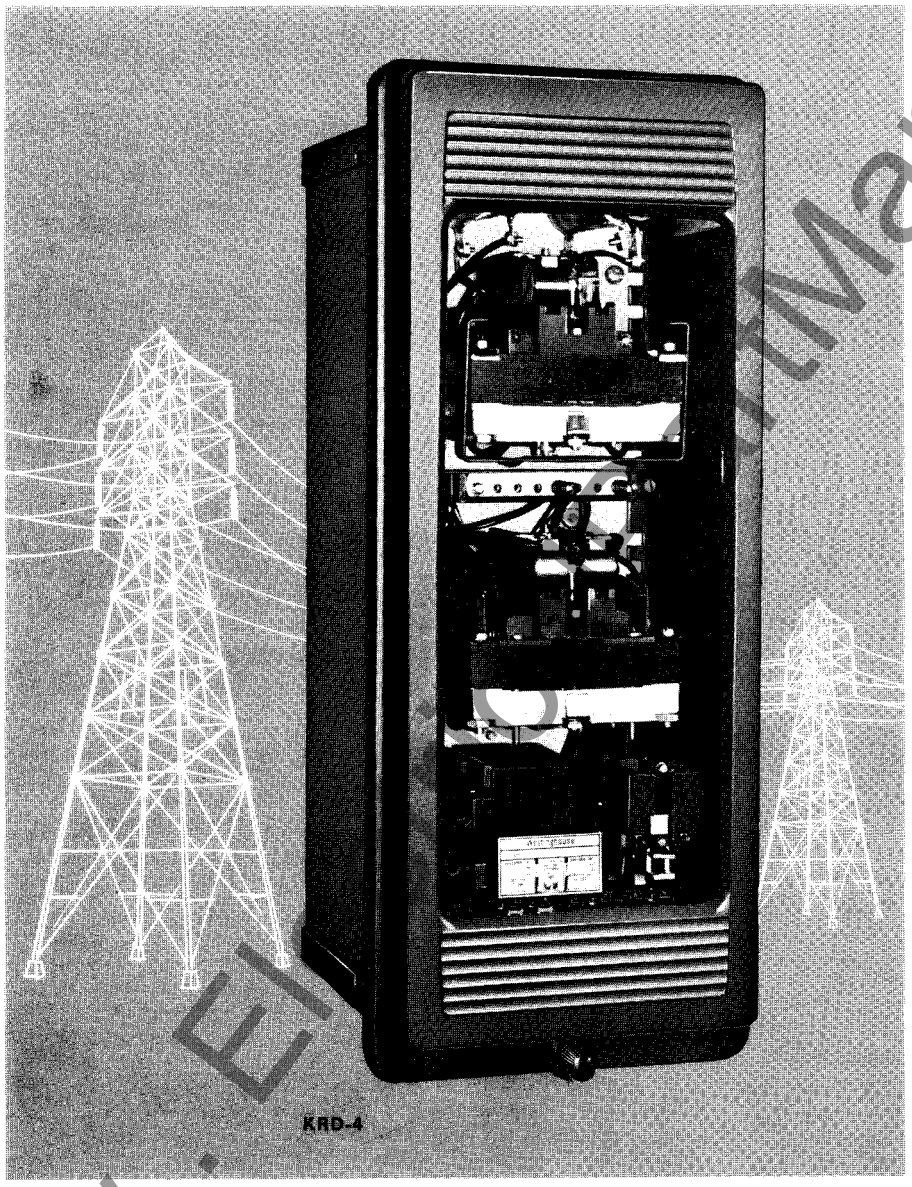
Westinghouse Electric Corporation
Relay Instrument Division
Newark, N.J. 07101

January, 1978
Supersedes DB 41-130D,
dated November, 1970
Mailed to: E, D, C/2013/DB

KRD-4 and KRQ Directional Overcurrent Ground Relays



Application

Westinghouse types KRD-4 and KRQ relays are high-speed, directional over-current relays. They are used for the detection of ground faults on transmission lines, feeder transmission lines, and feeder circuits.

They can also be used, without modification, to provide directional ground fault protection in K-Dar carrier relaying schemes.

Type KRD-4

This dual polarized relay can be polarized from a potential source, a local ground source, or from both simultaneously.

The directional unit compares the phase angle relationship between the ground fault current and the polarizing quantity to produce contact-closing torque for faults in the trip direction, and contact-opening torque for faults in the non-trip direction. Relay operation occurs when both the directional unit and the instantaneous overcurrent unit close their contacts. The fault current must therefore be greater than the tap setting of the overcurrent unit.

Type KRQ

The KRQ relay is a high-speed directional over-current ground relay in which the directional unit operates on negative sequence current and voltage, and the overcurrent unit operates on residual or ground current.

The phase angle between negative sequence voltage and negative sequence current is used for directional discrimination. Negative sequence polarization is applied as follows: (1) where zero sequence voltage or polarizing current is not available or the current is not a reliable source, or (2) where incorrect zero sequence polarization of directional units results from mutual indiction between transmission lines.

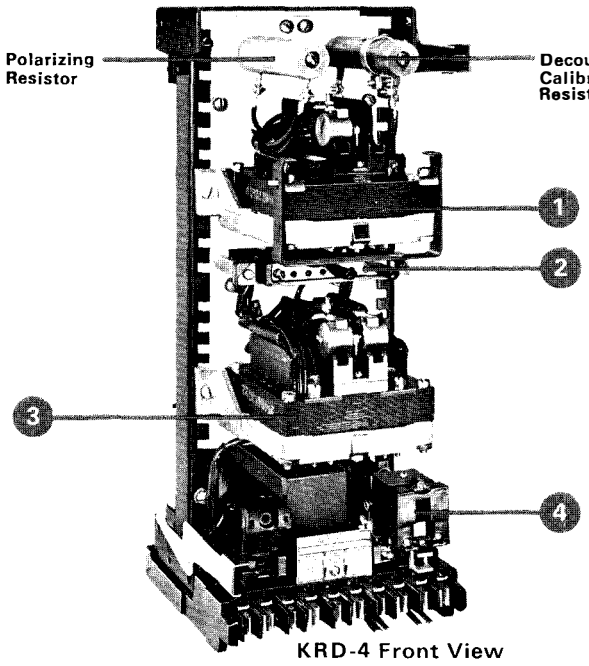
The negative sequence current and voltage are obtained by means of self-contained negative sequence filters connected between the directional unit and the current and potential transformers.

The KRQ relay is for use at locations where the present equipment or system conditions do not permit the use of the conventional types of directional ground relays operating entirely on residual current and voltage.

It is applicable for ground protection at undergrounded substations or grounded systems where only two potential transformers are available, or where the potential transformers are on the low-tension side of a wye-delta or delta-wye power transformer bank.

