INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TSO-1 OUT-OF-STEP BLOCKING RELAY

(For use With Type HZ Relays)

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 TSO-1 Blocking Relay is an auxiliary relay used with the type HZ impedance relay to prevent tripping while out-of-step or out-of-synchronism conditions exist on the system. It does not prevent or delay the type HZ relay from tripping on faults within its zones that occur during the out-of-step condition except for a three-phase fault. Type HZ relay operation is slightly delayed on three phase faults that occur during the out-of-step conditions.

CONSTRUCTION

The type TSO-1 Blocking Relay consists of a directional auxiliary, three voltage, a pendulum, and a time-delay drop-out elements. The construction of the elements are described below.

Directional Auxiliary Element

This is a solenoid type contactor switch designated as CSX. The plunger of the contactor switch operates a spring leaf arm with a silver contact surface on one end and rigidly fixed to the frame on the other end. The stationary contact is also fastened to the frame and in the deenergized position and contacts are held closed by the leaf spring. When the coil is energized, the plunger travels upward breaking the contacts. The CXS switch is energized by the operation of the directional and second impedance element of the type HZ phase relays. The purpose of this switch is to allow tripping a three-phase fault which occurs during an out-of-step condition.

Voltage Elements

The three voltage elements designated as A, B, C are standard contactor switches except that each is provided with a set of back or normally closed contacts as well as the normal make contacts. Their coils are energized thru contacts on the third impedance element of the corresponding type HZ phase relay from the trip voltage source. The back contacts of the voltage elements are connected in parallel and permit tripping through the terminals 1 and 2, as long as any one of the back contacts is closed. The front contacts of the voltage elements are in series with the back contact of the directional auxiliary element and the coil of the pendulum relay.

Pendulum and Time Delay Elements

The pendulum relay is a telephone type relay with a horizontal spring arm extending between two contact points. A counterweight is fastened to the free end of the arm. The X2 relay is a telephone type relay with slow drop-out characteristics. A solenoid attracts an iron right-angle bracket which in turn operates a set of break and make contacts. Drop-out delay is obtained by the air gap adjustment between the solenoid core and the armature, and the copper slug on the core. X2 is energized by the pendulum relay contacts with its back contact in parallel with the back contacts of the voltage switches and connected in the phase trip circuit. When the

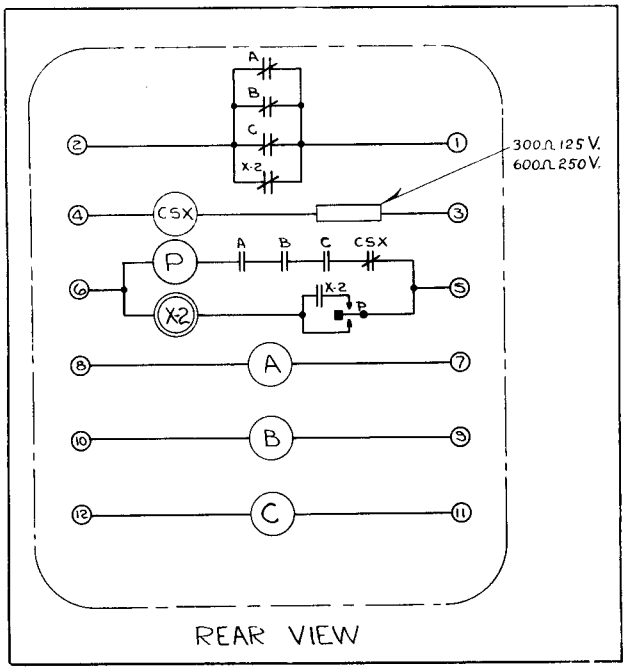

Fig. 1—Internal Schematic of the Type TSO-1 Relay in the Standard Case.

