INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE CA-5 PERCENTAGE DIFFERENTIAL RELAY

FOR TRANSFORMER AND GENERATOR PROTECTION

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 CA-5 percentage differential relay is designed for the differential protection of generators or power transformers. It has one restraining element, with two windings, and one operating element which is energized thru an external auxiliary saturating current transformer in accordance with the current flowing in the differential connection of the main current transformers. Taps controlling the sensitivity of the relay are incorporated in the external transformer.

The application of the relay requires that the normal currents flowing through the restraining windings be of equal magnitude and correct phase relation. Figures 13 and 14 show the external connections to the Type CA-5 relay for a typical installation. The delta-star connections of the main current transformers provide the proper phase relations of the secondary currents for a star-delta power transformer. Since the relay does not have ratio taps, external current balancing auto transformers are required where the main current transformers do not provide equal secondary currents. Figures 15 and 16 show the external connections of the Type CA-5 relay for generator protection.

CONSTRUCTION AND OPERATION

The type CA-5 relay consists of a restraining element, with two restraining windings, an operating element, a contactor switch, and an operation indicator.

The relay operates on the induction-disc principle, with both electromagnets operating on the same disc. The disc is mounted on a vertical shaft. The lower bearing for the shaft is a steel ball riding between concave sapphire jewel surfaces. A pin bearing is used on the upper end of the shaft.

The moving contact assembly is attached to a Micarta bushing on the disc shaft. When the moving contact strikes the stationary contact, the moving contact spring deflects to provide a wiping action. The electrical connection from the moving contact is made thru the spiral spring to the spring adjuster.

The stationary contact is mounted on a right angle bracket fastened to the element frame thru a Micarta insulating block. A contact screw projects thru the outer end of the bracket and provides adjustable contact separation.

The front electromagnet is the restraining element, with two separate windings. The rear electromagnet is the operating electromagnet. These are connected as shown in Figs. 1 thru 3.

Figure 5 shows the current through the relay for external and internal fault conditions. With the relay connected as in Fig. 5A, a through fault causes currents to flow through the two restraining windings in the same direction. If the main current transformers operate properly, these restraining currents are equal, and no current flows in the auxiliary saturating transformer and operating coil

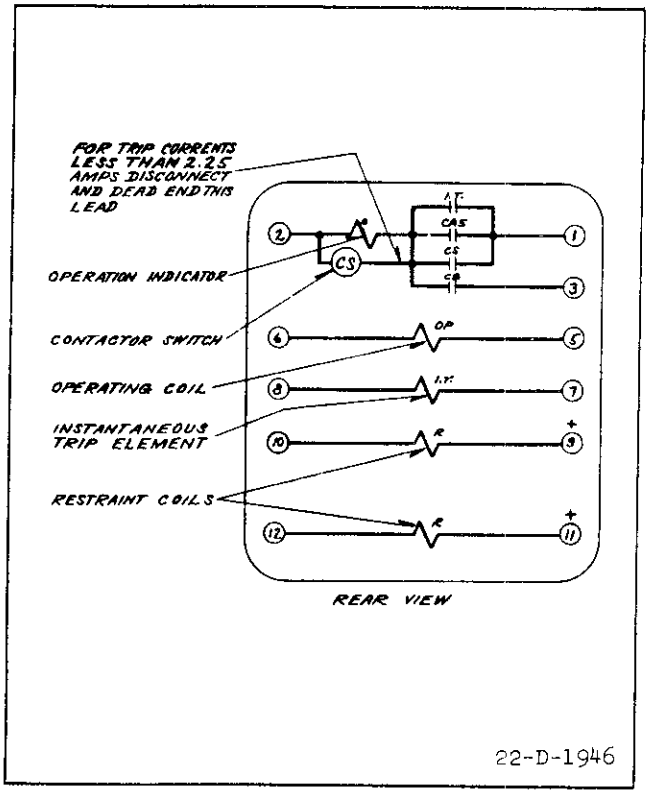
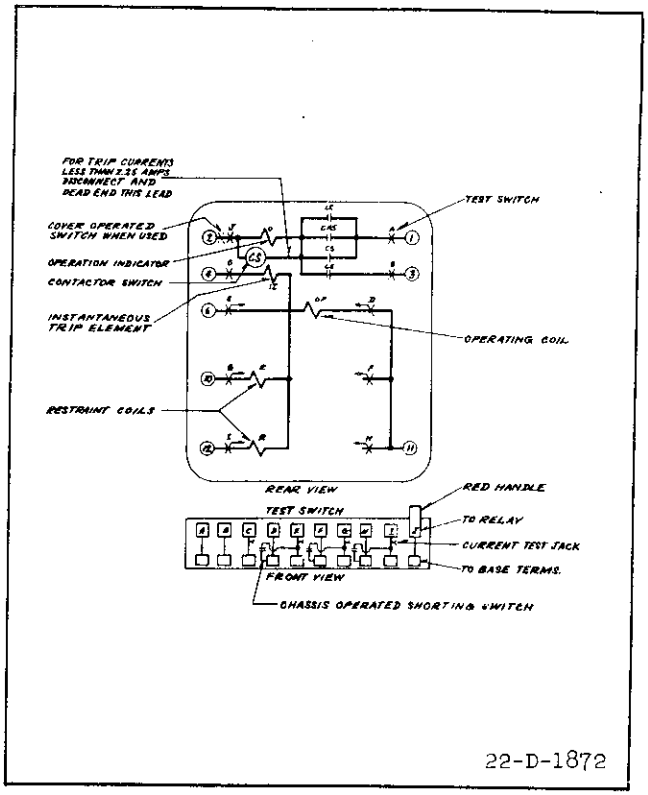
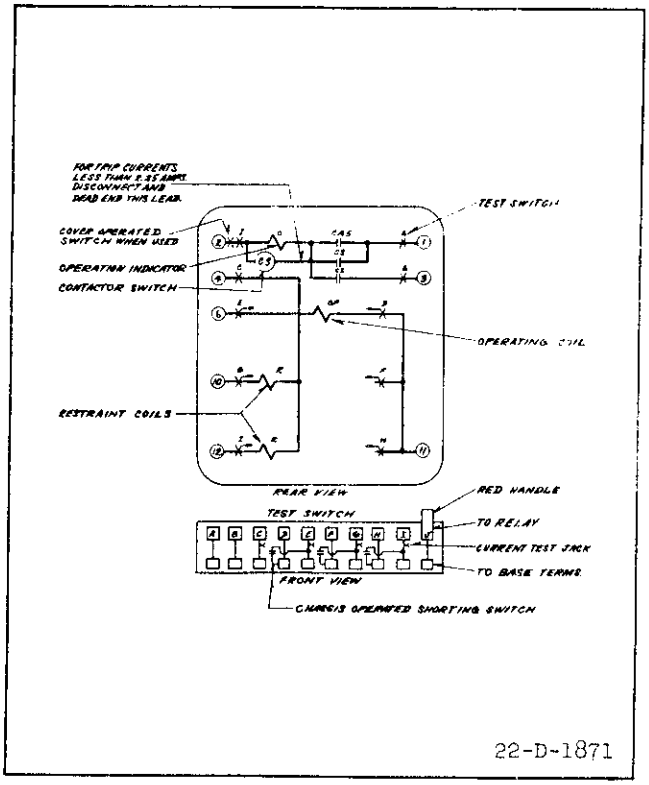


