Type CWP-1 Sensitive Directional Ground Relay

Effective: May 1992
Supersedes I.L. 41-242.5D, Dated August 1981
(I) Denotes Change Since Previous Issue

CAUTION

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

1.0 APPLICATION

The type CWP-1 relay is an induction only disc type relay used for directional ground fault protection only on high-resistance grounded power systems. It is similar to the type CWP relay except that it has a higher sensitivity and an entirely different maximum sensitivity angle.

The CWP-1 relay is applied for selective alarm or tripping for systems where the ground fault current is limited to a range of about 0.2% to 8% of rated full load current. The system may be resistance-grounded with conventional zig-zag grounding transformers or with a neutral resistor, in conjunction with a distribution transformer. An alternative arrangement is shown in Figure 6 where the grounding resistor is connected across the broken delta of the distribution transformers or potential transformers which are used to provide potential for the CWP-1 relay.

A window-type ct is used in Figure 7 to energize the CWP-1 current coil. With this arrangement, all three conductors are passed through the opening, thus avoiding the problem of false residual current that is encountered when three current transformers are used. The window-type ct is necessary where a relay sensitivity of about 1% or less of rated load current is required. Where fault current values permit a higher current pickup, three residually connected ct's may be used.

2.0 CONSTRUCTION AND OPERATION

The type CWP-1 relay consists of an operating unit, current transformer, phase shifting network, and an indicating contactor switch.

2.1 OPERATING UNIT

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Figure 2. The electromagnet is connected to the protected apparatus in a manner so that out-of-phase fluxes are produced by the flow of currents in both the upper and lower pole circuits. The out-of-phase fluxes cause either a contact opening or a contact closing torque depending upon the relative direction of current flow in the upper and lower pole circuits.

2.2 PHASE SHIFTER NETWORK

The phase shifter network of the type CWP-1 relay consists of capacitance and resistance connected in series with the lower pole circuit.

2.3 INDICATING CONTACTOR SWITCH UNIT (ICS)

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

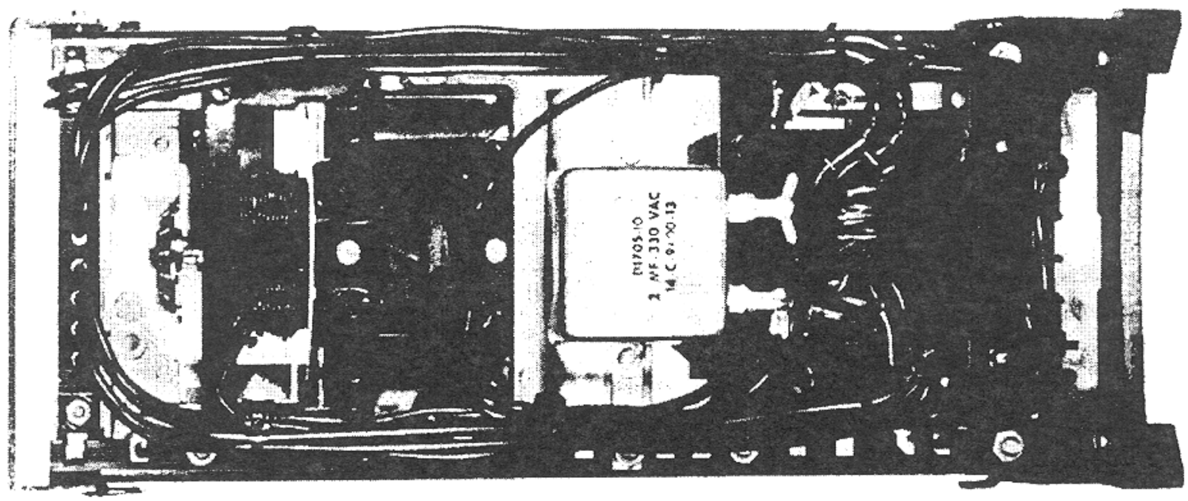

Figure 2. Type CWP-1 Ground Relay (Rear View)