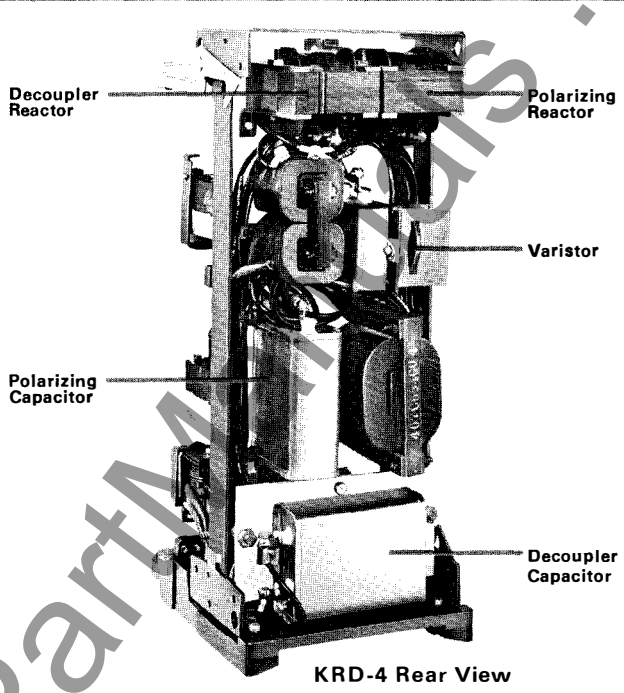
Device Number: 67N

Construction



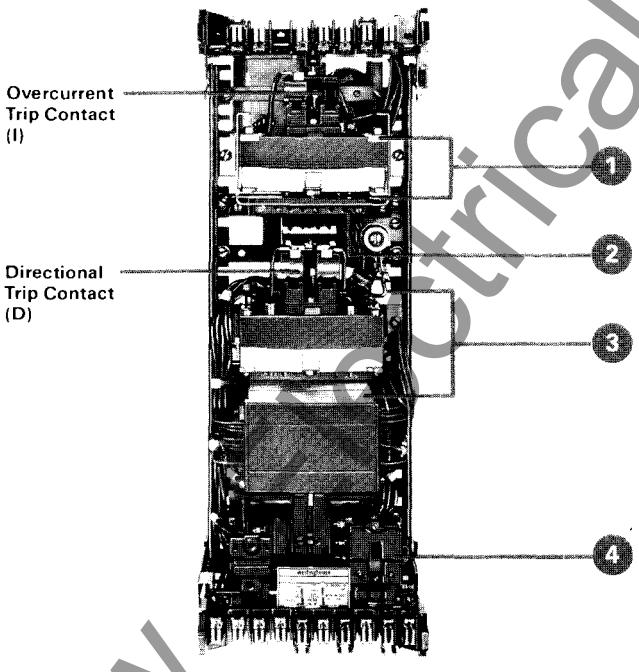
KRD-4 Front View

Fig. 1



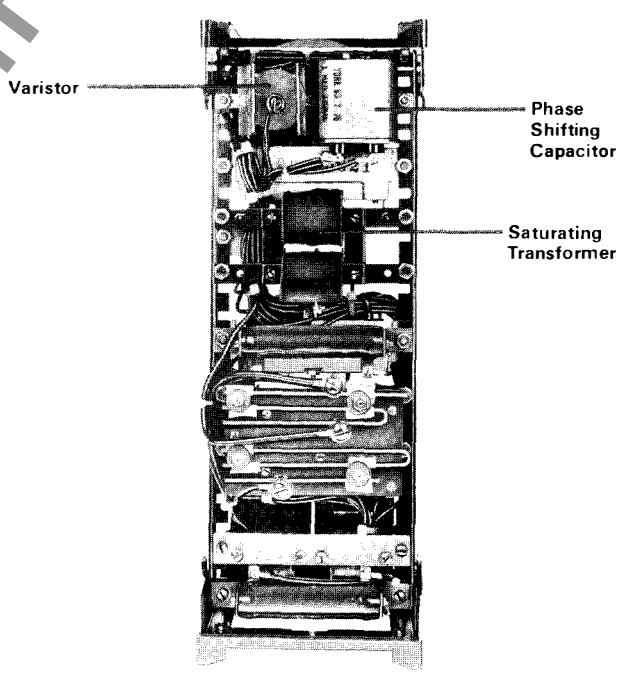
KRD-4 Rear View

Fig. 2



KRQ Front View

Fig. 3



KRQ Rear View

Fig. 4

KRD-4 and KRQ Directional Overcurrent Ground Relays

1 Overcurrent Unit (I)

The ground instantaneous overcurrent section consists of an induction cylinder unit with moving and stationary contact, phase shifting capacitor, varistor, saturating transformer with a tapped primary winding and a secondary winding, and a tap block for current pickup settings.

A varistor is connected across the secondary winding to reduce the voltage peaks applied to the induction unit and to the phase shifting capacitor.

2 Tap Block

The primary winding is tapped, and these taps are brought out to a tap block for ease in changing the pick up of the overcurrent unit. By using a tapped transformer, the relay can provide approximately the same energy level at a given multiple of pickup current for any tap setting, resulting in one time curve throughout the range of the relay.

3 Directional Unit (D)

KRD-4
The KRD-4's directional unit consists of an induction cylinder unit, phase shifting network, and a die-coupling network.

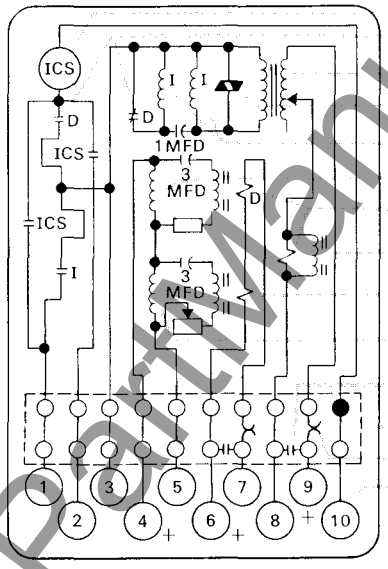
Since this single unit can be polarized from a potential source, from a local ground source, or from both simultaneously, a simplified trip circuit and one, instead of two, back contacts can be used in the overcurrent torque control circuit.

KRQ
The KRQ directional unit is a product induction cylinder type, which operates on the interaction between the polarizing circuit flux and the operating circuit flux.

4 Indicating Contactor Switch (ICS)

When the dc operated ICS is energized, the moving contacts bridge two stationary contacts, completing the trip circuit.

Internal Wiring Diagrams, Front View
KRD-4 Dual Polarized Directional Overcurrent Ground, FT-31 Case (Front View)

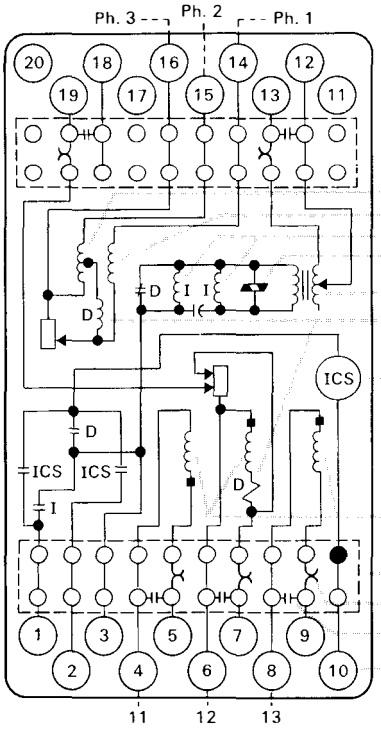


Indicating Contactor Switch
Directional Contacts (Lower Unit)
Saturating Transformer
Varistor
Overcurrent Unit (Upper Unit)
Reactor
Directional Unit (Lower Unit)
Saturable Shunt
Decoupler Transformer
Reactor
Chassis Operated Shorting Switch
Flexitest Switch
Current Test Jack
Case Terminals

NOTE. With Relative Instantaneous Polarity as shown, the Directional Unit Contacts Close.