Fig. 1—Internal Schematic for the Type CA-5 Relay in the Standard Case.



* Fig. 2—Internal Schematic for the Type CA-5 Relay with Instantaneous Trip Attachment in the Type FT Case.



* Fig. 3—Internal Schematic for the Type CA-5 Relay Without Instantaneous Trip Attachment in the Type FT Case.

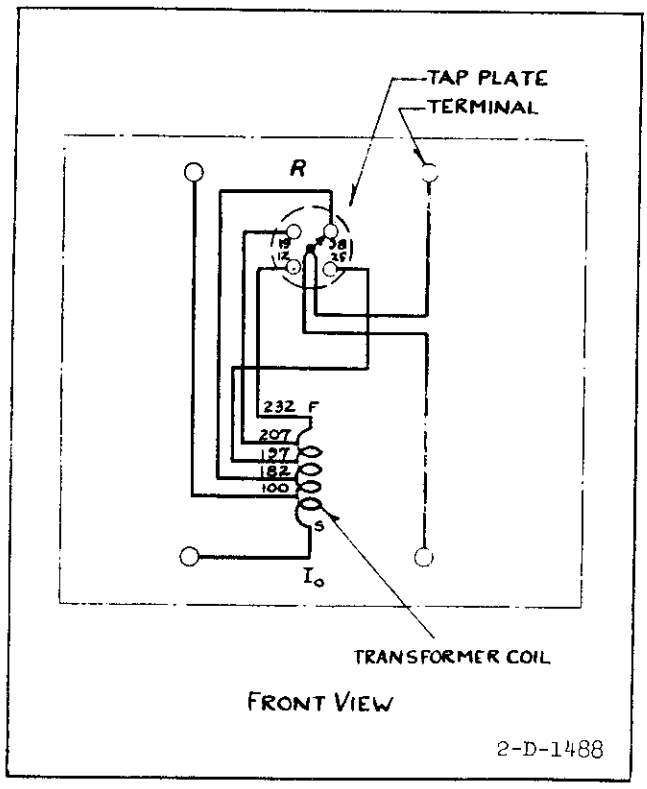


Fig. 4—Internal Schematic of the Auxiliary Adjusting Transformer.

winding. In this case, there will be only contact opening torque produced.

In the case of a heavy internal fault, when an external source feeds current into the fault, the restraining currents are in opposite directions, and restraining torque tends to cancel out as in Fig. 5B. When the currents fed from the two sides are equal the restraint is totally cancelled. When unequal currents flow in from the two sides, the restraint is equivalent to the difference in the two currents. In this case, the currents in the restraining windings will add together and go thru the operating winding, producing a contact closing torque. The operating curves for the relay are shown in Figs. 6 and 7.

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.

Instantaneous Trip (When Supplied)

The instantaneous trip attachment is a small solenoid type element. A cylindrical plunger rides up and down on a vertical guide rod in

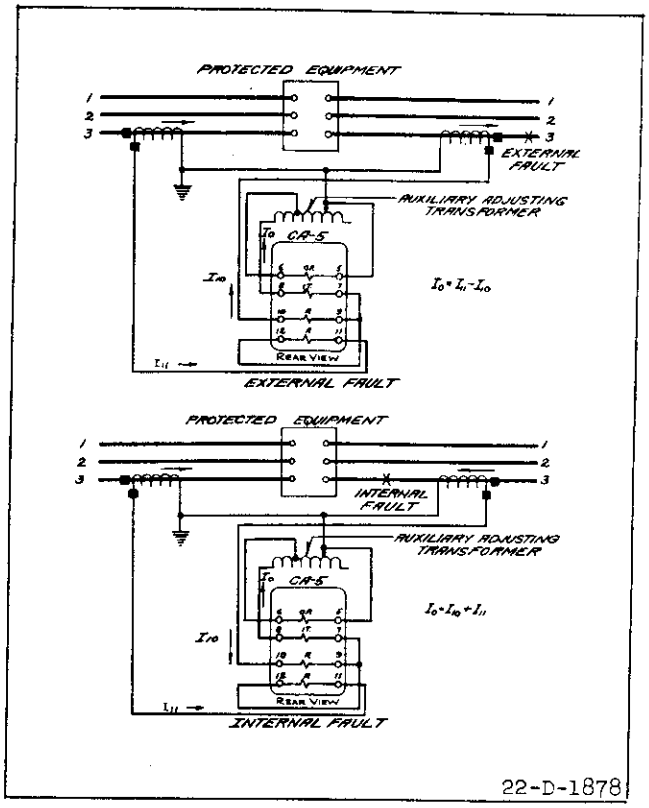


Fig. 5—Diagram Showing the Operation of the Type CA-5 Relay on External and Internal Faults.

