single trip directional control relay Type CRP with Indicating Instantaneous Trip Unit, in Type FT21 Case.

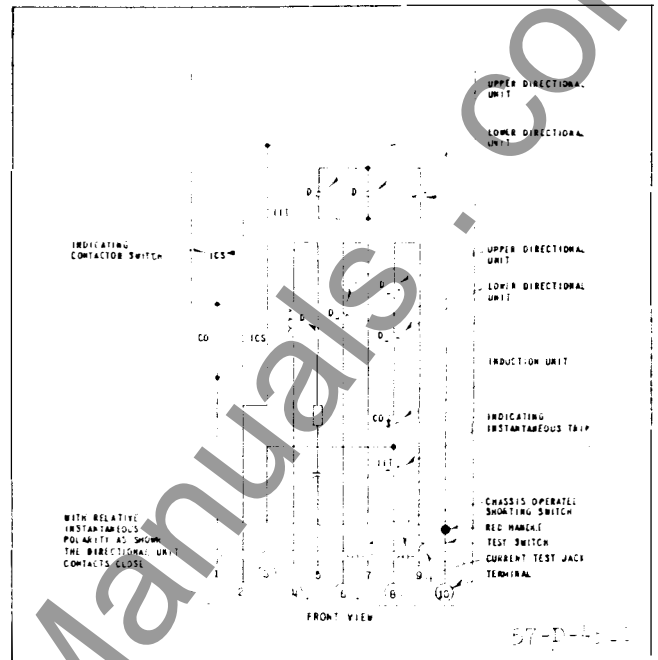


Fig. 12. Internal Schematic of single trip directional control relay Type CRD with Indicating Instantaneous Trip Unit, in Type FT31 Case.

SETTINGS

A. Overcurrent Unit (CO)

The overcurrent unit settings can be defined either by tap settings and time dial position or by tap setting and a specific time of operation at some current multiple of the tap setting (e.g. 4 tap setting, 2 time dial position or 4 tap setting, 0.6 seconds at 6 times tap value current).

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus breaker time is recommended between the relay being set and the relays with which coordination is to be effected.

The connector screw on the terminal plate above the time dial makes connections to various turns on the operating coil. By placing the screw in the various terminal plate holes, the relay will respond to multiples of tap value currents in accordance with the various typical time-current curves.

Caution

Since the tap block connector screw carries operating current, be sure that the screw is turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare tap screw in the desired tap position before removing the other tap screw from the original

tap position.

Instantaneous Reclosing

The factory adjustment of the CO unit contacts provides a contact follow. Where circuit breaker reclosing will be initiated immediately after a trip by the CO contact, the time of the opening of the contacts should be a minimum. This condition is obtained by loosening the stationary contact mounting screw, removing the contact plate and then replacing the plate with the bent end resting against the contact spring.

For double trip relays, the upper stationary contact is adjusted such that the contact spring rests solidly against the back stop. The lower stationary contact is then adjusted such that both stationary contacts make contact simultaneously with their respective moving contact.

B. Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 to 2.0 ampere tap setting. This selection is made by connecting the lead located in front of the tap block to the desired setting by means of the connecting screw.

C. Indicating Instantaneous Trip (ITT)

The core screw must be adjusted to the value of pick-up desired.

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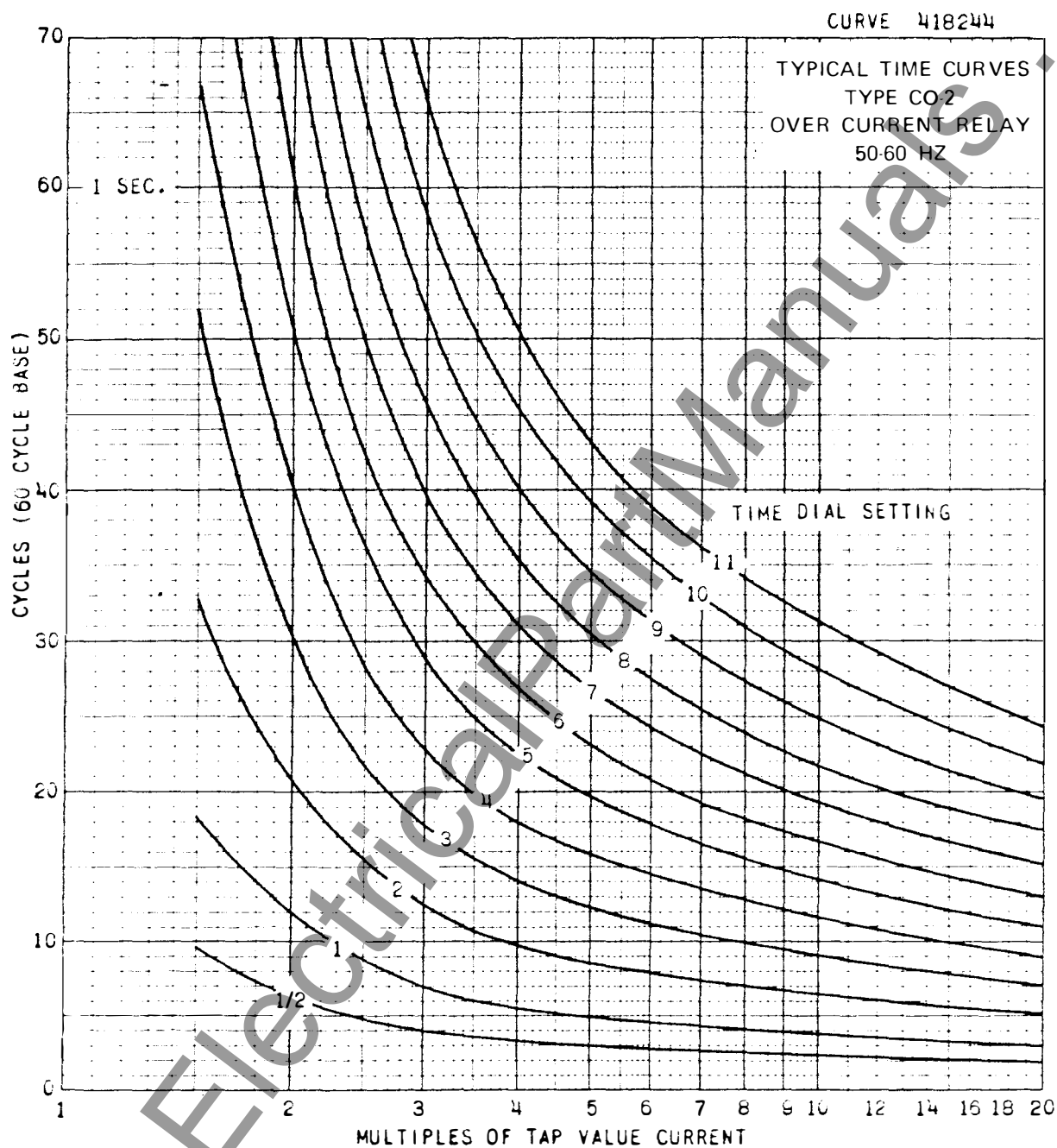


