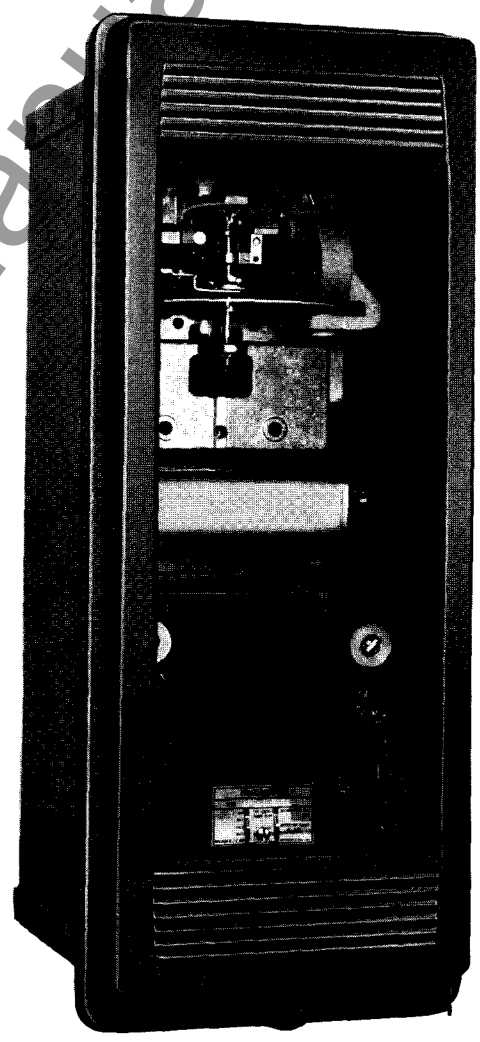
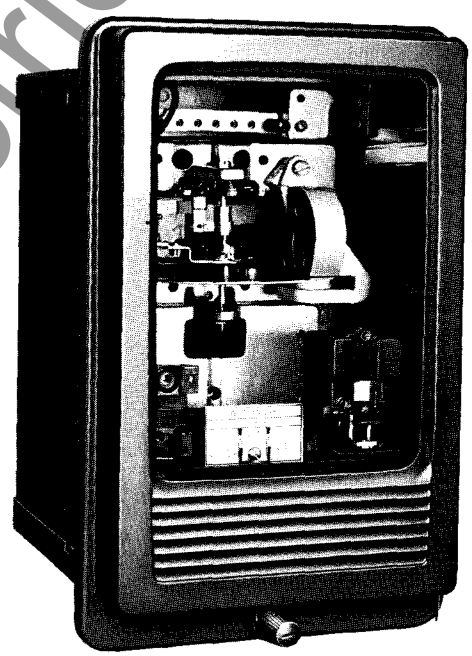
Directional Ground Relays

Type CWC



Type CWP-1



Type CWP

Application

The CWC, CWP, and CWP-1 relays are applied for directional ground fault protection on grounded neutral power systems.

Type CWC

The CWC relay is current polarized. The relay develops torque proportional to the product of the polarizing and residual currents and the cosine of the phase angle between them.

The CWC relay is recommended at stations where the power transformer bank neutral is grounded. In such cases the residual voltage will generally be small.

Type CWP

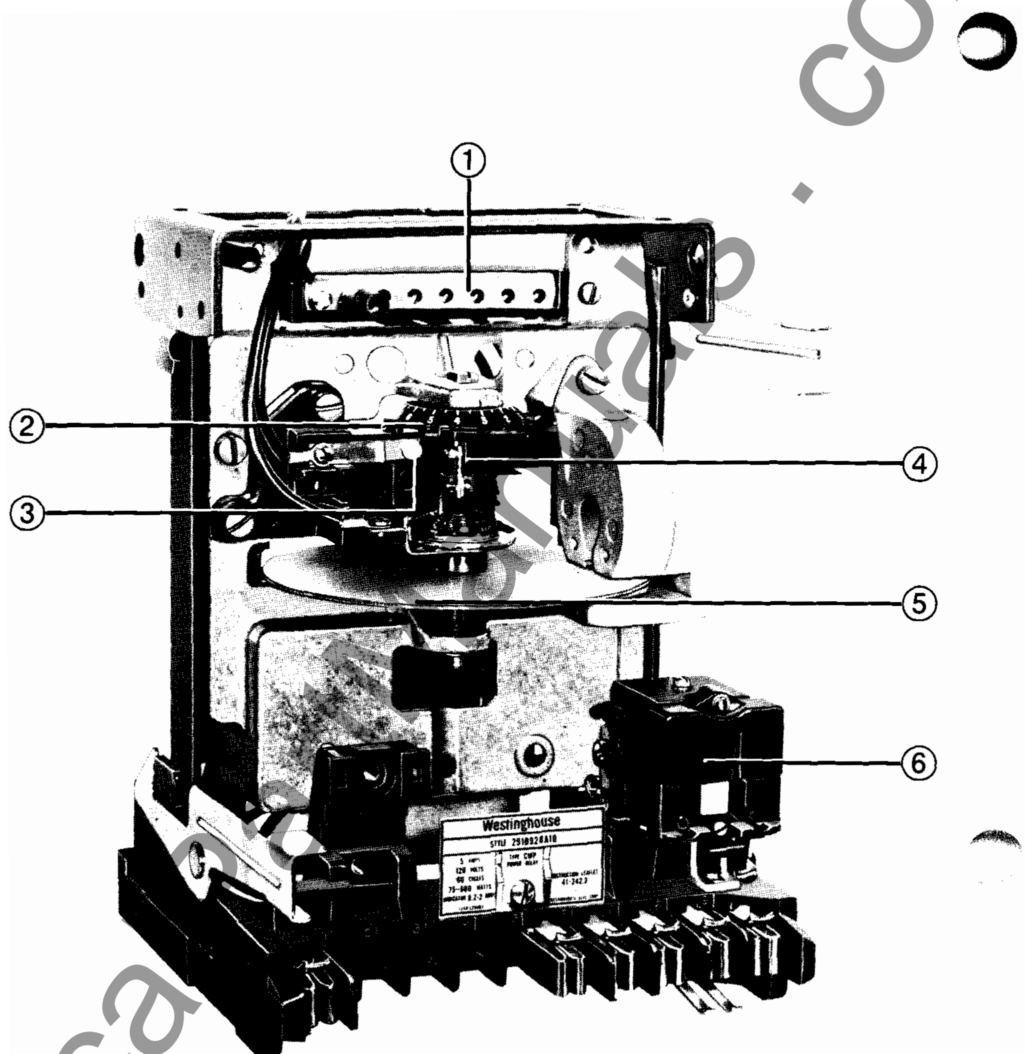
The CWP relay is voltage-polarized by residual voltage obtained across the open corner of the delta winding of a grounded wye-delta voltage transformer. The relay develops a torque proportional to the product of the polarizing voltage and the residual current and the cosine ($\theta - 60$) where the θ is the angle by which the relay current lags the relay voltage.

