Instruction Leaflet
41-181.21B

Type CM Phase Balance Current Relay

Class 1E Application

Effective: March, 2007
Supersedes 41-181.21A Dated April, 1982
(|) Denotes Change Since Previous Issue
Device Number: **46**

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 all moving parts operate freely. Inspect the contacts to see they are clean and close properly, operate the relay to check the settings and electrical connections. Verify all tap screws are tightened.

1.0 APPLICATION

CM Relays have been specially designed and tested to establish their suitability for Class 1E application in accordance with the ABB program for Class 1E Qualification Testing as detailed in the ABB bulletin STR-1.

"Class 1E" is the safety classification of electric equipment and systems in nuclear power generating stations that are essential to emergency shutdown of the reactor. An emergency reactor shutdown involves containment isolation, reactor core cooling, and reactor core heat removal, which are necessary in preventing significant release of radioactive material into the environment.

The type CM relay is an induction type relay designed to protect polyphase electrical machinery against phase unbalance or phase failure.

As shown in Figure 7, the relay may be used with either three or two current transformers (CT's). With three CT's, the accuracy class must be at least C50; with two CT's the accuracy class must be at least C70. Otherwise, CT errors during motor starting may cause undesired CM tripping.

2.0 CONSTRUCTION & OPERATION

The type CM relay consists of two main current units with their associated resistor and an Indicating Contactor Switch (ICS).

The principal component parts of the relay and their location are shown in Figures 1 and 2.

2.1 Main Unit

Each main unit has a pair of electromagnets operating on a single disc. The disc is damped by a permanent magnet. Each disc carries its own set of contacts with the two sets being connected in parallel, in order that either disc may close the trip circuit.

The electromagnet pair are mounted face to face on opposite sides of the disc, and connected so that the electrical torque of one electromagnet opposes that of the other, thus producing balanced operating torque on the disc when the magnitudes of the currents through each of the two electromagnets are equal. One of the electromagnets on the lower disc is connected in series with one of the electromagnets on the upper disc.

Thus, phase A current may balance phase B current on the upper disc, and phase B current balance phase C current on the lower disc. Consequently, with balanced system conditions, no operating torque is produced on the two discs; but with unbalanced conditions or with an open phase the balance on the disc is upset and one or two sets of contacts close.