Fig. 13. Typical Time Curves For Relays With CO-2 Units.

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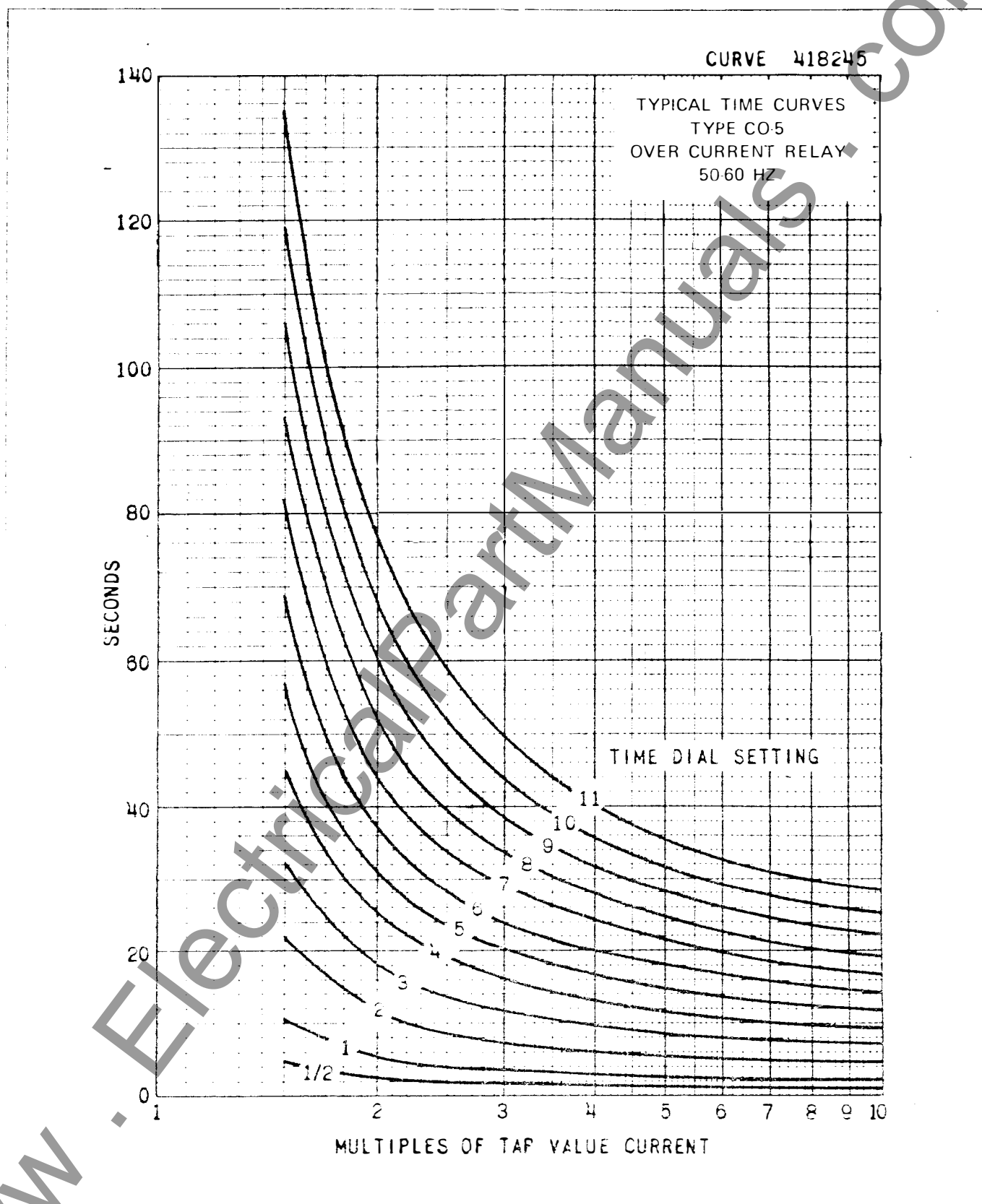


