

INSTRUCTIONS

MACHINE FIELD GROUND DETECTOR RELAY

TYPE PJG12B

GE Protection and Control
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MACHINE FIELD GROUND DETECTOR RELAY
TYPE PJG12B

DESCRIPTION

The PJG12B detects grounds in a normally ungrounded field winding by detecting current flow when a d-c voltage is applied between the field winding and ground. Instantaneous time-delayed (nominally 2 seconds) operation is obtained by link selection. The PJG12B is supplied in a size M1 drawout case. The internal connections are shown Fig. 3.

APPLICATION

Short circuits in normally ungrounded equipment can often be prevented by discovering and removing a ground as quickly as possible before a second ground can cause a fault and possible serious damage. The PJG12B relay is designed primarily for the detection of grounds in normally ungrounded machine field circuits, and can be used to sound an alarm, or for tripping duty. To ensure that this protection will function for a ground in the alternator field winding, it is necessary that the rotor iron be grounded without depending on the path through the bearings, as the oil film may withstand the voltage applied by the relay, and thus prevent the relay from operating when required. Grounding means must not be installed where it will bypass the bearing insulation which is provided for prevention of shaft currents.

The time delay is intended to override the transient conditions that may occur when an excitation system is transferred between manual and automatic control. It may also be desirable to prevent operation for short circuits that may occur due to maintenance on the field metering circuits.

RATINGS

The type PJG12B relays are rated at 120 or 240 VAC at 50 or 60 cycles. The relays should be ordered for the particular rating desired. If it later becomes necessary to use the relay on the other rating, the change may be easily affected as described in the section titled INSTALLATION PROCEDURE.

These relays may be used with machine fields rated 600 volts or less with ceiling excitation up to 750 volts. They should not be used with machine fields which can rise above 1000 volts buck or reverse excitation. The relay will withstand 3700 VAC 50/60 hertz from studs to frame for one minute.

The relay can be used for instantaneous or time-delay operation. For instantaneous operation, the operating time is no more than 100 milliseconds at rated voltage. For time-delay operation, the relay operating time is 2.0 $\pm$0.5 seconds at rated voltage and ambient temperature (25°C).

The filter capacitor may be removed from the circuit by moving capacitor (C1) lead from stud 3 to 3A. With the capacitor in circuit the relay introduces no more than 3 volts peak-to-peak ripple across studs 3 and 5.

The relay pickup sensitivity is shown in Figs. 1 and 2.

The current through the sensing circuit should not exceed 0.45 amps for more than five seconds for periods less than one second; the I^2t product must not exceed 0.5. Note also that the non-repetitive half-cycle ranges should not exceed 50 amps.

CONTACT RATINGS

AY unit

6 amperes make and carry continuously

30 amperes make and carry tripping duty.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

AX unit. Interruption ratings.

VDC	48	125	250	300	400	500	600
Amps	26	26	20	1.2	0.425	0.3	0.225

CHARACTERISTICS

PRINCIPLES OF OPERATION

The PJG12B relay is designed to sense machine field to ground resistance. If this field to ground resistance is low enough (due to an insulation failure, for instance), the relay senses this fault condition and picks up. Refer to Fig. 4. The negative terminal of the relay's d-c voltage source is grounded. The positive terminal of the relay's d-c voltage source is connected to the negative terminal of the machine field through the coil of the current sensing unit (Unit A), ground fault interrupting contacts (Unit AX normally closed contacts), and diode D_1. A fault on the field winding is a connection of the field winding to ground through fault resistance R_G. This fault resistance completes a circuit so that sensitivity current I_S flows from rectifier positive to negative through Unit A coil, AX "b" contact, diode D_1, field winding, fault resistance R_G, and ground.

Note that the positive terminal of the relay's rectifier must be connected to the negative terminal of the field. This is done so that a fault in the machine field causes a percentage of the machine field voltage to be combined additively with the relay's own d-c voltage source. This percentage is dependent on where in the field winding the fault occurs. If the fault occurs at the positive terminal, the percentage = 100 percent. If the fault occurs at the negative terminal, the percentage = 0 percent.

The Unit A coil is calibrated to pick up at a fixed minimum value of I_S. Thus, the factors determining the relay's sensitivity are those that make I_S exceed this value. If R_G increases, then applied voltage plus percent of field volts where fault occurs must increase. Since relay sensitivity is of interest, the smallest maximum value of R_G that the relay will sense is when the applied voltage is a minimum and the fault occurs at the negative terminal. When the applied voltage is 80 percent rated, the relay will sense 500 ohms or less at the negative terminal. This is worst case maximum sensitivity.

The principles discussed above are more clearly shown in the curves of Figs. 1 and 2. In determining whether the relay will operate, the following parameters must be known.

1) machine field voltage

2) percent of field voltage where fault occurs

3) percent of rated voltage applied.

As an example, assume machine field voltage is 300 volts, the percent of field voltage where fault occurs is 50 percent, and percent of rated voltage applied is 80 percent. Referring to Fig. 2, the 300 volt line is found at the 50 percent (ordinate) level. The corresponding maximum sensitivity (abcissa) is 5.85 kilo ohms. This is fault resistance if field resistance is neglected.

OPERATION

The sequence of operation is understood by referring to Fig. 5. Assume that the time-delay link is on the "In" position. The following is what happens during a continuous fault greater than two seconds.

1) Fault sensitivity current I_S flows from relay rectifier positive through Unit A coil, normally closed contact AX, diode D_1, machine field winding, and R_G (not shown) to ground. It returns to relay rectifier negative terminal through grounded stud 5. Unit A picks up and closes its contacts.

2) Thermal time-delay relay element (Unit T) is energized through A contact and time-delay link.

3) After two seconds, thermal timer contacts T close energizing AY coil directly and AX coil through R_2.

4) AX seals itself and AY in through its "a" contact; simultaneously it interrupts the I_S current flow through the A coil by opening its "b" contacts (make before break). This deenergizes Unit A and Unit T.

5) AY (sealed in through AX contacts) sets target and closes alarm or trip circuit contacts.

6) Unit AY cannot be reset until Unit T has cooled off. This takes a maximum of two minutes after it has operated. To reset, the AX coil is shorted through the reset contacts. This causes it to drop out and break the seal-in for both itself and the AY coils. For external electrical reset, a normally open switch may be used across studs 7-8.

For instantaneous operation, the time-delay link is placed on the "Out" position. The sequence of operation is as follows:
1) Same as 1) above
2) AX and AY are energized through the A contact and the time-delay link
3) Same as 4) above except only A unit deenergized
4) Same as 5) above
5) Same as 6) above except relay can be reset immediately.

CAUTION

THE PJG RELAY GENERATES AN INTERNAL DC VOLTAGE BETWEEN THE NEGATIVE TERMINAL OF THE GENERATOR FIELD AND GROUND. THIS INTERNAL VOLTAGE IS NOT REMOVED BY OPENING THE GENERATOR FIELD CIRCUIT BREAKER.

