INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CT TEMPERATURE-OVERLOAD RELAY

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 CT relay is an induction type relay operating from exploring coils imbedded in or attached to the equipment being protected, and from a line current transformer. The relay is used to protect a-c equipment from overheating resulting from overloads, open phase, or insulation failure when the line current may be insufficient to operate short circuit protective devices. In order for the relay to operate, the temperature of the windings of the apparatus and the current flowing in the apparatus must be above values for which the relay is set, and these two conditions must have existed for a certain period of time because of the inherent time-delay of the induction-type element. Thus, the danger of disconnecting the apparatus upon transient overloads is eliminated.

This relay is manufactured and set at the factory for each application and cannot be changed after shipment. In order to make the application, the following information is necessary:

1. Frequency of the connected system.
2. Power rating of the apparatus being protected.
3. Full load phase current.
4. Current transformer ratio. This should be chosen so that the full load secondary current is between 3.25 and 5 amperes if possible. This permits use of a 5°C. differential between the balance temperature and the operating temperature. However, by using a differential of 10°C between the balance temperature and the operating temperature, a full load secondary current as low as 2.25 amperes can be permitted in 60 cycle applications.
5. Maximum safe operating temperature at which the relay must trip if full load current or more is present.
6. The metal (usually copper) used in the exploring coil windings and its temperature coefficient of resistance at 25° Centigrade.
7. Resistance of each exploring coil at 25° Centigrade. (Standard relays are available for use with 10 ohm exploring coils only.)
8. Ambient temperature (if appreciably different from 25°C).
9. Resistance of the leads from the exploring coils to the relay terminals. However, if resistance of the leads can not be predetermined, the effect of lead resistance can be balanced out at slight sacrifice of sensitivity by using relays with additional terminals as shown in Figs. 3 and 5 and by using three leads to each exploring coil instead of two.

CONSTRUCTION

The type CT relay consists of an operating, element, two fixed resistor legs of the Wheatstone Bridge, a Contactor Switch, and Operation Indicator.

Operating Element

This element is the induction-disc type.

SUPERSEDES I. L. 41-297 A
* Denotes change from superseded issue.

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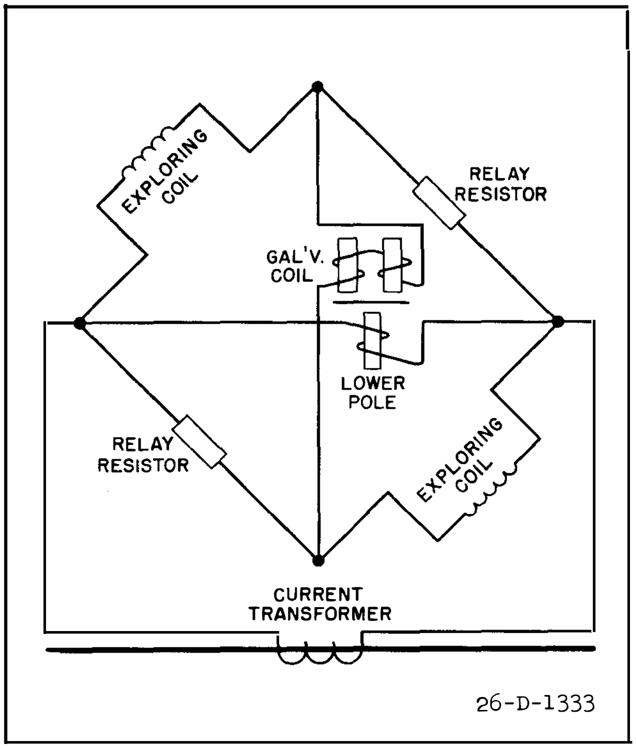


Fig. 1—Schematic Diagram of the Internal and External Connections of the Type CT Relay.

