



# INSTALLATION • OPERATION • MAINTENANCE INSTRUCTIONS

## TYPES HRK AND HRP CARRIER DIRECTIONAL OVERCURRENT GROUND RELAYS

**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

These relays are used to provide directional ground fault protection in the carrier relaying scheme using plate keyed carrier sets. The type HRK relay is used where neutral current from the power transformer banks is available for polarizing the directional element. The type HRP relay is used where this neutral current is not available, and residual voltage must be used for polarizing the element.

### CONSTRUCTION AND OPERATION

These relays consist of two beam-type overcurrent elements, a directional element, seal-in contactor switch, auxiliary contactor switch, and operation indicator. The trip circuit of the relay includes the directional contacts in series with the contacts of one overcurrent element, the operation indicator, and the contactor switch. The other overcurrent element is used to start carrier signal transmission. Operation of this relay in connection with the carrier scheme is fully described in I.L. 41-600.6.

#### Overcurrent Element

The construction details of the two overcurrent elements are shown in Figure 1. The element consists of a pivoted beam with con-

tact 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 hollow, silver, egg-shaped capsule 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 Element

The directional element is of the induction loop type. A small transformer causes a large current to flow in a single-turn movable aluminum secondary, which current is substantially in phase with the primary polarizing voltage or current. The current coils are mounted on a magnetic frame and the current and polarizing elements are assembled at right angles to each other with the one-turn loop in the air gaps of the current coil flux path. The interaction of the current and polarizing fluxes produces torque and rotates the loop in one of two directions, depending on the direction of power flow.

A Micarta arm extends from the moving loop which projects a short leaf spring. A small, thin-walled, cylindrical contact, filled with powdered tungsten, is rigidly attached to the

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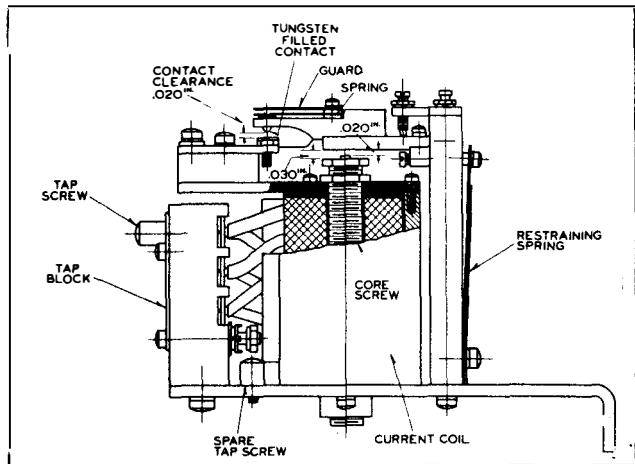


Fig. 1—Sectional View of the Overcurrent Elements.

outer end of the spring. When this contact strikes the rigid stationary contact, the movement of the tungsten powder creates sufficient friction to absorb practically all the energy of impact and thus the tendency of the contact to bounce is reduced to a minimum. Current is conducted into the moving contact by means of a flexible metal ribbon known as a pigtail.

The stationary contact screw fastens into a rigid projecting arm. Contact follow is secured by permitting the loop to travel for a short distance after the contacts close, thus deflecting the leaf spring. This is done by an adjustable stop screw. Another stop screw limits the travel of the loop in the opening direction. These stop screws act directly on the loop. This directional element has nearly true wattmeter characteristics.

### Seal-In Contactor Switch

The seal-in d-c contactor switch (CS) in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts re-

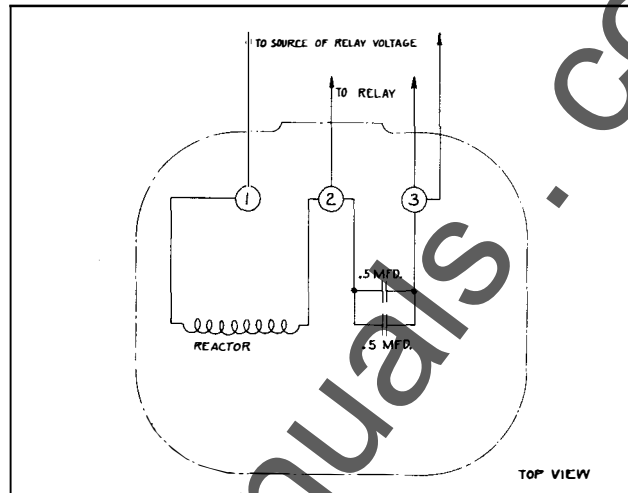


Fig. 2—Internal Schematic of the External Phase Shifter for the Type HRP Relay.

main closed until the trip circuit is opened by the auxiliary switch on the breaker. The contactor switch is equipped with a third point which is connected to a terminal on the relay to operate a bell alarm.

The seal-in contactor switch operates on a minimum of 2.0 amperes, but the trip circuit should draw at least 4 or 5 amperes in order to keep the time of operation of the switch to a minimum and provide positive operation.

### Auxiliary Contactor Switch

The auxiliary contactor switch (CS0) is of the same construction as the seal-in switch. The purpose of the CS0 switch is to short out the phase carrier stop circuit in installations using ground preference. The coil is in series with the carrier start overcurrent element contacts. The contacts of the CS0 switch are externally connected across the phase carrier stop circuit.

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The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to show the completion of the trip circuit. The high-speed action of the indicator is obtained by fastening a weight through a leaf spring to the armature. The added inertia causes the armature to continue

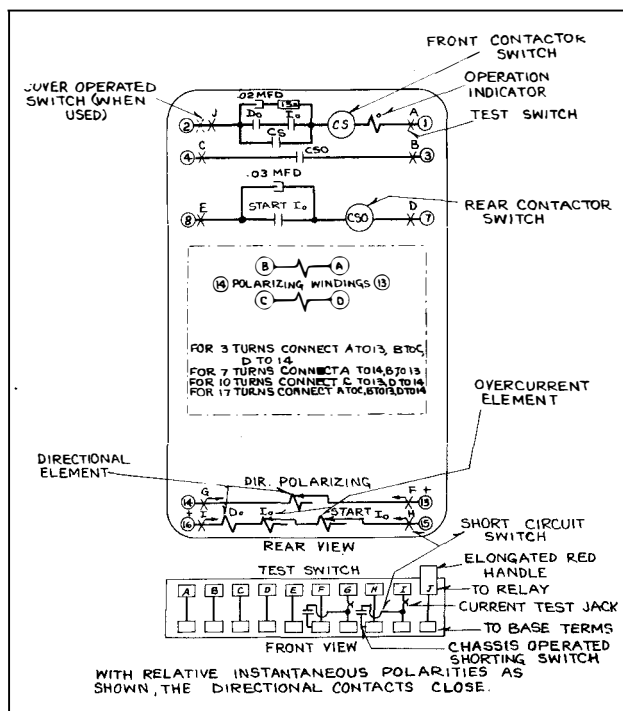


Fig. 3—Internal Schematic of the Type HRK Relays in the Type FT Case. The Relays in the Standard Case Have the Same Terminals But With the Test Switches Omitted.

its motion after the coil has been short-circuited.

## CHARACTERISTICS AND SETTINGS

The overcurrent element of the relays operates 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 pick-up.

It is desirable to set the carrier start overcurrent element on a lower tap than the tripping overcurrent element in most carrier installations. This insures positive starting of the carrier transmitter for all faults in the immediate vicinity. If the fault is external, the tripping overcurrent and directional elements in conjunction with the carrier relays will block tripping.

The polarizing coil of the type HRK relay is wound in two sections brought out to taps

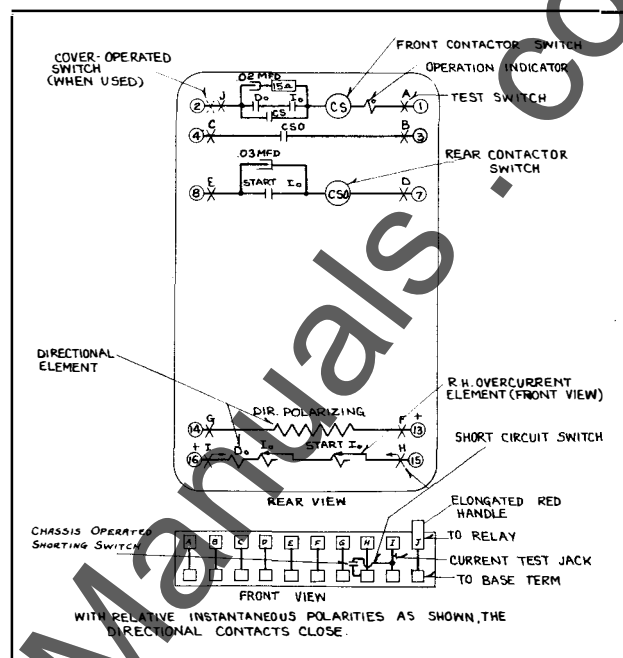


Fig. 4—Internal Schematic of the Type HRP Relays in the Type FT Case. The Relays in the Standard Case Have the Same Terminals But With the Test Switches Omitted.

marked A, B, C, and D. By various arrangement of the links between these taps and taps 13 and 14 which connect to the base terminals, the relay can be used at its best operating point when wide variations in polarizing currents are encountered. The characteristics of the 60 cycle polarizing coils are shown in Table 1.

TABLE I

Polarizing Turns	1 Minimum Pick-up Amps.	2 Maximum Polarizing Amps.	Connections of links
3	3.0	75.0	A to 13, B to C, D to 14
7	2.0	32.0	A to 14, B to 13.
10	1.5	25.0	C to 13, D to 14.
17	1.2	15.0	A to C, B to 13, D to 14.

<sup>1</sup>The approximate minimum pick-up current of the directional element with the polarizing and current winding in series.

## TYPES HRK AND HRP RELAYS

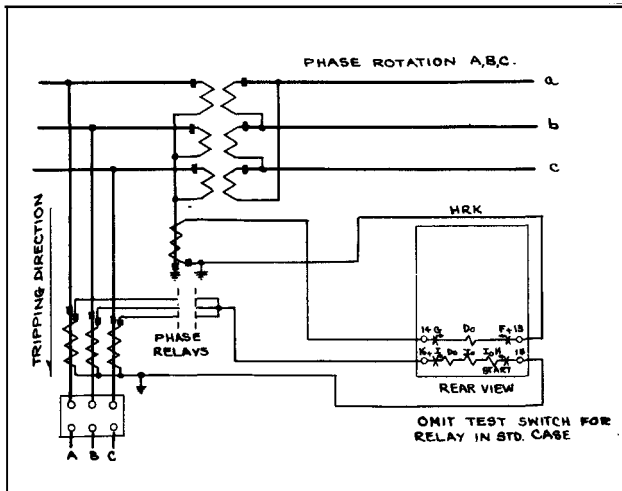


Fig. 5—External A-C Connections of the Type HRK Relay.

<sup>2</sup> The approximate maximum current that should be passed thru the polarizing winding for satisfactory operation.

Select the lowest number of turns which will permit the type HRK directional element to close under the minimum fault condition. This should insure satisfactory operation over the widest range of fault currents.

### RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

#### Removing Chassis

To remove the chassis, first remove the

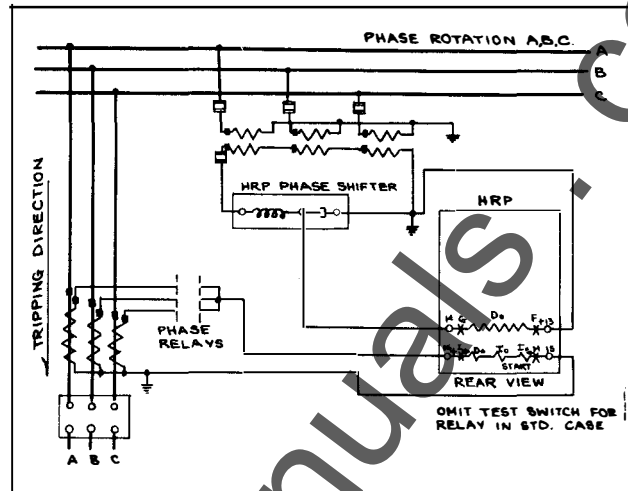


Fig. 6—External A-C Connections of the Type HRP Relay.

cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the

case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

#### Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately  $1/32$ " thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

#### Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

#### Testing in Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

#### Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

#### Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage. It is recommended that the relay be checked in

## TYPES HRK AND HRP RELAYS

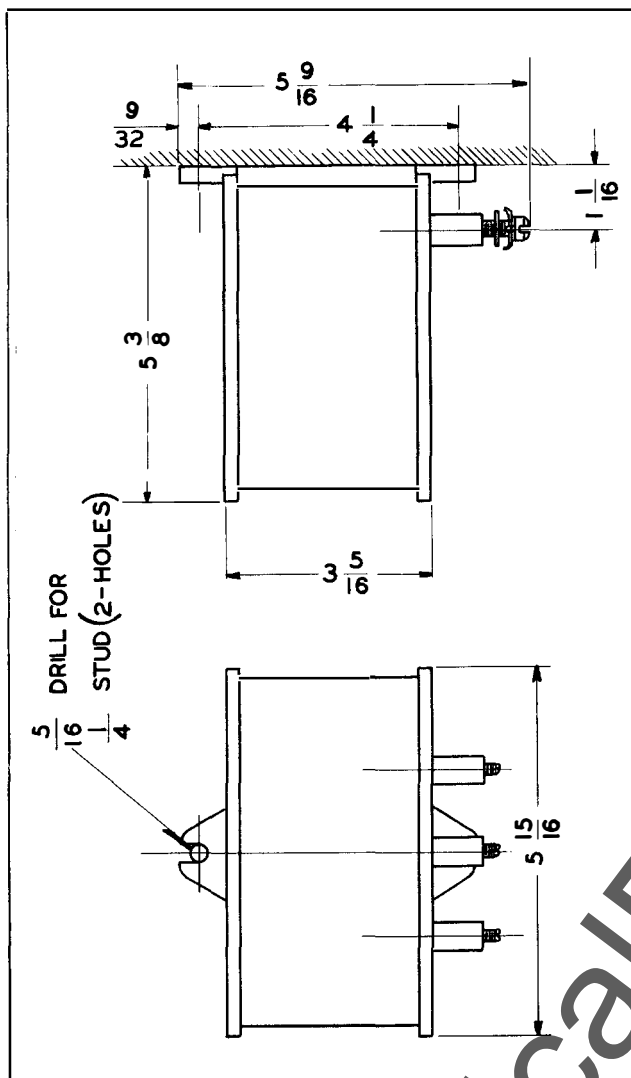


Fig. 7—Outline and Drilling Plan of the External Phase Shifter for the Type HRP Relay. For Reference Only.

position as a final check on calibration.

### 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 two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with

the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external a-c connections of both the type HRK and HRP relays are shown in Figures 5 and 6. 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 periodically cleaned with a fine file. S#1002110 file 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 Elements

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 element 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 Element

Check the free movement of the directional element loop. The loop should assume approximately a vertical position with contacts open when the element is completely de-energized.

The movement of the loop is limited in the contact opening direction by a stop screw which strikes the lower part of the loop. This screw is located on the left-hand side of the element to the rear of the current coil. This back stop screw should be screwed forward until it just touches the loop when it is in its natural de-energized position. The contacts should have a separation of .020 inch. The front stop screw should be adjusted so that it touches the loop at the same time the contacts close. Then back off this screw 1/2 of a turn to give the contacts the correct amount of follow.

Energize the loop with normal potential or current long enough to bring it up to temperature (about 10 or 15 minutes) and adjust the bearing screws so there is about .010 inch end play. See that the loop does not bind or strike against the iron or coil when pressed against either end jewel.

Type HRK relays only - With the directional element tap block set for 10 turns connect the directional element coil circuits in series, and pass 1.5 amperes with polarities as shown on the internal schematics. The directional contact should close. Reverse the connections to one coil and pass 20 amperes thru the circuit. The contacts should not bounce closed when the current is suddenly interrupted.

Type HRP relays only - Apply 2.5 volts to

the polarizing voltage winding and pass 4 amperes thru the current coil with the polarities as shown on the internal schematics. The directional contact should close. Repeat this test with 115 volts and 20 amperes. Reverse the leads to the potential coil and see that the contacts do not bounce closed with the relay energized at 115 volts and 20 amperes after the voltage is suddenly reduced to zero.

These tests are made without the external phase shifter, and under this condition the maximum torque occurs when the current lags the voltage approximately  $11^\circ$ . The external phase shifter of Figure 2 shifts this angle to approximately  $60^\circ$  lag instead of  $11^\circ$ .

## Seal-In Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/64 inch when the switch is picked up. This can be done by turning the relay up-side-down, or by disconnecting the switch and turning it up-side-down. Then screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the point where the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 1 ampere d-c. Test for sticking after 30 amperes d-c have been passed through the coil. The coil resistance is approximately 0.84 ohm.

## Auxiliary Contactor Switch

The adjustments are the same as for the seal-in contactor switch except that the contact separation should be 1/32 inch. The switch should pick up at 0.12 ampere d-c. Test for sticking at 1.0 ampere d-c. The coil resistance is approximately 27 ohms.

# TYPES HRK AND HRP RELAYS

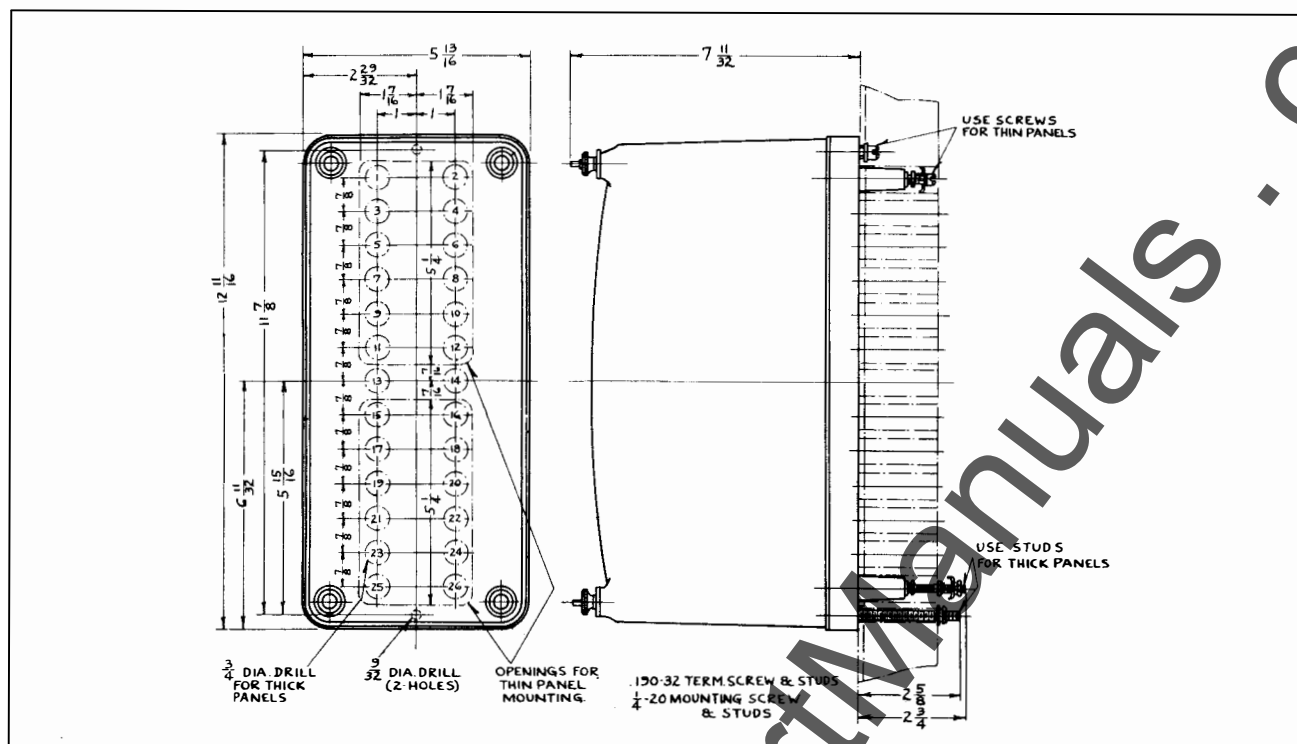


Fig. 8—Outline and Drilling Plan for the Standard Projection Type Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

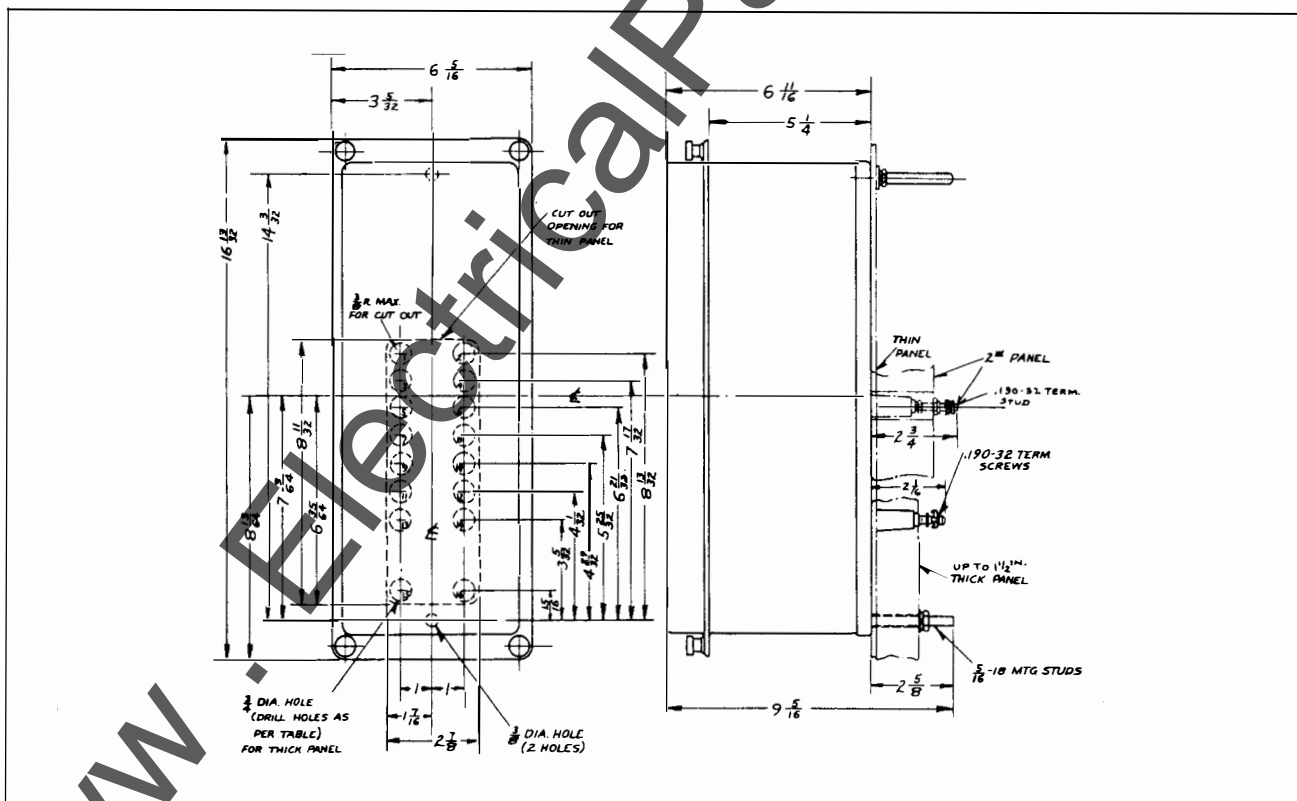


Fig. 9—Outline and Drilling Plan for the M10 Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.



### Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c gradually applied. Test for sticking after 30 amperes d-c is passed thru the coil. The coil resistance is approximately 0.16 ohm. Adjustments may be made by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Also, the amount of overhang of the armature on the latch may be adjusted by means of the small screw bearing on the flat spring carrying the inertia weight. The best adjustment will usually be found when this screw just touches the flat spring with the armature in the reset position. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching just beyond the elastic limit.

### 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 name-plate data.

### ENERGY REQUIREMENTS

The burdens of the various circuits of these relays are as follows:

#### HRK and HRP Relays

Each overcurrent element;

0.5 a. tap - 0.30 v.a. at 0.5 amp. - 39.9° lag  
6.0 a. tap - 0.93 v.a. at 6.0 amp. - 9.9° lag

Directional element and one overcurrent element in series.