BEFORE ANY MAINTENANCE IS PERFORMED ON THE GENERATOR, THIS RELAY-GENERATED VOLTAGE SHOULD BE DISCONNECTED FROM THE GENERATOR FIELD. THIS MAY BE ACCOMPLISHED BY REMOVING THE RELAY CONNECTION PLUG OR BY REMOVING THE AC SUPPLY TO RELAY TERMINALS 9 AND 10.

BURDENS

The maximum burdens are given as follows:

CYCLES	VA	PF	W	V
50	32.5	0.425	13.7	29.4
60	66.0	0.225	14.9	64.1

CONSTRUCTION

The Type PJG relays are assembled in the medium size single ended (M-1) drawout case having studs at one end in the rear for external connections. The electrical connections between the relay and case studs are through stationary molded inner and outer blocks between which nests a removable connecting plug. The inner block has the terminals for the internal connections.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads terminated at the inner block. This cradle is held firmly in the case with a latch at both top and bottom and by a guide pin at the back of the case. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also locks the latch in place. The cover, which is drawn to the case by thumbscrews, holds the connecting plugs in place. The target reset mechanism is a part of the cover assembly.

The relay case is suitable for either semiflush or surface mounting on all panels up to two inches thick and appropriate hardware is available. However, panel thickness must be indicated on the relay order to insure that proper hardware will be included. Outline and panel drilling is shown in Fig. 8.

A separate testing plug can be inserted in place of the connecting plug to test the relay in place on the panel either from its own source of current and voltage, or from other sources. Or the relay can be drawn out and replaced by another which has been tested in the laboratory.

The relays covered by these instructions include a plunger unit, two hinged armature type units: and a thermal time-delay unit.

The A unit is an instantaneous overcurrent plunger relay. It has been calibrated at the factory per the curves shown in Figs. 1 and 2.

The AX unit is a hinged armature relay with two normally closed contacts connected in series with blow-out magnets for d-c interruption duty. This relay also has an "a" contact adjusted for make-before-break operation to assure that the AX unit seals in. This relay interrupts the ground fault current.

The AY unit is a voltage-operated instantaneous unit which provides target indication and the output contacts connected to studs 1 and 2.

The time-delay unit is enabled or disabled by means of a link. With the time-delay unit enabled the fault must remain for the pickup time of the thermal unit before the trip contacts will close. With the time-delay unit disabled there is no intentional time delay between fault inception and the closing of the trip contacts.

The PJG relay also includes a d-c supply. This supply is filtered and will introduce no more than three volts peak-to-peak ripple. The filter capacitor may be disconnected by moving the capacitor lead to stud 3A.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as a part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Apparatus Sales Office.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured or the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed and cause trouble in the operation of the relay.

ACCEPTANCE TESTS

Immediately upon receipt of the relay an inspection and acceptance test should be made to insure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed.

These tests may be performed as part of the installation or acceptance test at the discretion of the user.

Since most operating companies use different procedures for acceptance and installation tests, the following section includes all applicable tests that may be performed on these relays.

VISUAL INSPECTION

Check the nameplate stamping to insure that the model number and rating of the relay agree with the requisition.

Remove the relay from its case and check that there are no broken or cracked molded parts or other signs of physical damage, and that all screws are tight.

MECHANICAL INSPECTION

Cradle and Case Blocks

Check that the fingers on the cradle and the case agree with the internal connection diagram. Check that the shorting bars are in the correct position. Check that each finger with a shorting bar makes contact with the shorting bar. Deflect each contact finger to insure that there is sufficient contact force available. Check that each auxiliary brush is bent high enough to contact the connection plug.

Check that the A unit plunger moves freely up and down within the calibration tube (do not change calibration), and contacts make correctly. The AX armature should operate so that contacts make before break and wires to moving contacts do not interfere with movement. The AY target armature should set the target and close its contacts uniformly.

Put the relay into its case. It should slide in without excessive binding. No wires should be pinched between case and cradle. Set the target by hand. Target should be clearly displayed. Place the glass cover on the relay case (reset button on lower left) and fasten in position with thumbscrews. Pressing the reset button slowly should cause the microswitch to "click" before the target drops.

ELECTRICAL CHECKS

Any electrical testing of the relay must occur in a case which is perfectly level in the upright position. Place the time-delay link on "In" positon. Apply rated voltage to studs 9-10, insert the connection plug, and fasten glass cover. Placing a jumper across studs 3-4 should cause the relay to operate in 2 $\pm$0.5 seconds (target appears). Remove the jumper. Pressing the lower left reset button after a minimum of two minutes causes the target to drop. Remove the glass cover, and pull out the connection plug. Place the time-delay link to "Out position. Reinsert the connection plug, fasten the cover into positon.

Placing a jumper across studs 3-4 should cause the target to appear instantaneously. Remove the jumper and press the reset button. The target should drop.

If readjustment is found to be necessary, refer to the section titled SERVICING.

INSTALLATION PROCEDURE

LOCATION AND MOUNTING

The relay should be mounted on a vertical surface in a location reasonably free from excessive heat, moisture, dust and vibration. The relay case may be grounded, if desired, using at least No. 12 AWG gage copper wire. The outline and panel drilling diagram for the Type PVD relays is shown in Fig. 1.

CONNECTIONS

The internal connection diagrams for the Type PJG12B relay is shown in Fig. 3. The elementary diagram of the external connections for a typical application is shown in Fig. 5.

Note that the transformer is connected for the proper a-c voltage; see Fig. 3 before energizing relay.

MOUNTING

The relay should be mounted on a vertical surface in a location that is clean and dry, free from excessive vibration, and well lighted to facilitate inspection and testing. It must be emphasized that the relay case is vertically upright and level. The case has provisions for either flush or semi-flush mounting. An assortment of hardware is provided for either mounting. Refer to Fig. 8 for outline and panel drilling dimensions.

MECHANICAL SETTINGS

Before any mechanical or electrical adjustments are made, the subsections titled VISUAL CHECKS AND MECHANICAL CHECKS should be followed. Additional attention must be given toward contact settings.

For the A plunger unit, the flexible contact lead should be formed such that it does not touch molded parts. It should be shaped such that movement is only at the terminals and the "a" contact makes without the moving contact missing the fixed contact. Contact gap should be 3/32 inch from fixed to moving contact.

For the AX hinged armature unit, contact gap for the normally closed contacts should be at least 1/16 inch when operated by hand. The normally open contact must close before the normally closed contacts open (make before break). Contact gap is approximately 1/8 inch.

For the AY hinged armature target unit, operation by hand should cause the two contacts to close at approximately the same time. In reset position, the moving contact buttons should set on the turned-in prongs of the front molded block evenly. Upper and lower contact buttons should be reasonably parallel.

If any difficulties are encountered in these mechanical settings, refer to the section titled SERVICING.