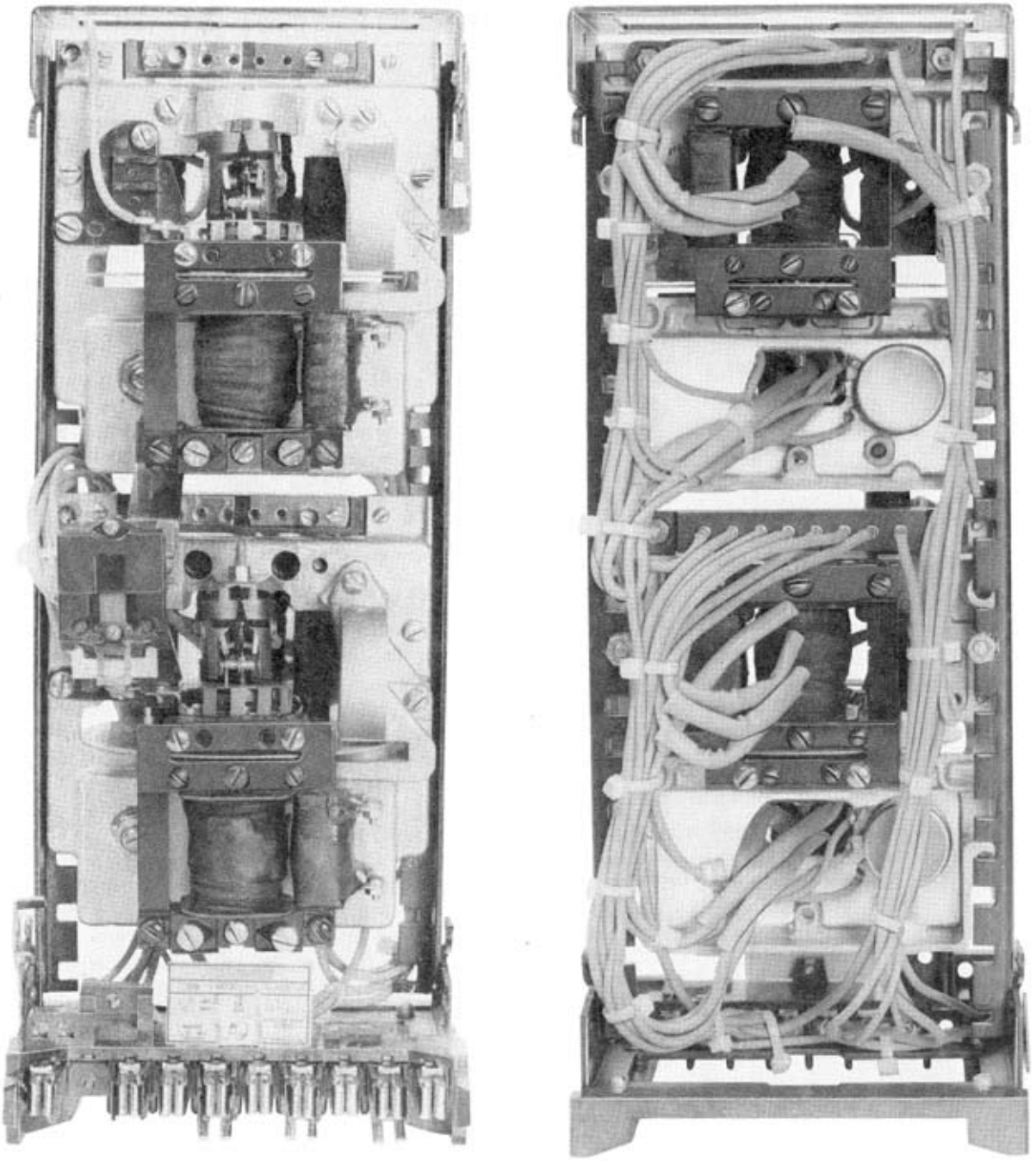

Figure 1 - Tapped CM Class 1E Relay Without Case (Front & Rear Views)

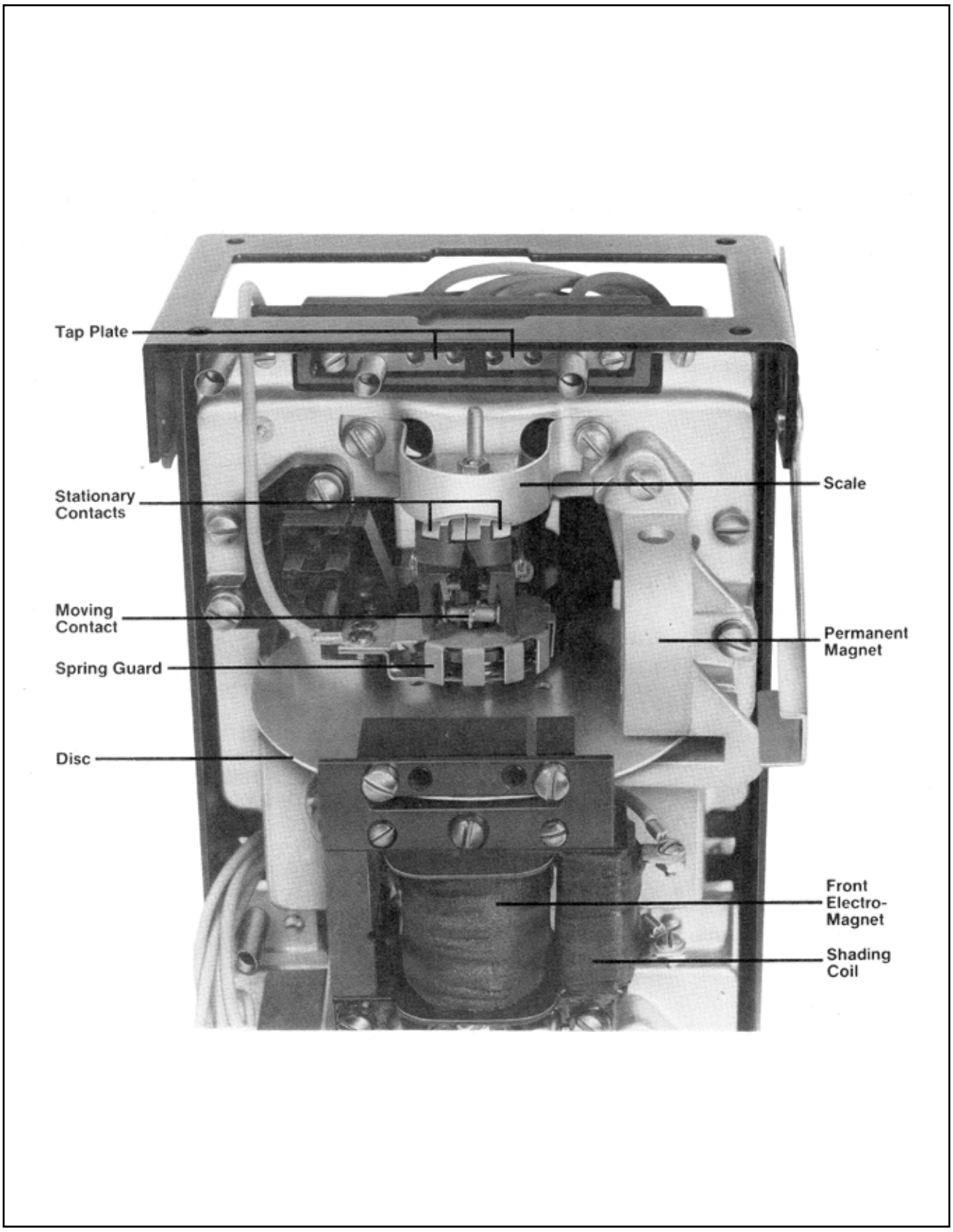

Figure 2 - Element Assembly of Tapped CM Class 1E Relay (Front View)

