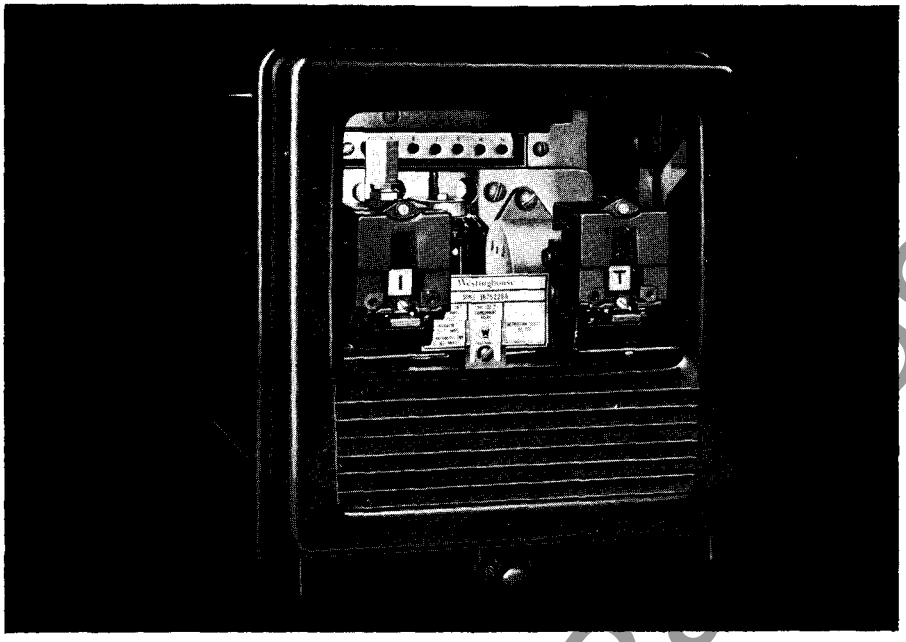
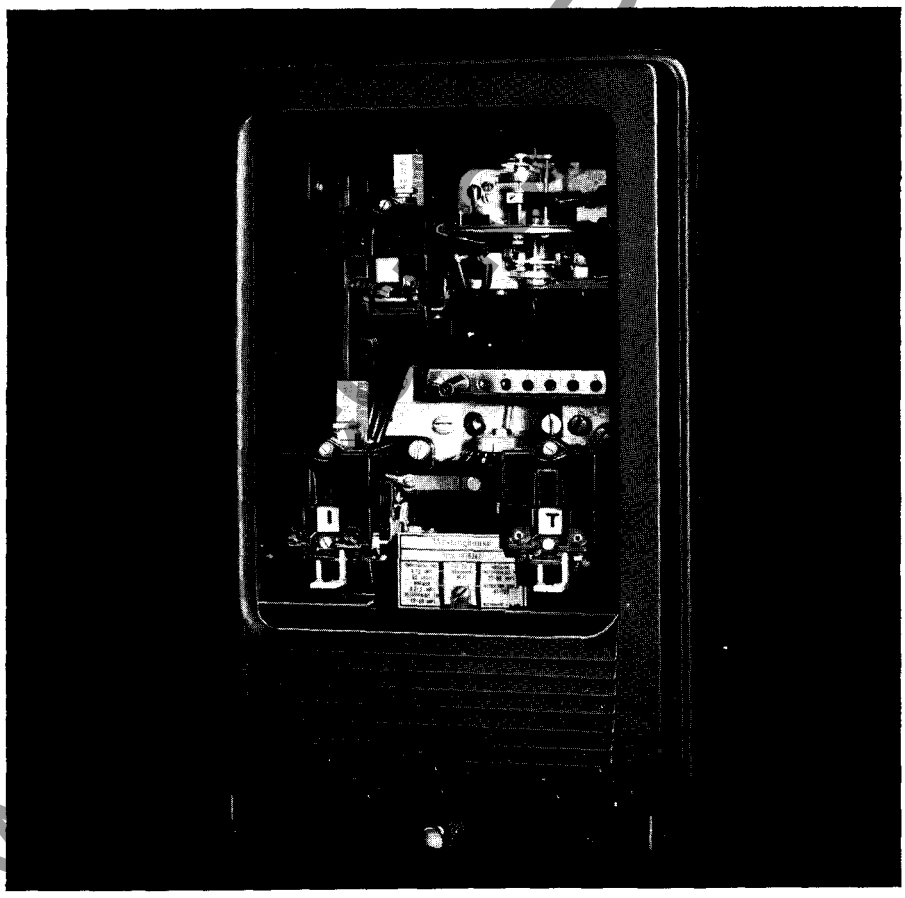
Westinghouse

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay





Application

Westinghouse CO relays, a complete coordinated line, assure accurate and reliable primary or backup protection against phase or ground faults. They provide the backbone of any protective relaying system, from generator to load.

For selective coordination between relays, seven different time curve characteristics are available. All are designed to operate faster at higher fault currents.

Each type has a wide range of current tap settings and time dial positions.

Properly applied, CO relays will provide maximum service continuity by tripping the fewest possible circuit breakers required to disconnect a faulted section.

For fast (½ cycle) clearing of heavy faults, CO relays can be equipped with adjustable instantaneous overcurrent units.

Where cold load pickup presents a problem due to heavy inrush currents to devices such as refrigerators, water heaters, etc., type CO relays can be equipped with high dropout instantaneous trip units (ITH) which will provide instantaneous trip protection for the protective line when initial load current is dropped to 90% of the ITH unit setting.

When ac current is necessary in the control-trip circuit, the indicating contactor switch (ICS) dc unit is replaced by the type ACS indicating contactor switch sealed-in unit. The ACS unit is similar in construction to the IIT unit, and has an adjustable range of .25 to .9 amperes ac.

Both non-torque and torque controlled designs are available.

Advantages

Low burden, high thermal capacity, negligible temperature error.

Accurate pickup, continuous "between tap" adjustment.

Simplified settings, ease of accessibility, lower maintenance cost.

Space saving Flexitest® universal cases, for semi-flush or projection mounting.

Device Number: 51

February, 1967
Supersedes DB 41-100A dated September, 1961
E, D, C/2013/DB

Westinghouse

Selector Guide

Relay Type	Time Curve	Comparative Operating Time①	Basic Application
CO-2	Short	0.47 Sec.	Differential protection of bus or generators where restraint windings are not required. Straight overcurrent protection where short operating time is necessary for system stability.
CO-4	Long (step)	25 Sec.	Designed primarily to provide effective relay coordination with the selective trip characteristics of Westinghouse DB breakers. Step-time operating characteristic coordinates with selective trip curve of DB breaker and associated fuses.
CO-5	Long	25 Sec.	Motor protection. Long time setting (150% of full load) prevents tripping due to motor starting currents, and allows motor to carry moderate overloads for safe periods. Inverse characteristic provides faster tripping at higher overloads.
CO-6	Definite	2 Sec.	For use where generating capacity and fault currents vary over a wide range. Relay has fixed operating time (per time dial setting) from approximately 10 to 20 times tap current, thus providing definite selective operation for sequential tripping.
CO-7	Moderately Inverse	2.48 Sec.	Overcurrent phase and/or ground fault detection on transmission or feeder lines where moderate changes in generating capacity occur, or on parallel lines where one line may be called on to carry both loads. Relay approaches definite time characteristics at high currents, allowing wide changes in fault current magnitude with little change in operating time.
CO-8	Inverse	2.52 Sec.	Phase and/or ground fault detection of subtransmission lines or feeders. Also supplied as primary protection or back-up for other relays. Wide range in time lever settings and slope of curves facilitate coordination and assure selective operation. Degree of inverseness required is determined by fault current magnitude, operating time desired, and the characteristics of nearby relays on the system.
CO-9	Very Inverse	1.53 Sec.	
CO-11	Extremely Inverse	0.8 Sec.	Used on feeder circuit breakers which must coordinate with main and branch line sectionalizing fuses. Also used where long time delay is required for light overload, such as where feeder is energized after extended outage.

① Values shown are with #10 time dial setting, and with 10 times tap value current applied.

Factors to Consider in Selecting Proper Relay Type

Apparatus or Circuit to be Protected: In general, the application will indicate the use of a specific relay. Short-time relays act fast to avoid equipment damage. Long-time relays hold off tripping on heavy initial overloads or more extended moderate overloads.

At higher fault currents, definite-time and moderately inverse relays maintain constant operating time, despite variation in connected generation and fault currents. Inverse and extremely inverse relays operate respectively faster on higher fault currents.

Selective Operation, Sequential Tripping: To maintain maximum continuity of service, as small a section as possible should be removed from a system during a fault. A common method is to set each successive relay, progressing from the generator, to operate 0.3 second sooner (exclusive of circuit breaker operating time) so that the relay nearest the fault will operate first to remove the faulted section. See figure 1.

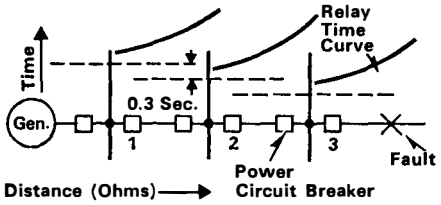


Fig. 1

Coordination With Adjacent Relays: To assure selective operation, relays in all sections of the protected line should have similar operating curves. Otherwise, curves may intercept, resulting in incorrect relay operation. See figure 2.

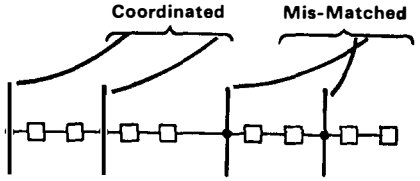


Fig. 2

Relay Tap Range: Magnitude of fault current available at a given location is usually determined by system studies. Tap range selection depends on the fault current as seen by the relay, which is determined by the current transformer ratio and its operating characteristics under fault conditions.

Ac or Dc Trip Circuit: Where a dc control source (24 to 250 volts) is available, circuit closing relays are used. If dc is not available, circuit opening relays are used with

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

ac tripping, using the output of a current transformer to energize the circuit breaker trip coil. Under normal conditions, the normally closed contacts of the relay shunt the breaker trip coil.

High Speed Short Circuit Fault Protection: Relays equipped with instantaneous overcurrent IIT or ITH units provide instantaneous overcurrent tripping, in addition to tripping with time delay on moderate overloads.

Construction and Operation①

Two basic designs are available:

Non-torque Controlled
This, the most widely used type, is designed so that the relay contacts close when tap value is applied. See figures 9 and 10.

Torque Controlled
This type has the lag coil connections of the "E" induction unit electromagnet brought out to separate terminals. This permits control of the time-overcurrent unit from an external relay contact, such as a directional or distance relay. See figures 13 and 14.

1 Time Delay Overcurrent Unit (CO)
See page 4.

2 Indicating Instantaneous Trip (IIT)
See page 5.

3 Indicating Contactor Switch (ICS)
See page 5.

4 ICS Taps
See page 5.

① CO-4 relay for relay coordination with 600 volt air circuit breaker is described on pages 10 and 11.

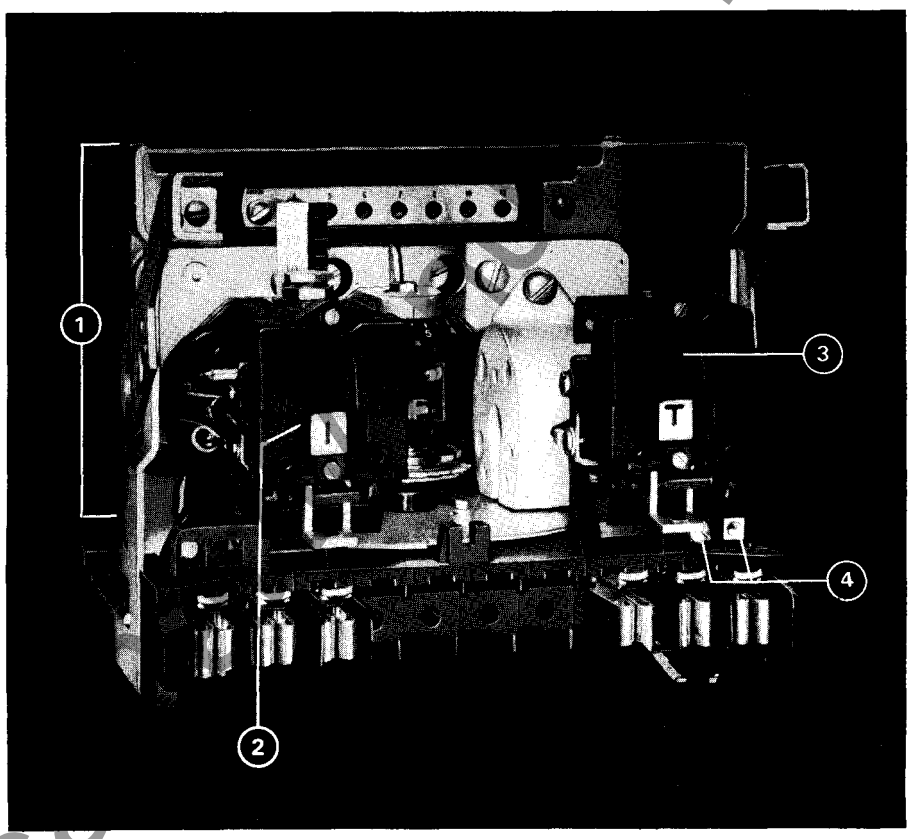


Fig. 3

Circuit Opening Types
Circuit opening CO relays in conjunction with an ac series trip coil are used to trip circuit breakers when a suitable station battery is not available.

As shown in figures 12 and 13, closing of the CO unit contacts energizes a De-ion® contactor switch (CS) whose contacts shunt the ac trip current through the breaker trip coil.

The circuit opening relay is recommended only in the 4 to 12 ampere range. A lower range relay is not desirable due to the excessive burden of a low current range trip coil.

Burden of the auxiliary current transformer (figures 12 and 13) with 4 amperes applied is 4.6 volt-amperes with the CO contacts closed, and 5.7 volt-amperes with the contacts open.

See page 5 for description and illustration of the De-ion contactor switch.

"Cold Load" Pickup Protection Types
Standard CO relays, equipped with a high dropout instantaneous unit (ITH) used in conjunction with reclosing relays, provide completely coordinated distribution feeder protection where "cold load" pickup is involved.

The ITH unit has a dropout ratio of 90% of pickup. With this unit set at minimum fault current on the protected feeder, when a fault occurs, the ITH picks up and, in conjunction with the reclosing relay, the breaker is tripped and immediately reclosed. The reclosing relay at the same time takes over control and locks out the ITH contact circuit.

After the fault has been cleared, the feeder is re-energized and, after a slight time delay in the recloser circuit, the ITH contact circuit is restored. However, under normal cold load pickup conditions, the line current has dropped to less than 90% of minimum fault current before this contact circuit is re-established and the ITH unit has dropped out, permitting the time delay necessary to pickup the cold load.

See page 5, for description of the ITH unit.

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Construction and Operation, Continued

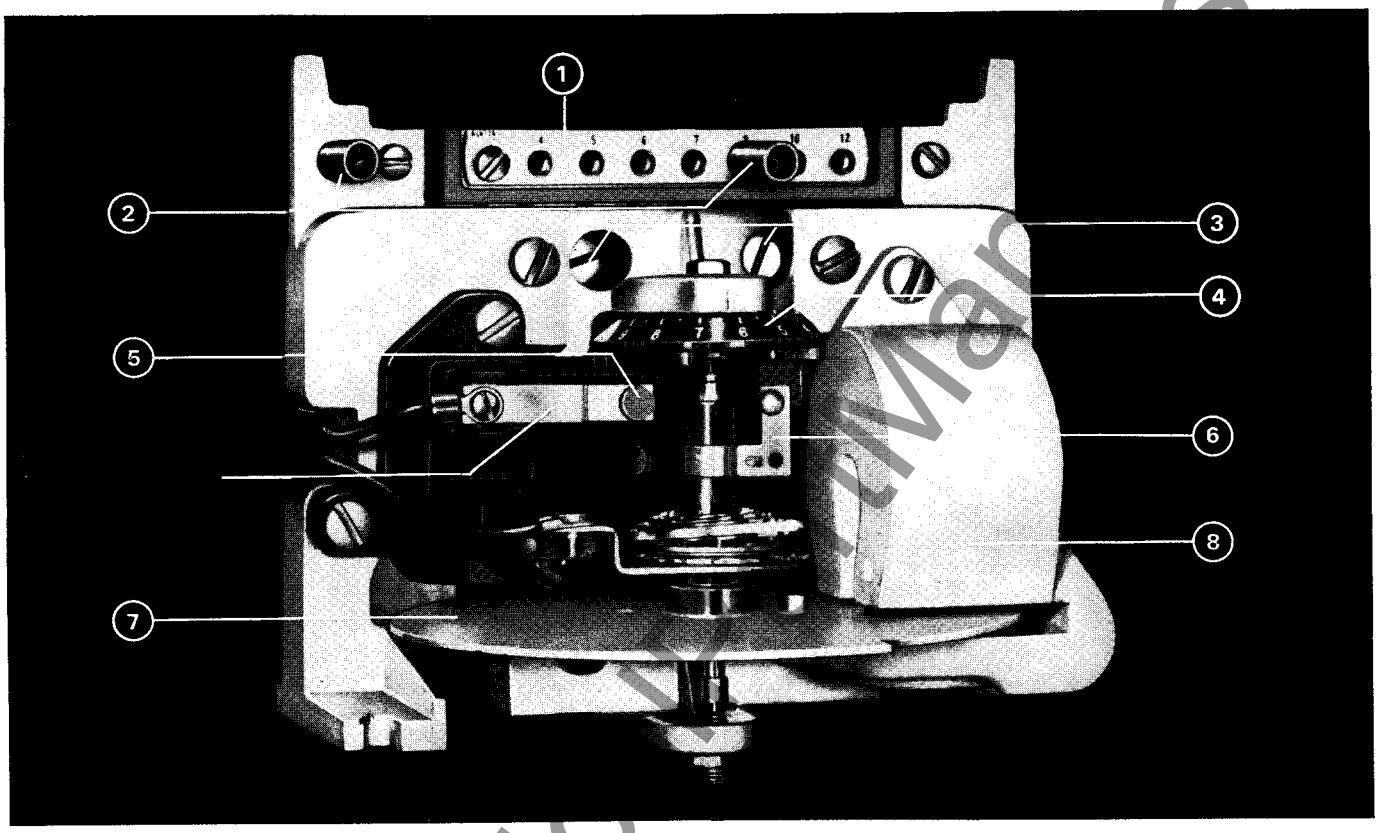

Fig. 4

Time Delay Overcurrent Unit (CO)
On CO-4, CO-5, CO-6, CO-7, CO-8, and CO-9 relays a main tapped coil is placed in the center leg of an "E" type laminated magnetic structure. Flux produced by this coil returns through the two outer legs of the electromagnet. A shading coil on the left leg of the electromagnet creates an out-of-phase flux which reacts with the main coil flux in the electromagnets air gap to cause disc rotation in the contact closing direction.

CO-2 and CO-11 electromagnets are similar in construction, except that both outer legs have windings to produce the necessary out-of-phase fluxes required for contact closing rotational torque.

1 Tap Block
Indicates minimum current required to just close the relay contacts.

2 Tap Screws
Two supplied. When changing tap range, the spare is inserted into the new position prior to removal of the existing tap setting screw. This prevents open circuiting of the associated current transformer.

3 Magnetic Plugs
May be screwed in or out of the magnetic circuit to control saturation and adjust calibration at high currents. A damping magnet and spring adjustment permits calibration at low currents.

4 Time Dial
Indicates initial position of the moving contact over a 270° range. Indexes from ½ (minimum time) to 11 (maximum time).

5 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 back-stop. On double-trip relays, adjustment of 1/64" contact follow (or wipe) is obtained by use of a vernier adjusting screw on the stationary contact plate.

6 Moving Contact
Also made of pure silver, the moving contact is clamped to the insulated section of the disc shaft. Electrical connection is made from the moving contact through a spiral spring to the spring adjuster frame, then to the relay terminal. Moving contacts will close 30 amperes at 250 volts dc.

7 Induction Disc
Spiral shaped to compensate for the spring windup which occurs throughout the moving contact travel. Provides accurate pickup at any disc position. A spring adjuster is provided to permit in-between tap pickup adjustment when desired.

8 Damping Magnet
Made of high strength Alnico. Controls relay operating time at low current values. A keeper screw permits micrometer adjustment of the damping magnet without shifting the location of the magnet, and allows the relay to be accurately calibrated at low currents.

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Indicating Contactor Switch (ICS)
(Partially Disassembled)

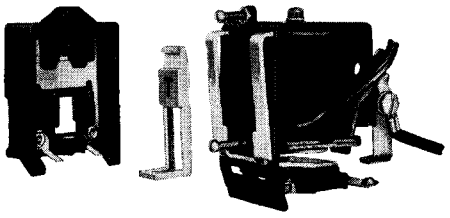

Fig. 5

The dc operated Indicating Contactor Switch has a clapper type magnetic armature to which leaf-spring contacts are attached.

When the switch is energized, the moving contacts bridge the stationary contacts, completing the trip circuit. The ICS contacts are connected in parallel with the main relay contacts, relieving them of carrying heavy trip currents.

During operation, two fingers on the armature deflect a spring, which allows the operation indicator target to drop. The target is orange color and readily visible.

Taps on the front of the unit provide connection for either 0.2 (left) or 2.0 (right) amperes dc pickup operation.

When using a 125 or 250 volt dc auxiliary WL auxiliary relay, the 0.2 ampere tap is recommended. The 2.0 ampere tap is used on 24 or 48 volt dc circuits.

Indicating Instantaneous Trip (IIT)

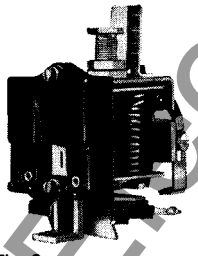

Fig. 6

Used for high speed protection against heavy fault currents. Construction is similar to that of the Indicating Contactor Switch, except that it is ac operated, and adjustable over a range of 1 to 4 times minimum pickup. Variable pickup is obtained by a core screw adjustment on the top of the unit.

