Westinghouse

TYPES PS-1, S-2, AND S-3 PILOT WIRE A-C SUPERVISORY RELAYS

INSTRUCTIONS

CAUTION

Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing 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

The types PS-1 and PS-2 supervisory relays are used to detect short circuits, open circuits, grounds and reversals on pilot wires, particularly those used with the type HCB relay. The type PS-1 relay may also be used to block operation of the type HCB relays when the pilot wires are opened. The type PS-1 relay is located at one terminal to introduce the supervisory d-c. current to the pilot wires and to initiate an alarm when the pilot wires are faulted. The type PS-2 relay is located at the other end of the pilot wire circuit and operates to initiate an alarm at that terminal when the pilot wire is opened or shorted. This relay also provides the continuous visual indication and means of adjusting the supervisory signal.

Where remote tripping is required, a type PS-3 relay with make contacts is used in place of the type PS-2 relay. This relay provides a means of tripping the local breaker by action of an auxiliary relay located at the type PS-1 relay terminal, but does not act as a fault detector to initiate an alarm at its station.

CONSTRUCTION AND OPERATION

The PS-1 relay consists of a small transformer, a rectox unit, a polarized relay, a reactor and a capacitor connected as shown in figure 1. The small transformer reduces the a-c. supply voltage to approximately 20 volts which is rectified by the rectox units to a pulsating current. The reactor and capacitor combination serves as a filter to smooth out this pulsation to practically constant direct current which is introduced on to the pilot wires at the mid-tap of the type HCB relay insulating transformer.

The polarized relay consists of an armature and contact mounted on a leaf spring supported symmetrically within a magnetic frame. The poles of a permanent magnet clamp directly to each side of this frame. Flux from the permanent magnet divides into two paths, one path across the air gap at the front of the element in which the armature is located, the other across two gaps at the base of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias causing it to move towards the left-hand contact (front view). Two operating coils are placed around the armature and within the magnetic frame. The windings are connected in series with each of the pilot wires.

With the correct adjustment of the magnetic shunts the armature will always tend to travel towards the north pole of the front air gap with the coils deenergized. This holds the left-hand contact closed. When either of the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move towards the south pole, and the right-hand contact. Normally, the current through the relay coils is of such a magnitude that the armature floats midway between the right and left stationary contacts.

The type PS-2 relay consists of a telephone type relay, a 0-5 milliammeter, an adjustable resistor, and a rectox unit connected as shown in figure 2. The contacts of the telephone relay are closed at the deenergized position. When the relay is energized, the contacts stand open.

The type PS-3 relay, figure 3, is identical to the type PS-2 except that the contacts are open in the deenergized position. This relay does not function to initiate an alarm when the pilot wires are faulted.

The operation of these relays to supervise the pilot wire is as follows:

(1). Normal Pilot Wire

The relays are continuously energized with .001 amperes d-c. which is introduced from an external a-c. source thru the type PS-1 relay and circulates over the pilot wire circuit. This current holds both the type PS-1 and PS-2 relay contacts open, and tends to close the type PS-3 relay contacts.

(2). Pilot Wire Short Circuited

Short circuits of 2,000 ohms resistance or less cause the circulating pilot wire current to increase above the normal value, thus closing the right-hand (front view) contacts of the type PS-1 relay and the undercurrent contacts of the PS-2 relay to initiate an alarm at both terminals of the pilot wire.

(3). Pilot Wire Open Circuited

Open circuits on the pilot wire will reduce the circulating supervisory current to zero, and again initiate an alarm at both the type PS-1 and PS-2 relay terminals. If it is desired to block the type HCB relay operation when this condition is encountered, the extra set of contacts on both relays should be connected across the pilot wire relay terminals, as shown in figure 5.

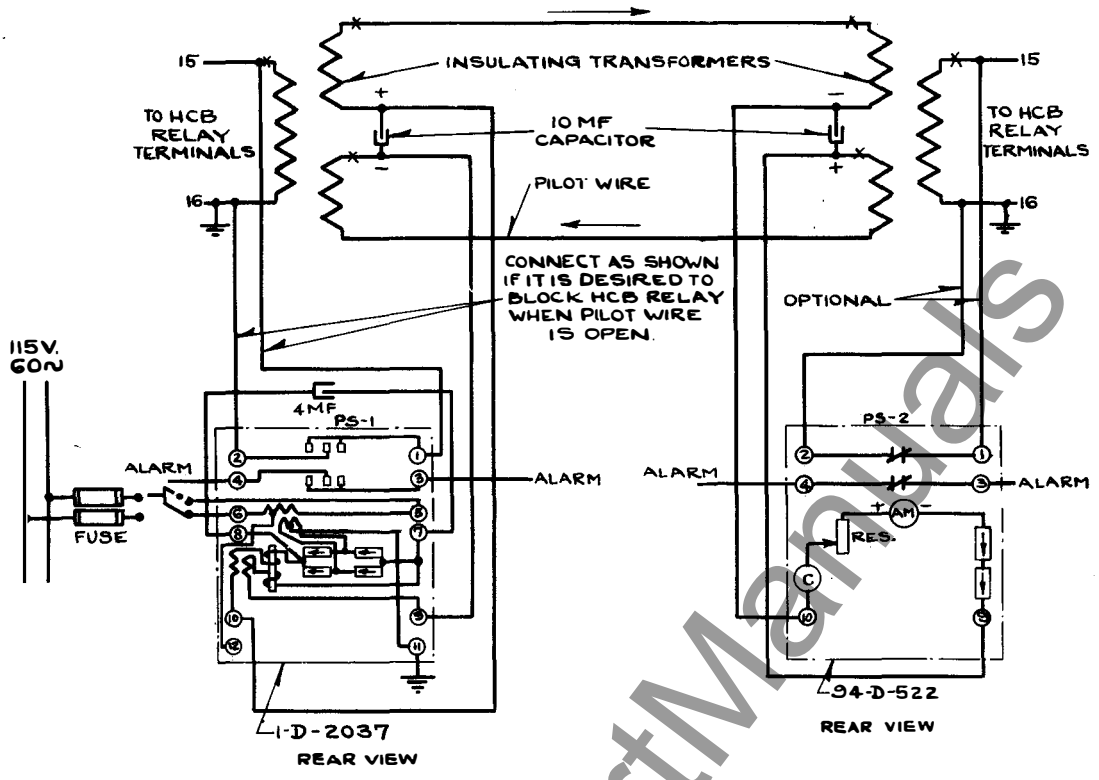

Figure 5
External Connections for the Types PS-1 and PS-2 Relays.

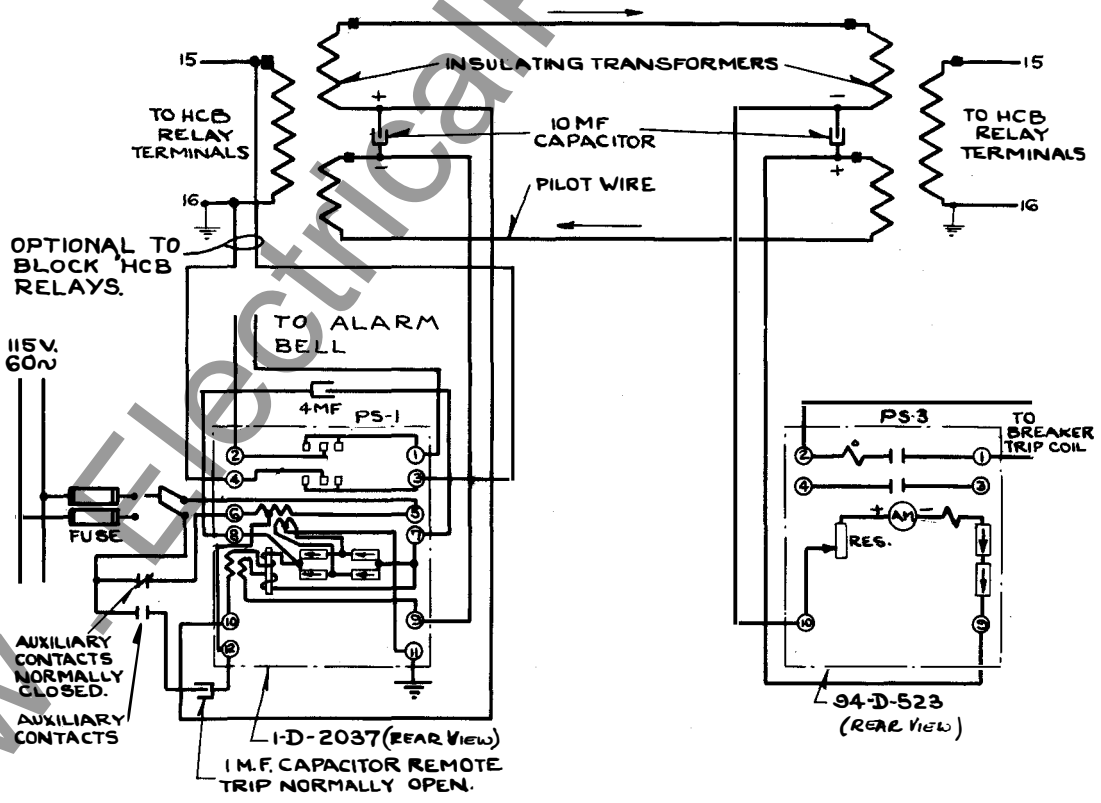

Figure 6
External Connections for the Types PS-1 and PS-3 Relays.

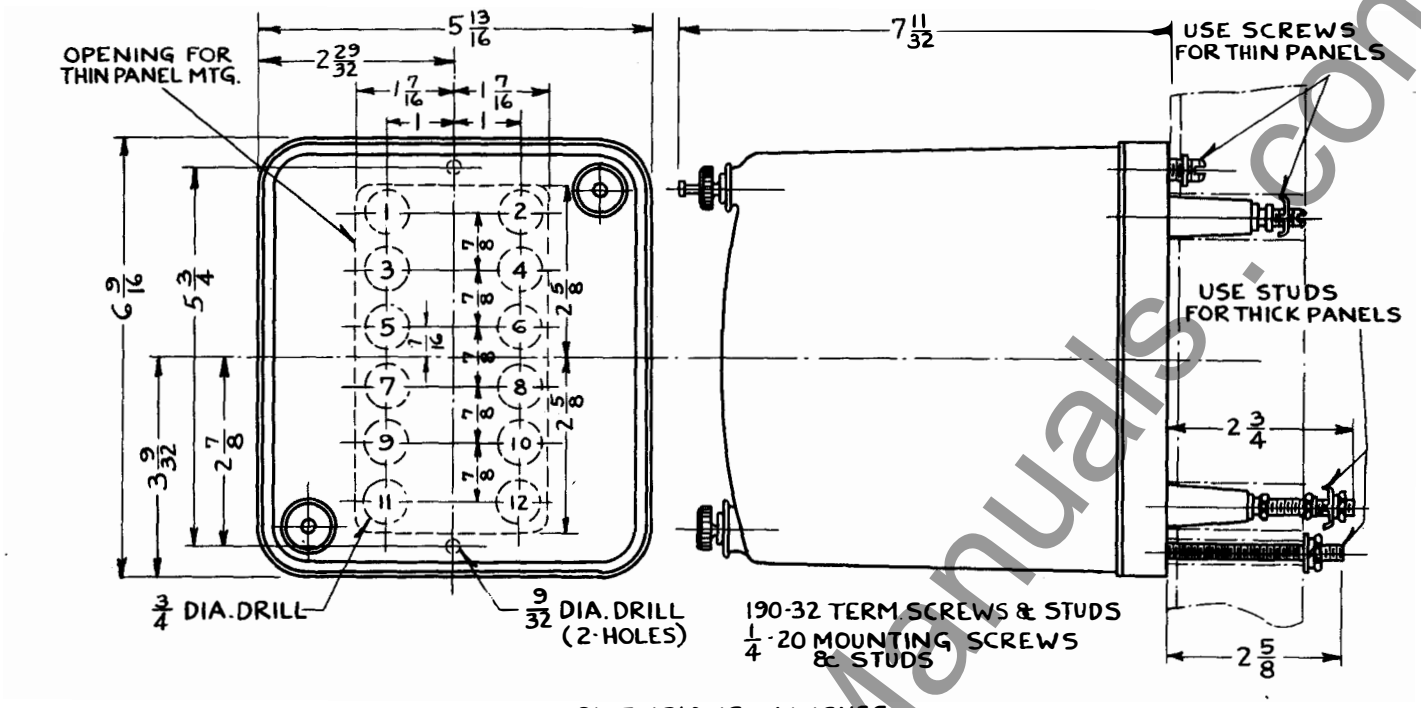

Figure 7
Outline & Drilling Plan for the Types PS-1, PS-2, and PS-3 Relays in the Standard Projection Type Case. (See figures 1, 2 and 3 for Terminals Supplied.)

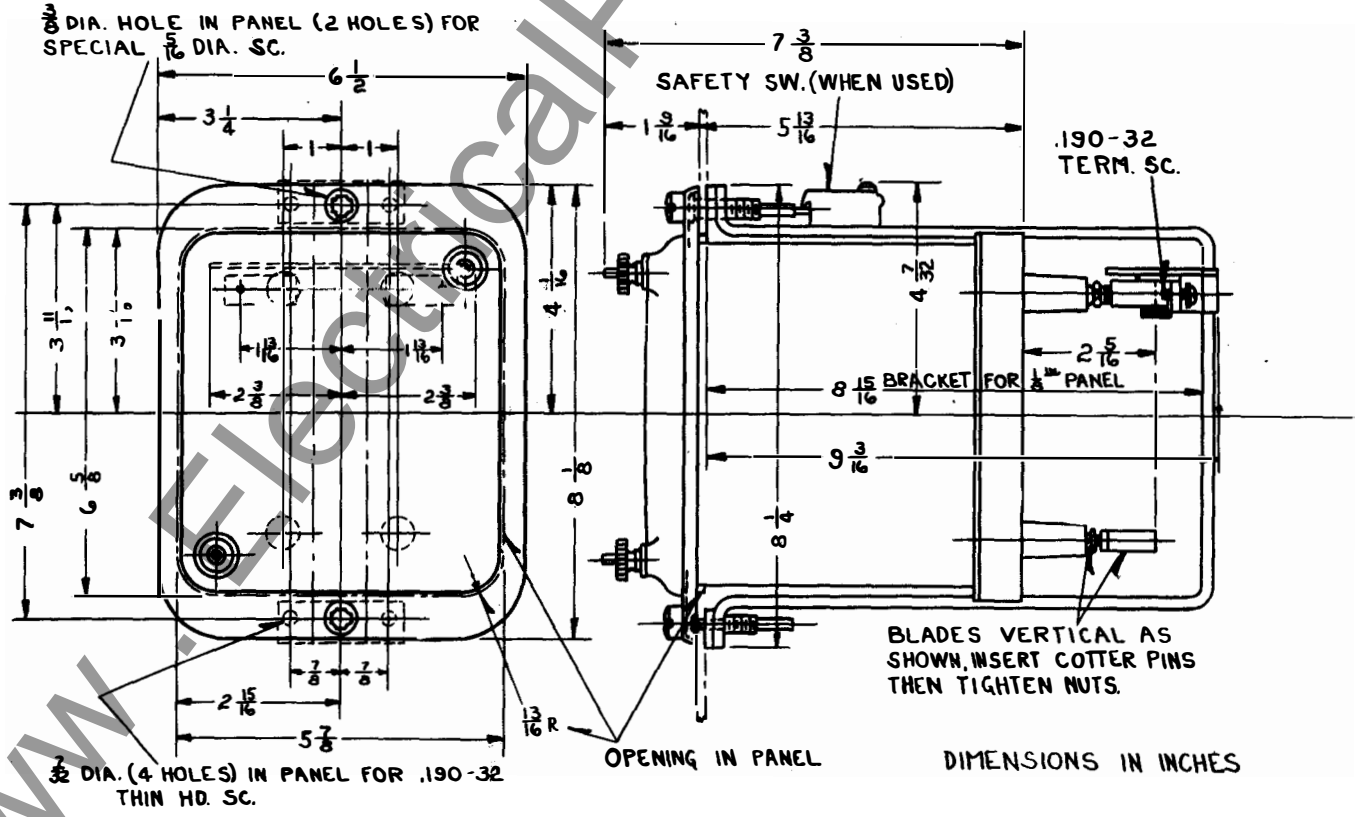

Figure 8
Outline & Drilling Plan for the Types PS-1, PS-2 and PS-3 Relays in the Standard Flush Detachable Type Case for 1/8" Panel mounting.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES PS-1, PS-2 AND PS-3 RELAYS

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing 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

The types PS-1 and PS-2 supervisory relays are used to detect short circuits, open circuits, grounds and reversals on pilot wires, particularly those used with the type HCB relay. The type PS-1 relay is located at one terminal to introduce the supervisory d-c. current to the pilot wires and to initiate an alarm when the pilot wires are faulted. The type PS-2 relay is located at the other end of the pilot wire circuit and operates to initiate and alarm at that terminal when the pilot wire is opened or shorted. This relay also provides the continuous visual indication and means of adjusting the supervisory current.

Where remote tripping is required, a type PS-3 relay with make contacts is used in place of the type PS-2 relay. This relay provides a means of tripping the local breaker by action of an auxiliary relay located at the type PS-1 relay terminal, but does not act as a fault detector to initiate an alarm at its station.

CONSTRUCTION AND OPERATION

The type PS-1 relay consists of a small transformer with taps on the primary, a full wave Rectox unit, a polarized relay, and a potentiometer for grounding the d-c circuit. The relay is also supplied with a 4 mfd. and a 10 mfd. condenser to be used with it as shown in figures 4 or 5.

The two capacitors serve as a filter to smooth out the pulsation of the rectified current to practically constant direct current which is introduced on to the pilot wires at the mid-tap of the type HCB relay insulating transformer.

The polarized relay consists of an armature and contact mounted on a leaf spring supported symmetrically within a magnetic frame. The poles of a permanent magnet clamp directly to each side of this frame. Flux from the permanent magnet divides into two paths, one path across the air gap at the front of the element in which the armature is located, the other across two gaps at the base of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias causing it to move towards the left-hand contact (front view). Two operating coils are placed around the armature and within the magnetic frame. The windings are connected in series with each of the pilot wires.

With the correct adjustment of the magnetic shunts the armature will always tend to travel towards the north pole of the front air gap with the coils deenergized. This holds the left-hand contact closed. When either of the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move towards the south pole, and the right-hand contact. Normally, the current through the relay coils is of such a magnitude that the armature floats midway between the right and left stationary contacts.

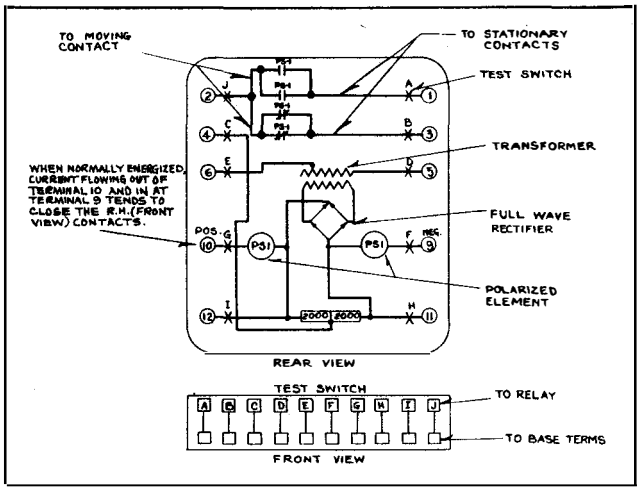

Fig. 1—Internal Schematic Of The Type PS-1 Relay In The Type FT Case.

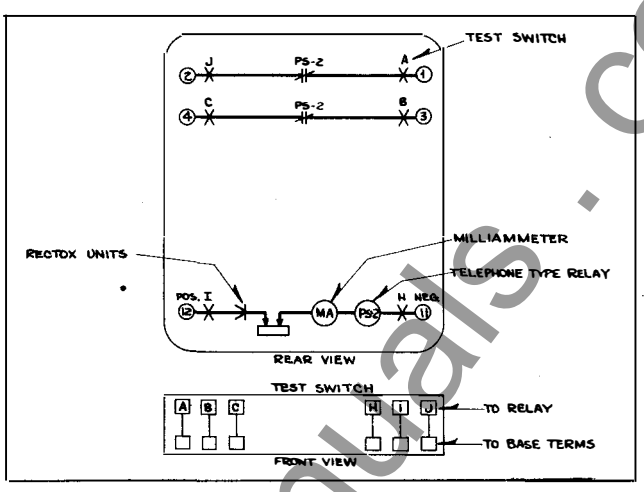

Fig. 2—Internal Schematic Of The Type PS-2 Relay In The Type FT Case.

