



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

TYPE CO (Hi Lo) OVERCURRENT RELAY

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

APPLICATION

These induction overcurrent relays are used to disconnect circuits or apparatus when the current in them exceeds a given value. Where a station battery (48 volts or over) is available, the circuit closing type relays are normally used to trip the circuit breaker.

CONTENTS

This instruction leaflet applies to the following types of relays:

- Type CO-2 Short Time Relay
- CO-5 Long Time Relay
- CO-6 Definite Minimum Time Relay
- CO-7 Moderately Inverse Time Relay
- CO-8 Inverse Time Relay
- CO-9 Very Inverse Time Relay
- CO-11 Extremely Inverse Relay

CONSTRUCTION AND OPERATION

The type CO relays consist of an overcurrent unit (CO), an indicating contactor switch (ICS), and an indicating instantaneous trip unit (IIT) when required.

Electromagnet

The electromagnets for the types CO-5, CO-6, CO-7, CO-8 and CO-9 relays have a main tapped coil located on the center leg of an "E" type laminated structure that 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.

The electromagnets for the types CO-2 and CO-11 relays have a main coil consisting of a tapped primary winding and a secondary winding. Two identical coils on the outer legs of the lamination structure are connected to the main coil secondary in a manner so that the combination of all the fluxes produced by the electromagnet result in out-of-phase fluxes in the air gap. The out-of-phase air gap fluxes produced cause a contact closing torque.

Indicating Contactor Switch Unit (ICS)

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

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

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.

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

A core screw accessible from the top of the switch and taps on the coil provides the adjustable pickup range.

CHARACTERISTICS

The relays are generally available in the following current ranges:

| Range | Taps |
|--------|--|
| .5-2.5 | 0.5, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5 |
| 1-12 | 1.0, 1.2, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0, 6.0, 7.0, 8.0, 10.0, 12.0 |

These relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers. The relays are wired per the internal schematics of Fig. 1 to 5.

The time vs. current characteristics are shown in Figs. 6 to 12. 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.

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 the lead locating in front of the tap block to the desired setting by means of a screw connection.

Trip Circuit Constants

Contactor Switch –

0.2 ampere tap. 6.5 ohms d-c resistance

2.0 ampere tap. 0.15 ohms d-c resistance

SETTINGS

CO Unit

The overcurrent unit setting can be defined by tap setting 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). The tap setting is the minimum current required to make the disc move.

To provide selective circuit breaker operation, a minimum coordinating time of 0.3 seconds plus circuit 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 this 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 on both the CO unit and ICS unit carries operating current, be sure that the screws are turned tight. In order to avoid opening the current transformer circuits when changing taps under load, connect the spare connector 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.

Indicating Contactor Switch (ICS)

The only setting required on the ICS unit is the selection of the 0.2 or 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.

Indicating Instantaneous Trip (IIT)

The proper tap must be selected and 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 the IIT unit. It is recommended that the IIT be set on the higher tap where there is a choice of tap settings. For example, for a 20 ampere setting use the 20 to 40 tap rather than the 6 to 20 tap.

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

For detail information on the FT case refer to I.L. 41-076.

ADJUSTMENTS & 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.

Acceptance Check

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

1. Contact

The index mark on the movement frame will coincide with the "0" 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 "0" 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 using the lowest tap setting, 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

For type CO-11 relay only, the 1.30 times tap value operating time from the number 6 time dial position is $54.9 \pm 5\%$ seconds and should be checked first. 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 (Figure 12). A 1% variation in the 1.30 times tap value current (including measuring instrument deviation) will change the nominal operating time by approximately 4%.

Table I 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 I, (e.g. for the CO-8, 2 and 20 times tap value current) and measure the operating time of the relay. The .5 to 2.5 amp. relay and all CO-2 relays should be set on the lowest tap. The 1 to 12 amp. relay should be set on the 2 amp. tap with the exception of 1-12 amp. CO-2 relay which should be set on 1 amp. tap. The operating times should equal those of Table I plus or minus 5%.

4. Indicating Instantaneous Trip Unit (IIT)

The core screw which is adjustable from the top of the trip unit and the tap located on the top of the IIT determines the pickup value. The trip unit has a nominal ratio of adjustment of 1 to 24.

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 HT. The operation indicator target should drop freely.

5. 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 be not greater than the particular ICS tap setting being used. The operation 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.

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 secondary 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. 14 as these relays are affected by a distorted waveform. 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 #182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

CALIBRATION

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

CO Unit

1. Contact

The index mark on the movement frame will coincide with the "0" 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 "0" 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 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 .5-2.5 amp relay and all CO-2 relays on the minimum tap setting. With the exception of CO-2 relay, set the 1-12 amp. relay on the 2 amp. tap setting. Set the 1-12 amp. CO-2 on the 1 amp. tap. Set time dial position 6 on all relays.

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 I for permanent magnet adjustment (e.g. CO-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 I.

For type CO-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. 12). 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 made.

Apply the indicated current per Table I for the electromagnet plug adjustment (e.g. CO-8, 20 times tap value) and measure the operating time. Adjust the proper plug until the operating time corresponds to the value in Table I. (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.

4. 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 be not greater than the particular ICS tap setting being used. The operation indicator target should drop freely.

5. Indicating Instantaneous Trip Unit (IIT)

The proper tap must be selected and the core

screw adjusted to the value of pickup current desired.

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

RENEWAL PARTS

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

TABLE I
TIME CURVE CALIBRATION DATA - 50 and 60 Hertz

| PERMANENT MAGNET ADJUSTMENT | | | |
|-----------------------------|--------------------|----------------------------------|------------------------|
| RELAY TYPE | TIME DIAL POSITION | CURRENT (MULTIPLES OF TAP VALUE) | OPERATING TIME SECONDS |
| CO-2 | 6 | 3 | 0.57 |
| CO-5 | 6 | 2 | 37.80 |
| CO-6 | 6 | 2 | 2.46 |
| CO-7 | 6 | 2 | 4.27 |
| CO-8 | 6 | 2 | 13.35 |
| CO-9 | 6 | 2 | 8.87 |
| CO-11 | 6 | 2 | 11.27 |
| ELECTROMAGNET PLUGS | | | |
| CO-2 | 6 | 20 | 0.22 |
| CO-5 | 6 | 10 | 14.30 |
| CO-6 | 6 | 20 | 1.19 |
| CO-7 | 6 | 20 | 1.11 |
| CO-8 | 6 | 20 | 1.11 |
| CO-9 | 6 | 20 | 0.65 |
| CO-11 | 6 | 20 | 0.24 |

Δ For 50 Hz. CO-11 relay 20 times operating time limits are $0.24 + 10\% - 5\%$.

ENERGY REQUIREMENTS

| INSTANTANEOUS TRIP UNIT (IIT) | | | | | | | | | | | |
|-------------------------------|--|----------------|-------------------|-----------|------|------|-------------------|--------------------|--------------------|-------------------------|----------------------------|
| TYPE OF IIT UNIT | RANGES AVAILABLE WITH CORE ADJUSTMENT | TAP SETTING | MINIMUM PICKUP | BURDEN | | | | | | CONT. RATING AMPS | 1 SECOND RATING AMPS |
| | | | | AT PICKUP | | | OHMS | | | | |
| | | | | R | XL | Z | 3 TIMES PICKUP | 10 TIMES PICKUP | 20 TIMES PICKUP | | |
| 2-48 | 2-7 | 2-7 | 2 | .68 | .42 | .8 | .72 | .67 | .67 | 2.5 | 70 |
| | 7-14 | 7-14 | 7 | .076 | .048 | .09 | .086 | .075 | .075 | 7 | 140 |
| | 14-48 | 14-48 | 14 | .032 | .012 | .035 | .035 | .035 | .035 | 10 | 185 |
| 6-144 | 6-20 | 6-20 | 6 | .108 | .067 | .127 | .125 | .125 | .100 | 7 | 88 |
| | 20-40 | 20-40 | 20 | .016 | .008 | .018 | .018 | .018 | .018 | 16 | 280 |
| | 40-144 | 40-144 | 40 | .007 | .002 | .007 | .007 | .007 | .007 | 25 | 460 |

ENERGY REQUIREMENTS

CO-2 SHORT TIME RELAY

| 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 | 530 | 2280 |
| | 2.5 | 2.50 | 28 | 29 | 7.9 | 73.6 | 700 | 2850 |
| 1/12 | 1.0 | 1.65 | 28 | 55 | 4.6 | 37.3 | 266 | 895 |
| | 1.2 | 1.90 | 28 | 54 | 4.6 | 38.0 | 280 | 1000 |
| | 1.5 | 2.20 | 28 | 53 | 4.8 | 40.0 | 310 | 1150 |
| | 2.0 | 3.30 | 28 | 54 | 4.8 | 40.5 | 315 | 1180 |
| | 2.5 | 4.00 | 56 | 56 | 4.7 | 39.2 | 282 | 970 |
| | 3.0 | 5.00 | 56 | 55 | 4.9 | 40.2 | 295 | 1050 |
| | 3.5 | 5.50 | 56 | 54 | 4.9 | 41.0 | 312 | 1125 |
| | 4.0 | 6.50 | 56 | 53 | 4.8 | 41.0 | 325 | 1150 |
| | 5.0 | 7.10 | 230 | 53 | 5.1 | 42.7 | 330 | 1200 |
| | 6.0 | 8.80 | 230 | 50 | 5.2 | 44.0 | 360 | 1350 |
| | 7.0 | 9.50 | 230 | 48 | 5.7 | 48.5 | 390 | 1600 |
| | 8.0 | 10.50 | 230 | 46 | 6.2 | 53.0 | 475 | 1800 |
| | 10.0 | 12.00 | 230 | 40 | 6.8 | 61.0 | 565 | 2500 |
| | 12.0 | 13.00 | 230 | 35 | 7.8 | 70.0 | 680 | 3300 |