Each electromagnet has a main coil located on the center leg of an “E” type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil located on one of the outer legs of the “E” structure causes the flux through that leg to lag the main pole flux. The out-of-phase fluxes thus produced in the air gap will cause disc rotation. A resistor located to the rear of each main unit is used as an aid in balancing the opposing torques by controlling the current flow through the shading coils.

For some CM relays, the front electromagnet may have adjustable plugs which are used to aid in calibration.

The contacts are single-pole, double throw. The moving contact is fastened directly to the disc shaft and the electrical connection is made through a spiral spring fastened to the moving contact arm and frame assembly.

2.2 Indicating Contactor Switch (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 energizing of the switch. When the switch closes, the moving contacts bridge two stationary contacts, completing the trip circuit. Also, during this operation, two fingers on the armature deflect a spring located on the front of the switch, allowing the operation indicator target to drop.

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

3.0 CHARACTERISTICS

The non-tapped type CM relay has a minimum pickup current of 1 ampere and a continuous thermal rating of 7 amperes. The tapped CM relay has a minimum pickup of 1, 2 or 3 amperes (depending on the tap setting) and a continuous thermal rating of 7 amperes. The minimum pickup current is defined as the pickup current of each electromagnet with the other paired electromagnet de-energized.

The relay may be utilized for continuous load currents of 1 to 7 amperes. The characteristic curve of the relay is shown in Figure 3.

3.1 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.

ICS - Indicating Contactor Switch

0.2 ampere pickup - 8.5 ohms dc resistance
1.0 ampere pickup - 0.37 ohms dc resistance
2.0 ampere pickup - 0.10 ohms dc resistance

4.0 ENERGY REQUIREMENTS

The burden of each electromagnet is as follows. This table represents the burden on the current transformer connected to terminals 4 and 5 or 8 and 9. The burden on the current transformer connected to terminals 6 and 7 is twice the stated values.

NON-TAPPED CM RELAY			
Current Amperes	Frequency	Volt Ampere	Power Factor Angle
1	60	0.95	74
5	60	15.00	73
1	50	0.85	72
5	50	14.5	71
1	25	0.46	55
5	25	8.00	54

TAPPED CM RELAY				
Tap	Current Amperes	Frequency	Volt Ampere	Power Factor Angle
1	1	60	0.95	74
1	5	60	15.00	73
2	2	60	0.95	65
2	5	60	5.8	65
3	3	60	1.05	54
3	5	60	2.8	54

5.0 SETTINGS

5.1 Main Units

No setting is required on the non-tapped relay because it is calibrated for 1 ampere sensitivity and is set to operate on an unbalance as shown in the operating curve of Figure 3. For the tapped relay,

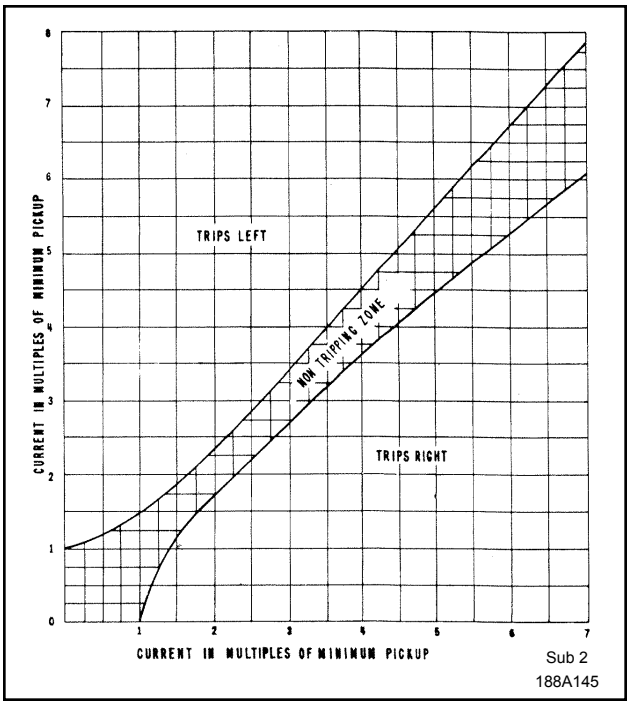

Figure 3 - Typical Operating Curve of the CM Relay

select the minimum tap that is compatible with the current transformer error expected during motor starting. **All taps should be set identically**. On the 2 and 3 ampere tap, the relay contact should make within ±5% of tap value with no current in the other unit on the same disc.