The type PS-2 relay consists of a telephone type relay, a milliammeter, an adjustable resistor, and two Rectox units. The contacts of the telephone relay are closed at the de-energized position. When the relay is energized, the contacts stand open.

The type PS-3 relay is identical to the type PS-2 except that the contacts are open in the deenergized position. This relay does not function to initiate an alarm when the pilot wires are faulted.

CHARACTERISTICS

The type PS-1 relay transformer has 100, 110, 120 and 130 volt taps on the transformer primary. With tap voltage applied to the transformer primary, the relay will supply .001 ampere d-c to the pilot wire at approximately 17 volts d-c at the output terminals. This is sufficient to handle a 2000 ohm pilot wire, and a type PS-2 or PS-3 relay adjusted for approximately 15,000 ohms internal resistance with .001 amp flowing.

The type PS-2 and type PS-3 relays are adjustable from roughly 9000 to 15,000 ohms. The milliammeter has a 0-5 milliampere scale.

The type PS-1, PS-2 and PS-3 relays function to supervise the pilot wire as follows:

(1). Normal Pilot Wire

The relays are continuously energized with .001 ampere, d-c. which is introduced from an external a-c. source thru the type PS-1 relay and circulates over the pilot wire circuit. This current holds both the type PS-1 and PS-2 relay contacts open, and tends to close the type PS-3 relay contacts.

(2). Pilot Wire Short Circuited

Short circuits of 2,000 ohms resistance or less cause the circulating pilot wire current to increase above the normal value, thus closing the right-hand (front view) contacts of the type PS-1 relay and the undercurrent contacts of the PS-2 relay to initiate an alarm at both terminals of the pilot wire.

(3). Pilot Wire Open Circuited

Open circuits on the pilot wire will reduce the circulating supervisory current to zero, and again initiate an alarm at both the type PS-1 and PS-2 relay terminals.

(4). Pilot Wire Grounded

The connection of the separate windings of the type PS-1 relay in each of the pilot wire circuits provides two circuits of equal impedance from the grounded midtap of the potentiometer in the type PS-1 relay to the remote terminal on the pilot wire. The type PS-2 relay contains a relatively high resistance, such that when either pilot wire becomes grounded at any point along its length, unequal currents flow to operate the type PS-1 relay. This provides supervision

for ground fault resistance values of 500 ohms or less.

(5). Reversed Pilot Wires.

A reversal of the pilot wires will tend to pass current thru the type PS-2 or PS-3 relays in the reversed direction. The back resistance of the Rectox units in these relays is sufficiently high and, therefore, limits the magnitude of supervisory current so that both the type PS-1 and PS-2 relays operate on under current. Where the type PS-3 relay is used in place of the type PS-2 relay, only the type PS-1 relay operates on under current to ring an alarm.

Remote tripping is accomplished by applying an increased d-c voltage to the pilot wire as indicated in figure 5. When a 90 volt source is used, such as a "B" battery, the two resistors shown in the diagram should be 1100 ohms each to limit the pilot wire current to .005 ampere, which is sufficient to operate the PS-5 relay adjusted for .0015 or .002 ampere pick up. On the other hand, a 45 volt battery source may be used and the resistors omitted, in which case the pilot wire current will increase to approximately .004 ampere for the remote tripping operation.

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 houses the relay elements and supports 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.

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.

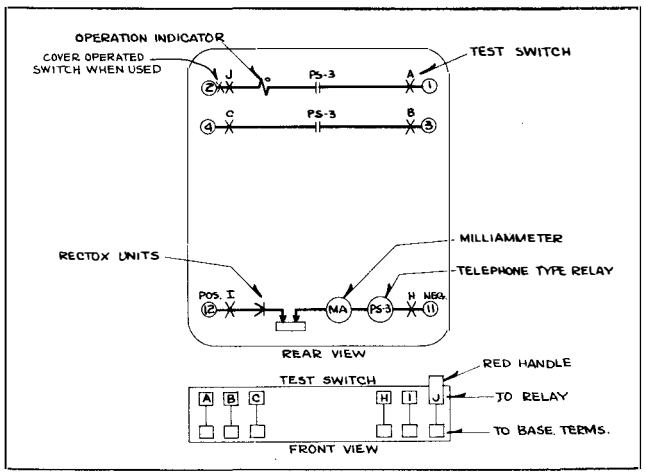

Fig. 3—Internal Schematic Of The Type PS-3 Relay In The Type FT Case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches.

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

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.

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 position as a final check on the 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 connections for the types PS-1 and PS-2 relays are shown in figure 4, and for the type PS-1 and PS-3 in figure 5. For information concerning the type HCB relay see I. L. 41-658.

CAUTION These relays are connected directly in the pilot wire circuit and must be protected against high potential resulting from induction or differences in ground potential between the pilot wire terminals.

SETTINGS

The relays are calibrated in the factory to be energized continuously with one milliampere

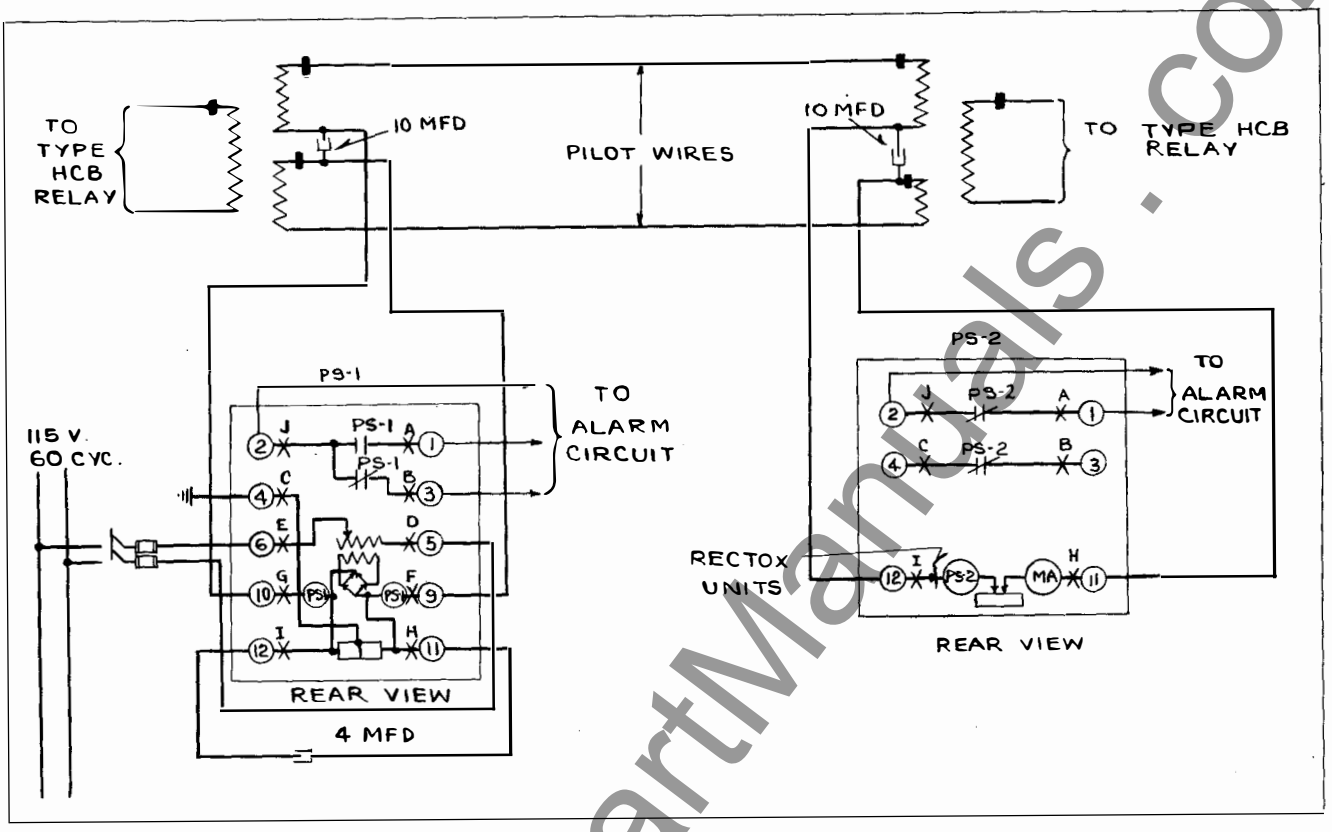

Fig. 4—External Connections For The Types PS-1 And PS-2 Relays For Pilot Wire Supervisory.

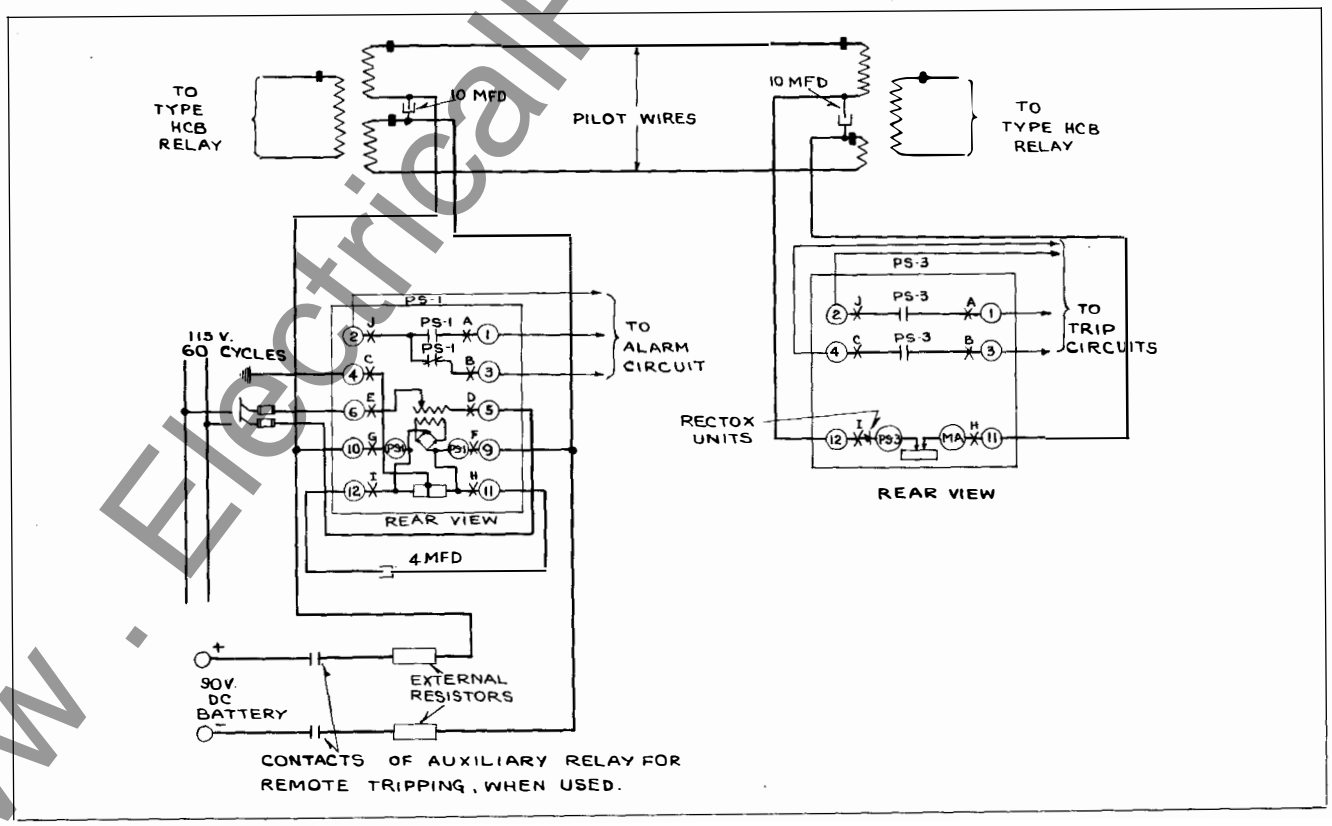

Fig. 5—External Connections Of The Types PS-1 And PS-3 Relays For Pilot Wire Supervisory And Remote Trip.

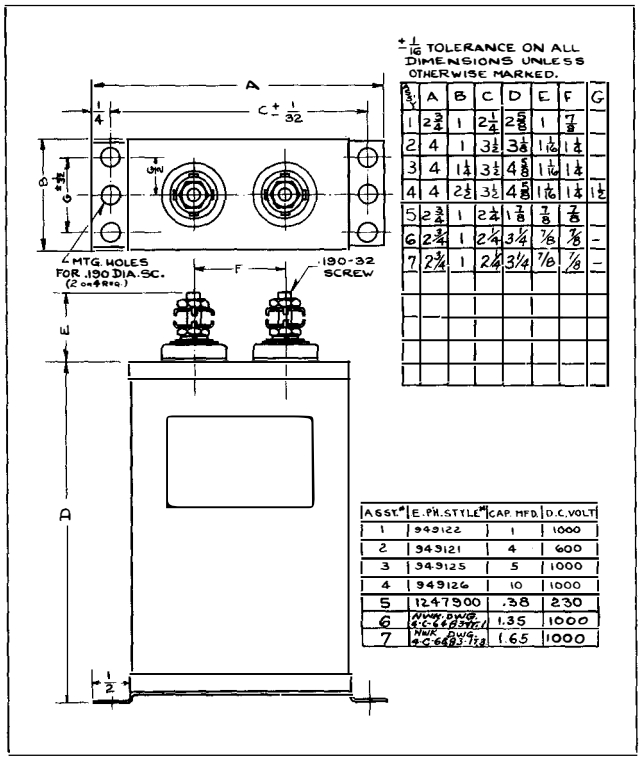

Fig. 6—Outline And Drilling Plan For The Auxiliary 4 And 10 Mfd. Capacitors. For Reference Only.

d-c. After the relays are checked and installed, the only setting required is to select the proper voltage tap in the type PS-1 relay and to adjust the slide wire resistance in the type PS-2 or PS-3 relay, so that the milliammeter in the relay indicates that one milliampere d-c. is circulating over the pilot wires. If difficulty is experienced in getting .001 ampere d-c supervisory current in the pilot wire, select the next lower or higher voltage tap in the PS-1 relay, as may be required.

If pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relays be set in the laboratory rather than while they are directly connected to the pilot wires. This precaution is to prevent injury to the personnel from high induced voltages. Neutralizing transformers are available for use to keep high voltages from the relay.

ADJUSTMENTS AND MAINTENANCE

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. Style #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.

Type PS-1 Relay, Polarized Element

With the relay de-energized and with the permanent magnet removed, the moving armature may be adjusted so that it floats between the poles or lightly touches the left-hand pole piece. This adjustment is made by loosening the core screw at the back of the element and shifting the entire core and contact assembly. Adjust the stationary contacts so that they make at the extreme limits of the armature travel. Then turn the contact screw from one-half to one turn to obtain contact follow. Varying this adjustment from one half to one turn is sometimes useful in trimming up the final adjustment of operating current values.

Reassemble the permanent magnet with the north pole to the left (front view) and pass .001 ampere thru the operating coils. This should be done by connecting the relays per figures 4 or 5 using an equivalent resistance in place of the pilot wires and insulating transformer. With this current thru the operating coils, adjust the magnetic shunts across the two rear air gaps so that the right-hand contacts close at approximately .0013 ampere, and the left-hand contacts close at approximately .0007 ampere. With this adjustment, the moving contacts should float approximately midway between the right and left-hand contacts at .001 ampere.

For three terminal pilot wire applications, the contacts should float at .002 ampere, close to the right at .0023 to .0024 ampere, and close to the left at .0016 to .0017 ampere.

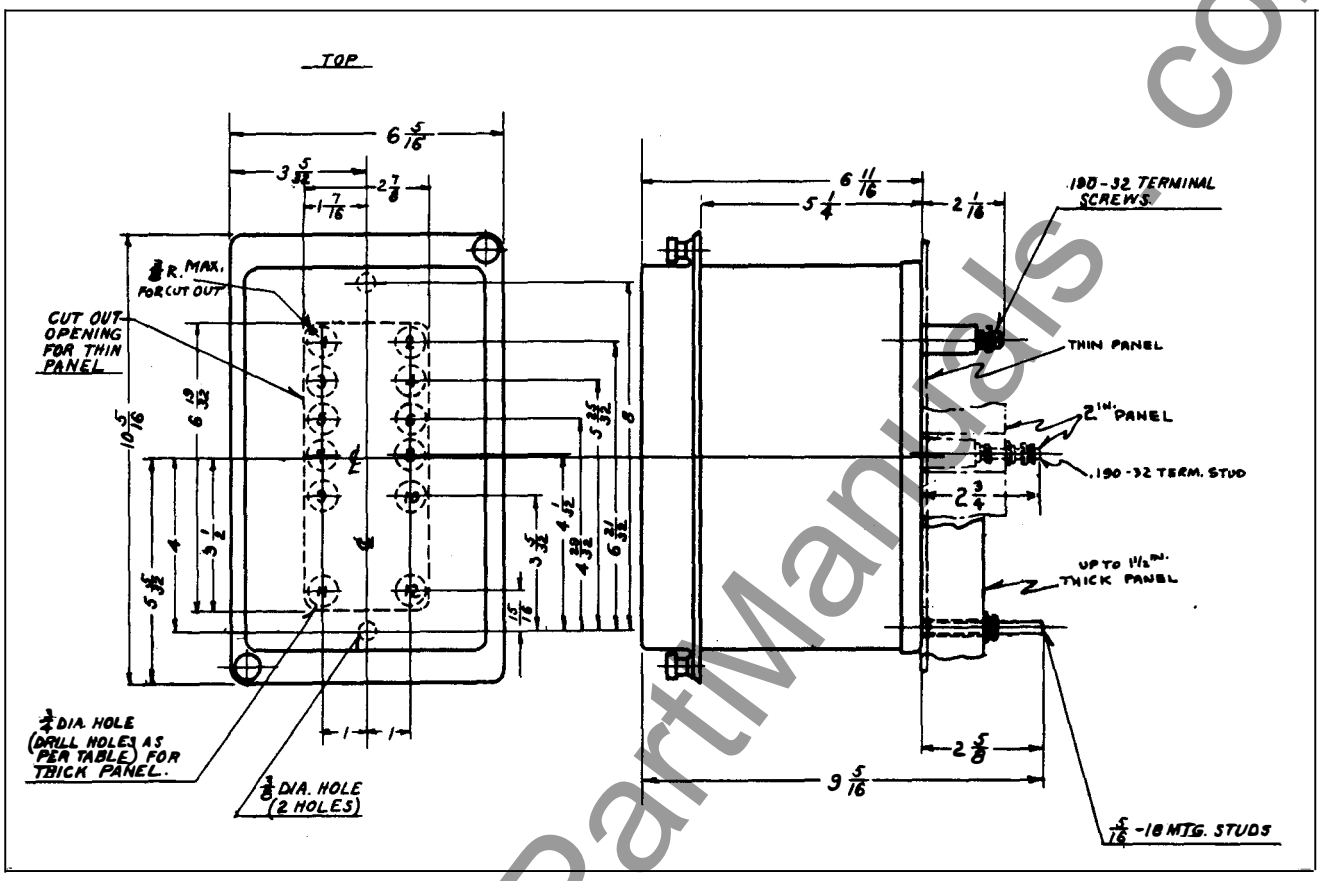

Fig. 7—Outline And Drilling Plan For The S10 Projection Type FT Flexitest Case. See The Internal Schematics For The Terminals Supplied. For Reference Only.

A good way to make the adjustment is to start with both shunts all the way in, then draw out the right hand shunt until the right hand contacts close at the desired current value, then draw out the left hand shunt until the left hand contacts close at the desired value, then readjust the right hand shunt, for closing the right hand contacts, working back and forth between the two sides until the adjustment is complete. The final readings should be taken with the shunts secured in place by means of the locking screws provided.

Type PS-2 Relays, Telephone Element

With the relays connected per figure 4, adjust the armature gap and spring tension of the telephone-type relay so that its contacts open with .0008 ampere and above and close at approximately .0006 ampere and below. The normal contact gap should be approx. 1/32 inch and should have a contact follow of approximately 1/64 inch.

