INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE ND ROTOR ROTATION INDICATING 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 ND relay is designed for use in synchronous condenser control. Its function is to detect a locked rotor in the synchronous condenser during the starting period. It will energize the shut-down circuit if the rotor does not begin to turn within a short time-interval after the starting breaker is closed.

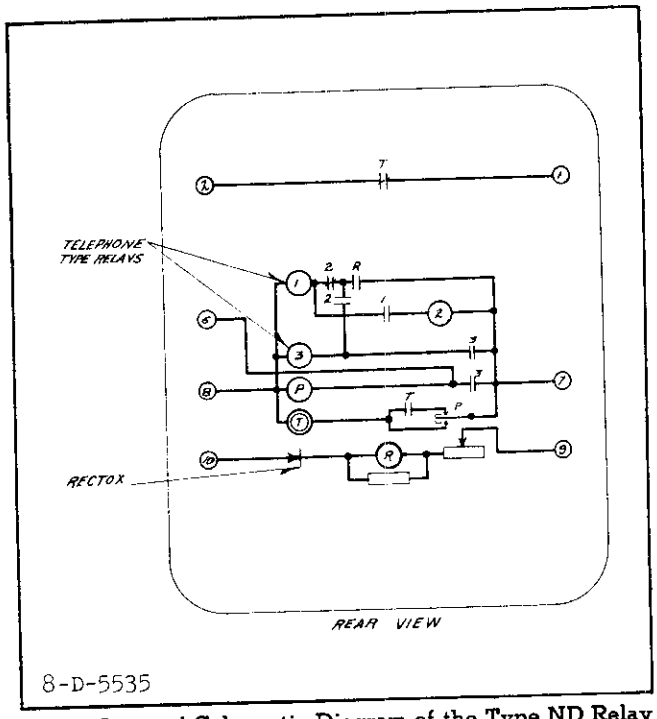
CONSTRUCTION AND OPERATION

The type ND relay consists of an assembly of six telephone-type relays, a Rectox rectifier and two resistors. These components may be mounted in either a standard rectangular or a Flexitest case. Seven terminals are required. Internal connections of the relay in the standard case are shown in Fig. 1, and connections of the relay in the Flexitest case are shown in Figure 2.

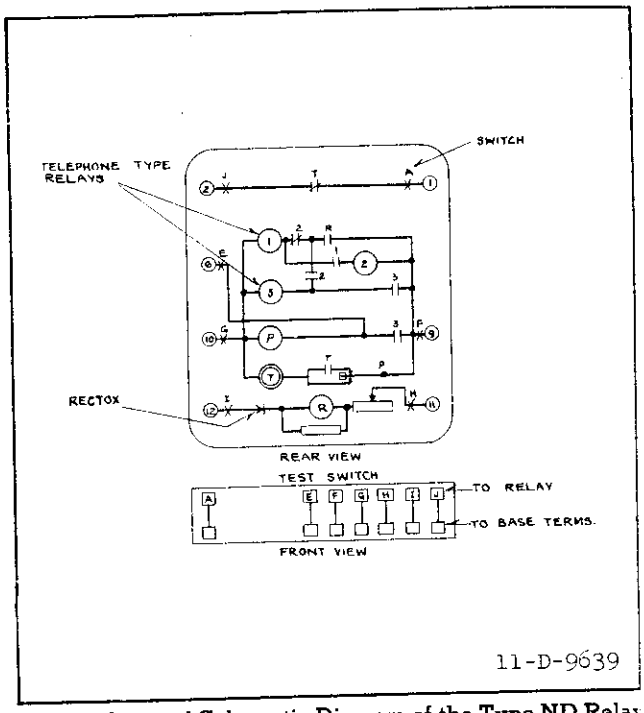
The relay designated as R in the diagrams alternately picks up and drops out as the rotor of the synchronous condenser turns. An a-c voltage, of magnitude and frequency dependent upon the rotor speed, is impressed on relay terminals 9-10 (std. case) or 11-12 (FT case), and the action of relay(R) is stabilized by the resistor connected across its coil and the half-wave rectifier connected in series. The variable resistor which also is in series with relay(R) is adjusted at the factory so that (R) is picked up approximately one-half of each cycle of beat voltage when the rotor is just starting to turn. Relays (1), (2) and (3) comprise a counting chain which counts the first few operations of relay (R). Relay (P) is a pendulum-type relay and relay (T) is a slug-type delayed-dropout relay. These two relays together form a timing circuit. If the timing chain functions and relay (3) picks up before the time-setting of the timing circuit, the starting sequence of the synchronous condenser control proceeds normally.

