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 element, three voltage elements, a pendulum element, and a time-delay drop-out element. 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 CSX 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 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

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* Denotes change from superseded issue.

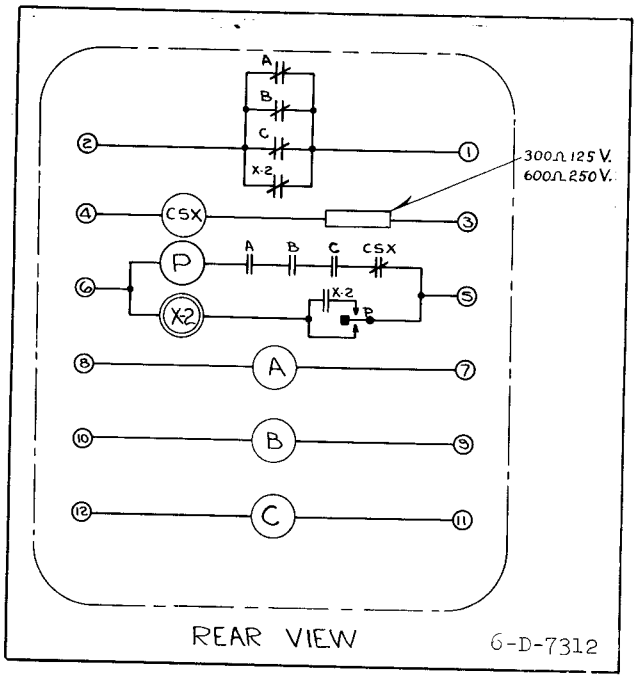

Fig. 1—Internal Schematic of the Type TSO-1 Relay in the Standard Case.

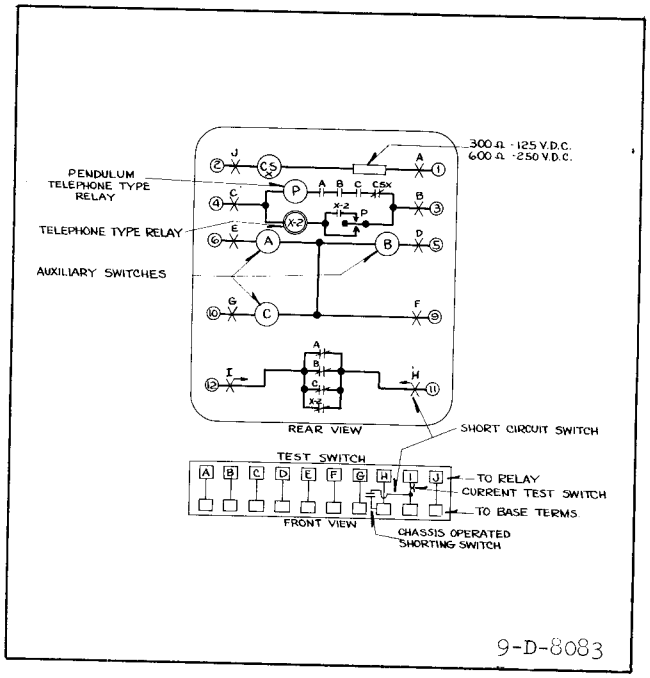

Fig. 2—Internal Schematic of the Type TSO-1 Relay in the Type FT Case.

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.

