INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWP-1 SENSITIVE DIRECTIONAL GROUND 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

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

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 Fig. 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 Fig. 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 currents 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 currents values permit a higher current pickup, three residually connected CT's may be used.

CONSTRUCTION AND OPERATION

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

Operating Unit

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 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.

Phase Shifter Network

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

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 drop.

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

SUPERSEDES I.L. 41-242.5
*Denotes change from superseded issue.

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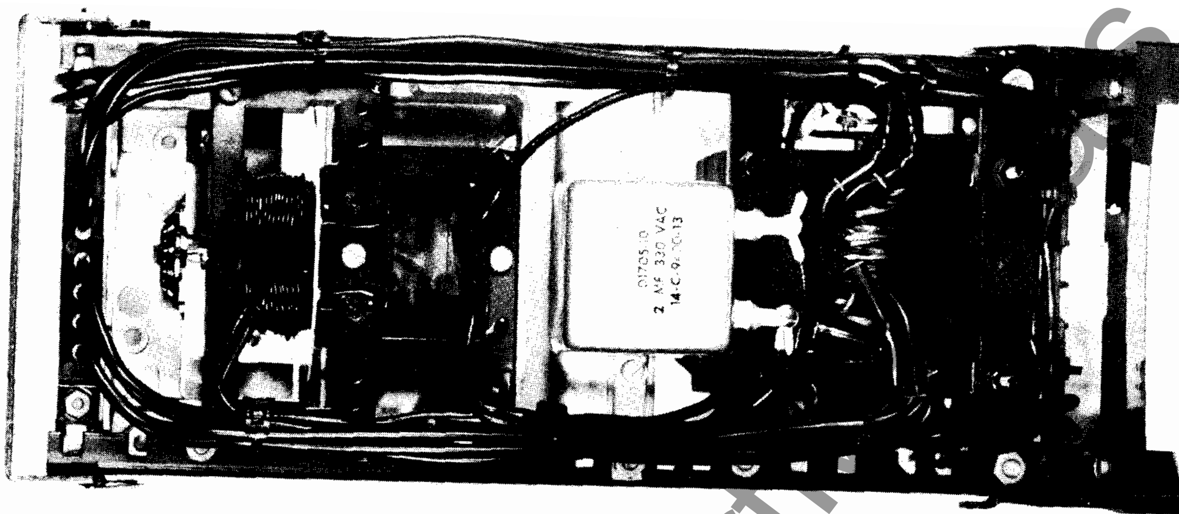


Fig. 2. Type CWP-1 Ground Relay (rear view)

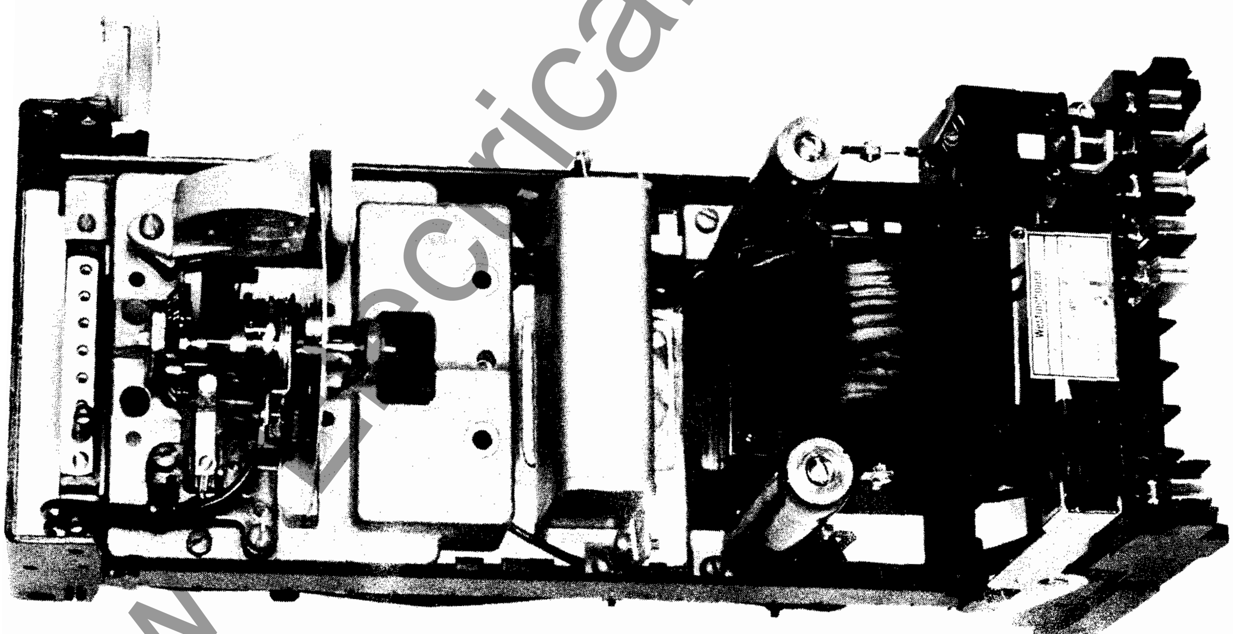


Fig. 1. Type CWP-1 Ground Relay (front view)

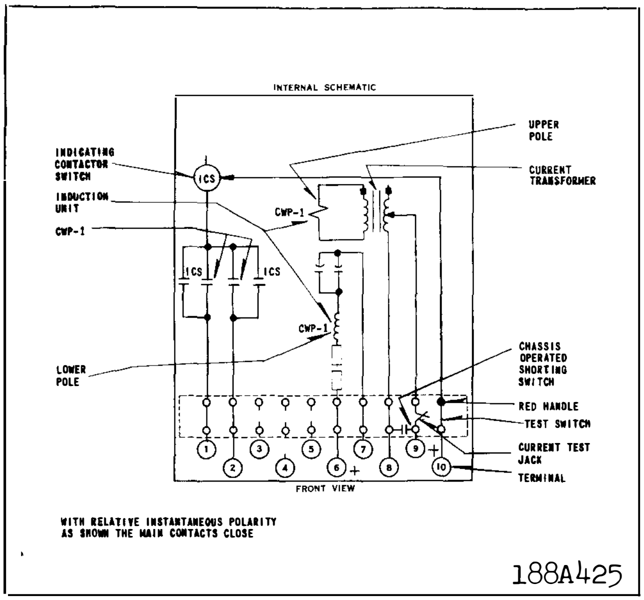


Fig. 3. Internal Schematic of the Double Trip CWP-1 Relay, FT31 Case. (Single Trip Relays have terminal 2 and associated circuits omitted).

Current Transformer

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

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 pick-up product of residual current (at an angle of 45° lead) times the residual voltage.

Typical 60 cycle time product curves for the type CWP-1 relay are shown in Fig. 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 V.A. 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.

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 contactor switch as two taps that provide a pickup setting of 0.2 or 2 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.

Trip Circuit Constants

Indicating Contactor Switch -

0.2 ampere tap - 6. 5 ohms -dc resistance
0.2 ampere tap - 0.15 ohms d-c resistance

Burden and Thermal Ratings

Current Circuit Burden

TAP	POWER FACTOR ANGLE - LAG 60 Cycles	50 Cycles
.5	23.0°	27.2°
.7	23.0	21.8
1.0	21.5	17.1
1.1	17.5	14.6
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 Cycles	50 Cycles
.5	0.0028	0.0021
.7	0.0030	0.0023
1.0	0.0034	0.0027
1.1	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 Cycles	9.68 va	60 Cycles	46°

Thermal Ratings

	60 Cycles	50 Cycles
Continuous Current	0.3 Amp.	0.3 Amp.
Continuous Voltage	250 Volts	175 Volts

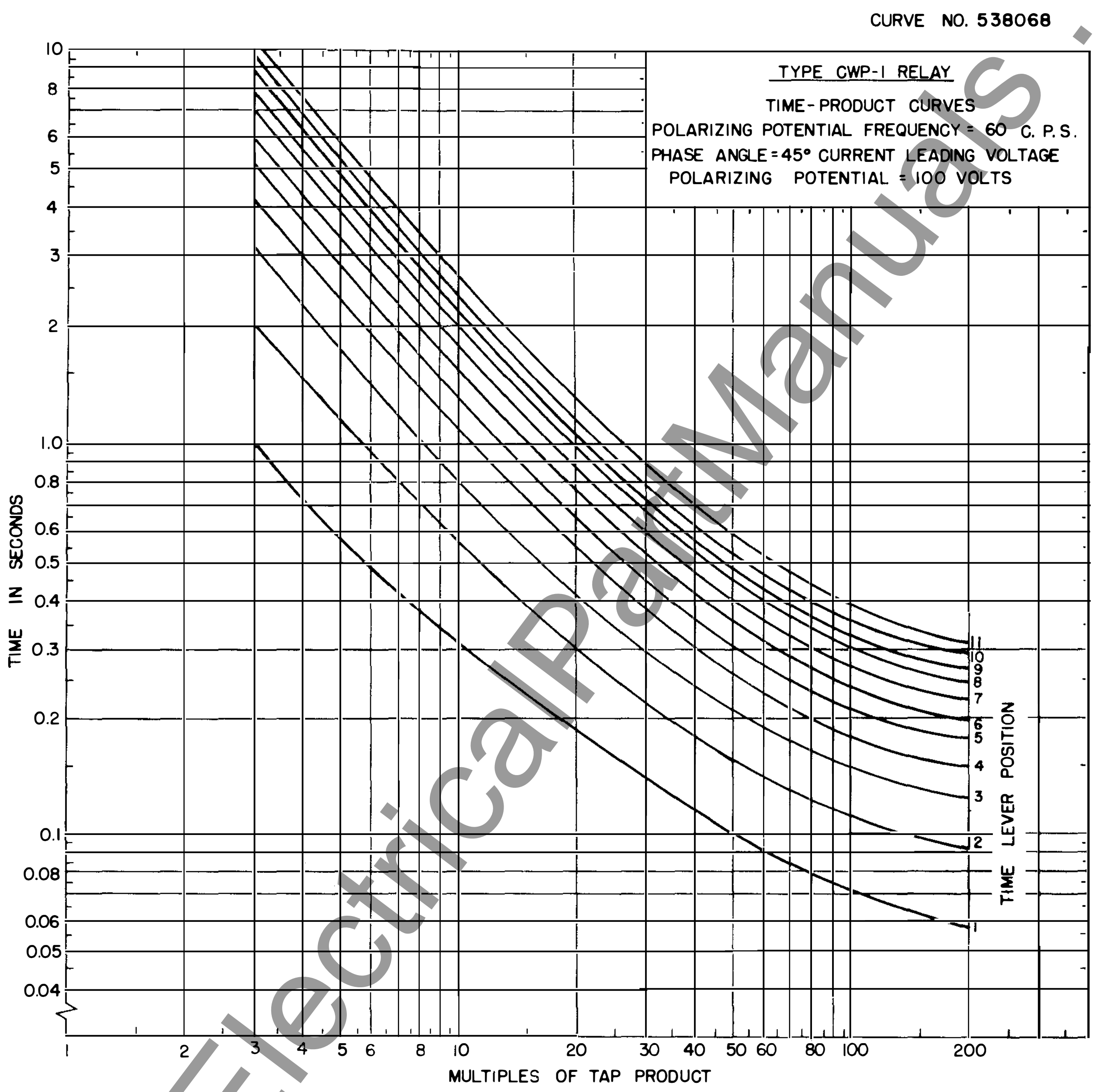


Fig. 4. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque. 100 volts 60 cycles across potential circuit.

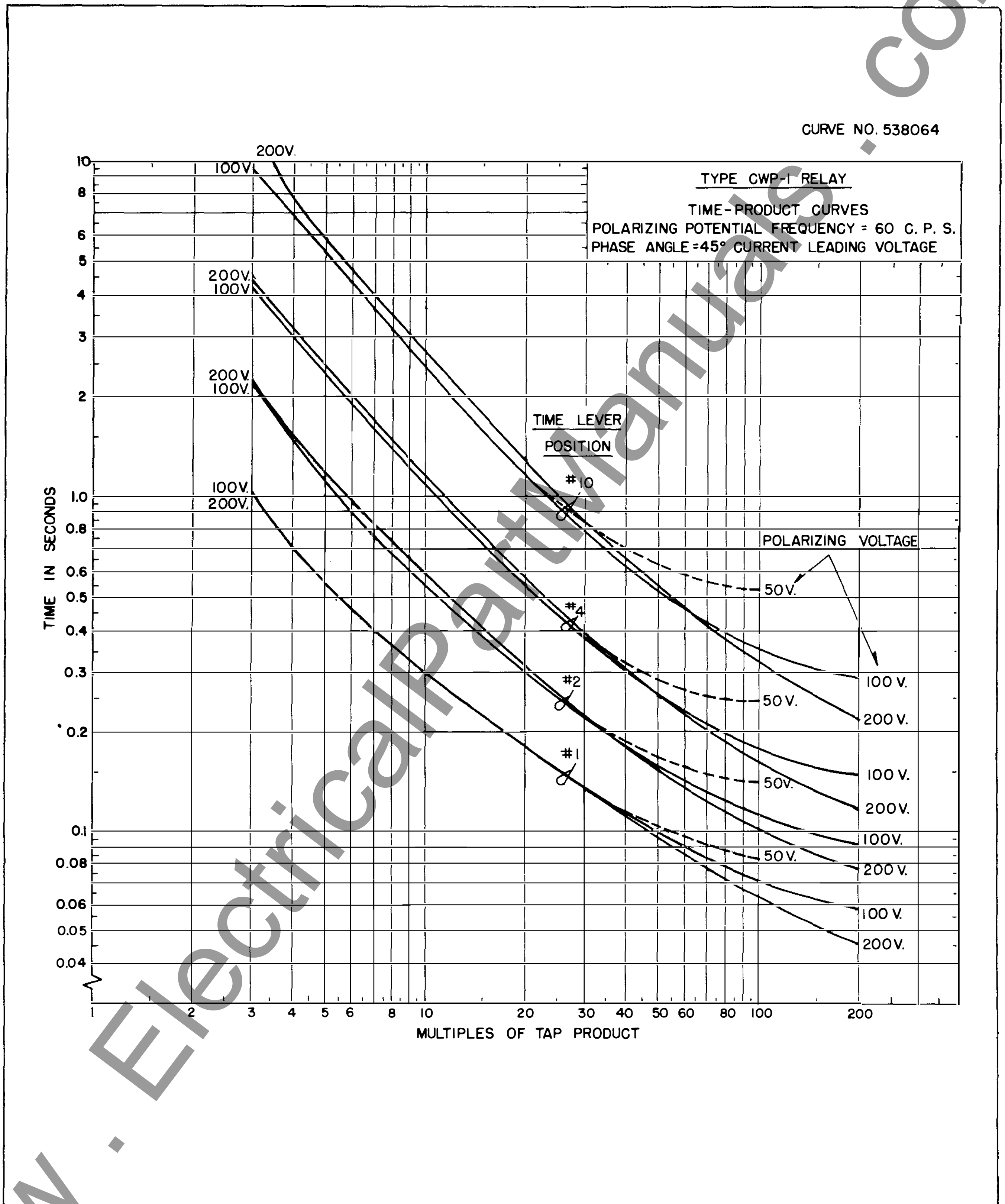


Fig. 5. *Representative Time-Product Curves, showing effect of variations of Potential Circuit Voltage - Maximum Torque Angle, 60 cycles.*

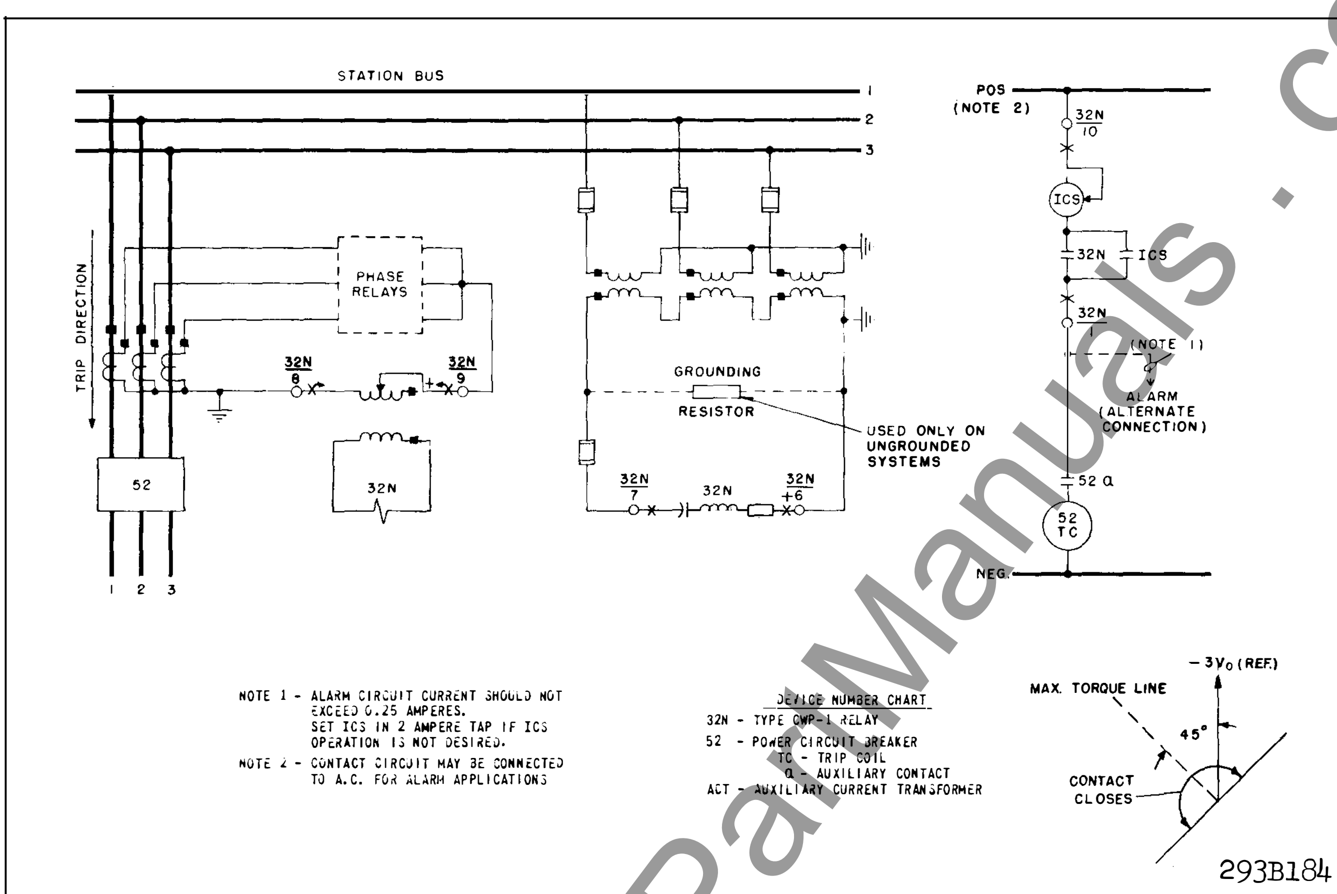


Fig. 6. External Schematic of the Type CWP-1 Relay in FT31 Case.

SETTING

The relay operates on the product of residual fault current and voltage. This product divided by and proper current and potential transformer ratio and by one of the transformer tap values is expressed as a multiple of the tap. The time curves of Fig. 4 gives the relay operating time for various time dial settings as a function of this multiple. Fig. 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 may 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 Figs. 3, 4 and 5.

However, the relay cannot distinguish between a fault on the line near the remote breaker for which they 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

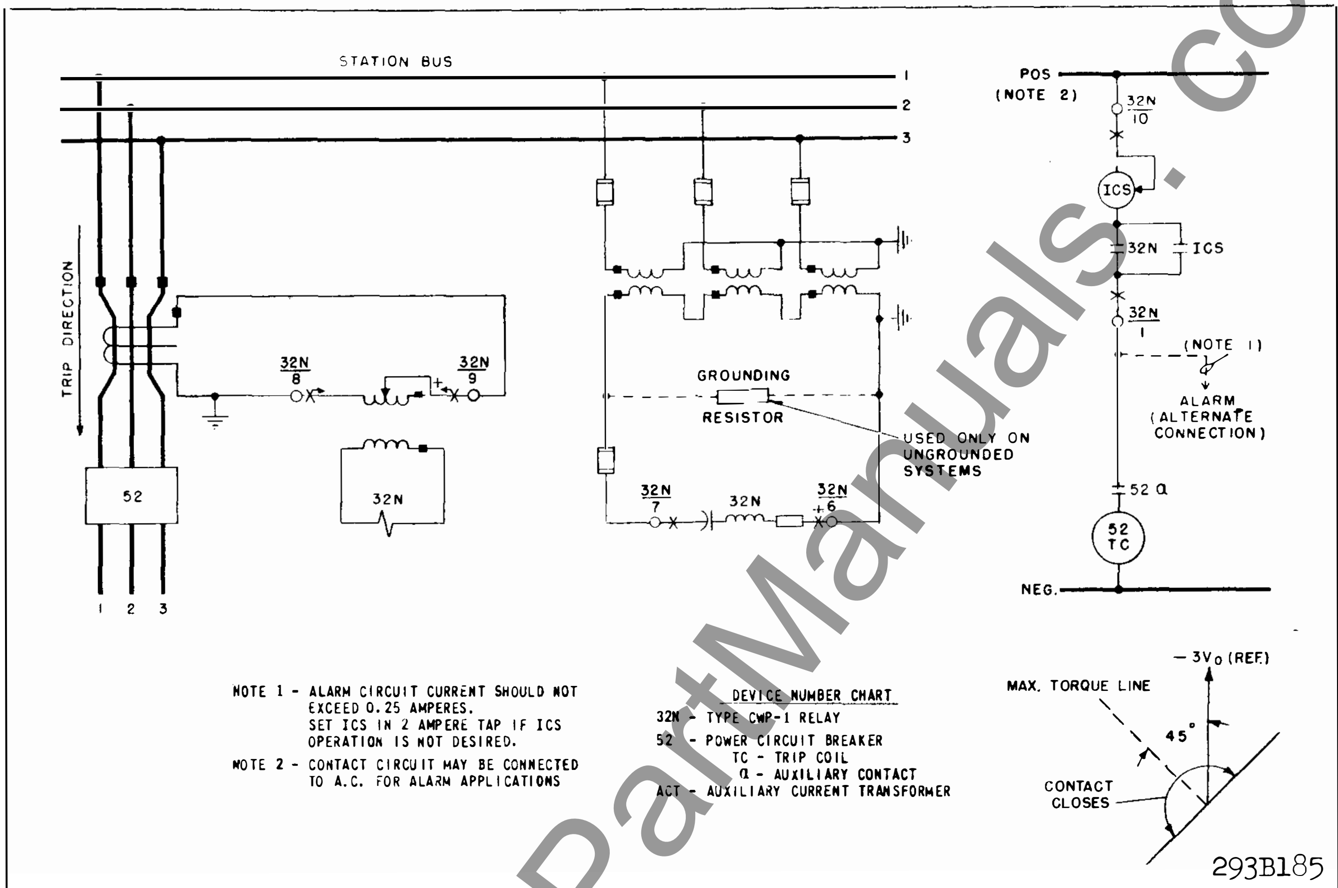


Fig. 7. External Schematic of the Type CWP-1 Relay in FT31 Case, using Window Type C.T.

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 indivi-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.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 volt or 250 volt d-c type WL relay switch, or equivalent, use the 0.2 ampere tap. For 48 volt d-c applications set ICS in 2 ampere tap and use S#304C209G01 type WL relay or equivalent.

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the

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

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

ADJUSTMENTS AND MAINTENANCE

The proper adjustment to insure 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.

Acceptance Check

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

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 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. Set the contacts to the time dial position and the tap plug in the 0.5 tap. Connect the relay as shown in Fig. 6. 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 by 45° voltage drop from relay terminal 6 to terminal 7.) The pickup current should be 0.005 amperes + 3%.

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

Current	Multiple of Tap Product	Time-seconds 60 Cycles	Time-seconds 50 Cycles
0.025	5	3.55 ± 10%	4.00 ± 10%
0.100	20	0.94 ± 5%	1.00 ± 5%
0.500	100	0.33 ± 10%	0.35 ± 10%

4. 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 by 135° (or 315°) ± 7°.

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 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.

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 paragraph 1 under "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.

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 until it is apparent that the relay is not in proper working order (See "Acceptance Check").

<u>**Contact**</u>

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".

<u>Induction Unit</u>

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 Fig. 6 and see 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 0.94 seconds (1.00 seconds for 50 cycle relay) in the 0.5 VA tap, with a potential of 100 volts. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked.

<u>**Indicating Contactor Switch (ICS)**</u>

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 simultaneously.

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.

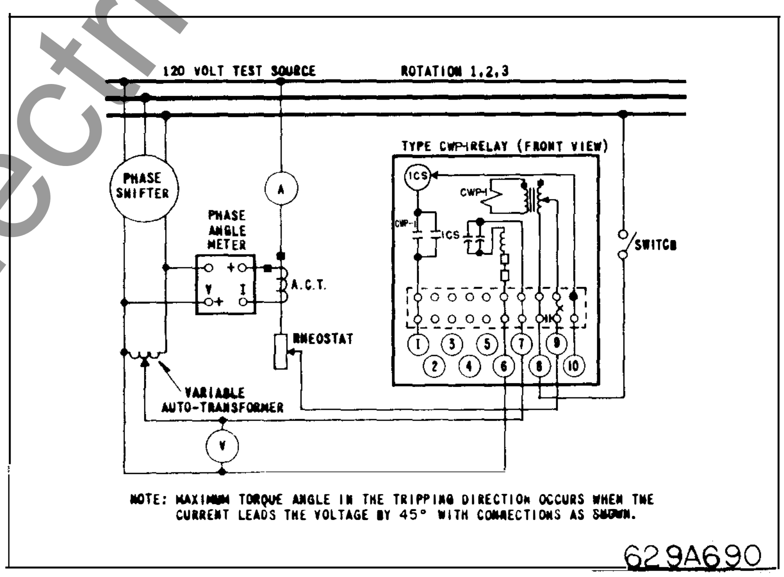


Fig. 8. Diagram of Test Connections for the Type CWP-1

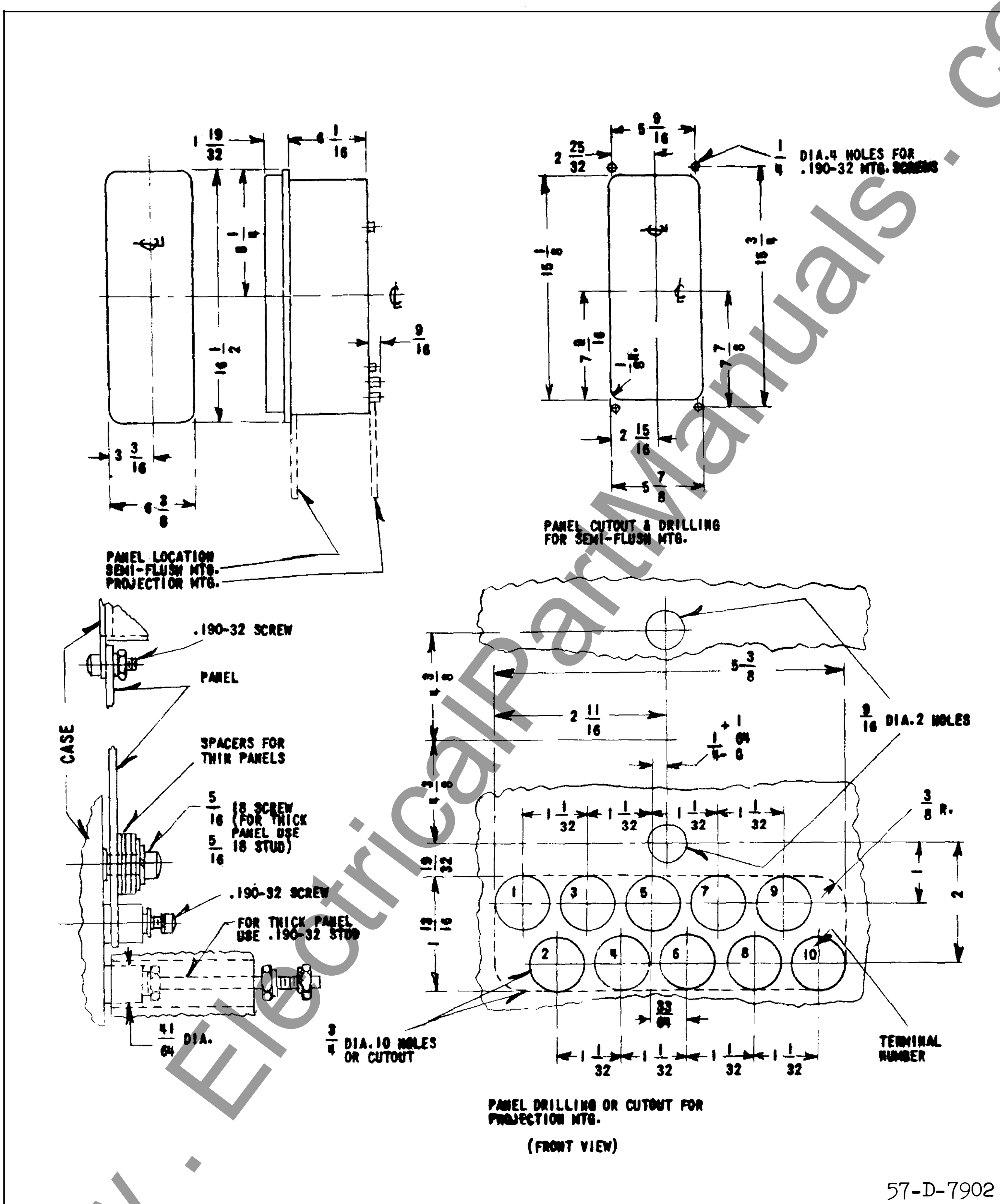


Fig. 9. Outline and Drilling Plan of the Type CWP-1 Relay in FT31 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWC AND CWP DIRECTIONAL GROUND RELAYS

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

APPLICATION

The type CWC and CWP relays are induction disc type relays used for directional ground fault protection on grounded neutral power systems. The type CWC relay is polarized by current from a suitably grounded power transformer bank neutral. Therefore, its application does not require potential transformer. The type CWP relay is potential polarized by residual voltage obtained across the open corner of the delta winding of a grounded star-delta potential transformer.

At stations where the power transformer bank netural is grounded, the residual voltage will be small generally, and the type CWC relay is recommended. At ungrounded stations, or at ground stations where the power transformer bank neutral is not available, the type CWP relay is applicable.

CONSTRUCTION

The type CWC and CWP relays consists of an operating unit, an indicating contactor switch, and optional indicating instantaneous trip unit. In addition to the above components, the type CWP relay has a phase shifter network. The principal component parts of the relay and their locations are shown in Fig. 1-8.

OPERATING UNIT

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 2 and 4. The upper pole of both the CWC and CWP relays are tapped. In addition, the lower pole is tapped on the type CWC relay.

The electromagnets are 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.

PHASE SHIFTER NETWORK

The phase shifter network of the type CWP relay consists of a capacitor and resistor connected in series with the lower pole circuit.

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 attacted 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, inaddition 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

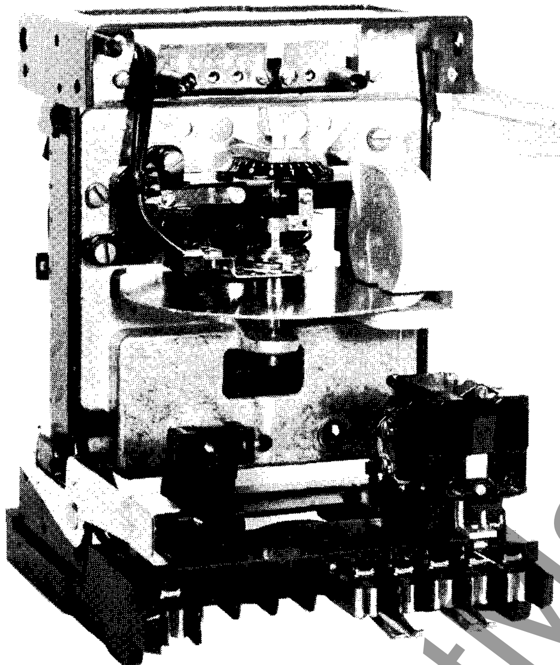


Fig. 1. Type CWC Relay (front view)

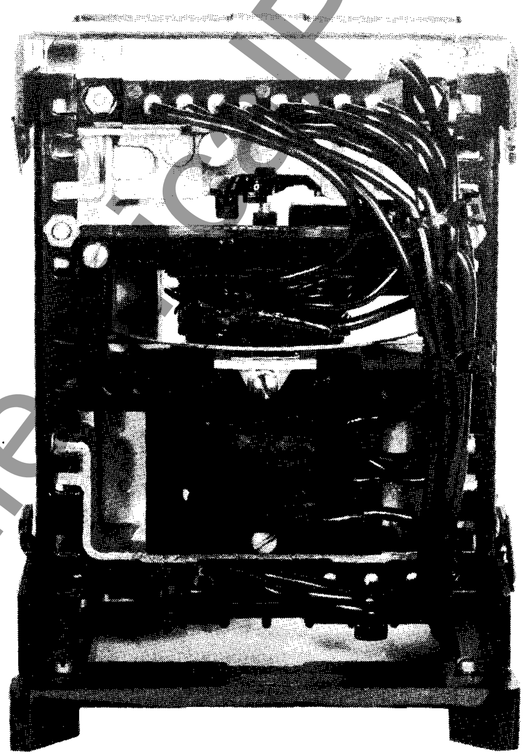


Fig. 2. Type CWC Relay (rear view)

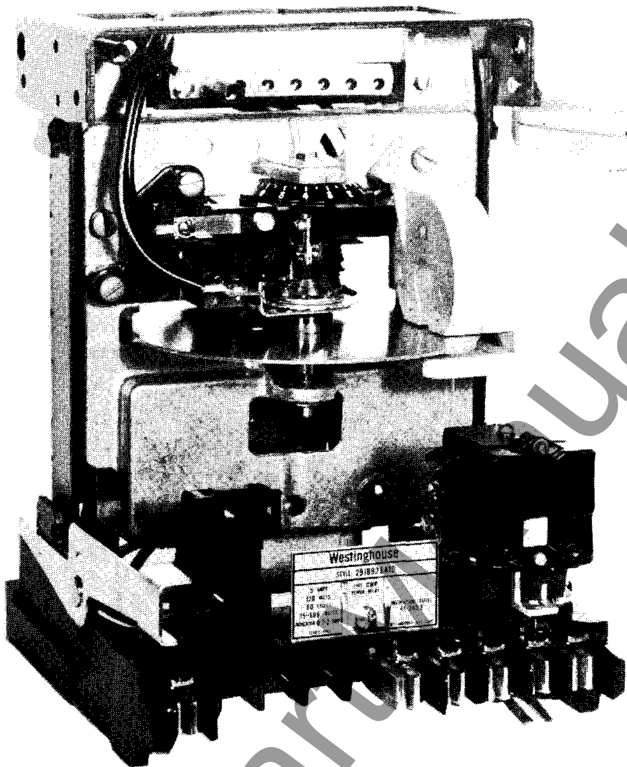


Fig. 3. Type CWP Relay (front view)

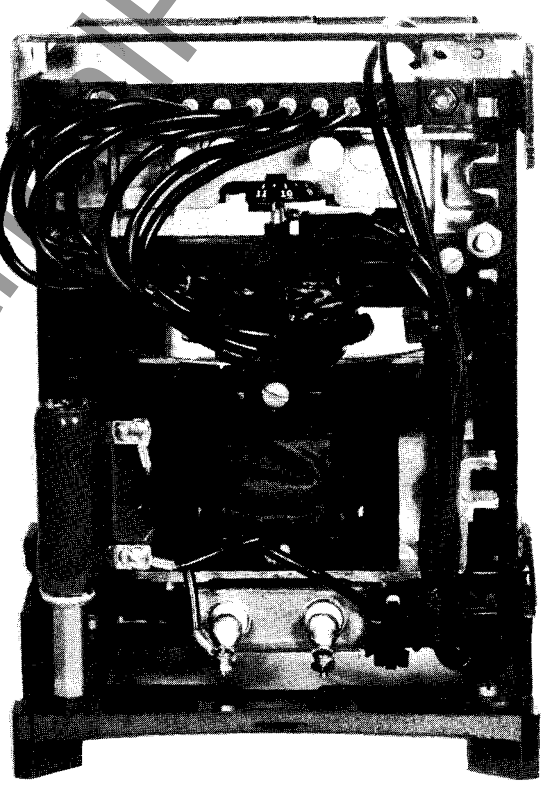


Fig. 4. Type CWP Relay (rear view)

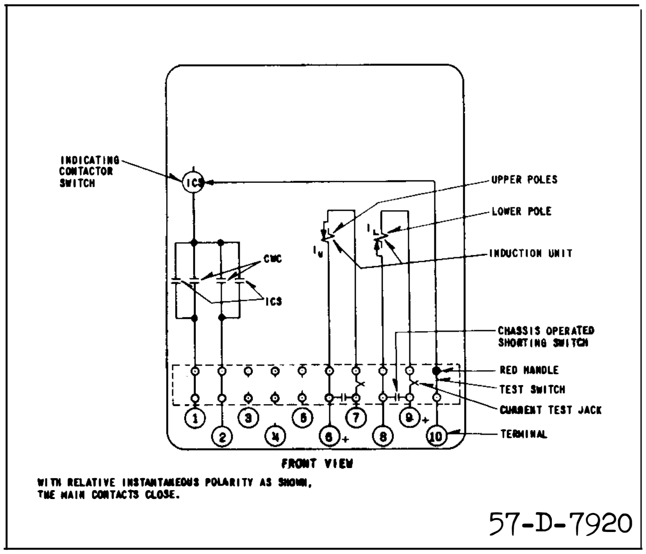


Fig. 5. Internal Schematic of Double Trip Type CWC Relay in the Type FT-21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

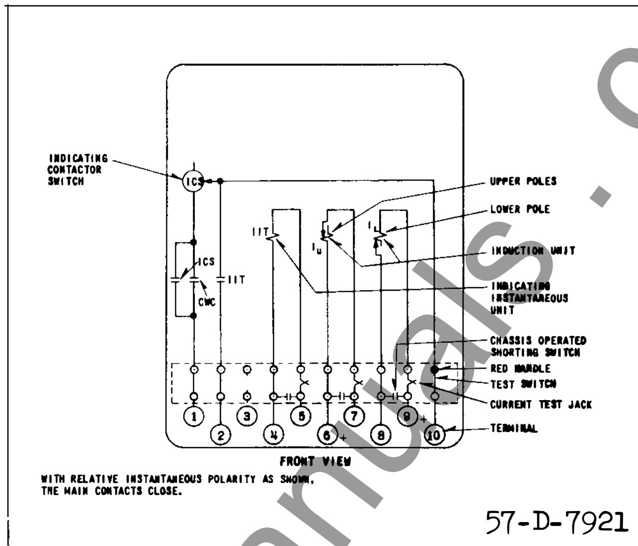


Fig. 6. Internal Schematic of the Type CWC Relay with Indicating Instantaneous Trip Unit in the Type FT-21 Case.

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. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

OPERATION AND CHARACTERISTICS

The operating torque for the CWC relay is obtained by energizing the lower pole coil with residual current (usually obtained from the line current transformer) and the 2 tapped upper pole coils with residual current from the current transformer in the power bank neutral. For the CWP relay the operating torque is obtained by energizing the upper pole coils with residual current (usually obtained from the line current transformer) and the lower pole with residual voltage.

TYPE CWC RELAY

The type CWC relay has two taps on the upper pole and four on the lower pole. They are marked in product which is the minimum pickup product of two equal or unequal currents.

Type CWC Relay Ranges and taps are:

.25 to 4 Product Range

* Product .25 .36 .64 1.0 1.44 2.56 4.0

2.25 to 36 Product Range

Product 2.25 4.0 6.25 9.0 16.0 25.0 36.0

The first four values are marked on the lower pole tap plate. The upper pole tap plate is marked x 1 and x 4 Product. The last four values are obtained by using the x 4 tap with the four lower pole taps.

Typical 60 Cycle time-product curves for the type CWC relay are shown in Fig. 9. These curves are taken at maximum torque which occurs with the currents in phase. For residual and Ground currents out of phase the relay operating time may be obtained by determining the operating time corresponding to the product $P' = P \cos \theta$, where P is the actual relay product in amperes squared, and θ is the angle between the residual and polarizing currents.

The limits for which these curves are accurate within ± 7% are shown in Fig. 10.

TYPE CWP RELAY

The type CWP relay taps are on the upper pole

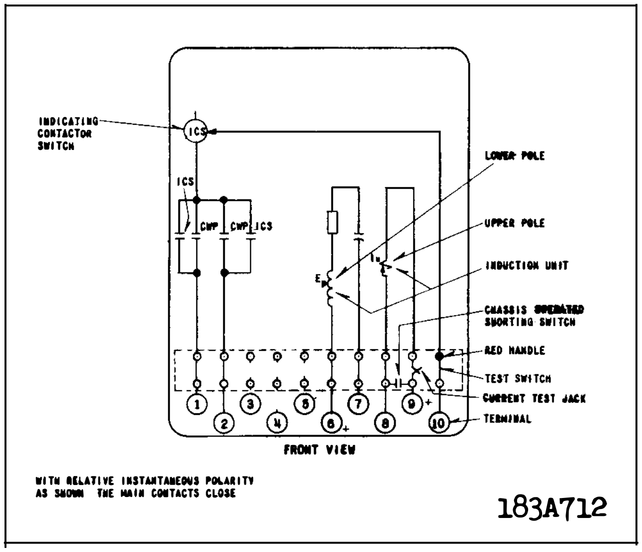


Fig. 7. Internal Schematic of the Type CWP Relay in the Type FT-21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

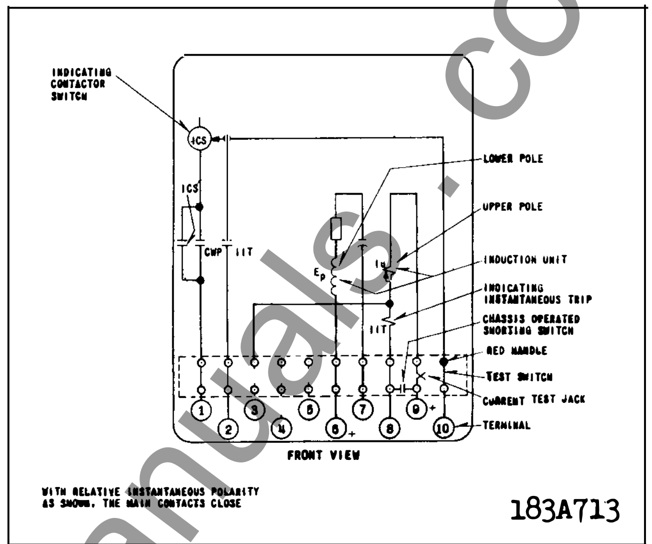


Fig. 8. Internal Schematic of the Type CWP Relay with Indicating Instantaneous Trip Unit in the Type FT21 Case.

current coil. They represent the minimum pickup product of current times voltage at maximum torque when the current lags the voltage by 60°. The range and taps are:

Product Range	Tap Markings						
20 - 150	20	30	40	50	75	100	150
75 - 600	75	100	150	200	300	400	600

Typical 60 cycle time product curves for the type CWP relay are shown in Fig. 11. These curves are taken at maximum torque which occurs with the current lagging the voltage 60°. For currents not lagging by this angle, the relay tripping time may be obtained by determining the operating time corresponding to the product $p' = P \cos(60° - \theta)$, where P is the actual relay V.A. product and θ is the angle the current lags the voltage. The curves are accurate within ± 7% if the multiple of tap product does not exceed the voltage on the relay coil.

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

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

SETTING

CWC INDUCTION UNIT

Select the desired upper and lower pole taps. Set the time dial by applying a preselected current to the relay coils, and adjusting the dial position to obtain the desired time of operation. Alternatively the dial may be set by inspection, if the timing coordination is not critical.

CWP INDUCTION UNIT

Select the desired upper pole tap. Set the dial position by applying a preselected voltage and current (current lagging voltage by 60° - see Fig. 16 to the

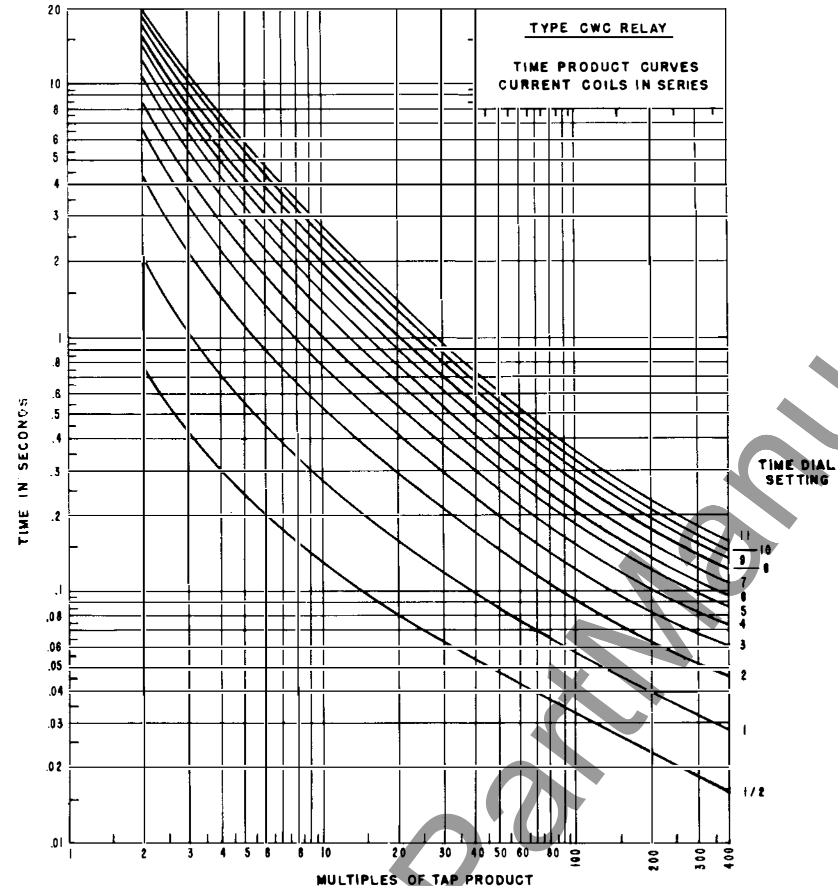


Fig. 9. Typical Time Curves of the Type CWC Relay – Current Coils in Series – See Fig. 10 for application limits.

relay coils and adjusting the dial position to obtained the desired time of operation. Alternatively the dial may be set by inspection, if the timing coordination is not critical.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 or 250 volt d-c type WL relay switch, or equivalent, use the 0.2 ampere tap; for 48 volt d-c applications set relay in 2 tap and use S#304C209G01 Type WL Relay or equivalent.

INDICATING INSTANTANEOUS TRIP (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of the pickup current desired.

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

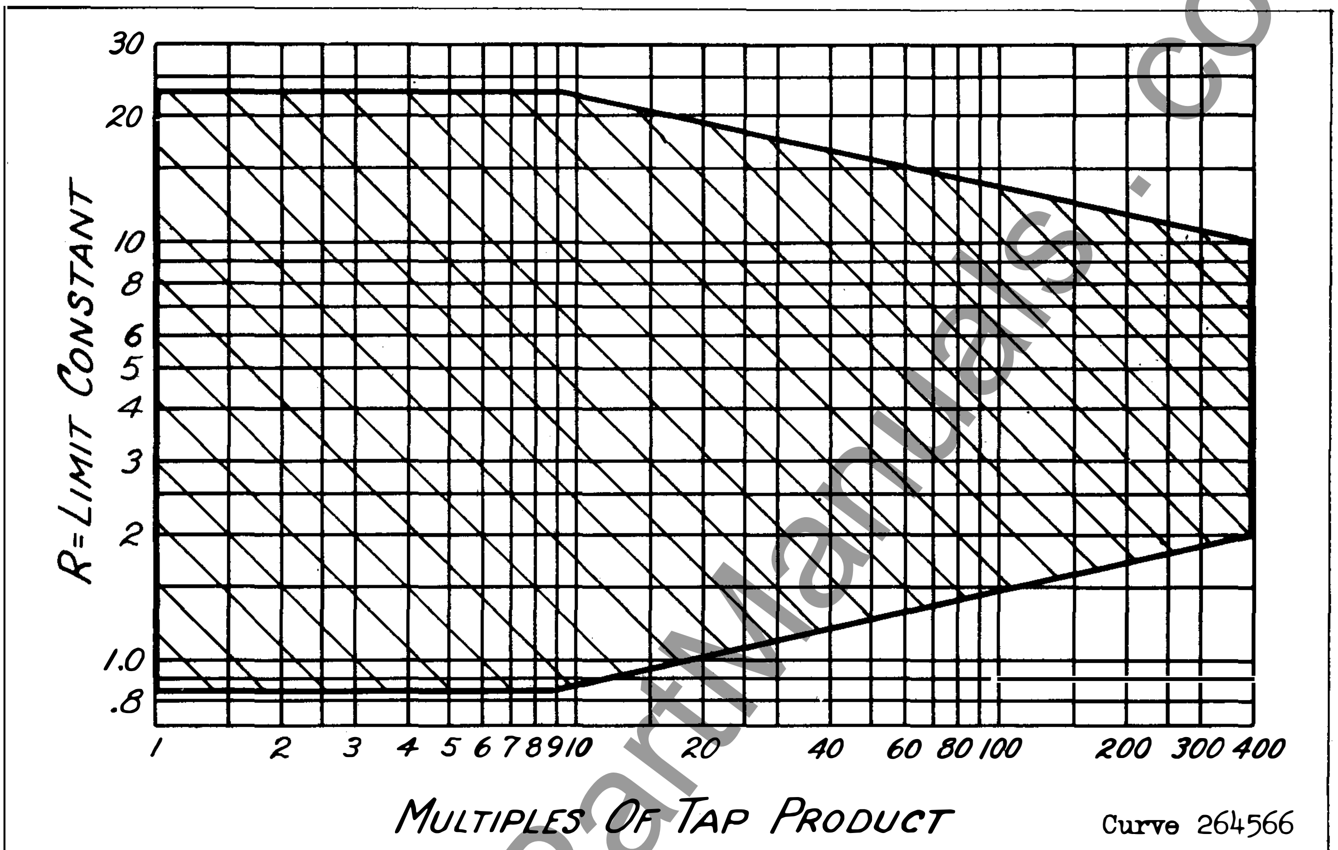
SETTING CALCULATIONS

The following information is required to set these relays:

1. The maximum and minimum ground fault current for faults at the relay and at the remote bus. These values should be residual current which is three times the zero sequence current.

2. The maximum and minimum polarizing current or voltage values for the faults above. The values should be residual currents or voltage which are three times the zero sequence values.

3. The current transformer ratios of the main and polarizing current transformers for the type CWC relay applications or the main current transformer ratio and the polarizing potential transformer ratio for the type CWP relay application.



For the 0.25 to 4 Product Range

$$R = M\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
M = value from the table below for various tap combinations.

For the 2.25 to 36 Product Range

$$R = N\frac{I_L}{I_U}$$

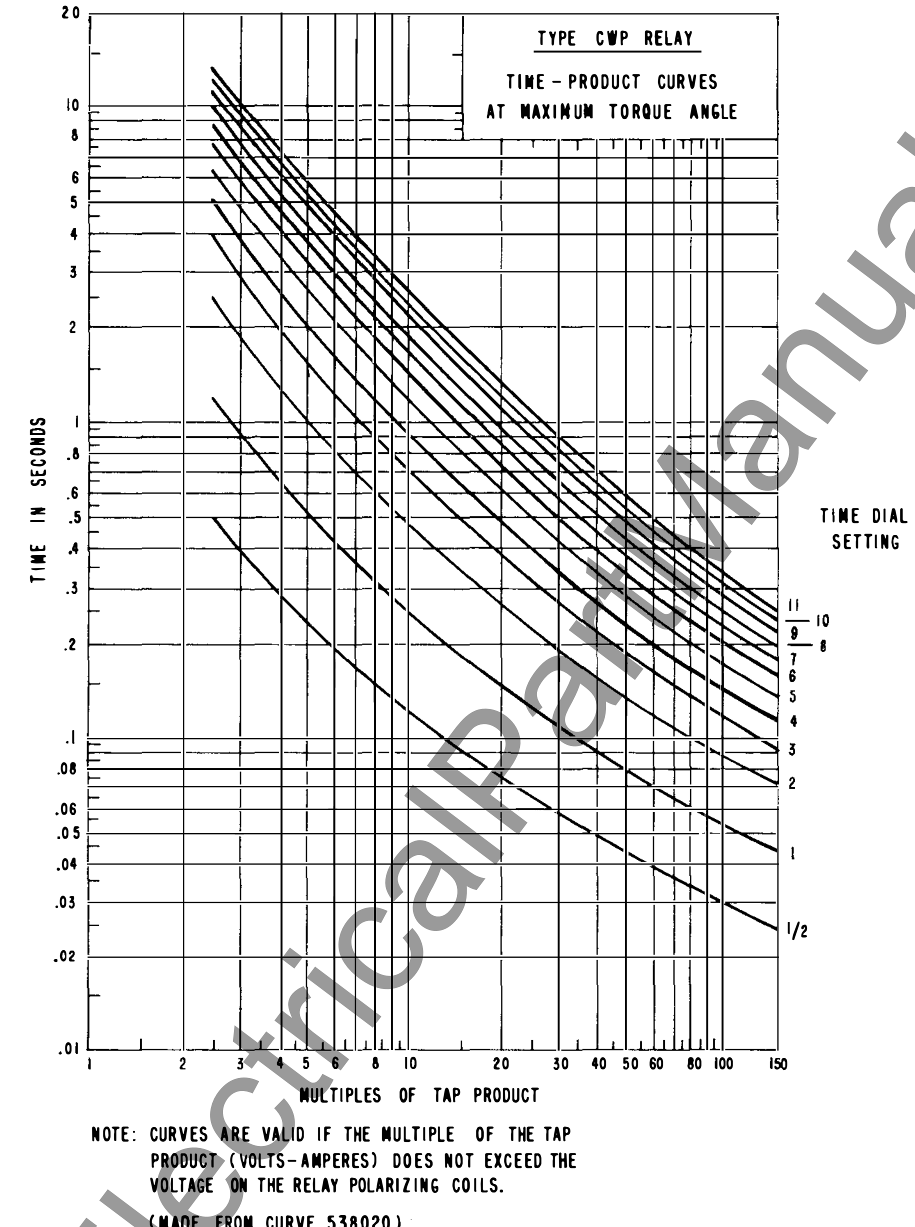
where I_L = the lower pole current.
I_U = the upper pole current.
N = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	M	K
.25	1	.25	4.0	10
.36	1	.36	2.78	12
.64	1	.64	1.56	16
1.0	1	1.0	1.0	20
1.0	4	.25	16.0	20
1.44	4	.36	11.1	24
2.56	4	.64	6.25	32
4	4	1.00	4.0	40

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	N	K
2.25	1	2.25	4.0	30
4.0	1	4.0	2.25	40
6.25	1	6.25	1.44	50
9.0	1	9.0	1.0	60
9.0	4	2.25	16.0	60
16.0	4	4.0	9.0	80
25.0	4	6.25	5.76	100
36.0	4	9.0	4.0	120

The Typical time curves for the Type CWC Relay apply if the values of R falls within the shaded area of the curve above, and if neither relay current is greater than K in amperes.