0.5 a. tap - 0.32 v.a. at 0.5 amp. - 40.3° lag  
6.0 a. tap - 2.34 v.a. at 6.0 amp. - 51.5° lag

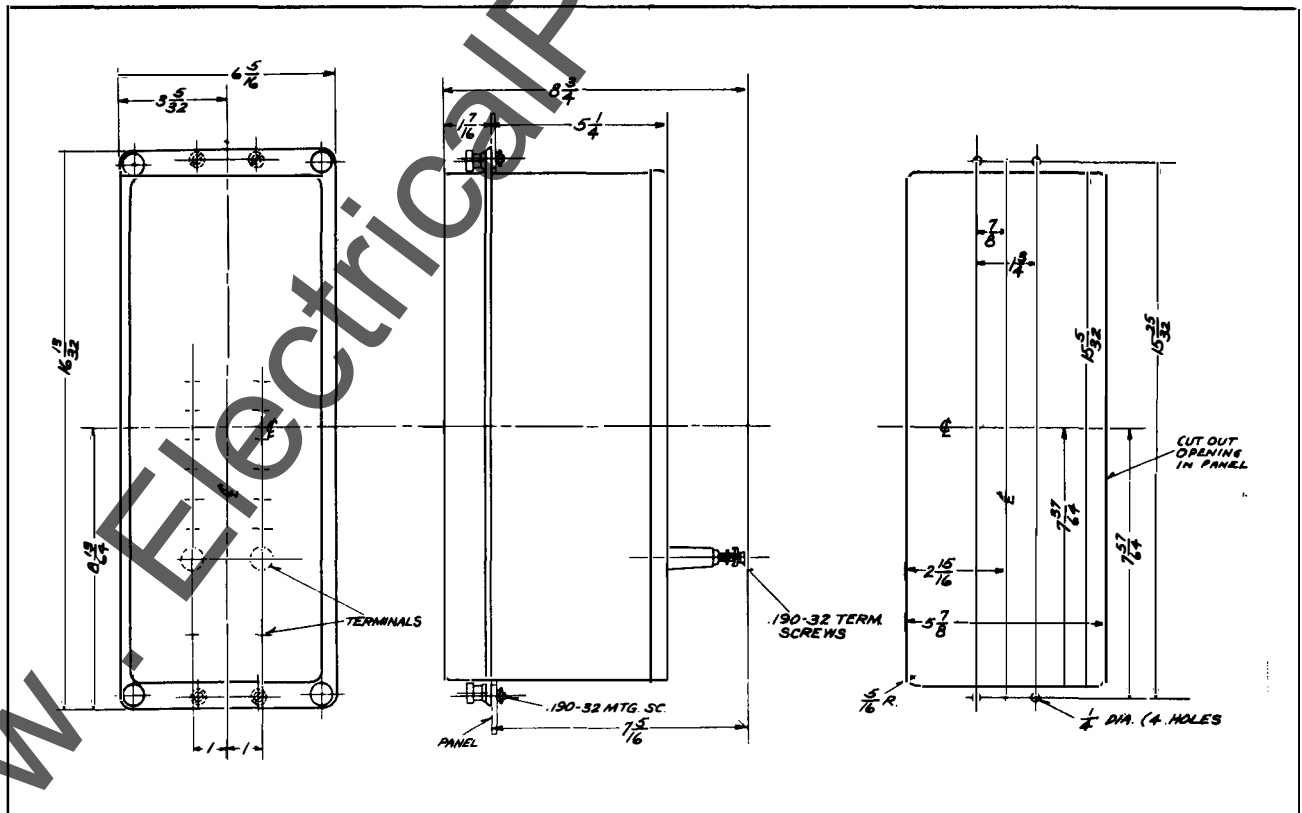


Fig. 10—Outline and Drilling Plan for the M10 Semi-Flush Type FT Case. For Reference Only.

## TYPES HRK AND HRP RELAYS

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### HRK Relay Only

Directional element polarizing winding.

#### Burdens at 5 amperes

3 turns	1.22 v.a.	2° lag
7 turns	0.78 v.a.	10.3° lag
10 turns	1.18 v.a.	10.2° lag
17 turns	2.75 v.a.	16° lag

### HRP Relay Only

Directional element polarizing winding (including external phase shifter).

6.84 v.a. - 17.5° lag at 115 volts, 60 cycles

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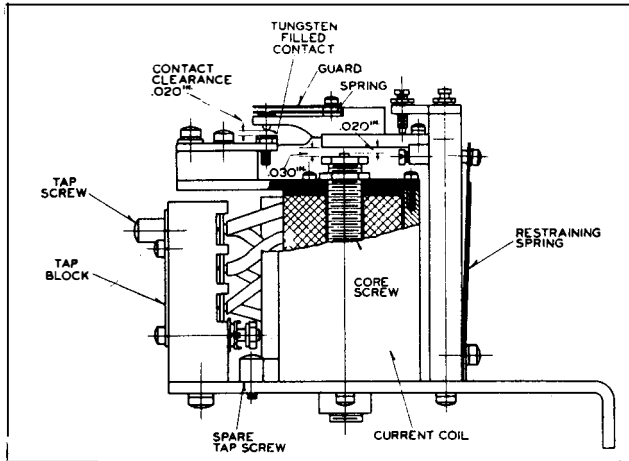


Fig. 1—Sectional View of the Overcurrent Elements.

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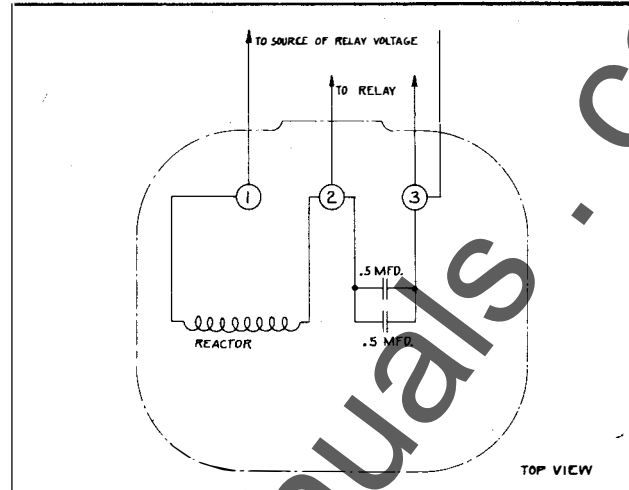


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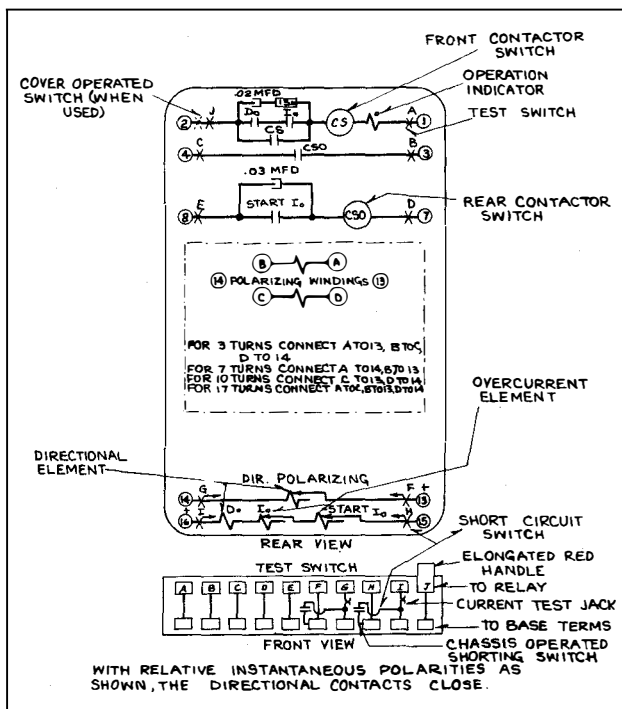


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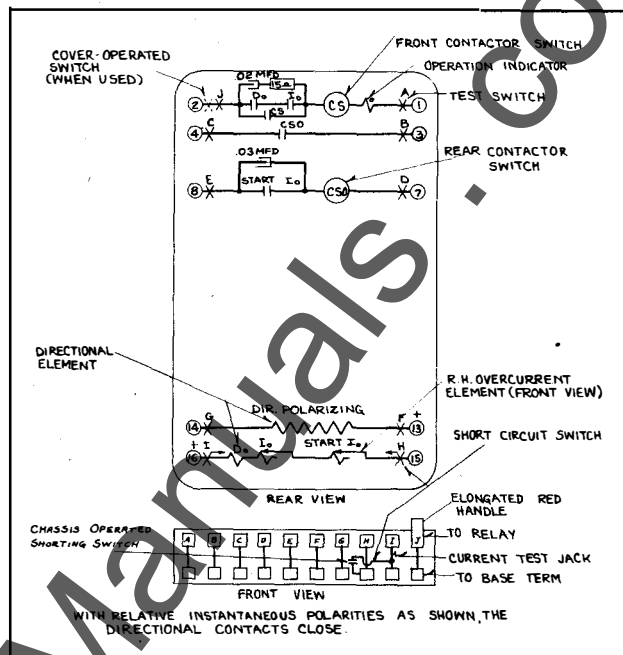


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17	1.2	15.0	A to C, B to 13, D to 14.

<sup>1</sup>The approximate minimum pick-up current of the directional element with the polarizing and current winding in series.

## TYPES HRK AND HRP RELAYS

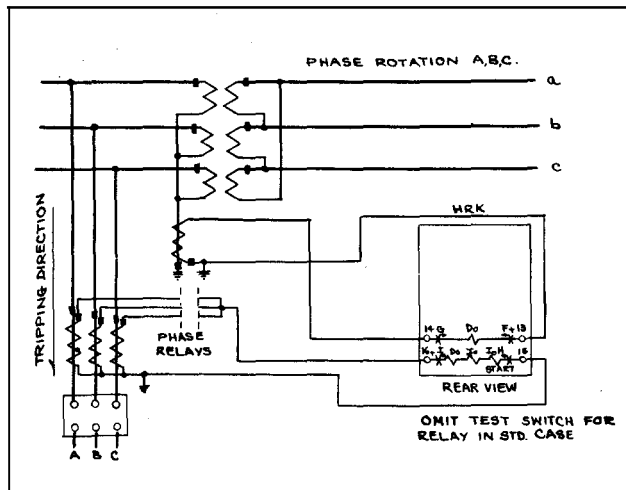


Fig. 5—External A-C Connections of the Type HRK Relay.

<sup>2</sup> The approximate maximum current that should be passed thru the polarizing winding for satisfactory operation.

Select the lowest number of turns which will permit the type HRK directional element to close under the minimum fault condition. This should insure satisfactory operation over the widest range of fault currents.

### RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

#### Removing Chassis

To remove the chassis, first remove the

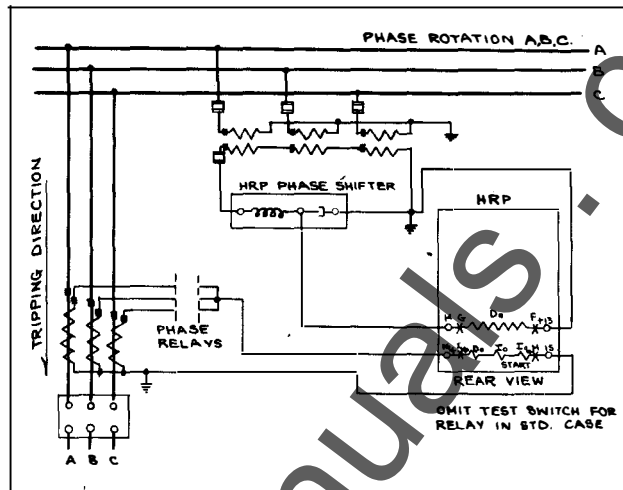


Fig. 6—External A-C Connections of the Type HRP Relay.

cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in the



case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

#### Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

#### Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

#### Testing in Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

#### Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

#### Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values by a small percentage. It is recommended that the relay be checked in

## TYPES HRK AND HRP RELAYS

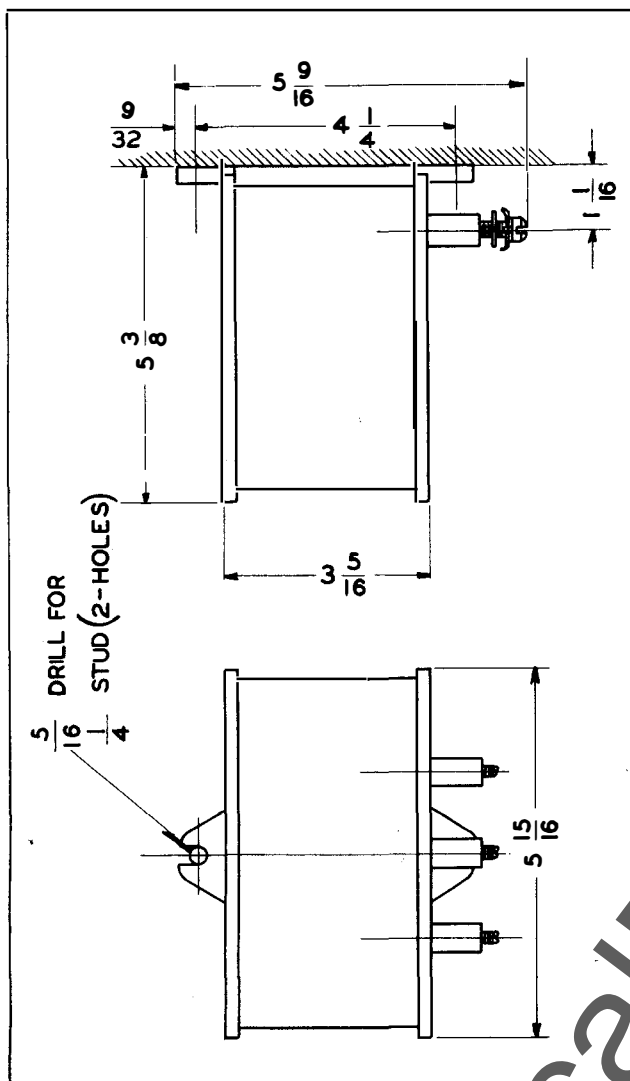


Fig. 7—Outline and Drilling Plan of the External Phase Shifter for the Type HRP Relay. For Reference Only.

position as a final check on calibration.

