INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

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

(D-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 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 d-c operated type PS-1 relay consists of a sensitive polarized relay element adapted to operate on .001 ampere or .002 ampere d-c pilot wire supervisory current. It is equipped with internal resistor tubes to obtain this current from a battery source. The 22 volt d-c relays utilize series resistors, whereas relays for operation from 48, 125, or 250 volt batteries utilize the resistors in a potentiometer arrangement. For three terminal lines, where the output of the type PS-1 relay is .002 ampere, the potentiometer models are equipped with different resistance values in the potentiometer than for two terminal lines, where the output of the type PS-1 is .001 ampere.

The polarized relay consists of an armature and contact assembly 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 toward the left-hand contact (front view). Two operating coils are placed around the armature wnd 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 left-hand side of the front air gap with the coils de-energized. This holds the left-hand contact closed. When either of

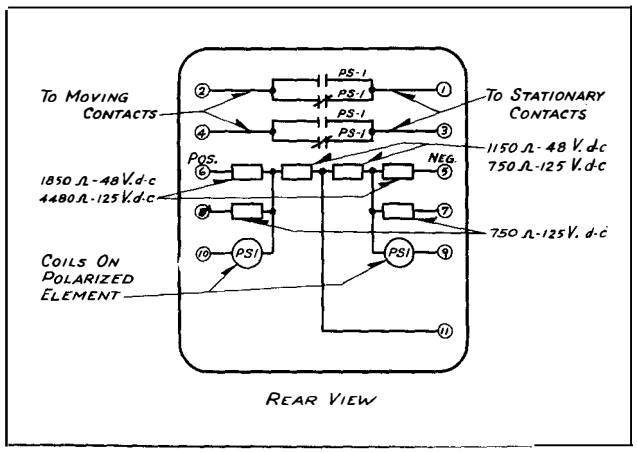

Fig. 1—Internal Schematic of the 48, or 125 Volt, D-C Type PS-1 Relay In the Standard Case. When Remote Tripping is not Required, or for 48 Volts D-C with or without Remote Tripping, Terminals 7 and 8 and Associated Resistors are Omitted.

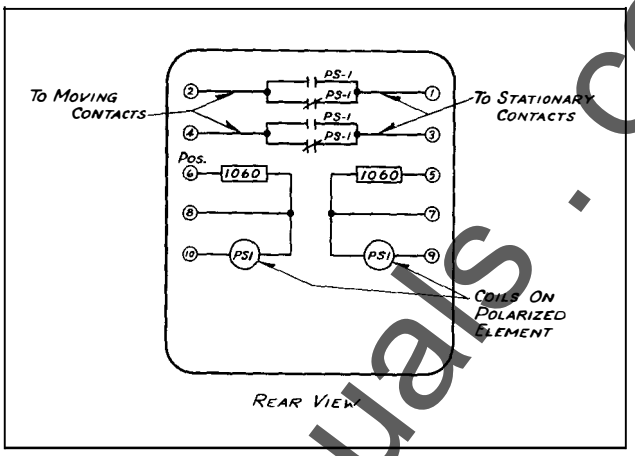

Fig. 2—Internal Schematic of the 22 Volt D-C Type PS-1 Relay In the Standard Case.

the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move towards 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, and adjustable resistor, and a rectox unit. 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 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:

(1a). Normal Pilot Wire - Two Terminal Lines

The relays are continuously energized with .001 ampere d-c which is introduced from the battery 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.

(1b). Normal Pilot Wire - Three Terminal Lines

The action here is the same in principle as for two terminal lines, except that the type PS-1 relay must furnish .002 ampere total, which allows .001 ampere for each of the two type PS-2 relays involved.

(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 type 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 types 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 of the type PS-1 relay to the remote

terminal on the pilot wire. In the 22 volt d-c models, the midpoint of the battery is grounded. 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 protection for ground fault resistance values of 500 ohms or less.

Station batteries are frequently grounded at the midpoint of a circuit consisting of two lamps connected in series across the battery terminals. An accidental ground on the station battery circuits will not affect the ability of the pilot wire supervisory relays to detect pilot wire short circuits or open circuits, although the relative sensitivity of the type PS-1 to grounds on one of the two wires of a pilot pair will be changed. Ground faults on the pilot wire will not affect the grounding lamps on the station battery because of the high internal resistance of the type PS-1 relay.

(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 types 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 PS-1 relay operates on under current to ring an alarm.

(6). Remote Tripping

Remote tripping is accomplished by applying a higher d-c voltage to the pilot wires at the sending end, where the type PS-1 relay is located. The polarity of this voltage is the same as the normal voltage. For 125 and 250 V. d-c sources, resistors are used to limit the pilot wire current. For the 22 volt models, an extra battery source of higher voltage must be used.

(7). Difference in Ground Potential

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. If the magnitude of this potential is between 200 and 500 volts, it is recommended that 5 mfd. capacitors be connected--one each between the relay pilot wire terminals and ground at the type PS-1 relay. If the magnitude of this potential exceeds 500 volts, special means of protecting the relays are available.

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

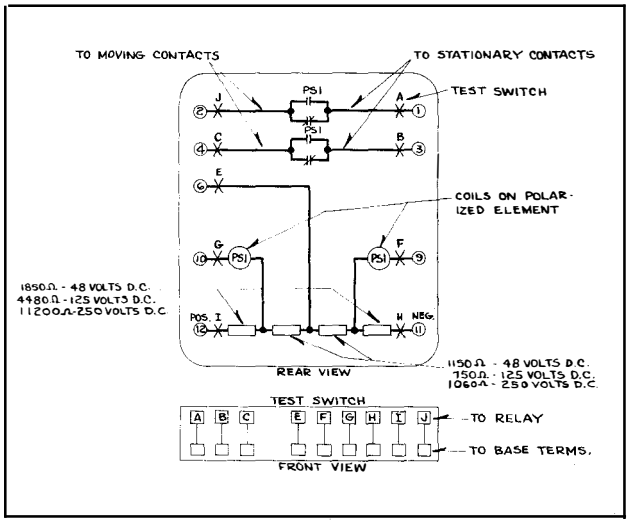

Fig. 3—Internal Schematic of the 48, 125 or 250 Volt, D-C Type PS-1 Relay in the Type FT Case.

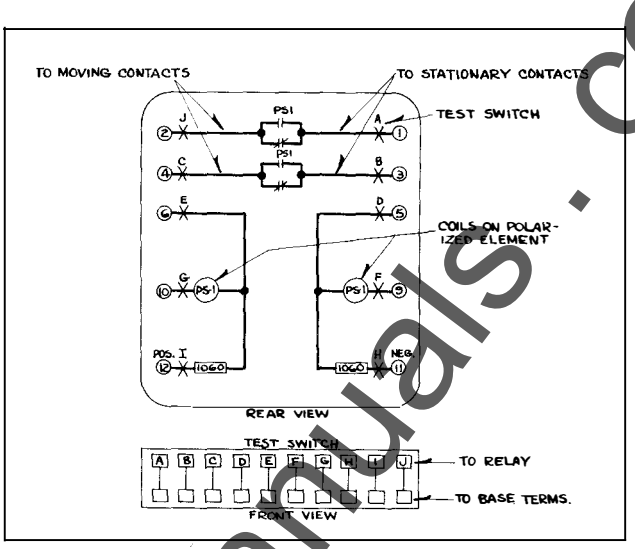

Fig. 4—Internal Schematic of the 22 Volt D-C Type PS-1 Relay in the Type FT Case.

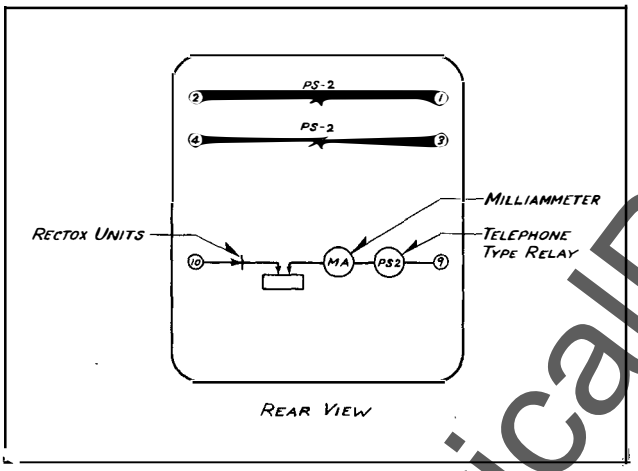

Fig. 5—Internal Schematic of the Type PS-2 Relay in the Standard Case.

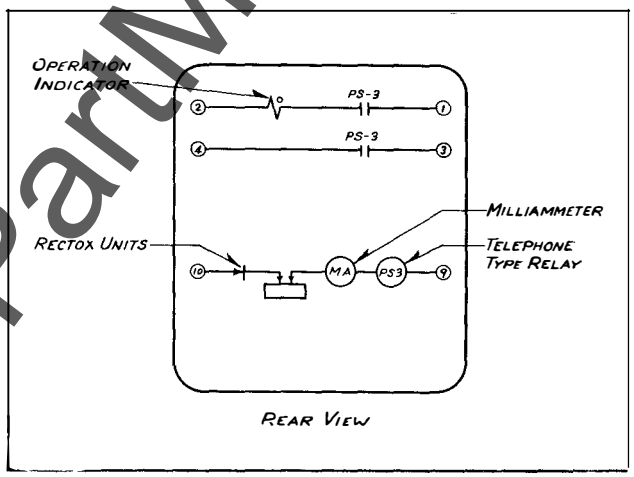

Fig. 6—Internal Schematic of the Type PS-3 Relay in the Standard Case.

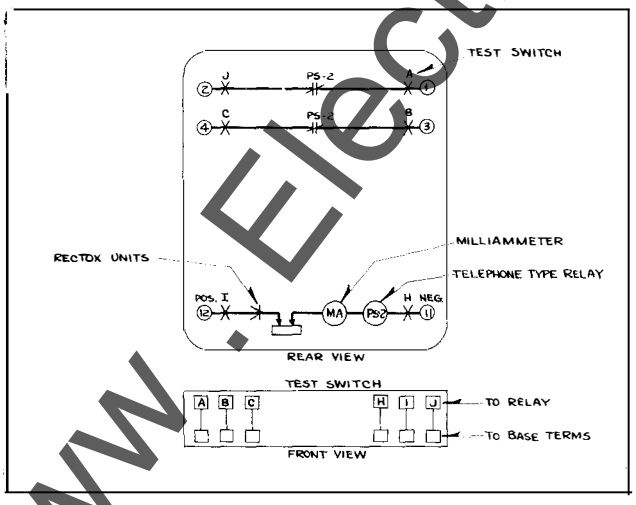

Fig. 7—Internal Schematic of the Type PS-2 Relay in the Type FT Case.

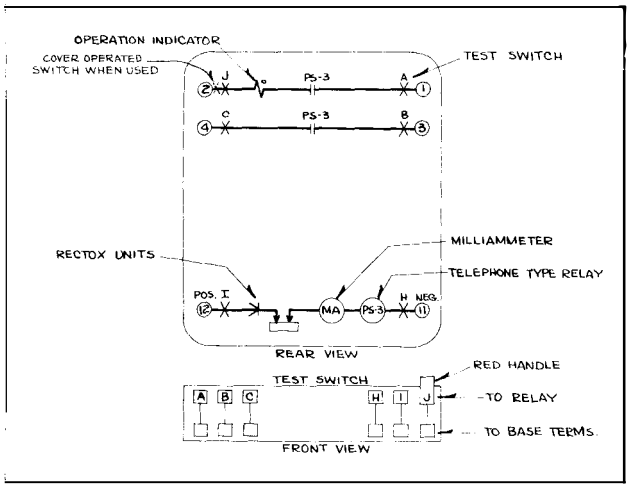

Fig. 8—Internal Schematic of the Type PS-3 Relay in the Type FT Case.

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 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 contacts 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.

Figures 9 to 13 show the external connections of the types PS-1 and PS-2 relays. Figures 14 to 17 show the external connections of the type PS-1 and PS-3 relays. For information concerning the type HCB relay see I.L. 41-658.

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 adjust the slide wire resistance in the type PS-2 or PS-3 relay, so that the milliameter in the relay indicates that one milliampere d-c is circulating over the pilot wires.

CAUTION If the pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relay 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 voltage 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. S#1002110 file is recommended for this purpose. The use of abrasive

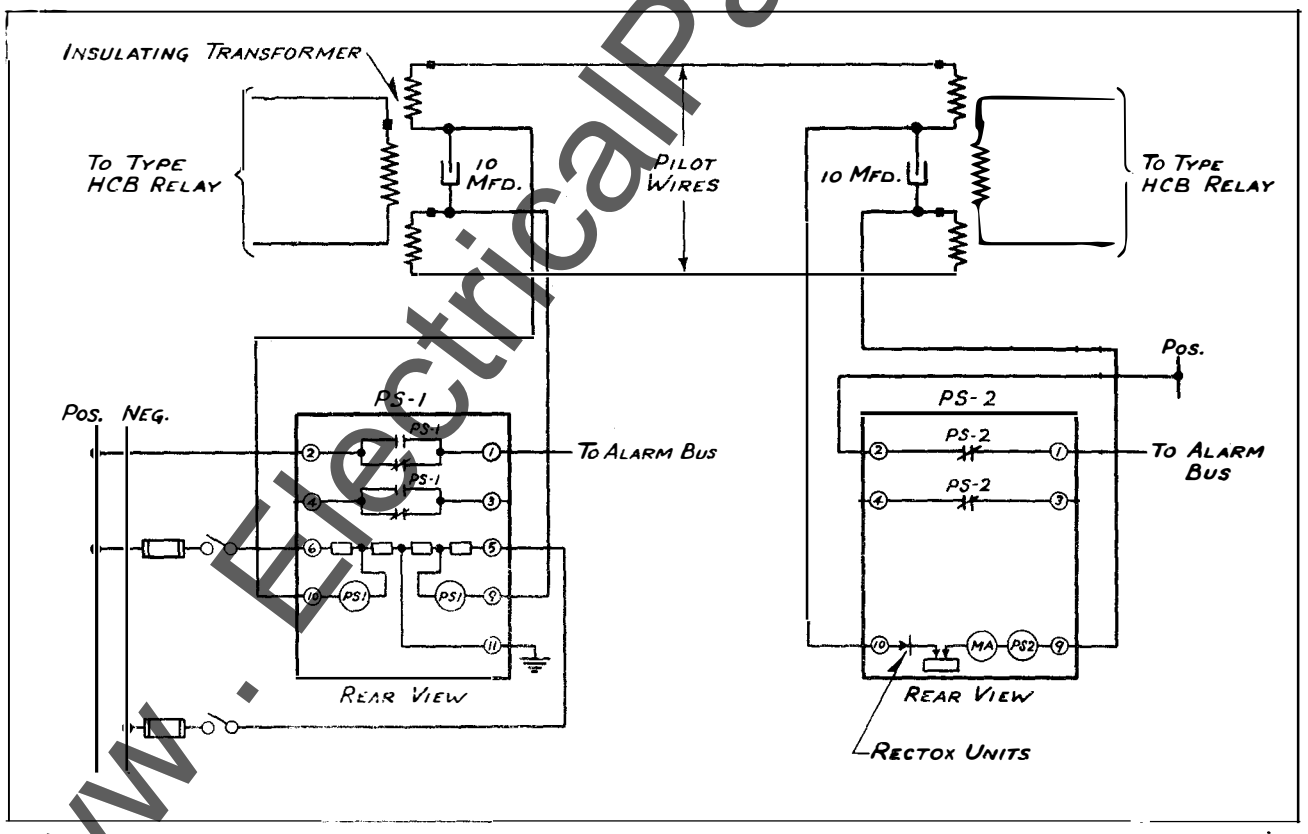

Fig. 9—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Standard Case For Pilot Wire Supervisory.

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, remove the permanent magnet and adjust the moving armature 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 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 one of the figures 9 or 17 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 moving contacts float midway between the stationary contacts. With this adjustment, the right-hand contacts should operate at approximately .0013 ampere, and the left-hand contacts should close at .0007 ampere. For three terminal lines, the type PS-1 relay contacts should float at .002 ampere, close to the right at .0023 ampere, and close to the left at .0017 ampere.

A good way to adjust the element is to start with both magnetic shunts at the extreme "in" position, then draw out the right-hand shunt until the right-hand contacts make at the desired current. Then lower the current and draw out the left hand shunt until the left-hand contacts make at the right value. This will upset the adjustment for the right hand contacts, which should then be rechecked. The process is easily carried back and forth until both values will check properly. 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 one of the figures 9 to 13, adjust the armature gap and spring tension of the telephone-type relays 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 one of the figures 14 to 17, adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .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.

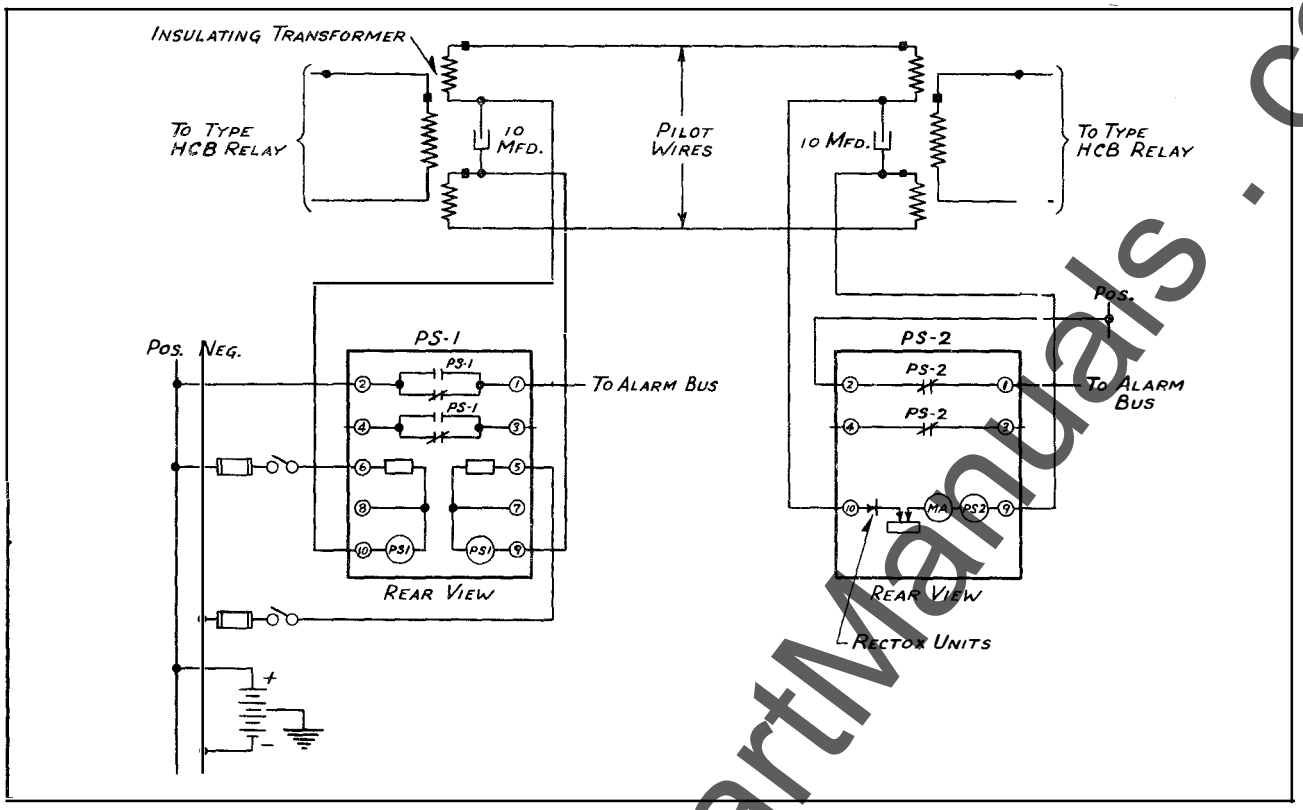

Fig. 10—External Connections of the 22 Volt D-C Type PS-1 and the Type PS-2 Relays in the Standard Case For Pilot Wire Supervisory.

