INSTRUCTIONS

GEI-68764

NEGATIVE-PHASE-SEQUENCE
TIME OVERCURRENT RELAY
TYPE INC 51A

GENERAL ELECTRIC

NOTES

NEGATIVE SEQUENCE TIME OVERCURRENT RELAY

TYPE INC15A

INTRODUCTION

The INC51A is a non-directional negative sequence time overcurrent relay having an inverse time-current characteristic. The relay includes a negative sequence current filter, the output of which drives an induction disc overcurrent unit all mounted in an M1 case with a universal 0.2/2.0 ampere target seal-in unit. The relay will operate for single phase-to-ground, double phase-to-ground and phase-to-phase faults where the negative sequence component of fault current exceeds the pick up setting of the relay. One INC51A relay is required per terminal to give this protection. A separate device would be required for three phase fault protection.

APPLICATION

The INC51A may be applied as a relatively long time non-directional back up relay for all except three phase faults. See Fig. 9 for operating times. The relay offers the advantage that it may be set to pick up for fault currents below full load values. Specifically the INC51A is particularly suited for application on the main terminals (1 and 2) of a line similar to that illustrated in Fig. 1 below:

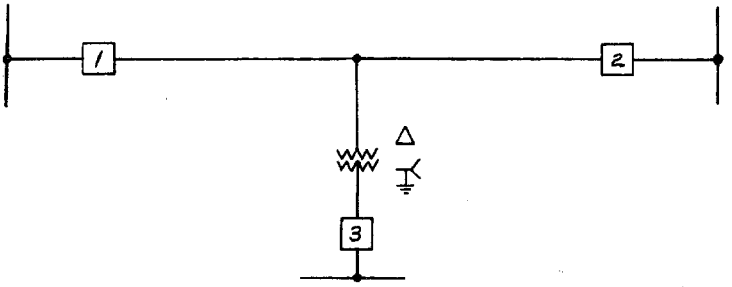


Fig. 1 (0165A7586-0) Typical Transmission Line Where INC51A Relay Finds Application For Backup Protection

When distance relays are used on the main terminals of this line, the phase shift in the delta-wye (or wye-delta) transformer makes these relays incapable of providing reliable time delay back-up protection for phase-to-phase and double phase-to-ground faults on the low side of the bank. One INC51A relay at each of the main terminals can provide this back-up protection plus single phase-to-ground back up while the distance relays provide three phase fault back up. The external connections to this relay are indicated in Fig. 2.

In the application of this relay it should be recognized that the negative sequence filter in the relay will saturate at high levels of current. For balanced three phase (pure positive sequence) faults the relay may pick up if this current exceeds twelve times the relay (negative sequence) tap setting.

RATING

The INC51A relay current coils are rated for a balanced three-phase current of 5 amperes on all taps. They have one second rating of 200 amperes either 3 phase or any pair of phases with any tap setting. The tap plate is marked five different tap settings as follows; 1.5A, 2.0A, 2.6A, 3.6A and 4.5 amperes. These tap settings are the relay pick up settings in negative phase sequence secondary current.

The circuit closing rating of the relay contact is 30 amperes for voltages not exceeding 250 volts. The current carrying rating of this contact is limited by the tap rating of the target seal-in coil as indicated in Table A.

TABLE A

	2 AMP TAP	0.2 AMP TAP
DC Resistance	0.13 ohms	7.0 ohms
Min. Oper.	2.0	0.2
Carry Continuously	3.0 amps	0.30 amps
Carry 30A For	4 secs	-----
Carry 10A For	30 secs	0.2 secs

The breaker trip coil circuit as indicated in Fig. 2 must be opened by a circuit breaker auxiliary switch or other suitable means as the INC51A relay contacts have no interrupting rating.

CHARACTERISTICS

The overcurrent unit is similar to the overcurrent relay Type IAC and picks up when the negative phase current reaches the tap setting ± 5 percent. The pick up times at the different time dial settings are given in Fig. 9. Time delay settings between the time dial settings can be obtained by interpolation and test. The overcurrent relay resets at 90 percent or more of the pick up value with a time delay of approximately 6 seconds with time dial setting #10.