Fig. 14. Typical Time Curves For Relays With CO-5 Units

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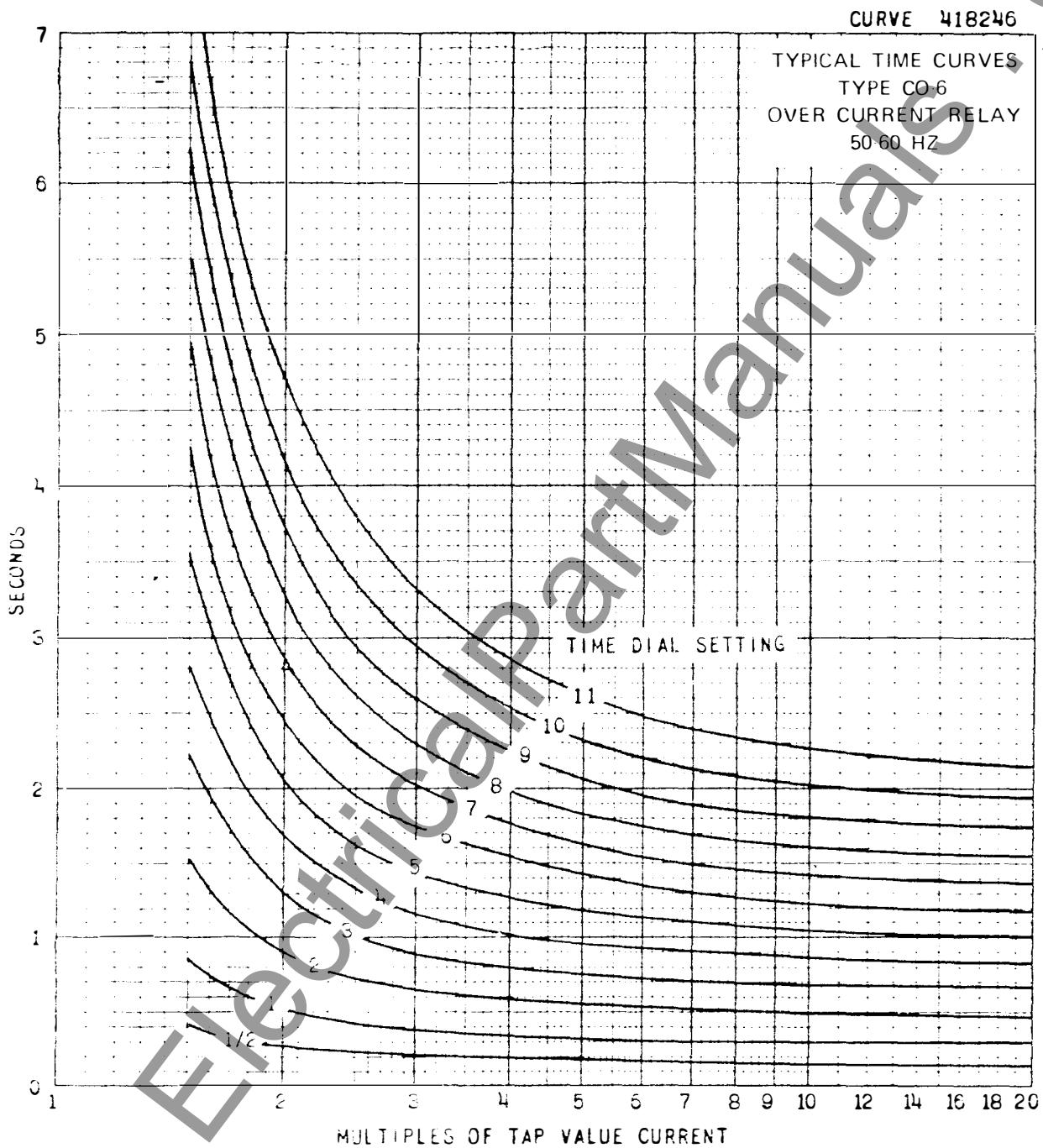


Fig. 15. Typical time curves for relays with CO-6 units.

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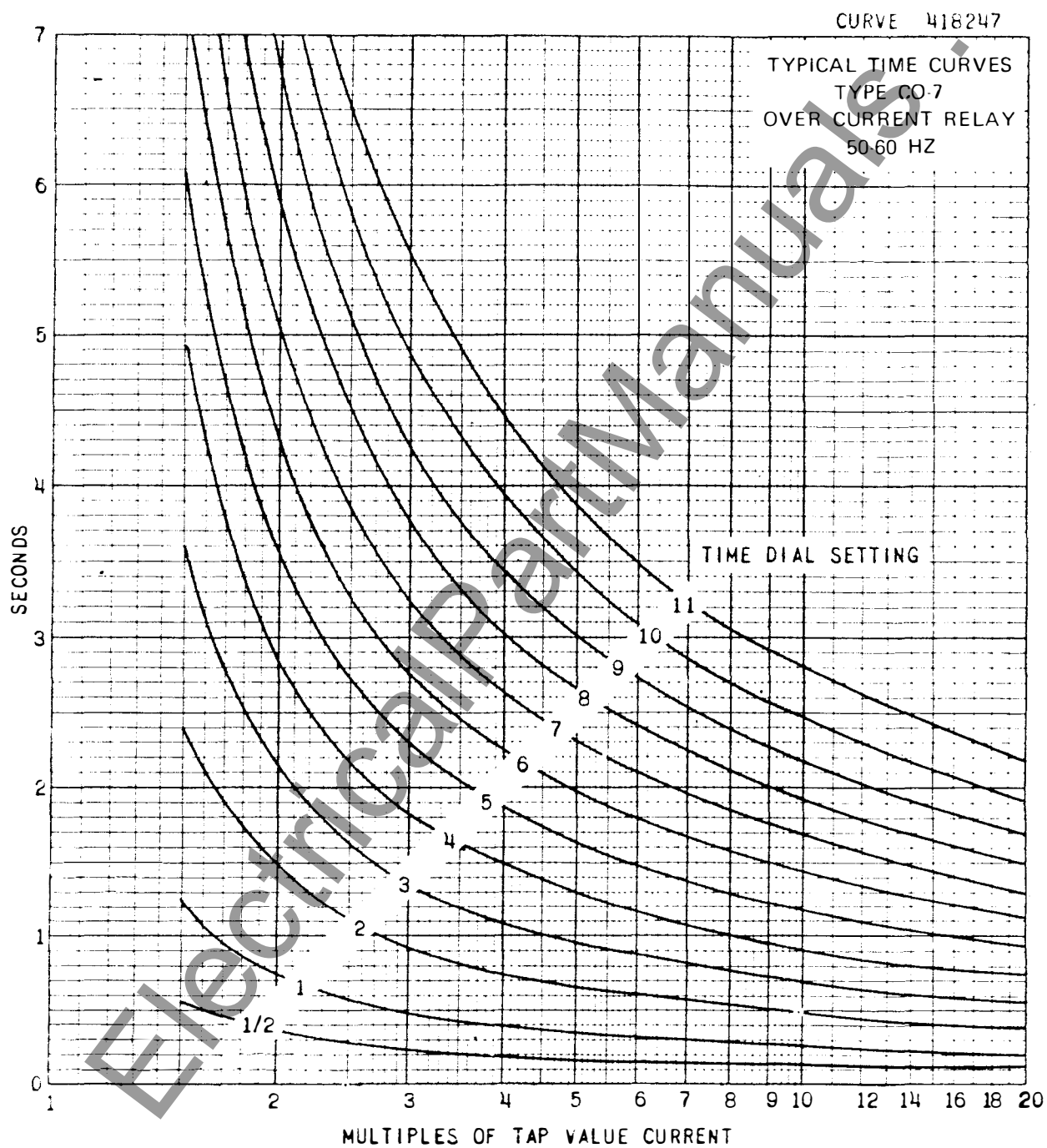


Fig. 16. Typical time curves for relays with CO-7 units.