Fig. 10. Limits for Application of the CWC Time Curves.



These Curves are valid if the multiple of tap Product (volt-amperes) does not exceed the voltage on the relay polarizing coils.

Fig. 11. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply if the Multiple of Tap Product in Volt-Amperes Does Not Exceed the Polarizing Voltage in Volts.

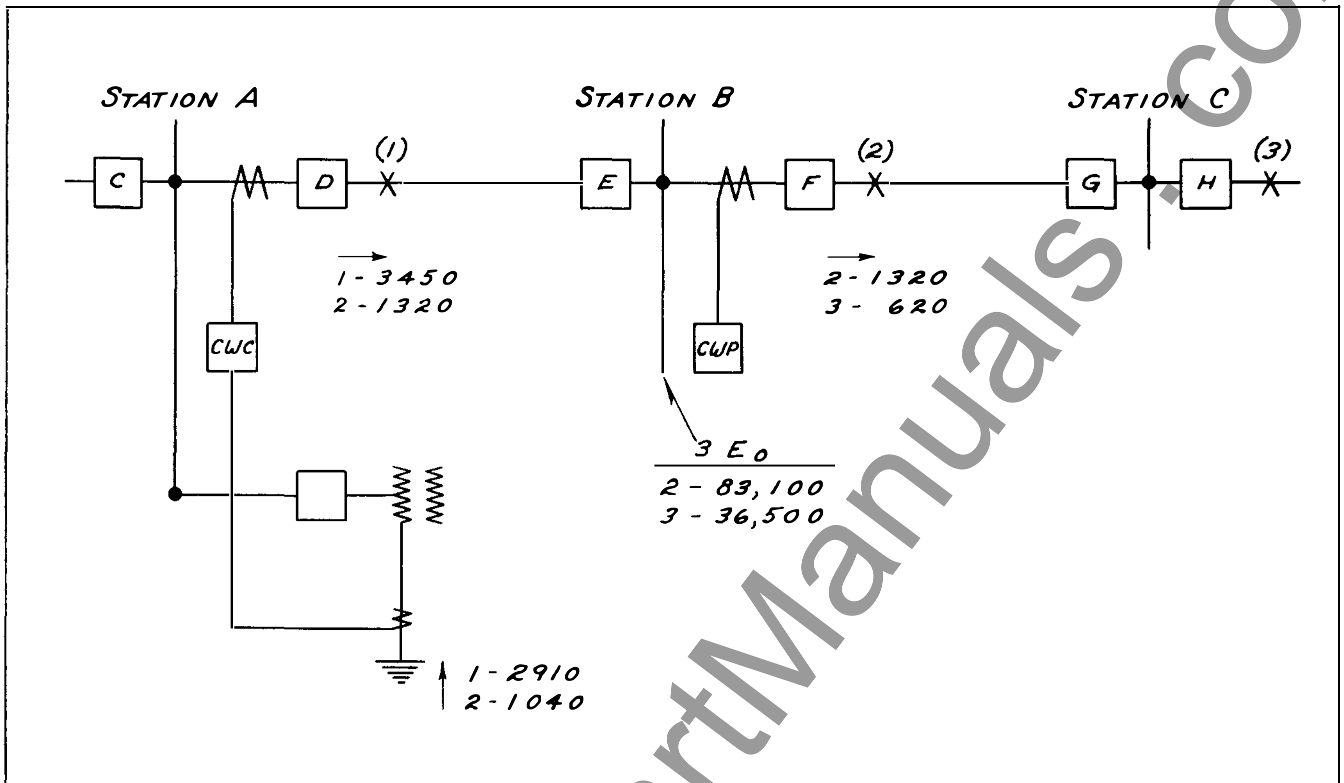


Fig. 12. Typical System for Setting Type CWC and CWP Relays.

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 range of 0.05 to 0.20 second as seen from the curves of Figs. 9 and 11.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 terminal. 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 difference between actual fault 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.

As an example, a type CWC relay is to be connected at Station A and set to protect the line running to Station B. It must select or coordinate with the type CWP relay connected at Station B and set to protect the line running to Station C. The fault current and voltage for single line-to-ground faults under minimum conditions for this system are shown in Fig. 12.

In setting the type CWC and CWP relays, it is convenient to set up Table as shown.

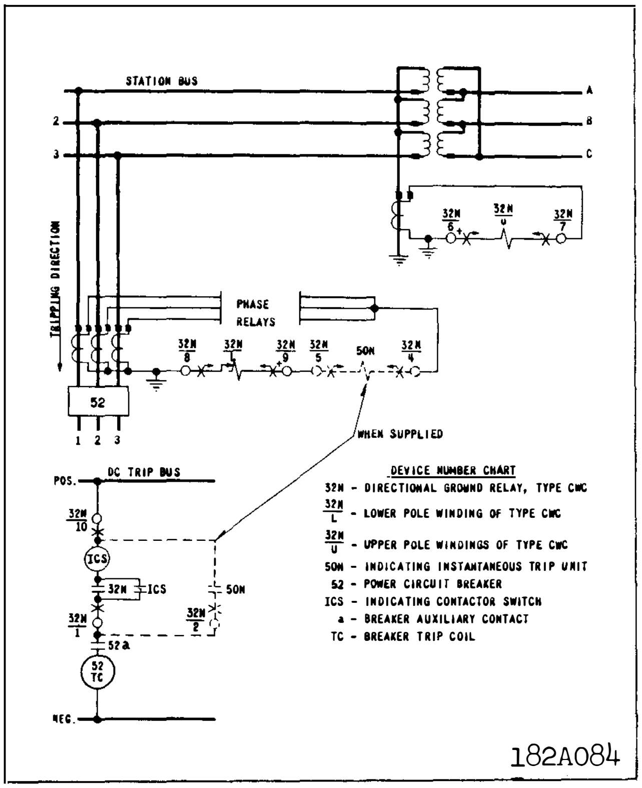


Fig. 13. External Schematic of the Type CWC Relay for Ground Protection.

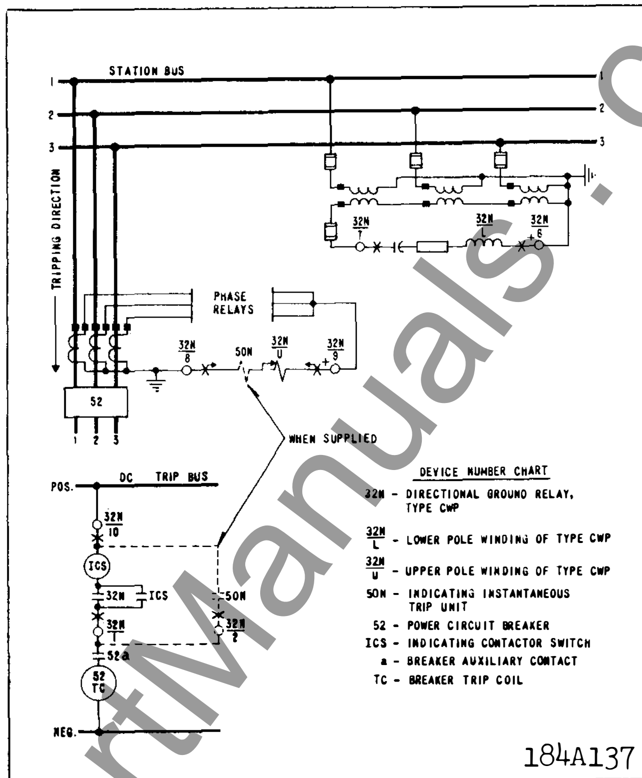


Fig. 14. External Schematic of the Type CWP Relay for Ground Protection.

TABLE 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Relay Location	Fault No.	Line Primary Amps.	Line C.T. Ratio	Polarizing Primary Amps. or Volts	Polarizing C.T. or P.T. Ratio	Line Secondary Amps. (I_L)	Polarizing Secondary Amps. (I_U)	* Product $I_U \times I_L$	$\frac{I_L}{I_U}$	Tap	Multiples of Tap Product	R	Time Dial	Time In Seconds
D	1	3450	300/5	2910	300/5	57.5	48.5	2780	1.19	36	77	4.76	2	.11
D	2	1320		1040		22.0	17.3	381	1.27		10.6	5.1		.52
F	2	1320	100/5	83,100V	1000/1	66.0	83.1V	5485	-	300	18.3	-	¾	.13
F	3	620		36,500V		31.0	36.5V	1130	-		3.8	-		.53

The relay location is shown in Column 1 and the fault location in Column 2. The primary line residual current available for the relay is recorded in Column 3. The ratio of these current transformers is specified in Column 4.

The primary fault current or voltage available for the polarizing winding is shown in Column 5, and the associated current or potential transformer ratio in Column 6. All of these fault values are residual values or three times the zero sequence current of voltage. The relay current for the lower pole windings is the value of Column 3 divided by the ratio of Column 4. The value is recorded in Column 7. The upper pole relay current is the value of Column 5 divided by the ratio of Column 6, and is recorded in Column 8. The relay operating product is the values of Column 7 and 8 multiplied together and recorded in Column 9. For the type CWC relays, the ratio of $\frac{I_L}{I_U}$ is written in Column 10. All of this data is fixed by the system constants and characteristics, and is preliminary to making the actual relay setting.

The choice of a tap recorded in Column 11 and of the time lever in Column 14 is a matter of trial and

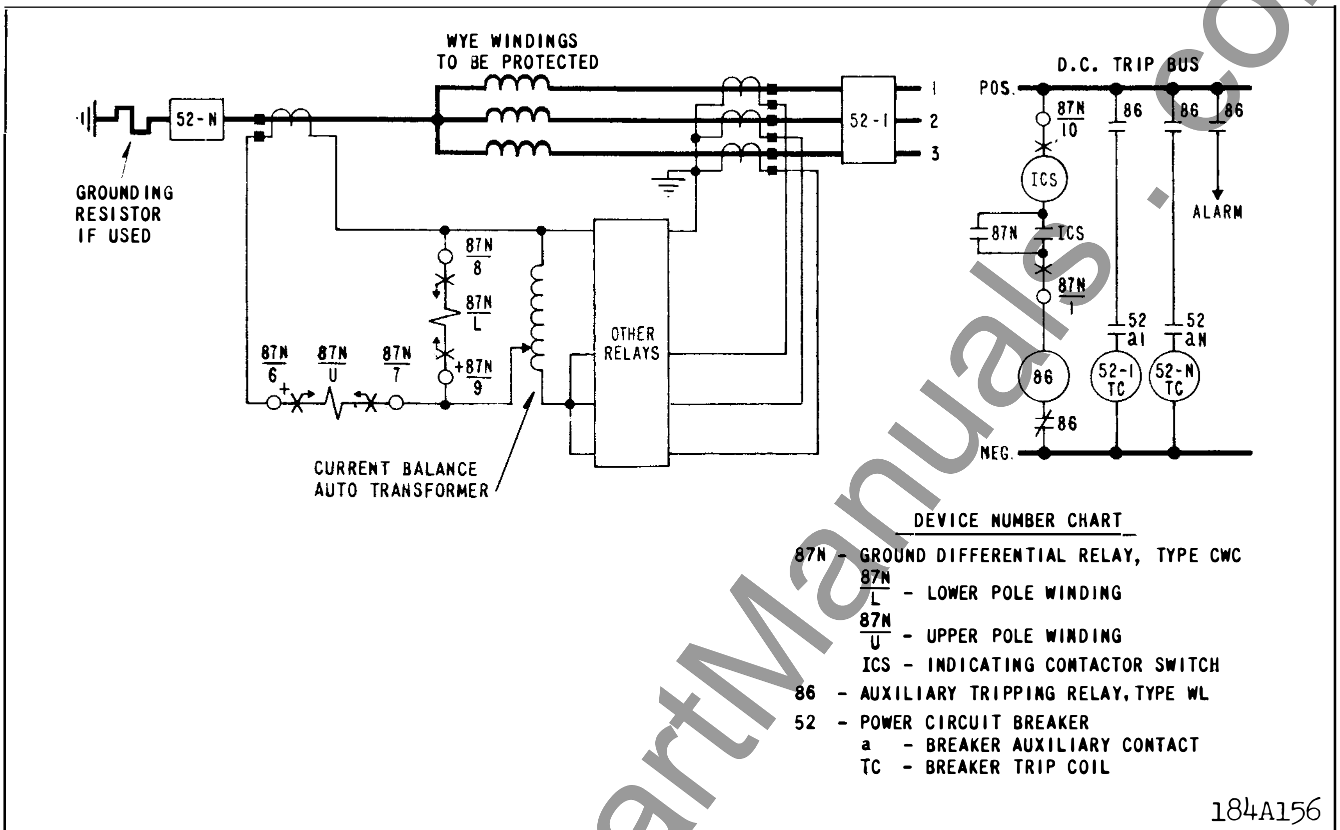


Fig. 15. External Schematic of the Type CW Relay for Ground Differential Protection of Wye or Zig-zag Winding of a Transformer or Rotating Machine.

error. The breakers on this system have 8 cycle operating time so that the coordinating time interval should be about .4 second. The tap should be chosen so that the relay times for the close-in fault and remote fault product values will differ by about the coordinating time interval or .4 second in this case. Practically this can be accomplished by several taps with equal results. Tap 36 was selected in this example. The product value divided by the tap is recorded in Column 12. This value is the abscissa of the time product relay curves. From these curves the lever Column 14 and relay operating time Column 15 were chosen so that the relay would operate at about .12 second for close-in faults and about .52 second for the remote faults. These times for the type CWC relay were obtained using time dial setting ¾. With the selection of a satisfactory tap value, the curves of Fig. 10 will quickly show if the combination of tap and current values provide relay operating times as indicated by the curve. The value of Column 10 multiplied by N = 4.0 for tap 36 gives the R values of Column 13. These are within the curve of Figure 10.

The same process is allowed in setting the type CWP relay at Station B on breaker F. Here tap 300 was selected with dial to provide relay operating times of 0.13 and 0.53 seconds respectively for close-in and remote faults. The operating limits using this tap are fulfilled since neither multiples of tap product value (Column 12) is greater than the polarizing voltage (Column 8).

After individual relay settings are made, it is necessary to check to see if the relays select properly with associated relays. In the example the coordinating time interval was 0.4 second. Therefore, for fault 2, the relay at D should not operate before the relay at F plus the coordinating time interval. In other words, the operating time of D should not be less than 0.13 second plus 0.4 = 0.53 second

Similarly, the time of the relay at breaker H should not be greater than 0.13 second in order to select with relay F for fault 3. If the time of relay H is greater, then the time of relay at F must be increased to provide proper selection. This change may

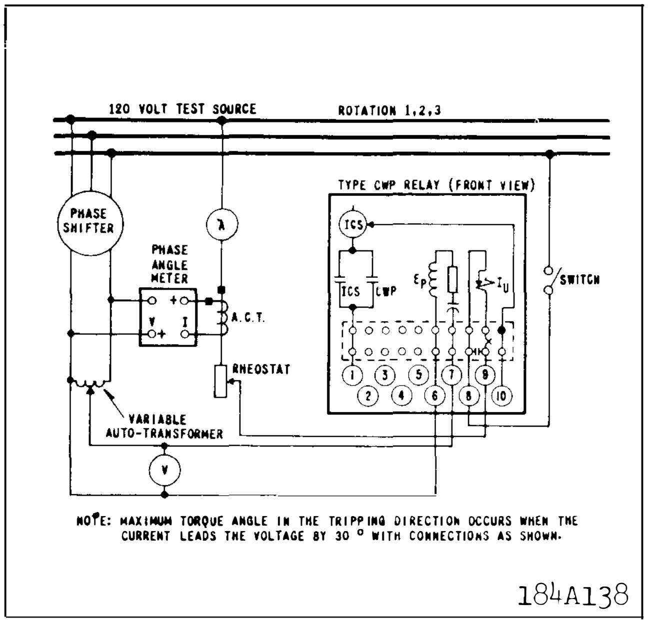


Fig. 16. Diagram of Test Connections for the Type CWP Relay in FT-21 Case.

be accomplished by a change in the time lever setting only, although often a new tap and lever setting may provide a more satisfactory setting. Changing the setting of relays at B probably will require a change in the setting of the relay at Station A.

After the setting 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 dial settings are required particularly if the maximum and minimum fault values are quite different.

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

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

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.

Acceptance Check

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

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 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

For the CWC relay, connect the upper and lower pole coils in series and pass a current equal to $\sqrt{\text{tap product x multiplier}}$ in polarity thru both coils. For the CWP relay connect the relay as per Fig. 16 and apply tap value product. The moving contacts on both relays should close within 5% of the applied values.

3. Time Curve

CWC Relay – Connect the upper and lower poles in series and pass current in polarity thru both coils. Set the time dial on the 6 position and taps on .25 or 2.25 product and 1 multiplier. Check several points on the time curve. Timing should be within * ±7% of that of Figure 9. (The multiples of top product shown in Figure 9 equal the square of the current thru the coils divided by the top product.)

CWP Relay - Connect the relay per Figure 16. Set the time dial on the 6 position and the tap in the 20 or 75 product. Check several points on the time curve by applying current leading the voltage by 300°. The timing should be within ±7% of the values shown on Fig. 11.

4. 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 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 not be greater than the particular ICS tap setting being used. The operation indicator target should drop freely. The contact gap should be approximately 0.47" 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.

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.

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").

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 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

Type CWC Relay - Connect the upper and lower pole coils in series and pass current in polarity on both coils. With one tap screw in the 1 multiplier position and the other screw in the .25 product tap for the .25 - 4 product range or the 2.25 product tap for the 2.25 – 36 product range, apply current and adjust the spring tension so that the contacts just close at tap value product.

Type CWP Relay - Connect the relay per Fig. 16. Set in the lowest tap, apply 100 volts across terminals 6 and 7, and apply minimum pickup current, leading the voltage by 300°, (0.20 amperes for the 20-150 range, 0.75 amperes for the 75-600 range.) Then, adjust the spring tension so that the contacts just close.

3. Time Curve Calibration

Type CWC relay – Set the time dial to position 6 and the product tap to .25 or 2.25. Set the multiplier tap to 1. Connect the upper and lower pole coils in series and pass a current equal to $4 \times \sqrt{\text{tap product}}$ in polarity thru the coils. Adjust the permanent magnet keeper until the operating time is between .95 and 1.01 seconds. Other points on the time curve of Figure 9 should be within ± 7% of the values shown. (The multiples of tap product shown in Figure 9 equal the square of the current passed thru the coils divided by the tap product.) *

Type CWP Relay - Connect the relay per the test circuit of Fig. 16. Set the 6 time dial and the lowest tap. Apply 100 volts to potential coil and 10 times tap current. (Current leading voltage by 300°). relay operate between 1.43 and 1.51 seconds. Other points of the time curve should be within ± 7% of the value shown on Fig. 11.

4. Indicating Contactor Switch (ICS)

Close the main relay contacts and pass suf-

ficient 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 operation indicator target should drop freely.

5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pickup current desired.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

CWC

The burden of the Type CWC relays at 5 amperes, 60 cycles is as follows:

Lower Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
.25-4	.25	82.7	29.3	88.0	19.5
	.36	57.3	14.1	59.0	13.8
	.64	32.1	4.43	32.4	7.85
2.25-36	1.00	20.6	1.83	20.7	5.10
	2.25	8.50	3.26	9.1	21.0
	4.0	4.78	1.03	4.89	12.1
	6.25	3.01	0.41	3.04	7.7
	9.0	2.13	0.21	2.14	5.5

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
.25-4	1	6.08	8.58	10.5	55
	4	1.52	0.54	1.61	20
2.25-36	1	0.79	0.95	1.24	50
	4	0.20	0.06	0.21	17

CWP

The burden of the Type CWC relays at 5 amperes, 115 volts, 60 cycles is as follows:

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
75-600	75	0.633	0.144	0.660	12.6
	100	0.557	0.095	0.560	9.8
	150	0.494	0.043	0.495	5.0
	200	0.460	0.032	0.460	4.0
	300	0.370	0.013	0.370	2.0
	400	0.340	0.006	0.340	1.0
	600	0.290		0.290	0.5
20-150	20	4.70	2.66	5.4	29.5
	30	3.23	1.21	3.45	20.5
	40	2.93	0.87	3.05	16.5
	50	2.31	0.57	2.38	14.0
	75	1.50	0.28	1.52	10.7
	100	1.15	0.11	1.15	5.5
	150	0.80	0.014	0.80	1.0

Lower Pole Potential Windings
(between relay terminals 6 and 7)

	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lead
All ranges -	5.5	2.78	6.15	26.8

CWC & CWP THERMAL RATINGS

Relay	Range	Pole Winding	Continuous Amperes	1 Sec Amperes
CWC	.25-4	All	4	110
CWC	2. 25-36	Upper	10	280
		Lower	12.7	370
CWP	20-150	Upper	3.2	88
	75-600	Upper	6.4	185

The potential coil circuit of the type CWP relay will stand 250 volts for 15 seconds.

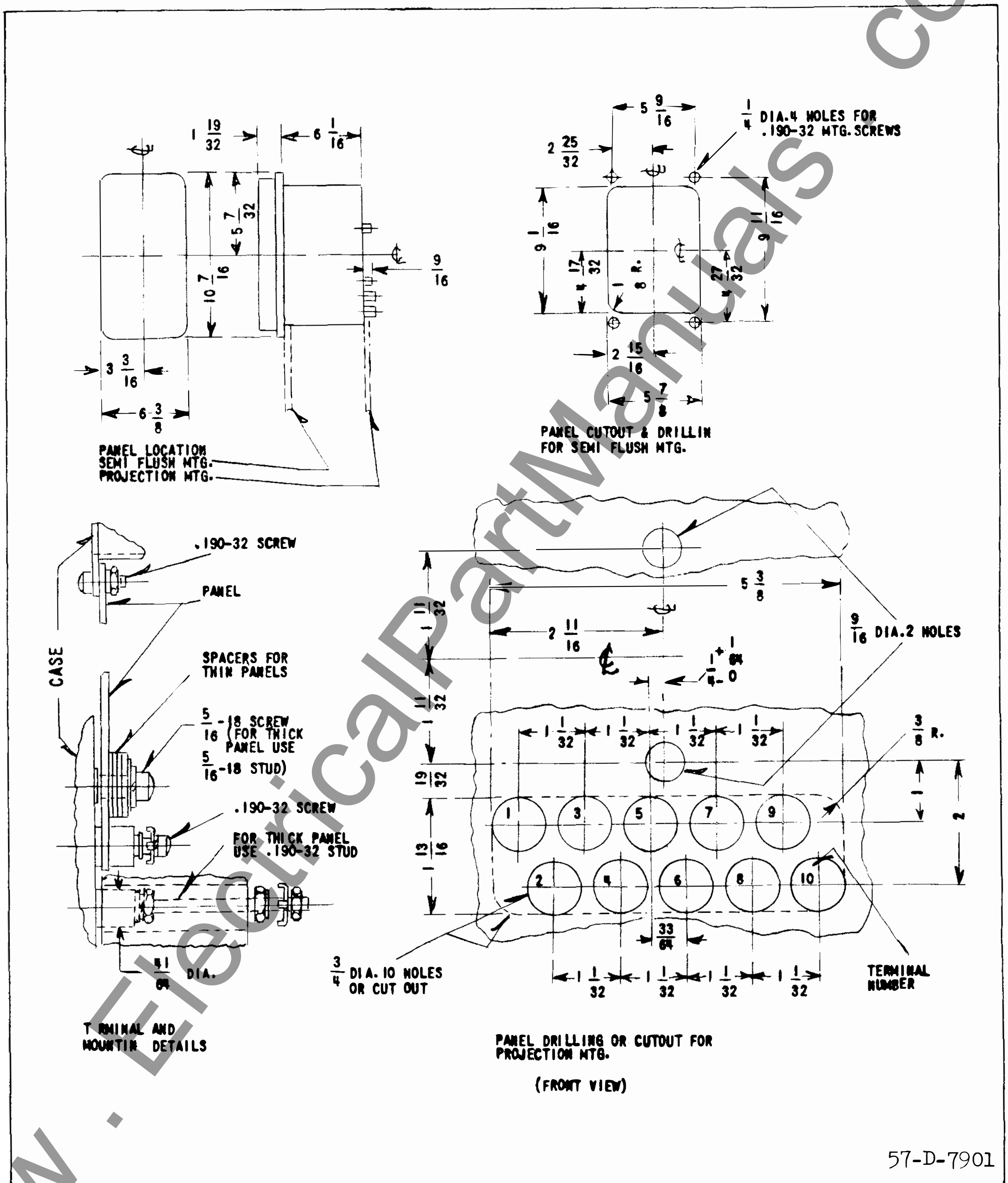


Fig. 17. Outline & Drilling Plan for the Type CWC and CWP Relays in the Type FT-21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE
INSTRUCTIONS

TYPE CWC AND CWP DIRECTIONAL GROUND RELAYS

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

APPLICATION

The Type CWC and CWP relays are induction disc type relays used for directional ground fault protection on grounded neutral power systems. The type CWC relay is polarized by current from a suitably grounded power transformer bank neutral. Therefore, its application does not require potential transformers. The type CWP relay is potential polarized by residual voltage obtained across the open corner of the delta winding of a grounded star-delta potential transformer.

At stations where the power transformer bank neutral is grounded, the residual voltage will be small generally, and the type CWC relay is recommended. At ungrounded stations, or at ground stations where the power transformer bank neutral is not available, the type CWP relay is applicable.

CONSTRUCTION AND OPERATION

The Type CWC and CWP relays consist of an induction disc type unit, an indicating contactor switch, and an optional indicating instantaneous trip unit. In addition an external phase shifting capacitor is supplied with the type CWP relays.

INDUCTION DISC UNIT

The induction disc unit contains a thin four-inch diameter disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The element is not geared. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf-spring. This spring is fastened to a moulded block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the moulded block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in front. The operating torque for the CWC relay is obtained by energizing the lower pole coil with residual current (usually obtained from the line current transformer) and the 2 tapped upper pole coils with residual current from the current transformer in the power transformer bank neutral. For the CWP relay the operating torque is obtained by energizing the upper pole coils with residual current (usually obtained from the line current transformer) and the lower pole with residual voltage.

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

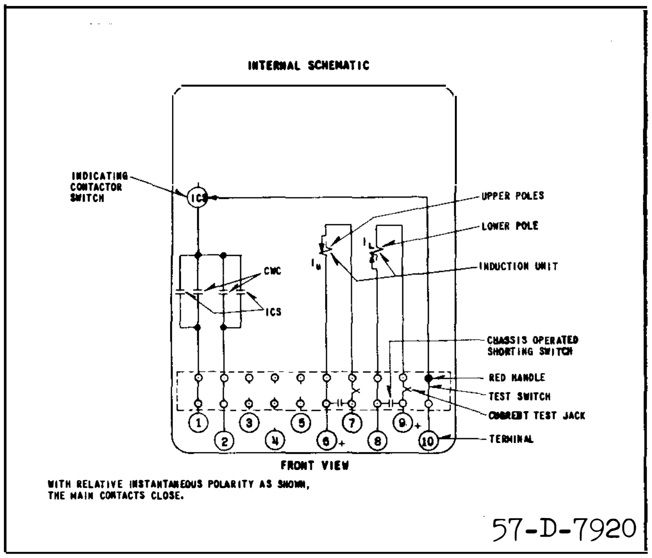


Fig. 1. Internal Schematic of Double Trip Type CWC Relay In the Type FT 21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

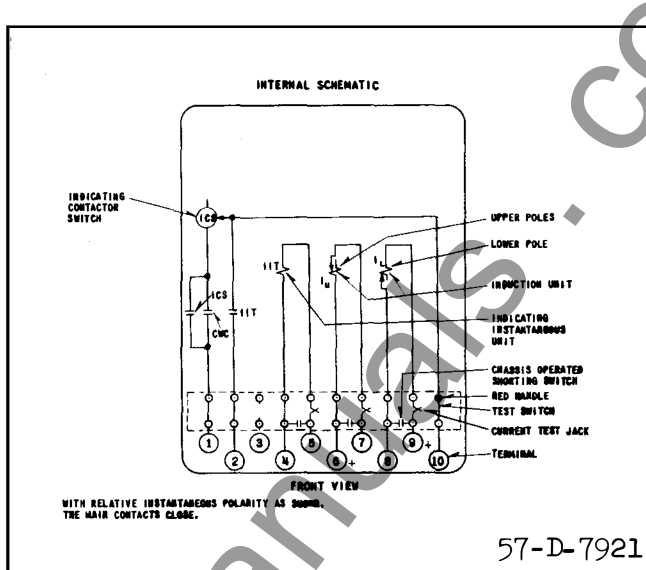


Fig. 2. Internal Schematic of the Type CWC Relay with Indicating Instantaneous Trip Unit in the Type FT 21 Case.

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.

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. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

CHARACTERISTICS

TYPE CWC RELAY

The type CWC relay has two taps on the upper pole and four on the lower pole. They are marked in amperes which is the current thru both windings in series at minimum pick-up, and in product which is the minimum pick-up product of two equal or unequal currents.

Type CWC Relay Ranges and taps are:

.5 to 2 ampere (.25 to 4 Product) Range

Amperes	.5	.6	.8	1.0	1.2	1.6	2.0
Product	.25	.36	.64	1.0	1.44	2.56	4.0

1.5 to 6 ampere (2.25 to 36 Product) Range

Amperes	1.5	2.0	2.5	3.0	4.0	5.0	6.0
Product	2.25	4.0	6.25	9.0	16.0	25.0	36.0

The first four values are marked on the lower pole top plate. The upper pole tap plate is marked x1 and x2 (x1 and x4 Product). The last four values are obtained by using the x2 tap with the four lower pole taps.

Typical 60 Cycle time-product curves for the type CWC relay are shown in Fig. 5. These curves are taken at maximum torque which occurs with the currents in phase. For residual and Ground currents

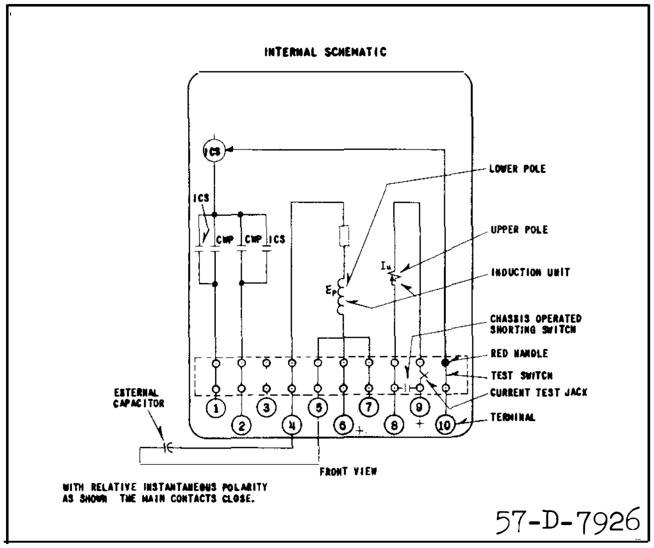


Fig. 3. Internal Schematic of the Type CWP Relay in the Type FT21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

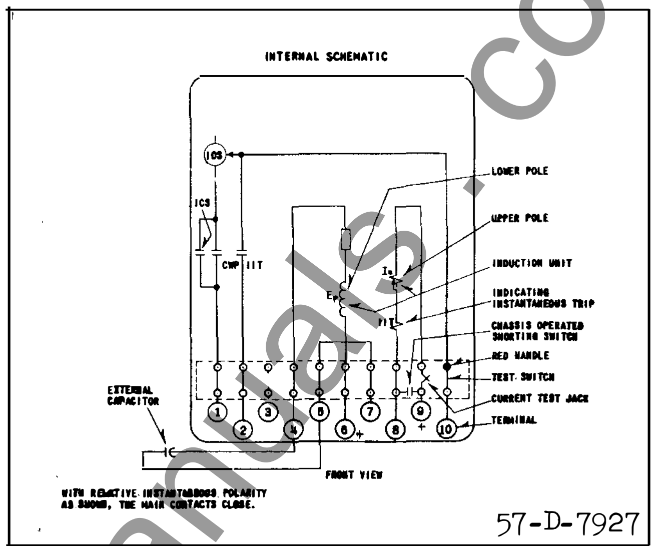


Fig. 4. Internal Schematic of the Type CWP Relay with Indicating Instantaneous Trip Unit in the Type FT21 Case.

out of phase the relay operating time may be obtained by determining the operating time corresponding to the product P = P Cos θ, where P is the actual relay product in amperes squared, and θ is the angle between the residual and polarizing currents.

The limits for which these curves are accurate within ± 7% are shown in Fig. 6.

TYPE CWP RELAY

The type CWP relay taps are on the upper pole current coil. They represent the minimum pick-up product of current times voltage at maximum torque when the current lags the voltage by 60°. The ranges and taps are:

Product Range	Tap Markings						
20 - 150	20	30	40	50	75	100	150
75 - 600	75	100	150	200	300	400	600

Typical 60 cycle time product curves for the type CWP relay are shown in Fig. 7. These curves are taken at maximum torque which occurs with the current lagging the voltage 60°. For currents not lagging by this angle, the relay tripping time may be obtained by determining the operating time corresponding to the product pl = P Cos (60° - θ), where P is the actual relay V.A. product and θ is the angle the current lags the voltage. The curves are accurate within ±7% if the multiple of tap product does not exceed the voltage on the relay coil.

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

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

SETTING CALCULATIONS

The following information is required to set these relays:

1. The maximum and minimum ground fault cur-

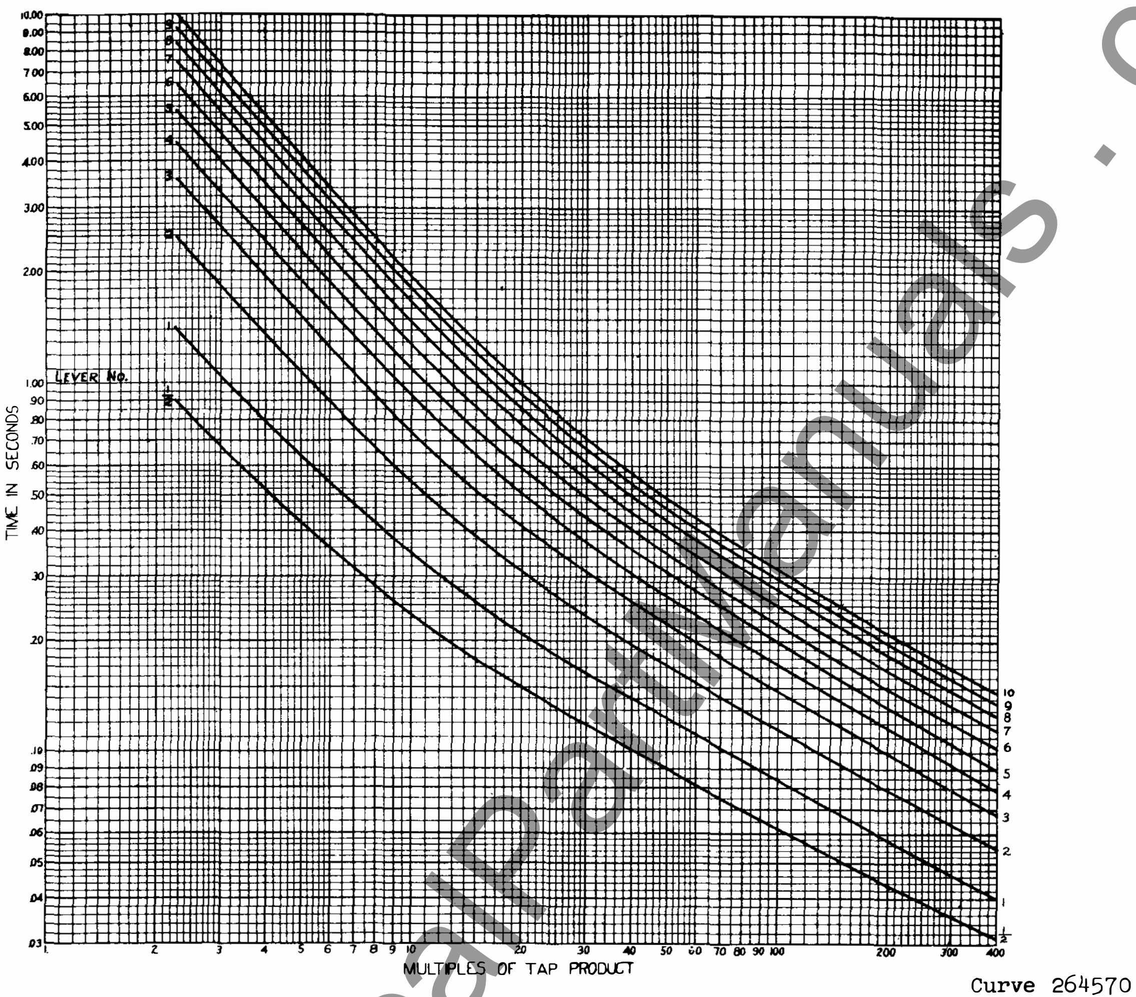


Fig. 5. Typical Time Curves of the Type CWC Relay - Current Coils in Series - See Figure 6 for application limits.

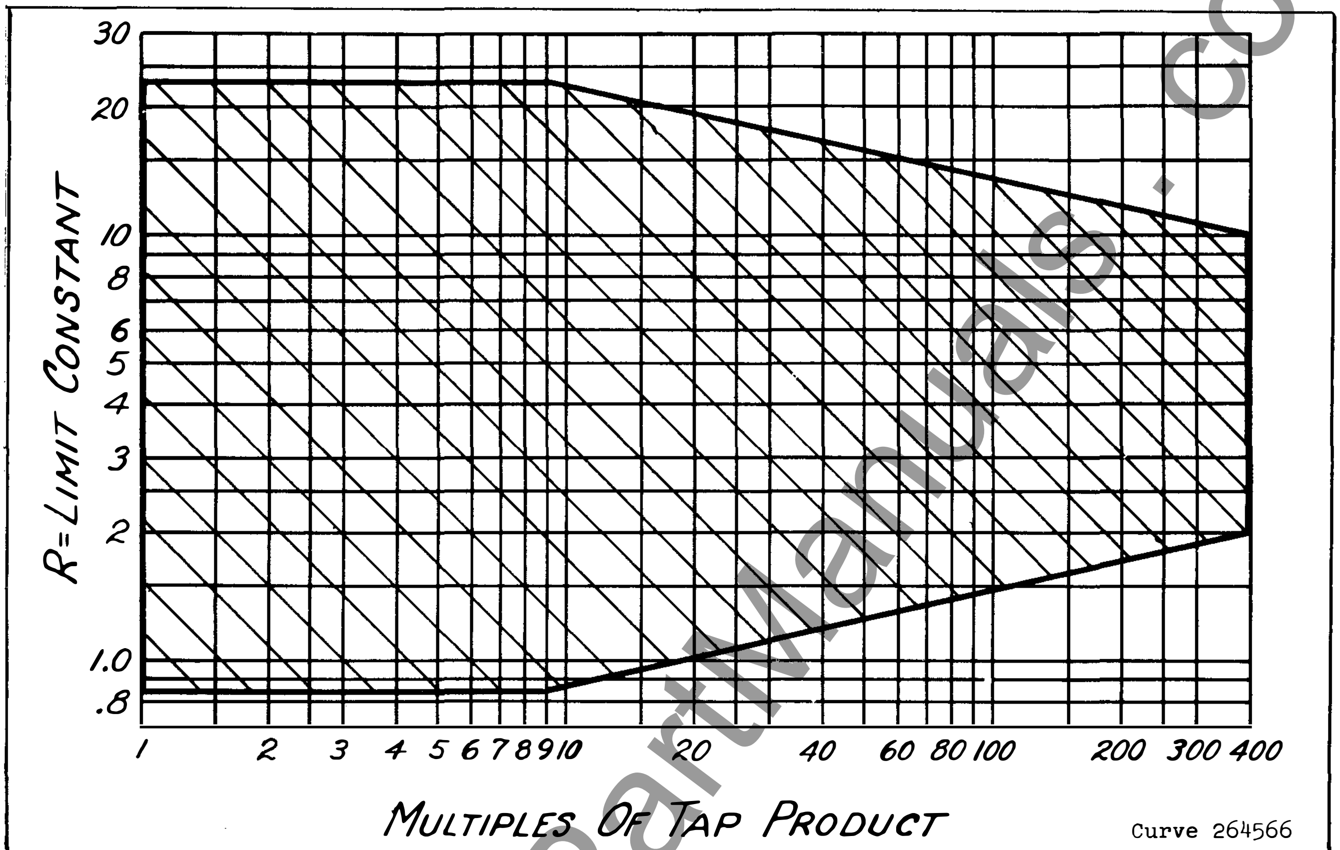
rents for faults at the relay and at the remote bus. These values should be residual current which is three times the zero sequence current.

2. The maximum and minimum polarizing current or voltage values for the faults above. The values should be residual currents or voltage which are three times the zero sequence values.

3. The current transformer ratios of the main and polarizing current transformers for the type CWC relay applications or the main current transformer ratio and the polarizing potential transformer ratio for the type CWP relay application.

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 range of 0.05 to 0.20 second as seen from the curves of Figs. 5 and 7.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 terminal. 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



For the 0.25 to 4 Product Range

$$R = M\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
M = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	M	K
.25	1	.25	4.0	10
.36	1	.36	2.78	12
.64	1	.64	1.56	16
1.0	1	1.0	1.0	20
1.0	4	.25	16.0	20
1.44	4	.36	11.1	24
2.56	4	.64	6.25	32
4	4	1.00	4.0	40

For the 2.25 to 36 Product Range

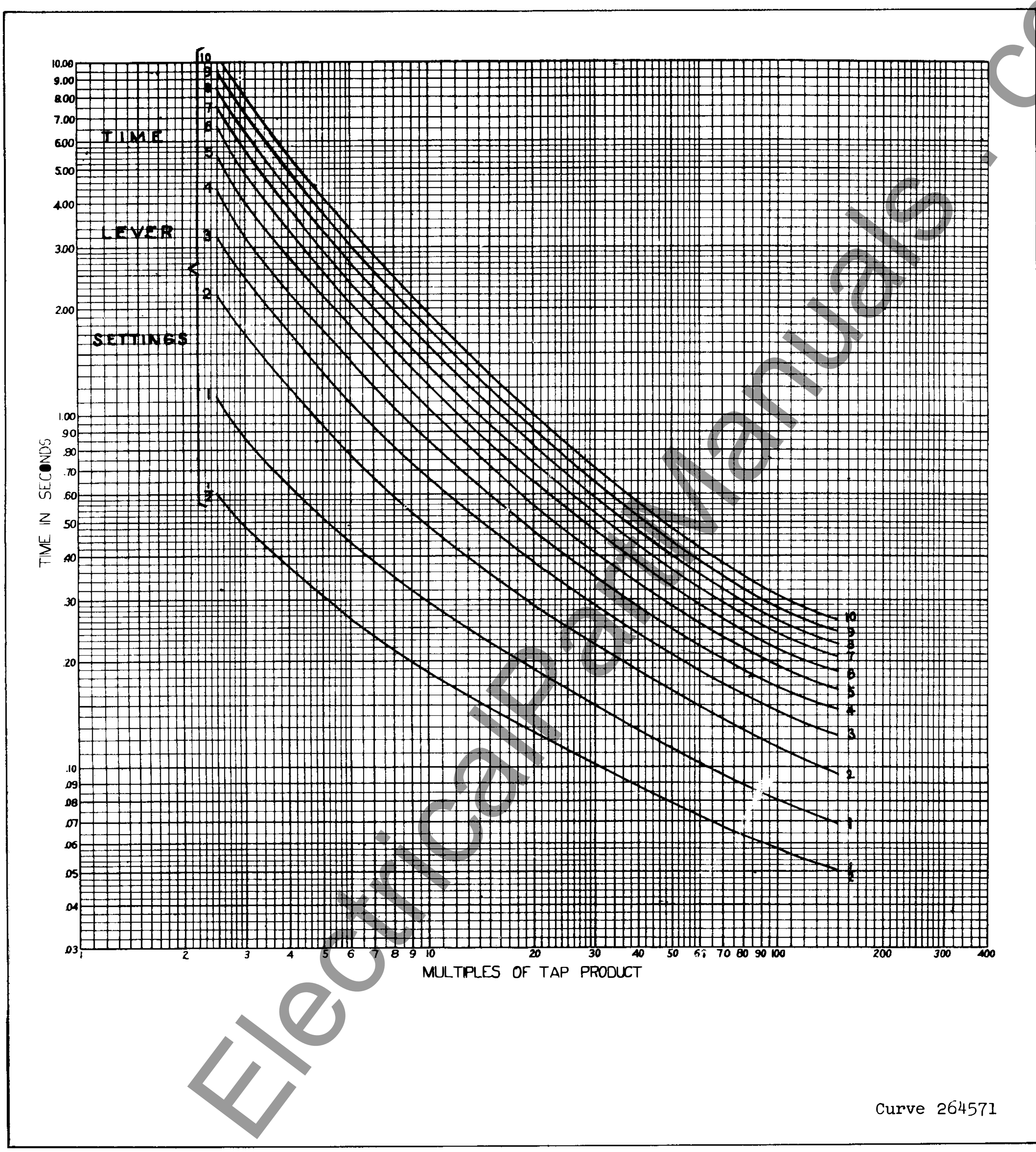
$$R = N\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
N = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	N	K
2.25	1	2.25	4.0	30
4.0	1	4.0	2.25	40
6.25	1	6.25	1.44	50
9.0	1	9.0	1.0	60
9.0	4	2.25	16.0	60
16.0	4	4.0	9.0	80
25.0	4	6.25	5.76	100
36.0	4	9.0	4.0	120

The Typical time curves for the Type CWC Relay apply if the values of R falls within the shaded area of the curve above, and if neither relay current is greater than K in amperes.

Fig. 6. Limits for Application of the CWC Time Curves.



These Curves are valid if the multiple of tap Product (volt-amperes) does not exceed the voltage on the relay polarizing coils.

Fig. 7. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply If the Multiple of Tap Product In Volt-Amperes Does Not Exceed the Polarizing Voltage In Volts.

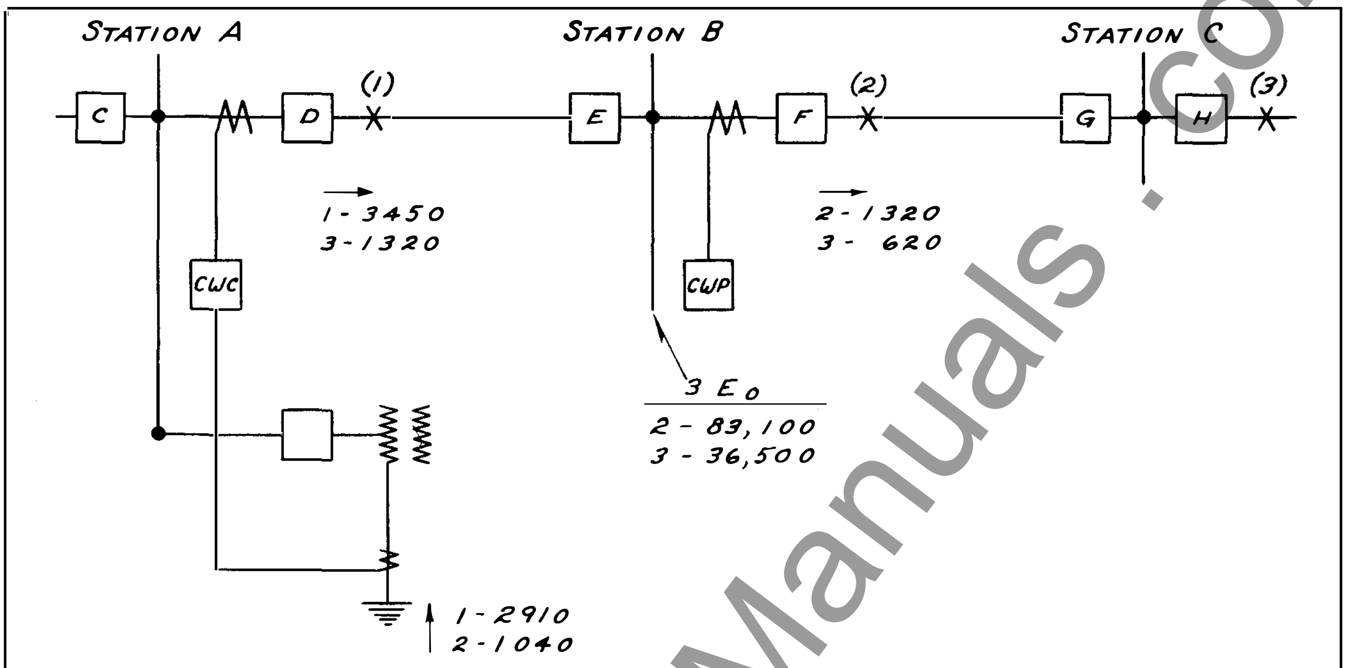


Fig. 8. Typical System for Setting Type CWC and CWP Relays.

TABLE I

1 Relay Location	2 Fault No.	3 Line Primary Amps.	4 Line C.T. Ratio	5 Polarizing Primary Amps. or Volts	6 Polarizing C.T. or P.T. Ratio	7 Line Secondary Amps. (I_L)	8 Polarizing Secondary Amps. (I_U)	9 Product $I_U \times I_L$	10 $\frac{I_L}{I_U}$	11 Tap	12 Multiples of Tap Product	13 R	14 Lever	15 Time In Seconds
D	1	3450	300/5	2910	300/5	57.5	48.5	2285	1.19	36	63.5	4.76	2-1/4	.16
D	2	1320		1040		22.0	17.3	381	1.27		10.6	5.1		.56
F	2	1320	100/5	83,100V	1000/1	66.0	83.1V.	5485	—	300	18.3	—	3/4	.16
F	3	620		36,500V		31.0	36.5V.	1130	—		3.8			.53

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 difference between actual fault 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.

As an example, a type CWC relay is to be connected at Station A and set to protect the line running to Station B. It must select or coordinate with the type CWP relay connected at Station B and set to protect the line running to Station C. The fault currents and voltage for single line-to-ground faults under minimum conditions for this system are shown in Fig. 8.

In setting the type CWC and CWP relays, it is convenient to set up Table as shown. The relay location is shown in Column 1 and the fault location in Column 2. The primary line residual current available for the relay is recorded in Column 3. The ratio of these current transformers is specified in Column 4.

The primary fault current or voltage available for the polarizing winding is shown in Column 5 and the associated current or potential transformer ratio in Column 6. All of these fault values are residual values or three times the zero sequence current or voltage. The relay current for the lower pole windings is the value of Column 3 divided by the ratio of Column 4. The value is recorded in Column 7. The upper pole relay current is the value of Column 5 divided by the ratio of Column 6, and is recorded in Column 8. The relay operating product is the values of Column 7 and 8 multiplied together and recorded in Column 9. For the type CWC relays, the ratio of $\frac{I_L}{I_U}$ is written in Column 10. All of this data is fixed by the system constants and characteristics,

panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

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

ADJUSTMENTS AND MAINTENANCE

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

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.

INDUCTION UNIT

The upper bearing screw should be screwed down until there is only 3 to 5 thousandths inch clearance between it and the shaft and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the disc fails to turn freely and then backing up a fraction of a turn. Great care must be taken in making this adjustment to prevent damage to the bearings.

Adjust the contacts to just barely touch when the time lever is set on zero by shifting the position of the contact stop on the time lever. This should be done with approximately the required contact follow. Final adjustment of the contacts can be more easily made by the contact follow set screw after the contact stop is securely fixed.