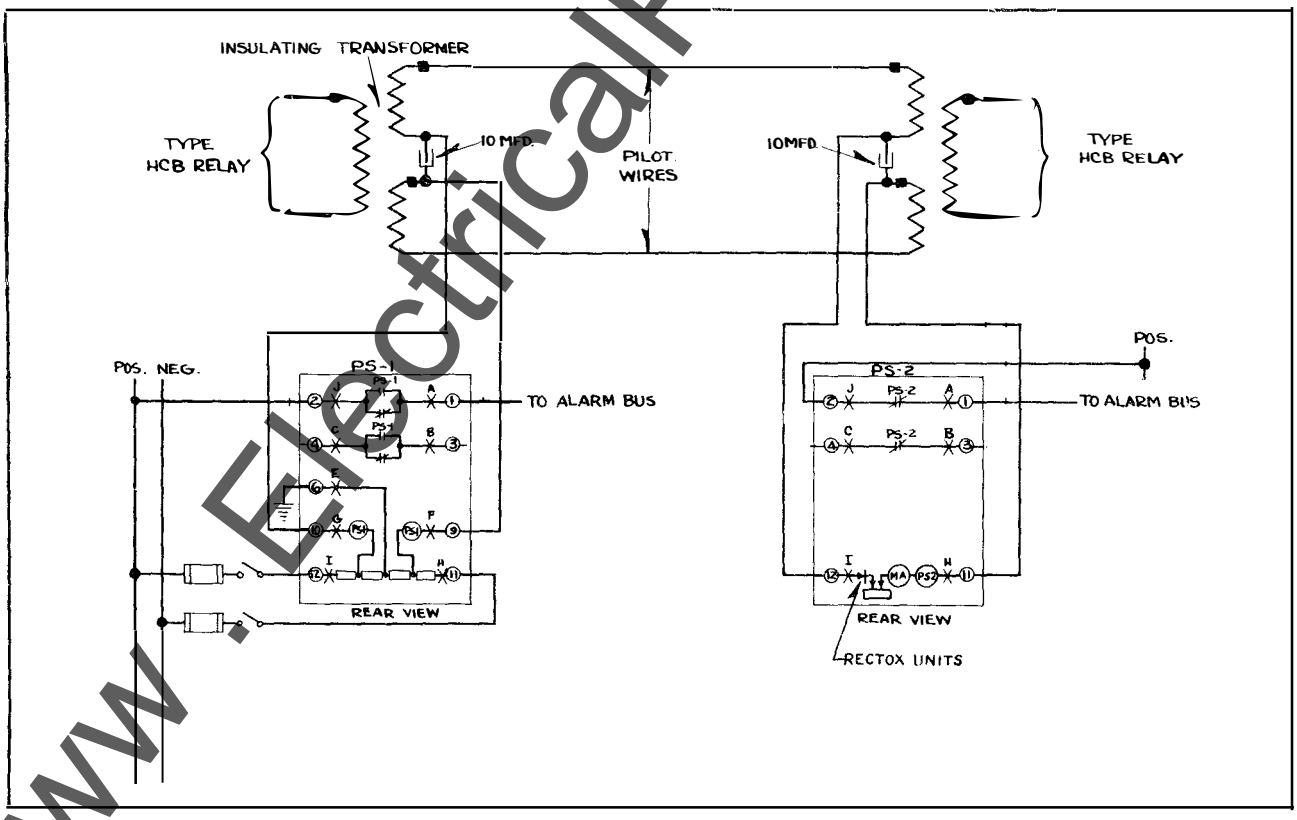

Fig. 11—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Type FT Case For Pilot Wire Supervisory.

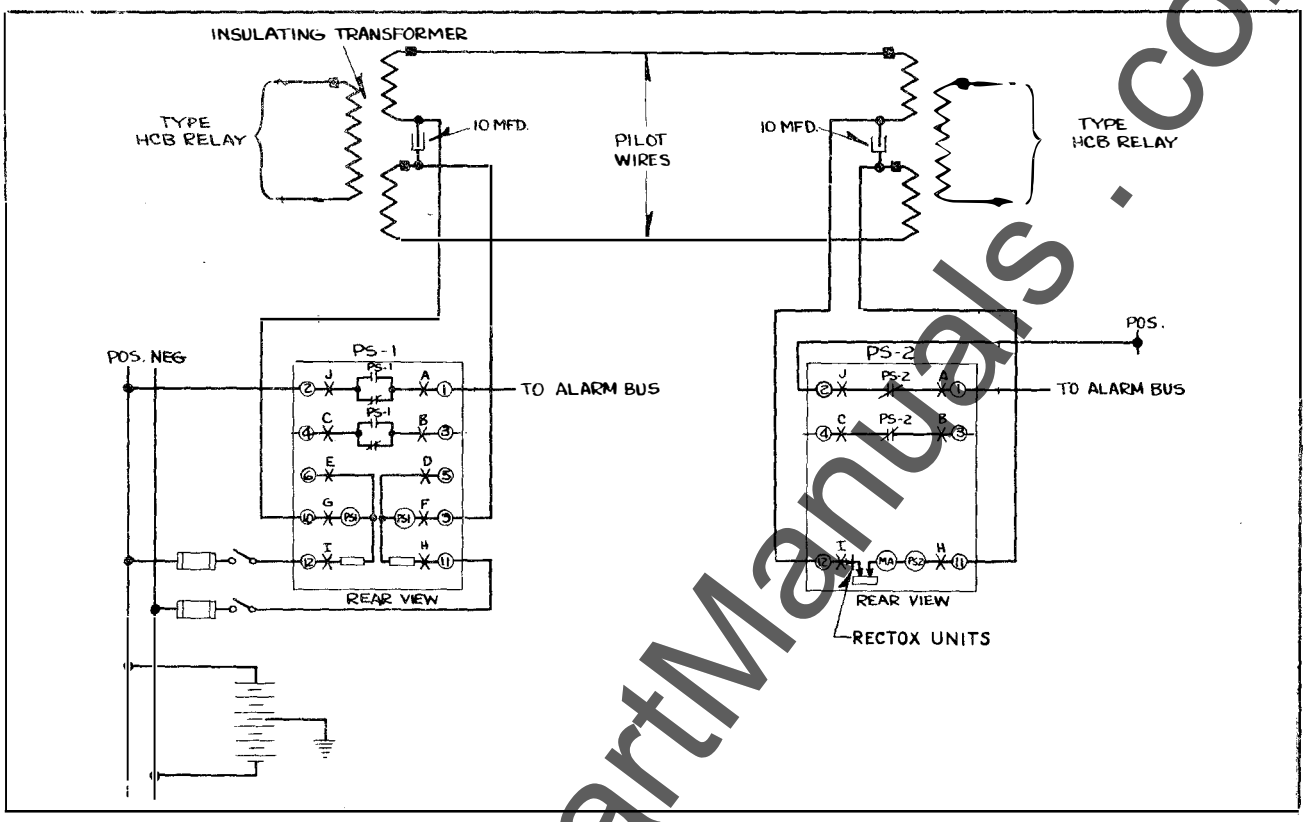

Fig. 12—External Connections of the 22 Volt D-C Types PS-1 and the PS-2 Relays in the Type FT Case For Pilot Wire Supervisory.

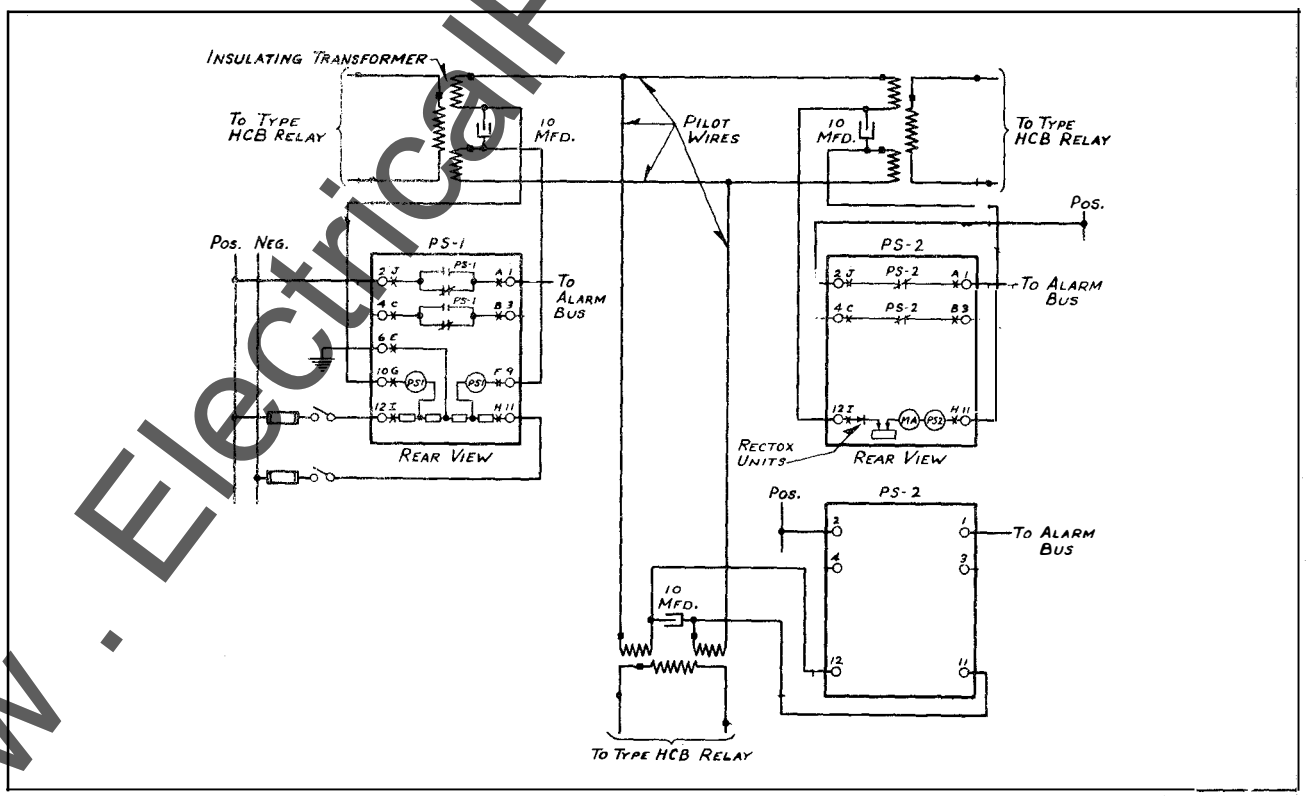

Fig. 13—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Type FT Case For Pilot Wire Supervisory of a Three Terminal Line.

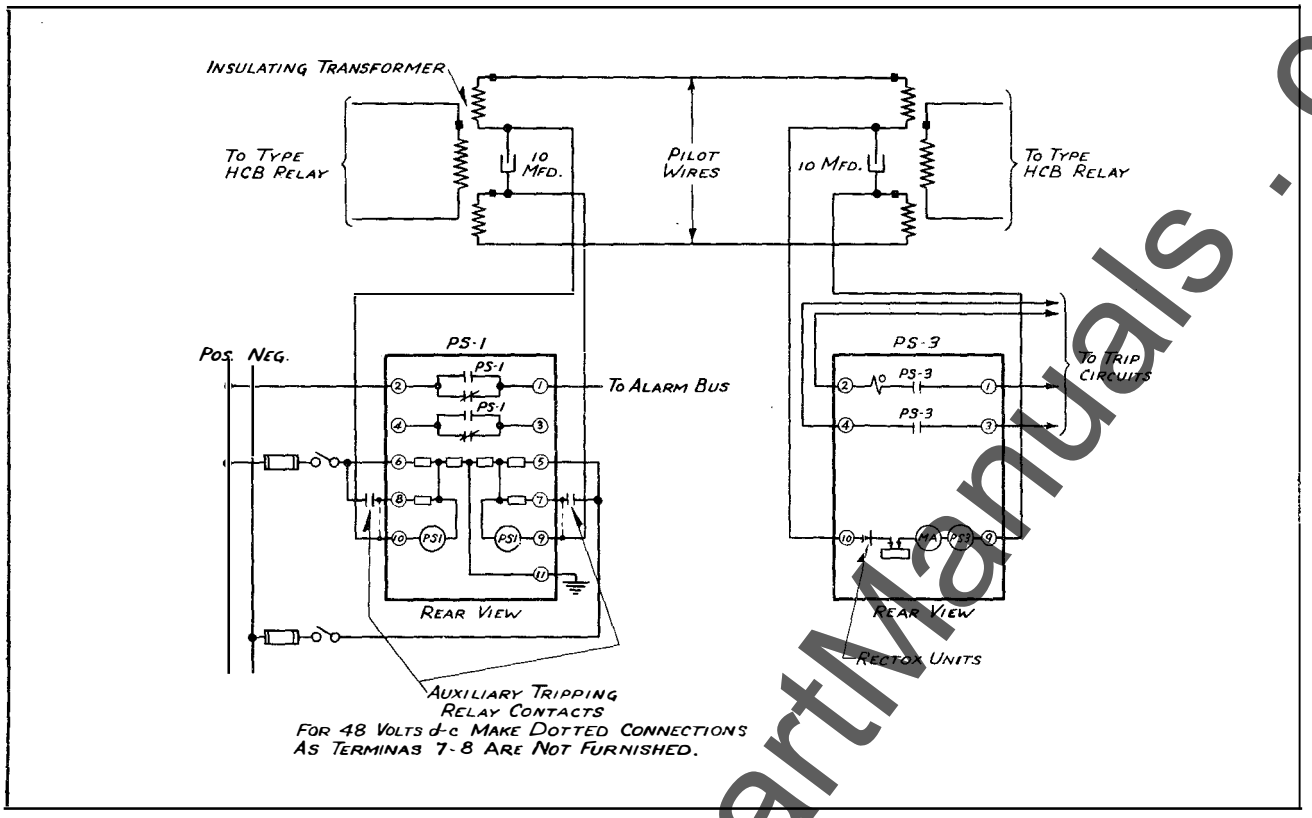

Fig. 14—External Connections of the 48, or 125 Volt D-C Type PS-1 and the Type PS-3 Relays in the Standard Case for Pilot Wire Supervisory and Remote Tripping.

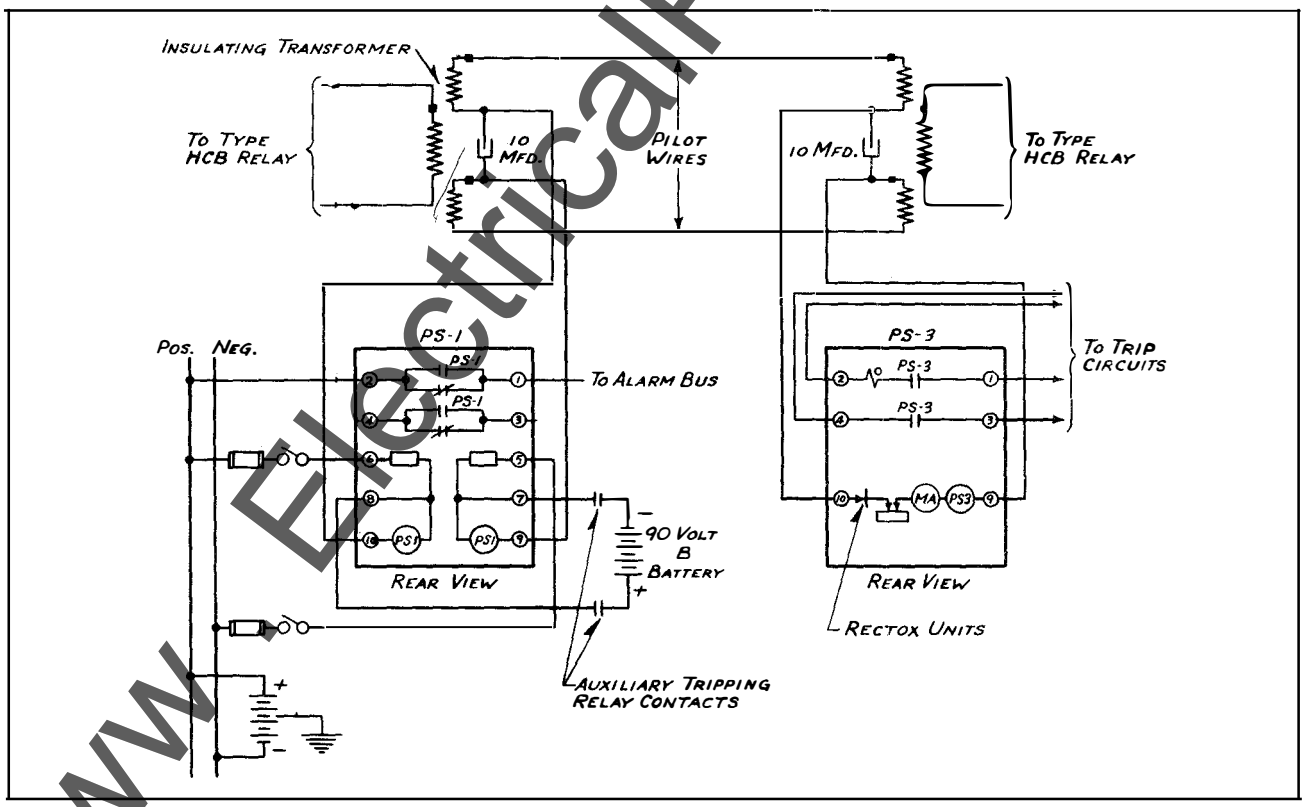

Fig. 15—External Connections of the 22 Volt D-C Type PS-1 and the Type PS-3 Relays in the Standard Case For Pilot Wire Supervisory and Remote Tripping.

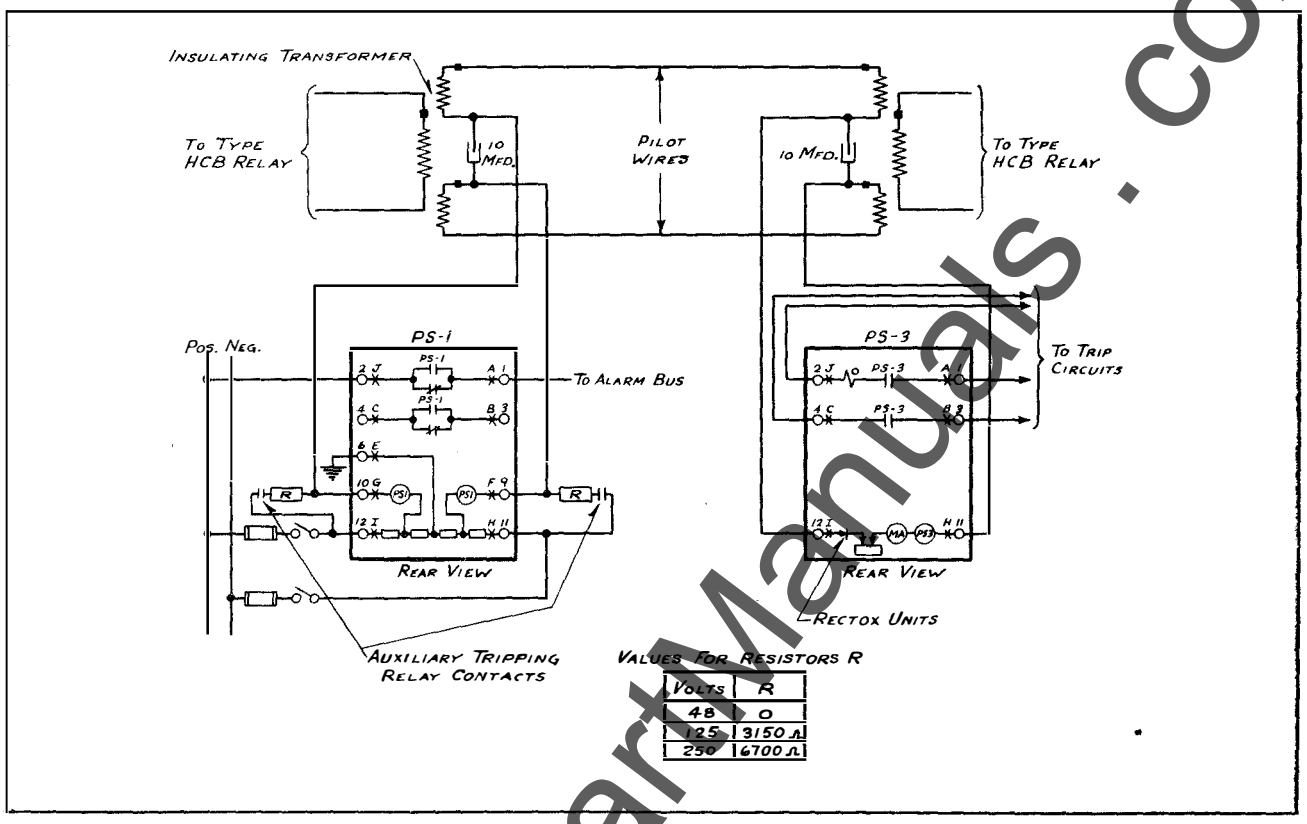

Fig. 16—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-3 Relays in the Type FT Case For Pilot Wire Supervisory and Remote Tripping.