6.0 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 more detailed information on the FT Case refer to Instruction Leaflet 41-076.

7.0 ADJUSTMENTS & MAINTENANCE

The proper adjustments to insure correct operation of this relay have been made at the factory. Upon receipt of the relay no customer adjustments, other than those covered under “5.0 SETTINGS” should be required.

7.1 Acceptance Check

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

7.1.1 Main Units

For all electrical checks refer to test diagram Figure 5. For tapped CM, put tap screw in 1 amp setting.

1. Contacts

Prior to checking the relay, the stationary contact assemblies should be aligned with respective marks located on scale plate. These marks indicate approximately 1 ampere of unbalance.

2. Minimum Trip Current

NOTE: The front electromagnet energized alone will produce a disc rotation to the left while a rear electromagnet energized alone will produce a disc rotation to the right.

Minimum trip can be checked by energizing either the front or rear electromagnets alone and noting that the moving contact makes with its respective stationary contact at 1 ampere.

3. Balance Check

Apply 1 ampere through the front and rear electromagnets simultaneously. The moving contact should remain substantially midway between the stationary contacts. A similar check should be made utilizing 6 amperes.

4. Time Curve

Contact travel is from balanced position to either the right or left stationary contacts.

Electromagnets are to be energized alone (zero restraint). Apply 10 amperes and note that contacts make at 1 second ±10%. Time curve characteristic per Figure 4.

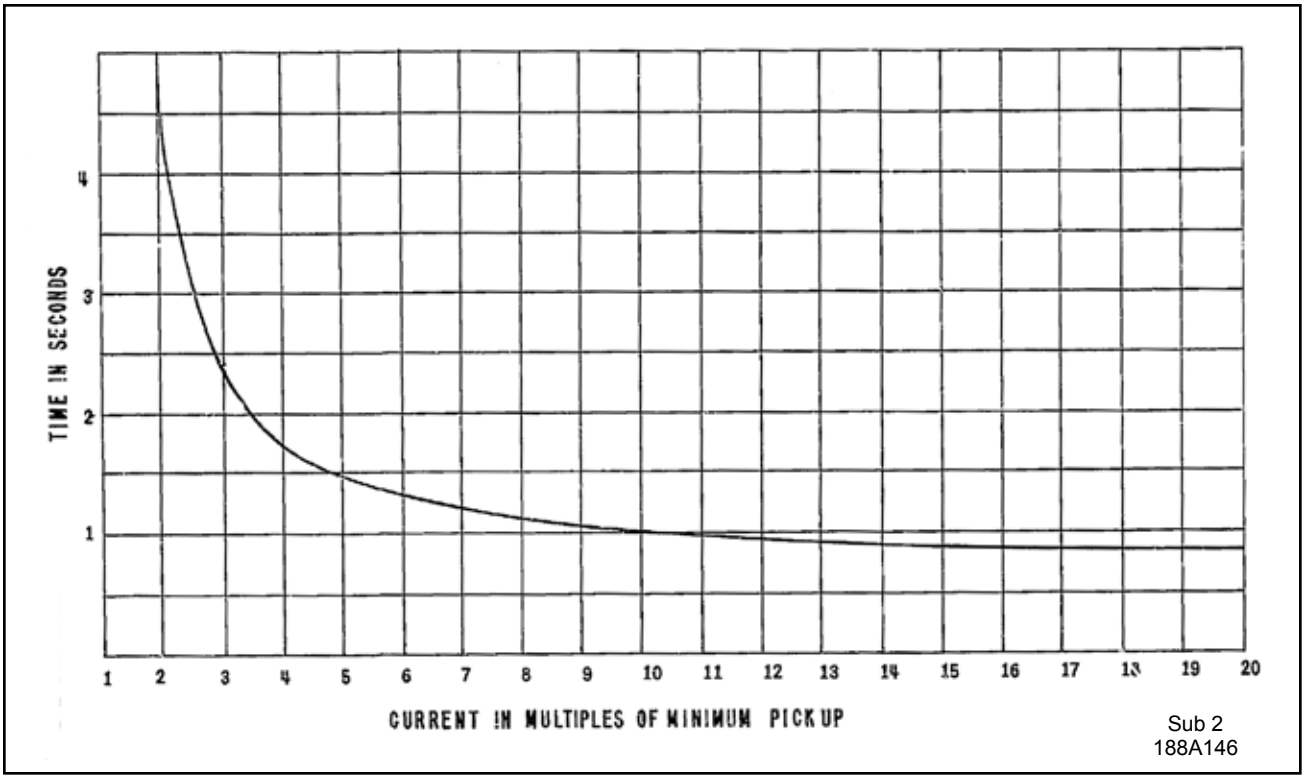

Figure 4 - Typical Time Curve with Zero Restraint of the Type CM Relay

7.1.2 Indicating Contactor 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 tap setting being used. The operation indicator target should drop freely.