* 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

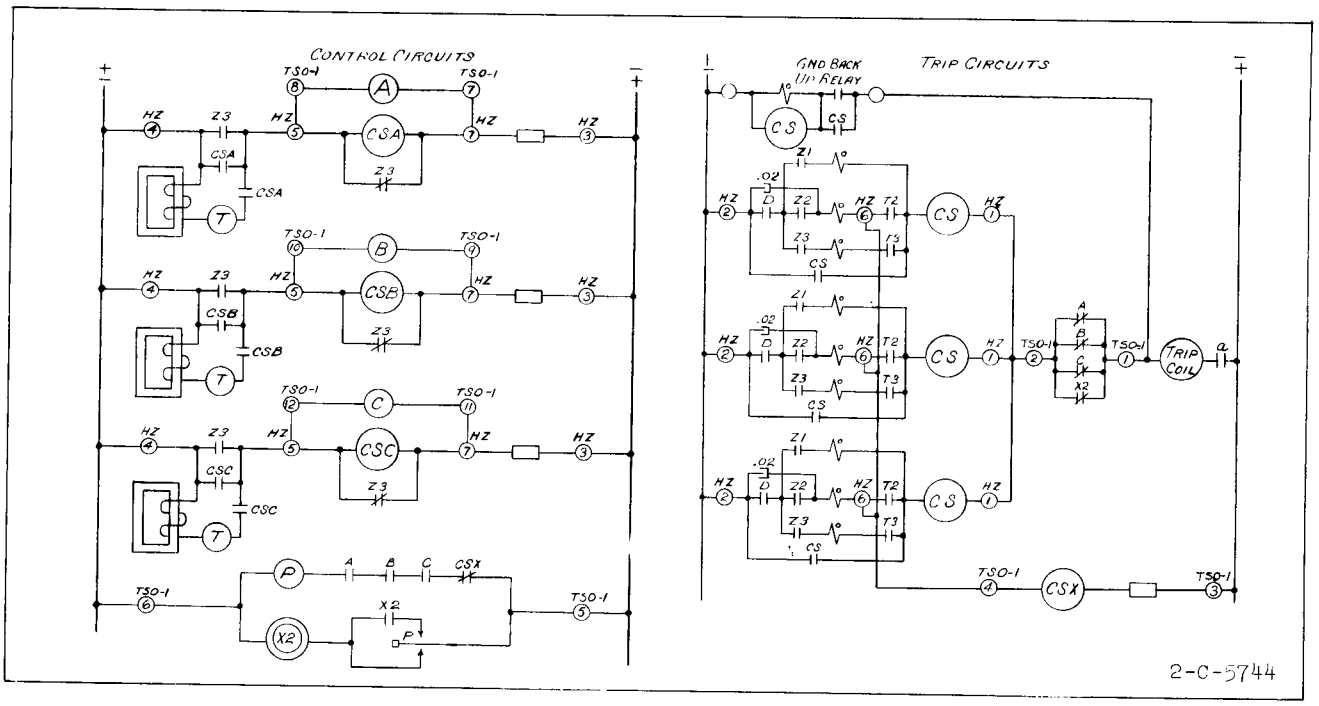

Fig. 3—External Connections of the Type TSO-1 Relay with the Two Make One Break Z3 Type HZ Relay both in the Standard Case.