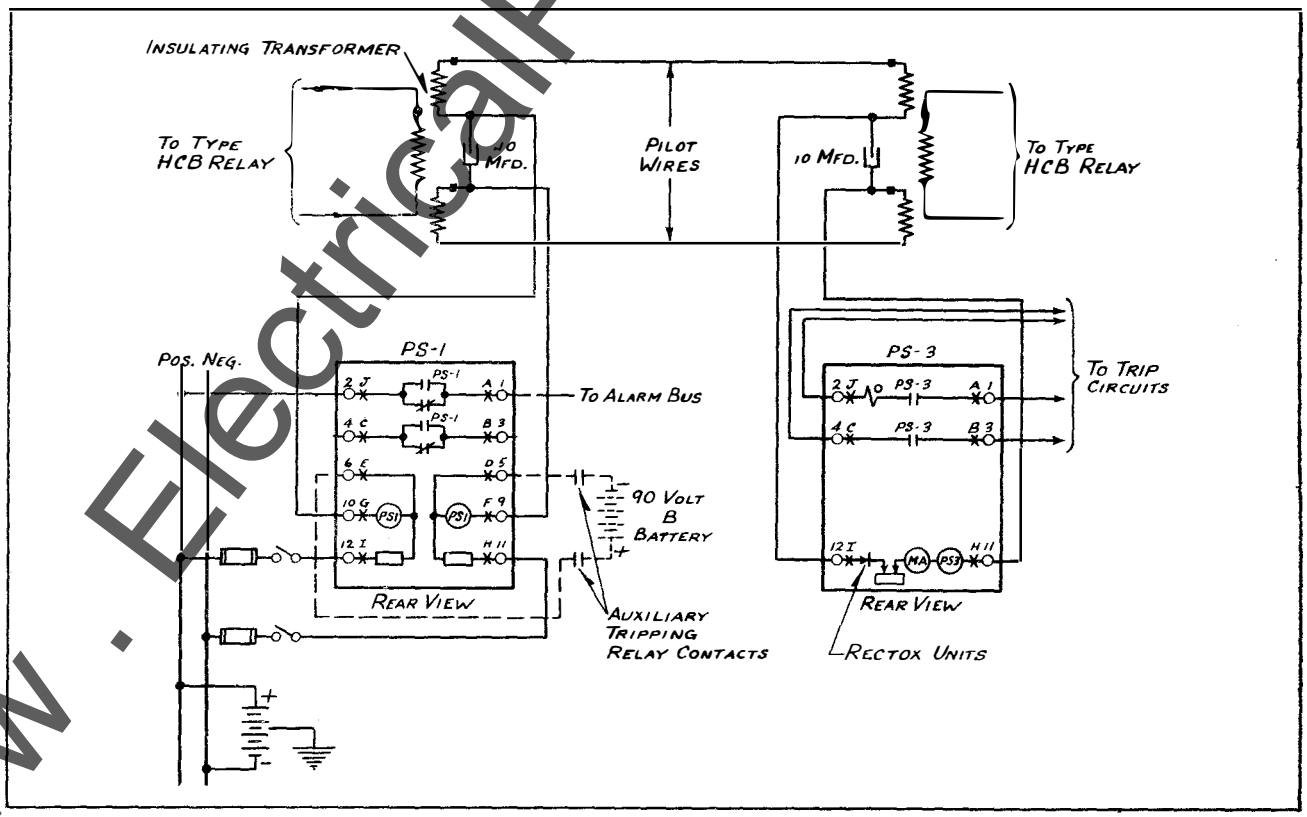

Fig. 17—External Connections of the 22 Volt D-C Type PS-1 and the Type PS-3 Relays in the Type FT Case For Pilot Wire Supervisory and Remote Tripping.

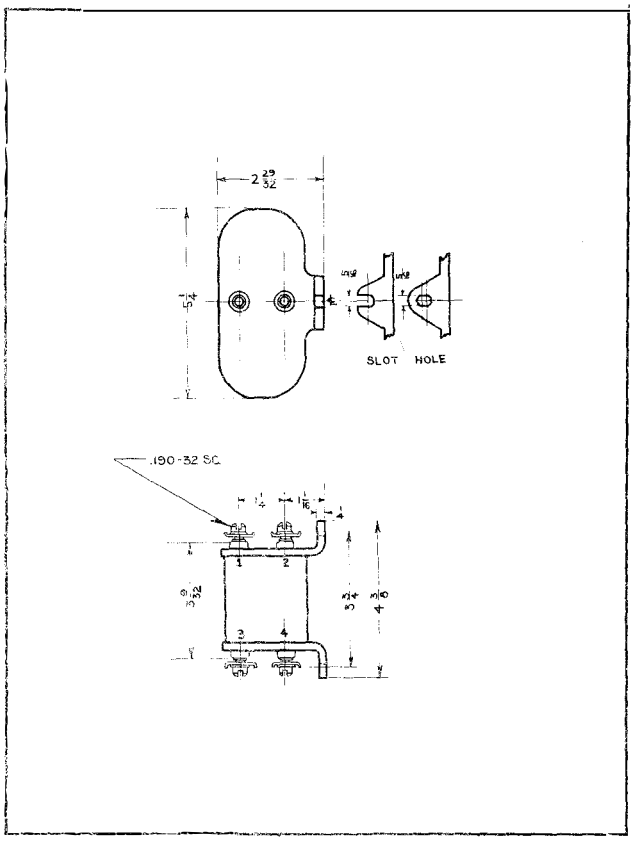

Fig. 18—Outline and Drilling Plan For the External Resistor Used With the Type PS-1 Relay in the Type FT Case For Remote Tripping. For Reference Only.

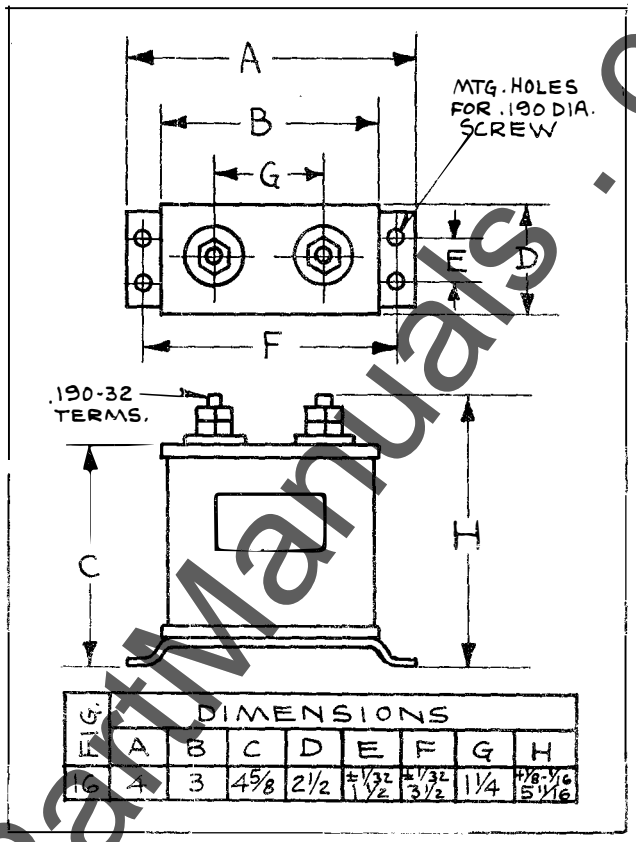

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
16	4	3	4 5/8	2 1/2	± 1/32 1 1/2	± 1/32 3 1/2	1 1/4	+1/8-3/16 5 1/16

Fig. 19—Outline and Drilling Plan For the 10 mfd. Capacitor. For Reference Only.

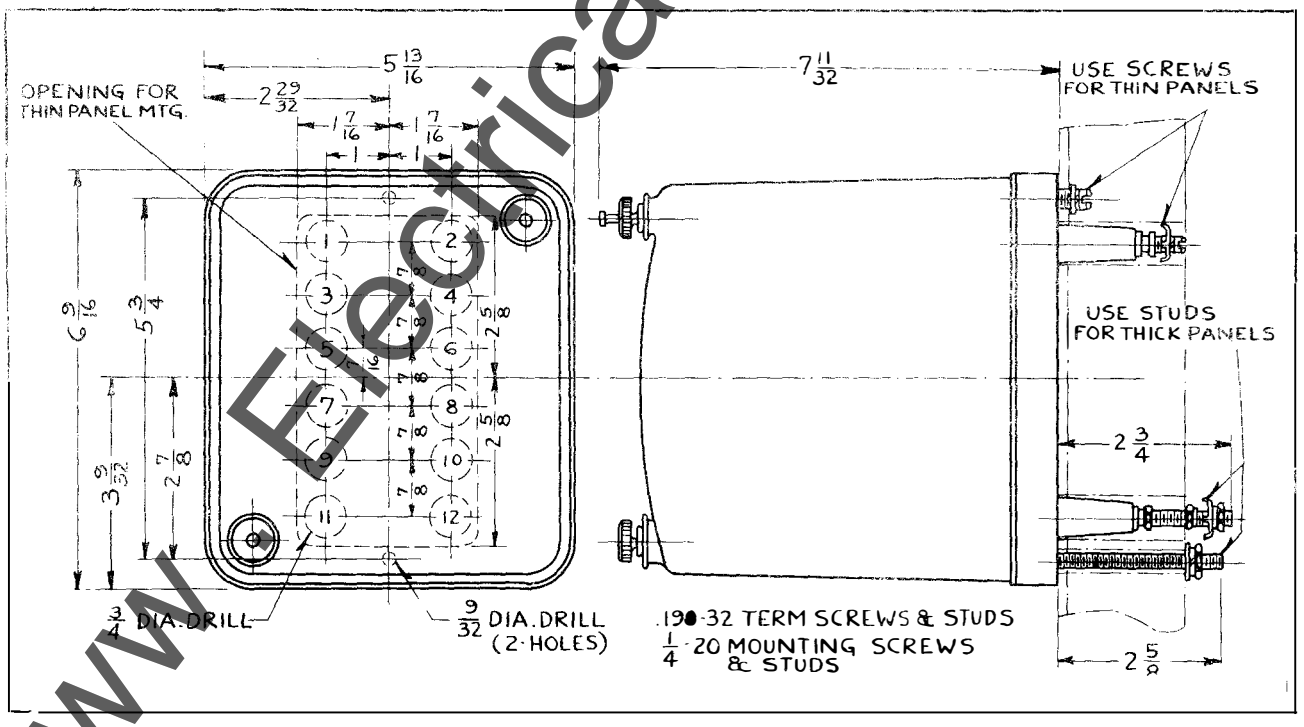

Fig. 20—Outline and Drilling Plan of the Projection Type Standard Case. See the Internal Schematics For the Terminals Supplied. For Reference Only.

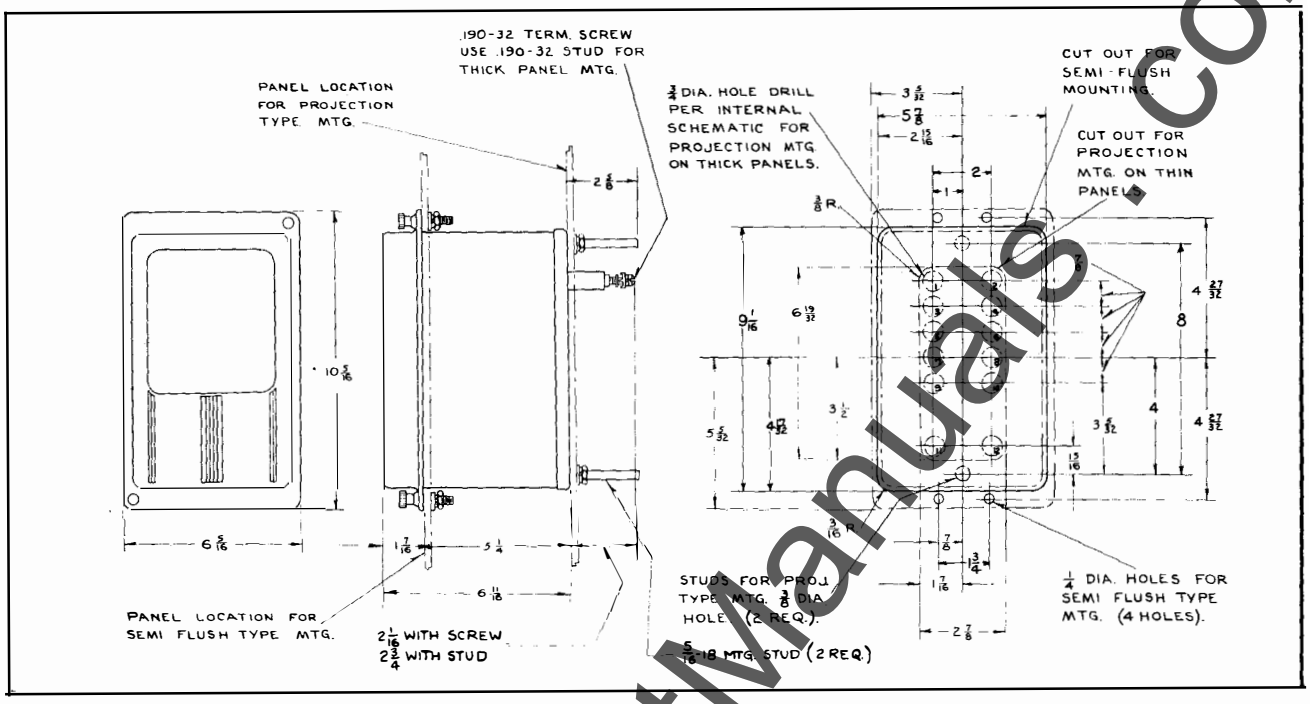

Fig. 21—Outline and Drilling Plan of the S10 Semi-flush or Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

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(D-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 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 d-c operated type PS-1 relay consists of a sensitive polarized relay element adapted to operate on .001 ampere or .002 ampere d-c pilot wire supervisory current. It is equipped with internal resistor tubes to obtain this current from a battery source. The 22 volt d-c relays utilize series resistors, whereas relays for operation from 48, 125, or 250 volt batteries utilize the resistors in a potentiometer arrangement. For three terminal lines, where the output of the type PS-1 relay is .002 ampere, the potentiometer models are equipped with different resistance values in the potentiometer than for two terminal lines, where the output of the type PS-1 is .001 ampere.

The polarized relay consists of an armature and contact assembly 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 toward the left-hand contact (front view). Two operating coils are placed around the armature wnd 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 left-hand side of the front air gap with the coils de-energized. This holds the left-hand contact closed. When either of

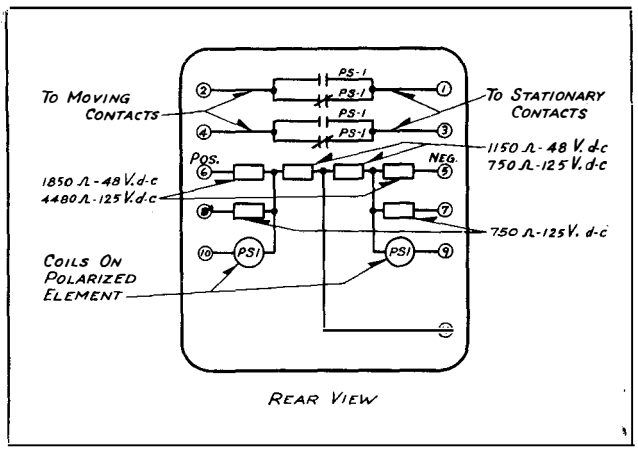

Fig. 1—Internal Schematic of the 48, or 125 Volt, D-C Type PS-1 Relay In the Standard Case. When Remote Tripping is not Required, or for 48 Volts D-C with or without Remote Tripping, Terminals 7 and 8 and Associated Resistors are Omitted.

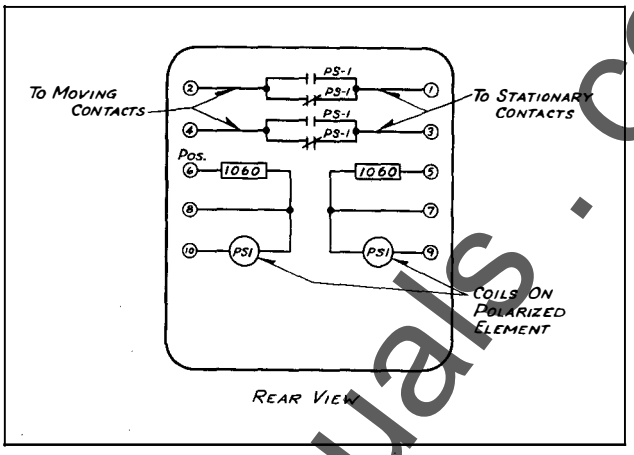

Fig. 2—Internal Schematic of the 22 Volt D-C Type PS-1 Relay In the Standard Case.

the operating coils are energized, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move towards 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, and adjustable resistor, and a rectox unit. 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 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:

(1a). Normal Pilot Wire - Two Terminal Lines

The relays are continuously energized with .001 ampere d-c which is introduced from the battery 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.

(1b). Normal Pilot Wire - Three Terminal Lines

The action here is the same in principle as for two terminal lines, except that the type PS-1 relay must furnish .002 ampere total, which allows .001 ampere for each of the two type PS-2 relays involved.

(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 type 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 types 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 the figures.

(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 of the type PS-1 relay to the remote

terminal on the pilot wire. In the 22 volt d-c models, the midpoint of the battery is grounded. 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 protection for ground fault resistance values of 500 ohms or less.

Station batteries are frequently grounded at the midpoint of a circuit consisting of two lamps connected in series across the battery terminals. An accidental ground on the station battery circuits will not affect the ability of the pilot wire supervisory relays to detect pilot wire short circuits or open circuits, although the relative sensitivity of the type PS-1 to grounds on one of the two wires of a pilot pair will be changed. Ground faults on the pilot wire will not affect the grounding lamps on the station battery because of the high internal resistance of the type PS-1 relay.

(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 types 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 PS-1 relay operates on under current to ring an alarm.

(6). Remote Tripping

Remote tripping is accomplished by applying a higher d-c voltage to the pilot wires at the sending end, where the type PS-1 relay is located. The polarity of this voltage is the same as the normal voltage. For 125 and 250 V. d-c sources, resistors are used to limit the pilot wire current. For the 22 volt models, an extra battery source of higher voltage must be used.

(7). Difference in Ground Potential

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. If the magnitude of this potential is between 200 and 500 volts, it is recommended that 5 mfd. capacitors be connected--one each between the relay pilot wire terminals and ground at the type PS-1 relay. If the magnitude of this potential exceeds 500 volts, special means of protecting the relays are available.

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

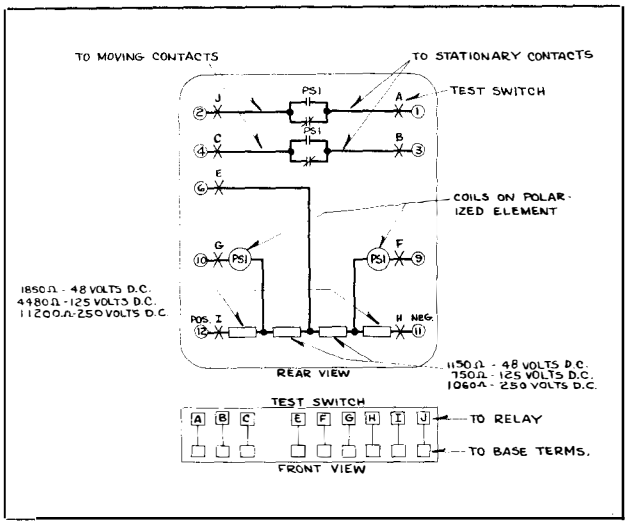

Fig. 3—Internal Schematic of the 48, 125 or 250 Volt, D-C Type PS-1 Relay in the Type FT Case.

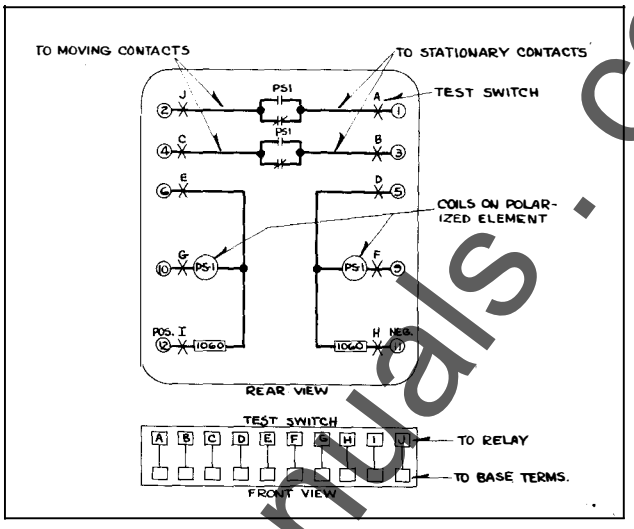

Fig. 4—Internal Schematic of the 22 Volt D-C Type PS-1 Relay in the Type FT Case.