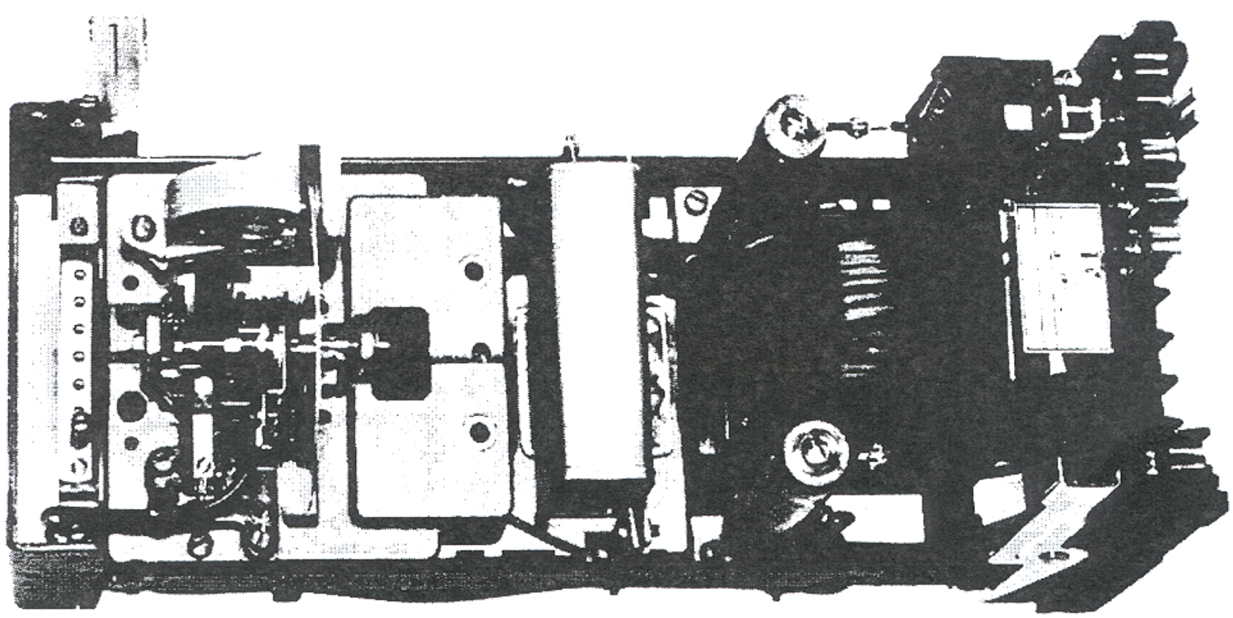

Figure 1. Type CWP-1 Ground Relay (Front View)

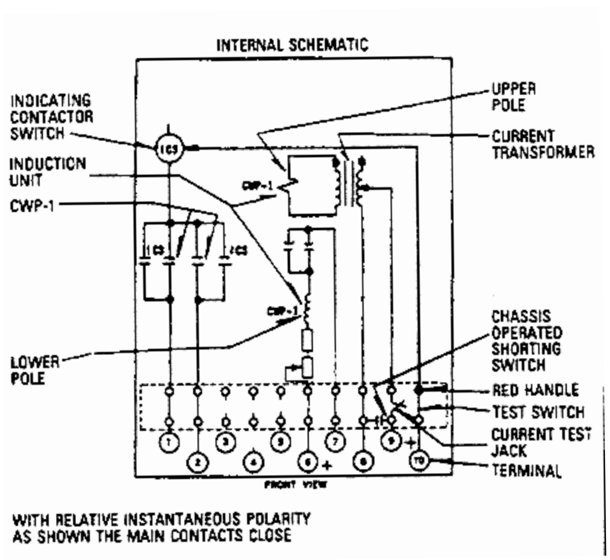

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Figure 3. Internal Schematic of the Double Trip CWP - 1 Relay, FT-31 Case. (Single Trip Relays have Terminal 2 and Associated Circuits Omitted)

armature deflect a spring located on the front of the switch, which allows the operation indicator 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.

Current Transformer

This is an auxiliary step-up transformer (maximum ratio 20/1) used to supply current to the upper poles of the electromagnet. The transformer is tapped to provide relay settings.

3.0 CHARACTERISTICS

The type CWP-1 relay taps are as follows:

0.5 - 0.7 - 1.0 - 1.4 - 2.0 - 2.8 - 4.0

The tap value represents the minimum pickup product of residual current (at an angle of 45° lead) times the residual voltage.

Typical 60 Hertz time product curves for the type CWP-1 relay are shown in Figure 4 with 100 volts across the potential circuit. These curves are taken at maximum torque which occurs with the current leading the voltage by 45°. For currents not leading by this angle, the relay tripping time may be obtained by determining the operating time corresponding to the product $P1 = P \cos(\theta - 45)$, where P is the actual relay VA product and θ is the angle the current leads the voltage. The curves are accurate within ±7% if the multiple of tap product does not exceed the voltage on the relay coil.

3.1 Trip Circuit

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

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2.0 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection.

3.2 Trip Circuit Constants

Indicating Contactor Switch.

- 0.2 ampere tap - 6.5 ohms dc resistance
- 2.0 ampere tap - 0.15 ohms dc resistance

4.0 SETTINGS

The relay operates on the product of residual fault current and voltage. This product divided by the proper current and potential transformer ratios and by one of the transformer tap values is expressed as a multiple of the tap. The time curves of Figure 4 gives the relay operating time for various time dial settings as a function of this multiple. Figure 5 shows times for 50, 100 and 200 volts across the relay coils.