The CWP relay is recommended for use where the power transformer bank neutral is not available.

Type CWP-1

The CWP-1 relay is similar to the type CWP relay except it has a higher sensitivity.

The relay is applicable 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 must be high-resistance grounded because of the maximum torque angle characteristic of the CWP-1 (maximum torque when current leads voltage by 45°).



Type CWP

Construction

(1) Tap Block

Volt-amperes indicated on tap plate represent the minimum pickup product of residual current and polarizing voltage at maximum torque angle. Tap changing is accomplished by a tap screw. When tap position is changed, the spare tap screw is inserted into the desired new position prior to removal of the original, to avoid open-circuiting of the current transformer.

(2) Time Dial

Indexed setting from ½ to 11 are clearly visible. With a fixed multiple of tap value, setting #11 gives the maximum operating time in seconds.

(3) Stationary Contact

Made of pure silver. Will close 30 amperes at 250 volts dc. Has sufficient wipe to assure positive contact. In fast breaker reclosing schemes which require quick-opening relay contacts, the metal plate is reversed, holding the stationary contact fixed against the backstop. On double-trip relays, adjustment of ⅞" contact follow (or wipe) is obtained by use of a vernier adjusting screw on the stationary contact plate.

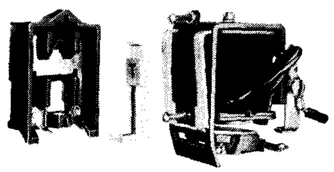
(4) Moving Contact

Also made of pure silver. Electrical connection is through a spiral spring from the contact to the spring adjuster frame, and then to the relay terminals.

(5) Induction Disc Unit

The moving disc assembly which carries the moving contact is rotated by an electromagnet located at the rear of the relay and, to obtain the desired time-product operating curve, is damped by a permanent magnet. The disc shaft is supported at the lower end by a steel ball bearing which rides between concave sapphire jewel surfaces, and at the upper end by a stainless steel pin.

⑥ Indicating Contactor Switch (ICS)



Indicates relay operation by means of a target which drops into visual position upon completion of a trip circuit.

When energized at or above pickup value, moving contacts bridge two stationary contacts and complete the trip circuit. The ICS contacts are connected in parallel with the main relay contacts and relieve them of carrying heavy circuits.

The main relay contacts will close 30 amperes at 250 volts dc, and the ICS contacts will safely carry this current long enough to trip a circuit breaker. Front-located taps provide connection for 0.2 or 2.0 ampere dc minimum pickup setting.

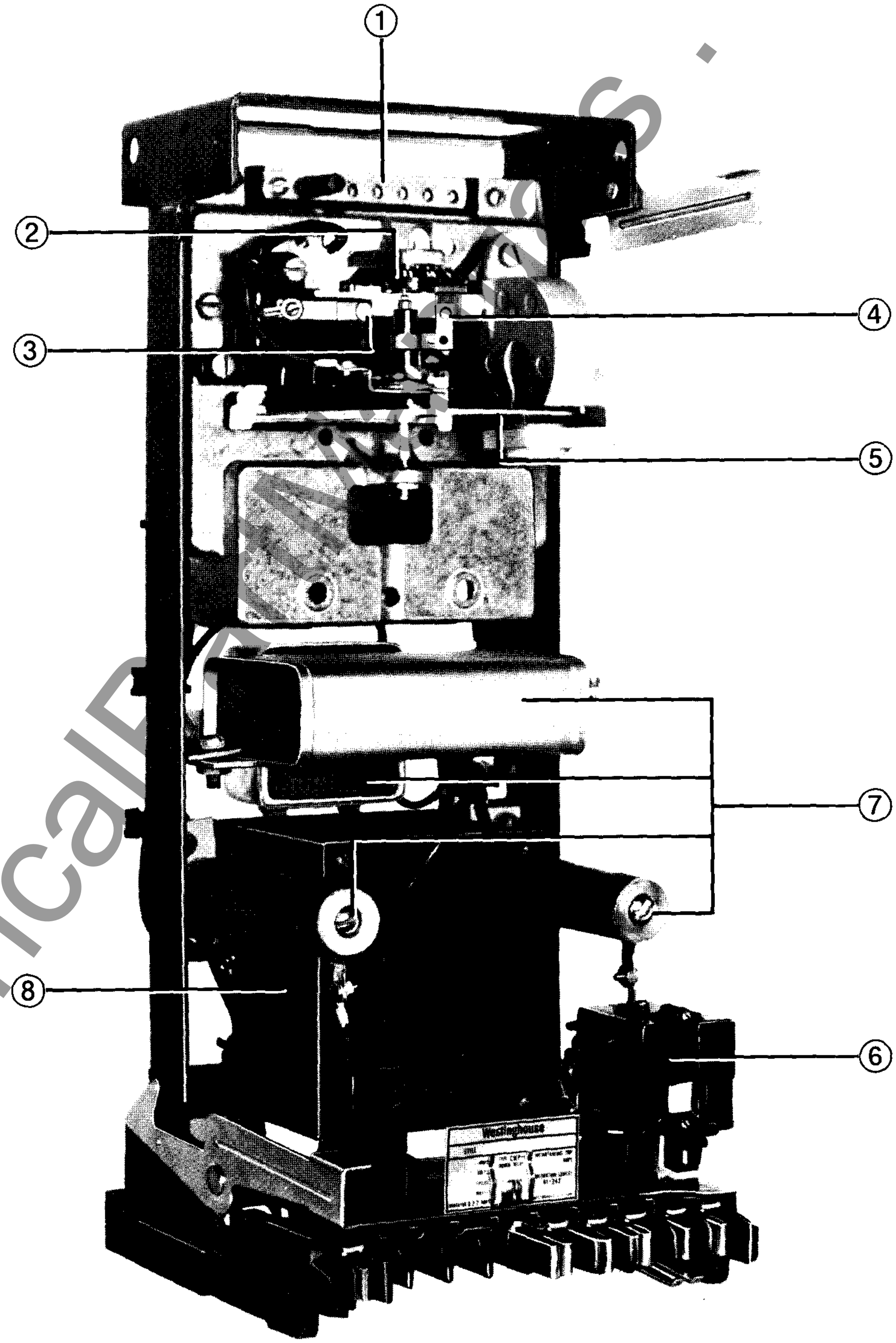
The operation indicator target is reset external to the relay case by means of a push rod located in the bottom of the relay cover.

⑦ Phase Shifting Transformer

Consists of a capacitor and resistor connected in series with the lower pole circuit.

⑧ Current Transformer

Relay settings are provided by a tapped auxiliary step up transformer which supplies current to the upper poles of the relay electromagnet. Transformer has a maximum ratio of 20/1.