Type PS-3 Relay, Telephone Element

With the relays connected per figure 5, adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .0015 or .002 ampere and above.

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 60 cycle burden of the type PS-1 relay is approximately 0.5 volt ampere at tap voltage with .001 ampere d-c flowing over the pilot wire.

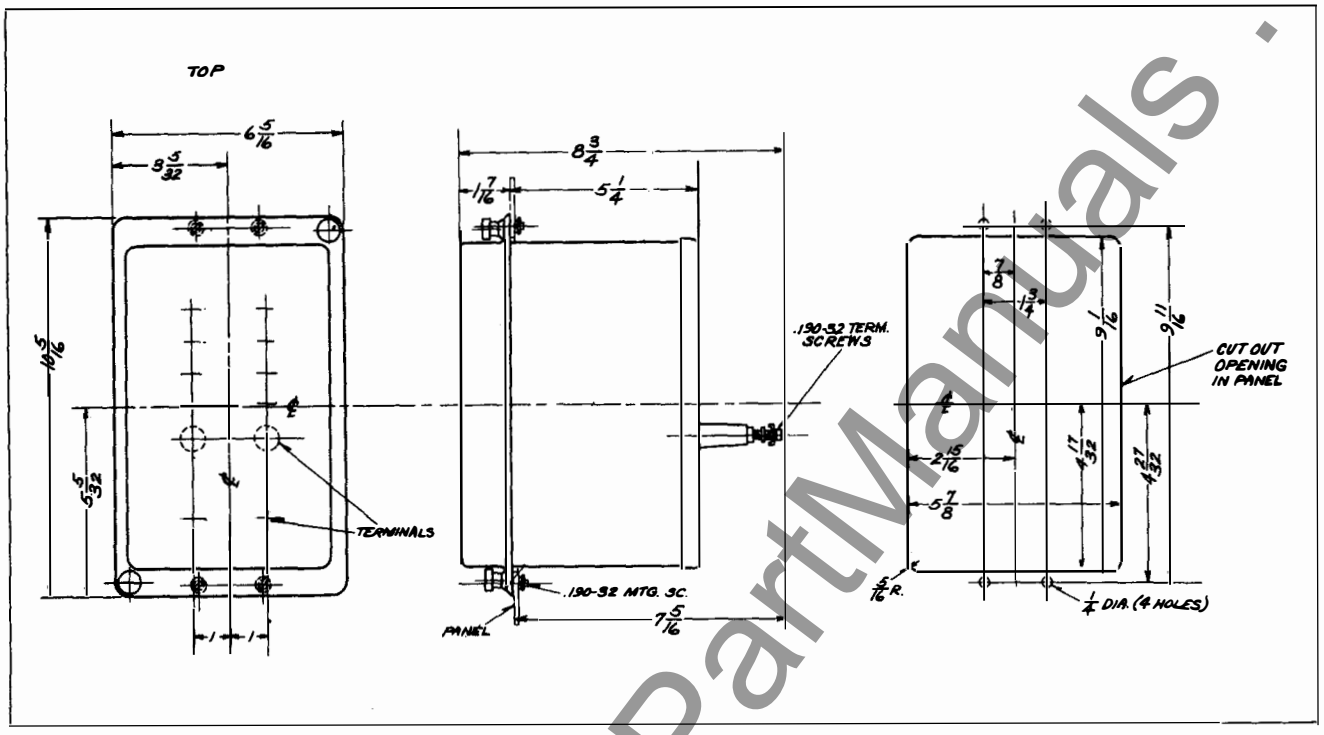

Fig. 8—Outline And Drilling Plan For The S10 Semi-Flush Type FT Flexitest Case. For Reference Only.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES PS-1, PS-2 AND PS-3 RELAYS

(A-C OPERATED)

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing 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

The types PS-1 and PS-2 supervisory relays are used to detect short circuits, open circuits, grounds and reversals on pilot wires, particularly those used with the type HCB relay. The type PS-1 relay is located at one terminal to introduce the supervisory d-c. current to the pilot wires and to initiate an alarm when the pilot wires are faulted. The type PS-2 relay is located at the other end of the pilot wire circuit and operates to initiate an alarm at that terminal when the pilot wire is opened or shorted. This relay also provides the continuous visual indication and means of adjusting the supervisory current.

Where remote tripping is required, a type PS-3 relay with make contacts is used in place of the type PS-2 relay. This relay provides a means of tripping the local breaker by action of an auxiliary relay located at the type PS-1 relay terminal, but does not act as a fault detector to initiate an alarm at its station.

CONSTRUCTION AND OPERATION

The type PS-1 relay consists of a small transformer with taps on the primary, a full wave Rectox unit, a polarized relay, and a potentiometer for grounding the d-c circuit. The relay is also supplied with a 4 mfd. and a 10 mfd. condenser to be used with it as shown in Figures 7 to 10.

The two capacitors serve as a filter to smooth out the pulsation of the rectified current to practically constant direct current which is introduced on to the pilot wires at the mid-tap of the type HCB relay insulating transformer.

The polarized relay consists of an armature and contact mounted on a leaf spring supported symmetrically within a magnetic frame. The poles of a permanent magnet clamp directly to each side of this frame. Flux from the permanent magnet divides into two paths, one path across the air gap at the front of the element in which the armature is located, the other across two gaps at the base of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias causing it to move towards the left-hand contact (front view). Two operating coils are placed around the armature and within the magnetic frame. The windings are connected in series with each of the pilot wires.

With the correct adjustment of the magnetic shunts the armature will always tend to travel towards the north pole of the front air gap with the coils deenergized. This holds the left-hand contact closed. When either of the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move toward the south poles, and the right-hand contact

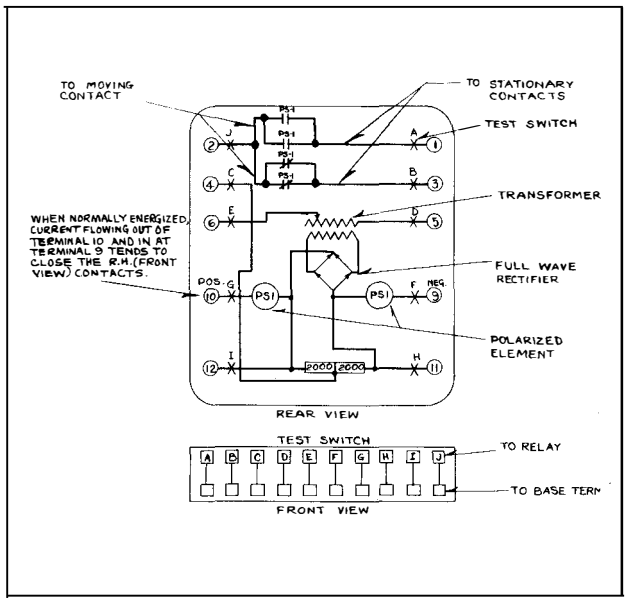

Fig. 1—Internal Schematic of the Type PS-1 Relay in the Type FT Case.

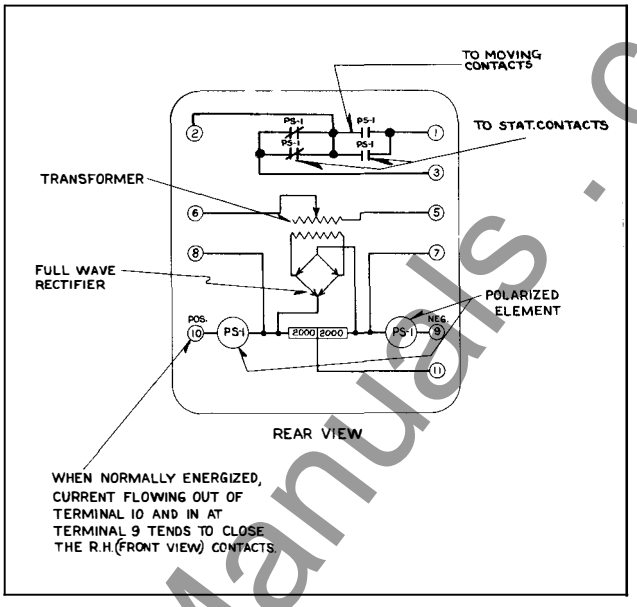

Fig. 2—Internal Schematic of the Type PS-1 Relay in the Standard Case.

Normally, the current through the relay coils is of such a magnitude that the armature floats midway between the right and left stationary contacts.

The type PS-2 relay consists of a telephone type relay, a milliammeter, an adjustable resistor, and two Rectox units. The contacts of the telephone relay are closed at the de-energized position. When the relay is energized, the contacts stand open.

The type PS-3 relay is identical to the type PS-2 except that the contacts are open in the deenergized position. This relay does not function to initiate an alarm when the pilot wires are faulted.

CHARACTERISTICS

The type PS-1 relay transformer has 100, 110, 120 and 130 volt taps on the transformer primary. With tap voltage applied to the transformer primary, the relay will supply .001 ampere d-c to the pilot wire at approximately 17 volts d-c at the output terminals. This is sufficient to handle a 2000 ohm pilot wire, and a type PS-2 or PS-3 relay adjusted for approximately 15,000 ohms internal resistance with .001 amp flowing.

The type PS-1, PS-2 and PS-3 relays function to supervise the pilot wire as follows:

(1). Normal Pilot Wire

The relays are continuously energized with .001 ampere d-c. which is introduced from an external a-c. source thru the type PS-1 relay and circulates over the pilot wire circuit. This current holds both the type PS-1 and PS-2 relay contacts open, and tends to close the type PS-3 relay contacts.

(2). Pilot Wire Short Circuited

Short circuits of 2,000 ohms resistance or less cause the circulating pilot wire current to increase above the normal value, thus closing the right-hand (front view) contacts of the type PS-1 relay and the undercurrent contacts of the PS-2 relay to initiate an alarm at both terminals of the pilot wire.

(3). Pilot Wire Open Circuited

Open circuits on the pilot wire will reduce the circulating supervisory current to zero, and again initiate an alarm at both the type PS-1 and PS-2 relay terminals.

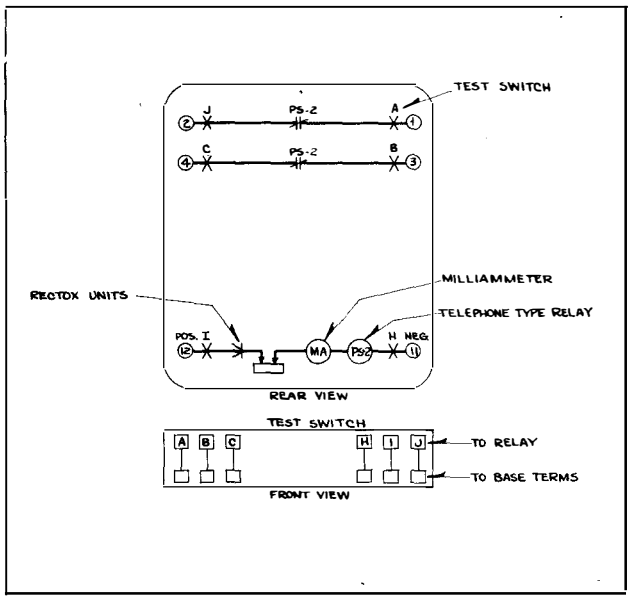

Fig. 3—Internal Schematic of the Type PS-2 Relay in the Type FT Case.

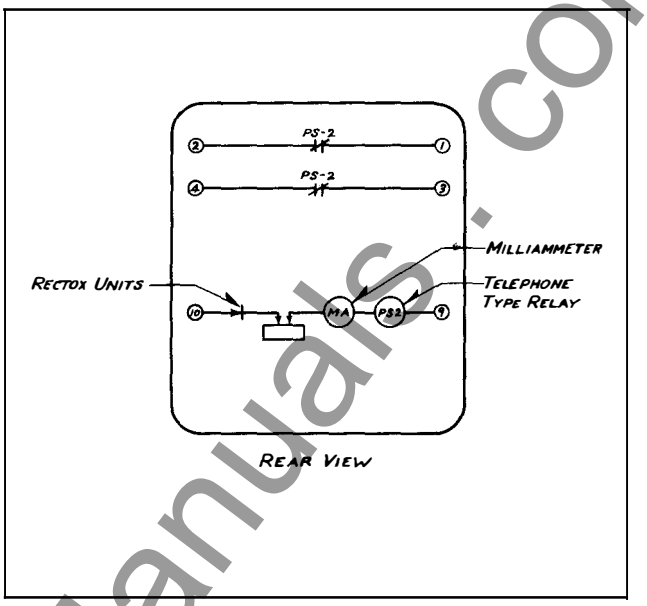

Fig. 4—Internal Schematic of the Type PS-2 Relay in the Standard Case.

(4). Pilot Wire Grounded

The connection of the separate windings of the type PS-1 relay in each of the pilot wire circuits provides two circuits of equal impedance from the gounded midtap of the potentiometer in the type PS-1 relay to the remote terminal on the pilot wire. The type PS-2 relay contains a relatively high resistance, such that when either pilotwire becomes gounded at any point along its length, unequal currents flow to operate the type PS-1 relay. This provides supervision for ground fault resistance values of 500 ohms or less.

(5). Reversed Pilot Wires.

A reversal of the pilot wires will tend to pass current thru the type PS-2 or PS-3 relays in the reversed direction. The back resistance of the Rectox units in these relays is sufficiently high and, therefore, limits the magnitude of supervisory current so that both the type PS-1 and PS-2 relays operate on under current. Where the type PS-3 relay is used in place of the type PS-2 relay, only the type PS-1 relay operates on under current to ring an alarm.

Remote tripping is accomplished by applying an increased d-c voltage to the pilot wire as indicated in Figures 8 and 10. When a 90 volt source is used, such as a "B" battery, the two resistors shown in the diagram should be 1100 ohms each to limit the pilot wire current to .005 ampere, which is sufficient to operate the PS-5 relay adjusted for .0015 or .002 ampere pick up. On the other hand, a 45 volt battery source may be used and the resistors omitted, in which case the pilot wire current will increase to approximately .004 ampere for the remote tripping operation.

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 houses the relay elements and supports the

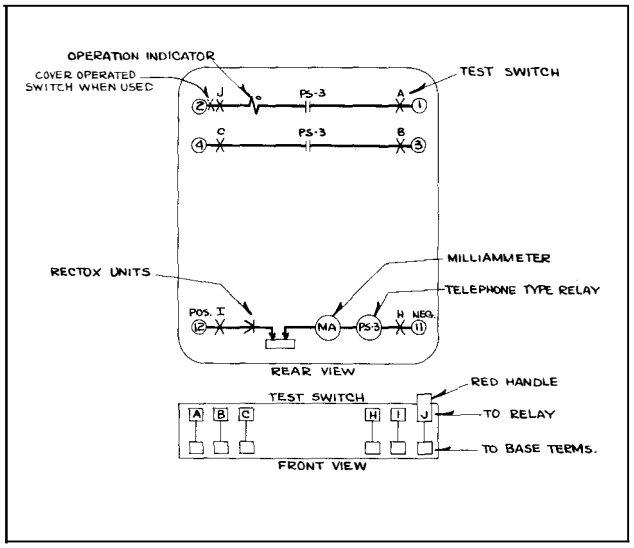

Fig. 5—Internal Schematic of the Type PS-3 Relay in the Type FT Case.

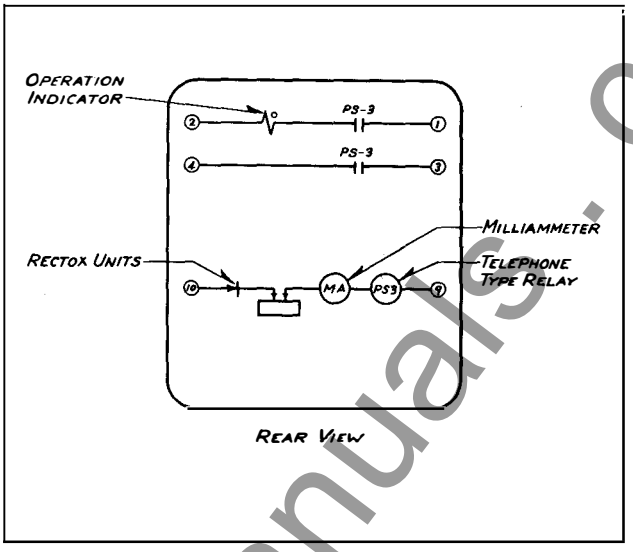

Fig. 6—Internal Schematic of the Type PS-3 Relay in the Standard Case.

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.

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.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit

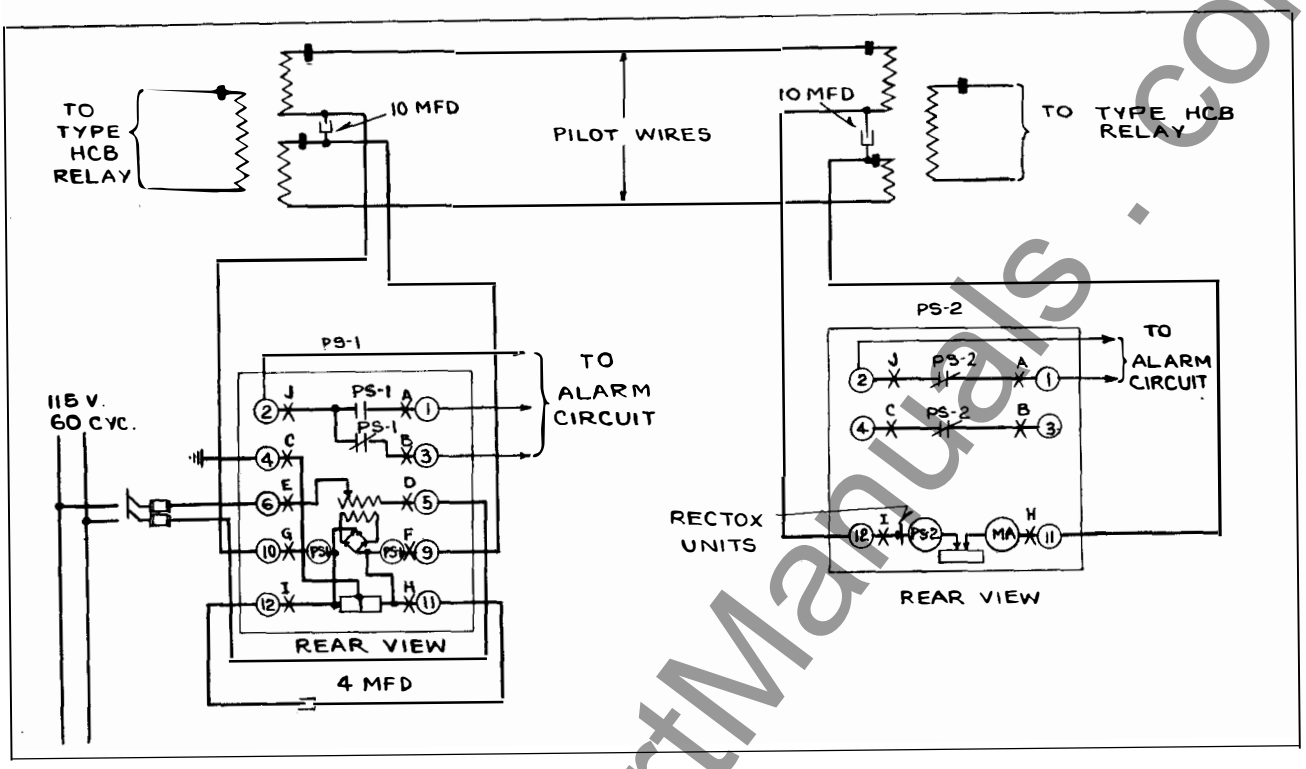

Fig. 7—External Connections for the Types PS-1 and PS-2 Relays in the Type FT Case for Pilot Wire Supervision of a Two Terminal Line.

