Instruction Leaflet
41-331.21

Type CA
Percentage Differential Relay
For Generator Protection

Class 1E Application

Effective: May 1980
NEW INFORMATION

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 percentage differential relay is designed for the differential protection of rotating ac machinery such as generators, motors and frequency changers.

These relays have been specially designed and tested to establish their suitability for Class IE applications. Materials have been selected and tested to insure that the relays will perform their intended function for their design life when operated in a normal environment as defined by ANSI standard C37.90-1971, when exposed to radiation levels up to 10^4 rads, and when subjected to seismic events producing a Shock Response Spectrum within the limits of the relay rating.

"Class IE" is the safety classification of the electric equipment and systems in nuclear power generating stations that are essential to emergency shutdown of the reactor, containment isolation, cooling of the reactor, and heat removal from the containment and reactor, or otherwise are essential in preventing significant release of radioactive material to the environment.

CONSTRUCTION

The type CA relay consists of a percentage differential unit and an indicating contactor switch. The principal component parts of the relay and their locations are shown in Fig. 1-3.

Percentage Differential Unit

This unit is an induction disc unit with an electromagnet that has poles above and below the disc as shown in Fig. 2. Two restraint coils are placed on the lower left-hand pole (front view) and are connected in series. Their junction point is connected to the operating coil wound on the lower right-hand pole. A transformer winding is supplied on both the left and right hand poles and these are connected in parallel to supply current to the upper pole windings. The upper pole current generates a flux which is in quadrature with the lower pole resultant flux, and the two fluxes react to produce a torque on the disc. If the operating winding is energized, this torque is in the contact closing direction; if current flows through the two restraining winding in the same direction a contact opening torque is produced.

Indicating Contactor Switch Unit (ICS)

The dc indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also during the operation two fingers on the armature deflect a spring

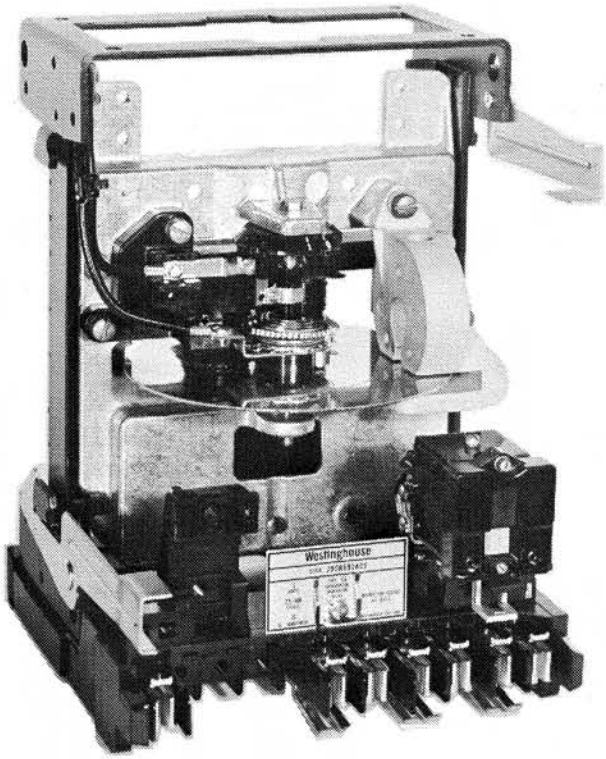

Fig. 1. Type CA Generator Relay (front view)

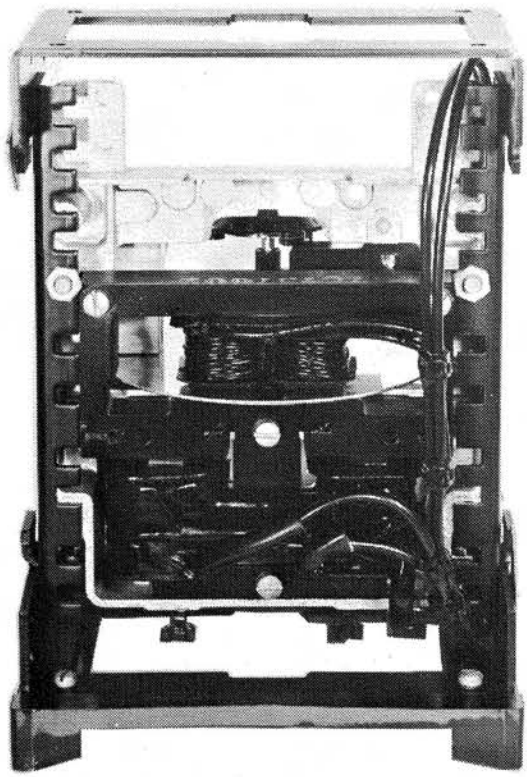

Fig. 2. Type CA Generator Relay (rear view)

