INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE PS-13 SUPERVISORY RELAY FOR REMOTE TRIPPING

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

APPLICATION

The type PS-13 supervisory relay is used with the type PS-2 or PS-3 relay on HCB pilot wire systems, where remote tripping is required from one terminal or both. If it is necessary to trip either breaker from the other end of the line, then a PS-3 relay is used with the type PS-13 relay. If the remote tripping is to be in one direction only then a type PS-2 relay may be used with the PS-13 relay. The type PS-13 relay is located at one terminal to introduce the supervisory current and to provide two separate functions. The supervisory element in the relay will detect short circuits, open circuits, grounds, and reversals on the pilot wire and will initiate an alarm when the pilot wires are faulted. The remote tripping element will trip the local breaker by action of an auxiliary relay located at the type PS-3 terminal. The type PS-3 relay is located at the other terminal and will trip the breaker at its station by action of an auxiliary relay at the PS-13 relay terminal. The type PS-3 relay also provides a continuous visual indication and means of adjusting the supervisory current, but does not act as a fault detector to initiate an alarm for pilot wire faults.

The type PS-2 relay may be used instead of the type PS-3 when it is unnecessary to have remote tripping from the PS-13 terminal. In this case, the PS-2 provides a continuous visual indication and means of adjusting the supervisory current and also acts as a fault detector to initiate an alarm for pilot wire faults.

Information on the types PS-2 and PS-3 relays is available in I.L. 41-659.2

CONSTRUCTION AND OPERATION

* The type PS-13 relay consists of two polarized relay elements, a contactor switch, an operation indicator, a telephone relay, a capacitor, and a set of resistors. These components are connected as shown in Figures 1 and 2.

Polar Type Relay

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 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 armature polarizes it and creates a magnetic bias causing it to move toward one or the other of the poles, depending upon the adjustment of the magnetic shunts. 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 of the lower element will

always tend to travel toward the left 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 toward the right-hand contact. (front view)

With the correct adjustment of the magnetic shunts the armature of the upper element will always tend to travel toward the right hand side of the front air gap with the coils de-energized. This holds the contacts open. When either of the operating coils are energized with normal pilot wire current, the armature is magnetized with a polarity that aids the initial bias, and the contacts remain open. When either of the operating coils are energized with reverse pilot wire current, the armature is magnetized with a polarity that reverses the initial bias, thus causing it to move toward the left hand side of the air gap. This causes the contacts to close.

The lower element of the PS-13 relay is the supervisory element. Its normal adjustment is to have the contacts floating in the open position at .001 ampere pilot wire current for two terminal lines, or .002 ampere for three terminal lines. The upper element is the remote tripping element, which is connected with opposite polarity to that of the supervisory element. Its normal adjustment holds the contacts open at .001 ampere normal pilot wire current, and closes the contacts at .001 ampere reverse pilot wire current. The reversal of pilot wire current is accomplished at the remote end of the pilot wires by means of auxiliary relay contacts. These connect two 5000 ohm resistors to the terminals of the PS-3 and to the remote battery with correct polarity so that the increased voltage across the PS-3 relay exceeds the voltage output of the PS-13 relay, and reverses the current. The external connections of the PS-13 and PS-3 relays are shown in Figure 3.

* Capacitor Shorting Device

The capacitor shorting device consists of a telephone relay in series with a capacitor. This unit is connected across the input terminals of the PS-13. The telephone relay contacts are connected across the output terminals of the PS-13. Whenever there is a complete loss of voltage at the input terminals of the PS-13, the telephone relay contacts provide a discharge path for the external (10 mfd.) capacitor, thus preventing the PS-13 (upper element) from tripping falsely.

Contactor Switch

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

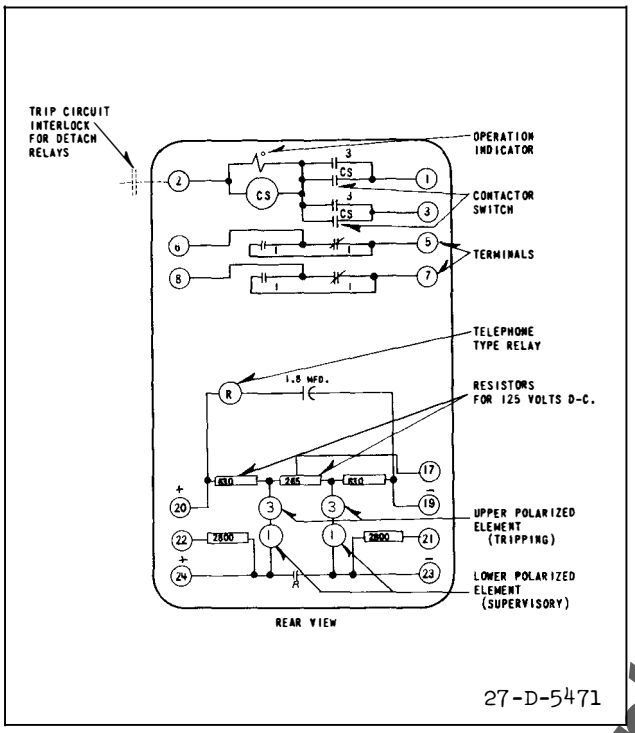
Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

The operation for type PS-13 and PS-3 relays for remote tripping and pilot wire supervision 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-13 relay and circulates over the pilot wire circuit. This current holds the PS-13 remote tripping and supervisory contacts open, and tends to close the PS-3 contacts.