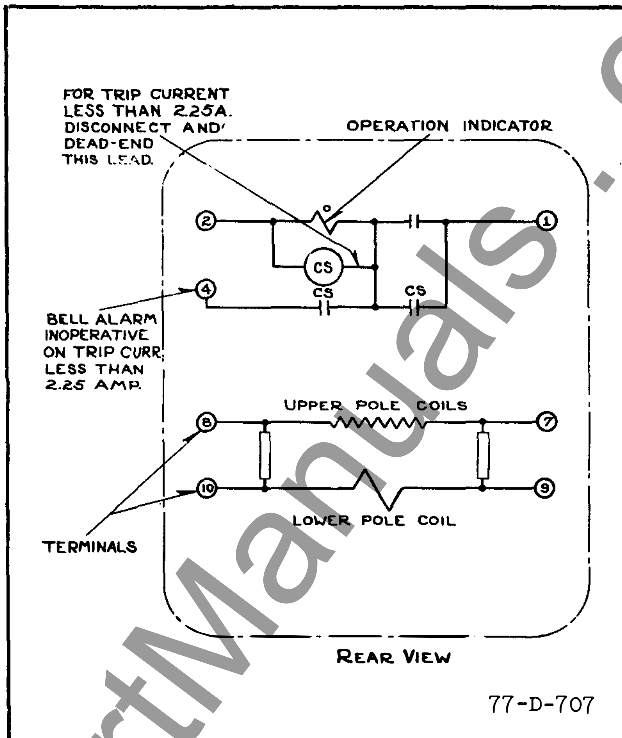


Fig. 2—Internal Schematic of the Type CT Relay in the Standard Case 7-Terminal Relay for Use Where Exploring Coil Lead Resistance Is Known When Relay is Manufactured.

The induction disc is mounted on a vertical shaft. A stop riveted to the disc prevents the contact from opening more than approx. 1/4 of an inch. The shaft is supported on the lower end by a steel ball bearing riding between concave sapphire jewel surfaces, and on the upper end by a stainless steel pin.

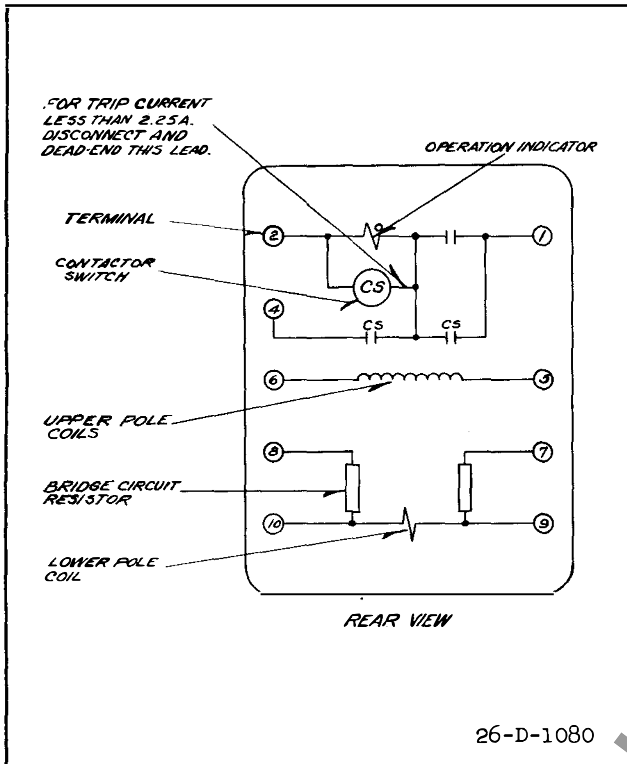
The moving contact is a small silver hemisphere fastened on the end of an arm. The other end of this arm is clamped to an insulated section of the disc shaft. The electrical connection is made from the moving contact thru the arm and spiral spring. One end of the spring is fastened to the arm, and the other to a slotted spring adjuster disc which in turn fastens to the element frame.

The stationary contact assembly consists of a silver contact attached to the free end of a leaf spring. This spring is fastened to a Micarta block and mounted on the element frame. A small set screw permits the adjustment of contact follow.

The moving disc is rotated by an electromagnet in the rear and damped by an electromagnet in the front. The upper pole windings are connected as the galvanometer leg of a Wheatstone Bridge circuit, and the lower pole winding in parallel with the Bridge as shown in Figure 1. The lower pole winding and the Bridge as shown in Figure 1. The lower pole winding and the bridge are energized from a current transformer connected to carry the load current of the apparatus being protected. Since the impedance of the bridge is largely resistance, and that of the lower winding almost entirely reactance, there is sufficient phase displacement between the currents in the two relay windings to give a positive rotational torque to the disc.

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



* Fig. 3—Internal Schematic of the Type CT Relay in the Standard Case 9-Terminal Relay for Use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.

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. The contactor switch is equipped with a third point which is connected to a terminal on the relay to operate a bell alarm.

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.