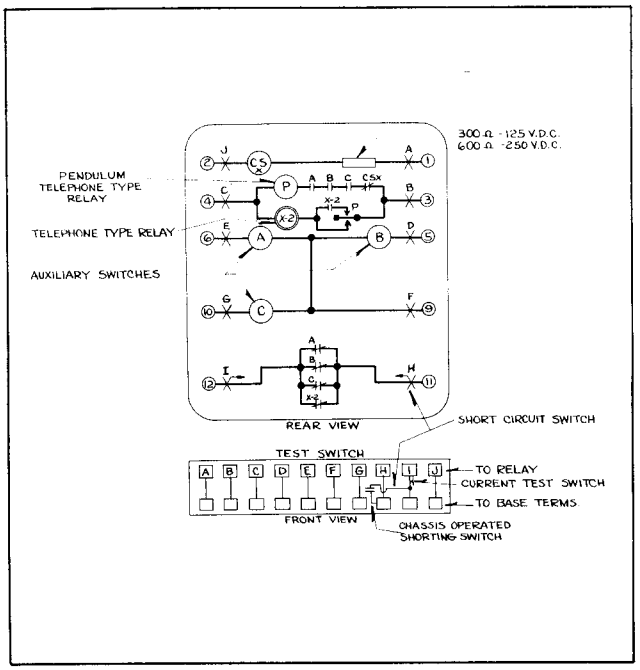

Fig. 2—Internal Schematic of the Type TSO-1 Relay in the Type FT Case.

pendulum relay is energized, its arm is pulled downward to close the lower contact. This energizes the type X2 relay. After the pendulum relay is deenergized, the pendulum will oscillate for a short time alternately breaking and making both of its contacts. Consequently, the type X2 relay will not drop out until after the pendulum oscillations have deenergized its coil.

Operation

The type TSO-1 Blocking Relay with the type HZ relays provides a means of preventing tripping during out-of-step conditions without impairing the ability to trip for internal faults occurring during out-of-step conditions. One fundamental difference between a three phase fault and an out-of-step condition is that a fault suddenly reduces the voltage and increases the current, whereas during the approach of an out-of-step condition the voltage and current changes are comparatively gradual.

A three phase fault operates all three impedance elements simultaneously, if they are to operate at all, while during out-of-step Z3 operates first, followed by Z2 and the Z1. As the system returns toward the "in-phase" position, the elements reset in the opposite order, that is Z1, Z2, Z3.

To prevent tripping during out-of-step it is only necessary to arrange for the opening of the three back contacts A, B, C in the trip circuit, and for the operation of an additional blocking relay to open the trip circuit. This blocking relay must have a slight time-delay so that it does not open the trip circuit before tripping on a three phase fault can occur. On the other hand, it must open the trip circuit during an out-of-step condition before the second element, Z2 is operated.

The out-of-step blocking contact is designated as X2, and is connected in the trip circuit as shown. In parallel with it are three contacts, A, B, C, which are the back contacts on the auxiliary switches A, B, C, operated by the Z3 control circuit contacts of the impedance relays. The make contacts of these switches are in series with the back contact, CSX of the directional auxiliary relay, and energize the coil, P, of a pendulum type time-delay relay, whose power contacts make and energize the coil of the X2 blocking relay.

Every time that all three of the Z3 control contacts close, the back contacts, A, B, C, and X2, open the trip circuit after a 3 to 4 cycle delay. Back contact X2 opens by virtue of all three make contacts, A, B, and C closing through CSX to energize and P coil and in turn, the X2 coil.

If the electrical center is inside the protected line section, and in other cases where the two voltage sources appear 180° out of phase the directional and impedance elements at each end of the line will be closed. This energizes CSX to allow its back contact to open and deenergize the pendulum relay, P, whose spring arm begins now to oscillate, alternately closing the bottom and top contacts, P. This keeps the X2 coil energized. After the amplitude of vibration of the pendulum has decreased to a certain value, it will not strike either of its contacts and X2 will reset. This action occurs in cycles and the time delay introduced by the pendulum relay should be longer than the time during which both directional elements "point in," which depends upon the length of the "slip cycle" of the system. It is desirable to clear internal faults occurring during an out-of-step condition, but it is not so essential to be able to clear them at high speed. The ground relay trip circuit is not blocked by the out-of-step relay, X2, and can trip instantly. On phase-to-phase faults, one or two of the Z3 contacts will reset when the system swings in phase, thus allowing one of the back contacts, A, B, or C to complete the trip circuit without waiting for the reset of X2, On a three-phase fault, however, none of the Z3 contacts will reset, and consequently, tripping will not occur until after the expiration of the X2 time delay. The reset of X2 if made possible by the opening of the directional auxiliary relay back contact CSX which in turn releases P.