Schematic external and internal connections for the type ND relay are shown in Fig. 3. In addition to the ND relay (device 14), a 6-contact type MG-6 auxiliary relay (14X), a 115/115 volt 25 v.a. insulating transformer, and a 2000 ohm potentiometer are needed. Also, an "a" contact of the starting breaker (6), a "b" contact of the running breaker (42), and a make contact of the master starting relay (4) must be available.

When the starting breaker is closed, a 60 cycle voltage is induced in the field winding and appears across the field discharge resistor. If the rotor turns, this voltage will change phase with respect to the bus voltage, and the frequency of the induced voltage will decrease as the rotor speed increases. If this voltage is beat against the bus voltage through the insulating transformer, the beat frequency will vary directly as the rotor speed. If the two voltages are of equal magnitude and the beat voltage is applied to a relay, this relay will alternately pick up and drop out as the net voltage varies from a maximum to zero due to turning of the rotor.



* Fig. 1—Internal Schematic Diagram of the Type ND Relay in the Standard Case.



* Fig. 2—Internal Schematic Diagram of the Type ND Relay in the Flexitest Case.

The magnitude of the induced voltage is reduced as the rotor speed increases, but if the drop out voltage of the voltage-sensitive relay is fairly high it will continue to pick up and drop out even though the minimum beat voltage is considerably more than zero.

The elements operate in the following sequence in a starting cycle. When the master control switch is turned to the start position and the master relay (4) closes, a contact of this relay energizes the pendulum relay (P) of the type ND relay (14) through a normally-closed contact of the MG-6 relay (14X). A contact of P picks up the slow-drop-out relay (T). The starting breaker (6) closes, and an auxiliary contact (6a) of this breaker picks up the auxiliary relay (14X). This de-energizes relay (P), and through the make contacts of relay (14X) the shut-down circuit is set up and the two a-c voltages are connected to relay (R). The pendulum of relay (P) starts swinging and makes intermittent contact in the circuit to relay (T). Depending upon the rotor position, relay (R) may or may not pick up immediately. If the rotor turns, however, relay (R) will pick up as the beat voltage increases and will drop out as it decreases. When relay (R) first picks up, relay (1) of the counting chain closes and sets up a circuit for relay (2) to pick up as soon as the by-pass around it is removed by the dropping out of relay (R). A contact of relay (2) sets up a circuit so that when relay (R) again picks up, relay (3) picks up and seals in through one of its own contacts. A second contact of relay (3) re-energizes relay (P) and holds the circuit to relay (T) closed. This prevents the contact of relay (T) in the shut-down circuit from closing. When the starting breaker (6) opens and the running breaker (42) closes, the auxiliary relay (14X) and the ND relay are completely de-energized.

If the rotor had not started to turn when the starting breaker closed, relay (R) either would not have picked up, or if it picked up it would not have dropped out again. Relays (2) and (3) in the counting chain would not have picked up, and relay (T) would have dropped out and completed the shut-down circuit through its back contact.