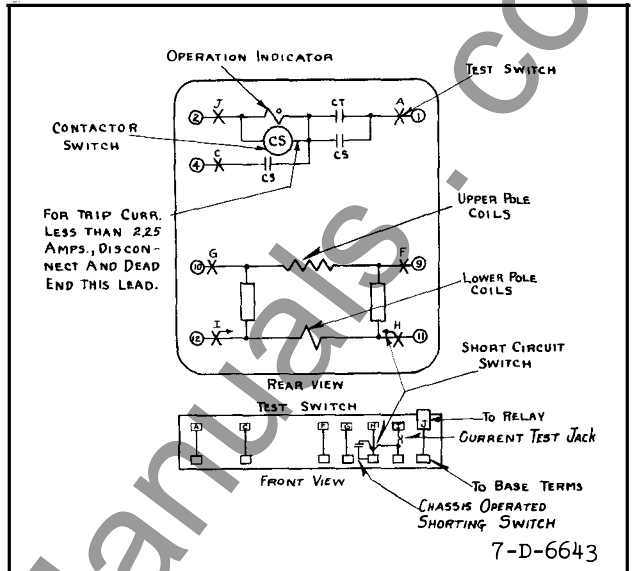


Fig. 4—Internal Schematic of the Type CT Relay in the Flexitest Case 7-Terminal Relay for Use Where Exploring Coil Lead Resistance is Known When Relay is Manufactured.

OPERATION AND CHARACTERISTICS

The operation of the relay is as follows with reference to Figure 1. When the resistance of the exploring coils is increased by the rising temperature of the apparatus to equal the resistance of the fixed sides of the bridge, no current will flow thru the upper pole of the relay and there will be no torque. The relay is normally set at the factory so that the bridge circuit is balanced at either 5° or 10° Centigrade below the operating temperature which the customer sets as being the limit which he does not want to exceed. The relay is connected so that when the resistances of the exploring coils are higher than the critical resistance the torque is in the contact closing direction, and when less the torque is in the contact opening direction. Thus the relay will not trip on any load current as long as the temperature of the machine as indicated by the change in resistance of the exploring coil is within the safe limits. If the temperature rises above the safe limit, and the full load current is exceeded, the relay contacts will close.

The closing torque of the Type CT relay is approximately proportional to the product of the current squared and the temperature difference from the balance point. With the rise of these values above the operating limits, the relay contact close with a rapidly increasing force. The limited travel of the disc permits a very short operating time when the operating limits are exceeded considerably.

When the resistance of the leads from the exploring coils to the relay is known at the time the relay is manufactured, each of the two resistors of the bridge circuit is constructed with a resistance equal to that of the exploring coil at the balance temperature plus the resistance of one pair of leads.. Since the lead resistance is not affected by the temperature of the exploring coil, the effect of appreciable lead resistance is to reduce the degree of unbalance of the bridge at temperatures above or below the balance point. However, lead resistances usually are less than 0.5 ohm per pair, and the reduction in sensitivity would not be serious with lead resistances of 1.0 ohm.

When the resistance of the leads from the exploring coils to the relay can not be determined accurately before the relay is manufactured, the CT relay can be used with internal connections as shown in Figs. 3 and 5. The upper pole winding (connected in the galvanometer circuit of the bridge) is connected to independent terminals, and three leads (instead of two) are required between the relay and each exploring coil. With additional leads added as shown by the dotted connections in Fig. 6, the resistance of one lead is inserted in each exploring coil leg of the bridge, and the resistance of one lead is inserted in each relay resistor leg. Thus, the balance of the bridge is not affected by the lead resistance. However, the resistance of two leads is inserted in the galvanometer circuit. The relay is rendered somewhat less sensitive by this, but with lead resistance of 0.5 ohm each the operating temperature at full load would be raised less than 2°C above the temperature for zero lead resistance. The necessity of using a total of six leads instead of four may be objectionable in some cases, however.