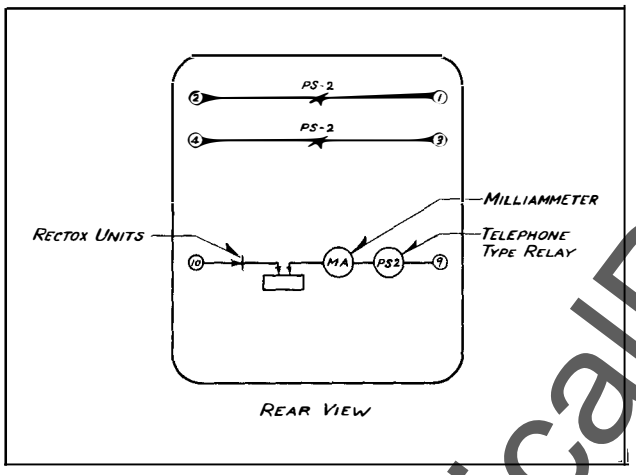

Fig. 5—Internal Schematic of the Type PS-2 Relay in the Standard Case.

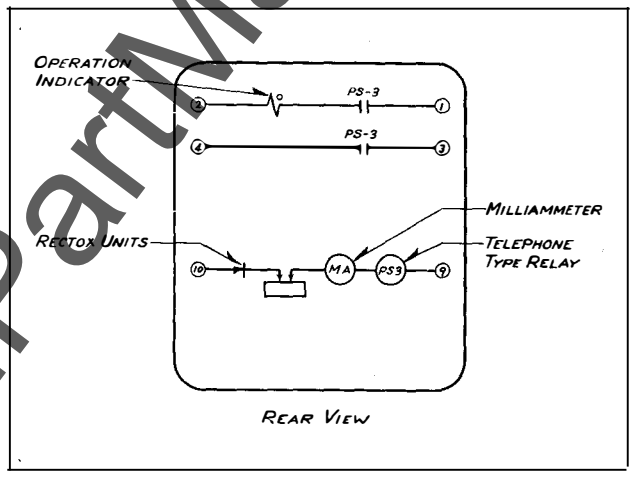

Fig. 6—Internal Schematic of the Type PS-3 Relay in the Standard Case.

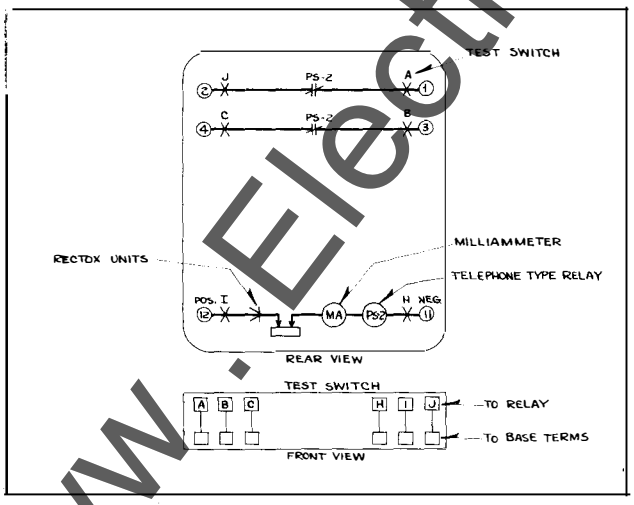

Fig. 7—Internal Schematic of the Type PS-2 Relay in the Type FT Case.

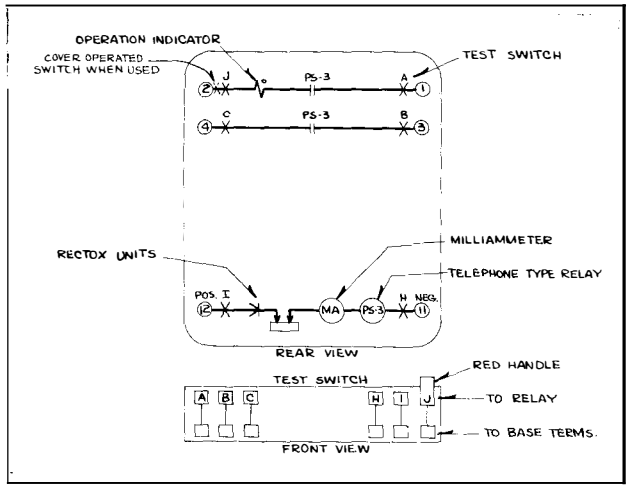

Fig. 8—Internal Schematic of the Type PS-3 Relay in the Type FT Case.

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 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 contacts 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.

Figures 9 to 13 show the external connections of the types PS-1 and PS-2 relays. Figures 14 to 17 show the external connections of the type PS-1 and PS-3 relays. For information concerning the type HCB relay see I.L. 41-658.

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 adjust the slide wire resistance in the type PS-2 or PS-3 relay, so that the milliameter in the relay indicates that one milliampere d-c is circulating over the pilot wires.

CAUTION If the pilot wires are subject to induction from adjacent transmission lines, it is recommended that the relay 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 voltage 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. S#1002110 file is recommended for this purpose. The use of abrasive

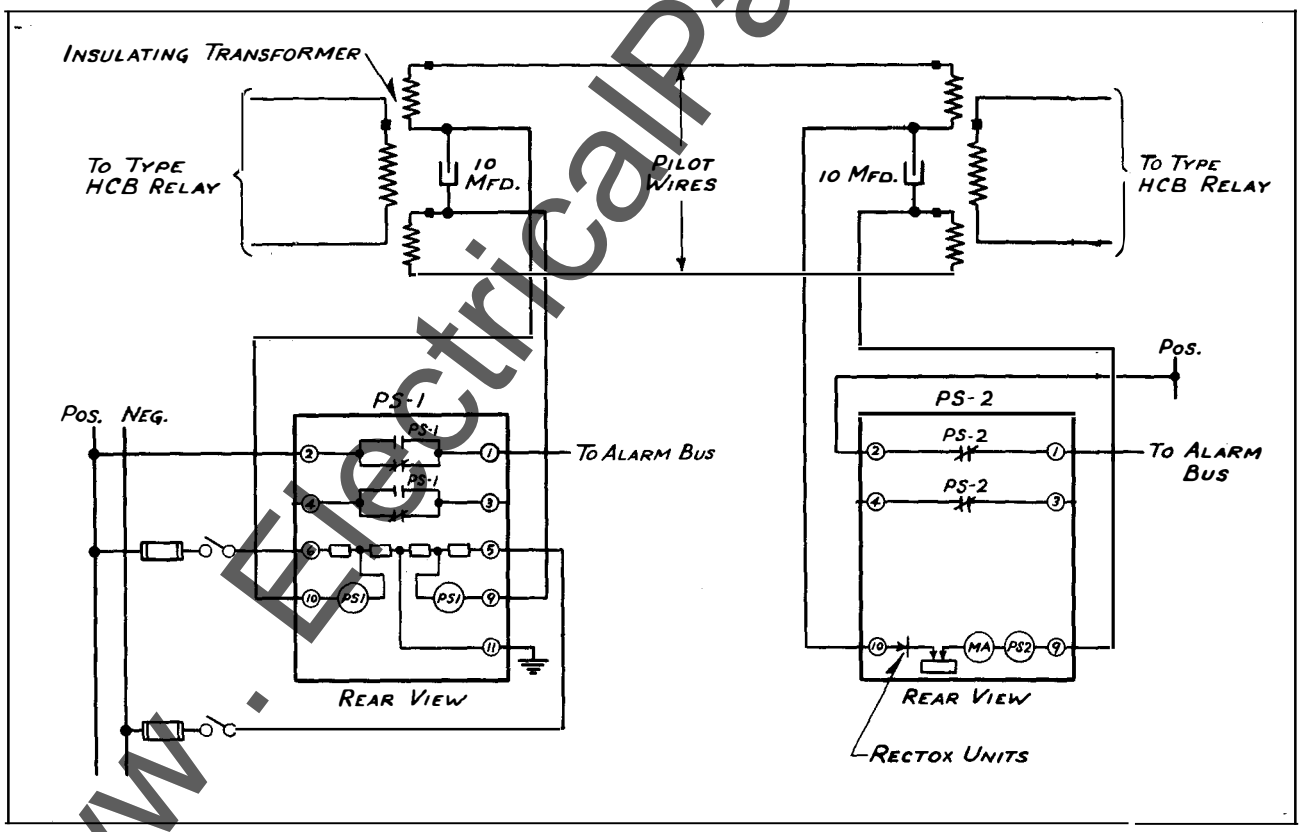

Fig. 9—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Standard Case For Pilot Wire Supervisory.

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, remove the permanent magnet and adjust the moving armature 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 one-half turn to obtain approximately .012 inch contact follow. 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 one of the figures 9 or 17 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 moving contacts float midway between the stationary contacts. With this adjustment, the right-hand contacts should operate at approximately .0013 ampere, and the left-hand contacts should close at .0007 ampere. For three terminal lines, the type PS-1 relay contacts should float at .002 ampere, close to the right at .0023 ampere, and close to the left at .0017 ampere.

A good way to adjust the element is to start with both magnetic shunts at the extreme "in" position, then draw out the right-hand shunt until the right-hand contacts make at the desired current. Then lower the current and draw out the left hand shunt until the left-hand contacts make at the right value. This will upset the adjustment for the right hand contacts, which should then be rechecked. The process is easily carried back and forth until both values will check properly. Final readings should be taken with the shunt locking screws tightened.

Type PS-2 Relays, Telephone Element

With the relays connected per one of the figures 9 to 13, adjust the armature gap and spring tension of the telephone-type relays 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 one of the figures 14 to 17, adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .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.

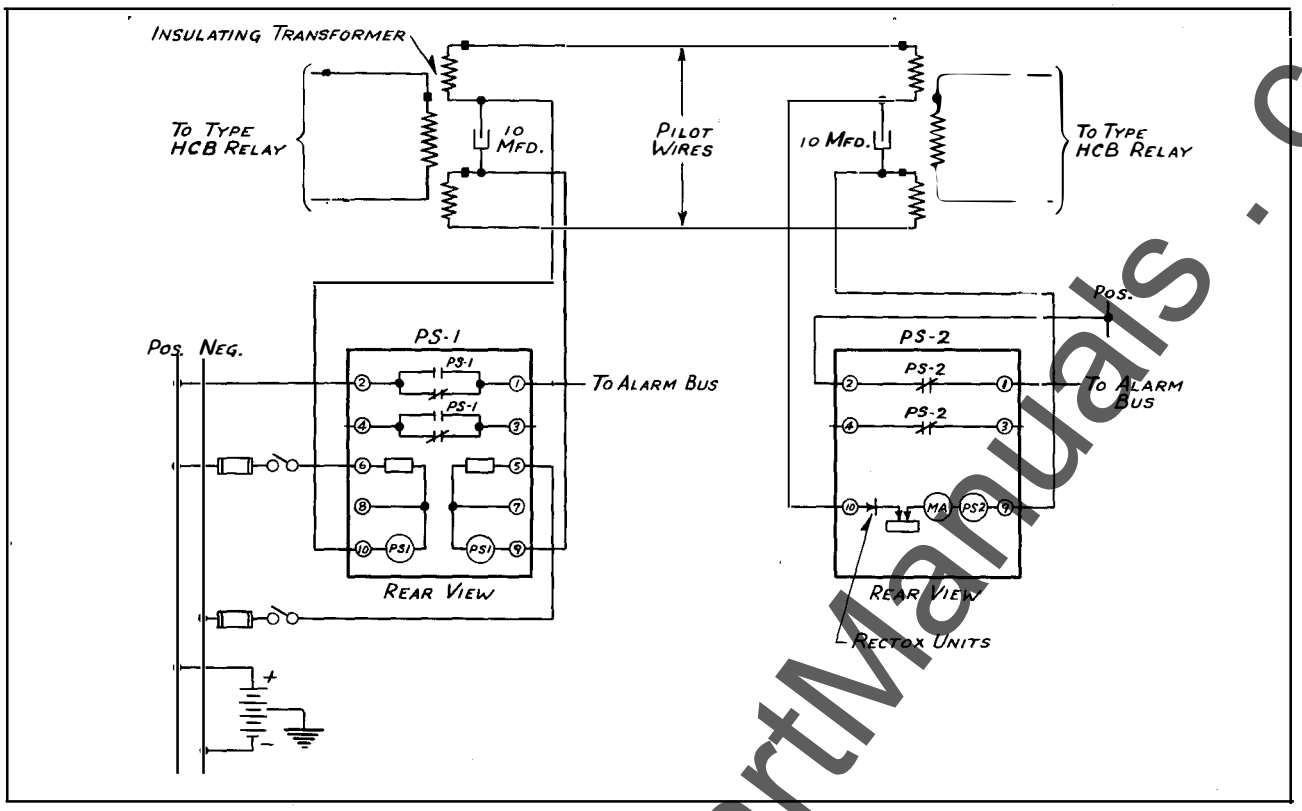

Fig. 10—External Connections of the 22 Volt D-C Type PS-1 and the Type PS-2 Relays in the Standard Case For Pilot Wire Supervisory.

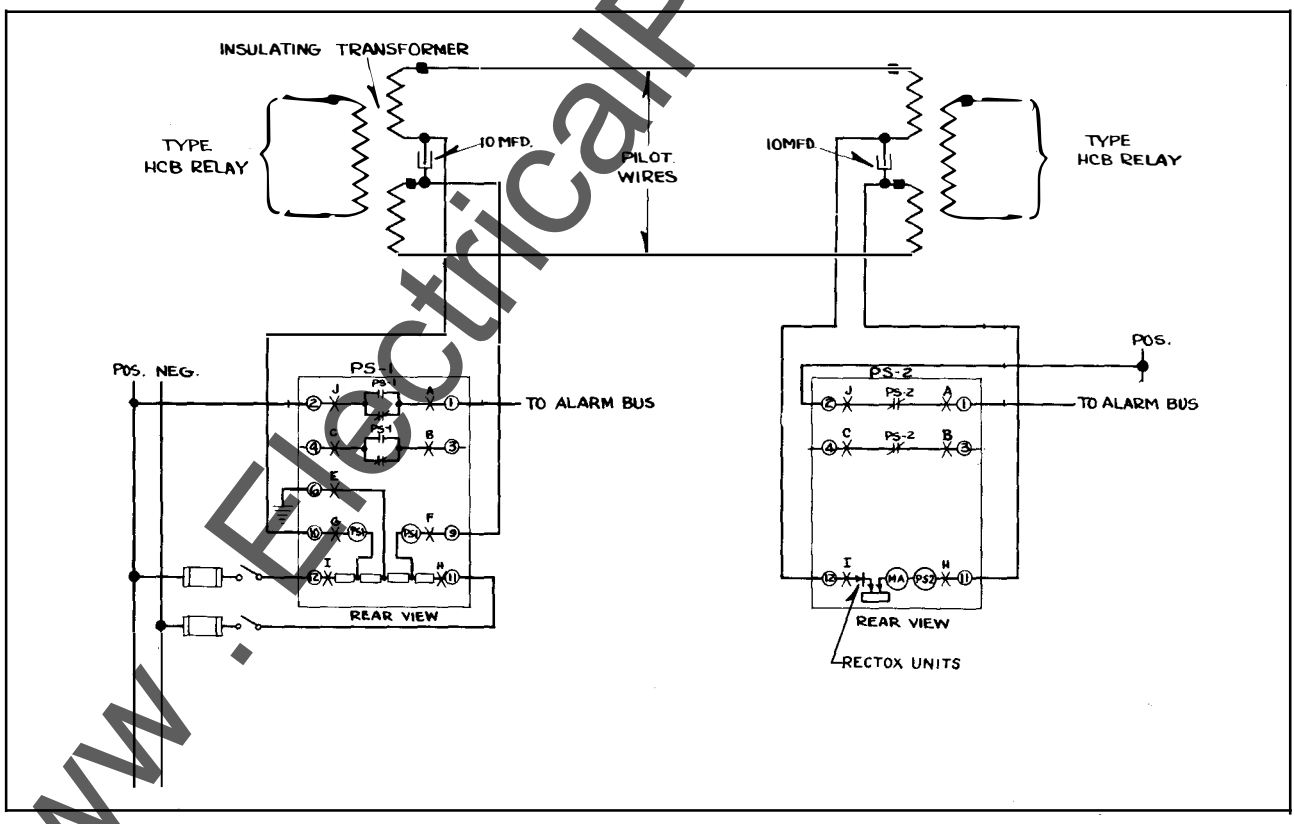

Fig. 11—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Type FT Case For Pilot Wire Supervisory.

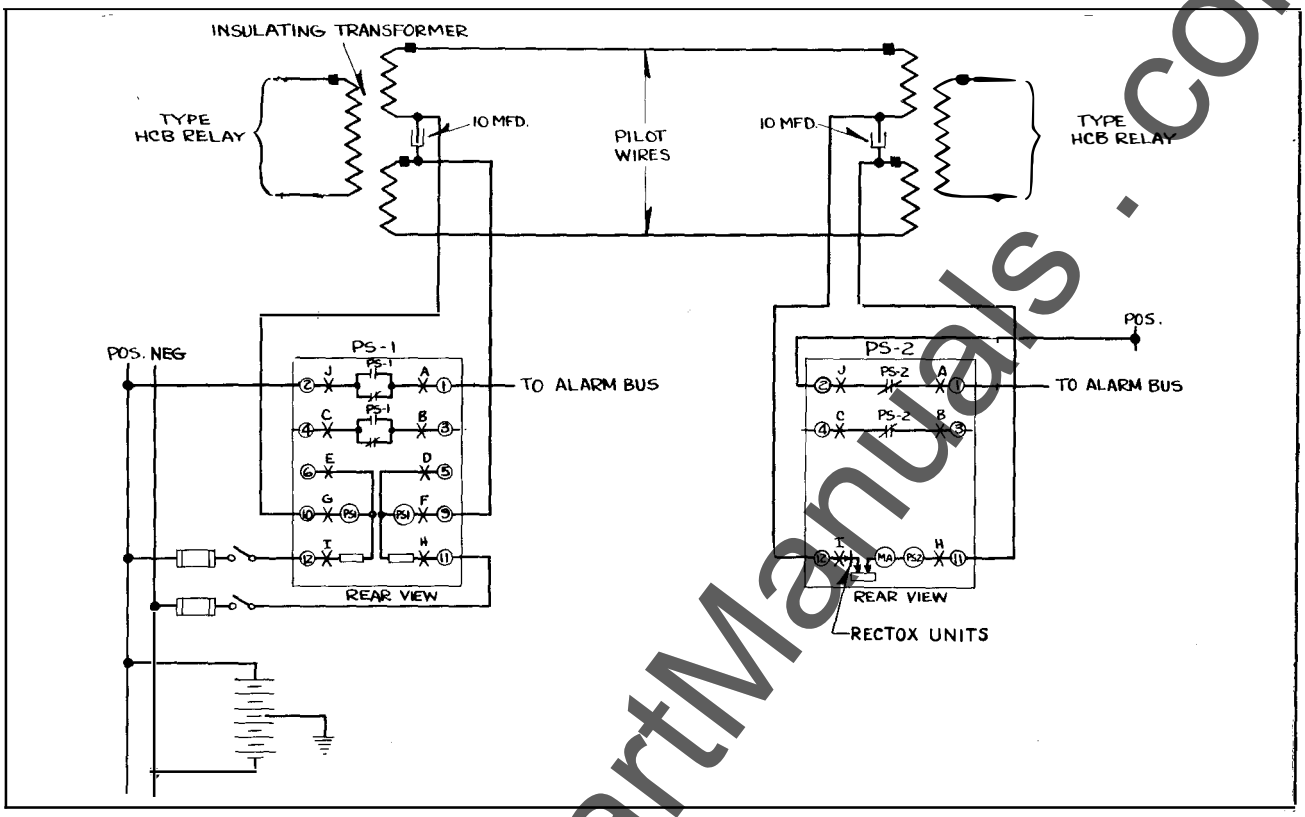

Fig. 12—External Connections of the 22 Volt D-C Types PS-1 and the PS-2 Relays in the Type FT Case For Pilot Wire Supervisory.