Since the relay operates on very small currents the main current transformer exciting current many not be negligible. When determining the main ct secondary note that the exciting current will be out-of-phase with the primary current, since the ct exciting impedance is reactive, while the burden is predominantly resistive.

Since this relay is designed for resistance grounded systems with small fault currents, selective current settings are usually not possible. This is because the effective neutral resistance value is large in comparison with line and transformer impedance values. Thus the fault current magnitude is relatively independent of the point on the system at which the ground fault occurs, and hence this magnitude cannot be used to discriminate between near and far faults.

If selective settings are possible, each relay should be set to operate as rapidly as possible for ground faults on the transmission lines near the breaker. The product available for the relay in these cases should be large enough to represent a large multiple of the tap product value so the operating times can be in the range of 0.05 to 0.20 second as seen from the curves of Figures 3, 4, and 5.

Table 1:
Burden and Thermal Ratings
Current Circuit Burden

TAP	POWER FACTOR ANGLE - lag 60 Hertz		50 Hertz
.5	23.0°		27.2°
.7	23.0°		21.8°
1.0	21.5°		17.1°
1.4	17.5°		17.1°
2.0	15.0°		10.0°
2.8	12.0°		7.0°
4.0	9.0°		3.8°
VOLT-AMPERES AT TAP VALUE CURRENT (100 Volts Applied to Potential Coil)			
TAP	**60 Hertz**		**50 Hertz**
.5	0.0028		0.0021
.7	0.0030		0.0023
1.0	0.0034		0.0027
1.4	0.0039		0.0032
2.0	0.0048		0.0041
2.8	0.0058		0.0051
4.0	0.0074		0.0067
Voltage Circuit Burden			
Volt-Amperes	110 Volts	Power Factor	Angle-Lag
60 Hertz	9.68 va	60 Hertz	46°
Thermal Ratings			
		60 Hertz	50 Hertz
Continuous Current		0.3 Amp	0.3 Amp
Continuous Voltage		250 Volts	175 Volts

However, the relay cannot distinguish between a fault on the line near the remote breaker for which it should operate, and a similar fault on the bus or adjacent line for which they should not operate until the bus differential or adjacent line relays have had an opportunity to operate and clear the fault. This requires an increased time setting of the relay for faults near the remote terminals. The product available for the relay in these cases will be smaller than that for the close faults and should represent a smaller multiple of the tap product previously chosen so the operating time can be from .4 to .75 second longer than the remote line or bus relay operating time. This .4 to .75 second interval is known as the coordinating time interval. It includes the circuit breaker operating time plus a factor allowing for differences between actual currents and calculated values, differences in individual relay performance, etc. For 8 cycle breakers the value of .4 second is commonly used while for 30 cycle breakers .75 second is used.

After the settings are made for all the relays under minimum generating conditions, then it is necessary to check the relay operating time and coordination under the maximum generating conditions. Often additional changes in tap and lever settings are required, particularly if the maximum and minimum fault values are quite different.

4.1 Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except the selection of the 0.2 or 2.0 amperes 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. When the relay energizes a 125 volt or 250 volt dc type WL relay switch, or equivalent, use the 0.2 ampere tap. For 48 volt dc applications set ICS in 2.0 ampere tap and use S#304C209G01 type WL relay or equivalent.

5.0 INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the mounting stud or 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 the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the location shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground wires should be affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other 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 detailed information on the FT case refer to I.L. 41-076.

6.0 ADJUSTMENTS AND MAINTENANCE

The proper adjustments to ensure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

6.1 Acceptance Check

The following procedure is recommended to ensure that the relay is in proper working order:

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 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”.

b. Set the contacts to the No. 10 time dial position and the tap screw in the 0.5 tap. Connect the relay as shown in Figure 8. Energize the potential coil with 100 volts and the auxiliary ct with sufficient current to just close the contacts. (The current in polarity on the auxiliary ct should be leading the voltage drop from relay terminal 6 to terminal 7 by 45°.) The pickup current should be 0.005 amps + 3%.

c. With 100 volts potential, energiz terminals 8 and 9 at the following current levels to check relay timing:

Current	Multiple of Tap Product	Time-seconds 60 Hertz	Time-seconds 50 Hertz
0.025	5	5.2 ± 10%	5.86 ± 10%
0.100	20	1.2 ± 5%	1.28 ± 5%
0.500	100	0.36 ± 10%	0.38 ± 10%

d. To check the zero torque line, adjust the input current to 0.25 amperes. With the potential at 100 volts, shift the current phase angle until the contact opens. The phase angle reading should be 135° (or 315°) ±7°. This angle can be varied by adjusting the right hand resistor.

6.2 Indicating Contactor Switch (ICS)

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

For proper contact adjustment, insert a .030" feeler gauge between the core pin and the armature. Hold the armature closed against the core pin and gauge and adjust the stationary contacts such that they just make with the moving contact. Both stationary contacts should make at approximately the same time. The contact follow will be approximately 1/64” to 3/64”.