the center of the solenoid coil. The guide rod is fastened to the stationary core, which in turn screws into the element frame. A silver disc is fastened to the moving plunger through a helical spring. When the coil is energized, the plunger moves upward carrying the silver disc which bridges three conical-shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact remains stationary. Thus, a-c vibrations of the plunger are prevented from causing contact bouncing. A Micarta disc screws on the bottom of the guide rod and is locked in position by a small nut. Its position determines the pick-up current of the element.

CHARACTERISTICS

The type CA-5 percentage differential relay is available in two designs: a relay with a minimum trip current of 0.14 amp. for generator protection and a relay with a range of adjustment of minimum trip current from 0.50 amp. to 2.0 amp. for transformer protection.

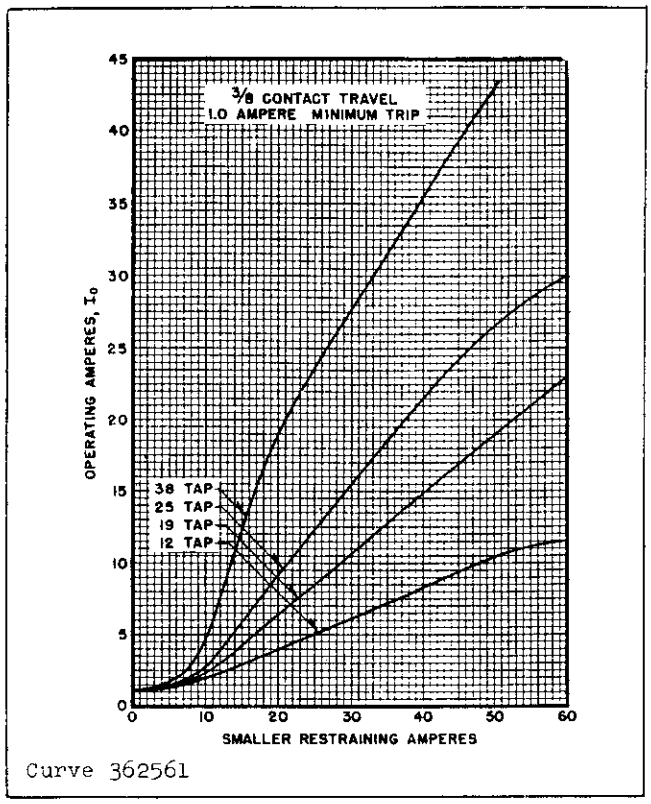


Fig. 6—Typical Operating Characteristics for the Type CA-5 Relay for Transformer Protection.

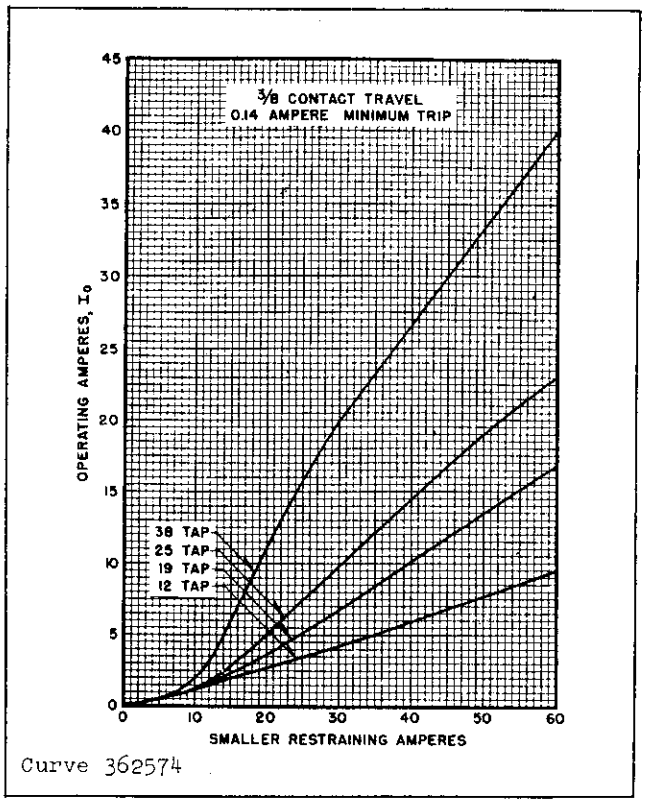


Fig. 7—Typical Operating Characteristics for the Type CA-5 Relay for Generator Protection.