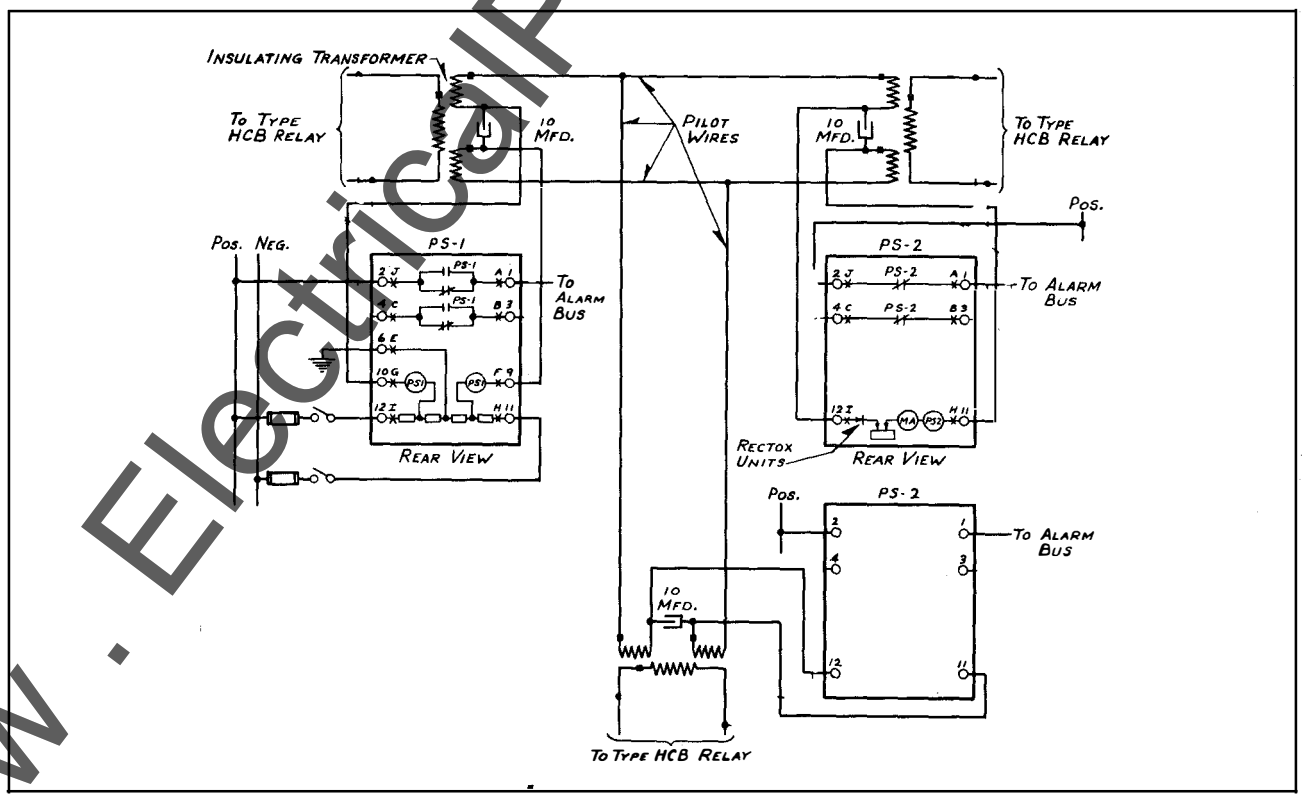

Fig. 13—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Type FT Case For Pilot Wire Supervisory of a Three Terminal Line.

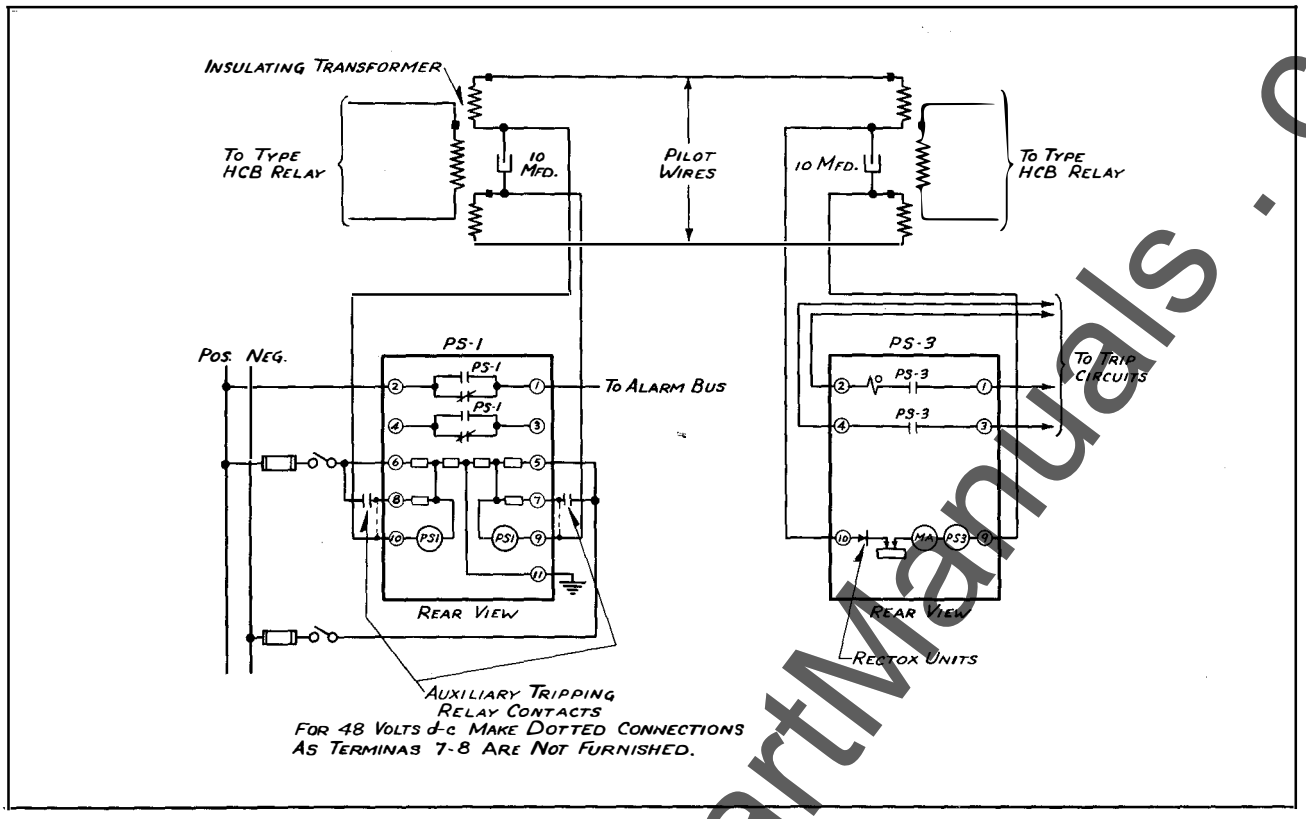

Fig. 14—External Connections of the 48, or 125 Volt D-C Type PS-1 and the Type PS-3 Relays in the Standard Case for Pilot Wire Supervisory and Remote Tripping.

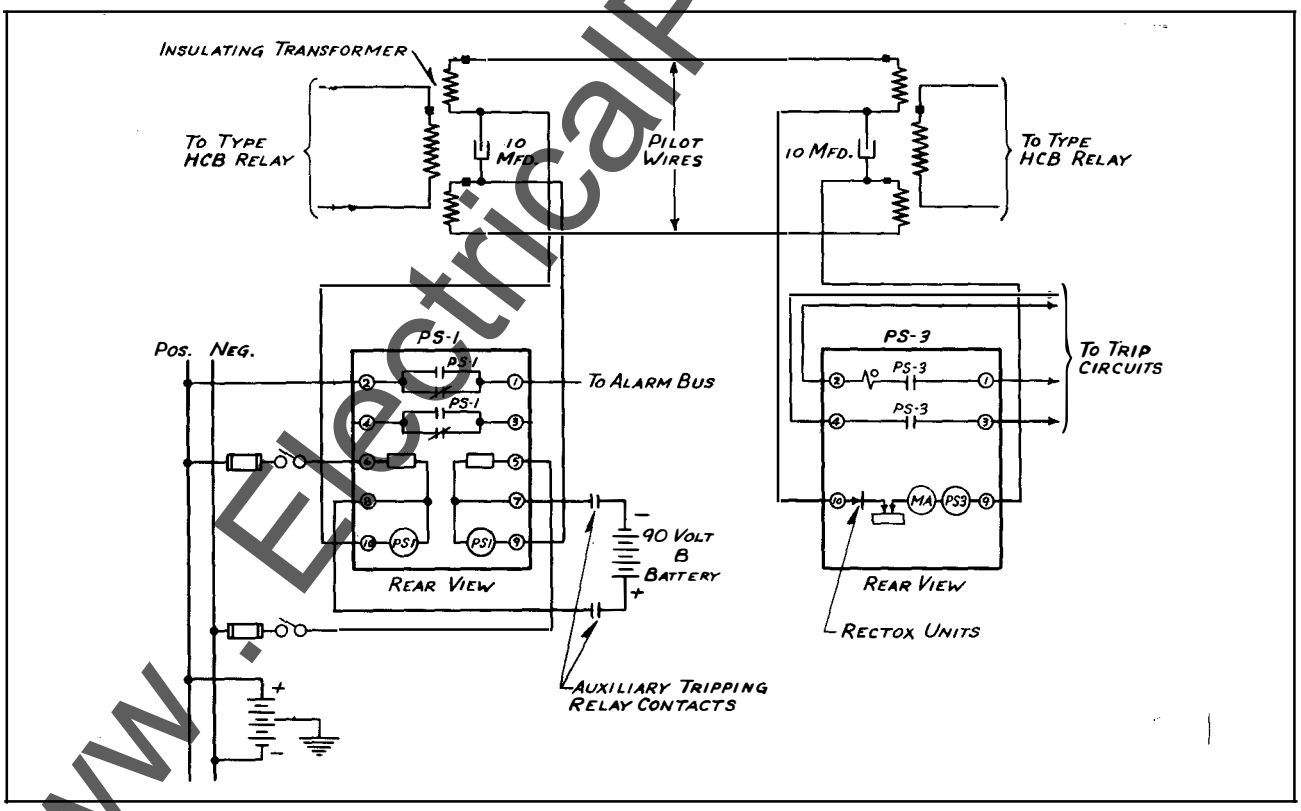

Fig. 15—External Connections of the 22 Volt D-C Type PS-1 and the Type PS-3 Relays in the Standard Case For Pilot Wire Supervisory and Remote Tripping.

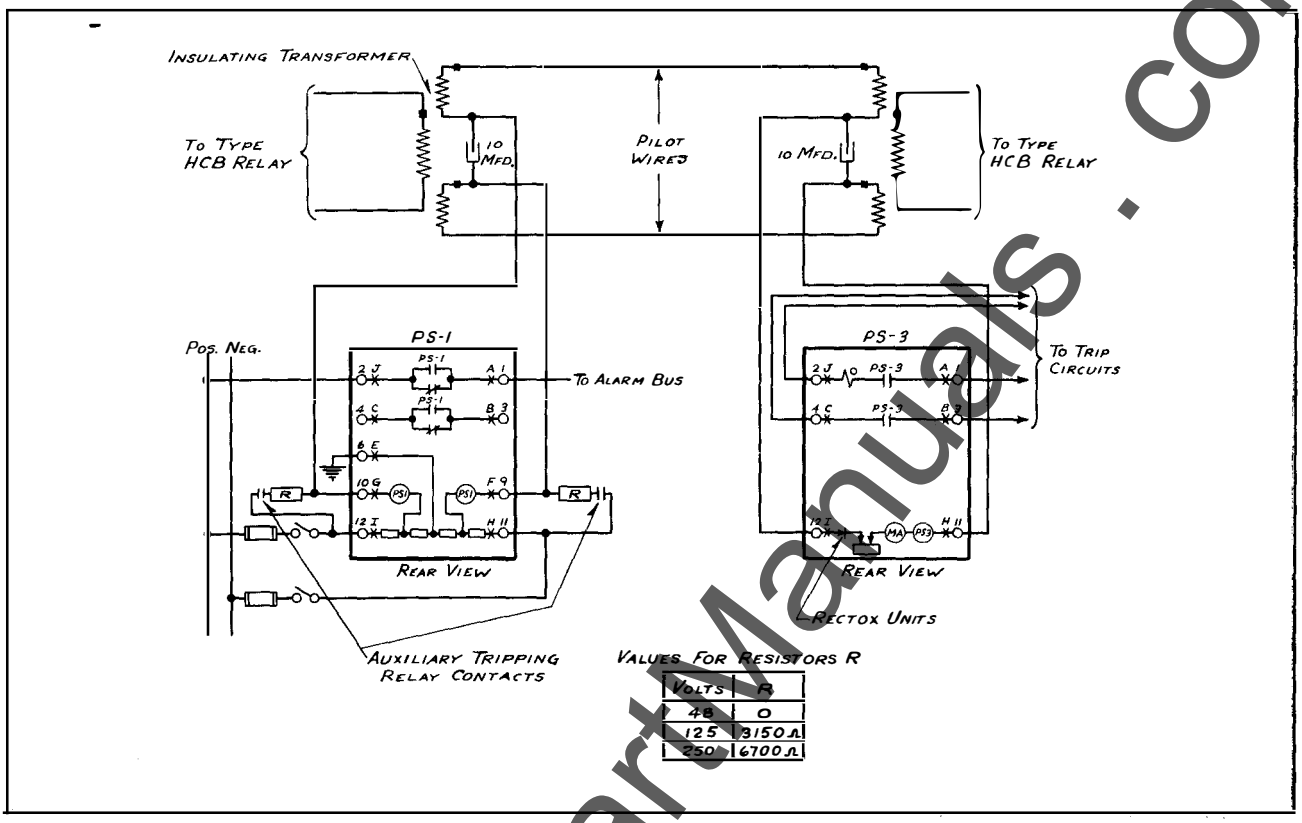

Fig. 16—External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-3 Relays in the Type FT Case For Pilot Wire Supervisory and Remote Tripping.

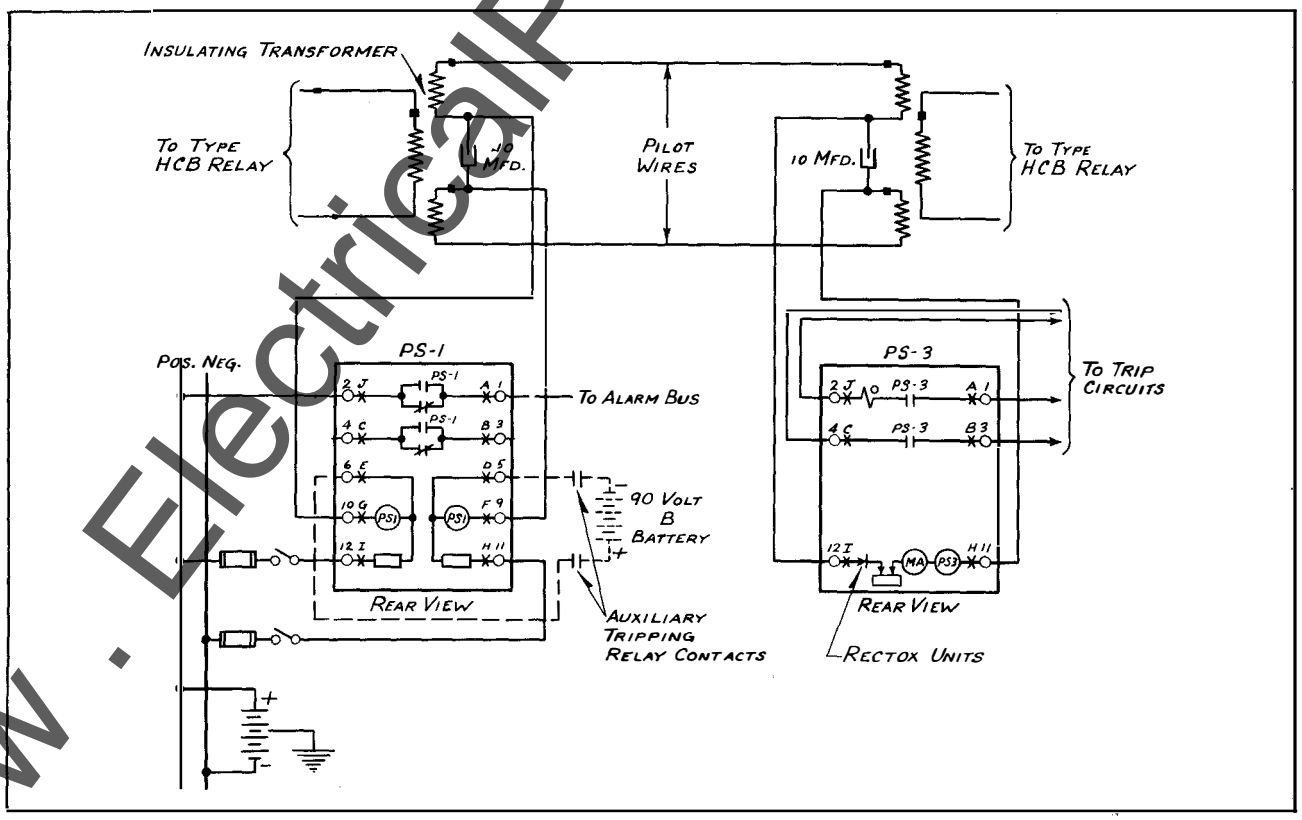

Fig. 17—External Connections of the 22 Volt D-C Type PS-1 and the Type PS-3 Relays in the Type FT Case For Pilot Wire Supervisory and Remote Tripping.

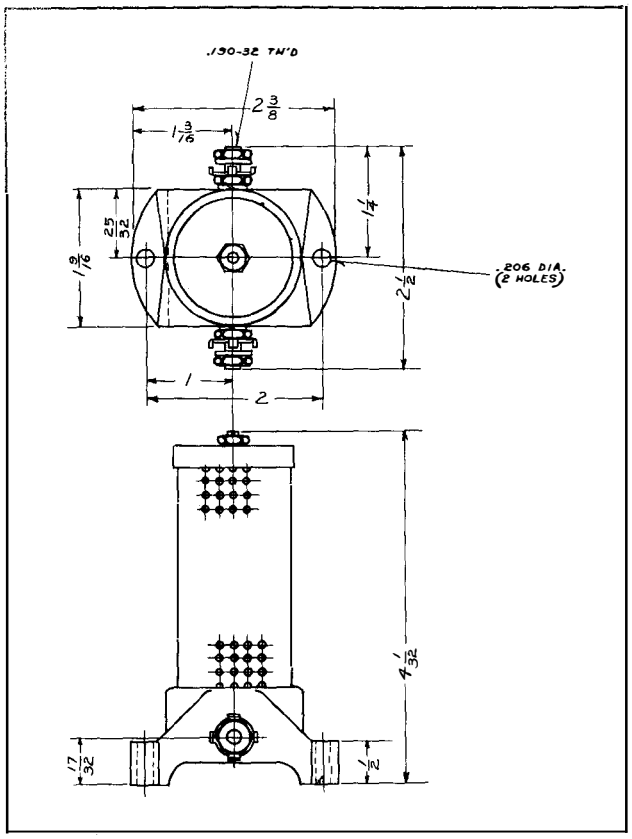

Fig. 18—Outline and Drilling Plan For the External Resistor Used With the Type PS-1 Relay in the Type FT Case For Remote Tripping. For Reference Only.

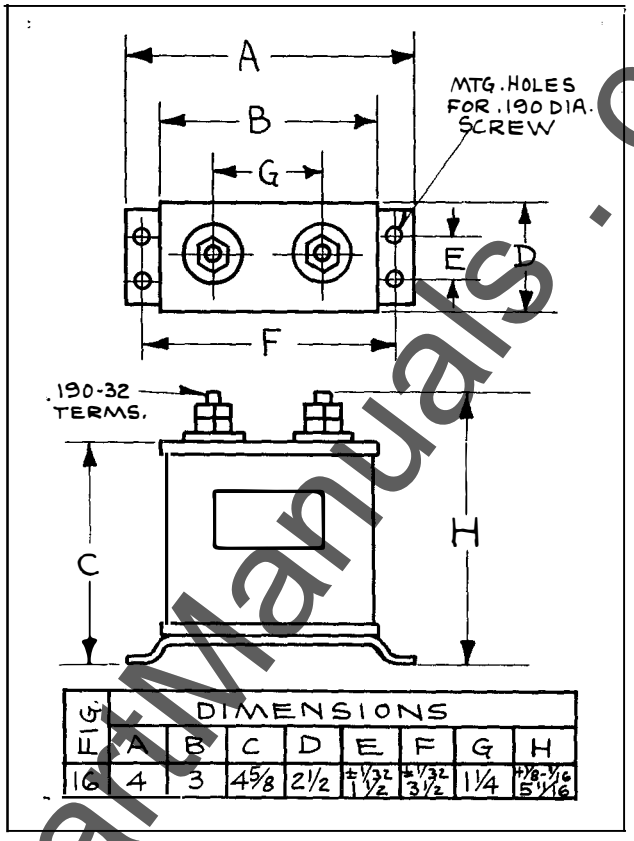

FIG.	DIMENSIONS							
	A	B	C	D	E	F	G	H
16	4	3	4 5/8	2 1/2	±1/32 1 1/2	±1/32 3 1/2	1 1/4	+1/8-1/16 5 1/16

Fig. 19—Outline and Drilling Plan For the 10 mfd. Capacitor. For Reference Only.