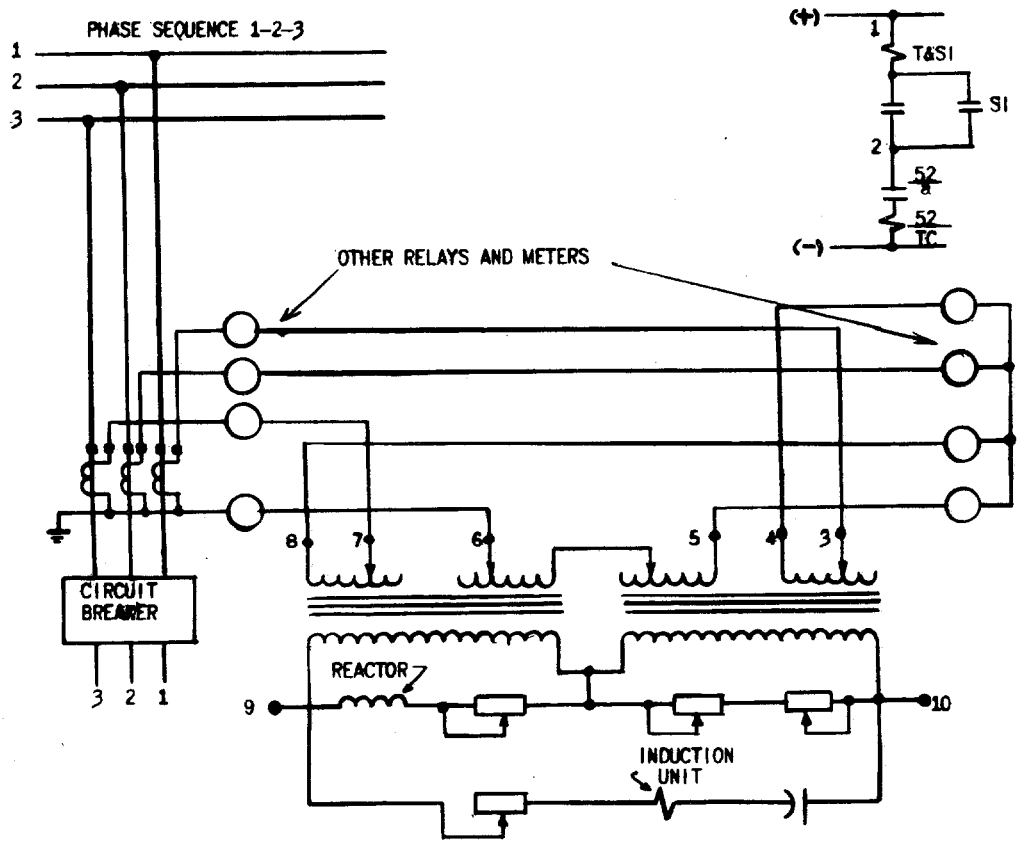


Fig. 2 (0104A8968-2) External Connection Diagram For The INC51A Relay

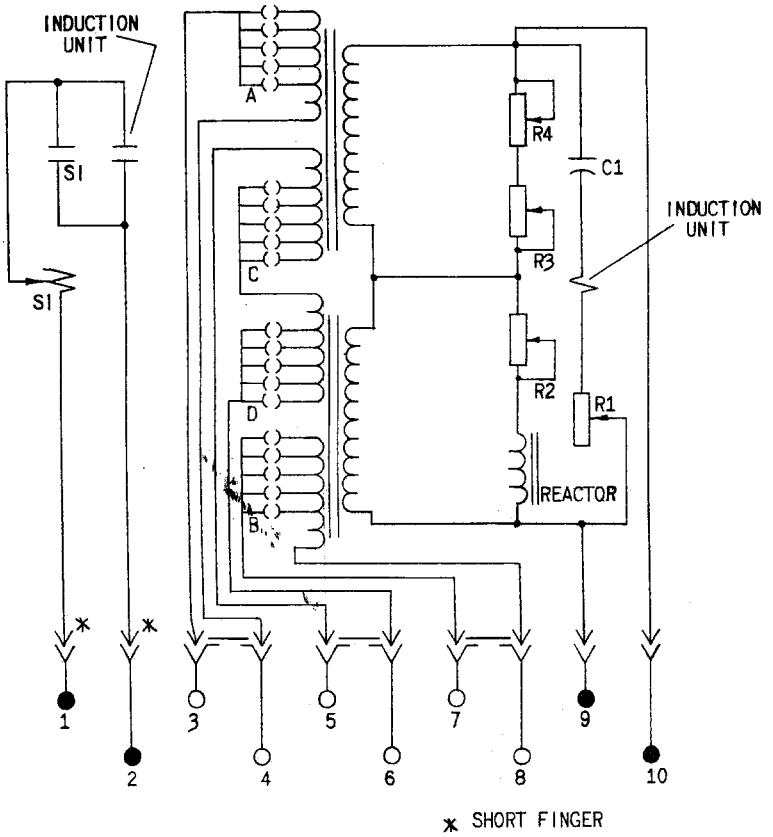


Fig. 3 (0104A8967-0) Internal Connection Diagram (Front View) Of The INC51A Relay

The burdens of the current coils are given in Table B for a balanced 3-phase condition.