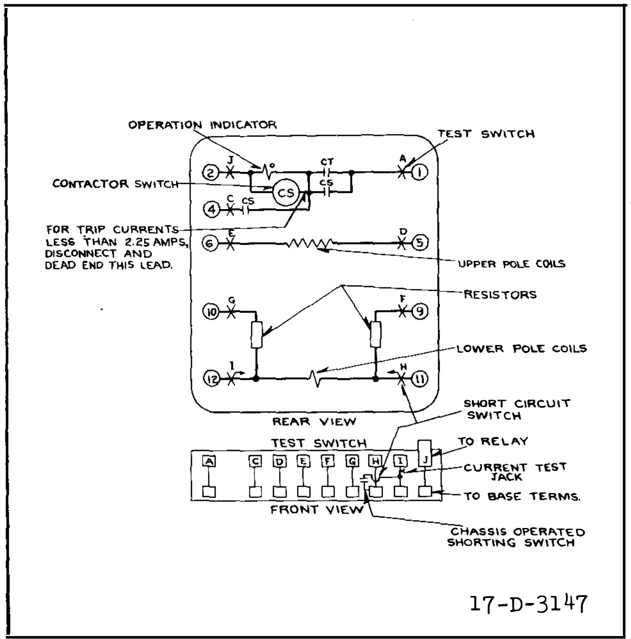
EXPLORING COILS

It is preferable to use exploring coils which are built into the apparatus to be protected at the time of manufacture as they can be placed in the winding slots or otherwise brought into proximity to the windings being protected close to the point of highest temperature rise. The physical design of these coils will vary with the individual apparatus, but exploring coils usually are copper, with a resistance of 10 ohms at 25° C.

If a motor or generator has been built without exploring coils and it is desired to provide temperature-overload protection by means of the type CT relay, a "Rope Coil" may be fastened to the end connections of the windings. Because of its location it can not indicate the winding temperature as accurately as a built-in exploring coil. The "Rope Coil" is a flat loop or skein of wire approximately 10 feet long. Two strands of enameled copper wire are wound in parallel and four leads are brought out, providing the two exploring coil sides of the bridge in the one winding. The coil then is insulated with a tape winding and is varnish dipped and baked. It is sufficiently flexible to permit placing and tying it around the end connections of the winding.

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-blade.



* **Fig. 5—Internal Schematic of the Type CT Relay in the Flexitest Case 9-Terminal Relay for Use Where Exploring Coil Lead Resistance is Unknown When Relay is Manufactured.**

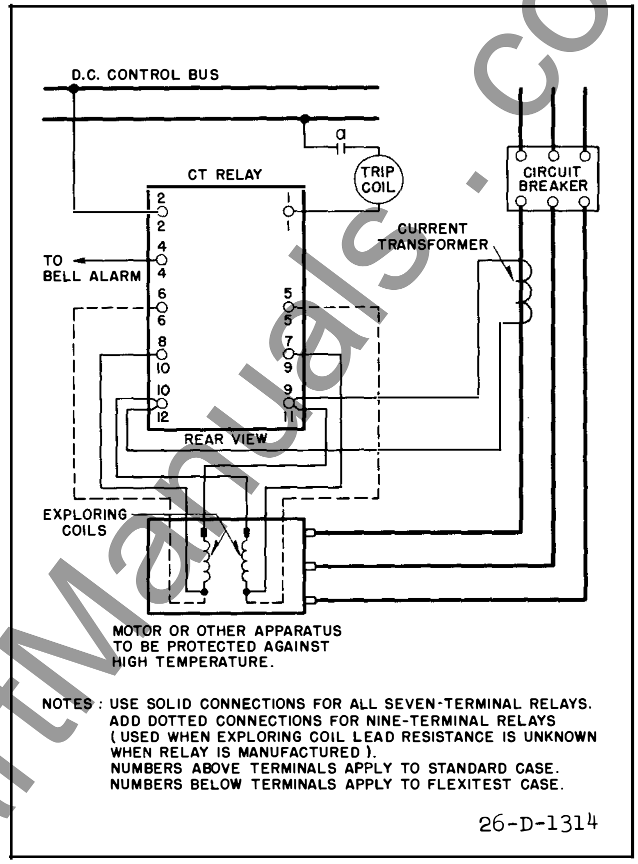


Fig. 6—Typical External Connections for the Type CT Relay.

Removing Chassis

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

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis.

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

Electrical Circuits

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

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

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

Testing

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

Testing In Service

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

Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaw. 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 post 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 may 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.

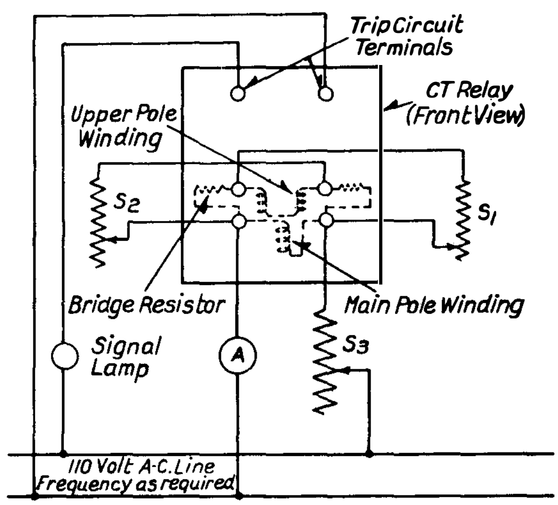
INSTALLATION

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 veritcally by means of two mounting studs. Either of these studs may be utilized for grounding the relay base. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

The external connections for the relays are shown in Fig. 6. The connections shown by solid lines are used with the 7-terminal relays (Figs. 2 and 4) in applications where the lead resistance is known beforehand. The additional terminals and leads shown dotted are used with 9-terminal relays (Figs. 3 and 5) in applications where the lead resistance is not known when the relay is manufactured.