Repeat above except pass 85% of ICS rated current (as stated on the relay Nameplate). Contacts should not pickup and target should not drop.

The contact gap should be approximately 0.047" between the bridging moving contact and the stationary contacts. The bridging moving contact should touch both stationary contacts simultaneously.

7.2 Routine Maintenance

All relays should be inspected periodically and the time of operation 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.

Phantom loads should not be used in testing induction-type relays because of the resulting distorted current wave form which produces an error in timing.

All contacts should be cleaned periodically. A contact burnisher, Style Number 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.

All tap screws should be torqued to between 5.5 and 7.9 in-lbs.

8.0 CALIBRATION

Use the following procedure for calibrating the 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 "7.1 Acceptance Check").

Note: A spring shield (See Figure 2) covers the spiral spring on each CM element. When adjustments to the spring(s) are deemed necessary, the spring shield must be carefully removed first.

8.1 Main Units

For all electrical checks refer to test diagram Figure 5. For tapped CM, put tap screw in 1 amp tap setting.

1. Balance Setting

a) Mechanical balance

Adjust spiral spring until moving contact is located substantially in the center of the scale plate.

b) Electrical Balance

1. Apply 2 amperes on front and rear electromagnets and adjust resistor at rear of specific unit being tested such that the moving contact is in balance, i.e., moving contact is aligned per part “a” above.

2. Apply 20 amperes on front and rear electromagnets for approximately 2 seconds and note that the moving contact does not deviate from the balanced condition more than approximately 1/4 inch.

For CM relays with adjustable magnetic plugs, only the right-hand plug may be adjusted. The right-hand plug is adjusted at the factory to help obtain a balanced condition of the contact at 20 amperes. The moving contact is again checked at 2 amperes. Little adjustment, if any, is expected to be necessary in the field.

2. Minimum Trip Setting

The front electromagnet energized alone should produce a disc rotation to the left while the rear electromagnet energized alone should produce a disc rotation to the right.

a) Apply 1 ampere to the front electromagnet and adjust the left stationary contact until it just makes with the moving contact. This setting should correspond with the marking on the scale plate.

b) Apply 1 ampere to the rear electromagnet and adjust the right stationary contact until it just makes with the moving contact. This setting should correspond with the marking on the scale plate.