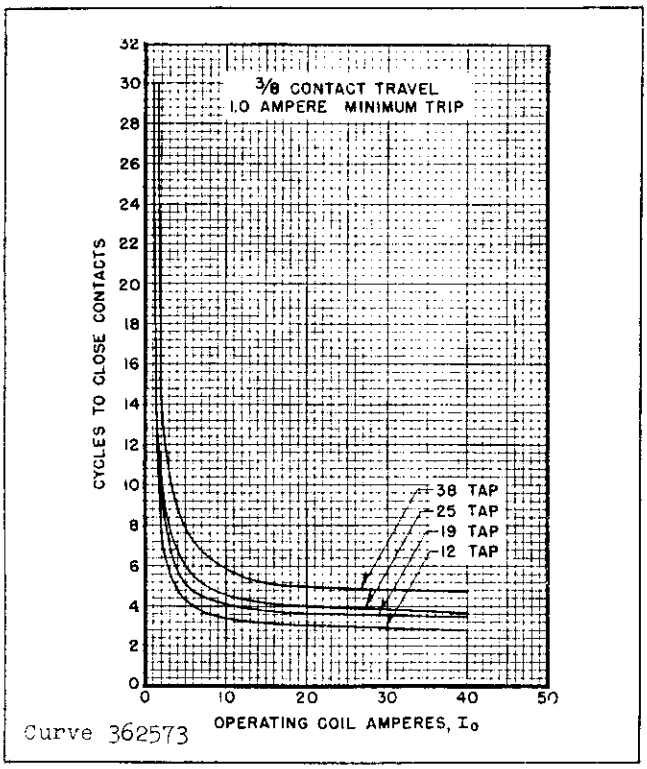


Fig. 8—Typical Time Curves of the Type CA-5 Relay for Transformer Protection.

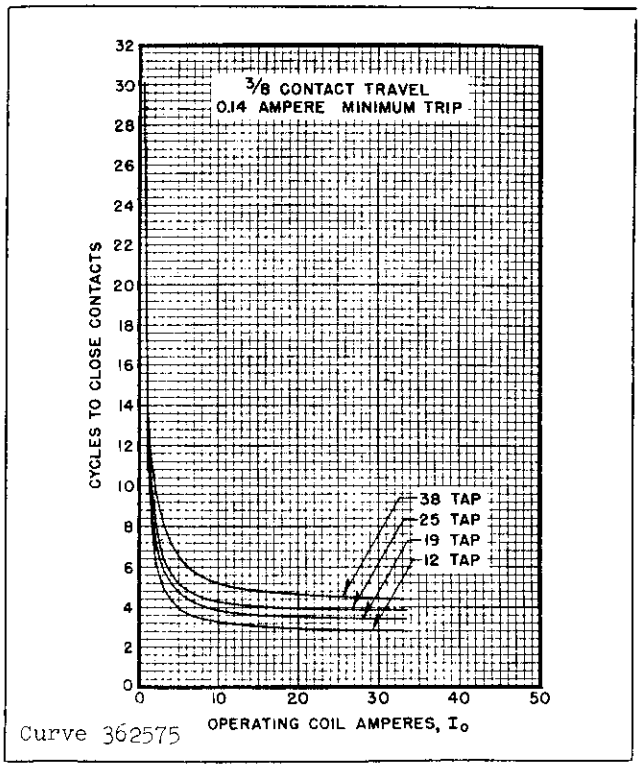


Fig. 9—Typical Time Curves of the Type CA-5 Relay for Generator Protection.

