

INSTALLATION • OPERATION • MAINTENANCE I N S T R U C T I O N S

TYPE HRD CARRIER DUAL POLARIZED DIRECTIONAL OVERCURRENT GROUND RELAY

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

APPLICATION

This relay is used to provide directional ground fault protection in the carrier relaying scheme using plate keyed carrier sets. The HRD relay has provision for dual polarization of the directional element. With this feature, the relay can be polarized by residual current from a power transformer bank or by residual voltage. In addition, both polarizing quantities can be used simultaneously.

CONSTRUCTION AND OPERATION

This relay consists of two beam-type overcurrent unit, a directional unit and an indicating contactor switch. The trip circuit of the relay includes the directional contacts in series with the contacts of one overcurrent unit and the indicating contactor switch. The other overcurrent unit is used to start carrier signal transmission. Operation of this relay in connection with the carrier scheme is described in I. L. 41-904.

OVERCURRENT UNIT

The construction details of the two overcurrent units are shown in Figure 1. The unit consists of a pivoted beam with contact arm on one end and a restraining spring acting on the other. The beam is pulled down to make contact by a current coil, and resets through the action of the restraining spring.

The moving contact is a thin-walled silver shell practically filled with tungsten powder.

When this contact strikes the rigid stationary contact, the movement of the tungsten powder creates sufficient friction to absorb practically all of the energy of impact and thus the tendency of the contact to bounce is reduced to a minimum. The moving contact is loosely mounted on the beam and held in place by a leaf spring. The construction is such that the beam continues to move slightly after the contacts close deflecting the spring. This provides the required contact follow. Current is conducted into the moving contact by means of a flexible metal ribbon.

DIRECTIONAL UNIT

The directional unit is made up of five basic parts: the die-cast aluminum frame, the electromagnet, the molded cover assembly, the moving element assembly, and the bridge and upper bearing pin assembly. The lower bearing pin and the magnetic core with its adjustment lever are mounted on the frame. The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected current coils mounted diametrically opposite one another and two magnetic plugs accessible through the cover. The moving element consists of a spring and contact arm assembly and a double aluminum loop mounted on a shaft which has end jewels for the top and bottom bearings. This shaft rides between the bottom steel bearing pin mounted in the frame and a similar pin in the bridge that mounts on the two longer studs of the electromagnet. The stops for the moving element are mounted on the cover and are easily accessible for the adjustment of the contact travel. The spring adjuster seats on the molded cover and is attached to the contact through a spiral spring. The moving contact is made of two thin-walled silver shells practically filled with tungsten powder and mounted back to back on a thin leaf spring. The stationary silver contacts are mounted on the molded cover. The

SUPERSEDES I.L. 41-917.1

*Denotes change from superseded issue

EFFECTIVE DECEMBER 1960

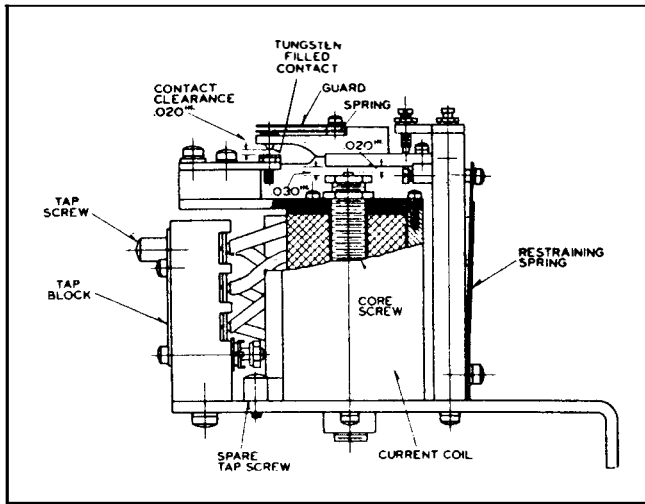


Fig. 1 Sectional View of the Overcurrent Units.

electrical connection is made from the stationary contact to the moving contact, through the spiral and spring adjuster to the spring adjuster clamp. The flux in each pole face is lagged on the outside edges by copper loops. This produces a torque that counter-balances the centering torque, caused by the small power factor angle of the moving element.

The torque of the unit is produced by the interaction of the current and flux which develops forces on the two aluminum loops. The resulting torque is substantially free of vibrations, because the double-frequency torques that are produced on the two loops are equal and opposite in sign.

*

The polarizing windings of the directional unit, a phase shifting circuit, a center tapped reactor and an equivalent impedance are connected so as to form the four legs of a bridge circuit. The equivalent impedance consists of a reactor and an adjustable resistor with a total impedance equal to the impedance of the polarizing windings of the directional element.

Energy from the current polarizing source is introduced into two opposite corners of the bridge circuit by means of an air gap transformer while energy from the voltage polarizing source is impressed directly upon the other two corners. The balanced bridge design is necessary so that the voltage and current transforming devices deliver secondary quantities which

do not affect each other and depend only on system conditions.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

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

CHARACTERISTICS AND SETTINGS

The overcurrent units of the relays operate in one cycle or less on values of ground fault current above 200% of the tap setting. The taps available are:

0.5, 0.75, 1.0, 2.0, 4.0, 6.0

The settings should be made by inserting the tap screw in the tap to give the required pickup.