When the IIT is energized above pickup setting, the target drops. Operating time is approximately one-half cycle above 250% of setting.

The IIT unit has a calibrated scale on which are marked the four divisional points of pickup range.

De-ion® Contactor Switch (CS)

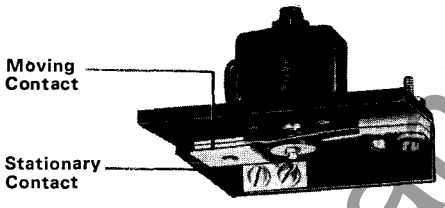

Fig. 7

Used in circuit opening type CO relays as shown schematically in figures 12 and 13. This scheme is applied where ac trip coils are used on the circuit breakers, energized by the line current transformers. When the CS coil is energized by a small transformer located within the relay case, its normally closed contacts open to remove the by-pass around the breaker trip coil, thus tripping the breaker.

The CS switch will pick up at 4 amperes ac and will safely by-pass 100 amperes ac through its contacts.

High Dropout Instantaneous Unit (ITH)

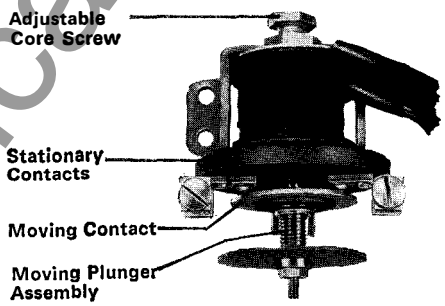

Fig. 8

The ITH unit is a solenoid operated device with an adjustable core screw which adjusts the ac current pickup of the device over a 2 to 1 range.

When the ITH coil is energized above pickup setting, the moving plunger assembly moves upward, carrying the silver disc which bridges three conical-shaped stationary contacts. The device opens its contacts when the coil current is reduced to 90% of its pickup value.

Operating range of the ITH unit can be increased to a 4 to 1 ratio, or four times the minimum pickup setting obtainable, by lowering the plunger after the core screw has been set at its maximum rated position.

If the plunger is lowered to increase the pickup current value, then at 300% of minimum trip the dropout ratio is 60% of the pickup current. At 400% of minimum trip the dropout ratio is 45% of the pickup current.

Operating speed of the ITH unit over nominal range (60 cycle base) is as follows:

at 200% of trip setting: less than 1 cycle
at 500% of trip setting: ½ cycle
at 1000% of trip setting: ¼ cycle

ACS Unit

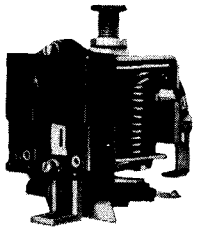

Fig. 9

Operating Range	.25 to .9 amps ac
Burden	.73 ohms ac
Coil Rating:	
Continuous	.25 amp
1-Second	7.0 amps

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Internal Wiring Diagrams (Front View)

Without External Torque Control

Spst-cc Contacts, FT-11 Case,
Without Indicating Instantaneous Trip (IIT)

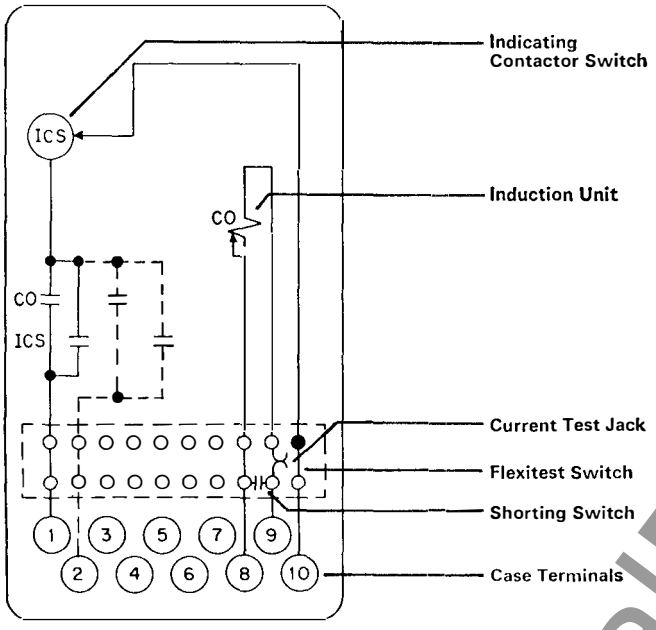

Fig. 10 57D4524

Spst-cc Contacts, FT-11 Case
With Indicating Instantaneous Trip (IIT)

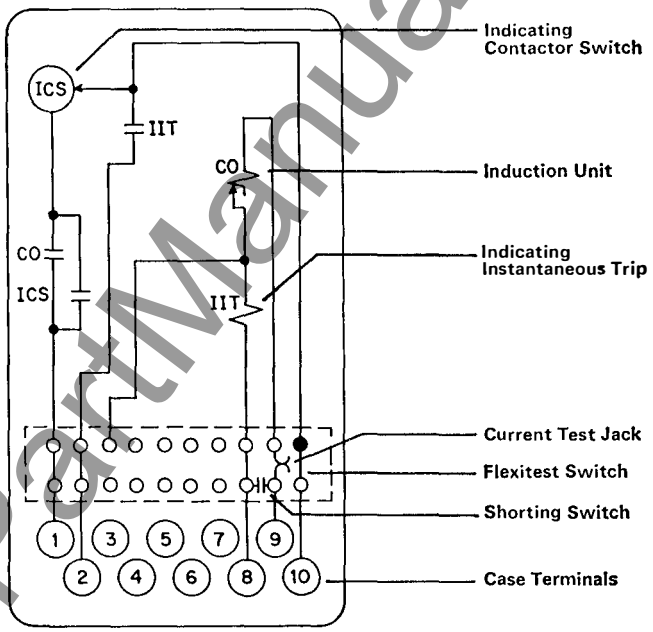

Fig. 11 57D4525

Spst-co Contacts, FT-21 Case
Without Indicating Instantaneous Trip (IIT)

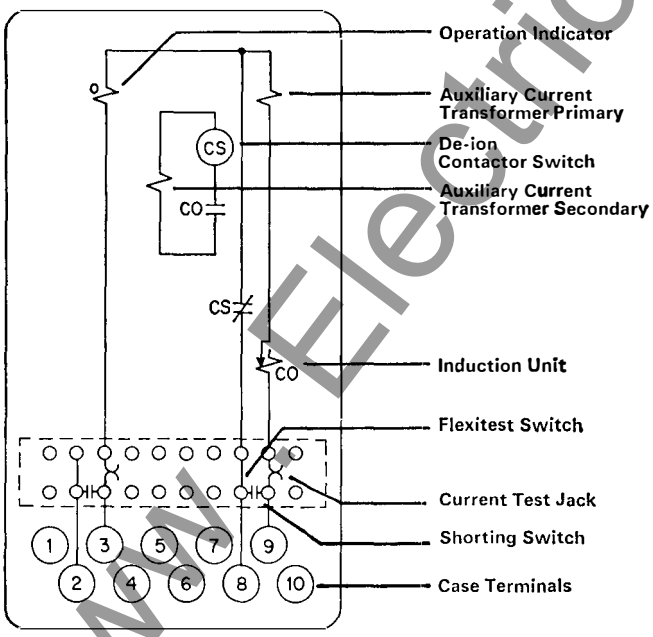

Fig. 12 183A055

Spst-co Contacts, FT-21 Case
With Indicating Instantaneous Trip (IIT)

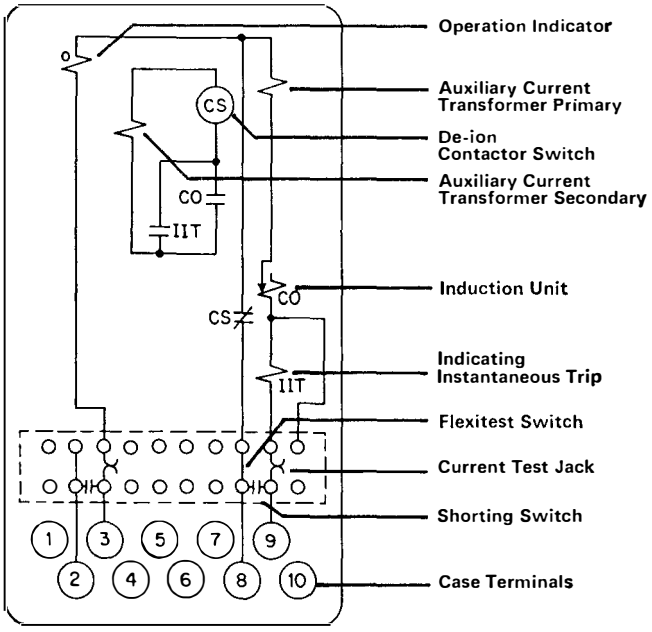

Fig. 13 183A054

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

With External Torque Control

Spst-cc Contacts, FT-11 Case
Without Indicating Instantaneous Trip (IIT)

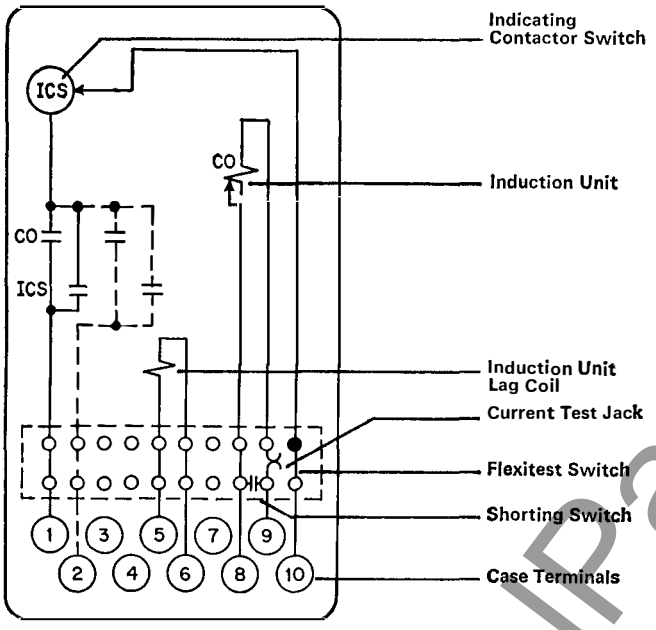

Fig. 14 57D4528

Spst-cc Contacts, FT-11 Case
With Indicating Instantaneous Trip (IIT)

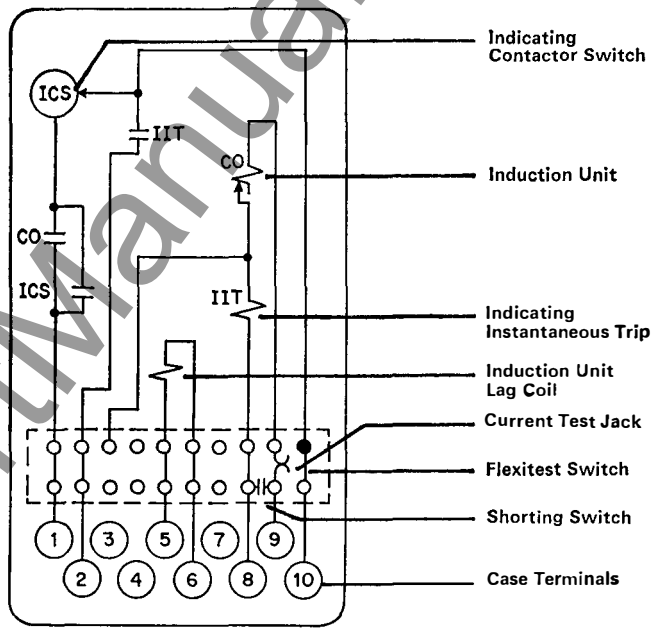

Fig. 15 57D4529

With High Dropout Instantaneous Unit (ITH)

Spst-cc Contacts, FT-11 Case

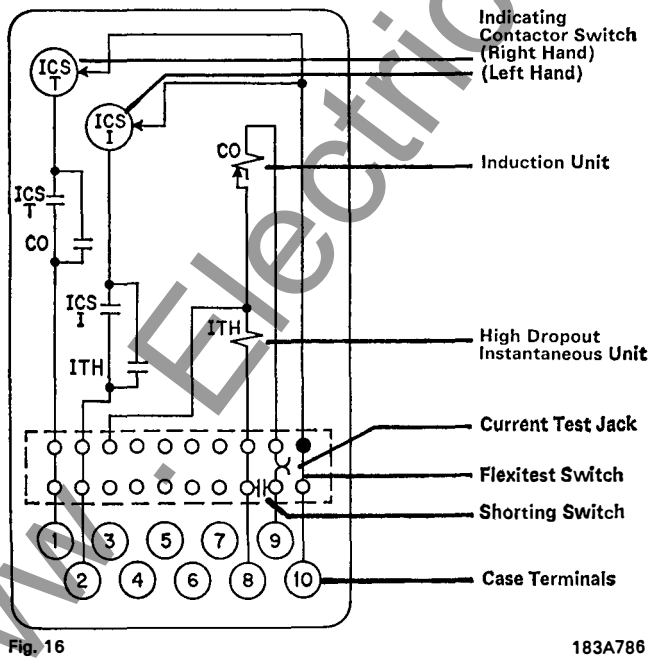

Fig. 16 183A786

Contact Legend

Spst-cc: single pole single throw – circuit closing
Spst-co: single pole single throw – circuit

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External Wiring Diagrams

Circuit Closing: For Phase and Ground Overcurrent Detection on a Three Phase System

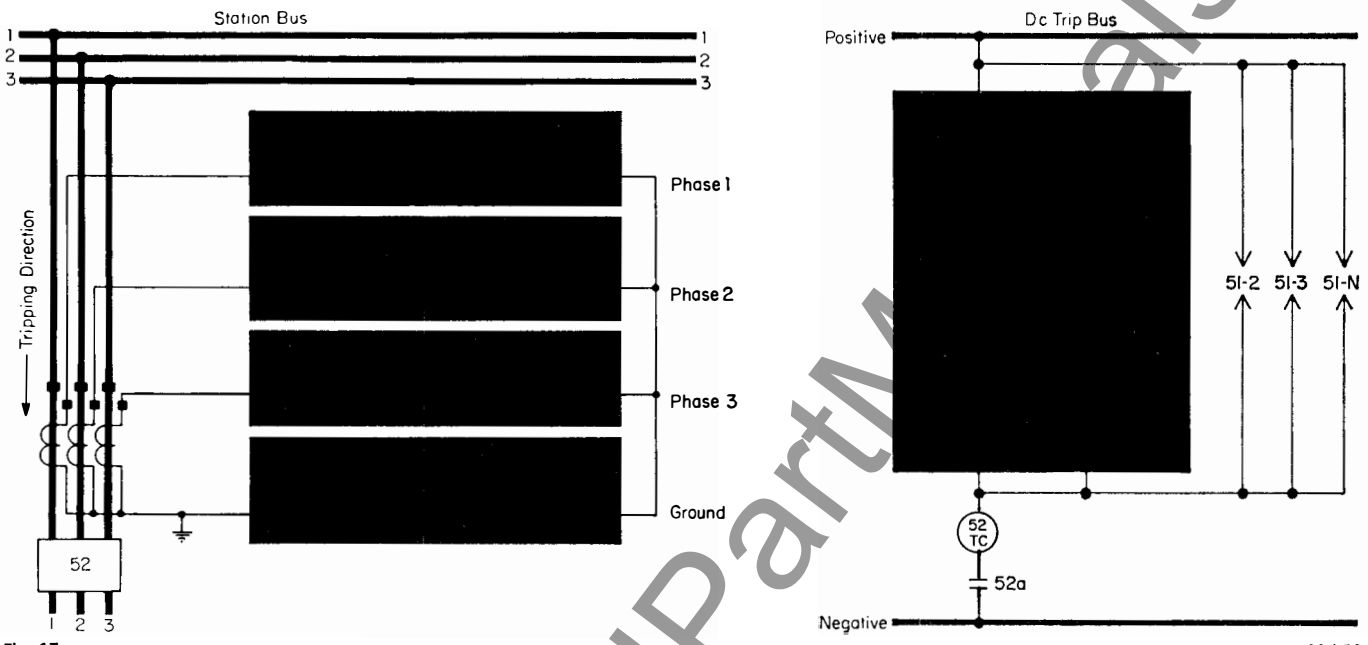

Fig. 17

182A75

Circuit Opening: For Phase Overcurrent Detection on a Three Phase System

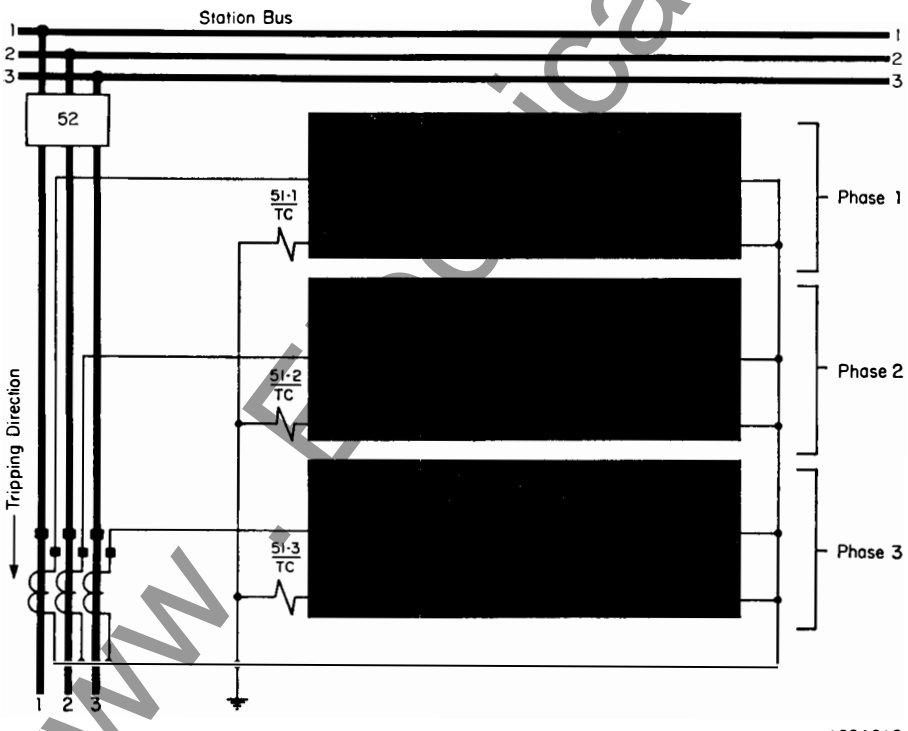

Fig. 18

183A213

Device Number Chart
(For Figures 17, 18, and 19).

51 – Overcurrent Relay, Type CO
51N – Ground Overcurrent Relay, Type CO
CS – De-ion Contactor Switch
32 – Directional Relay, Type H-3
32X – Auxiliary Relay, Type MG-6
CS1, **CS2** – Auxiliary Contactor Switches
ICS – Indicating Contactor Switch
IIT – Indicating Instantaneous Trip
52 – Power Circuit Breaker
52a – Breaker Auxiliary Contact
TC – Breaker Trip Coil
TO – Operation Indicator

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

Three Phase Overcurrent Detection: Using Type H-3 Directional Relay and Torque Controlling Type CO Relays with MG-6 Auxiliary Relay, 90 Degree Connection

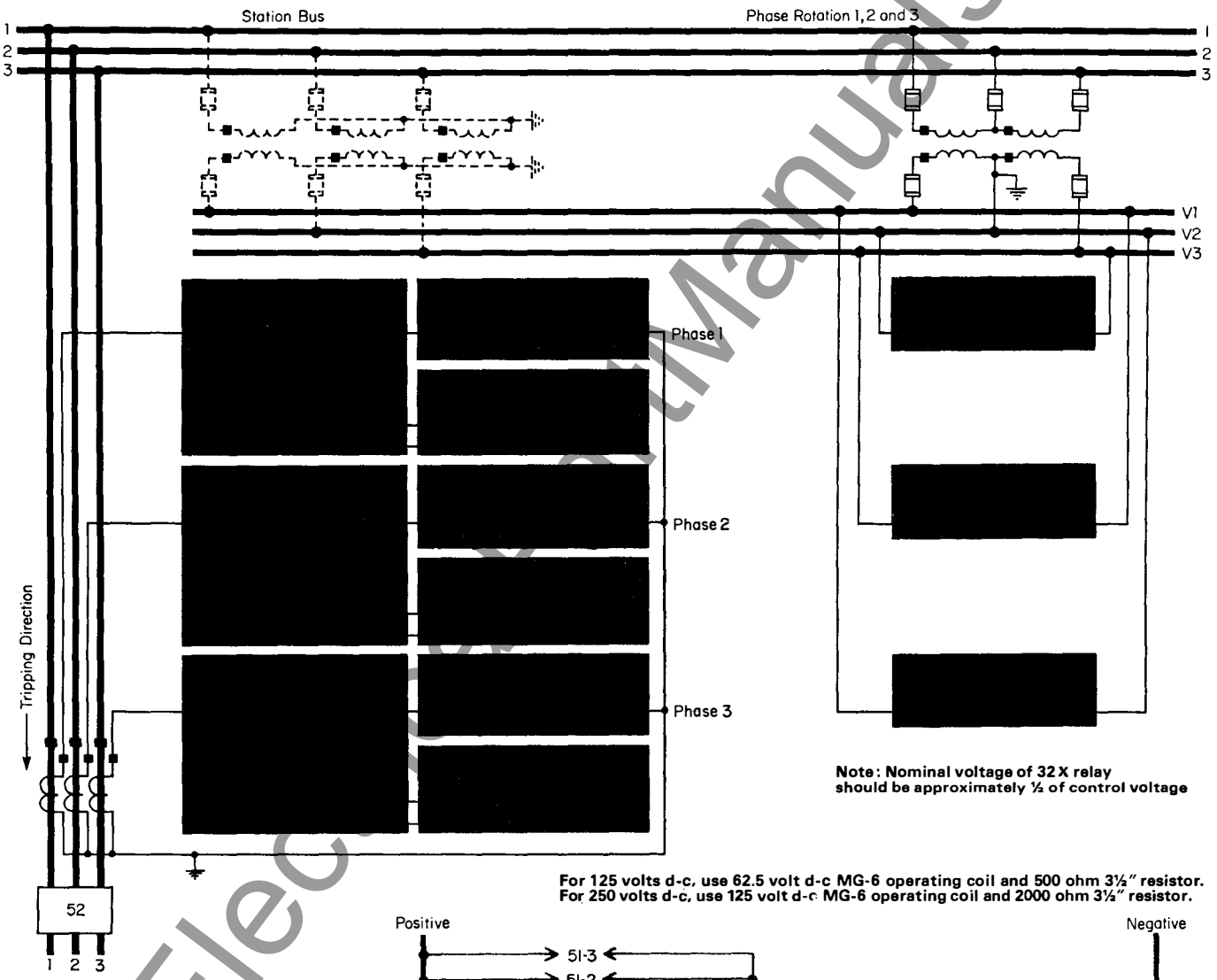

Fig. 19

289B077

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CO-4 Relay For Relay Coordination with 600 Volt Air Circuit Breakers

In 600 volt class equipment, protection is generally obtained through the use of overcurrent tripping devices which are an integral part of the circuit breakers.