A maximum contact follow of approximately 5/64 inch is obtained when the set screw on the stationary contact is all the way out. Where rigid contacts for quick reopening are required, the set screw should be all the way in to hold the stationary contact against the Micarta bracket. Readjust the zero setting after this is done.

CWC RELAY

Connect the upper and lower pole coils in series and pass current in polarity on both coils. With one tap screw in the 1 multiplier position and the other screw in the .36 product tap for the .25-4 product range or the 4 product tap for the 2.25-36 product range, apply current and adjust the spring tension so that the contacts just close with tap value of current flowing. This is 0.6 ampere, 60 cycles, on the .25-4 product range or 2.0 amperes, 60 cycles, on the 2.25-36 product range. The spring tension may by changed by means of a screw driver inserted in one of the notches of the plate to which the outside convolution of the spring is fastened.

Various points on the typical time-product curves can be checked approximately with the current coils in series. The multiples of tap product will be the square of the current passed thru the two coils, divided by the tap product. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked. Time curve calibration is obtained by adjusting the position of the permanent magnet.

TYPE CWP RELAY

Use the following procedure to check the zero torque line. Adjust the control spring for zero tension and connect per Fig. 11. Apply 120 volts across terminals 6 and 7 and five times minimum pick up current (tap value divided by 24). Zero torque should occur when the currents lead the voltage by 19° to 36°.

To calibrate the control spring, connect per Fig. 11, set in the lowest tap, apply 100 volts across terminals 6 and 7, and apply minimum pickup current, leading the voltage by 300°, (0.20 amperes for the 20-150 range, 0.75 amperes for the 75-600 range). Then, adjust the spring tension so that the contacts just close. Spring adjustment is changed by inserting a screw driver in one of the spring adjuster plate notches.

To check points on the time curve, connect per Fig. 11, and apply preselected current and voltage values, with current leading the voltage by 300° and measure the time of operation with a cycle counter. The time of several trials should be averaged. If the current coil is allowed to overheat, the timing will be affected. The potential coil should not be continuously energized above 115 volts.

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.

INDICATING INSTANTANEOUS TRIP (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%.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

CWC

The burden of the Type CWC relays at 5 amperes, 60 cycles is as follows:

Lower Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
.25-4	.25	82.7	29.3	88.0	19.5
	.36	57.3	14.1	59.0	13.8
	.64	32.1	4.43	32.4	7.85
	1.00	20.6	1.83	20.7	5.10
2.25-36	2.25	8.50	3.26	9.1	21.0
	4.0	4.78	1.03	4.89	12.1
	6.25	3.01	0.41	3.04	7.7
	9.0	2.13	0.21	2.14	5.5

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
.25-4	1	6.08	8.58	10.5	55
	4	1.52	0.54	1.61	20
2.25-36	1	0.79	0.95	1.24	50
	4	0.20	0.06	0.21	17

CWP

The burden of the type CWP relays at 5 amperes, 115 volts, 60 cycles is as follows:

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
75-600	75	0.633	0.144	0.660	12.6
	100	0.557	0.095	0.560	9.8
	150	0.494	0.043	0.495	5.0
	200	0.460	0.032	0.460	4.0
	300	0.370	0.013	0.370	2.0
	400	0.340	0.006	0.340	1.0
	600	0.290		0.290	0.5
20-150	20	4.70	2.66	5.4	29.5
	30	3.23	1.21	3.45	20.5
	40	2.93	0.87	3.05	16.5
	50	2.31	0.57	2.38	14.0
	75	1.50	0.28	1.52	10.7
	100	1.15	0.11	1.15	5.5
	150	0.80	0.014	0.80	1.0

Lower pole Potential Winding including external 0.38 mfd. phase shifting capacitor.

	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lead
All ranges -	5.5	2.78	6.15	26.8

CWC & CWP THERMAL RATINGS

Relay	Range	Pole Winding	Continuous Amperes	1 Sec Amperes
CWC	.25-4	All	4	110
CWC	2.25-36	Upper	10	280
		Lower	12.7	370
CWP	20-150	Upper	3.2	88
	75-600	Upper	6.4	185

The potential coil circuit of the type CWP relay will stand 250 volts for 15 seconds.

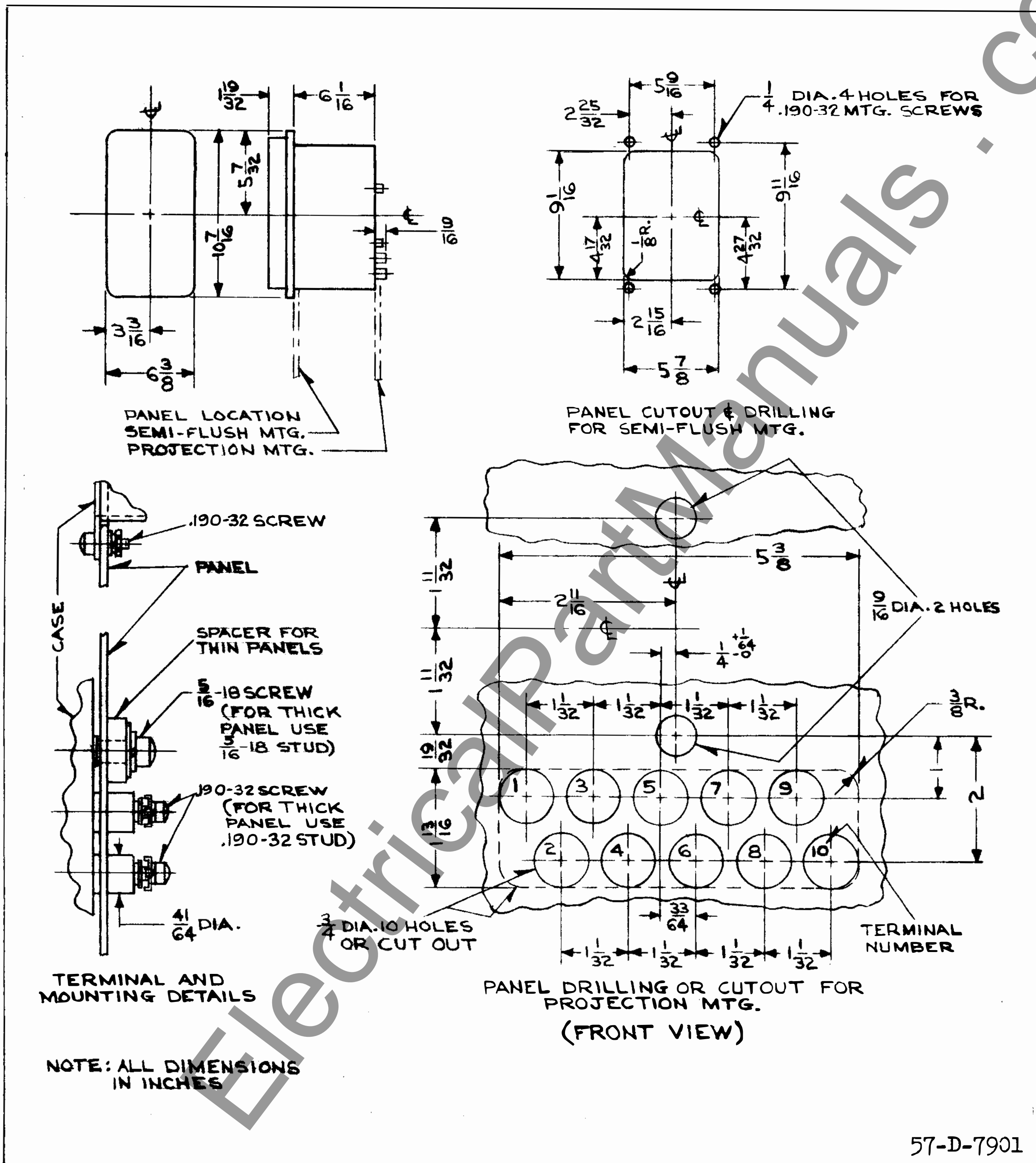


Fig. 13. Outline & Drilling Plan for the Type CWC and CWP Relays In the Type FT 21 Case.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWP-1 SENSITIVE DIRECTIONAL GROUND 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

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

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 Fig. 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 Fig. 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 currents 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 currents values permit a higher current pickup, three residually connected CT's may be used.

CONSTRUCTION AND OPERATION

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

Operating Unit

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 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.

Phase Shifter Network

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

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 drop.

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

SUPERSEDES I.L. 41-242.5
*Denotes change from superseded issue.

EFFECTIVE NOVEMBER 1967

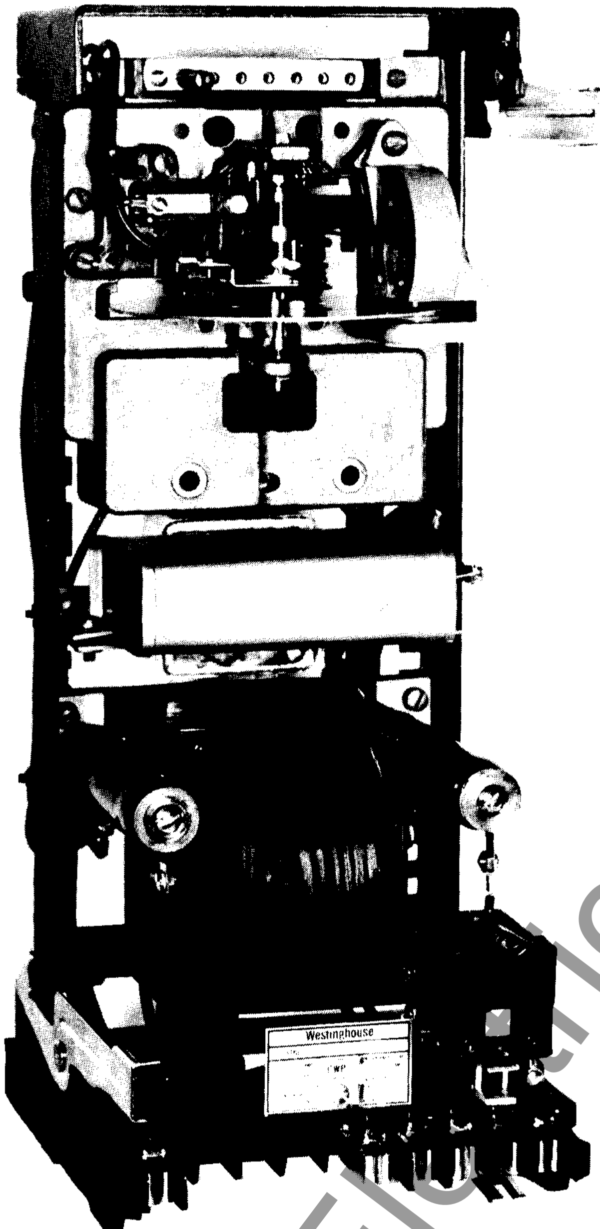


Fig. 1. Type CWP-1 Ground Relay (front view)

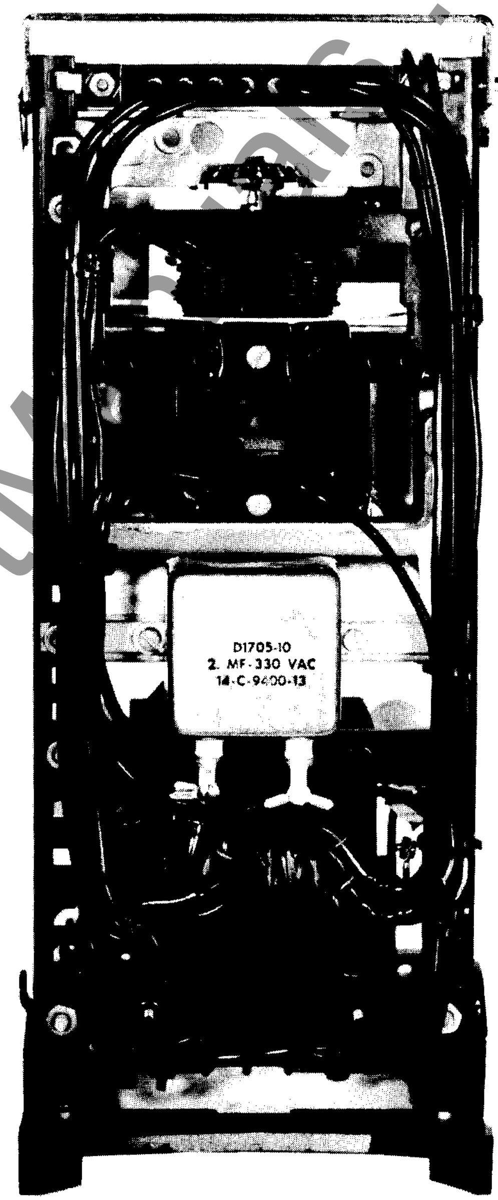


Fig. 2. Type CWP-1 Ground Relay (rear view)

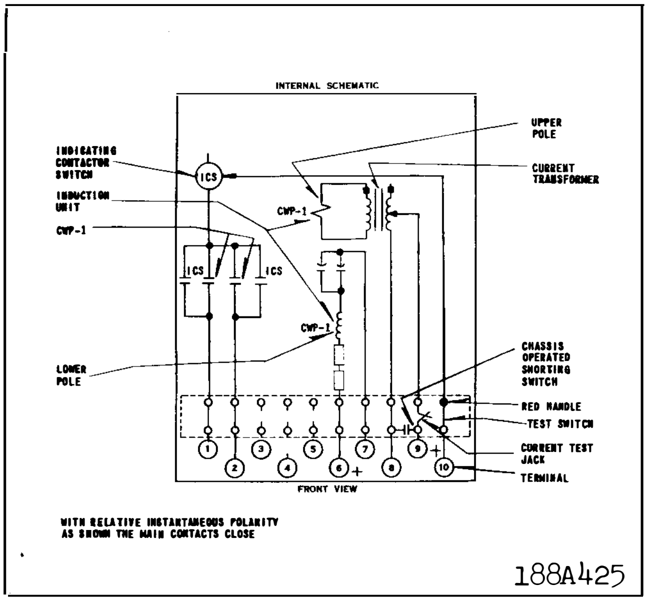


Fig. 3. Internal Schematic of the Double Trip CWP-1 Relay, FT31 Case. (Single Trip Relays have terminal 2 and associated circuits omitted).

Current Transformer

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

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 pick-up product of residual current (at an angle of 45° lead) times the residual voltage.

Typical 60 cycle time product curves for the type CWP-1 relay are shown in Fig. 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 V.A. 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.

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 contactor switch as two taps that provide a pickup setting of 0.2 or 2 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.

Trip Circuit Constants

Indicating Contactor Switch -

0.2 ampere tap - 6.5 ohms -dc resistance
0.2 ampere tap - 0.15 ohms d-c resistance

Burden and Thermal Ratings

Current Circuit Burden

	POWER FACTOR ANGLE - LAG	
TAP	60 Cycles	50 Cycles
.5	23.0°	27.2°
.7	23.0	21.8
1.0	21.5	17.1
1.1	17.5	14.6
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 Cycles	50 Cycles
.5	0.0028	0.0021
.7	0.0030	0.0023
1.0	0.0034	0.0027
1.1	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 Cycles	9.68 va	60 Cycles	46°

Thermal Ratings

	60 Cycles	50 Cycles
Continuous Current	0.3 Amp.	0.3 Amp.
Continuous Voltage	250 Volts	175 Volts

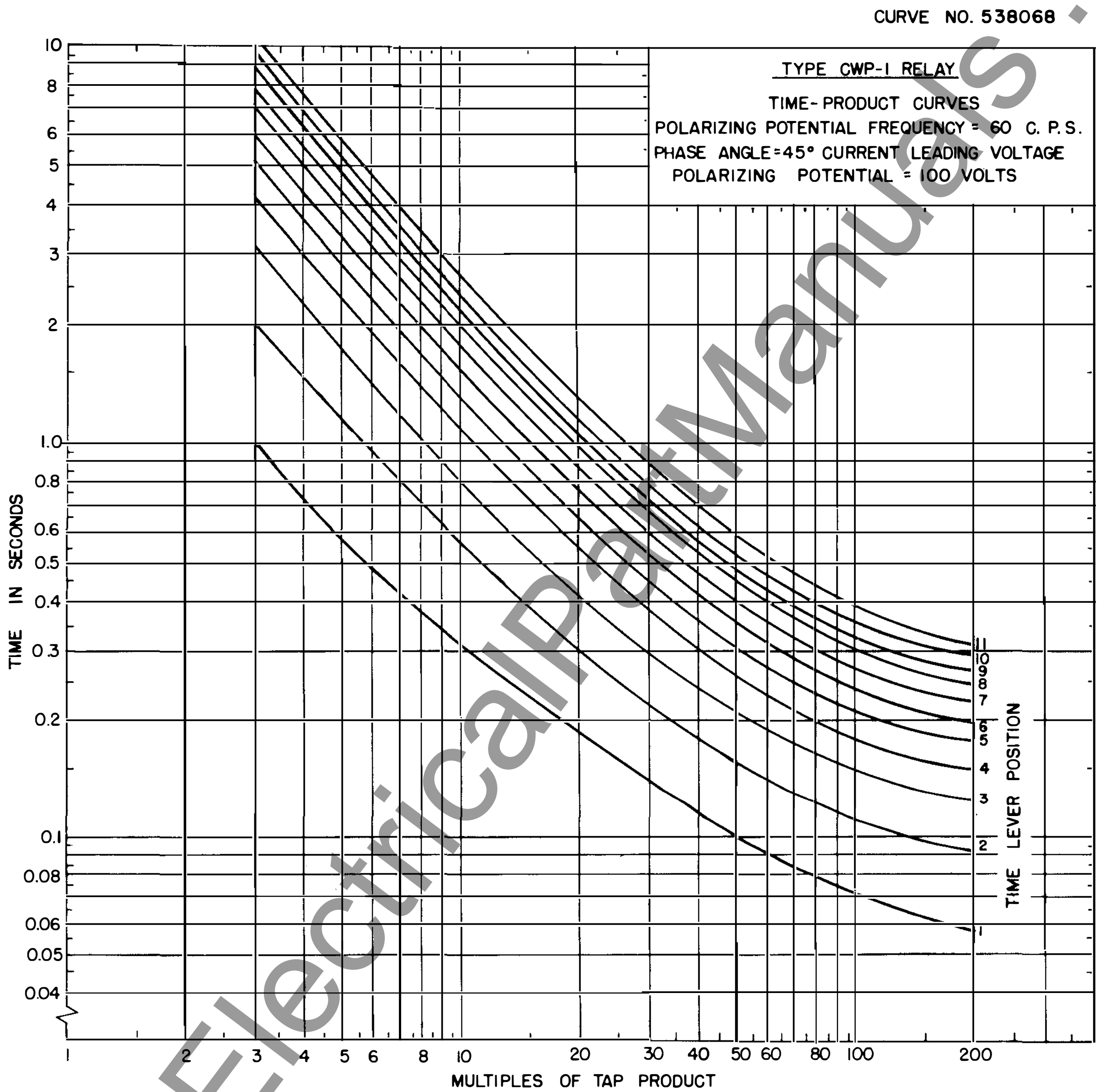


Fig. 4. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque. 100 volts 60 cycles across potential circuit.

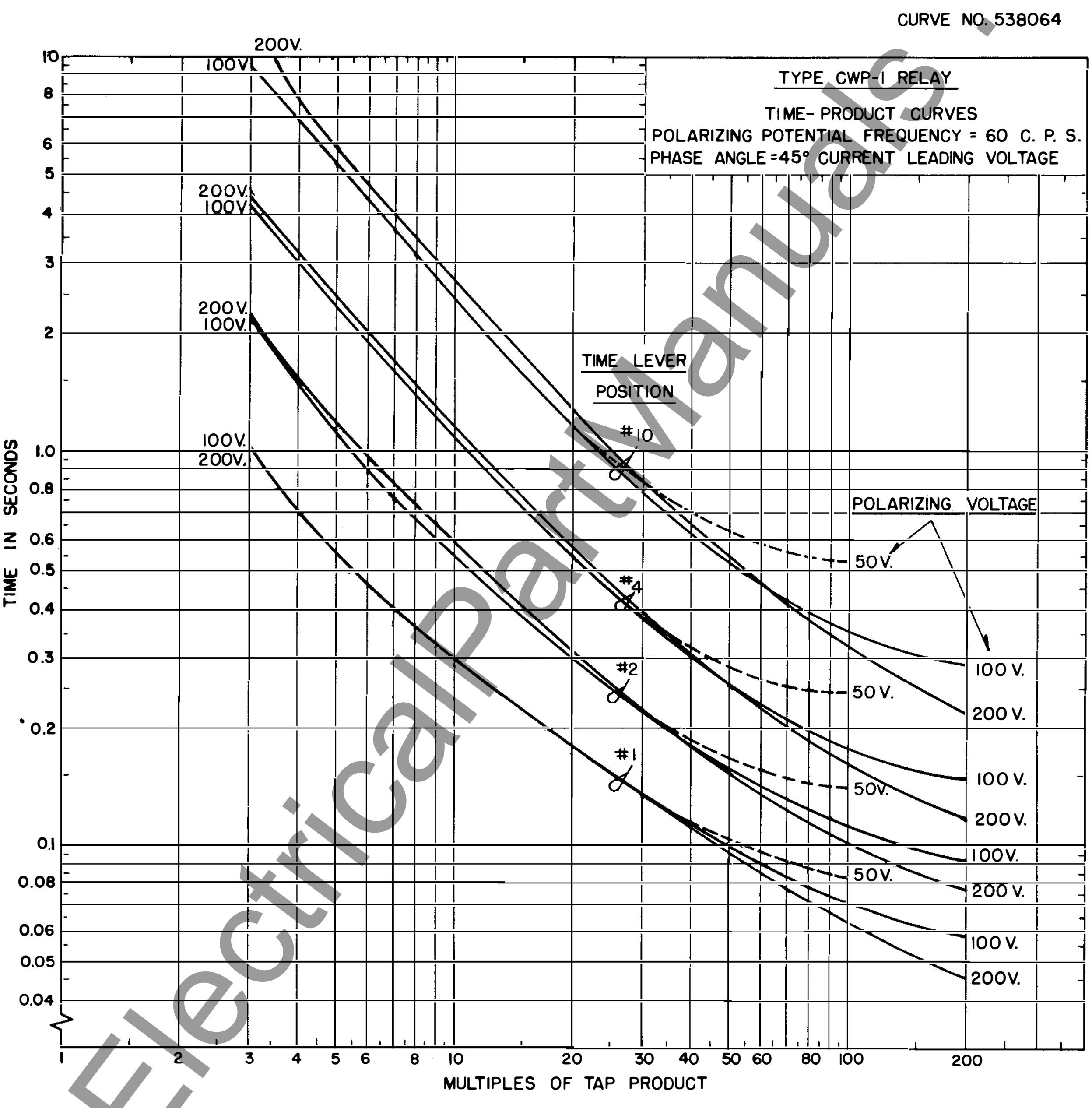


Fig. 5. Representative Time-Product Curves, showing effect of variations of Potential Circuit Voltage - Maximum Torque Angle, 60 cycles.

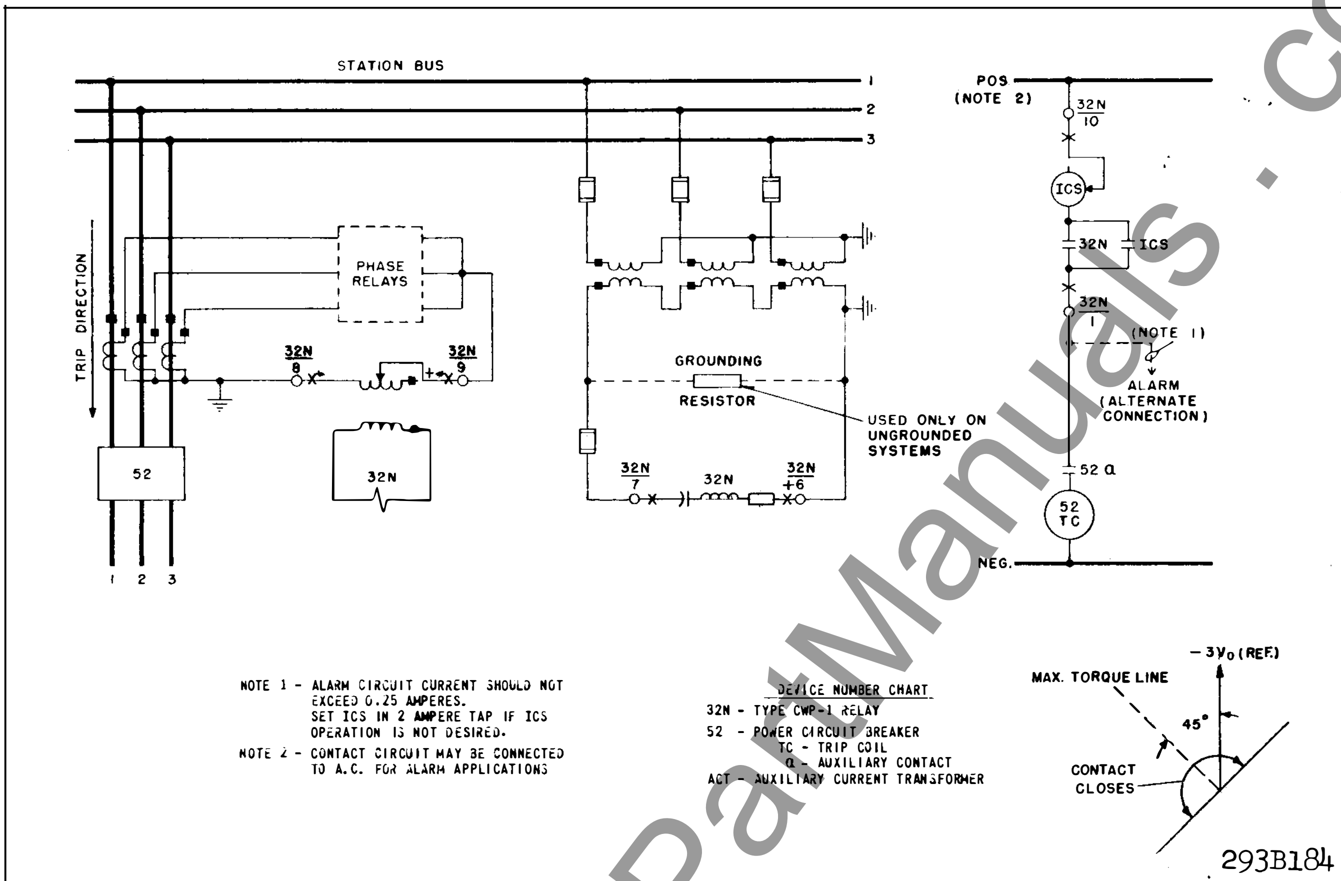


Fig. 6. External Schematic of the Type CWP-1 Relay in FT31 Case.

SETTING

The relay operates on the product of residual fault current and voltage. This product divided by and proper current and potential transformer ratio and by one of the transformer tap values is expressed as a multiple of the tap. The time curves of Fig. 4 gives the relay operating time for various time dial settings as a function of this multiple. Fig. 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 may 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 Figs. 3, 4 and 5.

However, the relay cannot distinguish between a fault on the line near the remote breaker for which they 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

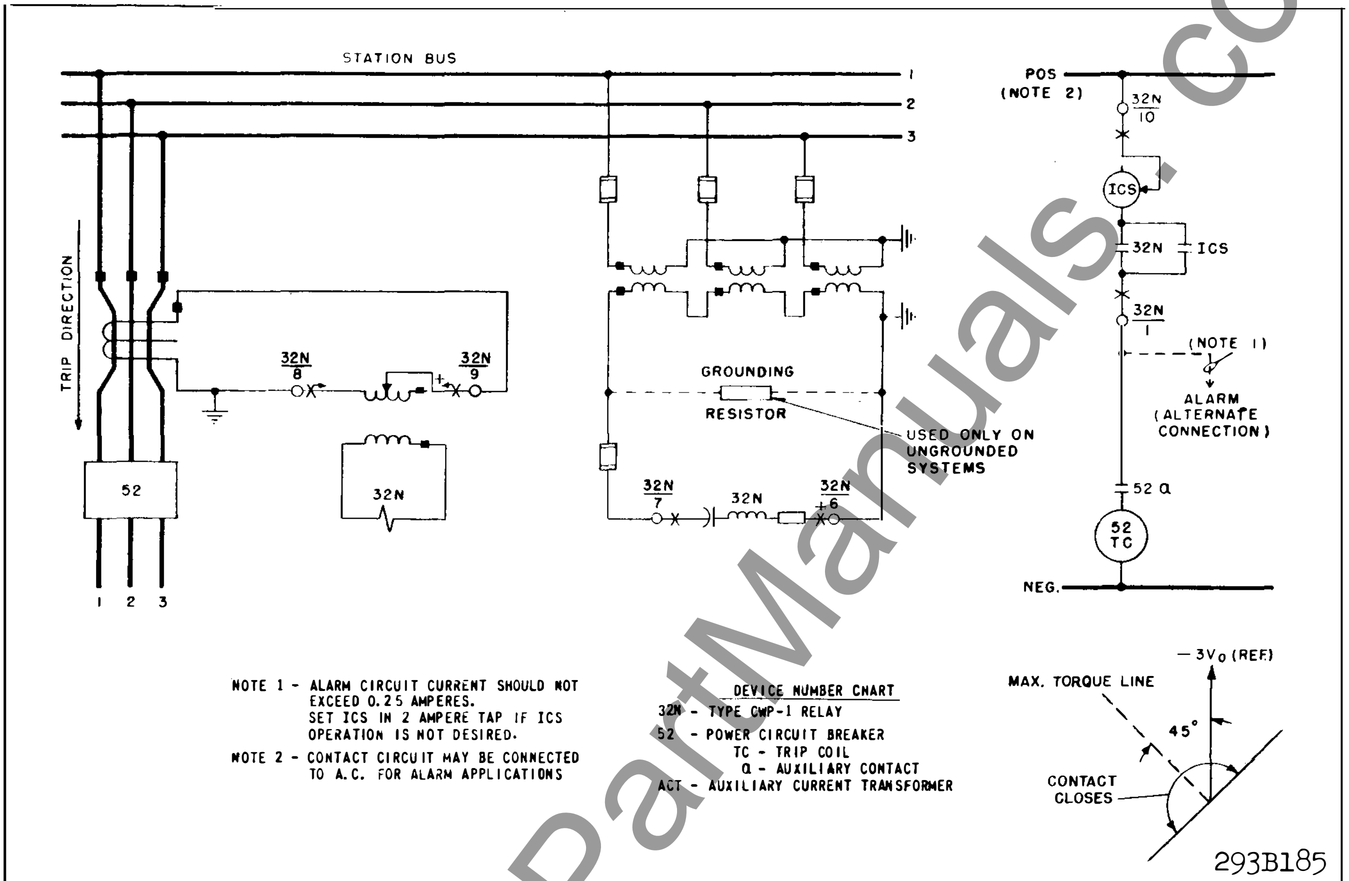


Fig. 7. External Schematic of the Type CWP-1 Relay in FT31 Case, using Window Type C.T.

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 individifferences 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.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 volt or 250 volt d-c type WL relay switch, or equivalent, use the 0.2 ampere tap. For 48 volt d-c applications set ICS in 2 ampere tap and use S#304C209G01 type WL relay or equivalent.

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the

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

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

ADJUSTMENTS AND MAINTENANCE

The proper adjustment to insure 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.

Acceptance Check

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

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 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. Set the contacts to the time dial position and the tap plug in the 0.5 tap. Connect the relay as shown in Fig. 6. 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 by 45° voltage drop from relay terminal 6 to terminal 7.) The pickup current should be 0.005 amperes + 3%.

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

Current	Multiple of Tap Product	Time-seconds 60 Cycles	Time-seconds 50 Cycles
0.025	5	3.55 ± 10%	4.00 ± 10%
0.100	20	0.94 ± 5%	1.00 ± 5%
0.500	100	0.33 ± 10%	0.35 ± 10%

4. 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 by 135° (or 315°) ± 7°.

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 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.

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 paragraph 1 under "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.

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 until it is apparent that the relay is not in proper working order (See "Acceptance Check").

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".

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 Fig. 6 and see 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 0.94 seconds (1.00 seconds for 50 cycle relay) in the 0.5 VA tap, with a potential of 100 volts. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked.

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 simultaneously.

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.

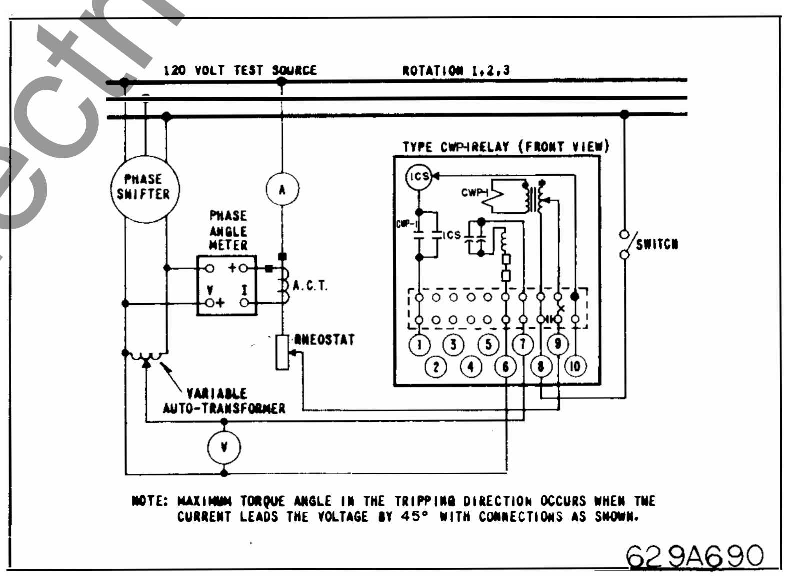


Fig. 8. Diagram of Test Connections for the Type CWP-1

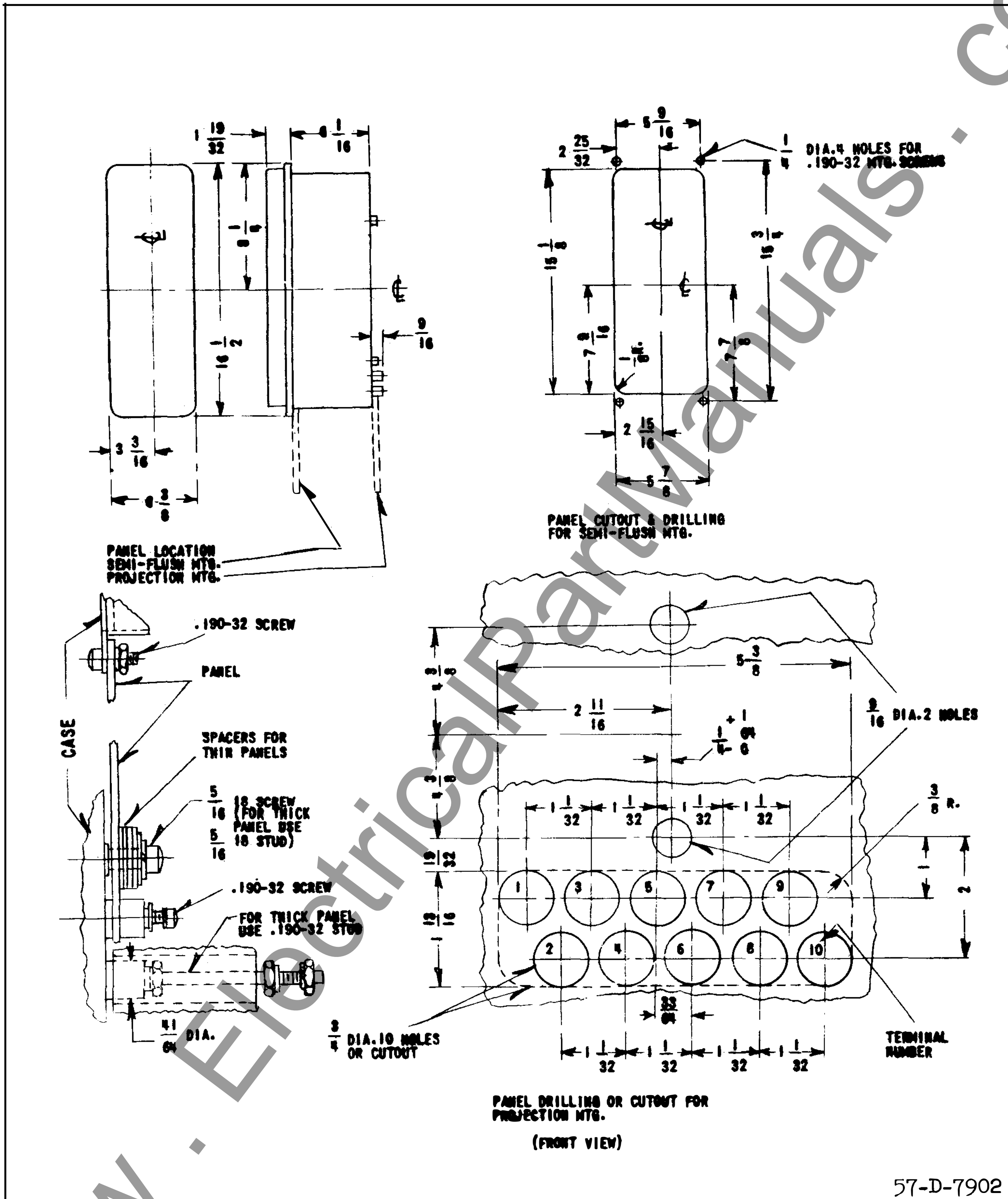


Fig. 9. Outline and Drilling Plan of the Type CWP-1 Relay in FT31 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWC AND CWP DIRECTIONAL GROUND RELAYS

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

APPLICATION

The type CWC and CWP relays are induction disc type relays used for directional ground fault protecttion on grounded neutral power systems. The type CWC relay is polarized by current from a suitably grounded power transformer bank neutral. Therefore, its application does not require potential transformer. The type CWP relay is potential polarized by residual voltage obtained across the open corner of the delta winding of a grounded star-delta potential transformer.

At stations where the power transformer bank netural is grounded, the residual voltage will be small generally, and the type CWC relay is recommended. At ungrounded stations, or at ground stations where the power transformer bank neutral is not available, the type CWP relay is applicable.

CONSTRUCTION

The type CWC and CWP relays consists of an operating unit, an indicating contactor switch, and optional indicating instantaneous trip unit. In addition to the above components, the type CWP relay has a phase shifter network. The principal component parts of the relay and their locations are shown in Fig. 1-8.

OPERATING UNIT

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 2 and 4. The upper pole of both the CWC and CWP relays are tapped. In addition, the lower pole is tapped on the type CWC relay.

The electromagnets are 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.

PHASE SHIFTER NETWORK

The phase shifter network of the type CWP relay consists of a capacitor and resistor connected in series with the lower pole circuit.

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 attacted 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, inaddition 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

SUPERSEDES I.L. 41-242.4C
*Denotes change from superseded issue.

EFFECTIVE NOVEMBER 1967

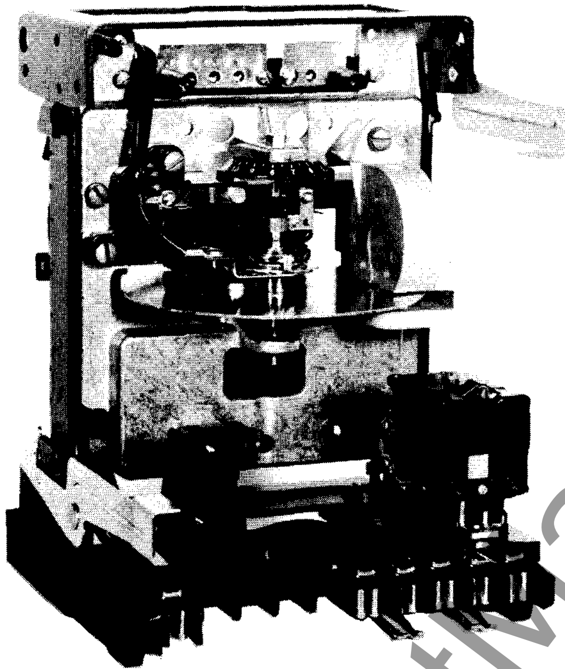


Fig. 1. Type CWC Relay (front view)

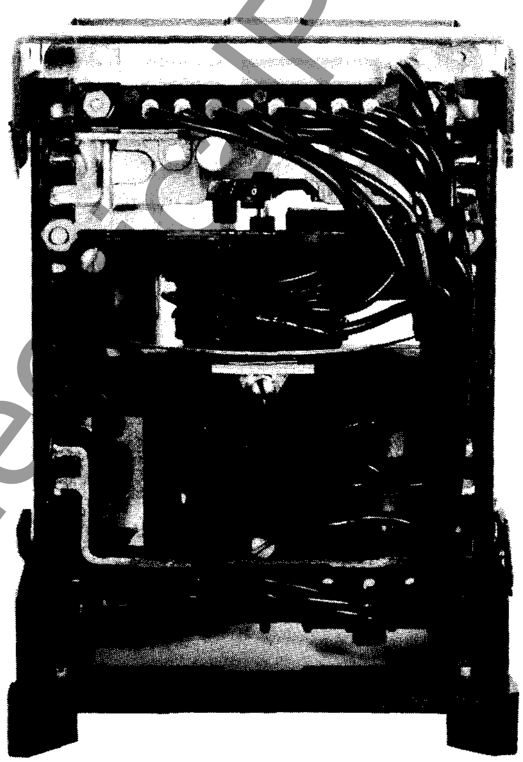


Fig. 2. Type CWC Relay (rear view)

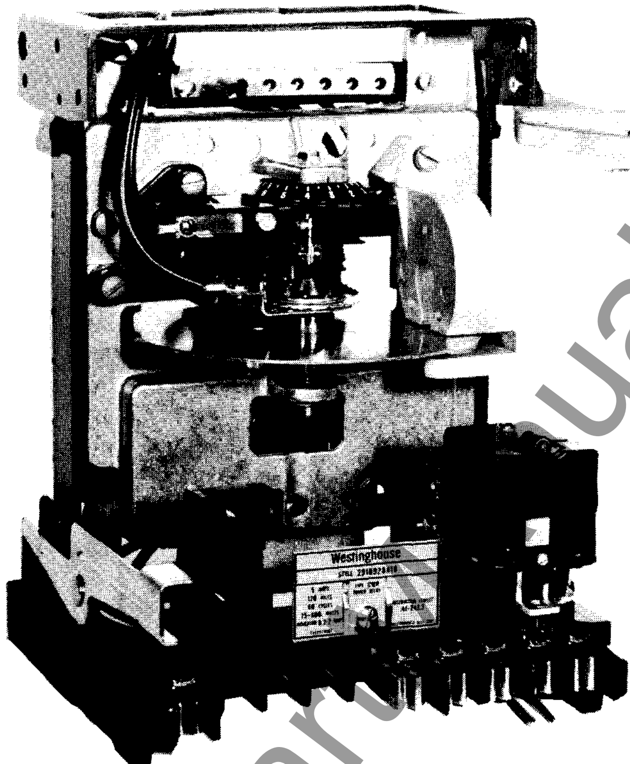


Fig. 3. Type CWP Relay (front view)

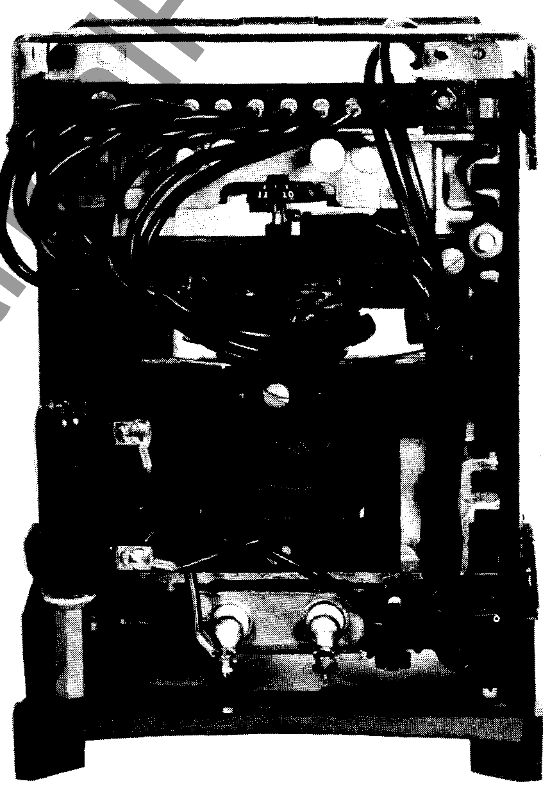


Fig. 4. Type CWP Relay (rear view)

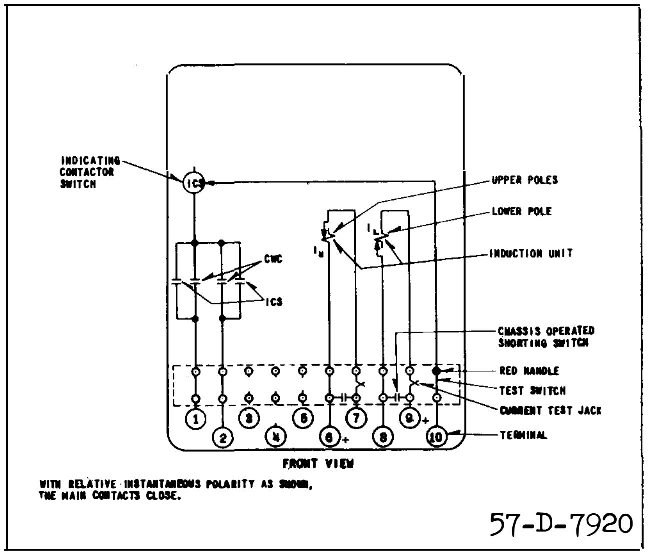


Fig. 5. Internal Schematic of Double Trip Type CWC Relay in the Type FT-21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

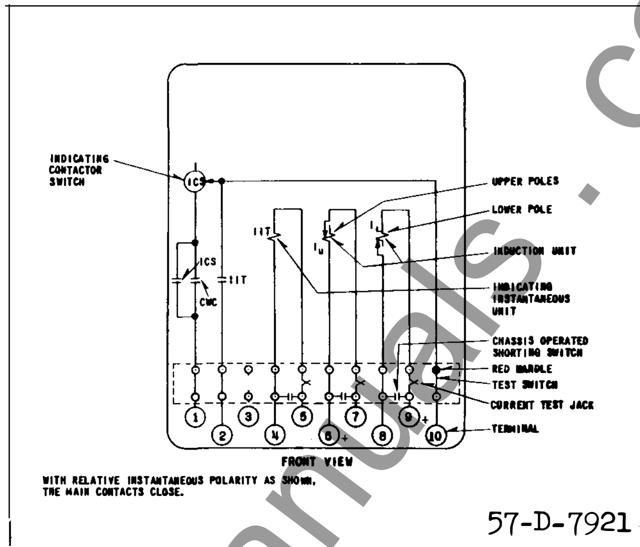


Fig. 6. Internal Schematic of the Type CWC Relay with Indicating Instantaneous Trip Unit in the Type FT-21 Case.

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. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

OPERATION AND CHARACTERISTICS

The operating torque for the CWC relay is obtained by energizing the lower pole coil with residual current (usually obtained from the line current transformer) and the 2 tapped upper pole coils with residual current from the current transformer in the power bank neutral. For the CWP relay the operating torque is obtained by energizing the upper pole coils with residual current (usually obtained from the line current transformer) and the lower pole with residual voltage.

TYPE CWC RELAY

The type CWC relay has two taps on the upper pole and four on the lower pole. They are marked in product which is the minimum pickup product of two equal or unequal currents.

Type CWC Relay Ranges and taps are:

.25 to 4 Product Range

Product	.25	.36	.64	1.0	1.44	2.66	4.0

2.25 to 36 Product Range

Product	2.25	4.0	6.25	9.0	16.0	25.0	36.0

The first four values are marked on the lower pole tap plate. The upper pole tap plate is marked x 1 and x 4 Product. The last four values are obtained by using the x 4 tap with the four lower pole taps.

Typical 60 Cycle time-product curves for the type CWC relay are shown in Fig. 9. These curves are taken at maximum torque which occurs with the currents in phase. For residual and Ground currents out of phase the relay operating time may be obtained by determining the operating time corresponding to the product $P' = P \cos \theta$, where P is the actual relay product in amperes squared, and θ is the angle between the residual and polarizing currents.

The limits for which these curves are accurate within ± 7% are shown in Fig. 10.

TYPE CWP RELAY

The type CWP relay taps are on the upper pole

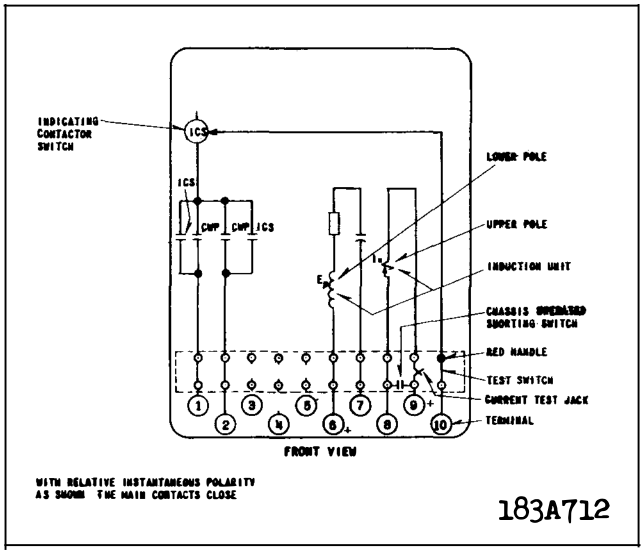


Fig. 7. Internal Schematic of the Type CWP Relay in the Type FT-21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

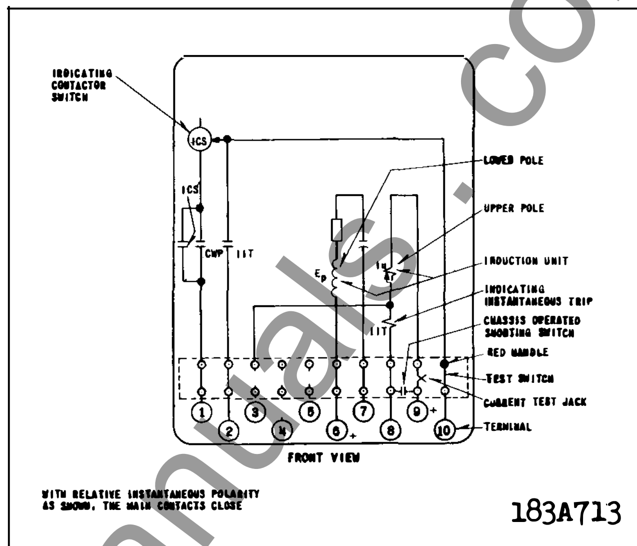


Fig. 8. Internal Schematic of the Type CWP Relay with Indicating Instantaneous Trip Unit in the Type FT21 Case.

current coil. They represent the minimum pickup product of current times voltage at maximum torque when the current lags the voltage by 60°. The range and taps are:

Product Range	Tap Markings						
20 - 150	20	30	40	50	75	100	150
75 - 600	75	100	150	200	300	400	600

Typical 60 cycle time product curves for the type CWP relay are shown in Fig. 11. These curves are taken at maximum torque which occurs with the current lagging the voltage 60°. For currents not lagging by this angle, the relay tripping time may be obtained by determining the operating time corresponding to the product $p' = P \cos (60° - \theta)$, where P is the actual relay V.A. product and θ is the angle the current lags the voltage. The curves are accurate within ± 7% if the multiple of tap product does not exceed the voltage on the relay coil.

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

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

SETTING

CWC INDUCTION UNIT

Select the desired upper and lower pole taps. Set the time dial by applying a preselected current to the relay coils, and adjusting the dial position to obtain the desired time of operation. Alternatively the dial may be set by inspection, if the timing coordination is not critical.