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

CO-5 LONG TIME AND CO-6 DEFINITE MINIMUM TIME RELAYS

| 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 | 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 |
| 1/12 | 1.0 | 4.5 | 88 | 69 | 3.98 | 21.0 | 100 | 265 |
| | 1.2 | 5.5 | 88 | 68 | 3.93 | 21.3 | 103 | 282 |
| | 1.6 | 6.0 | 88 | 67 | 4.00 | 21.8 | 109 | 308 |
| | 2.0 | 7.7 | 88 | 66 | 3.98 | 21.9 | 115 | 340 |
| | 2.5 | 9.5 | 88 | 65 | 3.98 | 22.2 | 122 | 363 |
| | 3.0 | 10.0 | 230 | 65 | 4.02 | 22.5 | 125 | 366 |
| | 3.5 | 12.0 | 230 | 65 | 4.06 | 23.2 | 132 | 403 |
| | 4.0 | 13.5 | 230 | 64 | 4.12 | 23.5 | 137 | 420 |
| | 5.0 | 15.0 | 230 | 61 | 4.18 | 24.6 | 150 | 500 |
| | 6.0 | 17.5 | 460 | 60 | 4.35 | 25.8 | 165 | 570 |
| | 7.0 | 20.5 | 460 | 57 | 4.44 | 27.0 | 185 | 630 |
| | 8.0 | 22.5 | 460 | 53 | 4.54 | 28.6 | 211 | 736 |
| | 10.0 | 23.5 | 460 | 48 | 4.80 | 32.5 | 266 | 940 |
| | 12.0 | 26.5 | 460 | 42 | 5.34 | 37.9 | 325 | 1152 |

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

| CO-7 MODERATELY INVERSE TIME RELAY | | | | | | | | |
|---|------|-----------------------------|-----------------------------|---------------------------|----------------------|------------------------------|-------------------------------|-------------------------------|
| 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 | 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 |
| 1/12 | 1.0 | 4.5 | 88 | 68 | 3.86 | 20.6 | 100 | 265 |
| | 1.2 | 5.5 | 88 | 67 | 3.82 | 20.4 | 104 | 270 |
| | 1.5 | 6.0 | 88 | 66 | 3.92 | 21.2 | 110 | 300 |
| | 2.0 | 7.7 | 88 | 65 | 3.90 | 21.8 | 117 | 312 |
| | 2.5 | 9.5 | 88 | 64 | 3.90 | 21.8 | 123 | 360 |
| | 3.0 | 10.0 | 230 | 63 | 3.92 | 22.5 | 127 | 390 |
| | 3.5 | 12.0 | 230 | 63 | 3.97 | 22.7 | 131 | 413 |
| | 4.0 | 13.5 | 230 | 63 | 4.02 | 22.9 | 136 | 420 |
| | 5.0 | 15.0 | 230 | 60 | 4.11 | 24.1 | 153 | 490 |
| | 6.0 | 17.5 | 460 | 58 | 4.29 | 25.5 | 165 | 528 |
| | 7.0 | 20.5 | 460 | 54 | 4.43 | 27.3 | 189 | 630 |
| | 8.0 | 22.5 | 460 | 50 | 4.50 | 30.8 | 206 | 732 |
| | 10.0 | 23.5 | 460 | 46 | 4.81 | 32.6 | 250 | 970 |
| | 12.0 | 26.5 | 460 | 42 | 5.04 | 36.9 | 342 | 1224 |
| CO-8 INVERSE TIME AND CO-9 VERY INVERSE TIME RELAYS | | | | | | | | |
| 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 |
| 1/12 | 1.0 | 4.5 | 88 | 73 | 2.33 | 20 | 135 | 347 |
| | 1.2 | 5.5 | 88 | 73 | 2.33 | 20 | 135 | 361 |
| | 1.5 | 6.0 | 88 | 72 | 2.35 | 20.1 | 142 | 383 |
| | 2.0 | 7.7 | 88 | 69 | 2.35 | 20.2 | 145 | 412 |
| | 2.5 | 9.5 | 88 | 68 | 2.36 | 20.3 | 146 | 415 |
| | 3.0 | 10.0 | 230 | 67 | 2.37 | 20.4 | 149 | 420 |
| | 3.5 | 12.0 | 230 | 66 | 2.38 | 20.9 | 153 | 450 |
| | 4.0 | 13.5 | 230 | 65 | 2.40 | 21.0 | 157 | 460 |
| | 5.0 | 15.0 | 230 | 63 | 2.40 | 21.0 | 164 | 500 |
| | 6.0 | 17.5 | 460 | 60 | 2.47 | 21.6 | 170 | 525 |
| | 7.0 | 20.5 | 460 | 57 | 2.51 | 21.8 | 180 | 600 |
| | 8.0 | 22.5 | 460 | 55 | 2.52 | 22.2 | 192 | 672 |
| | 10.0 | 23.5 | 460 | 48 | 2.77 | 24.5 | 230 | 830 |
| | 12.0 | 26.5 | 460 | 45 | 2.94 | 25.4 | 258 | 960 |

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 other current.

ϕ Degrees current lags voltage at tap value current.

** Voltages taken with Rectox type voltmeter.

ENERGY REQUIREMENTS

CO-11 EXTREMELY INVERSE TIME RELAY

| 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 | 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 |
| 1/12 | 1.0 | 3.5 | 56 | 30 | 0.82 | 7.4 | 82 | 300 |
| | 1.2 | 4.0 | 56 | 29 | 0.90 | 8.0 | 87 | 324 |
| | 1.5 | 5.5 | 56 | 26 | 0.97 | 8.6 | 93 | 350 |
| | 2.0 | 8.5 | 56 | 25 | 1.00 | 8.9 | 96 | 380 |
| | 2.5 | 10.0 | 56 | 24 | 1.10 | 9.0 | 96 | 377 |
| | 3.0 | 12.5 | 230 | 33 | 0.87 | 8.0 | 88 | 340 |
| | 3.5 | 14.0 | 230 | 31 | 0.88 | 8.2 | 88 | 340 |
| | 4.0 | 15.0 | 230 | 29 | 0.94 | 8.7 | 96 | 366 |
| | 5.0 | 17.0 | 230 | 25 | 1.10 | 10.0 | 110 | 435 |
| | 6.0 | 18.5 | 460 | 22 | 1.25 | 11.5 | 120 | 478 |
| | 7.0 | 20.0 | 460 | 20 | 1.40 | 12.3 | 135 | 560 |
| | 8.0 | 21.5 | 460 | 19 | 1.50 | 14.0 | 160 | 648 |
| | 10.0 | 25.0 | 460 | 14 | 1.9 | 18.3 | 210 | 900 |
| | 12.0 | 28.0 | 460 | 10 | 2.4 | 23.8 | 276 | 1200 |

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.