The carrier - start overcurrent unit at each line terminal is set on a lower tap than the tripping element at either end of the line. This arrangement insures proper blocking for remote external faults which may not pick up both overcurrent elements at each line terminal.

Select a tap for the tripping overcurrent unit (left-hand, front view) which will allow tripping the minimum internal ground fault. Set the carrier-start unit (right-hand, front view) on the next lower tap.

The HRD relay is designed so that for current polarization only, maximum torque occurs when the operating current leads the polarizing current by approximately 10° . The minimum

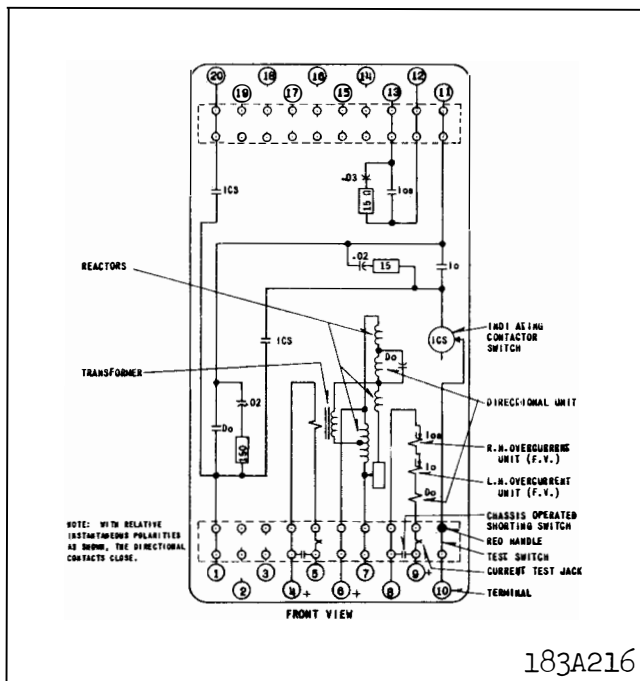


Fig. 2 Internal Schematic of the Type HRD Relay in the Type FT32 Case.

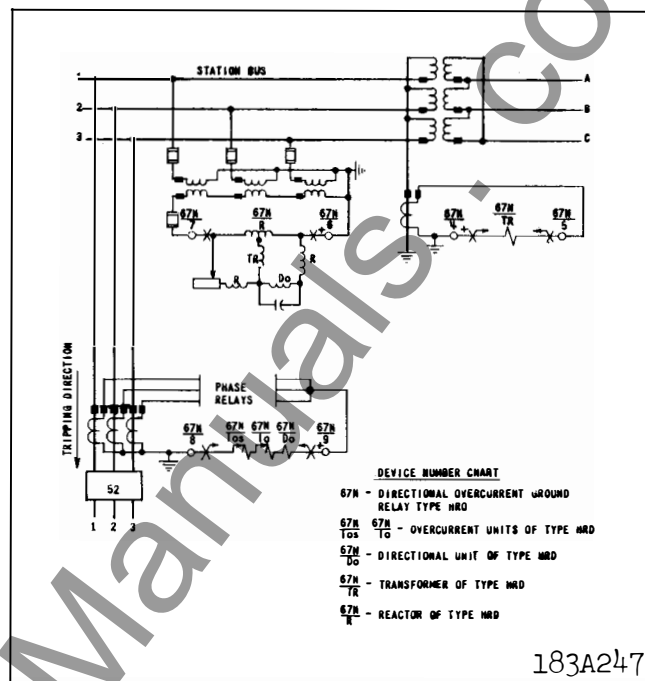


Fig. 3 External A-C Schematic of the Type HRD Relay.

pickup has been set by the spring tension to be approximately 1.3 amperes when the current circuits are connected in series. Greater sensitivity may be obtained by decreasing the spring tension; however, this will also decrease the restoring force when the unit is de-energized.

For potential polarization of the HRD relay, the maximum torque occurs when the operating current lags the polarizing voltage by approximately 60 degrees. With the spring tension at the factory setting, minimum pickup is approximately 2.5 volts and 4 amperes with the current lagging the voltage by 60°.

TRIP CIRCUIT

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

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection. No other settings are required.

* Set in the 2 ampere tap for all HRD Carrier Relaying Applications.

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

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

INSTALLATION

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

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

TYPE HRD RELAY

- * The external a-c connections of directional unit are shown in Fig. 3. If no voltage polarization source is to be connected to the directional unit, short-circuit the voltage polarizing circuit at the relay terminals. The carrier relaying d-c schematic (supplied with all carrier orders) should be consulted for the details of the external d-c connections of these relays.

ADJUSTMENTS

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

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

OVERCURRENT UNITS

Refer to Figure 1. Adjust the stop screw until the beam is in a horizontal position when resting against it. Adjust the magnetic gap to .020 inch. This is the gap between the beam and the stop pin. Adjust the stationary contact for an .020 inch gap when the beam is in the reset position. When the beam is in the operated position, there should be an .015 inch deflection of the moving contact. See that the spring which carries the moving element lies flat on the Micarta arm with no initial tension in either direction. Also, make sure that the flexible pigtail is at least 3/32 inch away from the end of the stationary contact.

Pass 0.5 ampere thru the unit with the tap screw in the 0.5 tap and adjust the beam spring tension until the beam just trips. This spring tension should hold the beam in the reset position, and when the beam is tripped on 0.5 ampere, the beam should deflect the moving contact spring and rest on the front stop pin. The tripping point of the other taps should be within $\pm 5\%$ of the tap values.