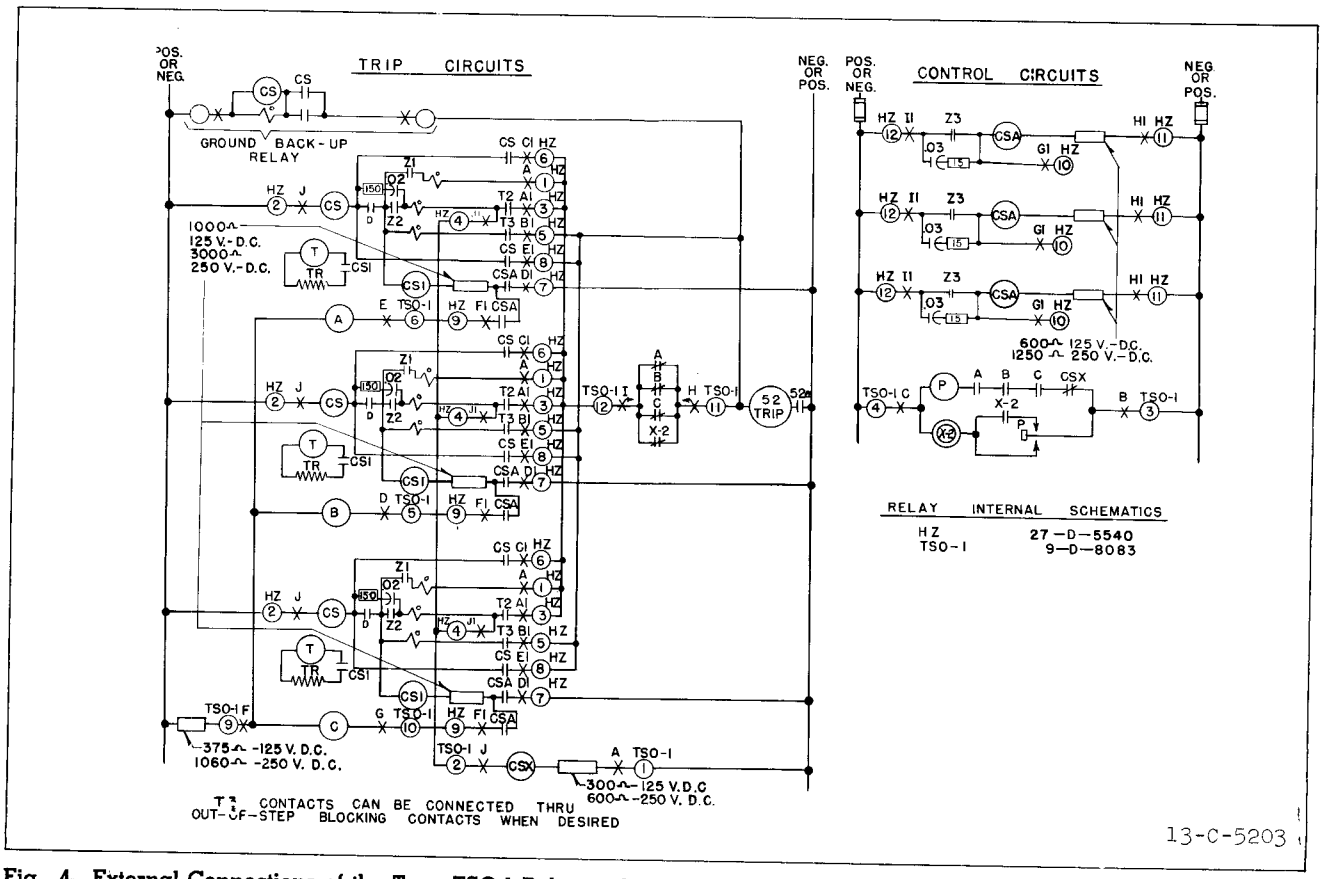

Fig. 4—External Connections of the Type TSO-1 Relay with the Single Z-3 Type HZ Relay both in the Type FT Case.

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 10 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 35 volts d-c for the 125 volt relay and 50 volts for the 250 volt relay. Check to make sure the switches do not stick closed after rated voltage (125 or 250 volts) is applied.

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.