6.3 Routine Maintenance

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 soft silver and thus impairing the contact.

Check relay pickup in accordance with the procedure of the first paragraph under Section 6.1, Acceptance Check, except with the tap position actually being used. Check relay timing at 5 and 100 times tap product or at the most critical energy level, as determined from setting calculations.

6.4 Calibration

Use the following procedure for calibrating the relay if the relay has been taken apart for repair, or the adjustment have been disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order (see Section 6.1, Acceptance Check).

6.5 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 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 position 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”.

6.6 Induction Unit

Connect 100 volts across terminals 6 and 7. Apply approximately 5 times the minimum pickup current (tap value divided by 100) through terminals 8 and 9 with the polarity and relay connections as shown in Figure 8. Adjust the right hand resistor so that zero torque occurs when the current and voltage are 135° out of phase within ±4°. There should be no spring tension on the relay for this test.

With the connections above apply 100 volts and current leading by 45°. With the tap screw in the lowest tap, adjust the spring tension so that the contacts just close with correct value of current flowing. This current will be tap value divided by 100, or 5 milliamperes on the 0.5 VA tap. The spring tension may be changed by means of a screwdriver inserted in one of the notches of the plate to which the outside convolution of the spring is fastened.

Calibrate the time delay by adjusting the permanent magnet gap to obtain 1.20 seconds (1.28 seconds for 50 cycle relay) in the 0.5 VA tap, with a potential of 100 volts. The timing can be checked by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked.

7.0 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.