Type CWP-1

Characteristics and Typical Time Curves

Type CWC

It has a lower pole winding which has 4 taps. This winding is energized from residual, or three times zero sequence current, from the line current transformers shown in figure 11. The upper pole winding has 2 taps which act as multipliers of the lower pole values by a multiple of x1 and x4.

The taps are marked in product values which is the minimum pickup product value of two unequal, but in-phase currents flowing in the upper and lower pole windings.

Ranges and Taps

Product Range	Taps			
.25 – 4	.25 1.44	.36 2.66	.64 4.0	1.0
2.25 – 36	2.25 16.0	4.0 25.0	6.25 36.0	9.0

The first four values are marked on the lower pole tap plate. As indicated, the upper pole tap plate is marked x1 and x4 product. The last three values are obtained by using the x4 tap with the lower pole taps (i.e., 4 x 6.25 = 25).

Typical 60 hertz time-product curves for the CWC relay are shown in figure 1. These curves are taken at maximum torque, which occurs with the currents in phase. For residual and ground currents out-of-phase. the relay time is obtained by determining the operating time corresponding to the product P' = Pcos where P is the actual relay product in amperes squared, and is the angle between the residual and polarizing currents. The limits for which these curves are accurate within +7% is shown in figure 2.

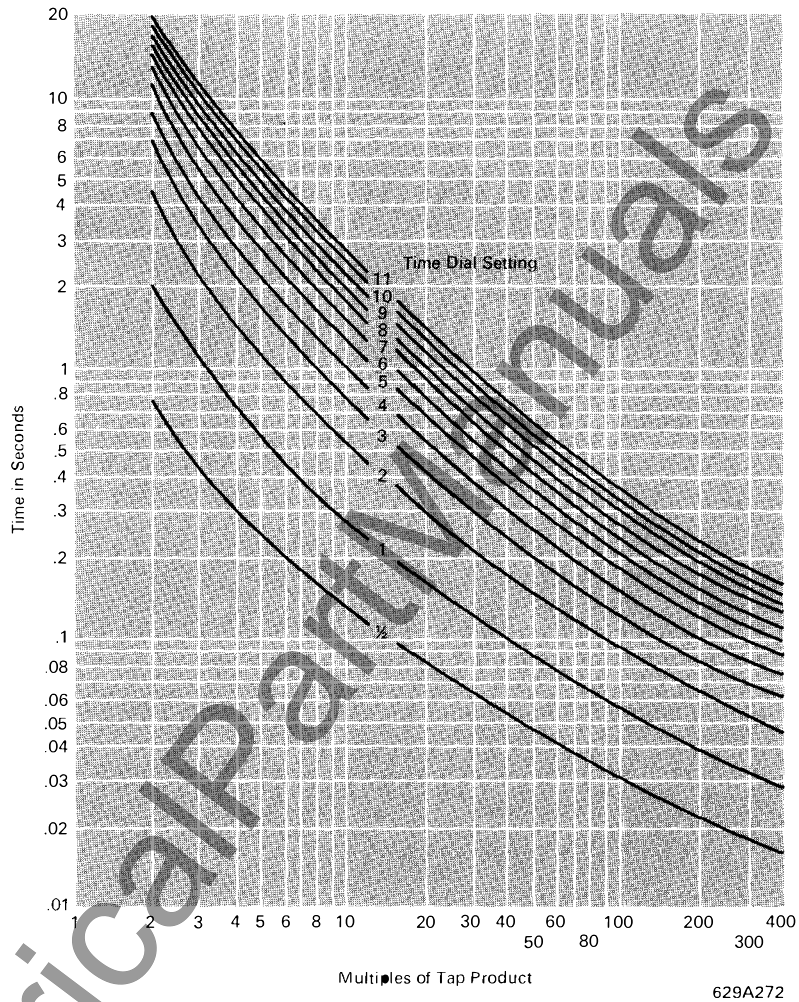


Fig. 1: Type CWC typical time-product curves. Current coils in series, currents in phase. See figure 2 for application limits.

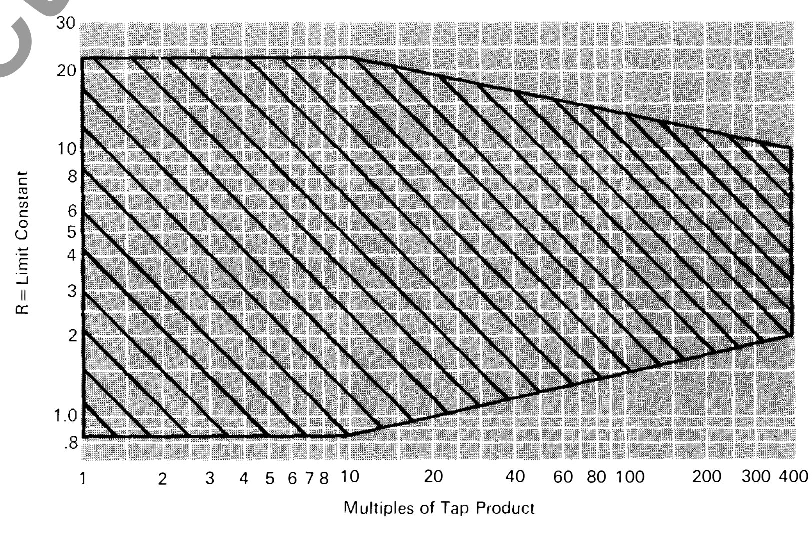


Fig. 2: Type CWC application limits.

CWC Application Limits

0.25 to 4.0 Product Range

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

where I_L = lower pole current
I_U = upper pole current
M = value from 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
4.0	4	1.0	4.0	40

2.25 to 36.0 Product Range

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

where I_L = lower pole current
I_U = upper pole current
N = value from 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 (figure 1) apply if the value of R falls within the shaded area of figure 2, and if neither relay current is greater than K in amperes.

Type CWP

The upper pole winding has 7 product or volt-ampere taps, and is energized from the residual current of the line current transformers.

These tap values represent the minimum pick-up product of current multiplied by polarizing voltage at maximum torque angle, or when current lags voltage by 60°.

The lower pole winding does not have taps. It is energized with polarizing voltage obtained from the open corner of the delta winding of a grounded wye-delta potential transformer. See figure 12.

Ranges and Taps

Product Range	Taps			
20-150	20 75	30 100	40 1500	50
75 600	75 300	100 400	150 600	200

Typical 60 hertz time-product curves for the CWP are shown in figure 3. These curves are taken at maximum torque, which occurs with the current lagging the voltage by 60°. For currents not lagging by this angle, relay tripping time is obtained by determining the operating time corresponding to the product P' = Pcos (60° − θ) where P is the actual relay volt-ampere product and θ is the angle at which current lags the voltage. Curves are accurate within +7%, provided the multiple of tap product does not exceed the voltage on the relay coil.