*** Fig. 1—Internal Schematic of the Type PS-13 Relay in the Standard Case.**

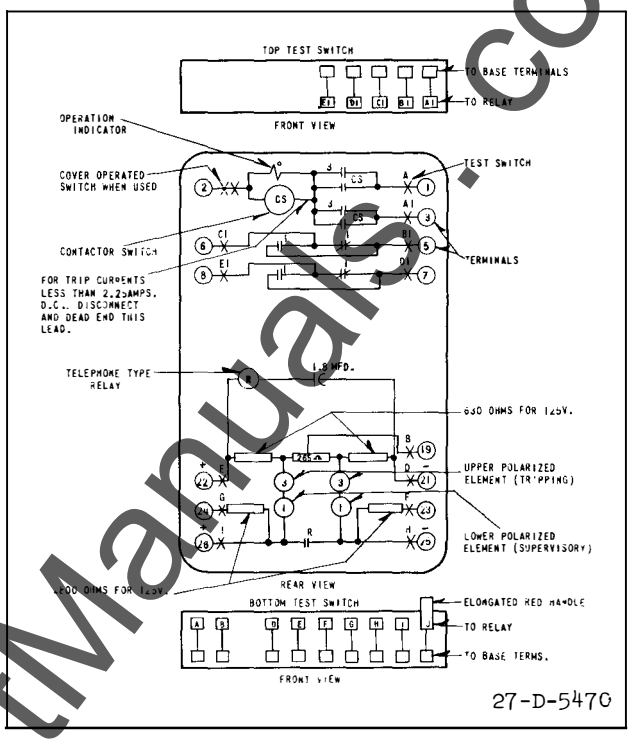


***Fig. 2—Internal Schematic of the Type PS-13 Relay in the Type FT Case.**

(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-13 relay must furnish .002 ampere total, which allows .001 ampere for each of the two type PS-3 relays involved.

(2) Pilot Wire Short Circuited

Short circuits of 2,000 ohms or less cause the circulating pilot wire current to increase above the normal value, thus closing the left-hand (front view) contacts of the supervisory element in the type PS-13 relay to initiate an alarm.

(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 the PS-13 relay terminal.

(4) Pilot Wire Grounded

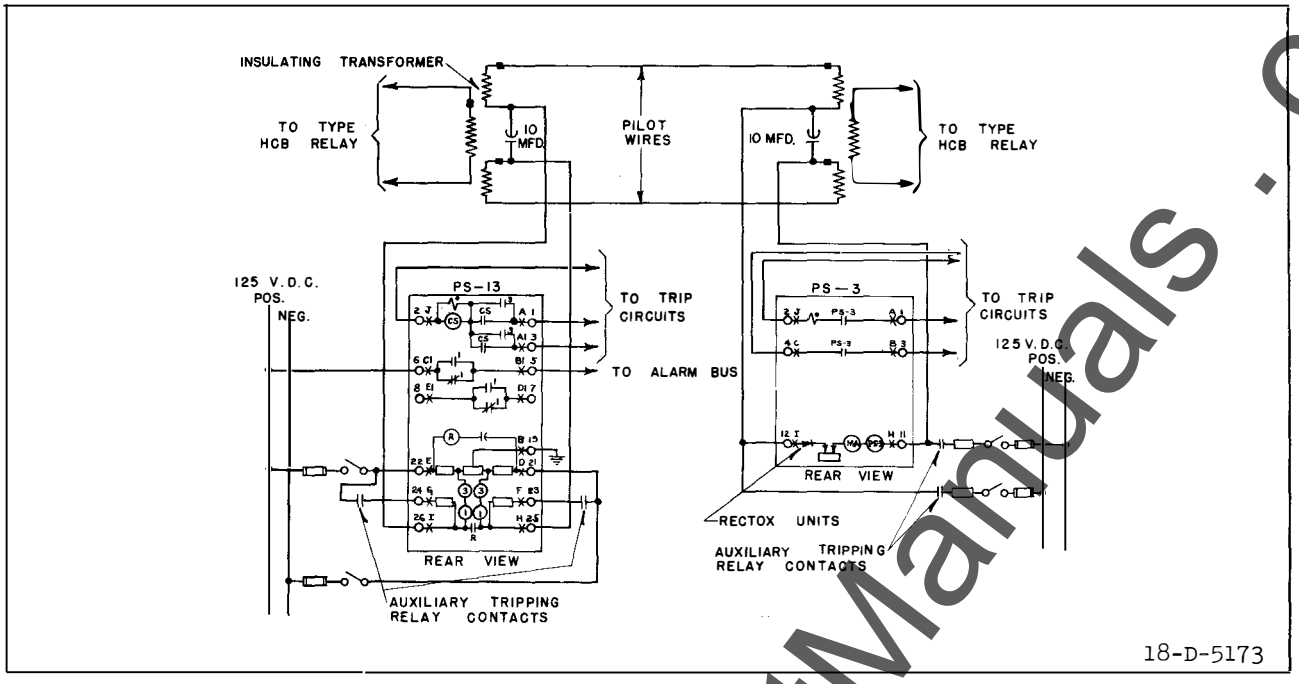
The connection of the separate windings of the type PS-13 relay in each of the pilot wire circuits provides two circuits of equal impedance from the grounded midtap of the potentiometer of the type PS-13 relay to the remote terminal on the pilot wire. The type PS-3 relay contains a relatively high resistance, such that when either pilot wire becomes grounded at any point along its length, unequal currents flow to operate the supervisory element in the type PS-13 relay. This provides protection of ground fault resistance values of 500 ohms or less.