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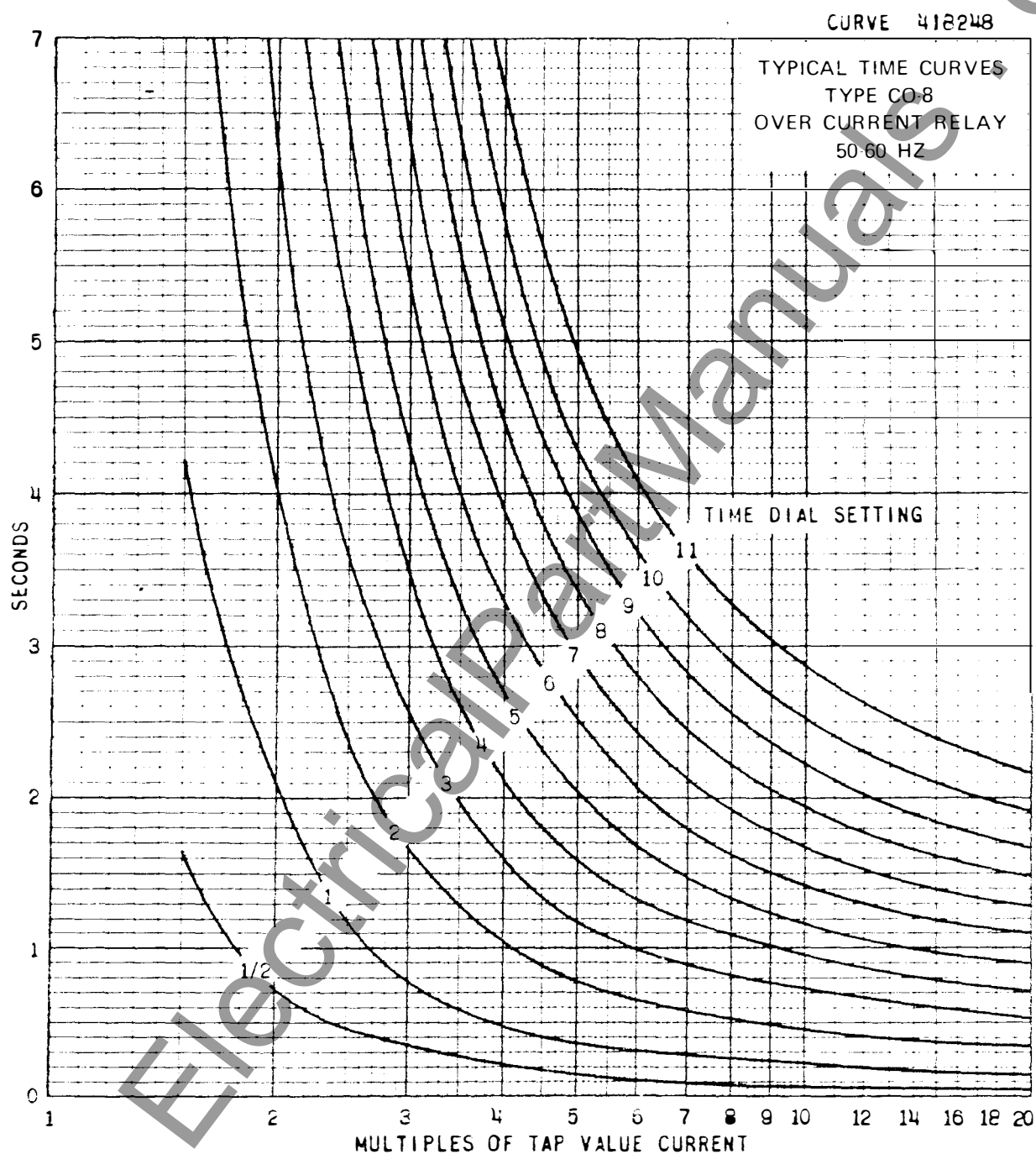


Fig. 17. Typical time curves for relays with CO-8 units.