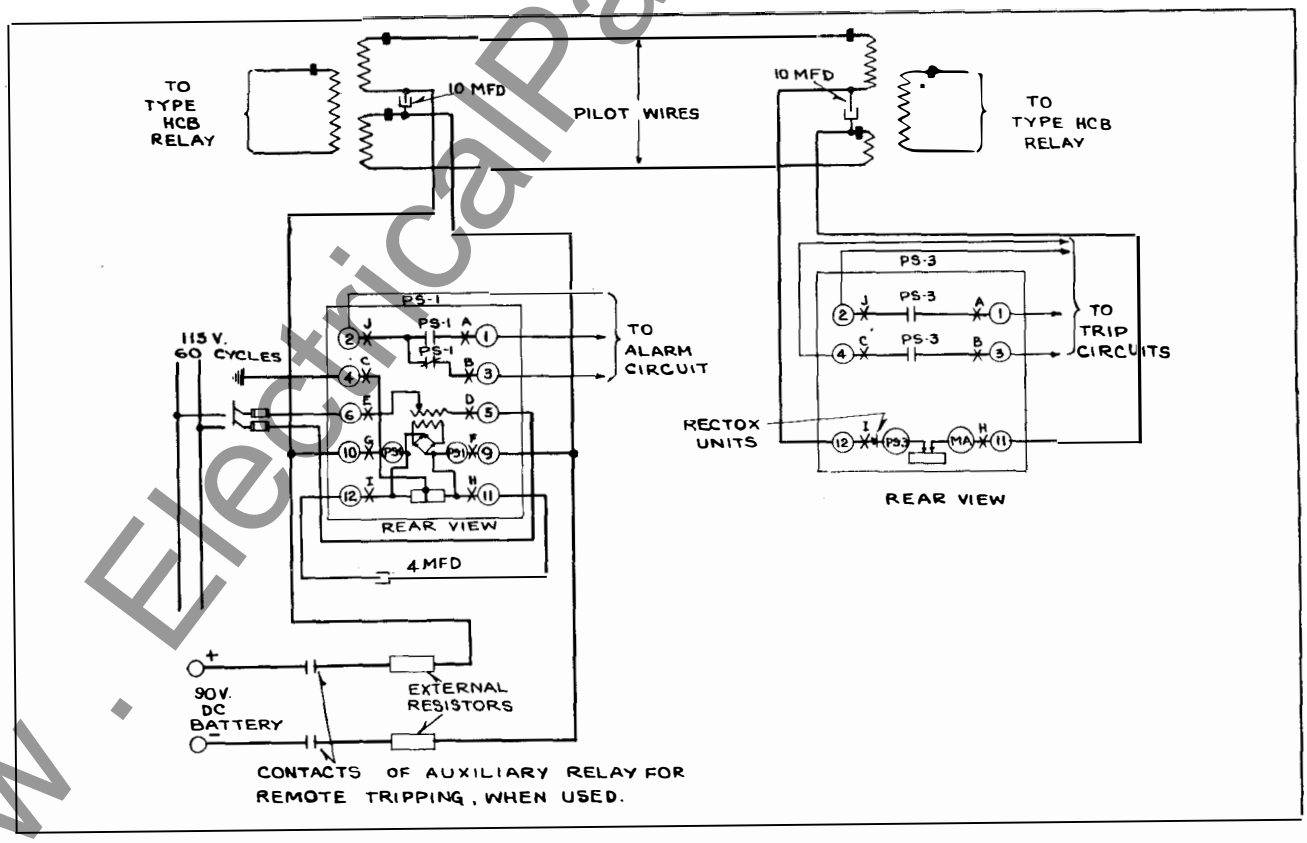

Fig. 8—External Connections of the Types PS-1 and PS-3 Relays in the Type FT Case for Pilot Wire Supervision and Remote Trip of a Two Terminal Line.

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

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.

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 position as a final check on the 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 connections for the types PS-1 and PS-2 relays are shown in Figures 7 or 9, and for the type PS-1 and PS-3 in Figures 8 or 10. For information concerning the type HCB relay see I.L. 41-658.

CAUTION These relays are connected directly in the pilot wire circuit and must be protected against high potential resulting from induction or differences in ground potential between the pilot wire terminals.

SETTINGS

The relays are calibrated in the factory to be energized continuously with one milliampere d-c. After the relays are checked and installed, the only setting required is to select the proper voltage tap in the type PS-1 relay and to adjust the slide wire resistance in the type PS-2 or PS-3 relay, so that the milliammeter in the relay indicates that one milliampere d-c. is circulating over the pilot wires. If difficulty is experienced in getting .001 ampere d-c supervisory current in the pilot wire, select the next lower or higher voltage tap in the PS-1 relay, as may be required.

If pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relays be set in the laboratory rather than while they are directly connected to the pilot wires. This precaution is to prevent injury to the personnel from high induced voltages. Neutralizing transformers

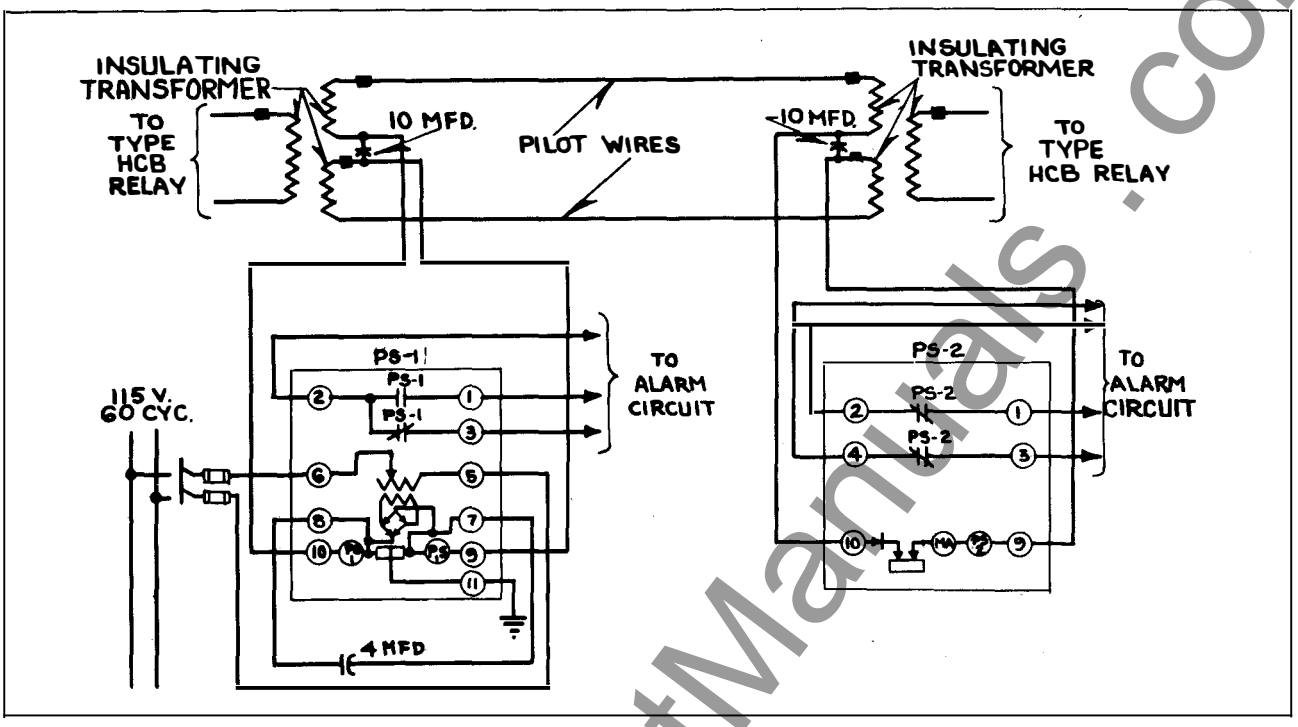

Fig. 9—External Connections of the Types PS-1 and PS-2 Relays in the Standard Case for Pilot Wire Supervision of a Three Terminal Line.

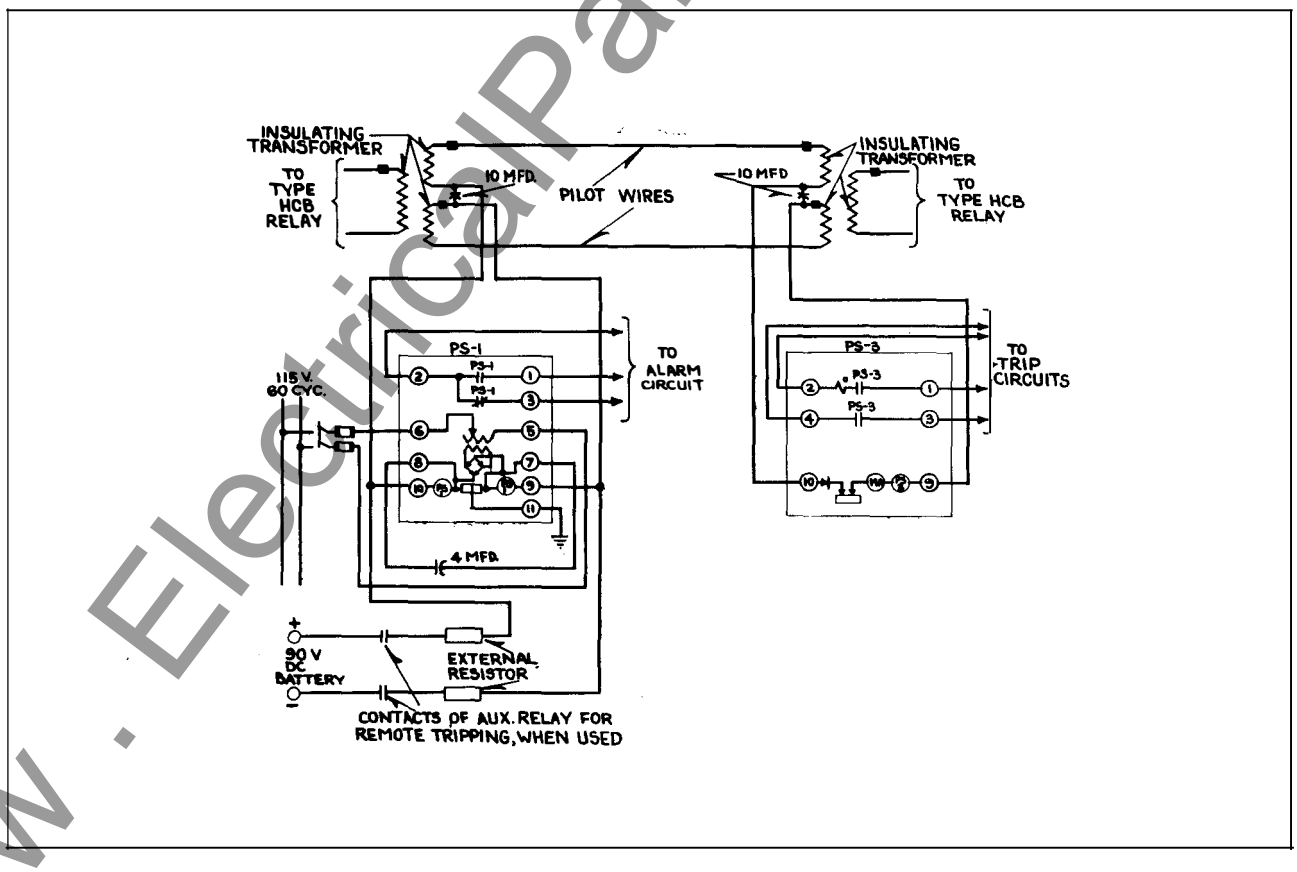

Fig. 10—External Connections of the Types PS-1 and PS-3 Relays in the Standard Case for Pilot Wire Supervision and Remote Trip of a Two Terminal Line.

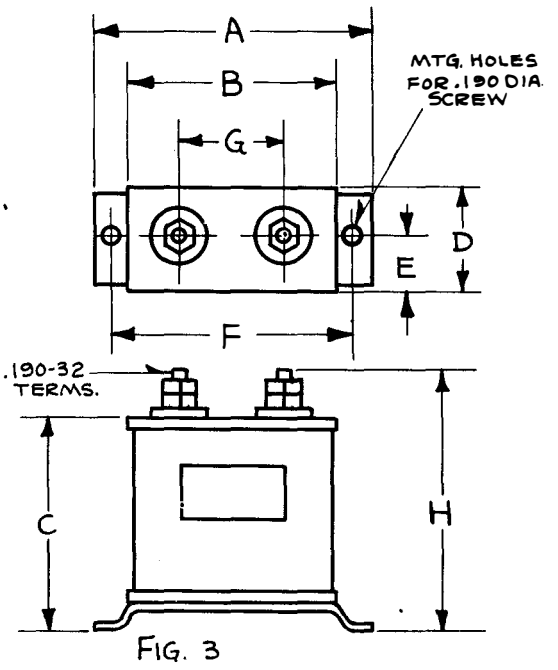

FIG. 3

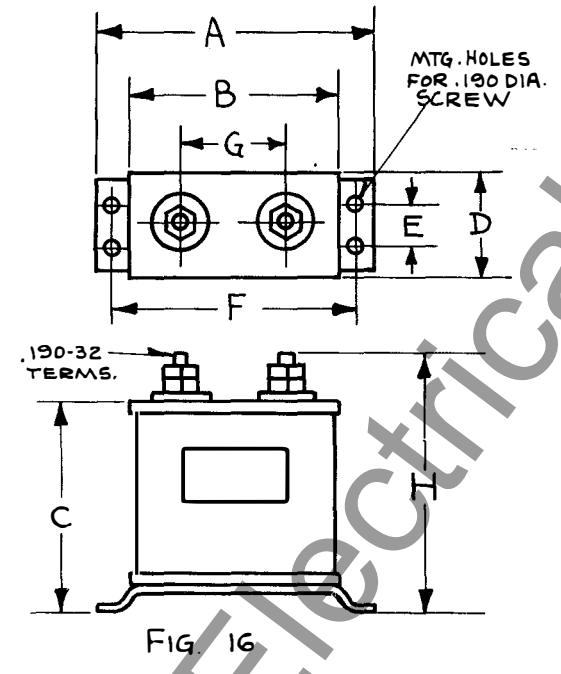

FIG. 16

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
3	±1/32 4	3	3 1/8	+1/16 -1/32	±1/32 1 1/2	±1/32 3 1/2	±1/32 1 1/4	+1/8-1/16 4 5/16
16	4	3	4 5/8	2 1/2	±1/32 1 1/2	±1/32 3 1/2	1 1/4	+1/8-1/16 5 1/16

Fig. 11—Outline and Drilling Plan for the Auxiliary 4 and 10 Mfd. Capacitors. For Reference Only.

are available for use to keep high voltages from the relay.

ADJUSTMENTS AND MAINTENANCE

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. Style #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.

Type PS-1 Relay, Polarized Element

With the relay de-energized and with the permanent magnet removed, the moving armature may be adjusted so that it floats between the poles or lightly touches the left-hand pole piece. This adjustment is made by loosening the core screw at the back of the element and shifting the entire core and contact assembly. Adjust the stationary contacts so that they make at the extreme limits of the armature travel. Then turn the contact screw from one-half to one turn to obtain contact follow. Varying this adjustment from one half to one turn is sometimes useful in trimming up the final adjustment of operating current values.

Reassemble the permanent magnet with the north pole to the left (front view) and pass .001 ampere thru the operating coils. This should be done by connecting the relays per Figures 7 to 10 using an equivalent resistance in place of the pilot wires and insulating transformer. With this current thru the operating coils, adjust the magnetic shunts across the two rear air gaps so that the

right-hand contacts close at approximately .0013 ampere, and the left-hand contacts close at approximately .0007 ampere. With this adjustment, the moving contacts should float approximately midway between the right and left-hand contacts at .001 ampere.

For three terminal pilot wire applications, the contacts should float at .002 ampere, close to the right at .0023 to .0024 ampere, and close to the left at .0016 to .0017 ampere.

A good way to make the adjustment is to start with both shunts all the way in, then draw out the right hand shunt until the right hand contacts close at the desired current value, then draw out the left hand shunt until the left hand contacts close at the desired value, then readjust the right hand shunt, for closing the right hand contacts, working back and forth between the two sides until the adjustment is complete. The final readings should be taken with the shunts secured in place by means of the locking screws provided.

Type PS-2 Relays, Telephone Element

With the relays connected per Figure 4, adjust the armature gap and spring tension of the telephone-type relay so that its contacts open with .0008 ampere and above and close at approximately .0006 ampere and below. The normal contact gap should be approx. 1/32 inch and should have a contact follow of approximately 1/64 inch.

Type PS-3 Relay, Telephone Element

With the relays connected per Figure 8 or 10 adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .0015 or .002 ampere and above.

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 60 cycle burden of the type PS-1 relay is approximately 0.5 volt ampere at tap voltage with .001 ampere d-c flowing over the pilot wire.

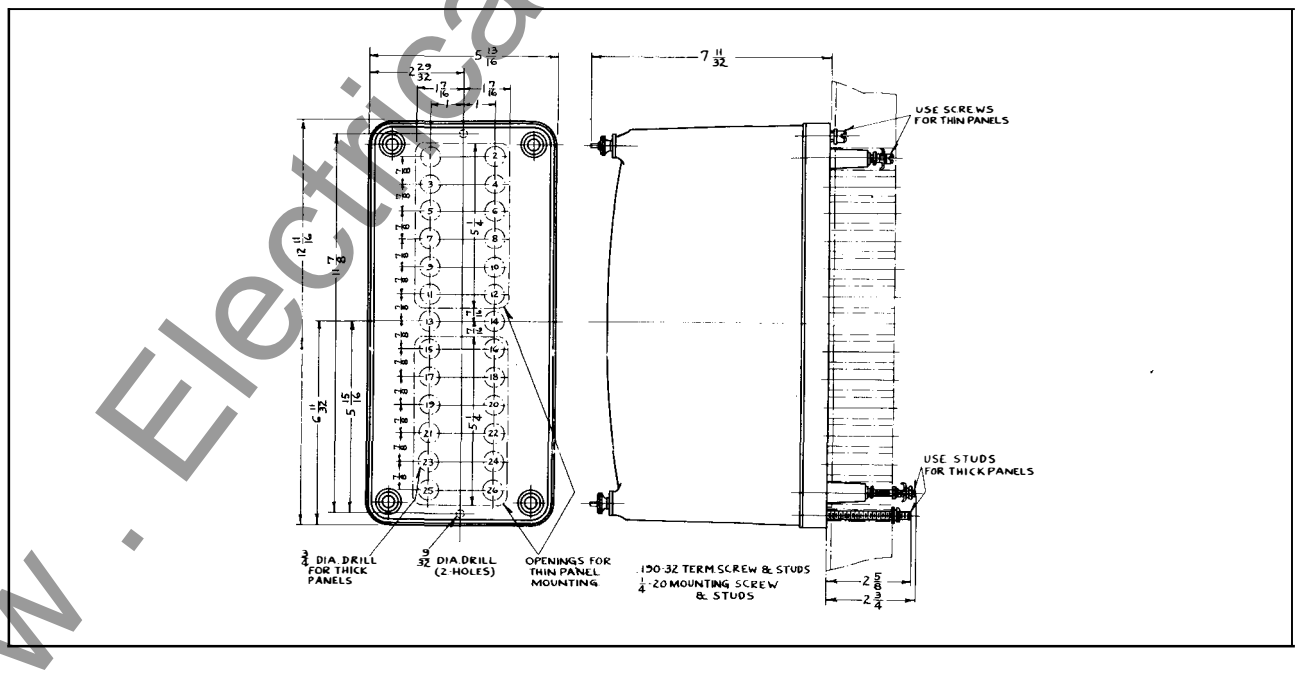

Fig. 12—Outline and Drilling Plan for the Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

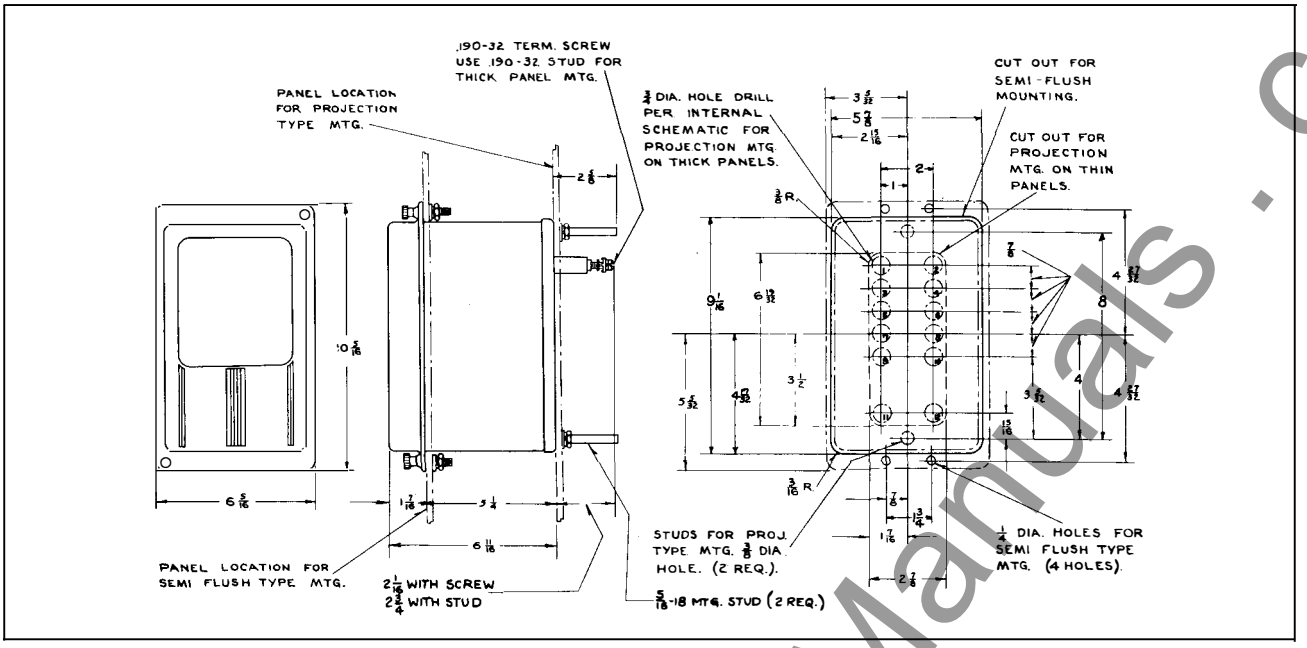

Fig. 13—Outline and Drilling Plan for the S10 Semi-flush or Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES PS-1, PS-2 AND PS-3 RELAYS

(A-C OPERATED)

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing 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

The types PS-1 and PS-2 supervisory relays are used to detect short circuits, open circuits, grounds and reversals on pilot wires, particularly those used with the type HCB relay. The type PS-1 relay is located at one terminal to introduce the supervisory d-c. current to the pilot wires and to initiate an alarm when the pilot wires are faulted. The type PS-2 relay is located at the other end of the pilot wire circuit and operates to initiate an alarm at that terminal when the pilot wire is opened or shorted. This relay also provides the continuous visual indication and means of adjusting the supervisory current.