ELECTRICAL TESTS

Since all drawout relays in service operate in their cases, it is recommended that they be tested in their cases or an equivalent steel case. In this way any magnetic effects of the enclosure will be accurately duplicated during testing. A relay may be tested without removing it from the panel by using a 12XLA13A test plug. This plug makes connections only with the relay and does not disturb any shorting bars in the case. Of course, the 12XLA12A test plug may also be used. Although this test plug allows greater testing flexibility, it also requires CT shorting jumpers and the exercise of greater care since connections are made to both the relay and the external circuitry.

All alternating current operated devices are affected by frequency. Since non-sinusoidal waveforms can be analyzed as a fundamental frequency plus harmonics of the fundamental frequency, it follows that alternating current devices (relays) will be affected by the applied waveform.

Therefore, in order to properly test alternating current relays it is essential to use a sine wave of current and/or voltage. The purity of the sine wave (i.e. its freedom from harmonics) cannot be expressed as a finite number for any particular relay, however, any relay using tuned circuits, R-L or RC networks, or saturating electromagnets (such as time overcurrent relays) would be essentially affected by non-sinusoidal wave forms.

Similarly, relays requiring d-c control power should be tested using d-c and not full wave rectified power. Unless the rectified supply is well filtered, many relays will not operate properly due to the dips in the rectified power. Zener diodes, for example, can turn off during these dips. As a general rule the d-c source should not contain more than 5 percent ripple.

It is recommended that the relay be tested using the 12XLA12A test plug connected as shown in Fig. 7. These tests ensure correct relay operation and correct grounding of relay and rotor.

1) Remove connection plug.
2) Place time-delay link on "In" position.
3) Make connections on test plug before inserting into relay. Apply rated voltage to studs 9-10.
4) Insert test plug into relay.
5) Close the test switch. A unit should pick up instantaneously. After 2 $\pm$0.5 seconds, AX and AY should seal in, target should appear, trip contacts close, and A unit drops out. Relay is now set. Open test switch.
6) Press microswitch and reset target after two or more minutes. AX and AY should drop out, and target should drop. Unit is now reset.
7) Remove test plug.
8) Place time-delay link on "OUT" position.
9) Reinsert test plug.
10) Close the test switch. Unit A should pick up causing AX and AY to seal in instantaneously. Unit A drops out as soon as seal-in is complete. Target appears and trip contacts close. Unit AY is now set. Open test switch.
11) Press microswitch, then reset target. AX and AY should drop out, and target should drop. Unit is now reset.
12) Remove the test plug.
13) Set time-delay link for desired operation.
14) Reinsert connection plug. If external connections have been made correctly, relay is now ready for operation.

CAUTION - Capacitors storing large charges may endanger testing personnel. Do not handle the relay after electrical testing until C_1 and C_2 capacitors have been discharged (two largest capacitors in back upper left and back middle).

If any difficulty arises in carrying out this procedure, refer to section titled SERVICING.

PERIODIC TESTING AND ROUTINE MAINTENANCE

In view of the vital role of protective relays in the operation of a power system it is important that a periodic test program be followed. It is recognized that the interval between periodic checks will vary depending upon environment, type of relay and the user's experience with periodic testing. Until the user has accumulated enough experience to select the test interval best suited to his individual requirements it is suggested that the points listed under INSTALLATION PROCEDURE be checked at an interval of from one to two years.

Check the items described under ACCEPTANCE TESTS - VISUAL INSPECTION AND MECHANICAL INSPECTION. Examine each component for signs of overheating, deterioration or other damage. Check that all connections are tight by observing that the lockwashers are fully collapsed.

CONTACTS

Examine the contacts for pits, arc or burn marks, corrosion, and insulating films. For cleaning contacts, a flexible burnishing tool should be used. This consists of a flexible strip of metal with an etched-roughened surface resembling in effect a superfine file. The polishing action is so delicate that no scratches are left, yet it will clean off any corrosion thoroughly and rapidly. Its flexibility insures the cleaning of the actual points of contact. Do not use knives, files, abrasive paper or cloth of any kind to clean relay contacts.

OPERATIONAL CHECKS

For more frequent operational checks when the machine rotor is not accessible, a modification to the connections of Fig. 7 may be made. Grounding inner pin 3 of the 12XLA12A plug through the test switch and 500 ohms resistor allows the tests outlined in INSTALLATION PROCEDURE to be followed. Note that this modification does not ensure proper rotor grounding.

In some applications, an external test-reset switch is connected as shown in Fig. 6. For operational testing when an external test-reset switch is included, follow the procedure outlined below:

Time-delay link on "IN" position

1) Turn switch to TEST position for at least three seconds. Relay should operate in 2 $\pm$0.5 seconds. Alarm should sound and target should be displayed. Relay is now set.

2) Turn the switch to RESET position after at least two minutes. Alarm should cease. Target does not drop. Target must be reset mechanically by pressing lower left reset button.

Time-delay link on "OUT" position

1) Turn switch to TEST position. Relay should operate instantaneously. Alarm should sound and target should be displayed. Relay is now set.

2) Turn the switch to RESET position. Target does not drop. Target must be reset mechanically by pressing lower left reset button.

Note that the tests of this paragraph do not test correct relay or rotor grounding.

ADDITIONAL CHECKS

Of course, whenever the relay is tested, it should be inspected for proper mechanical operation. All connections should be tight and mechanical parts should move freely. Be sure none of the wires are pinched between cradle and case.

SERVICING

MECHANICAL ADJUSTMENTS

All readjustment of contact shape, contact gap, spring tension and lead formation should be done with a certain amount of delicacy and, of course, the proper tools. Contacts are strained gradually so that no creases or permanent bends deform their shapes and render them non-operational. For adjustment purposes, a 12XRT11A1 relay tool kit is recommended.

1) Unit A – One normally open contact

   a) The stationary contact consists of three members. From top to bottom, they are the back stop, the moving contact, and contact rest arm. The moving contact must be formed such that contact gap is 3/32 inch (do not reshape with any additional sudden bends). The backstop is formed such that it is barely engaged when the plunger is in its fully picked up position. Any reshaping of the backstop must occur at the right angle bend next to the mounting screw. With these adjustments, contact wipe is approximately 3/64 inch.

   b) Lead is formed such that it does not touch molded parts or inhibit motion in any way.

2) Unit AX – One normally open contact, two normally closed contacts

   a) Normally open contact is formed such that contact gap is 0.125 to 0.150 inches.

   b) Normally closed contacts part within 1/64 inch of each other. Contact gap should be at least 1/16 inch when relay is operated by hand.

   c) Normally open contact must close before normally closed contacts open. If not, adjust gap screw on normally closed contacts.

3) Unit AY

   a) In reset position, cross member of "T" spring rests evenly on the turned-in prongs of the front molded block. A slight twisting of this member is made to make it horizontal.

b) Fixed contacts are adjusted so that contact buttons make at the same time with 1/32 inch wipe. Raising armature by hand until contacts just make should leave a 1/64 inch air gap between freeze pin of armature and pole piece.