(5) Reversed Pilot Wire

A reversal of the pilot wires will tend to pass current thru the type PS-3 relay in the reverse direction. The back resistance of the rectox units in this relay is sufficiently high and, therefore, limits the magnitude of supervisory current so that the supervisory element in the PS-13 relay operates on undercurrent.

(6) Remote Tripping

Remote tripping from the PS-13 terminal is accomplished by applying 125 volts d.c. to the



* **Fig. 3—External Connections of the Types PS-13 and PS-3 Relays for Remote Tripping from Either Terminal.**

two 2800 ohm resistors in the relay. This raises the pilot wire current, causing operation of the type PS-3 relay. Remote tripping from the PS-3 and is accomplished by applying 125 volts d.c., thru two 5000 ohm resistors, to the pilot wire. This sends a reverse current thru the type PS-13 relay and operates the remote tripping element in the relay.

(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-13 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 six case sizes, designated as S10, S20, M10, M20, L10, L20. S refers to the small; M the medium; and L, the large size chassis frame. The numbers refer to the possible number of test switch positions, 10 or 20.

To remove the chassis, first remove the cover which exposes the relay elements and test switches for inspection and testing. Next open the elongated red handle switches. These should always be opened first before any of the black handle switches or the cam action latches. This opens the trip cricuit to prevent accidental trip out. Then open all the remaining switches. With all the switches fully opened, grasp the two cam action latch arms and pull outward. 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.

The electrical circuits are as follows: Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on theiinternal 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.

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

For testing in service, the voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

For testing in the case the ten circuit test plug can be inserted in the contact jaws, with all blades in the full open position. 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 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.

For testing out of the case 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 of some relays by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

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

The relay is shipped with the operation indicator and the contactor switch coils in parallel. This circuit has a resistance of approximately 0.25 ohm and is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the switch. This lead should be fastened (dead-ended) under the small filister head screw located in the Micarta base of the contactor switch. To disconnect the coil in the type FT case relays, remove the coil lead at the spring adjuster and dead end it under the screw near the top of the moulded bracket

The operation indicaotr will operate for trip currents above 0,2 ampere d-c. The resistance of this coil is approximately 2.8 ohms.

When using the contactor switch, it is necessary to use an auxiliary switch on the circuit breaker so that when the circuit breaker is tripped the tripping circuit will be opened by this switch.

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 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 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.

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. Reassemble the permanent magnet with the north pole to the left (front view). 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.

Pass .001 ampere thru the operating coils. This should be done by applying normal voltage to the relay and connecting a variable resistance and a milliammeter across the PS-13 output terminals. With the resistance set for .001 ampere thru the operating coils, adjust the lower (supervisory) element as follows:

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 .0014 ampere, and the left-hand should close at .0005 ampere. For three terminal lines, the supervisory element 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 this element is to start with both magnetic shunts at the extreme "in" position, then draw out the left-hand shunt until the left-hand contacts make at the desired current. Then lower the current and draw out the right-hand shunt until the right hand contacts make at the right value. This will upset the adjustment for the left-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 firmly in place by means of a spring type clamp.

The upper element (remote trip) has polarity opposite to that of the lower element. Reverse the voltage applied to the relay in

order to calibrate this element. Adjust the magnetic shunts on the upper element so that the moving contacts rest against the right hand stops and close to the left at.001 ampere.

* The capacitor shorting device can be checked after the PS-13 has been calibrated by connecting a 10 mfd external capacitor across the output terminals of the PS-13. The relay should be energized with rated voltage long enough to charge up the external capacitor. The upper element of the PS-13 should not trip when the voltage is suddenly removed. If the relay does trip the telephone relay contacts should be adjusted until the false tripping has been eliminated. A check should be made after the final adjustment to make certain that the telephone relay contacts are not closed with the PS-13 de-energized.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/63" when the switch is picked up. This can be done by turning the relay up-side-down or by disconnecting the switch and turning it up-side-down. Then screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the points where the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32" by means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 0.2 ampere d-c. gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching to obtain the 0.2 ampere calibration. The coil resistance is approximately 2.8 ohm.

