INSTRUCTIONS

GEK-45364 A
Supersedes GEK-45364

AUTOMATIC RECLOSING RELAY

TYPE NSR21H

GENERAL ELECTRIC

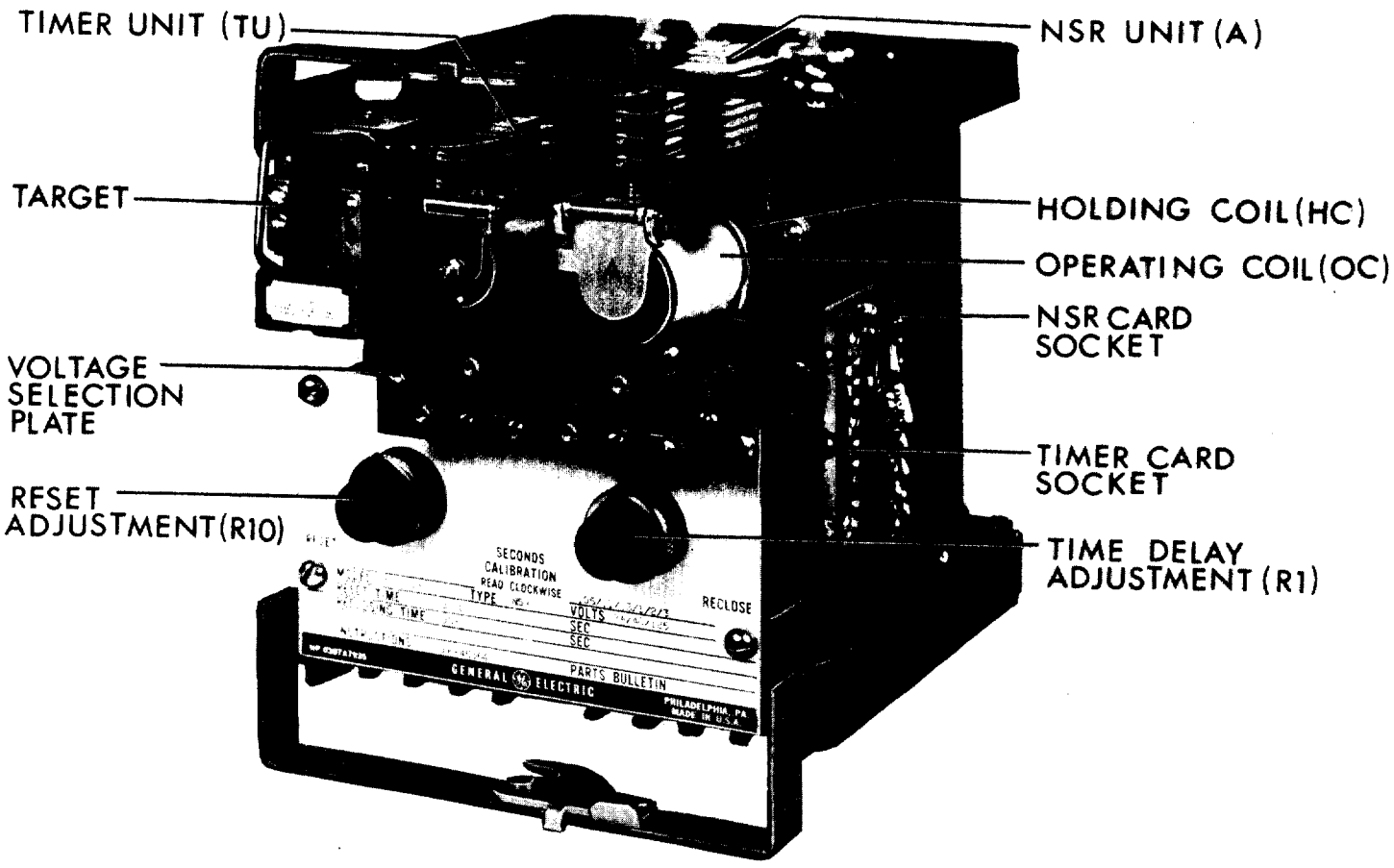


Figure No. 1 (8042599). Front view of the NSR21H Relay Removed from its Case.