PICKUP CALIBRATION

It is recommended that external voltage be applied with a 12XLA13A test plug. Voltage must be at rated frequency and accurately metered.

Before inserting test plug into the relay, apply voltage leads to studs 9-10, a 0-to-100 ohms rheostat across studs 3-4, and a continuity indicating lamp across studs 1-2. Time-delay link is placed on "OUT" position. Set resistance to maximum.

Insert test plug; voltage should be set to 79 to 81 percent of rated voltage. Reset relay by depressing the microswitch. The variable resistance is gradually decreased from 100 ohms. Unit A should pick up and set the AY unit (continuity light on) just at the zero ohm point. If pickup is too high (unit A plunger does not pick up when zero is reached), knurled armature is turned counterclockwise as viewed from the top. Similarly, if pickup is too low (unit A plunger picks up before zero is reached) knurled armature is turned clockwise as viewed from the top. After the setting is made, increase resistance to maximum, and reset the unit. Repeat decreasing resistance gradually to see if unit picks up without further adjustment. Correct calibration occurs when gradual resistance reduction to zero will cause the relay to operate for five successive tries without readjustment.

As a final check, 550 ohms is suddenly applied across studs 3-4. Unit A should not pick up.

Since the last edition, Figure 8 has been changed.

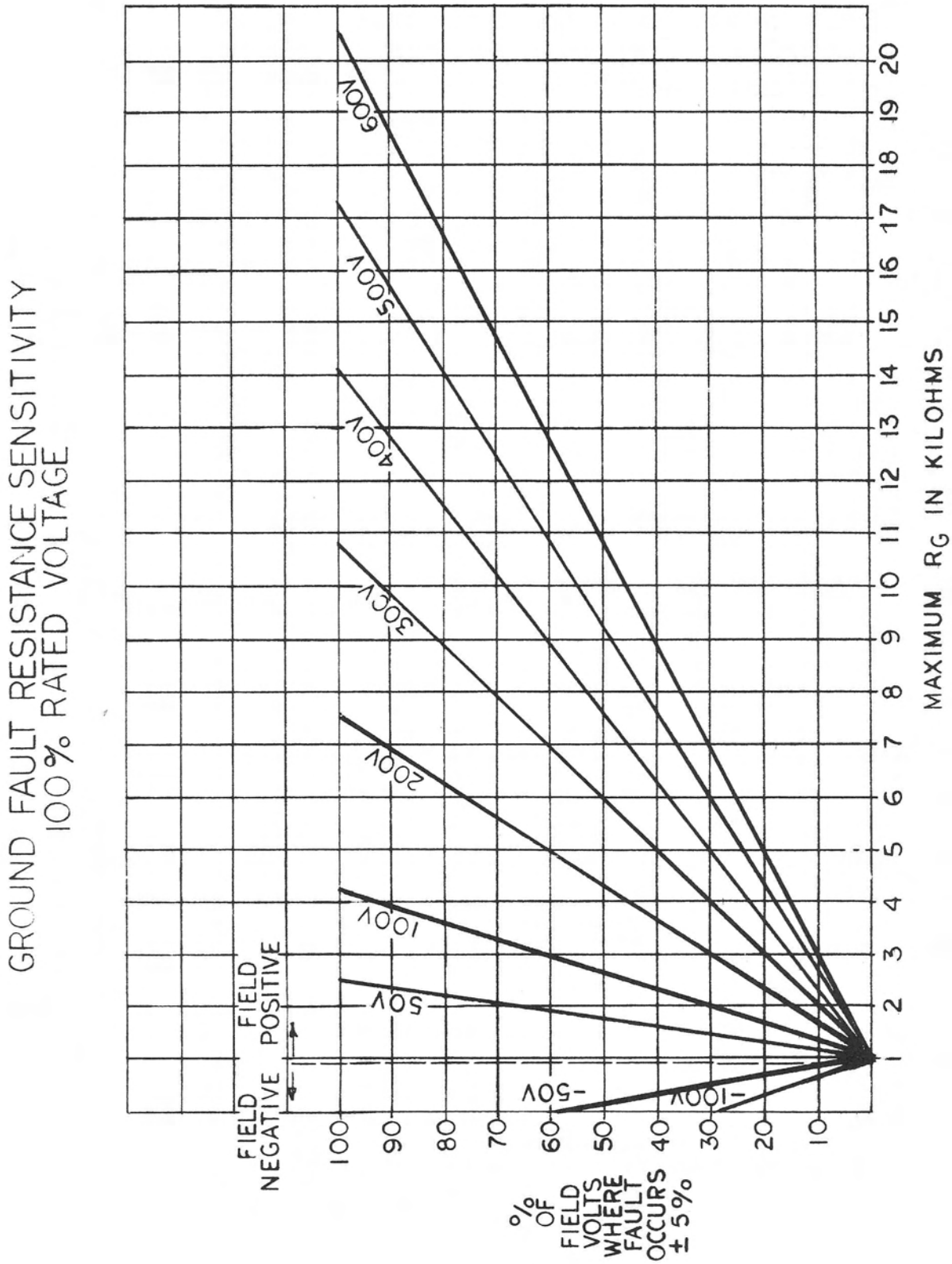


Fig. 1 (0269A3004-0) Ground Fault Resistance Sensitivity 100 Percent Rated Voltage