CWP INDUCTION UNIT

Select the desired upper pole tap. Set the dial position by applying a preselected voltage and current (current lagging voltage by 60° - see Fig. 16 to the

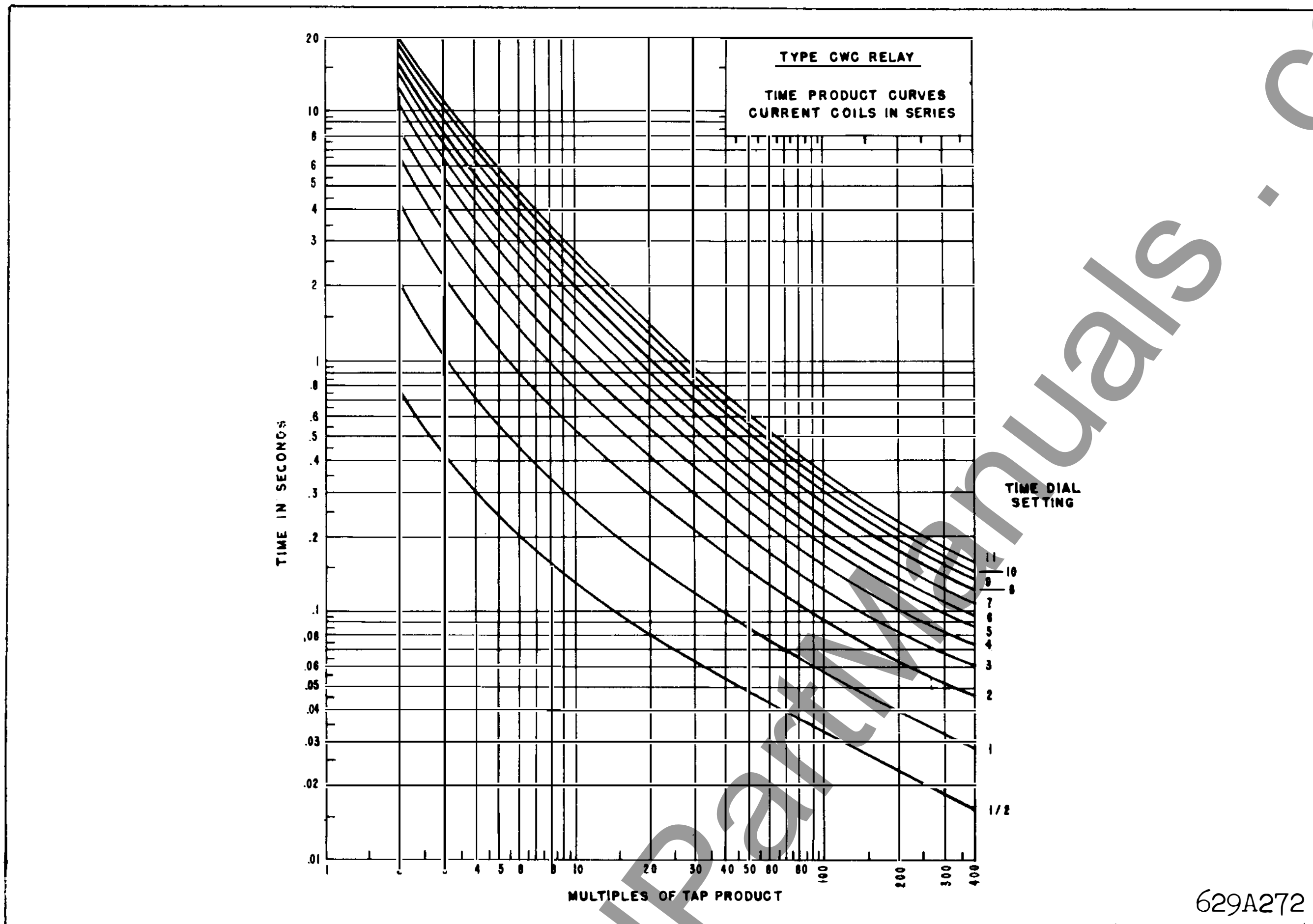


Fig. 9. Typical Time Curves of the Type CWC Relay – Current Coils in Series – See Fig. 10 for application limits.

relay coils and adjusting the dial position to obtained the desired time of operation. Alternatively the dial may be set by inspection, if the timing coordination is not critical.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 or 250 volt d-c type WL relay switch, or equivalent, use the 0.2 ampere tap; for 48 volt d-c applications set relay in 2 tap and use S#304C209G01 Type WL Relay or equivalent.

INDICATING INSTANTANEOUS TRIP (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of the pickup current desired.

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

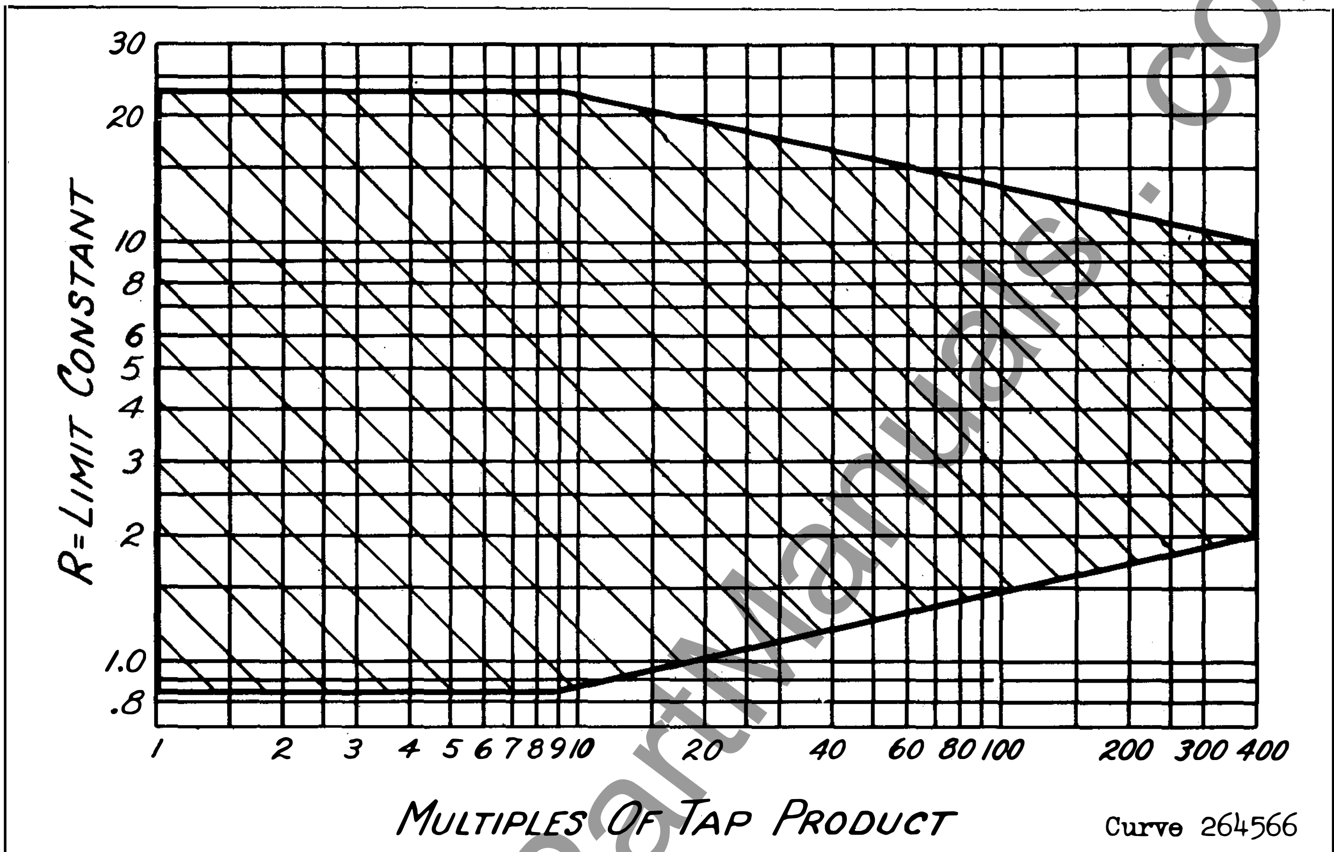
SETTING CALCULATIONS

The following information is required to set these relays:

1. The maximum and minimum ground fault current for faults at the relay and at the remote bus. These values should be residual current which is three times the zero sequence current.

2. The maximum and minimum polarizing current or voltage values for the faults above. The values should be residual currents or voltage which are three times the zero sequence values.

3. The current transformer ratios of the main and polarizing current transformers for the type CWC relay applications or the main current transformer ratio and the polarizing potential transformer ratio for the type CWP relay application.



<u>For the 0.25 to 4 Product Range</u>

$$R = M\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
M = value from the table below for various tap combinations.

<u>For the 2.25 to 36 Product Range</u>

$$R = N\frac{I_L}{I_U}$$

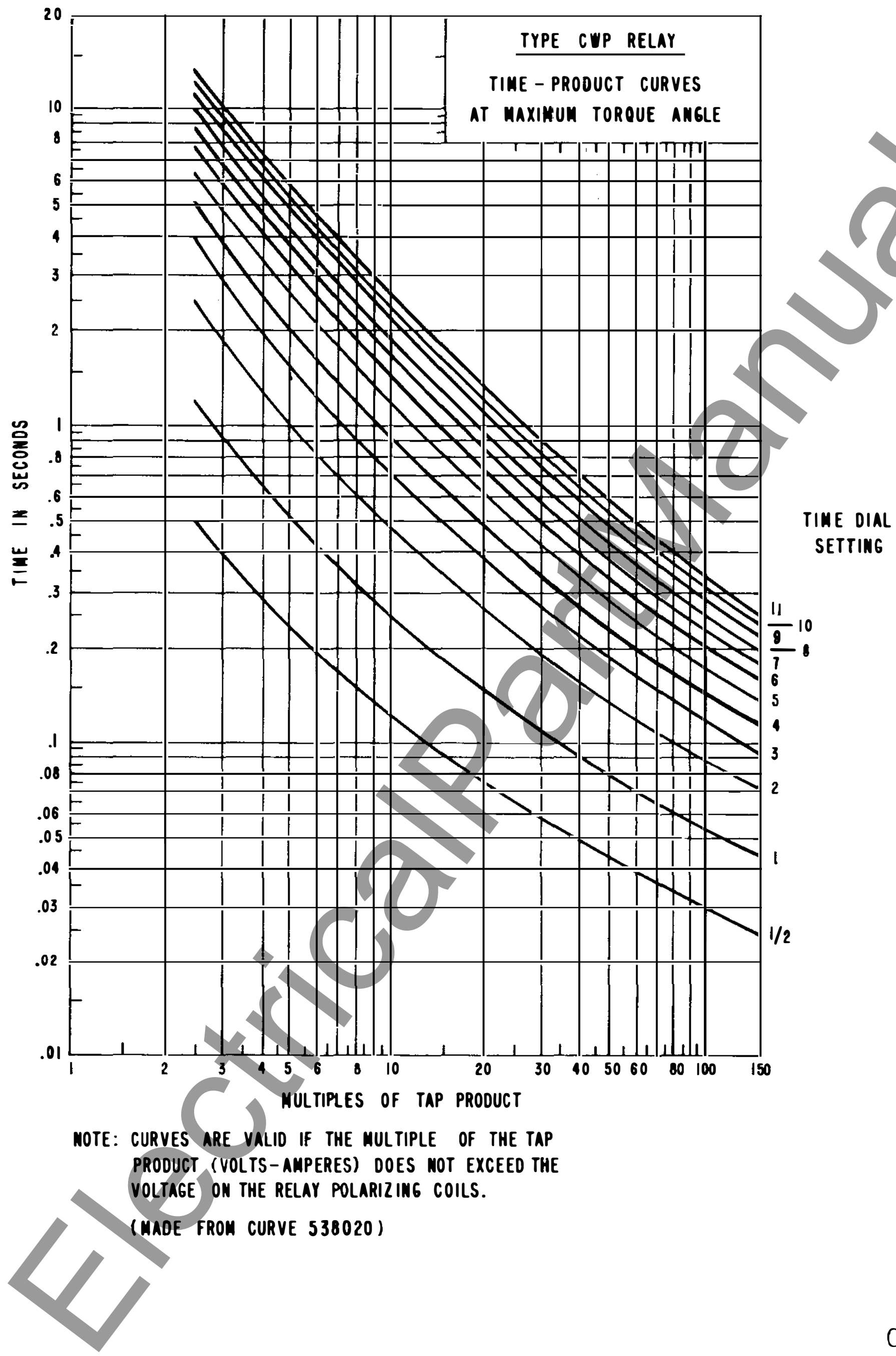
where I_L = the lower pole current.
I_U = the upper pole current.
N = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	M	K
.25	1	.25	4.0	10
.36	1	.36	2.78	12
.64	1	.64	1.56	16
1.0	1	1.0	1.0	20
1.0	4	.25	16.0	20
1.44	4	.36	11.1	24
2.56	4	.64	6.25	32
4	4	1.00	4.0	40

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	N	K
2.25	1	2.25	4.0	30
4.0	1	4.0	2.25	40
6.25	1	6.25	1.44	50
9.0	1	9.0	1.0	60
9.0	4	2.25	16.0	60
16.0	4	4.0	9.0	80
25.0	4	6.25	5.76	100
36.0	4	9.0	4.0	120

The Typical time curves for the Type CWC Relay apply if the values of R falls within the shaded area of the curve above, and if neither relay current is greater than K in amperes.

Fig. 10. Limits for Application of the CWC Time Curves.



These Curves are valid if the multiple of tap Product (volt-amperes) does not exceed the voltage on the relay polarizing coils.

Fig. 11. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply if the Multiple of Tap Product in Volt-Amperes Does Not Exceed the Polarizing Voltage in Volts.

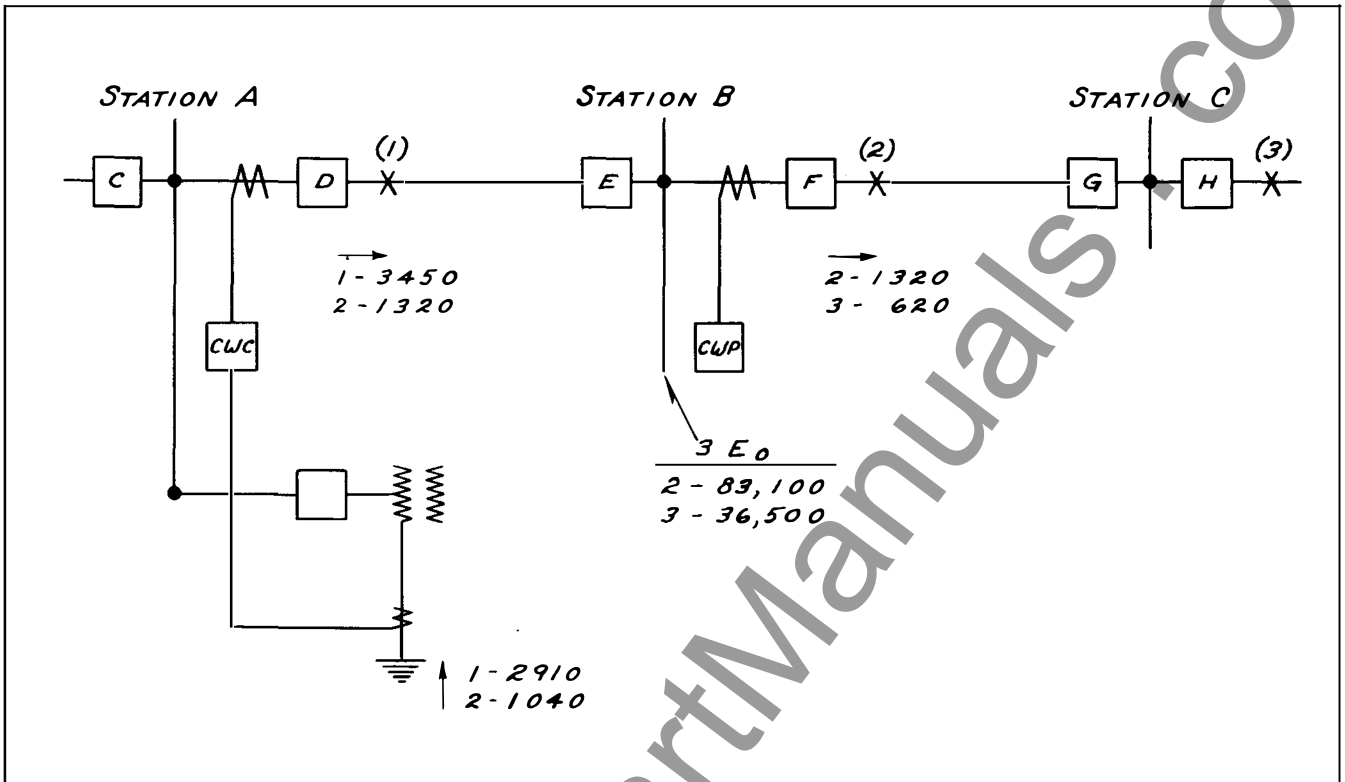


Fig. 12. Typical System for Setting Type CWC and CWP Relays.

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 range of 0.05 to 0.20 second as seen from the curves of Figs. 9 and 11.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 terminal. 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 difference between actual fault 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. *

As an example, a type CWC relay is to be connected at Station A and set to protect the line running to Station B. It must select or coordinate with the type CWP relay connected at Station B and set to protect the line running to Station C. The fault current and voltage for single line-to-ground faults under minimum conditions for this system are shown in Fig. 12.

In setting the type CWC and CWP relays, it is convenient to set up Table as shown.

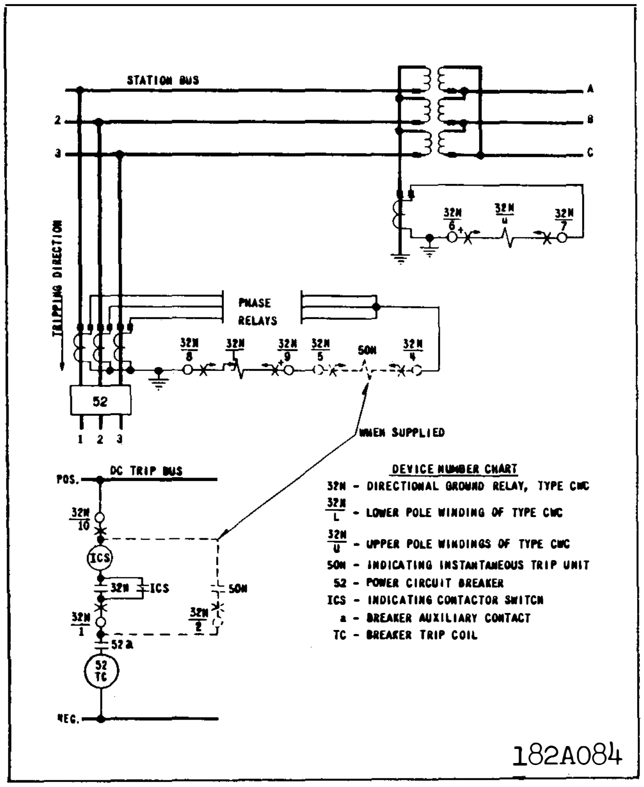


Fig. 13. External Schematic of the Type CWC Relay for Ground Protection.

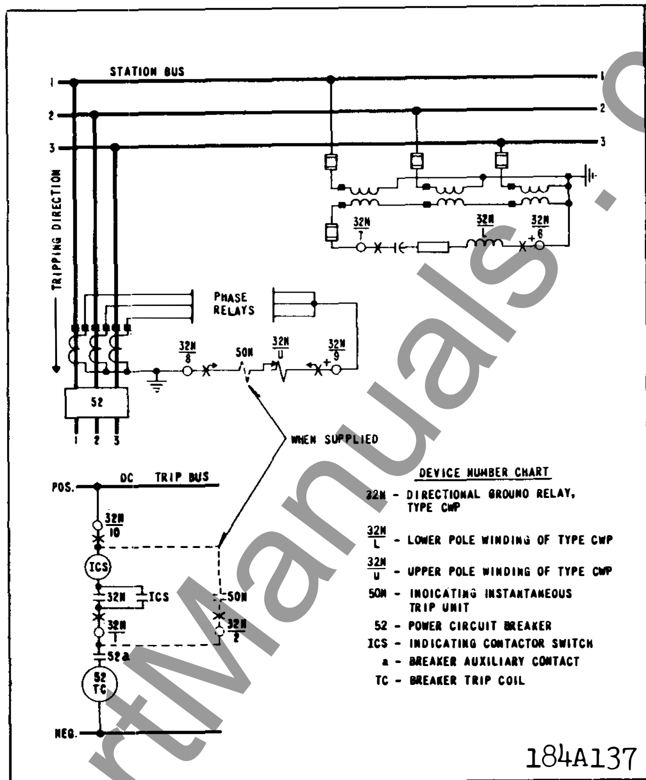


Fig. 14. External Schematic of the Type CWP Relay for Ground Protection.

TABLE 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Relay Location	• Fault No.	Line Primary Amps.	Line C.T. Ratio	Polarizing Primary Amps. or Volts	Polarizing C.T. or P.T. Ratio	Line Secondary Amps. (I_L)	Polarizing Secondary Amps. (I_U)	✱ Product $I_U \times I_L$	$\frac{I_L}{I_U}$	Tap	Multiples of Tap Product	R	Time Dial	Time In Seconds
D	1	3450	300/5	2910	300/5	57.5	48.5	2780	1.19	36	77	4.76	2	.11
D	2	1320		1040		22.0	17.3	381	1.27		10.6	5.1		.52
F	2	1320	100/5	83,100V	1000/1	66.0	83.1V	5485	-	300	18.3	-	¾	.13
F	3	620		36,500V		31.0	36.5V	1130	-		3.8	-		.53

The relay location is shown in Column 1 and the fault location in Column 2. The primary line residual current available for the relay is recorded in Column 3. The ratio of these current transformers is specified in Column 4.

The primary fault current or voltage available for the polarizing winding is shown in Column 5, and the associated current or potential transformer ratio in Column 6. All of these fault values are residual values or three times the zero sequence current of voltage. The relay current for the lower pole windings is the value of Column 3 divided by the ratio of Column 4. The value is recorded in Column 7. The upper pole relay current is the value of Column 5 divided by the ratio of Column 6, and is recorded in Column 8. The relay operating product is the values of Column 7 and 8 multiplied together and recorded in Column 9. For the type CWC relays, the ratio of $\frac{I_L}{I_U}$ is written in Column 10. All of this data is fixed by the system constants and characteristics, and is preliminary to making the actual relay setting.

The choice of a tap recorded in Column 11 and of the time lever in Column 14 is a matter of trial and

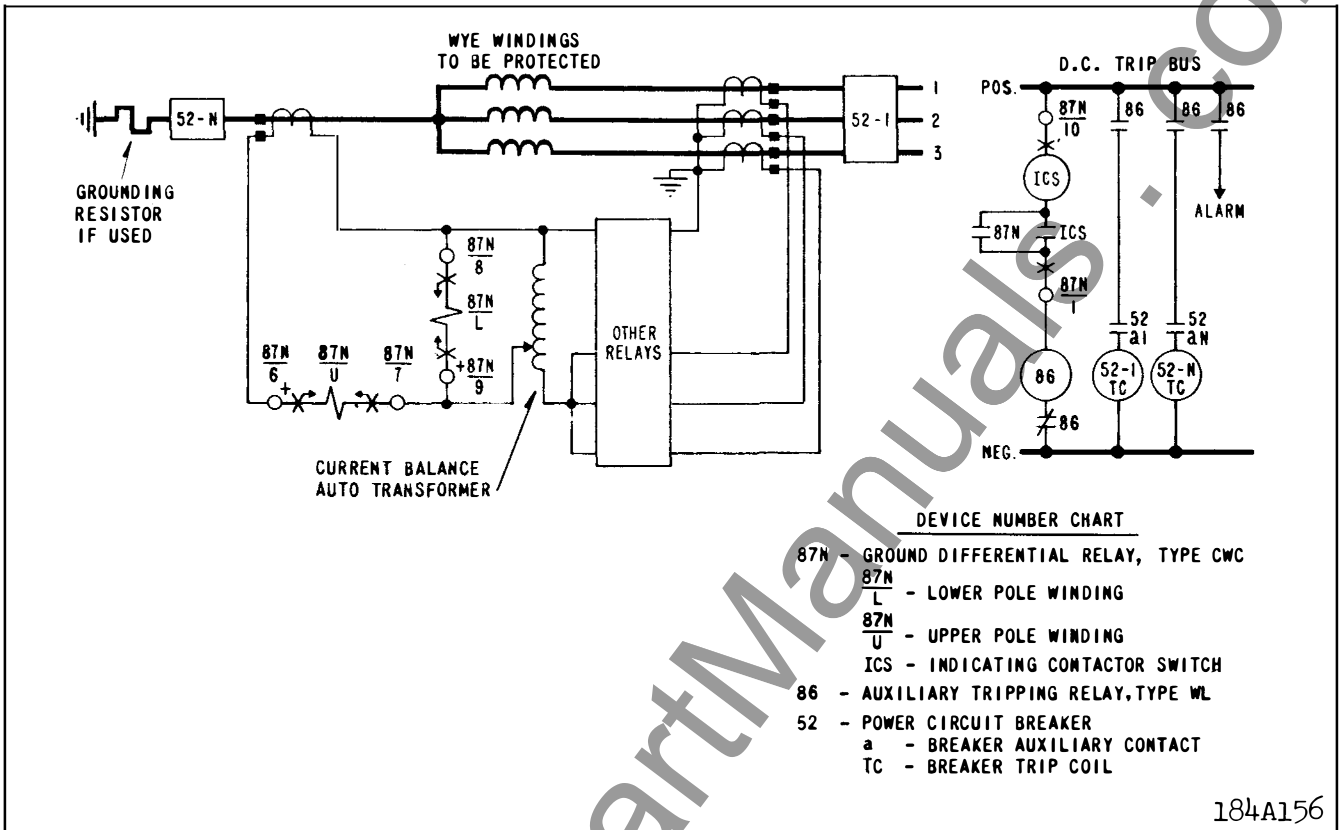


Fig. 15. External Schematic of the Type CW Relay for Ground Differential Protection of Wye or Zig-zag Winding of a Transformer or Rotating Machine.

error. The breakers on this system have 8 cycle operating time so that the coordinating time interval should be about .4 second. The tap should be chosen so that the relay times for the close-in fault and remote fault product values will differ by about the coordinating time interval or .4 second in this case. Practically this can be accomplished by several taps with equal results. Tap 36 was selected in this example. The product value divided by the tap is recorded in Column 12. This value is the abscissa of the time product relay curves. From these curves the lever Column 14 and relay operating time Column 15 were chosen so that the relay would operate at about .12 second for close-in faults and about .52 second for the remote faults. These times for the type CWC relay were obtained using time dial setting ¾. With the selection of a satisfactory tap value, the curves of Fig. 10 will quickly show if the combination of tap and current values provide relay operating times as indicated by the curve. The value of Column 10 multiplied by N = 4.0 for tap 36 gives the R values of Column 13. These are within the curve of Figure 10.

The same process is allowed in setting the type CWP relay at Station B on breaker F. Here tap 300 was selected with dial to provide relay operating times of 0.13 and 0.53 seconds respectively for close-in and remote faults. The operating limits using this tap are fulfilled since neither multiples of tap product value (Column 12) is greater than the polarizing voltage (Column 8).

After individual relay settings are made, it is necessary to check to see if the relays select properly with associated relays. In the example the coordinating time interval was 0.4 second. Therefore, for fault 2, the relay at D should not operate before the relay at F plus the coordinating time interval. In other words, the operating time of D should not be
* less than 0.13 second plus 0.4 = 0.53 second

Similarly, the time of the relay at breaker H should not be greater than 0.13 second in order to select with relay F for fault 3. If the time of relay H is greater, then the time of relay at F must be increased to provide proper selection. This change may

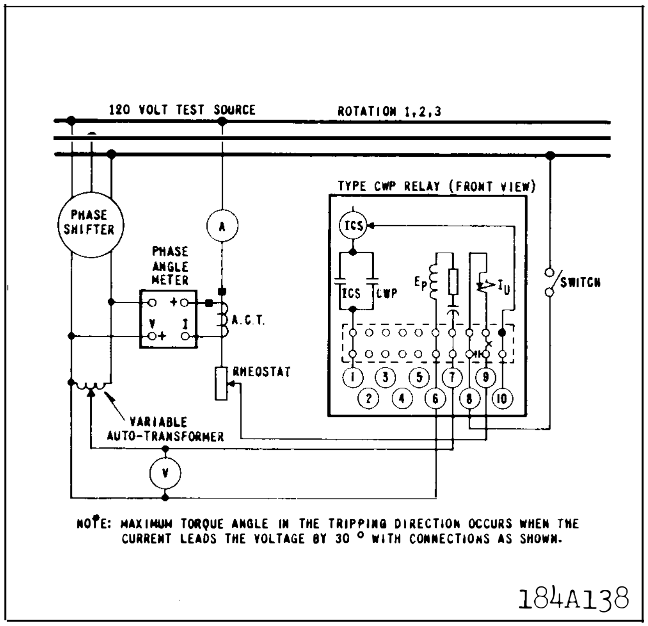


Fig. 16. Diagram of Test Connections for the Type CWP Relay in FT-21 Case.

be accomplished by a change in the time lever setting only, although often a new tap and lever setting may provide a more satisfactory setting. Changing the setting of relays at B probably will require a change in the setting of the relay at Station A.

After the setting 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 dial settings are required, particularly if the maximum and minimum fault values are quite different.

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

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

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.

Acceptance Check

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

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 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

For the CWC relay, connect the upper and lower pole coils in series and pass a current equal to $\sqrt{\text{tap product x multiplier}}$ in polarity thru both coils. For the CWP relay connect the relay as per Fig. 16 and apply tap value product. The moving contacts on both relays should close within 5% of the applied values.

3. Time Curve

CWC Relay — Connect the upper and lower poles in series and pass current in polarity thru both coils. Set the time dial on the 6 position and taps on .25 or 2.25 product and 1 multiplier. Check several points on the time curve. Timing should be within ±7% of that of Figure 9.

CWP Relay - Connect the relay per Figure 16. Set the time dial on the 6 position and the tap in the 20 or 75 product. Check several points on the time curve by applying current leading the voltage by 300°. The timing should be within ±7% of the values shown on Fig. 11.

4. 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 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 not be greater than the particular ICS tap setting being used. The operation indicator target should drop freely. The contact gap should be approximately 0.47" 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.

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.

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").

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 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

Type CWC Relay - Connect the upper and lower pole coils in series and pass current in polarity on both coils. With one tap screw in the 1 multiplier position and the other screw in the .25 product tap for the .25-4 product range or the 2.25 product tap for the 2.25 – 36 product range, apply current and adjust the spring tension so that the contacts just close at tap value product.

Type CWP Relay - Connect the relay per Fig. 16. Set in the lowest tap, apply 100 volts across terminals 6 and 7, and apply minimum pickup current, leading the voltage by 300°, (0.20 amperes for the 20-150 range, 0.75 amperes for the 75-600 range.) Then, adjust the spring tension so that the contacts just close.

3. Time Curve Calibration

Type CWC relay — Set the time dial to position 6 and the product tap to .25 or 2.25. Set the multiplier tap to 1. Connect the upper and lower pole coils in series and pass a current equal to $4 \times \sqrt{\text{tap product}}$ in polarity thru the coils. Adjust the permanent magnet keeper until the operating time is between .95 and 1.01 seconds. Other points on the time curve of Figure 9 should be within ± 7% of the values shown. (The multipliers of tap product shown in Figure 9 equal the square of the current passed thru the coils divided by the tap product.)

Type CWP Relay - Connect the relay per the test circuit of Fig. 16. Set the 6 time dial and the lowest tap. Apply 100 volts to potential coil and 10 times tap current. (Current leading voltage by 300°). relay operate between 1.43 and 1.51 seconds. Other points of the time curve should be within ± 7% of the value shown on Fig. 11.

4. Indicating Contactor Switch (ICS)

Close the main relay contacts and pass suf-

ficient 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 operation indicator target should drop freely.

5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pickup current desired.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

CWC

The burden of the Type CWC relays at 5 amperes, 60 cycles is as follows:

Lower Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
.25-4	.25	82.7	29.3	88.0	19.5
	.36	57.3	14.1	59.0	13.8
	.64	32.1	4.43	32.4	7.85
2.25-36	1.00	20.6	1.83	20.7	5.10
	2.25	8.50	3.26	9.1	21.0
	4.0	4.78	1.03	4.89	12.1
	6.25	3.01	0.41	3.04	7.7
	9.0	2.13	0.21	2.14	5.5

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
.25-4	1	6.08	8.58	10.5	55
	4	1.52	0.54	1.61	20
2.25-36	1	0.79	0.95	1.24	50
	4	0.20	0.06	0.21	17

CWP

The burden of the Type CWC relays at 5 amperes, 115 volts, 60 cycles is as follows:

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
75-600	75	0.633	0.144	0.660	12.6
	100	0.557	0.095	0.560	9.8
	150	0.494	0.043	0.495	5.0
	200	0.460	0.032	0.460	4.0
	300	0.370	0.013	0.370	2.0
	400	0.340	0.006	0.340	1.0
	600	0.290		0.290	0.5
20-150	20	4.70	2.66	5.4	29.5
	30	3.23	1.21	3.45	20.5
	40	2.93	0.87	3.05	16.5
	50	2.31	0.57	2.38	14.0
	75	1.50	0.28	1.52	10.7
	100	1.15	0.11	1.15	5.5
	150	0.80	0.014	0.80	1.0

Lower Pole Potential Windings
(between relay terminals 6 and 7)

	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lead
All ranges -	5.5	2.78	6.15	26.8

CWC & CWP THERMAL RATINGS

Relay	Range	Pole Winding	Continuous Amperes	1 Sec Amperes
CWC	.25-4	All	4	110
CWC	2.25-36	Upper	10	280
		Lower	12.7	370
CWP	20-150	Upper	3.2	88
	75-600	Upper	6.4	185

The potential coil circuit of the type CWP relay will stand 250 volts for 15 seconds.

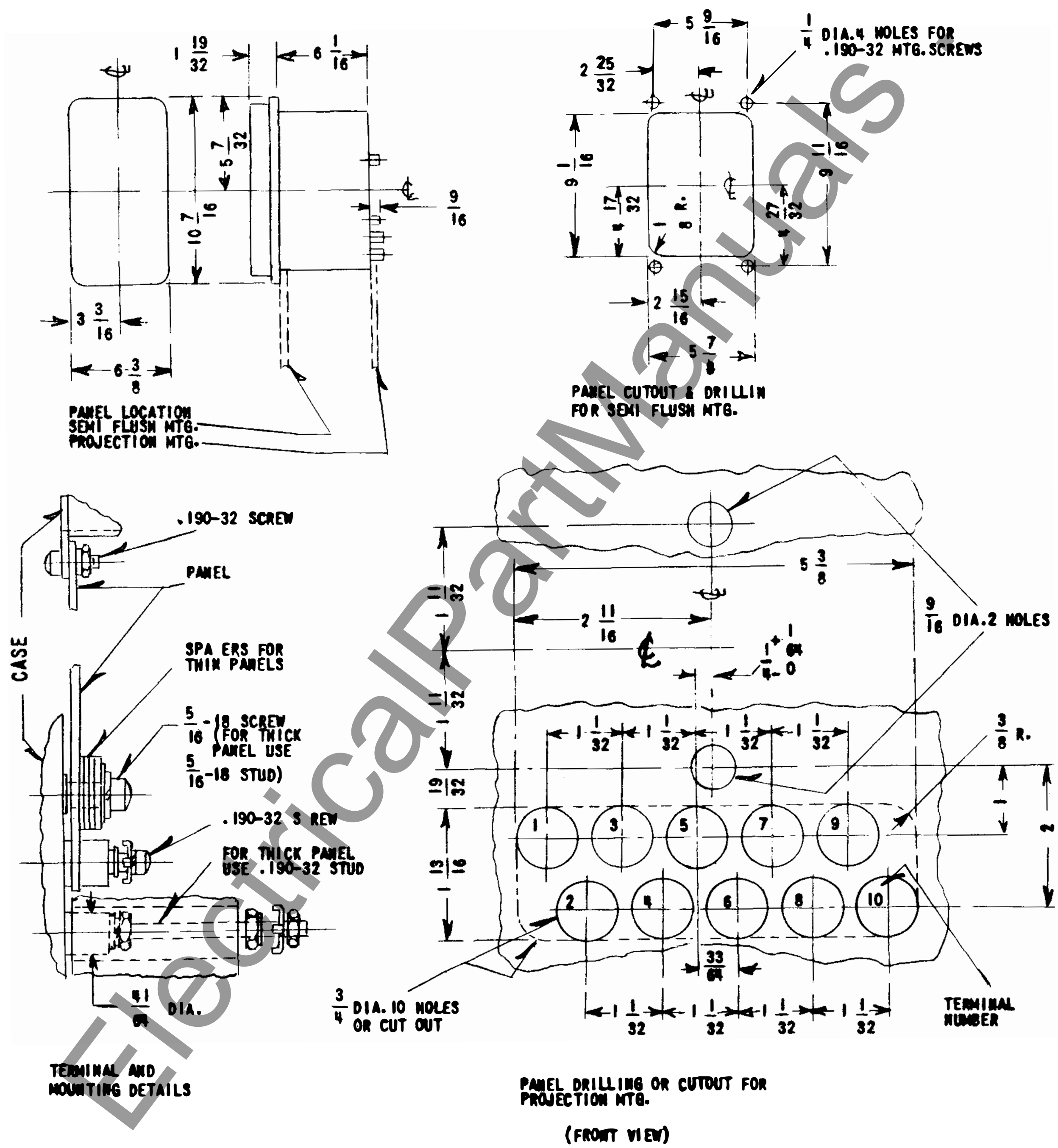


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Fig. 17. Outline & Drilling Plan for the Type CWC and CWP Relays in the Type FT-21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWP-1
SENSITIVE DIRECTIONAL GROUND 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

The type CWP-1 relay is an induction disc type relay used for directional ground fault protection on high-resistance grounded power systems. It is similar to the type CWP relay except that the relay has a higher sensitivity and has maximum torque when the residual current and voltage are in phase.

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 transforms or with a neutral resistor, in conjunction with a distribution transformer. An alternative arrangement is shown in Fig. 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 Fig. 6 to energize the CWP-1 current coil. With this arrangement all three conductors are passed through the opening: thus avoiding the problem of false residued currents 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 currents values permit a higher current pickup, three residually connected CT's may be used.

CONSTRUCTION AND OPERATION

The Type CWP-1 relay consists of an induction disc type unit, an indicating contactor switch, and an external current transformer.

Induction Disc Unit

The induction disc unit contains a thin four-inch diameter disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The element is not geared. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf-spring. This spring is fastened to a molded block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the molded block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in front. The operating torque is obtained by energizing the lower pole with residual voltage and the upper poles with residual current.

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 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.

External Current Transformer

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

CHARACTERISTICS

The Type CWP-1 relay taps are on the external current transformer supplied with the relay and not on the relay itself. The taps are as follows:

0.5 — 0.7 — 1.0 — 1.4 — 2.0 — 2.8 — 4.0

The tap value represents the minimum pick up product of residual current times residual voltage at maximum torque (unity power factor).

Typical time-product curves are shown in Figs. 3 & 4 with 100 volts across the potential coil. Fig. 5 shows time data with a potential 50 and 200 volts for comparative purposes. These curves were taken at maximum torque; that is, with current and voltage in phase. For currents not in phase with the voltage, the approximate relay operating times is: $t_\theta = \frac{t_0}{\cos\theta}$; where t_0 is the tripping time for unity power factor and θ is the angle by which the residual current actually lags the residual voltage.

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 contactor switch has two taps that provide a pickup setting of 0.2 or 2 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.

Trip Circuit Constants

Indicating Contactor Switch —

0.2 ampere tap — 6.5 ohms d-c resistance
2.0 ampere tap — 0.15 ohms d-c resistance

Burden and Thermal Ratings

Current Circuit Burden

TAP	Power Factor Angle — Lag 60 Cycles	Power Factor Angle — Lag 50 Cycles	Volt-Amperes at Tap Value Current (100 Volts Applied to Potential Coil) 60 Cycles	Volt-Amperes at Tap Value Current (100 Volts Applied to Potential Coil) 50 Cycles
.5	23.0°	27.2°	0.0028	0.0021
.7	23.0	21.8	0.0030	0.0023
1.0	21.5	17.1	0.0034	0.0027
1.4	17.5	14.6	0.0039	0.0032
2.0	15.0	10.0	0.0048	0.0041
2.8	12.0	7.0	0.0058	0.0051
4.0	9.0	3.8	0.0074	0.0067

Voltage Circuit Burden

Volt-Amperes 110 Volts 60 Cycles	Volt-Amperes 110 Volts 50 Cycles	Power Factor Angle-Lag 60 Cycles	Power Factor Angle-Lag 50 Cycles
7.0	9.9 ◆	81°	80°

Thermal Ratings

	60 Cycles	50 Cycles
Continuous Current	0.3 amp.	0.3 amp.
Continuous Voltage	250 volts	175 volts

SETTINGS

The relay operates on the product of residual fault current and voltage. This product divided by the proper current and potential transformer ratio and by one of the transformer tap values is expressed as a multiple of the tap. The time curves of Figs. 3 & 4 give the relay operating time for various lever settings as a

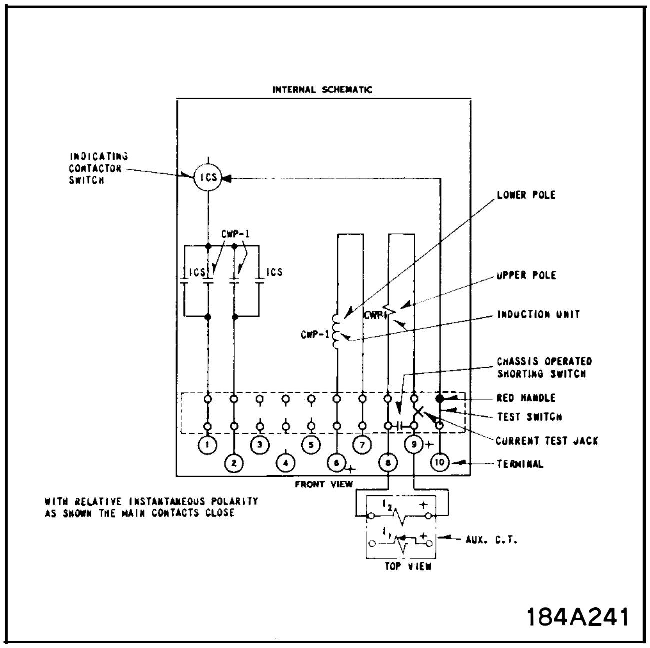

Fig. 1. Internal Schematic of the Double Trip Type CWP-1 Relay, FT21 Case. (Single Trip Relays Have Terminal 2 and Associated Circuits Omitted).

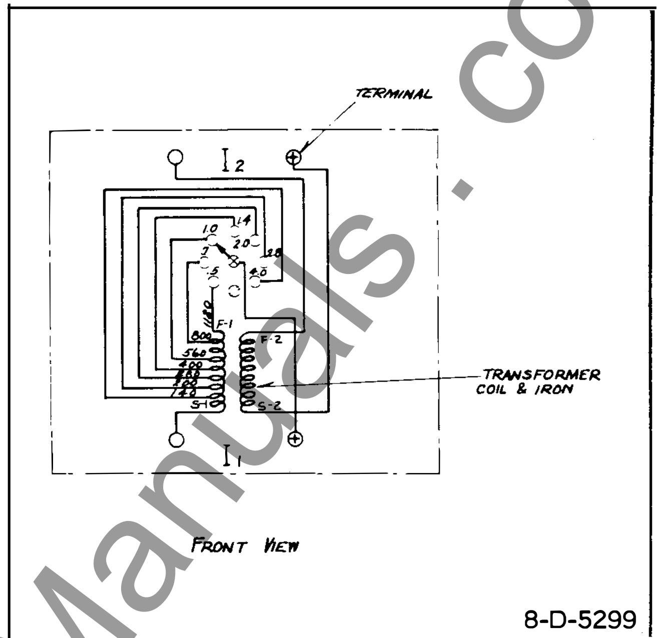

Fig. 2. Internal Connections of the External Auxiliary Current Transformer.

function of this multiple. Fig. 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 may 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 Figs. 3, 4 and 5.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 shave 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.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 volt or 250 volt d.c. type WL relay switch, or equivalent, use the 0.2 ampere tap. For 48 volt d.c. applications set ICS in 2 ampere tap and use S#304C 209G01 type WL relay or equivalent.

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

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

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the 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.

Acceptance Check

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

1. Set the contacts in the #10 time lever position and the tap plug in the 0.5 tap. Connect the auxiliary CT as shown in Fig. 6. Energize the the potential coil with 100 volts and the external auxiliary CT with sufficient current to just close the contacts. (The current in polarity on the auxiliary CT should be in phase with the voltage drop from relay terminal 6 to terminal 7.) The pickup current should be 0.005 amperes ± 3%.

2. With 100 volts potential, energize the auxiliary CT at the following current levels to check relay timing:

Current	Multiple of Tap Product	Time-seconds 60 Cycles	50 Cycles
0.025	5	3.55 ± 10%	4.00 ± 10%
0.100	20	0.94 ± 5%	1.00 ± 5%
0.500	100	0.33 ± 10%	0.35 ± 10%

3. To check the zero torque line, adjust the input current to the auxiliary current transformer 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 90° (or 270°) ± 7°.

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 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.

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 paragraph 1 under "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.

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 until it is apparent that the relay is not in proper working order (See **"Acceptance Check"**).

Induction Unit

The upper bearing screw should be screwed down until there is only 3 to 5 thousandths inch clearance between it and the shaft and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the disc fails to turn freely and then backing up a fraction of a turn. Great care must be taken in making this adjustment to prevent damage to the bearings.

Adjust the contacts to just barely touch when the time lever is set on zero by shifting the position of the contact stop on the time lever. This should be done with approximately the required contact follow. Final adjustment of the contacts can be more easily made by the contact follow set screw after the contact stop is securely fixed.

A maximum contact follow of approximately 5/64 inch is obtained when the set screw on the stationary contact is all the way out. Where rigid contacts for quick reopening are required, the set screw should be all the way in to hold the stationary contact against the Micarta bracket. Readjust the zero setting after this is done.

Connect 115 volts across the relay potential coil. Apply approximately 5 times the minimum pick-up current (tap value divided by 115) through the auxiliary transformer primary with the polarity and relay connections as shown in Fig. 6 and see that zero torque occurs when the current and voltage are 90° out of phase within $\pm 4^{\circ}$. There should be no spring tension on the relay for this test.

With the connections above apply 100 volts, and current in phase. 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 screw driver 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 0.94 seconds (1.00 seconds for 50 cycle relay) in the 0.5 VA tap, with a potential of 100 volts. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked. The position of the permanent magnet over the disc will affect the timing and shape of the curves.

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 simultaneously.

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.

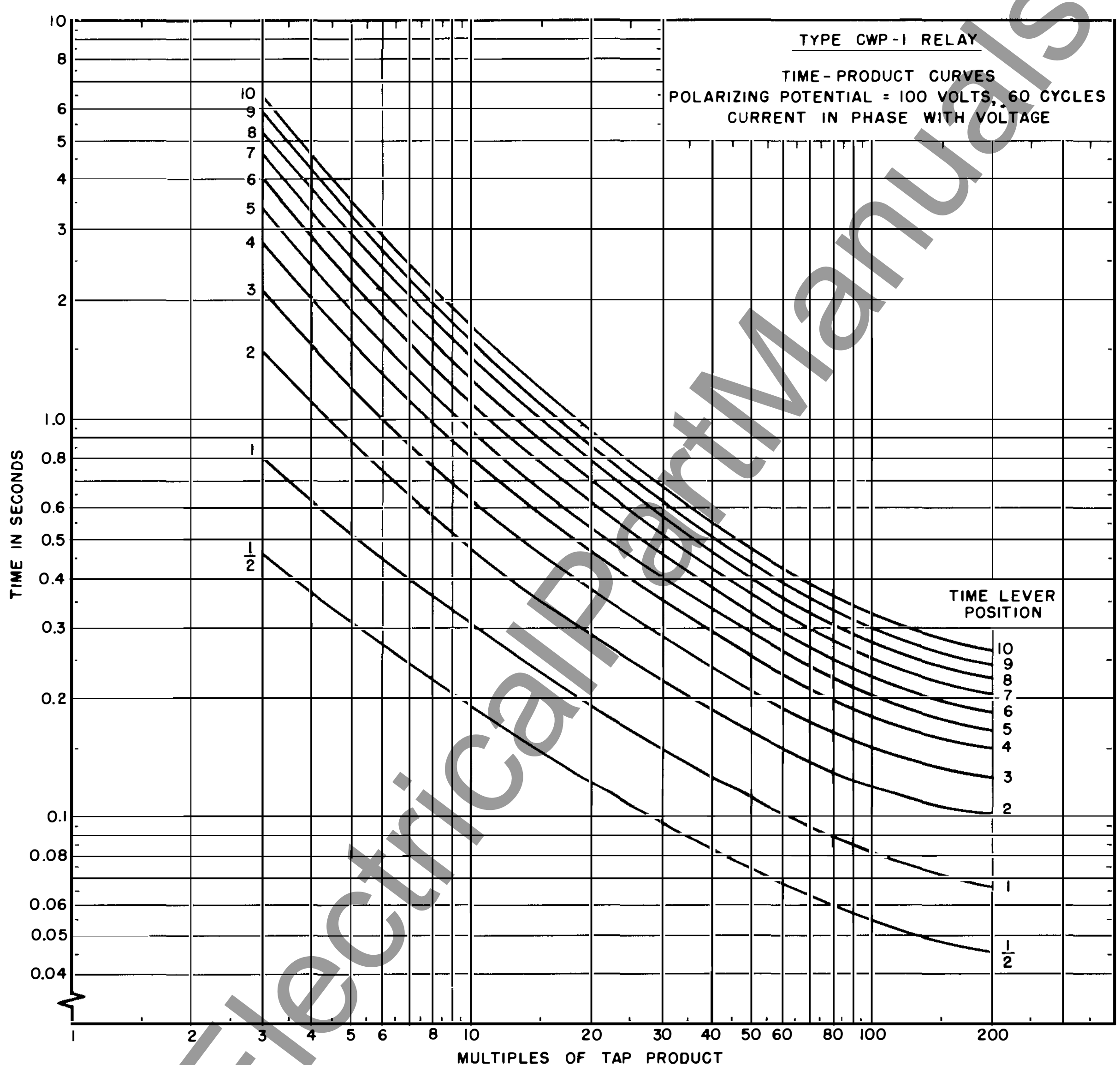

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Fig. 3. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque-100 Volts, 60 cycles Across Potential Coil.

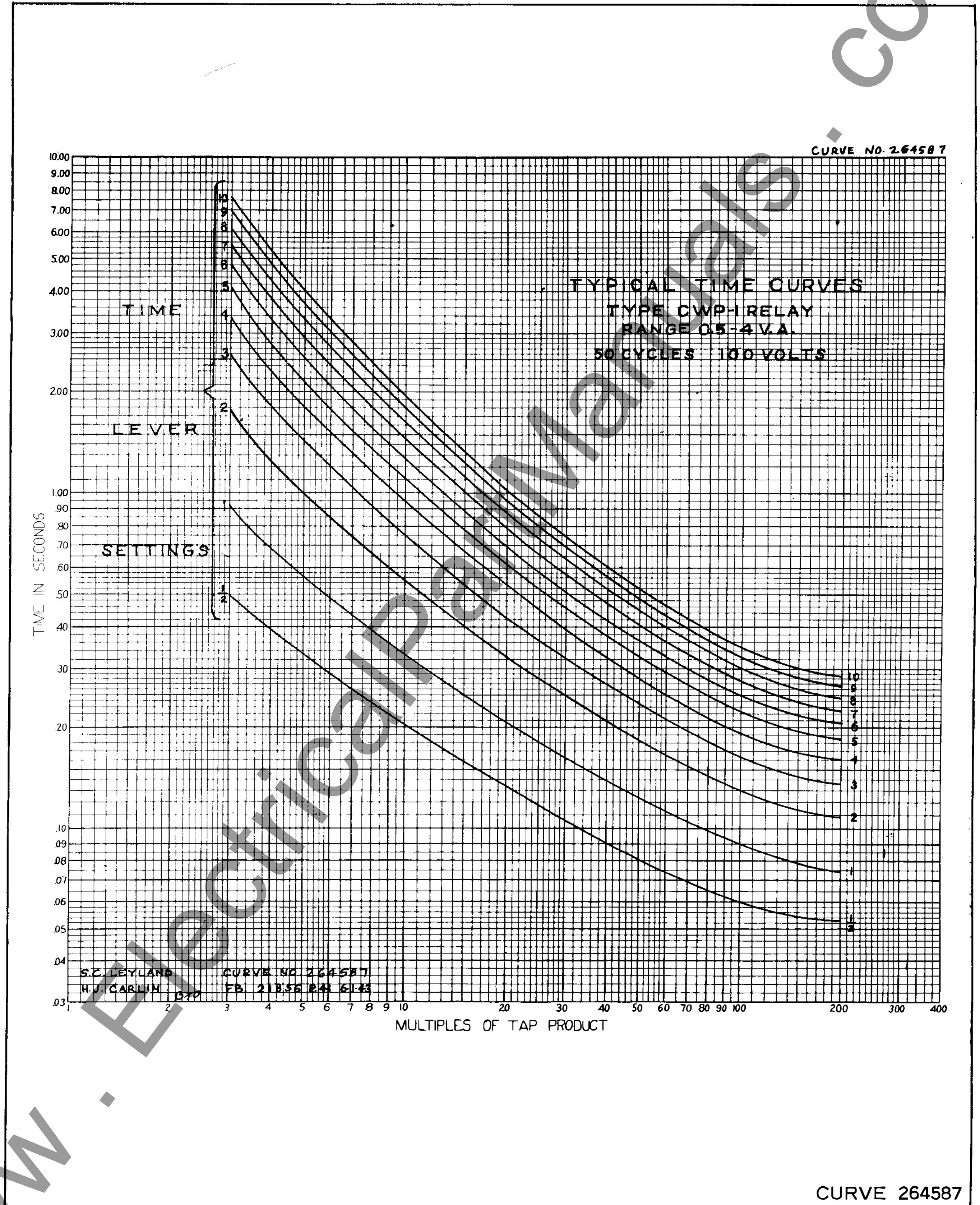


Fig. 4. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque-100 Volts, 50 cycles Across Potential Coil.