### 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 two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with

the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external a-c connections of both the type HRK and HRP relays are shown in Figures 5 and 6. 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 periodically cleaned with a fine file. S#1002110 file 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 Elements

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 element 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 Element

Check the free movement of the directional element loop. The loop should assume approximately a vertical position with contacts open when the element is completely de-energized.

The movement of the loop is limited in the contact opening direction by a stop screw which strikes the lower part of the loop. This screw is located on the left-hand side of the element to the rear of the current coil. This back stop screw should be screwed forward until it just touches the loop when it is in its natural de-energized position. The contacts should have a separation of .020 inch. The front stop screw should be adjusted so that it touches the loop at the same time the contacts close. Then back off this screw  $1/2$  of a turn to give the contacts the correct amount of follow.

Energize the loop with normal potential or current long enough to bring it up to temperature (about 10 or 15 minutes) and adjust the bearing screws so there is about .010 inch end play. See that the loop does not bind or strike against the iron or coil when pressed against either end jewel.

Type HRK relays only - With the directional element tap block set for 10 turns connect the directional element coil circuits in series, and pass 1.5 amperes with polarities as shown on the internal schematics. The directional contact should close. Reverse the connections to one coil and pass 20 amperes thru the circuit. The contacts should not bounce closed when the current is suddenly interrupted.

Type HRP relays only - Apply 2.5 volts to

the polarizing voltage winding and pass 4 amperes thru the current coil with the polarities as shown on the internal schematics. The directional contact should close. Repeat this test with 115 volts and 20 amperes. Reverse the leads to the potential coil and see that the contacts do not bounce closed with the relay energized at 115 volts and 20 amperes after the voltage is suddenly reduced to zero.

These tests are made without the external phase shifter, and under this condition the maximum torque occurs when the current lags the voltage approximately  $11^\circ$ . The external phase shifter of Figure 2 shifts this angle to approximately  $60^\circ$  lag instead of  $11^\circ$ .

#### Seal-In Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of  $1/64$  inch when the switch is picked up. This can be done by turning the relay up-side-down, or by disconnecting the switch and turning it up-side-down. Then screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the point where the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for  $3/32$  inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c have been passed through the coil. The coil resistance is approximately 0.25 ohm.

#### Auxiliary Contactor Switch

The adjustments are the same as for the seal-in contactor switch except that the contact separation should be  $1/32$  inch. The switch should pick up at 0.12 ampere d-c. Test for sticking at 1.0 ampere d-c. The coil resistance is approximately 27 ohms.

## TYPES HRK AND HRP RELAYS

Fig. 8—Outline and Drilling Plan for the Standard Projection Type Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

Fig. 9—Outline and Drilling Plan for the M10 Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

**Fig. 9—Outline and Drilling Plan for the M10 Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.**

### Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c gradually applied. Test for sticking after 30 amperes d-c is passed thru the coil. The coil resistance is approximately 0.16 ohm. Adjustments may be made by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Also, the amount of overhang of the armature on the latch may be adjusted by means of the small screw bearing on the flat spring carrying the inertia weight. The best adjustment will usually be found when this screw just touches the flat spring with the armature in the reset position. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching just beyond the elastic limit.

### 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 name-plate data.

### ENERGY REQUIREMENTS

The burdens of the various circuits of these relays are as follows:

#### HRK and HRP Relays

Each overcurrent element;

0.5 a. tap - 0.30 v.a. at 0.5 amp. - 39.9° lag  
6.0 a. tap - 0.93 v.a. at 6.0 amp. - 9.9° lag

Directional element and one overcurrent element in series.

0.5 a. tap - 0.32 v.a. at 0.5 amp. - 40.3° lag  
6.0 a. tap - 2.34 v.a. at 6.0 amp. - 51.5° lag

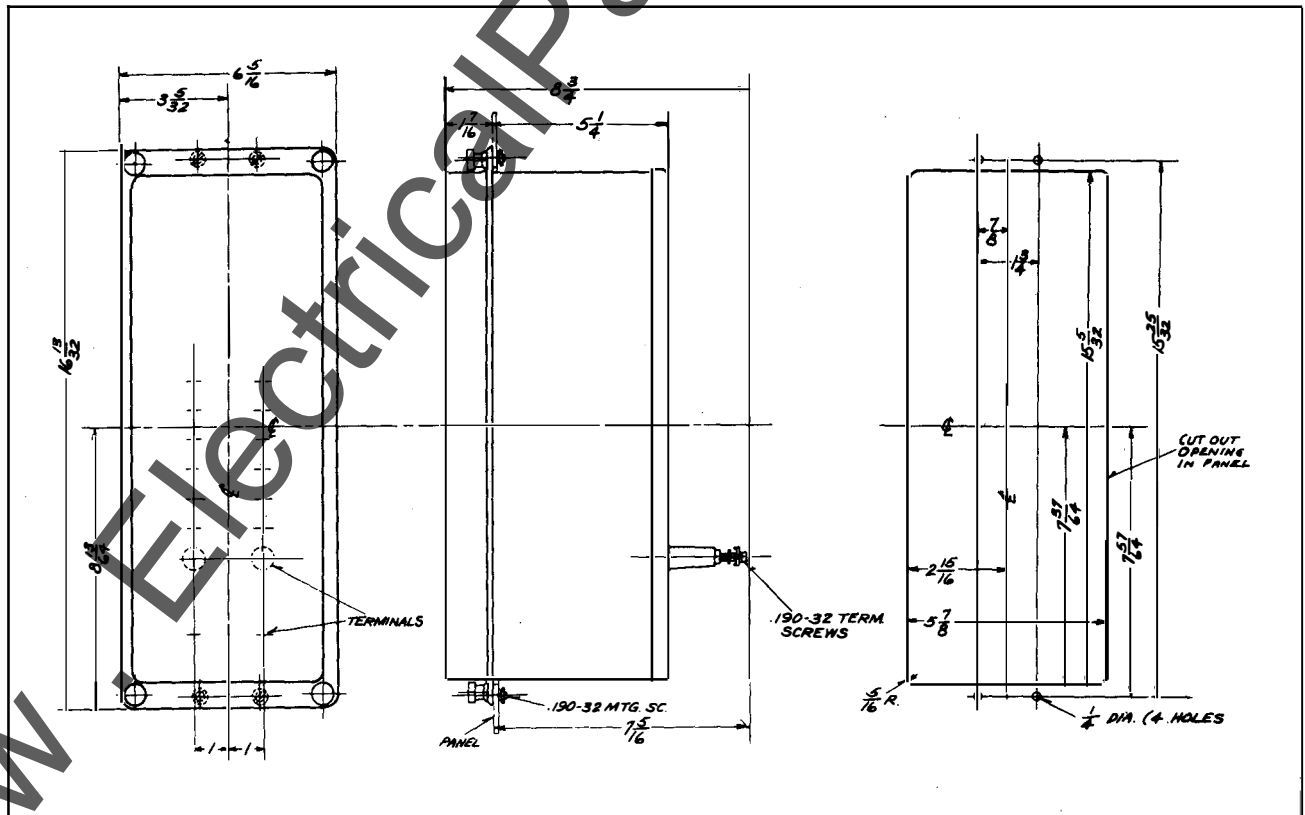


Fig. 10—Outline and Drilling Plan for the M10 Semi-Flush Type FT Case. For Reference Only.

## TYPES HRK AND HRP RELAYS

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### HRK Relay Only

Directional element polarizing winding.

#### Burdens at 5 amperes

3 turns	1.22 v.a.	2° lag
7 turns	0.78 v.a.	10.3° lag
10 turns	1.18 v.a.	10.2° lag
17 turns	2.75 v.a.	16° lag

### HRP Relay Only

Directional element polarizing winding (including external phase shifter).

6.84 v.a. - 17.5° lag at 115 volts, 60 cycles.

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**WESTINGHOUSE ELECTRIC CORPORATION**

**METER DIVISION**

**NEWARK, N.J.**

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# Westinghouse

## TYPES HRK AND HRP CARRIER DIRECTIONAL OVERCURRENT GROUND RELAYS (For Plate Keyed Carrier Sets)

### INSTRUCTIONS

#### 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

These relays are used to provide directional ground fault protection in the carrier relaying scheme using plate keyed carrier sets. The type HRK relay is used where neutral current from the power transformer banks is available for polarizing the directional element. The type HRP relay is used where this neutral current is not available, and residual voltage must be used for polarizing the element.

#### CONSTRUCTION AND OPERATION

These relays consist of two beam-type overcurrent elements, a directional element, seal-in contactor switch, auxiliary contactor switch, and operation indicator. The trip circuit of the relay includes the directional contacts in series with the contacts of one overcurrent element, the operation indicator, and the contactor switch. The other overcurrent element is used to start carrier signal transmission. Operation of this relay in connection with the carrier scheme is fully described in I.L. 41-600.6.

##### Overcurrent Element

The construction details of the two overcurrent elements are shown in Figure 1. The element consists of a pivoted beam with a 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 hollow, silver, egg-shaped capsule 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 Element

The directional element is of the induction loop type. A small transformer causes a large current to flow in a single-turn movable aluminum secondary, which current is substantially in phase with the primary polarizing voltage or current. The current coils are mounted on a magnetic frame and the current and polarizing elements are assembled at right angles to each other with the one-turn loop in the air gaps of the current coil flux path. The interaction of the current and polarizing fluxes produces torque and rotates the loop in one of two directions, depending on the direction of power flow.

A Micarta arm extends from the moving loop from which projects a short leaf spring. A small, thin-walled, cylindrical contact, filled with powdered tungsten, is rigidly attached to the outer end of the spring. When this contact strikes the rigid stationary contact, the movement of the tungsten powder creates sufficient friction to absorb practically all the energy of impact and thus the tendency of the contact to bounce is reduced to a minimum. Current is conducted into the moving contact by means of a flexible metal ribbon known as a pigtail.

The stationary contact screw fastens into a rigid projecting arm. Contact follow is secured by permitting the loop to travel for a short distance after the contacts close, thus deflecting the leaf spring. This is done by an adjustable stop screw. Another stop screw limits the travel of the loop in the opening direction. These stop screws act directly on the loop. This directional element has nearly true wattmeter characteristics.

##### Seal-In Contactor Switch

The seal-in d-c contactor switch (CS) in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker. The contactor switch is equipped with a third point which is connected to a terminal on the relay to operate a bell alarm.

The seal-in contactor switch operates on a minimum of 2.0 amperes, but the trip cir-

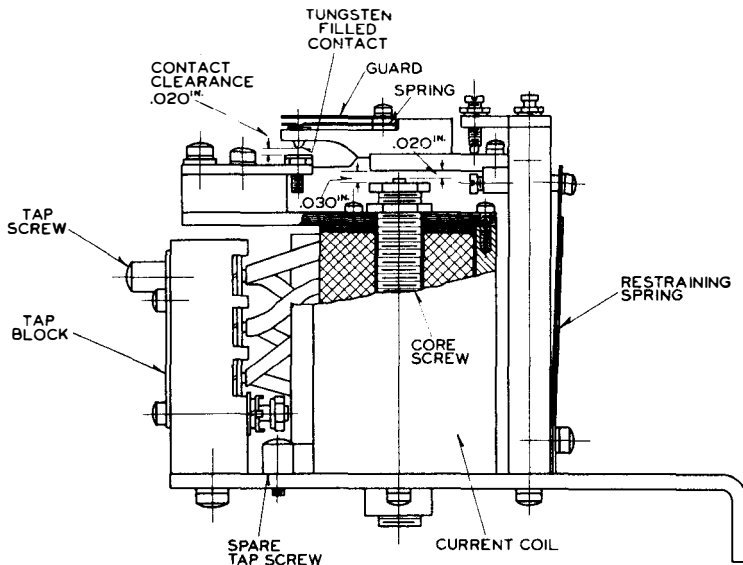
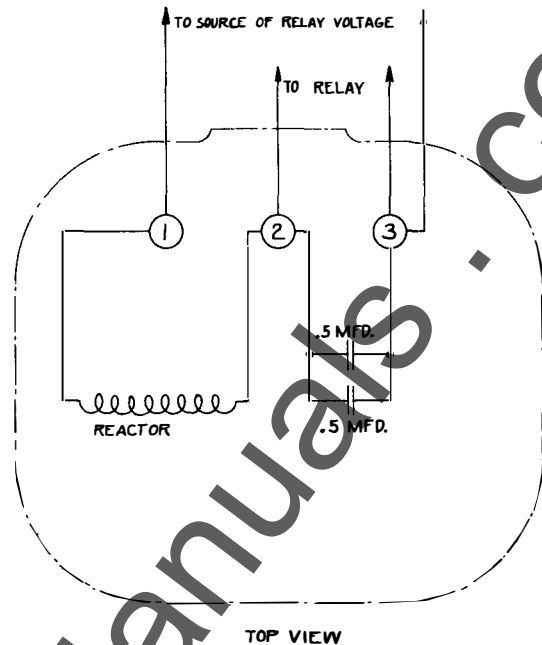


Figure 1  
Sectional View of the Overcurrent Elements.