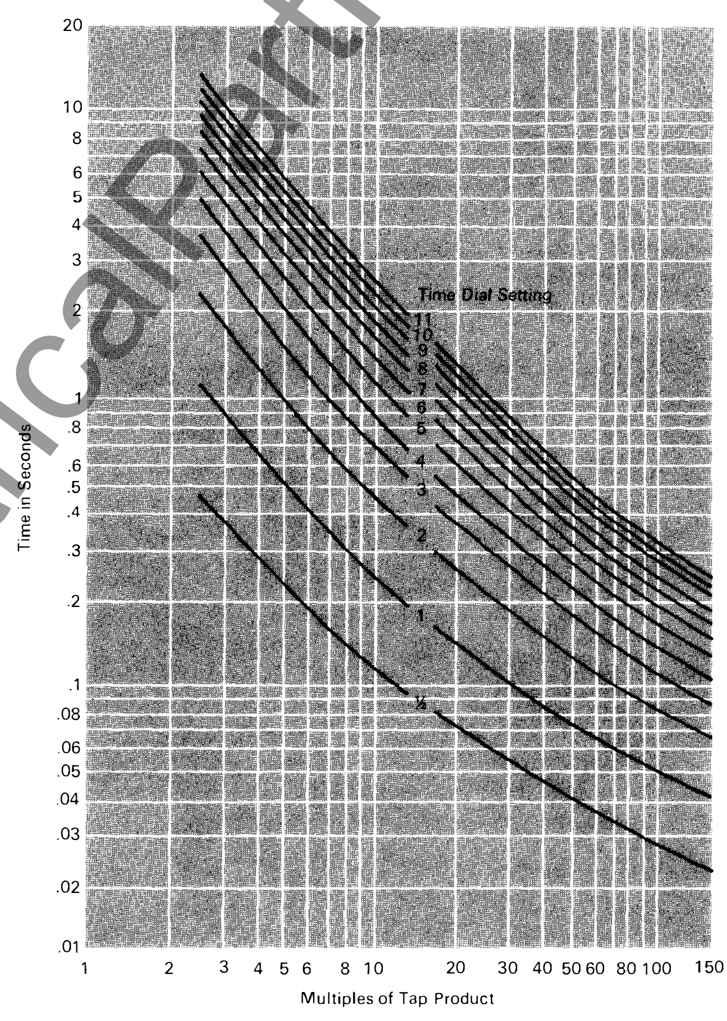


Fig 3: Type CWP typical-product time curves (at maximum torque angles).

Characteristics and Typical Time Curves, *Continued*

CWP-1

The residual fault current is fed through the auxiliary current transformer (See Figure 14) to the upper pole winding of the operating unit. Polarizing voltage is applied to the lower pole winding through the phase-shifting network. The out-of-phase current created in the electromagnet produces fluxes which produce either contact opening or contact closing torque, depending upon the relative direction of current flow in the upper and lower pole circuits.

The auxiliary current transformer feeding the upper pole has 7 taps which represent the minimum pickup product of residual current and voltage, at a maximum torque angle of current leading voltage by 45°.

Sensitivity and Taps

Amps	Volts	Product Taps
.008	120	.5 .7 1.0 1.1
.3	250	2.0 2.8 4.0

Typical time-product curves for the CWP-1 relay are shown in figure 4 with 100 volts applied across the polarizing circuit, and at maximum torque angle. For currents not leading by 45°, the relay tripping time is obtained by calculating the operating time corresponding to the product P′ = Pcos (θ − 45°) where P is the actual relay volt-ampere product and θ is the angle the current leads the voltage. Curves are accurate within +7% if the multiple of tap product does not exceed the voltage on the relay coil.

Representative time-product curves illustrating the effect of variations of potential circuit voltage on the CWP-1 are shown in figure 5.

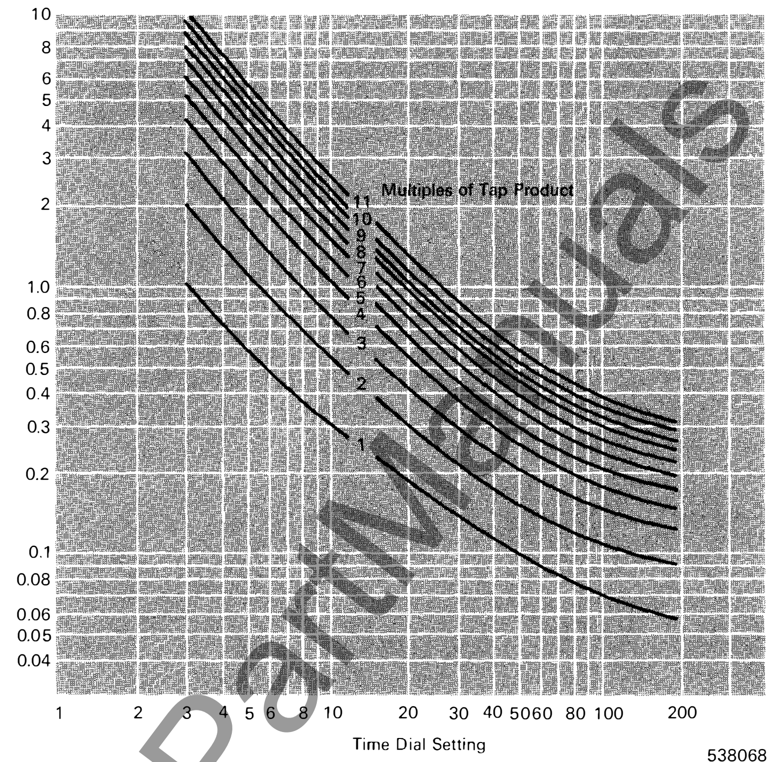


Fig.4: Type CWP-1 typical time-product curves. Relay at maximum torque, 100 volts, 60 hertz across potential circuit.