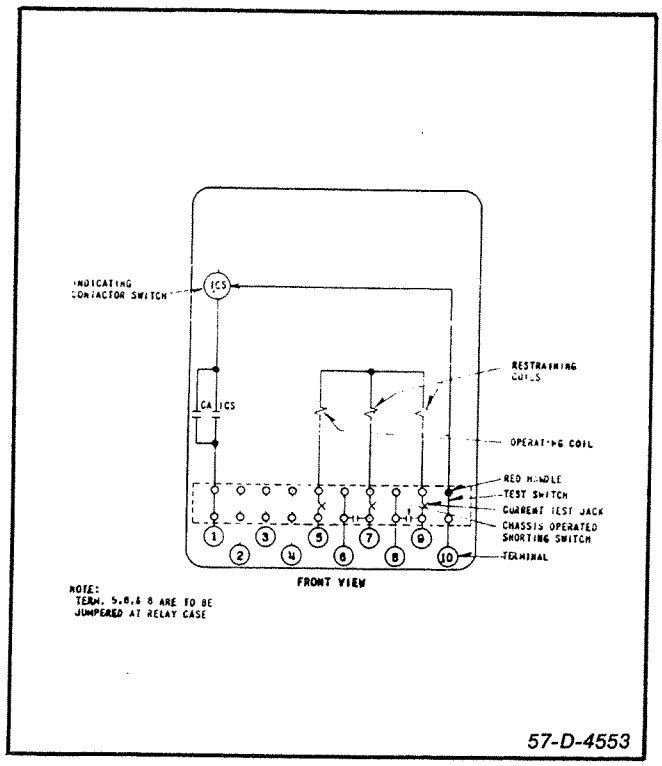

Fig. 3. Internal Schematic of the 10% or 25% type CA generator relay in type FT21 Case.

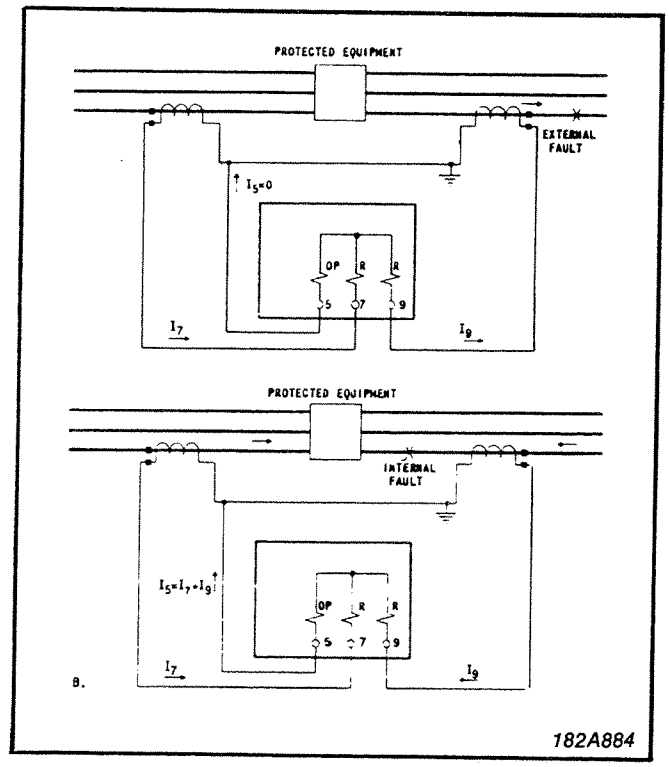

Fig. 4. Schematic diagrams of the percentage differential relays (A) shows the fault current distribution for an external fault; (B) the distribution for an internal fault.

located on the front of the switch which allows the operation indicator target to drop. The target is reset from the outside of the case by a push rod located at the bottom of the cover.

The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pick-up value of the switch.

OPERATION

With the relay connected as in the schematic diagram Fig. 4A, a through fault causes currents to flow through two restraint windings in the same direction.

If the current transformers operate properly, these restraining currents are equal and no current flows in the operating coil winding, and hence only contact opening torque is produced. If the currents in the two restraining windings are unequal, the difference must flow in the operating coil. The operating coil current required to overcome the restraining torque and close the relay contacts is a function of restraining current.

In the case of 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 illustrated in Fig. 4B. 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, divided by two, but since the more sensitive operating coil is energized by the sum of the two currents, the restraint in this case is inconsequential, and a large amount of closing torque is produced.

CHARACTERISTICS

The type CA generator relay is available in two designs: One for 10% sensitivity and the other for 25% sensitivity.