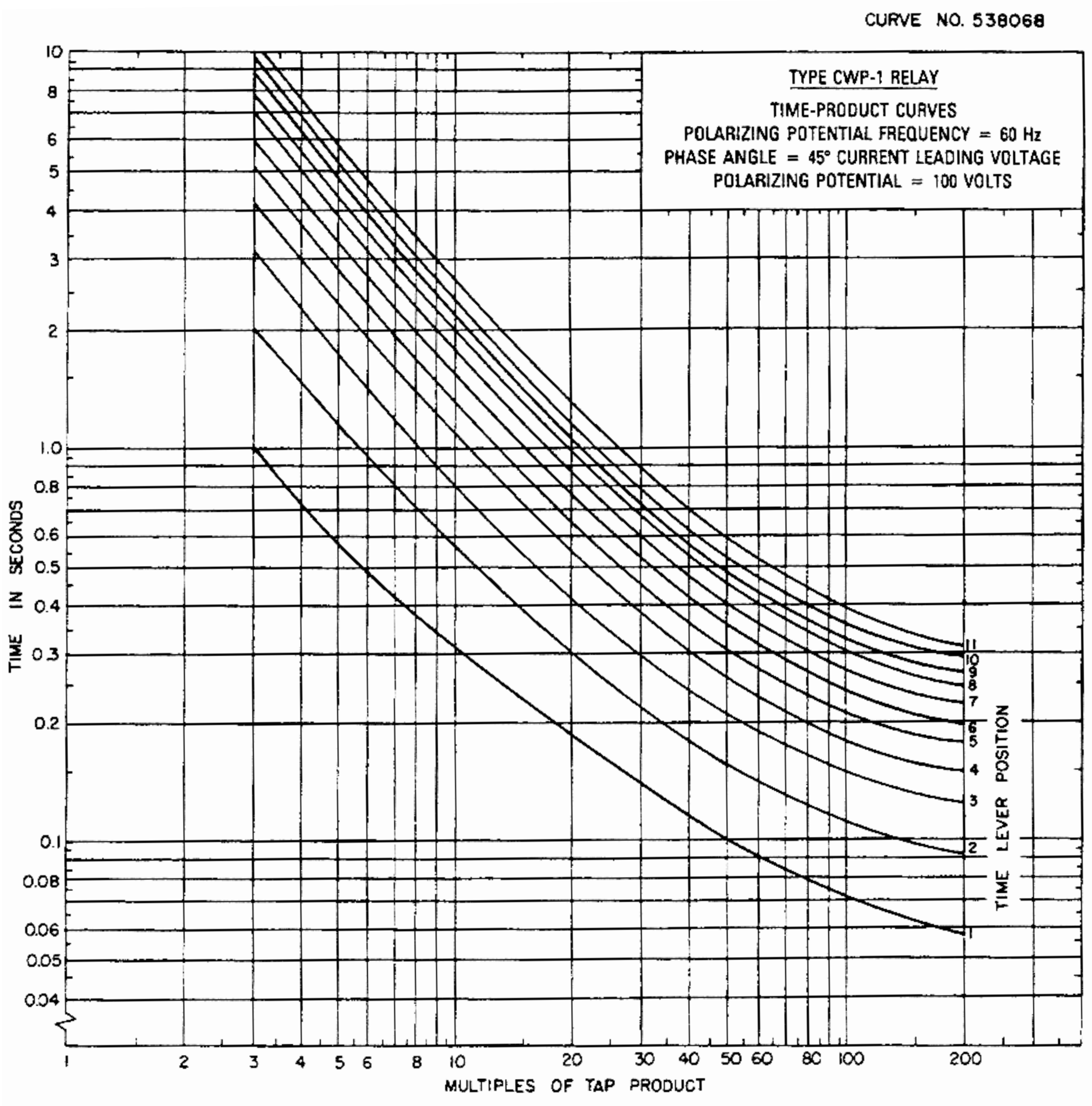

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Figure 4. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque. 100 volts, 60 Hertz across Potential Circuit.