Two types of air circuit breakers are generally used in low voltage applications for industrials and power plants. One type, such as the Westinghouse AB breaker, uses a thermal magnetic tripping device. The other is the Westinghouse DB type which uses series overcurrent tripping units that employ a dashpot device to obtain time delay.

The tripping characteristic of the DB breaker has a pronounced bend as shown in figure 20. The use of standard CO relays would necessitate a high current pickup setting in order to keep the relay time-current characteristic beyond the bend of the breaker operating curve. This high current pickup setting in turn, makes coordination with other relays near the source difficult or impossible.

Inasmuch as it is not practical to sacrifice coordination and proper protection of the primary system merely to obtain selectivity on the low voltage system, the CO-4 relay was developed.

The CO-4 has a step-time characteristic which is obtained by the combination of the CO-5 long time induction disc overcurrent unit, two instantaneous overcurrent units, and one timer. The resultant curve is illustrated by figure 22.

The induction disc-overcurrent unit is set to coordinate with the overload portion of the breaker curve.

The instantaneous unit (IT) energizes the timer (T) to provide .25-3 seconds delay, and the IIT unit trips directly.

Consequently, the CO-4 step-time characteristic effects selective coordination with other relays nearer to the power source.

DB Breaker Tripping Characteristics

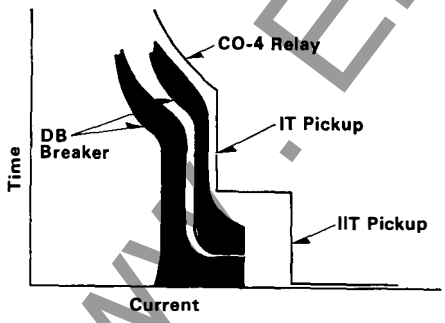


Fig. 20

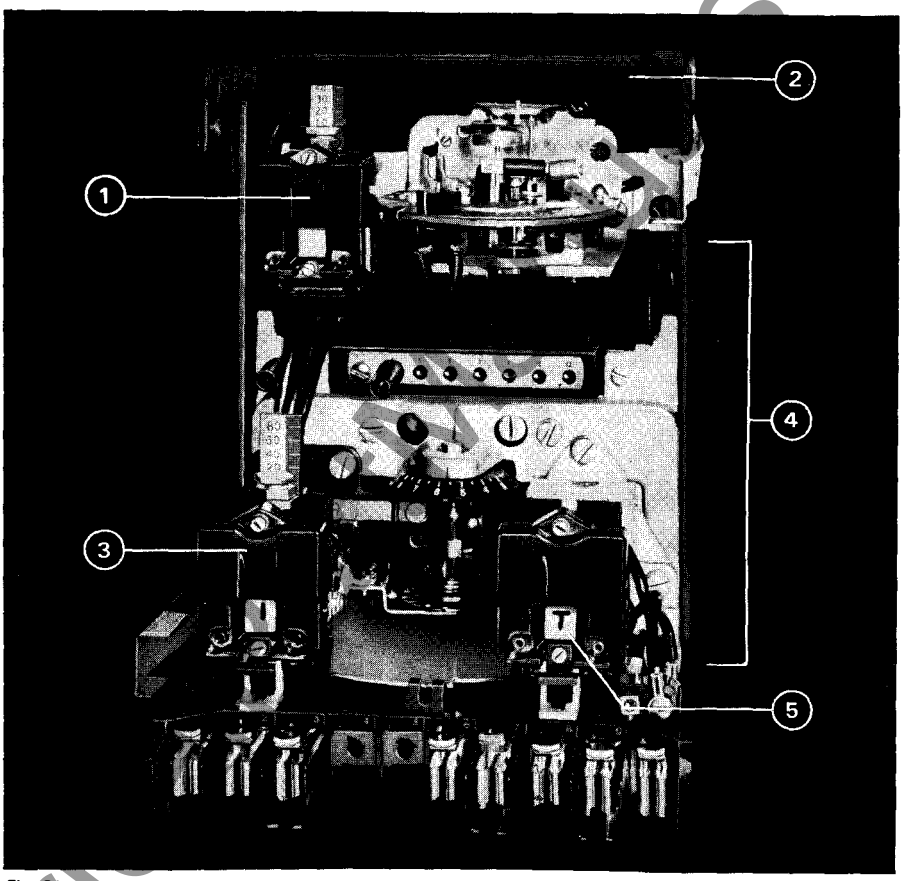


Fig. 21

1 Instantaneous Trip Unit (IT)

Ac operated. An adjustable core varies the current pickup of the unit. When the IT contacts close, the timer circuit is completed, providing an adjustable time delay before tripping.

2 Timer Unit(T)

Consists of a small synchronous motor which is energized from the secondary circuit of a saturating transformer which has a current-energized primary (see figure 22). The motor has a floating rotor which meshes with the gear train only when the motor is energized.

Upon de-energization, the rotor drops out of mesh with the gear train, allowing a spring to quickly reset the contact arm.

The contact on the moving arm is a loosely fitted cylindrical sleeve. When the arm rotates, the sleeve bridges two butt type stationary contacts, completing the circuit. The stationary contacts are mounted on a molded insulator block which is adjustable around the semi-circular calibrated scale.

Maximum setting of the timer is 3 seconds, indexed at 10 cycle points.

The timer motor will operate satisfactorily over a range of 10 to 100 amperes ac. Timing accuracy is ±5% of setting.

3 Indicating Instantaneous Trip (IIT)

4 Time Delay Overcurrent Unit (CO)

5 Indicating Contactor Switch (ICS)

See page 5.

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

Typical CO-4 Time-Current Curve Bands

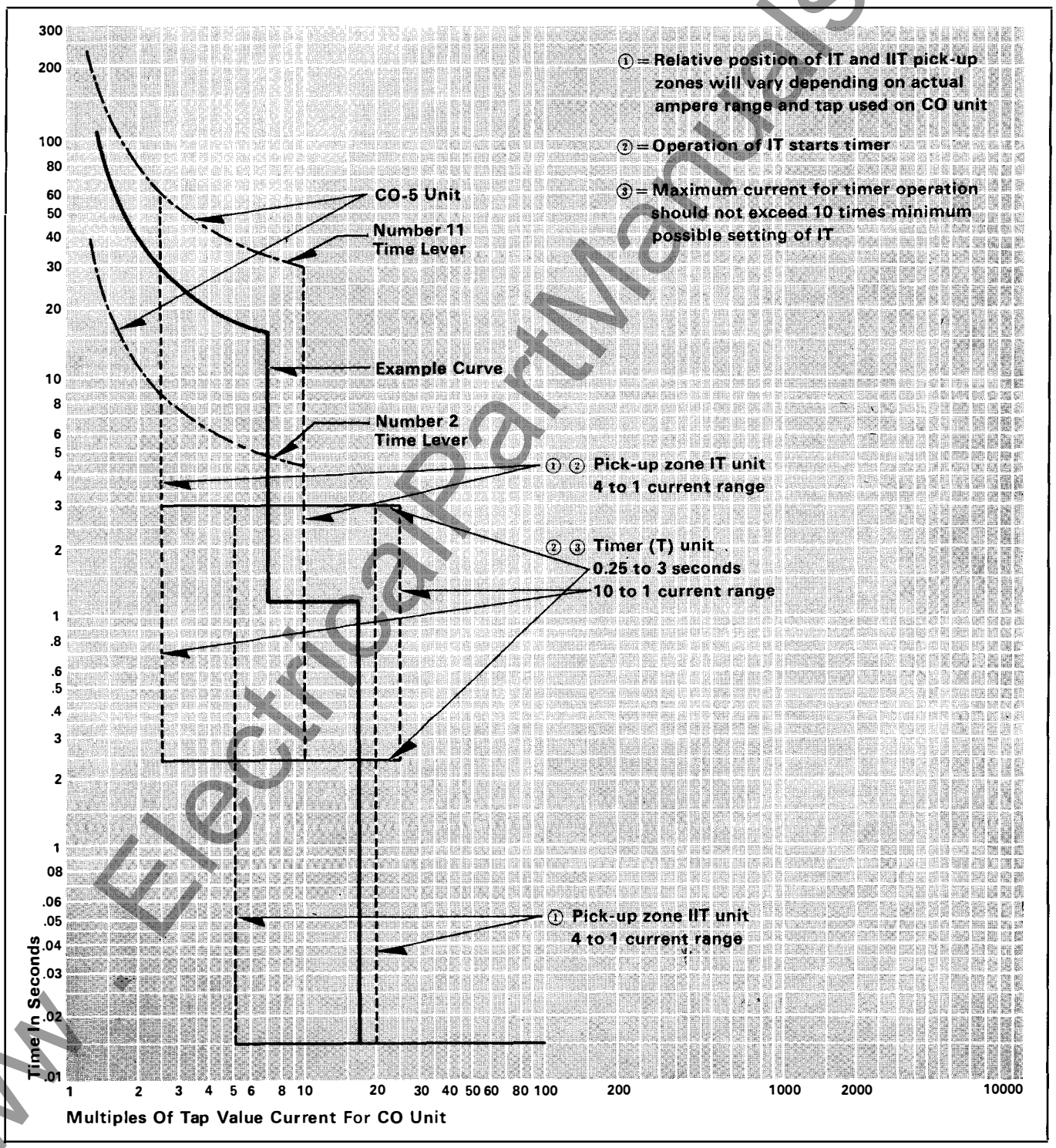


Fig. 22

406C935

Type CO
Overcurrent Relays

Non-directional, Single Phase,
Adjustable Time Delay

CO-4 Internal Wiring, Spst-cc Contacts, FT-21 Case

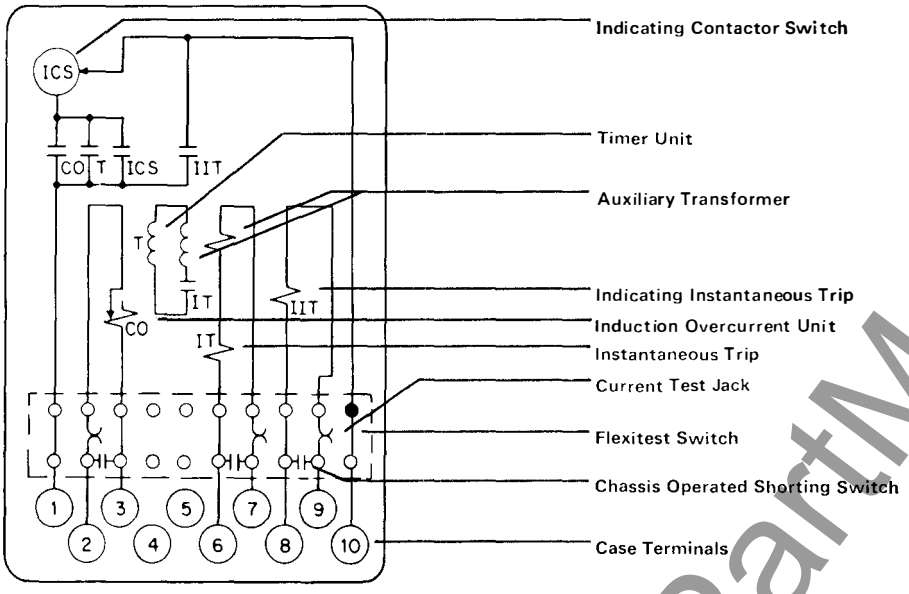


Fig. 23 183A115

Shipping Weights and Dimensions

Relay Type	Flexitest Case Type	Weight, Lbs.: Approx. Net	Weight, Lbs.: Approx. Shipping	Domestic Shipping Carton Dimensions: Inches
CO-2, 5, 6, 7, 8, 9, 11 Circuit Closing	FT-11	8	11	9 x 9 x 10
CO-6, CO-8, CO-9, CO-11 Circuit Opening	FT-21	10	13	9 x 12 x 13
CO-4	FT-21	12	16	9 x 12 x 13

Further Information

List Prices, Ordering Information	PL 41-020
Instructions:	
Circuit Closing CO Relays	IL 41-101
Circuit Opening CO Relays	IL 41-103
CO-4 Relays	IL 41-106
Renewal Parts	RPD 41-101A1
Flexitest Case Dimensions	DB 41-075
Other Westinghouse Protective Relays	SG 41-000

Burden Data and Thermal Characteristics (All Types)

Time Delay Overcurrent Unit, etc.

See Performance Data 41-000

CS De-ion Switch (Ac Operated)
(Used in contact opening CO relays)

4 amps ac pickup. Will bypass 100 amps ac in trip circuit.

Timer
(Used in CO-4 relay).

Burden of the timer unit and auxiliary current transformer at 5 amps, 60 cycles, with an IT range of 10 to 40 amps is:

IT contacts open: 0.7 volt-ampere at 80° lag
IT contacts closed: 0.6 volt-ampere at 65° lag

Current Tap Ranges (Ac)

Range	Taps
Contact Closing Relays	
0.5 – 2.5	0.5, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5
2 – 6	2, 2.5, 3, 3.5, 4, 5, 6
4 – 12	4, 5, 6, 7, 8, 10, 12
Contact Opening Relays	
4 – 12	4, 5, 6, 7, 8, 10, 12

Time Curves

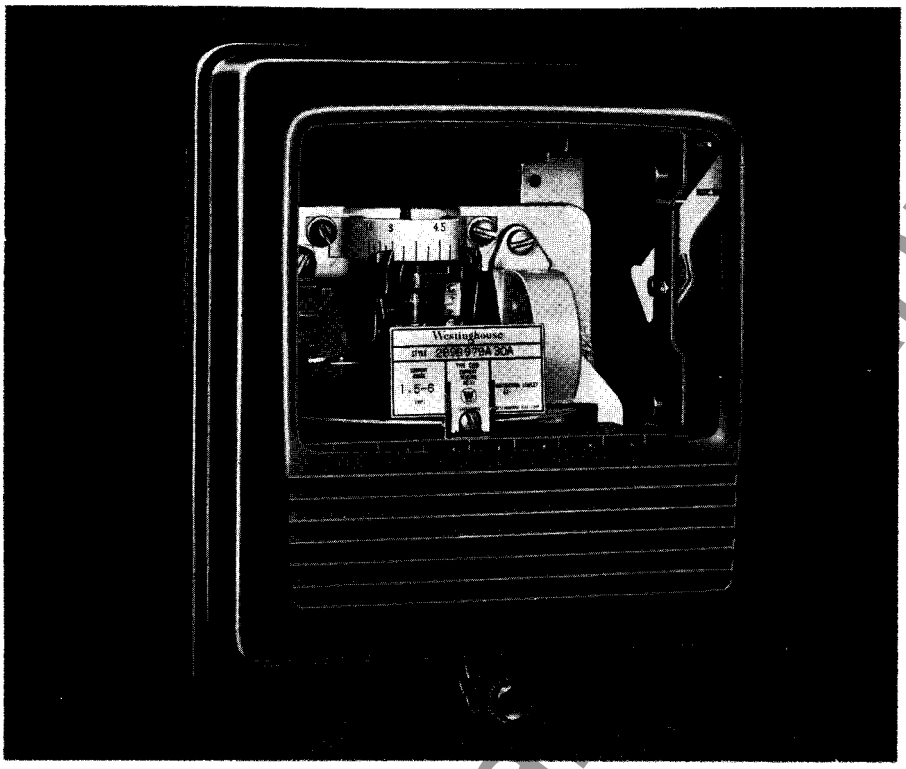
See Performance Data 41-000.

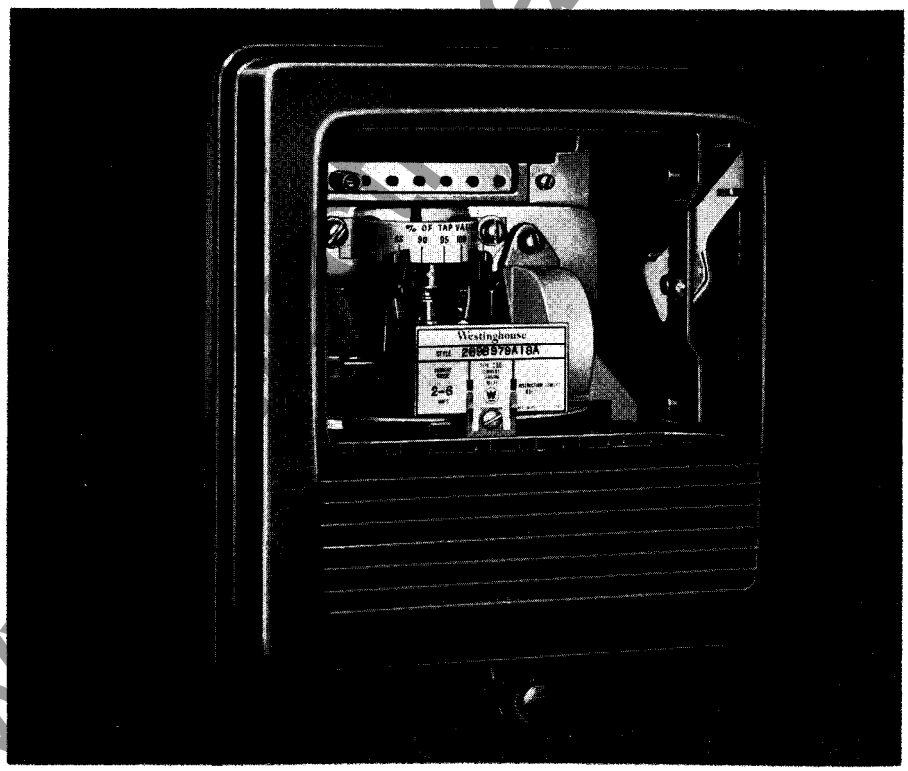
Westinghouse Electric Corporation
Relay-Instrument Division: Newark Plant, Newark, N. J
Printed in USA

Westinghouse

Type COD
Current Sensing Relay

For Relaying Control Schemes





Application

The COD current sensing relay is used to initiate switching or control functions upon a change in line current. It is equipped with independently adjustable high current and low current circuit closing contacts, and operates similar to a contact closing ac ammeter with inverse time delay.

The moving contact assumes a position corresponding to the current applied, moving to other relative positions as line current changes occur. As the relay has inverse timing, the greater the change in applied current the faster the moving contact will travel to its new position.

Two COD designs are available: (1) A single range non-tapped unit with calibrated scale marked for specific values of current within the range of the relay, and (2) a multi-range unit equipped with taps and a calibrated scale marked with percentage of tap value current from 80% to 110%.

The COD relay unit is commonly used for capacitor switching applications. When the high current contact closes, capacitors are connected to the power line in order to raise line voltage.

Conversely, when line current drops sufficiently to maintain the low-set COD relay current contact for a preset time, switching is initiated to disconnect capacitors from the power line.

The COD is used in conjunction with time-delay relays to avoid undesired switching due to load current swings.

Auxiliary relays having relatively heavy duty contacts are used with the COD to avoid damage to the COD contacts due to control current interruptions.

Types are also available with Indicating Contactor Switch units in the overcurrent and undercurrent circuits.

Device Number: 90

July, 1973
Supersedes DB 41-100B dated April, 1969
E, D, C/2013/DB

Westinghouse

Construction and Operation

1 **Moving Contact**

8 **Adjustable Contacts**

3 **Indexed Scale**

4 **Tap Block**

Applies to multi-range type only.

5 **Induction Disc**

6 **Damping Magnet**

7 **Spiral Spring Assembly**

Both the single-range and multi-range COD relays consist of an induction disc unit which embodies an "E" type laminated magnetic structure.

The main current coil (either tapped or untapped) is located on the center leg of this magnetic structure. Flux produced by the main current coil returns through the two outer legs of the electromagnet.

A shading coil located on one of the outer legs of the magnetic structure creates an out-of-phase flux which reacts with the main coil flux to cause rotation of the disc in the air gap of the electromagnet.

Rotation of the disc is opposed by a spiral spring on the induction disc shaft which also carries the moving contact. Torque created by the electromagnet is balanced by the opposing torque of the spiral spring, and the disc shaft assembly with the moving contact assumes a position corresponding to the current applied to the electromagnet, unless the travel is limited by the setting of the adjustable contacts.

Disc rotation is damped by the horseshoe shaped magnet.

When the magnitude of applied current is less than the setting of the low current adjustable contact, the moving contact rests against the adjustable contact. Applied current values between the high and low settings will cause the moving contact to float between the high and low adjustable contacts. Current values above the high current setting will cause moving contact to close the high current circuit.

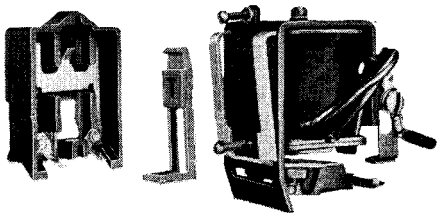
The induction disc unit has inherent inverse time characteristics. A small change in current will cause the disc to move slowly from its original position and a large change in applied current will move the disc at a faster rate.

The adjustable contact settings also have an effect on the speed of response. Consequently, for the same rate of change in current a close setting of the adjustable contacts will produce faster contact operation than a wide separation, since the moving contact has farther to travel to make contact with a wide separation of the stationary contacts.