The operating curves for the 10% and 25% type CA generator relays are shown in Fig. 5 and 6, respectively. For the 10% relay, 10% of the smaller restraint current must flow in the operating coil to cause tripping when the restraining currents are in

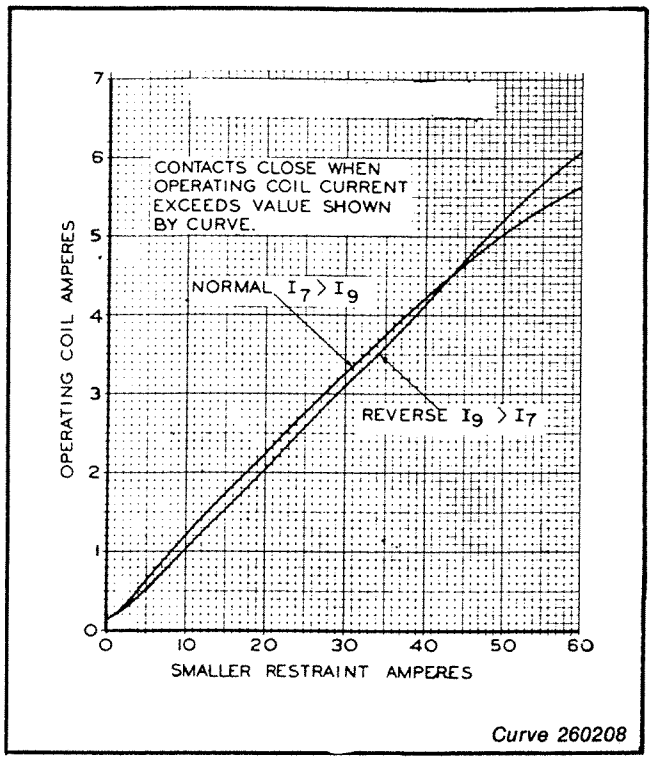

Fig. 5. Typical operating curves for the 10% sensitivity type CA generator relay.

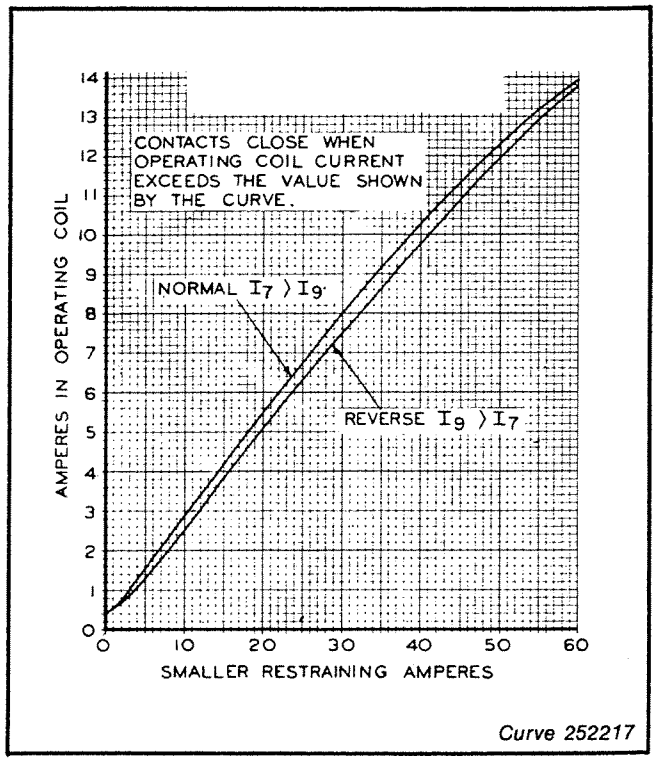

Fig. 6. Typical operating curves for the 25% sensitivity type CA generator relay.

phase. Similarly, 25% of the smaller restraint current is required to cause the 25% relay to close contacts.

Fig. 7 and 8 shows the operating curves for both relays with the restraint currents 180° out of phase. These curves also apply when current flows in only one restraint coil and the operating coil.

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts dc and the seal-in contacts of the indicating contactor switch will safely carry this current long enough to trip a circuit breaker.

Trip Circuit Constant

Indicating Contactor Switch (ICS)

0.2 Amp Rating	8.5 Ohms dc
1.0 Amp Rating	0.37 Ohms dc
2.0 Amp Rating	0.10 Ohms dc

ENERGY REQUIREMENTS

The 60 cycle burdens of the 10% and 25% sensitivity type CA relay are best given in curve form, as illustrated by Figs. 9, 10, and 11.

The restraining windings of either relay have a continuous rating of 10 amperes. The operating winding of the 10% relay has a continuous rating of 2.5 amperes and 1 second rating of 70 amperes. The operating winding of the 25% relay has a continuous rating of 5 amperes and a 1 second rating of 140 amperes.

SETTINGS

One setting is required for the percentage differential unit; that is, the setting of the time dial. This setting should be on the number 1 position.