Where remote tripping is required, a type PS-3 relay with make contacts is used in place of the type PS-2 relay. This relay provides a means of tripping the local breaker by action of an auxiliary relay located at the type PS-1 relay terminal, but does not act as a fault detector to initiate an alarm at its station.

CONSTRUCTION AND OPERATION

The type PS-1 relay consists of a small transformer with taps on the primary, a full wave Rectox unit, a polarized relay, and a potentiometer for grounding the d-c circuit. The relay is also supplied with a 4 mfd. and a 10 mfd. condenser to be used with it as shown in Figures 7 to 10.

The two capacitors serve as a filter to smooth out the pulsation of the rectified current to practically constant direct current which is introduced on to the pilot wires at the mid-tap of the type HCB relay insulating transformer.

The polarized relay consists of an armature and contact mounted on a leaf spring supported symmetrically within a magnetic frame. The poles of a permanent magnet clamp directly to each side of this frame. Flux from the permanent magnet divides into two paths, one path across the air gap at the front of the element in which the armature is located, the other across two gaps at the base of the frame. Two adjustable shunts are located across the rear air gaps. These change the reluctance of the magnetic path so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armature polarizes it and creates a magnetic bias causing it to move towards the left-hand contact (front view). Two operating coils are placed around the armature and within the magnetic frame. The windings are connected in series with each of the pilot wires.

With the correct adjustment of the magnetic shunts the armature will always tend to travel towards the north pole of the front air gap with the coils deenergized. This holds the left-hand contact closed. When either of the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move toward the south poles, and the right-hand contact.

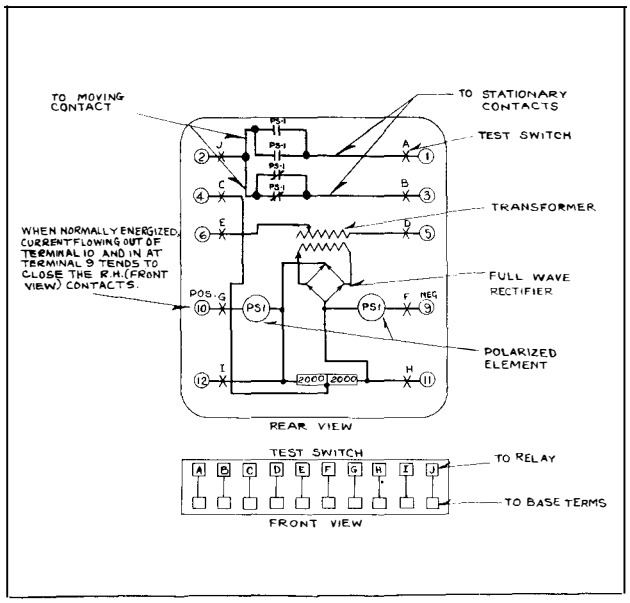

Fig. 1—Internal Schematic of the Type PS-1 Relay in the Type FT Case.

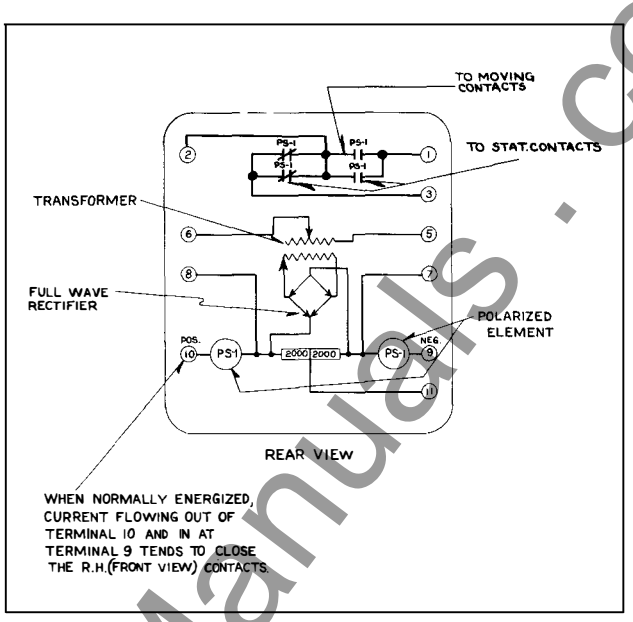

Fig. 2—Internal Schematic of the Type PS-1 Relay in the Standard Case.

Normally, the current through the relay coils is of such a magnitude that the armature floats midway between the right and left stationary contacts.

The type PS-2 relay consists of a telephone type relay, a milliammeter, an adjustable resistor, and two Rectox units. The contacts of the telephone relay are closed at the de-energized position. When the relay is energized, the contacts stand open.

The type PS-3 relay is identical to the type PS-2 except that the contacts are open in the deenergized position. This relay does not function to initiate an alarm when the pilot wires are faulted.

CHARACTERISTICS

The type PS-1 relay transformer has 100, 110, 120 and 130 volt taps on the transformer primary. With tap voltage applied to the transformer primary, the relay will supply .001 ampere d-c to the pilot wire at approximately 17 volts d-c at the output terminals. This is sufficient to handle a 2000 ohm pilot wire, and a type PS-2 or PS-3 relay adjusted for approximately 15,000 ohms internal resistance with .001 amp. flowing. If necessary as much as 130 volts may be used continuously on any of the taps marked from 100 to 130.

The type PS-1, PS-2 and PS-3 relays function to supervise the pilot wire as follows:

(1). Normal Pilot Wire

The relays are continuously energized with .001 ampere d-c. which is introduced from an external a-c. source thru the type PS-1 relay and circulates over the pilot wire circuit. This current holds both the type PS-1 and PS-2 relay contacts open, and tends to close the type PS-3 relay contacts.

(2). Pilot Wire Short Circuited

Short circuits of 2,000 ohms resistance or less cause the circulating pilot wire current to increase above the normal value, thus closing the right-hand (front view) contacts of the type PS-1 relay and the undercurrent contacts of the PS-2 relay to initiate an alarm at both terminals of the pilot wire.

(3). Pilot Wire Open Circuited

Open circuits on the pilot wire will reduce the circulating supervisory current to zero, and again initiate an alarm at both the type PS-1 and PS-2 relay terminals.

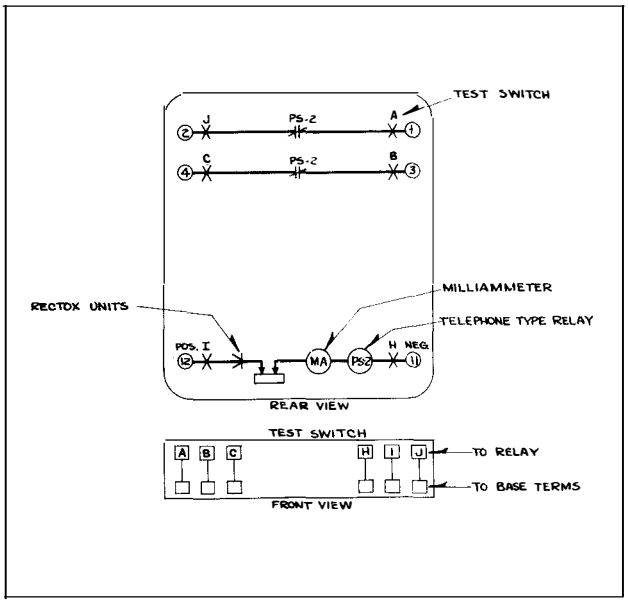

Fig. 3—Internal Schematic of the Type PS-2 Relay in the Type FT Case.

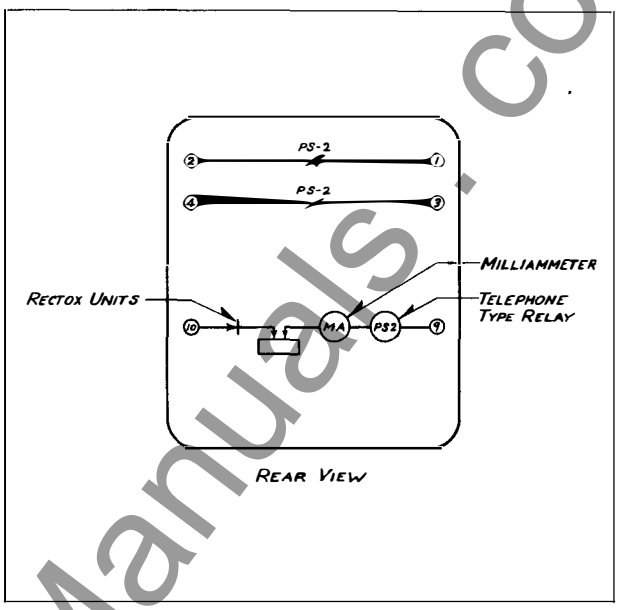

Fig. 4—Internal Schematic of the Type PS-2 Relay in the Standard Case.

(4). Pilot Wire Grounded

The connection of the separate windings of the type PS-1 relay in each of the pilot wire circuits provides two circuits of equal impedance from the grounded midtap of the potentiometer in the type PS-1 relay to the remote terminal on the pilot wire. The type PS-2 relay contains a relatively high resistance, such that when either pilot wire becomes grounded at any point along its length, unequal currents flow to operate the type PS-1 relay. This provides supervision for ground fault resistance values of 500 ohms or less.

(5). Reversed Pilot Wires

A reversal of the pilot wires will tend to pass current thru the type PS-2 or PS-3 relays in the reversed direction. The back resistance of the Rectox units in these relays is sufficiently high and, therefore, limits the magnitude of supervisory current so that both the type PS-1 and PS-2 relays operate on under current. Where the type PS-3 relay is used in place of the type PS-2 relay, only the type PS-1 relay operates on under current to ring an alarm.

Remote tripping is accomplished by applying an increased d-c voltage to the pilot wire as indicated in Figures 8 and 10. When a 90 volt source is used, such as a "B" battery, the two resistors shown in the diagram should be 1100 ohms each to limit the pilot wire current to .005 ampere, which is sufficient to operate the PS-3 relay adjusted for .0015 or .002 ampere pick up. On the other hand, a 45 volt battery source may be used and the resistors omitted, in which case the pilot wire current will increase to approximately .004 ampere for the remote tripping operation.

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

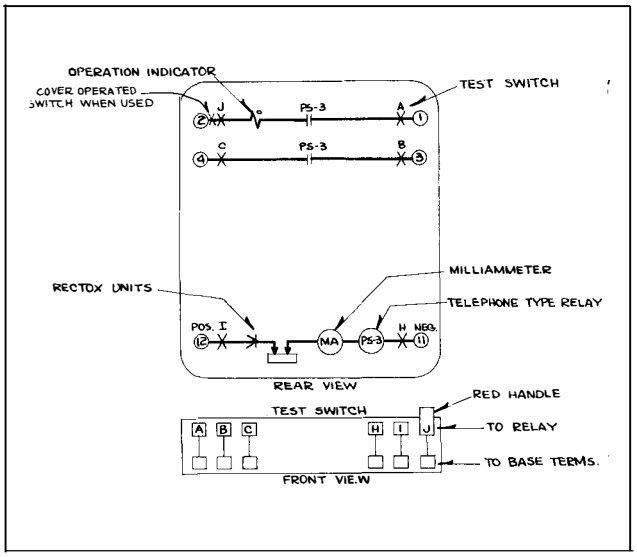

Fig. 5—Internal Schematic of the Type PS-3 Relay in the Type FT Case.

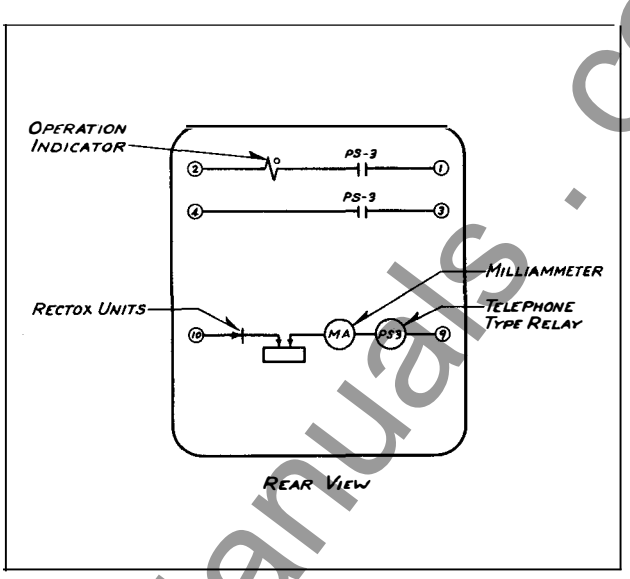

Fig. 6—Internal Schematic of the Type PS-3 Relay in the Standard Case.

houses the relay elements and supports 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.

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.

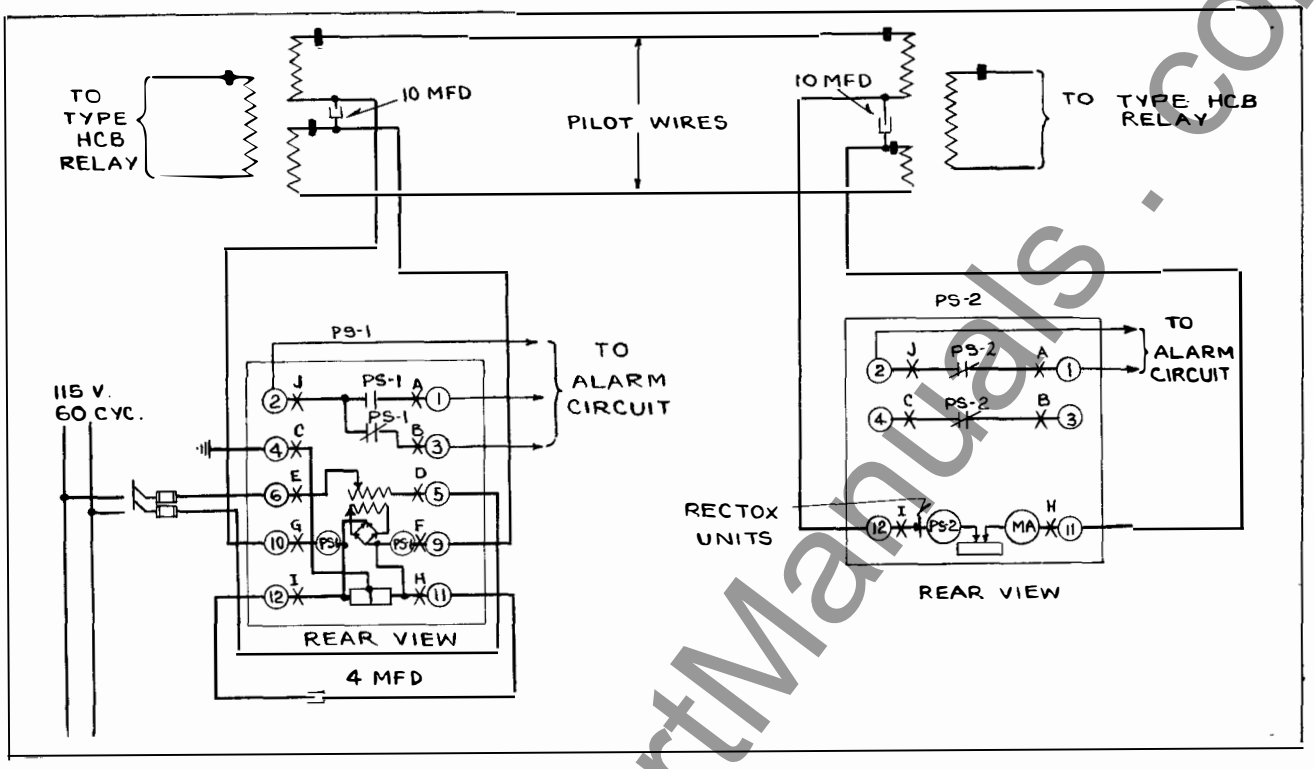

Fig. 7—External Connections for the Types PS-1 and PS-2 Relays in the Type FT Case for Pilot Wire Supervision of a Two Terminal Line.

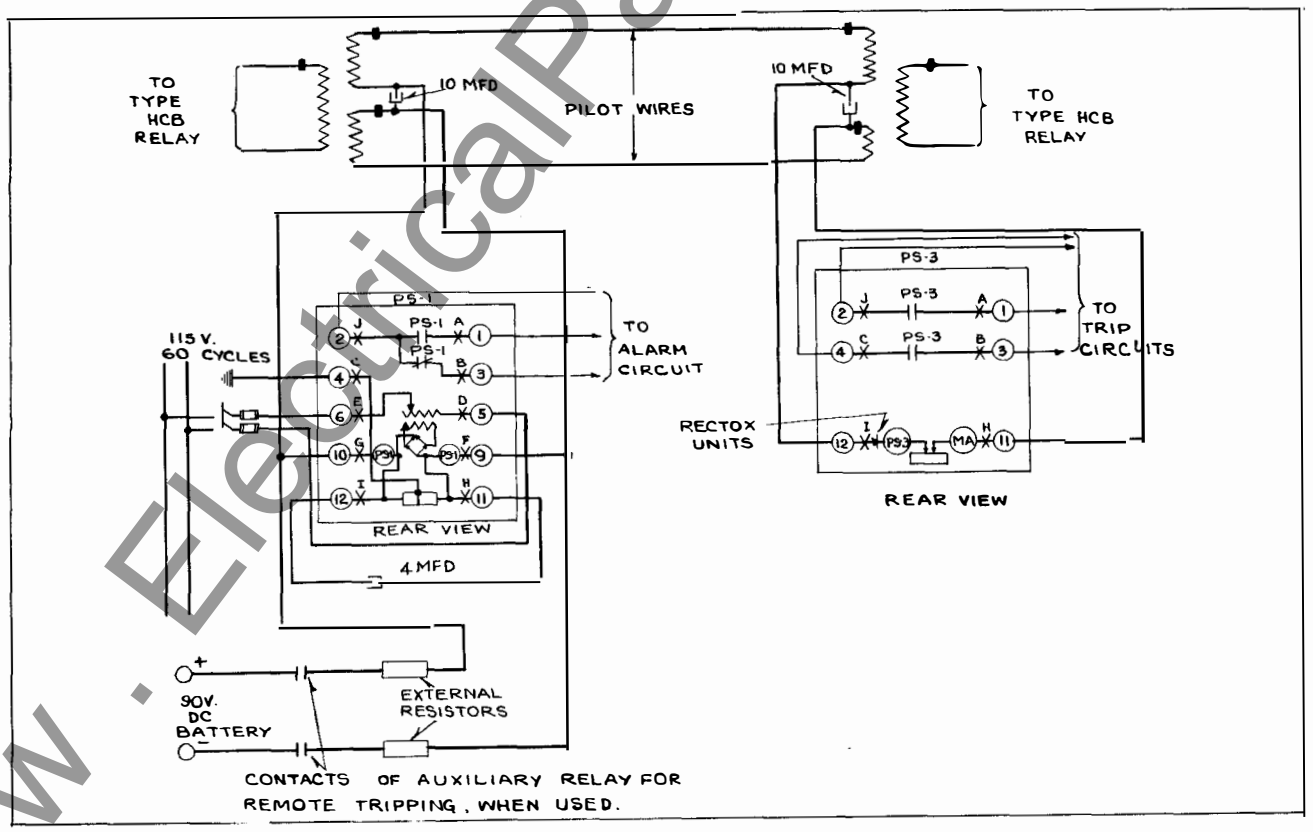

Fig. 8—External Connections of the Types PS-1 and PS-3 Relays in the Type FT Case for Pilot Wire Supervision and Remote Trip of a Two Terminal Line.