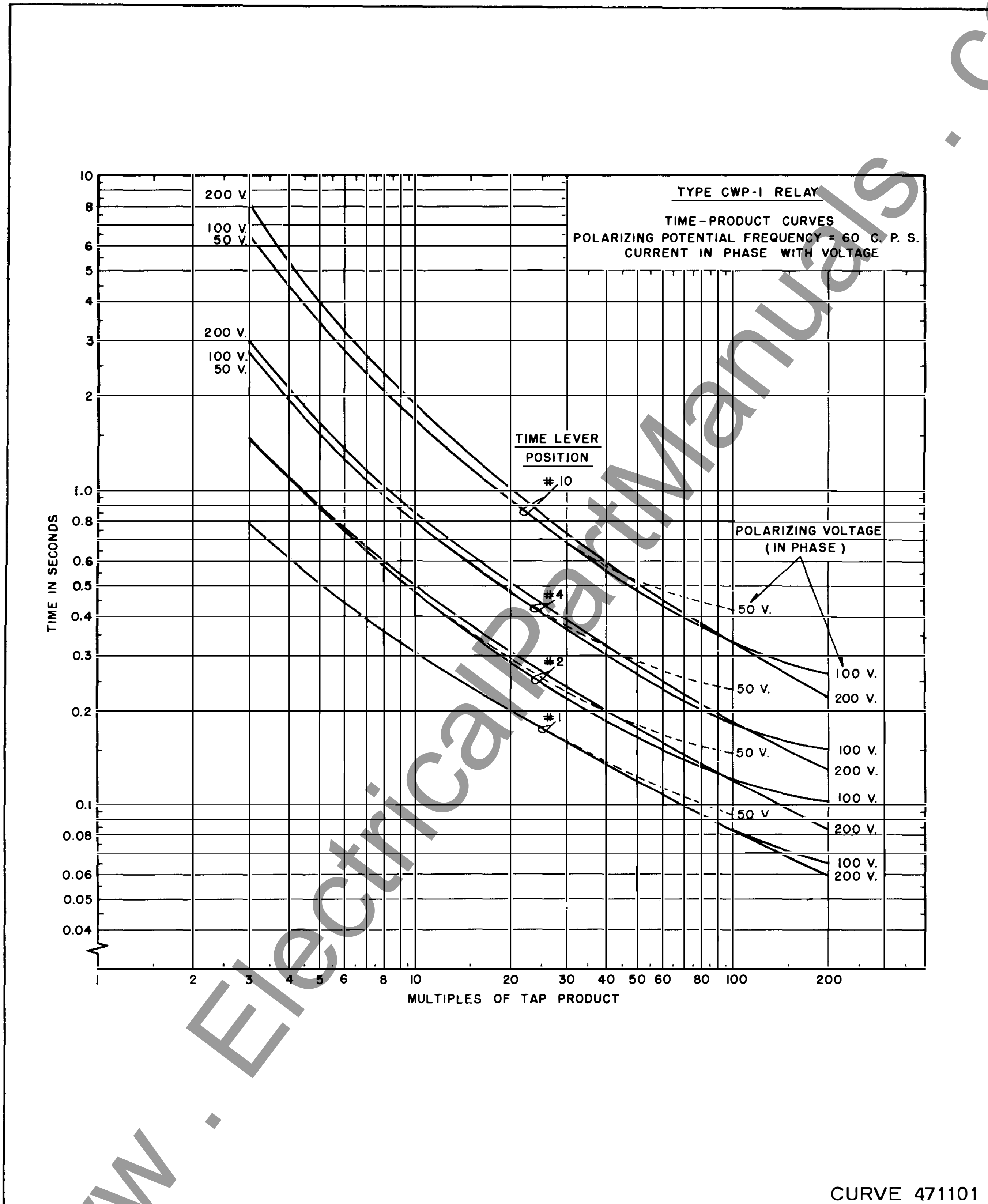


Fig. 5. Representative Time-Product Curves, Showing the Effect of Variations of Potential Coil Voltage — Maximum Torque Angle, 60 cycles.

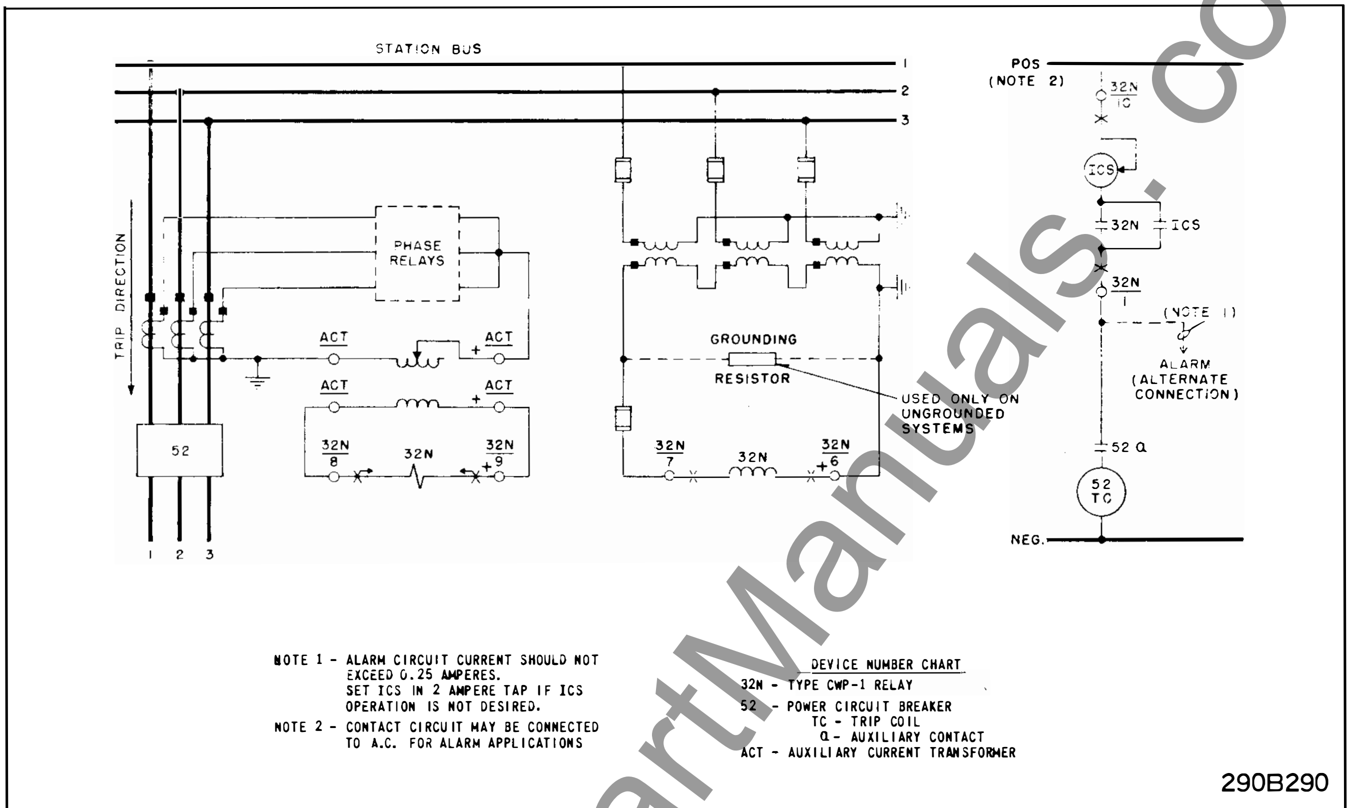


Fig. 6. External Schematic of the Type CWP-1 Relay in FT-21 Case.

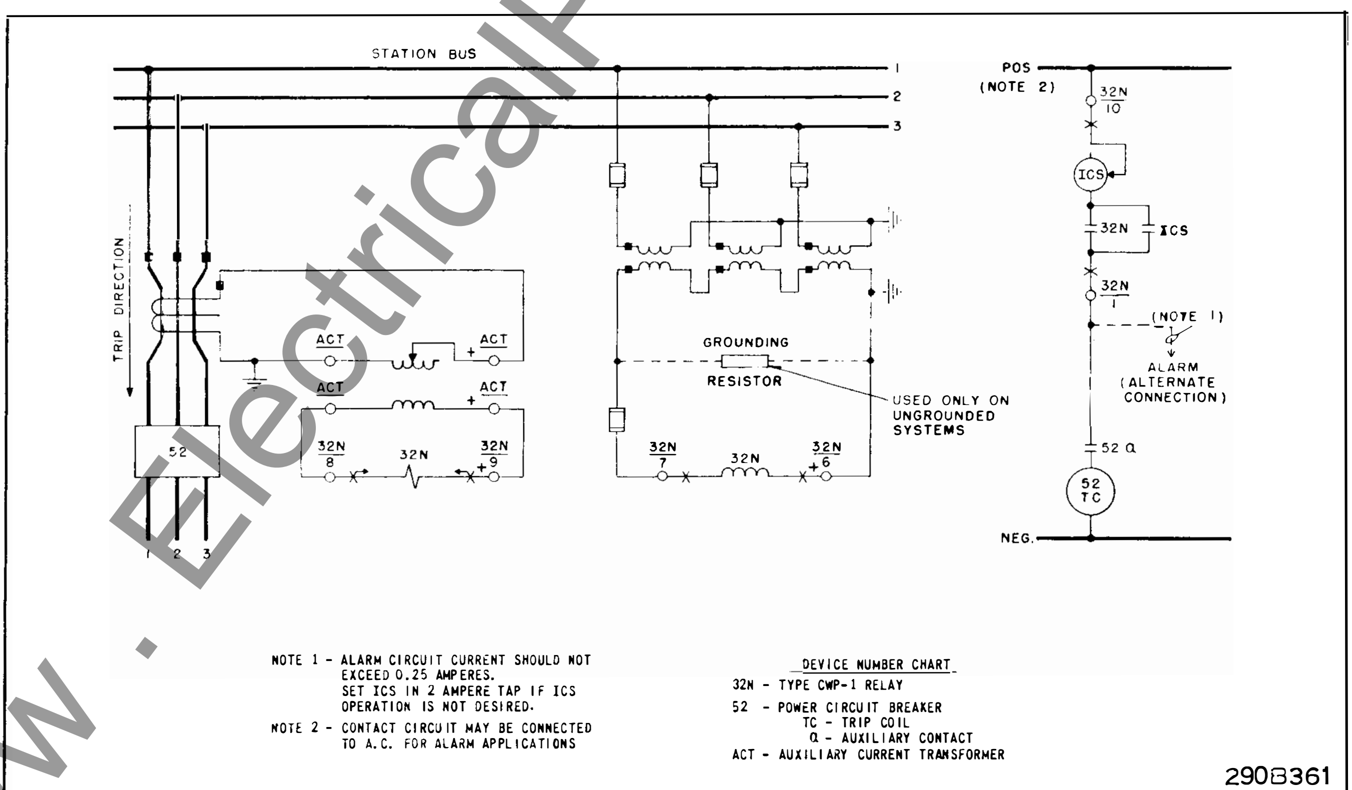


Fig. 7. External Schematic of the Type CWP-1 Relay in FT-21 Case, Using Window Type C.T.

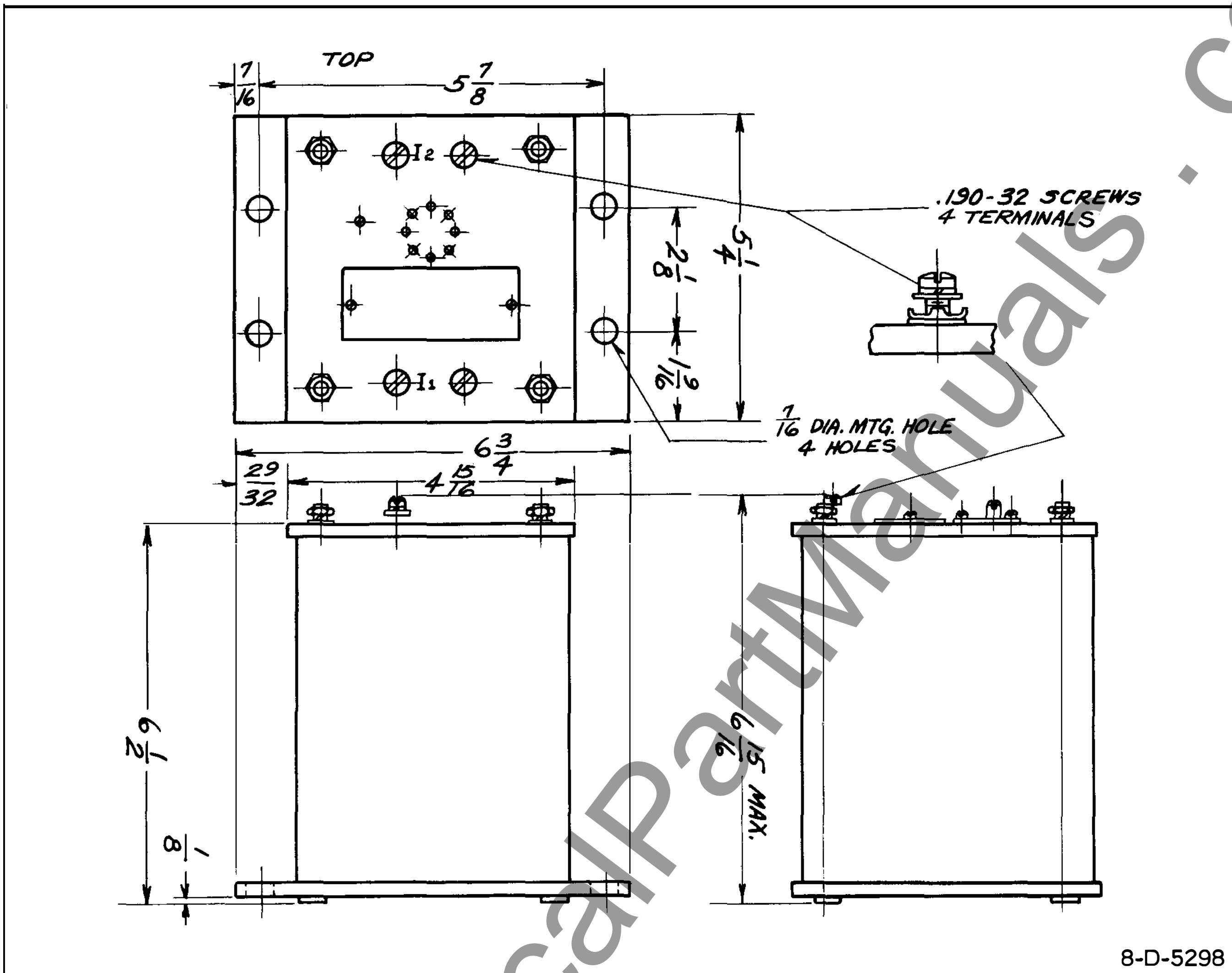


Fig. 8. Outline and Drilling Plan of the External Auxiliary Current Transformer

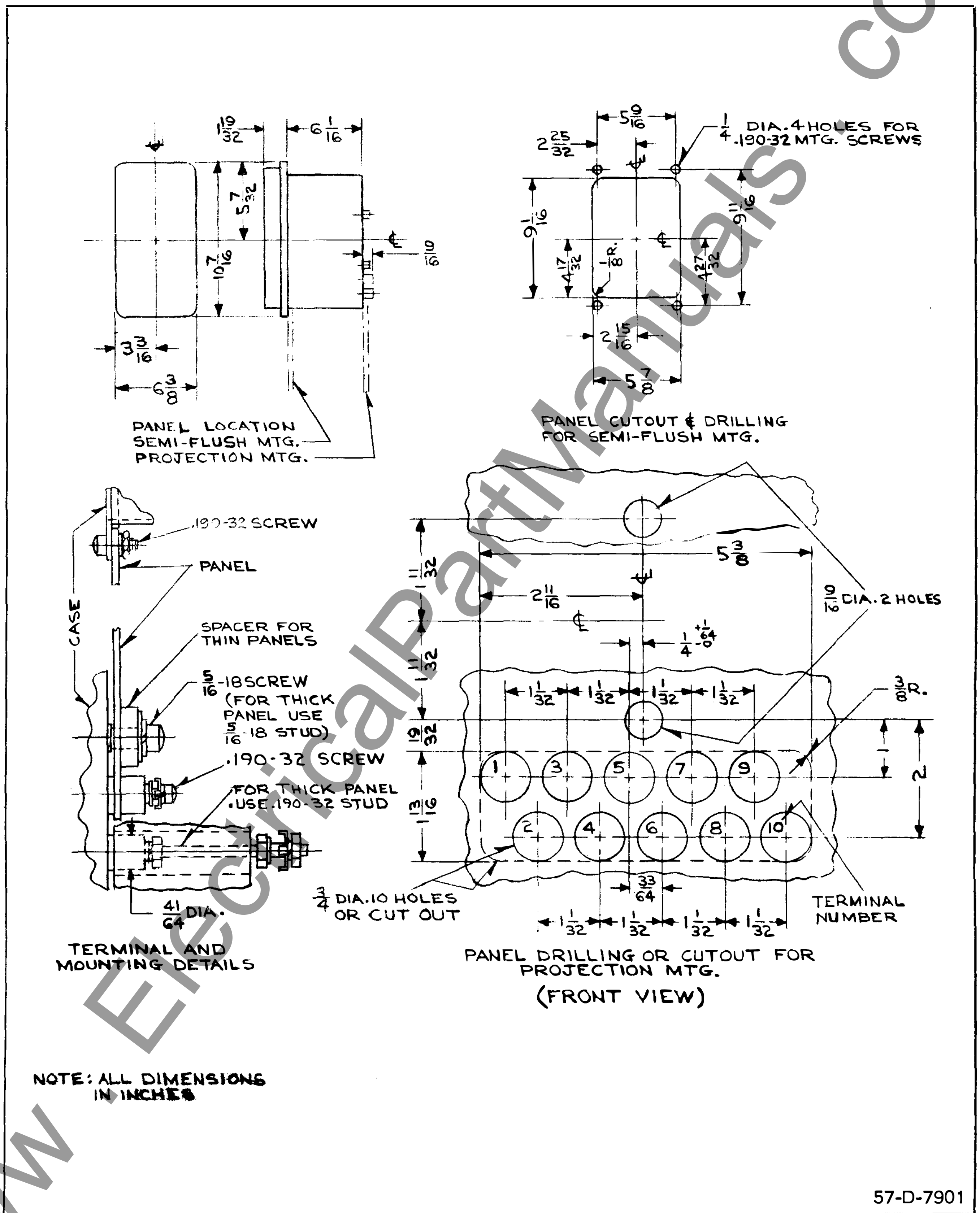


Fig. 9. Outline and Drilling Plan of the Type CWP-1 Relay in FT-21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWP-1
SENSITIVE DIRECTIONAL GROUND 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

The type CWP-1 relay is an induction disc type relay used for directional ground fault protection on high-resistance grounded power systems. It is similar to the type CWP relay except that the relay has a higher sensitivity and has maximum torque when the residual current and voltage are in phase.

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 transforms or with a neutral resistor, in conjunction with a distribution transformer. An alternative arrangement is shown in Fig. 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 Fig. 6 to energize the CWP-1 current coil. With this arrangement all three conductors are passed through the opening: thus avoiding the problem of false residued currents 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 currents values permit a higher current pickup, three residually connected CT's may be used.

CONSTRUCTION AND OPERATION

The Type CWP-1 relay consists of an induction disc type unit, an indicating contactor switch, and an external current transformer.

Induction Disc Unit

The induction disc unit contains a thin four-inch diameter disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The element is not geared. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf-spring. This spring is fastened to a molded block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the molded block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in front. The operating torque is obtained by energizing the lower pole with residual voltage and the upper poles with residual current.

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 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.

External Current Transformer

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

CHARACTERISTICS

The Type CWP-1 relay taps are on the external current transformer supplied with the relay and not on the relay itself. The taps are as follows:

0.5 – 0.7 – 1.0 – 1.4 – 2.0 – 2.8 – 4.0

The tap value represents the minimum pick up product of residual current times residual voltage at maximum torque (unity power factor).

Typical time-product curves are shown in Figs. 3 & 4 with 100 volts across the potential coil. Fig. 5 shows time data with a potential 50 and 200 volts for comparative purposes. These curves were taken at maximum torque; that is, with current and voltage in phase. For currents not in phase with the voltage, the approximate relay operating times is: $t_\theta = \frac{t_o}{\cos \theta}$; where t_o is the tripping time for unity power factor and θ is the angle by which the residual current actually lags the residual voltage.

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 contactor switch has two taps that provide a pickup setting of 0.2 or 2 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.

Trip Circuit Constants

Indicating Contactor Switch –

0.2 ampere tap – 6.5 ohms d-c resistance
2.0 ampere tap – 0.15 ohms d-c resistance

Burden and Thermal Ratings

Current Circuit Burden

TAP	Power Factor Angle – Lag 60 Cycles	Power Factor Angle – Lag 50 Cycles	Volt-Amperes at Tap Value Current (100 Volts Applied to Potential Coil) 60 Cycles	Volt-Amperes at Tap Value Current (100 Volts Applied to Potential Coil) 50 Cycles
.5	23.0°	27.2°	0.0028	0.0021
.7	23.0	21.8	0.0030	0.0023
1.0	21.5	17.1	0.0034	0.0027
1.4	17.5	14.6	0.0039	0.0032
2.0	15.0	10.0	0.0048	0.0041
2.8	12.0	7.0	0.0058	0.0051
4.0	9.0	3.8	0.0074	0.0067

Voltage Circuit Burden

Volt-Amperes 110 Volts 60 Cycles	Volt-Amperes 110 Volts 50 Cycles	Power Factor Angle-Lag 60 Cycles	Power Factor Angle-Lag 50 Cycles
7.0	9.9	81°	80°

Thermal Ratings

	60 Cycles	50 Cycles
Continuous Current	0.3 amp.	0.3 amp.
Continuous Voltage	250 volts	175 volts

SETTINGS

The relay operates on the product of residual fault current and voltage. This product divided by the proper current and potential transformer ratio and by one of the transformer tap values is expressed as a multiple of the tap. The time curves of Figs. 3 & 4 give the relay operating time for various lever settings as a

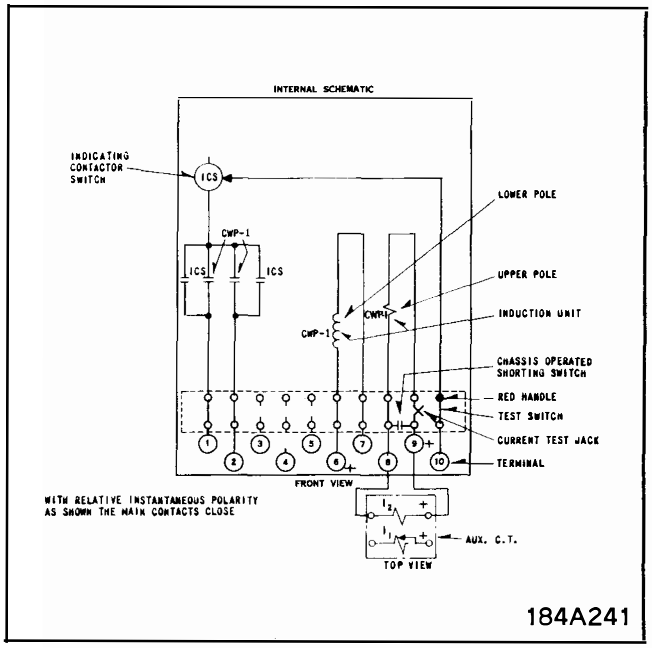


Fig. 1. Internal Schematic of the Double Trip Type CWP-1 Relay, FT21 Case. (Single Trip Relays Have Terminal 2 and Associated Circuits Omitted).

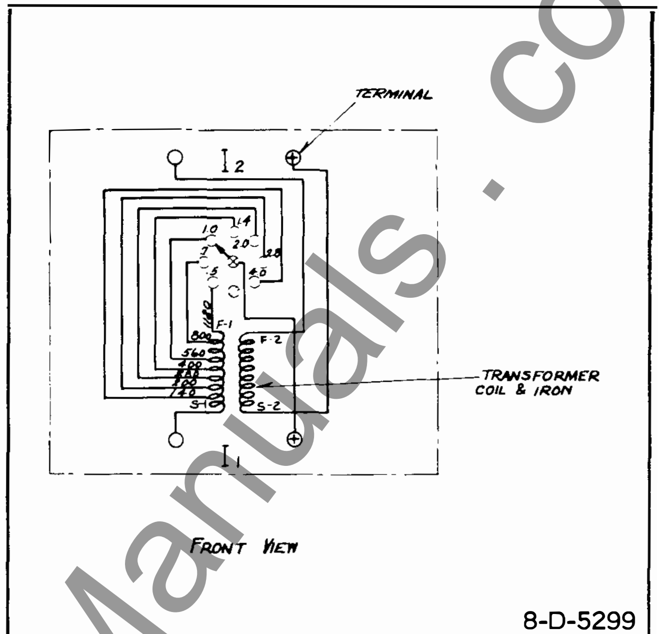


Fig. 2. Internal Connections of the External Auxiliary Current Transformer.

function of this multiple. Fig. 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 may 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 Figs. 3, 4 and 5.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 shave 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.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 volt or 250 volt d.c. type WL relay switch, or equivalent, use the 0.2 ampere tap. For 48 volt d.c. applications set ICS in 2 ampere tap and use S#304C 209G01 type WL relay or equivalent.

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

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

ADJUSTMENTS AND MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the 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.

Acceptance Check

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

1. Set the contacts in the #10 time lever position and the tap plug in the 0.5 tap. Connect the auxiliary CT as shown in Fig. 6. Energize the the potential coil with 100 volts and the external auxiliary CT with sufficient current to just close the contacts. (The current in polarity on the auxiliary CT should be in phase with the voltage drop from relay terminal 6 to terminal 7.) The pickup current should be 0.005 amperes ± 3%.

2. With 100 volts potential, energize the auxiliary CT at the following current levels to check relay timing:

Current	Multiple of Tap Product	Time-seconds 60 Cycles	50 Cycles
0.025	5	3.55 ± 10%	4.00 ± 10%
0.100	20	0.94 ± 5%	1.00 ± 5%
0.500	100	0.33 ± 10%	0.35 ± 10%

3. To check the zero torque line, adjust the input current to the auxiliary current transformer 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 90° (or 270°) ± 7°.

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 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.

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 paragraph 1 under "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.

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 until it is apparent that the relay is not in proper working order (See **"Acceptance Check"**).

Induction Unit

The upper bearing screw should be screwed down until there is only 3 to 5 thousandths inch clearance between it and the shaft and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the disc fails to turn freely and then backing up a fraction of a turn. Great care must be taken in making this adjustment to prevent damage to the bearings.

Adjust the contacts to just barely touch when the time lever is set on zero by shifting the position of the contact stop on the time lever. This should be done with approximately the required contact follow. Final adjustment of the contacts can be more easily made by the contact follow set screw after the contact stop is securely fixed.

A maximum contact follow of approximately 5/64 inch is obtained when the set screw on the stationary contact is all the way out. Where rigid contacts for quick reopening are required, the set screw should be all the way in to hold the stationary contact against the Micarta bracket. Readjust the zero setting after this is done.

Connect 115 volts across the relay potential coil. Apply approximately 5 times the minimum pick-up current (tap value divided by 115) through the auxiliary transformer primary with the polarity and relay connections as shown in Fig. 6 and see that zero torque occurs when the current and voltage are 90^{o} out of phase within $\pm 4^{o}$. There should be no spring tension on the relay for this test.

With the connections above apply 100 volts, and current in phase. 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 screw driver 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 0.94 seconds (1.00 seconds for 50 cycle relay) in the 0.5 VA tap, with a potential of 100 volts. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked. The position of the permanent magnet over the disc will affect the timing and shape of the curves.

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 simultaneously.

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.

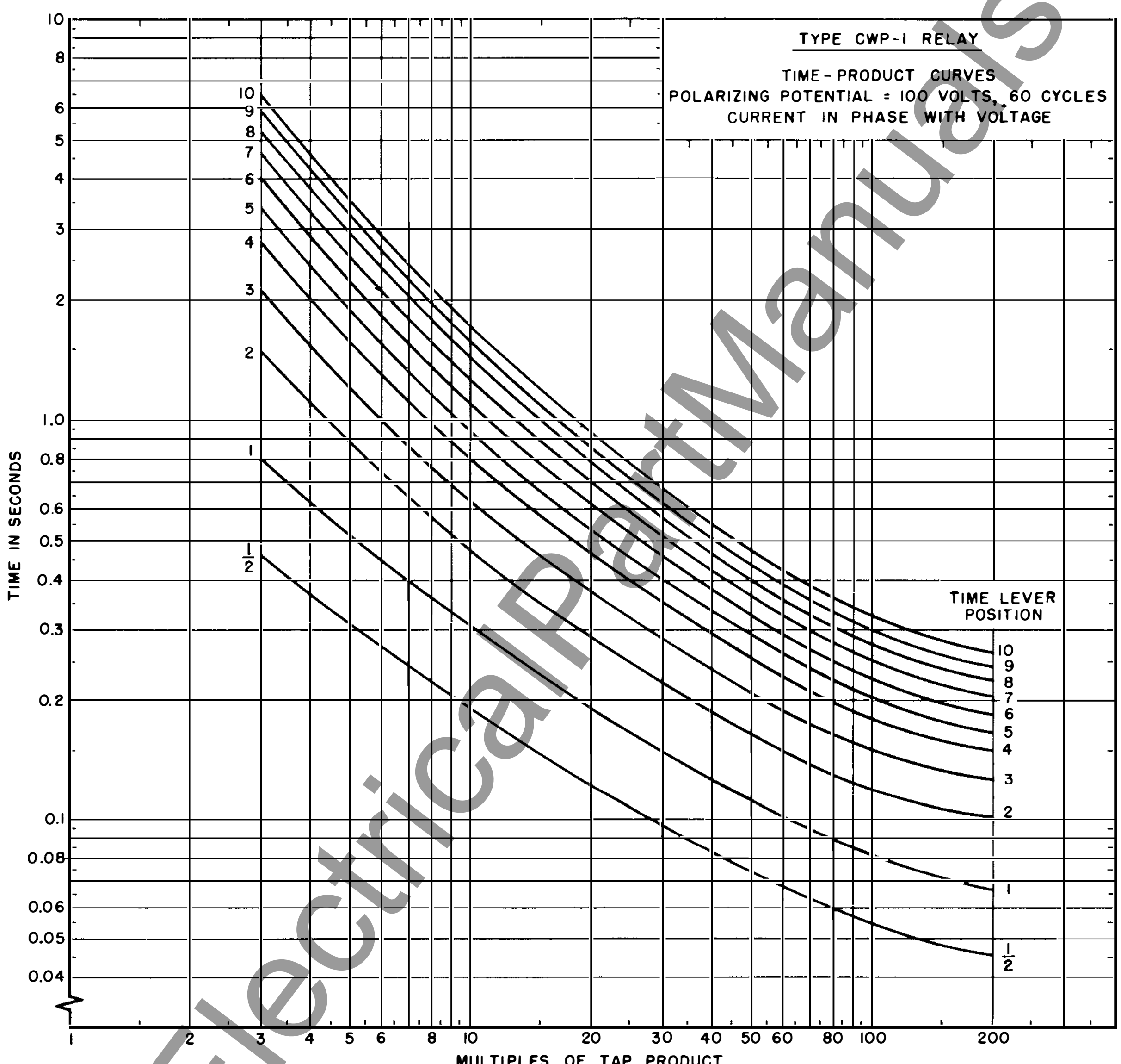
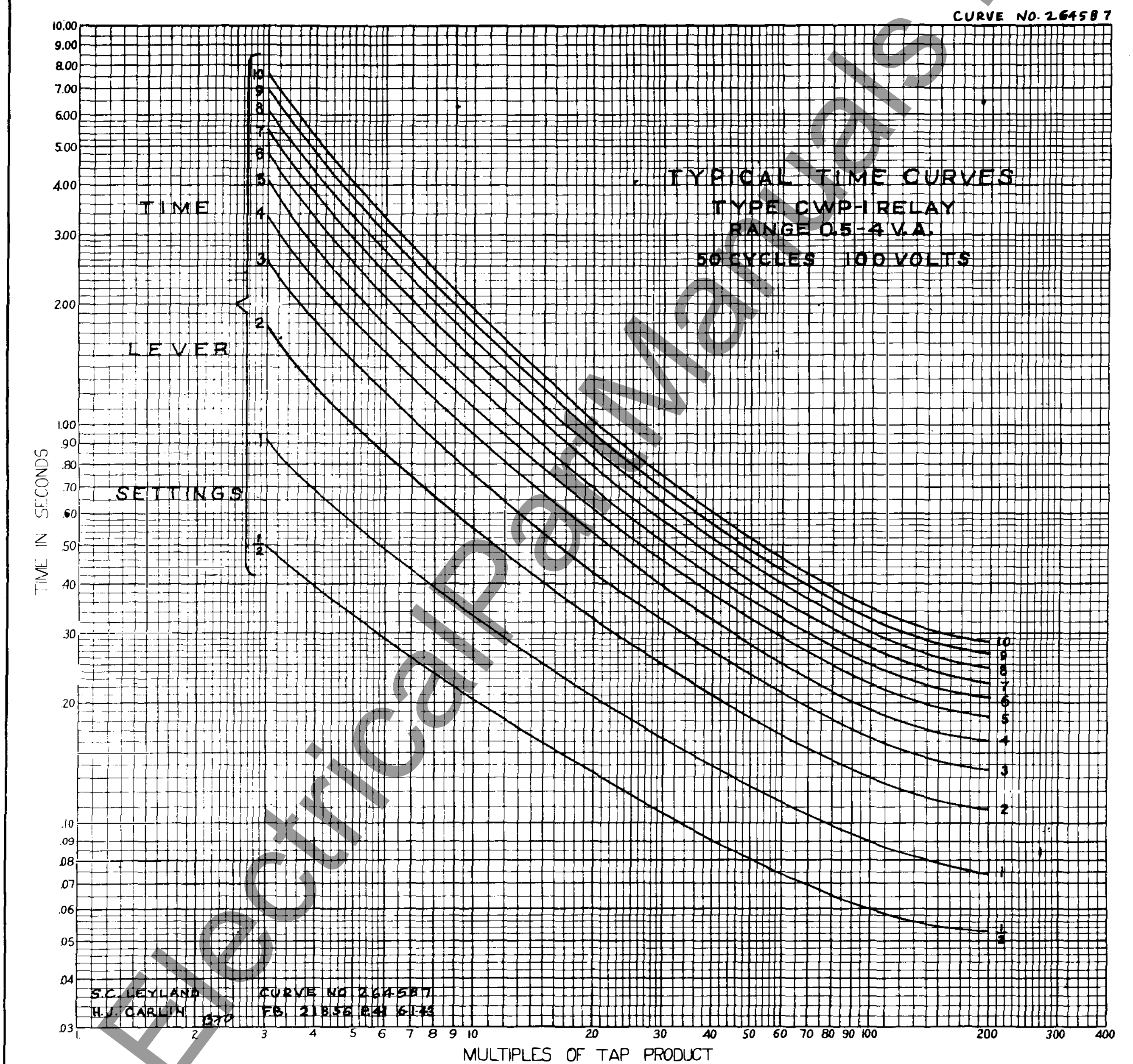


Fig. 3. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque-100 Volts, 60 cycles Across Potential Coil.



CURVE 264587

Fig. 4. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque-100 Volts, 50 cycles Across Potential Coil.

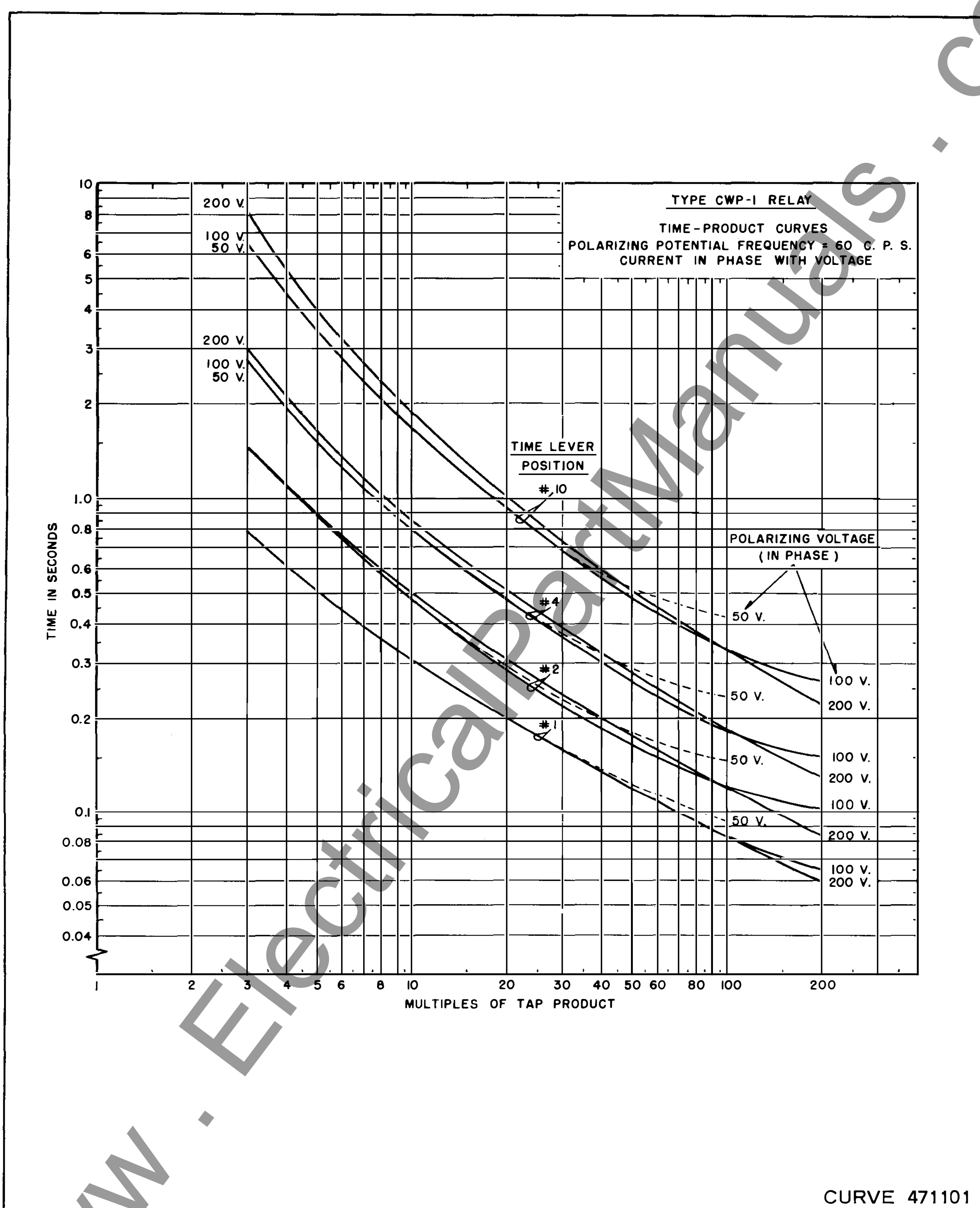


Fig. 5. Representative Time-Product Curves, Showing the Effect of Variations of Potential Coil Voltage — Maximum Torque Angle, 60 cycles.

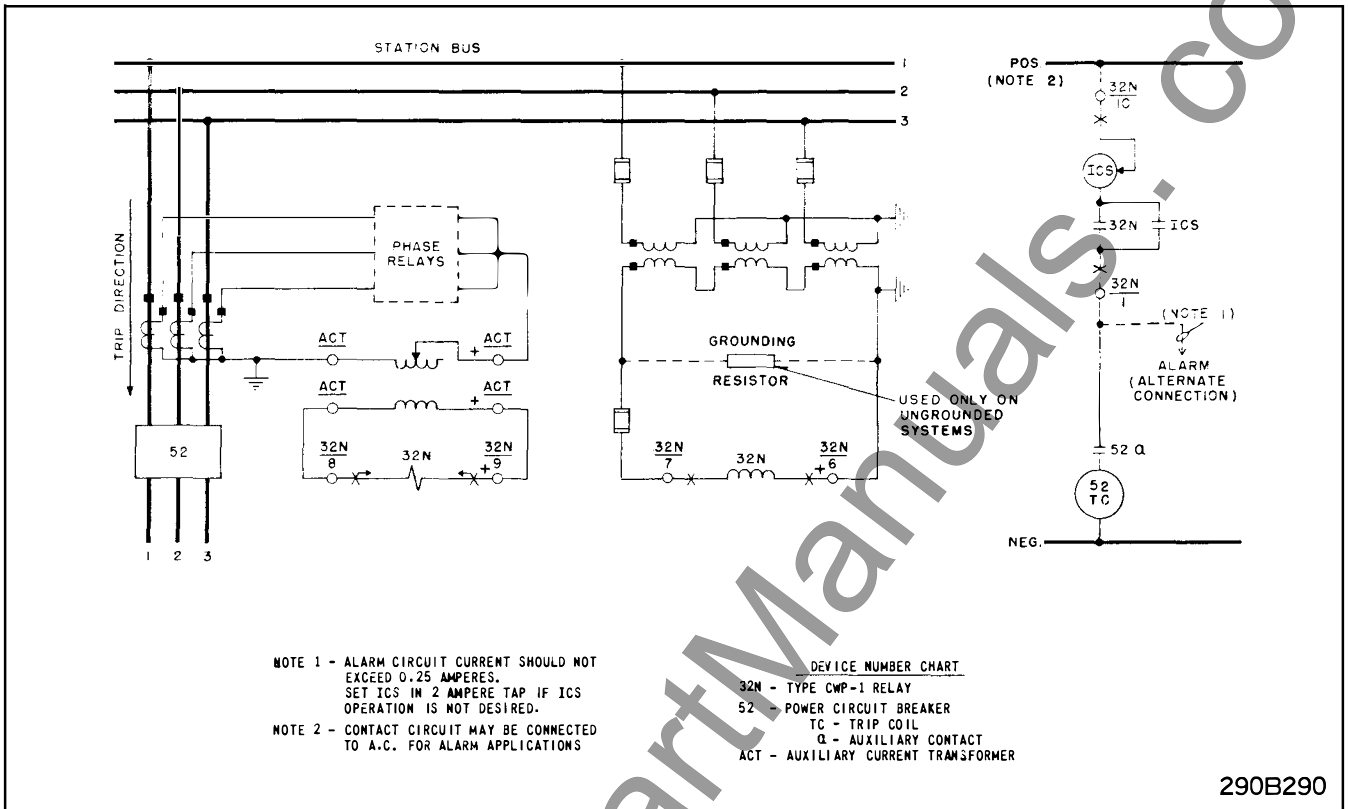


Fig. 6. External Schematic of the Type CWP-1 Relay in FT-21 Case.

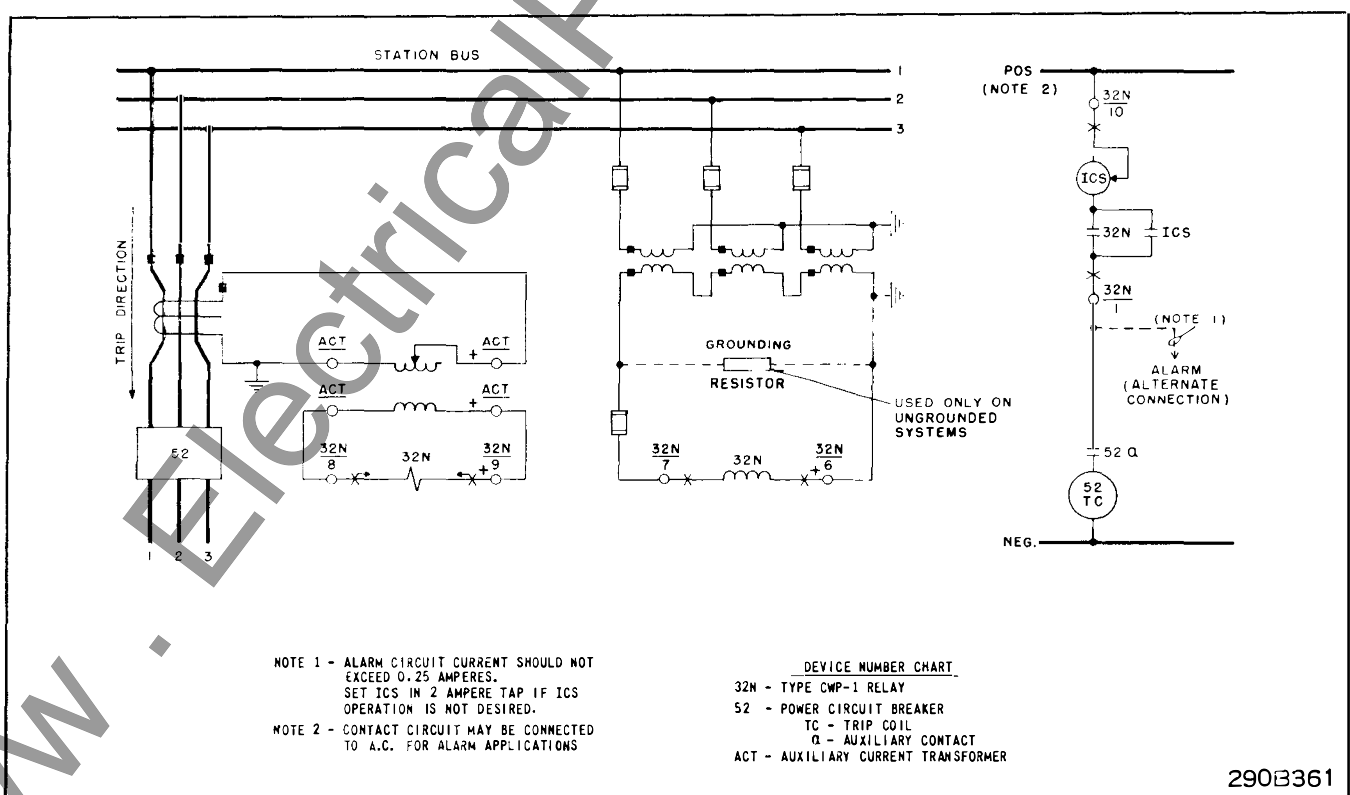


Fig. 7. External Schematic of the Type CWP-1 Relay in FT-21 Case, Using Window Type C.T.

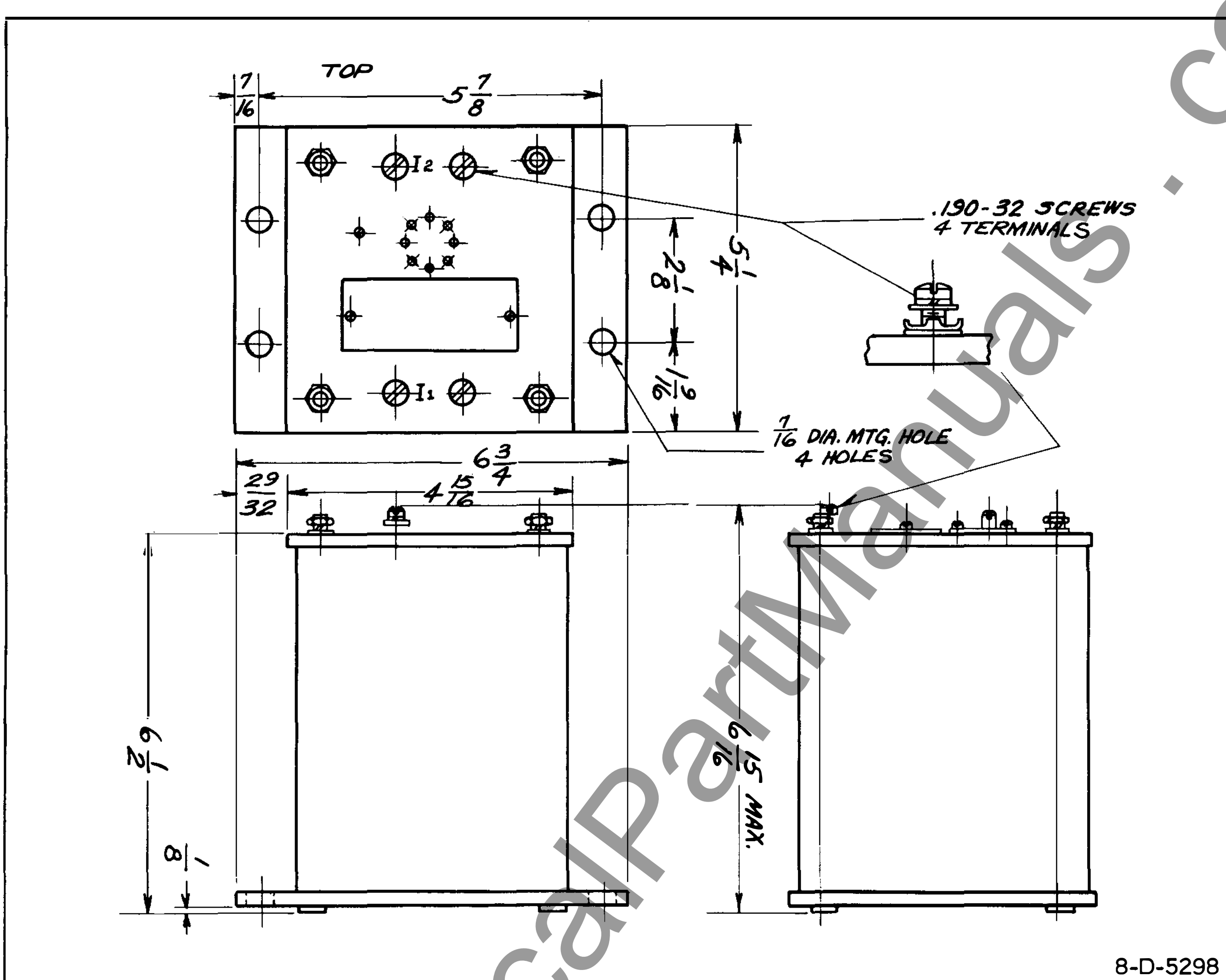


Fig. 8. Outline and Drilling Plan of the External Auxiliary Current Transformer

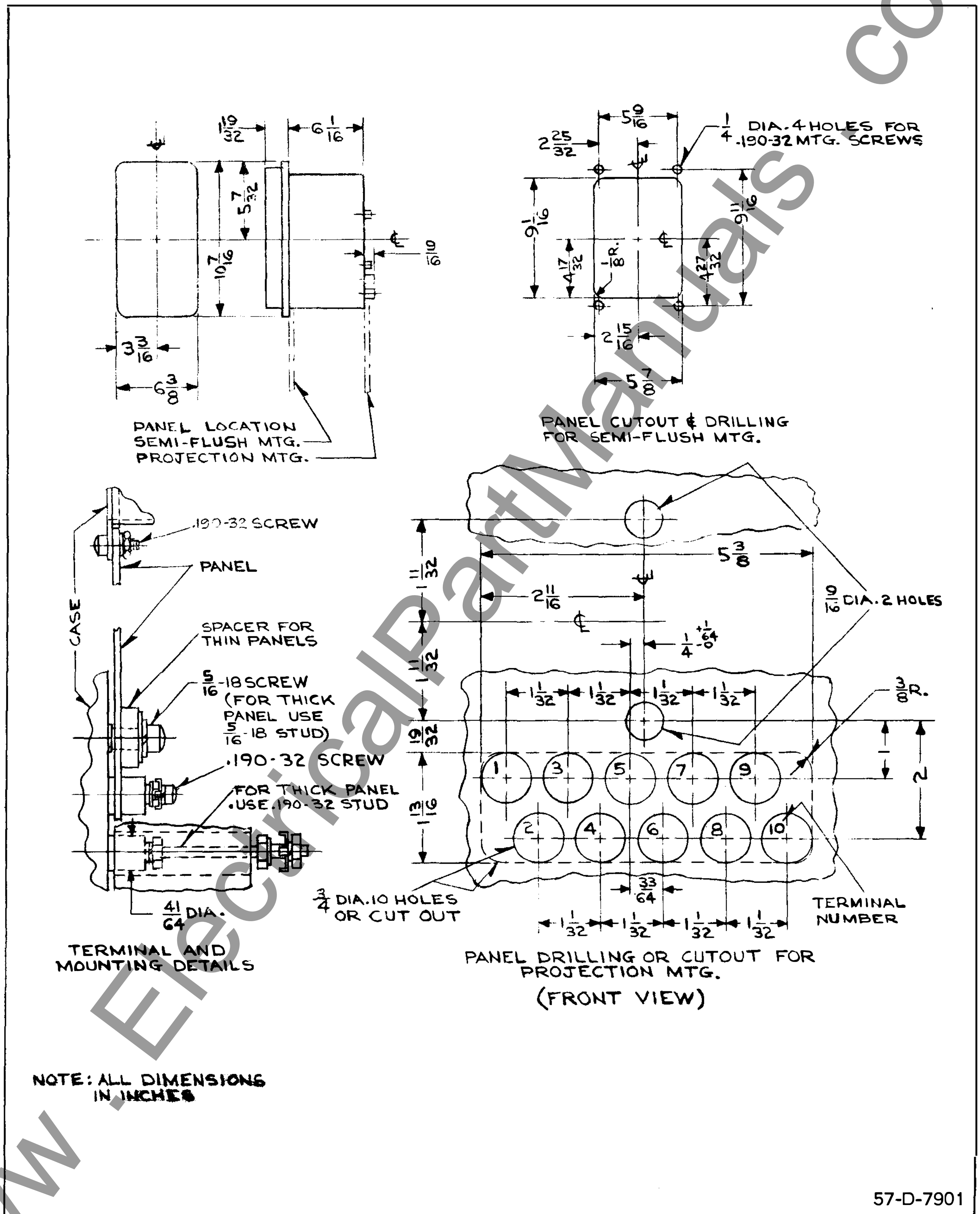


Fig. 9. Outline and Drilling Plan of the Type CWP-1 Relay in FT-21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY DEPARTMENT **NEWARK, N. J.**

Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWP-1
SENSITIVE DIRECTIONAL GROUND 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

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

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 Fig. 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 Fig. 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 currents 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 currents values permit a higher current pickup, three residually connected CT's may be used.