As an example, when using the 0.5-2 0 ampere untapped single range relay with the high current contact set at maximum and the low current contact set at minimum (approximately 150° separation), and 2.0 amperes applied to the relay, a sudden reduction in the current to zero will result in the relay taking 14 seconds to close the low current contact circuit. Closer spacing of the adjustable contacts will produce a correspondingly shorter time for the relay to close its contact under the same circumstances.

Indicating Contactor Switch (ICS)

Both single-range and multi-range COD relays are also available with an ICS unit in the overcurrent circuit, and the single range type is also available with an ICS unit in both the overcurrent and undercurrent circuits (see figures 2, 3, and 5). The ICS unit is mounted on a pedestal located on the switch jaw block.



The dc operated Indicating Contactor Switch has a clapper type magnetic armature to which leaf-spring contacts are attached.

When the switch is energized, the moving contacts bridge the stationary contacts, completing the trip circuit. The ICS contacts are connected in parallel with the main relay contacts, and relieve them of carrying heavy trip currents.

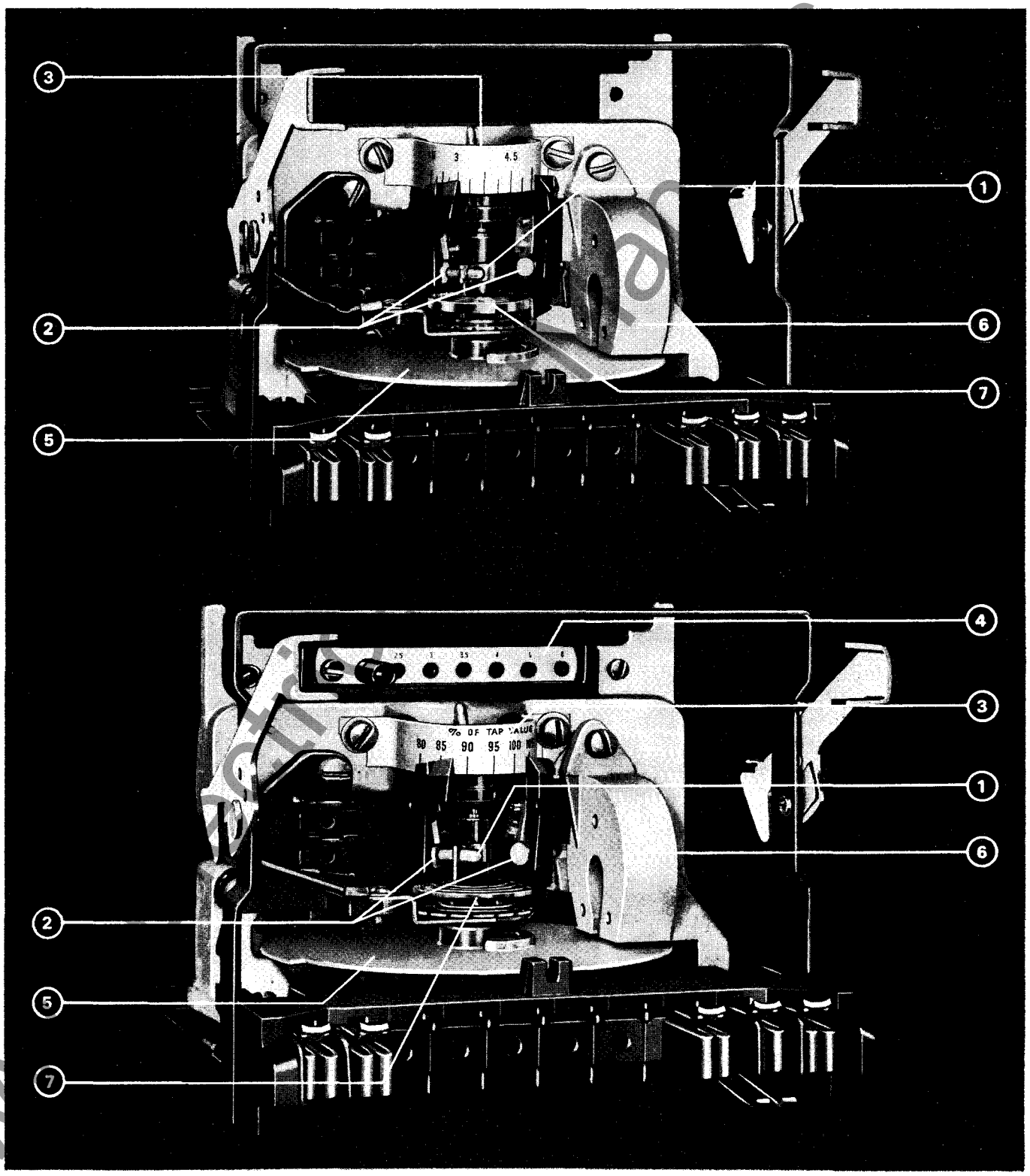
During operation, two fingers on the armature deflect a spring which allows an operation indicator target to drop. The target is orange in color and readily visible.

Taps on the front of the unit provide connection for either 0.2 (left) or 2.0 (right) amperes dc pickup operation.

When using a 125 or 250 volt dc auxiliary WL relay, the 0.2 ampere tap is recommended. The 2.0 ampere tap is used on 24 or 48 volt dc circuits.

Type COD
Current Sensing Relay

For Relaying Control Schemes



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Internal Wiring (Front View) FT-11 Case

Single Range

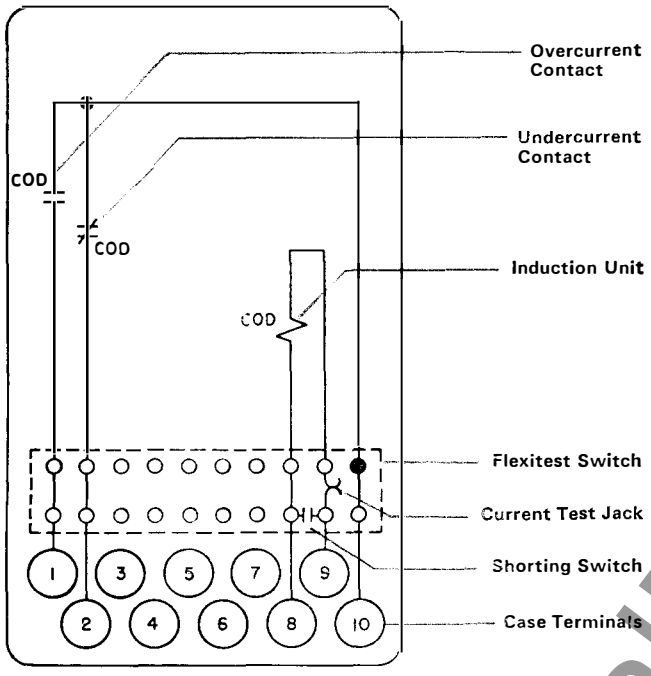


Fig. 1 184A541

Single Range
With ICS in Overcurrent Circuit

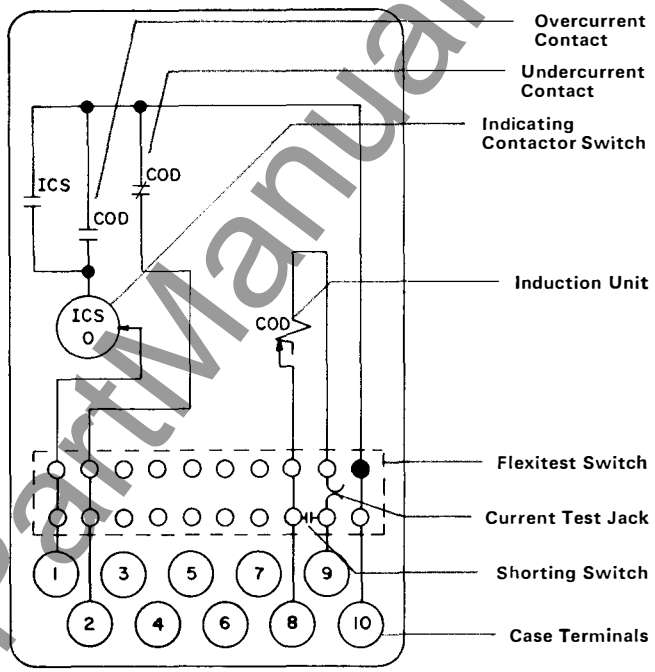


Fig. 2 185A430

Single Range With ICS in Both Overcurrent and Undercurrent Circuits

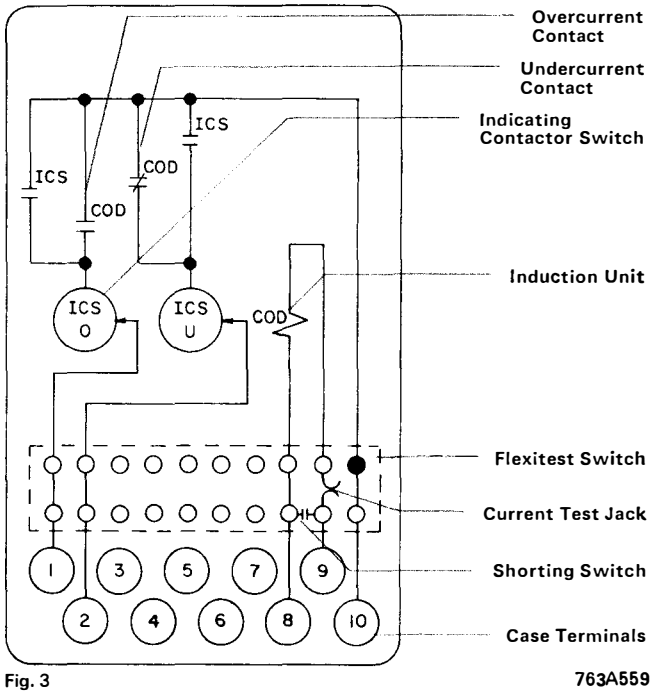


Fig. 3 763A559

Type COD
Current Sensing Relay

For Relaying Control Schemes

Multi-Range

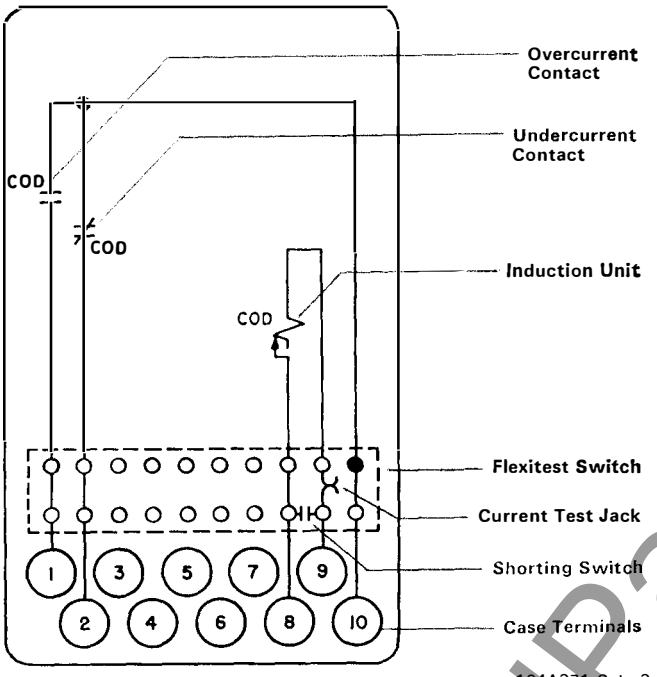


Fig. 4 184A371 Sub. 3

Multi-Range
With ICS in Overcurrent Circuit

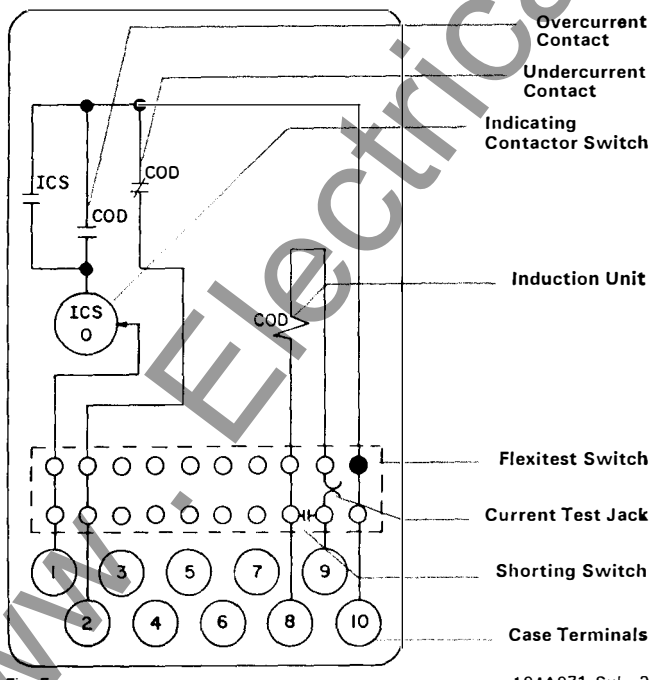
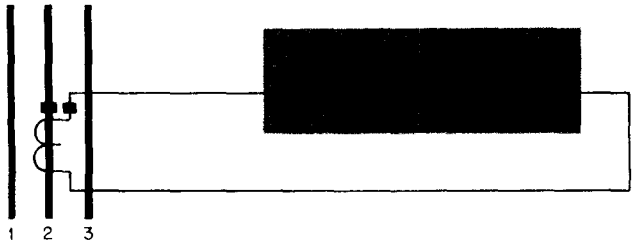


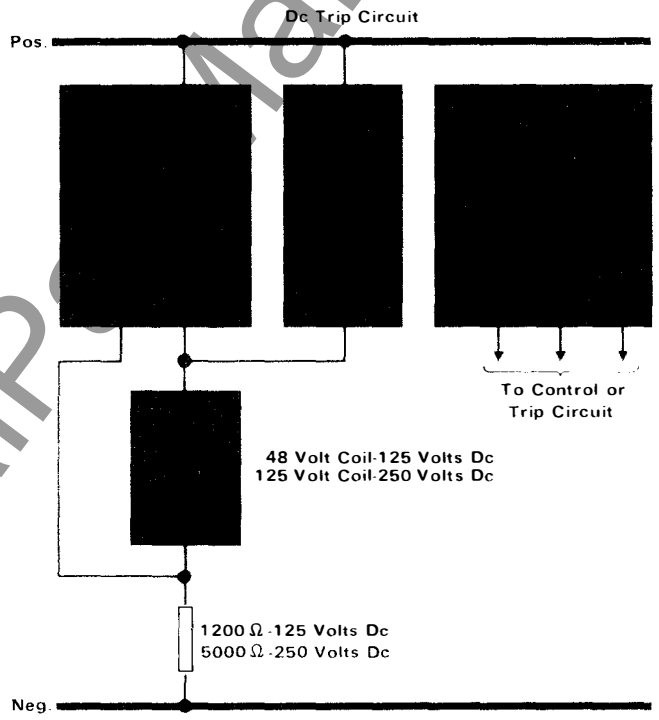
Fig. 5 184A871 Sub. 2

Westinghouse

Typical Application

The illustrated control scheme utilizes the COD current sensing relay and an SG auxiliary relay. Closing of the high current COD contact energizes the SG auxiliary relay. One contact of the SG seals in around the COD contact, and the remaining SG contacts can be used in the control or trip circuit. The SG will remain energized until the low current COD contact closes and shorts out the coil of the SG.





Device Number Chart
90 -Control Relay, Type COD
90X-Auxiliary Relay, Type SG

Type COD
Current Sensing Relay

For Relaying Control Schemes

Burden Data and Thermal Capacities

Single Range Type

Ampere Range	Continuous Rating: Amperes	Power Factor Angle (Lag)①	Volt-Ampere Burden		
			At Minimum Setting	At Maximum Setting	At 5 Amps
0.5-2	5	76°	0.48	7.6	42.5
1.5-6	12	74°	0.48	7.6	4.7

Multi-Range Type

	Ampere Range:	0.5 to 2.5							2 to 6							4 to 12						
	Tap Setting:	0.5	0.6	0.8	1.0	1.5	2.0	2.5	2	2.5	3	3.5	4	5	6	4	5	6	7	8	10	12
Coil Ratings, Amperes	Continuous	2.7	3.1	3.7	4.1	5.7	6.8	7.7	8	8.8	9.7	10.4	11.2	12.5	13.7	16	18.8	19.3	20.8	22.5	25	28
	1 Second②	88	88	88	88	88	88	88	230	230	230	230	230	230	230	460	460	460	460	460	460	460
Pf Angle, Lag①		72°	71°	69°	67°	62°	57°	53°	70°	66°	64°	62°	60°	58°	56°	68°	63°	60°	57°	54°	48°	45°
VA Burden	❶ Tap	2.38	2.38	2.40	2.42	2.51	2.65	2.74	2.38	2.40	2.42	2.48	2.53	2.64	2.75	2.38	2.46	2.54	2.62	2.73	3.00	3.46
	3 x Tap	21	21	21.1	21.2	22	23.5	24.8	21	21.1	21.5	22	22.7	24	25.2	21.3	21.8	22.6	23.6	24.8	27.8	31.4
	10 x Tap	132	134	142	150	170	200	228	136	142	149	157	164	180	198	146	158	172	190	207	248	292
	20 x Tap	350	365	400	440	530	675	800	360	395	430	470	500	580	660	420	480	550	620	700	850	1020

① Degrees current lags voltage at tap value current.

② Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.

Shipping Weights and Carton Dimensions

Relay Type	Flexitest Case Type	Weight: Lbs.		Domestic Shipping Carton Dimensions: Inches
		Net	Shipping	
COD	FT-11	8	11	9 x 9 x 10

Further Information

Prices: PL 41-020
Case Dimensions (FT-11): DB 41-075
Instructions: IL 41-112
Renewal Parts: RPD 41-101A1
Other Protective Relays: SG 41-000

Type COD
Current Sensing Relay

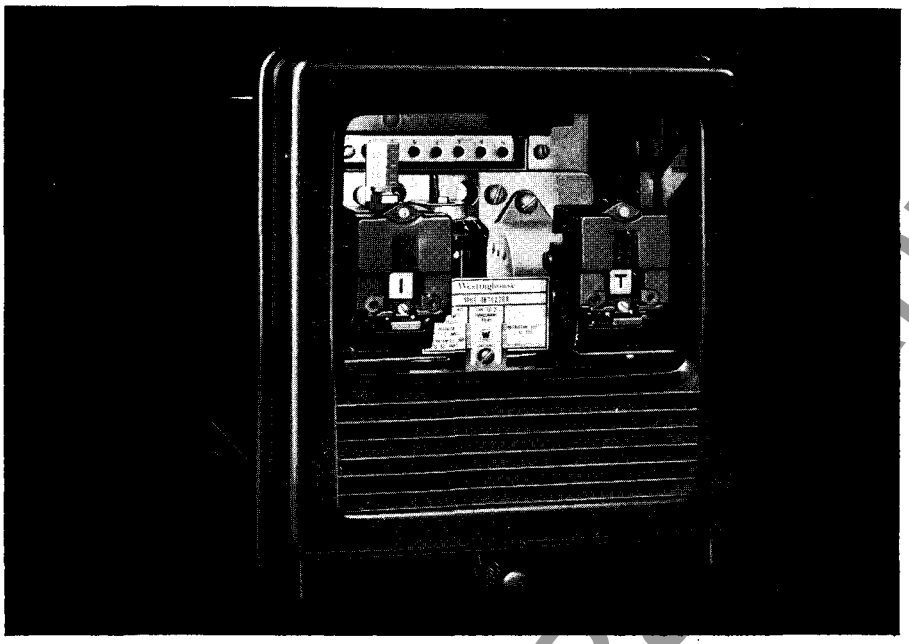
For Relaying Control Schemes

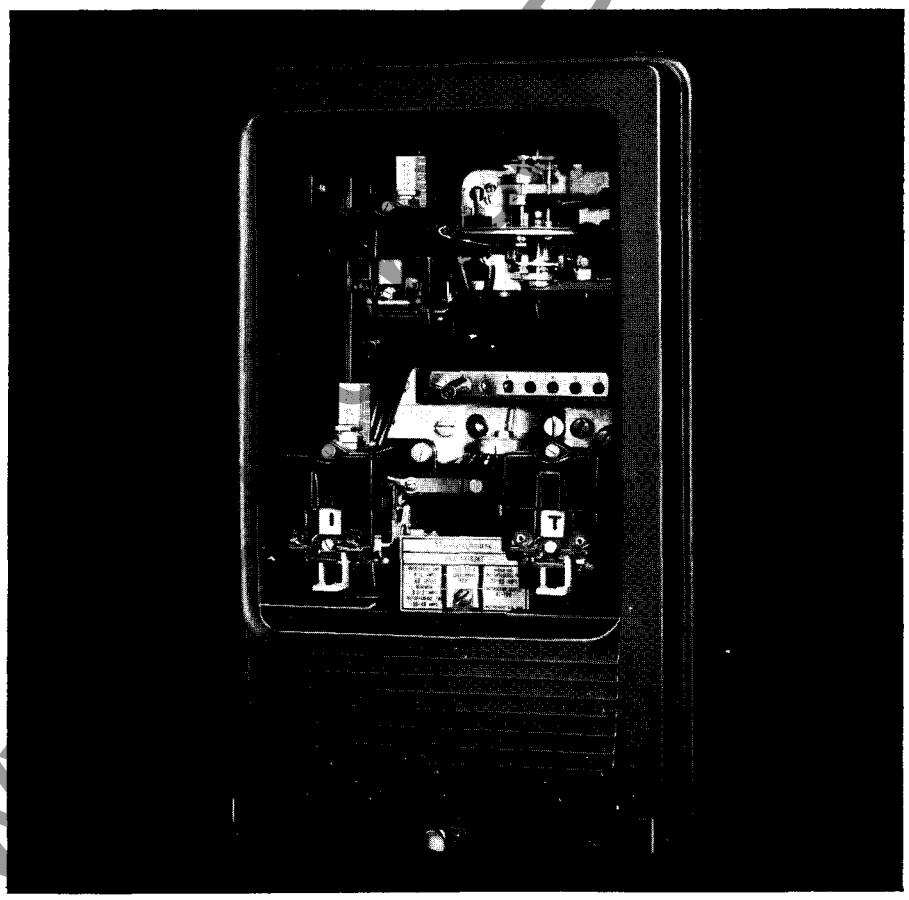
Westinghouse Electric Corporation
Relay-Instrument Division, Newark, N. J. 07101
Printed in USA

Westinghouse

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay





Application

Westinghouse CO relays, a complete coordinated line, assure accurate and reliable primary or backup protection against phase or ground faults. They provide the backbone of any protective relaying system, from generator to load.