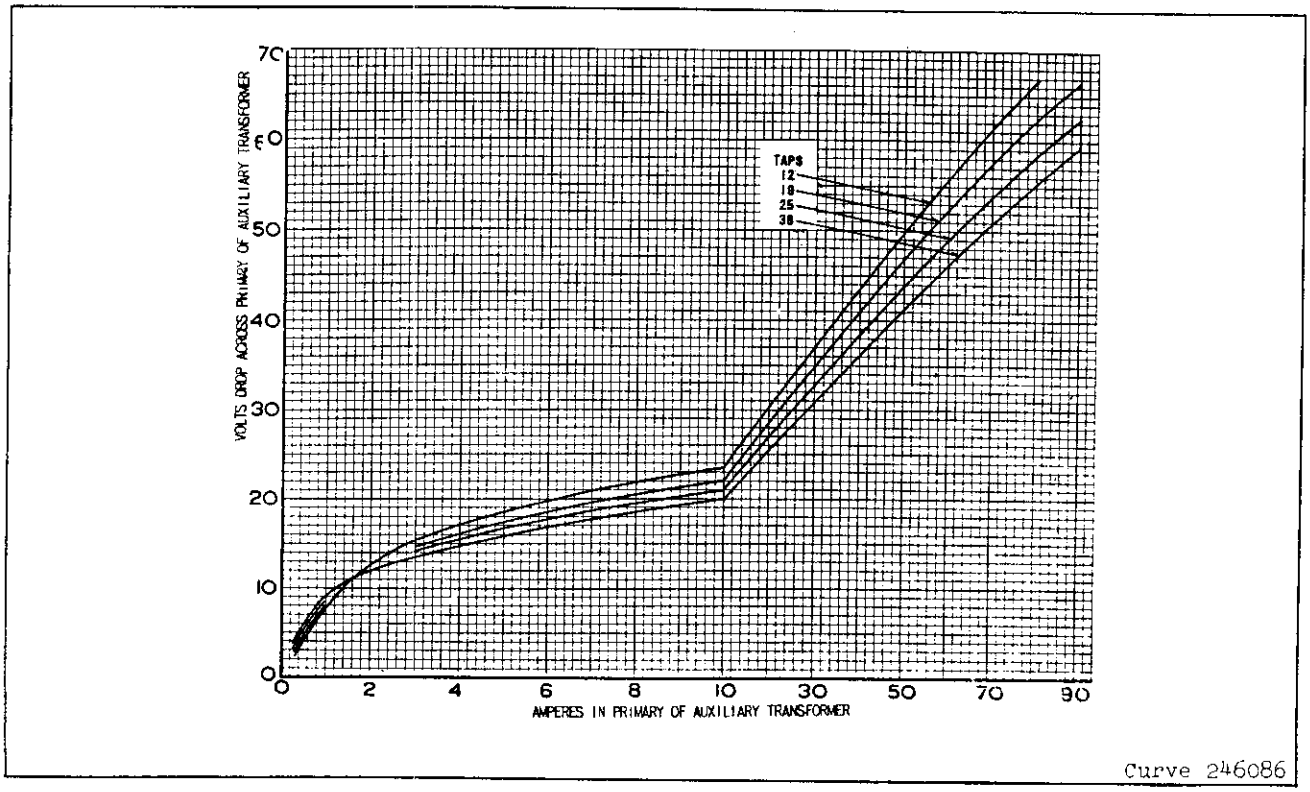


Fig. 10—Typical Burden Curves of the Operating Coil Circuit of the Type CA-5 Relay.

The relay has variable percentage characteristics which means that the operating coil current required to close the relay contacts, expressed in per cent of the total restraint current, varies with the magnitude of the restraint current. The relay sensitivity is high, corresponding to a low percentage ratio, at light internal faults in the transformer bank being protected. At the same time, however, its reduced sensitivity at the higher currents allows the various current transformers involved to depart from their true ratio to a large extent without causing false tripping of the relay for external faults.

Figures 6 and 7 show typical operating curves for the relay, on each of the four taps. Typical time of operation curves are shown in Figure 8 and 9.

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 indicator will operate for trip currents above 0.2 ampere d-c. The resistance of this coil is approximately 2.8 ohms.

The main contacts will safely close 30 amperes at 250v. d-c, and the switch contacts will safely carry this current long enough to trip a breaker.

SETTINGS

Each type relay is designed for a specific sensitivity and hence once the correct relay is chosen for a given application, no adjustment is necessary. If necessary, the tension controlling minimum operating current may be altered slightly.

In general, a study of the current transformer characteristic curves under short circuit conditions should indicate which tap setting, on the auxiliary transformer, should be used.

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 cleaned periodically. A contact burnisher S#182A836H01 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.

Adjust the top bearing screw to have approximately .002" clearance between it and the shaft. Adjust the stationary contact so that 3/8 inch contact separation is obtained when the moving contact is held in the maximum open position.

The tension of the spiral spring should be adjusted so that the required minimum trip operation is obtained with current flowing thru the operating coil circuit and one restraining coil.

The polarity of the restraining coils, as indicated on the wiring diagram, Figure 1, should be checked if any rewiring has been done.

The relay percentage characteristics may be checked by means of the test circuit of Figure 11 or 12. In these tests, readings should be taken with the relay and transformer cold. Heating of the restraining circuits due to normal current flow has very little effect on the relay characteristics. However, the operating circuit normally carries no current so it is important to prevent overheating of the operating coil or auxiliary transformer during test.

Instantaneous Trip Attachment

The position of the Micarta disc at the bottom of the element with reference to the calibrated guide indicates the minimum overcurrent required to operate the element. The disc should be lowered or raised to the proper position by loosening the lock nut and rotating the Micarta disc. The nominal range of adjustment is 1 to 4; for example, 10 to 40 amperes, and it has an accuracy of about 10%.

The drop-out value is varied by raising or lowering the core screw at the top of the switch, and after the final adjustment is made, the core screw should be securely locked in place with the lock nut. The drop-out should be adjusted for about 2/3 of the minimum pick-up. Adjusting the drop-out will slightly effect the value of pick-up.

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 burden of each restraining coil is .75 volt-amperes, 70% power factor at 5 amperes, 60 cycles. The burden of the operating coil

circuit, including the external adjusting transformer is variable, depending upon the current flowing thru it. Under normal system operation it introduces no burden at all in the current transformer circuit because of the fact that no current flows in the differential circuit. Under minimum tripping conditions, the burden of the operating coil circuit varies from 7 to 9 ohms at approximately 90°) lag, depending upon the tap. Under maximum internal fault conditions, when all of the current must flow thru the operating coil, the burden is reduced to approximately 1 ohm, because of saturation. Figure 10 shows the variation in burden of the operating coil circuit for different current values.

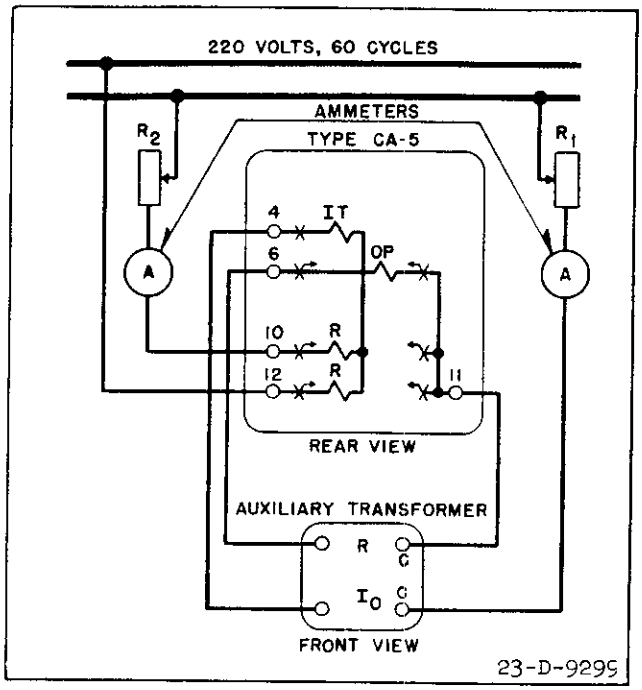


Fig. 11—Diagram of Test Connections for the Type CA-5 Relay in the Type FT Case.