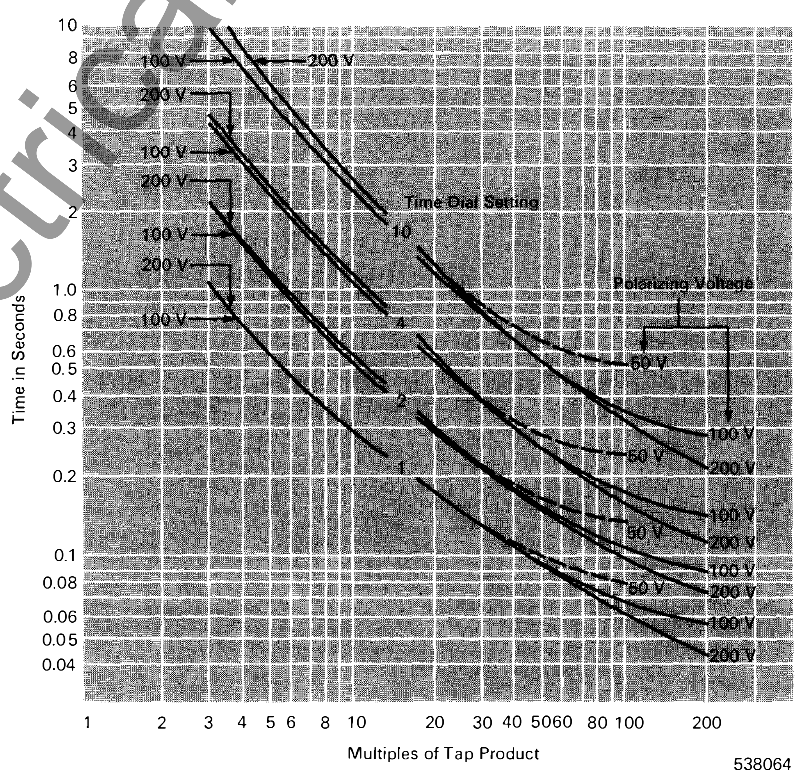
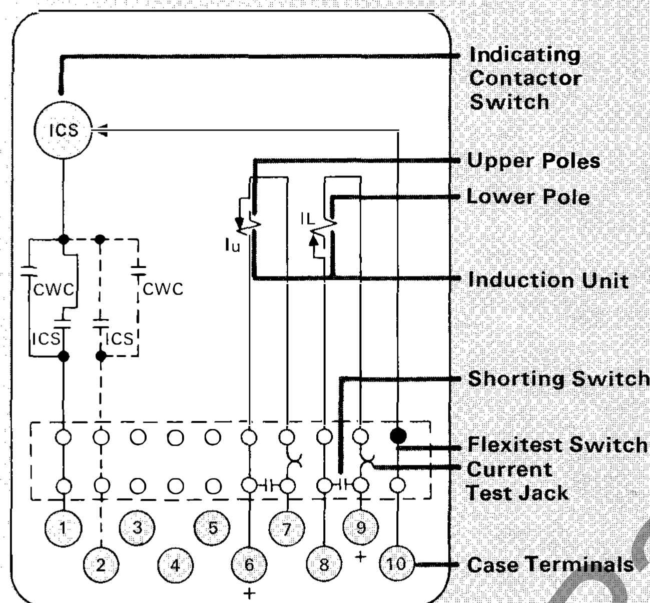


Fig. 5: Type CWP-1 representative time-product curves showing effect of variations of potential circuit voltage. Maximum torque angle, 60 hertz.

Internal Wiring (Front View)

Type CWC Single Trip – FT-21 Case
Dash line indicated CWC with double trip contacts.

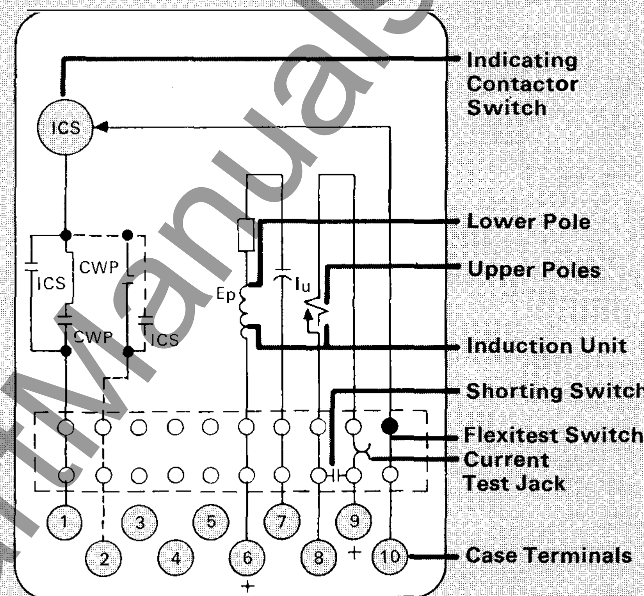


With relative instantaneous polarity as shown, the main contacts close.

57D7920

Fig. 6

Type CWP Single Trip – FT-21 Case
Dash line indicates CWP with double trip contacts.

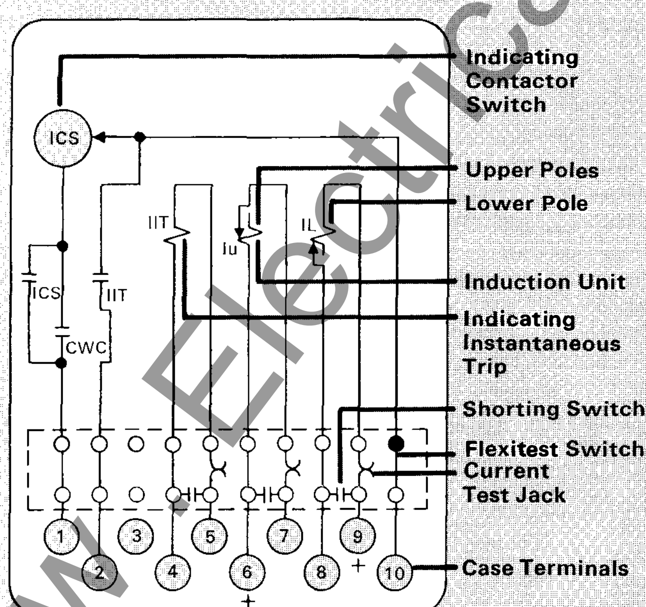


With relative instantaneous polarity as shown, the main contacts close.

183A712

Fig. 8

Type CWC Single Trip – With Indicating Instantaneous Trip – FT-21 Case

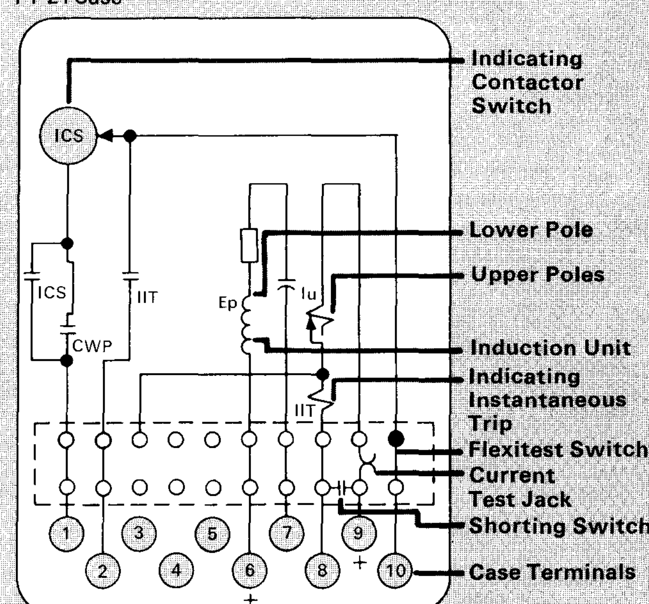


With relative instantaneous polarity as shown, the main contacts close.