CONSTRUCTION AND OPERATION

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

Operating Unit

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 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.

Phase Shifter Network

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

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 drop.

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

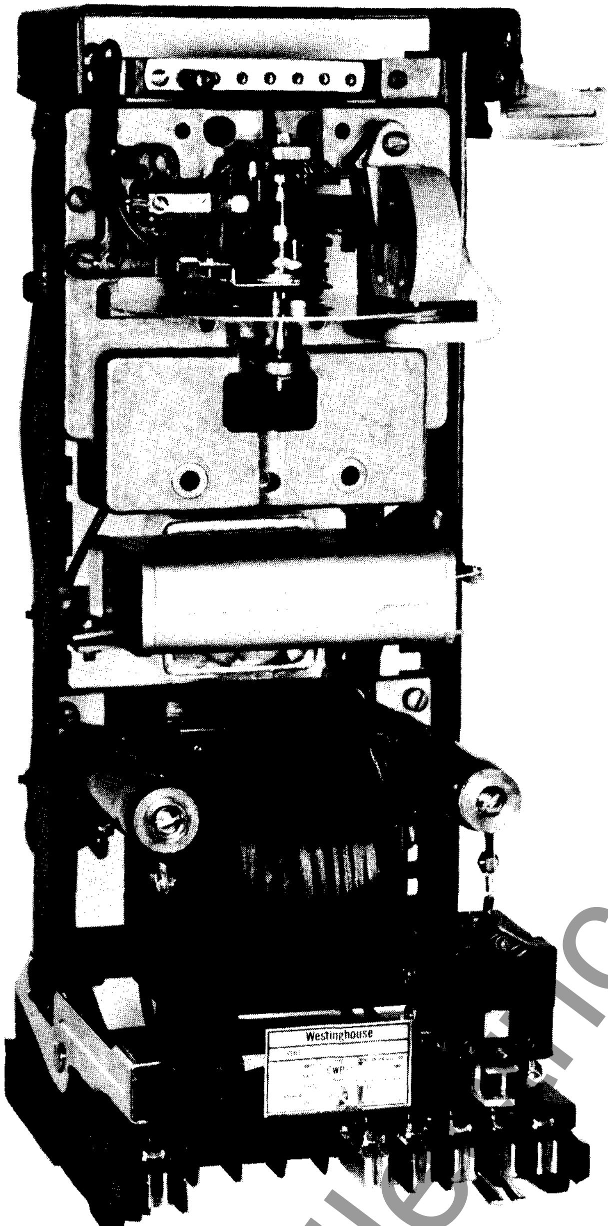


Fig. 1. Type CWP-1 Ground Relay (front view)

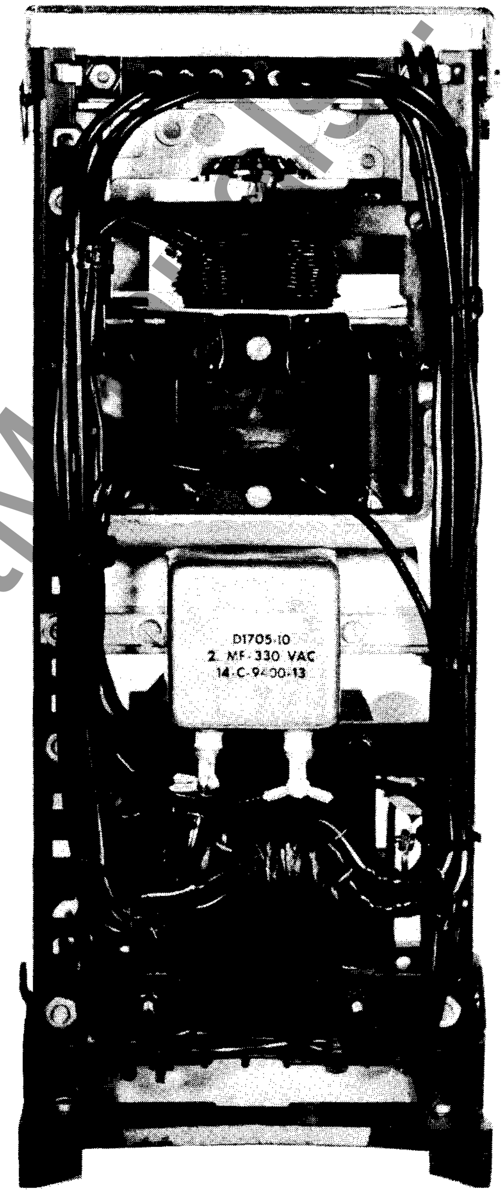


Fig. 2. Type CWP-1 Ground Relay (rear view)

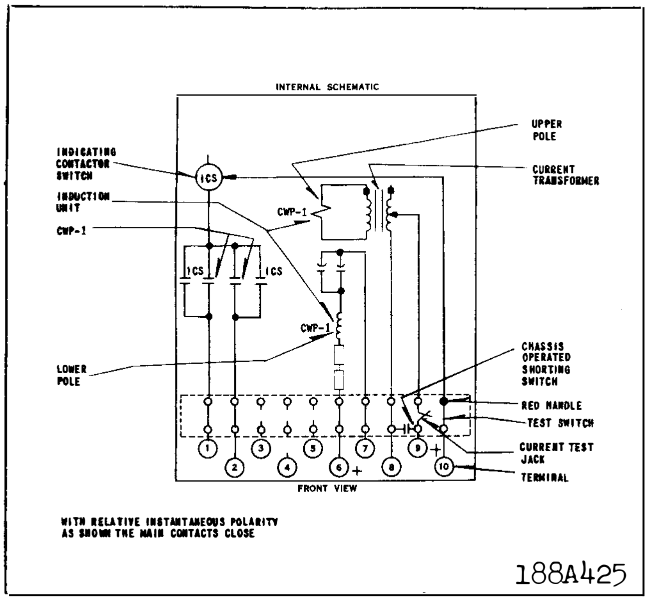


Fig. 3. Internal Schematic of the Double Trip CWP-1 Relay, FT31 Case. (Single Trip Relays have terminal 2 and associated circuits omitted).

Current Transformer

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

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 cycle time product curves for the type CWP-1 relay are shown in Fig. 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 V.A. 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.

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 contactor switch as two taps that provide a pickup setting of 0.2 or 2 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.

Trip Circuit Constants

Indicating Contactor Switch -

0.2 ampere tap - 6. 5 ohms -dc resistance
0.2 ampere tap - 0.15 ohms d-c resistance

Burden and Thermal Ratings

Current Circuit Burden

TAP	POWER FACTOR ANGLE - LAG 60 Cycles	50 Cycles
.5	23.0°	27.2°
.7	23.0	21.8
1.0	21.5	17.1
1.1	17.5	14.6
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)

60 Cycles	50 Cycles
0.0028	0.0021
0.0030	0.0023
0.0034	0.0027
0.0039	0.0032
0.0048	0.0041
0.0058	0.0051
0.0074	0.0067

Voltage Circuit Burden

Volt-Amperes	110 Volts	Power Factor	Angle-Lag
60 Cycles	9.68 va	60 Cycles	46°

Thermal Ratings

	60 Cycles	50 Cycles
Continuous Current	0.3 Amp.	0.3 Amp.
Continuous Voltage	250 Volts	175 Volts

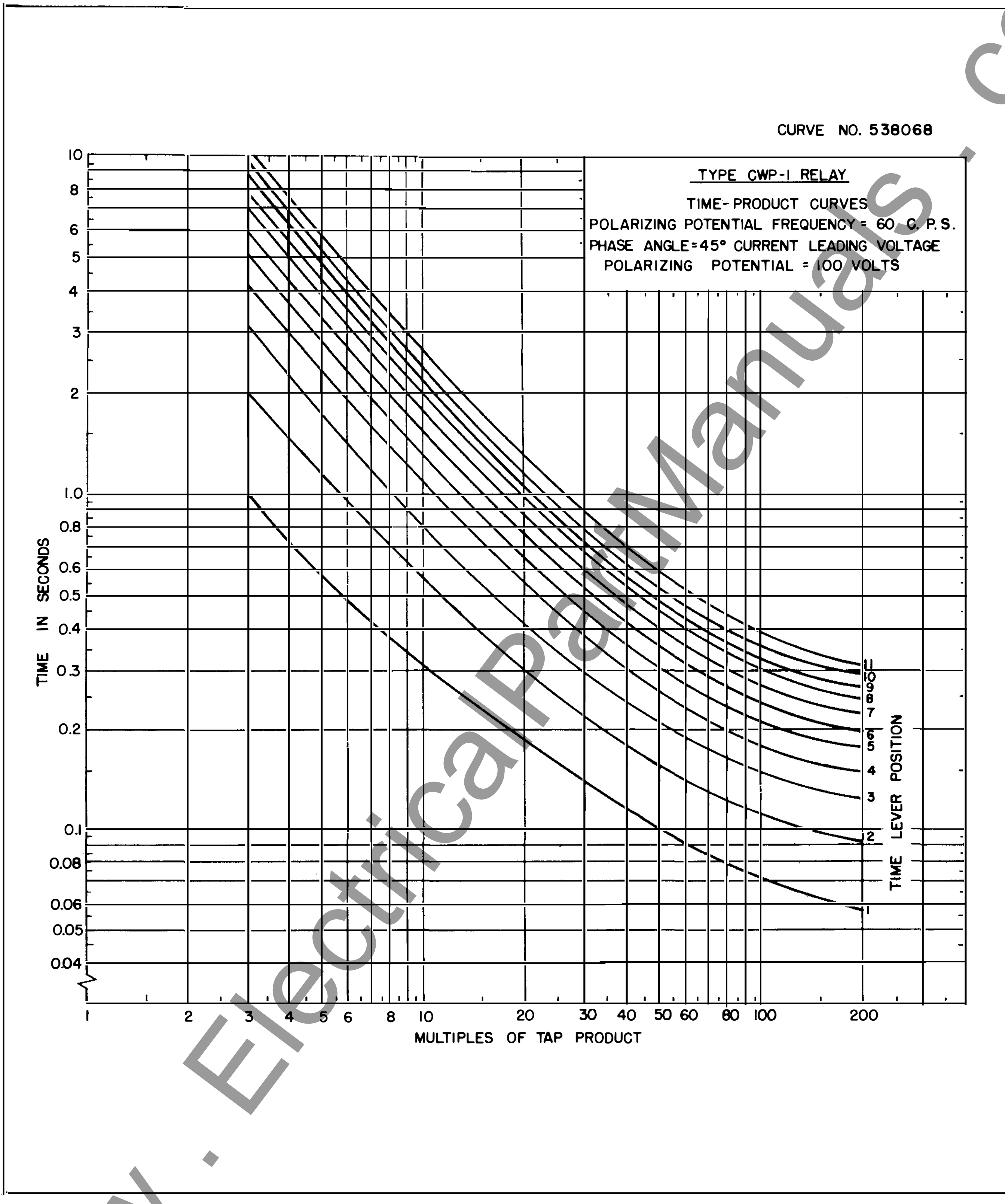


Fig. 4. Typical Time-Product Curves of the Type CWP-1 Relay at Maximum Torque. 100 volts 60 cycles across potential circuit.

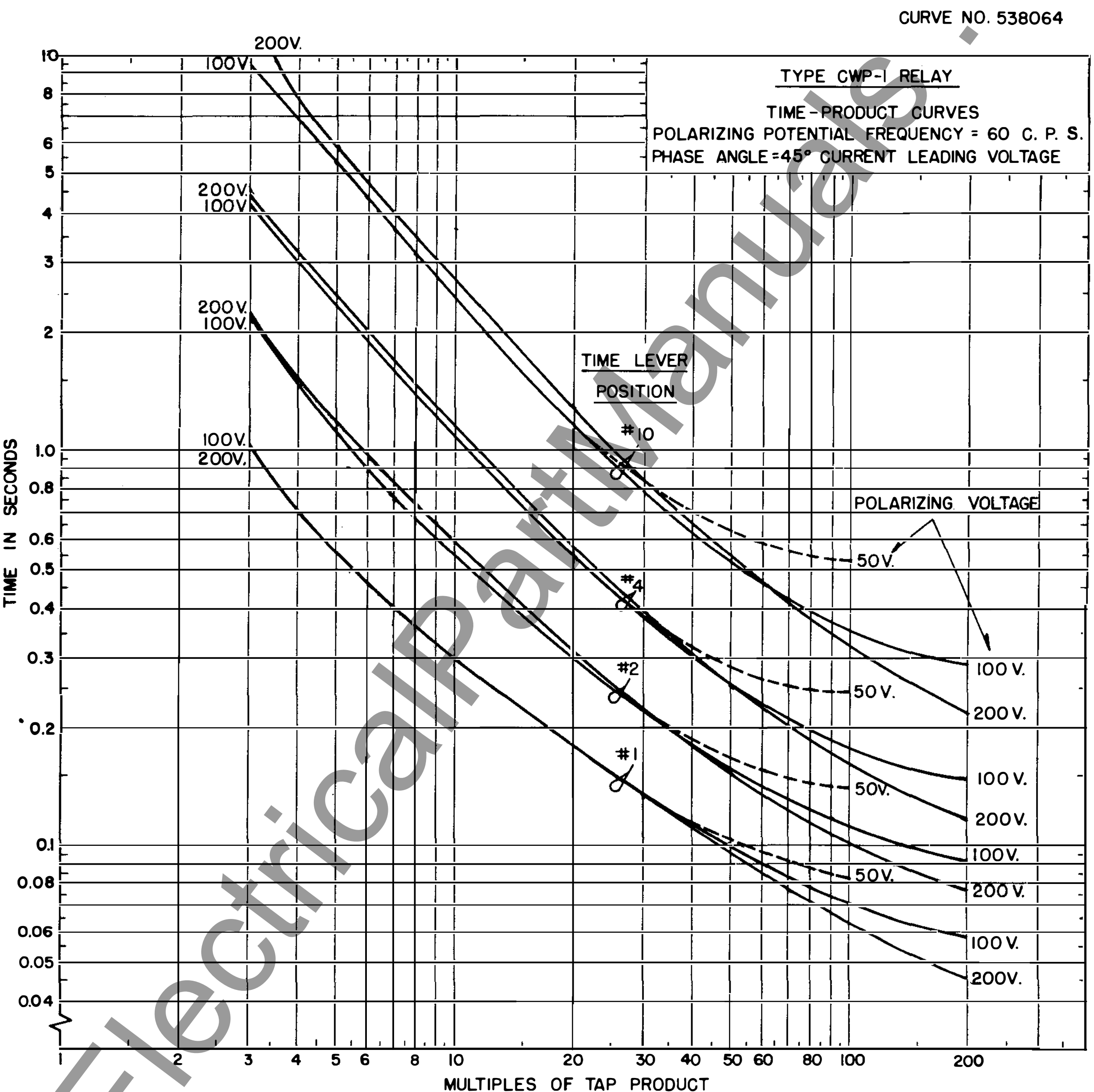


Fig. 5. Representative Time-Product Curves, showing effect of variations of Potential Circuit Voltage - Maximum Torque Angle, 60 cycles.

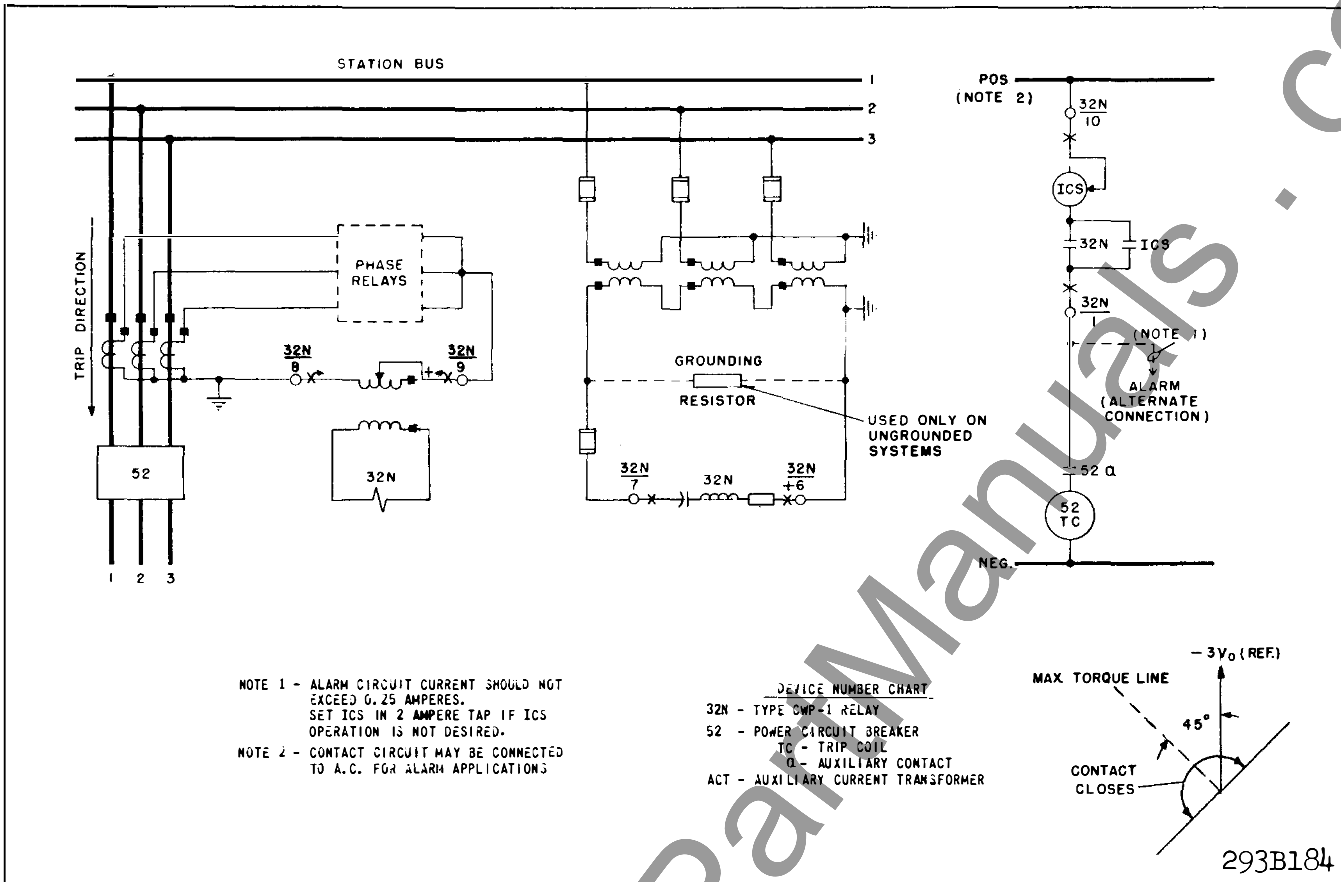


Fig. 6. External Schematic of the Type CWP-1 Relay in FT31 Case.

SETTING

The relay operates on the product of residual fault current and voltage. This product divided by and proper current and potential transformer ratio and by one of the transformer tap values is expressed as a multiple of the tap. The time curves of Fig. 4 gives the relay operating time for various time dial settings as a function of this multiple. Fig. 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 may 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 Figs. 3, 4 and 5.

However, the relay cannot distinguish between a fault on the line near the remote breaker for which they 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

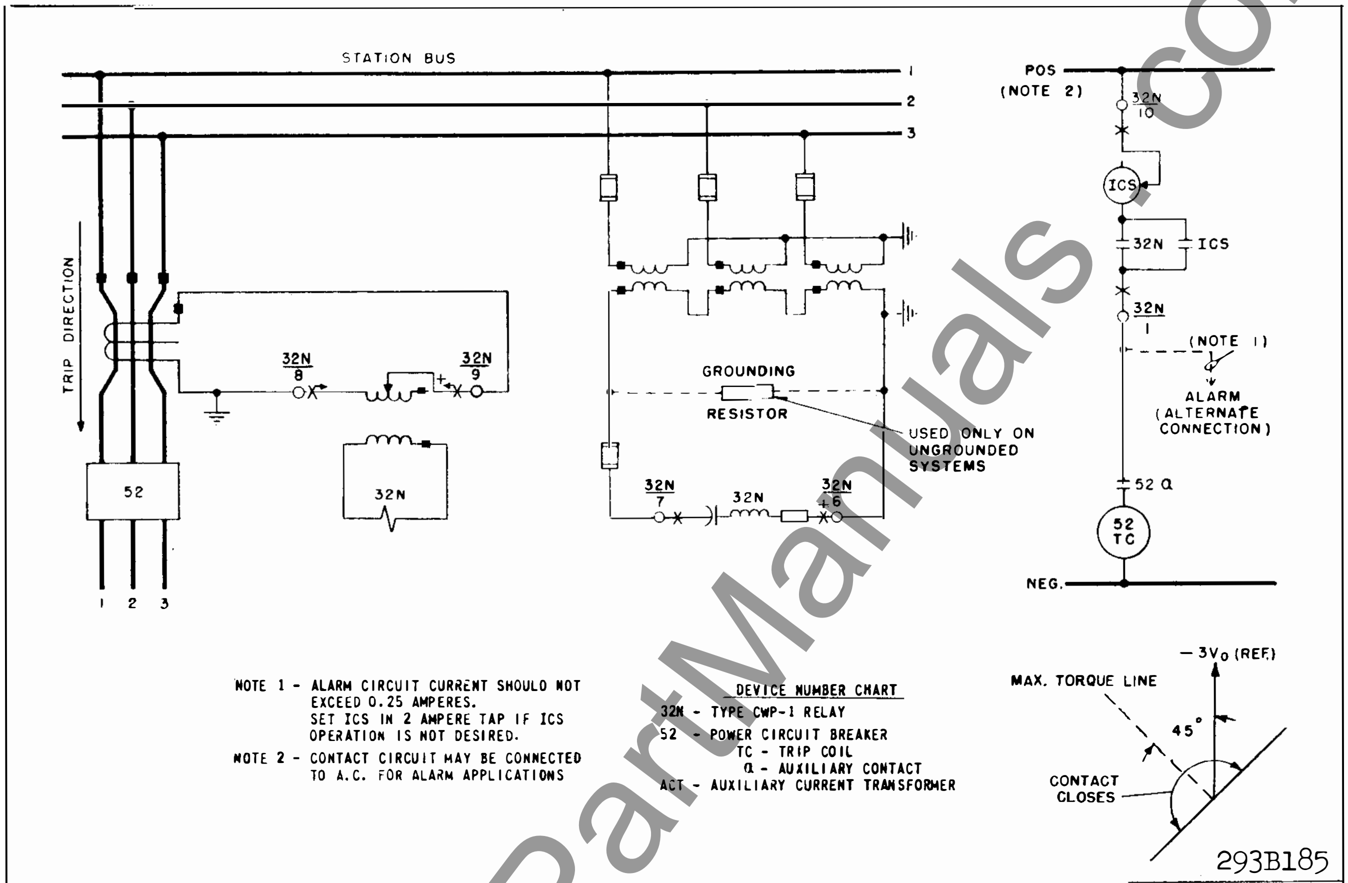


Fig. 7. External Schematic of the Type CWP-1 Relay in FT31 Case, using Window Type C.T.

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 indivi-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.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 volt or 250 volt d-c type WL relay switch, or equivalent, use the 0.2 ampere tap. For 48 volt d-c applications set ICS in 2 ampere tap and use S#304C209G01 type WL relay or equivalent.

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the

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

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

ADJUSTMENTS AND MAINTENANCE

The proper adjustment to insure 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.

Acceptance Check

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

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 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. Set the contacts to the time dial position and the tap plug in the 0.5 tap. Connect the relay as shown in Fig. 6. 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 by 45° voltage drop from relay terminal 6 to terminal 7.) The pickup current should be 0.005 amperes + 3%.

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

Current	Multiple of Tap Product	Time-seconds 60 Cycles	50 Cycles
0.025	5	3.55 ± 10%	4.00 ± 10%
0.100	20	0.94 ± 5%	1.00 ± 5%
0.500	100	0.33 ± 10%	0.35 ± 10%

4. 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 by 135° (or 315°) ± 7°.

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 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.

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 paragraph 1 under "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.

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 until it is apparent that the relay is not in proper working order (See "Acceptance Check").

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".

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 Fig. 6 and see 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 0.94 seconds (1.00 seconds for 50 cycle relay) in the 0.5 VA tap, with a potential of 100 volts. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked.

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 simultaneously.

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.

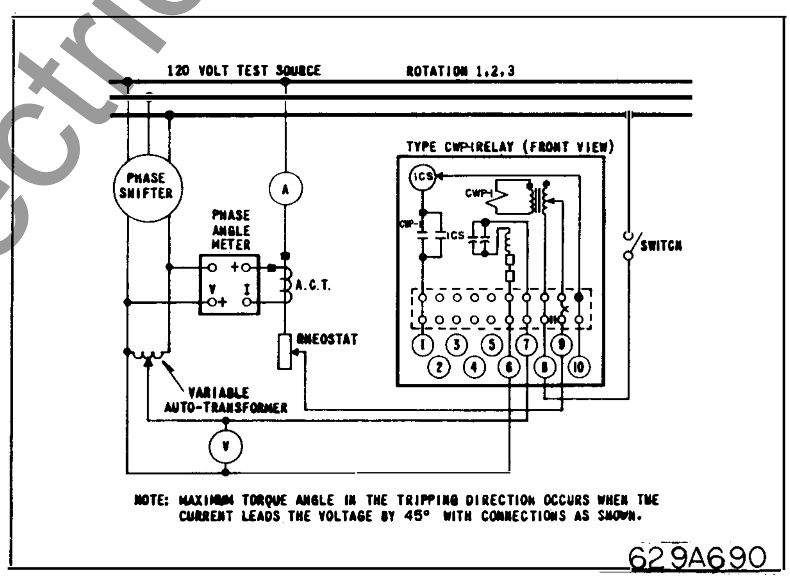


Fig. 8. Diagram of Test Connections for the Type CWP-1

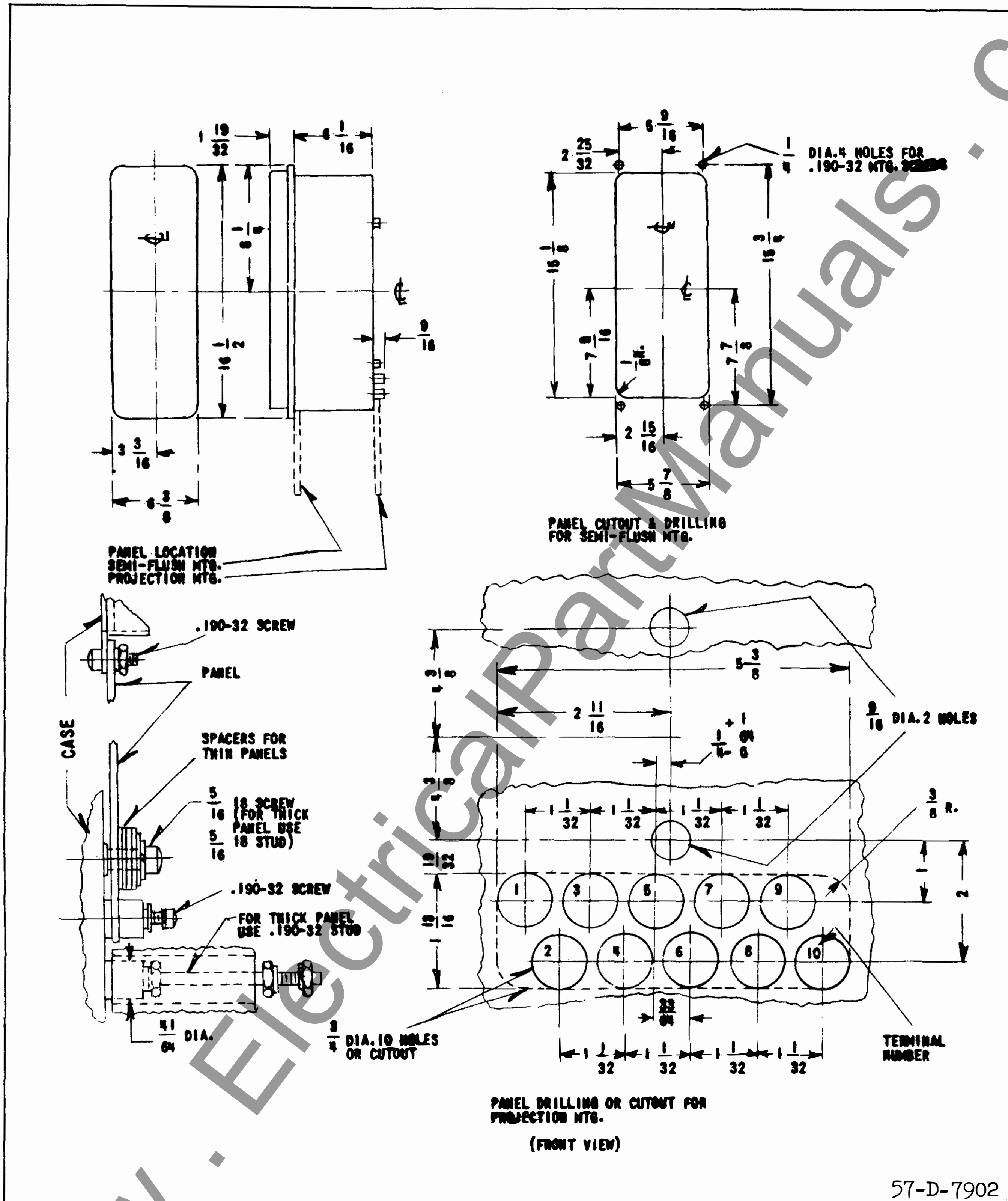


Fig. 9. Outline and Drilling Plan of the Type CWP-1 Relay in FT31 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWC AND CWP DIRECTIONAL GROUND RELAYS

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

APPLICATION

The type CWC and CWP relays are induction disc type relays used for directional ground fault protection on grounded neutral power systems. The type CWC relay is polarized by current from a suitably grounded power transformer bank neutral. Therefore, its application does not require potential transformer. The type CWP relay is potential polarized by residual voltage obtained across the open corner of the delta winding of a grounded star-delta potential transformer.

At stations where the power transformer bank netural is grounded, the residual voltage will be small generally, and the type CWC relay is recommended. At ungrounded stations, or at ground stations where the power transformer bank neutral is not available, the type CWP relay is applicable.

CONSTRUCTION

The type CWC and CWP relays consists of an operating unit, an indicating contactor switch, and optional indicating instantaneous trip unit. In addition to the above components, the type CWP relay has a phase shifter network. The principal component parts of the relay and their locations are shown in Fig. 1-8.

OPERATING UNIT

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 2 and 4. The upper pole of both the CWC and CWP relays are tapped. In addition, the lower pole is tapped on the type CWC relay.

The electromagnets are 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.

PHASE SHIFTER NETWORK

The phase shifter network of the type CWP relay consists of a capacitor and resistor connected in series with the lower pole circuit.

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 attacted 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, inaddition 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

SUPERSEDES I.L. 41-242.4C
*Denotes change from superseded issue.

EFFECTIVE NOVEMBER 1967

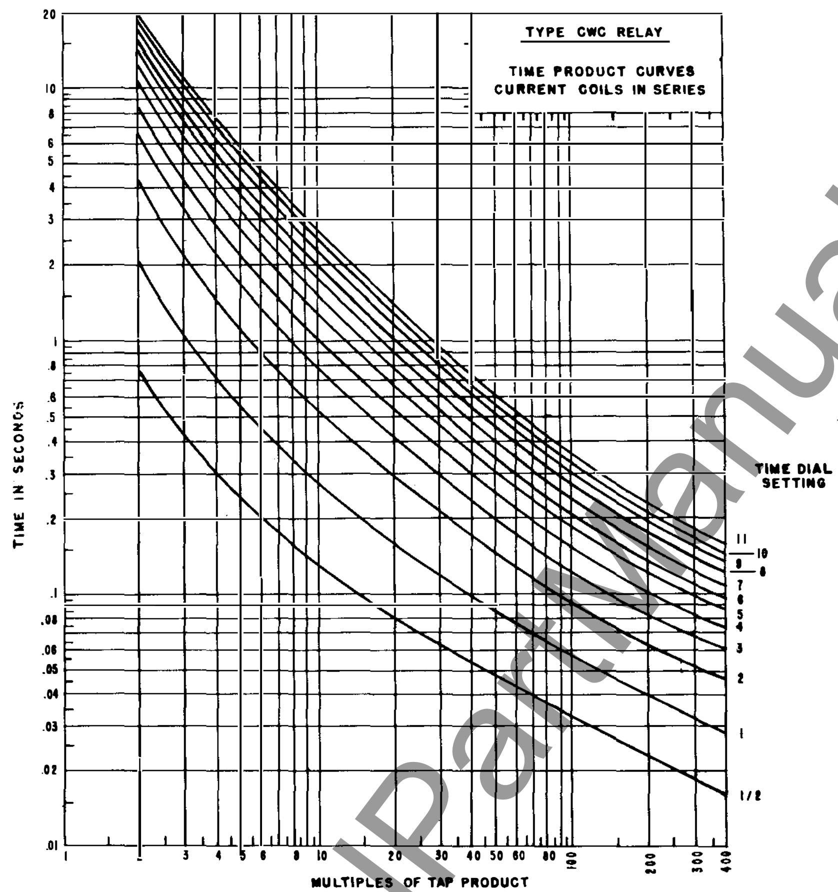


Fig. 9. Typical Time Curves of the Type CWC Relay – Current Coils in Series – See Fig. 10 for application limits.

relay coils and adjusting the dial position to obtained the desired time of operation. Alternatively the dial may be set by inspection, if the timing coordination is not critical.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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. When the relay energizes a 125 or 250 volt d-c type WL relay switch, or equivalent, use the 0.2 ampere tap; for 48 volt d-c applications set relay in 2 tap and use S#304C209G01 Type WL Relay or equivalent.

INDICATING INSTANTANEOUS TRIP (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, the core screw must be adjusted to the value of the pickup current desired.

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

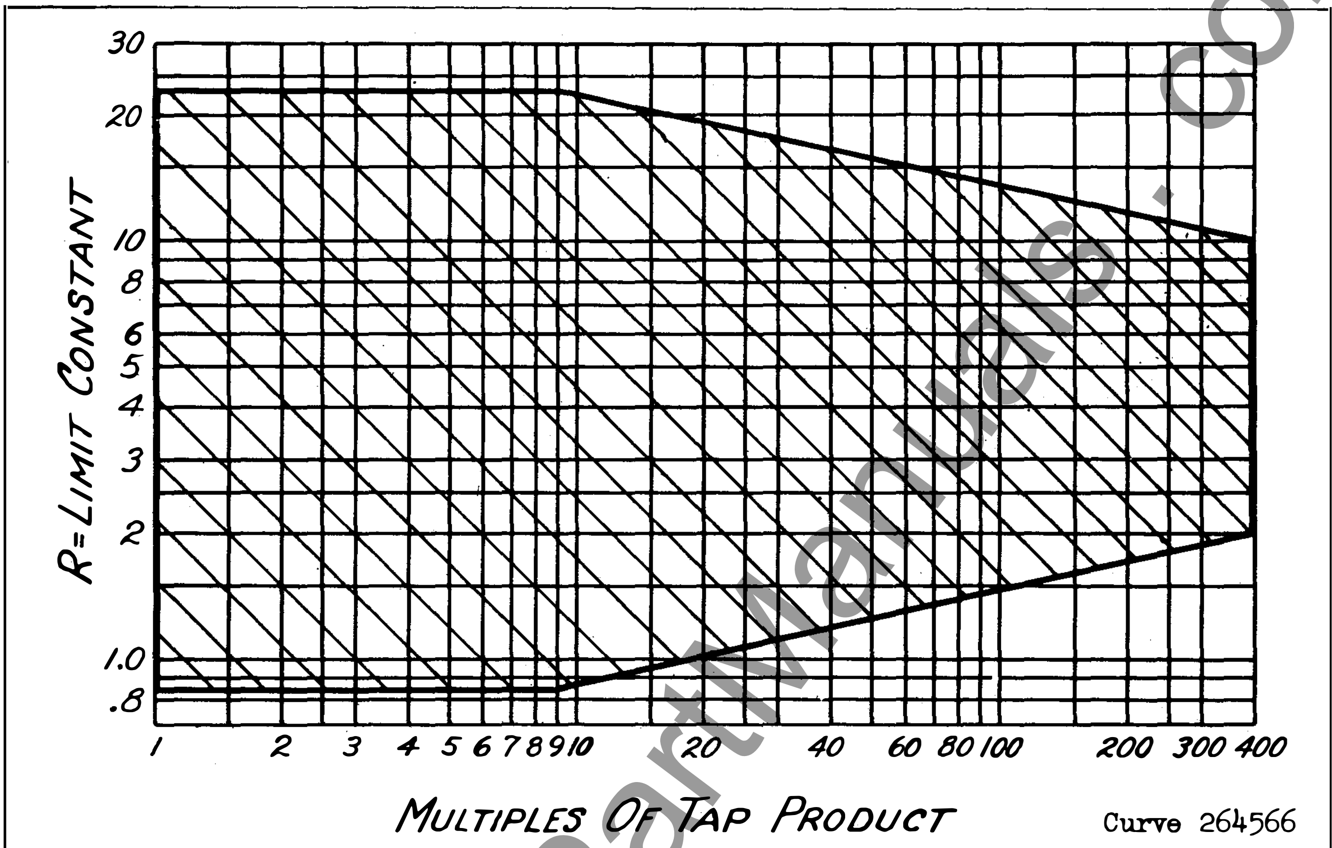
SETTING CALCULATIONS

The following information is required to set these relays:

1. The maximum and minimum ground fault current for faults at the relay and at the remote bus. These values should be residual current which is three times the zero sequence current.

2. The maximum and minimum polarizing current or voltage values for the faults above. The values should be residual currents or voltage which are three times the zero sequence values.

3. The current transformer ratios of the main and polarizing current transformers for the type CWC relay applications or the main current transformer ratio and the polarizing potential transformer ratio for the type CWP relay application.



For the 0.25 to 4 Product Range

$$R = M\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
M = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	M	K
.25	1	.25	4.0	10
.36	1	.36	2.78	12
.64	1	.64	1.56	16
1.0	1	1.0	1.0	20
1.0	4	.25	16.0	20
1.44	4	.36	11.1	24
2.56	4	.64	6.25	32
4	4	1.00	4.0	40

For the 2.25 to 36 Product Range

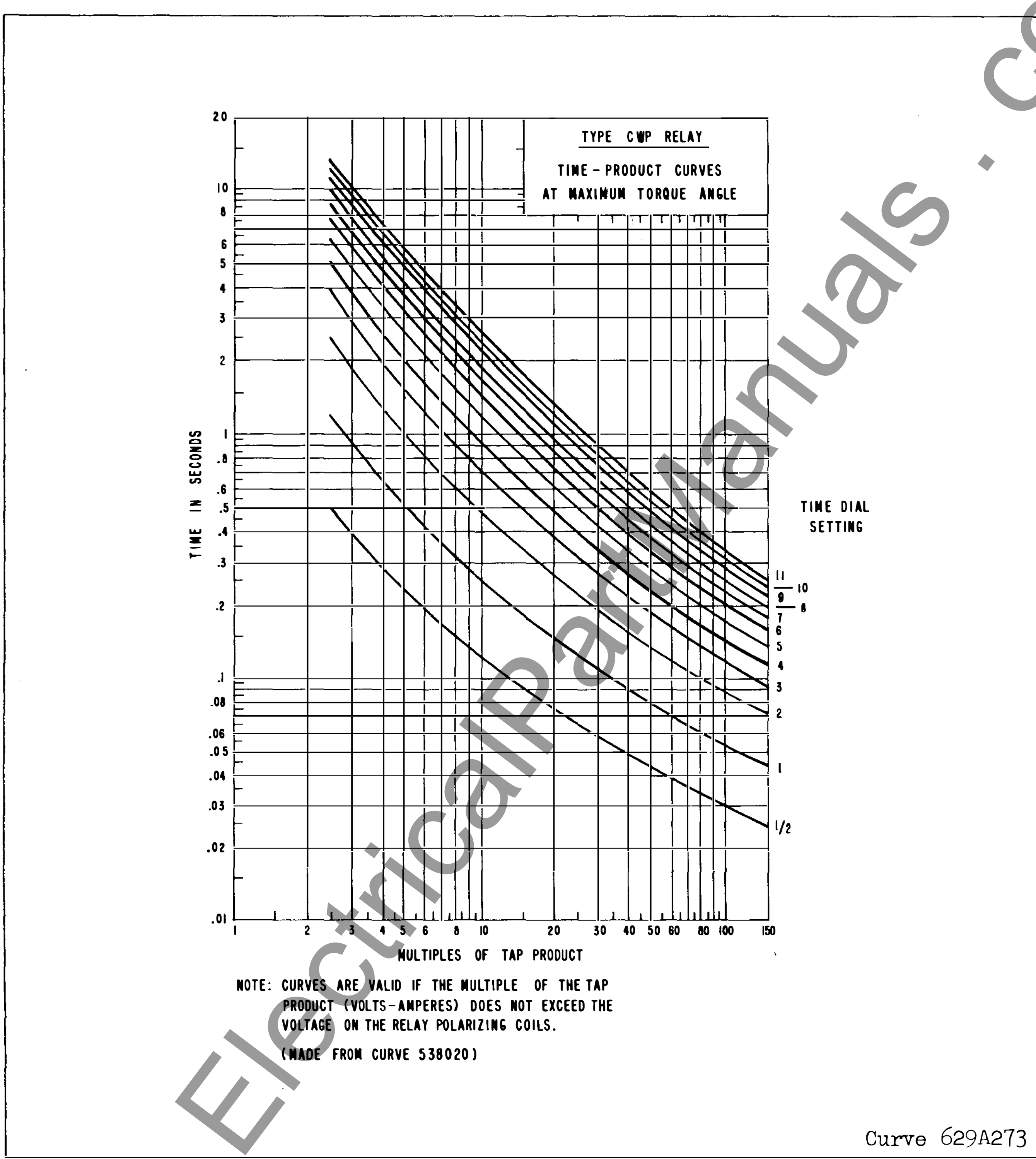
$$R = N\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
N = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	N	K
2.25	1	2.25	4.0	30
4.0	1	4.0	2.25	40
6.25	1	6.25	1.44	50
9.0	1	9.0	1.0	60
9.0	4	2.25	16.0	60
16.0	4	4.0	9.0	80
25.0	4	6.25	5.76	100
36.0	4	9.0	4.0	120

The Typical time curves for the Type CWC Relay apply if the values of R falls within the shaded area of the curve above, and if neither relay current is greater than K in amperes.

Fig. 10. Limits for Application of the CWC Time Curves.



These Curves are valid if the multiple of tap Product (volt-amperes) does not exceed the voltage on the relay polarizing coils.

Fig. 11. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply if the Multiple of Tap Product in Volt-Amperes Does Not Exceed the Polarizing Voltage in Volts.

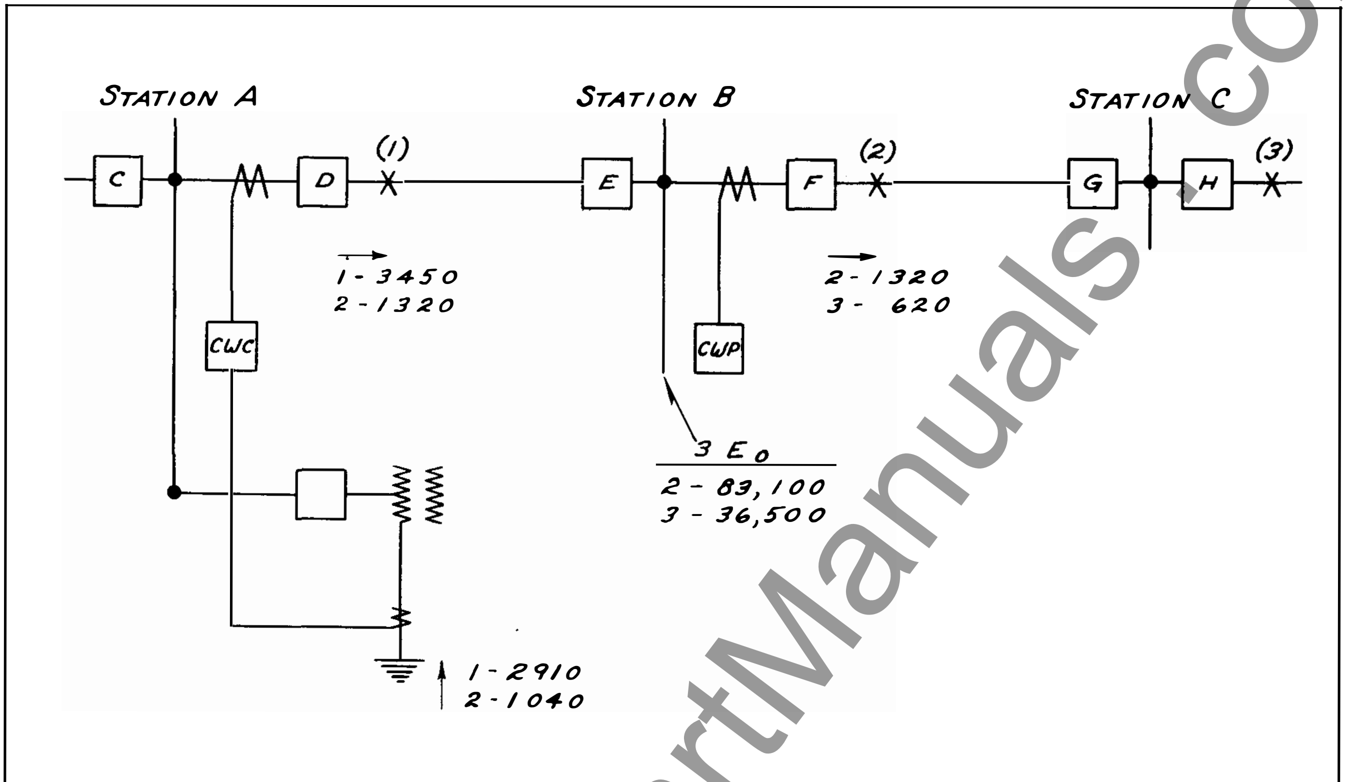


Fig. 12. Typical System for Setting Type CWC and CWP Relays.

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 range of 0.05 to 0.20 second as seen from the curves of Figs. 9 and 11.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 terminal. 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 difference between actual fault 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.

As an example, a type CWC relay is to be connected at Station A and set to protect the line running to Station B. It must select or coordinate with the type CWP relay connected at Station B and set to protect the line running to Station C. The fault current and voltage for single line-to-ground faults under minimum conditions for this system are shown in Fig. 12.

In setting the type CWC and CWP relays, it is convenient to set up Table as shown.

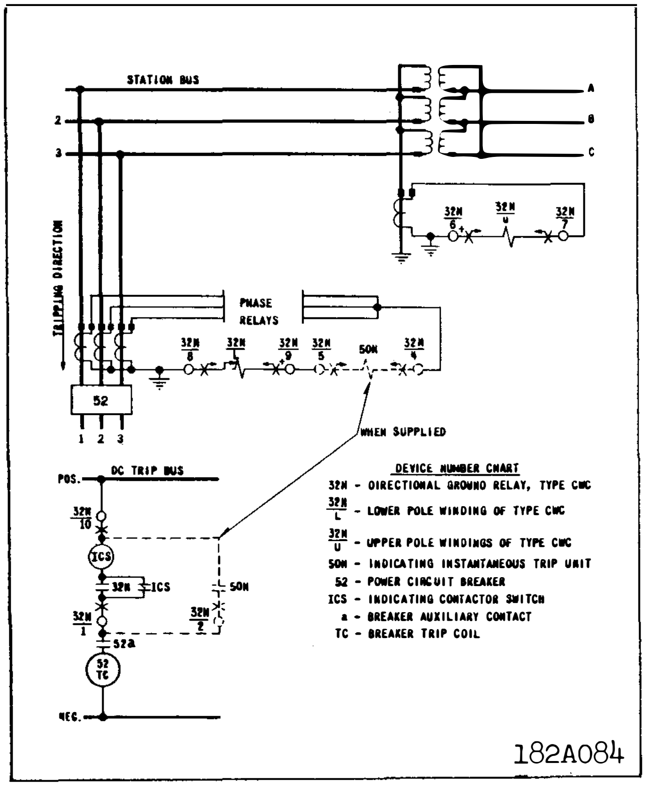


Fig. 13. External Schematic of the Type CWC Relay for Ground Protection.

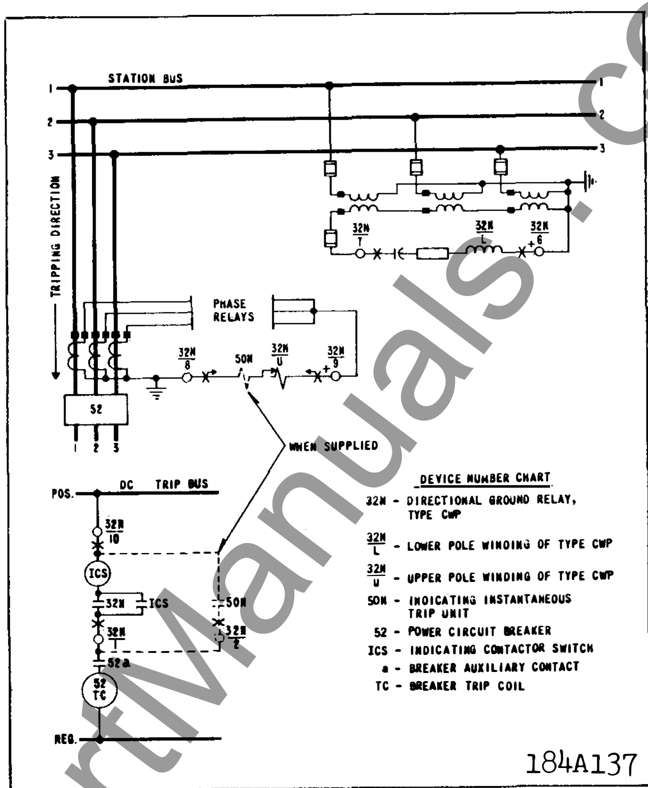


Fig. 14. External Schematic of the Type CWP Relay for Ground Protection.

TABLE 1

1 Relay Location	2 • Fault No.	3 Line Primary Amps.	4 Line C.T. Ratio	5 Polarizing Primary Amps. or Volts	6 Polarizing C.T. or P.T. Ratio	7 Line Secondary Amps. (I_L)	8 Polarizing Secondary ✱ Amps. (I_U)	9 Product $I_U \times I_L$	10 $\frac{I_L}{I_U}$	11 Tap	12 Multiples of Tap Product	13 R	14 Time Dial	15 Time In Seconds
D	1	3450	300/5	2910	300/5	57.5	48.5	2780	1.19	36	77	4.76	2	.11
D	2	1320		1040		22.0	17.3	381	1.27		10.6	5.1		.52
F	2	1320	100/5	83,100V	1000/1	66.0	83.1V	5485	-	300	18.3	-	¾	.13
F	3	620		36,500V		31.0	36.5V	1130	-		3.8	-		.53

The relay location is shown in Column 1 and the fault location in Column 2. The primary line residual current available for the relay is recorded in Column 3. The ratio of these current transformers is specified in Column 4.

The primary fault current or voltage available for the polarizing winding is shown in Column 5, and the associated current or potential transformer ratio in Column 6. All of these fault values are residual values or three times the zero sequence current of voltage. The relay current for the lower pole windings is the value of Column 3 divided by the ratio of Column 4. The value is recorded in Column 7. The upper pole relay current is the value of Column 5 divided by the ratio of Column 6, and is recorded in Column 8. The relay operating product is the values of Column 7 and 8 multiplied together and recorded in Column 9. For the type CWC relays, the ratio of $\frac{I_L}{I_U}$ is written in Column 10. All of this data is fixed by the system constants and characteristics, and is preliminary to making the actual relay setting.