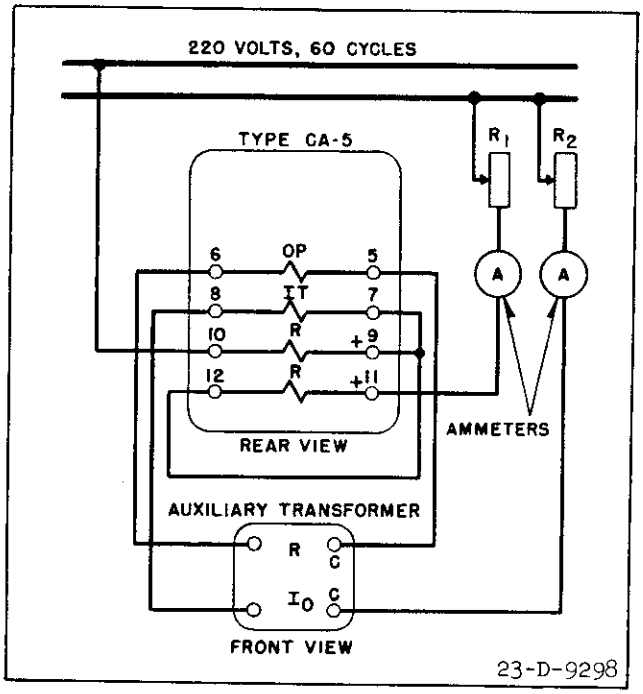


Fig. 12—Diagram of Test Connections for the Type CA-5 Relay in the Standard Case.

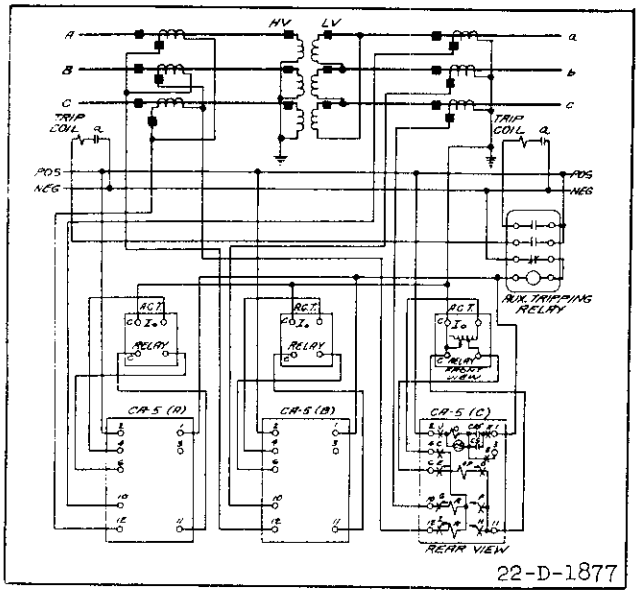


Fig. 13—External Connections of the Type CA-5 Relay in the Type FT Case for the Differential Protection of a Star-Delta Transformer Bank.

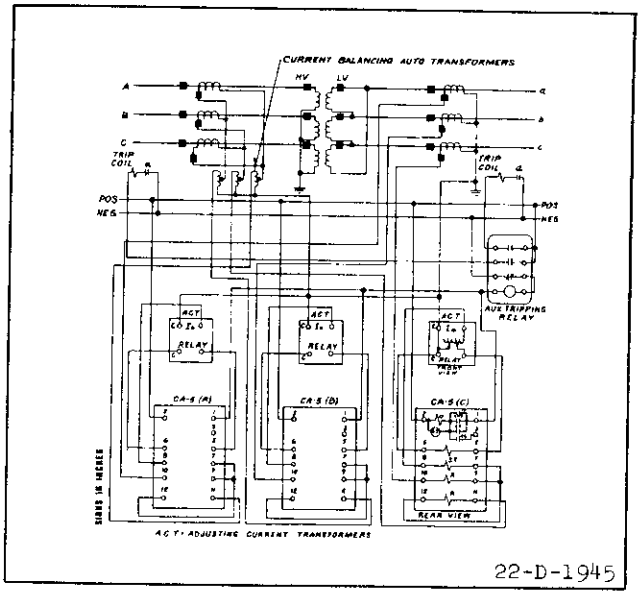


Fig. 14—External Connections of the Type CA-5 Relay in the Standard Case for the Differential Protection of a Star-Delta Transformer Bank.

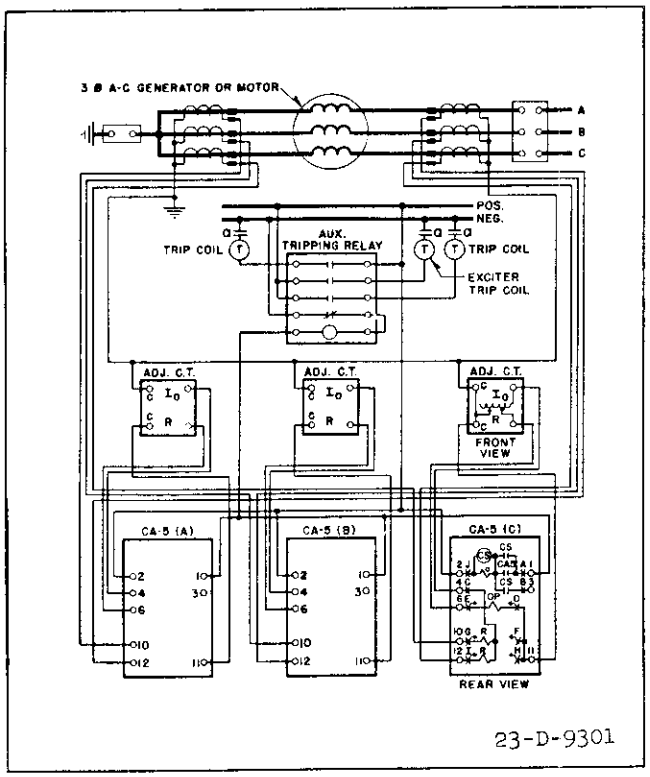


Fig. 15—External Connections of the Type CA-5 Relay in the Type FT Case for the Differential Protection of a Generator.