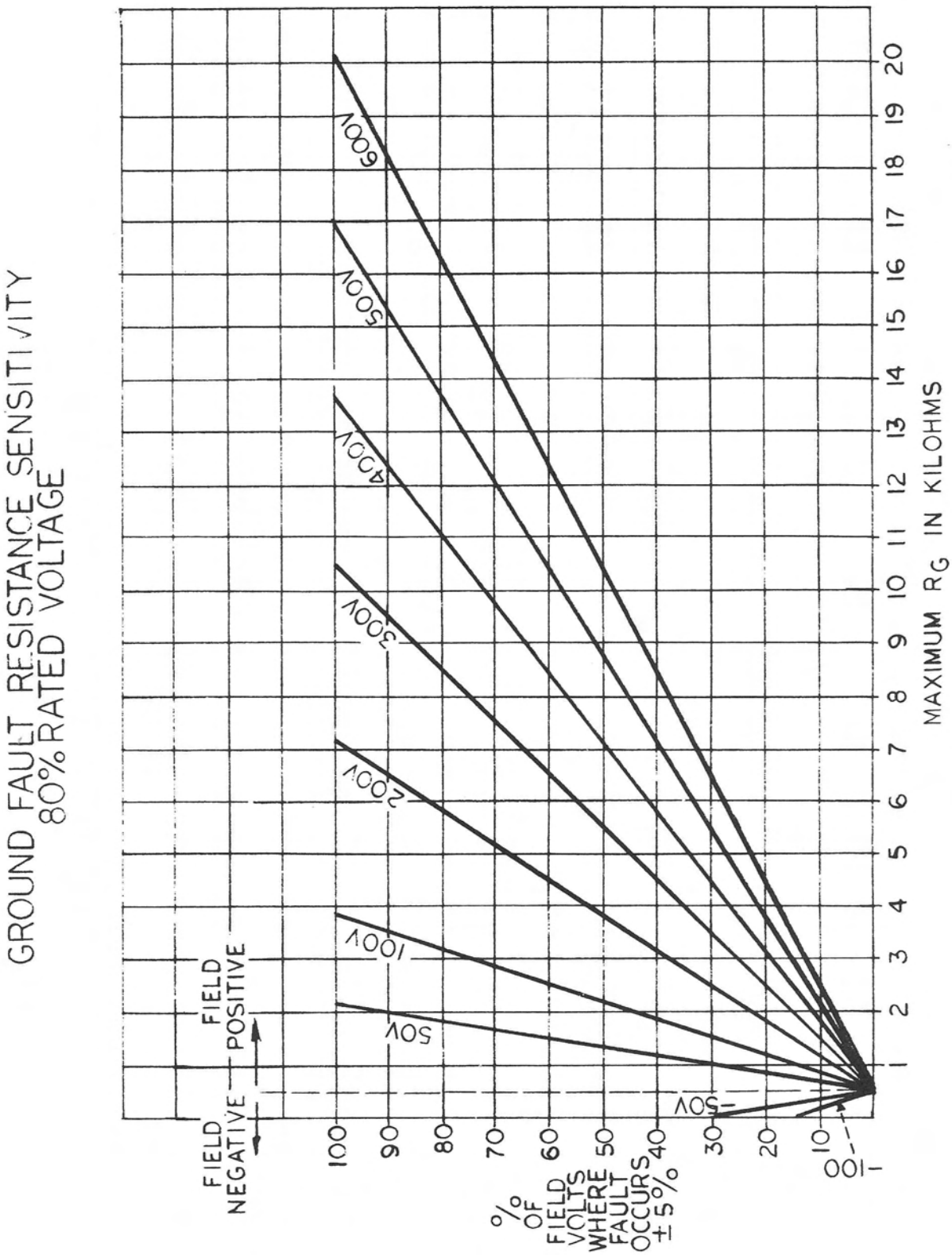


Fig. 2 (0269A3005-0) Ground Fault Resistance Sensitivity 80 Percent Rated Voltage

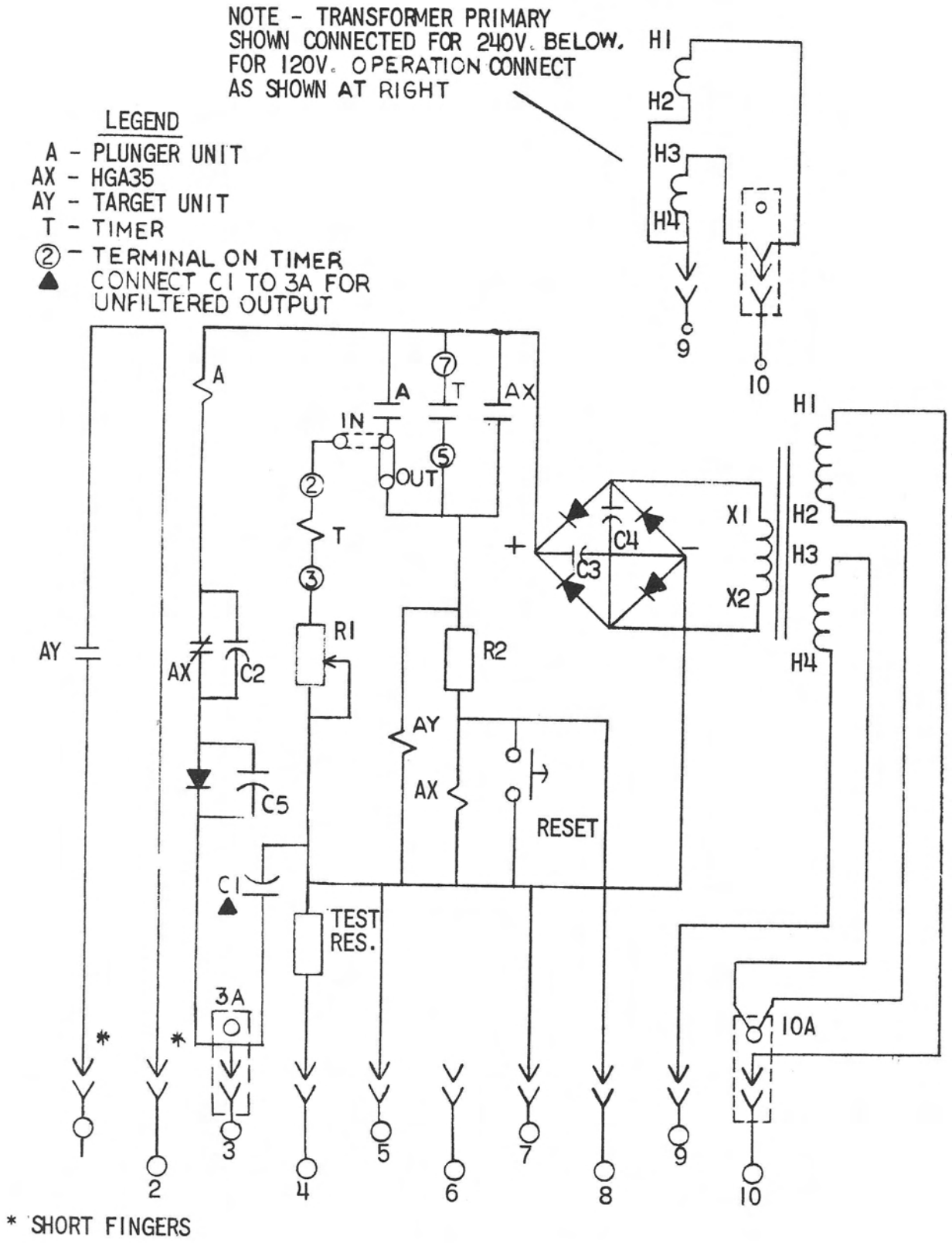


Fig. 3 (0246A6971-4) Internal Connections (Front View)