TABLE B

BURDEN WITH BALANCED 3 Ø LOAD OF 5 AMP. SEC. CURRENT

PHASE	V.A.	W.	PF
1	32	18	.57
3	32	18	.57

The negative phase sequence filter consists of two auxiliary current transformers each with a double primary winding and a single secondary winding. These two secondary windings are connected in series and across them are connected suitable resistors and a reactor, as shown in Fig. 3, to give a total output voltage of substantially zero across the overcurrent unit when the 3 activating currents are balanced. When unbalanced conditions occur, a current proportional to the negative phase current flows thru the overcurrent unit. The pick up of this unit is controlled by the tap settings on the primary current coils. Additional adjustment of the pick up can be made by changing the value of variable resistor R1 which is shown in Fig. 3.

CONSTRUCTION

The inverse time overcurrent unit consists of a current coil wound on a U-magnet iron structure. The U-magnet includes a shading coil which produces a flux out of phase with the flux produced by the operating current. These two fluxes interact to produce a torque which tends to rotate the disk and closes the relay contact. A spiral spring restrains the disk and establishes the pick up point. The spring adjustment is compensated to provide the same pick up at all time lever settings. The motion of the disk is retarded by an alnico drag magnet which produces the desired time characteristic. The time delay is adjusted by changing the distance the rotating disk must travel to close the relay contact.

The target seal-in unit is a small hinged armature type relay consisting of a "U" shaped magnet frame, fixed pole piece, armature, and a tapped coil. The armature carries a "T" shaped moving contact which bridges the two stationary contacts, and also operates a hand reset target.

The relay components are mounted in a cradle assembly which is latched into a draw-out case when the relay is in operation but it can be easily removed when desired. To do this, the relay is first disconnected by removing the connection plug which completes the electrical connections between the case block and the cradle block. To test the relay in its case this connection block can be replaced by a test plug. The cover, which is attached to the front of the relay case, contains the target reset mechanism and an interlock arm which prevents the cover from being replaced until the connection plugs have been inserted.

The relay case is suitable for either semi-flush or surface mounting on all panels up to 2 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. For outline and drilling dimensions, see Fig. 10.

Every circuit in the drawout case has an auxiliary brush, as shown in Fig. 4, to provide adequate overlap when the connecting plug is withdrawn or inserted. Some circuits are equipped with shorting bars (see Fig. 3) and on these circuits it is especially important that the auxiliary brush makes contact as indicated in Fig. 4 with adequate pressure to prevent the opening of C.T. secondary circuits or important interlock circuits.

RECEIVING, HANDLING AND STORAGE

These relays, when not included as 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. 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.

VISUAL INSPECTION

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

Remove the relay from its case and check by visual inspection that there are no broken or cracked molded parts or other signs of physical damage, and that all screws are tight. The drag magnets should be fastened securely in position on their mounting shelves. There must not be any metallic particles or other foreign matter in the air gap of either the drive magnet or the drag magnet.

Check that the shorting bars are in the correct locations as indicated in Fig. 3 and that the auxiliary brushes are properly adjusted.

MECHANICAL INSPECTION

It is recommended that the following mechanical adjustments be checked:

(A) Time Overcurrent Units

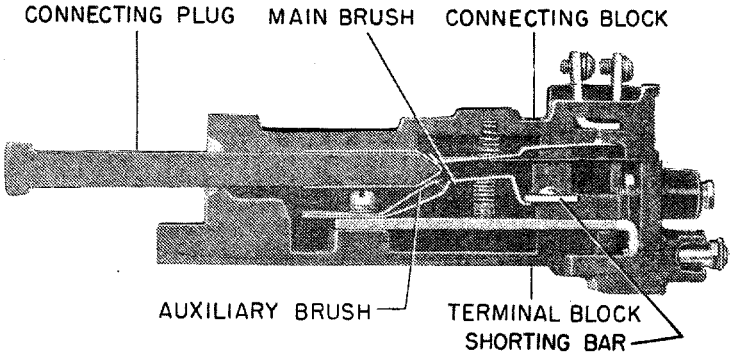
1. With the time dial at the zero position the moving contact should just touch the stationary contact. There should be sufficient clearance between the stationary contact brush and its backing strip to allow for at least 1/32" wipe. Then set the dial at the approximate setting which will be used when the relay is installed.

2. The disk and shaft assembly should have a vertical end play of from 1/64" to 1/32". The set screws for the upper pivot and lower jewel screw must be tight. The disk should be approximately centered in the air gap of both the driving magnet assembly and the drag magnet. The minimum permissible clearance between the disk and either the driving or drag magnet is .008". The disk and shaft assembly should turn freely without noticeable friction.

3. Check the stop arm assembly located near the top of the disk shaft. There should be approximately 1/64" deflection of the leaf spring.

(B) Target Seal-In Unit

Operate the target seal-in unit manually to check that it operates without any binds and that the target shield drops before the contacts make.



NOTE: AFTER ENGAGING AUXILIARY BRUSH, CONNECTING PLUG TRAVELS 1/4 INCH BEFORE ENGAGING THE MAIN BRUSH ON THE TERMINAL BLOCK.