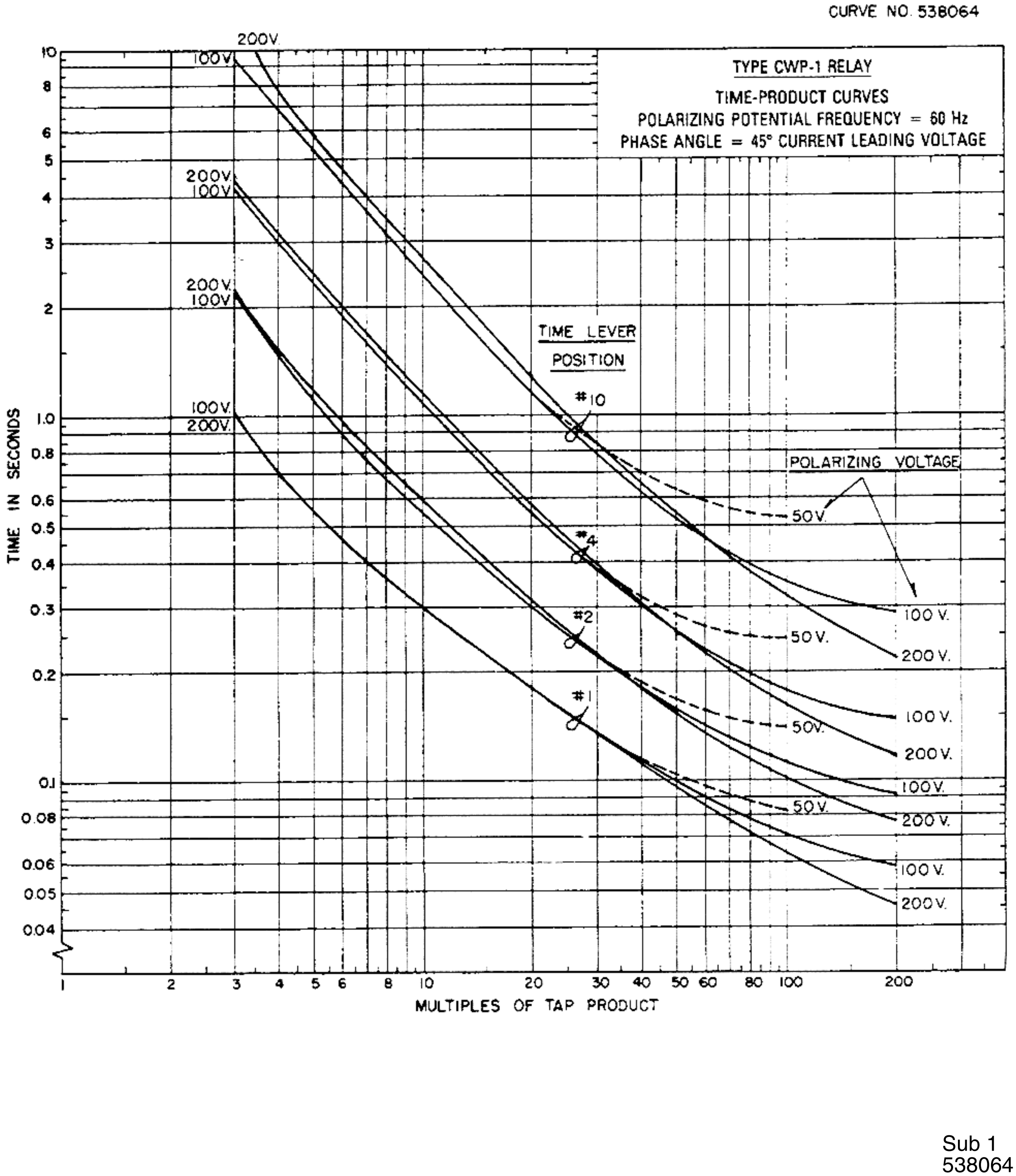

Figure 5. Representative Time-Product Curves, showing effect of variations of Potential Circuit Voltage; Maximum Torque Angle, 60 Hertz.