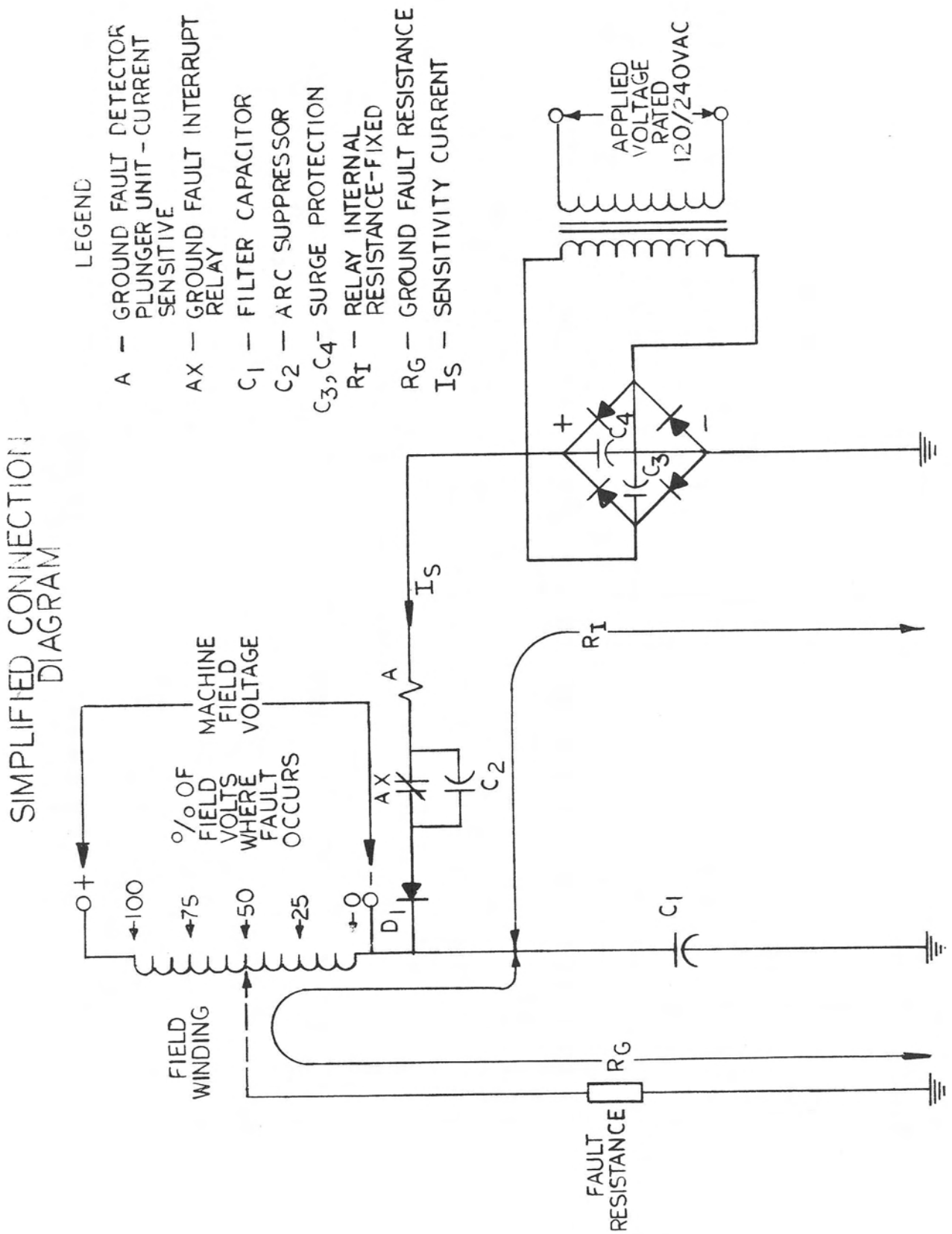
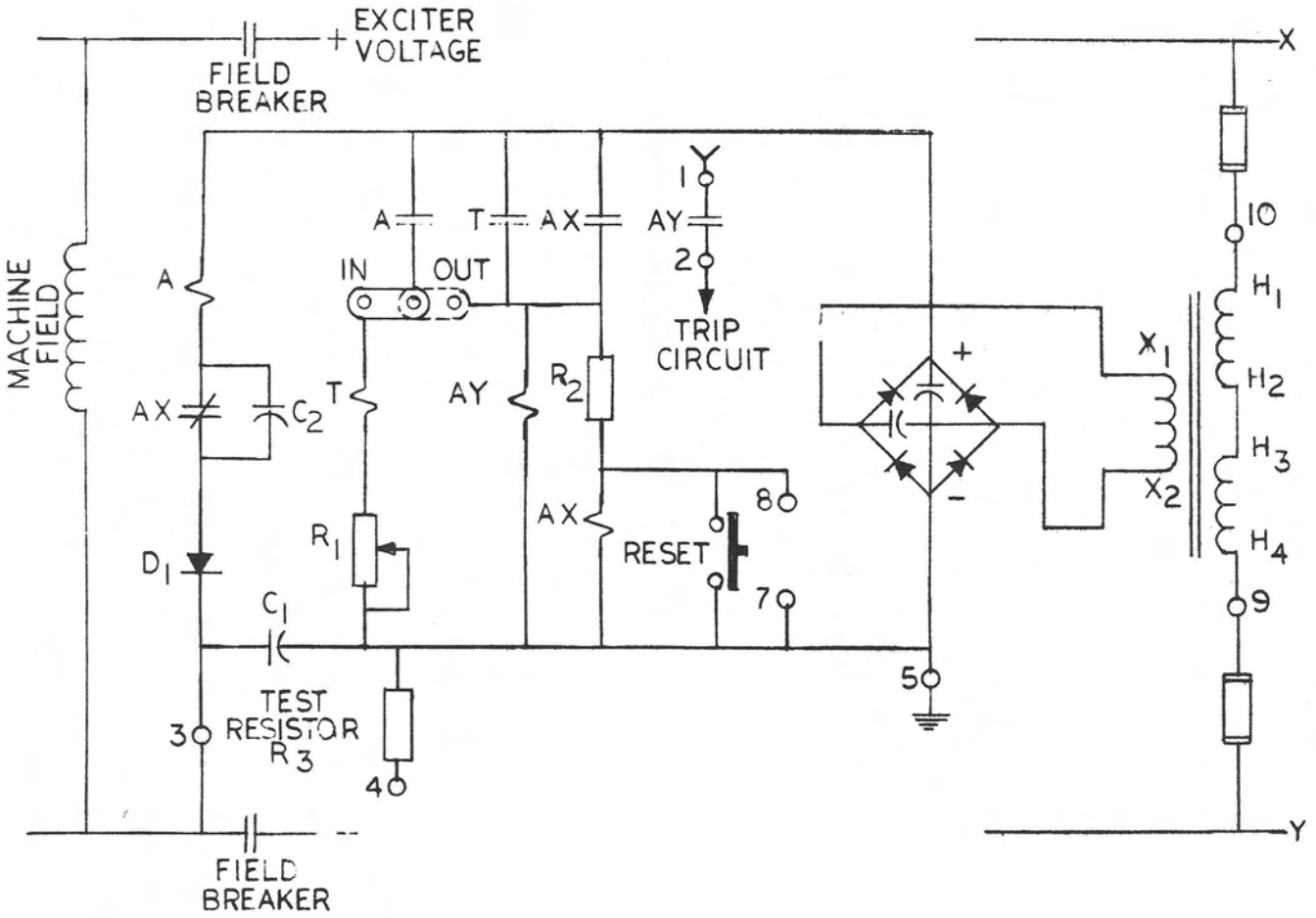


Fig. 4 (0269A3006-0) Simplified Connection Diagram



NOTE:

1 – STUD NUMBERS REFFR TO PJG12B RELAY.