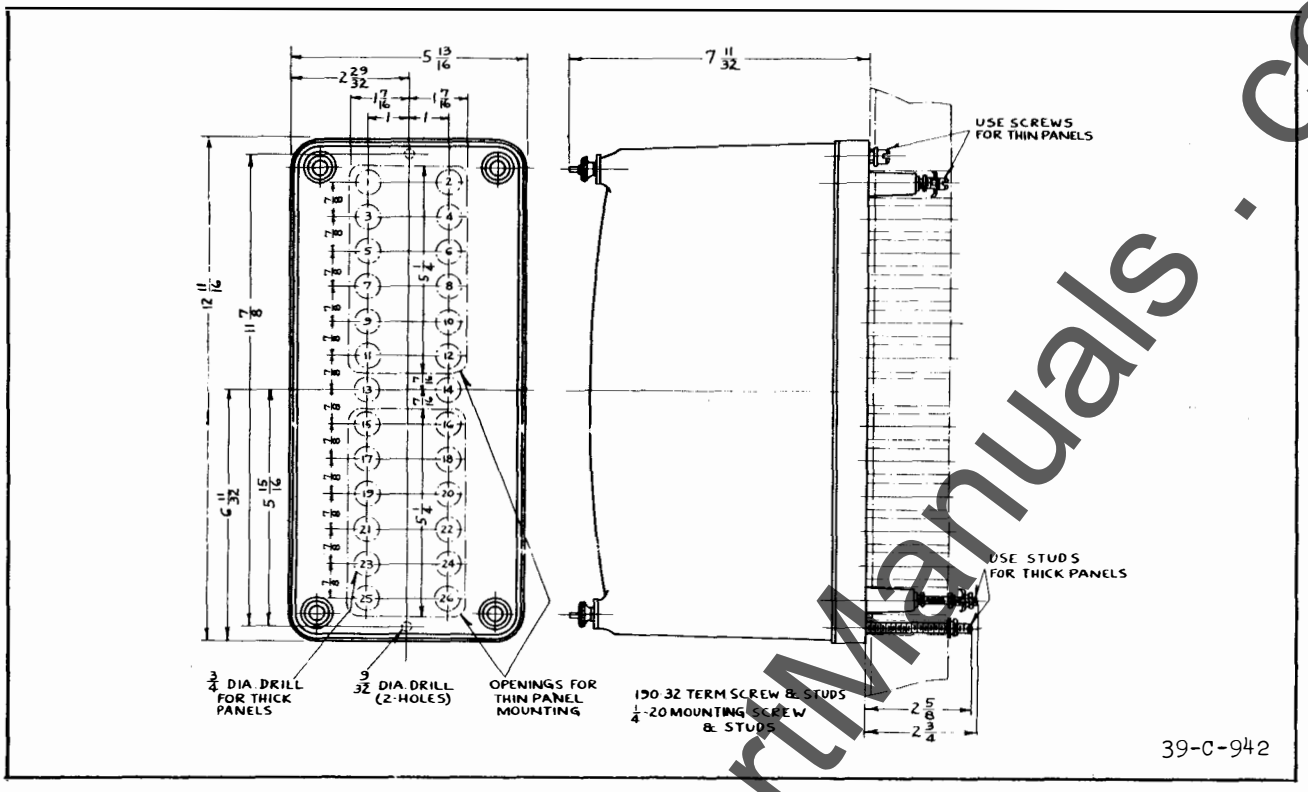


Fig. 4—Outline and Drilling Plan for the Standard Projection Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

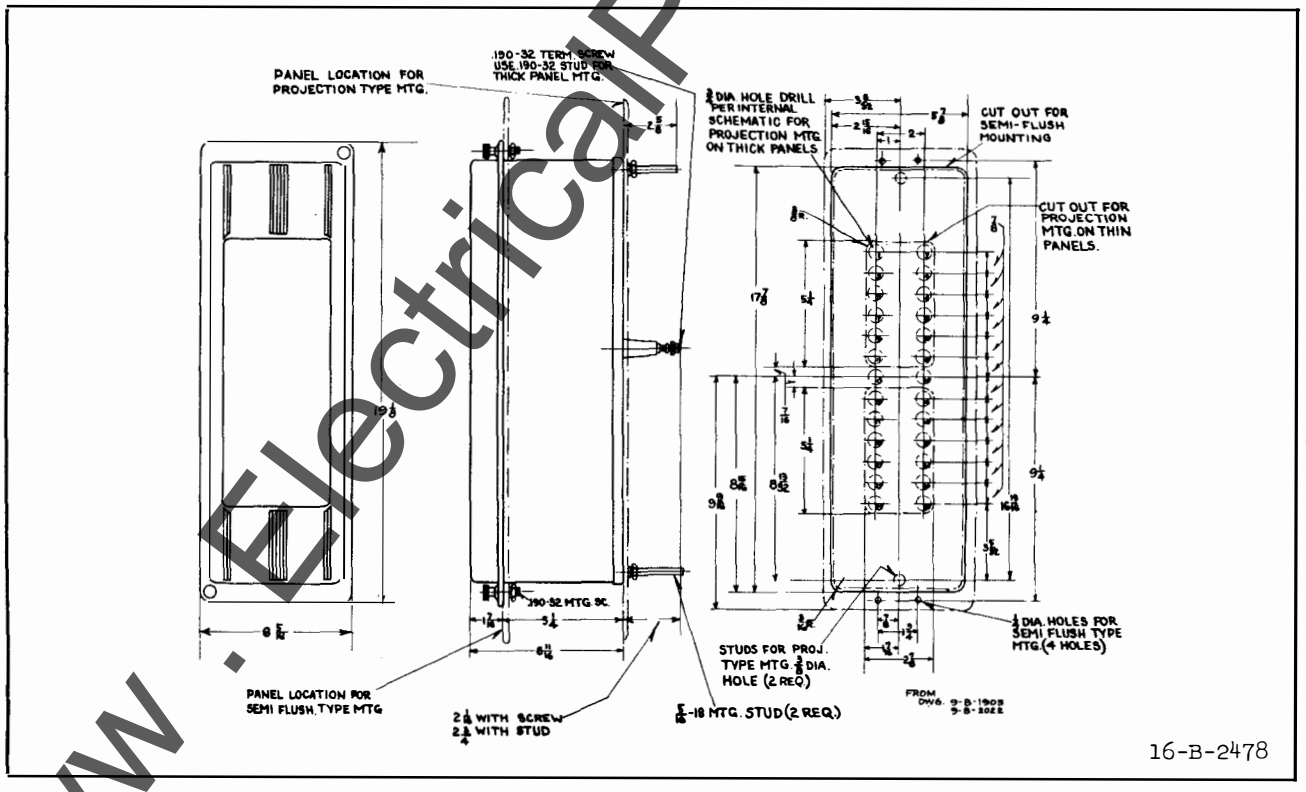


Fig. 5—Outline and Drilling Plan for the M20 Semi-flush or Projection Type Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE PS-13 SUPERVISORY RELAY FOR REMOTE TRIPPING