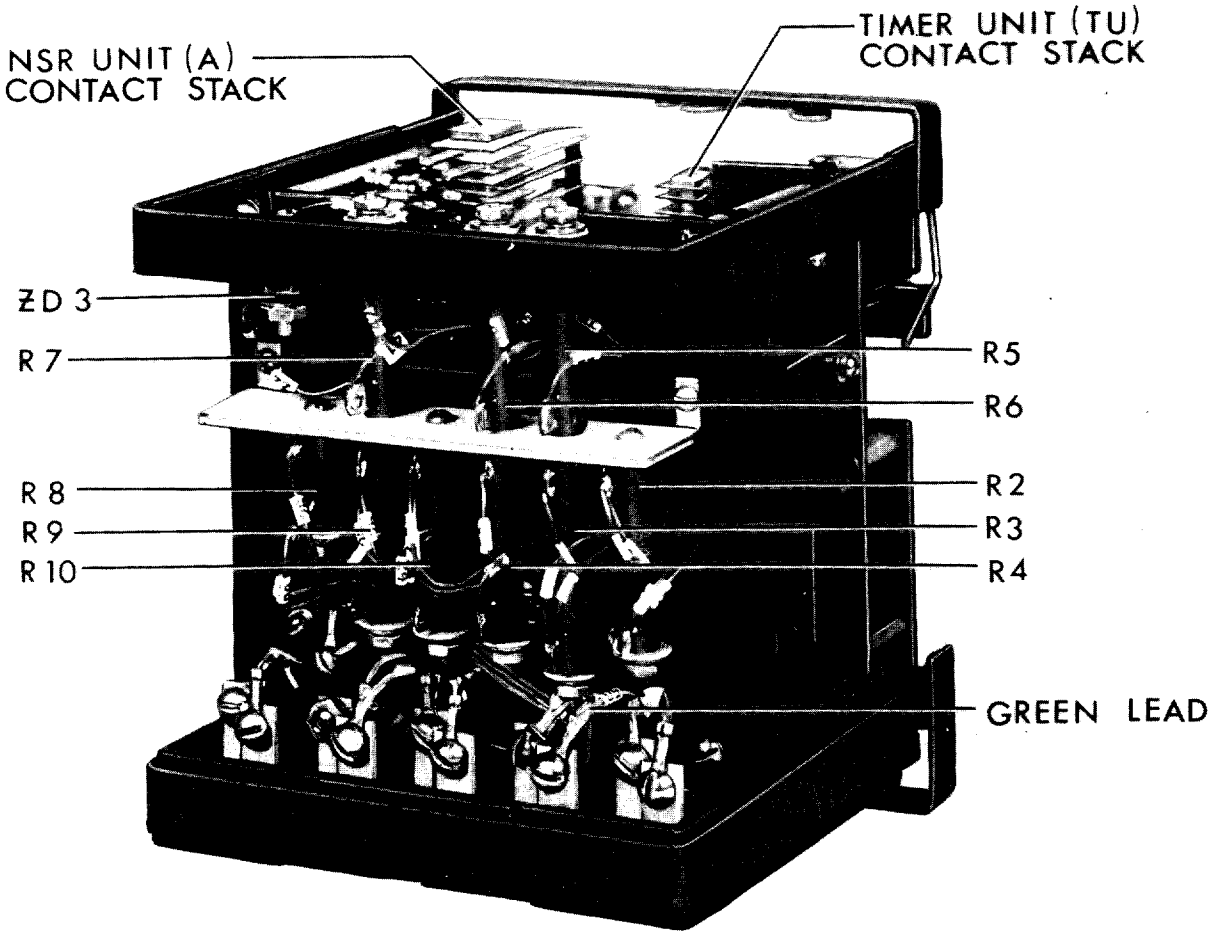


Figure No. 2 (8042600). Rear View of the NSR21H Relay Removed from its Case.

CONTENTS

INTRODUCTION

These instructions furnish the information needed to test and install the General Electric Type NSR21H relay.

DESCRIPTION

GENERAL

All type NSR relays are single-shot, automatic reclosing relays. The NSR21H offers:

1. adjustable, time-delay reset, a standard NSR feature,
2. triple rated for use on any of three DC supply voltages, another NSR standard,
3. adjustable auxiliary timer to delay reclosing by a precise time,
4. a dual rated target on the auxiliary timer output, and
5. a standard draw-out case packaging in the S1 size.