It will be noted from Figure 3 that the back-up tripping through D, Z3 and T3 is shown blocked by the out-of-step contacts, in which case, back-up protection of three-phase faults during out-of-step is not possible. It is arranged, however, so that T3 connections can be made on the other side of the out-of-step contacts, and in this case, tripping on out-of-step cannot be prevented for a period of longer than the time setting of T3.

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

Removing Chassis

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

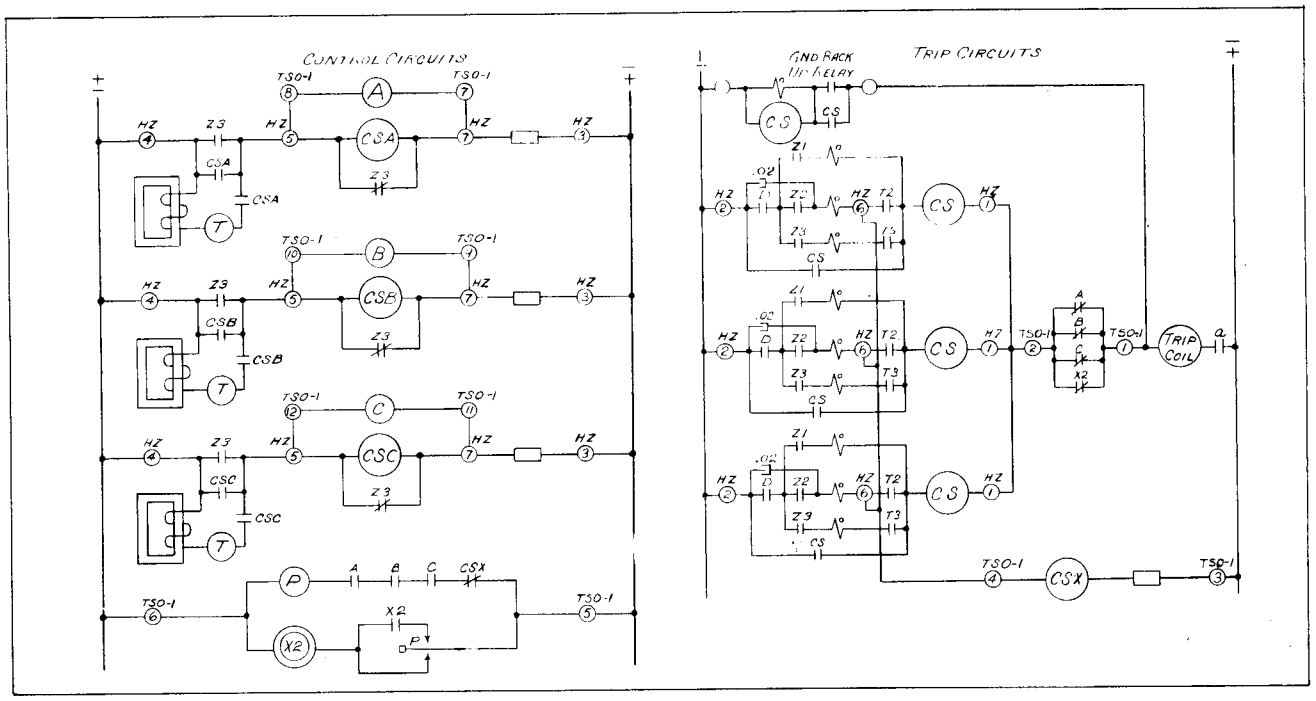

Fig. 3—External Connections of the Type TSO-1 Relay with the Two Make One Break Z3 Type HZ Relay both in the Standard Case.