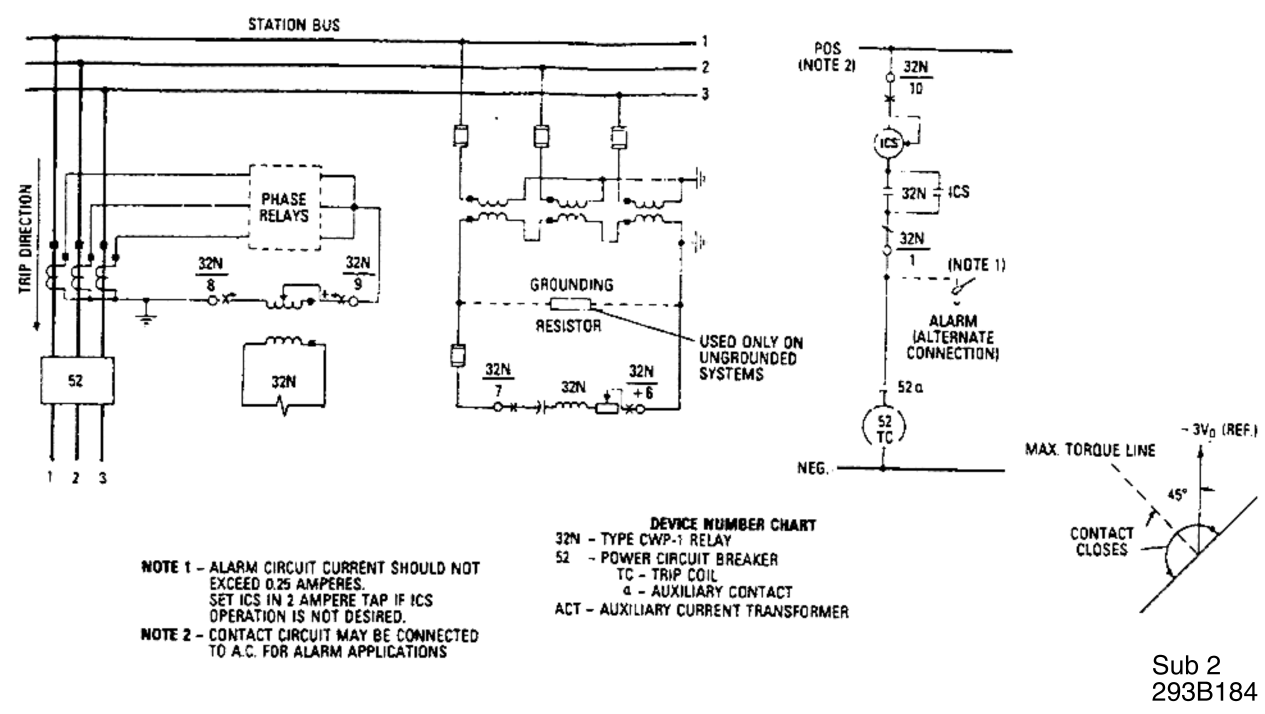

Figure 6. External Schematic of the Type CWP-1 Relay in FT31 Case

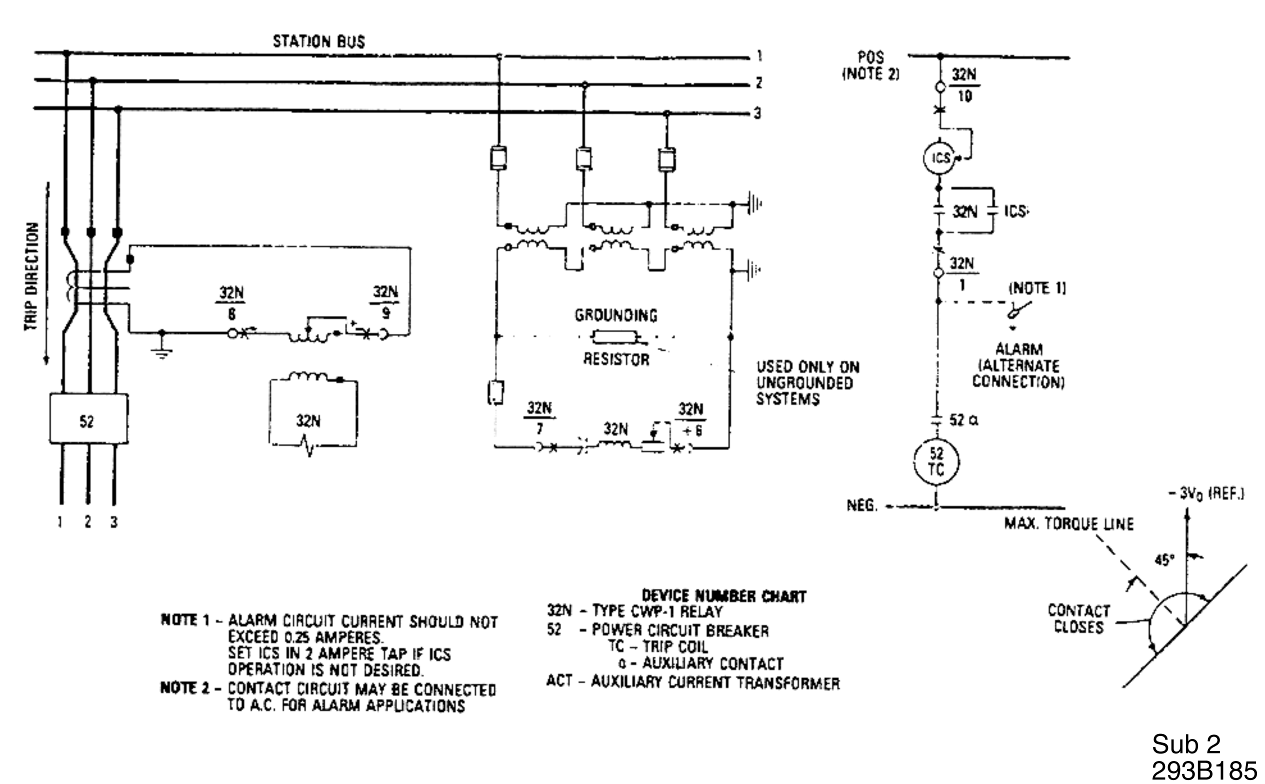

Figure 7. External Schematic of the Type CWP-1 Relay in FT31 Case, Using Window Type ct