2 – TRANSFORMER PRIMARY SHOWN CONNECTED FOR 240VAC. FOR 120VAC, PRIMARIES ARE CONNECTED AS FOLLOWS:

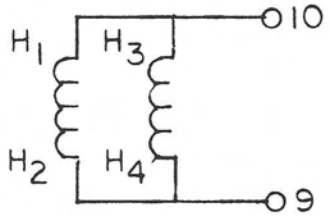
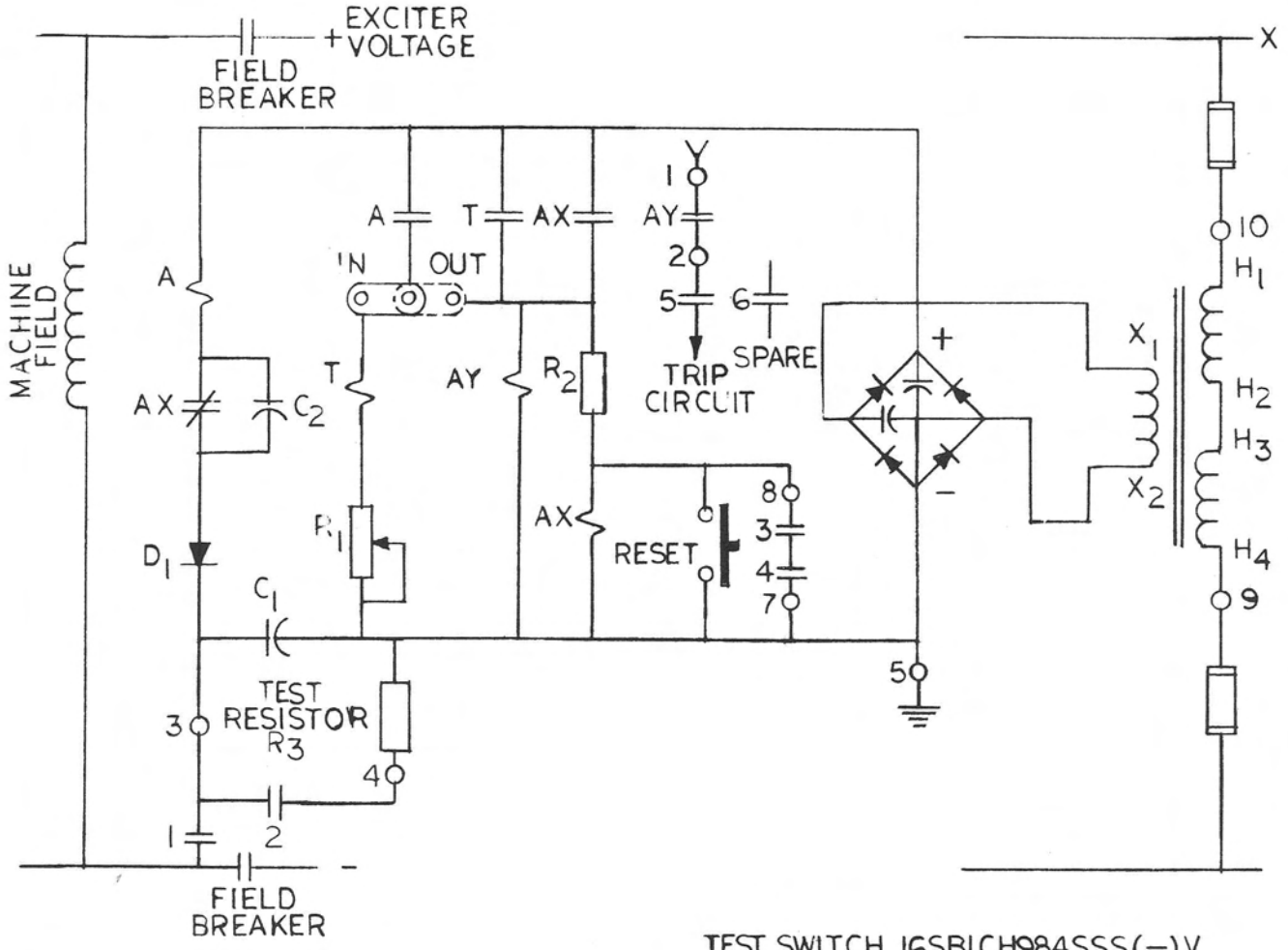


Fig. 5 (0269A3007-0) External Connections for PJG12B Relay Without External Test Switch



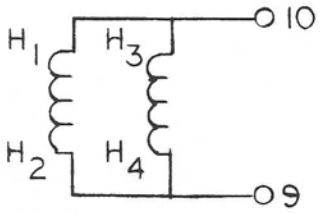
TEST SWITCH 16SB1CH984SSS(-)V
"X" DENOTES CONTACT CLOSED

CONTACTS HANDLE END		(FV) POSITIONS NOR	RESET	TEST
1 o-||-o 2	1	X		
	2			X
3 o-||-o 4	3		X	
	4		X	
5 o-||-o 6	5	X		
	6		X	X

NOTE:

1 - STUD NUMBERS REFER TO PJG12B RELAY.

2 - TRANSFORMER PRIMARY SHOWN CONNECTED FOR 240VAC. FOR 120VAC PRIMARIES ARE CONNECTED AS FOLLOWS:



3 - THIS TEST CHECKS CORRECT RELAY OPERATION BUT NOT THE FACT THAT THE ROTOR IS PROPERLY GROUNDED.

Fig. 6 (0269A3008-0) External Connections for PJG12B Relay with External Test Switch