Fig. 4 (8025039) Cross Section Of Drawout Case Showing Position Of Auxiliary Brush

ELECTRICAL TESTS

It is recommended that the following electrical checks be made immediately upon receipt of the relay. Note that all tests should be made with the relay in its case and in a level position. A source of power with a good wave form must be used for these tests.

1. With the tap screws in the 1.5A position, the time dial at the # 1/2 setting and the relay connected in accordance with Fig. 5, close switches S1 and S3. The overcurrent unit should pick up and close its contact at 2.6A ± 5%.

2. Turn the time dial to #10 and again check the pick up. This test checks the restraining spring compensation. The pick up should be the same as the pick up at the 1/2 time lever settings within the accuracy limits indicated.

3. With the time dial at #10 and the tap screw in the 1.5A position and with the overcurrent unit picked up, reduce the current until the unit completely resets. The overcurrent unit should reset at 90% of its minimum pick up current or above.

4. Check the pick up of the other tap settings with the time dial at the #1/2 position. The current required to just close the overcurrent unit contact at each of the taps is given in Table C. The pick up of the unit should be within ± 5% of these values.

TABLE C

TAP	P.U. AMPS
2.0	3.45
2.6	4.50
3.6	6.23
4.5	7.70

5. With the tap screws in 1.5 positions check the pick up with (a) switches S1 and S2 closed and then (B) with switches S2 and S3 closed. The pick up in each case should be the same as the pick up in the test when switch S1 and S3 were closed.

6. With the relay connected as shown in Fig. 6, the dial in the No. 5 position and the tap screws in the 1.5A positions adjust the circuit so that the current flowing thru the ammeter is as listed in Table D. Check the contact closing time of the overcurrent unit which should agree with values given in Table D.

TABLE D

Ammeter Amps	Neg. Phase Sequence Amps.	Time To Close Contact	
		Min.	Max.
5.2	3.0	3.20 Sec.	3.80 Sec.
7.8	4.5	2.34	2.86
10.4	6.0	2.03	2.47
13.0	7.5	1.88	2.28
18.2	10.5	1.60	1.93

7. Using connections shown in Fig. 6, omit the timer connections and connect a DC power source thru a suitable variable resistor, and an ammeter to studs 1 and 2. Check that the seal-in unit picks up at approximately the nominal rating of each of the coil taps, and check that the target operates correctly.

8. Connect the relay to a 3-phase source of power and check that the relay does not pick up when a balanced load of 10 amperes is used. Use the time setting #1/2 for this test.

INSTALLATION PROCEDURE

If after the ACCEPTANCE TESTS the relay is held in storage before shipment to the job site, it is recommended that the visual and mechanical inspection described under the section on ACCEPTANCE TESTS be repeated before INSTALLATION.

Before any of the following electrical tests are made, the relay should be in its case preferably mounted in its permanent location. A source of power with a good wave form must be used for these tests.

RELAY PICK-UP AND TIME SETTING

1. The relay should be set for the pick-up and time delay to be used in its final location. Connect the relay as shown in Fig. 7 and close the switches S1 and S3. Adjust the current thru ammeter 1 to give the desired negative phase sequence current by using the following equation.

$$I_{Neg.\ \emptyset\ Seq.} = \frac{I_1}{\sqrt{3}}$$

The correct tap settings should give approximately the correct pick up and further adjustment can be made by varying resistor R1. Check both the pick up and the time delay. The approximate time delay setting required can be made by referring to Fig. 9 but this time should be checked and adjusted as required.

2. Open switch S1 and close switch S2 and check that the relay picks up at approximately the desired setting. The negative phase sequence current will be the same for this relay connection.

3. Open switch S3 and close switch S1 and check that the relay pick up is unchanged from the previous tests.

PERIODIC CHECKS AND ROUTINE MAINTENANCE

In view of the vital roll 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 following points be checked at an interval of from one to two years.

MECHANICAL INSPECTION

Repeat the Mechanical Inspection recommended under ACCEPTANCE TESTS.