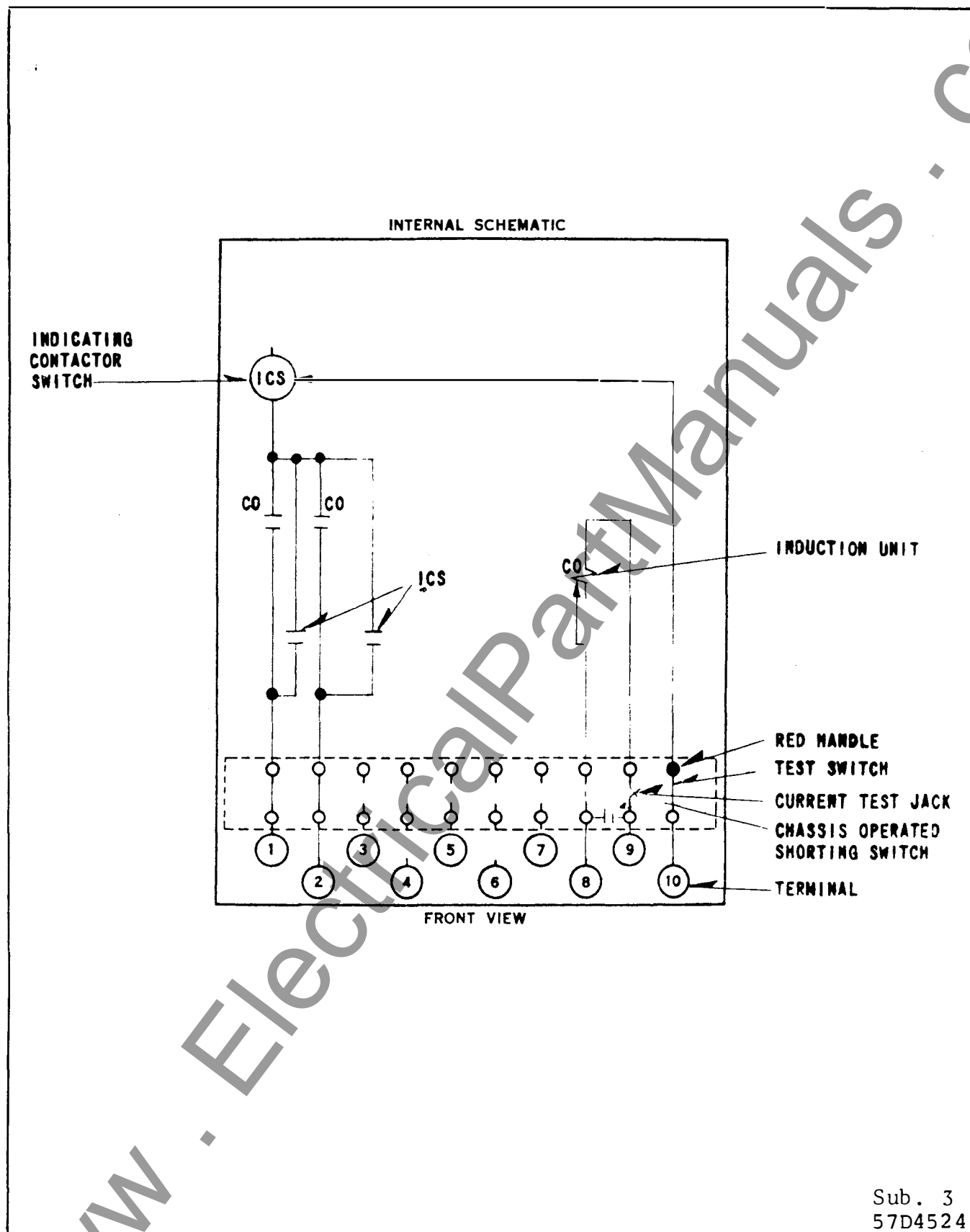


Fig. 1 Internal Schematic of the Double Trip Relay Without IIT

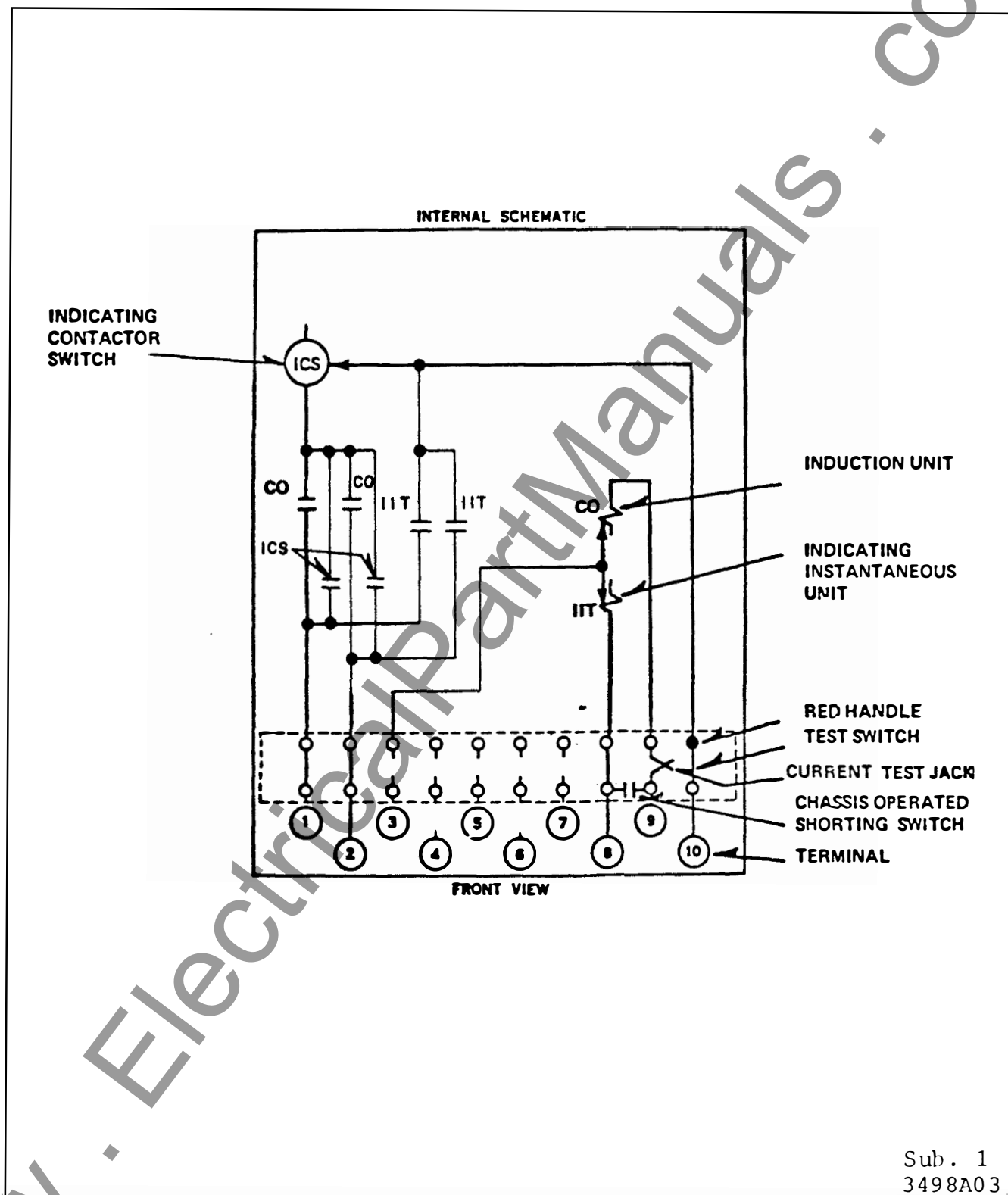


Fig. 2 Internal Schematic of the