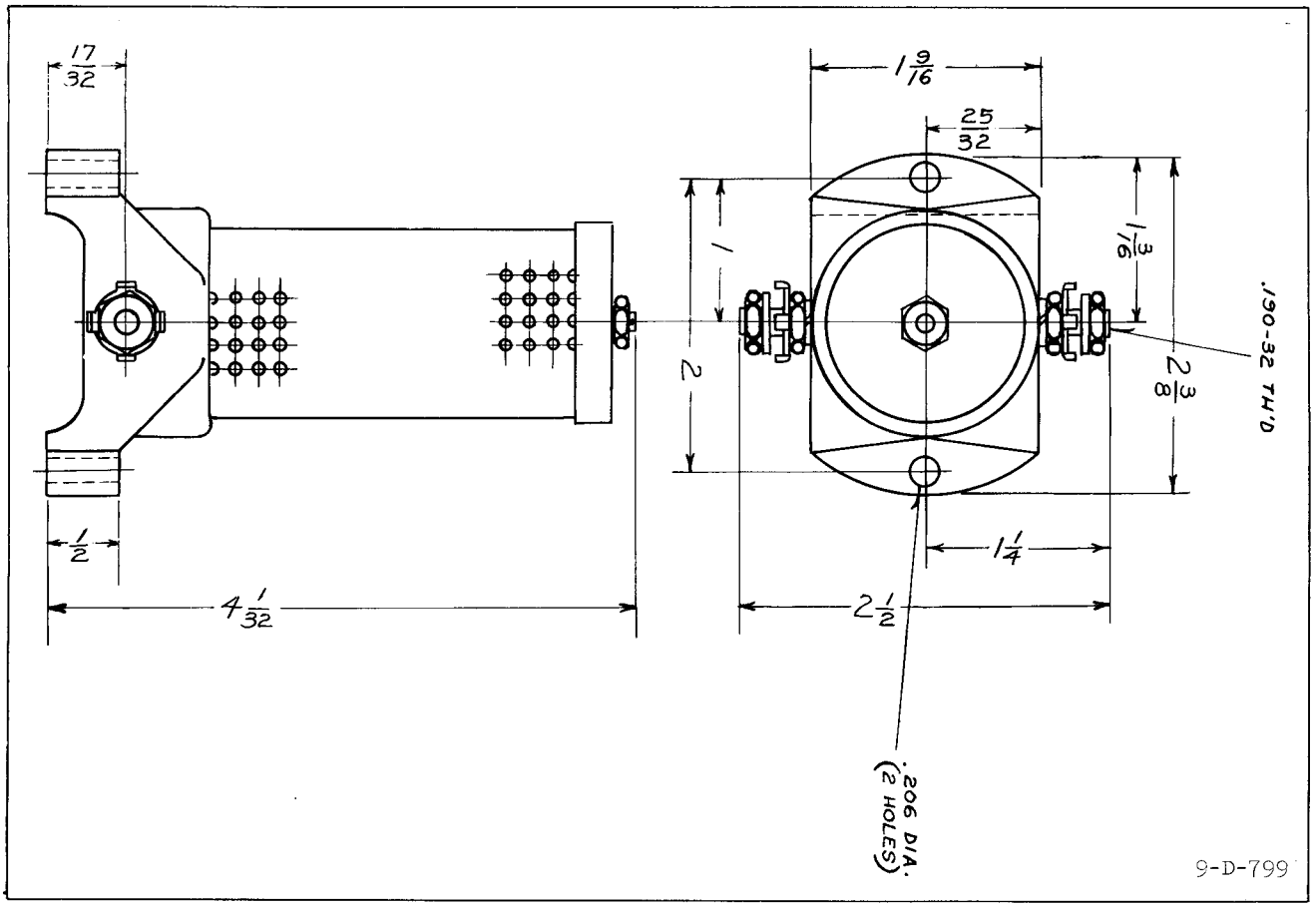

Fig. 5—Outline and Drilling Plan of the External Resistor Used with Scheme of Figure 4. For Reference Only.