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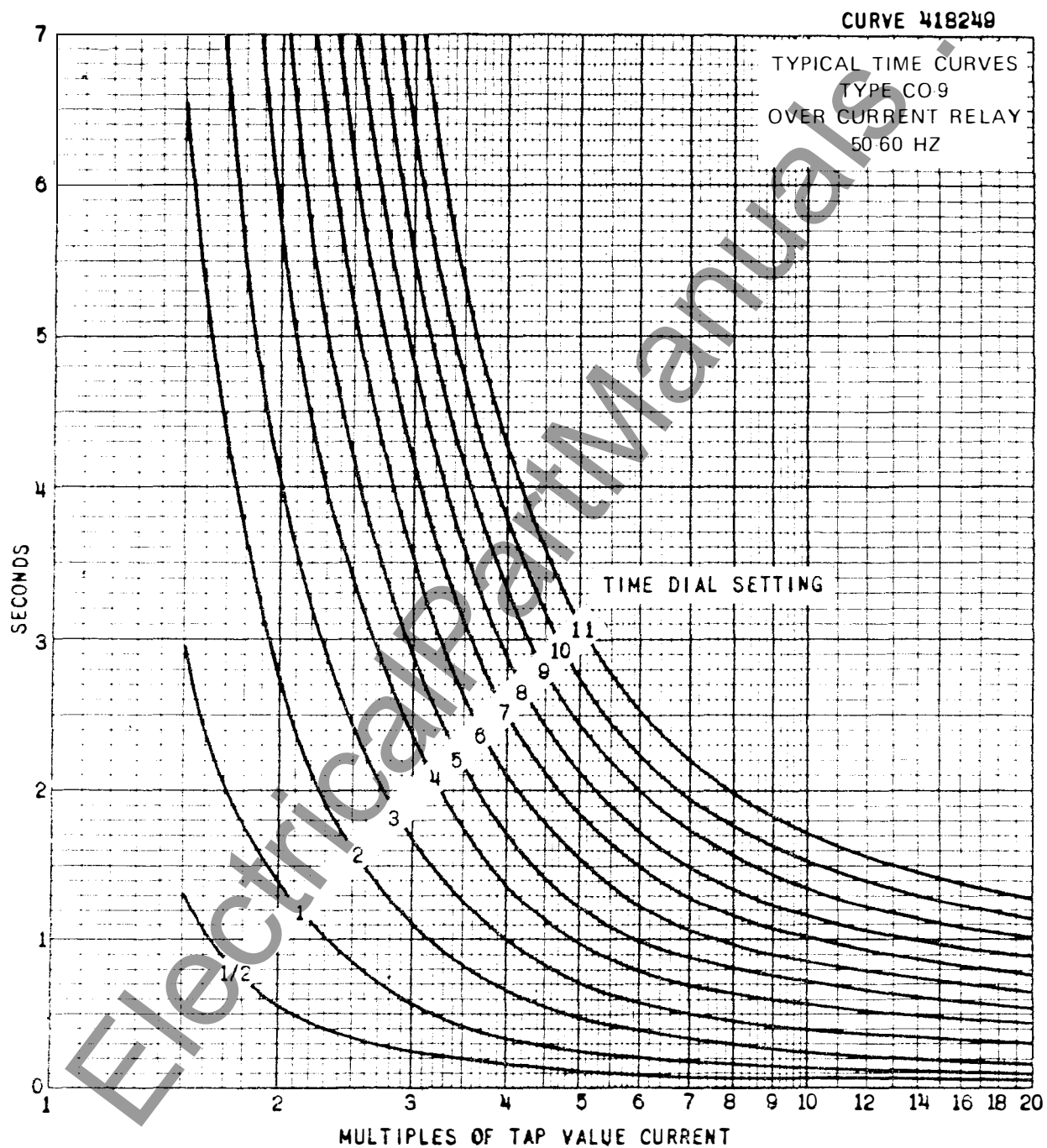
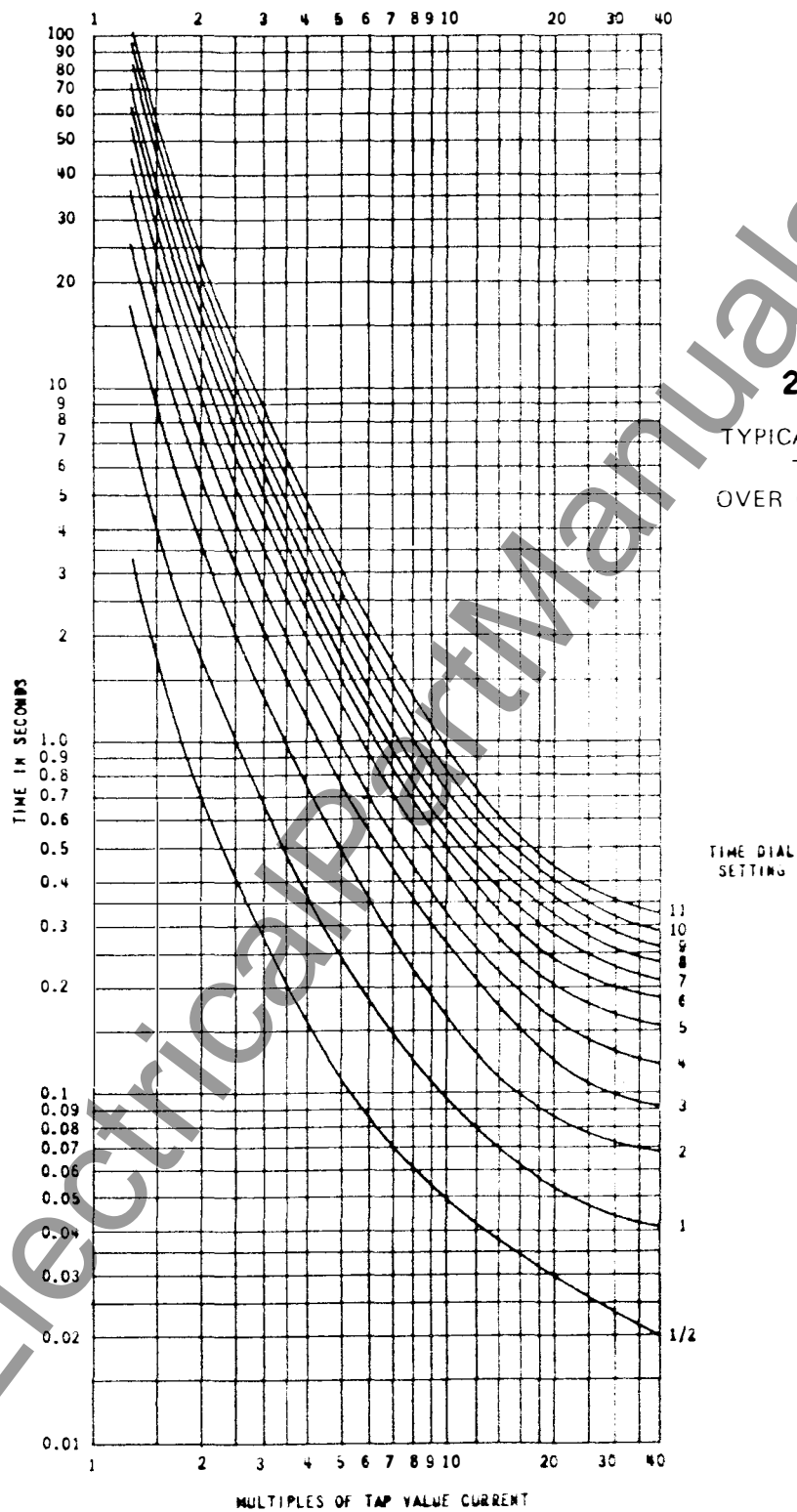


Fig. 18. Typical time curves for relays with CO-9 units.