The choice of a tap recorded in Column 11 and of the time lever in Column 14 is a matter of trial and

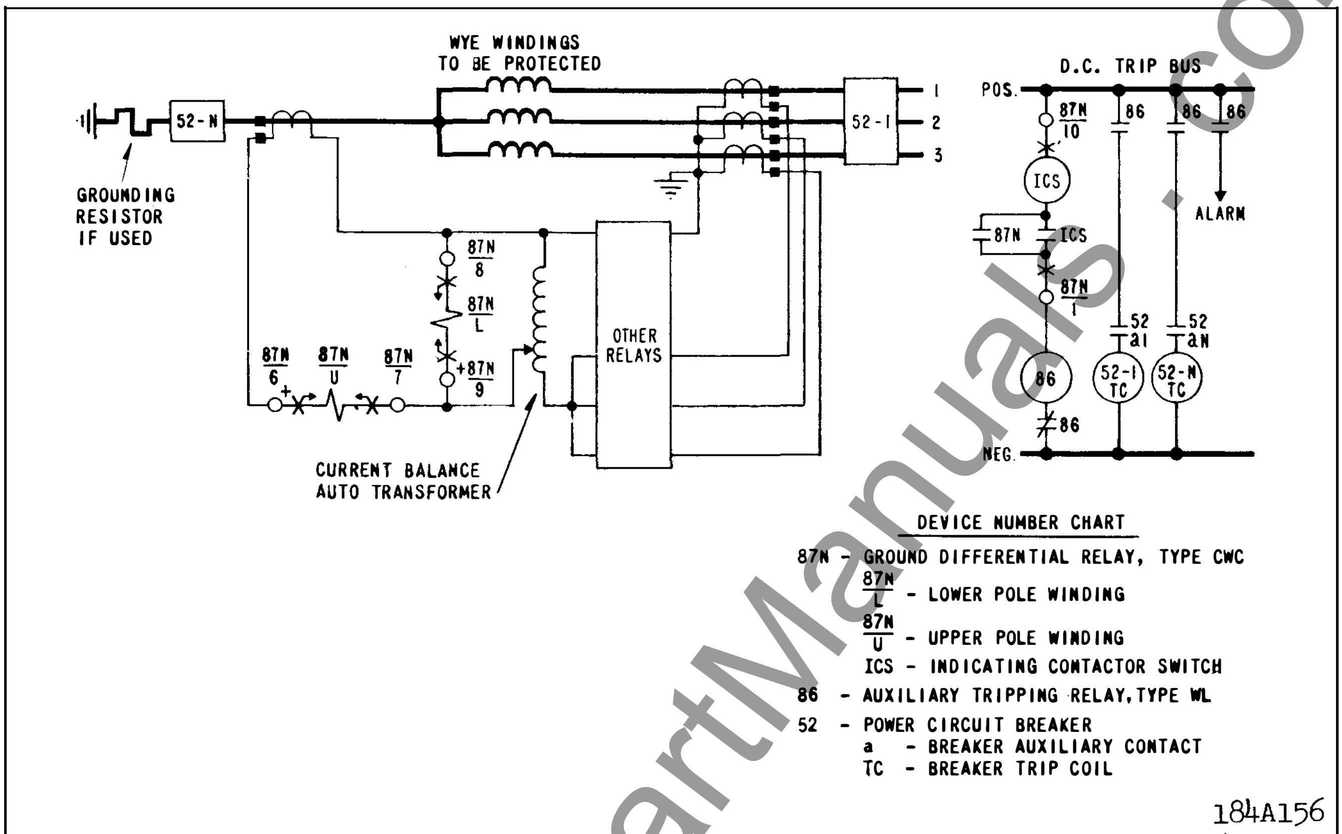


Fig. 15. External Schematic of the Type CW Relay for Ground Differential Protection of Wye or Zig-zag Winding of a Transformer or Rotating Machine.

error. The breakers on this system have 8 cycle operating time so that the coordinating time interval should be about .4 second. The tap should be chosen so that the relay times for the close-in fault and remote fault product values will differ by about the coordinating time interval or .4 second in this case. Practically this can be accomplished by several taps with equal results. Tap 36 was selected in this example. The product value divided by the tap is recorded in Column 12. This value is the abscissa of the time product relay curves. From these curves the lever Column 14 and relay operating time Column 15 were chosen so that the relay would operate at about .12 second for close-in faults and about .52 second for the remote faults. These times for the type CWC relay were obtained using time dial setting ¾. With the selection of a satisfactory tap value, the curves of Fig. 10 will quickly show if the combination of tap and current values provide relay operating times as indicated by the curve. The value of Column 10 multiplied by N = 4.0 for tap 36 gives the R values of Column 13. These are within the curve of Figure 10.

The same process is allowed in setting the type CWP relay at Station B on breaker F. Here tap 300 was selected with dial to provide relay operating times of 0.13 and 0.53 seconds respectively for close-in and remote faults. The operating limits using this tap are fulfilled since neither multiples of tap product value (Column 12) is greater than the polarizing voltage (Column 8).

After individual relay settings are made, it is necessary to check to see if the relays select properly with associated relays. In the example the coordinating time interval was 0.4 second. Therefore, for fault 2, the relay at D should not operate before the relay at F plus the coordinating time interval. In other words, the operating time of D should not be less than 0.13 second plus 0.4 = 0.53 second

* Similarly, the time of the relay at breaker H should not be greater than 0.13 second in order to select with relay F for fault 3. If the time of relay H is greater, then the time of relay at F must be increased to provide proper selection. This change may

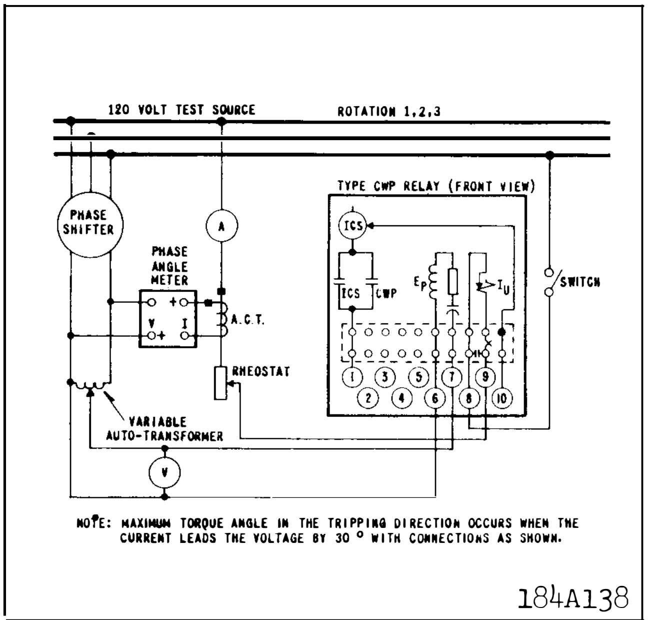


Fig. 16. Diagram of Test Connections for the Type CWP Relay in FT-21 Case.

be accomplished by a change in the time lever setting only, although often a new tap and lever setting may provide a more satisfactory setting. Changing the setting of relays at B probably will require a change in the setting of the relay at Station A.

After the setting 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 dial settings are required, particularly if the maximum and minimum fault values are quite different.

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

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

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.

Acceptance Check

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

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 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

For the CWC relay, connect the upper and lower pole coils in series and pass a current equal to $\sqrt{\text{tap product x multiplier}}$ in polarity thru both coils. For the CWP relay connect the relay as per Fig. 16 and apply tap value product. The moving contacts on both relays should close within 5% of the applied values.

3. Time Curve

CWC Relay — Connect the upper and lower poles in series and pass current in polarity thru both coils. Set the time dial on the 6 position and taps on .25 or 2.25 product and 1 multiplier. Check several points on the time curve. Timing should be within ± 7% of that of Figure 9.

CWP Relay - Connect the relay per Figure 16. Set the time dial on the 6 position and the tap in the 20 or 75 product. Check several points on the time curve by applying current leading the voltage by 300°. The timing should be within ±7% of the values shown on Fig. 11.

4. 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 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 not be greater than the particular ICS tap setting being used. The operation indicator target should drop freely. The contact gap should be approximately 0.47" 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.

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.

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").

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 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

Type CWC Relay - Connect the upper and lower pole coils in series and pass current in polarity on both coils. With one tap screw in the 1 multiplier position and the other screw in the .25 product tap for the .25-4 product range or the 2.25 product tap for the 2.25 — 36 product range, apply current and adjust the spring tension so that the contacts just close at tap value product.

Type CWP Relay - Connect the relay per Fig. 16. Set in the lowest tap, apply 100 volts across terminals 6 and 7, and apply minimum pickup current, leading the voltage by 300°, (0.20 amperes for the 20-150 range, 0.75 amperes for the 75-600 range.) Then, adjust the spring tension so that the contacts just close.

3. Time Curve Calibration

Type CWC relay — Set the time dial to position 6 and the product tap to .25 or 2.25. Set the multiplier tap to 1. Connect the upper and lower pole coils in series and pass a current equal to $4 \times \sqrt{\text{tap product}}$ in polarity thru the coils. Adjust the permanent magnet keeper until the operating time is between .95 and 1.01 seconds. Other points on the time curve of Figure 9 should be within ± 7% of the values shown. (The multipliers of tap product shown in Figure 9 equal the square of the current passed thru the coils divided by the tap product.)

Type CWP Relay - Connect the relay per the test circuit of Fig. 16. Set the 6 time dial and the lowest tap. Apply 100 volts to potential coil and 10 times tap current. (Current leading voltage by 300°). relay operate between 1.43 and 1.51 seconds. Other points of the time curve should be within ± 7% of the value shown on Fig. 11.

4. Indicating Contactor Switch (ICS)

Close the main relay contacts and pass suf-

ficient 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 operation indicator target should drop freely.

5. Indicating Instantaneous Trip Unit (IIT)

The core screw must be adjusted to the value of pickup current desired.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

CWC

The burden of the Type CWC relays at 5 amperes, 60 cycles is as follows:

Lower Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
.25-4	.25	82.7	29.3	88.0	19.5
	.36	57.3	14.1	59.0	13.8
	.64	32.1	4.43	32.4	7.85
2.25-36	1.00	20.6	1.83	20.7	5.10
	2.25	8.50	3.26	9.1	21.0
	4.0	4.78	1.03	4.89	12.1
	6.25	3.01	0.41	3.04	7.7
	9.0	2.13	0.21	2.14	5.5

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
.25-4	1	6.08	8.58	10.5	55
	4	1.52	0.54	1.61	20
2.25-36	1	0.79	0.95	1.24	50
	4	0.20	0.06	0.21	17

CWP

The burden of the Type CWC relays at 5 amperes, 115 volts, 60 cycles is as follows:

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lag
75-600	75	0.633	0.144	0.660	12.6
	100	0.557	0.095	0.560	9.8
	150	0.494	0.043	0.495	5.0
	200	0.460	0.032	0.460	4.0
	300	0.370	0.013	0.370	2.0
	400	0.340	0.006	0.340	1.0
	600	0.290		0.290	0.5
20-150	20	4.70	2.66	5.4	29.5
	30	3.23	1.21	3.45	20.5
	40	2.93	0.87	3.05	16.5
	50	2.31	0.57	2.38	14.0
	75	1.50	0.28	1.52	10.7
	100	1.15	0.11	1.15	5.5
	150	0.80	0.014	0.80	1.0

Lower Pole Potential Windings
(between relay terminals 6 and 7)

	Watts	Vars	Volt-Amperes	P. F. Angle Degrees Lead
All ranges -	5.5	2.78	6.15	26.8

CWC & CWP THERMAL RATINGS

Relay	Range	Pole Winding	Continuous Amperes	1 Sec Amperes
CWC	.25-4	All	4	110
CWC	2.25-36	Upper	10	280
		Lower	12.7	370
CWP	20-150	Upper	3.2	88
	75-600	Upper	6.4	185

The potential coil circuit of the type CWP relay will stand 250 volts for 15 seconds.

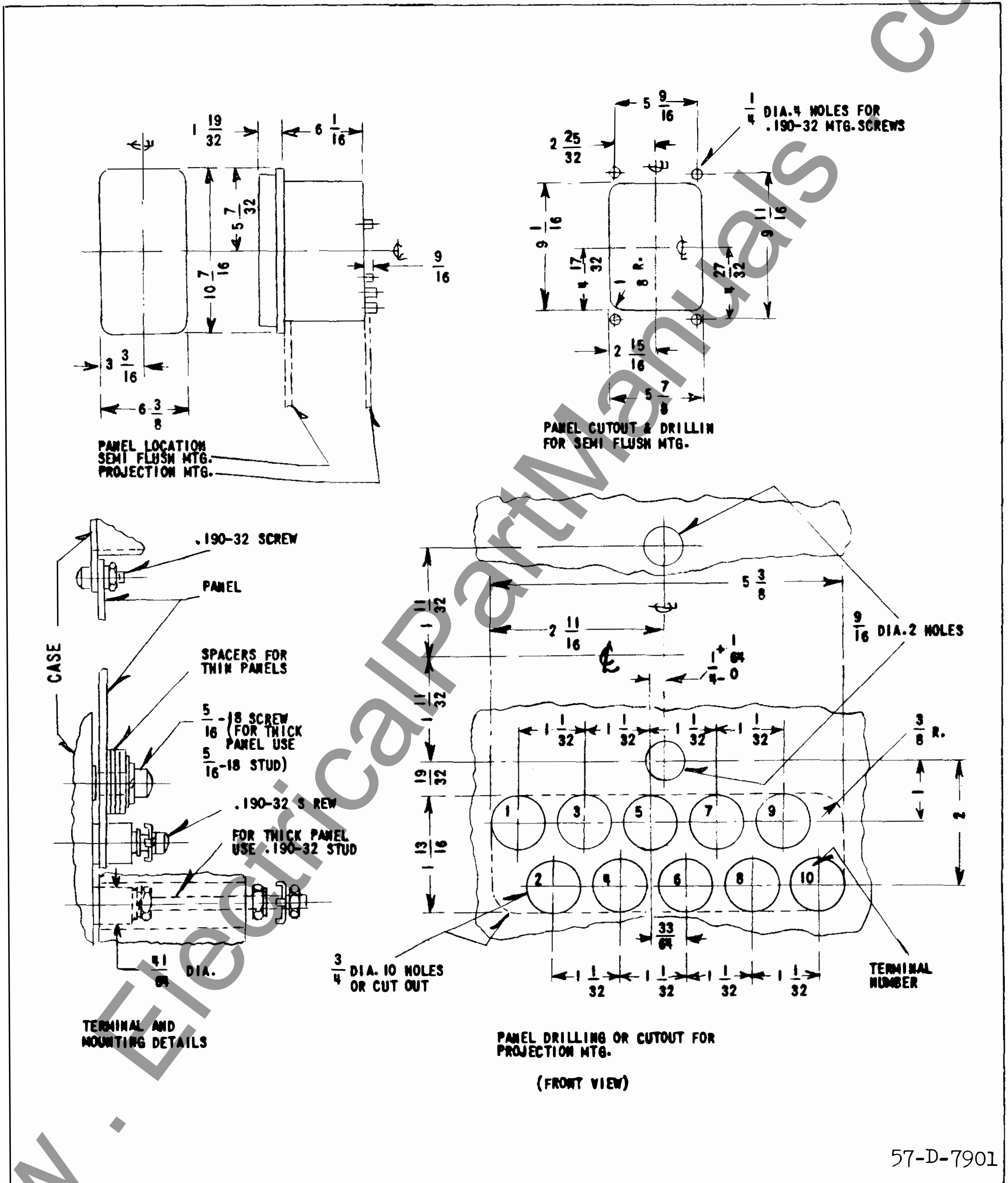


Fig. 17. Outline & Drilling Plan for the Type CWC and CWP Relays in the Type FT-21 Case.

WESTINGHOUSE ELECTRIC CORPORATION

RELAY-INSTRUMENT DIVISION **NEWARK, N. J.**

Printed in U.S.A.

WESTINGHOUSE

INSTALLATION • OPERATION • MAINTENANCE
INSTRUCTIONS

TYPE CWC AND CWP DIRECTIONAL GROUND RELAYS

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

APPLICATION

The Type CWC and CWP relays are induction disc type relays used for directional ground fault protection on grounded neutral power systems. The type CWC relay is polarized by current from a suitably grounded power transformer bank neutral. Therefore, its application does not require potential transformers. The type CWP relay is potential polarized by residual voltage obtained across the open corner of the delta winding of a grounded star-delta potential transformer.

At stations where the power transformer bank neutral is grounded, the residual voltage will be small generally, and the type CWC relay is recommended. At ungrounded stations, or at ground stations where the power transformer bank neutral is not available, the type CWP relay is applicable.

CONSTRUCTION AND OPERATION

The Type CWC and CWP relays consist of an induction disc type unit, an indicating contactor switch, and an optional indicating instantaneous trip unit.

INDUCTION DISC UNIT

The induction disc unit contains a thin four-inch diameter disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The element is not geared. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf-spring. This spring is fastened to a moulded block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the moulded block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in front. The operating torque for the CWC relay is obtained by energizing the lower pole coil with residual current (usually obtained from the line current transformer) and the 2 tapped upper pole coils with residual current from the current transformer in the power transformer bank neutral. For the CWP relay the operating torque is obtained by energizing the upper pole coils with residual current (usually obtained from the line current transformer) and the lower pole with residual voltage.

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

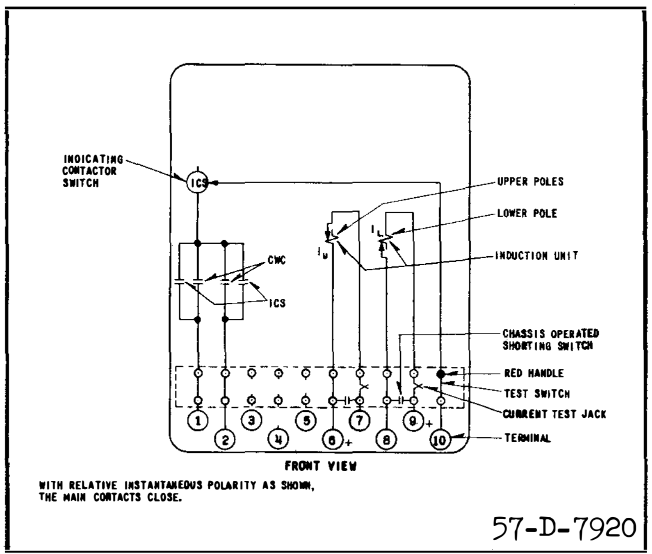


Fig. 1. Internal Schematic of Double Trip Type CWC Relay In the Type FT-21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

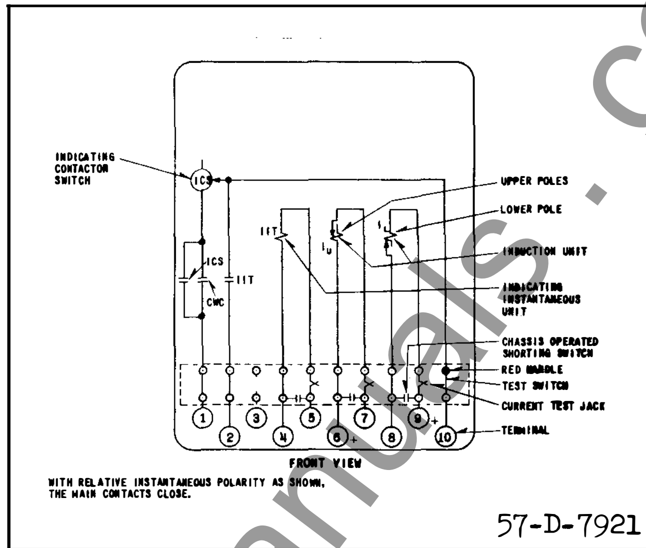


Fig. 2. Internal Schematic of the Type CWC Relay with Indicating Instantaneous Trip Unit In the Type FT-21 Case.

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.

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. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

CHARACTERISTICS

TYPE CWC RELAY

The type CWC relay has two taps on the upper pole and four on the lower pole. They are marked in amperes which is the current thru both windings in series at minimum pick-up, and in product which is the minimum pick-up product of two equal or unequal currents.

Type CWC Relay Ranges and taps are:

.5 to 2 ampere (.25 to 4 Product) Range

Amperes	.5	.6	.8	1.0	1.2	1.6	2.0
Product	.25	.36	.64	1.0	1.44	2.56	4.0

1.5 to 6 ampere (2.25 to 36 Product) Range

Amperes	1.5	2.0	2.5	3.0	4.0	5.0	6.0
Product	2.25	4.0	6.25	9.0	16.0	25.0	36.0

The first four values are marked on the lower pole top plate. The upper pole tap plate is marked x1 and x2 (x1 and x4 Product). The last four values are obtained by using the x2 tap with the four lower pole taps.

Typical 60 Cycle time-product curves for the type CWC relay are shown in Fig. 5. These curves are taken at maximum torque which occurs with the currents in phase. For residual and Ground currents

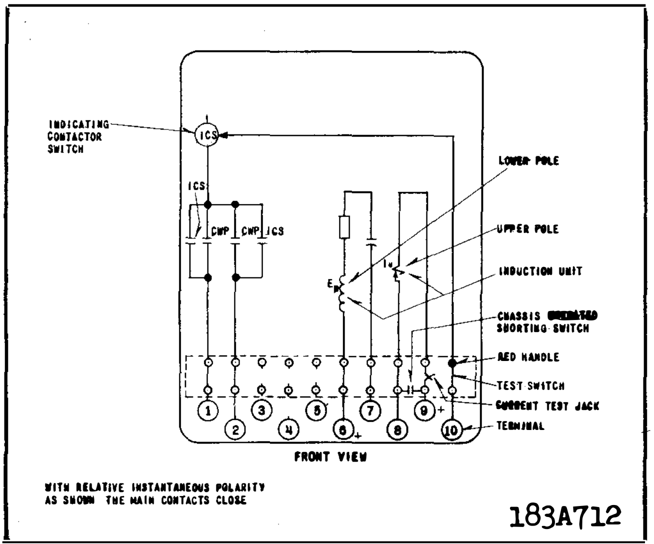


Fig. 3. Internal Schematic of the Type CWP Relay in the Type FT21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

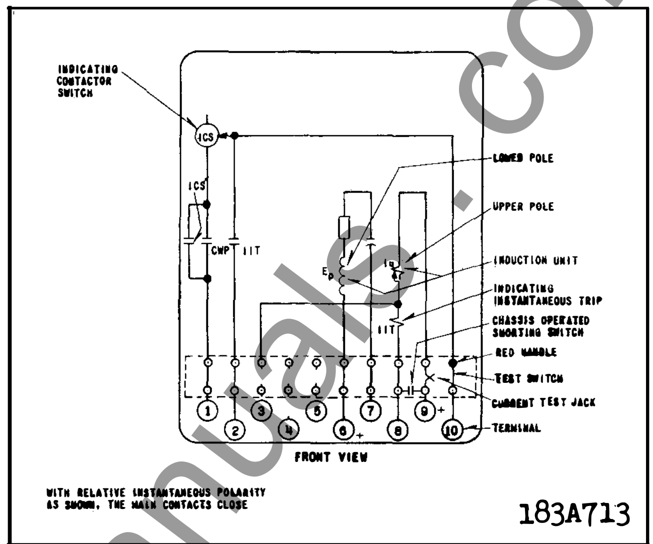


Fig. 4. Internal Schematic of the Type CWP Relay with Indicating Instantaneous Trip Unit in the Type FT21 Case.

out of phase the relay operating time may be obtained by determining the operating time corresponding to the product $P' = P \cos \theta$, where P is the actual relay product in amperes squared, and θ is the angle between the residual and polarizing currents.

The limits for which these curves are accurate within ± 7% are shown in Fig. 6.

TYPE CWP RELAY

The type CWP relay taps are on the upper pole current coil. They represent the minimum pick-up product of current times voltage at maximum torque when the current lags the voltage by 60°. The ranges and taps are:

Product Range	Tap Markings						
20 - 150	20	30	40	50	75	100	150
75 - 600	75	100	150	200	300	400	600

Typical 60 cycle time product curves for the type CWP relay are shown in Fig. 7. These curves are taken at maximum torque which occurs with the current lagging the voltage 60°. For currents not lagging by this angle, the relay tripping time may be obtained by determining the operating time corresponding to the product $p' = P \cos (60° - \theta)$, where P is the actual relay V.A. product and θ is the angle the current lags the voltage. The curves are accurate within ±7% if the multiple of tap product does not exceed the voltage on the relay coil.

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

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

SETTING CALCULATIONS

The following information is required to set these relays:

1. The maximum and minimum ground fault cur-

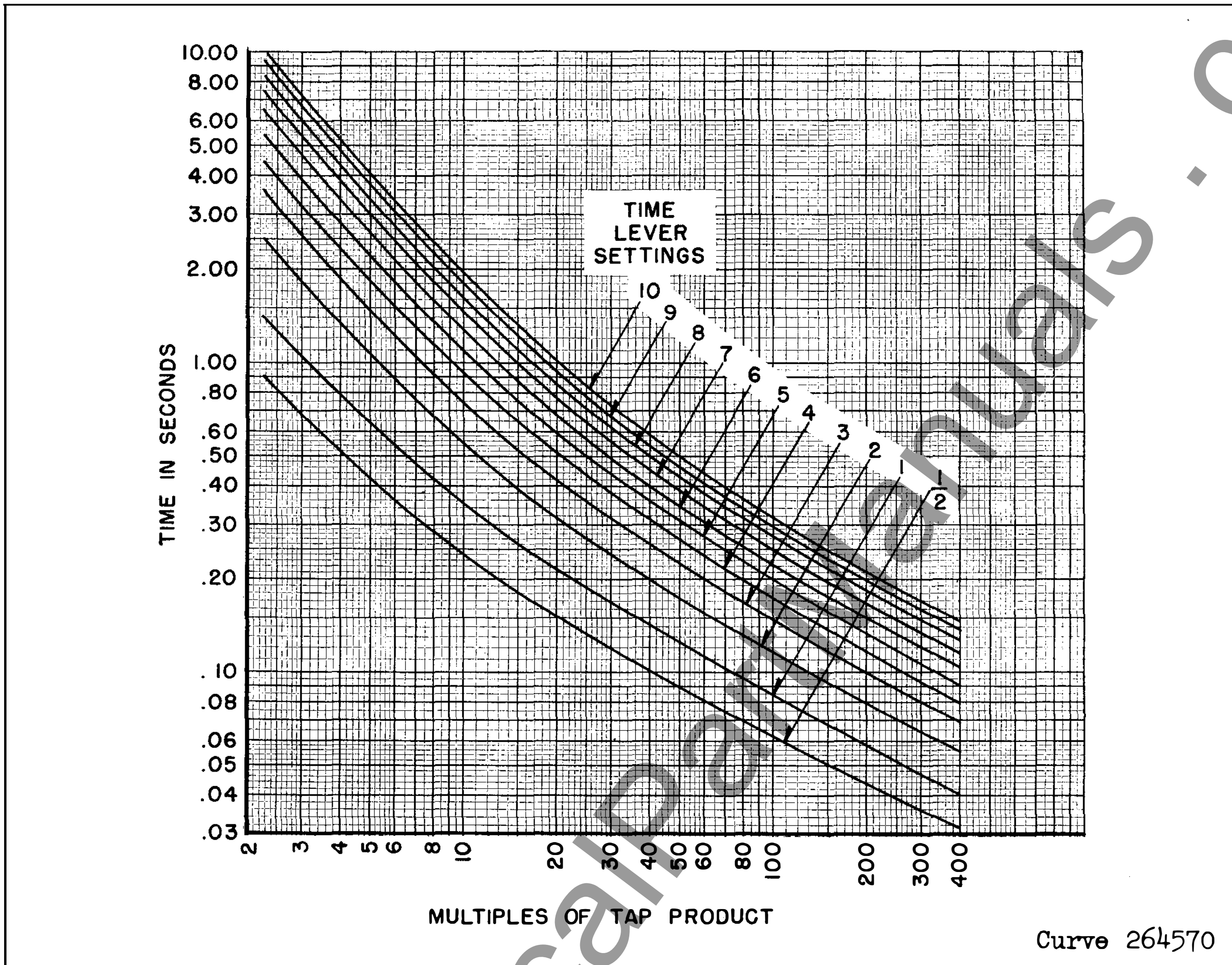


Fig. 5. Typical Time Curves of the Type CWC Relay - Current Coils In Series - See Figure 6 for application limits.

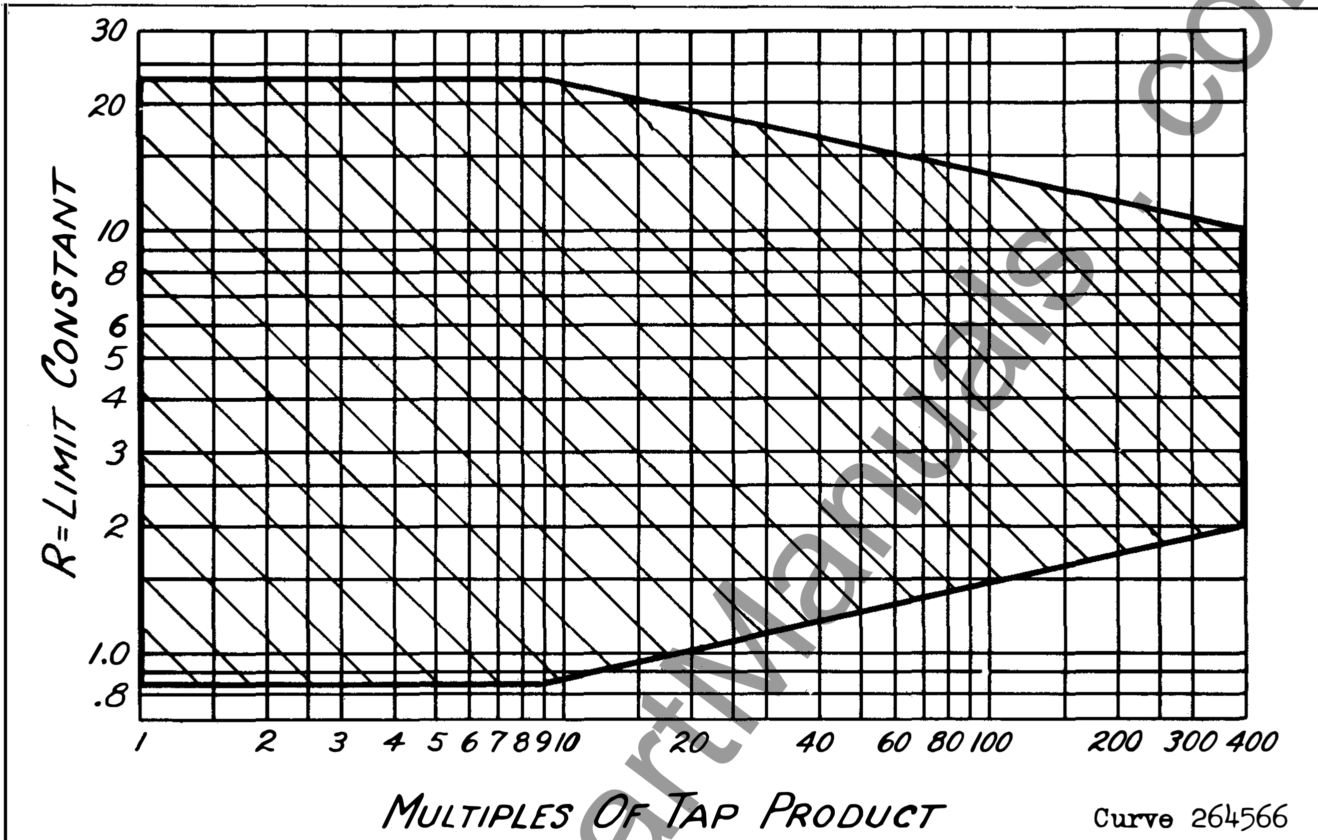
rents for faults at the relay and at the remote bus. These values should be residual current which is three times the zero sequence current.

2. The maximum and minimum polarizing current or voltage values for the faults above. The values should be residual currents or voltage which are three times the zero sequence values.

3. The current transformer ratios of the main and polarizing current transformers for the type CWC relay applications or the main current transformer ratio and the polarizing potential transformer ratio for the type CWP relay application.

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 range of 0.05 to 0.20 second as seen from the curves of Figs. 5 and 7.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 terminal. 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



For the 0.25 to 4 Product Range

$$R = M\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
M = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	M	K
.25	1	.25	4.0	10
.36	1	.36	2.78	12
.64	1	.64	1.56	16
1.0	1	1.0	1.0	20
1.0	4	.25	16.0	20
1.44	4	.36	11.1	24
2.56	4	.64	6.25	32
4	4	1.00	4.0	40

For the 2.25 to 36 Product Range

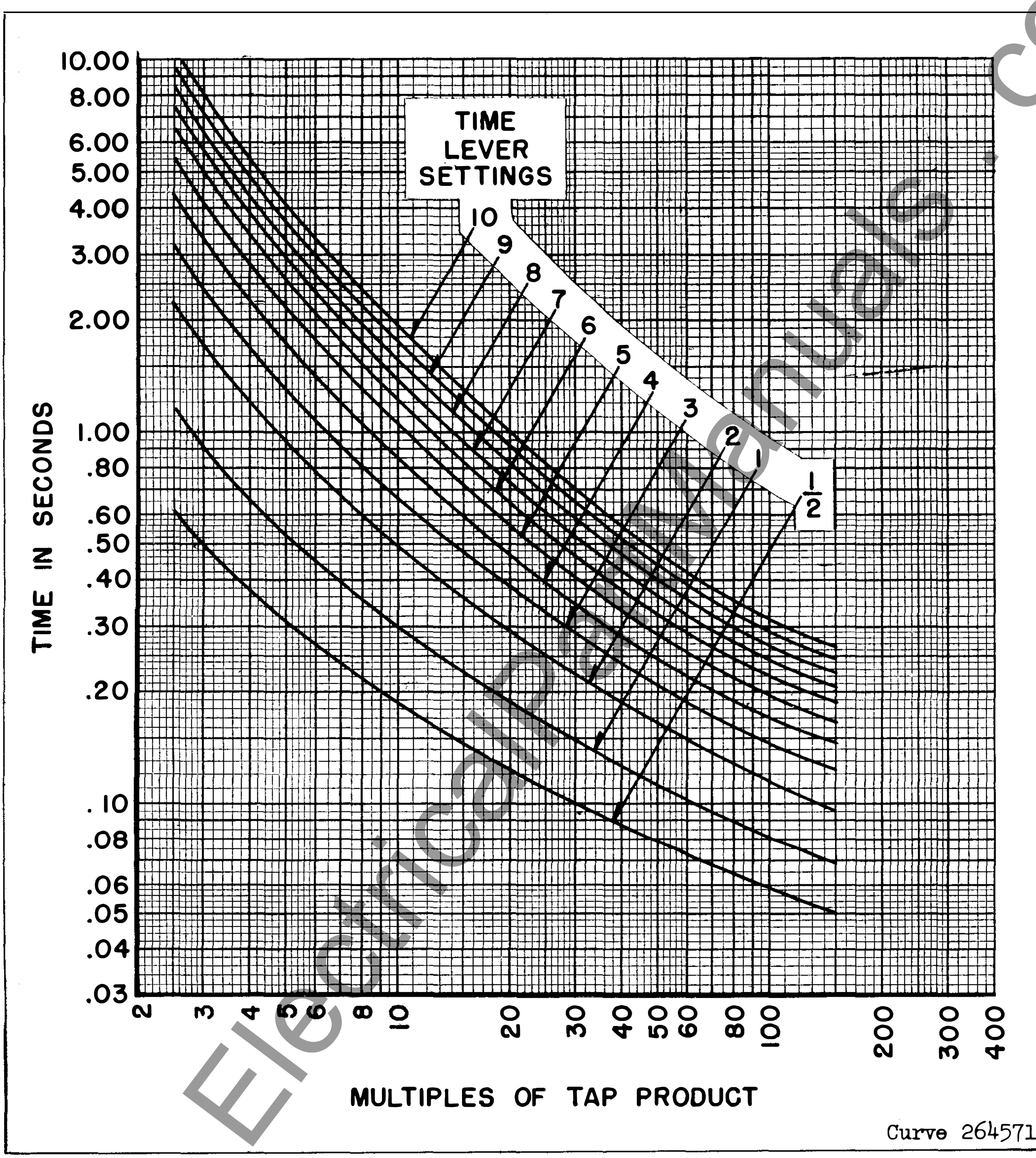
$$R = N\frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
N = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	N	K
2.25	1	2.25	4.0	30
4.0	1	4.0	2.25	40
6.25	1	6.25	1.44	50
9.0	1	9.0	1.0	60
9.0	4	2.25	16.0	60
16.0	4	4.0	9.0	80
25.0	4	6.25	5.76	100
36.0	4	9.0	4.0	120

The Typical time curves for the Type CWC Relay apply if the values of R falls within the shaded area of the curve above, and if neither relay current is greater than K in amperes.

Fig. 6. Limits for Application of the CWC Time Curves.



These Curves are valid if the multiple of tap Product (volt-amperes) does not exceed the voltage on the relay polarizing coils.

Fig. 7. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply If the Multiple of Tap Product In Volt-Amperes Does Not Exceed the Polarizing Voltage In Volts.

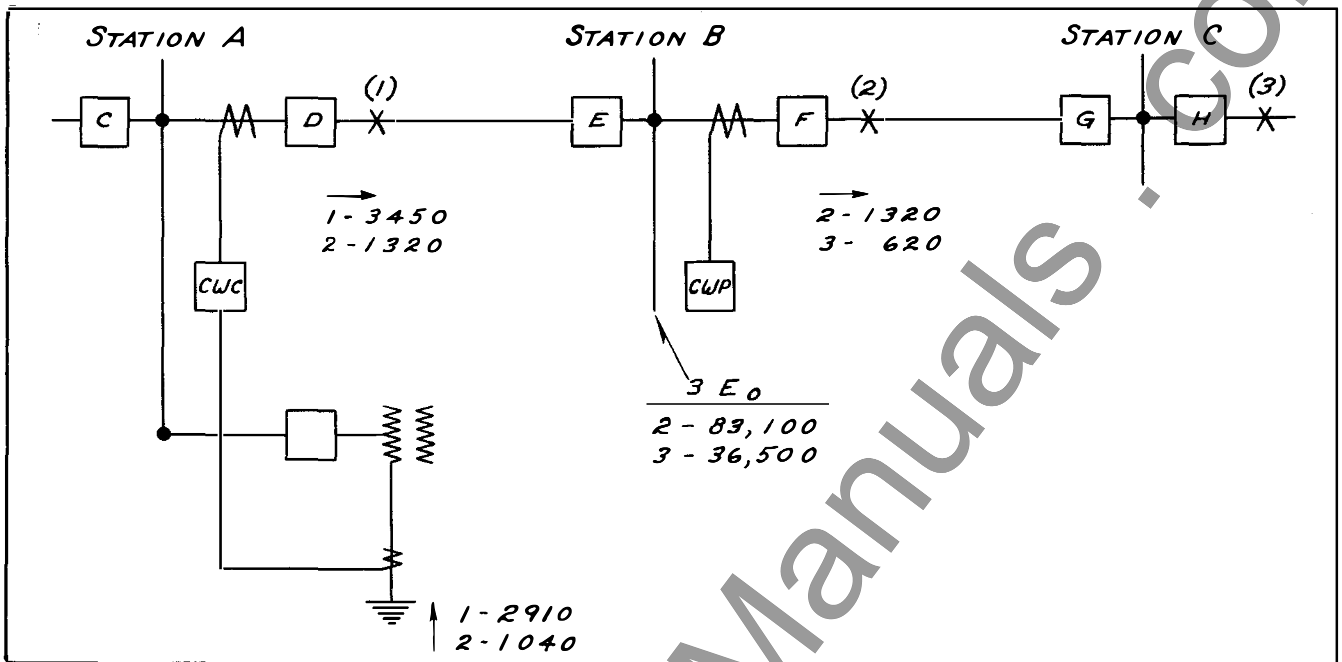


Fig. 8. Typical System for Setting Type CWC and CWP Relays.

TABLE I

1 Relay Location	2 Fault No.	3 Line Primary Amps.	4 Line C.T. Ratio	5 Polarizing Primary Amps. or Volts	6 Polarizing C.T. or P.T. Ratio	7 Line Secondary Amps. (I_L)	8 Polarizing Secondary Amps. (I_U)	9 Product $I_U \times I_L$	10 $\frac{I_L}{I_U}$	11 Tap	12 Multiples of Tap Product	13 R	14 Lever	15 Time In Seconds
D	1	3450	300/5	2910	300/5	57.5	48.5	2780	1.19	36	77	4.76	2-1/4	.14
D	2	1320		1040		22.0	17.3	381	1.27		10.6	5.1		.56
F	2	1320	100/5	83,100V	1000/1	66.0	83.1V.	5485	—	300	18.3	—	3/4	.16
F	3	620		36,500V		31.0	36.5V.	1130	—		3.8			.53

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 difference between actual fault 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.

As an example, a type CWC relay is to be connected at Station A and set to protect the line running to Station B. It must select or coordinate with the type CWP relay connected at Station B and set to protect the line running to Station C. The fault currents and voltage for single line-to-ground faults under minimum conditions for this system are shown in Fig. 8.

In setting the type CWC and CWP relays, it is convenient to set up Table as shown. The relay location is shown in Column 1 and the fault location in Column 2. The primary line residual current available for the relay is recorded in Column 3. The ratio of these current transformers is specified in Column 4.

The primary fault current or voltage available for the polarizing winding is shown in Column 5 and the associated current or potential transformer ratio in Column 6. All of these fault values are residual values or three times the zero sequence current or voltage. The relay current for the lower pole windings is the value of Column 3 divided by the ratio of Column 4. The value is recorded in Column 7. The upper pole relay current is the value of Column 5 divided by the ratio of Column 6, and is recorded in Column 8. The relay operating product is the values of Column 7 and 8 multiplied together and recorded in Column 9. For the type CWC relays, the ratio of $\frac{I_L}{I_U}$ is written in Column 10. All of this data is fixed by the system constants and characteristics,

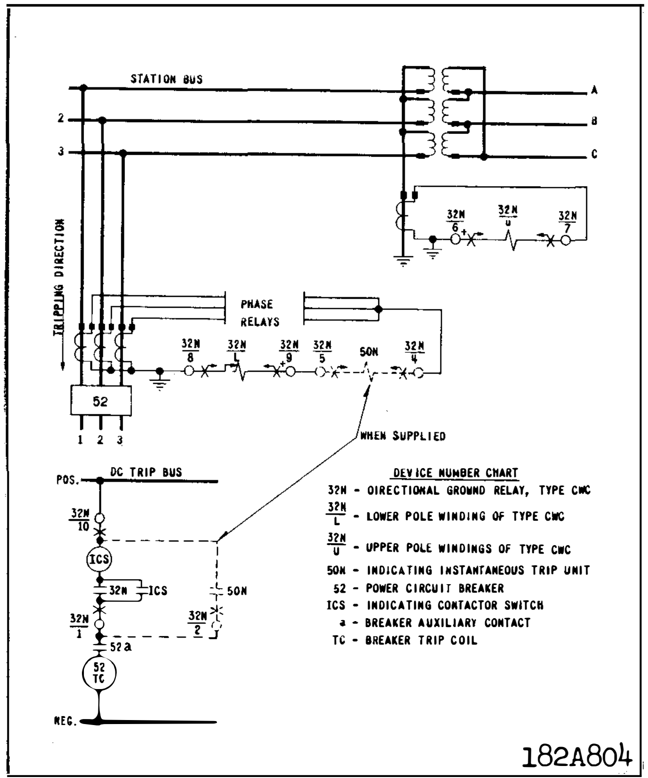


Fig. 9. External Schematic of the Type CWC Relay for Ground Protection.

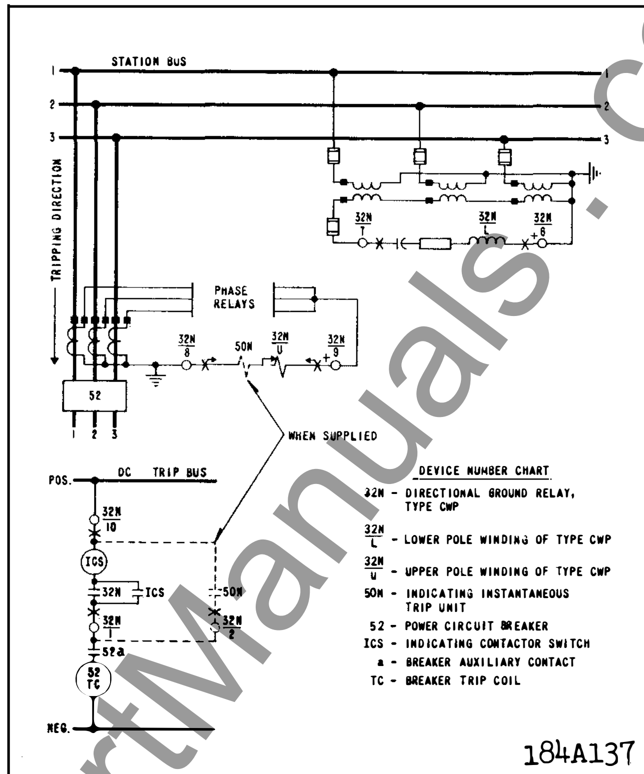


Fig. 10. External Schematic of the Type CWP Relay for Ground Protection.

and is preliminary to making the actual relay setting.

The choice of a tap recorded in Column 11 and of the time lever in Column 14 is a matter of trial and error. The breakers on this system have 8 cycle operating time so that the coordinating time interval should be about .4 second. The tap should be chosen so that the relay times for the close-in fault and remote fault product values will differ by about the coordinating time interval or .4 second in this case. Practically this can be accomplished by several taps with equal results. Tap 36 was selected in this example. The product value divided by the tap is recorded in Column 12. This value is the abscissa of the time product relay curves. From these curves the lever Column 14 and relay operating time Column 15 were chosen so that the relay would operate at about .15 second for close-in faults and about .56 second for the remote faults. These times for the type CWC relay were obtained using time lever setting no. 2-1/4.

With the selection of a satisfactory tap value, the curves of Fig. 6 will quickly show if the combination of tap and current values provide relay operating times as indicated by the curve. The value of Column 10 multiplied by N = 4.0 for tap 36 gives the R values of Column 13. These are within the curve of Figure 6.

The same process is allowed in setting the type CWP relay at Station B on breaker F. Here tap 300 was selected with lever 3/4 to provide relay operating times of 0.16 and 0.53 seconds respectively for close-in and remote faults. The operating limits using this tap are fulfilled since neither multiples of tap product value (Column 12) is greater than the polarizing voltage (Column 8).

After individual relay settings are made, it is necessary to check to see if the relays select properly with associated relays. In the example the coordinating time interval was 0.4 second. Therefore, for fault 2, the relay at D should not operate before the relay at F plus the coordinating time interval. In other words, the operating time of D should be not less than 0.16 second plus 0.40 = 0.56 second.

Similarly the time of the relay at breaker H should not be greater than 0.13 second in order to select with relay F for fault 3. If the time of relay

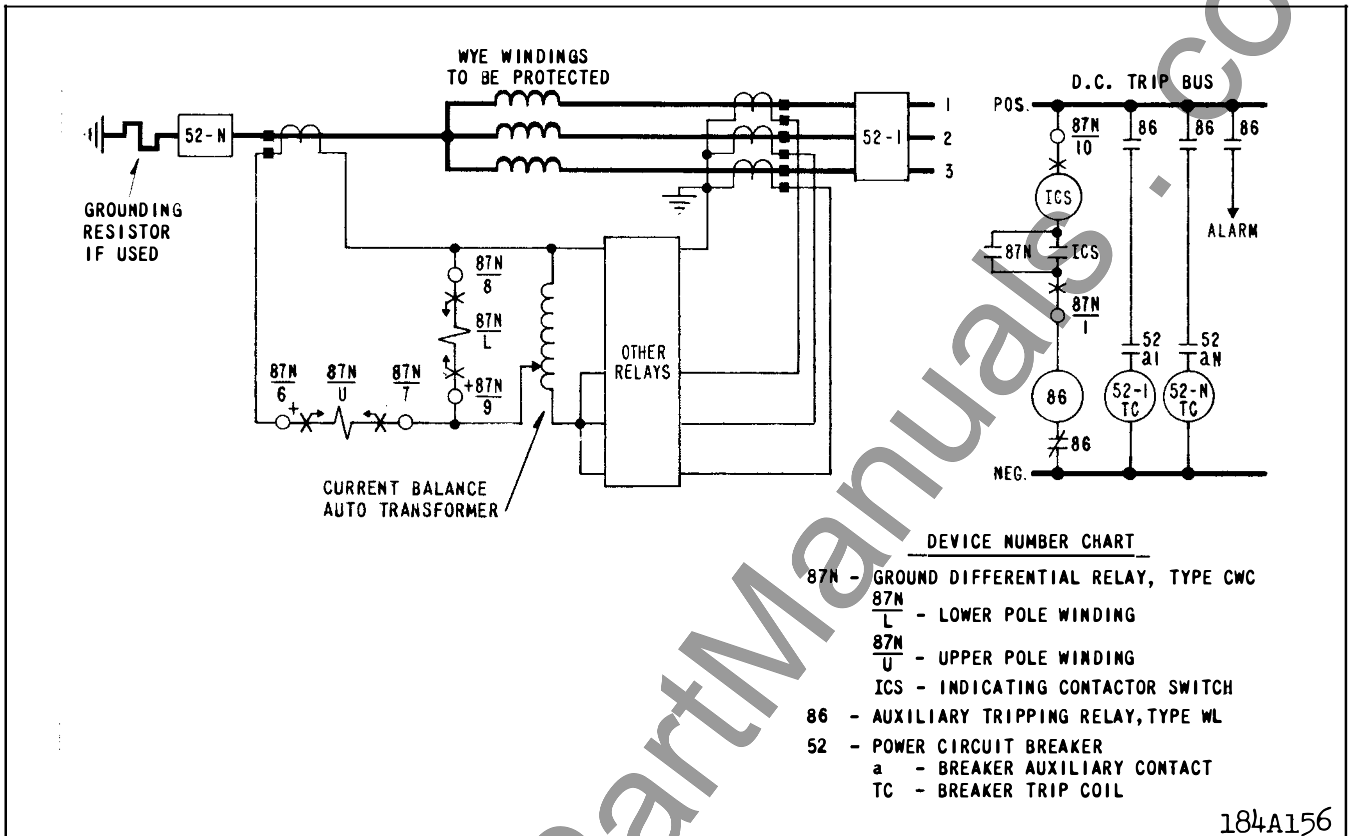


***Fig. 11.** External Schematic of the Type CW Relay for Ground Differential Protection of Wye or Zig-zag Winding of a Transformer or Rotating Machine.*

H is greater, then the time of relay at F must be increased to provide proper selection. This change may be accomplished by a change in the time lever setting only, although often a new tap and lever setting may provide a more satisfactory setting. Changing the setting of relays at B probably will require a change in the setting of the relay at Station A.

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.

SETTING THE RELAY

CWC INDUCTION UNIT

Select the desired upper and lower pole taps. Set the lever position by applying a preselected current to the relay coils, and adjusting the lever position to obtain the desired time of operation. Alternatively the lever may be set by inspection, if the timing coordination is not critical.

CWP INDUCTION UNIT

Select the desired upper pole tap. Set the lever position by applying a preselected voltage and current (current lagging voltage by 60° - see Fig. 11) to the relay coils and adjusting the lever position to obtain the desired time of operation. Alternatively the lever may be set by inspection, if the timing coordination is not critical.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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 balock to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt d-c type WL relay switch, or equivalent, use the 0.2-ampere tap; for 48-volt d-c applications set relay in 2 tap and use S#304C209G01 Type WL Relay or equivalent.

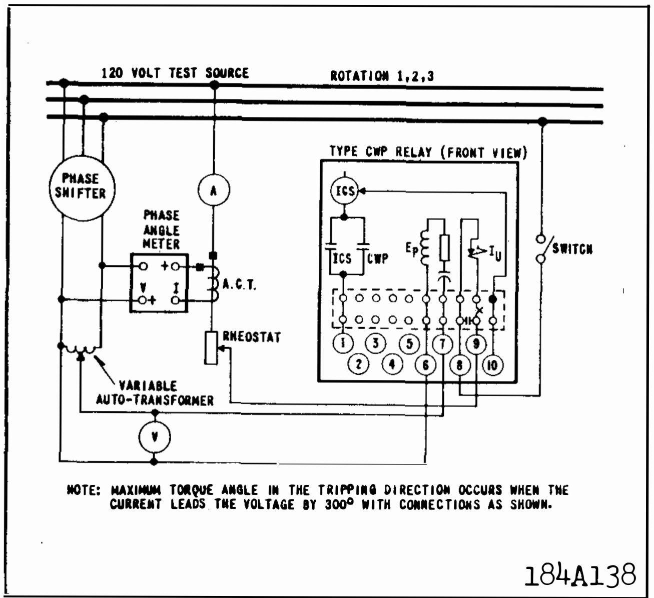


Fig. 12: Diagram of Test Connections for the Type CWP Relay in FT-21 Case.

INDICATING INSTANTANEOUS TRIP (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, 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.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

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

ADJUSTMENTS AND MAINTENANCE

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

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.

INDUCTION UNIT

The upper bearing screw should be screwed down until there is only 3 to 5 thousandths inch clearance between it and the shaft and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the disc fails to turn freely and then backing up a fraction of a turn Great care must be taken in making this adjustment to prevent damage to the bearings.

Adjust the contacts to just barely touch when the time lever is set on zero by shifting the position of the contact stop on the time lever. This should be done with approximately the required contact follow. Final adjustment of the contacts can be more easily made by the contact follow set screw after the contact stop is securely fixed.

A maximum contact follow of approximately 5/64 inch is obtained when the set screw on the stationary contact is all the way out. Where rigid contacts for quick reopening are required, the set screw should be all the way in to hold the stationary contact against the Micarta bracket. Readjust the zero setting after this is done.

CWC RELAY

Connect the upper and lower pole coils in series and pass current in polarity on both coils. With one tap screw in the 1 multiplier position and the other screw in the .36 product tap for the .25-4 product range or the 4 product tap for the 2.25-36 product range, apply current and adjust the spring tension so that the contacts just close with tap value of current flowing. This is 0.6 ampere, 60 cycles, on the .25-4 product range or 2.0 amperes, 60 cycles, on the 2.25-36 product range. The spring tension may by changed by means of a screw driver inserted in one of the notches of the plate to which the outside convolution of the spring is fastened.

Various points on the typical time-product curves can be checked approximately with the current coils in series. The multiples of tap product will be the square of the current passed thru the two coils, divided by the tap product. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked. Time curve calibration is obtained by adjusting the position of the permanent magnet.