57D7921

Fig. 7

Type CWP Single Trip – With Indicating Instantaneous Trip – FT-21 Case



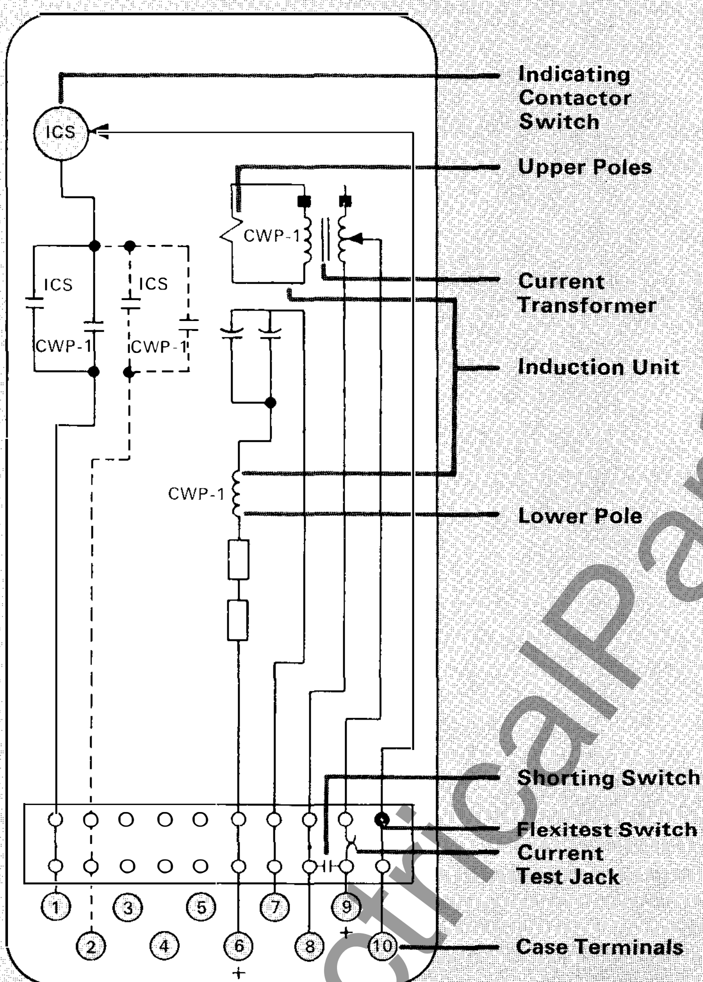
With relative instantaneous polarity as shown, the main contacts close.

183A713

Fig. 9

Internal Wiring (Front View), Continued

Type CWP-1 Single Trip – FT-31 Case
Dash line indicates CWP-1 with double trip contacts.



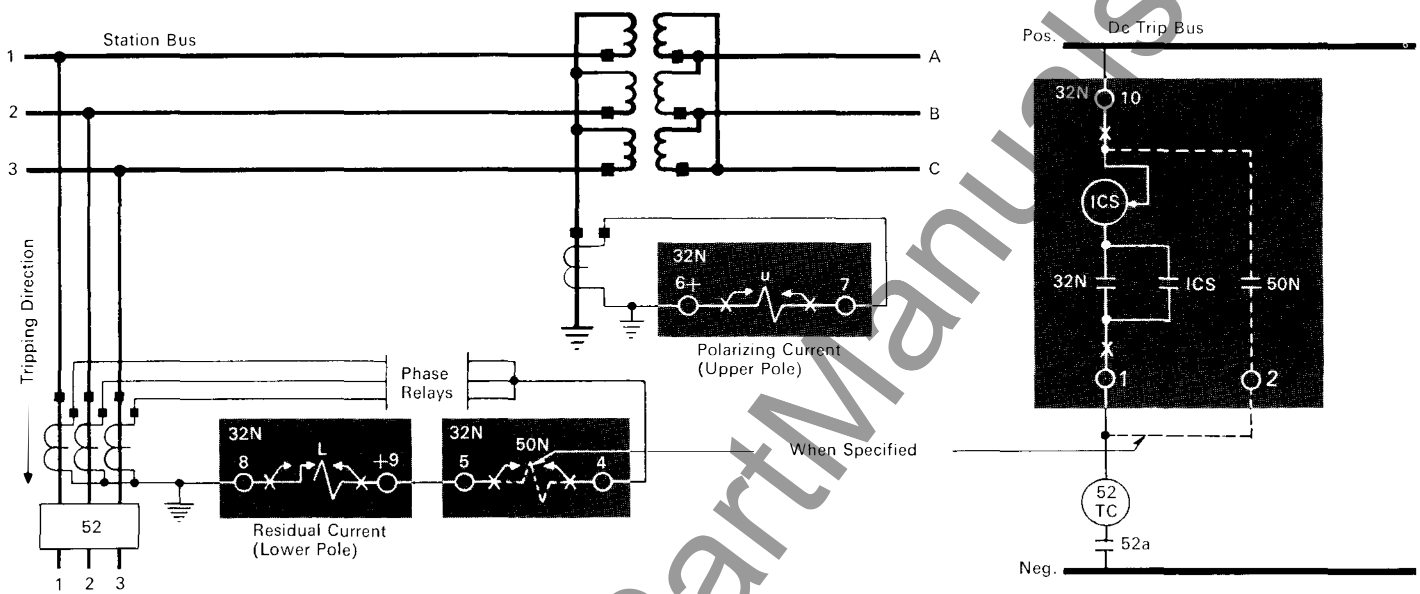
With relative instantaneous polarity as shown, the main contacts close.