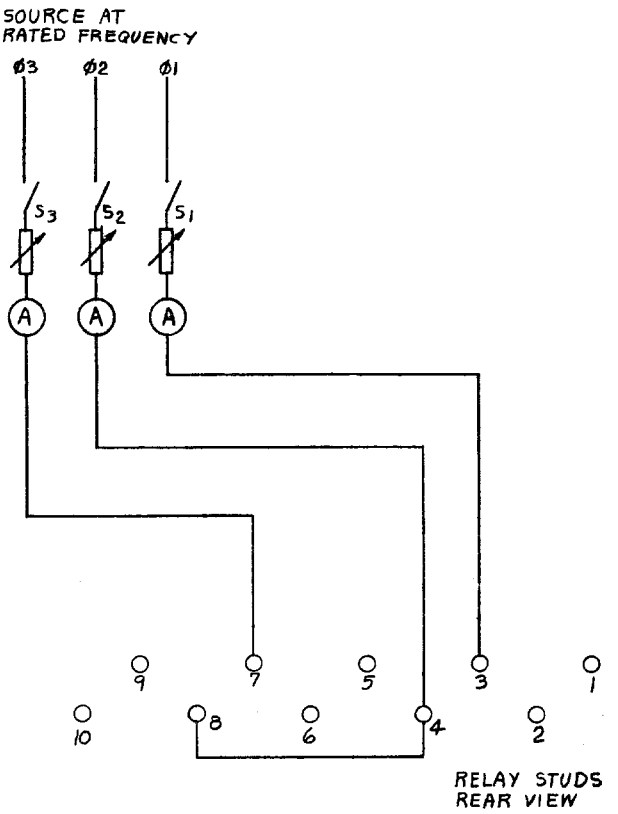


Fig. 5 (0165A7587-0) Laboratory Test Connections For Checking Pick-up Of Relay Type INC51A

ELECTRICAL TESTS

Repeat the Electrical Tests recommended under INSTALLATION PROCEDURE. If test results vary slightly from those recorded in the INSTALLATION TESTS but are within acceptable accuracy limits (± 5%) the relay adjustment should not be disturbed. If, however, it is found that adjustments are necessary, refer to section on SERVICING.

SERVICING

If any of the tests described in previous sections indicate that adjustments are required, the following instructions should be observed in making them.

NEGATIVE SEQUENCE NETWORK ADJUSTMENT

Connect the relay as shown in Fig. 8 using a source of 3-phase power with a good wave form and ammeters which have been very carefully calibrated. Set the variable load resistors to provide 4 amperes thru each ammeter. Adjust the resistors so that R_3 -R_4 combined have 400 ohms and R_2 170 ohms resistance (refer to Fig. 4). The resistors can be temporarily disconnected to facilitate measuring their resistance if desired. Adjust R_2 and R_3 -R_4 so that with the balanced 4 ampere load the voltage across the relay studs 9-10 is less than 1.8 volts with the relay tap screws in the 1.5A position. A high resistance 5 volt voltmeter will be required for this reading.

This adjustment is accomplished by "cross adjustment" of the R_2 and the R_3-R_4 combination. That is starting with the preliminary settings first change R_2 to provide a minimum voltage output. Then adjust R_3-R_4 to produce a minimum voltage. Next readjust R_2 again and repeat the process until any change in either resistance tends to increase the voltage output.

If the voltage is slightly above 1.8 volts after final adjustments are made, it is probably due to poor wave form of the source.

After final adjustments of the rheostats tighten their locknuts securely to prevent accidental changes in resistance settings.

After the above adjustment, check the network at the following 3-phase balanced load amperes to be sure the voltage across studs 9-10 fall within the limits given in Table E with tap screws in 1.5 ampere position.

TABLE E

BALANCE 3-PHASE AMPS	VOLTS 9-10 STUDS
8A	4-6V
10A	11-16V

MECHANICAL ADJUSTMENTS

(A) Time Overcurrent Units

1. Contact Adjustments

The contacts should have approximately 1/32 inch wipe. That is, the stationary contact should be deflected about 1/32 inch when the disk completes its travel. The contact wipe is adjusted by turning the screws in the contact brush which regulates the position of the brush in relation to the brush stop.

When the time dial is moved to a position where the contacts just close, the time dial scale should indicate zero. If this is found incorrect, and the brushes are correctly adjusted, regulate the dial to read zero. This is done by changing the position of the arm attached to the shaft, which is located below the time dial. Loosen the screw which clamps the arm to the shaft and turn the arm relative to the shaft until the contacts just make at the zero time-dial setting.

The leaf spring on the stop arm should be so formed that there is approximately 1/64" deflection. The deflection can be increased if necessary by forcing a thin screwdriver blade between the leaf spring and the stop arm.

2. Shaft End Play

End Play is determined by the relative positions of the lower jewel bearing and upper pivot. Both bearing and pivot are held in position by means of set screws in the die-cast supporting frame. The lower jewel must be located so that the disk is approximately centered in the airgaps of the driving magnet and the drag magnet. The upper pivot should then be located so that the shaft has 1/64 inch to 1/32 inch end play. Be sure that both set screws are securely tightened after the adjustment is completed.

3. Friction

If a tendency to bind or excessive friction is eivdent, first check for obstructions to the disk travel. Dirt or metallic particles in the wattmetric or drag magnet gaps can interfere with the motion of the disk.

ELECTRICAL ADJUSTMENTS

The pick up should be adjusted by means of the resistor R_1, (see Fig. 3) and not by winding up the restraining spring. The restraining spring has been compensated to provide the same pick up at all time lever positions and winding up this spring may destroy this adjustment.