For selective coordination between relays, seven different time curve characteristics are available. All are designed to operate faster at higher fault currents.

Each type has a wide range of current tap settings and time dial positions.

Properly applied, CO relays will provide maximum service continuity by tripping the fewest possible circuit breakers required to disconnect a faulted section.

For fast (½ cycle) clearing of heavy faults, CO relays can be equipped with adjustable instantaneous overcurrent units.

Where cold load pickup presents a problem due to heavy inrush currents to devices such as refrigerators, water heaters, etc., type CO relays can be equipped with high dropout instantaneous trip units (ITH) which will provide instantaneous trip protection for the protective line when initial load current is dropped to 90% of the ITH unit setting.

When ac current is necessary in the control-trip circuit, the indicating contactor switch (ICS) dc unit is replaced by the type ACS indicating contactor switch sealed-in unit. The ACS unit is similar in construction to the IIT unit, and has an adjustable range of .25 to .9 amperes ac.

Both non-torque and torque controlled designs are available.

Advantages

Low burden, high thermal capacity, negligible temperature error.

Accurate pickup, continuous "between tap" adjustment.

Simplified settings, ease of accessibility, lower maintenance cost.

Space saving Flexitest® universal cases, for semi-flush or projection mounting.

Device Number: 51

February, 1967
Supersedes DB 41-100A dated September, 1961
E, D, C/2013/DB

Westinghouse

Selector Guide

Relay Type	Time Curve	Comparative Operating Time①	Basic Application
CO-2	Short	0.47 Sec.	Differential protection of bus or generators where restraint windings are not required. Straight overcurrent protection where short operating time is necessary for system stability.
CO-4	Long (step)	25 Sec.	Designed primarily to provide effective relay coordination with the selective trip characteristics of Westinghouse DB breakers. Step-time operating characteristic coordinates with selective trip curve of DB breaker and associated fuses.
CO-5	Long	25 Sec.	Motor protection. Long time setting (150% of full load) prevents tripping due to motor starting currents, and allows motor to carry moderate overloads for safe periods. Inverse characteristic provides faster tripping at higher overloads.
CO-6	Definite	2 Sec.	For use where generating capacity and fault currents vary over a wide range. Relay has fixed operating time (per time dial setting) from approximately 10 to 20 times tap current, thus providing definite selective operation for sequential tripping.
CO-7	Moderately Inverse	2.48 Sec.	Overcurrent phase and/or ground fault detection on transmission or feeder lines where moderate changes in generating capacity occur, or on parallel lines where one line may be called on to carry both loads. Relay approaches definite time characteristics at high currents, allowing wide changes in fault current magnitude with little change in operating time.
CO-8	Inverse	2.52 Sec.	Phase and/or ground fault detection of subtransmission lines or feeders. Also supplied as primary protection or back-up for other relays. Wide range in time lever settings and slope of curves facilitate coordination and assure selective operation. Degree of inverseness required is determined by fault current magnitude, operating time desired, and the characteristics of nearby relays on the system.
CO-9	Very Inverse	1.53 Sec.	
CO-11	Extremely Inverse	0.8 Sec.	Used on feeder circuit breakers which must coordinate with main and branch line sectionalizing fuses. Also used where long time delay is required for light overload, such as where feeder is energized after extended outage.

① Values shown are with #10 time dial setting, and with 10 times tap value current applied.

Factors to Consider in Selecting Proper Relay Type

Apparatus or Circuit to be Protected: In general, the application will indicate the use of a specific relay. Short-time relays act fast to avoid equipment damage. Long-time relays hold off tripping on heavy initial overloads or more extended moderate overloads.

At higher fault currents, definite-time and moderately inverse relays maintain constant operating time, despite variation in connected generation and fault currents. Inverse and extremely inverse relays operate respectively faster on higher fault currents.

Selective Operation, Sequential Tripping: To maintain maximum continuity of service, as small a section as possible should be removed from a system during a fault. A common method is to set each successive relay, progressing from the generator, to operate 0.3 second sooner (exclusive of circuit breaker operating time) so that the relay nearest the fault will operate first to remove the faulted section. See figure 1.

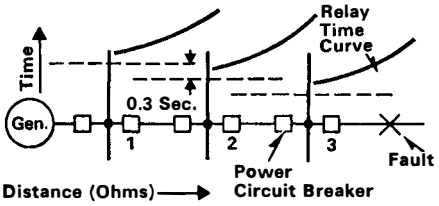


Fig. 1

Coordination With Adjacent Relays: To assure selective operation, relays in all sections of the protected line should have similar operating curves. Otherwise, curves may intercept, resulting in incorrect relay operation. See figure 2.

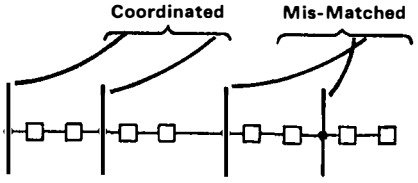


Fig. 2

Relay Tap Range: Magnitude of fault current available at a given location is usually determined by system studies. Tap range selection depends on the fault current as seen by the relay, which is determined by the current transformer ratio and its operating characteristics under fault conditions.

Ac or Dc Trip Circuit: Where a dc control source (24 to 250 volts) is available, circuit closing relays are used. If dc is not available, circuit opening relays are used with

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

ac tripping, using the output of a current transformer to energize the circuit breaker trip coil. Under normal conditions, the normally closed contacts of the relay shunt the breaker trip coil.

High Speed Short Circuit Fault Protection: Relays equipped with instantaneous overcurrent IIT or ITH units provide instantaneous overcurrent tripping, in addition to tripping with time delay on moderate overloads.

Construction and Operation①

Two basic designs are available:

Non-torque Controlled
This, the most widely used type, is designed so that the relay contacts close when tap value is applied. See figures 9 and 10.

Torque Controlled
This type has the lag coil connections of the "E" induction unit electromagnet brought out to separate terminals. This permits control of the time-overcurrent unit from an external relay contact, such as a directional or distance relay. See figures 13 and 14.

1 Time Delay Overcurrent Unit (CO)
See page 4.

2 Indicating Instantaneous Trip (IIT)
See page 5.

3 Indicating Contactor Switch (ICS)
See page 5.

4 ICS Taps
See page 5.

① CO-4 relay for relay coordination with 600 volt air circuit breaker is described on pages 10 and 11.

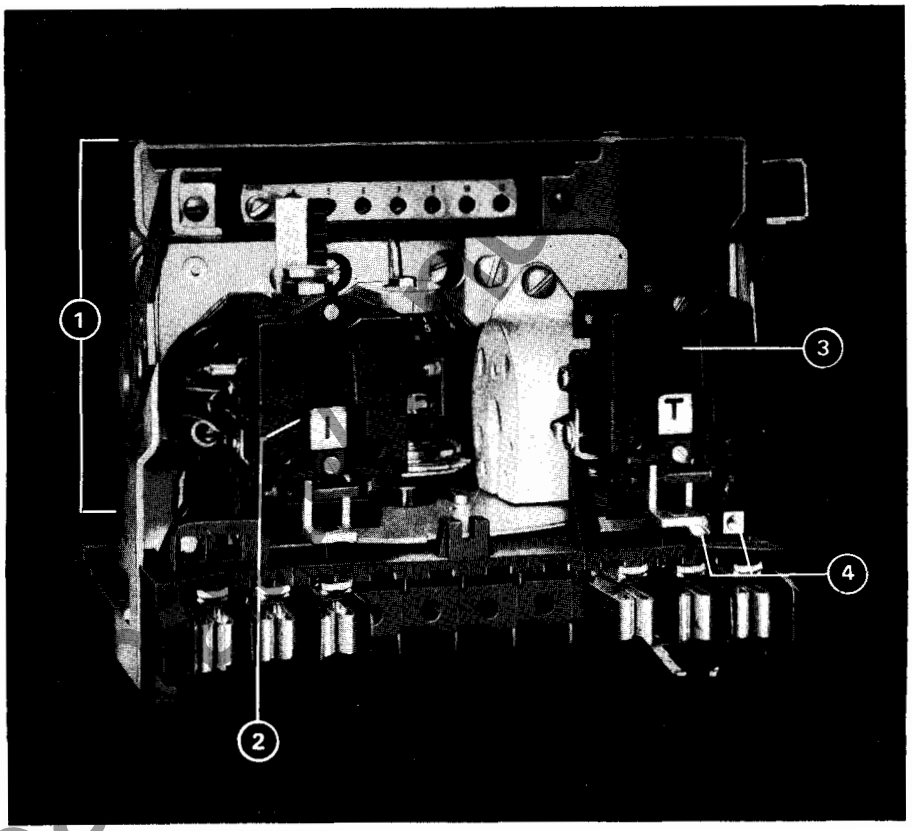


Fig. 3

Circuit Opening Types
Circuit opening CO relays in conjunction with an ac series trip coil are used to trip circuit breakers when a suitable station battery is not available.

As shown in figures 12 and 13, closing of the CO unit contacts energizes a De-ion® contactor switch (CS) whose contacts shunt the ac trip current through the breaker trip coil.

The circuit opening relay is recommended only in the 4 to 12 ampere range. A lower range relay is not desirable due to the excessive burden of a low current range trip coil.

Burden of the auxiliary current transformer (figures 12 and 13) with 4 amperes applied is 4.6 volt-amperes with the CO contacts closed, and 5.7 volt-amperes with the contacts open.

See page 5 for description and illustration of the De-ion contactor switch.

"Cold Load" Pickup Protection Types
Standard CO relays, equipped with a high dropout instantaneous unit (ITH) used in conjunction with reclosing relays, provide completely coordinated distribution feeder protection where "cold load" pickup is involved.

The ITH unit has a dropout ratio of 90% of pickup. With this unit set at minimum fault current on the protected feeder, when a fault occurs, the ITH picks up and, in conjunction with the reclosing relay, the breaker is tripped and immediately reclosed. The reclosing relay at the same time takes over control and locks out the ITH contact circuit.

After the fault has been cleared, the feeder is re-energized and, after a slight time delay in the recloser circuit, the ITH contact circuit is restored. However, under normal cold load pickup conditions, the line current has dropped to less than 90% of minimum fault current before this contact circuit is re-established and the ITH unit has dropped out, permitting the time delay necessary to pickup the cold load.

See page 5, for description of the ITH unit.

Westinghouse

Construction and Operation, Continued

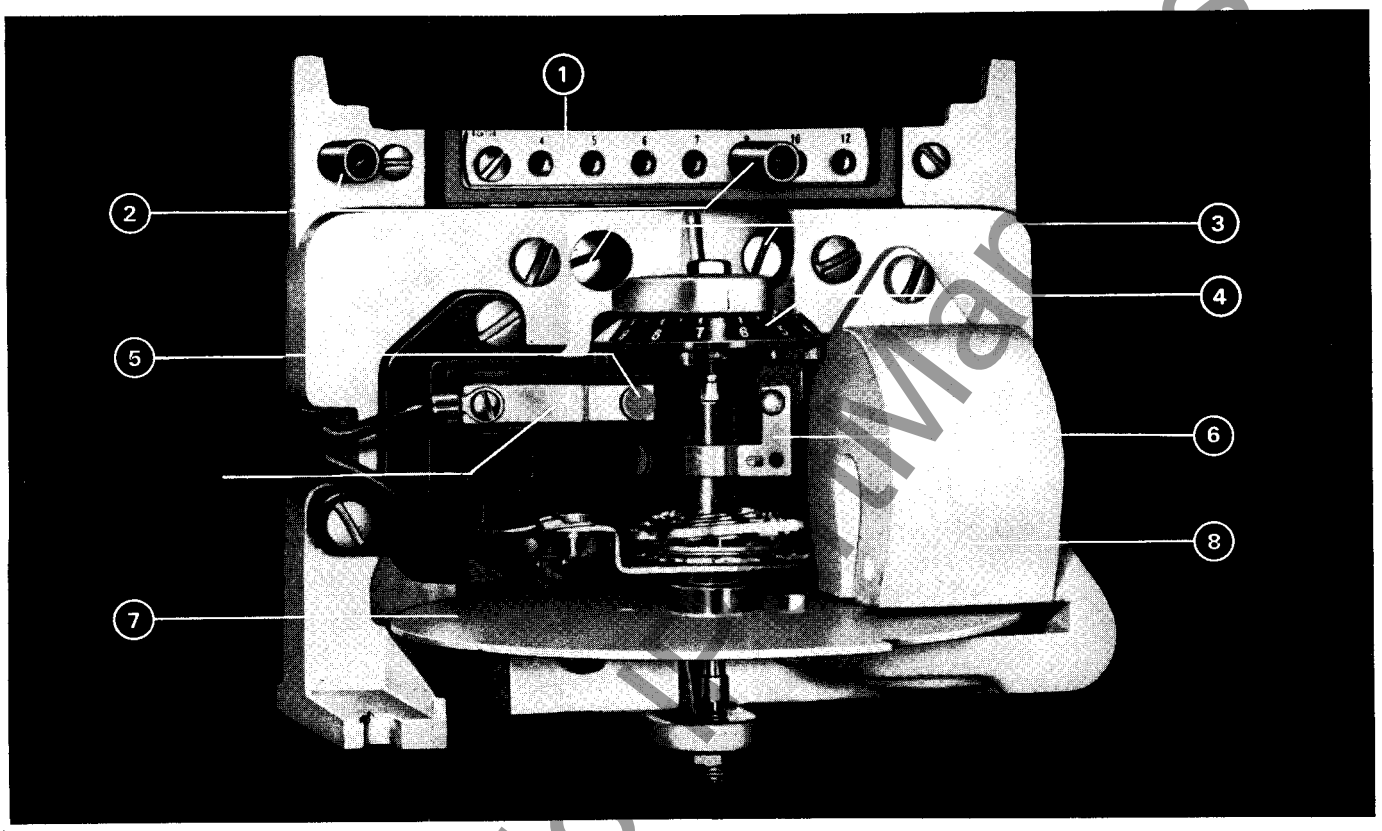


Fig. 4

Time Delay Overcurrent Unit (CO)
On CO-4, CO-5, CO-6, CO-7, CO-8, and CO-9 relays a main tapped coil is placed in the center leg of an "E" type laminated magnetic structure. Flux produced by this coil returns through the two outer legs of the electromagnet. A shading coil on the left leg of the electromagnet creates an out-of-phase flux which reacts with the main coil flux in the electromagnets air gap to cause disc rotation in the contact closing direction.

CO-2 and CO-11 electromagnets are similar in construction, except that both outer legs have windings to produce the necessary out-of-phase fluxes required for contact closing rotational torque.

1 Tap Block
Indicates minimum current required to just close the relay contacts.

2 Tap Screws
Two supplied. When changing tap range, the spare is inserted into the new position prior to removal of the existing tap setting screw. This prevents open circuiting of the associated current transformer.

3 Magnetic Plugs
May be screwed in or out of the magnetic circuit to control saturation and adjust calibration at high currents. A damping magnet and spring adjustment permits calibration at low currents.

4 Time Dial
Indicates initial position of the moving contact over a 270° range. Indexes from ½ (minimum time) to 11 (maximum time).

5 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 back-stop. On double-trip relays, adjustment of 1/64" contact follow (or wipe) is obtained by use of a vernier adjusting screw on the stationary contact plate.

5 Moving Contact
Also made of pure silver, the moving contact is clamped to the insulated section of the disc shaft. Electrical connection is made from the moving contact through a spiral spring to the spring adjuster frame, then to the relay terminal. Moving contacts will close 30 amperes at 250 volts dc.

7 Induction Disc
Spiral shaped to compensate for the spring windup which occurs throughout the moving contact travel. Provides accurate pickup at any disc position. A spring adjuster is provided to permit in-between tap pickup adjustment when desired.

8 Damping Magnet
Made of high strength Alnico. Controls relay operating time at low current values. A keeper screw permits micrometer adjustment of the damping magnet without shifting the location of the magnet, and allows the relay to be accurately calibrated at low currents.

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

Indicating Contactor Switch (ICS)
(Partially Disassembled)

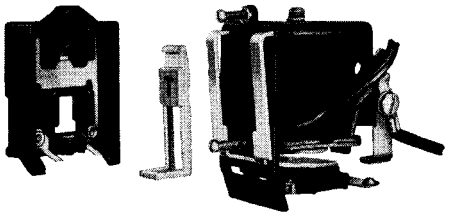


Fig. 5

The dc operated Indicating Contactor Switch has a clapper type magnetic armature to which leaf-spring contacts are attached.

When the switch is energized, the moving contacts bridge the stationary contacts, completing the trip circuit. The ICS contacts are connected in parallel with the main relay contacts, relieving them of carrying heavy trip currents.

During operation, two fingers on the armature deflect a spring, which allows the operation indicator target to drop. The target is orange color and readily visible.

Taps on the front of the unit provide connection for either 0.2 (left) or 2.0 (right) amperes dc pickup operation.

When using a 125 or 250 volt dc auxiliary WL auxiliary relay, the 0.2 ampere tap is recommended. The 2.0 ampere tap is used on 24 or 48 volt dc circuits.

Indicating Instantaneous Trip(IIT)

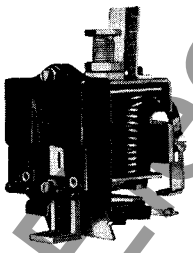


Fig. 6

Used for high speed protection against heavy fault currents. Construction is similar to that of the Indicating Contactor Switch, except that it is ac operated, and adjustable over a range of 1 to 4 times minimum pickup. Variable pickup is obtained by a core screw adjustment on the top of the unit.

When the IIT is energized above pickup setting, the target drops. Operating time is approximately one-half cycle above 250% of setting.

The IIT unit has a calibrated scale on which are marked the four divisional points of pickup range.

De-ion® Contactor Switch (CS)

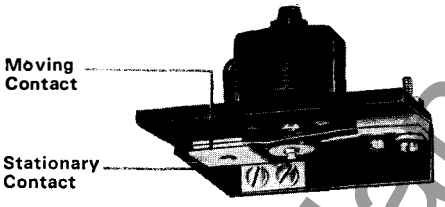


Fig. 7

Used in circuit opening type CO relays as shown schematically in figures 12 and 13. This scheme is applied where ac trip coils are used on the circuit breakers, energized by the line current transformers. When the CS coil is energized by a small transformer located within the relay case, its normally closed contacts open to remove the by-pass around the breaker trip coil, thus tripping the breaker.

The CS switch will pick up at 4 amperes ac and will safely by-pass 100 amperes ac through its contacts.

High Dropout Instantaneous Unit (ITH)

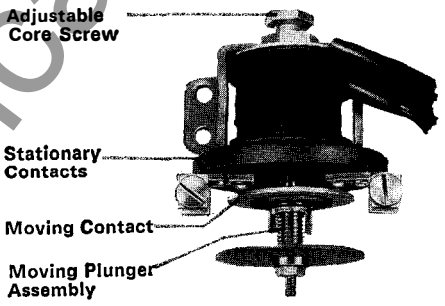


Fig. 8

The ITH unit is a solenoid operated device with an adjustable core screw which adjusts the ac current pickup of the device over a 2 to 1 range.

When the ITH coil is energized above pickup setting, the moving plunger assembly moves upward, carrying the silver disc which bridges three conical-shaped stationary contacts. The device opens its contacts when the coil current is reduced to 90% of its pickup value.

Operating range of the ITH unit can be increased to a 4 to 1 ratio, or four times the minimum pickup setting obtainable, by lowering the plunger after the core screw has been set at its maximum rated position.

If the plunger is lowered to increase the pickup current value, then at 300% of minimum trip the dropout ratio is 60% of the pickup current. At 400% of minimum trip the dropout ratio is 45% of the pickup current.