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosur

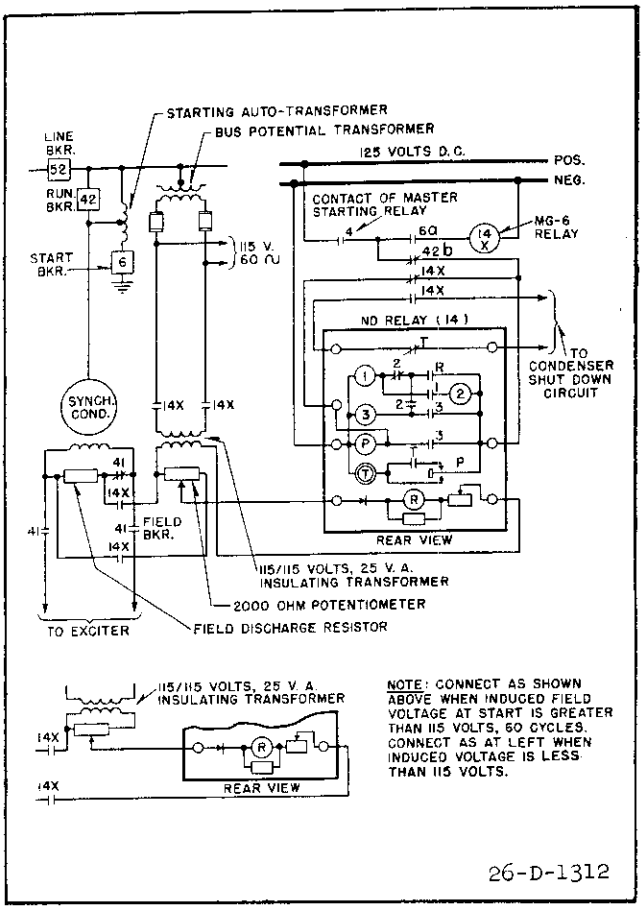


Fig. 3—Schematic External and Internal Connection Diagram of the Type ND Relay, Showing Principle of Operation.

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.

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. The order of opening the 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 reverse order.