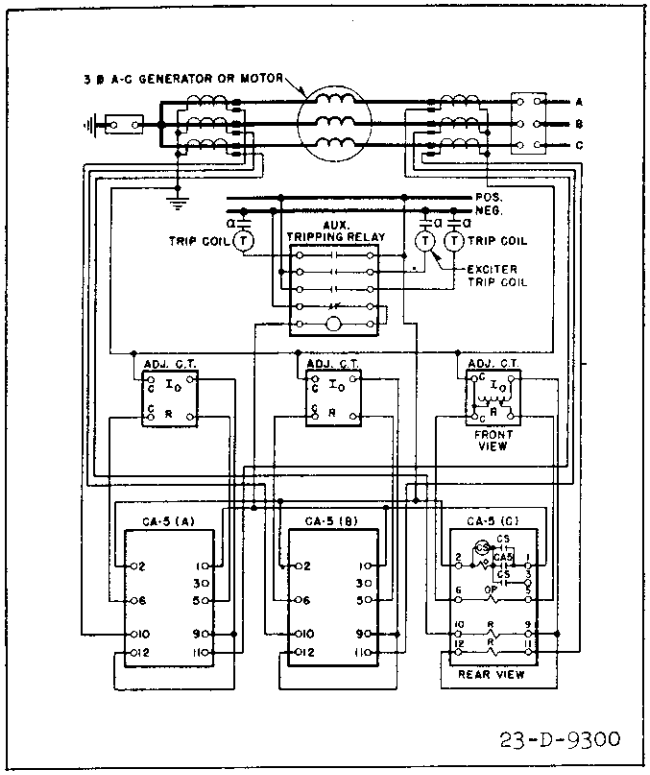


Fig. 16—External Connections of the Type CA-5 Relay in the Standard Case for the Differential Protection of a Generator.

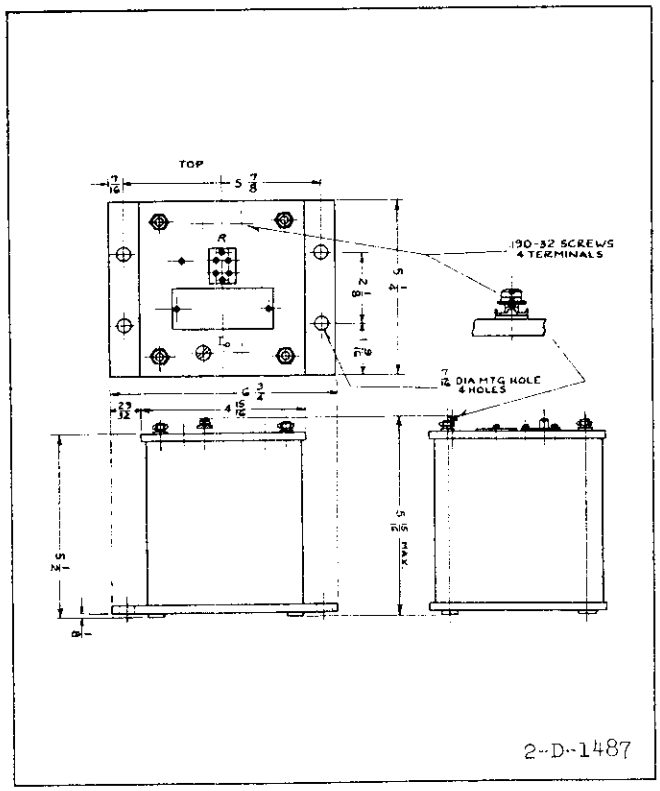


Fig. 17—Outline and Drilling Plan for the Auxiliary Adjusting Transformer. For Reference Only.