Operating speed of the ITH unit over nominal range (60 cycle base) is as follows:

at 200% of trip setting: less than 1 cycle
at 500% of trip setting: ½ cycle
at 1000% of trip setting: ¼ cycle

ACS Unit

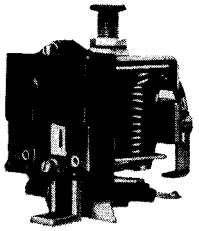


Fig. 9

Operating Range	.25 to .9 amps ac
Burden	.73 ohms ac
Coil Rating:	
Continuous	.25 amp
1-Second	7.0 amps

Westinghouse

Internal Wiring Diagrams (Front View)

Without External Torque Control

Spst-cc Contacts, FT-11 Case,
Without Indicating Instantaneous Trip (IIT)

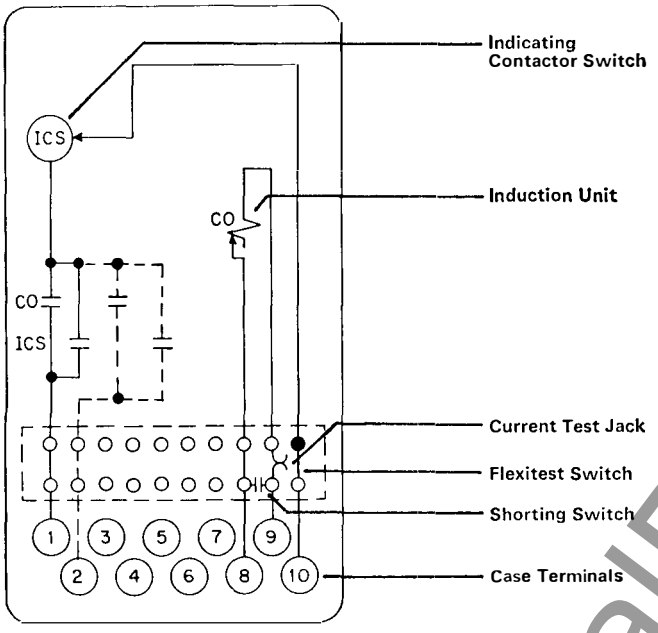


Fig. 10 57D4524

Spst-cc Contacts, FT-11 Case
With Indicating Instantaneous Trip (IIT)

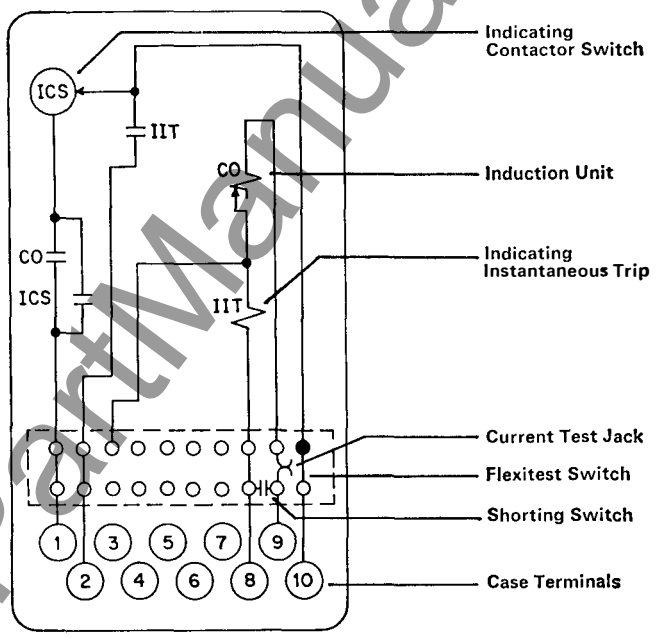


Fig. 11 57D4525

Spst-co Contacts, FT-21 Case
Without Indicating Instantaneous Trip (IIT)

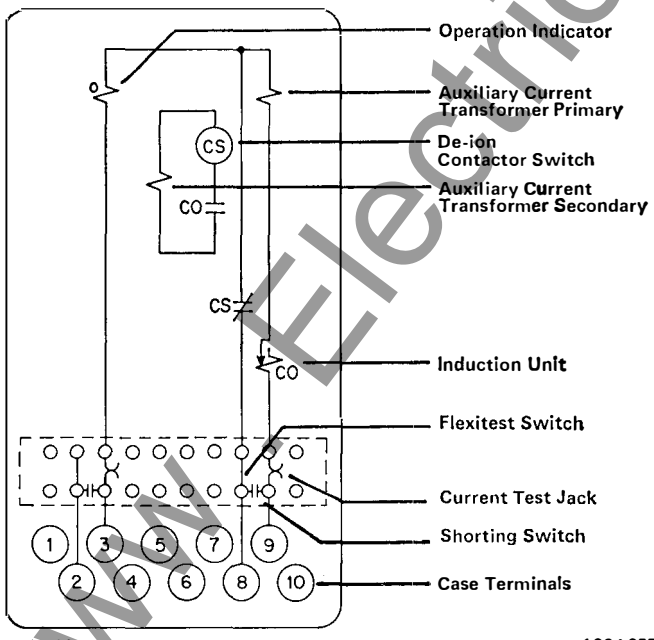


Fig. 12 183A055

Spst-co Contacts, FT-21 Case
With Indicating Instantaneous Trip (IIT)

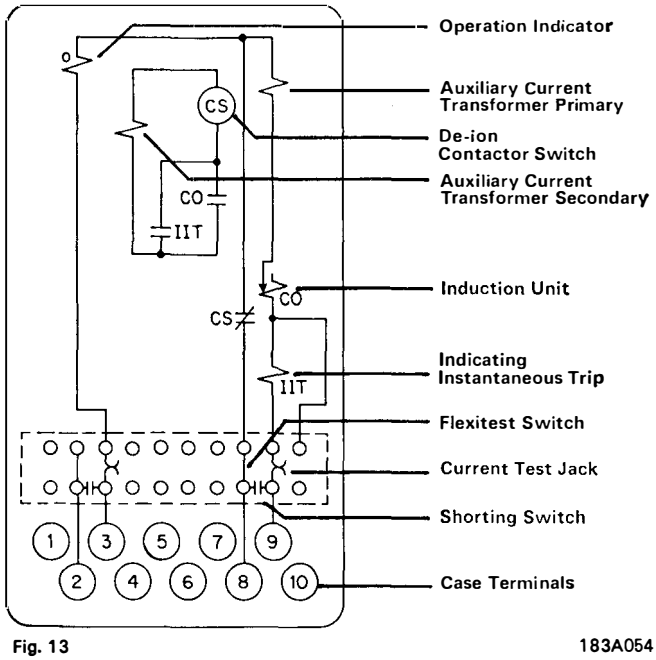


Fig. 13 183A054

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

With External Torque Control

Spst-cc Contacts, FT-11 Case
Without Indicating Instantaneous Trip (IIT)

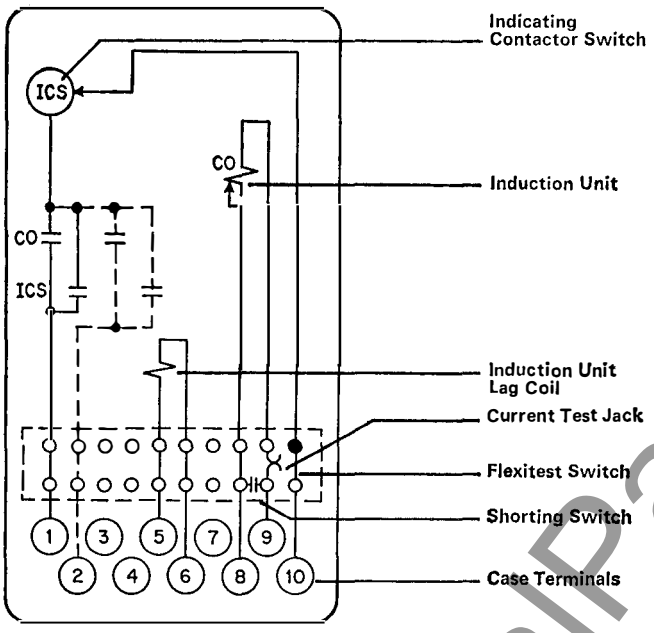


Fig. 14 57D4528

Spst-cc Contacts, FT-11 Case
With Indicating Instantaneous Trip (IIT)

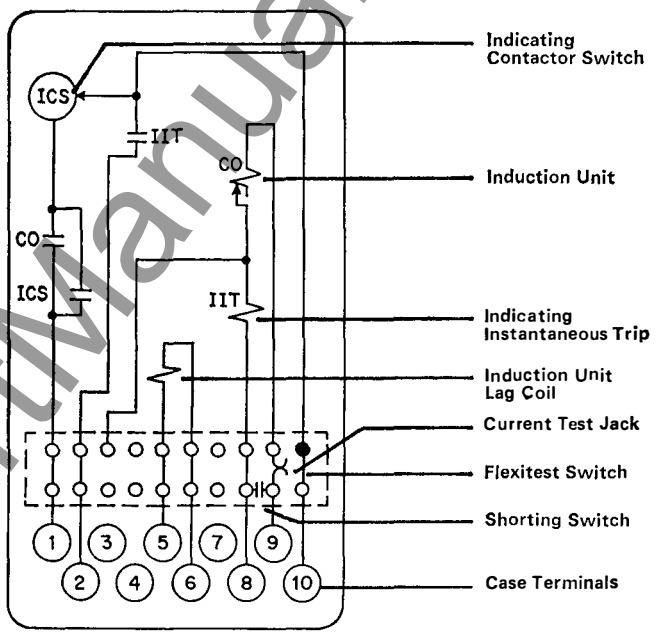


Fig. 15 57D4529

With High Dropout Instantaneous Unit (ITH)

Spst-cc Contacts, FT-11 Case

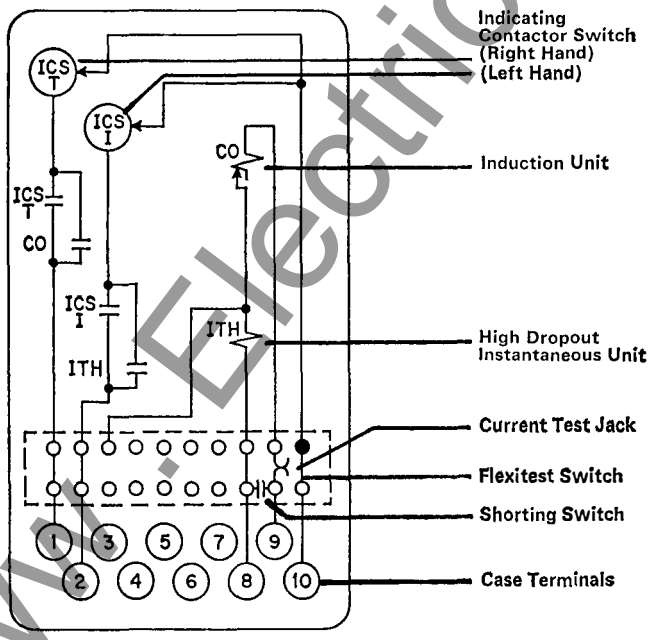


Fig. 16 183A786

Contact Legend

Spst-cc: single pole single throw – circuit closing
Spst-co: single pole single throw – circuit

Westinghouse

External Wiring Diagrams

Circuit Closing: For Phase and Ground Overcurrent Detection on a Three Phase System

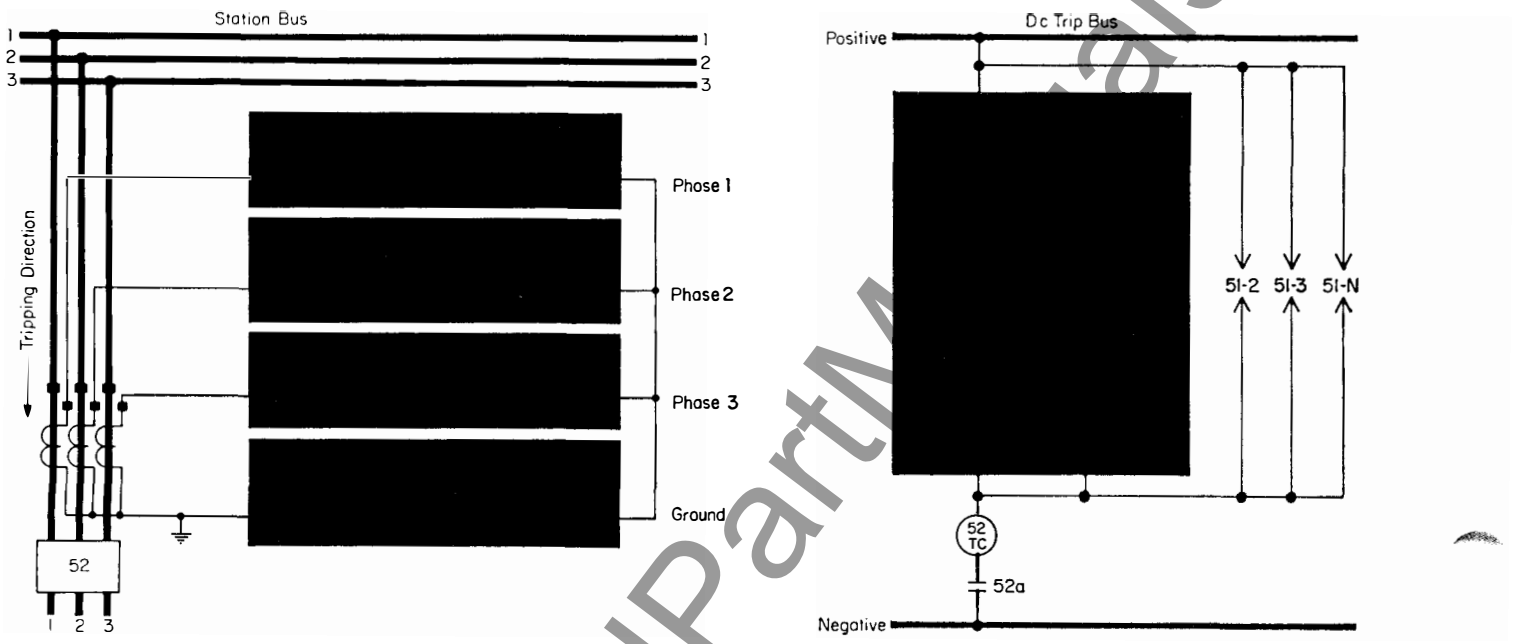


Fig. 17 182A75

Circuit Opening: For Phase Overcurrent Detection on a Three Phase System

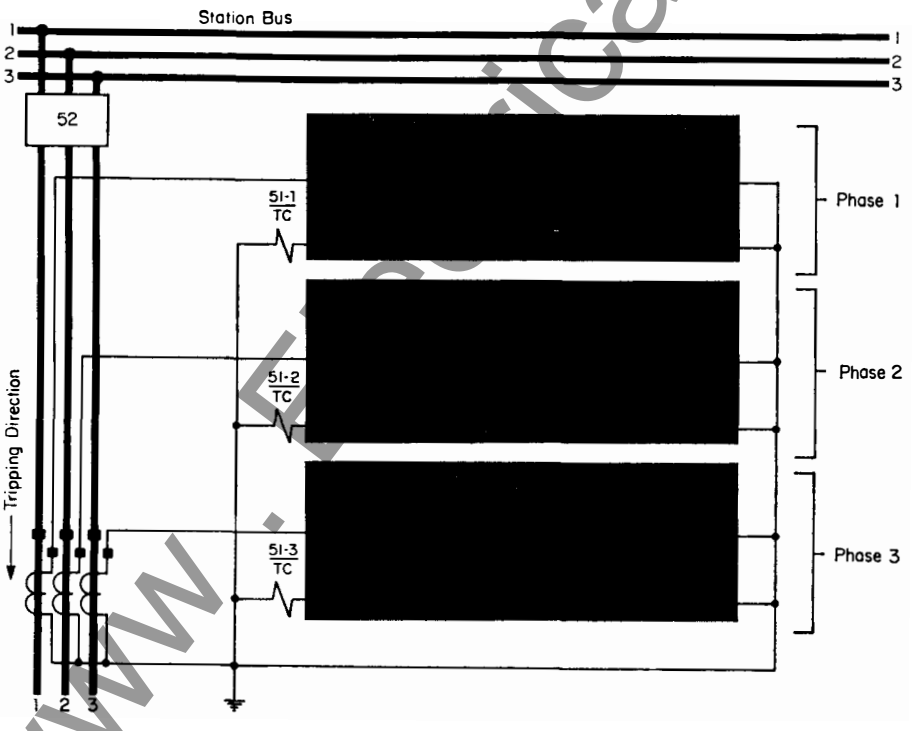


Fig. 18 183A213

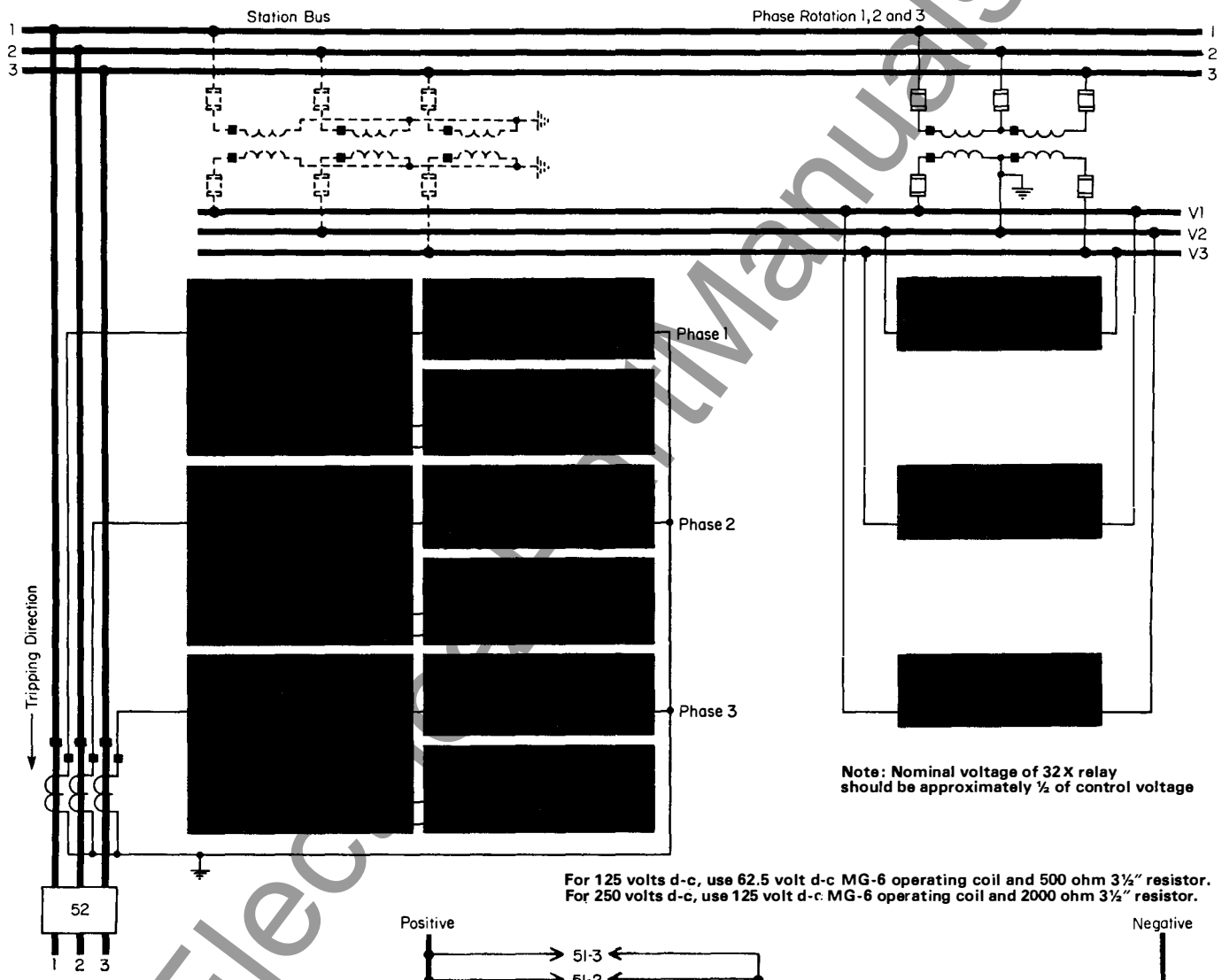
Device Number Chart
(For Figures 17, 18, and 19).

51 – Overcurrent Relay, Type CO
51N – Ground Overcurrent Relay, Type CO
CS – De-ion Contactor Switch
32 – Directional Relay, Type H-3
32X – Auxiliary Relay, Type MG-6
CS1 – Auxiliary Contactor Switches
CS2
ICS – Indicating Contactor Switch
IIT – Indicating Instantaneous Trip
52 – Power Circuit Breaker
52a – Breaker Auxiliary Contact
TC – Breaker Trip Coil
TO – Operation Indicator

Type CO Overcurrent Relays

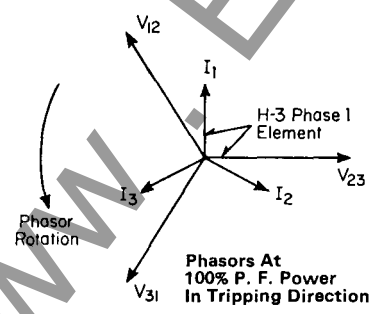
Non-directional, Single Phase, Adjustable Time Delay

Three Phase Overcurrent Detection: Using Type H-3 Directional Relay and Torque Controlling Type CO Relays with MG-6 Auxiliary Relay, 90 Degree Connection



Note: Nominal voltage of 32X relay should be approximately ½ of control voltage

For 125 volts d-c, use 62.5 volt d-c MG-6 operating coil and 500 ohm 3½" resistor.
For 250 volts d-c, use 125 volt d-c MG-6 operating coil and 2000 ohm 3½" resistor.



Phasors At 100% P. F. Power In Tripping Direction

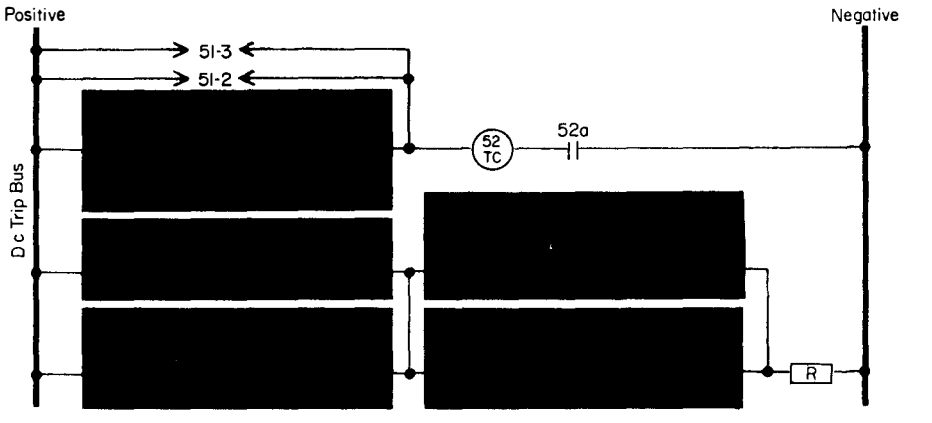


Fig. 19

289B077

Westinghouse

CO-4 Relay For Relay Coordination with 600 Volt Air Circuit Breakers

In 600 volt class equipment, protection is generally obtained through the use of overcurrent tripping devices which are an integral part of the circuit breakers.

Two types of air circuit breakers are generally used in low voltage applications for industrials and power plants. One type, such as the Westinghouse AB breaker, uses a thermal magnetic tripping device. The other is the Westinghouse DB type which uses series overcurrent tripping units that employ a dashpot device to obtain time delay.

The tripping characteristic of the DB breaker has a pronounced bend as shown in figure 20. The use of standard CO relays would necessitate a high current pickup setting in order to keep the relay time-current characteristic beyond the bend of the breaker operating curve. This high current pickup setting in turn, makes coordination with other relays near the source difficult or impossible.