Double Trip Relay With IIT

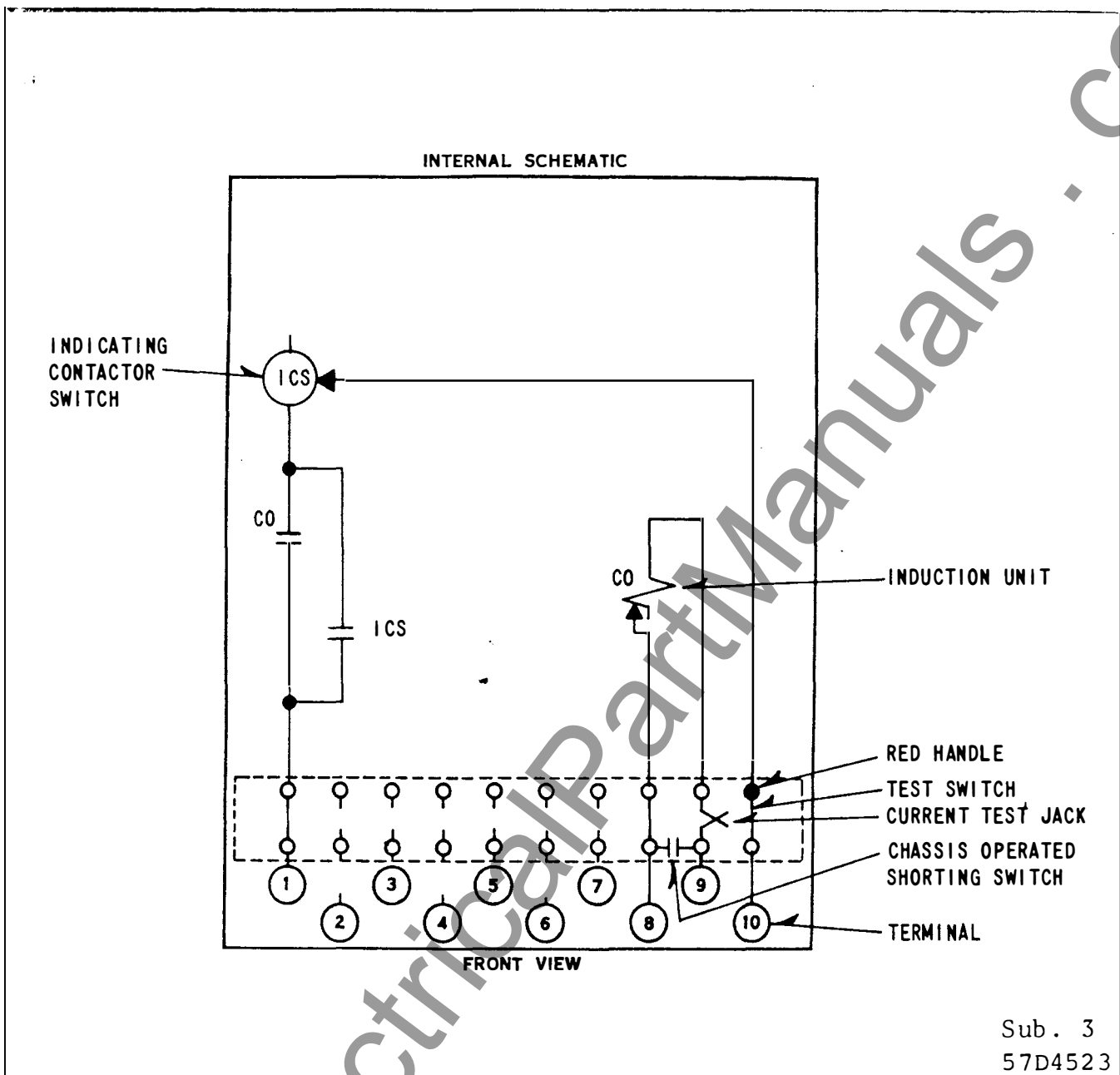


Fig. 3. Internal Schematic of the Single Trip Relay Without IIT

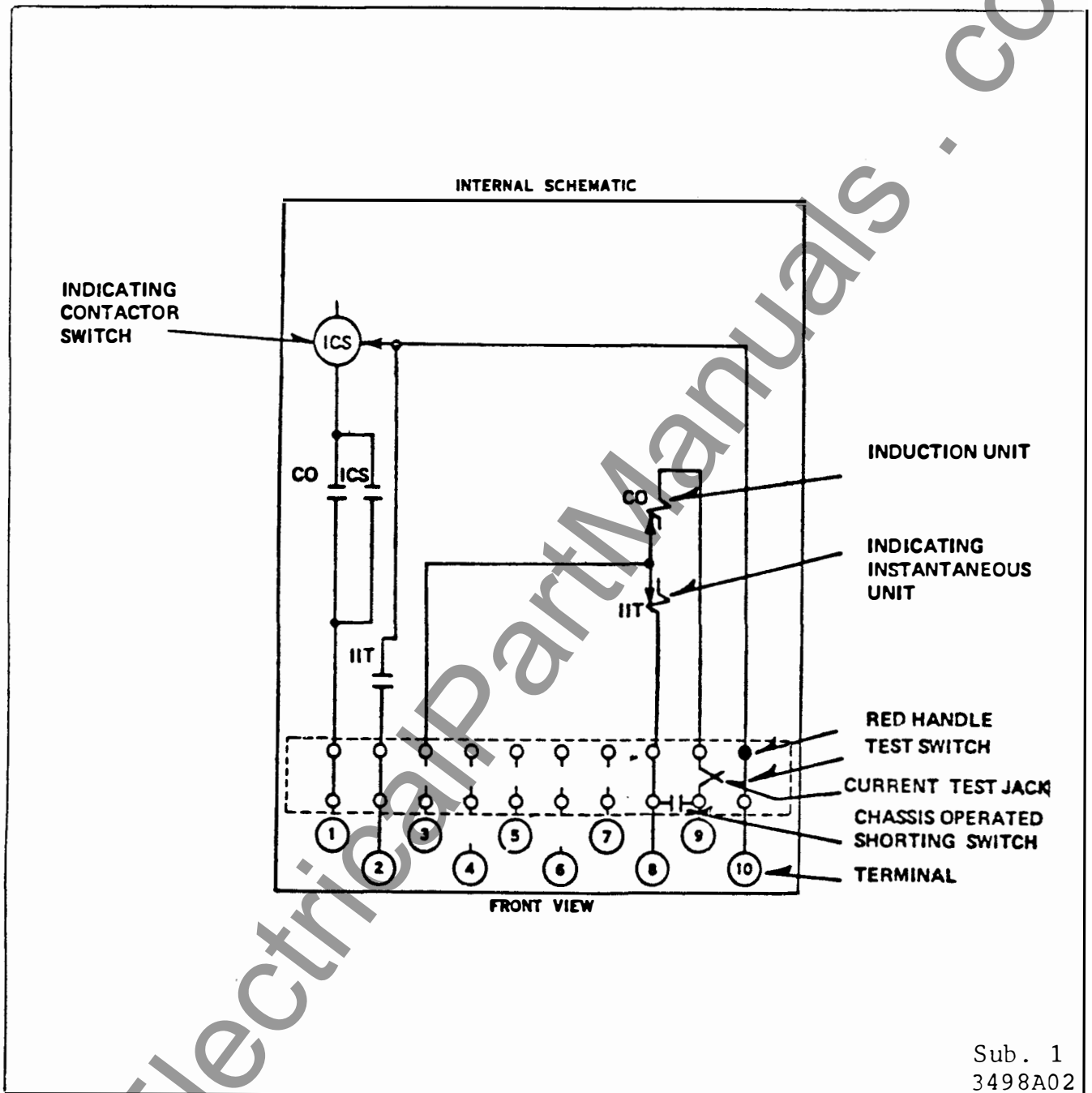