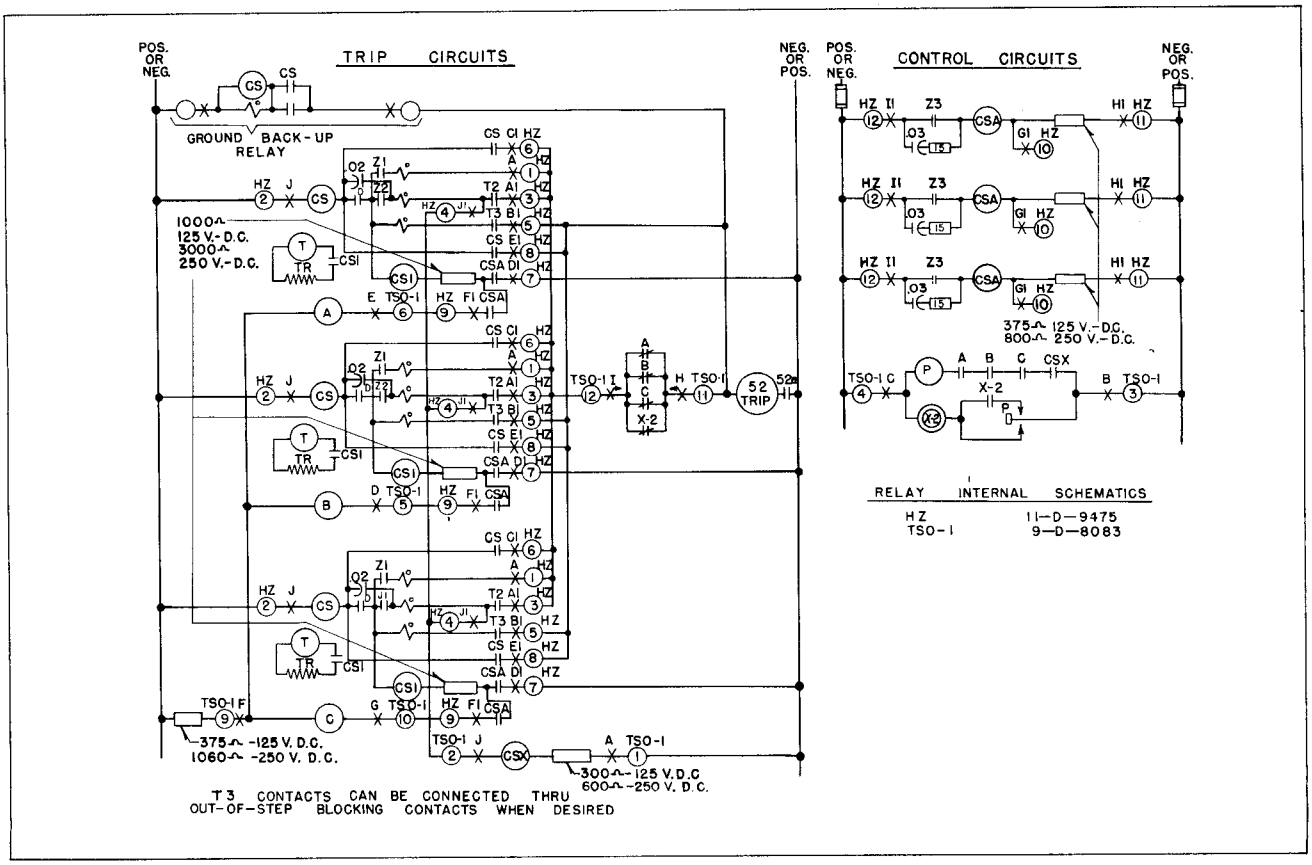

Fig. 4—External Connections of the Type TSO-1 Relay with the Single Z-3 Type HZ Relay both in the Type FT Case.

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

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

Electrical Circuits

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

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

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

Testing

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

Testing in Service

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

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

Testing in Case

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

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

Testing Out of Case

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

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.

Directional Auxiliary Element

The contactor switch, CSX, has adjustable plunger travel. Adjust the two nuts on the bottom of the fixed shaft so that the plunger has 1/8" travel after the lower contacts make. The plunger should have 1/64" travel in the opposite direction after the upper contacts make. This is adjustable by screwing down the set screw on top of the switch until the upper contacts are just able to make as the plunger hits the upper stop. Then back off this screw one turn and lock in place.

The contactor switch has a resistor in series with it, and will pick up positively when rated trip circuit voltage is applied across the coil and its section of the resistor. The resistance of the coil and resistors are:

	125 V.	250 V.
Coil	70 ohms	70 ohms
Resistor	300 ohms	600 ohms

The minimum pick-up of the coil and resistor is 40 volts for a 125 volt relay and 100 volts for a 250 volt relay.