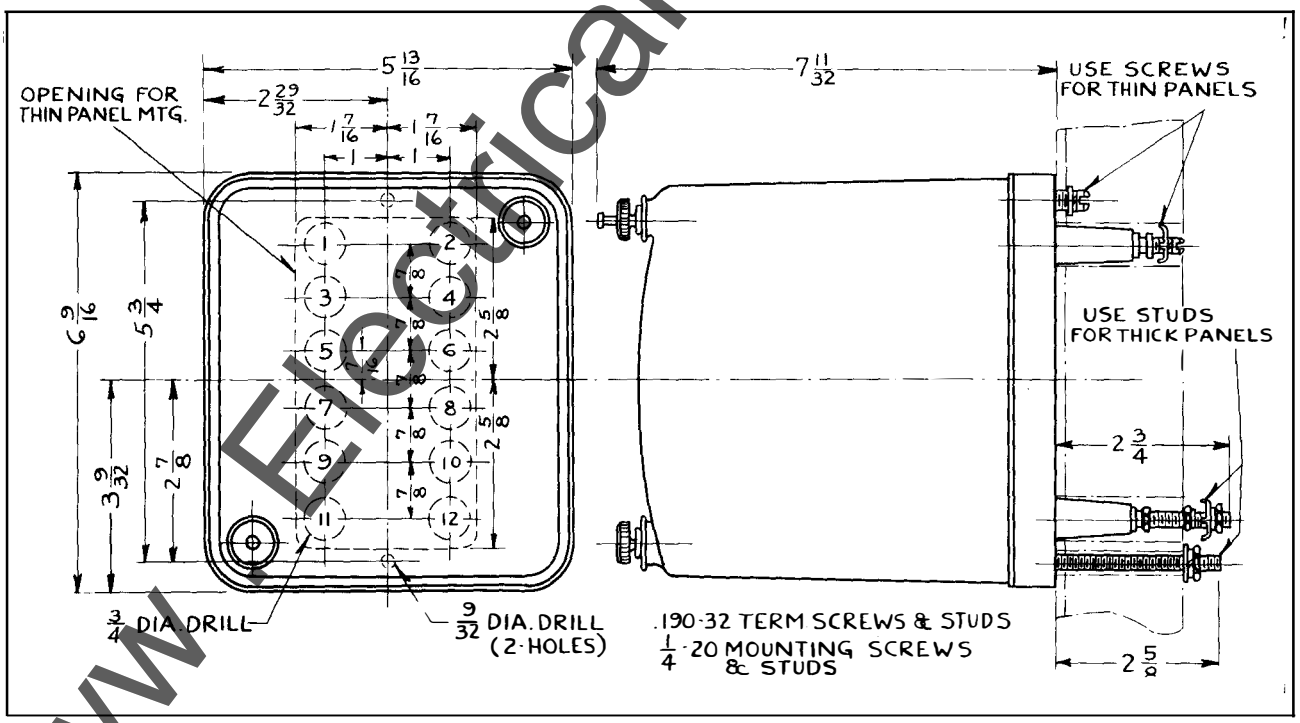

Fig. 20—Outline and Drilling Plan of the Projection Type Standard Case. See the Internal Schematics For the Terminals Supplied. For Reference Only.

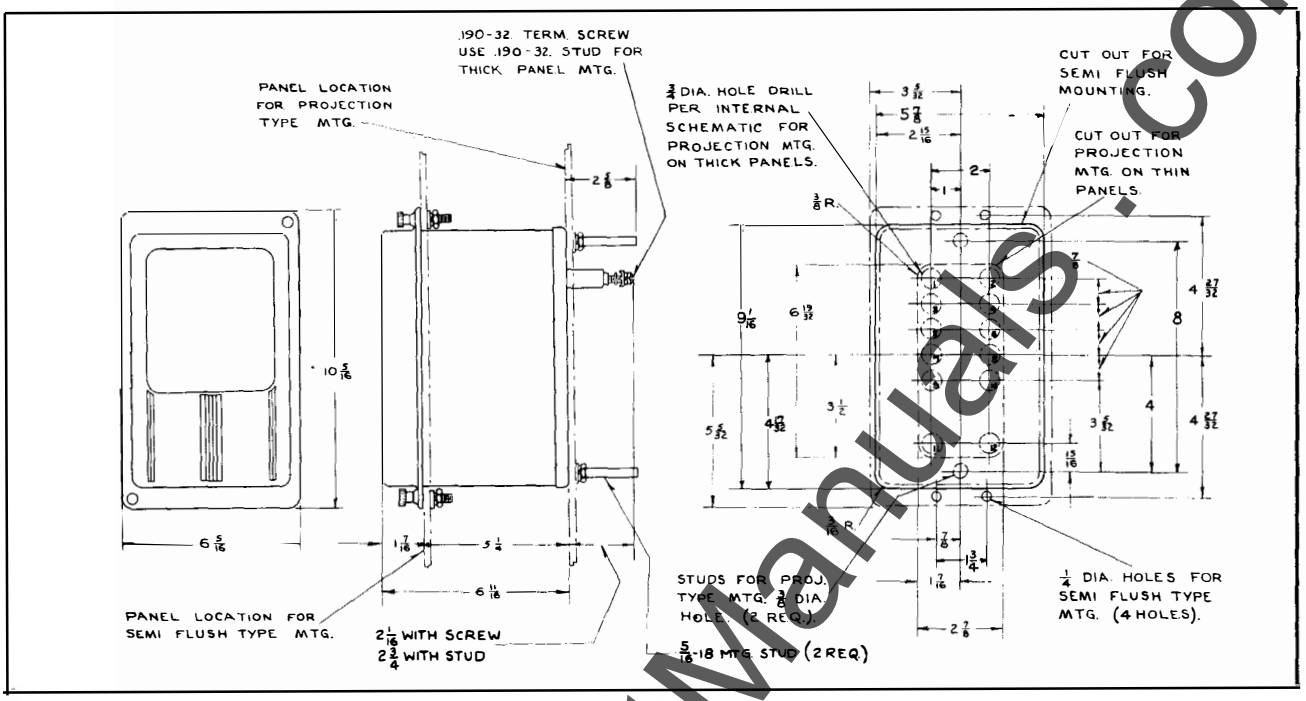

Fig. 21—Outline and Drilling Plan of the S10 Semi-flush or Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

WESTINGHOUSE · ELECTRIC CORPORATION

METER DIVISION • **NEWARK, N.J.**

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Westinghouse

TYPES PS-1, PS-2 AND PS-3 PILOT WIRE SUPERVISORY RELAYS (D-C OPERATED)

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 d-c operated type PS-1 relay consists of a sensitive polarized relay element adapted to operate on .001 ampere or .002 ampere d-c pilot wire supervisory current. It is equipped with internal resistor tubes to obtain this current from a battery source. The 22 volt d-c relays utilize series resistors, whereas relays for operation from 48, 125, or 250 volt batteries utilize the resistors in a potentiometer arrangement. For three terminal lines, where the output of the type PS-1 relay is .002 ampere, the potentiometer models are equipped with different resistance values in the potentiometer than for two terminal lines, where the output of the type PS-1 is .001 ampere.

The polarized relay consists of an armature and contact assembly 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 left-hand side of the front air gap with the coils de-energized. 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 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 rectifier unit. 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 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:

(1a). Normal Pilot Wire - Two Terminal Lines.

The relays are continuously energized with .001 ampere d-c which is introduced from the battery 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.

(1b). Normal Pilot Wire - Three Terminal Lines.

The action here is the same in principle as for two terminal lines, except that the type PS-1 relay must furnish .002 ampere total, which allows .001 ampere for each of the two type PS-2 relays involved.

(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 type PS-2 relay to initiate an alarm at both terminals of the pilot wire.

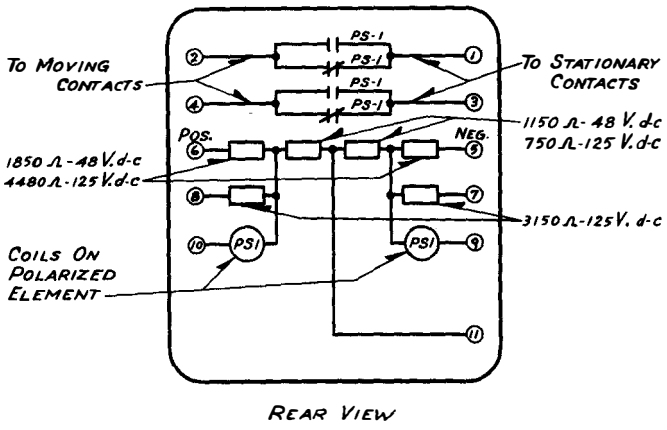

Figure 1
Internal Schematic of the 48, 125 or 250 Volt, D-C Type PS-1 Relay In the Standard Case. When Remote Tripping is not Required, Terminals 7 and 8 and Associated Resistors are Omitted.

(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 types 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 the figures.

(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 of the type PS-1 relay to the remote terminal on the pilot wire. In the 22 volt d-c models, the midpoint of the battery is grounded. 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 protection for ground fault resistance values of 500 ohms or less.

Station batteries are frequently grounded at the midpoint of a circuit consisting of two lamps connected in series across the battery terminals. An accidental ground on the station battery circuits will not affect the ability of the pilot wire supervisory relays to detect pilot wire short circuits or open circuits, although the relative sensitivity of the type PS-1 to grounds on one of the two wires of a pilot pair will be changed. Ground faults on the pilot wire will not affect the grounding lamps on the station battery because of the high internal resistance of the type PS-1 relay.

(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 types 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.

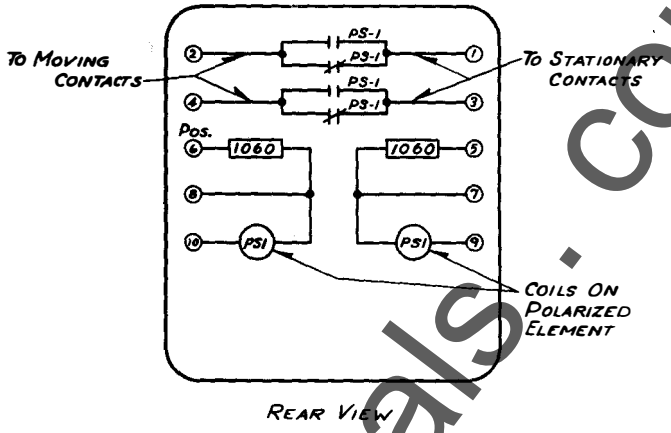

Figure 2
Internal Schematic of the 22 Volt D-C Type PS-1 Relay In the Standard Case.

(6). Remote Tripping

Remote tripping is accomplished by applying a higher d-c voltage to the pilot wires at the sending end, where the type PS-1 relay is located. The polarity of this voltage is the same as the normal voltage. For 125 and 250 V. d-c sources, resistors are used to limit the pilot wire current. For the 22 volt models, an extra battery source of higher voltage must be used.

(7). Difference in Ground Potential

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. If the magnitude of this potential is between 200 and 500 volts, it is recommended that 5 mfd. capacitors be connected--one each between the relay pilot wire terminals and ground at the type PS-1 relay. If the magnitude of this potential exceeds 500 volts, special means of protecting the relays are available.

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

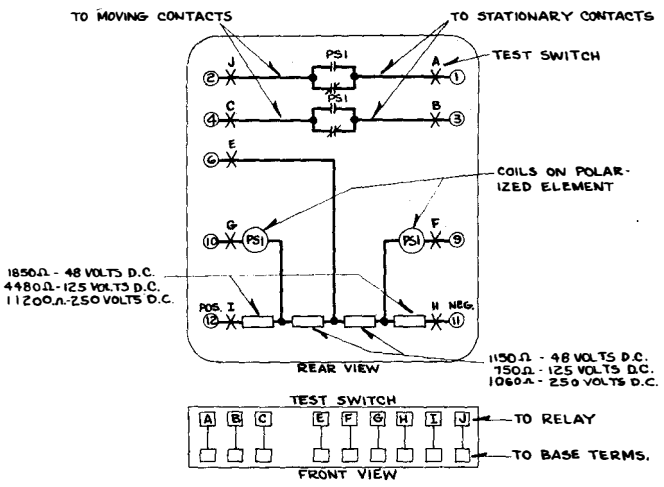

Figure 3
Internal Schematic of the 48, 125 or 250 Volt, D-C Type PS-1 Relay in the Type FT Case.

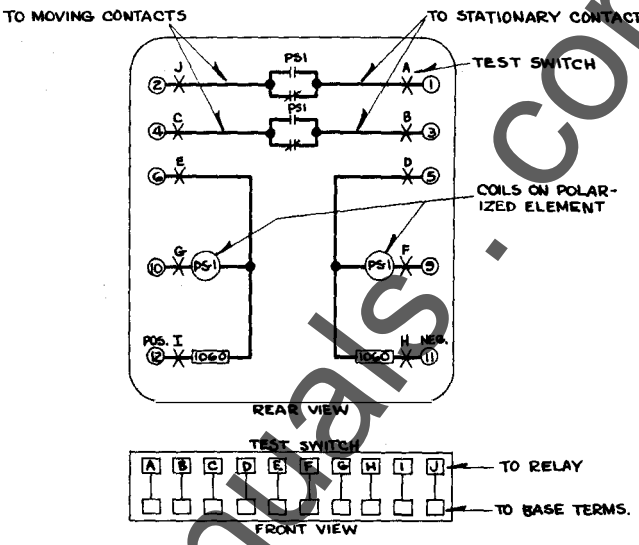

Figure 4
Internal Schematic of the 22 Volt D-C Type PS-1 Relay in the Type FT Case.

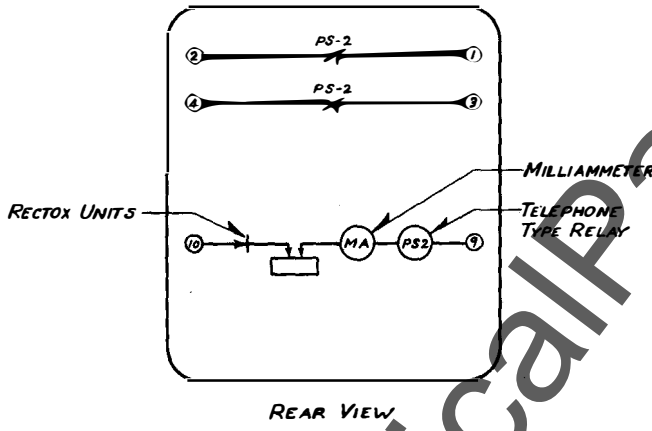

Figure 5
Internal Schematic of the Type PS-2 Relay in the Standard Case.

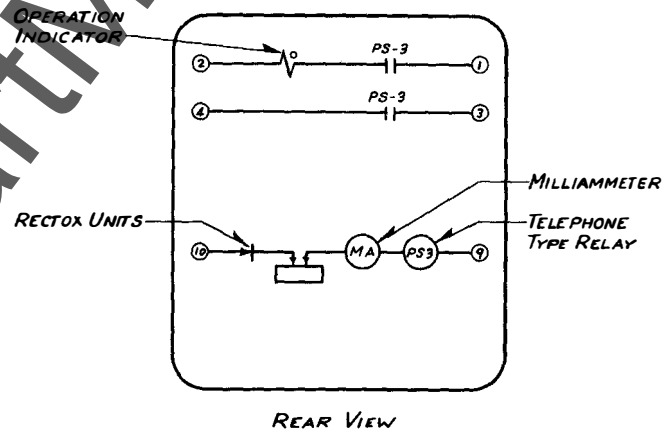

Figure 6
Internal Schematic of the Type PS-3 Relay in the Standard Case.

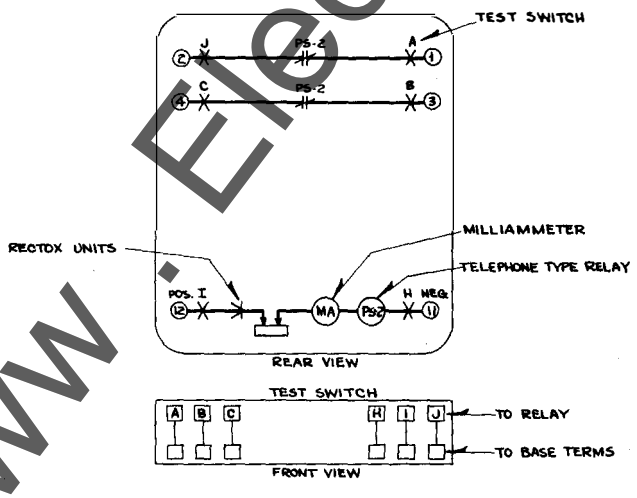

Figure 7
Internal Schematic of the Type PS-2 Relay in the Type FT Case.

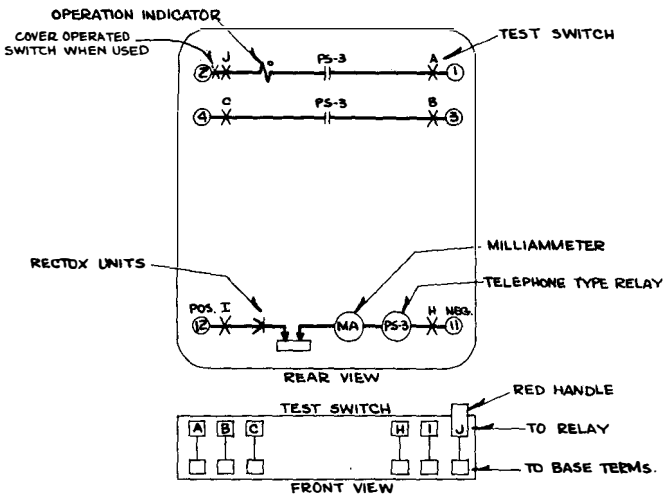

Figure 8
Internal Schematic of the Type PS-3 Relay in the Type FT Case.

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 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 contacts 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.

Figures 9 to 13 show the **external** connections of the types PS-1 and PS-2 relays. Figures 14 to 17 show the external connections of the type PS-1 and PS-3 relays. For information concerning the type HCB relay see I.L. 41-658.

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 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.

CAUTION

If pilot wires are subject to induction from adjacent transmission lines, it is recommended that the realy 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 voltage from the relay.

ADJUSTMENT 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. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

Type PS-1 Relay, Polarized Element

With the relay de-energized, remove the permanent magnet and adjust the moving armature 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 en-

tire 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 one-half turn to obtain approximately .012 inch contact follow. Re-assemble 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 one of the figures 9 or 17 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 moving contacts float midway between the stationary contacts. With this adjustment, the right-hand contacts should operate at approximately .0013 ampere, and the left-hand contacts should close at .0007 ampere. For three terminal lines, the type PS-1 relay contacts should float at .002 ampere, close to the right at .0023 ampere, and close to the left at .0017 ampere.

A good way to adjust the element is to start with both magnetic shunts at the extreme "in" position, then draw out the right-hand shunt until the right-hand contacts make at the desired current. Then lower the current and draw out the left hand shunt until the left-hand contacts make at the right value. This will upset the adjustment for the right hand contacts, which should then be rechecked. The process is easily carried back and forth until both values will check properly. Final readings should be taken with the shunt locking screws tightened.

Type PS-2 Relays, Telephone Element

With the relays connected per one of the figures 9 to 13, adjust the armature gap and spring tension of the telephone-type relays 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 one of the figures 14 to 17, adjust the armature gap and the spring tension of the telephone relay so that its contacts close at .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.