Fig. 4 Internal Schematic of the Single Trip Relay With IIT

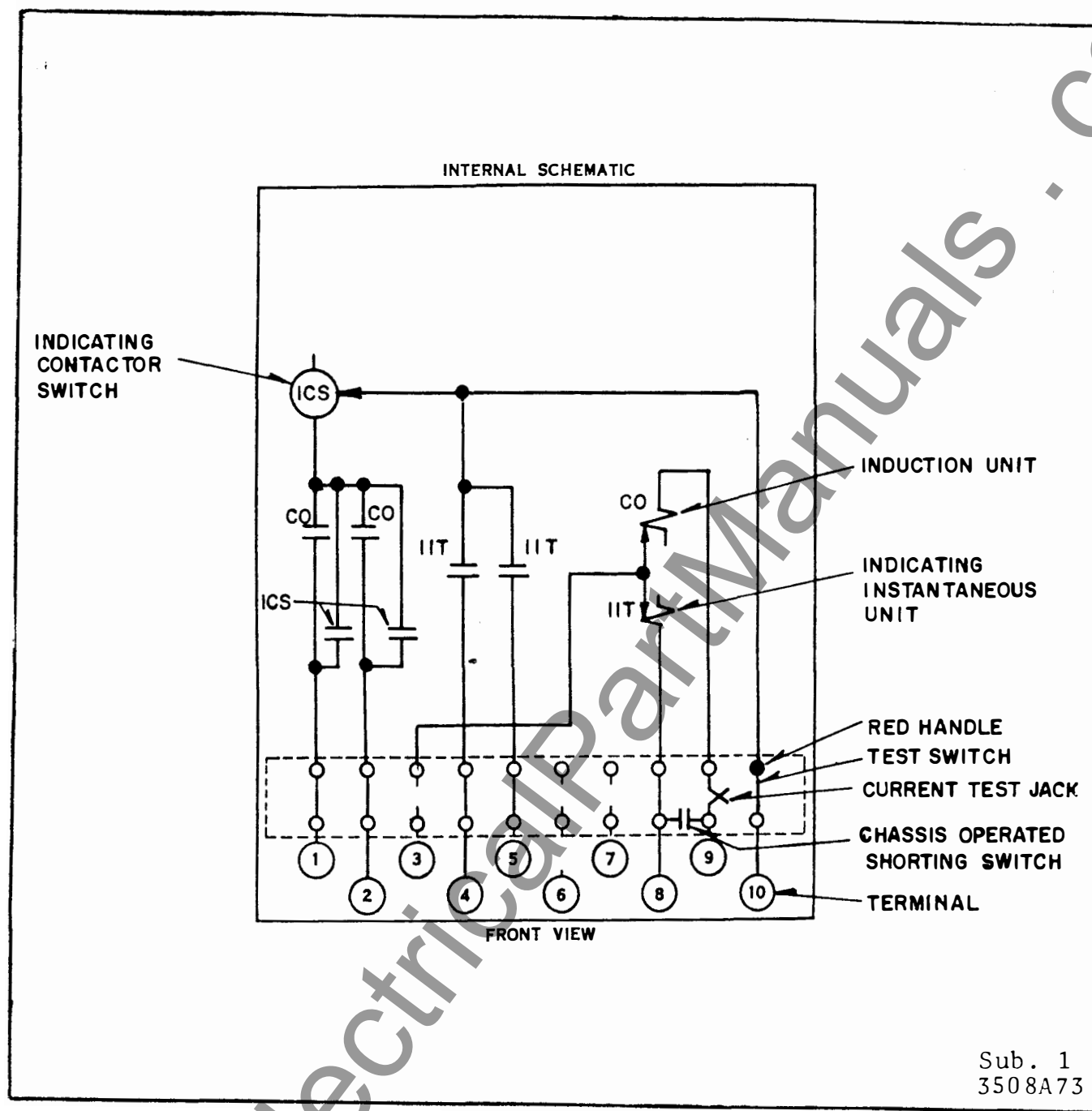
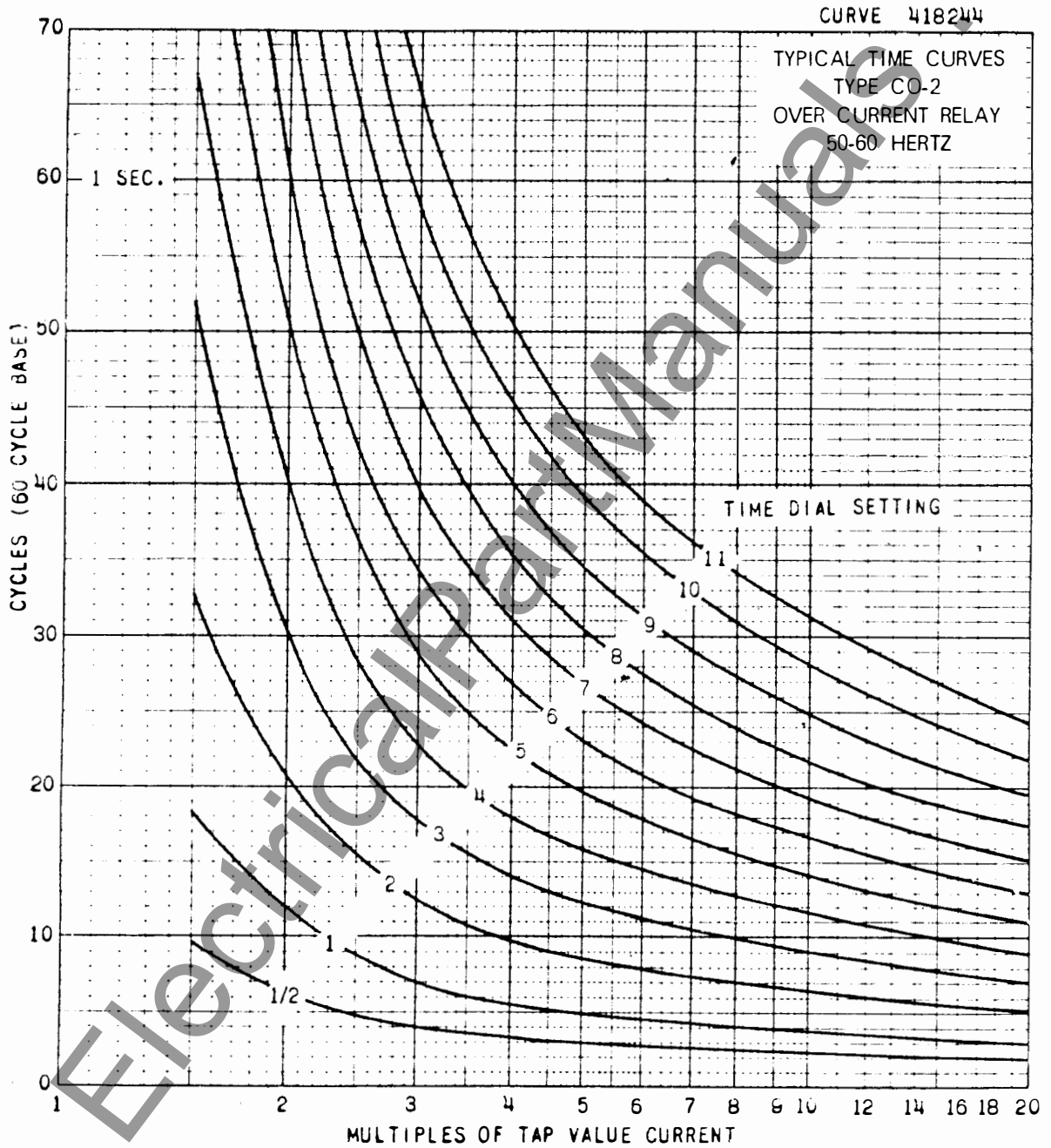
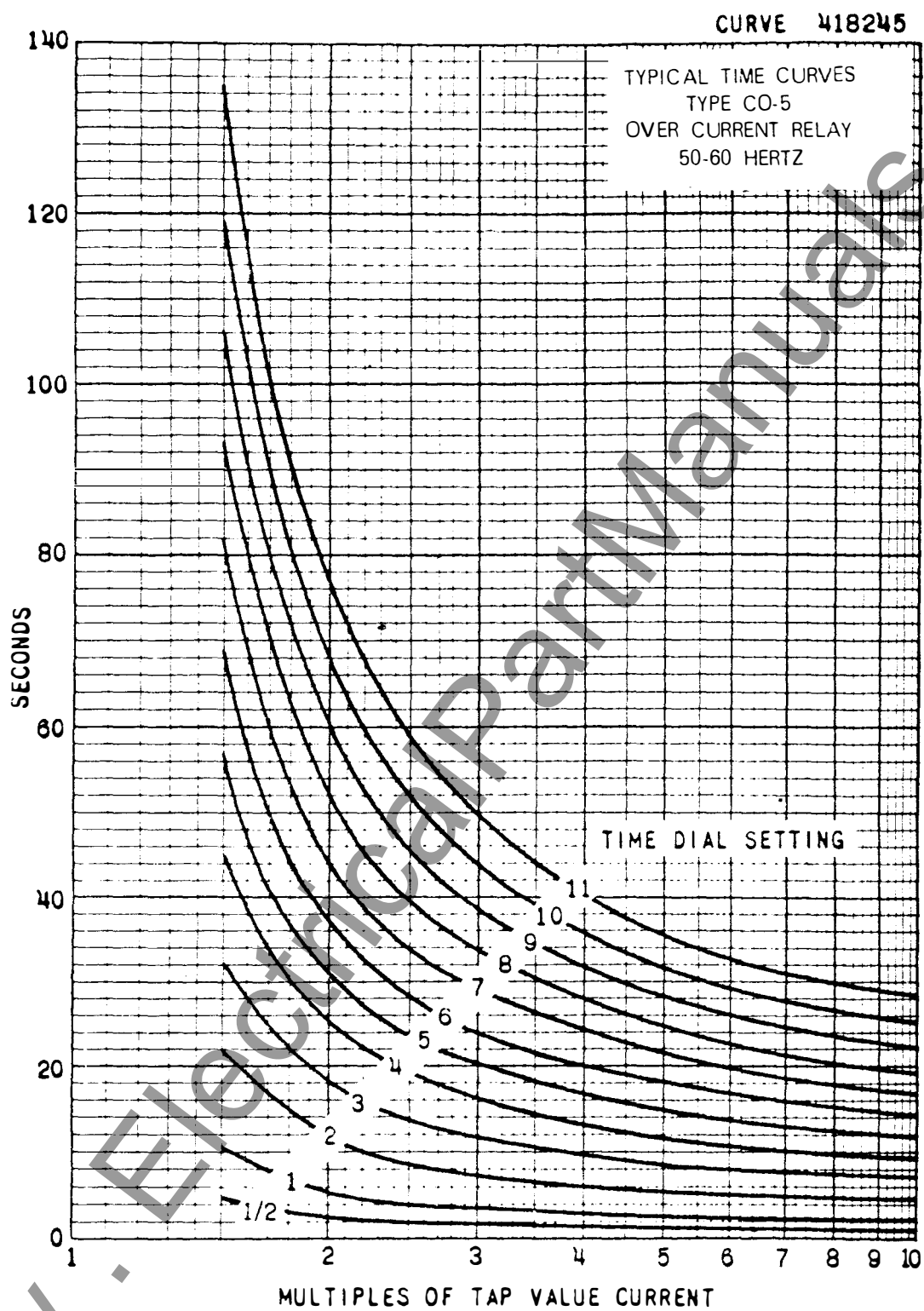