Fig. 5 629A509 Sub. 1

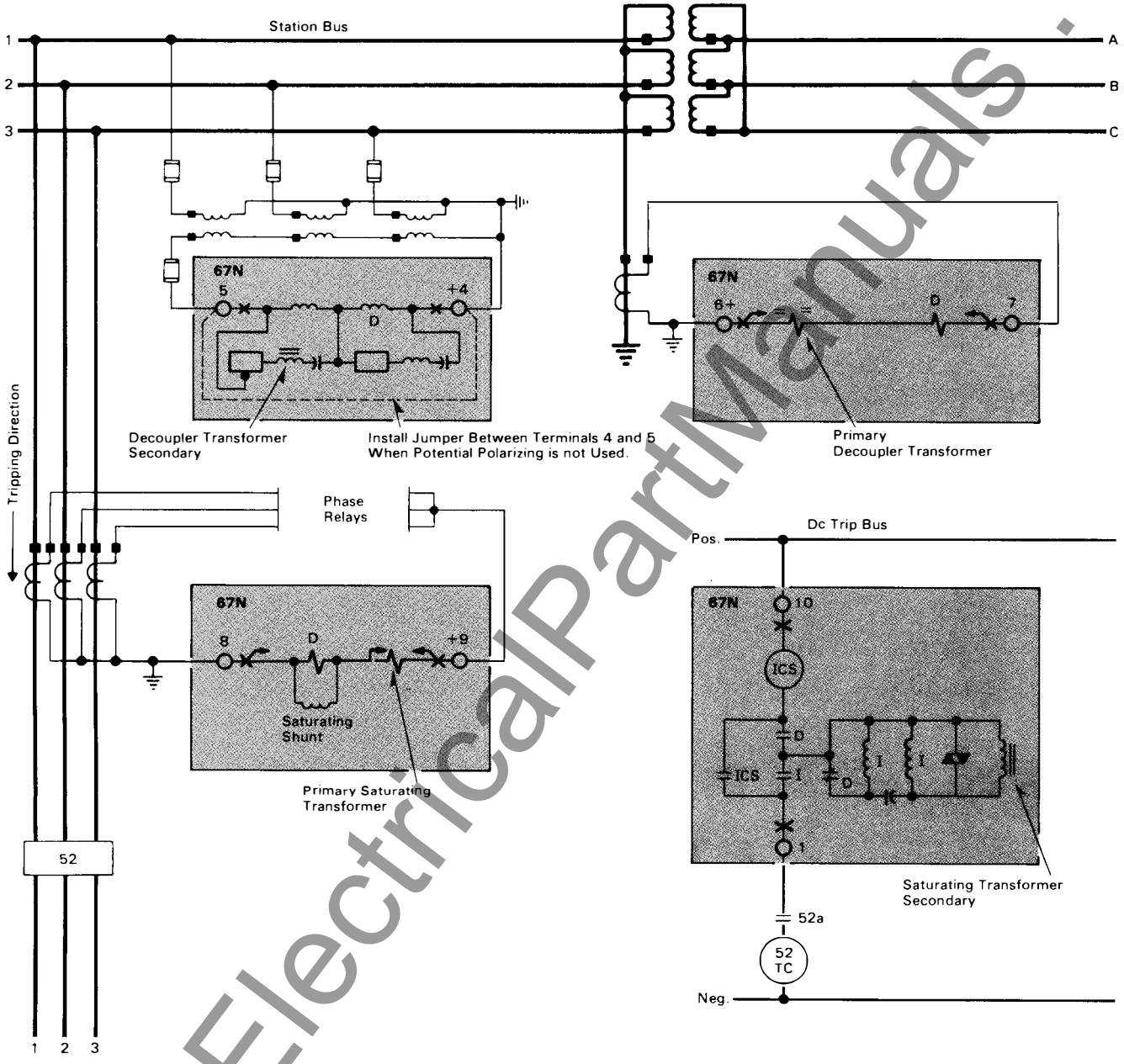
KRQ High Speed Directional Overcurrent Negative Sequence Ground, FT-42 Case (Front View)



Auto-Transformer
Reactor
Overcurrent Unit (Top Unit)
Varistor
Saturating Transformer
Directional Unit (Lower Unit)
Indicating Contactor Switch
Mutual Reactor
Flexitest Switch
Current Test Jack
Chassis Operated Shorting Switch
Case Terminals

Fig. 6 184A546 Sub. 1

Type KRD-4 External Wiring Diagram, For Ground Fault Protection



Device Number Chart

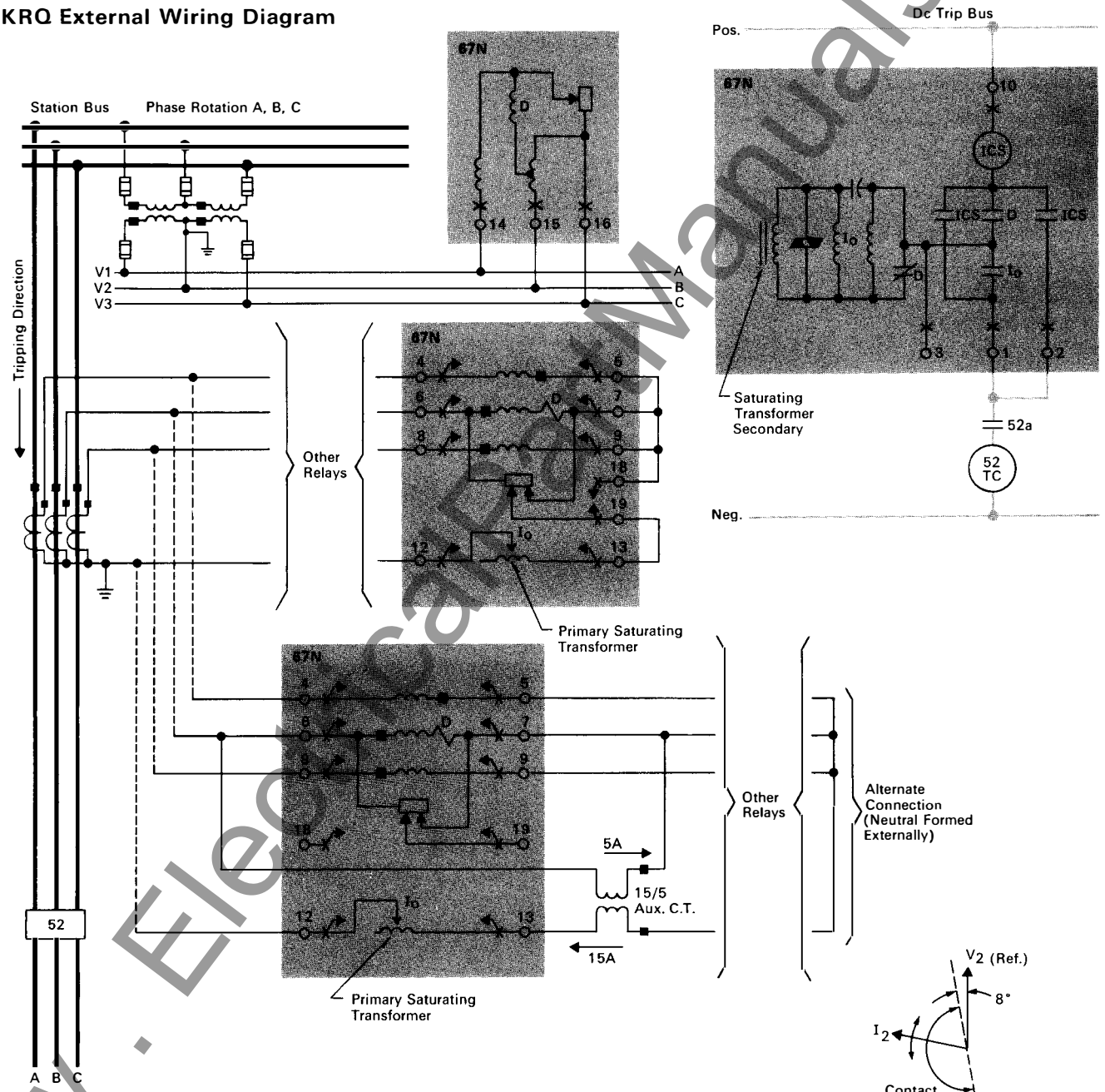
67N — Directional Overcurrent Ground Relay, Type KRD-4
I — Overcurrent Unit of Type KRD-4
D — Directional Unit of Type KRD-4
52 — Power Circuit Breaker
ICS — Indicating Contactor Switch
52a — Breaker Auxiliary Contact
52TC — Breaker Trip Coil

Fig. 7

629A946
Sub. 2

KRD-4 and KRQ Directional Overcurrent Ground Relays

KRQ External Wiring Diagram



Directional Unit Phase Angle Characteristics

Device Number Chart

67N — Directional Overcurrent Negative Sequence Ground Relay, Type KRQ
I_o — Overcurrent Unit of Type KRQ
D — Directional Unit of Type KRQ
ICS — Indicating Contactor Switch
52 — Power Circuit Breaker
52a — Breaker Auxiliary Contact
52TC — Breaker Trip Coil