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

APPLICATION

The type PS-13 supervisory relay is used with the type PS-2 or PS-3 relay on HCB pilot wire systems, where remote tripping is required from one terminal or both. If it is necessary to trip either breaker from the other end of the line, then a PS-3 relay is used with the type PS-13 relay. If the remote tripping is to be in one direction only then a type PS-2 relay may be used with the PS-13 relay. The type PS-13 relay is located at one terminal to introduce the supervisory current and to provide two separate functions. The supervisory element in the relay will detect short circuits, open circuits, grounds, and reversals on the pilot wire and will initiate an alarm when the pilot wires are faulted. The remote tripping element will trip the local breaker by action of an auxiliary relay located at the type PS-3 terminal. The type PS-3 relay is located at the other terminal and will trip the breaker at its station by action of an auxiliary relay at the PS-13 relay terminal. The type PS-3 relay also provides a continuous visual indication and means of adjusting the supervisory current, but does not act as a fault detector to initiate an alarm for pilot wire faults.

The type PS-2 relay may be used instead of the type PS-3 when it is unnecessary to have remote tripping from the PS-13 terminal. In this case, the PS-2 provides a continuous visual indication and means of adjusting the supervisory current and also acts as a fault detector to initiate an alarm for pilot wire faults.

Information on the types PS-2 and PS-3 relays is available in I.L. 41-659.2

CONSTRUCTION AND OPERATION

The type PS-13 relay consists of two polarized relay elements, a contactor switch, an operation indicator, and a set of resistors. These components are connected as shown in Figures 1 and 2.

Polar Type Relay

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 lelement 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 right 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 right hand side of the front air gap with the coils de-energized. This holds the right 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 left-hand contact.

The lower element of the PS-13 relay is the supervisory element. Its normal adjustment is to have the contacts floating in the open position at .001 ampere pilot wire current for two terminal lines, or .002 ampere for three terminal lines. The upper element is the remote tripping element, which is connected with opposite polarity to that of the supervisory element. Its normal adjustment holds the contacts open at .001 ampere normal pilot wire current, and closes the contacts at .001 ampere reverse pilot wire current. The reversal of pilot wire current is accomplished at the remote end of the pilot wires by means of auxiliary relay contacts. These connect two 5000 ohm resistors to the terminals of the PS-3 and to the remote battery with correct polarity so that the increased voltage across the PS-3 relay exceeds the voltage output of the PS-13 relay, and reverses the current. The external connections of the PS-13 and PS-3 relays are shown in Figure 3.

Contactor Switch

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

Operation Indicator

The operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized, a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator is reset from outside of the case by a push rod in the cover or cover stud.

The operation for type PS-13 and PS-3 relays for remote tripping and pilot wire supervision 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-13 relay and circulates over the pilot wire circuit. This current holds the PS-13 remote tripping and supervisory contacts open, and tends to close the PS-3 contacts.

(1b) Normal Pilot Wire - Three Terminal Lines

The action heree is the same in principle as for two terminal lines, except that the type PS-13 relay must furnish .002 ampere total, which allows .001 ampere for each of the two type PS-3 relays involved.

(2) Pilot Wire Short Circuited

Short circuits of 2,000 ohms or less cause the circulating pilot wire current to increase above the normal value, thus closing the left-hand (front view) contacts of the supervisory element in the type PS-13 relay to initiate an alarm.

(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 the PS-13 relay terminal.

(4) Pilot Wire Grounded

The connection of the separate windings of

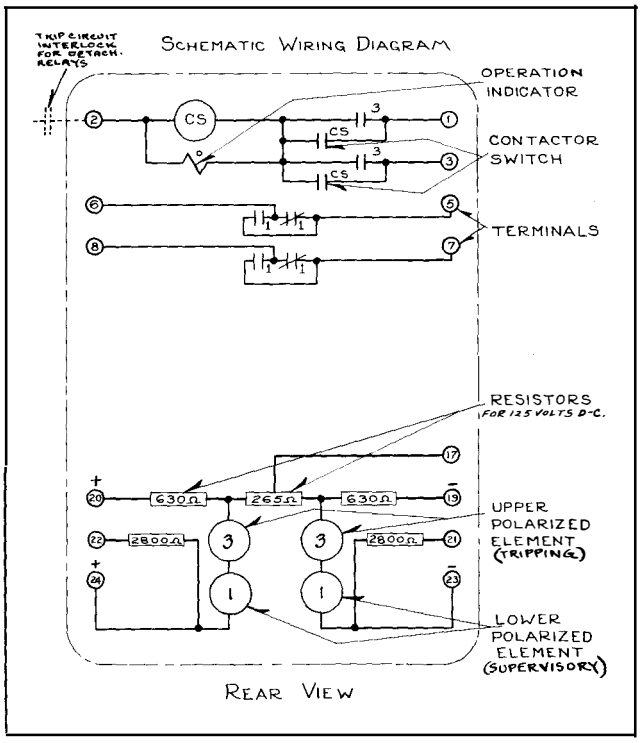


Fig. 1—Internal Schematic of the Type PS-13 Relay in the Standard Case.