APPLICATION

The type NSR21H reclosing relay is usually applied with transmission line circuit breakers where a single reclosure with a slight time delay is desired, and where if this single reclosure attempt is unsuccessful, it is desired to lock out the breaker. The usual application of this relay is with transmission line relaying schemes, either electromechanical or static, which include a reclosure initiation function (RI) to initiate the reclose sequence when these protective relays operate. The external connections for such an application are shown in figure 7. Note that for this application the green color-coded lead must be connected to terminal 8.

On some transmission line applications, it is desirable to block reclosing in the event that the breaker is tripped during an out-of-step condition. The diagram in figure 7 shows the use of contacts of an auxiliary unit OB for this purpose. This OB unit is included in the out-of-step detecting relay identified as device 68.

On applications where a single reclosure is desired when the breaker is tripped by any line protective relays, reclosing can be initiated by the "b" switch of the breaker (52/b). The application of the NSR21H relay in such a scheme is covered by the external connection diagram of figure 8. Note that for this application the green color-coded lead must be connected to terminal 3.

With the scheme as shown in figure 8, the short delay in the reclosure will be present regardless of which protective relays tripped the breaker. A possible alternate arrangement is to use the spare 79/A unit contact (between studs 9-10) in conjunction with the RI contact to bypass the 79/TV contact as shown in figure 9. This will provide high-speed reclosing when the breaker is tripped by high-speed pilot relaying, and delayed reclosing following a time-delay trip.

GENERAL CONSIDERATIONS

The following general points must be considered when applying automatic reclosing relays:

1. Interrupting Rating of Power Circuit Breaker - The derating factor applying to the interrupting rating of the power circuit breaker should be checked prior to the application of a reclosing relay or the selection of a reclosing cycle.
2. Closing Control Circuits - When automatic reclosing is used, it is essential that the closing circuits with solenoid mechanism ensure complete closure of the breaker even though the auxiliary switch on the breaker mechanism opens before the closure is complete.

3. Latch-Checking Switches - In order to ensure successful operation of a breaker reclosed by a Type NSR relay, it is necessary that the breaker mechanism be equipped with a latch-checking switch if the mechanism is trip-free. This switch ensures that the mechanism latch is properly set for reclosure before the closing circuit is completed. Latch-checking switches are not required for non-trip-free mechanisms.

4. Control Switches - A control switch (typically Model 16SB1B9) should be provided with automatic reclosing schemes using the Type NSR reclosing relays. This switch includes contacts to prevent the breaker from being automatically reclosed after it has been tripped by the control switch. The breaker must be reclosed by means of the switch before the automatic reclosing feature will be restored.

5. Undervoltage Devices - Where undervoltage devices are involved on the circuit fed by the breaker, it is usually necessary to coordinate the reclosing time and the trip time of the undervoltage device to ensure that the desired results are obtained. Where the UVD is involved in a throwover scheme, the initial reclosure usually should be faster. Where motor control is involved, it may or may not be desirable for the initial reclosure to be faster. Each application should be checked to determine the required coordination.

6. Associated Protective Relays - If high-speed reclosing is to be successful, the protective relays that tripped the breaker obviously must reopen their contacts before the breaker recloses. Some of the superseded types of induction time-overcurrent relays are not suitable for use with high-speed reclosing. If distance relays are supplied from line-side potential, their contacts should be supervised by contacts of instantaneous fault detectors to ensure that the trip circuit is open before the breaker recloses.

RATINGS

AMBIENT TEMPERATURE

The type NSR relay is designed to operate over an interval of ambient temperatures; the boundaries of this interval are $-20^{o}C$ ($-4^{o}F$) and $+55^{o}C$ ($+131^{o}F$).

SURGE WITHSTAND CAPABILITY

The NSR relay will withstand the following test voltage waveform without incorrect operation or damage to any component.

The test voltage waveform consists of a high frequency damped oscillation with frequency of 1.5 megahertz. The source has an internal impedance of 150 ohms. The initial value (zero to peak) is 2,500 volts and the damping is such that the envelope of the waveform decays to half the initial value (1,250 volts) in 6.0 microseconds. The test voltage is applied across all combinations of relay terminals and the case.

POWER SUPPLY

All the NSR relays covered by this book contain a regulated power supply. This power supply regulates the voltage so that the relays perform properly over a range of applied d-c voltage from 80 percent to 110 percent of rated voltage The maximum deviation in reset time for settings made at nominal voltage is 15 percent.