Fig. 8

Further Information
Specifications and Ordering Information –
Tech. Data 41-020
Prices – Price List 41-020
Instructions Maintenance and Testing –
KRD-4 IL 41-137.3; KRQ IL 41-164
Flexitest Cases – Descriptive Bulletin 41-075
Other Westinghouse Protective Relays –
Selector Guides 41-000 A, B, C

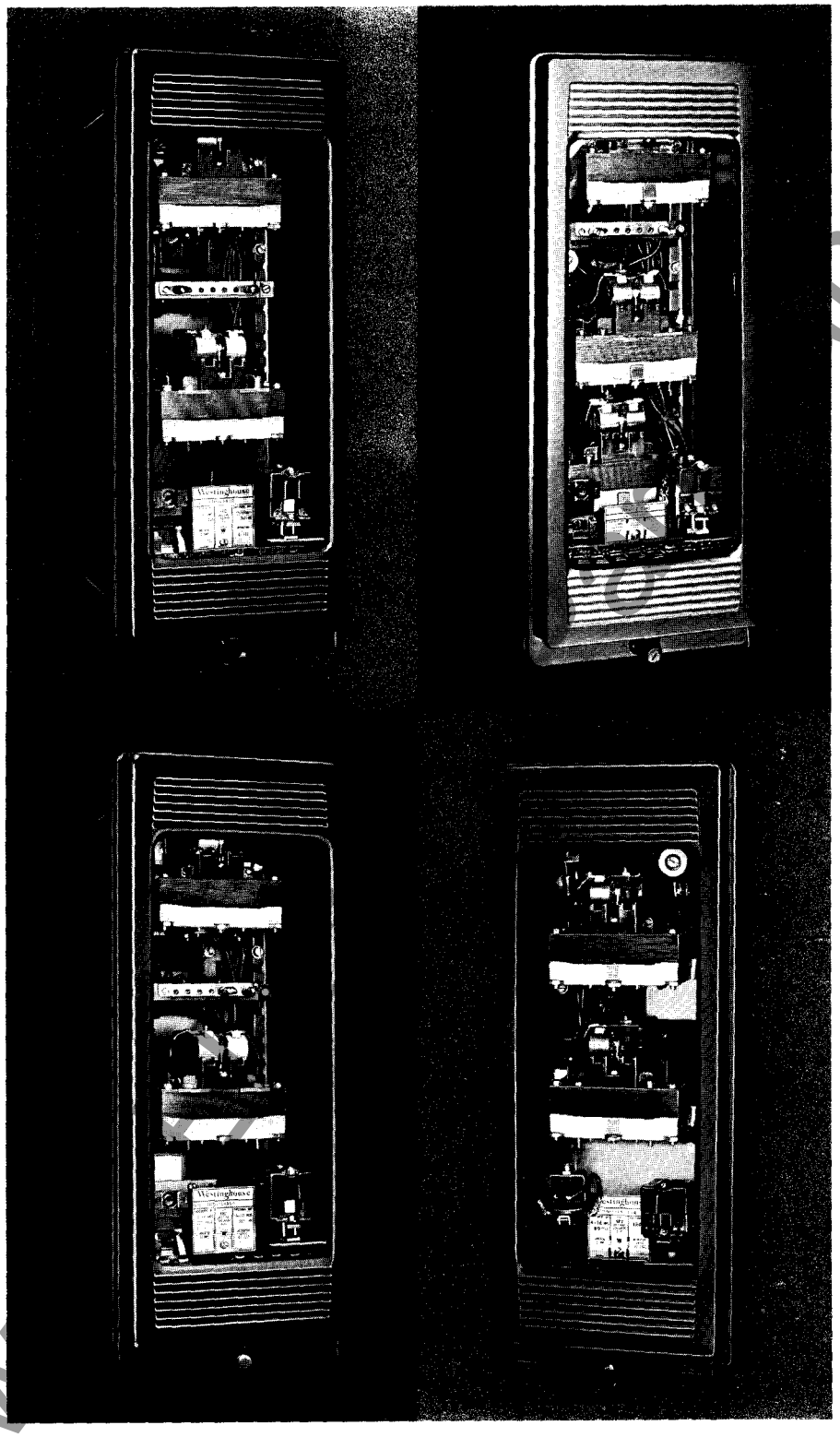
Printed in U.S.A.

Westinghouse Electric Corporation
Relay Instrument Division
Newark, N.J. 07101

Westinghouse

Directional Overcurrent Relays

For Phase and Ground Fault Detection
on Transmission Lines and
Feeder Circuits
Types KRC, KRD, KRP, KRV



Application

Types KRC, KRD and KRP single-phase high-speed directionally controlled overcurrent relays are designed to protect transmission lines and feeder circuits from damage due to ground faults.

They can also be used, without modification, to provide directional ground fault detection with the K-Dar carrier or microwave relaying schemes.

Phase fault detection is provided by the type KRV relay.

Types Available

Type	Directional Unit Polarization
KRC	Residual Current
KRD	Residual Current and Voltage
KRP	Residual Voltage
KRV	Line Voltage