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288B655

TYPICAL TIME CURVES
TYPE CO-11
OVER CURRENT RELAY
50 60 HZ

Fig. 15. Typical time curves for relays with CO-11 units.

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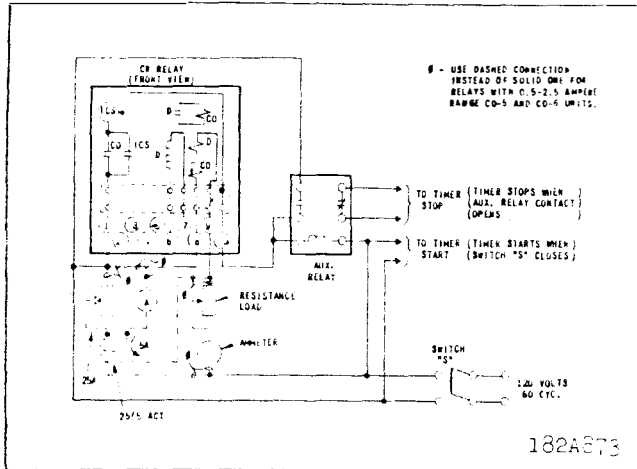


Fig. 20. Diagram of test connections of the overcurrent unit.

The nameplate data will furnish the actual current range that may be obtained from IIT unit.

D. Directional Unit (D)

No setting is required.

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 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 directly to the terminals by means of screws for steel panel mounting or to 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 studs and then turning the proper nut with a wrench.

The external a-c connections of the directional overcurrent relays are shown in Figs. 21 to 24.

ADJUSTMENTS 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.

For relays which include an indicating instantaneous trip unit (IIT), the junction of the induction and indicating instantaneous trip coils is brought out to switch jaw #3. With this arrangement the overcurrent units can be tested separately.

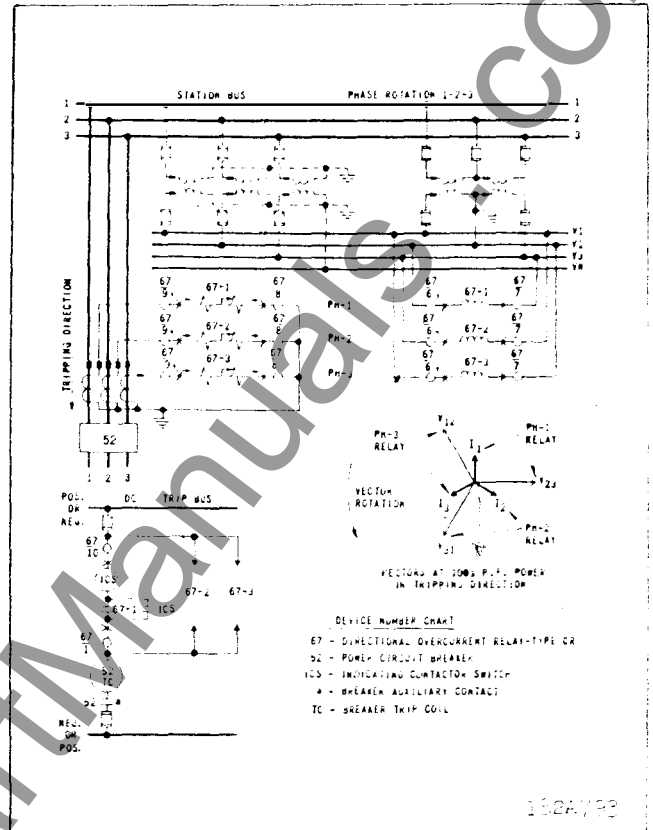


Fig. 21. External Schematic of the type CR Relay for phase fault protection.

Acceptance Check

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

A. Overcurrent Unit (CO)

The directional unit contacts must be in the closed position when checking the operation of the overcurrent unit.

1. Contact

- By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".
- For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right

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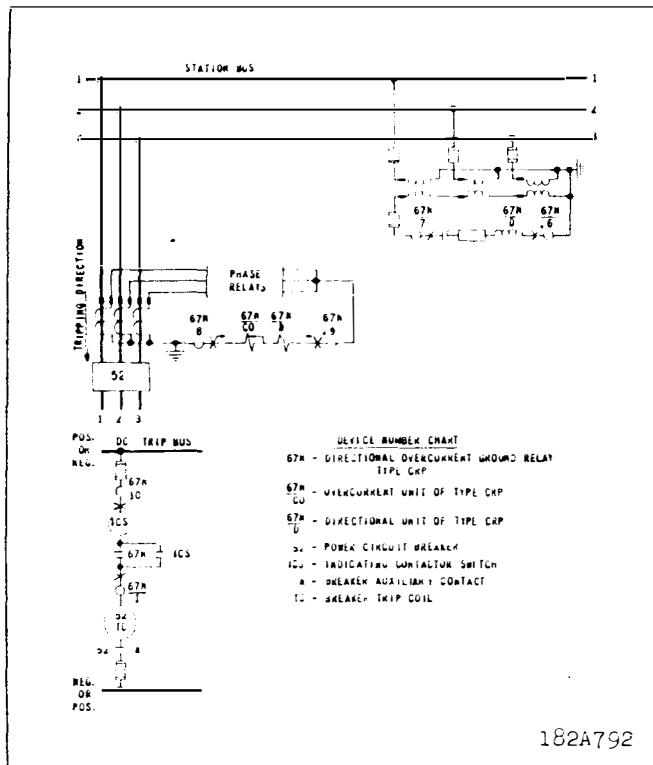


Fig. 22. External Schematic of the type CRP Relay for ground fault protection.