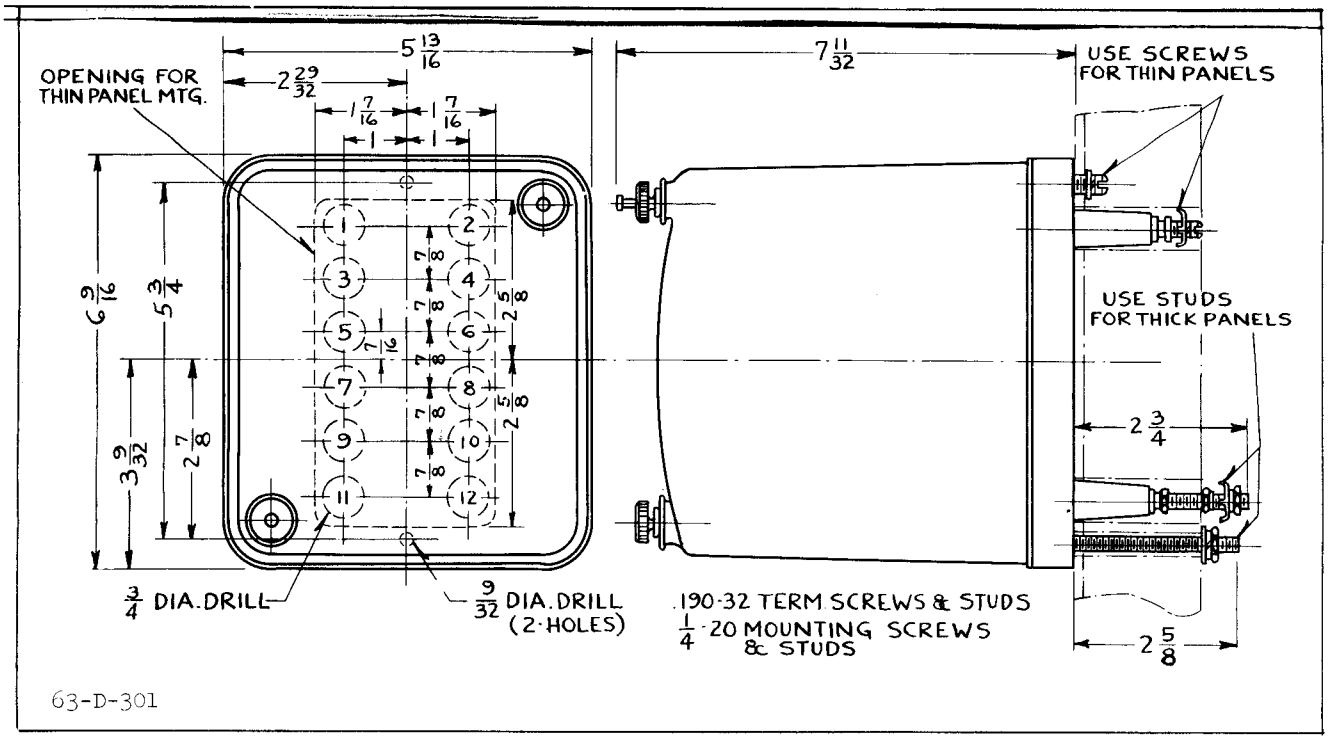

Fig. 6—Outline and Drilling Plan for the Relays in the Projection Type Standard Case. See the Internal Schematics for Terminals Supplied. For Reference Only.

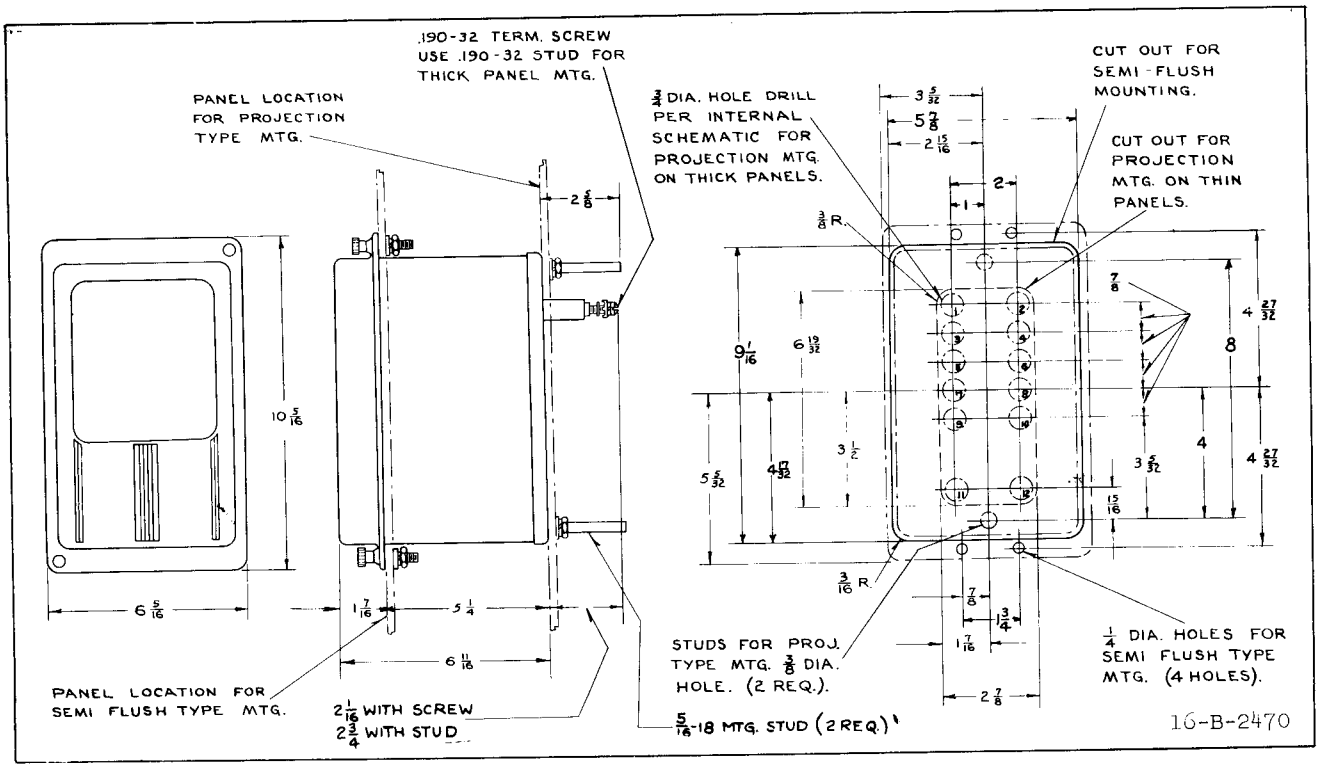

Fig. 7—Outline and Drilling Plan for the S10 Semi-Flush or Projection Type FT Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

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