Device Numbers

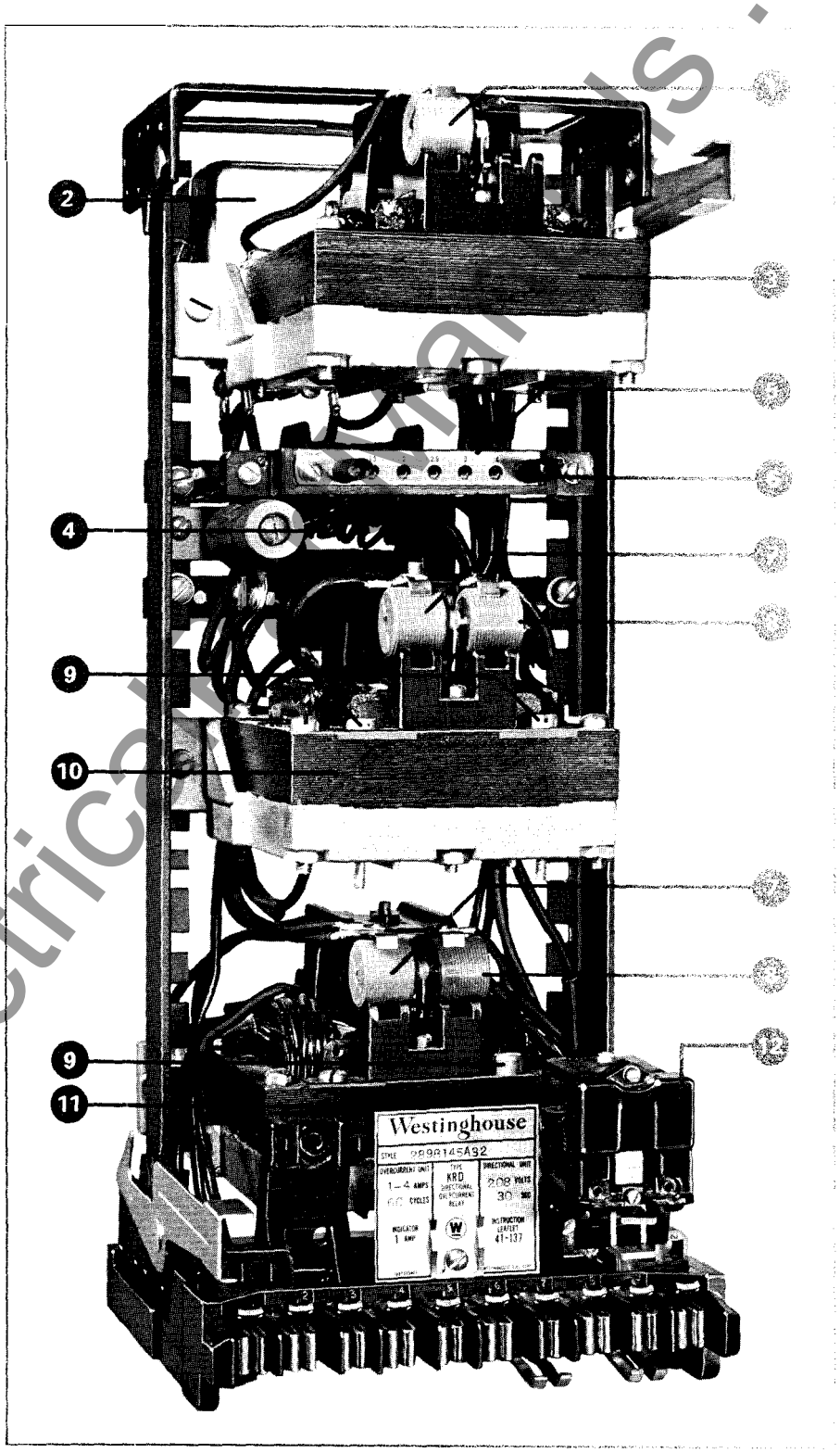
KRC, KRD, KRP.....67N
KRV.....67

February, 1971
Supersedes Descriptive Bulletin 41-130C Dated
May, 1962
E, D, C/2013/DB

Westinghouse

Construction and Operation

1. Overcurrent Trip Contact (I)
2. Overcurrent Unit Phase Shifter
3. High-speed Overcurrent Unit
4. Saturating Transformer
5. Overcurrent Unit Tap Block
6. Spare Tap Screw
7. Directional Trip Contact (D)
8. Directional Torque Control Contact (D)
9. Magnetic Adjusting Plugs
10. Voltage Polarized Directional Unit
11. Current Polarized Directional Unit
12. Indicating Contactor Switch (ICS unit)



Type KRC
The KRC relay is current polarized as shown in figure 10, page 6. Maximum torque on the directional unit occurs when the operating current (Io) leads the polarizing current (Ip) by approximately 40°.

Type KRD
The KRD relay is dual polarized (see figure 11). It utilizes the current polarized directional unit of the KRC and the potential polarized unit of the KRP relay.

Type KRP
Type KRP is potential polarized as shown in figure 12. It has its maximum torque when the residual current lags the polarizing voltage by approximately 60°. The maximum torque angle is shifted by means of an internally mounted capacitor-resistor combination as shown in figure 8.

Type KRV
Type KRV is potential polarized from line voltage as shown in figure 13. Maximum torque on the directional unit occurs when the operating current leads the polarizing voltage by 30°. By connecting the directional unit, using phase current in one phase and polarizing potential across the other two phases, the maximum torque occurs when the fault current lags its 100 percent PF position by approximately 60°. This connection is shown in figure 9.

Directional Unit (D)
Consists of a die-cast aluminum frame which supports an electro-magnet, a single-pole double-throw moving contact assembly, and a molded bridge. The electromagnet has two series-connected polarizing coils mounted opposite one another; and two series connected operating coils mounted on alternate opposing sides. The moving contact assemble shaft is supported on both ends by jewel bearings. A moving aluminum cylinder with a molded insulating hub supports the moving contact assembly and rotates in the air gap between the electromagnet and the magnetic core. Spurious torques are balanced out by means of two magnetic adjusting plugs.

Overcurrent Unit (I)
KRC, KRD, KRP Ground Relays
This is a cylinder-design unit similar in construction to the directional unit, except that it has one circuit closing contact. Each pair of pole windings is energized by ground current from the operating circuit. In order to develop the necessary rotational torque, a capacitor is series-connected with one pair of pole windings to obtain the desired time-phase relationship between the current in the two pairs of coils. As shown in figures 6, 7, 8, and 9, one of the directional unit contacts is connected across one pair of pole windings of the overcurrent unit. This contact shunts the operating current around the pole windings, preventing the unit from developing rotational torque. However, when the directional unit picks up under fault conditions, the short on the overcurrent unit coils is removed; allowing the overcurrent unit to rotate almost simultaneously with the directional unit, thereby providing high-speed operation.

A saturating transformer is used to feed the overcurrent unit. It limits the energy applied to the unit at high current values. The primary winding of the saturating transformer has taps connected to a tap block to facilitate changing the current pickup values of the unit.

Tap value current is the minimum current required to just close the relay contacts. This tapped transformer arrangement supplies the same amount of energy to the overcurrent unit for any tap setting, at a given multiple of tap current. Thus, the relays have one operating time current curve (see figures 14 and 15) throughout their entire range.

A non-linear resistor (varistor) is connected across the secondary winding of the transformer and overcurrent coils to reduce the voltage peaks applied to the capacitor and overcurrent unit.

KRV Phase Relay
The KRV's cylinder-design directional unit is similar to the ground relay instantaneous overcurrent unit, except that it receives its energy from the phase current transformer. As shown in figure 9 the capacitor phase shifting circuit is controlled by one of the contacts on the CS-1 switch, which in turn is operated by the directional unit. Contact closing torque is produced in the overcurrent unit when the directional unit closes its contact and operates the CS-1 switch.

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Directional Unit Sensitivity

Relay Type	Ampere Rating	Minimum Pickup Values+		Phase Angle Relationship
		Volts	Amperes	
KRC KRD (current unit)	.5-2 1-4	. .	0.5■	Io leading Ip by 40°*
	2-8	. .	0.65■	In phase
	4-16	. .	1.0■	Io leading Ip by 40°*
	10-40	. .	1.3■	In phase
KRP KRD (voltage unit)	.5-2 1-4	1	2.0	I lagging V by 60°*
	2-8	1	4.0	I in phase with V
	4-16	1	4.0	I lagging V by 60°*
	10-40	1	8.0	I in phase with V
KRV	.5-2 1-4	1.2	2.0	I leading V by 30°
	2-8	1.2	2.0	I leading V by 30°
	4-16	1.2	4.0	I leading V by 30°
	10-40	1.2	8.0	I leading V by 30°
	20-80	1.2	8.0	I leading V by 30°

+ Energization quantities are input quantities at the relay terminals.
* Maximum torque angle.
■ In each winding.

Directional Unit Polarizing Circuit Burden

Relay Type	Rating		Volt Amps+	Power Factor Angle◉
	Amps (1 sec.)	Volts (30 sec.)		
KRC	230	. . .	1.45	8° lag
KRD (current unit)	230	. . .	1.45	8° lag
KRD (voltage unit)	. . .	208	11.2	28° lead
KRP	. . .	208	11.2	28° lead
KRV	. . .	. . .	12.5	15° lead

+ Burden of voltage polarized units taken at 120 volts; current polarized units taken at 5 amperes.
◉ Degrees current leads or lags voltage at 120 volts on voltage polarized units and 5 amperes on current polarized units.