Each type 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 spring tension controlling minimum operating current may be altered slightly.

In general, for generator protection, a study of the current transformer characteristic curves un-

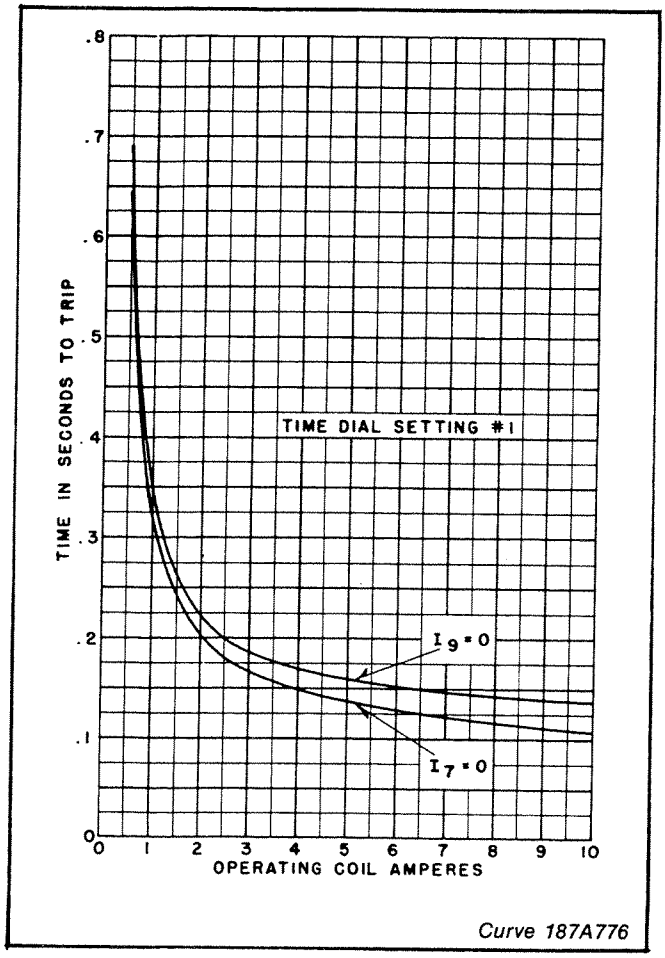

Fig. 7. Typical time curves for the 10% sensitivity type CA generator relay.

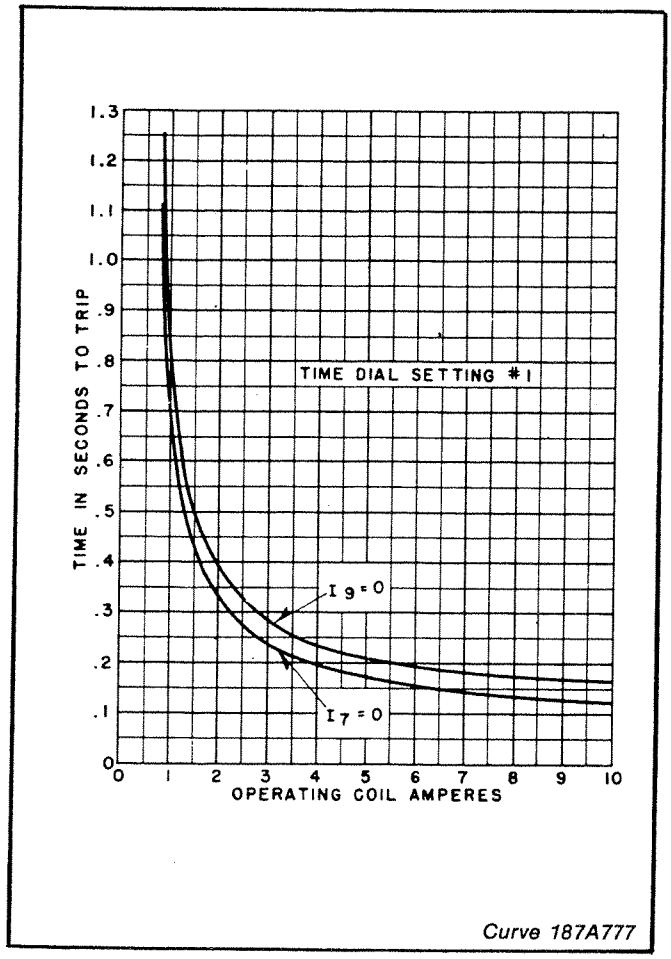

Fig. 8. Typical time curves for the 25% sensitivity type CA generator relay.

der short circuit conditions should indicate whether the high sensitivity (10%) or the low sensitivity (25%) relay should be used. Use the 25% relay, if ac saturation causes more than 1% ratio error in either set of CT's.

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 four mounting holes on the flange for the semi-flush type FT case. The mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outline and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws and the relay panel. Ground Wires are affixed to the mounting screws as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting.