Fig. 5 Internal Schematic of Double Trip Relay With IIT to Separate Terminals.



418244

Fig. 6 Typical Time Curve of the Type CO-2 Relay



418245

Fig. 7 Typical Time Curve of the Type CO-5 Relay

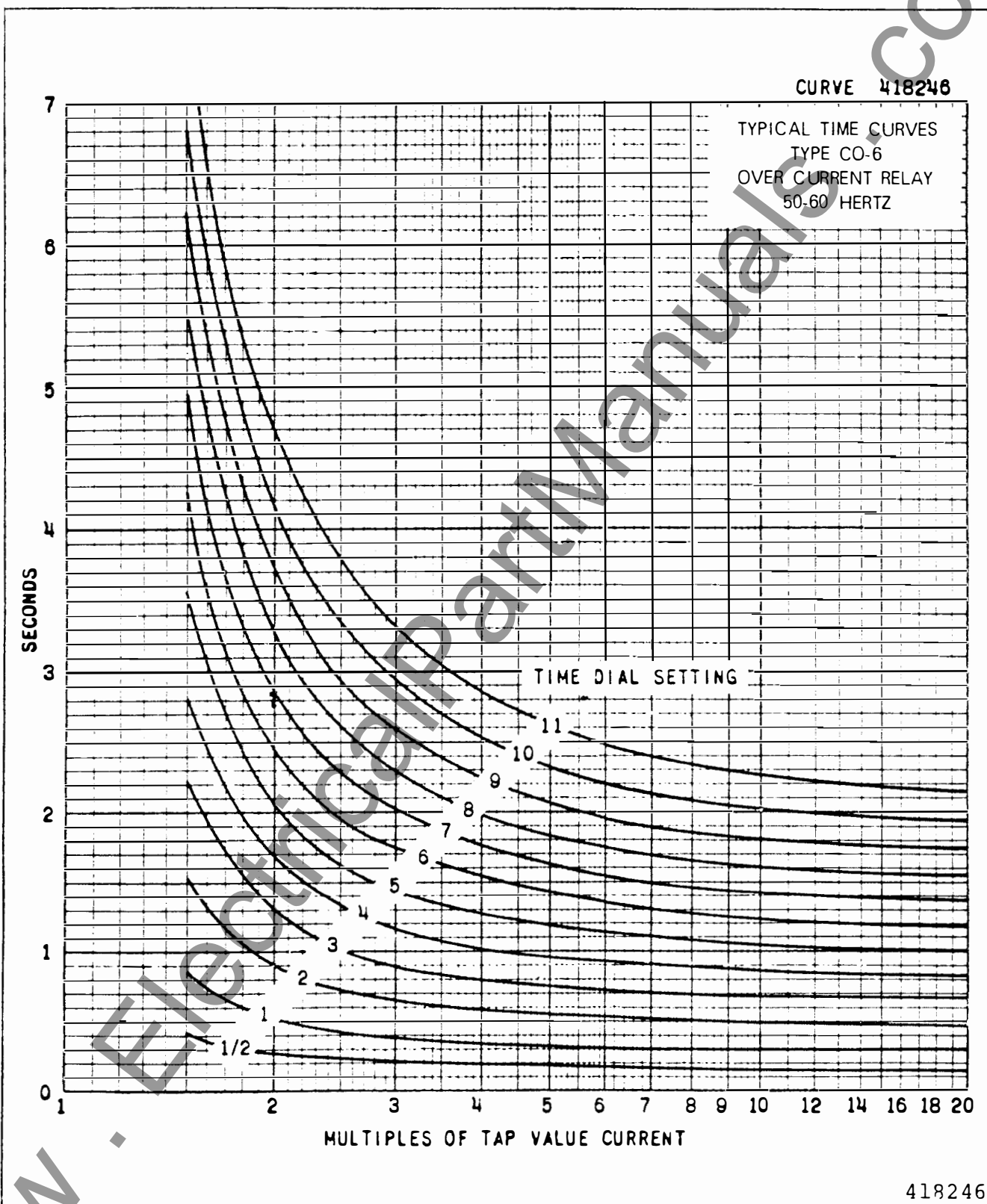


Fig. 8 Typical Time Curve of the Type CO-6 Relay

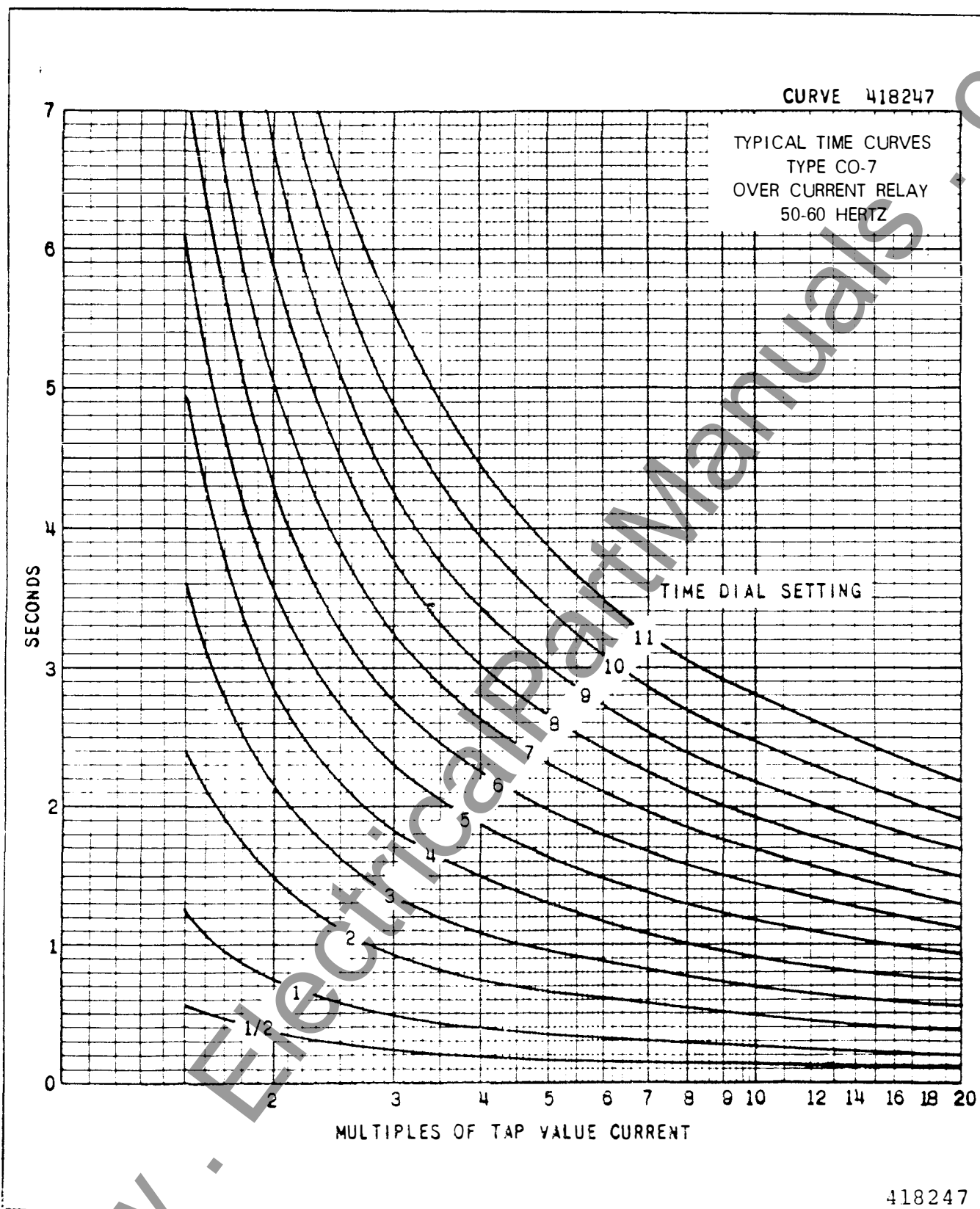


Fig. 9 Typical Time Curve of the Type CO-7 Relay

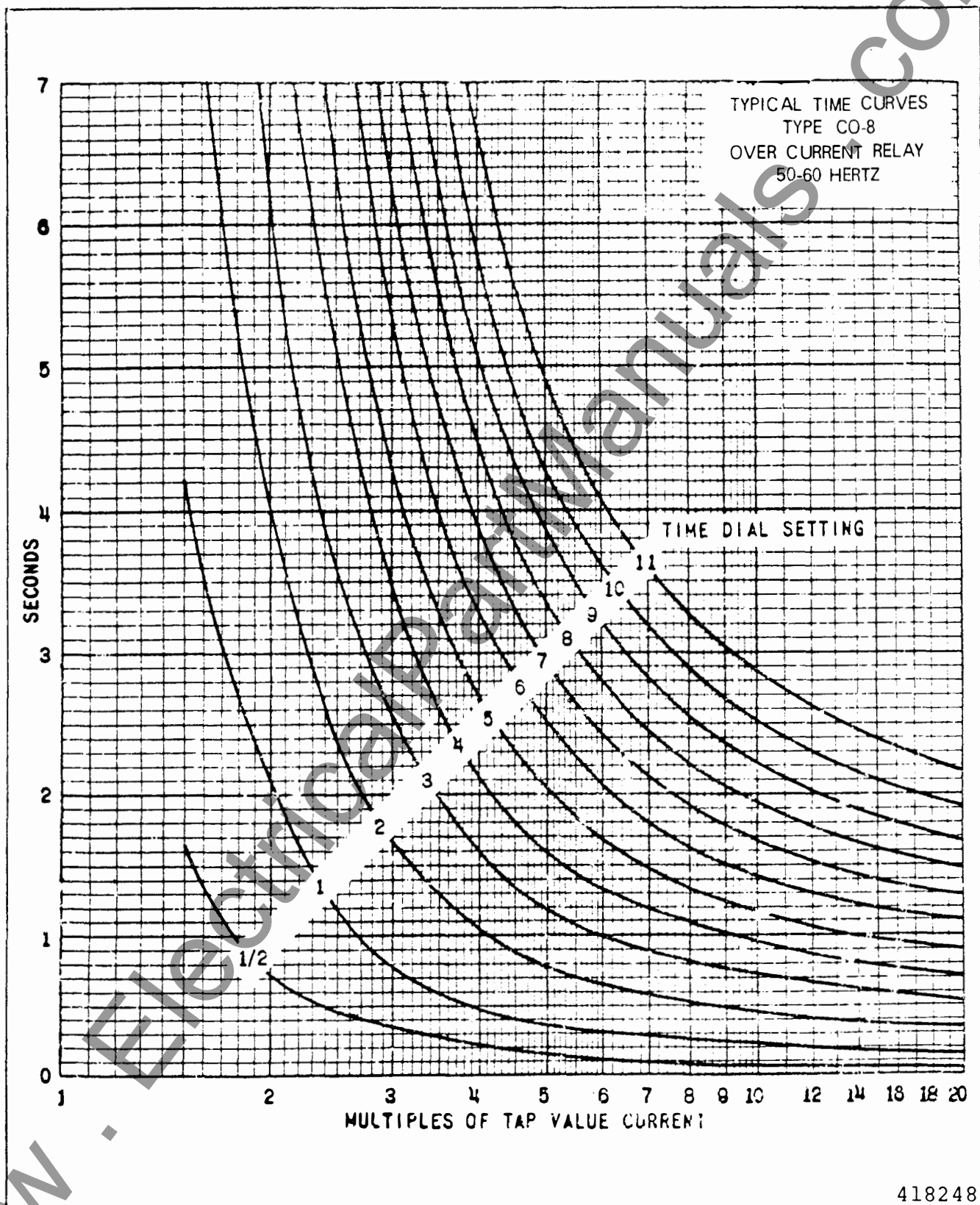