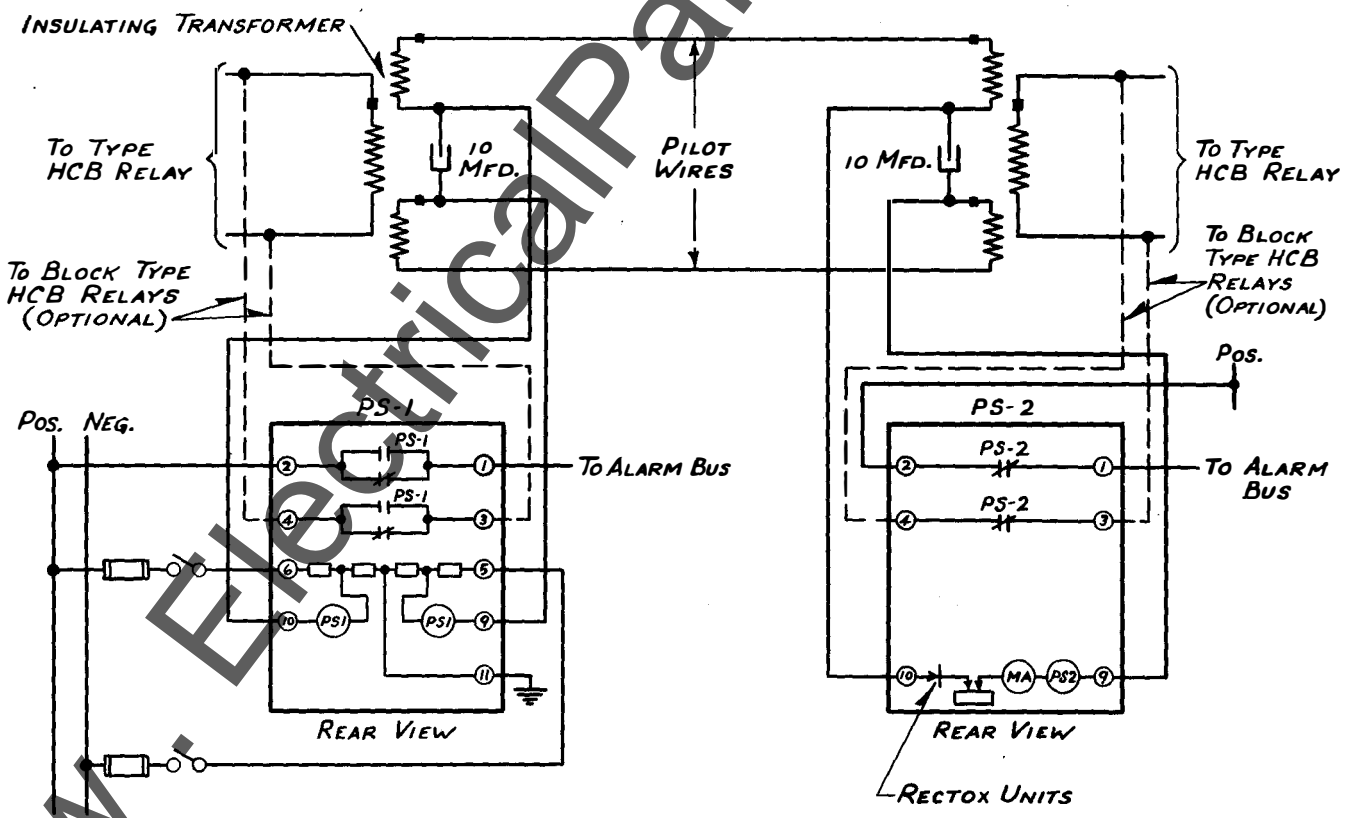

Figure 9
External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Standard Case For Pilot Wire Supervisory.

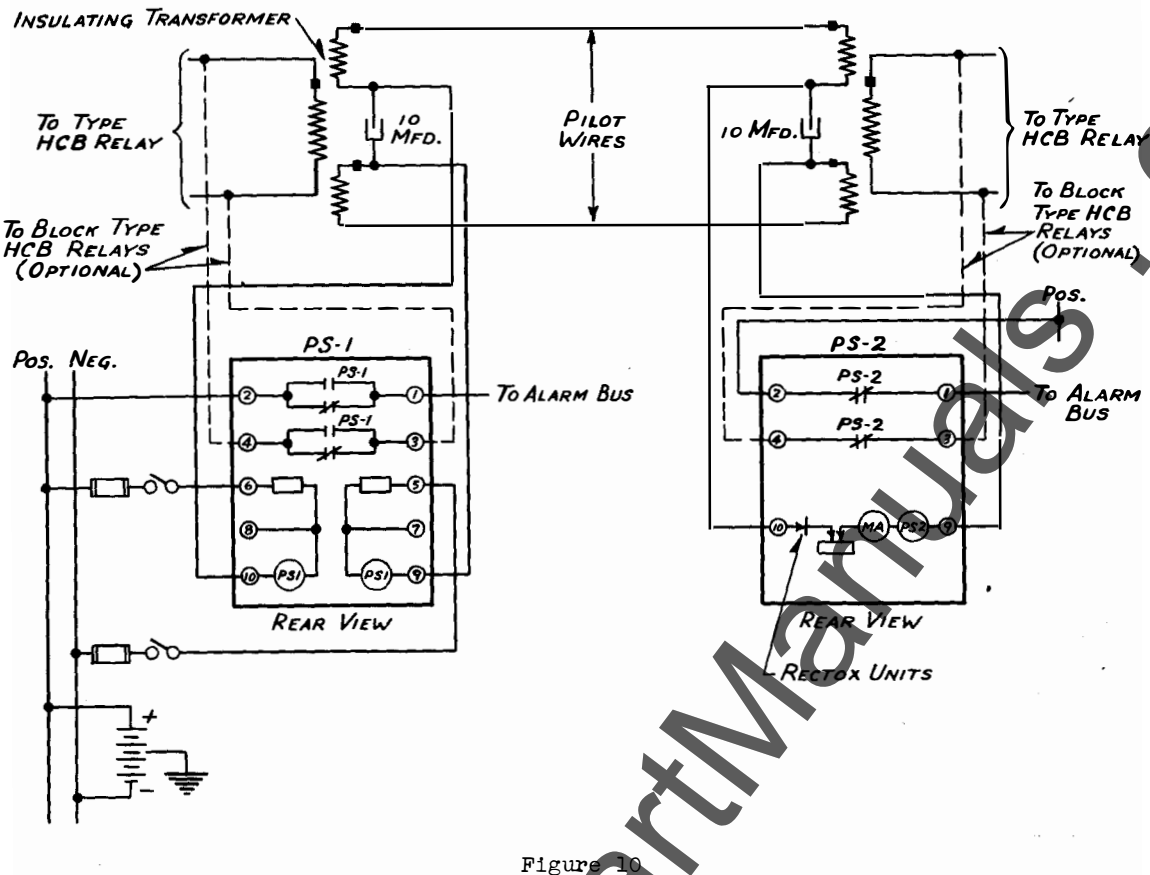

Figure 10
External Connections of the 22 Volt D-C Type PS-1 and the Type PS-2 Relays in the Standard Case For Pilot Wire Supervisory.

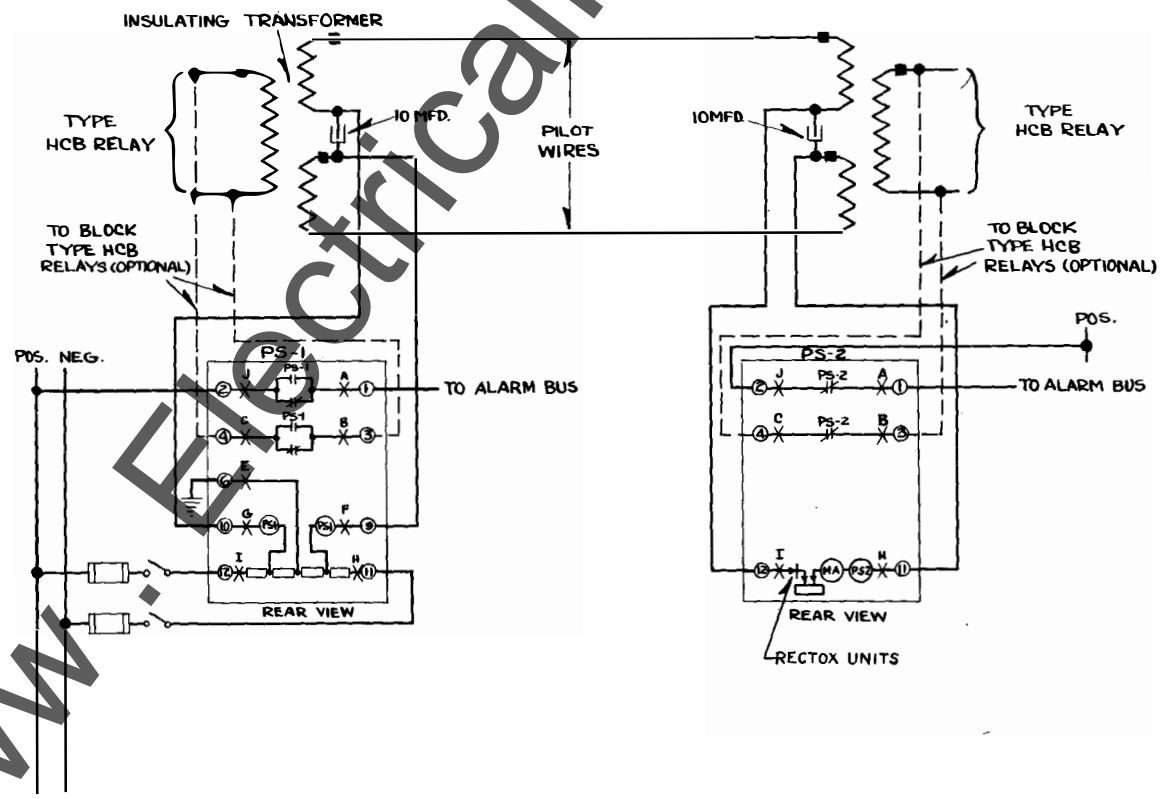

Figure 11
External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Type FT Case For Pilot Wire Supervisory.

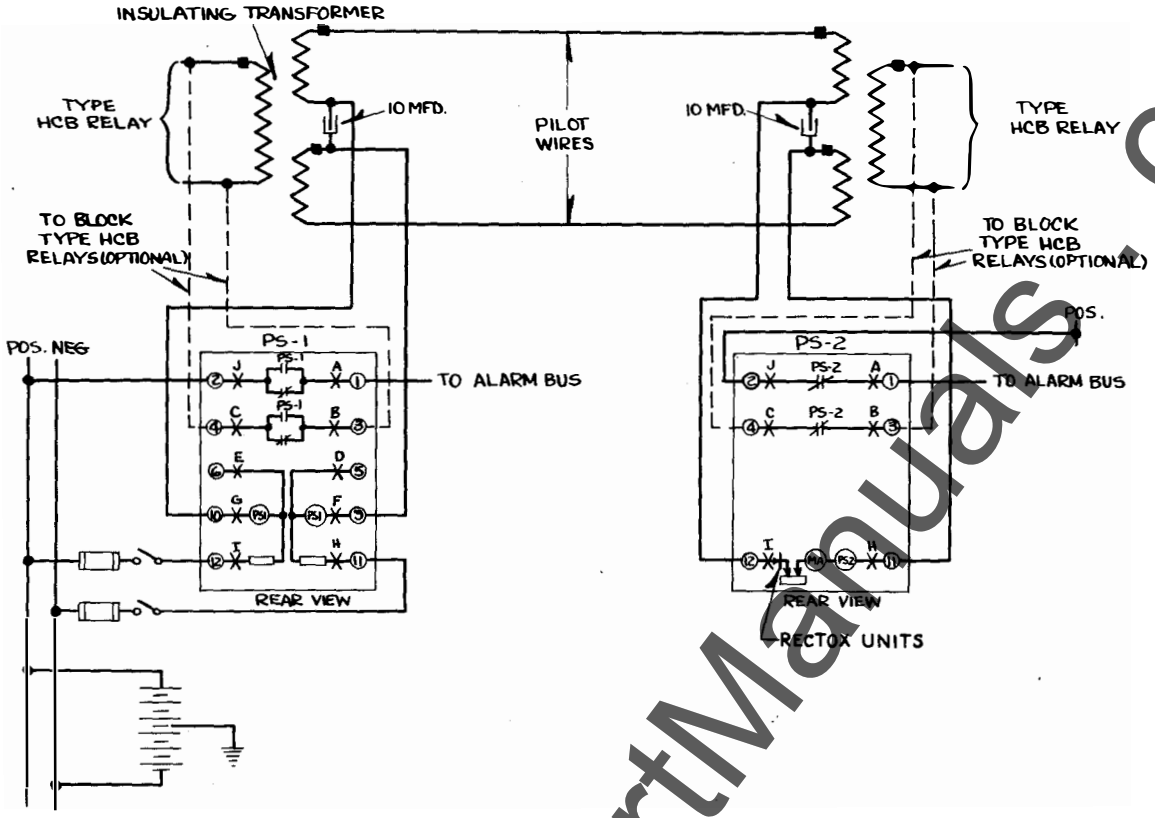

Figure 12
External Connections of the 22 Volt D-C Types PS-1 and the PS-2 Relays in the Type FT Case For Pilot Wire Supervisory.

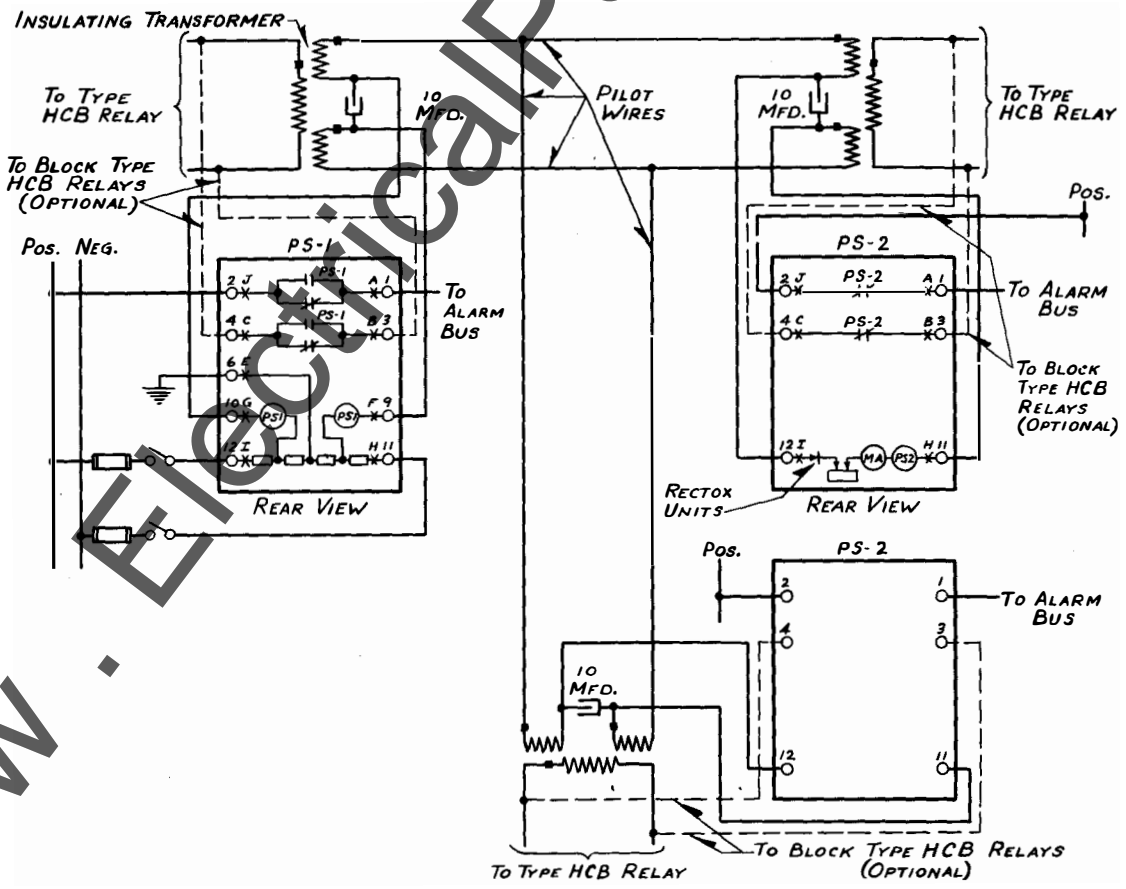

Figure 13
External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-2 Relays in the Type FT Case For Pilot Wire Supervisory of a Three Terminal Line.

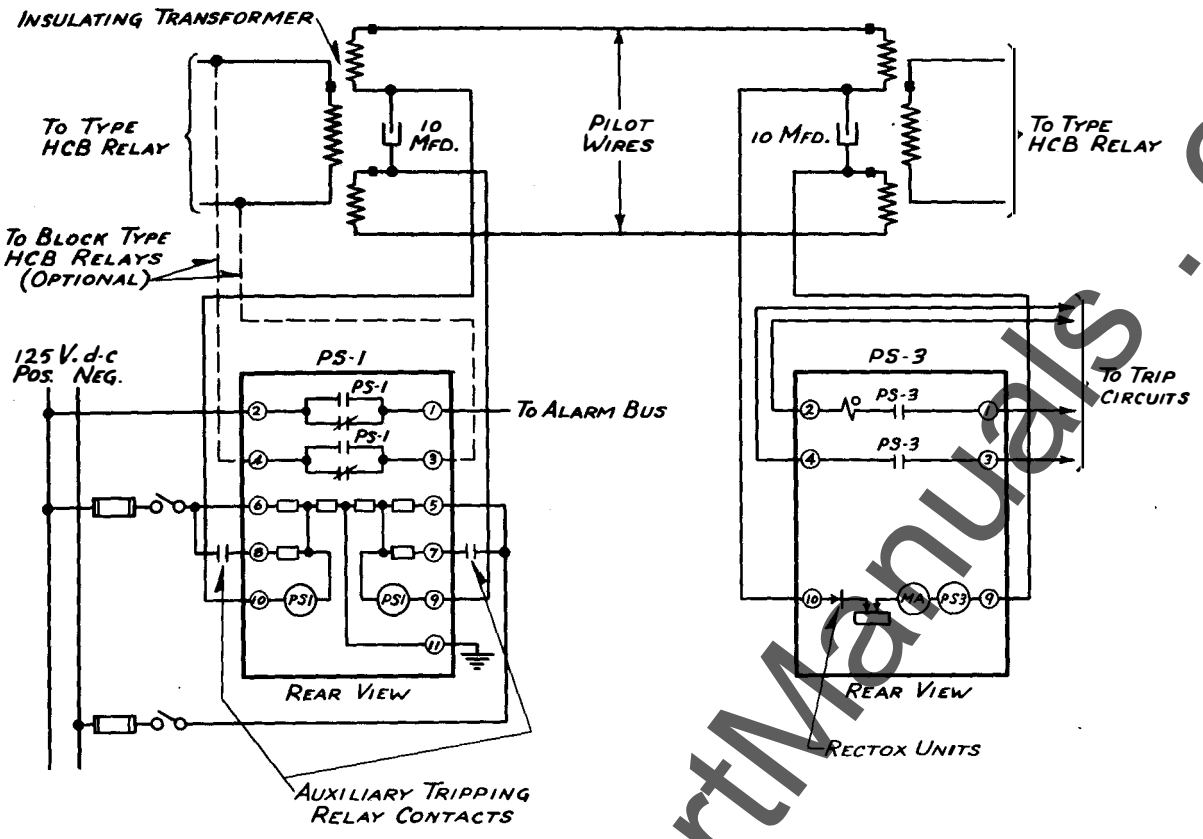

Figure 14
External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-3 Relays in the Standard Case For Pilot Wire Supervisory and Remote Tripping.