Time Delay Drop-Out Relay

Energize the telephone relays, X2, by applying 80 volts d-c with the pendulum relay armature held in the operated position. The telephone relay should operate positively when the pendulum relay armature is held down to make the lower contact and should not operate when the armature is held up to make the top contact.

Pendulum Relay

To check the operation of the pendulum relay connect jumpers across the make contact on the voltage elements, A, B, and C, and apply 125 volts or 250 volts d-c. (The voltage will depend upon the relay range). The pendulum relay armature should be pulled against the core screws and the X2 telephone relay should pick up. Remove the jumpers from the voltage

switch contacts. The pendulum relay armature should oscillate and hold the X2 relay closed for approximately 3 seconds. This is the standard factory adjustment. The drop-out time of the X2 and P combination may be varied to any desired value between 20 cycles to 15 seconds. This time may be varied slightly by adjusting the spacing of the two outer contacts by means of the set screws on the P element. The drop-out time also can be decreased by screwing the set screw on the armature of the X2 element. The space between the armature and core should not be less than 10 mils.

Voltage Switches

Voltage switches, A, B, and C should be adjusted so that there is a clearance of 1/64" between the plunger and the core with the plunger picked up. The switches should pick up at 25 volts d-c, and not stick closed after 90 volts d-c, is passed.

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.