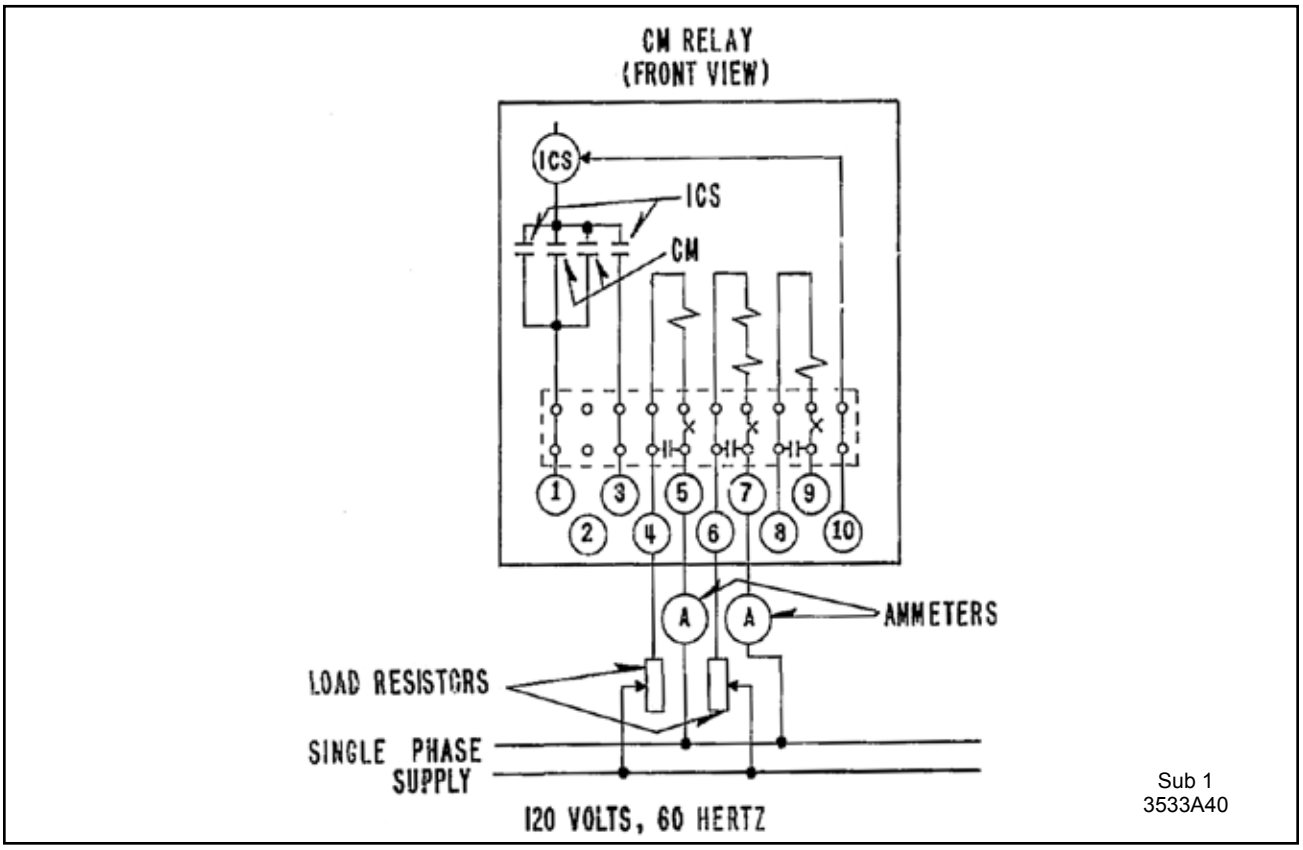

Figure 5 - Diagram of Test Connections for the Non-tapped CM Relay.
For Tapped CM Relay, Place Tap Screw in 1 Amp Tap Setting.

3. Operating Curve

Apply 6 amperes to front electromagnet and vary current flowing through rear electromagnet.

a) The moving contact should make with the right stationary contact between 6.5 and 7.1 amperes.

b) The moving contact should make with the left stationary contact between 5.5 and 5.0 amperes.

4. Time Curve

NOTE: Contact travel is from balanced position to either the right or left stationary contacts.

a) Apply 10 amperes to rear electromagnet (front electromagnet de-energized) and adjust permanent magnet for an operating time to right contact of 1.0 ± 0.10 seconds.

b) Apply 10 amperes to front electromagnet (rear electromagnet de-energized) and check to see that operating time to left contact is 1.0 ± 0.10 seconds.

8.2 Indicating Contactor Switch (ICS)

Initially adjust unit on the pedestal so that armature fingers do not touch the yoke in the reset position (as viewed from top of switch between cover and frame). This can be done by loosening the mounting screw in the molded pedestal and moving the ICS in a downward direction.

Contact Wipe Adjust 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.

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 not drop with a slight jar.

Pickup The 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 amounts. Apply 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 spring bent outward equal amounts on both sides.

9.0 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.