Electrical Circuits

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

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

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

Testing

The relays can be tested in service, in the

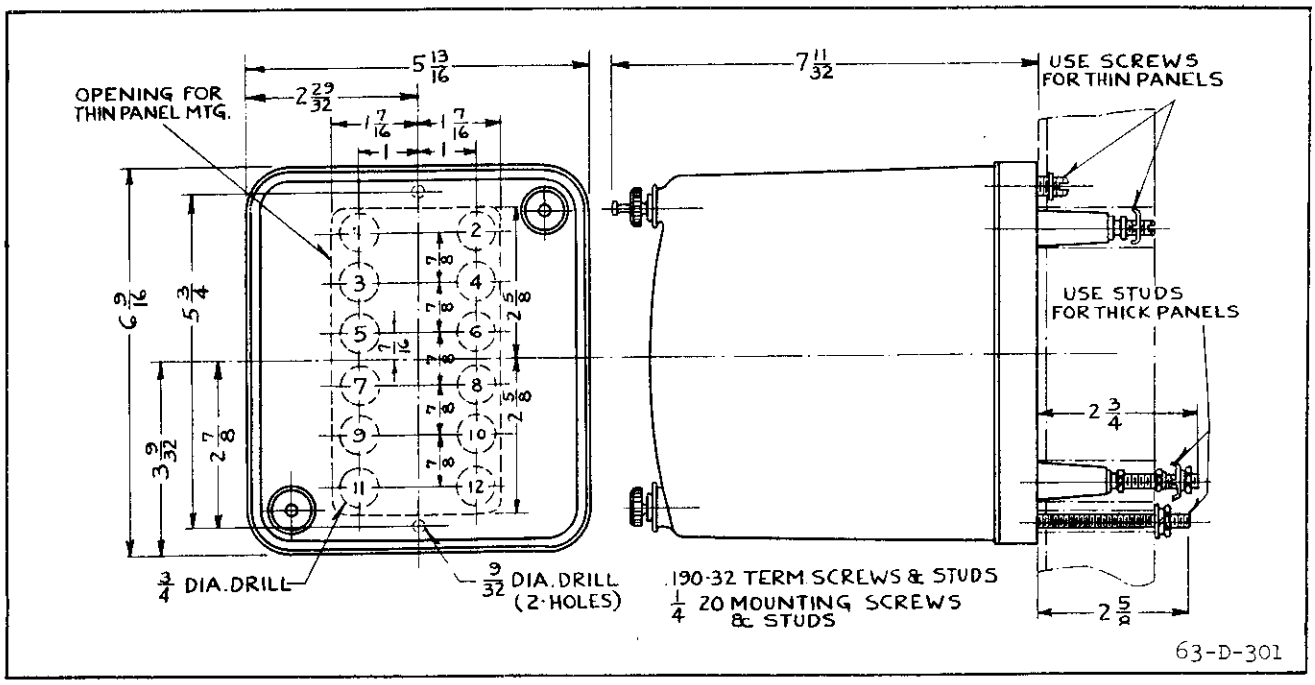


Fig. 4—Outline and Drilling Plan for Relays in Standard Case. See the Internal Schematic for the Terminals Used. For Reference Only.

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 posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug.

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case 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 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

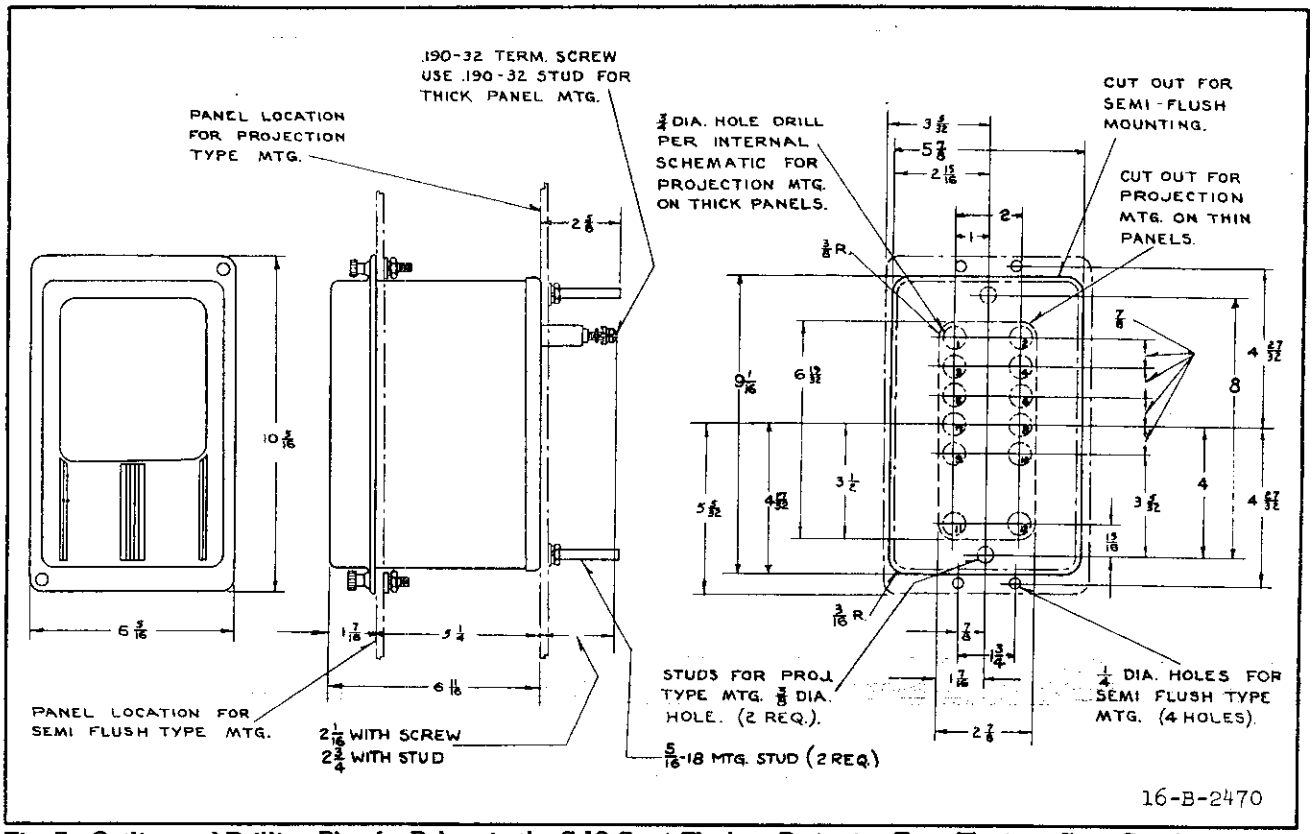


Fig. 5—Outline and Drilling Plan for Relays in the S-10 Semi-Flush or Projection Type Flexitest Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