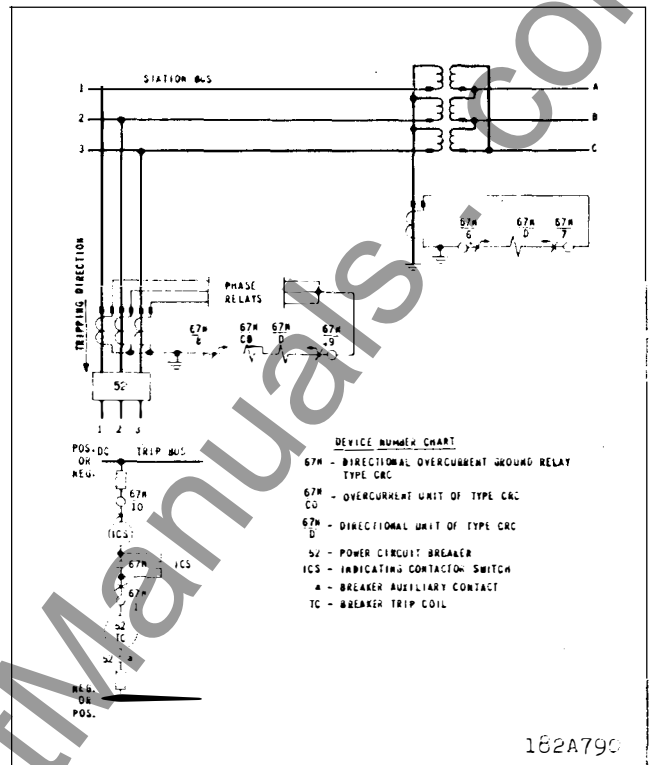


Fig. 23. External Schematic of the type CRC Relay for ground fault protection.

of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current — Set the time dial to position 6. Alternately apply tap value current plus 3% and tap value current minus 3%. The moving contact should leave the backstop at tap value current plus 3% and should return to the backstop at tap value current minus 3%.

3. Time Curve — Table 2 shows the time curve calibration points for the various types of relays. With the time dial set to the indicated position, apply the currents specified by Table 2 (e.g. for the CR-8, 2 and 20 times tap value current) and measure the operating time of the relay. The operating times should equal those of Table 2 plus or minus 5 percent.

For type CR-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary

because of the steepness of the slope of the time-current characteristic (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

B. Indicating Contactor Switch (ICS) — Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS tap setting being used. The indicator target should drop freely.

The contact gap should be approximately .047" between the bridging moving contact and the adjustable stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

C. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pick-up current desired.

The nameplate data will furnish the actual current range that may be obtained from IIT unit.

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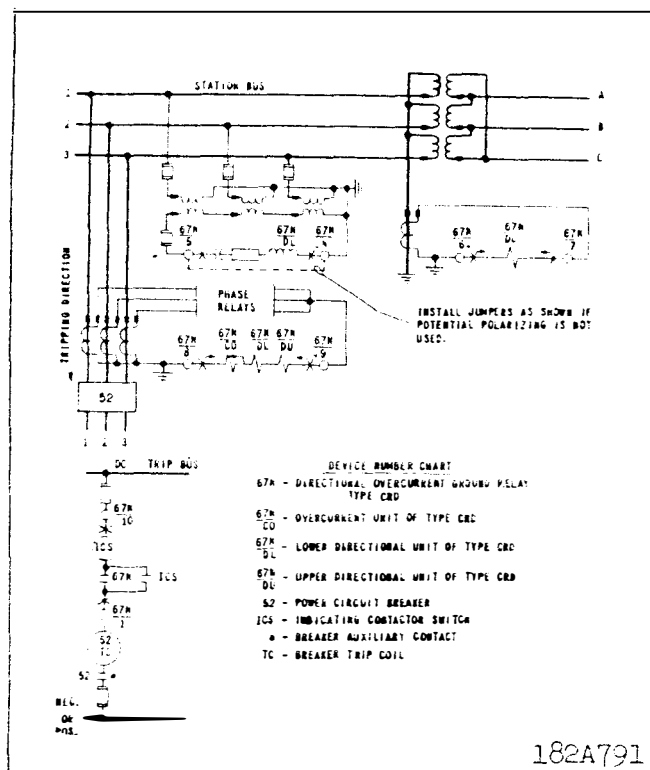


Fig. 24. External Schematic of the type CRD Relay for ground fault protection.

D. Directional Unit (D)

1. Contact Gap - The gap between the stationary contact and moving contact with the relay in a de-energized position should be approximately .020".

2. Sensitivity - The respective directional units should trip with value of energization and phase angle relationships as indicated in Table 3.

3. Spurious Torque Adjustments - There should be no spurious closing torques when the operating circuits are energized per Table 4 with the polarizing circuits short-circuited for the voltage polarized units and open-circuited for the current polarized units.

Routine Maintenance

All relays should be inspected and checked periodically to assure proper operation. Generally a visual inspection should call attention to any noticeable changes. A minimum suggested check on the relay system is to close the contacts manually to assure that the breaker trips and the target drops. Then release the contacts and observe that the reset is smooth and positive.

If an additional time check is desired, pass sec-

ondary current through the relay and check the time of operation. It is preferable to make this at several times pick-up current at an expected operating point for the particular application. For the .5 to 2.5 ampere range CO-5 and CO-6 induction unit use the alternative test circuit in Fig. 20 as these relays are affected by a distorted wave form. With this connection the 25 5 ampere current transformers should be worked well below the knee of the saturation (i.e., use 10L50 or better).

All contacts should be periodically cleaned. 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

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").

A. Overcurrent Unit (CO)

1. Contact

a) By turning the time dial, move the moving contacts until they deflect the stationary contact to a position where the stationary contact is resting against its backstop. The index mark located on the movement frame should coincide with the "O" mark on the time dial. For double trip relays, the follow on the stationary contacts should be approximately 1/64".

b) For relays identified with a "T", located at lower left of stationary contact block, the index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the various time dial positions in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current - The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the

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TABLE 2
TIME CURVE CALIBRATION DATA - 50 AND 60 CYCLES FOR
OVERCURRENT UNIT

| Relay Type | Time Dial Position | Permanent Magnet Adjustment | | Electromagnet Plug Adjustment | |
|------------|--------------------|----------------------------------|--------------------------|----------------------------------|--------------------------|
| | | Current (Multiples of Tap Value) | Operating Time (Seconds) | Current (Multiples of Tap Value) | Operating Time (Seconds) |
| 2 | 6 | 3 | 0.57 | 20 | 0.22 |
| 5 | 6 | 2 | 37.80 | 10 | 14.30 |
| 6 | 6 | 2 | 2.46 | 20 | 1.19 |
| 7 | 6 | 2 | 4.27 | 20 | 1.11 |
| 8 | 6 | 2 | 13.35 | 20 | 1.11 |
| 9 | 6 | 2 | 8.87 | 20 | 0.65 |
| 11 | 6 | 2 | 11.27 | 20 | 0.24 Δ |

* Δ For 50 hertz Vo-11, 20 times operating Time Limits are 0.24 ± 10% -5%

damping magnet removed.