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

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.

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 position as a final check on the 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 connections for the types PS-1 and PS-2 relays are shown in Figures 7 or 9, and for the type PS-1 and PS-3 in Figures 8 or 10. For information concerning the type HCB relay see I.L. 41-658.

CAUTION These relays are connected directly in the pilot wire circuit and must be protected against high potential resulting from induction or differences in ground potential between the pilot wire terminals.

SETTINGS

The relays are calibrated in the factory to be energized continuously with one milliampere d-c. After the relays are checked and installed, the only setting required is to select the proper voltage tap in the type PS-1 relay and to adjust the slide wire resistance in the type PS-2 or PS-3 relay, so that the milliammeter in the relay indicates that one milliampere d-c. is circulating over the pilot wires. If difficulty is experienced in getting .001 ampere d-c supervisory current in the pilot wire, select the next lower or higher voltage tap in the PS-1 relay, as may be required.

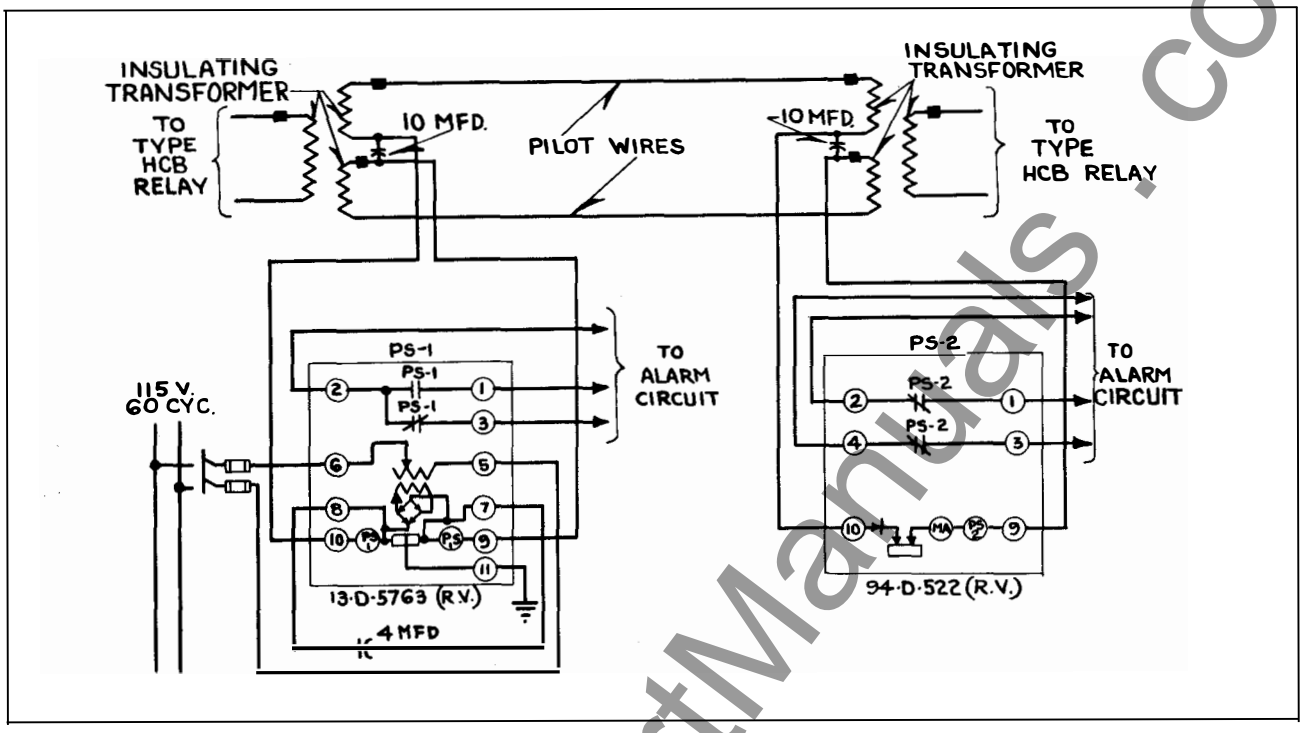

Fig. 9—External Connections of the Types PS-1 and PS-2 Relays in the Standard Case for Pilot Wire Supervision of a Three Terminal Line.

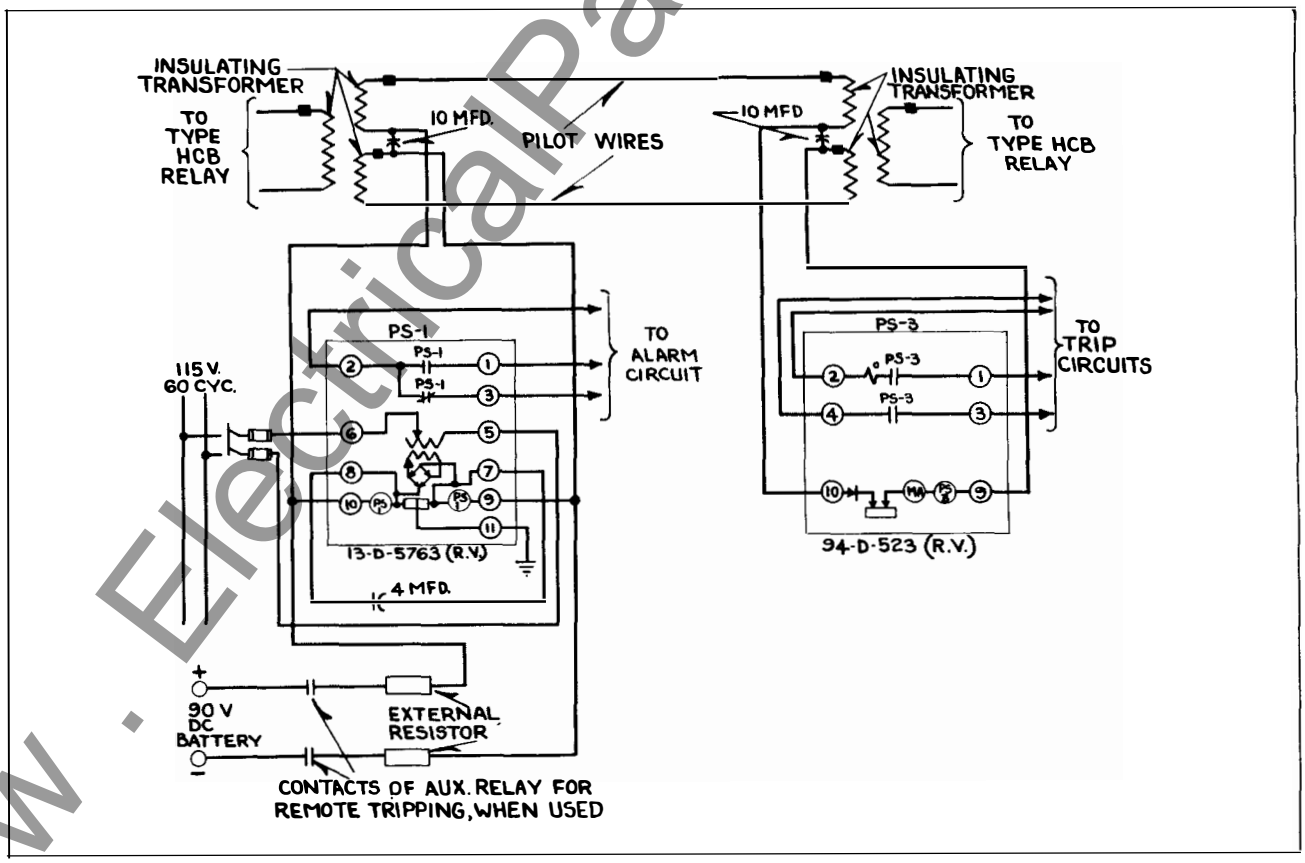

Fig. 10—External Connections of the Types PS-1 and PS-3 Relays in the Standard Case for Pilot Wire Supervision and Remote Trip of a Two Terminal Line.

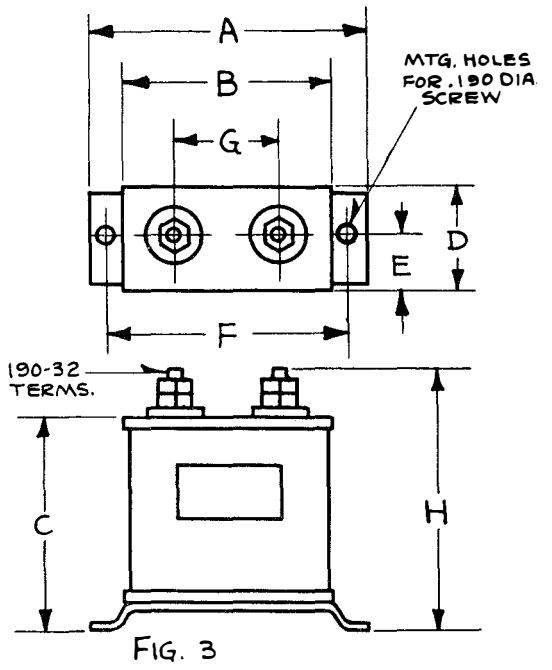

FIG. 3

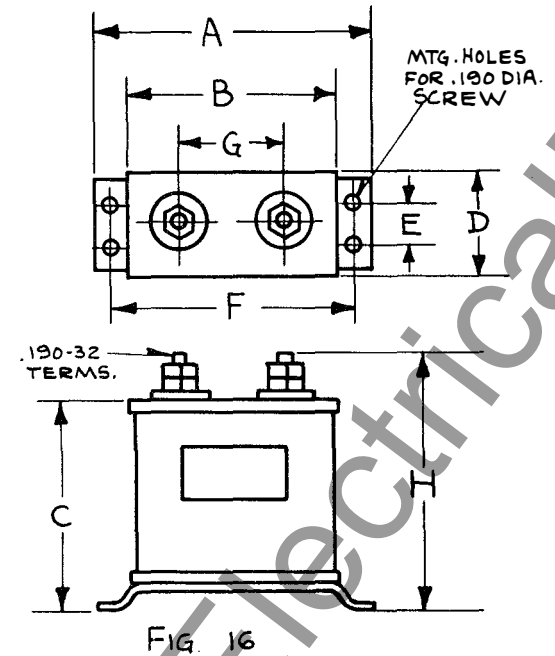

FIG. 16

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
3	±1/32 4	3	3 1/8	+1/16 -1/32 1 1/2	±1/32 1 1/2	±1/32 3 1/2	±1/32 1 1/4	+1/8-1/16 4 5/16
16	4	3	4 5/8	2 1/2	±1/32 1 1/2	±1/32 3 1/2	1 1/4	+1/8-1/16 5 1/16

Fig. 11—Outline and Drilling Plan for the Auxiliary 4 and 10 Mfd. Capacitors. For Reference Only.

Due to a relatively wise variation in rectox forward resistance characteristics it is necessary to provide an extra terminal on the transformer secondary coil in the PS-1 relay for purposes of adjustment. In the event that .001 ampere d-c supervisory current can not be obtained by the combined adjustments of the slide wire resistance in the type PS-2 or PS-3 relay and the use of the primary voltage taps in the PS-1 relay then the connection to the transformer secondary coil in the PS-1 relay must be changed. In such cases, remove the lead from the center terminal on the secondary coil and connect it to the extra terminal, which is the top terminal on the coil. This connection will raise the voltage output of the PS-1 relay so that the current may be adjusted to .001 amp. by means of the slide wire resistance in the PS-2 or PS-3 relay.

NOTE: Add tap to all PS-1 schematics.

If pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relays be set in the laboratory rather than while they are directly connected to the pilot wires. This precaution is to prevent injury to the personnel from high induced voltages. Neutralizing transformers are available for use to keep high voltages from the relay.

ADJUSTMENTS AND MAINTENANCE

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. Style #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.

Type PS-1 Relay, Polarized Element

With the relay de-energized and with the permanent magnet removed, the moving armature may be adjusted so that it floats between the poles or lightly touches the left-hand pole piece. This adjustment is made by loosening the core screw at the back of the element and shifting the entire core and contact assembly. Adjust the stationary contacts so that they make at the extreme limits of the armature travel. Then turn the contact screw from one-half to one turn to obtain contact follow. Varying this adjustment from one half to one turn is sometimes useful in trimming up the final adjustment of operating current values.

Reassemble the permanent magnet with the north pole to the left (front view) and pass .001 ampere thru the operating coils. This should be done by connecting the relays per Figures 7 to 10 using an equivalent resistance in place of the pilot wires and insulating transformer. With this current thru the operating coils, adjust the magnetic shunts across the two rear air gaps so that the right-hand contacts close at approximately .0013 ampere, and the left-hand contacts close at approximately .0007 ampere. With this adjustment, the moving contacts should float approximately midway between the right and left-hand contacts at .001 ampere.

For three terminal pilot wire applications, the contacts should float at .002 ampere, close to the right at .0023 to .0024 ampere, and close to the left at .0016 to .0017 ampere.

A good way to make the adjustment is to start with both shunts all the way in, then draw out the right hand shunt until the right hand contacts close at the desired current value, then draw out the left hand shunt until the left hand contacts close at the desired value, then readjust the right hand shunt, for closing the right hand contacts, working back and forth between the two sides until the adjustment is complete. The final readings should be taken with the shunts secured in place by means of the locking screws provided.

Type PS-2 Relays, Telephone Element

With the relays connected per Figure 4,

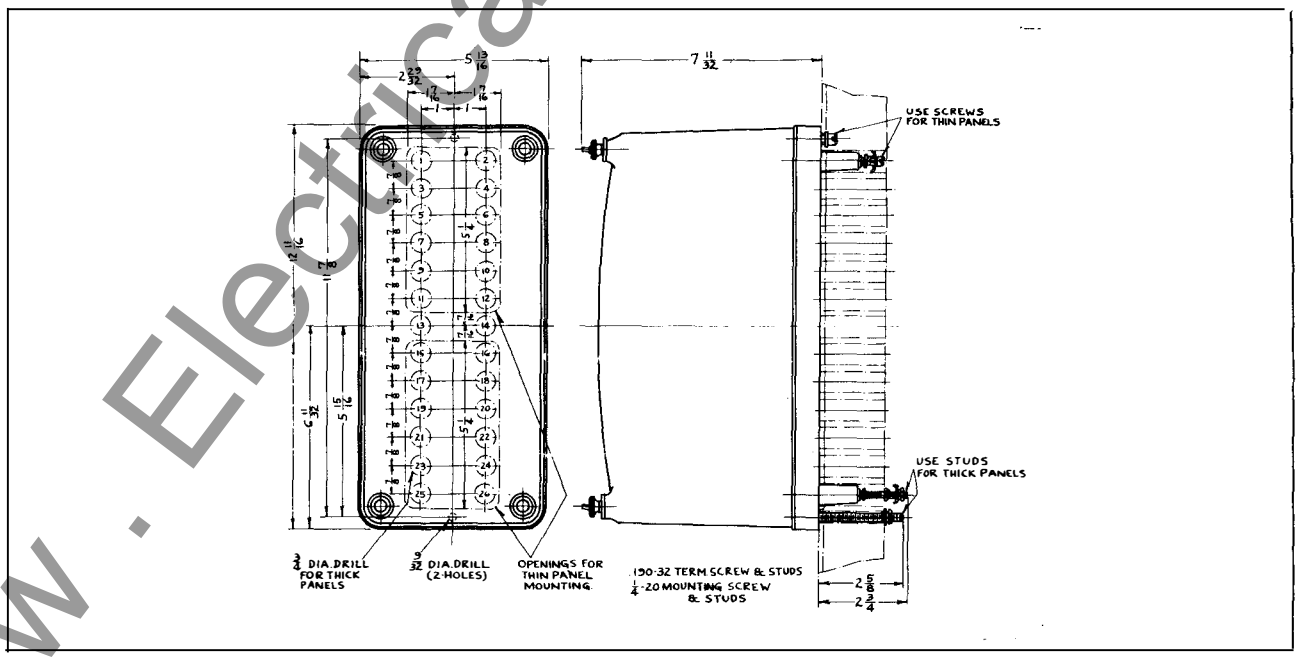

Fig. 12—Outline and Drilling Plan for Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

adjust the armature gap and spring tension of the telephone-type relay so that its contacts open with .0008 ampere and above and close at approximately .0006 ampere and below. The normal contact gap should be approx. 1/32 inch and should have a contact follow of approximately 1/64 inch.

Type PS-3 Relay, Telephone Element

With the relays connected per Figure 8 or 10 adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .0015 or .002 ampere and above.

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 60 cycle burden of the type PS-1 relay is approximately 0.5 volt ampere at tap voltage with .001 ampere d-c flowing over the pilot wire.

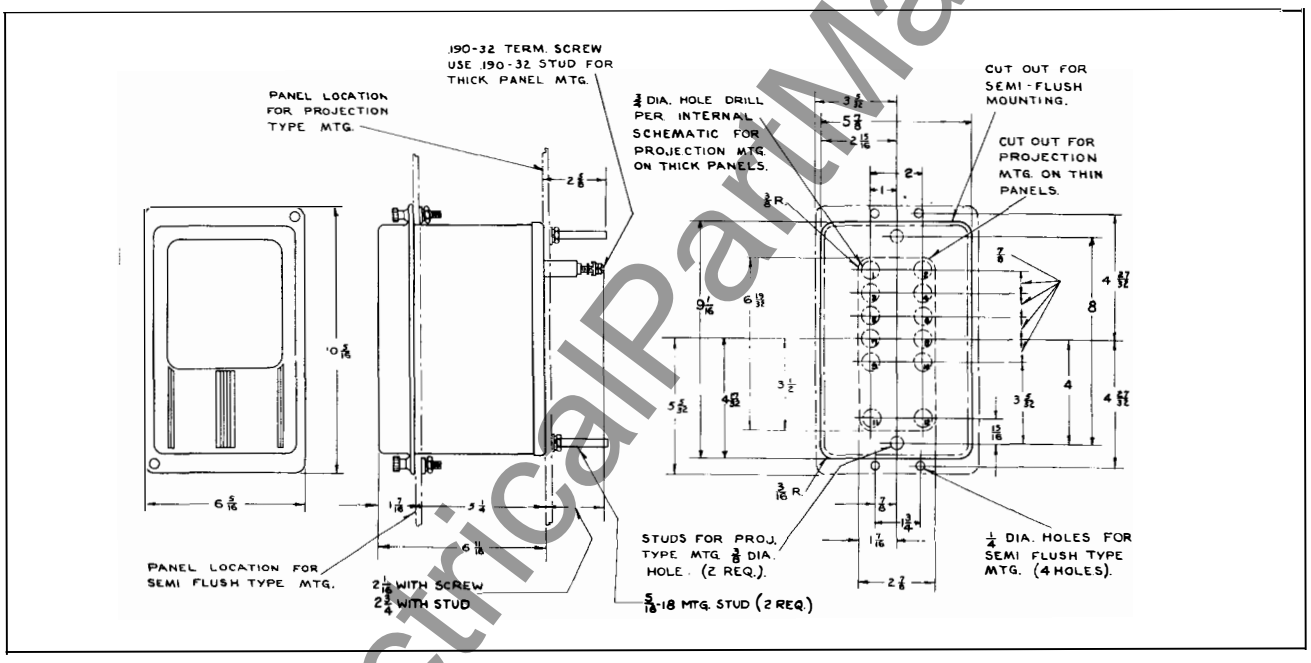

Fig. 13—Outline and Drilling Plan for the S10 Semi-flush or Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES PS-1, PS-2 AND PS-3 RELAYS

(A-C OPERATED)

CAUTION Before putting protective relays into service, remove all blocking which may have been inserted for the purpose of securing 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

The types PS-1 and PS-2 supervisory relays are used to detect short circuits, open circuits, grounds and reversals on pilot wires, particularly those used with the type HCB relay. The type PS-1 relay is located at one terminal to introduce the supervisory d-c current to the pilot wires and to initiate an alarm when the pilot wires are faulted. The type PS-2 relay is located at the other end of the pilot wire circuit and operates to initiate an alarm at that terminal when the pilot wire is opened or shorted. This relay also provides the continuous visual indication and means of adjusting the supervisory current.