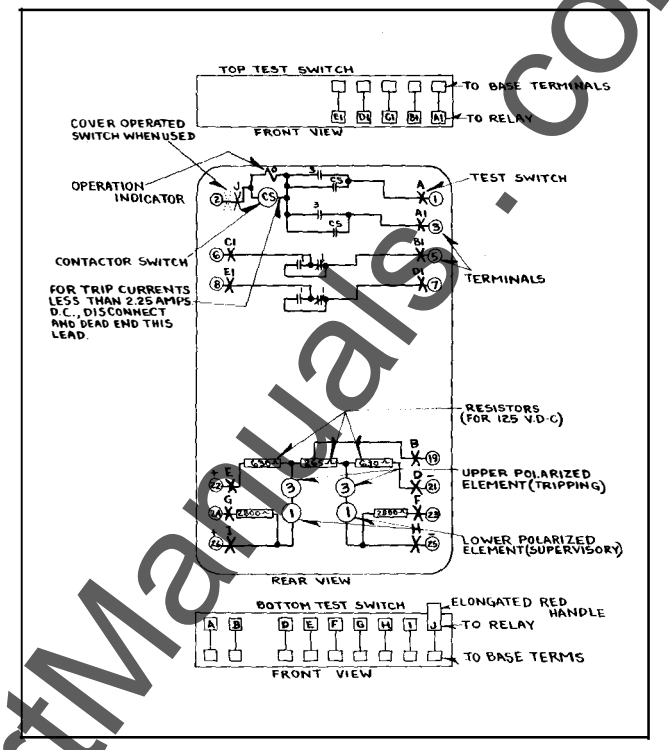


Fig. 2—Internal Schematic of the Type PS-13 Relay in the Type FT Case.

the type PS-13 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-13 relay to the remote terminal on the pilot wire. The type PS-3 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 supervisory element in the type PS-13 relay. This provides protection of ground fault resistance values of 500 ohms or less.

(5) Reversed Pilot Wire

A reversal of the pilot wires will tend to pass current thru the type PS-3 relay in the reverse direction. The back resistance of the rectox units in this relay is sufficiently high and, therefore, limits the magnitude of supervisory current so that the supervisory element in the PS-13 relay operates on undercurrent.

(6) Remote Tripping

Remote tripping from the PS-13 terminal is accomplished by applying 125 volts d.c. to the two 2800 ohm resistors in the relay. This raises the pilot wire current, causing operation of the type PS-3 relay. Remote tripping from the PS-3 and is accomplished by applying 125 volts d.c., thru two 5000 ohm resistors, to the pilot wire. This sends a reverse current thru the type PS-13 relay and operates the remote tripping element in the relay.

(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-13 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

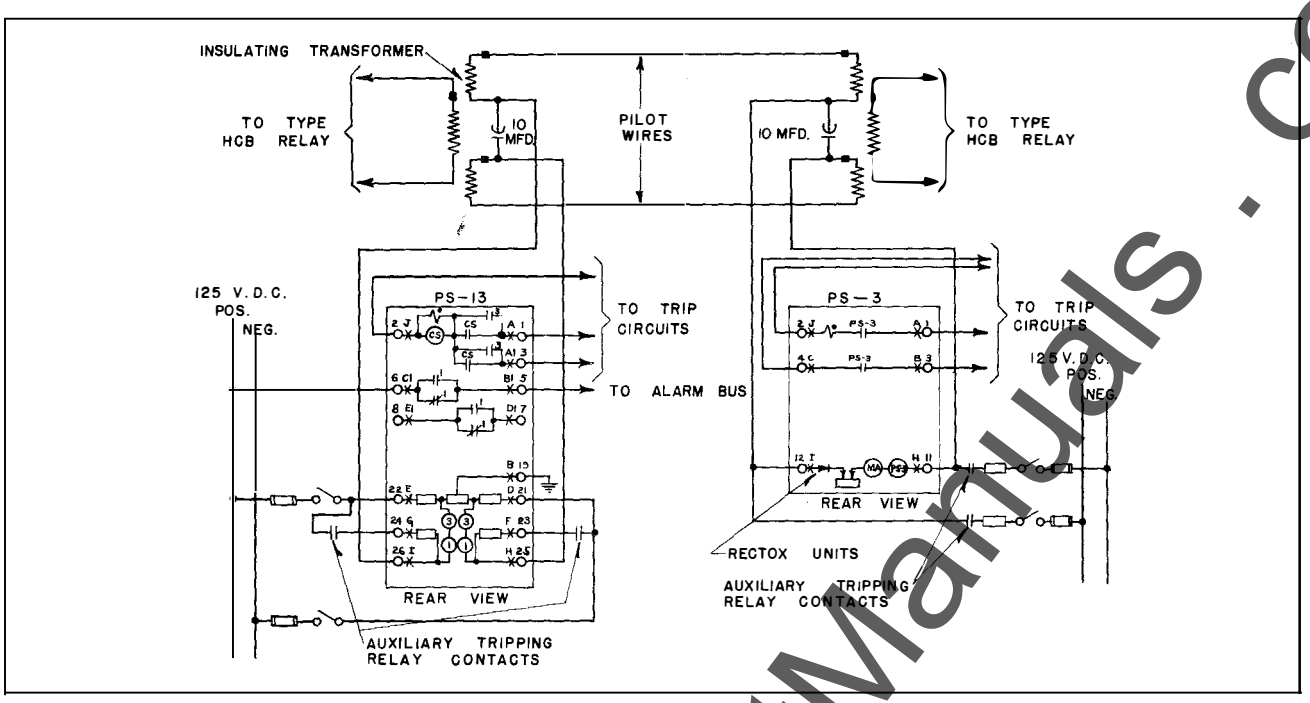


Fig. 3—External Connections of the Types PS-13 and PS-3 Relays for Remote Tripping from Either Terminal.