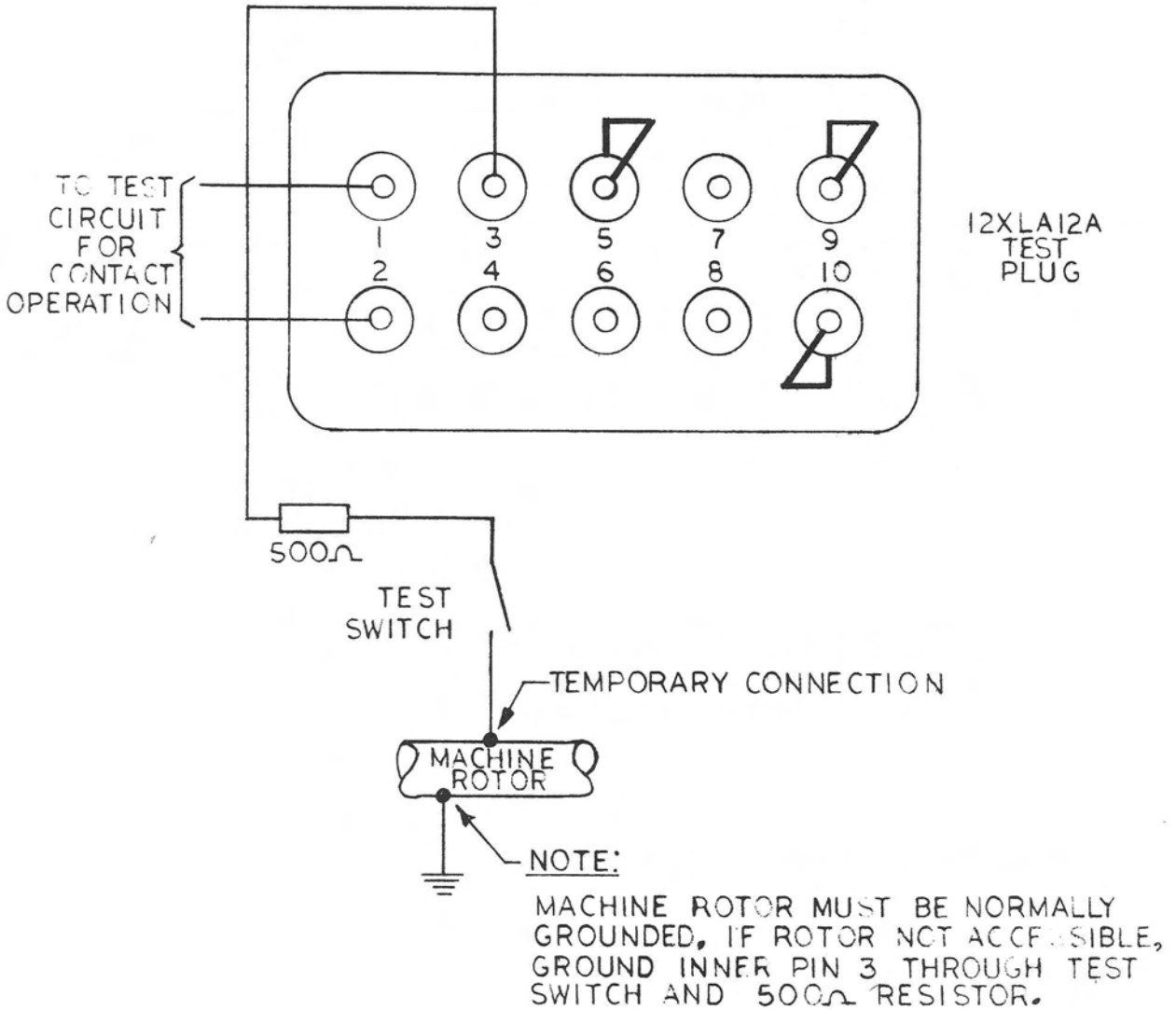


Fig. 7 (0269A3009-0) Test Plug Connections for Relay Operation and Suitable Grounding

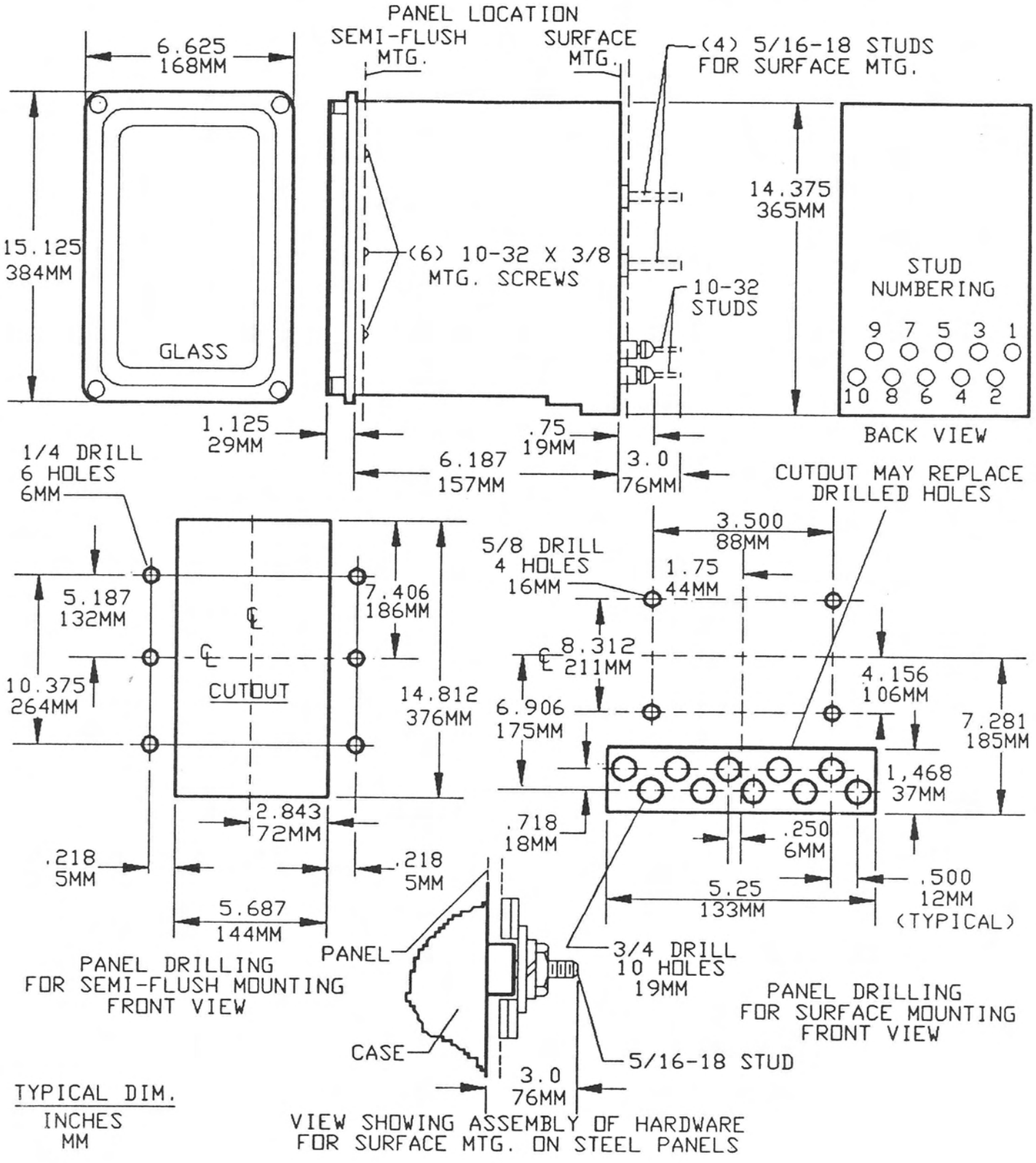


Fig.8 (6209273 [5]) Outline and Panel Drilling

Protection and Control
Business Department

(8/93) (200)

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