Where remote tripping is required, a type PS-3 relay with make contacts is used in place of the type PS-2 relay. This relay provides a means of tripping the local breaker by action of an auxiliary relay located at the type PS-1 relay terminal, but does not act as a fault detector to initiate an alarm at its station.

CONSTRUCTION AND OPERATION

The type PS-1 relay consists of a small transformer with taps on the primary, and secondary windings, a full wave Rectox unit, a polarized relay, and a potentiometer for grounding the d-c circuit. The relay is also supplied with a 4 mfd. and a 10 mfd. condenser to be used with it as shown in Figures 7 to 10.

The two capacitors serve as a filter to smooth out the pulsation of the rectified current to practically constant direct current which is introduced on to the pilot wires at the mid-tap of the type HCB relay insulating transformer.

The polarized relay consists of an armature and contact mounted on a leaf spring supported symmetrically within a magnetic frame. The poles of a permanent magnet clamp directly to each side of this frame. Flux from the permanent magnet divides into two paths, one path across the air gap at the front of the element in which the armature is located, the other across two gaps at the base of the frame. Two adjustable screw type shunts are located in the rear air gaps. These change the reluctance of the magnetic path so as to force some of the flux thru the moving armature which is fastened to the frame midway between the two rear air gaps. Flux in the armatute polarizes it and creates a magnetic bias causing it to move towards the left-hand contact (front view). Two operating coils are placed around the armature and within the magnetic frame. The windings are connected in series with each of the pilot wires.

With the correct adjustment of the magnetic shunts the armature will always tend to travel towards the north pole of the front air gap with the coils deenergized. This holds the left-hand contact closed. When either of the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move toward the south poles, and the right-hand contact.

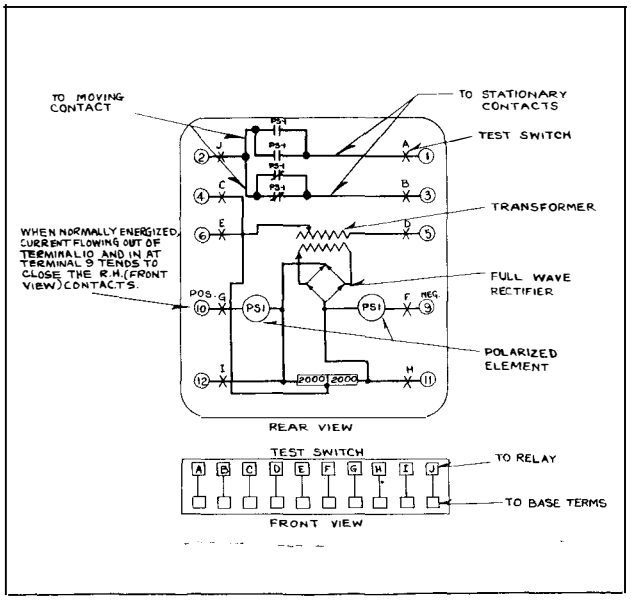

Fig. 1—Internal Schematic of the Type PS-1 Relay in the Type FT Case.

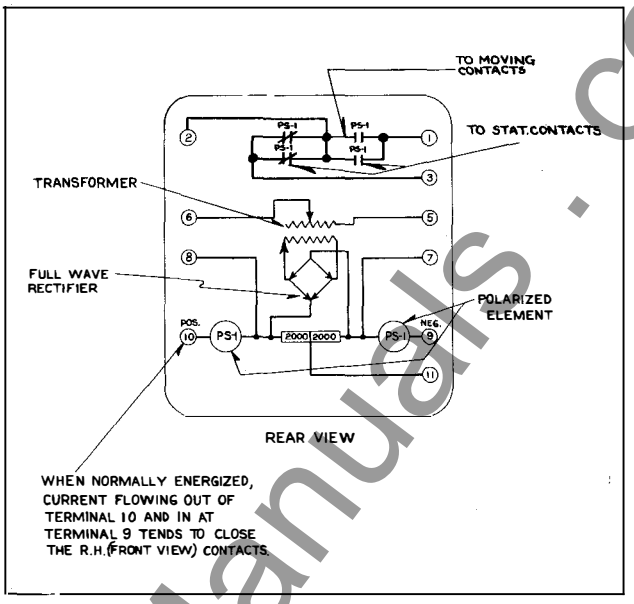

Fig. 2—Internal Schematic of the Type PS-1 Relay in the Standard Case.

Normally, the current through the relay coils is of such a magnitude that the armature floats midway between the right and left stationary contacts.

The type PS-2 relay consists of a telephone type relay, a milliammeter, an adjustable resistor, and two Rectox units. The contacts of the telephone relay are closed at the de-energized position. When the relay is energized, the contacts stand open.

The type PS-3 relay is identical to the type PS-2 except that the contacts are open in the deenergized position. This relay does not function to initiate an alarm when the pilot wires are faulted.

CHARACTERISTICS

The type PS-1 relay transformer has 100, 110, 120 and 130 volt taps on the transformer primary. With tap voltage applied to the transformer primary, the relay will supply .001 ampere d-c to the pilot wire at approximately 17 volts d-c at the output terminals. This is sufficient to handle a 2000 ohm pilot wire, and a type PS-2 or PS-3 relay adjusted for approximately 15,000 ohms internal resistance with .001 amp. flowing. If necessary as much as 130 volts may be used continuously on any of the taps marked from 100 to 130.

The secondary winding also has a tap, the use of which is described under "Settings".

The type PS-1, PS-2 and PS-3 relays function to supervise the pilot wire as follows:

(1). Normal Pilot Wire

The relays are continuously energized with .001 ampere d-c. which is introduced from an external a-c. source thru the type PS-1 relay and circulates over the pilot wire circuit. This current holds both the type PS-1 and PS-2 relay contacts open, and tends to close the type PS-3 relay contacts.

(2). Pilot Wire Short Circuited

Short circuits of 2,000 ohms resistance or less cause the circulating pilot wire current to increase above the normal value, thus closing the right-hand (front view) contacts of the type PS-1 relay and the undercurrent contacts of the PS-2 relay to initiate an alarm at both terminals of the pilot wire.

(3). Pilot Wire Open Circuited

Open circuits on the pilot wire will reduce the circulating supervisory current to zero, and again initiate an alarm at both the type PS-1 and PS-2 relay terminals.

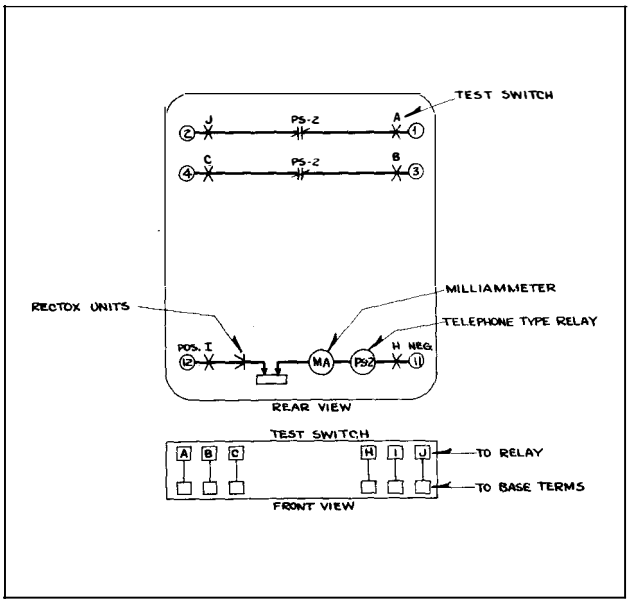

Fig. 3—Internal Schematic of the Type PS-2 Relay in the Type FT Case.

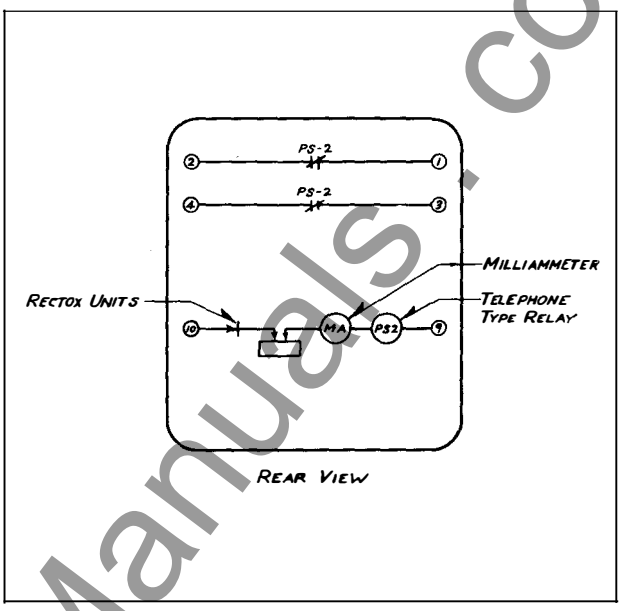

Fig. 4—Internal Schematic of the Type PS-2 Relay in the Standard Case.

(4). Pilot Wire Grounded

The connection of the separate windings of the type PS-1 relay in each of the pilot wire circuits provides two circuits of equal impedance from the grounded midtap of the potentiometer in the type PS-1 relay to the remote terminal on the pilot wire. The type PS-2 relay contains a relatively high resistance, such that when either pilot wire becomes grounded at any point along its length, unequal currents flow to operate the type PS-1 relay. This provides supervision for ground fault resistance values of 500 ohms or less.

(5). Reversed Pilot Wires

A reversal of the pilot wires will tend to pass current thru the type PS-2 or PS-3 relays in the reversed direction. The back resistance of the Rectox units in these relays is sufficiently high and, therefore, limits the magnitude of supervisory current so that both the type PS-1 and PS-2 relays operate on under current. Where the type PS-3 relay is used in place of the type PS-2 relay, only the type PS-1 relay operates on under current to ring an alarm.

Remote tripping is accomplished by applying an increased d-c voltage to the pilot wire as indicated in Figures 8 and 10. When a 90 volt source is used, such as a "B" battery, the two resistors shown in the diagram should be 1100 ohms each to limit the pilot wire current to .005 ampere, which is sufficient to operate the PS-3 relay adjusted for .0015 or .002 ampere pick up. On the other hand, a 45 volt battery source may be used and the resistors omitted, in which case the pilot wire current will increase to approximately .004 ampere for the remote tripping operation.

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

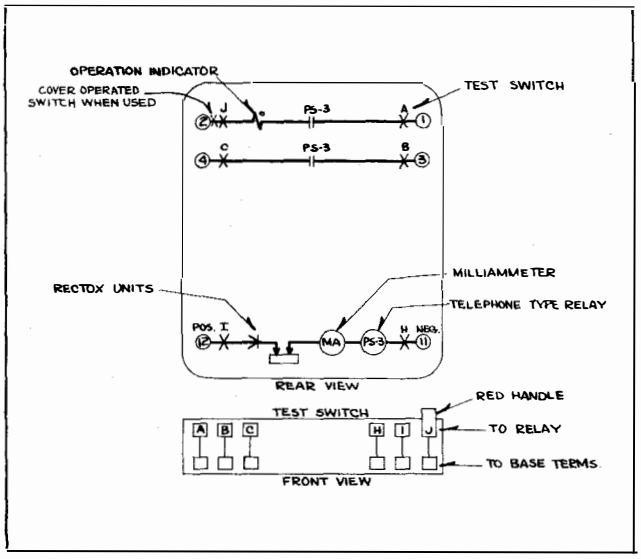

Fig. 5—Internal Schematic of the Type PS-3 Relay in the Type FT Case.

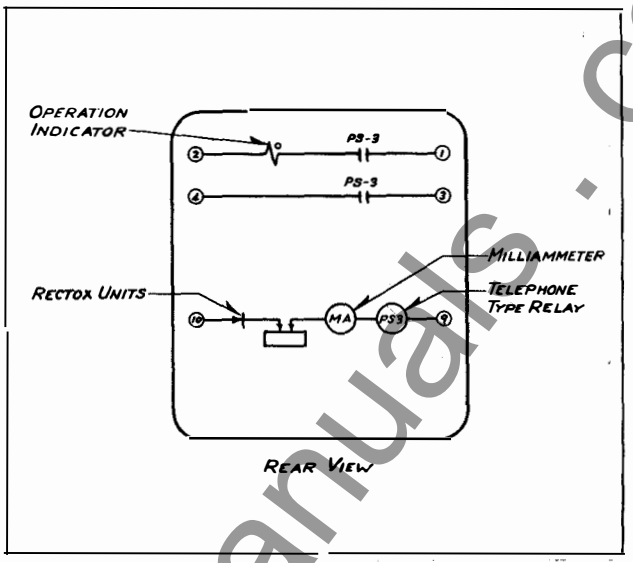

Fig. 6—Internal Schematic of the Type PS-3 Relay in the Standard Case.

houses the relay elements and supports 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.

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.

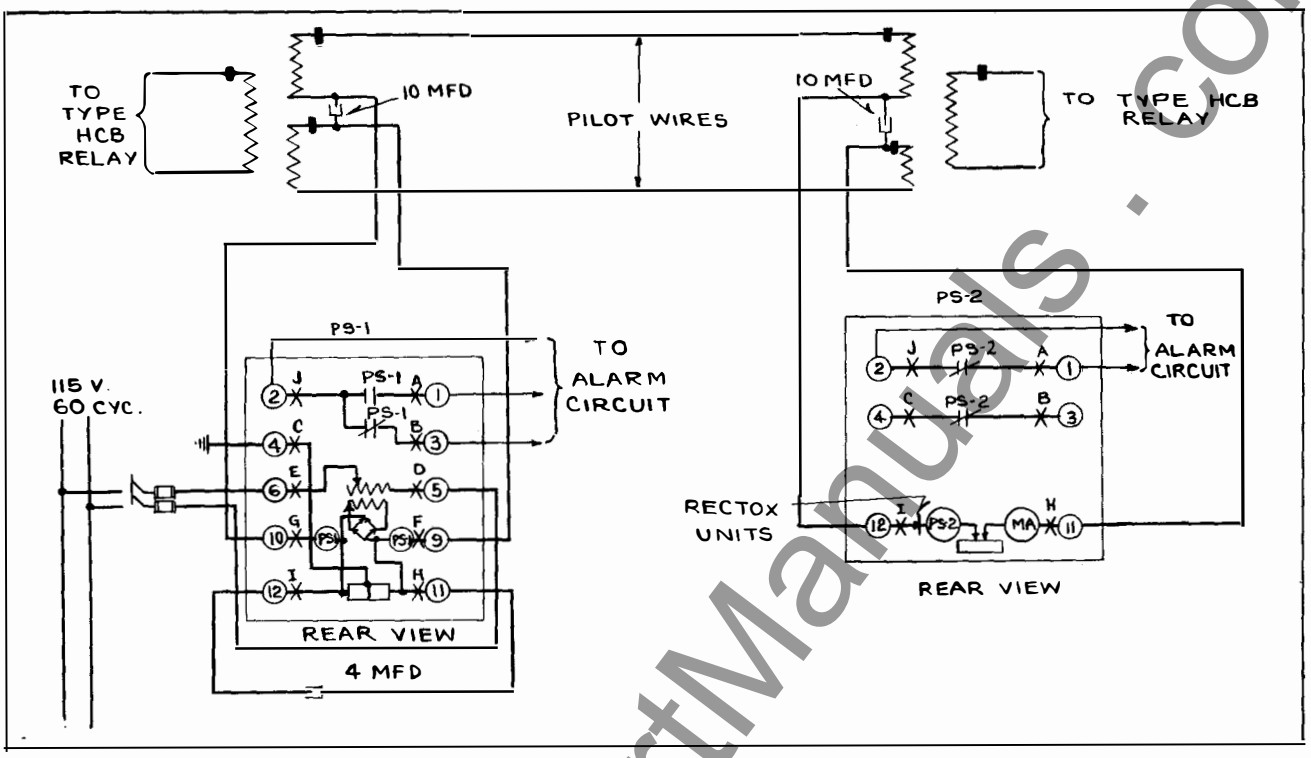

Fig. 7—External Connections for the Types PS-1 and PS-2 Relays in the Type FT Case for Pilot Wire Supervision of a Two Terminal Line.

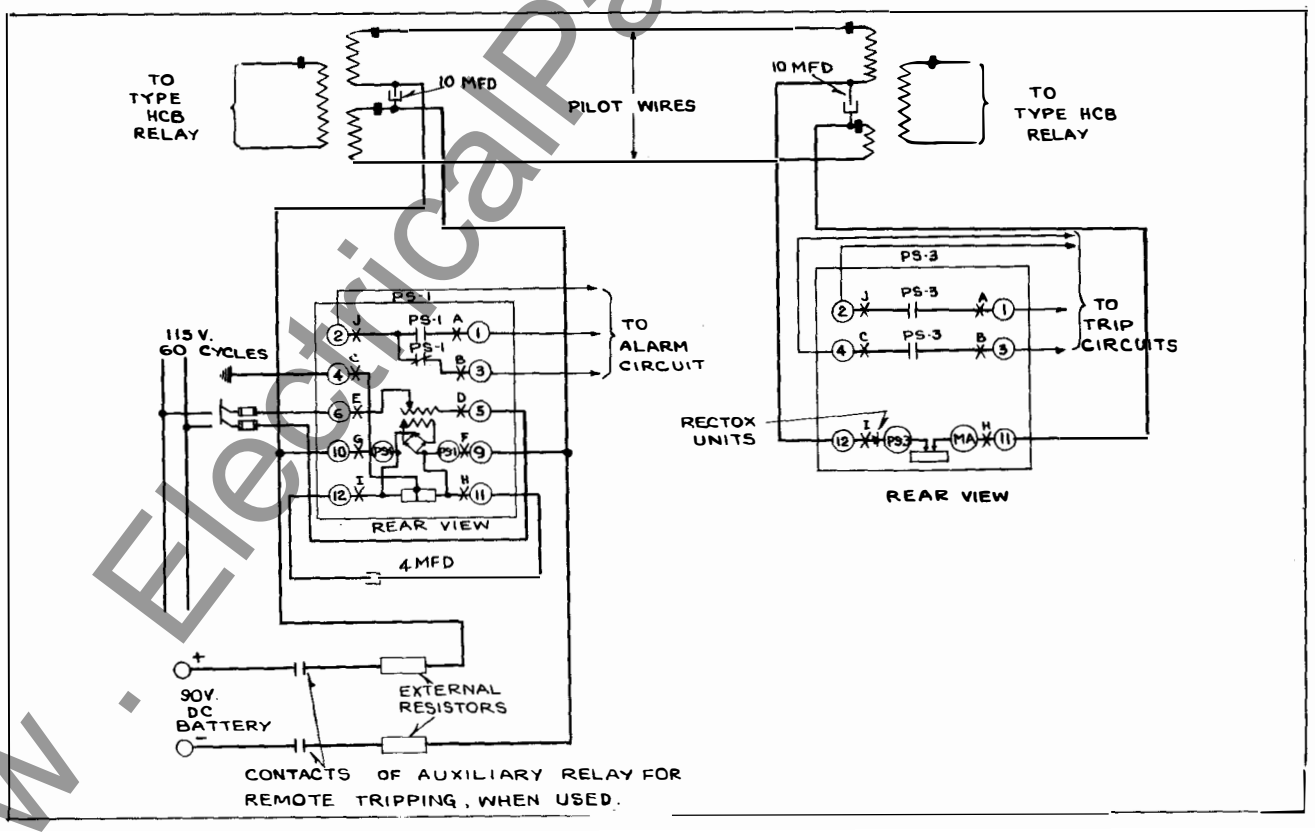

Fig. 8—External Connections of the Types PS-1 and PS-3 Relays in the Type FT Case for Pilot Wire Supervision and Remote Trip of a Two Terminal Line.