If the pick up time for a particular time dial setting and pick up multiple is found to be outside the limits given in ACCEPTANCE TESTS, it can be restored by changing the position of the drag magnetic on its supporting shelf. Moving the magnet towards the shaft decreases the time while moving it away from the shaft increases the time. Be sure that the magnet in its final position clears the counter weight on the disk for all positions of the disk and shaft assembly. If the magnet is moved away from the shaft, its outer edge must be at least 1/8" from the edge of the disk at the smallest radius of the disk.

For cleaning fine silver contacts, a flexible burnishing tool should be used. This consists of an etched roughened strip of flexible metal, resembling a superfine file which removes corroded material quickly without scratching the surface. The flexibility of the tool insures the cleaning of the actual points of contact. Never use knives, files, abrasive paper or cloth to clean fine silver contacts. A burnishing tool as described above can be obtained from the factory.

RENEWAL PARTS

It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken or damaged.

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of the part wanted, and give complete nameplate data. If possible, give the General Electric requisition number on which the relay was furnished.

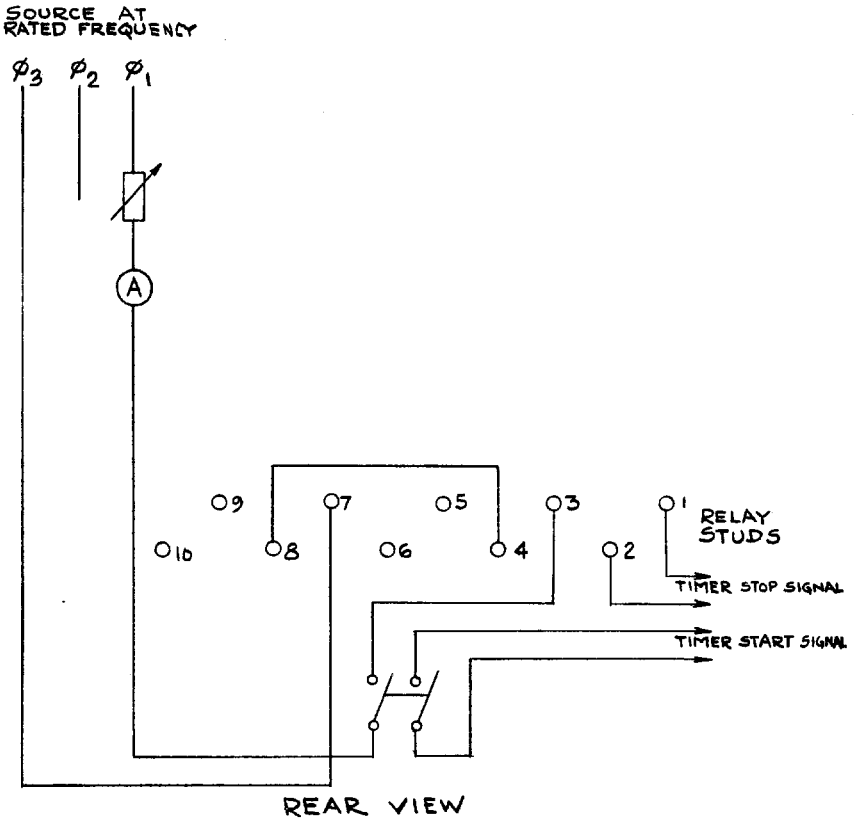


Fig. 6 (0165A7583-0) Laboratory Test Connections For Timing Test Of Relay Type INC51A