Fig. 10 Typical Time Curve of the Type CO-8 Relay

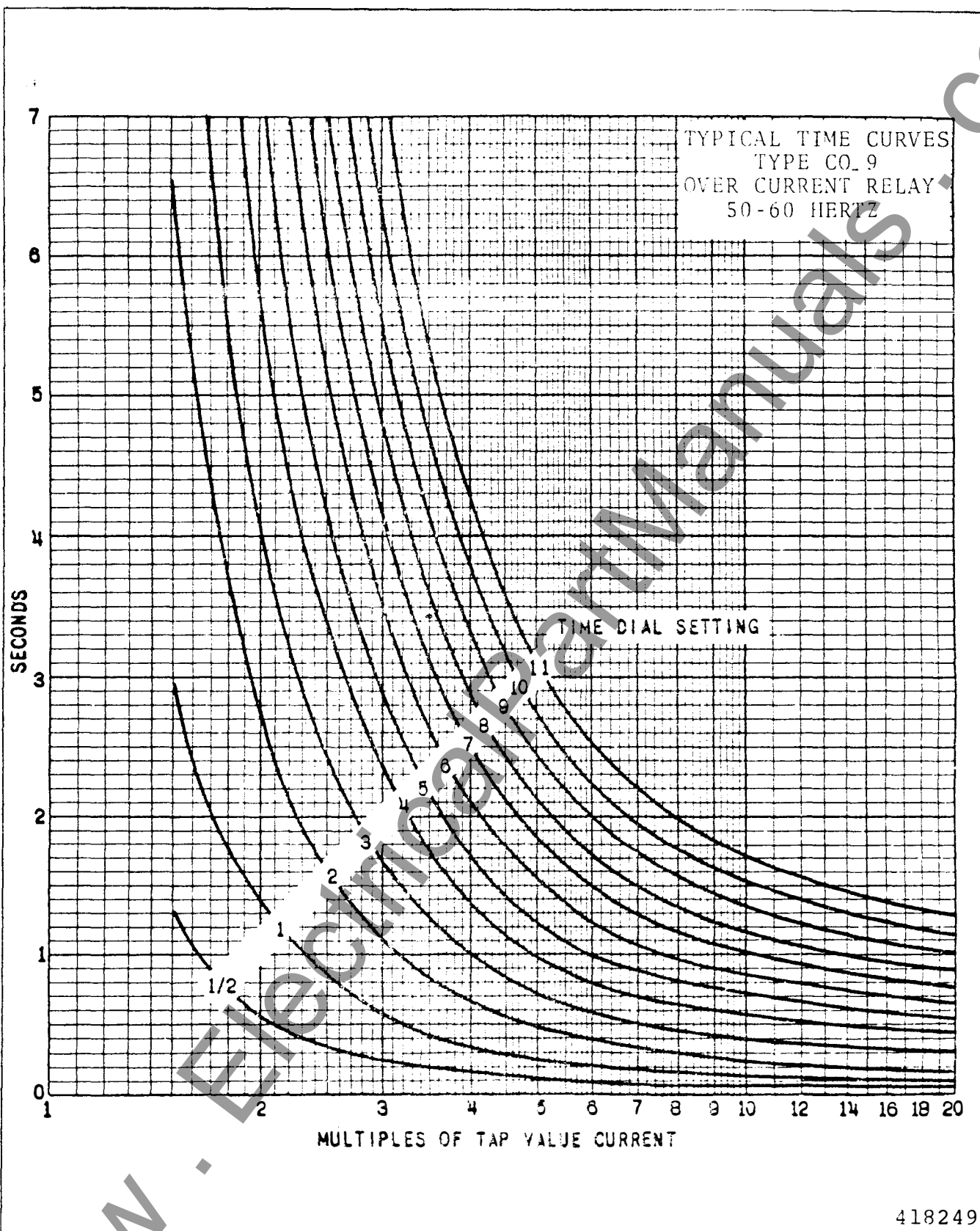
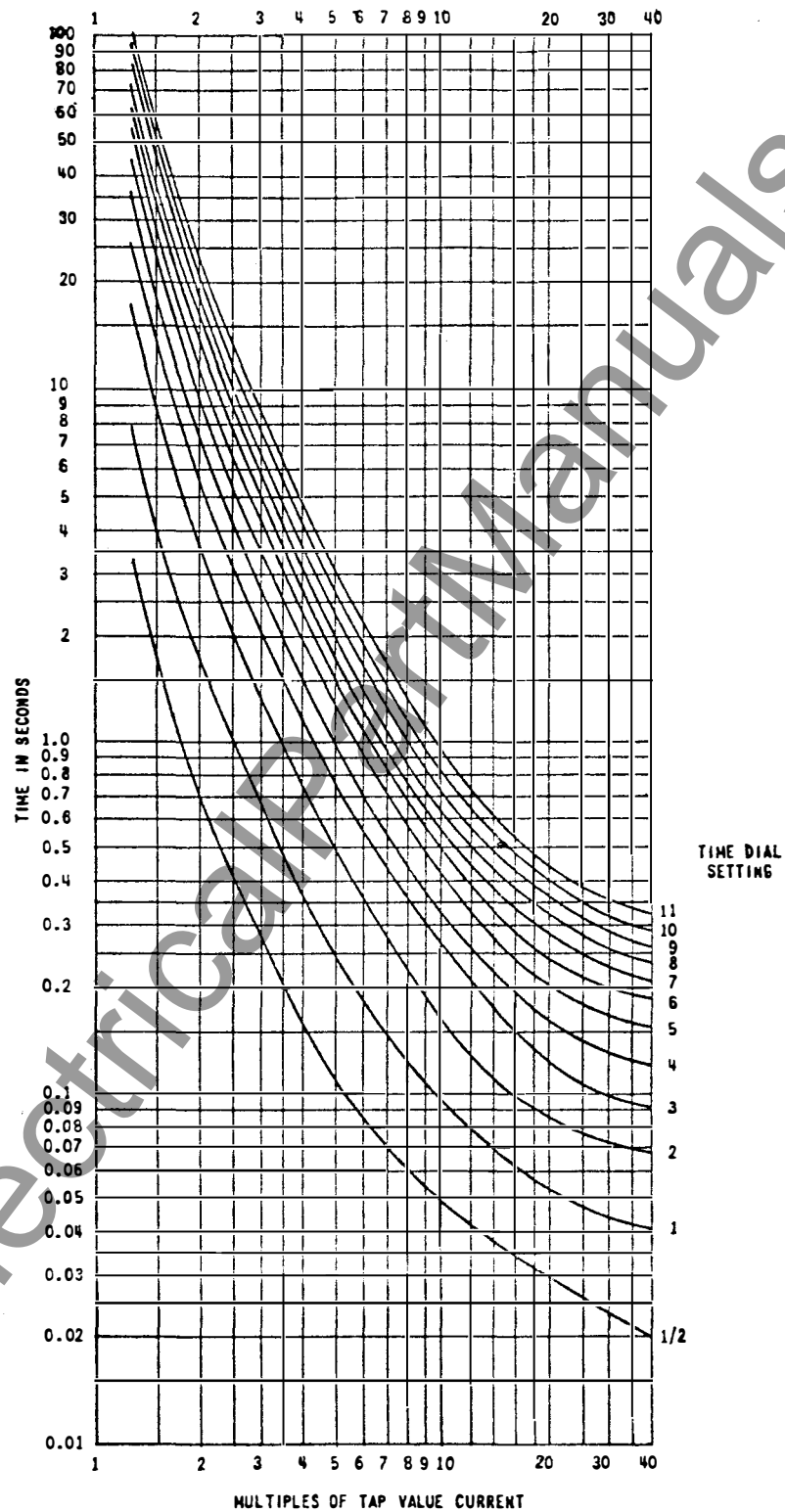


Fig. 11 Typical Time Curve of the Type CO-9 Relay



288B655

Fig. 12 Typical Time Curve of the Type CO-11 Relay

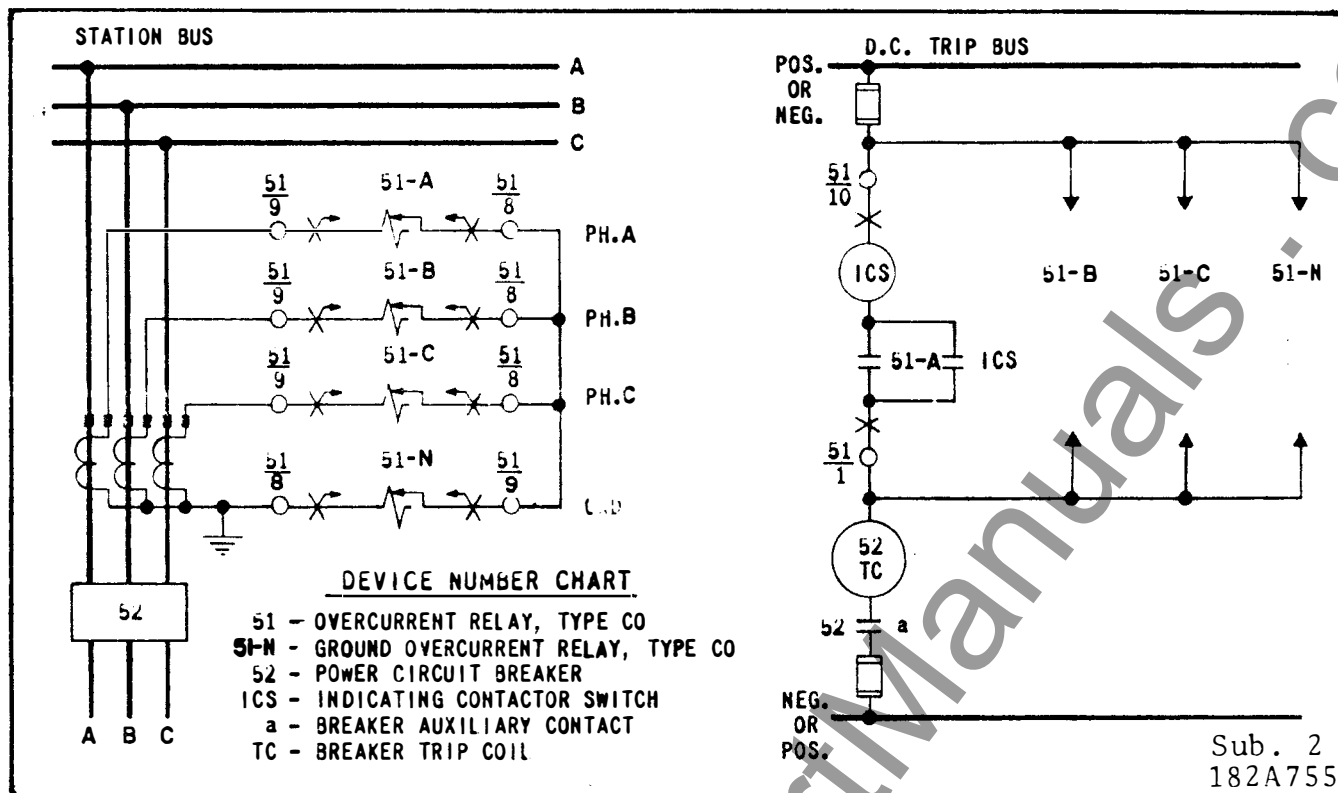


Fig. 13 External Schematic of HiLo CO relay for Phase and Ground Overcurrent Protection on a Three Phase System.