188A425

Fig. 10

External Wiring

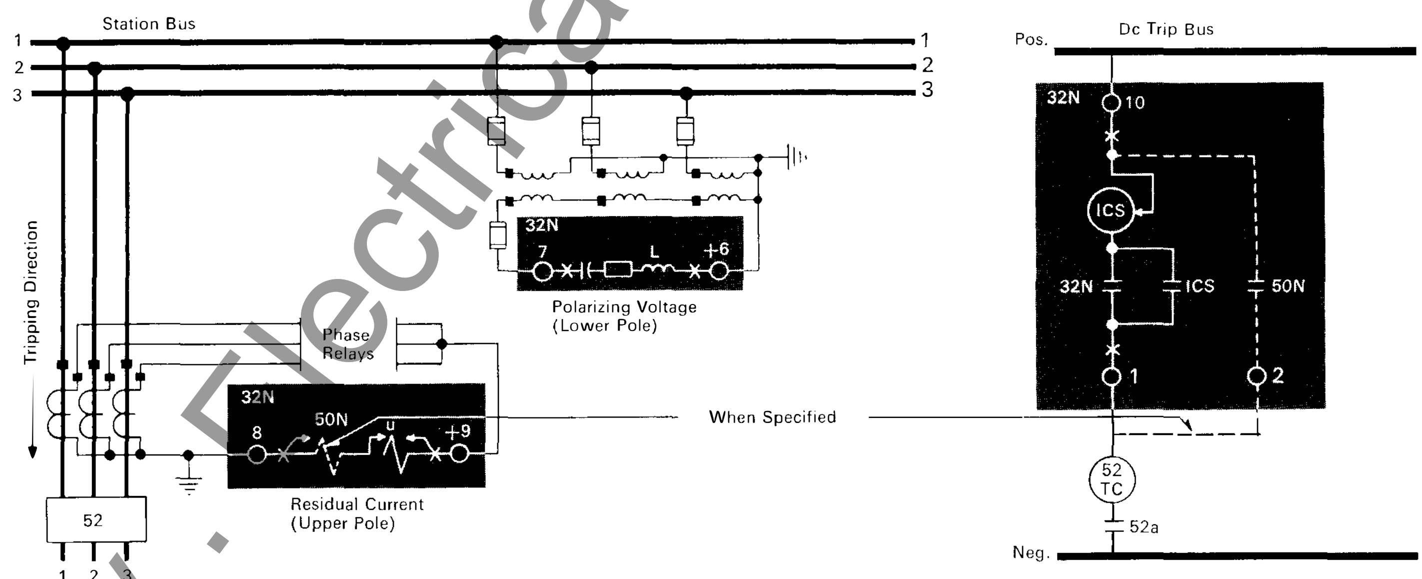
Type CWC – Ground Fault Detection



182A084

Fig. 11

Type CWP – Ground Fault Detection



184A137

Fig. 12

Key to Device Number

32N – Directional Ground Relay, Type CWC or CWP

$\frac{32N}{L}$ – Lower Pole Winding, Type CWC or CWP

$\frac{67N}{u}$ – Upper Pole Winding, Type CWC or CWP

50N – Indicating Instantaneous Trip Unit (IIT)

ICS – Indicating Contactor Switch

52 – Power Circuit Breaker

52a – Breaker Auxiliary Contact

52TC – Breaker Trip Coil

External Wiring, *Continued*

Type CWC – Transformer or Rotating Machine Protection

(Using Type CWC in a Differential Scheme)

As shown in Figure 13, a differential relay scheme is set up around the wye windings which have their common neutral point grounded through a current limiting resistor. Ground current flowing in the neutral current transformer is balanced against the residual current from the three line current transformers. Thus, external ground fault current circulates a current around the lower pole differential winding of the relay and through the upper pole polarizing winding. In order for the relay to trip, currents above pickup value of the relay must flow into polarity in both windings of the relay.

An internal ground fault in the protected windings will cause a current to flow through the differential and polarizing windings of the relay, causing the relay contacts to close.

In the usual differential scheme, even without a ground fault occuring, the differential relay is subject to varying amounts of false differential transient current whenever the three line current transformers saturate unequally, or when Dc components exist in 3-phase offset fault, magnetizing or inrush currents.

However, these transient error currents cannot trip a CWC relay when connected as shown if Figure 13, because the error currents circulate only in the differential winding of the CWC relay and the relay must also have current in its polarizing winding in order to trip. Both currents must be of the correct polarity and above pickup value.

Thus, to trip, a ground fault must occur on the system in order to have current flow in the neutral current transformer and CWC upper pole winding. Also, an internal ground fault must exist to cause current to flow in the proper direction (in polarity) in the lower pole or differential winding of the CWC relay.

Polarity connections to the CWC relay must be such that the grounded neutral and line current transformer secondary currents are in series and aid in circulating current for external ground faults.

The low range (0.25 – 4.0 product) CWC relay is recommended in this scheme. Using the ¼ ampere product tap, a ½ ampere pickup is obtained with both windings of the relay in series. Since the relay is not affected by external faults or transients, it can be set for minimum time lever setting to get fast clearance of internal faults.

The current balance auto-transformer in Figure 13 is required to boost the current which is supplied from the line ct's. This assures relay contact opening torque on external faults. Otherwise, current in the lower pole could be in either direction, depending on relative saturation of this line and neutral ct's.