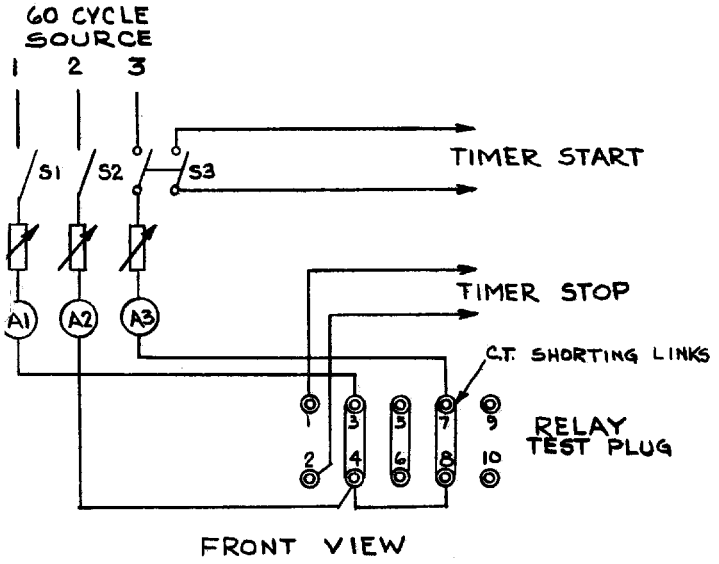


Fig. 7 (0165A7584-0) Field Test Connections For Checking Pick-up And Time Delay

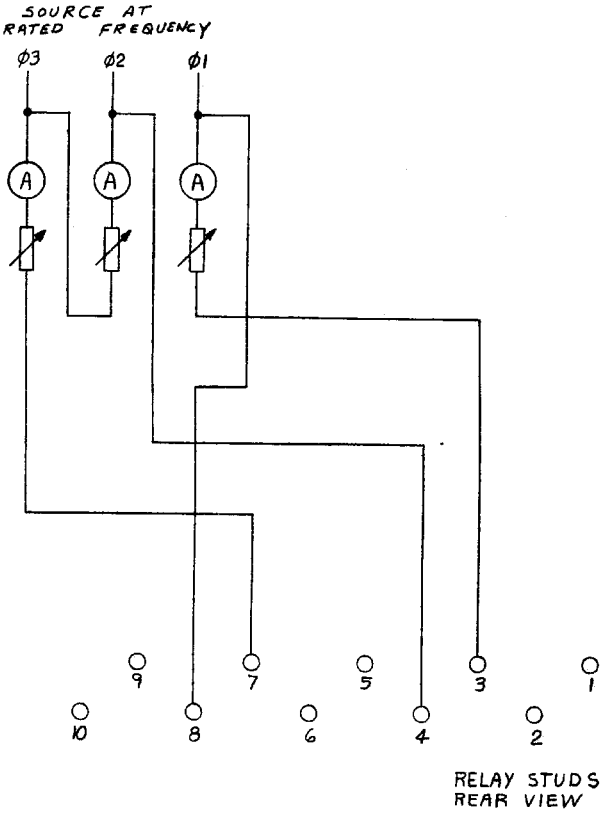


Fig. 8 (0165A7585-0) Test Connections For Adjustment Of Negative Sequence Network