DIRECTIONAL UNIT

- * Apply 120 volts a-c to the voltage polarizing circuit, adjust the resistor so that a minimum voltage appears across the secondary of the current polarizing transformer (lower right hand position, front view).

The upper bearing screw should be screwed down until there is only three to four thousandths of an inch clearance between it and the shaft, and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the double loop fails to turn freely and then backing up 1/8 of a turn. Great care must be taken in making this adjustment to prevent damage to the bearings.

The travel of the moving contact is limited by the stationary contacts mounted on the molded cover. The contact gap should be adjusted as follows: With the moving contact centered between the studs, close the contact gaps by advancing the two front stationary contacts. Then back off the right-hand stationary contact .035 inch and lock both contacts in place. The front contact spring should be positioned in the center of the .020 inch slot of the aluminum guard by means of the small adjusting screw located on the nut plate that holds the spring on the moving element. The complete moving element is limited in travel by two stop screws located on the molded cover assembly.

- * The moving elements stops should be adjusted so that the moving contacts barely touch the front stationary contacts and just miss the others when energized in the opening and closing direction with 5.0 amperes in phase in the current circuits. The right-hand stationary contact should be turned 1/6 of a turn to obtain .005 inch contact follow. Energize the element in the opening direction by passing 60 amperes through the current circuits in series. The contact should not bounce closed when the element is suddenly deenergized. Slight readjustment of the left-hand stop may be necessary to insure that this does not happen.

There are two separate magnetic adjustments. A small lever arm extending to the front on the bottom of the element controls a magnetic bias in the center of the electromagnet. This should be adjusted so that the unit will operate with .1 to .6 volts applied to the voltage polariz-

ing circuit with 25 amperes at 60° lagging in the operating coils and the current polarizing circuit open. This adjustment can be made approximately merely by shorting the voltage circuit and with the 25 amperes, adjust the lever so that the contacts just remain open. The second magnetic adjustment is made by magnetic plugs accessible from the top. With the voltage between .1 and .6 volt and the current polarizing circuit opened, the plugs should be adjusted so that with approximately 60 amperes at 60° lag, applied momentarily in the operating coil, the contacts should just close. Raising the right hand plug will produce torque to the right when considering the front moving contact. This adjustment also can be made approximately merely by shorting the voltage circuit and with 60 amperes applied momentarily in the operating coil, adjust the plugs so that the contacts just remain open. Excess heating, the overcurrent tap settings, and the particular setting of the lever and plugs have a slight influence on the final setting of these magnetic adjustments.

INDICATING CONTACTOR SWITCH (ICS)

- * Adjust the contact gap for .047". The bridging moving contact should touch both stationary contacts simultaneously. Bend the third contact spring of the moving arm so that the third contact makes at approximately the same instant as the other two contacts.

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

The typical 60-cycle burdens of the various circuits of the relay are as follows:

Directional element and overcurrent unit in series:

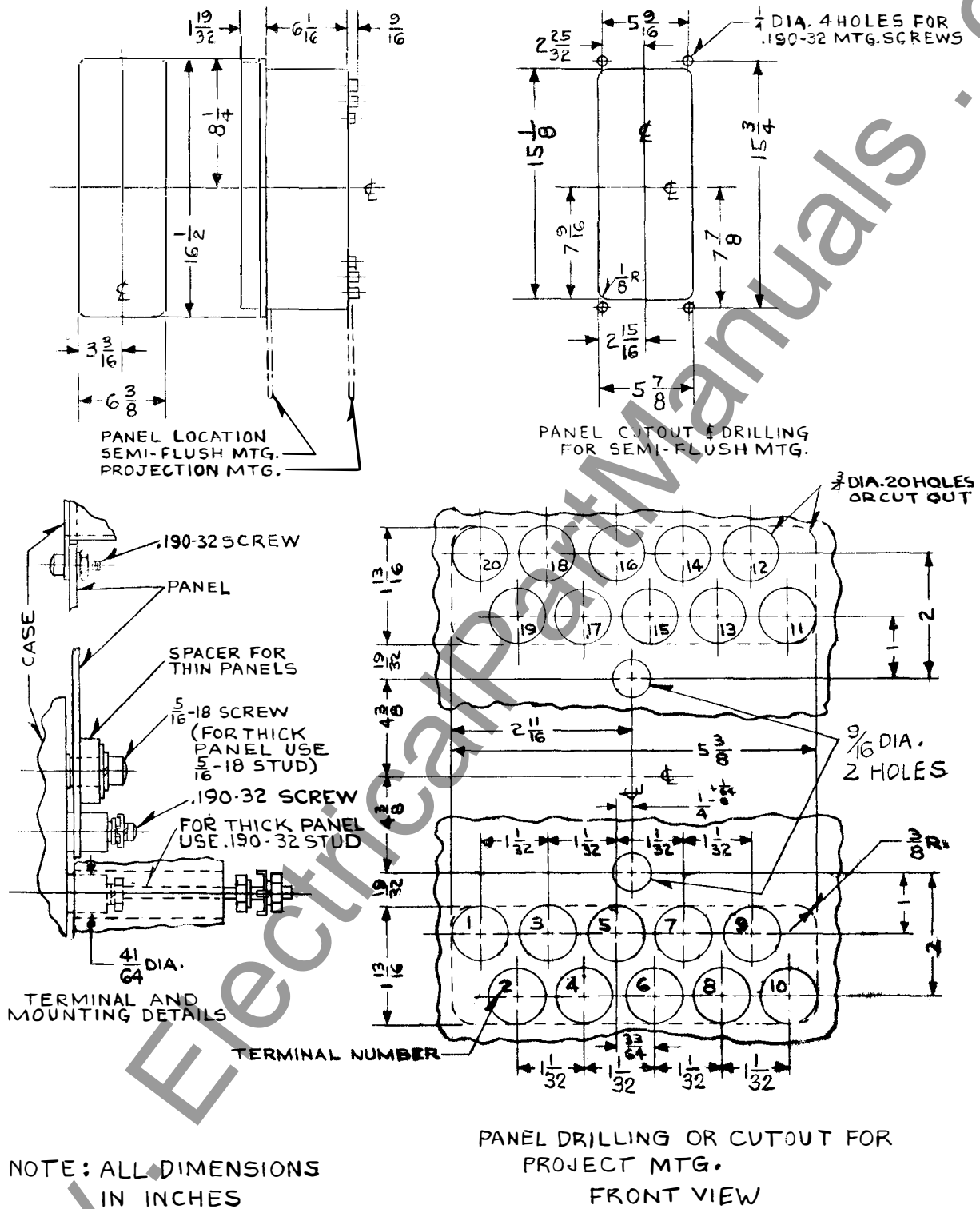
0.5 amp. tap at 0.5 amps.	.6 v.a.	41° lag
6.0 amp. tap at 6.0 amps.	6.7 v.a.	40° lag