For detail information on the FT case refer to I.L. 41-076 for semi-flush mounting.

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.

Acceptance Tests

The following check is recommended to insure that the relay is in proper working order.

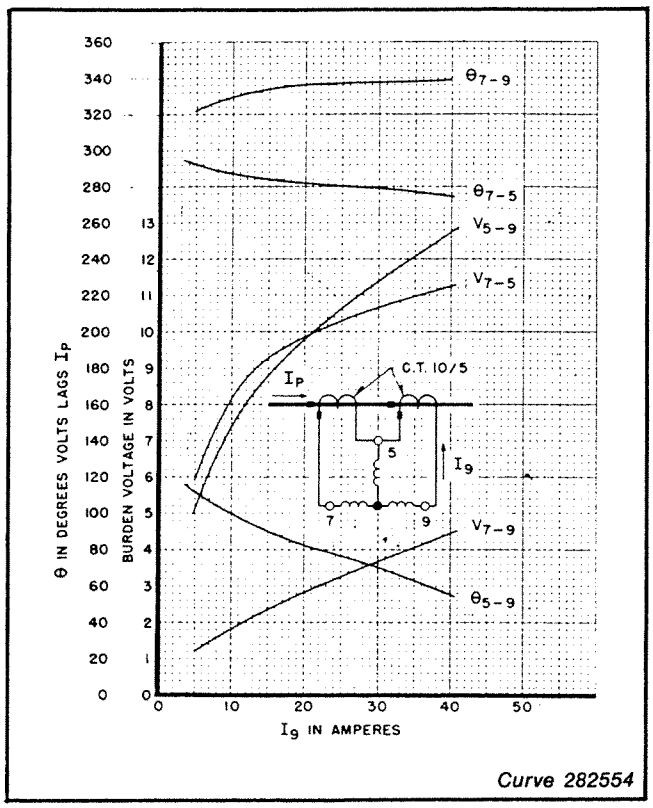

Fig. 9. Typical 60 cycles burden curves for the 10% sensitivity type CA generator type.

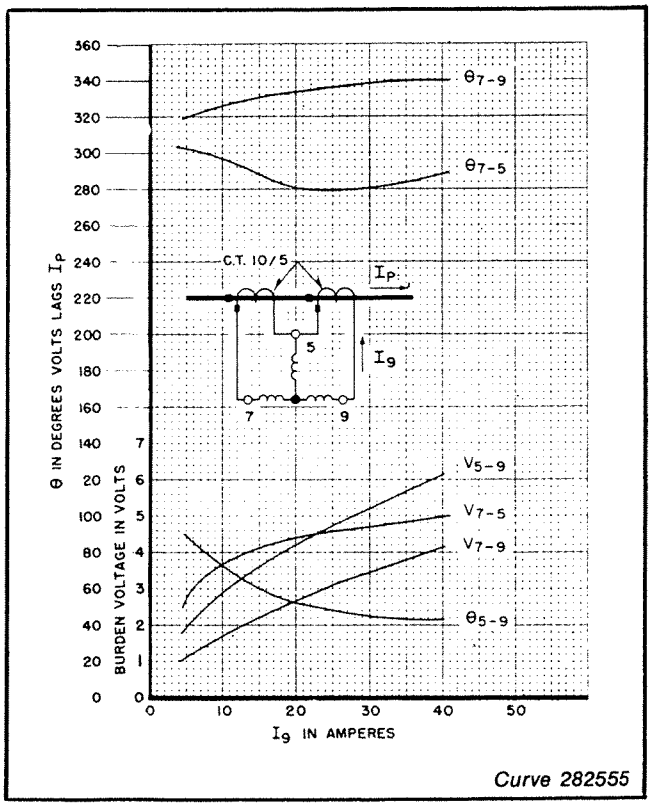

Fig. 10. Typical 60 cycle burden curves for the 25% sensitivity type CA generator relay.

1. Contact

The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020 inch. The placement of the one time dial position in line with the index mark will give operating times as shown on the respective time-current curves. For double trip relays, the follow on the stationary contacts should be approximately 1/32 inch.

2. Minimum Trip Current

With current applied to terminals 9 and 5 of the relay, the contacts should close within the following limits:

10% Sensitivity Relay	0.17 to 0.19 Amps
25% Sensitivity Relay	0.42 to 0.47 Amps

3. Differential Characteristics

Connect the relay per test circuit of Fig. 12. (Normal connection). With 20 amperes applied to terminal 9 (meter A), the relay should operate between following limits:

10% Sensitivity Relay	2.14 to 2.36 Amps
25% Sensitivity Relay	5.2 to 5.8 Amps

The above points should be taken with the relay cool. Care should be taken not to overheat the relay.