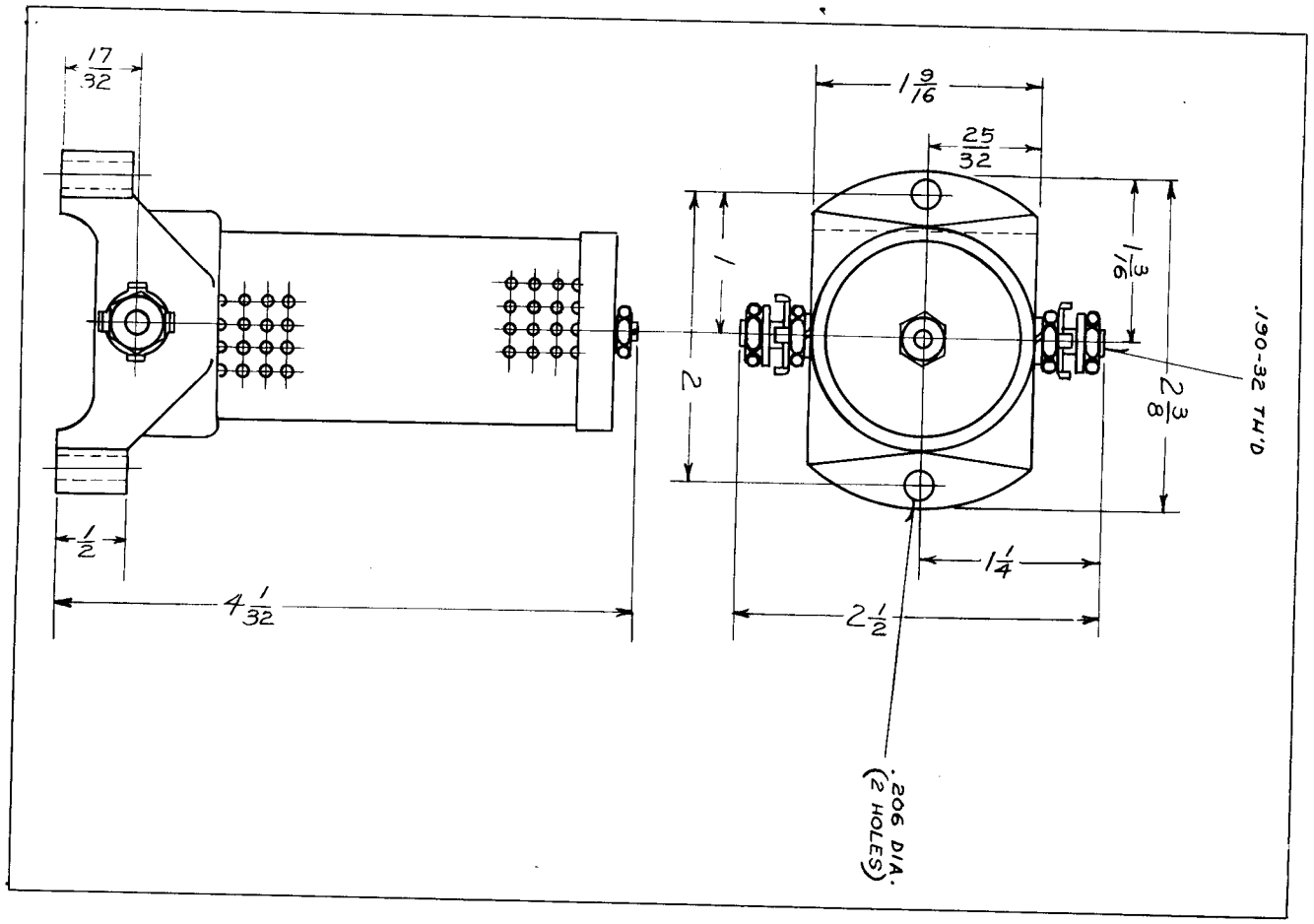

Fig. 5—Outline and Drilling Plan of the External Resistor Used with Scheme of Figure 4. For Reference Only.