Directional unit current polarizing circuit:

At 5.0 amperes	1.0 v.a.	35° lag
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Directional unit voltage polarizing circuit:

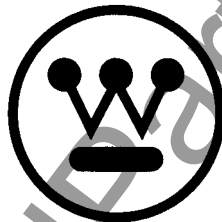
At 120 volts	7.2 v.a.	43° lag
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* Fig. 4 Outline and Drilling Plan for the Type HRD Relay in the Type FT32 Case.

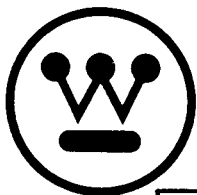
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RELAY DEPARTMENT

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TYPE HRD CARRIER DUAL POLARIZED DIRECTIONAL OVERCURRENT GROUND RELAY

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APPLICATION

This relay is used to provide directional ground fault protection in the carrier relaying scheme using plate keyed carrier sets. The HRD relay has provision for dual polarization of the directional element. With this feature, the relay can be polarized by residual current from a power transformer bank or by residual voltage. In addition, both polarizing quantities can be used simultaneously.

CONSTRUCTION AND OPERATION

This relay consists of two beam-type overcurrent unit, a directional unit and an indicating contactor switch. The trip circuit of the relay includes the directional contacts in series with the contacts of one overcurrent unit and the indicating contactor switch. The other overcurrent unit is used to start carrier signal transmission. Operation of this relay in connection with the carrier scheme is described in I. L. 41-904.

OVERCURRENT UNIT

The construction details of the two overcurrent units are shown in Figure 1. The unit consists of a pivoted beam with contact arm on one end and a restraining spring acting on the other. The beam is pulled down to make contact by a current coil, and resets through the action of the restraining spring.

The moving contact is a thin-walled silver shell practically filled with tungsten powder.

When this contact strikes the rigid stationary contact, the movement of the tungsten powder creates sufficient friction to absorb practically all of the energy of impact and thus the tendency of the contact to bounce is reduced to a minimum. The moving contact is loosely mounted on the beam and held in place by a leaf spring. The construction is such that the beam continues to move slightly after the contacts close deflecting the spring. This provides the required contact follow. Current is conducted into the moving contact by means of a flexible metal ribbon.

DIRECTIONAL UNIT

The directional unit is made up of five basic parts: the die-cast aluminum frame, the electromagnet, the molded cover assembly, the moving element assembly, and the bridge and upper bearing pin assembly. The lower bearing pin and the magnetic core with its adjustment lever are mounted on the frame. The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected current coils mounted diametrically opposite one another and two magnetic plugs accessible through the cover. The moving element consists of a spring and contact arm assembly and a double aluminum loop mounted on a shaft which has end jewels for the top and bottom bearings. This shaft rides between the bottom steel bearing pin mounted in the frame and a similar pin in the bridge that mounts on the two longer studs of the electromagnet. The stops for the moving element are mounted on the cover and are easily accessible for the adjustment of the contact travel. The spring adjuster seats on the molded cover and is attached to the contact through a spiral spring. The moving contact is made of two thin-walled silver shells practically filled with tungsten powder and mounted back to back on a thin leaf spring. The stationary silver contacts are mounted on the molded cover. The

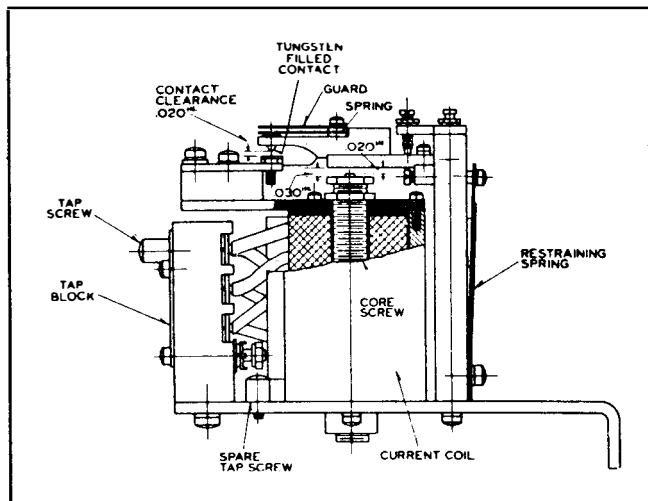


Fig. 1 Sectional View of the Overcurrent Units.