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 six case sizes, designated as S10, S20, M10, M20, L10, L20. S refers to the small; M the medium; and L, the large size chassis frame. The numbers refer to the possible number of test switch positions, 10 or 20.

To remove the chassis, first remove the cover which exposes the relay elements and test switches for inspection and testing. Next open the elongated red handle switches. These should always be opened first before any of the black handle switches or the cam action latches. This opens the trip cricuit to prevent accidental trip out. Then open all the remaining switches. With all the switches fully opened, grasp the two cam action latch arms and pull outward. 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.

The electrical circuits are as follows: Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on theiinternal 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.

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

For testing in service, the voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

For testing in the case the ten circuit test plug can be inserted in the contact jaws, with all blades in the full open position. 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 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.

For testing out of the case 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 of some relays by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

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

The relay is shipped with the operation indicator and the contactor switch coils in parallel. This circuit has a resistance of approximately 0.25 ohm and is suitable for all trip currents above 2.25 amperes d-c. If the trip current is less than 2.25 amperes, there is no need for the contactor switch and it should be disconnected. To disconnect the coil in the standard case relays, remove the short lead to the coil on the front stationary contact of the switch. This lead should be fastened (dead-ended) under the small filister head screw located in the Micarta base of the contactor switch. To disconnect the coil in the type FT case relays, remove the coil lead at the spring adjuster and dead end it under the screw near the top of the moulded bracket. The operation indicaotr will operate for trip currents above 0,2 ampere d-c. The resistance of this coil is approximately 2.8 ohms.

When using the contactor switch, it is necessary to use an auxiliary switch on the circuit breaker so that when the circuit breaker is tripped the tripping circuit will be opened by this switch.

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 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 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.

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 left (front view) and pass .001 ampere thru the operating coils.

This should be done by applying normal voltage to the relay and connecting a variable resistance and a milliammeter across the PS-13 output terminals. With the resistance set for .001 ampere thru the operating coils, adjust the lower (supervisory) element as follows:

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 left-hand contacts should operate at approximately .0013 ampere, and the right-hand should close at .0007 ampere. For three terminal lines, the supervisory element contacts should float at .002 ampere, close to the left at .0023 ampere, and close to the right at .0017 ampere. A good way to adjust this element is to start with both magnetic shunts at the extreme "in" position, then draw out the left-hand shunt until the left-hand contacts make at the desired current. Then lower the current and draw out the right-hand shunt until the right hand contacts make at the right value. This will upset the adjustment for the left-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 firmly in place by means of a spring type clamp.

The upper element (remote trip) has polarity opposite to that of the lower element. Reverse the voltage applied to the relay in order to calibrate this element. Adjust the magnetic shunts on the upper element so that the moving contacts rest against the right hand stops and close to the left at .001 ampere.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core of 1/63" when the switch is picked up. This can be done by turning the relay up-side-down or by disconnecting the switch and turning it up-side-down. Then screw up the core screw until the moving core starts rotating. Now, back off the core screw until the moving core stops rotating. This indicates the points where the play in the assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the core screw approximately one turn and lock in place. This prevents the moving core from striking and sticking to the stationary core because of residual magnetism. Adjust the contact clearance for 3/32" by

means of the two small nuts on either side of the Micarta disc. The switch should pick up at 2 amperes d-c. Test for sticking after 30 amperes have been passed through the coil.

Operation Indicator

Adjust the indicator to operate at 0.2 ampere d-c. gradually applied by loosening the two screws on the under side of the assembly, and moving the bracket forward or backward. If the two helical springs which reset the armature are replaced by new springs, they should be weakened slightly by stretching to obtain the 1 ampere calibration. The coil resistance is approximately 2.8 ohm.