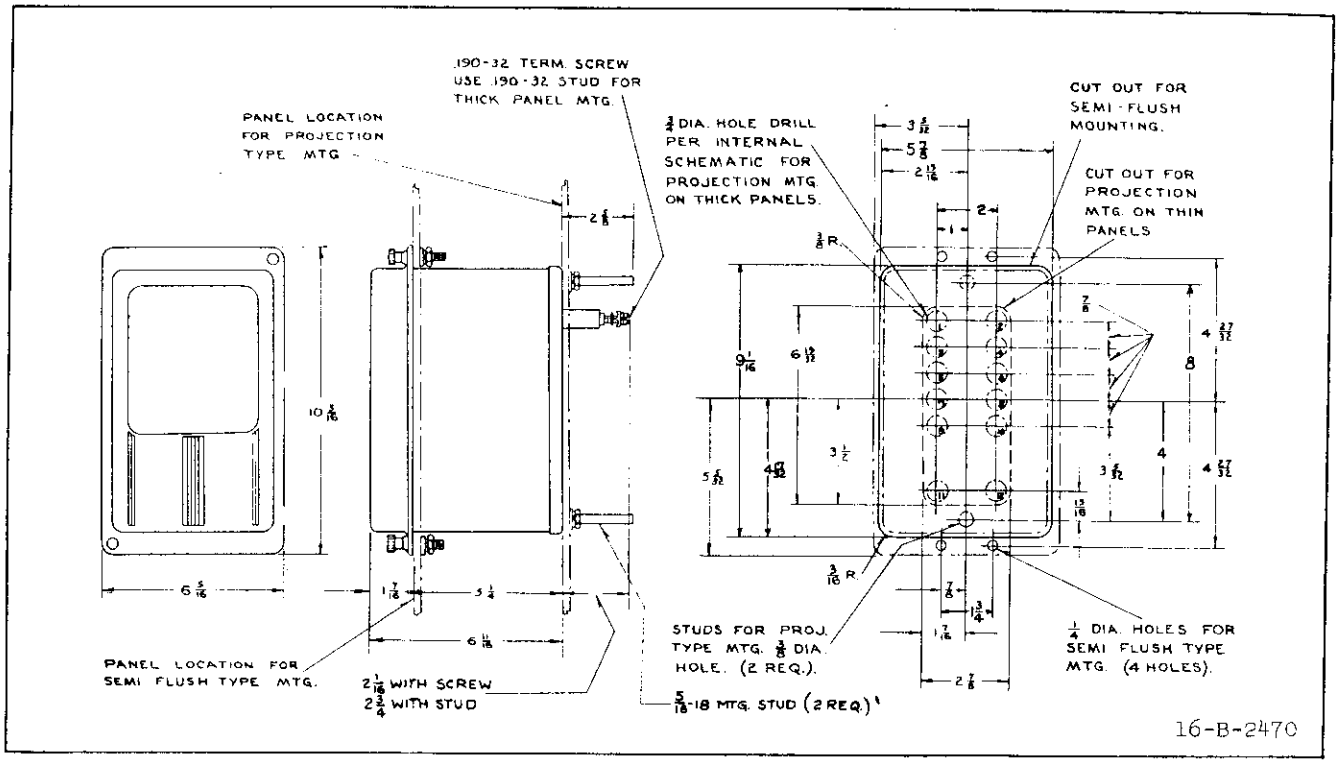


Fig. 18—Outline and Drilling Plan of the S-10 Semi-Flush in the Projection Type **FT** Flexitest Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

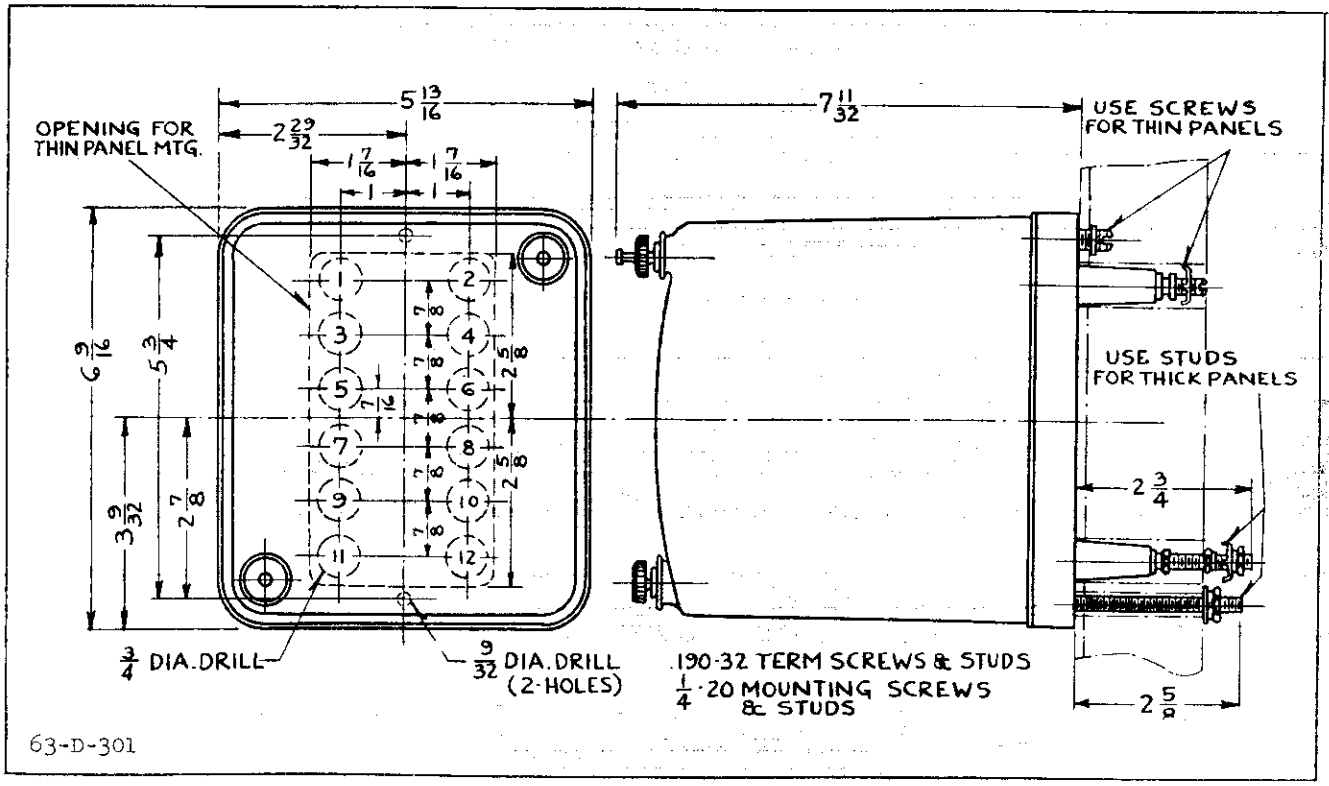


Fig. 19—Outline and Drilling Plan of the Projection Type Standard Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.