electrical connection is made from the stationary contact to the moving contact, through the spiral and spring adjuster to the spring adjuster clamp. The flux in each pole face is lagged on the outside edges by copper loops. This produces a torque that counter-balances the centering torque, caused by the small power factor angle of the moving element.

The torque of the unit is produced by the interaction of the current and flux which develops forces on the two aluminum loops. The resulting torque is substantially free of vibrations, because the double-frequency torques that are produced on the two loops are equal and opposite in sign.

*

The polarizing windings of the directional unit, a phase shifting circuit, a center tapped reactor and an equivalent impedance are connected so as to form the four legs of a bridge circuit. The equivalent impedance consists of a reactor and an adjustable resistor with a total impedance equal to the impedance of the polarizing windings of the directional element.

Energy from the current polarizing source is introduced into two opposite corners of the bridge circuit by means of an air gap transformer while energy from the voltage polarizing source is impressed directly upon the other two corners. The balanced bridge design is necessary so that the voltage and current transforming devices deliver secondary quantities which

do not affect each other and depend only on system conditions.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

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

CHARACTERISTICS AND SETTINGS

The overcurrent units of the relays operate in one cycle or less on values of ground fault current above 200% of the tap setting. The taps available are:

0.5, 0.75, 1.0, 2.0, 4.0, 6.0

The settings should be made by inserting the tap screw in the tap to give the required pickup.

The carrier - start overcurrent unit at each line terminal is set on a lower tap than the tripping element at either end of the line. This arrangement insures proper blocking for remote external faults which may not pick up both overcurrent elements at each line terminal.

Select a tap for the tripping overcurrent unit (left-hand, front view) which will allow tripping the minimum internal ground fault. Set the carrier-start unit (right-hand, front view) on the next lower tap.

The HRD relay is designed so that for current polarization only, maximum torque occurs when the operating current leads the polarizing current by approximately 10° . The minimum

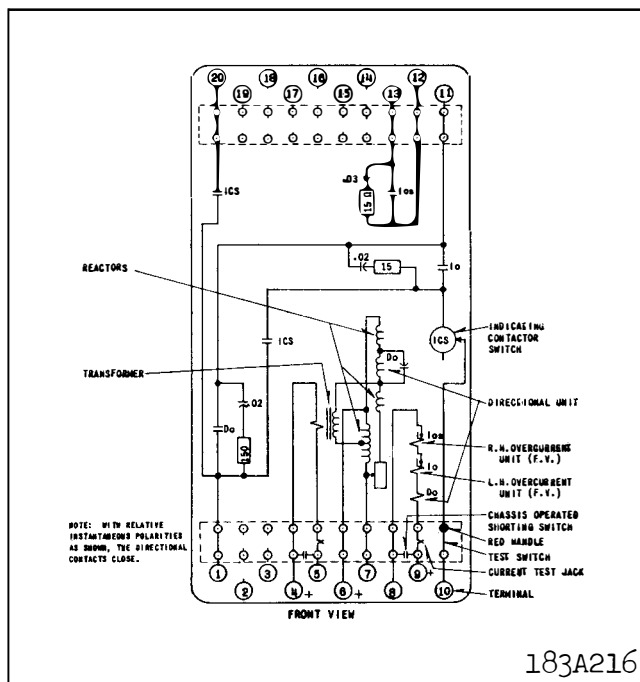


Fig. 2 Internal Schematic of the Type HRD Relay in the Type FT32 Case.

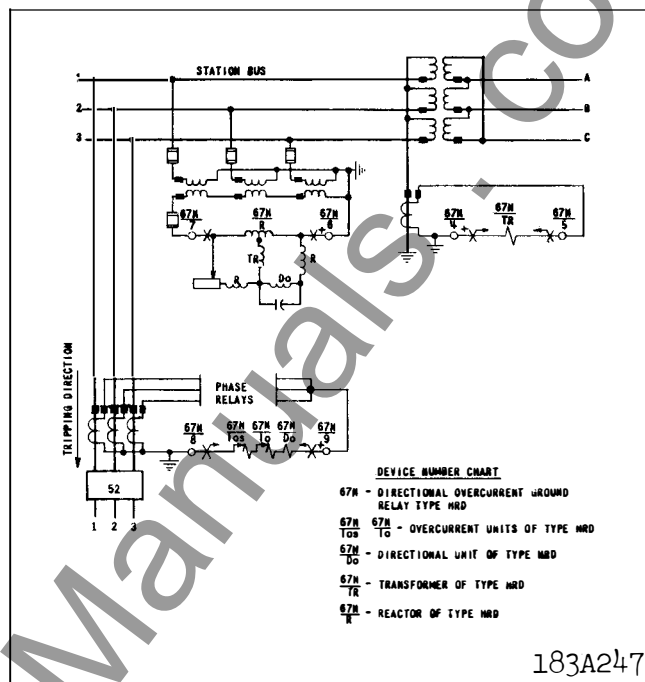


Fig. 3 External A-C Schematic of the Type HRD Relay.

pickup has been set by the spring tension to be approximately 1.3 amperes when the current circuits are connected in series. Greater sensitivity may be obtained by decreasing the spring tension; however, this will also decrease the restoring force when the unit is de-energized.