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

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.

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 position as a final check on the 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 connections for the types PS-1 and PS-2 relays are shown in Figures 7 or 9, and for the type PS-1 and PS-3 in Figures 8 or 10. For information concerning the type HCB relay see I.L. 41-658.

CAUTION These relays are connected directly in the pilot wire circuit and must be protected against high potential resulting from induction or differences in ground potential between the pilot wire terminals.

SETTINGS

The relays are calibrated in the factory to be energized continuously with one milliampere d-c. After the relays are checked and installed, the only setting required is to select the proper voltage tap in the type PS-1 relay and to adjust the slide wire resistance in the type PS-2 or PS-3 relay, so that the milliammeter in the relay indicates that one milliampere d-c. is circulating over the pilot wires. If difficulty is experienced in getting .001 ampere d-c supervisory current in the pilot wire, select the next lower or higher voltage tap in the PS-1 relay, as may be required.

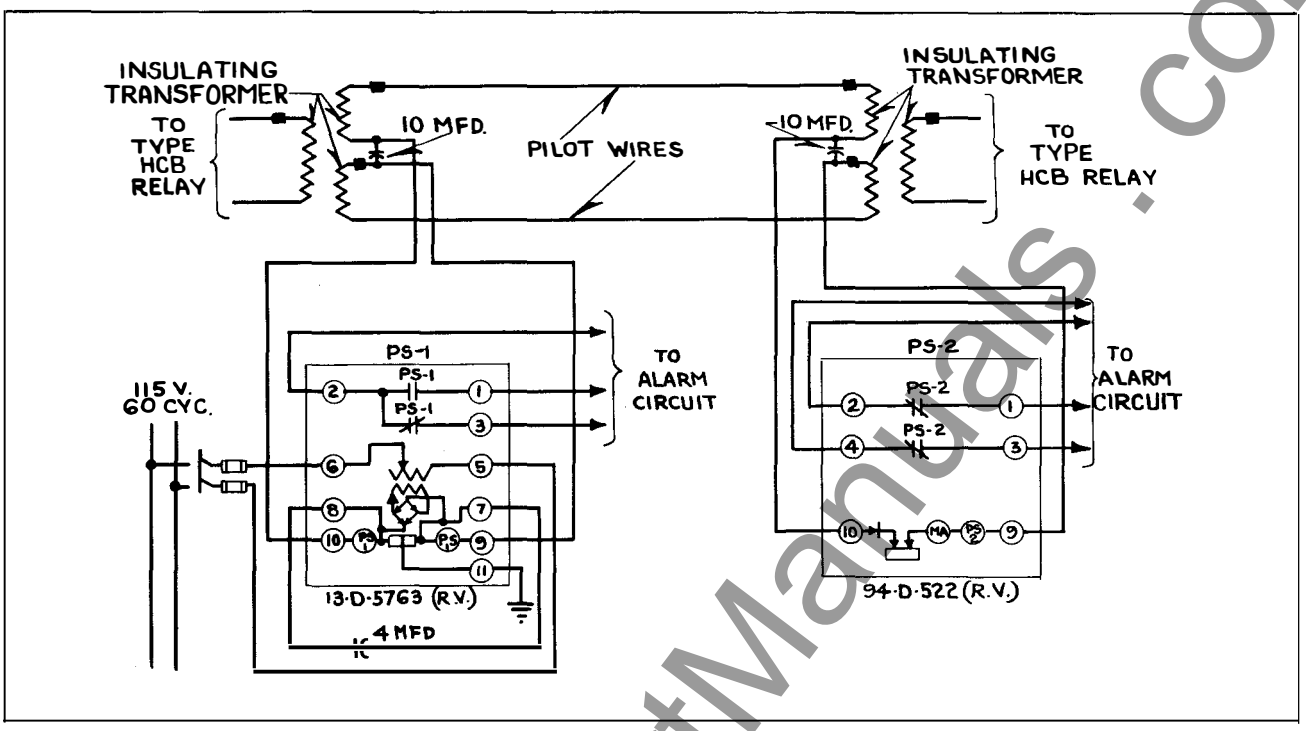

Fig. 9—External Connections of the Types PS-1 and PS-2 Relays in the Standard Case for Pilot Wire Supervision of a Two Terminal Line.

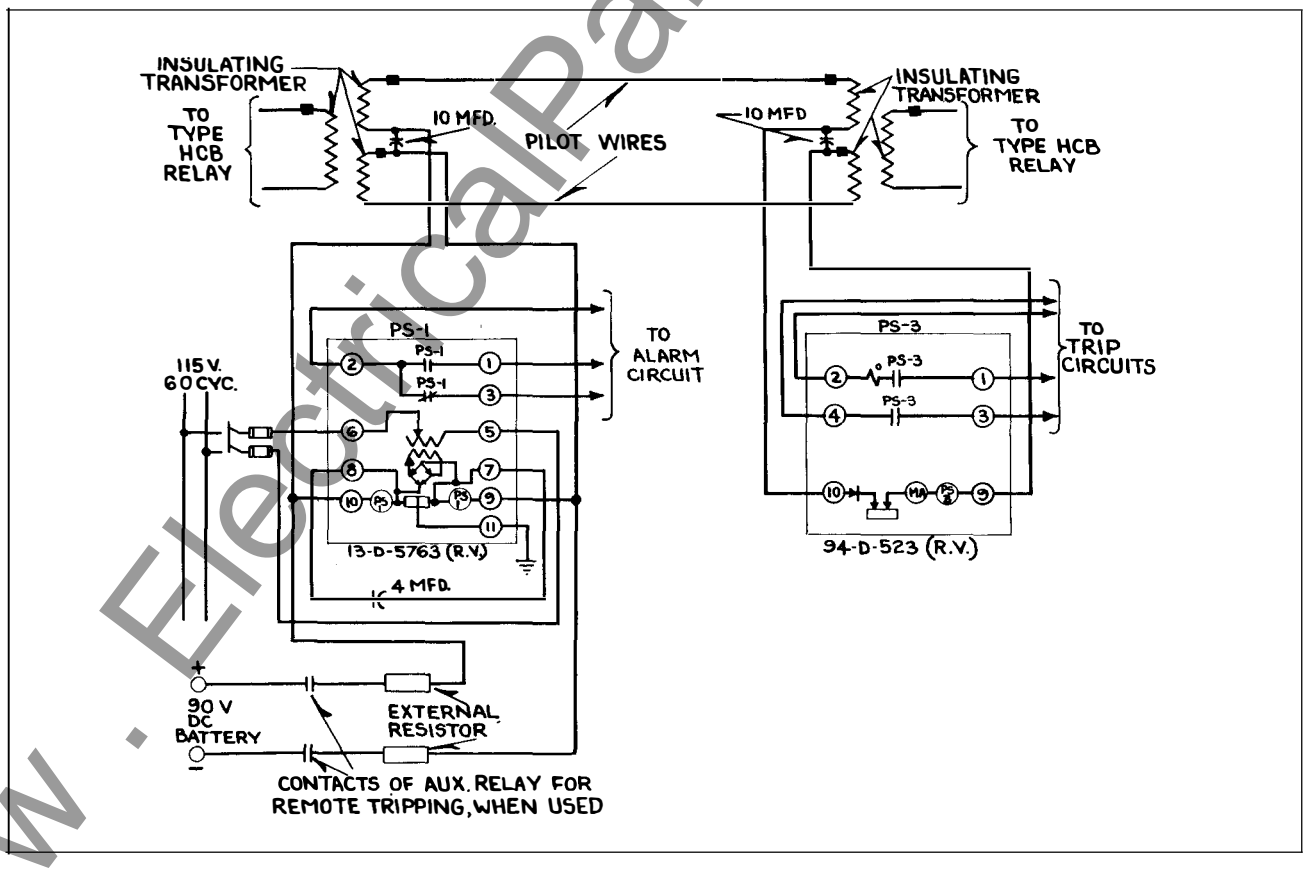

Fig. 10—External Connections of the Types PS-1 and PS-3 Relays in the Standard Case for Pilot Wire Supervision and Remote Trip of a Two Terminal Line.

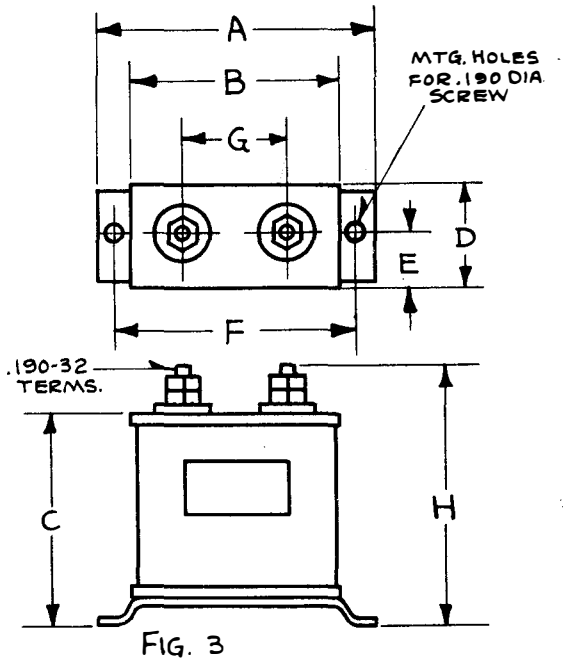

FIG. 3

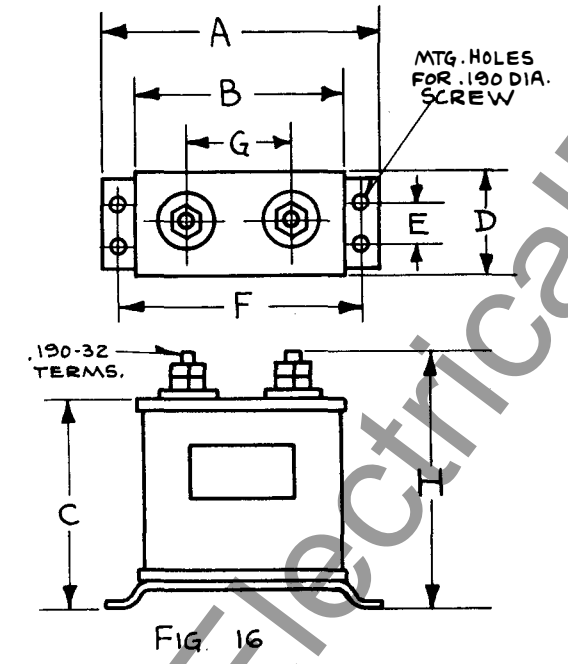

FIG. 16

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
3	±1/32 4	3	3 1/8	+1/16 -1/32 1	±1/32 1/2	±1/32 3 1/2	±1/32 1/4	+1/8 -1/16 4 5/16
16	4	3	4 5/8	2 1/2	±1/32 1/2	±1/32 3 1/2	1 1/4	+1/8 -1/16 5 1/16

Fig. 11—Outline and Drilling Plan for the Auxiliary 4 and 10 Mfd. Capacitors. For Reference Only.

Due to a relatively wide variation in rectox forward resistance characteristics it is necessary to provide an extra terminal on the transformer secondary coil in the PS-1 relay for purposes of adjustment. In the event that .001 ampere d-c supervisory current can not be obtained by the combined adjustments of the slide wire resistance in the type PS-2 or PS-3 relay and the use of the primary voltage taps in the PS-1 relay then the connection to the transformer secondary coil in the PS-1 relay must be changed. In such cases, remove the lead from the center terminal on the secondary coil and connect it to the extra terminal, which is the top terminal on the coil. This connection will raise the voltage output of the PS-1 relay so that the current may be adjusted to .001 amp. by means of the slide wire resistance in the PS-2 or PS-3 relay.

If pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relays be set in the laboratory rather than while they are directly connected to the pilot wires. This precaution is to prevent injury to the personnel from high induced voltages. Neutralizing transformers are available for use to keep high voltages from the relay.

ADJUSTMENTS AND MAINTENANCE

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. Style #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.

Type PS-1 Relay, Polarized Element

With the relay de-energized and with the permanent magnet removed, the moving armature may be adjusted so that it floats between the poles. This adjustment is made by loosening the core screw at the back of the element and shifting the entire core and contact assembly. Adjust the stationary contacts so that they make at the extreme limits of the armature travel. Then turn each contact screw four turns to obtain approximately 5/32" between the stationary contacts.

Reassemble the permanent magnet with the north pole to the right (front view) and pass .001 ampere thru the operating coils. This should be done by connecting the relays per Figures 7 to 10 using an equivalent resistance in place of the pilot wires and insulating transformer. With this current thru the operating coils, adjust the magnetic shunts across the two rear air gaps so that the right-hand contacts close at approximately .0013 ampere, and the left-hand contacts close at approximately .0007 ampere. With this adjustment, the moving contacts should float approximately midway between the right and left-hand contacts at .001 ampere.

For three terminal pilot wire applications, the contacts should float at .002 ampere, close to the right at .0023 to .0024 ampere, and close to the left at .0016 to .0017 ampere.

A good way to make the adjustment is to start with both shunts all the way in, then draw out the right hand shunt until the right hand contacts close at the desired current value, then draw out the left hand shunt until the left hand contacts close at the desired value, then readjust the right hand shunt, for closing the right hand contacts, working back and forth between the two sides until the adjustment is complete. The shunts are held securely in place by means of a spring type clamp.

Type PS-2 Relays, Telephone Element

With the relays connected per Figure 7 or 9,

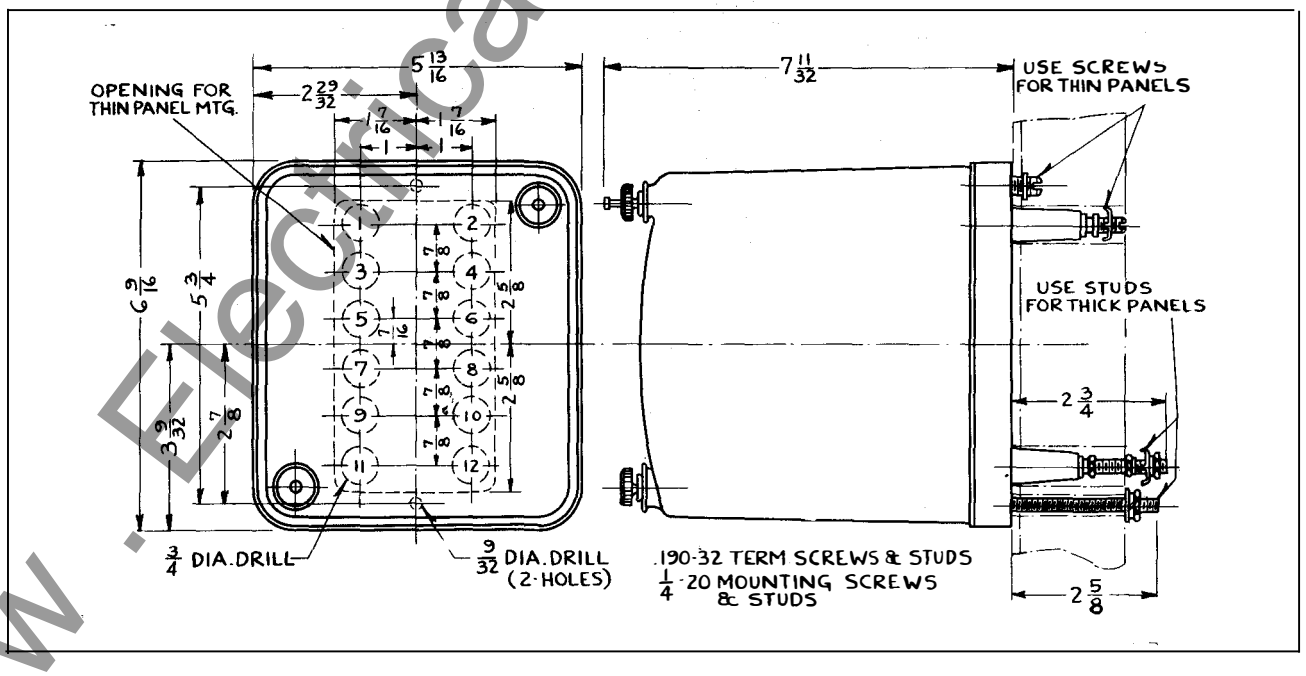

Fig. 12—Outline and Drilling Plan for the Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

adjust the armature gap and spring tension of the telephone-type relay so that its contacts open with .0008 ampere and above and close at approximately .0006 ampere and below. The normal contact gap should be approx. 1/32 inch and should have a contact follow of approximately 1/64 inch.

Type PS-3 Relay, Telephone Element

With the relays connected per Figure 8 or 10 adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .0015 or .002 ampere and above.

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 60 cycle burden of the type PS-1 relay is approximately 0.5 volt ampere at tap voltage with .001 ampere d-c flowing over the pilot wire.

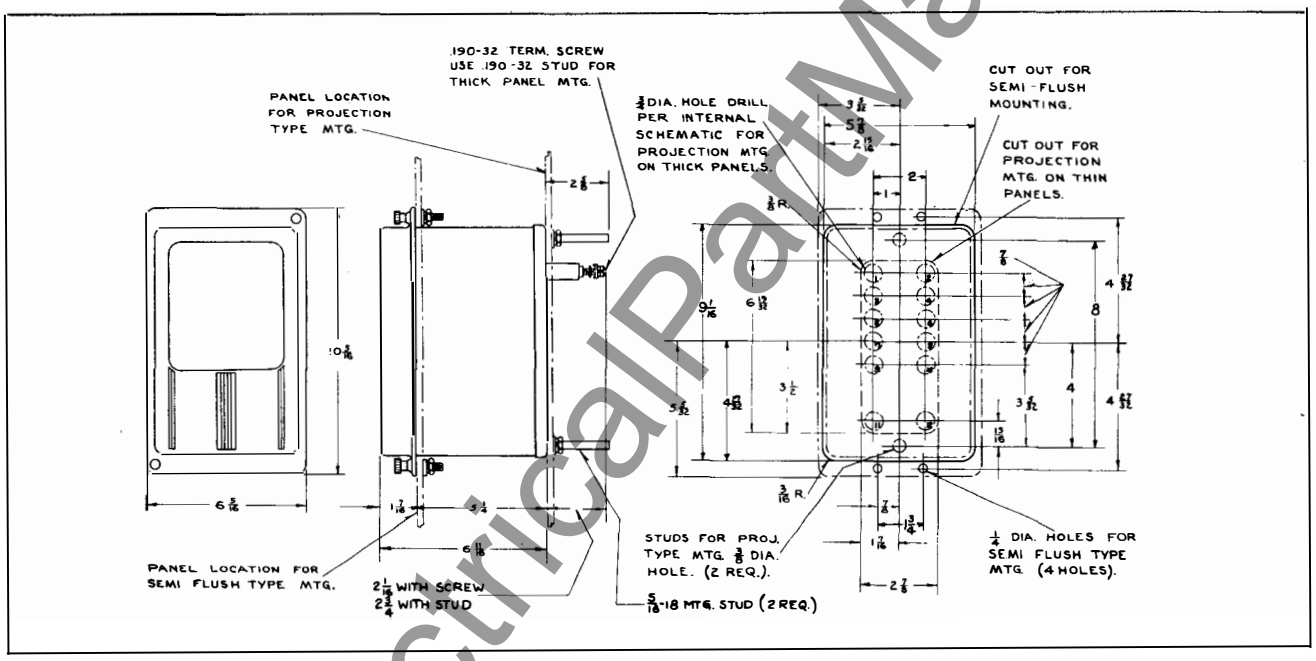

Fig. 13—Outline and Drilling Plan for the S10 Semi-flush or Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

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