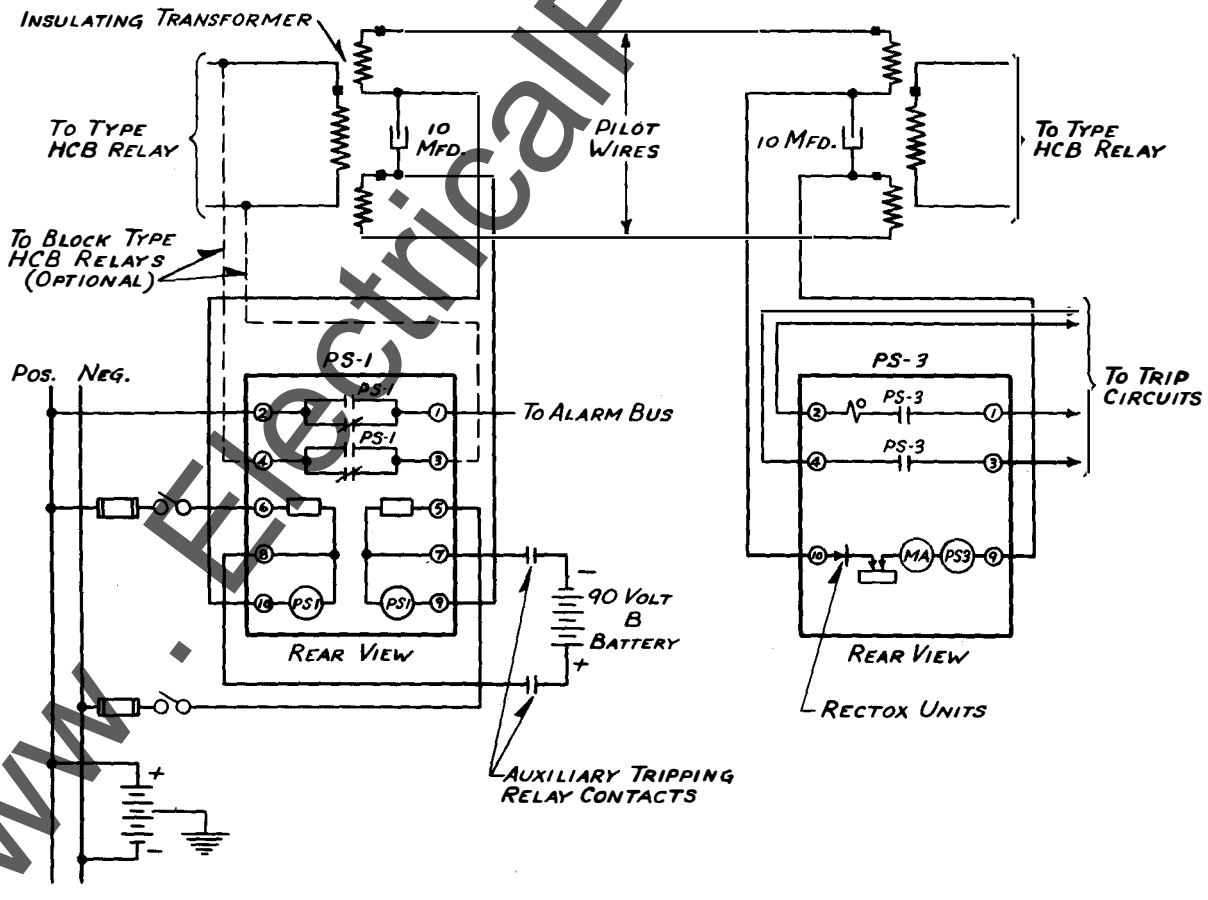

Figure 15
External Connections of the 22 Volt D-C Type PS-1 and the Type PS-3 Relays in the Standard Case For Pilot Wire Supervisory and Remote Tripping.

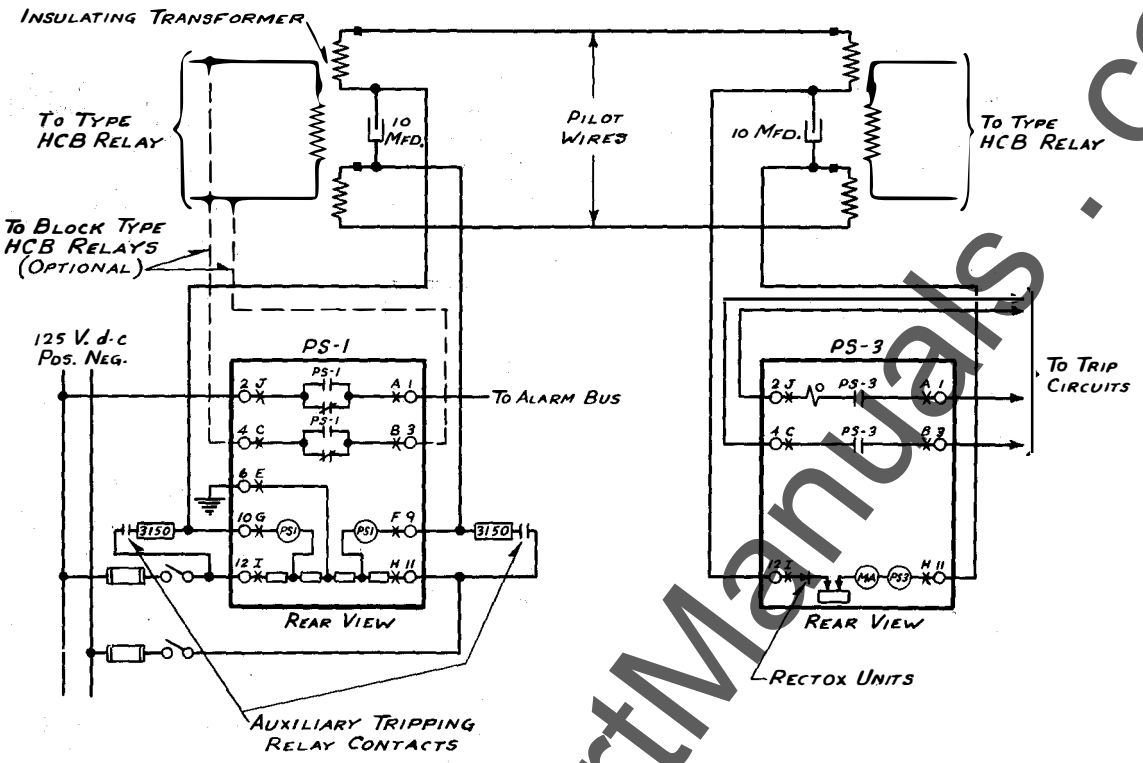

Figure 16
External Connections of the 48, 125 or 250 Volt D-C Type PS-1 and the Type PS-3 Relays in the Type FT Case For Pilot Wire Supervisory and Remote Tripping.

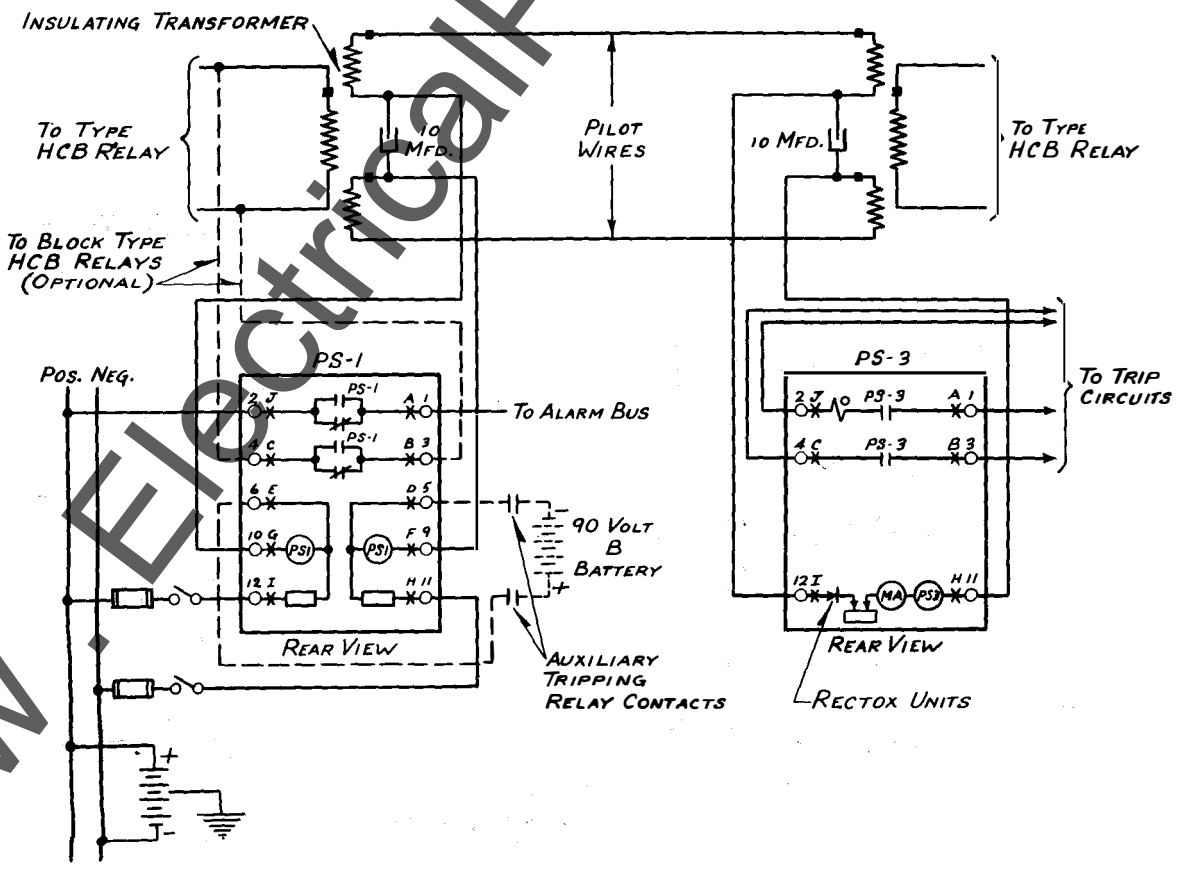

Figure 17
External Connections of the 22 Volt D-C Type PS-1 and the Type PS-3 Relays in the Type FT Case For Pilot Wire Supervisory and Remote Tripping.

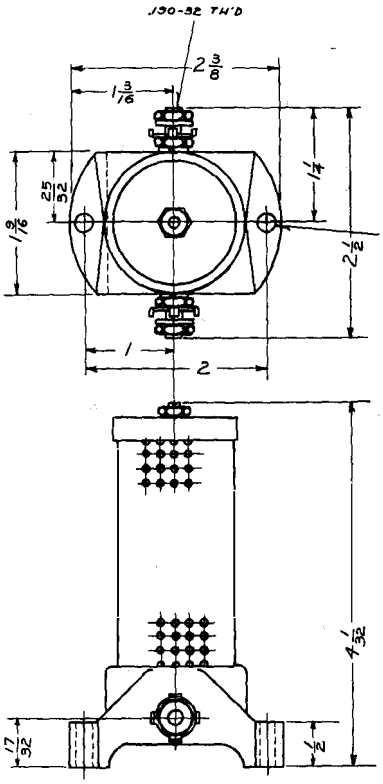

Figure 18
Outline and Drilling Plan For the External Resistor Used With the Type PS-1 Relay in the Type FT Case For Remote Tripping. For Reference Only.

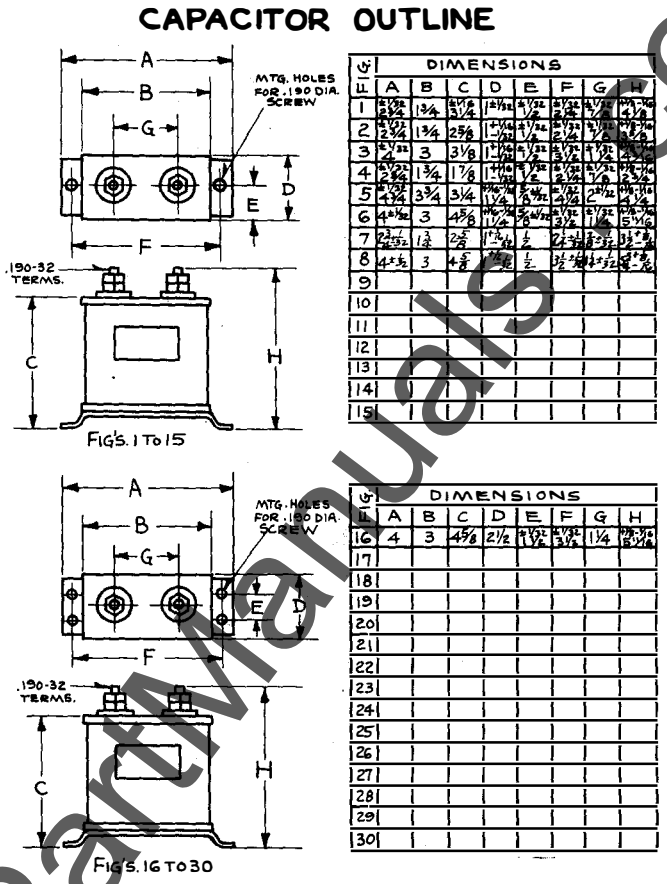

Figure 19
Outline and Drilling Plan For the 10 mfd. Capacitor. For Reference Only.

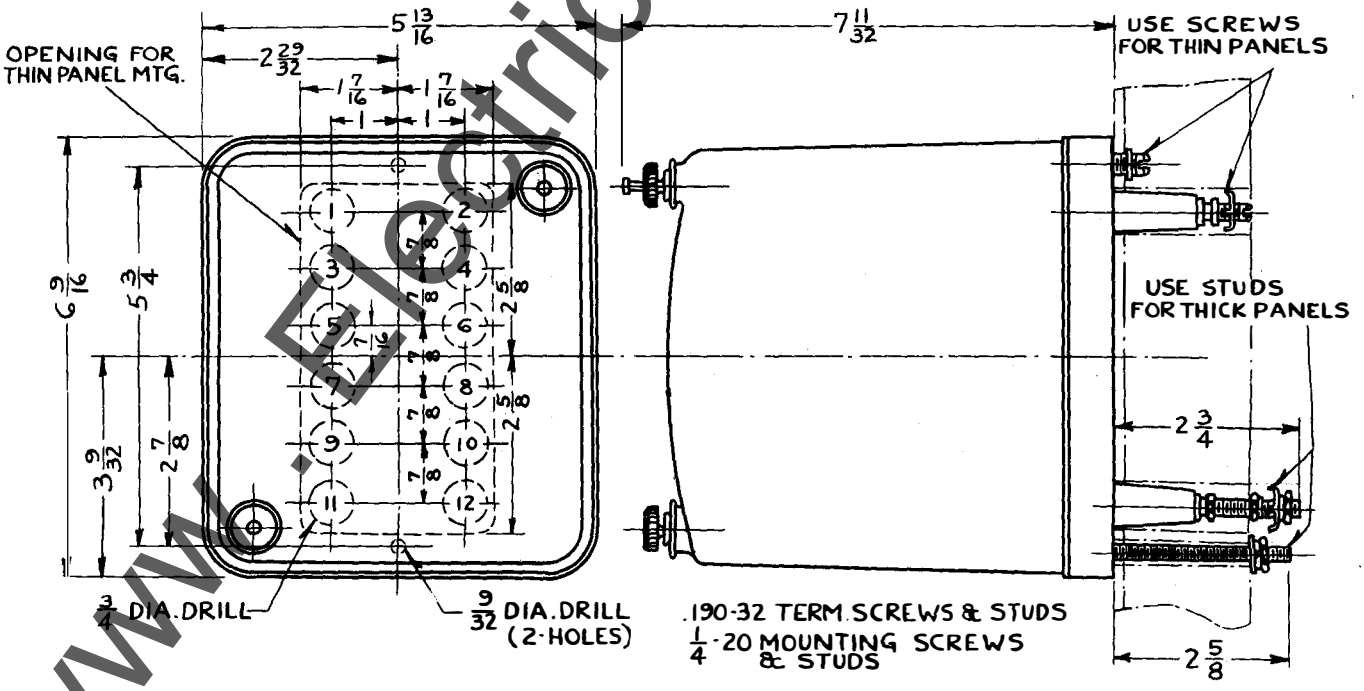

Figure 20
Outline and Drilling Plan of the Projection Type Standard Case. See the Internal Schematics For the Terminals Supplied. For Reference Only.

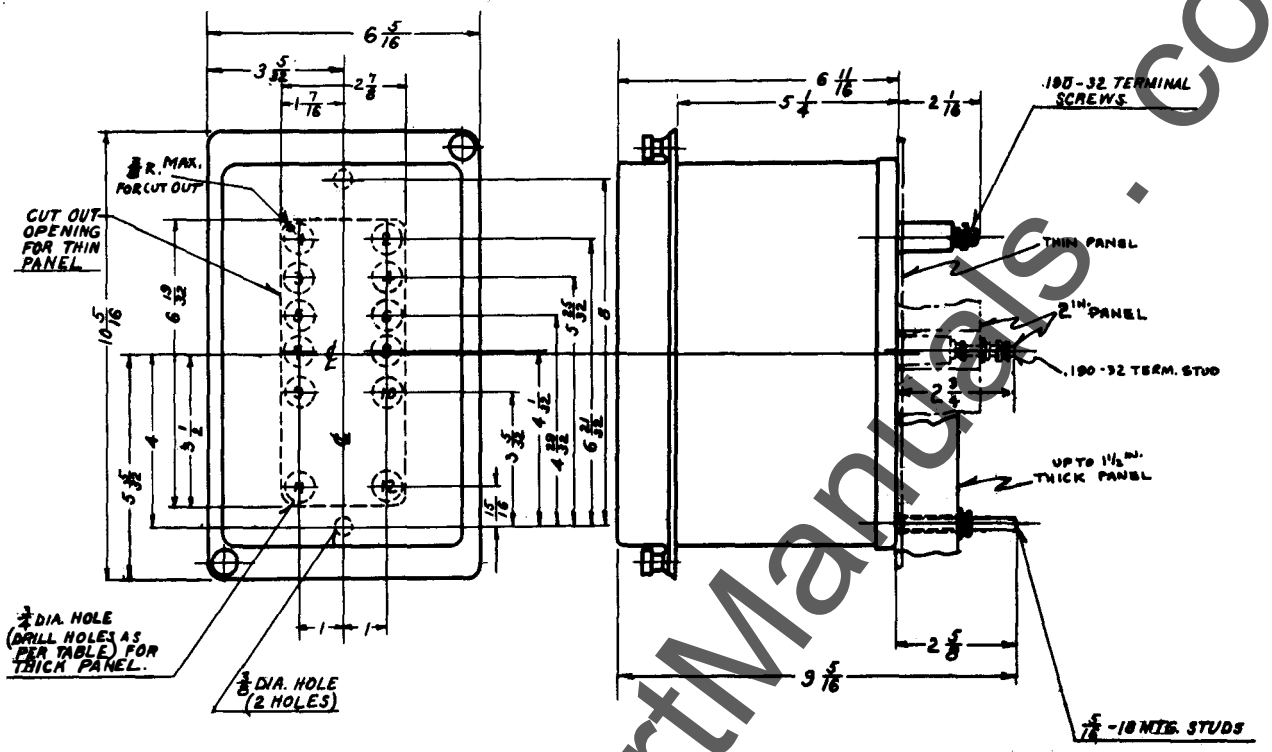

Figure 21
Outline and Drilling Plan of the S10 Projection Type FT Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

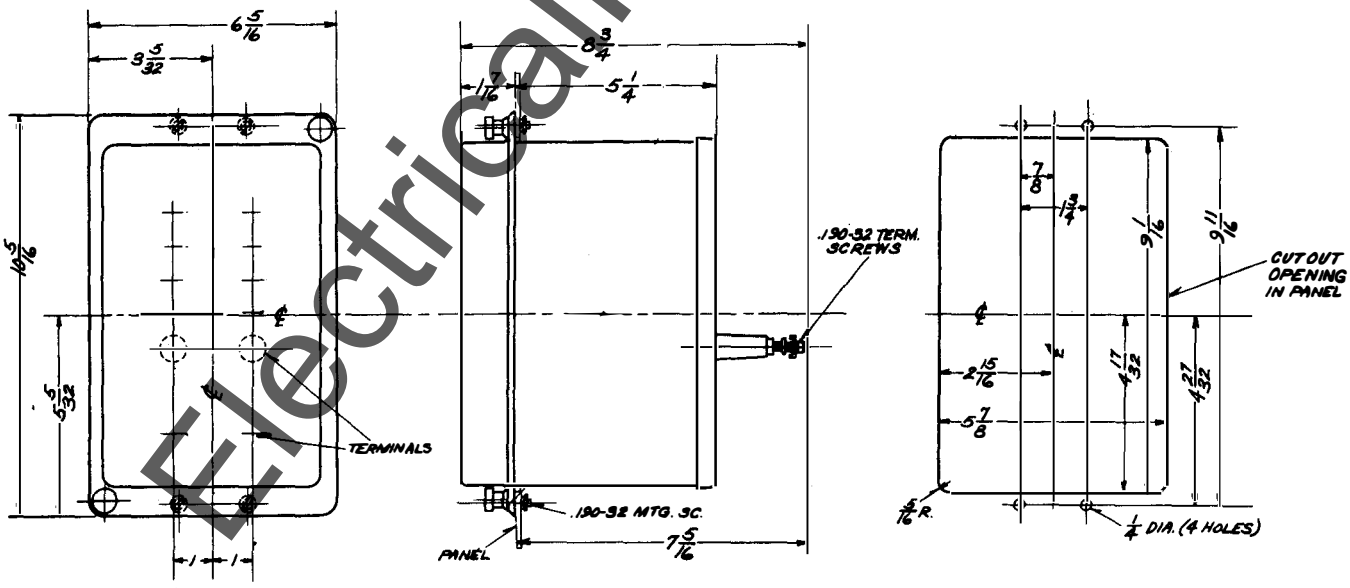

Figure 22
Outline and Drilling Plan of the S10 Semi-Flush Type FT Flexitest Case. For Reference Only.

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