terminal studs may be easily removed or inserted by locking the two nuts on the studs and then turning the proper nut with a wrench.

The values of the induced voltage which appears across the field discharge resistor at the moment the starting breaker is closed (before the rotor begins to turn) should be ascertained, and the 2000 ohm potentiometer shown in the connection diagram (Fig. 3) should be connected and adjusted so that the two voltages that are to be beat against each other are equal initially.

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 it it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

The time delay between de-energization of relay (P) and dropping-out of relay (T), should be approximately 3 seconds. With the relay in its normal operating position, this delay may be checked by connecting terminals 9 and 10 (for relays wired as shown in Fig. 2) to a 125 volt d.c. source and picking up the relay (P) by connecting terminal 6 to terminal 9 momentarily. The interval between the de-energization of relay (P) and closing of the (T) contact connected between terminals 1 and 2 can be measured with a cycle counter or other time-measuring means. The two contact gaps of relay (P) should be approximately equal when the relay is de-energized. If the time delay is too long the gaps should be increased by equal amounts, using the adjusting screws provided. If the delay is too short, the gaps should be reduced by equal amounts until the required delay is obtained.

If the initial voltage across the field discharge resistor is 115 volts or more the potentiometer associated with the insulating transformer should be adjusted for a balance

between the 115 volt bus voltage and the field discharge resistor voltage. Then relay (R) should be adjusted to pick-up with approximately 170 volts, 60 cycles, impressed across terminals 11 and 12, and to drop out at approximately 145 volts. These values will allow relay (R) to be picked up for approximately one-half of each of the first beat cycles, and they are used in the factory adjustment. The pickup and dropout adjustment probably can be made with sufficient accuracy entirely by means of the series adjustable resistor. However, if the dropout voltage is considerably different from 145 volts when the pickup voltage is 170 volts, it may be corrected by changing the initial pressure of the lower contact spring against the operating arm and changing the follow of the upper contact spring. If required, the position of the core and coil in the relay frame may be altered to change the air gap between the armature and the pole face.

With the voltage adjustments recommended for relay (R), the variation of the beat voltage between maximum and minimum allows ample voltage margin and time interval for relay (R) and the counting chain to respond to the beat voltage. However, if the initial voltage across the field discharge resistor should be less than 115 volts, the alternate connections shown at the bottom of Fig. 3 should be used. The potentiometer should be adjusted so that the voltage at the tap is equal to the initial voltage across the field resistor and the pickup and dropout voltages of relay (R) should be reduced accordingly. For example, if the initial voltage across the field resistor should be only 90 volts, the pickup and dropout voltages of relay (R) should be 90/115 of 170 and 145 volts, or approximately 133 and 114 volts respectively.

The function of the counting chain, relays (1), (2) and (3), may be checked by connecting terminals 9 and 10 to a 125 volt d. c. source and manually operating the armature of relay (R). On closing the armature of (R), relay (1) should pick-up; and on releasing the armature, relay (2) should pick up. On the second closing of relay (R), relay (3) should pick up and seal in.

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 contact material and thus impairing the contact.

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 coils of the various elements of the ND relay have the following burdens. The duty is momentary.

(R) element and Rectox . 7 v.a. at 230 (max) v. 60 cyc.
(P) element ..... 8 watts at 125 v. d.c.
(T) element ..... 5 watts at 125 v. d.c.
(1) and (3) elements . 3 watts at 125 v. d.c.
(2) element {in series with (1)}.. 0.8 watts at 62.5 v. d.c.