Reverse connections to terminals 7 and 9 and apply 20 amperes to terminal 7 (meter A). The relay should operate between the following limits:

10% Sensitivity Relay	1.9 to 2.15 Amps
25% Sensitivity Relay	4.8 to 5.4 Amps

4. Time Curve

With the time dial on the number 1 position

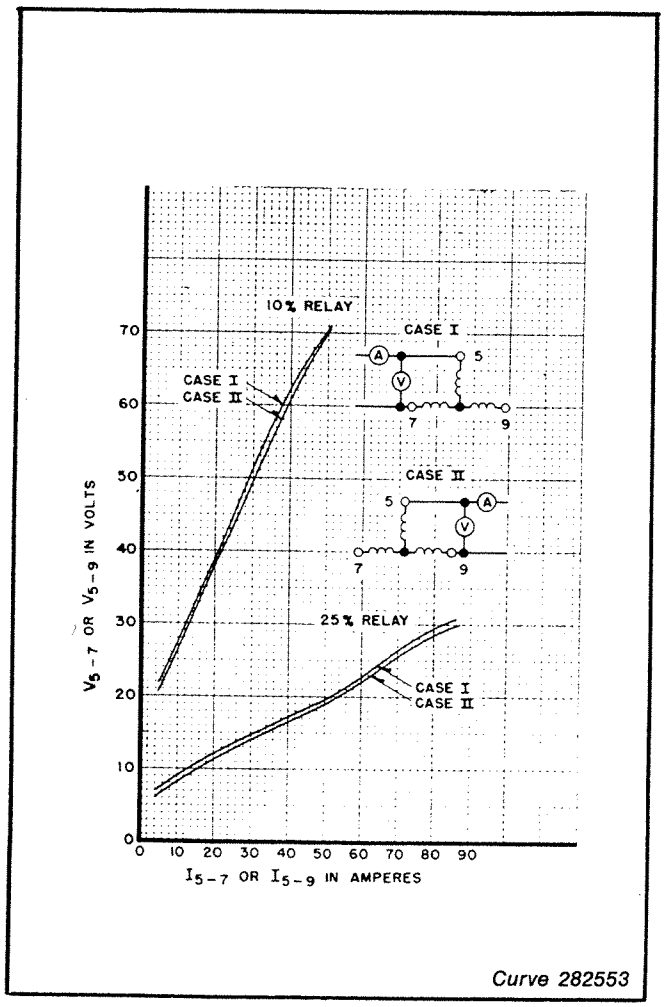

Fig. 11. Typical 60 cycle saturation curves for the type CA generator relay.

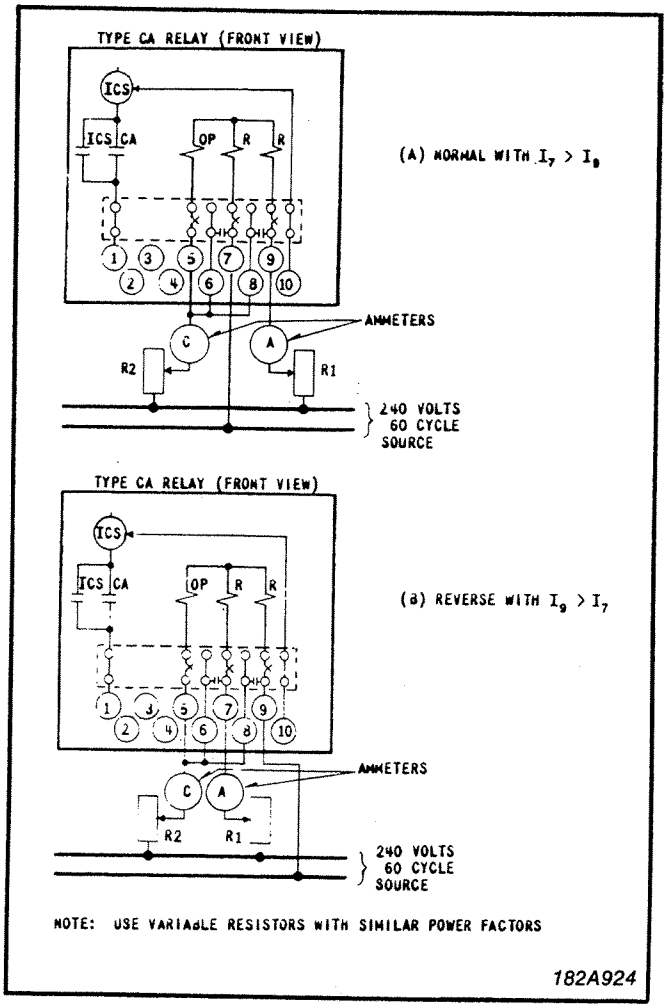

Fig. 12. Diagrams of test connections for the type CA generator relay in the type FT21 Case.

apply 10 amperes to terminals 9 and 5. The relay should operate within the following times:

10% Sensitivity Relay	0.098 to 0.112
25% Sensitivity Relay	0.115 to 0.128

Indicating Contractor Switch (ICS) – Close the main relay contacts and pass sufficient dc current through the trip circuit to close the contacts of the ICS. This value of current should not be greater than the particular ICS nameplate rating. The indicator target should drop freely.