The main contacts of the relay will safely close 30 amperes at 250 v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker. The relay is shipped with the operation indicator and the contactor switch connected in parallel. This circuit has a resistance of approximately 0.23 ohms 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, remove the short lead to the coil on the front stationary contact of the contactor switch. This lead should be fastened (dead ended) under the small filister-head screw located in the Micarta base of the contactor switch. The operation indicator will operate for trip currents above 0.2 amperes d.c. The resistance of its 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.



A - 5-10 Amp. A-C Ammeter

S_1-S_2 - Non-inductive slide resistors adjustable from 10 to approx. 15 ohms in steps of approx. .05 ohms or less. Slide must have negligible contact resistance.

S_3 - Variable resistance giving from 3 to 10 amperes and with 5 amperes continuous rating. Currents between 3 and 5 amperes should be adjustable in steps of about .05 amperes.

Fig. 7—Diagram of Test Connections for the Type CT Relay. (Relay Internal Connections Shown Schematically).

ADJUSTMENTS AND MAINTENANCE

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.

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.

Operating Coil

To check the operating coils, connect the relay per Figure 7. The relay should trip at "A" amperes and "T" degrees C. as marked on its nameplate. The temperature may be represented by increasing the resistance of the exploring coil sides of the bridge by means of slide wire resistances, to the values corresponding as shown in the following table:*

Resistance	Temperature	Resistance	Temperature
10.00 ohms	25°C.	12.89	100
10.96	50	13.28	110
11.35	60	13.66	120
11.73	70	14.05	130
12.12	80	14.43	140
12.50	90	14.82	150

*NOTE - This table applies only to copper wire coils having 10 ohms resistance at 25°C.

Contactor Switch

Adjust the stationary core of the switch for a clearance between the stationary core and the moving core when the switch is picked up. This can be most conveniently done by turning the relay up-side-down. 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 point where the play in the moving contact assembly is taken up, and where the moving core just separates from the stationary core screw. Back off the stationary core screw one turn beyond this point 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 inch 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 d-c have been passed thru 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 ohms.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

ENERGY REQUIREMENTS

The 60 cycle burden of the relay on the current transformer is 15.0 volt-amperes at 5 amperes, 49° lag Power Factor. The continuous rating of the winding is 5 amperes (10 ohms exploring coil), and the one second rating 150 amperes, 60 cycles.