Overcurrent Unit: Amperes

Range	Taps
0.5 – 2.5	0.5 – 0.75 – 1 – 1.25 – 1.5 – 2
1 – 4	1 – 1.5 – 2 – 2.5 – 3 – 4
2 – 8	2 – 3 – 4 – 5 – 6 – 8
4 – 16	4 – 6 – 8 – 9 – 12 – 16
10 – 40	10 – 15 – 20 – 24 – 30 – 40
20 – 80	20 – 30 – 40 – 48 – 60 – 80

Directional Overcurrent Relays

For Phase and Ground Fault Detection
on Transmission Lines and
Feeder Circuits
Types KRC, KRD, KRP, KRV

Internal Wiring

KRC

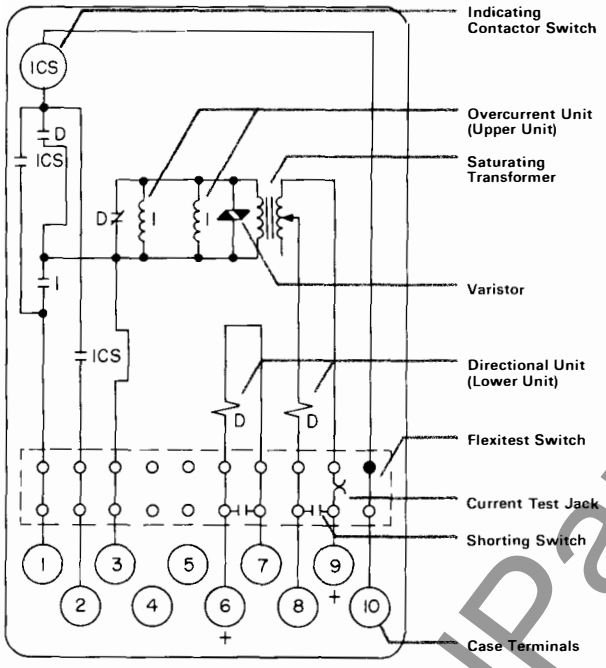


Fig. 6

KRD

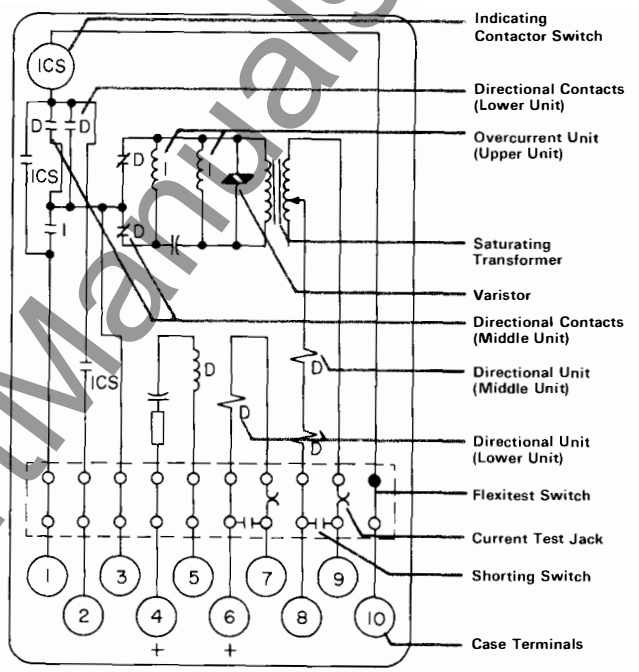


Fig. 7

KRP

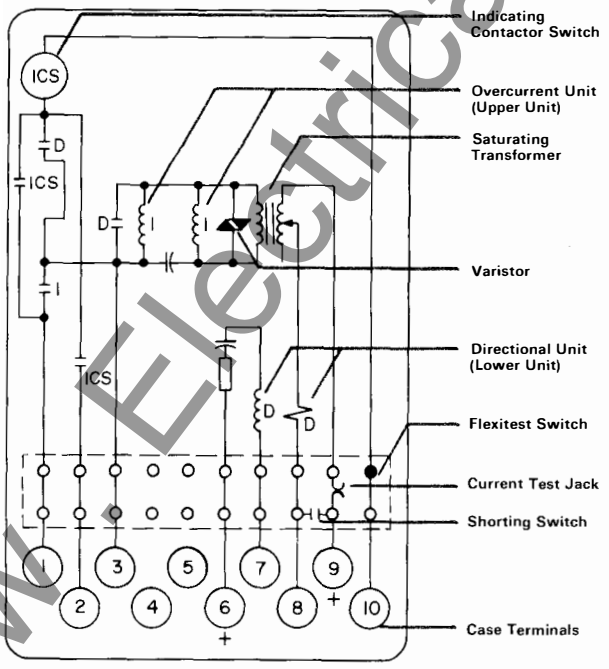
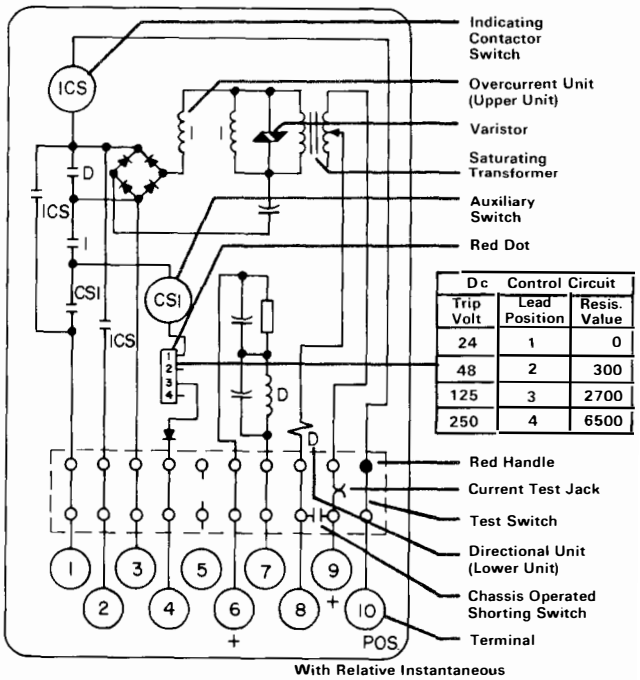


Fig. 8

- With Relative Instantaneous Polarity As Shown, The Directional Unit Contacts Close

KRV



Dc Control Circuit		
Trip Volt	Lead Position	Resis. Value
24	1	0
48	2	300
125	3	2700
250	4	6500

Fig. 9

With Relative Instantaneous Polarity As Shown, The Directional Unit Contacts Close.

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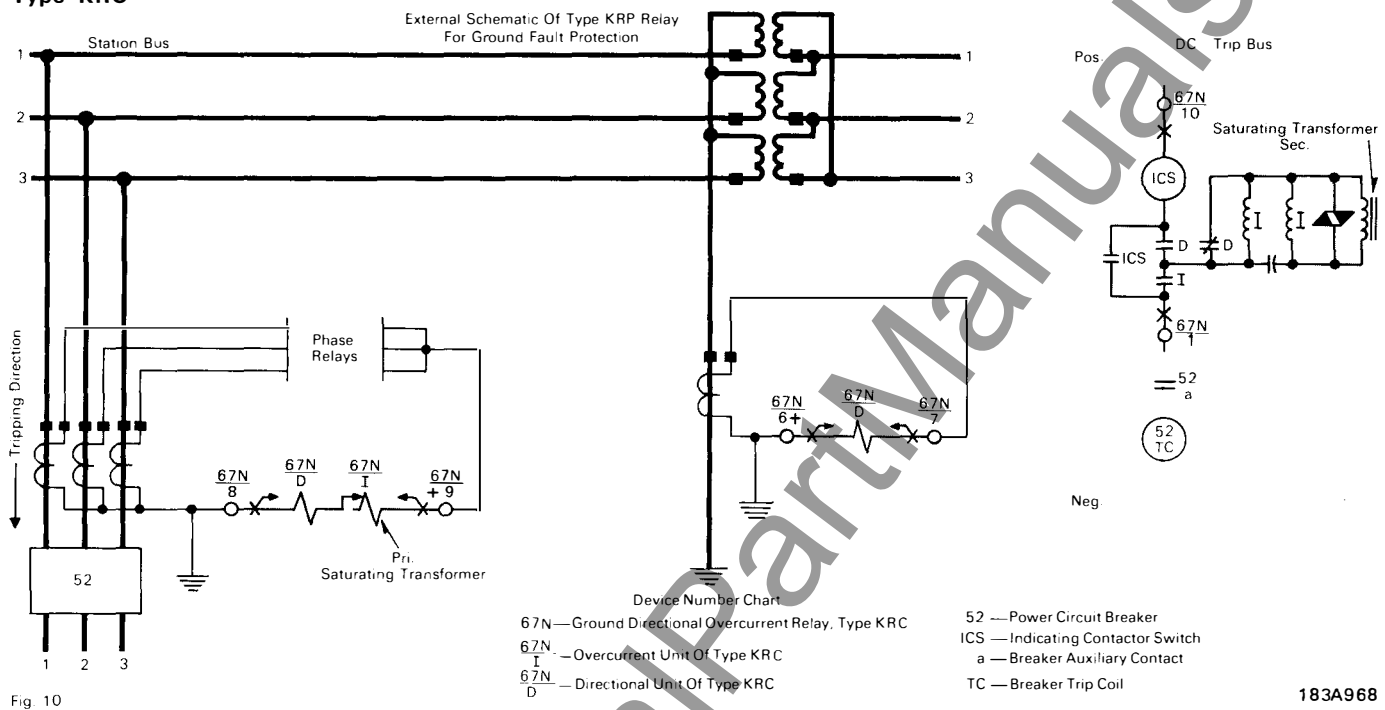
External Wiring