TOP VIEW

Figure 2  
Internal Schematic of the  
External Phase Shifter for  
the Type HRP Relay.

cuit should draw at least 4 or 5 amperes in order to keep the time of operation of the switch to a minimum and provide positive operation.

#### Auxiliary Contactor Switch

The auxiliary contactor switch (CS0) is of the same construction as the seal-in switch. The purpose of the CS0 switch is to short out the phase carrier stop circuit in installations using ground preference. The coil is in series with the carrier start overcurrent element contacts. The contacts of the CS0 switch are externally connected across the phase carrier stop circuit.

#### Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to show the completion of the trip circuit. The high-speed action of the indicator is obtained by fastening a weight through a leaf spring to the armature. The added inertia causes the armature to continue its motion after the coil has been short-circuited.

#### CHARACTERISTICS AND SETTINGS

The overcurrent element of the relays operates 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 pick-up.

It is desirable to set the carrier start overcurrent element on a lower tap than the tripping overcurrent element in most carrier installations. This insures positive starting of the carrier transmitter for all faults in the immediate vicinity. If the fault is external, the tripping overcurrent and directional elements in conjunction with the carrier relays will block tripping.

The polarizing coil of the type HRK relay is wound in two sections brought out to taps marked A, B, C, and D. By various arrangement of the links between these taps and taps 13 and 14 which connect to the base terminals, the relay can be used at its best operating point when wide variations in polarizing currents are encountered. The characteristics of the 60 cycle polarizing coils are shown in Table I.

TABLE I

Polarizing Turns	1 Minimum Pick-up Amps.	2 Maximum Polarizing Amps.	Connections of links
3	3.0	75.0	A to 13, B to C, D to 14
7	2.0	32.0	A to 14, B to 13
10	1.5	25.0	C to 13, D to 14
17	1.2	15.0	A to C, B to 13, D to 14

<sup>1</sup>The approximate minimum pick-up current of the directional element with the polarizing and current winding in series.

<sup>2</sup>The approximate maximum current that should be passed thru the polarizing winding for satisfactory operation.

Select the lowest number of turns which will permit the type HRK directional element to close under the minimum fault condition. This should insure satisfactory operation over the widest range of fault currents.

#### RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the

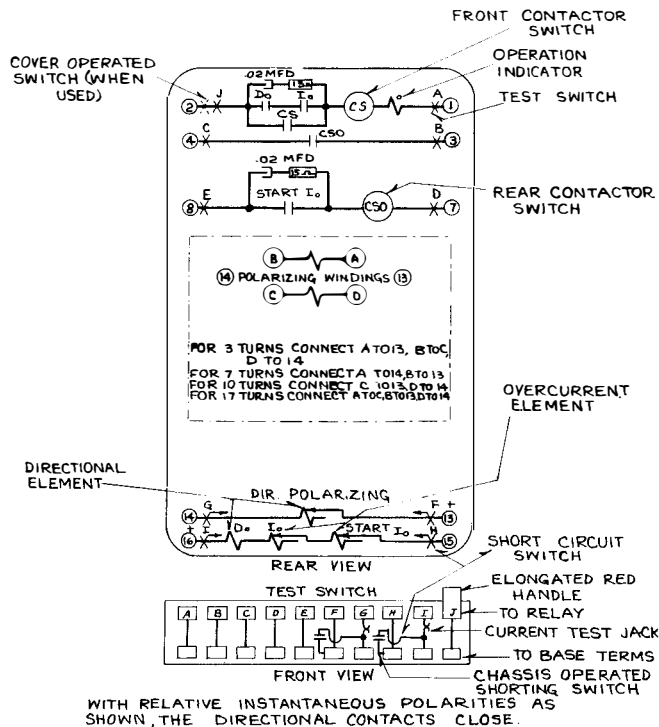


Figure 3

Internal Schematic of the Type HRK Relays in the Type FT Case. The Relays in the Standard Case Have the Same Terminals But With the Test Switches Omitted.

terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

#### Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in

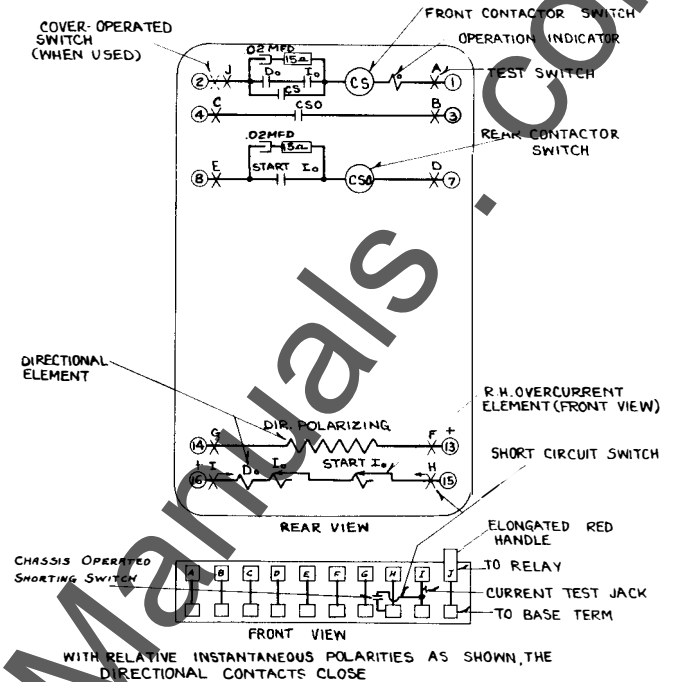


Figure 4

Internal Schematic of the Type HRP Relays in the Type FT Case. The Relays in the Standard Case Have the Same Terminals But With the Test Switches Omitted.

the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

#### Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

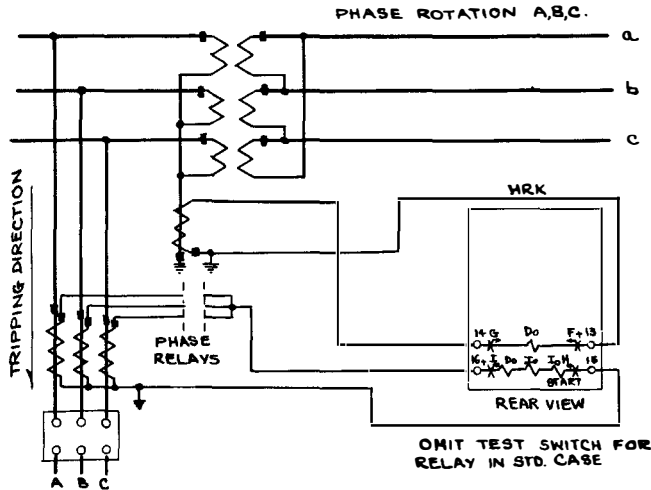


Figure 5  
External A-C Connections of the Type HRK Relay.

### Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

### Testing in Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

### Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

### Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the cali-

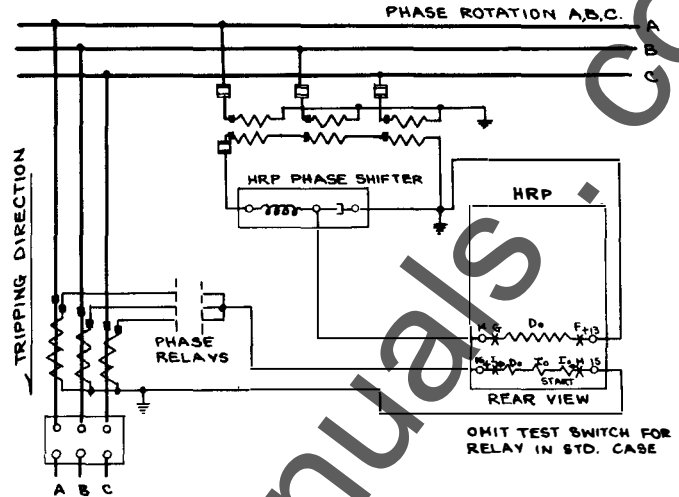


Figure 6  
External A-C Connections of the Type HRP Relay.

bration values by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

### 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 two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external a-c connections of both the type HRK and HRP relays are shown in Figures 5 and 6. 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 periodically cleaned with a fine file. S#1002110 file 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 Elements

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 element 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 Element

Check the free movement of the directional element loop. The loop should assume approximately a vertical position with contacts open when the element is completely de-energized.

The movement of the loop is limited in the contact opening direction by a stop screw which strikes the lower part of the loop. This screw is located on the left-hand side of the element to the rear of the current coil. This back stop screw should be screwed forward until it just touches the loop when it is in its natural de-energized position. The contacts should have a separation of .020 inch. The front stop screw should be adjusted so that it touches the loop at the same time the contacts close. Then back off this screw  $1/2$  of a turn to give the contacts the correct amount of follow.

Energize the loop with normal potential or current long enough to bring it up to temperature (about 10 or 15 minutes) and adjust the bearing screws so there is about .010 inch end play. See that the loop does not bind or strike against the iron or coil when pressed against either end jewel.

Type HRK relays only - With the directional element tap block set for 10 turns connect the directional element coil circuits in series, and pass 1.5 amperes with polarities as shown on the internal schematics. The directional contact should close. Reverse the connections to one coil and pass 20 amperes thru the circuit. The contacts should not bounce closed when the current is suddenly interrupted.

Type HRP relays only - Apply 2.5 volts to the polarizing voltage winding and pass 4 amperes thru the current coil with the polarities as shown on the internal schematics. The directional contact should close. Repeat this test with 115 volts and 20 amperes. Reverse the leads to the potential coil and see that the contacts do not bounce closed with the relay energized at 115 volts and 20 amperes after the voltage is suddenly reduced to zero.

These tests are made without the external phase shifter, and under this condition the maximum torque occurs when the current lags the voltage approximately  $11^\circ$ . The external phase shifter of Figure 2 shifts this angle to approximately  $60^\circ$  lag instead of  $11^\circ$ .

#### Seal-In Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of  $1/64$  inch when the switch is picked up. This can be done by turning the relay up-side-down, or by disconnecting the switch and turning it up-side-down. Then screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the point where the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for  $3/32$  inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c have been passed through the coil. The coil resistance is approximately 0.25 ohm.

#### Auxiliary Contactor Switch

The adjustments are the same as for the seal-in contactor switch except that the contact separation should be  $1/32$  inch. The switch should pick up at 0.12 ampere d-c. Test for sticking at 1.0 ampere d-c. The coil resistance is approximately 27 ohms.

#### Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c gradually applied. Test for sticking after 30 amperes d-c is passed thru the coil. The coil resistance is approximately 0.16 ohm. Adjustments may be made by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Also, the amount of overhang of the armature on the latch may be adjusted by means of the small screw bearing on the flat spring carrying the inertia weight. The best adjustment will usually be found when this screw just touches the flat spring with the armature in the reset position. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching just beyond the elastic limit.

#### 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 burdens of the various circuits of these relays are as follows:

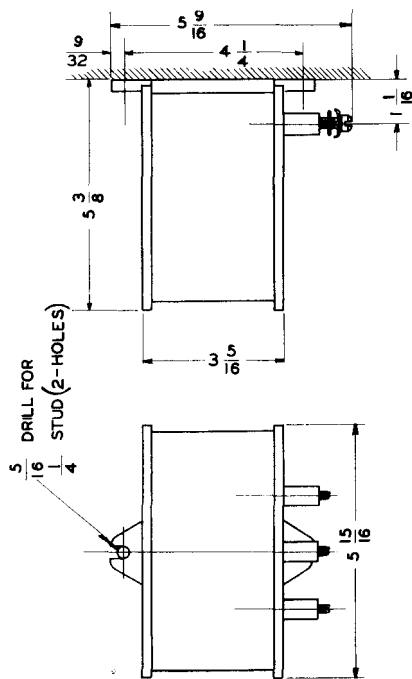
##### HRK and HRP Relays

Each overcurrent element

0.5 a. tap - 0.30 v.a. at 0.5 amp. -  $39.9^\circ$  lag  
6.0 a. tap - 0.93 v.a. at 6.0 amp. -  $9.9^\circ$  lag

Directional element and one overcurrent element in series.

0.5 a. tap - 0.32 v.a. at 0.5 amp. -  $40.3^\circ$  lag  
6.0 a. tap - 2.34 v.a. at 6.0 amp. -  $51.5^\circ$  lag



HRK Relay Only

Directional element polarizing winding

Burdens at 5 amperes

3 turns	1.22 v.a.	2° lag
7 turns	0.78 v.a.	10.3° lag
10 turns	1.18 v.a.	10.2° lag
17 turns	2.75 v.a.	16° lag

HRP Relay Only

Directional element polarizing winding (Including external phase shifter.)