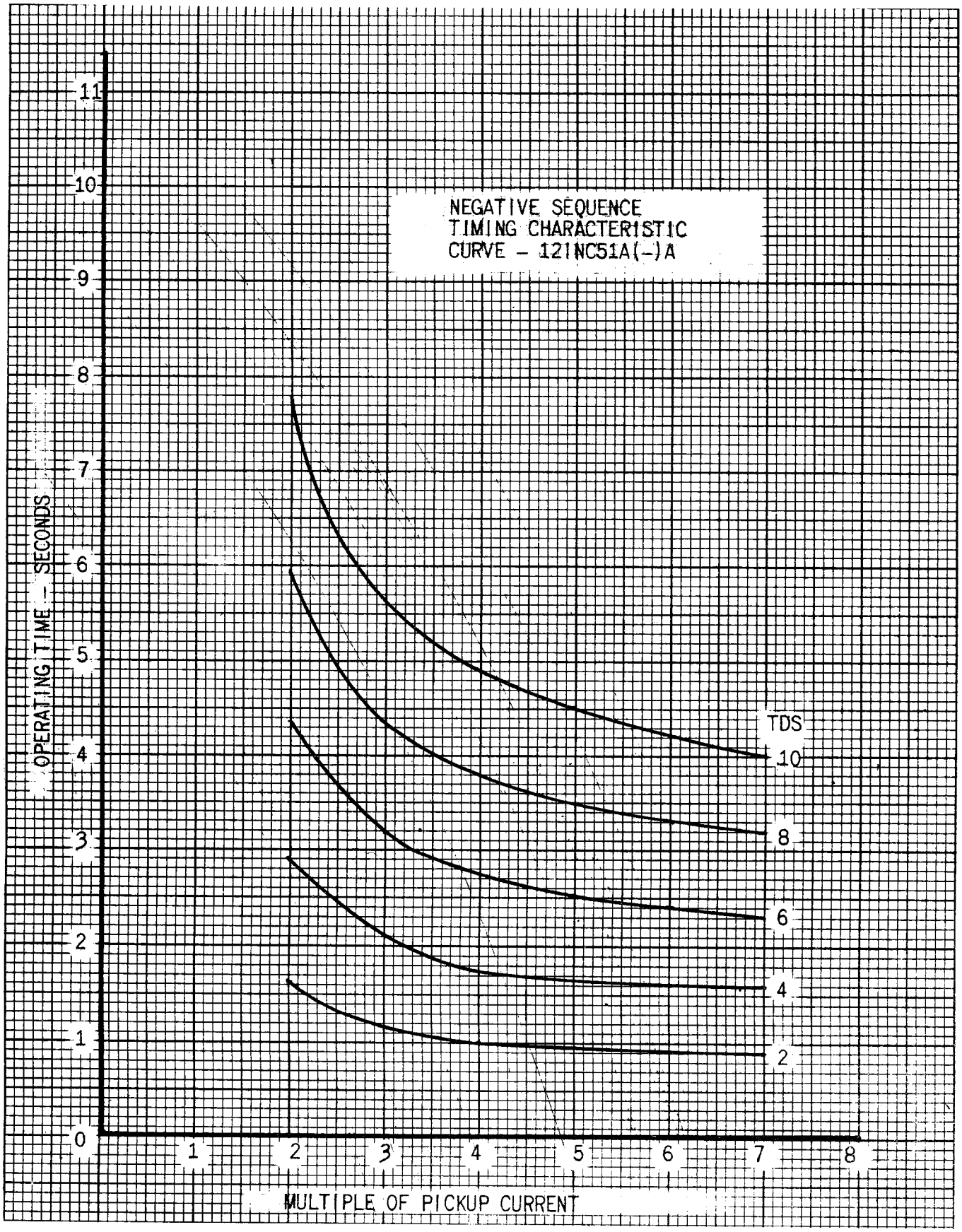


Fig. 9 (0104A8988-0) Typical Time Current Curves Of The INC51A Relay

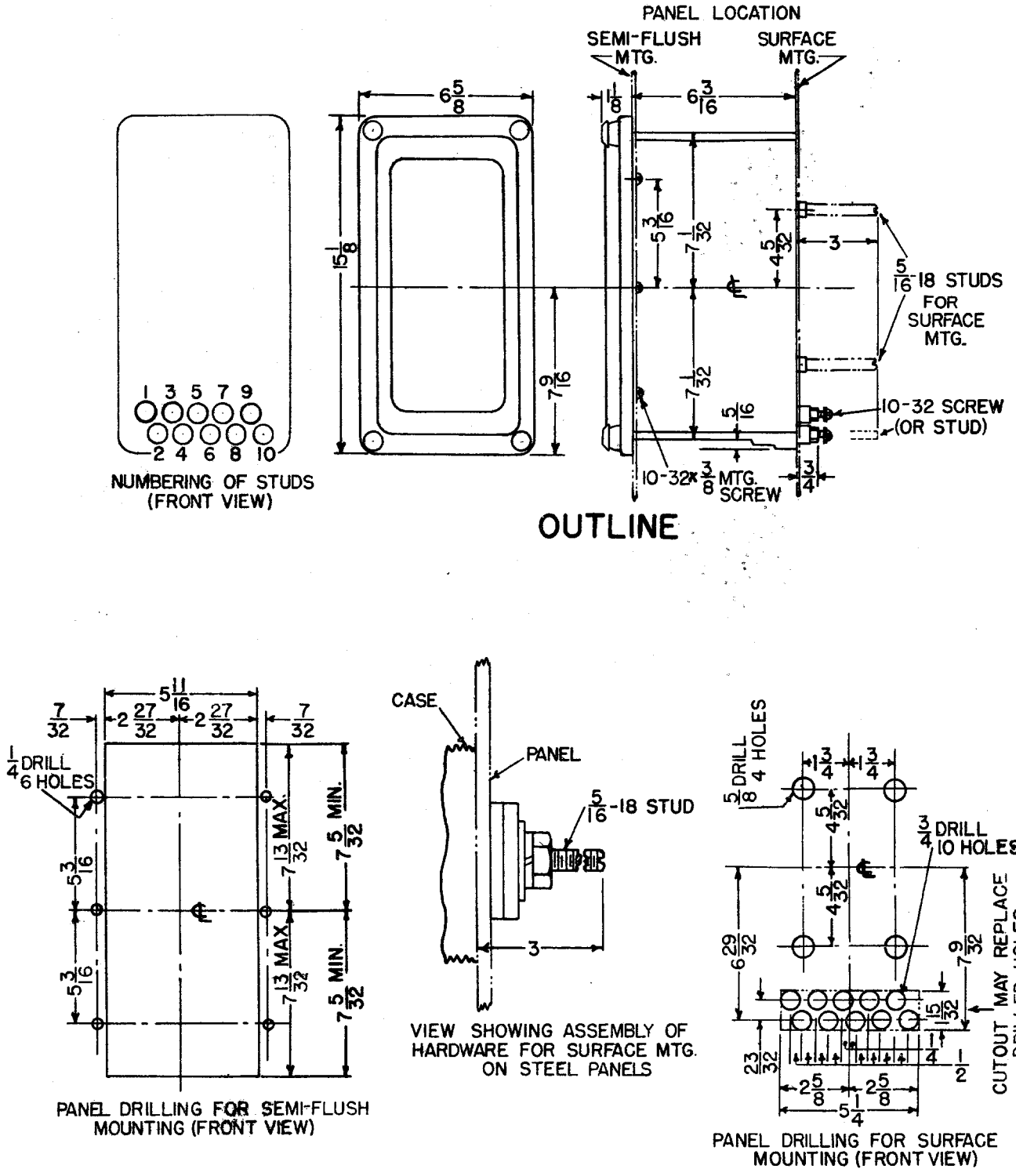


Fig. 10 (K-6209273) Outline And Panel Drilling Dimensions For The INC51C Relay

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