Repeat above except to pass 85% of ICS nameplate rating current. Contacts should not pick up and target should not drop.

Routine Maintenance

All relays should be checked at least once every year or at such other time intervals as may be dictated by experience to be suitable to the particular application.

All contacts should be periodically cleaned. 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.

CALIBRATION

Use the following procedure for calibrating the

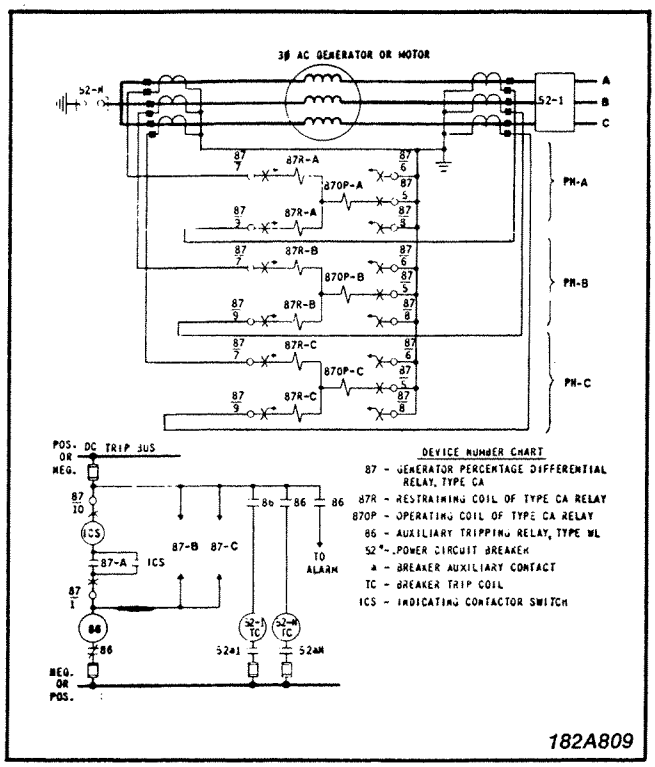

Fig. 13. External schematic diagram of the type CA generator relay in the type FT21 Case for phase and ground protection of the AC generators and motors.

relay if the relay has been taken apart for repairs or the adjustments disturbed. This procedure should not be used until it is apparent that the relay is not in proper working order (See "Acceptance Check").

1. Contact

The index mark on the movement frame will coincide with the "O" mark on the time dial when the stationary contact has moved through approximately one-half of its normal deflection. Therefore, with the stationary contact resting against the backstop, the index mark is offset to the right of the "O" mark by approximately .020". The placement of the one time dial position in line with the index mark will give operating times as shown on the respective time current curve. For double trip relays, the follow on the stationary contacts should be approximately 1/32".

2. Minimum Trip Current

The adjustment of the spring tension in setting the minimum trip current value of the relay is most conveniently made with the damping magnet removed.

Apply current to terminals 9 and 5 of the relay and adjust the control spring tension so that the moving contact just closes between the following limits.

10% Sensitivity Relay	0.175 to 0.185 Amps
25% Sensitivity Relay	0.44 to 0.46 Amps

3. Percentage Slope Characteristic

Points on the percentage slope curve can be checked by use of the test circuit of Fig. 12. The operating current required to operate the relay should be within ± 7% of the curve value. Care should be taken not to overheat the relay during these tests.

4. Time Curve

Place the permanent magnet on the relay and set the time dial at the number 1 position. Adjust the permanent magnet keeper until the contacts close in the following times with 10 amperes applied to terminals 9 and 5.

10% Sensitivity Relay	0.100 to 0.110 Sec.
25% Sensitivity Relay	0.118 to 0.125 Sec.

5. Indicating Contactor Switch (ICS)

Initially adjust unit on the pedestal so that armature fingers do not touch the yoke in the reset position. This can be done by loosening the mounting screw in the molded pedestal and moving the ICS in the downward position.

1. **Contact Wipe.** Adjust the stationary contacts so that both stationary contacts make with the moving contacts simultaneously and wipe 1/64" to 3/64" when the armature is against the core.

Note - Use for double trip type only -

Adjust the third contact so that is makes with its stationary contacts at the same time as the two main contacts or up to 1/64" ahead.