For potential polarization of the HRD relay, the maximum torque occurs when the operating current lags the polarizing voltage by approximately 60 degrees. With the spring tension at the factory setting, minimum pickup is approximately 2.5 volts and 4 amperes with the current lagging the voltage by 60°.

TRIP CIRCUIT

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

The indicating contactor switch has two taps that provide a pickup setting of 0.2 or 2 amperes. To change taps requires connecting the lead located in front of the tap block to the desired setting by means of a screw connection. No other settings are required.

* Set in the 2 ampere tap for all HRD Carrier Relaying Applications.

TRIP CIRCUIT CONSTANT

Indicating Contactor Switch (ICS)

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

INSTALLATION

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

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

TYPE HRD RELAY

- * The external a-c connections of directional unit are shown in Fig. 3. If no voltage polarization source is to be connected to the directional unit, short-circuit the voltage polarizing circuit at the relay terminals. The carrier relaying d-c schematic (supplied with all carrier orders) should be consulted for the details of the external d-c connections of these relays.

ADJUSTMENTS

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

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

OVERCURRENT UNITS

Refer to Figure 1. Adjust the stop screw until the beam is in a horizontal position when resting against it. Adjust the magnetic gap to .020 inch. This is the gap between the beam and the stop pin. Adjust the stationary contact for an .020 inch gap when the beam is in the reset position. When the beam is in the operated position, there should be an .015 inch deflection of the moving contact. See that the spring which carries the moving element lies flat on the Micarta arm with no initial tension in either direction. Also, make sure that the flexible pigtail is at least 3/32 inch away from the end of the stationary contact.

Pass 0.5 ampere thru the unit with the tap screw in the 0.5 tap and adjust the beam spring tension until the beam just trips. This spring tension should hold the beam in the reset position, and when the beam is tripped on 0.5 ampere, the beam should deflect the moving contact spring and rest on the front stop pin. The tripping point of the other taps should be within $\pm 5\%$ of the tap values.

DIRECTIONAL UNIT

- * Apply 120 volts a-c to the voltage polarizing circuit, adjust the resistor so that a minimum voltage appears across the secondary of the current polarizing transformer (lower right hand position, front view).

The upper bearing screw should be screwed down until there is only three to four thousandths of an inch clearance between it and the shaft, and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the double loop fails to turn freely and then backing up 1/8 of a turn. Great care must be taken in making this adjustment to prevent damage to the bearings.

The travel of the moving contact is limited by the stationary contacts mounted on the molded cover. The contact gap should be adjusted as follows: With the moving contact centered between the studs, close the contact gaps by advancing the two front stationary contacts. Then back off the right-hand stationary contact .035 inch and lock both contacts in place. The front contact spring should be positioned in the center of the .020 inch slot of the aluminum guard by means of the small adjusting screw located on the nut plate that holds the spring on the moving element. The complete moving element is limited in travel by two stop screws located on the molded cover assembly.

- * The moving elements stops should be adjusted so that the moving contacts barely touch the front stationary contacts and just miss the others when energized in the opening and closing direction with 5.0 amperes in phase in the current circuits. The right-hand stationary contact should be turned 1/6 of a turn to obtain .005 inch contact follow. Energize the element in the opening direction by passing 60 amperes through the current circuits in series. The contact should not bounce closed when the element is suddenly deenergized. Slight readjustment of the left-hand stop may be necessary to insure that this does not happen.

There are two separate magnetic adjustments. A small lever arm extending to the front on the bottom of the element controls a magnetic bias in the center of the electromagnet. This should be adjusted so that the unit will operate with .1 to .6 volts applied to the voltage polariz-

ing circuit with 25 amperes at 60° lagging in the operating coils and the current polarizing circuit open. This adjustment can be made approximately merely by shorting the voltage circuit and with the 25 amperes, adjust the lever so that the contacts just remain open. The second magnetic adjustment is made by magnetic plugs accessible from the top. With the voltage between .1 and .6 volt and the current polarizing circuit opened, the plugs should be adjusted so that with approximately 60 amperes at 60° lag, applied momentarily in the operating coil, the contacts should just close. Raising the right hand plug will produce torque to the right when considering the front moving contact. This adjustment also can be made approximately merely by shorting the voltage circuit and with 60 amperes applied momentarily in the operating coil, adjust the plugs so that the contacts just remain open. Excess heating, the overcurrent tap settings, and the particular setting of the lever and plugs have a slight influence on the final setting of these magnetic adjustments.

INDICATING CONTACTOR SWITCH (ICS)

- * Adjust the contact gap for .047". The bridging moving contact should touch both stationary contacts simultaneously. Bend the third contact spring of the moving arm so that the third contact makes at approximately the same instant as the other two contacts.

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

RENEWAL PARTS

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

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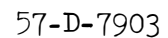
0.5 amp. tap at 0.5 amps.	.6 v.a.	41° lag
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Directional unit current polarizing circuit:

At 5.0 amperes	1.0 v.a.	35° lag
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Directional unit voltage polarizing circuit:

At 120 volts	7.2 v.a.	43° lag
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* Fig. 4 Outline and Drilling Plan for the Type HRD Relay in the Type FT32 Case.