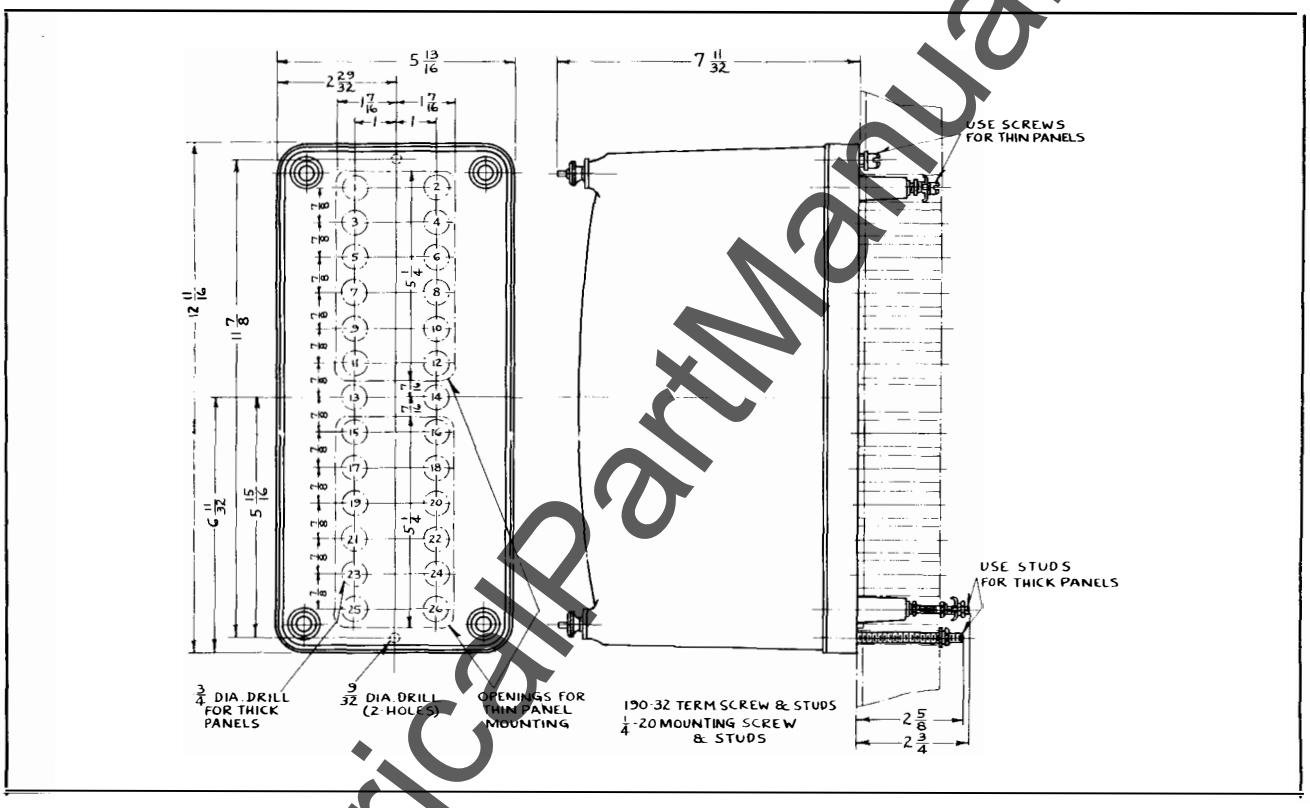


Fig. 4—Outline and Drilling Plan for the Standard Projection Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

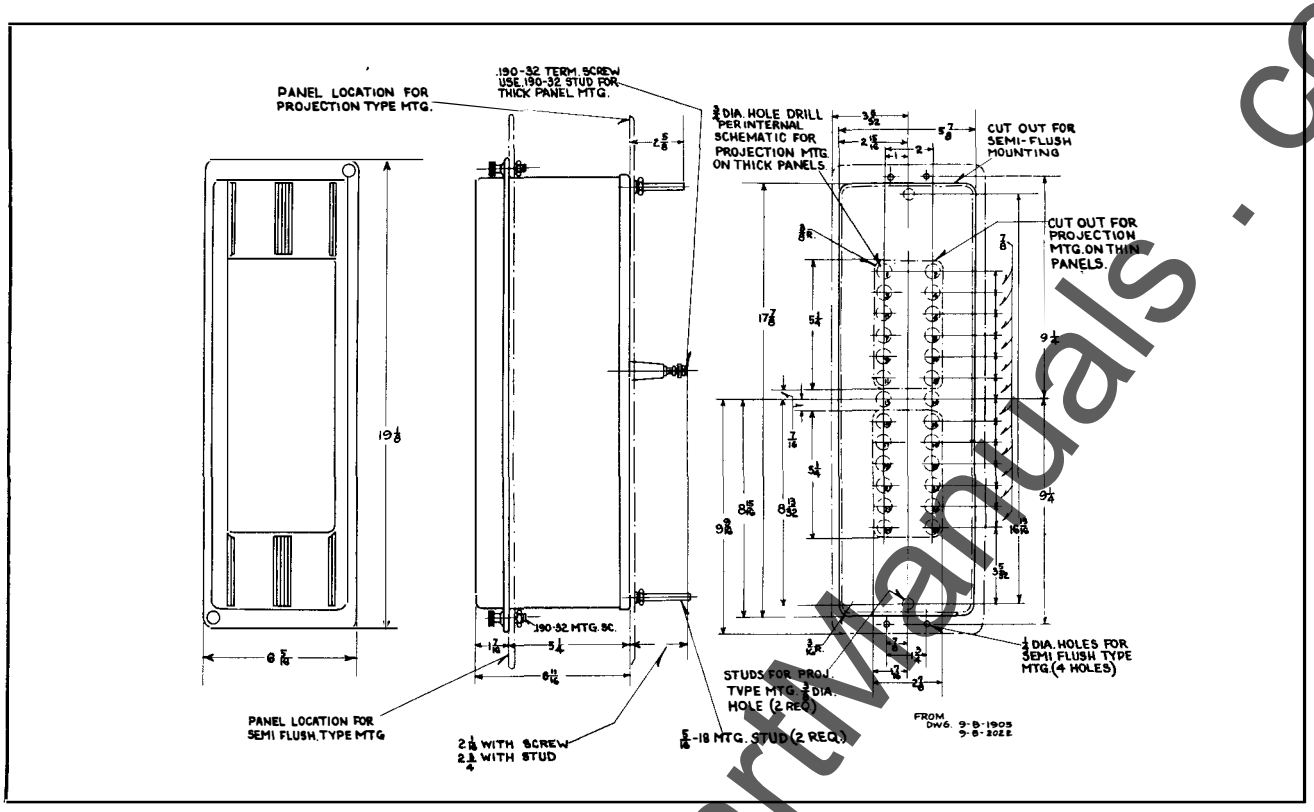


Fig. 5—Outline and Drilling Plan for the M20 Semi-flush or Projection Type Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.