6.84 v.a. - 17.5° lag at 115 volts, 60 cycles.

Figure 7  
Outline and Drilling Plan of the External Phase Shifter for the Type HRP Relay. For Reference Only.

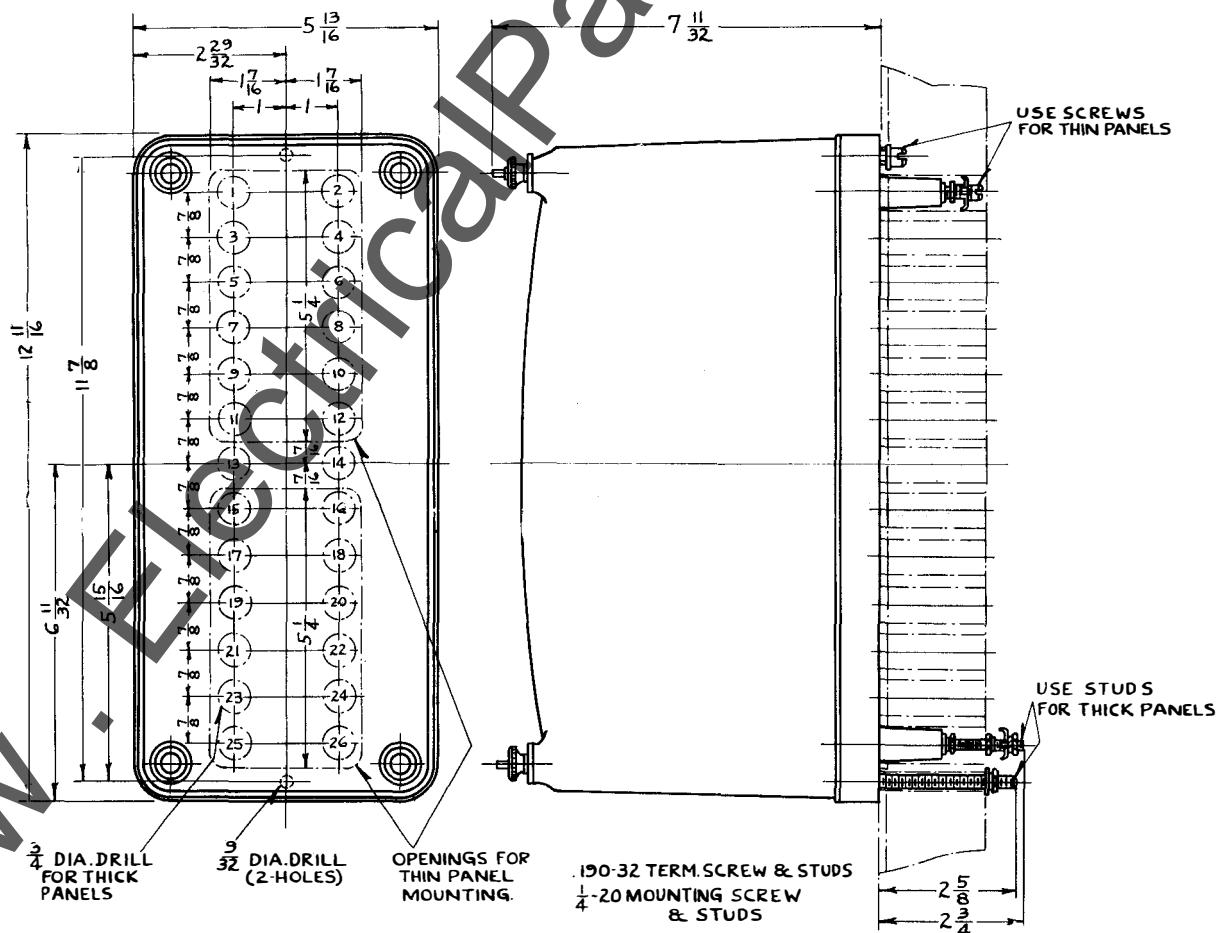


Figure 8  
Outline and Drilling Plan For the Standard Projection Type Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

# TYPES HRK AND HRP RELAYS

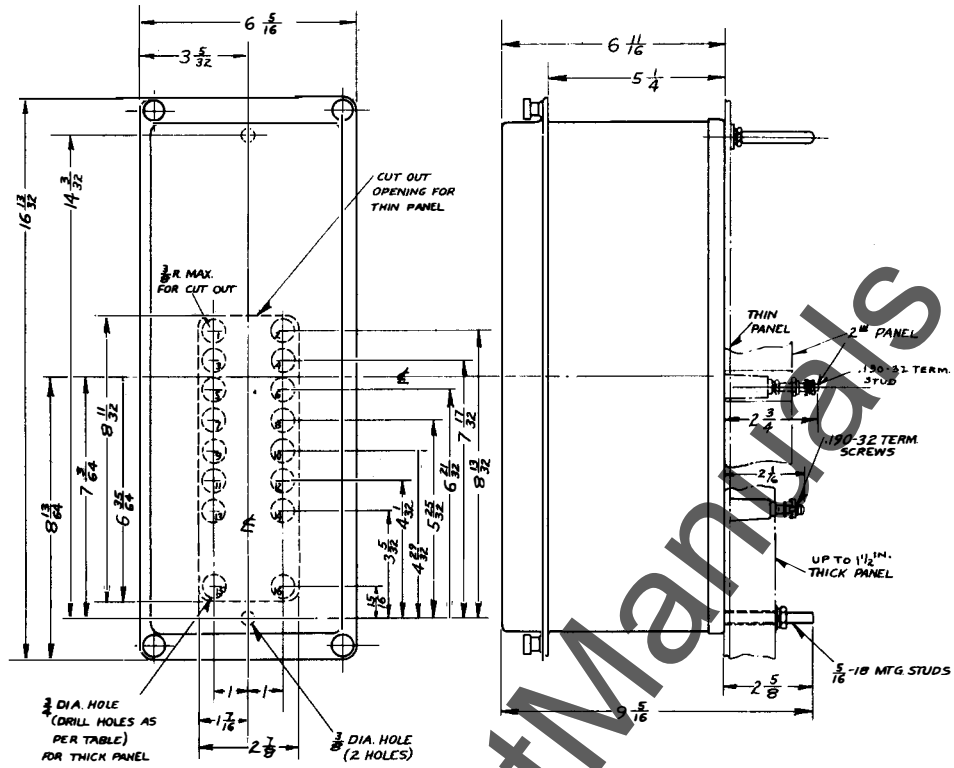


Figure 9  
Outline and Drilling Plan for the M10 Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

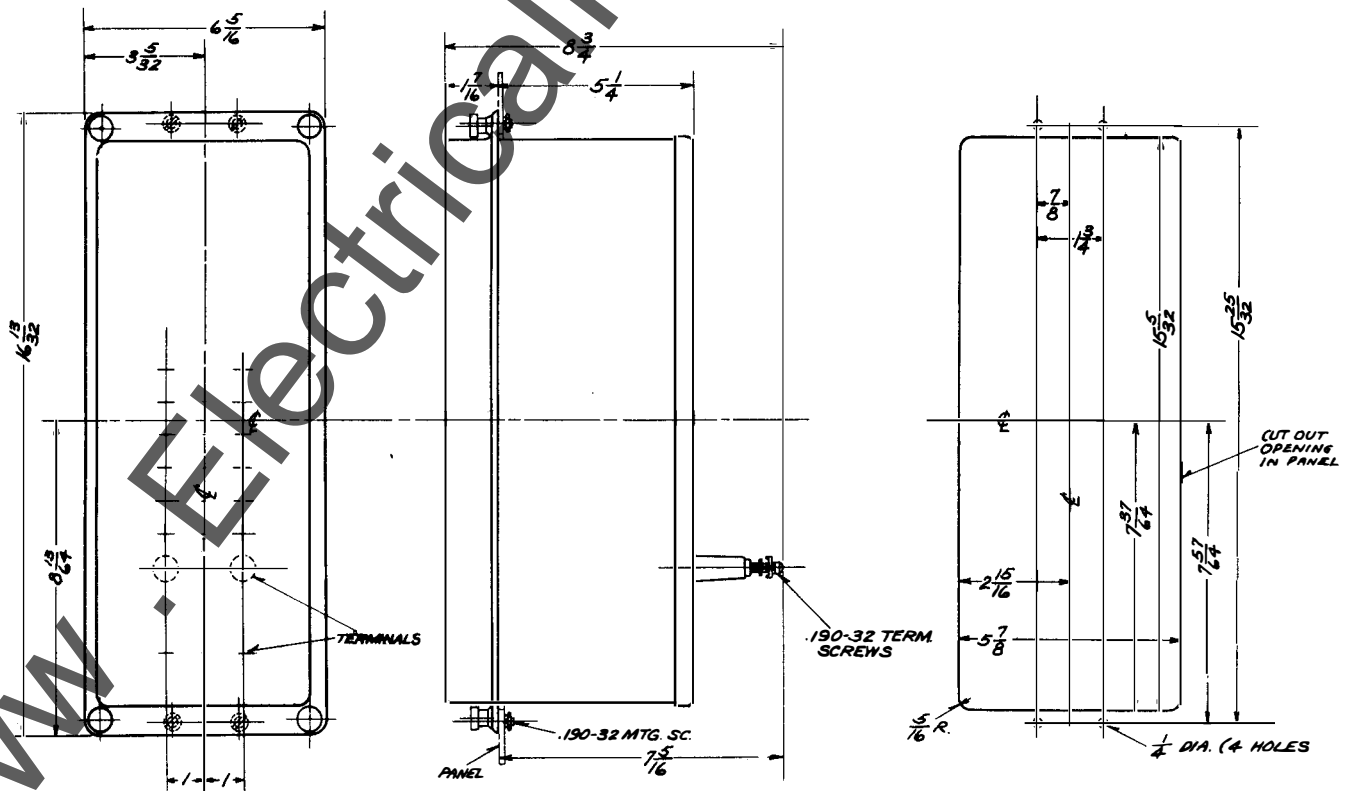


Figure 10  
Outline and Drilling Plan for the M10 Semi-Flush Type FT Case. For Reference Only.





# Westinghouse

## TYPES HRK AND HRP CARRIER DIRECTIONAL OVERCURRENT GROUND RELAYS (For Plate Keyed) Carrier Sets)

### INSTRUCTIONS

#### 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

These relays are used to provide directional ground fault protection in the carrier relaying scheme using plate keyed carrier sets. The type HRK relay is used where neutral current from the power transformer banks is available for polarizing the directional element. The type HRP relay is used where this neutral current is not available, and residual voltage must be used for polarizing the element.

#### CONSTRUCTION AND OPERATION

These relays consist of two beam-type overcurrent elements, a directional element, seal-in contactor switch, auxiliary contactor switch, and operation indicator. The trip circuit of the relay includes the directional contacts in series with the contacts of one overcurrent element, the operation indicator, and the contactor switch. The other overcurrent element is used to start carrier signal transmission. Operation of this relay in connection with the carrier scheme is fully described in I.L. 41-600.6.

##### Overcurrent Element

The construction details of the two overcurrent elements are shown in Figure 1. The element consists of a pivoted beam with a 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 hollow, silver, egg-shaped capsule 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 Element

The directional element is of the induction loop type. A small transformer causes a large current to flow in a single-turn movable aluminum secondary, which current is substantially in phase with the primary polarizing voltage or current. The current coils are mounted on a magnetic frame and the current and polarizing elements are assembled at right angles to each other with the one-turn loop in the air gaps of the current coil flux path. The interaction of the current and polarizing fluxes produces torque and rotates the loop in one of two directions, depending on the direction of power flow.

A Micarta arm extends from the moving loop from which projects a short leaf spring. A small, thin-walled, cylindrical contact, filled with powdered tungsten, is rigidly attached to the outer end of the spring. When this contact strikes the rigid stationary contact, the movement of the tungsten powder creates sufficient friction to absorb practically all the energy of impact and thus the tendency of the contact to bounce is reduced to a minimum. Current is conducted into the moving contact by means of a flexible metal ribbon known as a pigtail.

The stationary contact screw fastens into a rigid projecting arm. Contact follow is secured by permitting the loop to travel for a short distance after the contacts close, thus deflecting the leaf spring. This is done by an adjustable stop screw. Another stop screw limits the travel of the loop in the opening direction. These stop screws act directly on the loop. This directional element has nearly true wattmeter characteristics.

##### Seal-In Contactor Switch

The seal-in d-c contactor switch (CS) in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid. As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts remain closed until the trip circuit is opened by the auxiliary switch on the breaker. The contactor switch is equipped with a third point which is connected to a terminal on the relay to operate a bell alarm.