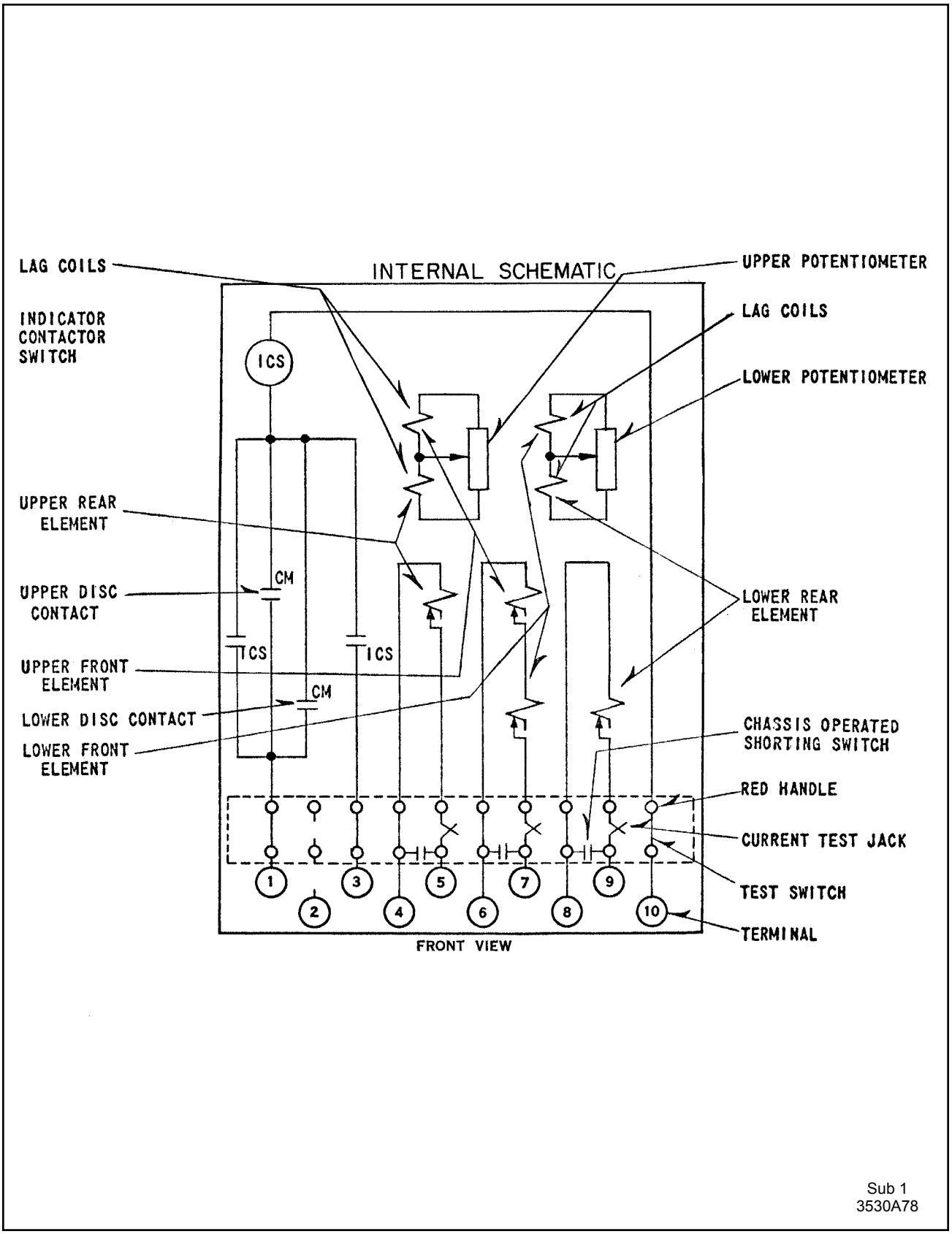

Figure 6 - Internal Schematic of Tapped CM Class 1E Relay, in FT-31 Case

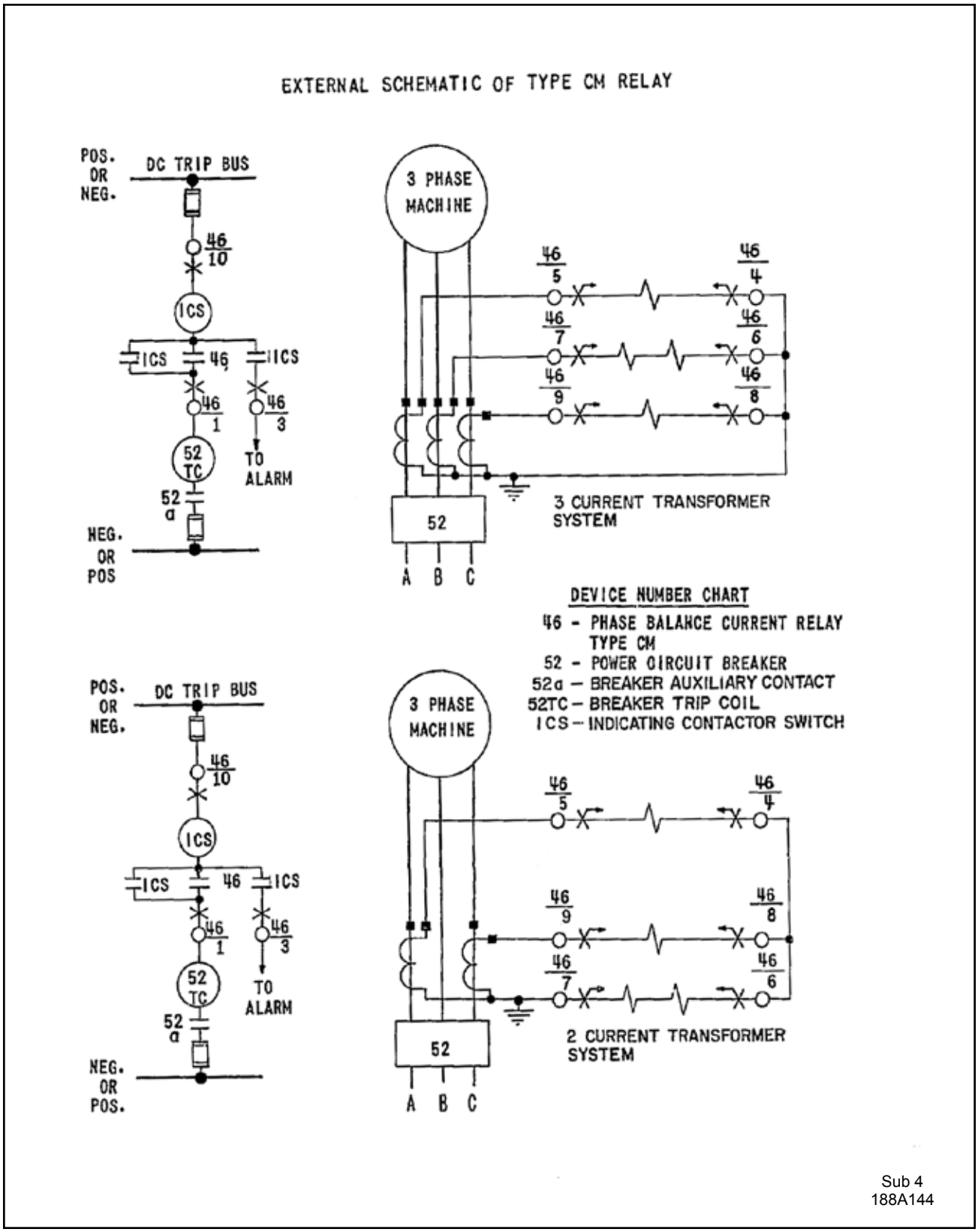

Figure 7 - External Schematic Diagram for the Type CM Relay in FT-31 Case