With the time dial set on "0", wind up the spiral spring by means of the spring adjuster until approximately 6-3/4 convolutions show.

Set the relay on the minimum tap setting, the time dial to position 6.

Adjust the control spring tension so that the moving contact will leave the backstop at tap value current +1.0% and will return to the backstop at tap value current -1.0%.

3. Time Curve Calibration - Install the permanent magnet.

Apply the indicated current per Table 2 for the permanent magnet adjustment (e.g. CR-8, 2 times tap value) and measure the operating time. Adjust the permanent magnet keeper until the operating time corresponds to the value of Table 2.

For type CR-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds. It is important that the 1.30 times tap value current be maintained accurately. The maintaining of this current accurately is necessary because of the steepness of the slope of the time-current characteristic (Fig. 19). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%. If the operating time at 1.3 times tap value is not within these limits, a minor adjustment of the control spring will give the correct operating time without any undue effect on the minimum pick-up of the relay. This check is to be made after the 2 times tap value adjustment has been completed.

Apply the indicated current per Table 2 for the electromagnet plug adjustment (e.g. CR-8, 20 times

tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table 2. (Withdrawing the left-hand plug, front view, increases the operating time and withdrawing the right-hand plug, front view, decreases the time.) In adjusting the plugs, one plug should be screwed in completely and the other plug run in or out until the proper operating time has been obtained.

Recheck the permanent magnet adjustment. If the operating time for this calibration point has changed, readjust the permanent magnet and then recheck the electromagnet plug adjustment.

B. Indicating Contactor Switch - Unit (ICS)

Close the main relay contacts and pass sufficient d-c current through the trip circuit to close the contacts of the ICS. This value of current should be not greater than the particular ICS tap setting being used. The indicator target should drop freely.

C. Indicating Instantaneous Trip Unit (ITI)

The core screw which is adjustable from the top of the trip unit determines the pickup value. The trip unit has a normal ratio of adjustment of 1 to 4 and an accuracy within the limits of 10%.

The making of the contacts and target indication should occur at approximately the same instant. Position the stationary contact for a minimum of 1/32" wipe. The trailing moving contact should touch both stationary contacts simultaneously.

Apply sufficient current to operate the ITI. The indicator target should drop freely.

D. Directional Unit (D)

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

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lock nut. The lower bearing position is fixed and cannot be adjusted.

2. The contact gap adjustment for the directional unit is made as follows:

With the moving contact in the normally-opened position, i.e. against the right stop on bridge, screw in the stationary contact until both contacts just close as indicated by a neon lamp in the contact circuit. Then, screw the stationary contact away from the moving contact $3/4$ of a turn. 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.

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

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

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.

The spring is to be adjusted such that the contacts will close as indicated by a neon lamp in the contact circuit when energized with the required current and voltage as shown in Table 3. This table indicates that the spring can be adjusted when the

phase angle relationship between the operating circuit and the polarizing circuit is at the maximum torque angle or when the circuit relationship has the operating and polarizing circuits in phase. It is recommended that a single phase (in phase relationship) set-up be used as a matter of ease and convenience.

4. The magnetic plugs 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 in the following manner:

a) Voltage circuit terminals on the voltage polarized relays (CR, CRP and CRD voltage polarized unit) are short-circuited.

b) The polarizing circuit of the current polarized relays (CRC and CRD current polarized unit) are open-circuited.

Upon completion of either "a" or "b", current is applied to the operating circuit terminals as per Table 4.

Plug adjustment is then made per table 4 such that the spurious torques are reversed. The plugs are held in position by upper and lower plug clips. These clips need not be disturbed in any manner when making the necessary adjustment.

The magnetic plug adjustment may be utilized to positively close the contacts on current alone. This may be desired on some installations in order to insure that the relay will always trip the breaker on zero potential.

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.

* TABLE 3
DIRECTIONAL UNIT SENSITIVITY

| Relay Type | Rating | Values for Min. Pick-Up ¹ | | Phase Angle Relationship |
|---------------------------|---------|--------------------------------------|---------|--|
| | | Volts ^{2,3} | Amperes | |
| CR | 0.5-2.5 | 1 | 2.0 | I leading V by 30° ⁴ |
| | | 1 | 2.3 | I in-phase with V |
| | 4-12 | 1 | 4.0 | I leading V by 30° ⁴ |
| | | 1 | 4.6 | I in-phase with V |
| CRP | 0.5-2.5 | 1 | 2.0 | I lagging V by 60° ⁴ |
| CRD (Voltage Unit) | 2-6 | 1 | 4.0 | I in-phase with V |
| | 4-12 | 1 | 4.0 | I lagging V by 60° ⁴ |
| | | 1 | 5.0 | I in phase with V |
| CRC CRD (Current Unit) | 0.5-2.5 | | 0.5 | In-phase |
| | 2-6 | | 1.0 | |

¹ The energization quantities are input quantities at the relay terminals.

² Maximum torque angle.

³ For relays rated 240 volt, apply 2 volt.

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TABLE 4
DIRECTIONAL UNIT CALIBRATION

| Relay Rating | Current Amperes | Both Plugs In Condition | Adjustment |
|----------------------|--------------------|--|--|
| 0.5 to 2.5 2 to 6 | 40 | Spurious Torque In Contact Closing Direction (Left Front View) | Right (Front-View) Plug Screwed Out Until Spurious Torque is Reversed |
| 4 to 12 | 80 | | |
| 0.5 to 2.5 2 to 6 | 40 | Spurious Torque In Contact Opening Direction (Right Front View) (Contacts remain open) | Left (Front View) Plug Screwed Out Until Spurious Torque is in Contact Closing Direction, Then the plug is screwed in until spurious torque is reversed. |
| 4 to 12 | 80 | | |

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