Type KRC



Device Number Chart

67N—Ground Directional Overcurrent Relay, Type KRC

67N/I—Overcurrent Unit Of Type KRC

67N/D—Directional Unit Of Type KRC

52—Power Circuit Breaker

ICS—Indicating Contactor Switch

a—Breaker Auxiliary Contact

TC—Breaker Trip Coil

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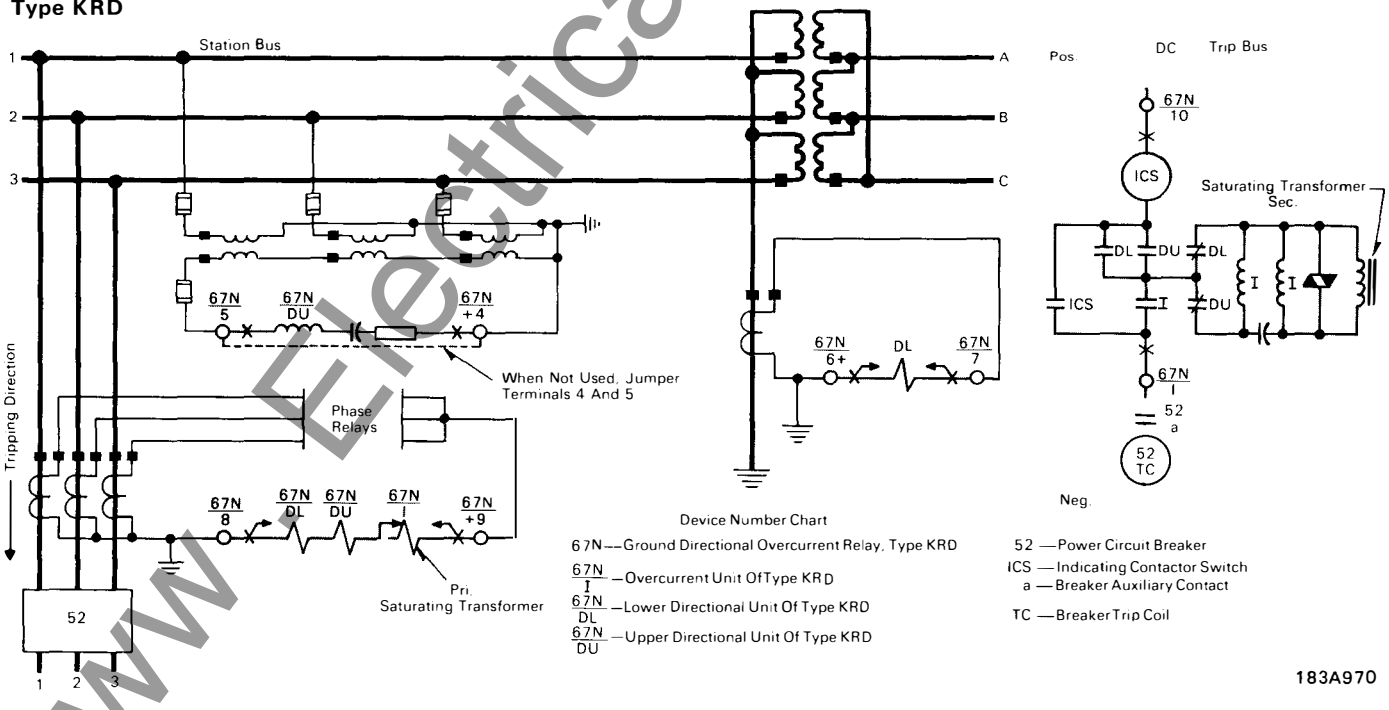
Fig. 10

Type KRD



Device Number Chart

67N—Ground Directional Overcurrent Relay, Type KRD

67N/I—Overcurrent Unit Of Type KRD

67N/DL—Lower Directional Unit Of Type KRD

67N/DU—Upper Directional Unit Of Type KRD

52—Power Circuit Breaker

ICS—Indicating Contactor Switch

a—Breaker Auxiliary Contact

TC—Breaker Trip Coil

183A970

Fig. 11

Directional Overcurrent Relays

For Phase and Ground Fault Detection
on Transmission Lines and
Feeder Circuits
Types KRC, KRD, KRP, KRV