Inasmuch as it is not practical to sacrifice coordination and proper protection of the primary system merely to obtain selectivity on the low voltage system, the CO-4 relay was developed.

The CO-4 has a step-time characteristic which is obtained by the combination of the CO-5 long time induction disc overcurrent unit, two instantaneous overcurrent units, and one timer. The resultant curve is illustrated by figure 22.

The induction disc-overcurrent unit is set to coordinate with the overload portion of the breaker curve.

The instantaneous unit (IT) energizes the timer (T) to provide .25-3 seconds delay, and the IIT unit trips directly.

Consequently, the CO-4 step-time characteristic effects selective coordination with other relays nearer to the power source.

DB Breaker Tripping Characteristics

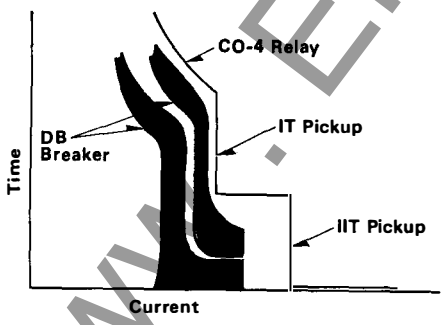


Fig. 20

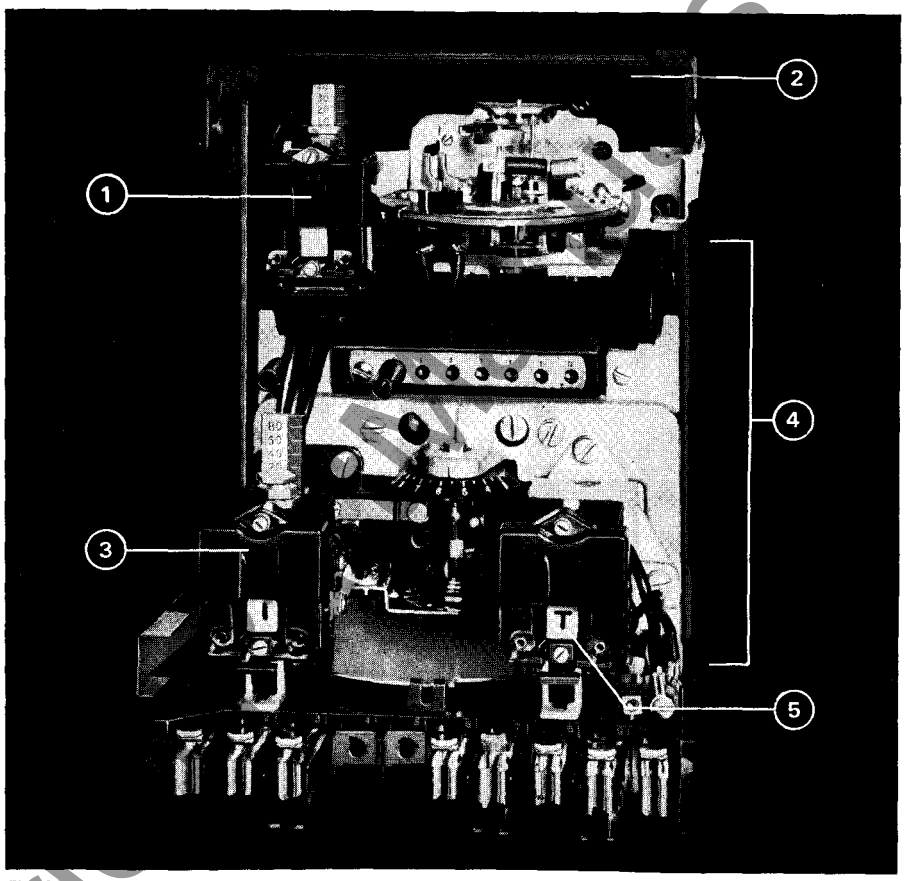


Fig. 21

1 Instantaneous Trip Unit (IT)

Ac operated. An adjustable core varies the current pickup of the unit. When the IT contacts close, the timer circuit is completed, providing an adjustable time delay before tripping.

2 Timer Unit(T)

Consists of a small synchronous motor which is energized from the secondary circuit of a saturating transformer which has a current-energized primary (see figure 22). The motor has a floating rotor which meshes with the gear train only when the motor is energized.

Upon de-energization, the rotor drops out of mesh with the gear train, allowing a spring to quickly reset the contact arm.

The contact on the moving arm is a loosely fitted cylindrical sleeve. When the arm rotates, the sleeve bridges two butt type stationary contacts, completing the circuit. The stationary contacts are mounted on a molded insulator block which is adjustable around the semi-circular calibrated scale.

Maximum setting of the timer is 3 seconds, indexed at 10 cycle points.

The timer motor will operate satisfactorily over a range of 10 to 100 amperes ac. Timing accuracy is ±5% of setting.

3 Indicating Instantaneous Trip (IIT)

4 Time Delay Overcurrent Unit (CO)

5 Indicating Contactor Switch (ICS)

See page 5.

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

Typical CO-4 Time-Current Curve Bands

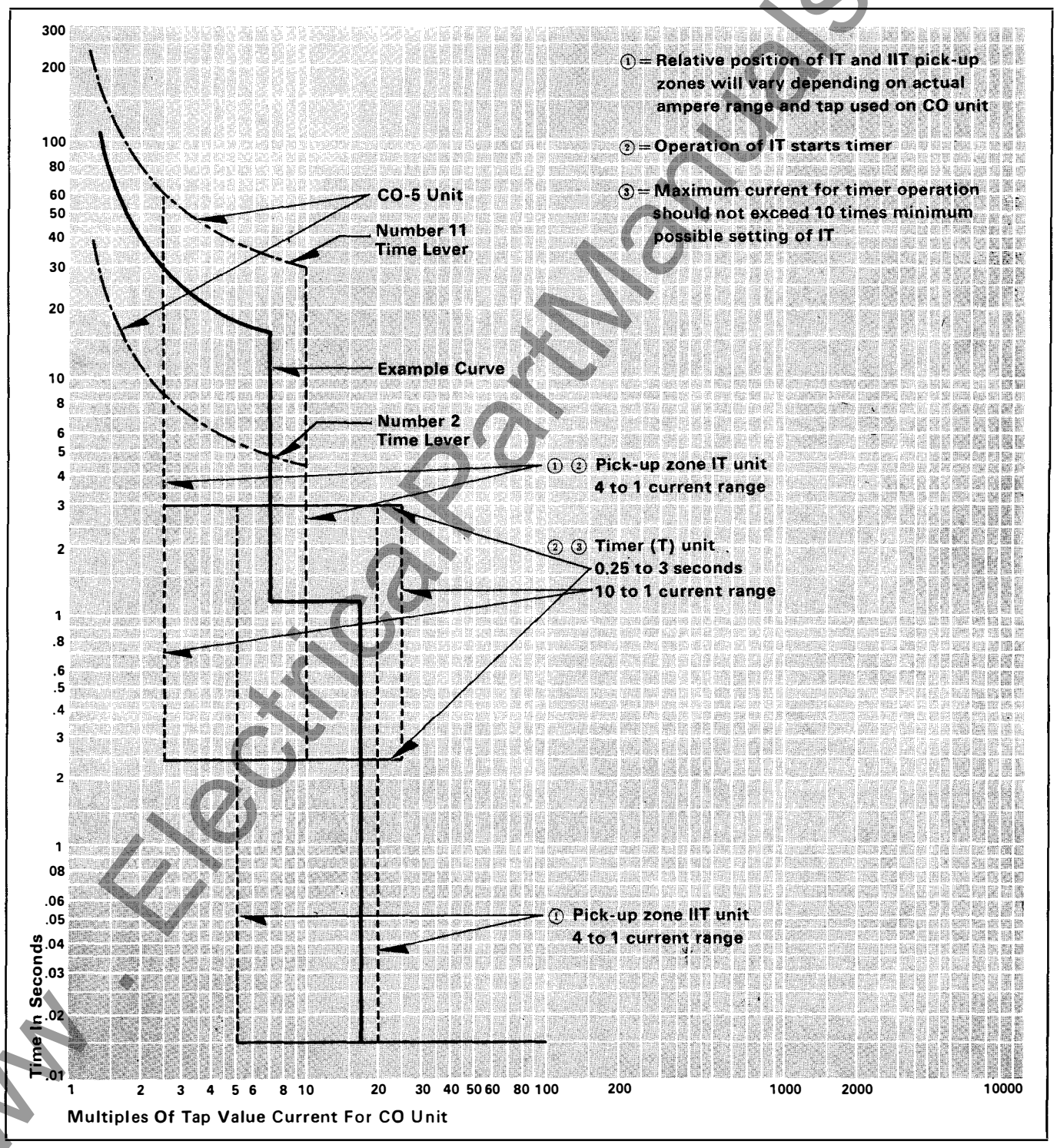


Fig. 22

406C935

Type CO Overcurrent Relays

Non-directional, Single Phase, Adjustable Time Delay

CO-4 Internal Wiring, Spst-cc Contacts, FT-21 Case

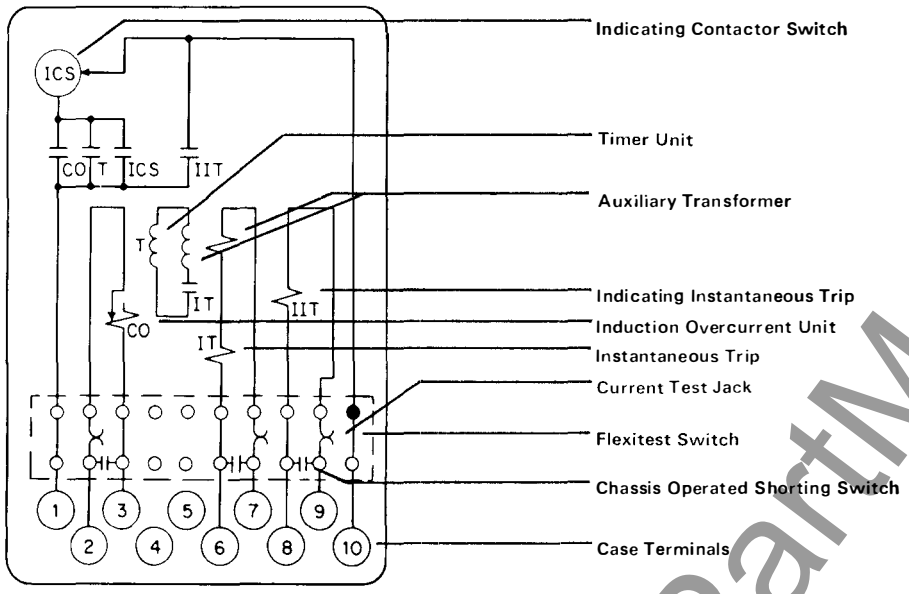


Fig. 23 183A115

Shipping Weights and Dimensions

Relay Type	Flexitest Case Type	Weight, Lbs.: Approx. Net	Weight, Lbs.: Approx. Shipping	Domestic Shipping Carton Dimensions: Inches
CO-2, 5, 6, 7, 8, 9, 11 Circuit Closing	FT-11	8	11	9 x 9 x 10
CO-6, CO-8, CO-9, CO-11 Circuit Opening	FT-21	10	13	9 x 12 x 13
CO-4	FT-21	12	16	9 x 12 x 13

Further Information

List Prices, Ordering Information	PL 41-020
Instructions:	
Circuit Closing CO Relays	IL 41-101
Circuit Opening CO Relays	IL 41-103
CO-4 Relays	IL 41-106
Renewal Parts	RPD 41-101A1
Flexitest Case Dimensions	DB 41-075
Other Westinghouse Protective Relays	SG 41-000

Burden Data and Thermal Characteristics (All Types)

Time Delay Overcurrent Unit, etc.

See Performance Data 41-000

CS De-ion Switch (Ac Operated)
(Used in contact opening CO relays)

4 amps ac pickup. Will bypass 100 amps ac in trip circuit.

Timer
(Used in CO-4 relay).

Burden of the timer unit and auxiliary current transformer at 5 amps, 60 cycles, with an IT range of 10 to 40 amps is:

IT contacts open: 0.7 volt-ampere at 80° lag
IT contacts closed: 0.6 volt-ampere at 65° lag

Current Tap Ranges (Ac)

Range	Taps
Contact Closing Relays	
0.5 – 2.5	0.5, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5
2 – 6	2, 2.5, 3, 3.5, 4, 5, 6
4 – 12	4, 5, 6, 7, 8, 10, 12
Contact Opening Relays	
4 – 12	4, 5, 6, 7, 8, 10, 12

Time Curves

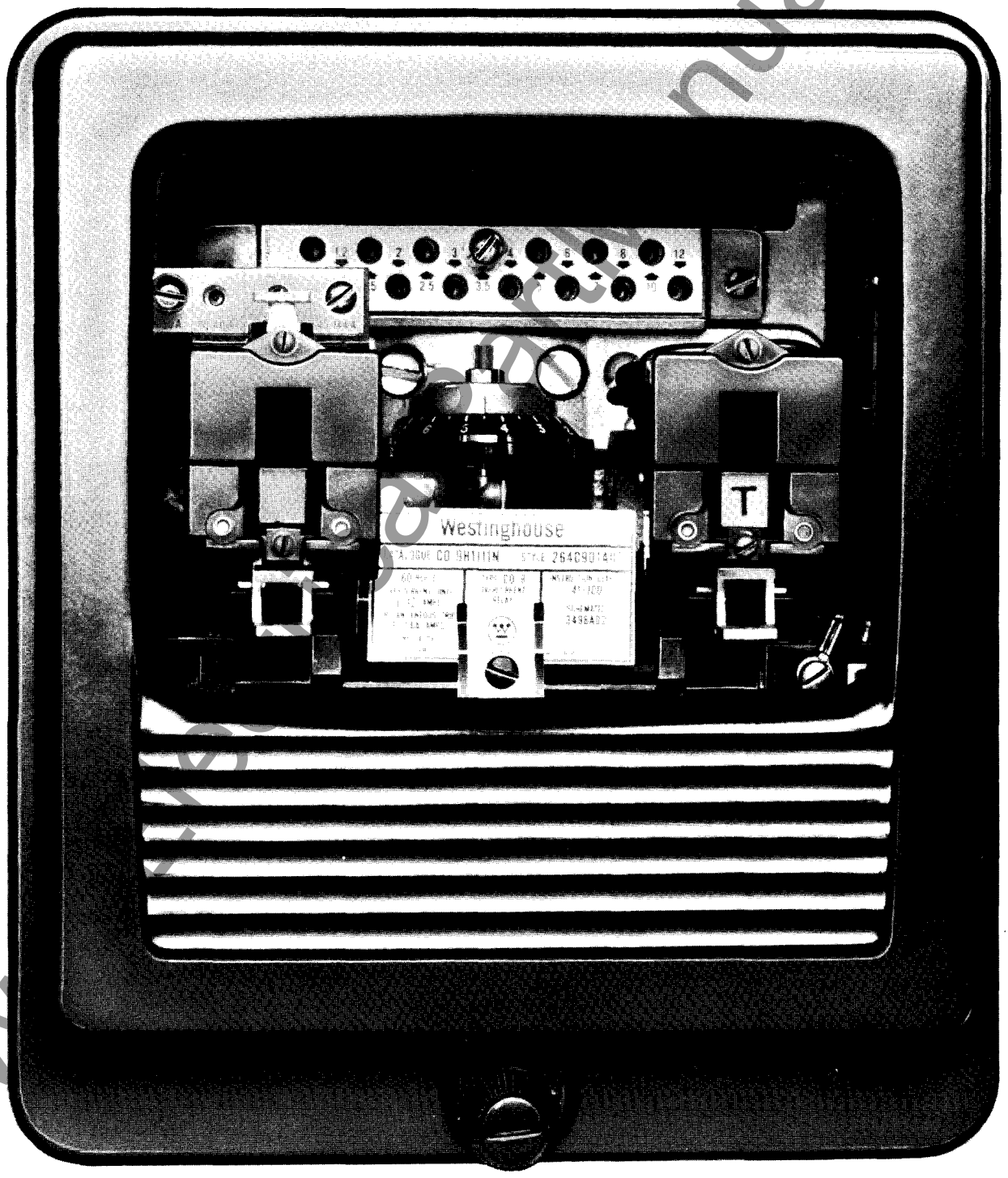
See Performance Data 41-000.

Westinghouse Electric Corporation
Relay and Telecommunications Division
Coral Springs, FL 33065

February, 1985
Supersedes Descriptive Bulletin 41-100
DWEA dated October, 1982
Mailed to: E, D, C/41-200A

Non-Directional, Single Phase
Device No. 50 or 50/51

Type Hi-Lo CO Overcurrent Relays



The Hi-Lo CO is the latest development of the Westinghouse line of induction disc overcurrent protection protective relays.

These induction-disc type overcurrent relays are activated when the current in them exceeds given values. The circuit closing type relays are normally used to trip a circuit breaker. They may have either single or double contacts for tripping one or two circuit breakers.

The complete, coordinated line assures accurate, reliable primary and backup protection for phase or ground faults. Seven different time curves are available for system coordination.

Features
The traditional CO design advantages: Low burden, high thermal capacity, negligible temperature error.

Accurate pickup, continuous "between tap adjustment".

Simple, easy to get at, settings.

Space saving Flexitest® case for semi-flush or projection mounting.

Two Wide Ranges
The Hi-Lo CO relay offers two wide ranges; a high and a low.

Hi Range
The "Hi" range has an induction-disc time unit, rated 1 to 12 amperes with 14 taps. To complement the time unit, the relay is available with an instantaneous unit rated 6 to 144 amps with three tap positions. The core screw of the instantaneous unit is used to set the actual current pickup within any one of the three ranges.

The 1-12 amp. time unit along with the 6-144 amp. instantaneous unit in one relay style offers considerable savings in stocking and flexibility of application. This one rating will satisfy the phase and ground requirements in most cases.

Lo Range
The "Lo" range CO contains the same 0.5 to 2.5 amp induction-disc time unit with 7 taps as standard CO relay designs. However, the instantaneous unit has a wide range of 2 to 48 amperes using 3 taps. The core screw of the instantaneous unit is used to set the actual current pickup within the range used.

The 0.5-2.5 amp. time unit and 2-48 amp. instantaneous unit combination result in substantial stock advantage of relays for ground fault protection and other low current applications.

Induction Disc Unit Ranges & Taps

Ground (0.5-2.5A)
Lo Range 0.5, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5

Ground & Phase Unit (1-12A)
Hi Range 1.0, 1.2, 1.5, 2.0, 2.5, 3.0, 3.5, 4, 5, 6, 7, 8, 10, 12

Instantaneous Unit Ranges & Taps

Ground (2-48A)
Lo Range 2-7, 7-14, 14-48

Ground or Phase Unit (6-144A)
Hi Range 6-20, 20-40, 40-144

Setting Adjustments
All adjustments are made from the front of the relay. The taps eliminate the need to switch leads. All settings are readily visible from the front of the relay through the glass window of the cover.

Interchangeability
Electrically and mechanically interchangeable with all existing CO relay installations.

Factors to Consider in Selecting Proper Relay Type

Apparatus or Circuit to be Protected: In general, the application will indicate the use of a specific relay. Short-time relays act fast to avoid equipment damage. Long-time relays hold off tripping on heavy initial overloads or more extended moderate overloads.

At higher fault currents, definite-time and moderately inverse relays maintain constant operating time, despite variation in connected generation and fault currents. Inverse and extremely inverse relays operate respectively faster on higher fault currents.

Selective Operation, Sequential Tripping: To maintain maximum continuity of service, as small a section as possible should be removed from a system during a fault. A common method is to set each successive relay, progressing from the generator, to operate 0.3 second sooner (plus circuit breaker operating time) so that the relay nearest the fault will operate first to remove the faulted section. See figure 1.

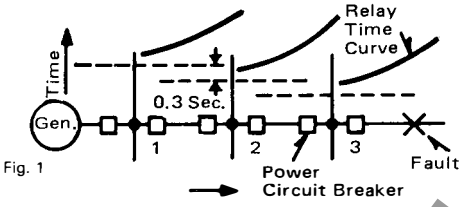


Fig. 1

Coordination With Adjacent Relays: To assure selective operation, relays in all sections of the protected line should have similar operating curves. Otherwise, curves may intercept, resulting in incorrect relay operation. See figure 2.

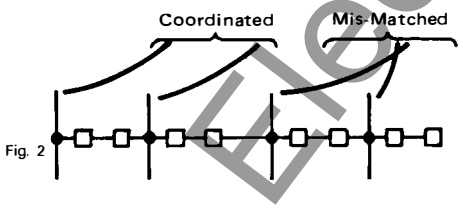


Fig. 2

Relay Tap Range: Magnitude of fault current available at a given location is usually determined by system studies. Tap range selection depends on the fault current as seen by the relay, which is determined by the current transformer ratio and its operating characteristics under fault conditions.