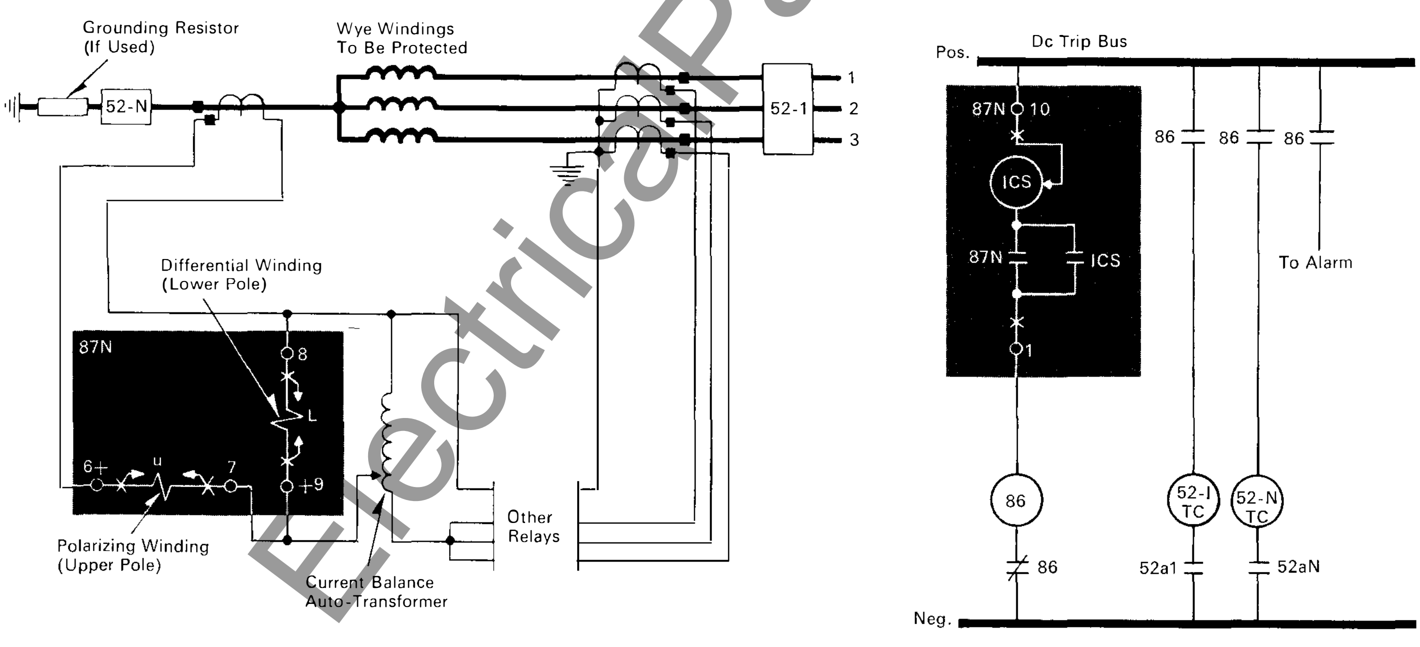


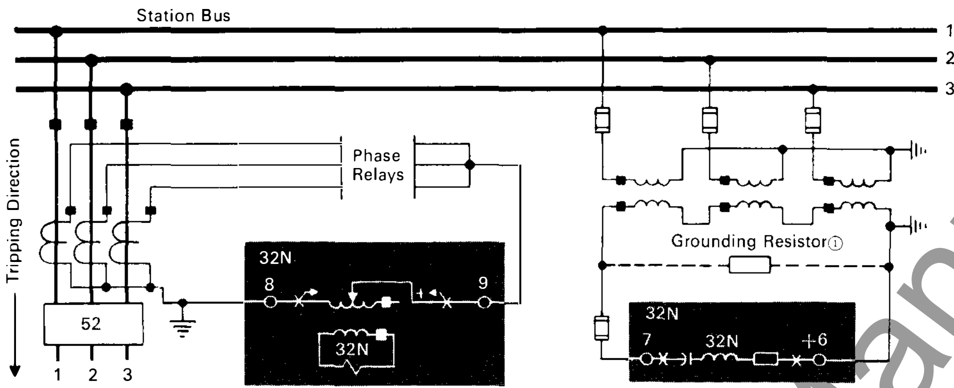
Fig. 13

Key to Device Number

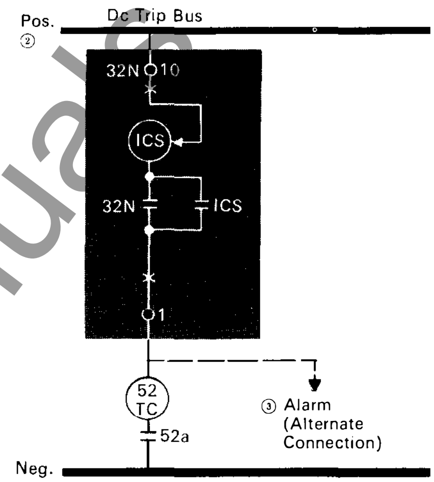
87N – Ground Differential Relay, Type CWC
87N/L – Lower Pole Winding
87N/u – Upper Pole Winding
ICS – Indicating Contactor Switch

86 – Auxiliary Tripping Relay, Type WL
52 – Power Circuit Breaker
52a – Breaker Auxiliary Contact
52TC – Breaker Trip Coil

Type CWP-1 – Ground Fault Detection



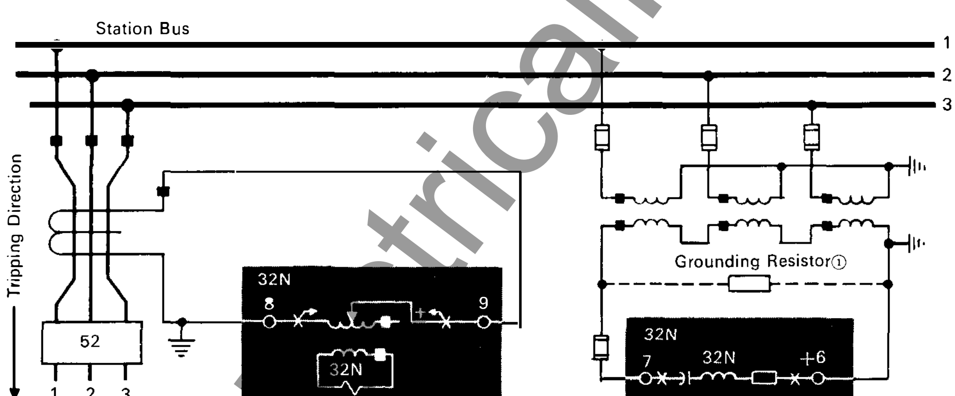
① Used only on ungrounded systems.
③ Contact circuit may be connected to ac for alarm applications.
③ Alarm circuit current should not exceed 0.25 ampere. Set ICS in 2.0 ampere tap if ICS operation is not desired.



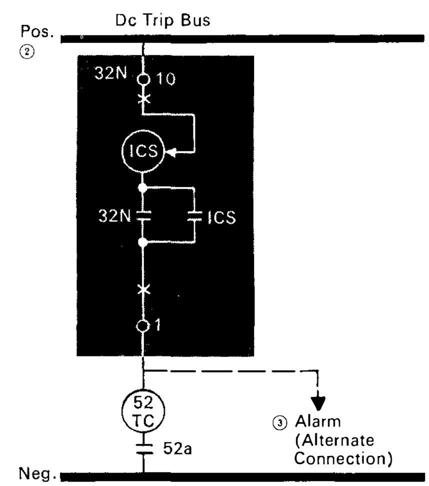
293B184

Fig. 14

Type CWP-1 – Ground Fault Detection
(Using Window Type Current Transformer)



① Used only on ungrounded systems.
② Contact circuit may be connected to ac for alarm applications.
③ Alarm circuit current should not exceed 0.25 ampere. Set ICS in 2.0 ampere tap if ICS operation is not desired.



293B185

Fig. 15

Key to Device Number

32N – Ground Differential Relay, Type CWP-1
52 – Power Circuit Breaker
52a – Breaker Trip Coil
52TC – Breaker Trip Coil

Note 1: Alarm circuit current should not exceed 0.25 ampere. Set ICS in 2 ampere tap, if ICS operation is not desired.

Note 2: Contact circuit may be connected to a-c for alarm applications.

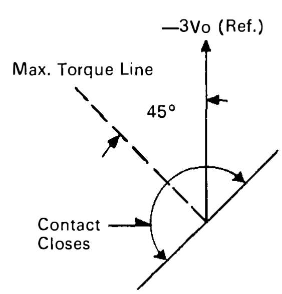


Fig. 16. Applies to figures 14 and 15.

Shipping Weights and Carton Dimensions

Relay Type	Flexitest Case Type	Weight, Lbs., Approx. (KG)		Domestic Shipping Carton Dimensions: Inches (Cm)
		Net	Shipping	
CWC	FT-21	12 (5.5)	16 (7.3)	9 x 12 x 13 (23 x 30 x 33)
CWP	FT-21	12 (5.5)	16 (7.3)	9 x 12 x 13 (23 x 30 x 33)
CWP-1	FT-31	16 (7.3)	20 (9.1)	13 x 13 x 21 (33 x 33 x 53)

Further Information

Prices: PL 41-020
Technical and Ordering Information: TD 41-020
Dimensions: DB 41-075 (Flexitest Case)
Instructions, Operation, Burden and Thermal Data: CWC Relay – Inst. Leaflet 41-242.2
CWP Relay – Inst. Leaflet 41-242.2
CWP-1 Relay – Inst. Leaflet 41-242.5
Other Protective Relays: Selector Guides 41-000 A, B, and C

Westinghouse Electric Corporation
Relay-Instrument Division
Coral Springs, FL 33065

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