2. **Target.** Manually raise the moving contacts and check to see that the target drops at the same time as the contacts make or up to 1/16" ahead. The cover may be removed and the tab holding the target reformed slightly if necessary. However care should be exercised so that the target will drop with a slight jar.

3. **Pickup.** Unit should pickup at 98% of rating and not pickup at 85% of rating. If necessary the cover leaf springs may be adjusted. To lower the pickup current, use a tweezer or similar tool and squeeze each leaf spring approximately, equal, by applying the tweezer between the leaf spring and the front surface of the cover at the bottom of the lower window.

   If the pickup is low the front cover must be removed and the leaf springs bent outward equally.

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.

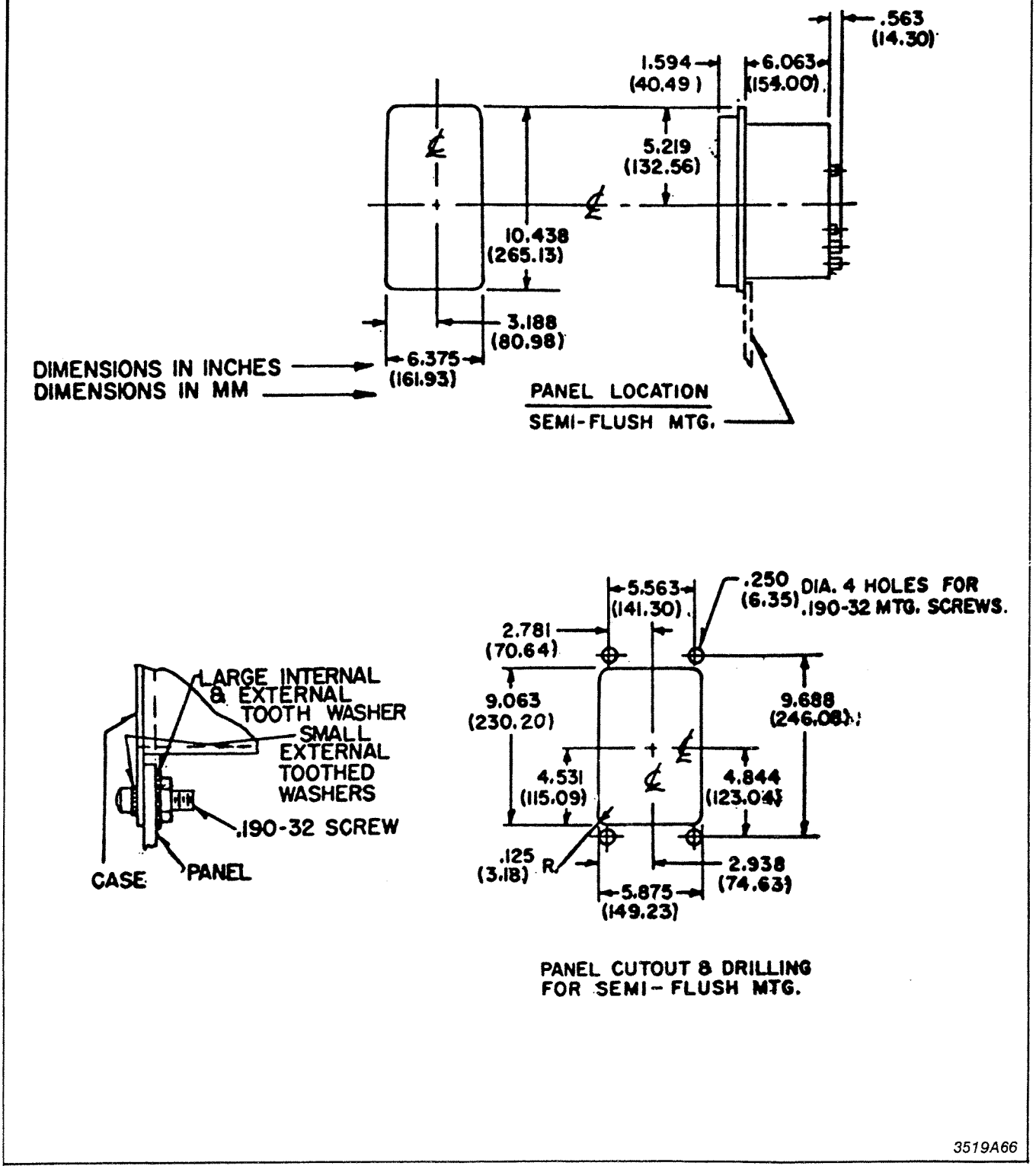

Fig. 14. Outline and drilling for the type CA generator relay in the type FT21 Case.

NOTES

IL 41-331.21 - New Information

ABB Inc.

4300 Coral Ridge Drive
Coral Springs, Florida 33065

Telephone: +1 954-752-6700
Fax: +1 954-345-5329

www.abb.com/substation automation