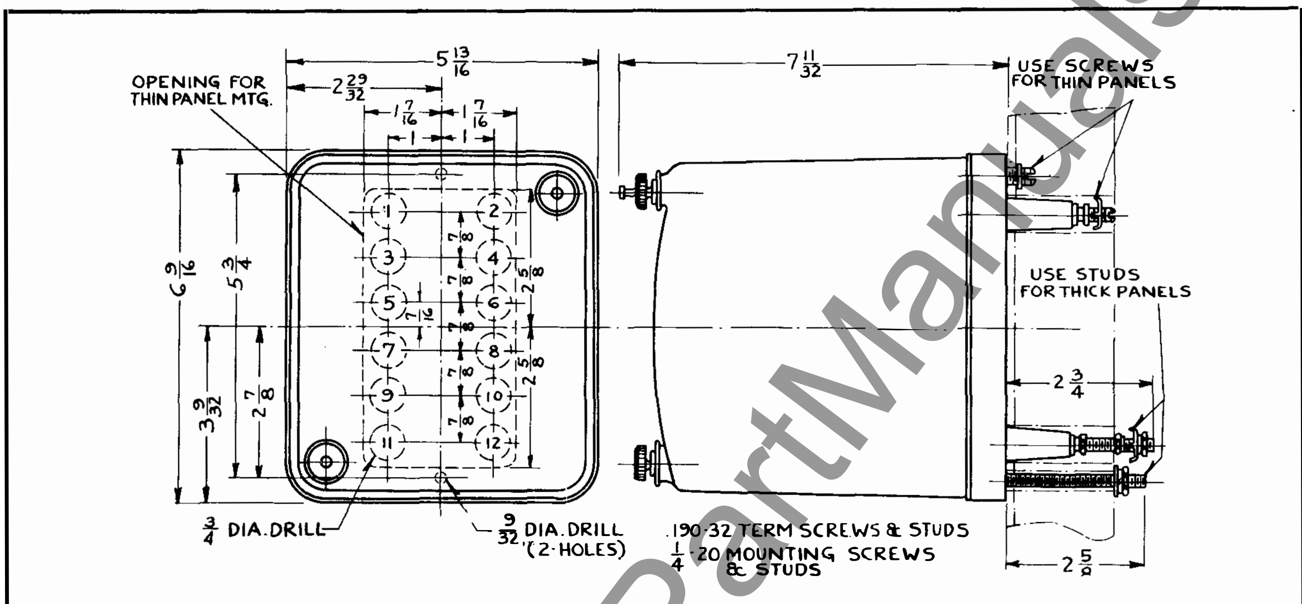


Fig. 8—Outline and Drilling Plan for Relays in the Standard Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.

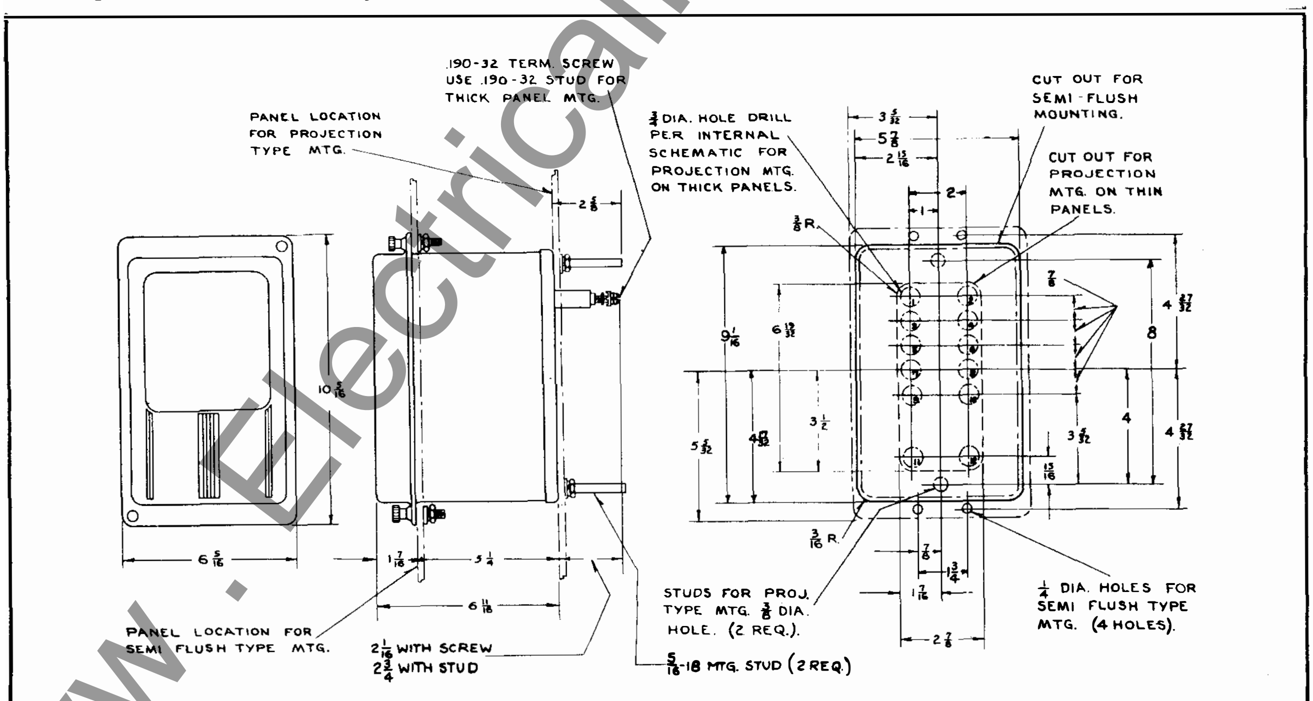


Fig. 9—Outline and Drilling Plan for Relays in the S10 Semi-Flush or Projection Type Flexitest Case. See the Internal Schematics for the Terminals Supplied. For Reference Only.