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RELAY DEPARTMENT

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TYPES HRD CARRIER DUAL POLARIZED DIRECTIONAL OVERCURRENT GROUND RELAY

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OVERCURRENT UNIT

The construction details of the two overcurrent units are shown in Figure 1. The unit consists of a pivoted beam with contact arm on one end and a restraining spring acting on the other. The beam is pulled down to make contact by a current coil, and resets through the action of the restraining spring.

The moving contact is a thin-walled silver shell practically filled with tungsten powder.

When this contact strikes the rigid stationary contact, the movement of the tungsten powder creates sufficient friction to absorb practically all of the energy of impact and thus the tendency of the contact to bounce is reduced to a minimum. The moving contact is loosely mounted on the beam and held in place by a leaf spring. The construction is such that the beam continues to move slightly after the contacts close deflecting the spring. This provides the required contact follow. Current is conducted into the moving contact by means of a flexible metal ribbon.

DIRECTIONAL UNIT

The directional unit is made up of five basic parts: the die-cast aluminum frame, the electromagnet, the molded cover assembly, the moving element assembly, and the bridge and upper bearing pin assembly. The lower bearing pin and the magnetic core with its adjustment lever are mounted on the frame. The electromagnet has two series-connected polarizing coils mounted diametrically opposite one another, two series-connected current coils mounted diametrically opposite one another and two magnetic plugs accessible through the cover. The moving element consists of a spring and contact arm assembly and a double aluminum loop mounted on a shaft which has end jewels for the top and bottom bearings. This shaft rides between the bottom steel bearing pin mounted in the frame and a similar pin in the bridge that mounts on the two longer studs of the electromagnet. The stops for the moving element are mounted on the cover and are easily accessible for the adjustment of the contact travel. The spring adjuster seats on the molded cover and is attached to the contact through a spiral spring. The moving contact is made of two thin-walled silver shells practically filled with tungsten powder and mounted back to back on a thin leaf spring. The stationary silver contacts are mounted on the molded cover. The

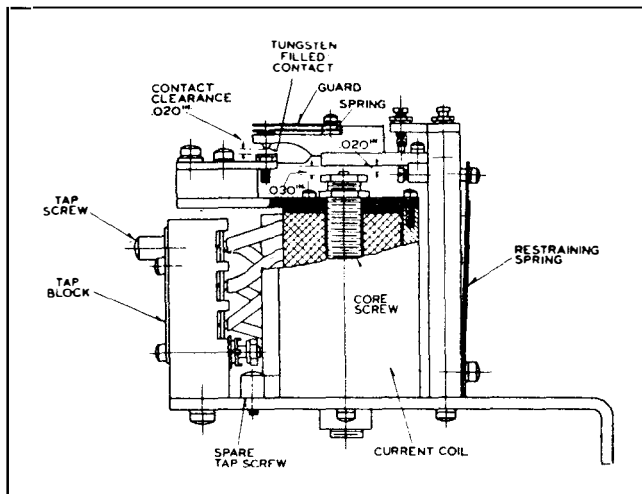


Fig. 1 Sectional View of the Overcurrent Units.

electrical connection is made from the stationary contact to the moving contact, through the spiral and spring adjuster to the spring adjuster clamp. The flux in each pole face is lagged on the outside edges by copper loops. This produces a torque that counter-balances the centering torque, caused by the small power factor angle of the moving element.

The torque of the unit is produced by the interaction of the current and flux which develops forces on the two aluminum loops. The resulting torque is substantially free of vibrations, because the double-frequency torques that are produced on the two loops are equal and opposite in sign. The flux in each pole face is lagged on the outside edges. This produces a torque that counter-balances the centering torque, caused by the small power factor angle of the moving element.

The polarizing windings of the directional unit, a phase shifting circuit, a center tapped reactor and an equivalent impedance are connected so as to form the four legs of a bridge circuit. The equivalent impedance consists of a reactor and an adjustable resistor with a total impedance equal to the impedance of the polarizing windings of the directional element.

Energy from the current polarizing source is introduced into two opposite corners of the bridge circuit by means of an air gap transformer while energy from the voltage polarizing source is impressed directly upon the other two

corners. The balanced bridge design is necessary so that the voltage and current transforming devices deliver secondary quantities which do not affect each other and depend only on system conditions.

INDICATING CONTACTOR SWITCH UNIT (ICS)

The d-c indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

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

CHARACTERISTICS AND SETTINGS

The overcurrent units of the relays operate in one cycle or less on values of ground fault current above 200% of the tap setting. The taps available are:

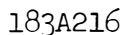
0.5, 0.75, 1.0, 2.0, 4.0, 6.0

The settings should be made by inserting the tap screw in the tap to give the required pickup.

The carrier - start overcurrent unit at each line terminal is set on a lower tap than the tripping element at either end of the line. This arrangement insures proper blocking for remote external faults which may not pick up both overcurrent elements at each line terminal.

Select a tap for the tripping overcurrent unit (left-hand, front view) which will allow tripping the minimum internal ground fault. Set the carrier-start unit (right-hand, front view) on the next lower tap.