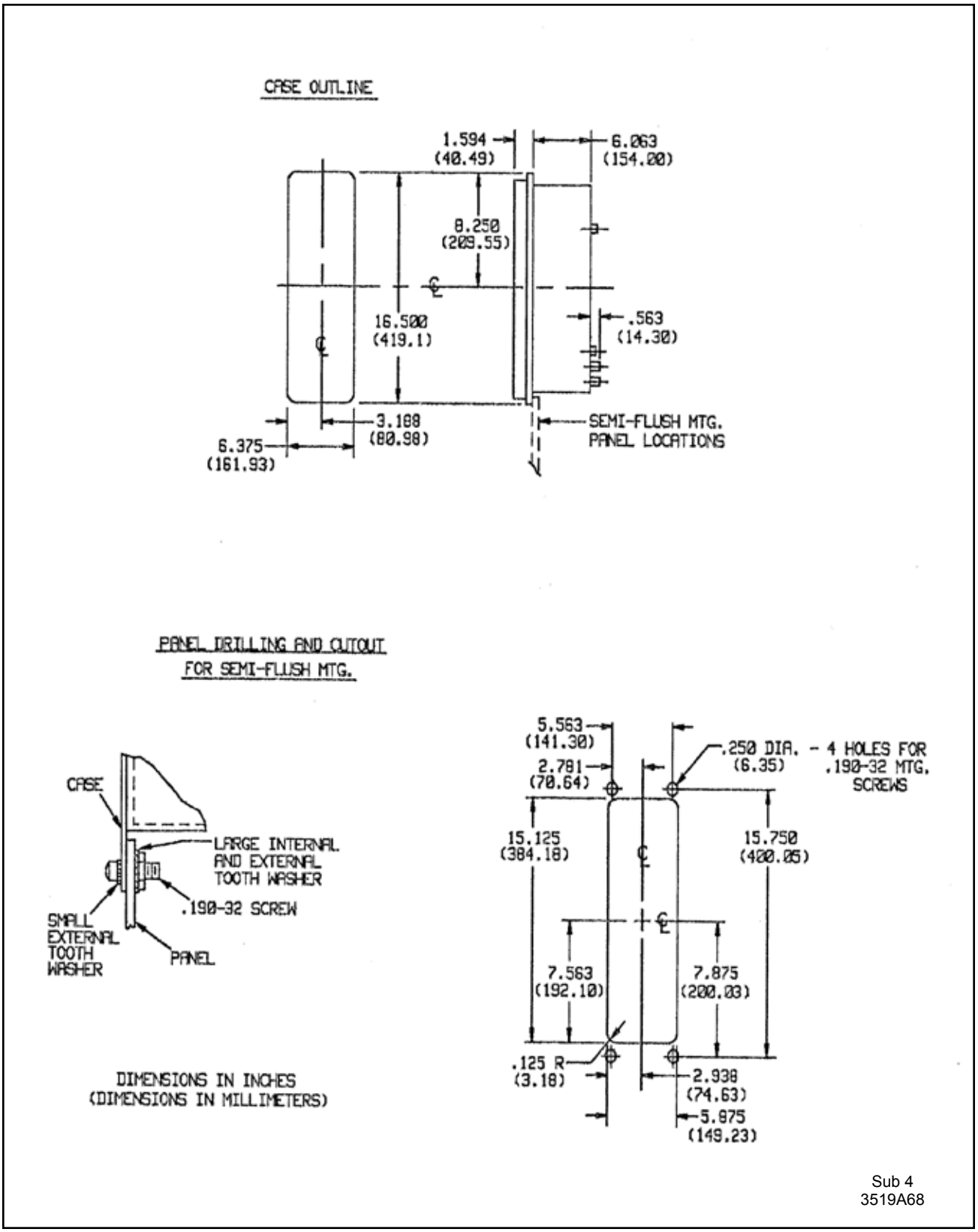

Figure 8 - Outline and Drilling Plan for the Type CM Class 1E Relay in FT-31 Case

IL 41-181.21 Rev. B

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