The seal-in contactor switch operates on a minimum of 2.0 amperes, but the trip cir-

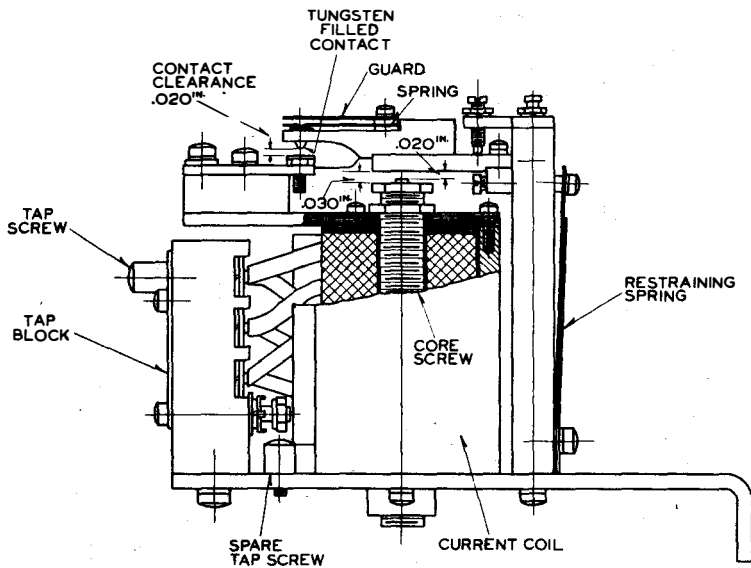


Figure 1  
Sectional View of the Overcurrent Elements.

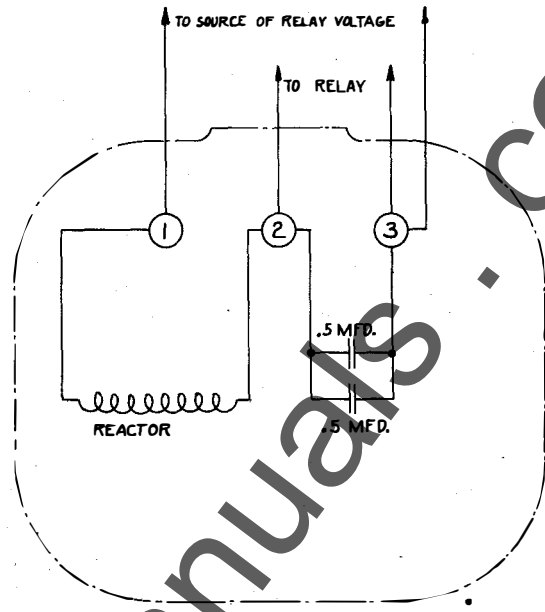


Figure 2  
Internal Schematic of the  
External Phase Shifter for  
the Type HRP Relay.

cuit should draw at least 4 or 5 amperes in order to keep the time of operation of the switch to a minimum and provide positive operation.

#### Auxiliary Contactor Switch

The auxiliary contactor switch (CSO) is of the same construction as the seal-in switch. The purpose of the CSO switch is to short out the phase carrier stop circuit in installations using ground preference. The coil is in series with the carrier start overcurrent element contacts. The contacts of the CSO switch are externally connected across the phase carrier stop circuit.

#### Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to show the completion of the trip circuit. The high-speed action of the indicator is obtained by fastening a weight through a leaf spring to the armature. The added inertia causes the armature to continue its motion after the coil has been short-circuited.

#### CHARACTERISTICS AND SETTINGS

The overcurrent element of the relays operates 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 pick-up.

It is desirable to set the carrier start overcurrent element on a lower tap than the tripping overcurrent element in most carrier installations. This insures positive starting of the carrier transmitter for all faults in the immediate vicinity. If the fault is external, the tripping overcurrent and directional elements in conjunction with the carrier relays will block tripping.

The polarizing coil of the type HRK relay is wound in two sections brought out to taps marked A, B, C, and D. By various arrangement of the links between these taps and taps 13 and 14 which connect to the base terminals, the relay can be used at its best operating point when wide variations in polarizing currents are encountered. The characteristics of the 60 cycle polarizing coils are shown in Table I.

TABLE I

Polarizing Turns	1 Minimum Pick-up Amps.	2 Maximum Polarizing Amps.	Connections of links
3	3.0	75.0	A to 13, B to C, D to 14
7	2.0	32.0	A to 14, B to 13
10	1.5	25.0	C to 13, D to 14
17	1.2	15.0	A to C, B to 13, D to 14

<sup>1</sup>The approximate minimum pick-up current of the directional element with the polarizing and current winding in series.

<sup>2</sup>The approximate maximum current that should be passed thru the polarizing winding for satisfactory operation.

Select the lowest number of turns which will permit the type HRK directional element to close under the minimum fault condition. This should insure satisfactory operation over the widest range of fault currents.

#### RELAYS IN TYPE FT CASE

The type FT case's are dust-proof enclosures combining relay elements and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all welded steel housing containing the hinge half of the knife-blade test switches and the

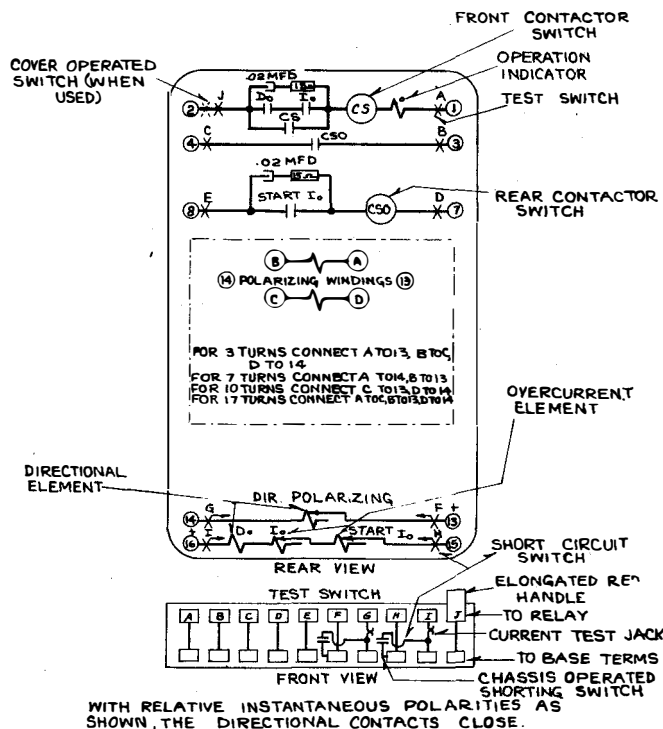


Figure 3  
Internal Schematic of the Type HRK Relays in the Type FT Case. The Relays in the Standard Case Have the Same Terminals But With the Test Switches Omitted.

terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a frame that supports the relay elements and the contact jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades.

#### Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis operated shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type test switches are closed.

When the chassis is to be put back in

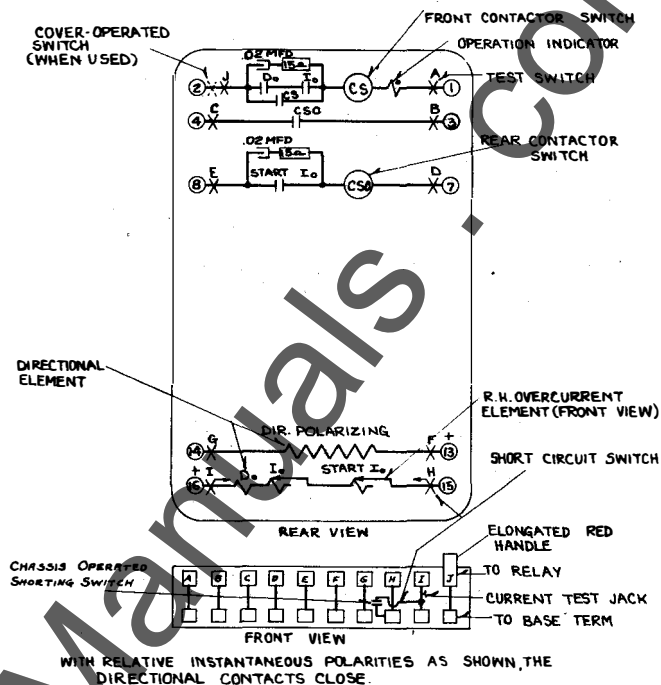


Figure 4  
Internal Schematic of the Type HRP Relays in the Type FT Case. The Relays in the Standard Case Have the Same Terminals But With the Test Switches Omitted.

the case, the above procedure is to be followed in the reversed order. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

#### Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

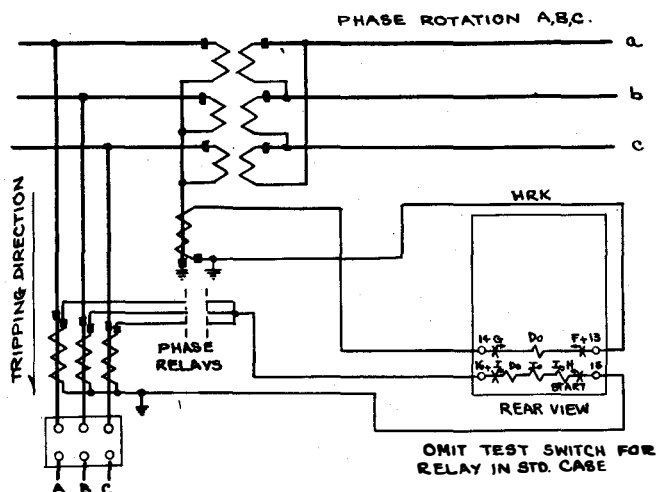


Figure 5  
External A-C Connections of the Type HRK Relay.

### Testing

The relays can be tested in service, in the case but with the external circuits isolated or out of the case as follows:

#### Testing in Service

The ammeter test plug can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out thru holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

#### Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above, under "Electrical Circuits".

#### Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the cali-

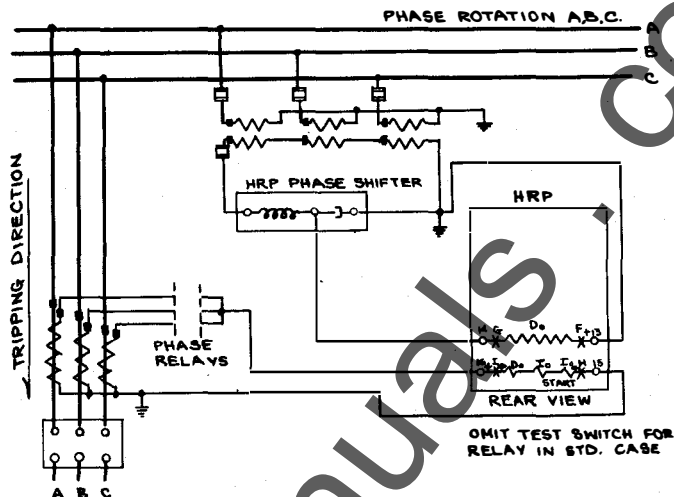


Figure 6  
External A-C Connections of the Type HRP Relay.

bration values by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

### 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 two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external a-c connections of both the type HRK and HRP relays are shown in Figures 5 and 6. 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 periodically cleaned with a fine file. S#1002110 file 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 Elements

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

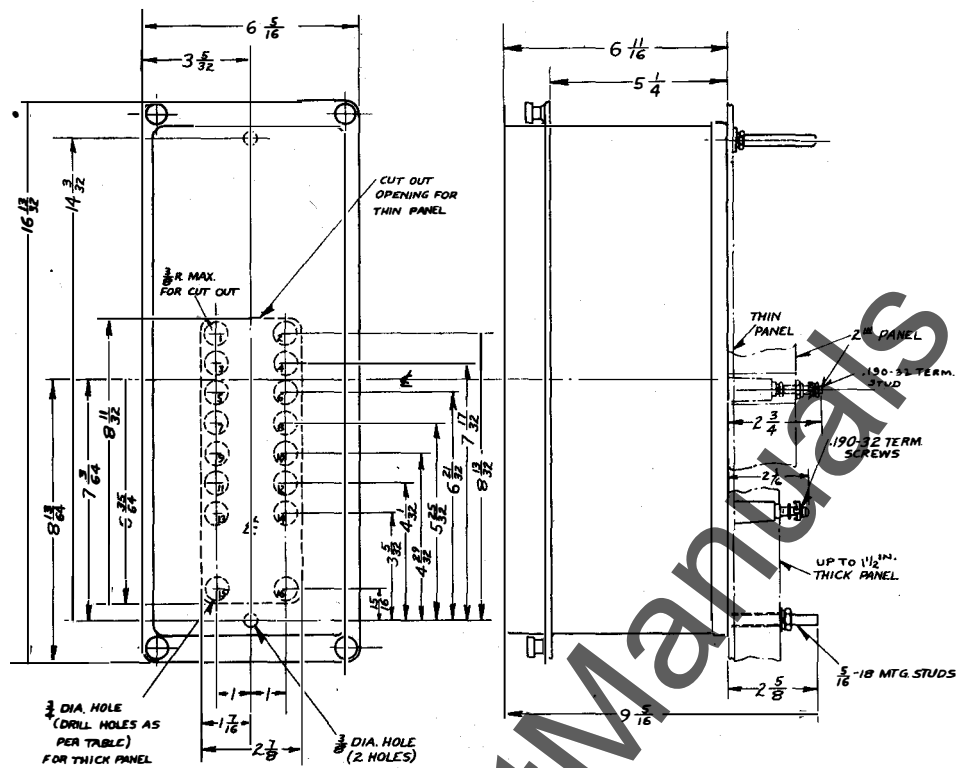


Figure 9  
Outline and Drilling Plan for the M10 Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