The HRD relay is designed so that for current polarization only, maximum torque occurs when the operating current leads the polarizing current by approximately 10° . The minimum



STATION BUS

A
B
C

TRIPPING DIRECTION

S2

1 2 3

PHASE RELAYS

DEVICE NUMBER CHART

67N - DIRECTIONAL OVERCURRENT GROUND RELAY TYPE HRD	67N _{TDS} - OVERCURRENT UNITS OF TYPE HRO
67N _{DO} - DIRECTIONAL UNIT OF TYPE HRO	67N _{TR} - TRANSFORMER OF TYPE HRD
67N _R - REACTOR OF TYPE HRD	

183A247

Fig. 3 External A-C Schematic of the Type HRD Relay.

0.2 tap if energizing a WL relay switch or equivalent.

Indicating Contactor Switch (ICS)

INSTALLATION

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

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

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. No other settings are required. Set in the

TYPE HRD RELAY

The AC external schematic of the type HRD relay is shown in Figure 3. The carrier relaying d-c schematic (supplied with all carrier orders) should be consulted for the details of the external d-c connections of these relays.

ADJUSTMENTS

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

All contacts should be cleaned periodically. A contact burnisher S#182A836H01 is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

OVERCURRENT UNITS

Refer to Figure 1. Adjust the stop screw until the beam is in a horizontal position when resting against it. Adjust the magnetic gap to .020 inch. This is the gap between the beam and the stop pin. Adjust the stationary contact for an .020 inch gap when the beam is in the reset position. When the beam is in the operated position, there should be an .015 inch deflection of the moving contact. See that the spring which carries the moving element lies flat on the Micarta arm with no initial tension in either direction. Also, make sure that the flexible pigtail is at least 3/32 inch away from the end of the stationary contact.

Pass 0.5 ampere thru the unit with the tap screw in the 0.5 tap and adjust the beam spring tension until the beam just trips. This spring tension should hold the beam in the reset position, and when the beam is tripped on 0.5 ampere, the beam should deflect the moving contact spring and rest on the front stop pin. The tripping point of the other taps should be within $\pm 5\%$ of the tap values.

DIRECTIONAL UNIT

The upper bearing screw should be screwed down until there is only three to four thousandths of an inch clearance between it and the

shaft, and then securely locked in position with the lock nut. This adjustment can be made best by carefully screwing down the top bearing screw until the double loop fails to turn freely and then backing up 1/8 of a turn. Great care must be taken in making this adjustment to prevent damage to the bearings.

The travel of the moving contact is limited by the stationary contacts mounted on the molded cover. The contact gap should be adjusted as follows: With the moving contact centered between the studs, close the contact gaps by advancing the two front stationary contacts. Then back off the right-hand stationary contact .035 inch and lock both contacts in place. The front contact spring should be positioned in the center of the .020 inch slot of the aluminum guard by means of the small adjusting screw located on the nut plate that holds the spring on the moving element. The complete moving element is limited in travel by two stop screws located on the molded cover assembly.

The moving element stops should be adjusted so that the moving contacts barely touch the right front stationary contacts and just miss the others when energized in the opening and closing direction with 5.0 amperes in phase in the current circuits. The right-hand stationary contact should be turned 1/6 of a turn to obtain .005 inch contact follow. Energize the element in the opening direction by passing 60 amperes through the current circuits in series. The contact should not bounce closed when the element is suddenly deenergized. Slight readjustment of the left-hand stop may be necessary to insure that this does not happen.

There are two separate magnetic adjustments. A small lever arm extending to the front on the bottom of the element controls a magnetic bias in the center of the electromagnet. This should be adjusted so that the unit will operate with .1 to .6 volts applied to the voltage polarizing circuit with 25 amperes at 60° lagging in the operating coils and the current polarizing circuit open. This adjustment can be made approximately merely by shorting the voltage circuit and with the 25 amperes, adjust the lever so that the contacts just remain open. The second magnetic adjustment is made by magnetic plugs accessible from the top. With the voltage between .1 and .6 volt and the current

polarizing circuit opened, the plugs should be adjusted so that with approximately 60 amperes at 60° lag, applied momentarily in the operating coil, the contacts should just close. Raising the right hand plug will produce torque to the right when considering the front moving contact. This adjustment also can be made approximately merely by shorting the voltage circuit and with 60 amperes applied momentarily in the operating coil, adjust the plugs so that the contacts just remain open. Excess heating, the overcurrent tap settings, and the particular setting of the lever and plugs have a slight influence on the final setting of these magnetic adjustments.

INDICATING CONTACTOR SWITCH (ICS)

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

RENEWAL PARTS

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

ENERGY REQUIREMENTS

The typical 60-cycle burdens of the various circuits of the relay are as follows:

Directional element and overcurrent unit in series:

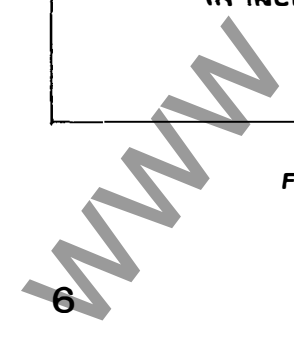
0.5 amp. tap at 0.5 amps.	.6 v.a.	41° lag
6.0 amp. tap at 6.0 amps.	6.7 v.a.	40° lag

Directional unit current polarizing circuit:

At 5.0 amperes	1.0 v.a.	35° lag
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Directional unit voltage polarizing circuit:

At 120 volts	7.2 v.a.	43° lag
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