TYPE CWP RELAY

Use the following procedure to check the zero torque line. Adjust the control spring for zero tension and connect per Fig. 12. Apply 120 volts across terminals 6 and 7 and five times minimum pick up current (tap value divided by 24). Zero torque should occur when the currents lead the voltage by 19° to 36°.

To calibrate the control spring, connect per Fig. 11, set in the lowest tap, apply 100 volts across terminals 6 and 7, and apply minimum pickup current, leading the voltage by 300°, (0.20 amperes for the 20-150 range, 0.75 amperes for the 75-600 range). Then, adjust the spring tension so that the contacts just close. Spring adjustment is changed by inserting a screw driver in one of the spring adjuster plate notches.

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.

To check points on the time curve, connect per Fig. 11, and apply preselected current and voltage values, with current leading the voltage by 300° and measure the time of operation with a cycle counter. The time of several trials should be averaged. If the current coil is allowed to overheat, the timing will be affected. The potential coil should not be continuously energized above 115 volts.

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.

INDICATING INSTANTANEOUS TRIP (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%.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

CWC

The burden of the Type CWC relays at 5 amperes, 60 cycles is as follows:

Lower Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
.25-4	.25	82.7	29.3	88.0	19.5
	.36	57.3	14.1	59.0	13.8
	.64	32.1	4.43	32.4	7.85
	1.00	20.6	1.83	20.7	5.10
2.25-36	2.25	8.50	3.26	9.1	21.0
	4.0	4.78	1.03	4.89	12.1
	6.25	3.01	0.41	3.04	7.7
	9.0	2.13	0.21	2.14	5.5

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
.25-4	1	6.08	8.58	10.5	55
	4	1.52	0.54	1.61	20
2.25-36	1	0.79	0.95	1.24	50
	4	0.20	0.06	0.21	17

CWP

The burden of the type CWP relays at 5 amperes, 115 volts, 60 cycles is as follows:

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
75-600	75	0.633	0.144	0.660	12.6
	100	0.557	0.095	0.560	9.8
	150	0.494	0.043	0.495	5.0
	200	0.460	0.032	0.460	4.0
	300	0.370	0.013	0.370	2.0
	400	0.340	0.006	0.340	1.0
	600	0.290		0.290	0.5
20-150	20	4.70	2.66	5.4	29.5
	30	3.23	1.21	3.45	20.5
	40	2.93	0.87	3.05	16.5
	50	2.31	0.57	2.38	14.0
	75	1.50	0.28	1.52	10.7
	100	1.15	0.11	1.15	5.5
	150	0.80	0.014	0.80	1.0

Lower Pole Potential Winding
(between relay terminals 6 and 7)

	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lead
All ranges -	5.5	2.78	6.15	26.8

CWC & CWP THERMAL RATINGS

Relay	Range	Pole Winding	Continuous Amperes	1 Sec Amperes
CWC	.25-4	All	4	110
CWC	2.25-36	Upper	10	280
		Lower	12.7	370
CWP	20-150	Upper	3.2	88
	75-600	Upper	6.4	185

The potential coil circuit of the type CWP relay will stand 250 volts for 15 seconds.

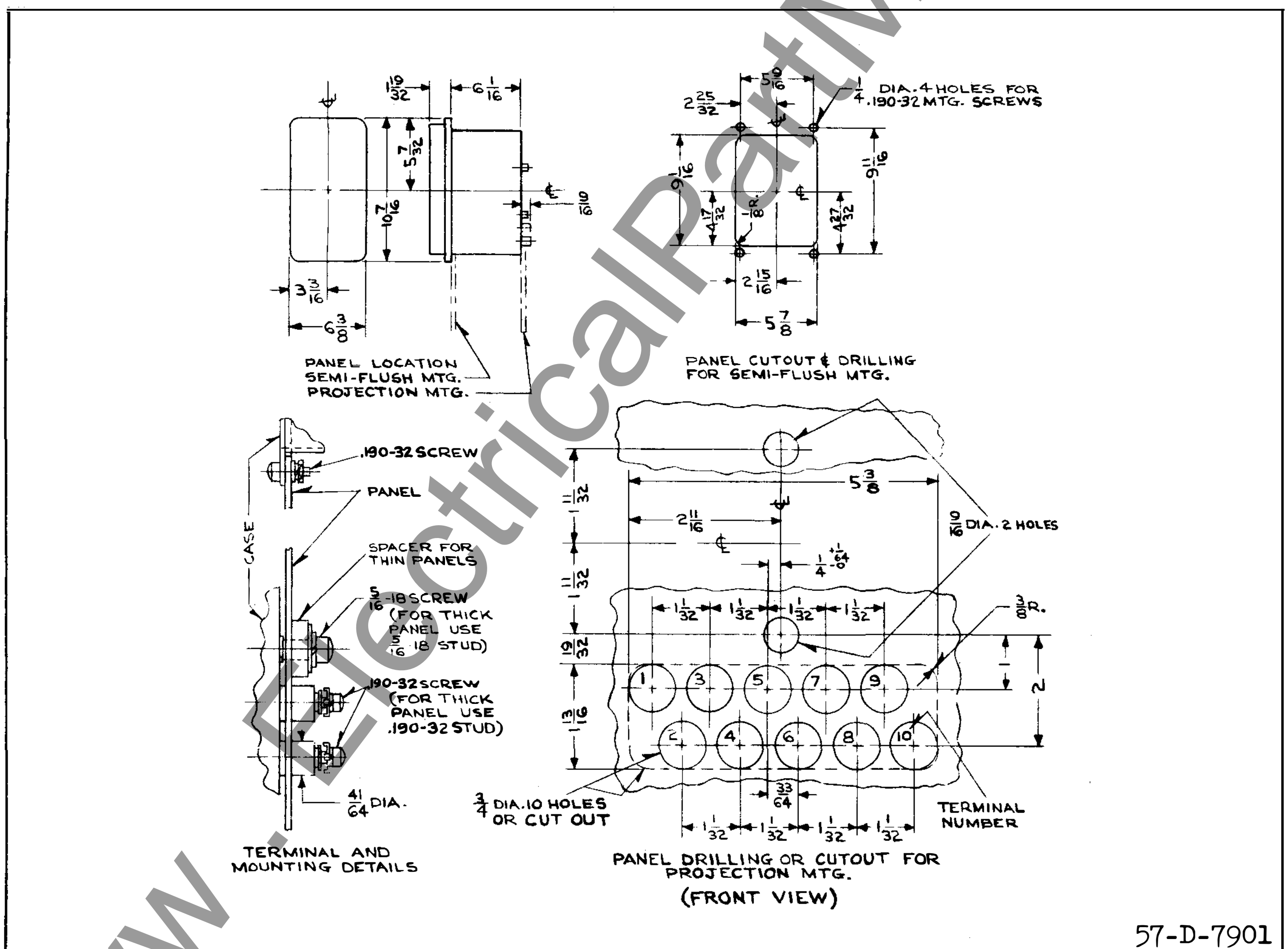


Fig. 13. Outline & Drilling Plan for the Type CWC and CWP Relays in the Type FT-21 Case.

WESTINGHOUSE ELECTRIC CORPORATION
RELAY DEPARTMENT NEWARK, N. J.
Printed in U. S. A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CWC AND CWP DIRECTIONAL GROUND RELAYS

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

APPLICATION

The Type CWC and CWP relays are induction disc type relays used for directional ground fault protection on grounded neutral power systems. The type CWC relay is polarized by current from a suitably grounded power transformer bank neutral. Therefore, its application does not require potential transformers. The type CWP relay is potential polarized by residual voltage obtained across the open corner of the delta winding of a grounded star-delta potential transformer.

At stations where the power transformer bank neutral is grounded, the residual voltage will be small generally, and the type CWC relay is recommended. At ungrounded stations, or at ground stations where the power transformer bank neutral is not available, the type CWP relay is applicable.

CONSTRUCTION AND OPERATION

The Type CWC and CWP relays consist of an induction disc type unit, an indicating contactor switch, and an optional indicating instantaneous trip unit.

INDUCTION DISC UNIT

The induction disc unit contains a thin four-inch diameter disc mounted on a vertical shaft. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The element is not geared. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf-spring. This spring is fastened to a moulded block mounted on the element frame. A small set screw permits the adjustment of contact follow. When double trip is required, another leaf spring is mounted on the moulded block and a double contact is mounted on the rigid moving arm. Then the stationary contact set screws permit adjustment so that both circuits will be made simultaneously.

The moving disc is rotated by an electromagnet in the rear and damped by a permanent magnet in front. The operating torque for the CWC relay is obtained by energizing the lower pole coil with residual current (usually obtained from the line current transformer) and the 2 tapped upper pole coils with residual current from the current transformer in the power transformer bank neutral. For the CWP relay the operating torque is obtained by energizing the upper pole coils with residual current (usually obtained from the line current transformer) and the lower pole with residual voltage.

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

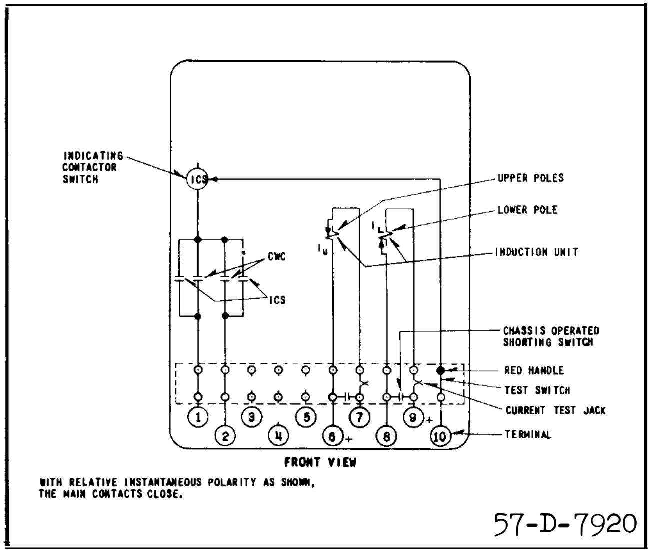


Fig. 1. Internal Schematic of Double Trip Type CWC Relay in the Type FT-21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

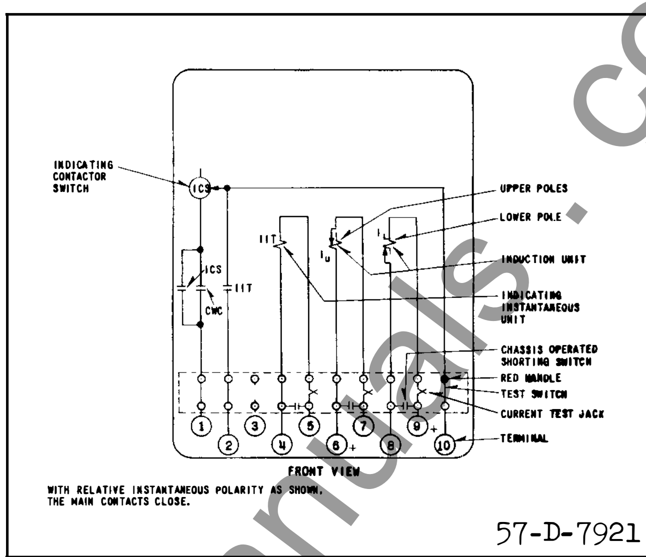


Fig. 2. Internal Schematic of the Type CWC Relay with Indicating Instantaneous Trip Unit in the Type FT-21 Case.

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.

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. The minimum and maximum pickup points are indicated on the scale, which is located to the rear of the core screw.

CHARACTERISTICS

TYPE CWC RELAY

The type CWC relay has two taps on the upper pole and four on the lower pole. They are marked in amperes which is the current thru both windings in series at minimum pick-up, and in product which is the minimum pick-up product of two equal or unequal currents.

Type CWC Relay Ranges and taps are:

.5 to 2 ampere (.25 to 4 Product) Range

Amperes	.5	.6	.8	1.0	1.2	1.6	2.0
Product	.25	.36	.64	1.0	1.44	2.56	4.0

1.5 to 6 ampere (2.25 to 36 Product) Range

Amperes	1.5	2.0	2.5	3.0	4.0	5.0	6.0
Product	2.25	4.0	6.25	9.0	16.0	25.0	36.0

The first four values are marked on the lower pole top plate. The upper pole tap plate is marked x1 and x2 (x1 and x4 Product). The last four values are obtained by using the x2 tap with the four lower pole taps.

Typical 60 Cycle time-product curves for the type CWC relay are shown in Fig. 5. These curves are taken at maximum torque which occurs with the currents in phase. For residual and Ground currents

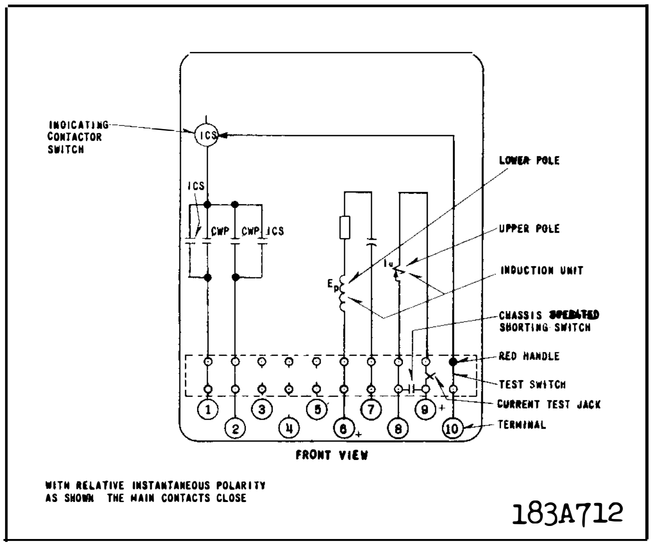


Fig. 3. Internal Schematic of the Type CWP Relay in the Type FT21 Case. For the Single Trip Relay the Circuits Associated with Terminal 2 are omitted.

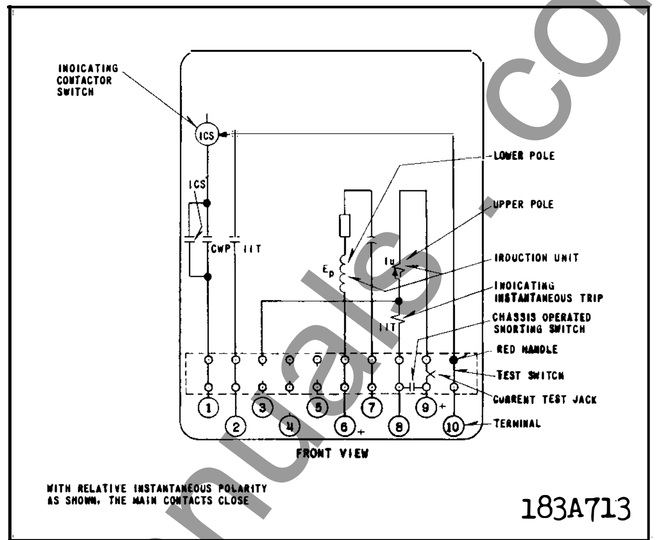


Fig. 4. Internal Schematic of the Type CWP Relay with Indicating Instantaneous Trip Unit in the Type FT21 Case.

out of phase the relay operating time may be obtained by determining the operating time corresponding to the product P' = P Cos θ, where P is the actual relay product in amperes squared, and θ is the angle between the residual and polarizing currents.

The limits for which these curves are accurate within ± 7% are shown in Fig. 6.

TYPE CWP RELAY

The type CWP relay taps are on the upper pole current coil. They represent the minimum pick-up product of current times voltage at maximum torque when the current lags the voltage by 60°. The ranges and taps are:

Product Range	Tap Markings						
20 - 150	20	30	40	50	75	100	150
75 - 600	75	100	150	200	300	400	600

Typical 60 cycle time product curves for the type CWP relay are shown in Fig. 7. These curves are taken at maximum torque which occurs with the current lagging the voltage 60°. For currents not lagging by this angle, the relay tripping time may be obtained by determining the operating time corresponding to the product p' = P Cos (60° - θ), where P is the actual relay V.A. product and θ is the angle the current lags the voltage. The curves are accurate within ±7% if the multiple of tap product does not exceed the voltage on the relay coil.

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

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

0.2 ampere tap 6.5 ohms d-c resistance
2.0 ampere tap 0.15 ohms d-c resistance

SETTING CALCULATIONS

The following information is required to set these relays:

1. The maximum and minimum ground fault cur-

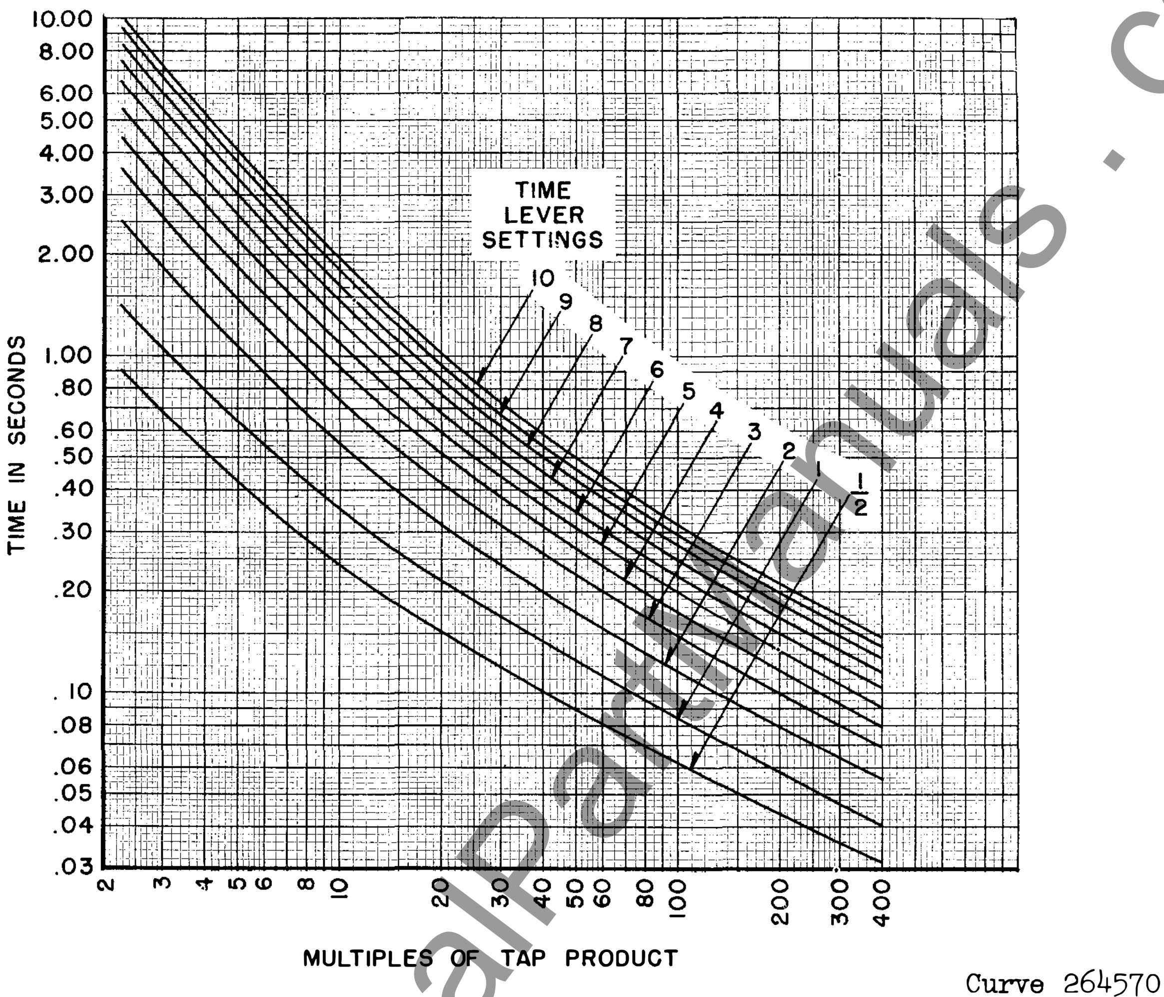


Fig. 5. Typical Time Curves of the Type CWC Relay - Current Coils in Series - See Figure 6 for application limits.

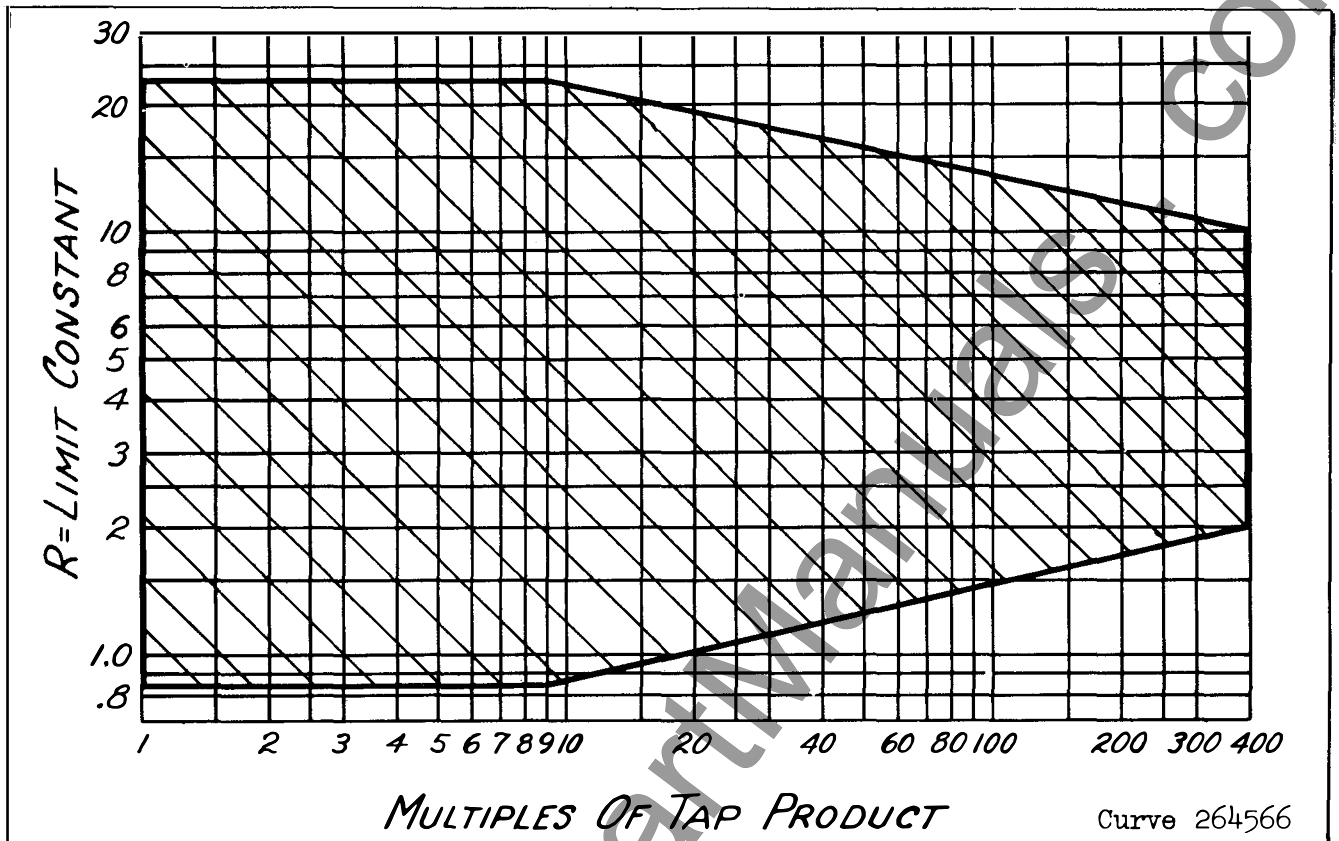
rents for faults at the relay and at the remote bus. These values should be residual current which is three times the zero sequence current.

2. The maximum and minimum polarizing current or voltage values for the faults above. The values should be residual currents or voltage which are three times the zero sequence values.

3. The current transformer ratios of the main and polarizing current transformers for the type CWC relay applications or the main current transformer ratio and the polarizing potential transformer ratio for the type CWP relay application.

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 range of 0.05 to 0.20 second as seen from the curves of Figs. 5 and 7.

However, the relays cannot distinguish between a fault on the line near the remote breaker for which they 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 terminal. 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



For the 0.25 to 4 Product Range

$$R = M \frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
M = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	M	K
.25	1	.25	4.0	10
.36	1	.36	2.78	12
.64	1	.64	1.56	16
1.0	1	1.0	1.0	20
1.0	4	.25	16.0	20
1.44	4	.36	11.1	24
2.56	4	.64	6.25	32
4	4	1.00	4.0	40

For the 2.25 to 36 Product Range

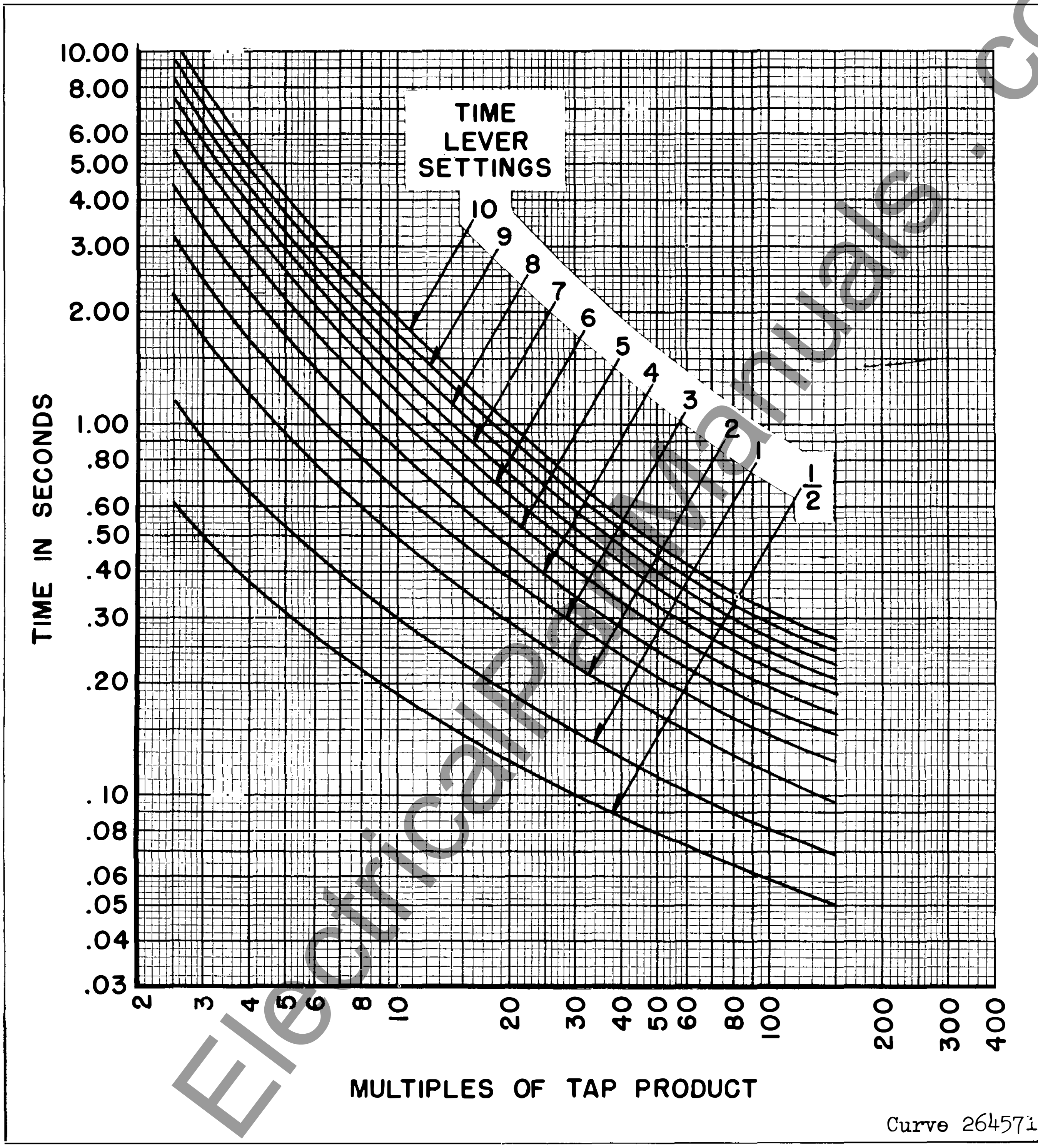
$$R = N \frac{I_L}{I_U}$$

where I_L = the lower pole current.
I_U = the upper pole current.
N = value from the table below for various tap combinations.

Tap Product	Upper Pole Product Tap	Lower Pole Product Tap	N	K
2.25	1	2.25	4.0	30
4.0	1	4.0	2.25	40
6.25	1	6.25	1.44	50
9.0	1	9.0	1.0	60
9.0	4	2.25	16.0	60
16.0	4	4.0	9.0	80
25.0	4	6.25	5.76	100
36.0	4	9.0	4.0	120

The Typical time curves for the Type CWC Relay apply if the values of R falls within the shaded area of the curve above, and if neither relay current is greater than K in amperes.

Fig. 6. Limits for Application of the CWC Time Curves.



These Curves are valid if the multiple of tap Product (volt-amperes) does not exceed the voltage on the relay polarizing coils.

Fig. 7. Typical Time Curves of the Type CWP Relay at Maximum Torque Angle - Curves Apply if the Multiple of Tap Product in Volt-Amperes Does Not Exceed the Polarizing Voltage in Volts.

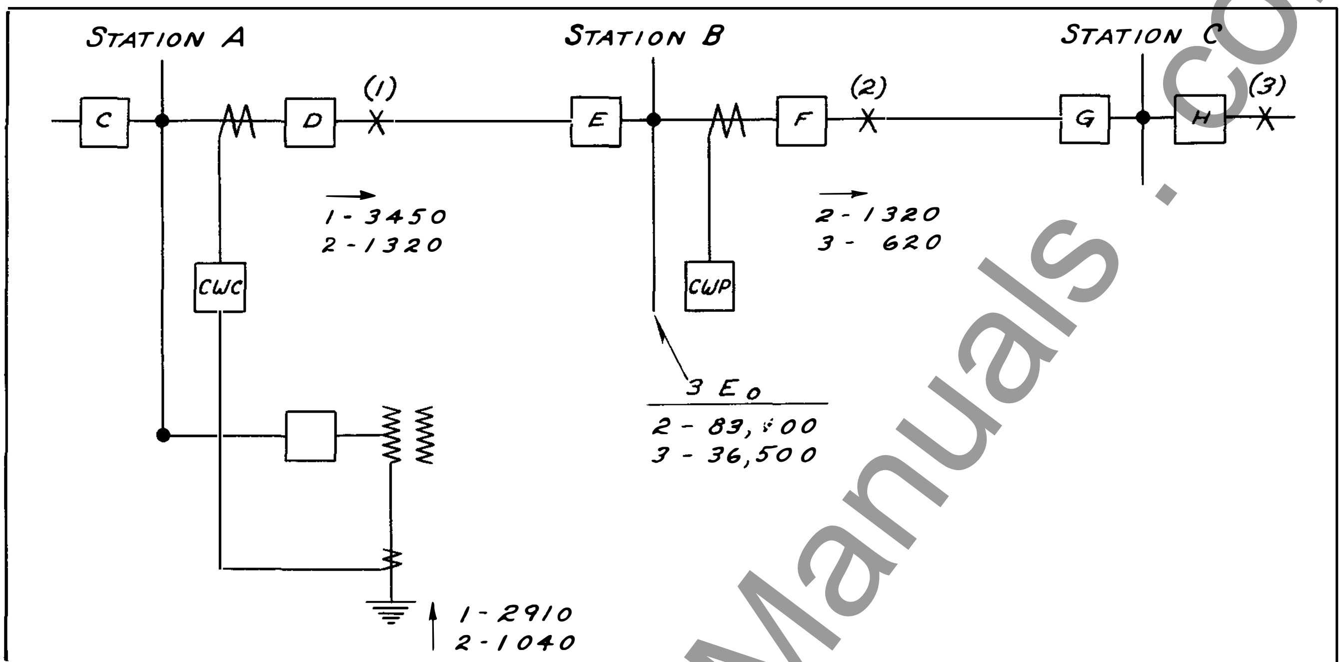


Fig. 8. Typical System for Setting Type CWC and CWP Relays.

TABLE I

1 Relay Location	2 Fault No.	3 Line Primary Amps.	4 Line C.T. Ratio	5 Polarizing Primary Amps. or Volts	6 Polarizing C.T. or P.T. Ratio	7 Line Secondary Amps. (I_L)	8 Polarizing Secondary Amps. (I_U)	9 Product $I_U \times I_L$	10 $\frac{I_L}{I_U}$	11 Tap	12 Multiples of Tap Product	13 R	14 Lever	15 Time In Seconds
D	1	3450	300/5	2910	300/5	57.5	48.5	2780	1.19	36	77	4.76	2-1/4	.14
D	2	1320		1040		22.0	17.3	381	1.27		10.6	5.1		.56
F	2	1320	100/5	83,100V	1000/1	66.0	83.1V.	5485	—	300	18.3	—	3/4	.16
F	3	620		36,500V		31.0	36.5V.	1130	—		3.8			.53

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 difference between actual fault 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.

As an example, a type CWC relay is to be connected at Station A and set to protect the line running to Station B. It must select or coordinate with the type CWP relay connected at Station B and set to protect the line running to Station C. The fault currents and voltage for single line-to-ground faults under minimum conditions for this system are shown in Fig. 8.

In setting the type CWC and CWP relays, it is convenient to set up Table as shown. The relay location is shown in Column 1 and the fault location in Column 2. The primary line residual current available for the relay is recorded in Column 3. The ratio of these current transformers is specified in Column 4.

The primary fault current or voltage available for the polarizing winding is shown in Column 5 and the associated current or potential transformer ratio in Column 6. All of these fault values are residual values or three times the zero sequence current or voltage. The relay current for the lower pole windings is the value of Column 3 divided by the ratio of Column 4. The value is recorded in Column 7. The upper pole relay current is the value of Column 5 divided by the ratio of Column 6, and is recorded in Column 8. The relay operating product is the values of Column 7 and 8 multiplied together and recorded in Column 9. For the type CWC relays, the ratio of $\frac{I_L}{I_U}$ is written in Column 10. All of this data is fixed by the system constants and characteristics,

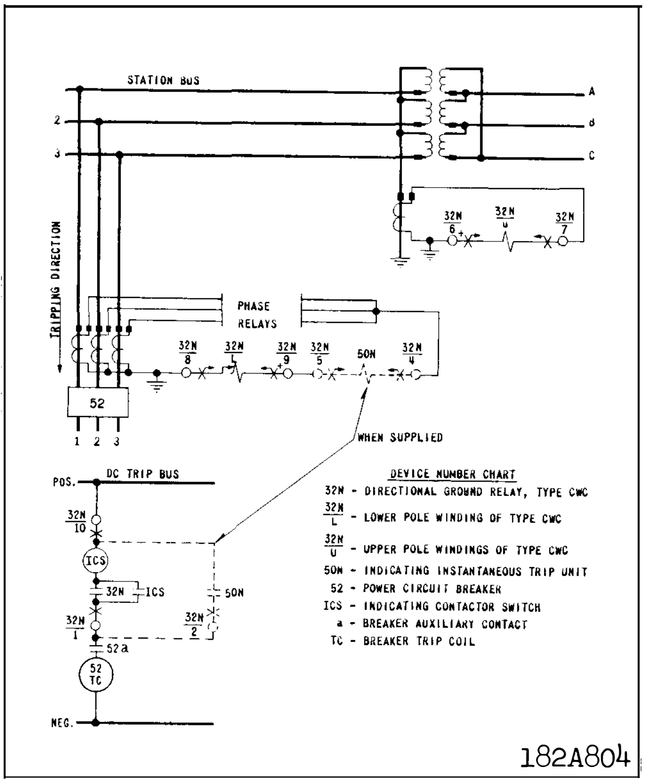


Fig. 9. External Schematic of the Type CWC Relay for Ground Protection.

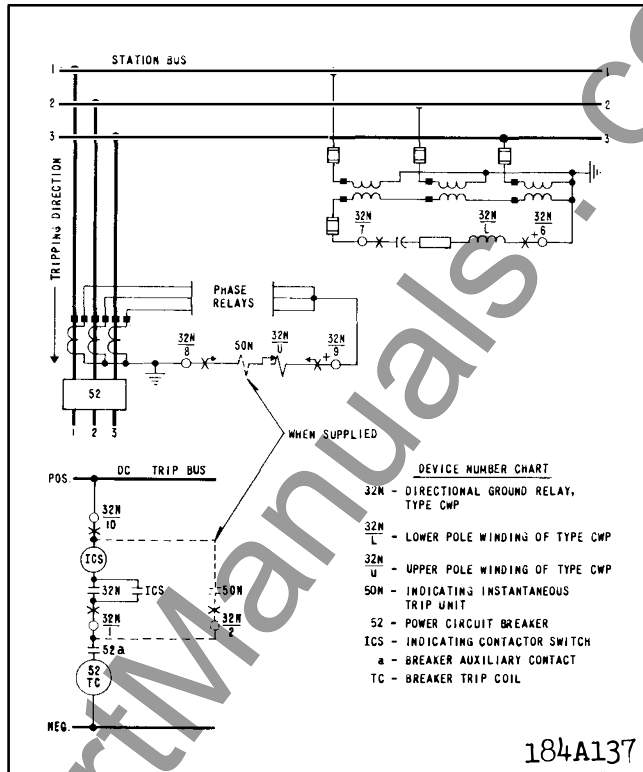


Fig. 10. External Schematic of the Type CWP Relay for Ground Protection.

and is preliminary to making the actual relay setting.

The choice of a tap recorded in Column 11 and of the time lever in Column 14 is a matter of trial and error. The breakers on this system have 8 cycle operating time so that the coordinating time interval should be about .4 second. The tap should be chosen so that the relay times for the close-in fault and remote fault product values will differ by about the coordinating time interval or .4 second in this case. Practically this can be accomplished by several taps with equal results. Tap 36 was selected in this example. The product value divided by the tap is recorded in Column 12. This value is the abscissa of the time product relay curves. From these curves the lever Column 14 and relay operating time Column 15 were chosen so that the relay would operate at about .15 second for close-in faults and about .56 second for the remote faults. These times for the type CWC relay were obtained using time lever setting no. 2-1/4.

With the selection of a satisfactory tap value, the curves of Fig. 6 will quickly show if the combination of tap and current values provide relay operating times as indicated by the curve. The value of Column 10 multiplied by N = 4.0 for tap 36 gives the R values of Column 13. These are within the curve of Figure 6.

The same process is allowed in setting the type CWP relay at Station B on breaker F. Here tap 300 was selected with lever 3/4 to provide relay operating times of 0.16 and 0.53 seconds respectively for close-in and remote faults. The operating limits using this tap are fulfilled since neither multiples of tap product value (Column 12) is greater than the polarizing voltage (Column 8).

After individual relay settings are made, it is necessary to check to see if the relays select properly with associated relays. In the example the coordinating time interval was 0.4 second. Therefore, for fault 2, the relay at D should not operate before the relay at F plus the coordinating time interval. In other words, the operating time of D should be not less than 0.16 second plus 0.40 = 0.56 second.

Similarly the time of the relay at breaker H should not be greater than 0.13 second in order to select with relay F for fault 3. If the time of relay

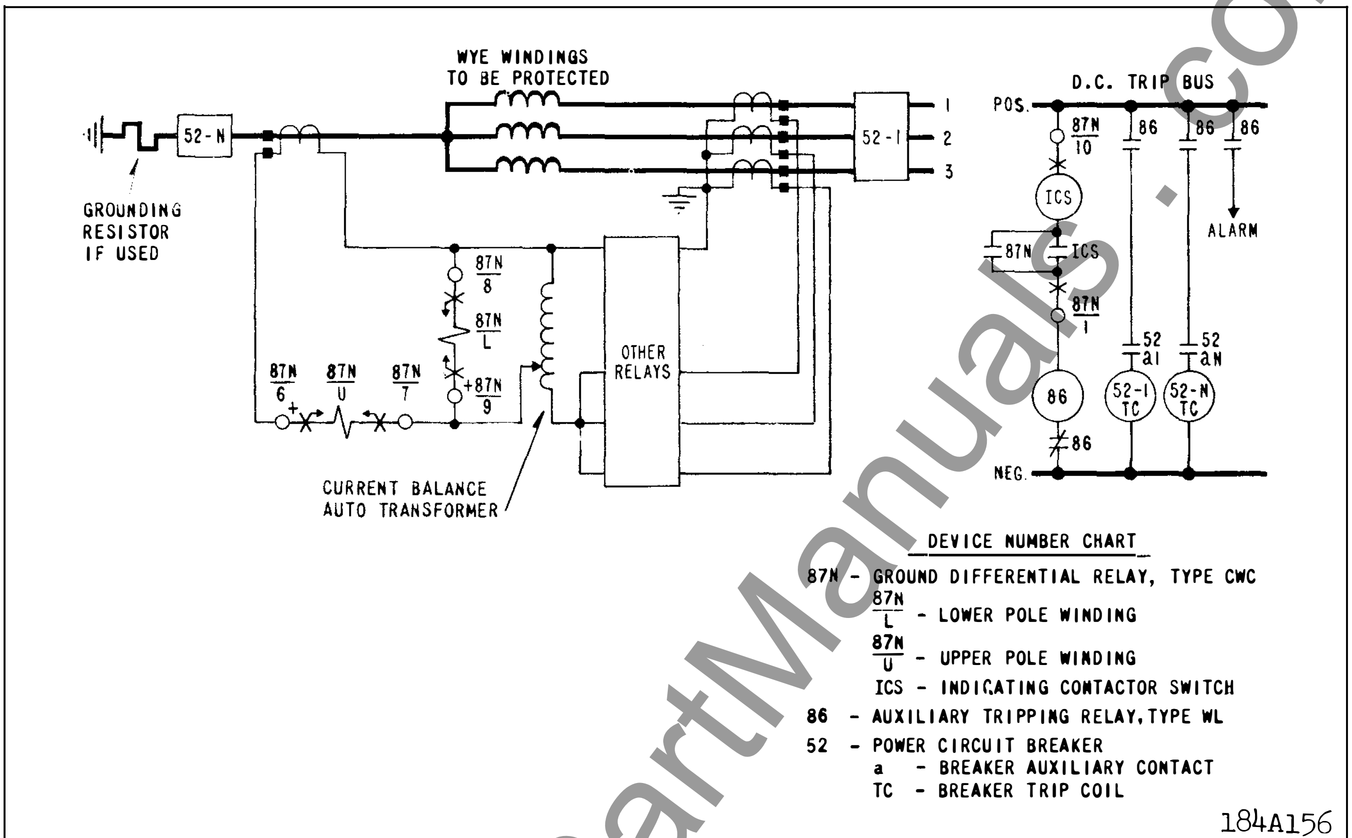


Fig. 11. External Schematic of the Type CW Relay for Ground Differential Protection of Wye or Zig-zag Winding of a Transformer or Rotating Machine.

H is greater, then the time of relay at F must be increased to provide proper selection. This change may be accomplished by a change in the time lever setting only, although often a new tap and lever setting may provide a more satisfactory setting. Changing the setting of relays at B probably will require a change in the setting of the relay at Station A.

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.

SETTING THE RELAY

CWC INDUCTION UNIT

Select the desired upper and lower pole taps. Set the lever position by applying a preselected current to the relay coils, and adjusting the lever position to obtain the desired time of operation. Alternatively the lever may be set by inspection, if the timing coordination is not critical.

CWP INDUCTION UNIT

Select the desired upper pole tap. Set the lever position by applying a preselected voltage and current (current lagging voltage by 60° - see Fig. 11) to the relay coils and adjusting the lever position to obtain the desired time of operation. Alternatively the lever may be set by inspection, if the timing coordination is not critical.

Indicating Contactor Switch (ICS)

No setting is required on the ICS unit except 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 balock to the desired setting by means of the connecting screw. When the relay energizes a 125-or 250-volt d-c type WL relay switch, or equivalent, use the 0.2-ampere tap; for 48-volt d-c applications set relay in 2 tap and use S#304C209G01 Type WL Relay or equivalent.

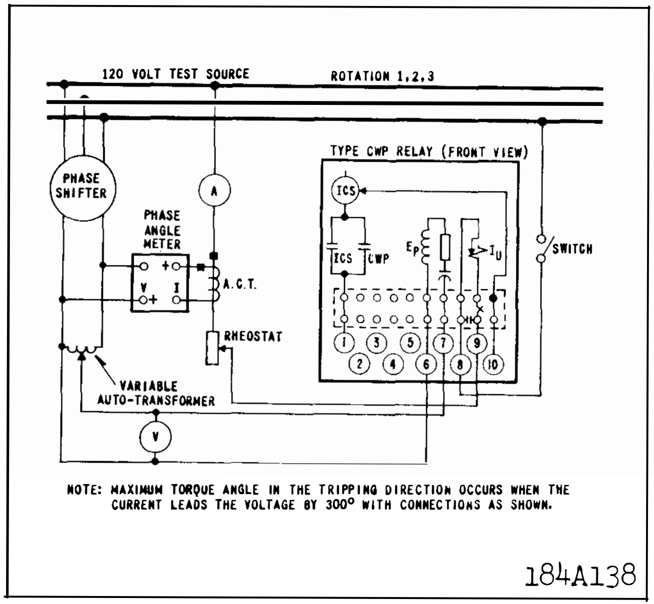


***Fig. 12:** Diagram of Test Connections for the Type CWP Relay in FT-21 Case.*

INDICATING INSTANTANEOUS TRIP (IIT)

Since the minimum and maximum markings on the scale only indicate the working range of the core screw, 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.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration, and heat. Mount the relay vertically by means of the four mounting holes on the flange for semi-flush mounting or by means of the rear mounting stud or studs for projection mounting. Either a mounting stud or the mounting screws may be utilized for grounding the relay. The electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal studs furnished with the relay for thick panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

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

ADJUSTMENTS AND MAINTENANCE

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

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.

INDUCTION UNIT

The upper bearing screw should be screwed down until there is only 3 to 5 thousandths inch clearance between it and the shaft and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the disc fails to turn freely and then backing up a fraction of a turn Great care must be taken in making this adjustment to prevent damage to the bearings.

Adjust the contacts to just barely touch when the time lever is set on zero by shifting the position of the contact stop on the time lever. This should be done with approximately the required contact follow. Final adjustment of the contacts can be more easily made by the contact follow set screw after the contact stop is securely fixed.

A maximum contact follow of approximately 5/64 inch is obtained when the set screw on the stationary contact is all the way out. Where rigid contacts for quick reopening are required, the set screw should be all the way in to hold the stationary contact against the Micarta bracket. Readjust the zero setting after this is done.

CWC RELAY

Connect the upper and lower pole coils in series and pass current in polarity on both coils. With one tap screw in the 1 multiplier position and the other screw in the .36 product tap for the .25-4 product range or the 4 product tap for the 2.25-36 product range, apply current and adjust the spring tension so that the contacts just close with tap value of current flowing. This is 0.6 ampere, 60 cycles, on the .25-4 product range or 2.0 amperes, 60 cycles, on the 2.25-36 product range. The spring tension may by changed by means of a screw driver inserted in one of the notches of the plate to which the outside convolution of the spring is fastened.

Various points on the typical time-product curves can be checked approximately with the current coils in series. The multiples of tap product will be the square of the current passed thru the two coils, divided by the tap product. The timing can be checked with a cycle counter by averaging a number of trials. Make sure that the coils do not overheat, otherwise the curves cannot be checked. Time curve calibration is obtained by adjusting the position of the permanent magnet.

TYPE CWP RELAY

Use the following procedure to check the zero torque line. Adjust the control spring for zero tension and connect per Fig. 12. Apply 120 volts across terminals 6 and 7 and five times minimum pick up current (tap value divided by 24). Zero torque should occur when the currents lead the voltage by 19° to 36°.

To calibrate the control spring, connect per Fig. 11, set in the lowest tap, apply 100 volts across terminals 6 and 7, and apply minimum pickup current, leading the voltage by 300°, (0.20 amperes for the 20-150 range, 0.75 amperes for the 75-600 range). Then, adjust the spring tension so that the contacts just close. Spring adjustment is changed by inserting a screw driver in one of the spring adjuster plate notches.

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.

To check points on the time curve, connect per Fig. 11, and apply preselected current and voltage values, with current leading the voltage by 300° and measure the time of operation with a cycle counter. The time of several trials should be averaged. If the current coil is allowed to overheat, the timing will be affected. The potential coil should not be continuously energized above 115 volts.

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.

INDICATING INSTANTANEOUS TRIP (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%.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

CWC

The burden of the Type CWC relays at 5 amperes, 60 cycles is as follows:

Lower Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
.25-4	.25	82.7	29.3	88.0	19.5
	.36	57.3	14.1	59.0	13.8
	.64	32.1	4.43	32.4	7.85
	1.00	20.6	1.83	20.7	5.10
2.25-36	2.25	8.50	3.26	9.1	21.0
	4.0	4.78	1.03	4.89	12.1
	6.25	3.01	0.41	3.04	7.7
	9.0	2.13	0.21	2.14	5.5

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
.25-4	1	6.08	8.58	10.5	55
	4	1.52	0.54	1.61	20
2.25-36	1	0.79	0.95	1.24	50
	4	0.20	0.06	0.21	17

CWP

The burden of the type CWP relays at 5 amperes, 115 volts, 60 cycles is as follows:

Upper Pole Windings

Product Range	Product Tap Value	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lag
75-600	75	0.633	0.144	0.660	12.6
	100	0.557	0.095	0.560	9.8
	150	0.494	0.043	0.495	5.0
	200	0.460	0.032	0.460	4.0
	300	0.370	0.013	0.370	2.0
	400	0.340	0.006	0.340	1.0
	600	0.290		0.290	0.5
20-150	20	4.70	2.66	5.4	29.5
	30	3.23	1.21	3.45	20.5
	40	2.93	0.87	3.05	16.5
	50	2.31	0.57	2.38	14.0
	75	1.50	0.28	1.52	10.7
	100	1.15	0.11	1.15	5.5
	150	0.80	0.014	0.80	1.0

Lower Pole Potential Winding
(between relay terminals 6 and 7)

	Watts	Vars	Volt-Amperes	P.F. Angle Degrees Lead
All ranges -	5.5	2.78	6.15	26.8

CWC & CWP THERMAL RATINGS

Relay	Range	Pole Winding	Continuous Amperes	1 Sec Amperes
CWC	.25-4	All	4	110
CWC	2.25-36	Upper	10	280
		Lower	12.7	370
CWP	20-150	Upper	3.2	88
	75-600	Upper	6.4	185

The potential coil circuit of the type CWP relay will stand 250 volts for 15 seconds.

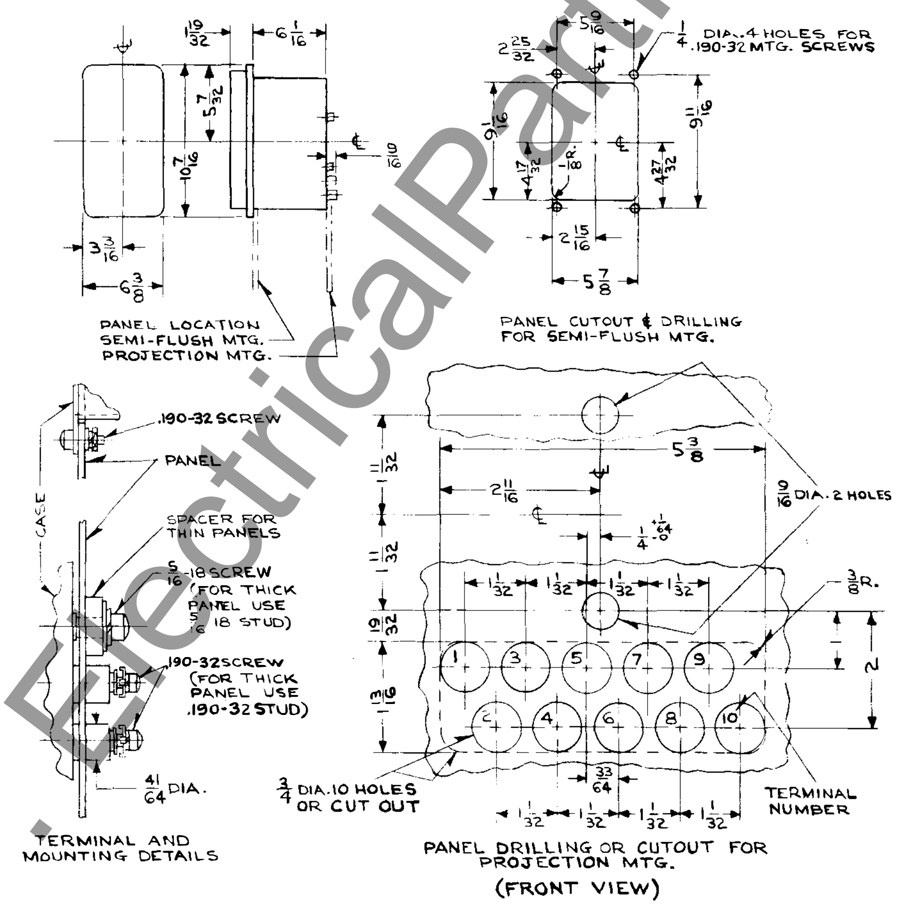


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Fig. 13. Outline & Drilling Plan for the Type CWC and CWP Relays in the Type FT-21 Case.