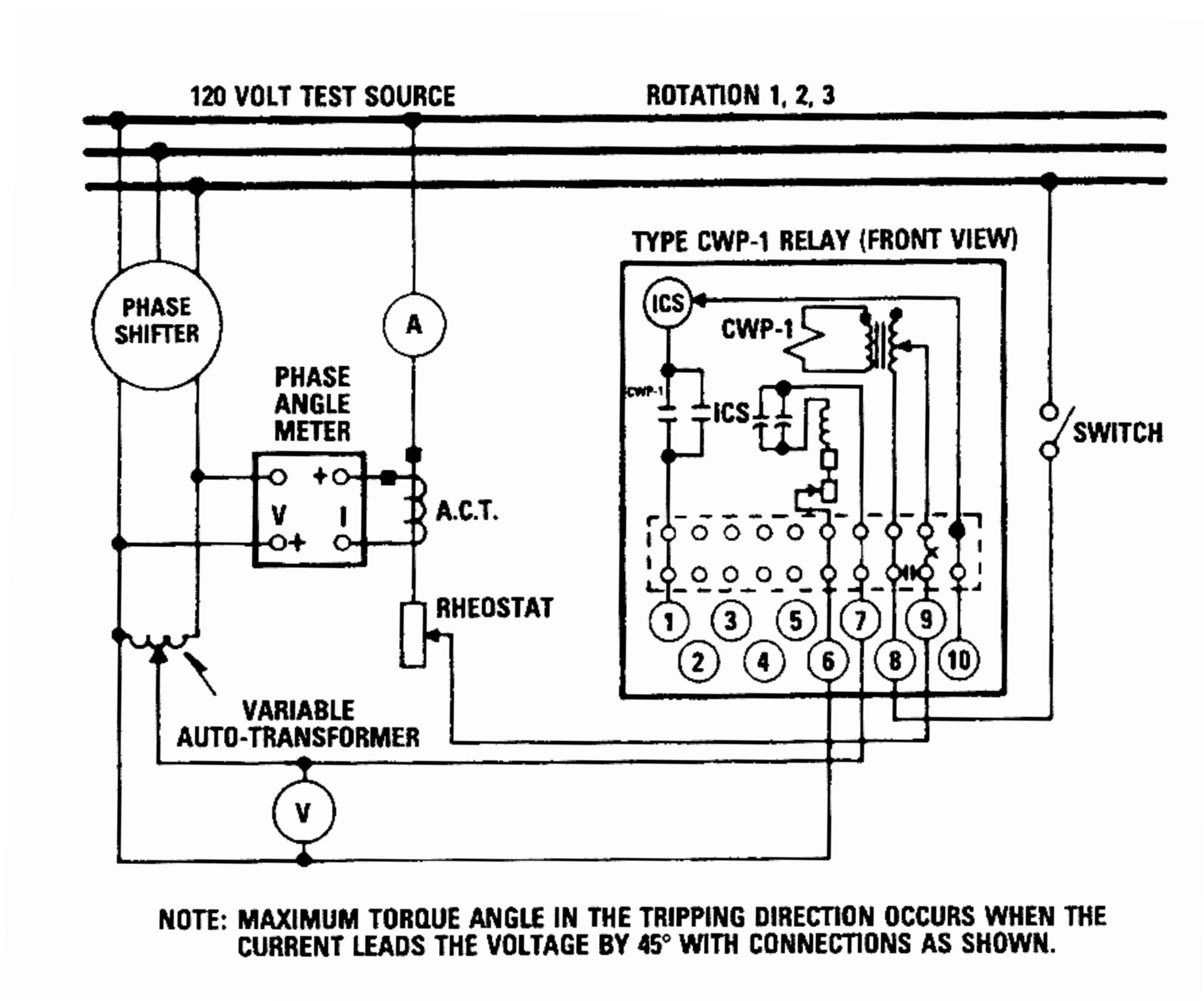

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Figure 8. Diagram of Test Connections for the Type CWP-1

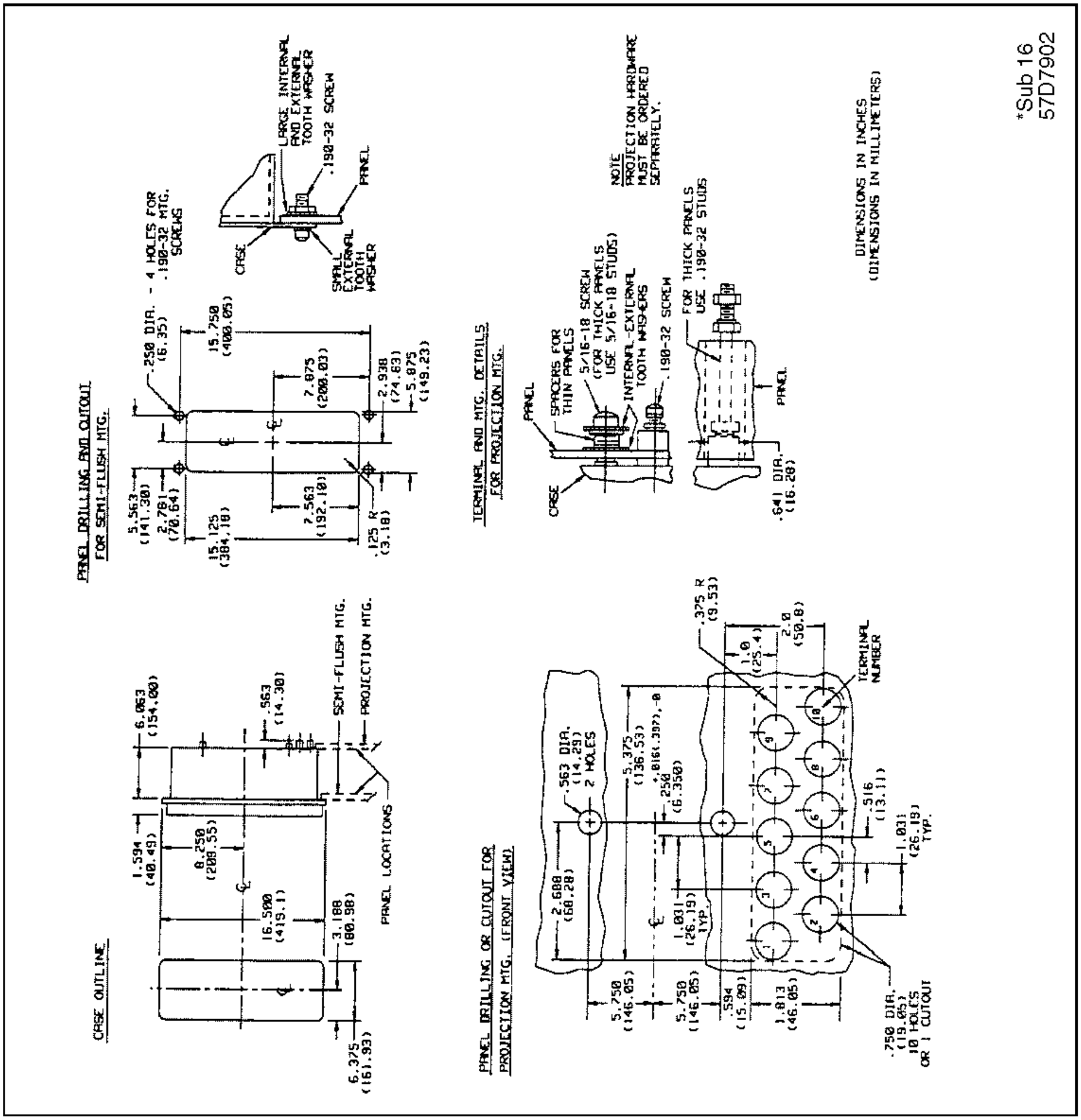

Figure 9. Outline and Drilling Plan of the Type CWP-1 Relay in FT-31 Case.

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