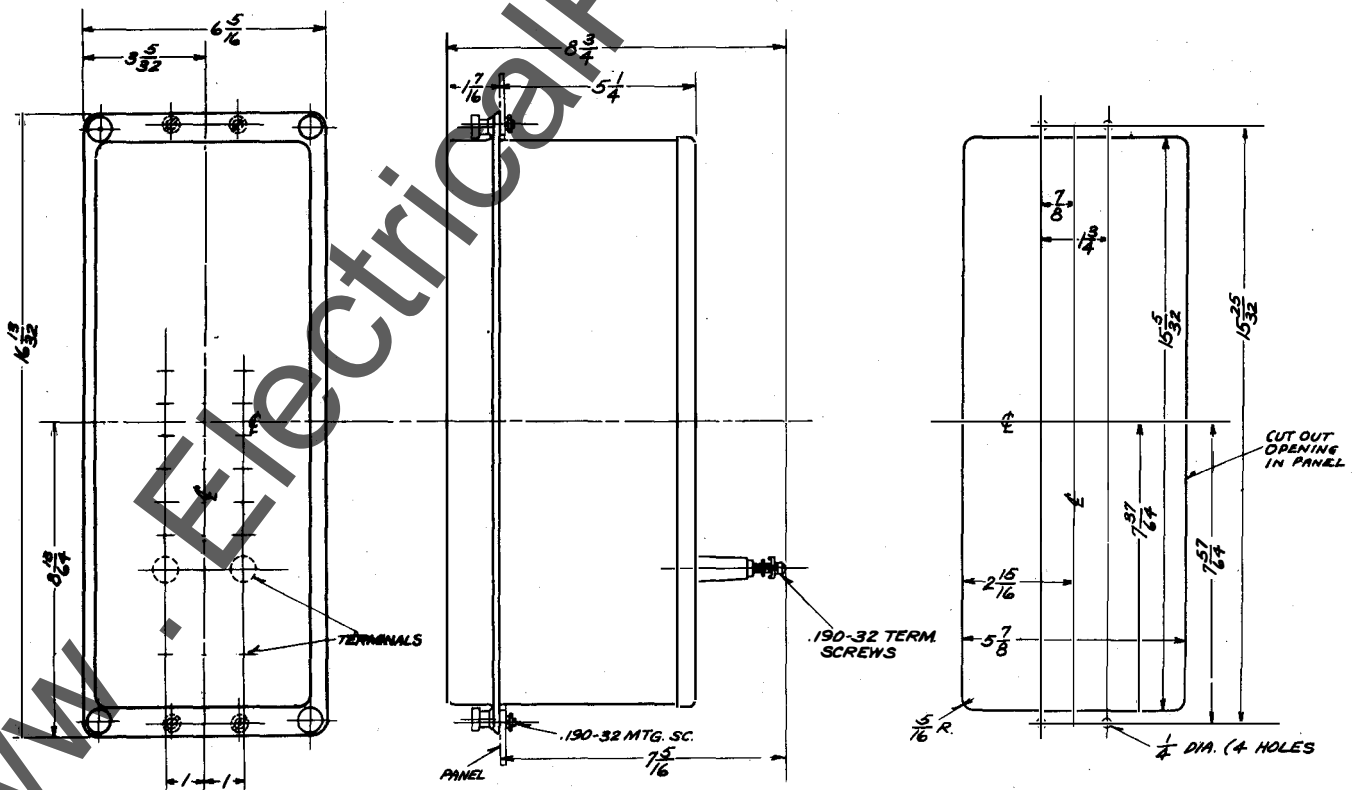


Figure 10  
Outline and Drilling Plan for the M10 Semi-Flush Type FT Case. For Reference Only.



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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 element 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 Element

Check the free movement of the directional element loop. The loop should assume approximately a vertical position with contacts open when the element is completely de-energized.

The movement of the loop is limited in the contact opening direction by a stop screw which strikes the lower part of the loop. This screw is located on the left-hand side of the element to the rear of the current coil. This back stop screw should be screwed forward until it just touches the loop when it is in its natural de-energized position. The contacts should have a separation of .020 inch. The front stop screw should be adjusted so that it touches the loop at the same time the contacts close. Then back off this screw 1/2 of a turn to give the contacts the correct amount of follow.

Too much follow on the directional contacts should be avoided in order to allow the directional element to reset fast enough by gravity to properly coordinate with the overcurrent element.

Energize the loop with normal potential or current long enough to bring it up to temperature (about 10 or 15 minutes) and adjust the bearing screws so there is about .010 inch end play. See that the loop does not bind or strike against the iron or coil when pressed against either end jewel.

Type HRK relays only - With the directional element tap block set for 10 turns connect the directional element coil circuits in series, and pass 1.5 amperes with polarities as shown on the internal schematics. The directional contact should close. Reverse the connections to one coil and pass 20 amperes thru the circuit. The contacts should not bounce closed when the current is suddenly interrupted.

Type HRP relays only - Apply 2.5 volts to the polarizing voltage winding and pass 4 amperes thru the current coil with the polarities as shown on the internal schematics. The directional contact should close. Repeat this test with 115 volts and 20 amperes. Reverse the leads to the potential coil and see that the contacts do not bounce closed with the relay energized at 115 volts and 20 amperes after the voltage is suddenly reduced to zero.

These tests are made without the external phase shifter, and under this condition the maximum torque occurs when the current lags the voltage approximately  $11^\circ$ . The external phase shifter of Figure 2 shifts this angle to approximately  $60^\circ$  lag instead of  $11^\circ$ .

#### Seal-In Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/64 inch when the switch is picked up. This can be done by turning the relay up-side-down, or by disconnecting the switch and turning it up-side-down. Then screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the point where the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32 inch by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes d-c have been passed through the coil. The coil resistance is approximately 0.25 ohm.

#### Auxiliary Contactor Switch

The adjustments are the same as for the seal-in contactor switch except that the contact separation should be 1/32 inch. The switch should pick up at 0.12 ampere d-c. Test for sticking at 1.0 ampere d-c. The coil resistance is approximately 27 ohms.

#### Operation Indicator

Adjust the indicator to operate at 1.0 ampere d-c gradually applied. Test for sticking after 30 amperes d-c is passed thru the coil. The coil resistance is approximately 0.16 ohm. Adjustments may be made by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. Also, the amount of overhang of the armature on the latch may be adjusted by means of the small screw bearing on the flat spring carrying the inertia weight. The best adjustment will usually be found when this screw just touches the flat spring with the armature in the reset position. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching just beyond the elastic limit.

#### 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 burdens of the various circuits of these relays are as follows:

##### HRK and HRP Relays

Each overcurrent element

0.5 a. tap - 0.30 v.a. at 0.5 amp. -  $39.9^\circ$  lag  
6.0 a. tap - 0.93 v.a. at 6.0 amp. -  $9.9^\circ$  lag

Directional element and one overcurrent element in series.

0.5 a. tap - 0.32 v.a. at 0.5 amp. -  $40.3^\circ$  lag  
6.0 a. tap - 2.34 v.a. at 6.0 amp. -  $51.5^\circ$  lag

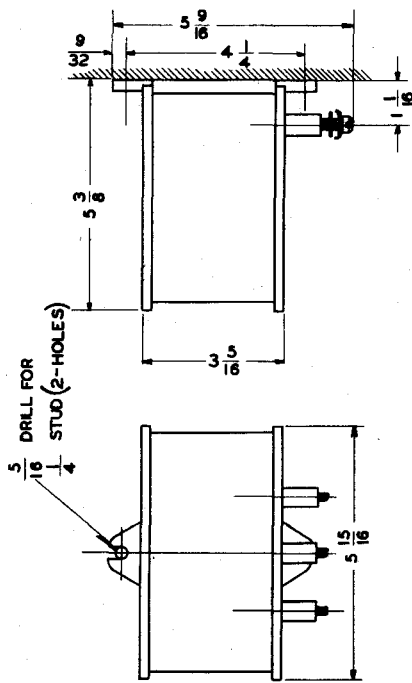


Figure 7  
Outline and Drilling Plan of the External Phase Shifter for the Type HRP Relay. For Reference Only.

HRK Relay Only

Directional element polarizing winding

Burdens at 5 amperes

3 turns	1.22 v.a.	2° lag
7 turns	0.78 v.a.	10.3° lag
10 turns	1.18 v.a.	10.2° lag
17 turns	2.75 v.a.	16° lag

HRP Relay Only

Directional element polarizing winding (Including external phase shifter.)

6.84 v.a. - 17.5° lag at 115 volts, 60 cycles.

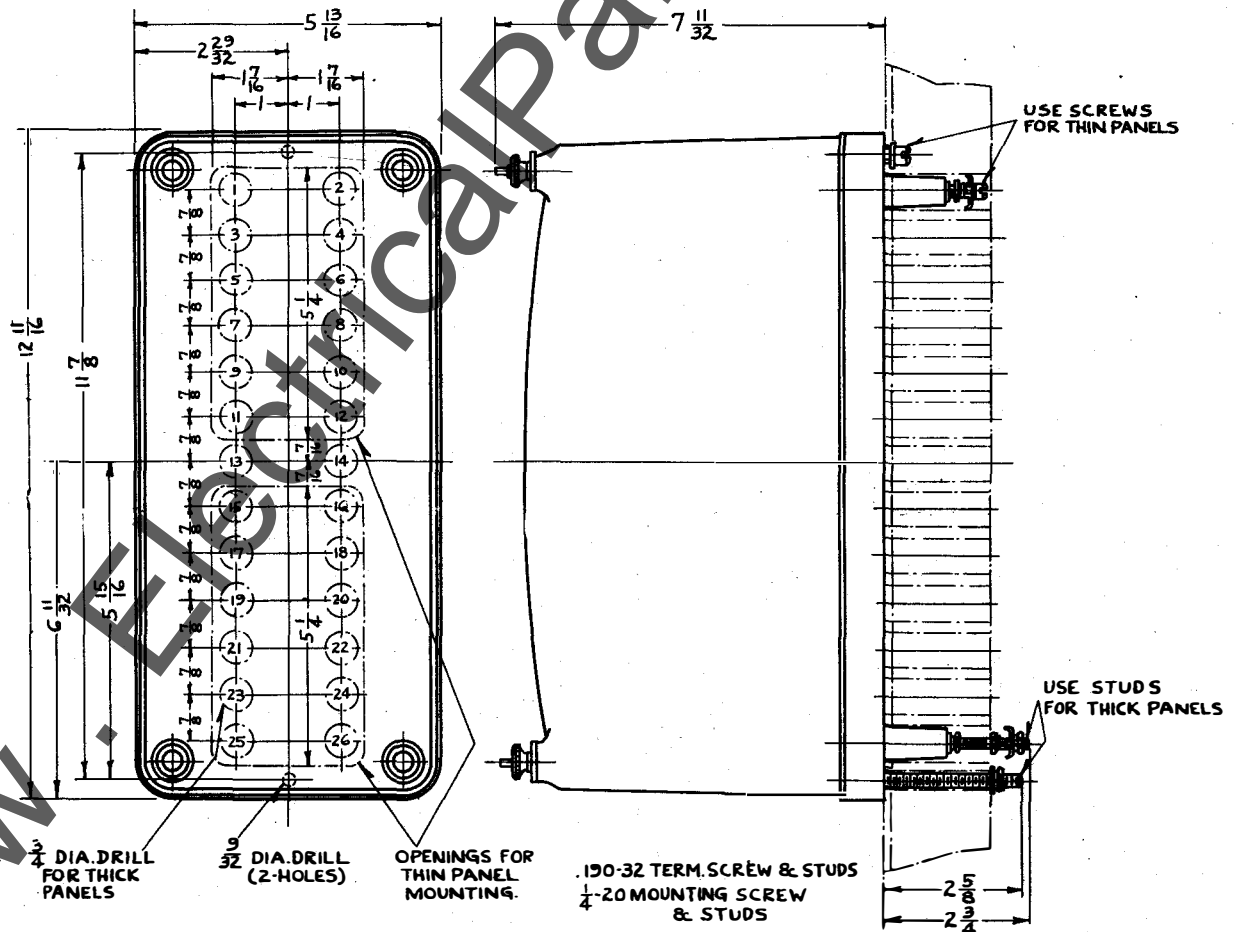


Figure 8

Outline and Drilling Plan For the Standard Projection Type Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.