Type KRP

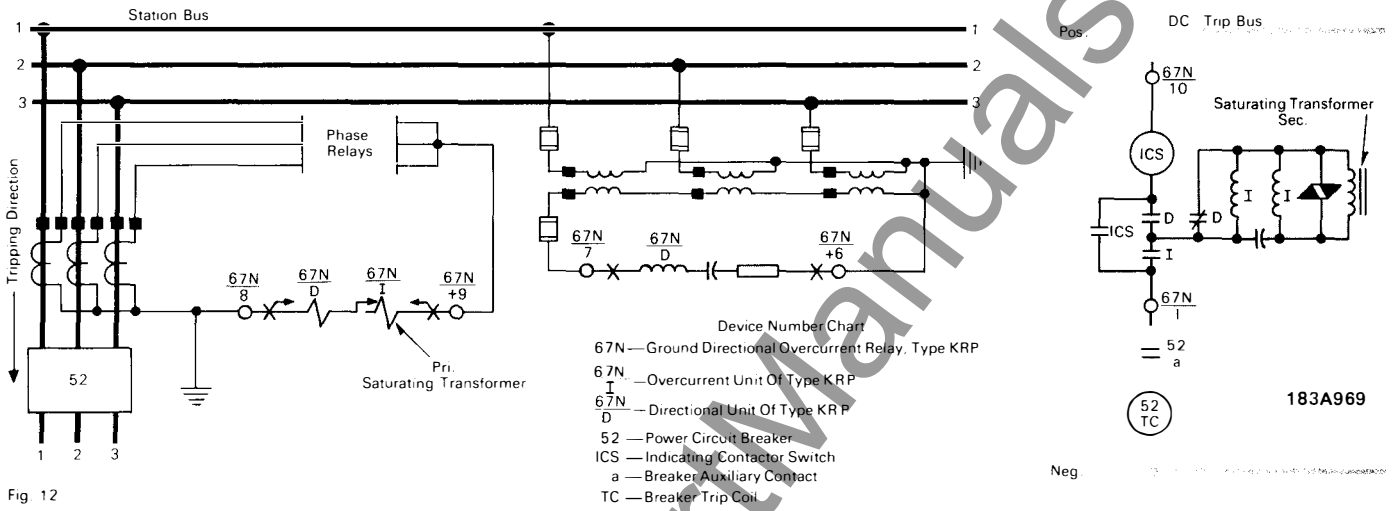


Fig. 12

Type KRV

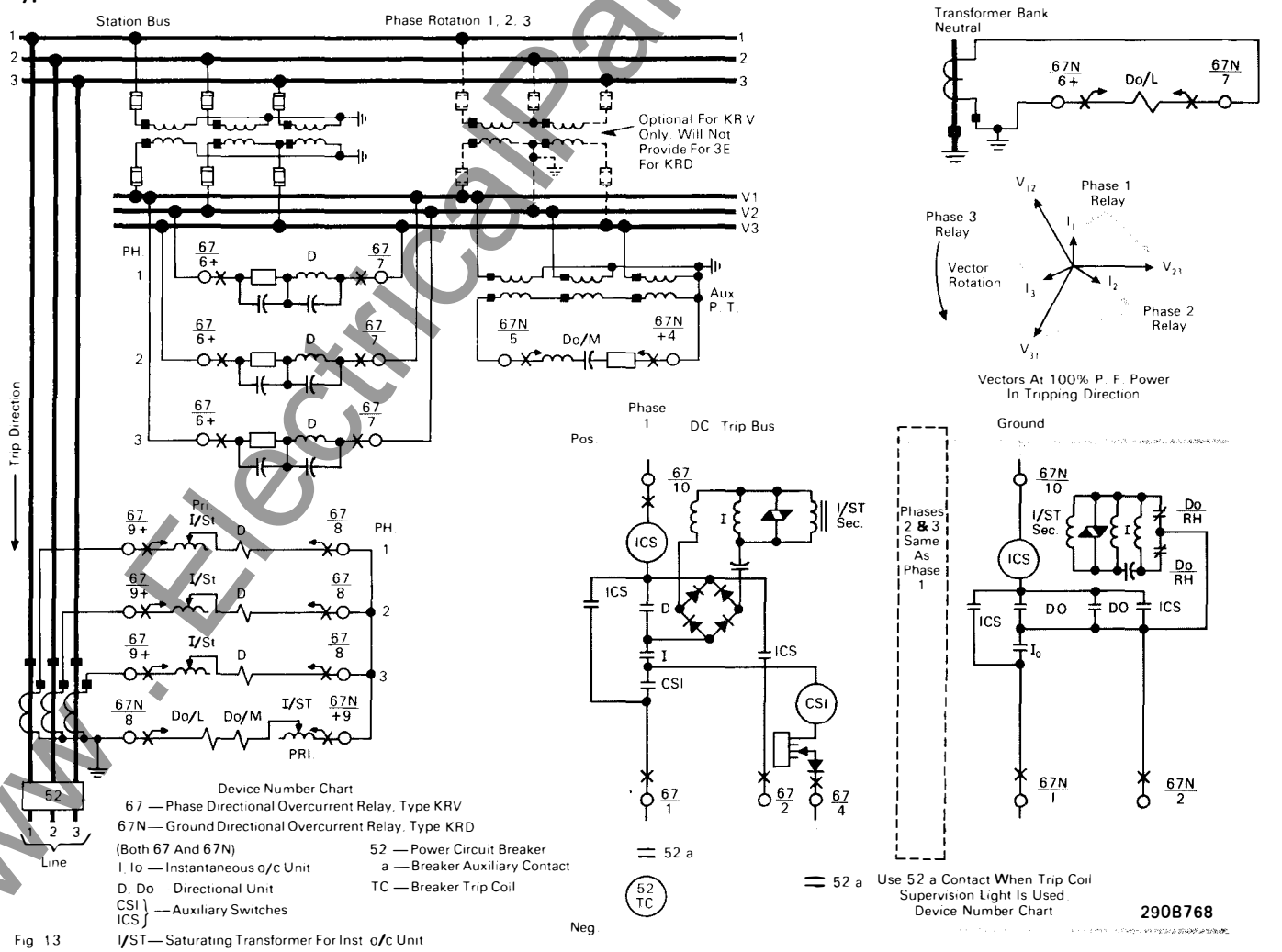


Fig. 13

Directional Overcurrent Relays

For Phase and Ground Fault Detection
on Transmission Lines and
Feeder Circuits
Types KRC, KRD, KRP, KRV

Typical Time Curves

Types KRC and KRD (Current Polarized)

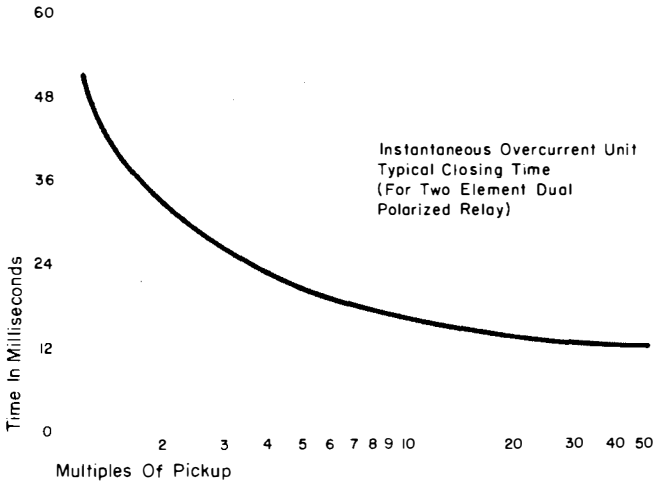


Fig. 14

Type KRV

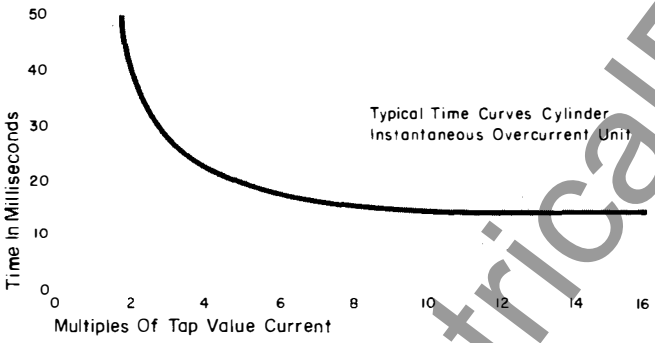


Fig. 16 184A946

Types KRD and KRP (Potential Polarized)

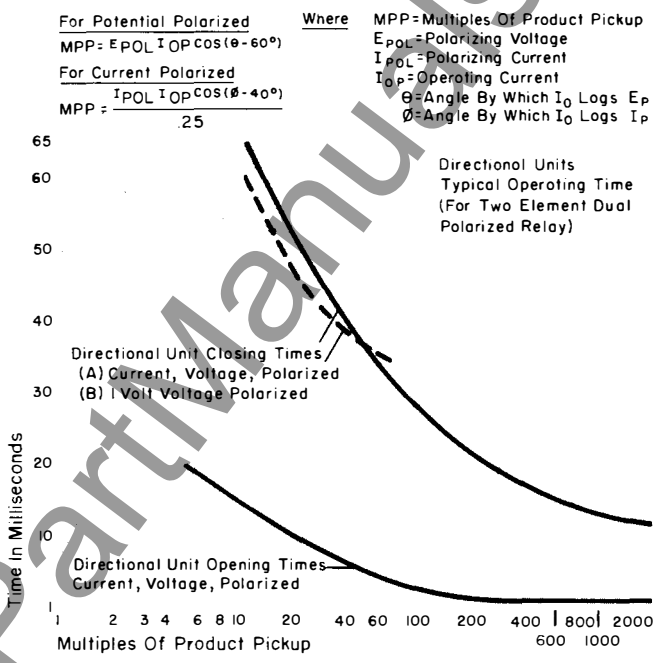


Fig. 15 538108

Shipping Weights and Carton Dimensions

Type	Case Type	Weight: Lbs. Net	Weight: Lbs. Shipping	Domestic Shipping Carton: Inches
KRC, KRP, KRV	FT-31	16	20	8 x 10 x 21
KRD		19	23	

Further Information:

Prices, ordering information: Price List 41-020
Dimensions: Descriptive Bulletin 41-075
Inquiries: Nearest Westinghouse Sales Office
Flexitest case: Descriptive Bulletin 41-075
Instructions:
KRC, KRD, KRP Instruction Leaflet 41-137
KRV Instruction Leaflet 41-137.1
Other protective relays: Index 41-000

Westinghouse Electric Corporation
Relay Instrument Division: Newark Plant, Newark, N. J. 07101
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