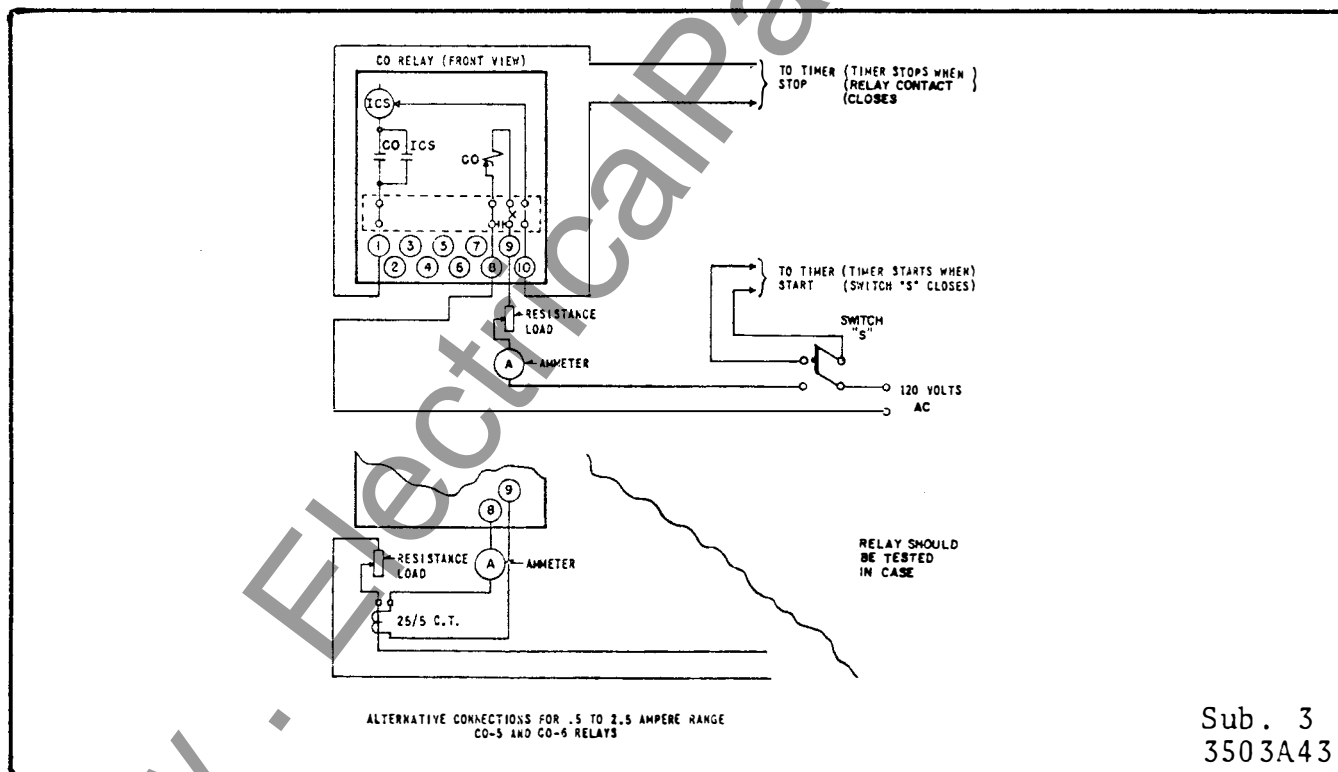


Fig. 14 Diagram of Test Connections for the Type CO Relay.

RELAY TYPE

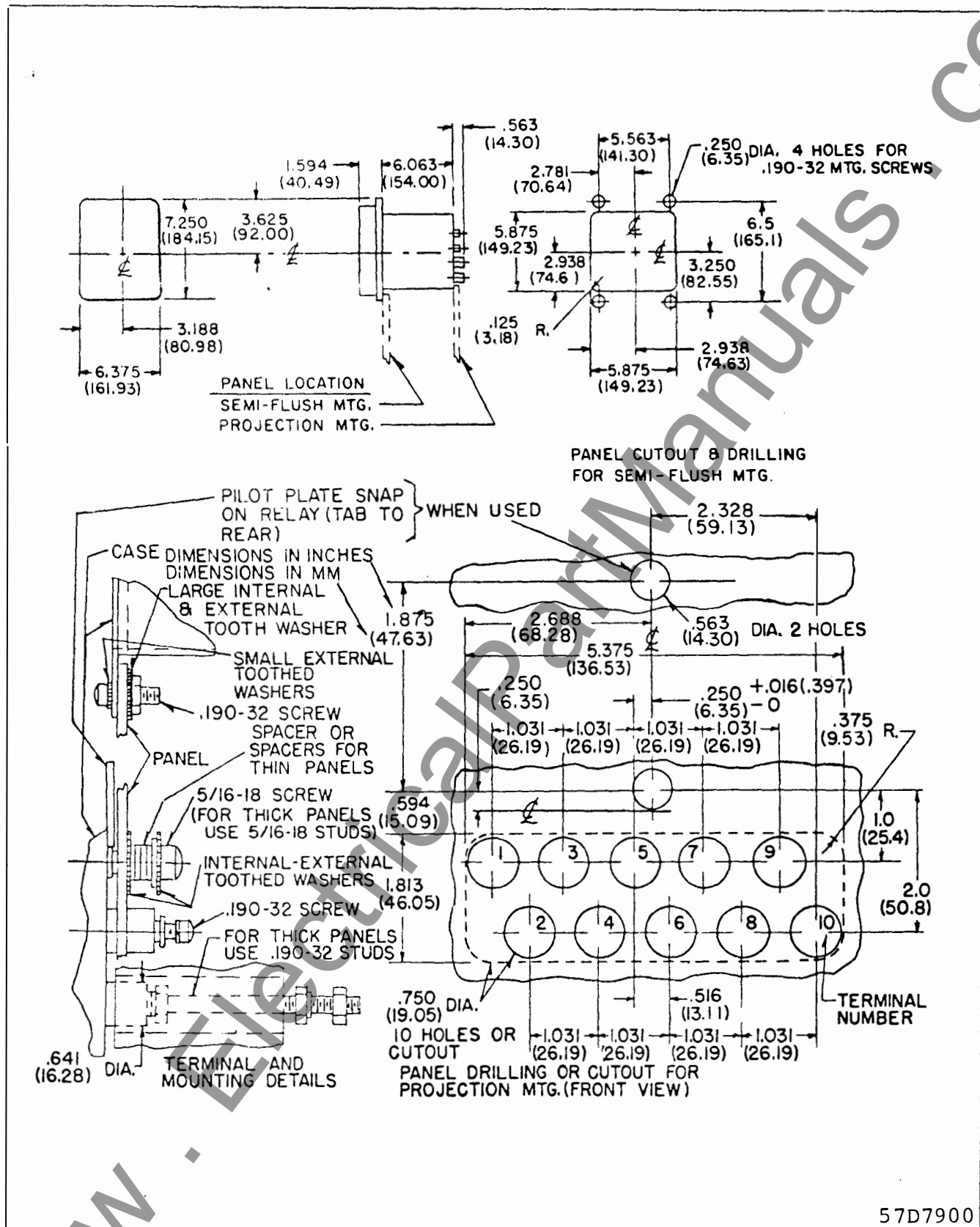
FIRST 7 DIGITS OF STYLE NO.

| | |
|-------|---------|
| CO-2 | 265C195 |
| CO-5 | 264C897 |
| CO-6 | 264C898 |
| CO-7 | 264C899 |
| CO-8 | 264C900 |
| CO-9 | 264C901 |
| CO-11 | 265C047 |

| LAST THREE DIGITS OF STYLE NUMBER | | RANGE CO | RANGE IIT | DESCRIPTION | SCHEMATIC |
|-----------------------------------|-------|----------|-----------|--|------------------|
| 60 HZ | 50 HZ | | | | |
| A01 | A21 | .5 - 2.5 | — | SINGLE TRIP | 57D4523 (FIG. 3) |
| A02 | A22 | .5 - 2.5 | — | DOUBLE TRIP | 57D4524 (FIG. 1) |
| A03 | A23 | .5 - 2.5 | 2 - 48 | SINGLE TRIP | 3498A02 (FIG. 4) |
| A04 | A24 | .5 - 2.5 | 2 - 48 | DOUBLE TRIP | 3498A03 (FIG. 2) |
| A05 | A25 | 1 - 12 | — | SINGLE TRIP | 57D4523 (FIG. 3) |
| A06 | A26 | 1 - 12 | — | DOUBLE TRIP | 57D4524 (FIG. 1) |
| A07 | A27 | 1 - 12 | 6 - 144 | SINGLE TRIP | 3498A02 (FIG. 4) |
| A08 | A28 | 1 - 12 | 6 - 144 | DOUBLE TRIP | 3498A03 (FIG. 2) |
| A09 | A29 | .5 - 2.5 | 6 - 144 | SINGLE TRIP | 3498A02 (FIG. 4) |
| A10 | A30 | .5 - 2.5 | 6 - 144 | DOUBLE TRIP | 3498A03 (FIG. 2) |
| A11 | A31 | 1 - 12 | 2 - 48 | SINGLE TRIP | 3498A02 (FIG. 4) |
| A12 | A32 | 1 - 12 | 2 - 48 | DOUBLE TRIP | 3498A03 (FIG. 2) |
| A13 | A33 | .5 - 2.5 | 2 - 48 | DOUBLE TRIP WITH IIT CONTACTS WIRED TO SEPARATE CONTACTS | 3508A73 (FIG. 5) |
| A14 | A34 | 1 - 12 | 6 - 144 | DOUBLE TRIP WITH IIT CONTACTS WIRED TO SEPARATE CONTACTS | 3508A73 (FIG. 5) |
| A15 | A35 | .5 - 2.5 | 6 - 144 | DOUBLE TRIP WITH IIT CONTACTS WIRED TO SEPARATE CONTACTS | 3508A73 (FIG. 5) |
| A16 | A36 | 1 - 12 | 2 - 48 | DOUBLE TRIP WITH IIT CONTACTS WIRED TO SEPARATE CONTACTS | 3508A73 (FIG. 5) |

Fig. 15. CO Relay Style Descriptions

SUB. 6
775B349



57D7900

Fig. 16 Outline and Drilling Plan for the Type CO Relay.