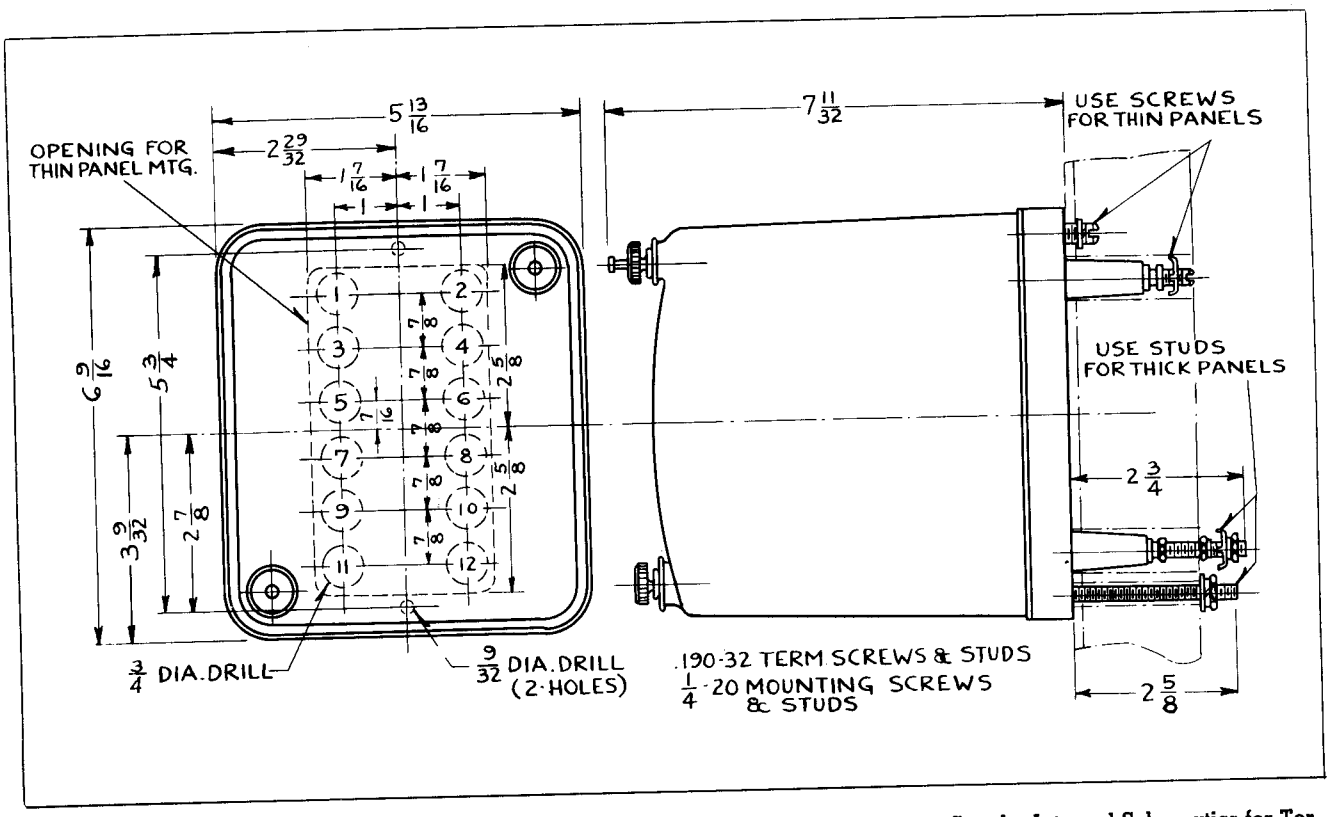

Fig. 6—Outline and Drilling Plan for the Relays in the Projection Type Standard Case. See the Internal Schematics for Terminals Supplied. For Reference Only.

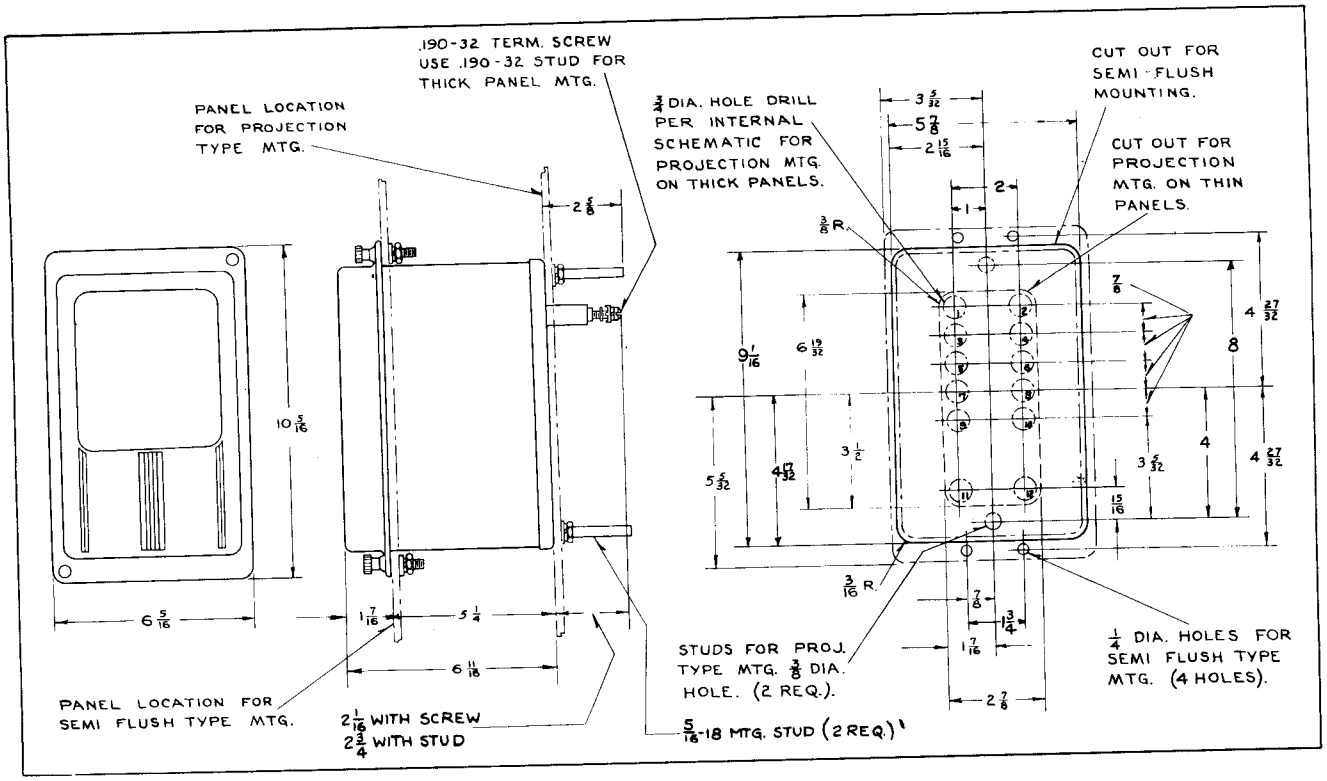

Fig. 7—Outline and Drilling Plan for the S10 Semi-Flush or Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

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