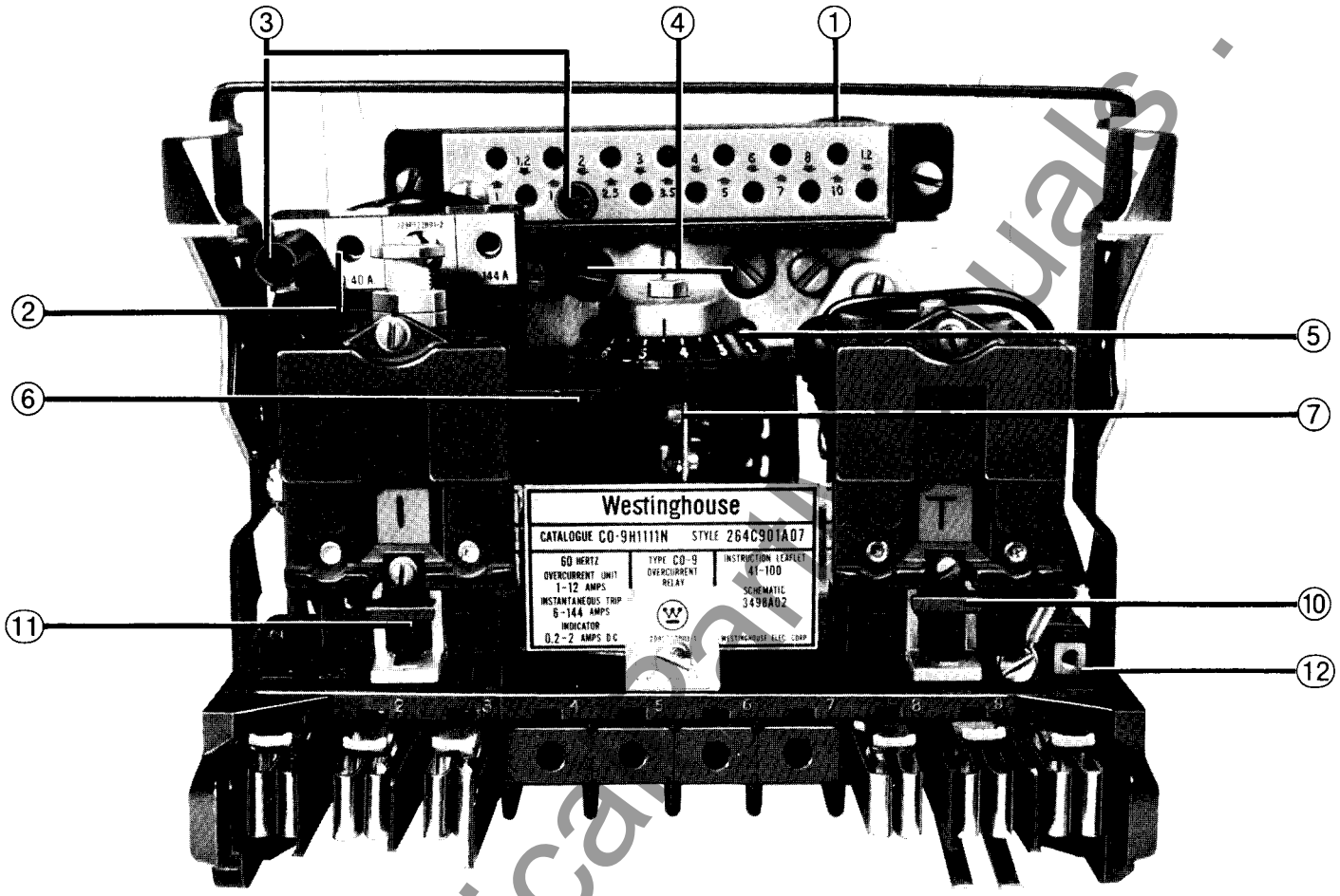
Selector Guide

Relay Type	Time Curve	Comparative Operating Time①	Basic Application
CO-2	Short	0.47 Sec.	Differential protection of bus or generators where restraint windings are not required. Straight overcurrent protection where short operating time is necessary.
CO-5	Long	25 Sec.	Motor locked rotor protection. Long time setting prevents tripping due to motor starting currents. Inverse characteristic provides faster tripping at higher currents.
CO-6	Definite	2 Sec.	For use where generating capacity and fault currents vary over a wide range. Relay has fixed operating time (per time dial setting) from approximately 10 to 20 times tap current, most useful where no coordination is required with downstream devices.
CO-7	Moderately Inverse	2.48 Sec.	Overcurrent phase and/or ground fault detection on transmission or feeder lines where moderate changes in generating capacity occur, or on parallel lines where one line may be called on to carry both loads. Relay approaches definite time characteristics at high currents, allowing wide changes in fault current magnitude with little change in operating time.
CO-8	Inverse	2.52 Sec.	Phase and/or ground fault detection of subtransmission lines or feeders. Also supplied as primary protection or back-up for other relays. Wide range in time lever settings and slope of curves facilitate coordination and assure selective operation. Degree of inverseness required is determined by fault current magnitude, operating time desired, and the characteristics of nearby relays on the system.
CO-9	Very Inverse	1.53 Sec.	
CO-11	Extremely Inverse	0.8 Sec.	Used on feeder circuit breakers which must coordinate with main and branch line sectionalizing fuses. Also used where long time delay is required for overload, such as where feeder is energized after extended outage.

① Values shown are with #10 time dial setting, and with 10 times tap value current applied.

Ac or Dc Trip Circuit: Where a dc control source (24 to 250 volts) is available, circuit closing relays are used. If dc is not available, circuit opening relays are used with ac tripping, using the output of a current transformer to energize the circuit breaker trip coil. Under normal conditions, the normally closed contacts of the relay shunt the breaker trip coil.

High Speed Short Circuit Fault Protection: Relays equipped with instantaneous overcurrent IIT or ITH units provide instantaneous overcurrent tripping, in addition to tripping with time delay on moderate overloads.



Construction

A main tapped coil is placed on the center leg of an "E" type laminated structure. This produces a flux which divides and returns through the two outer legs. A shading coil on the left leg creates an out-of-phase flux which reacts with current induced in the disc by the main coil flux in the air gap to cause disc rotation in the contact-closing direction.

Types CO-2 and CO-11 relays are similar in electromagnet construction except that both outer legs have windings to produce the necessary out-of-phase fluxes required for contact-closing rotational torque.

(1) Time Unit Tap Block

(2) Instantaneous Unit Tap Block

(3) Tap Screws

(4) Magnetic Plugs

May be screwed in or out of the magnetic circuit to control saturation and adjust calibration at high currents. A damping magnet and spring adjustment permit calibration at low currents.

(5) Time Dial

Indicates starting position of the moving contact over a 270° range. Indexes from ½ (minimum time) to 11 (maximum time).

(6) 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 back-stop. On double-trip relays, adjustment of 1/64" contact follow (or wipe) is obtained by use of a vernier adjusting screw on the stationary contact plate.

(7) Moving Contact

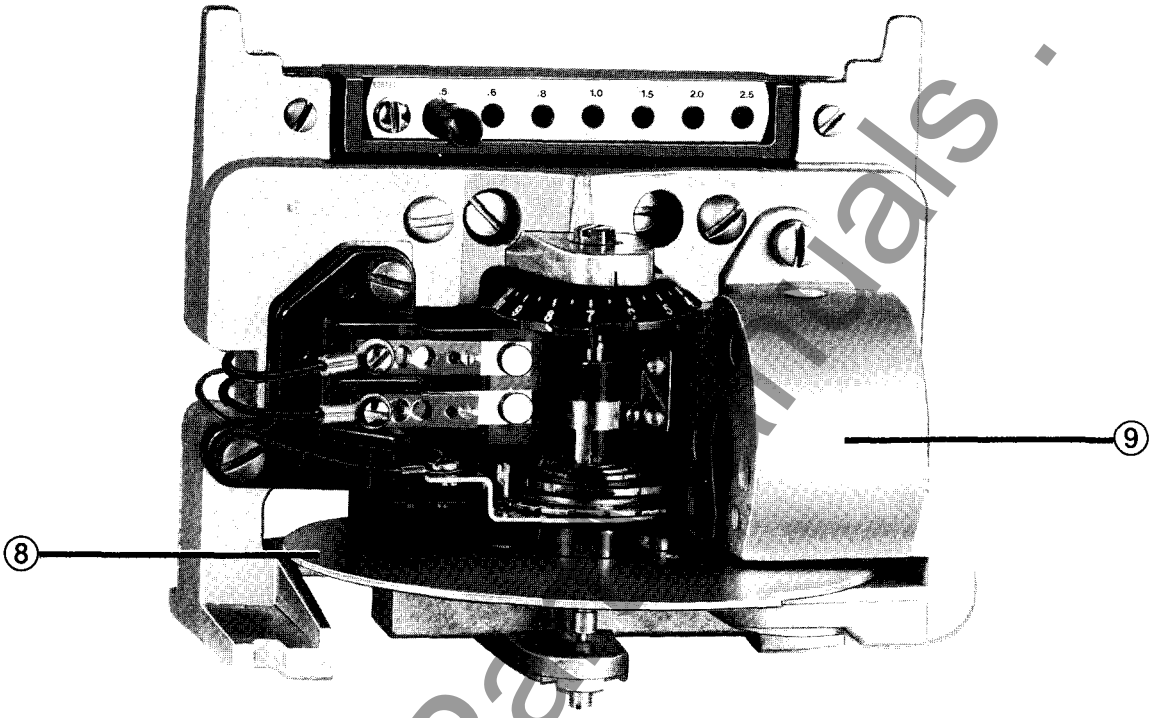
Also made of pure silver, the moving contact is clamped to the insulated section of the disc shaft. Electrical connection is made from the moving contact through a spiral spring to the spring adjuster frame, then to the relay terminal. Moving contacts will close 30 amperes at 250 volts dc.

(8) Induction Disc

Spiral shaped to compensate for the spring windup which occurs throughout the moving contact travel. Provides accurate pickup at any disc position. A spring adjuster is provided to permit in-between tap pickup adjustment when desired.

(9) Damping Magnet

Made of high strength Alnico. Controls relay operating time at low current values. A keeper screw permits micrometer adjustment of the damping magnet without shifting the location of the magnet, and allows the relay to be accurately calibrated at low currents.

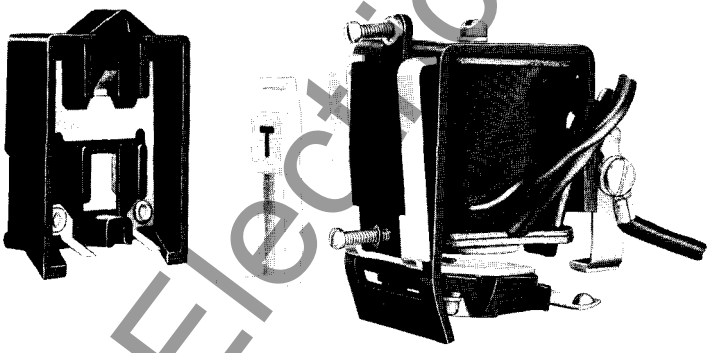


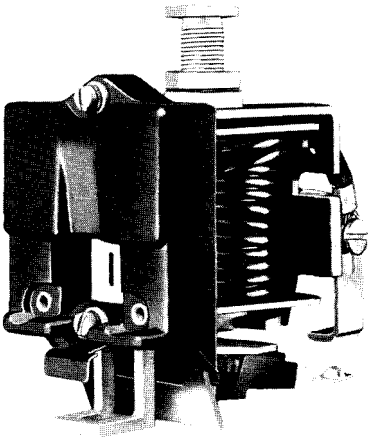
⑩ Indicating Contactor Switch (ICS)
(Partially Disassembled)

⑪ Indicating Instantaneous Trip (IIT)

⑫ ICS Tap Selection

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.





The dc operated Indicating Contactor Switch has a clapper type magnetic armature to which leaf-spring contacts are attached.

When the switch is energized, the moving contacts bridge the stationary contacts, completing the trip circuit. The ICS contacts are connected in parallel with the main relay contacts, relieving them of carrying heavy trip currents.

During operation, two fingers on the armature deflect a spring, which allows the operation indicator target to drop. The target is orange color and readily visible.

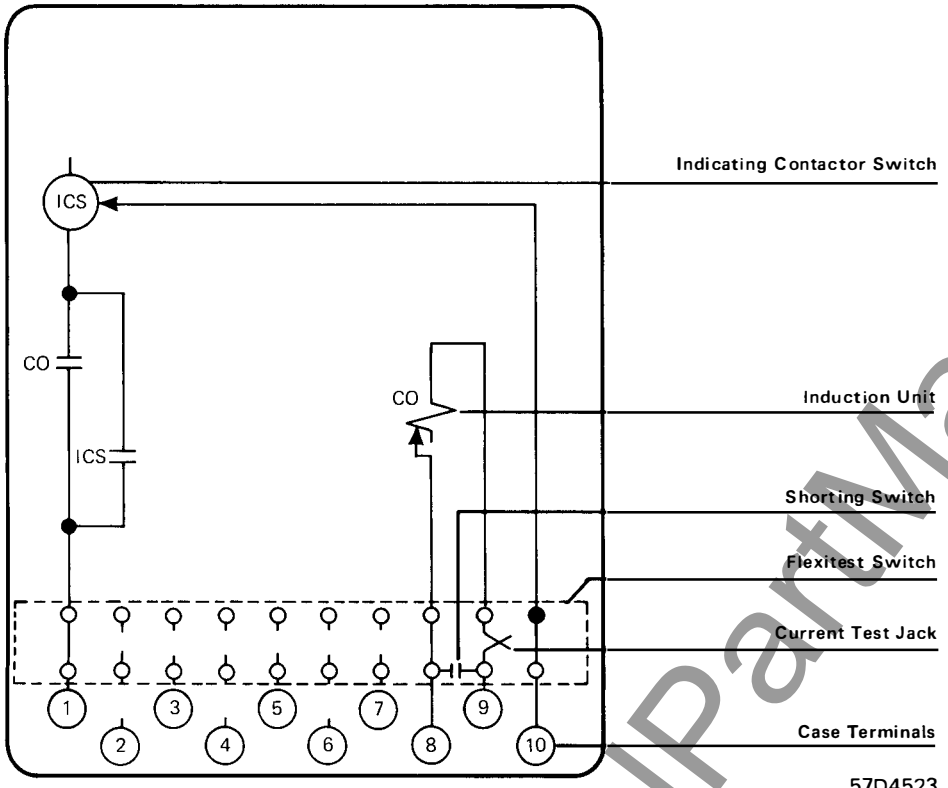
Taps on the front of the unit provide connection for either 0.2 (left) or 2.0 (right) amperes dc pickup operation.

When using a 125 or 250 volt dc auxiliary WL auxiliary relay, the 0.2 ampere tap is recommended. The 2.0 ampere tap is used with WL relays on 24 or 48 volt dc circuits.

Used for high speed detection of large fault currents. Construction is similar to that of the Indicating Contactor Switch, except that it is ac operated, and adjustable over the range. Variable pickup is obtained by a core screw adjustment on the top of the unit.

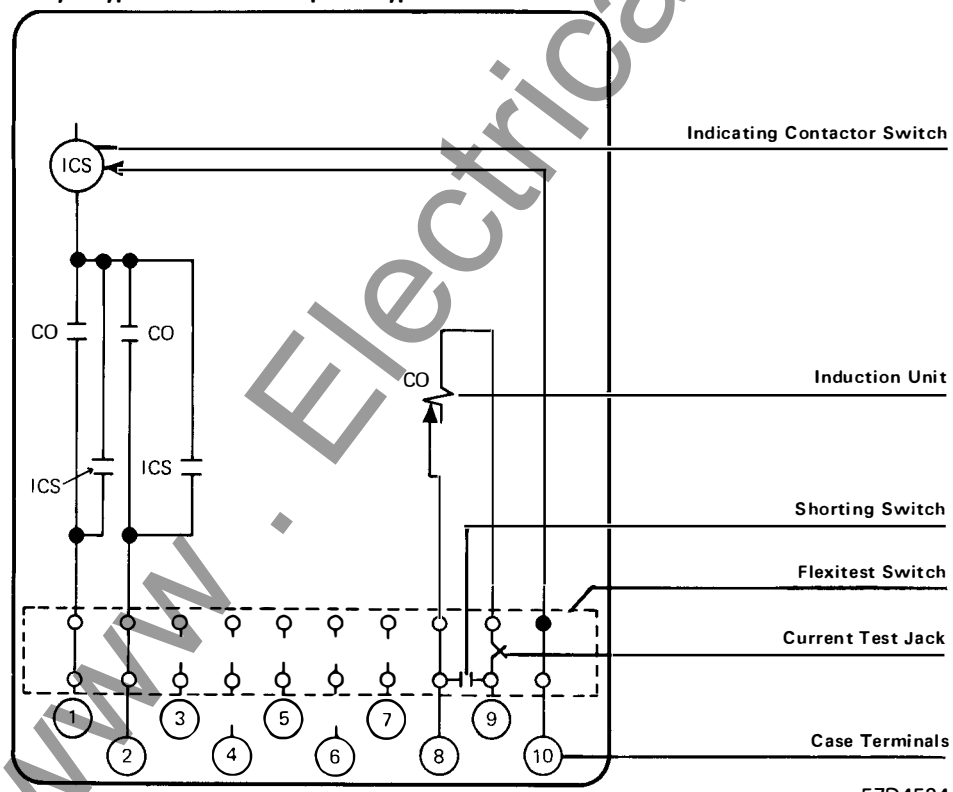
When the IIT is energized above pickup setting, the target drops.

Relay – Type CO – Single Trip – In Type FT-11 Case



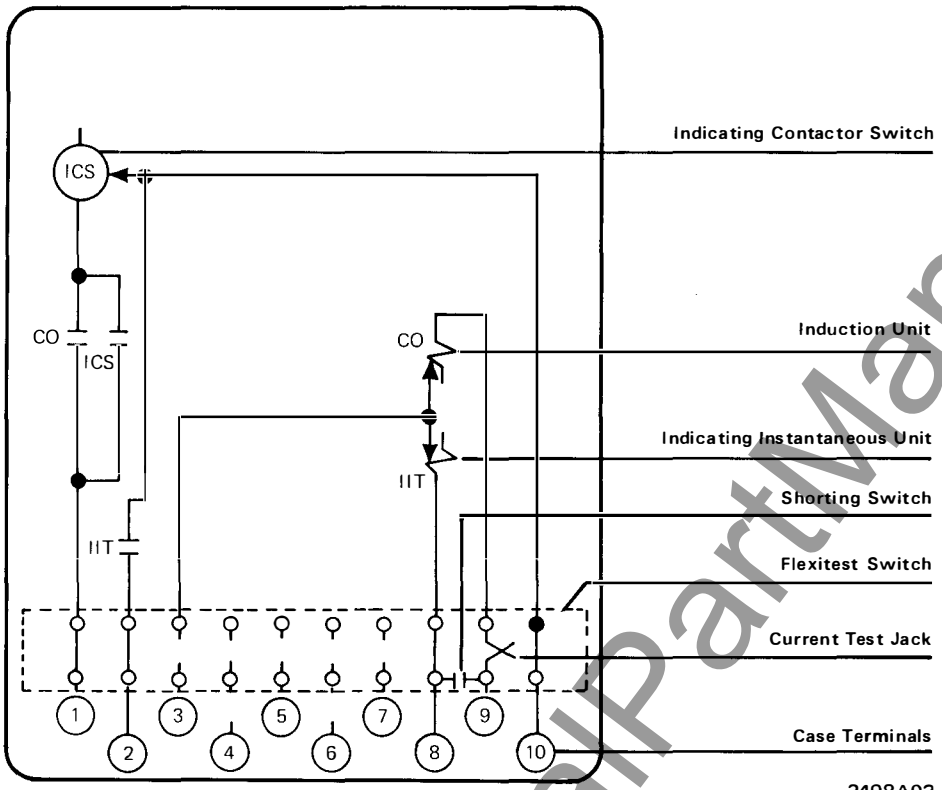
57D4523
(Sub. 3)

Relay – Type CO – Double Trip – In Type FT-11 Case



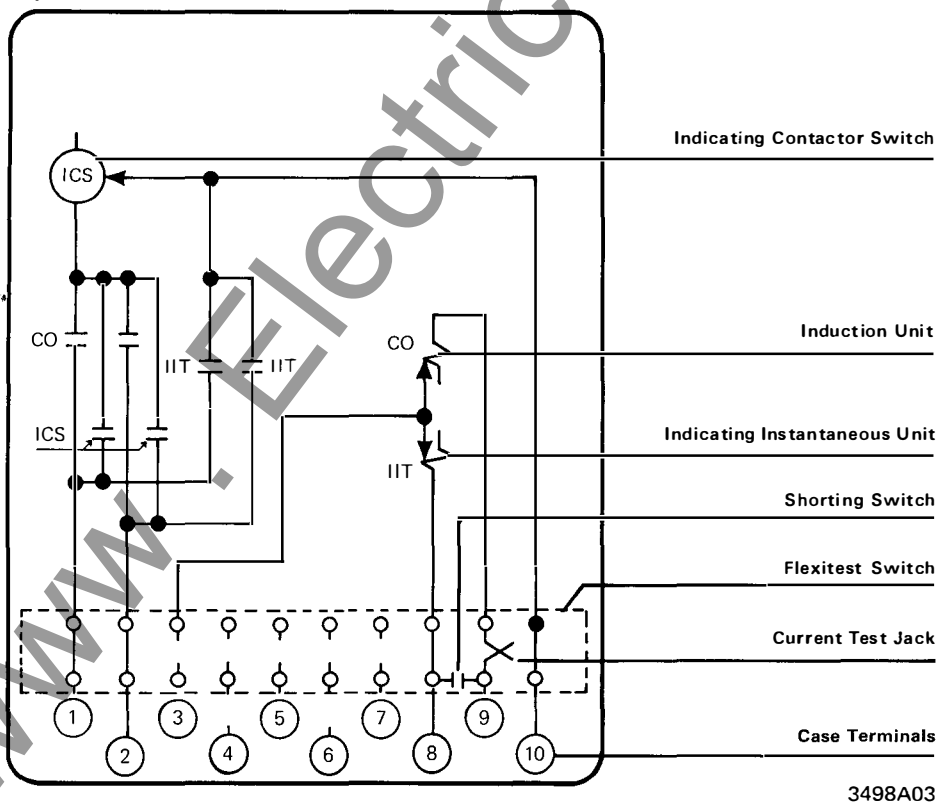
57D4524
(Sub. 3)

Relay – Type CO – Single Trip With Instantaneous Trip Unit – In Type FT-11 Case



3498A02
(Sub. 1)

Relay – Type CO – Double Trip With Instantaneous Trip Unit – In FT-11 Case



3498A03
(Sub. 1)

Energy Requirements
See Instruction Leaflet 41-100.

Current Tap Ranges

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

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

The indicating instantaneous trip contacts will safely close 30 amperes at 250 volts dc, 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 Constants
Contactor Switch –
0.2 ampere tap .... **6.5 ohms Dc resistance**

2.0 ampere tap .... **0.15 ohms Dc resistance**

Time Curves
See Performance Data 41-000

Westinghouse Electric Corporation
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