RECLOSE UNIT: OUTPUT CIRCUIT

The Reclose unit output is provided by a single normally open contact. This contact is designated A4 and is wired between relay terminal studs 9 and 10 as shown in the internal connections diagram, figure 4.

Table I below gives the alarm reclose interrupting ratings. These contacts will make and carry three amperes continuously or 30 amperes for two seconds.

TABLE I

RECLOSE UNIT CONTACT INTERRUPTING RATINGS

Circuit Voltage	Inductive*	Non-Inductive
115 a-c	0.75 amperes	2.0
230 a-c	0.5 amperes	1.5
48 d-c	1.0 amperes	3.0
125 d-c	0.5 amperes	1.5
250 d-c	0.25 amperes	1.0

*The inductive rating is based on the inductance of a coil having an X_L/R ration of three to one.

TIMER UNIT: OUTPUT CIRCUIT

The internal connection diagram, figure 4, shows the schematic of the output circuit of the timer unit. It is wired between terminals 1 and 2. Electrical continuity is initiated by closure of TU, a telephone relay contact controlled by the static portion of the timer unit. Closure of TU energizes the target coil which limits the tripping duty of the output circuit. Included in Table II are the ratings for the NSR21H target unit.

TABLE II

Target Unit	1.0/4.0 Unit	
	1.0 Amp Tap	4.0 Amp Tap
Maximum to Insure Operation (amperes)	1.0	4.0
Carry Continuously (amperes)	2.5	6.0
Carry 30 amps for (seconds)	1.0	5.0
Carry 10 amps for (seconds)	10.0	50.0
d-c Resistance (ohms)	0.25	0.034
60-cycle Impedance (ohms)	2.0	0.13

CHARACTERISTICS

OPERATING PRINCIPLES: SINGLE-SHOT, RECLOSE CIRCUIT

The operation of these relays is best understood by referring to the typical external connection diagram in figure 8. With the circuit breaker closed the auxiliary switch 52/b will be open and the timing capacitor (79/CAP) will be charged through the closed contacts of 86 and 79CO, and the charging rheostat (79/RHEO). The capacitor voltage at full charge is limited to 15 volts by the zener regulator connected across the capacitor and rheostat. The regulator ensures that the voltage across the capacitor-rheostat combination, and hence the reset time, will be independent of reasonable variations in the supply voltage.

When the breaker is tripped closure of the 52/b contact will discharge the capacitor through the operating coil of the telephone-type unit (79/OC) causing that unit to pick up and seal-in by means of its holding coil (79/HC), and energize the included static timer (79/TU). Subsequent closure of the timer contacts between terminals 1 and 2 will energize the breaker closing circuit.

Another 79 contact discharges the capacitor through the 47 ohm discharge resistor. This ensures that the timing capacitor will be fully discharged so that full reset time will be realized after each operation.

When the breaker recloses, the 52/b switch will open deenergizing the holding coil and causing the relay to reset. The timing capacitor will then commence to recharge. The reset time of the relay is defined as the time required for the capacitor to recharge to the point where its stored energy will be sufficient to pick up the telephone-type relay if the 52/b contact should again discharge the capacitor through 79/OC. This reset time is adjustable over a range of three to 20 seconds (or as defined on the nameplate) by means of the charging rheostat.

If the breaker remains closed for a time longer than the reset time as set by the rheostat, the relay will be ready to initiate a reclosure if the breaker is again tripped. However, if a subsequent opening of the breaker occurs in a time shorter than the reset time of the relay, the stored energy in the capacitor will not be sufficient to pick up the telephone-type relay and the NSR relay will be locked out.

On typical applications with transmission line circuit breakers, high-speed reclosing is initiated by a contact of a reclosure initiating unit (RI) which in turn is operated by the high-speed primary pilot relaying. Operation of the NSR relay in such a scheme, as represented by figure 11, is similar to that described above except that it is now the closure of the RI contact that discharges the capacitor through the operating coil (79/OC) to pick up the telephone-type relay. The RI contact also provides an interim seal-in to 79/HC via diode D1 until the breaker auxiliary switch (52/b) closes. As previously noted, a 79 contact discharges the timing capacitor so that full reset time will be realized after each operation. In addition the 52/b contact provides a second discharge path through diode D3 to ensure discharge of the timing capacitor following a manual trip or a trip by backup relaying which does not operate the RI unit.

OPERATING PRINCIPLES: TIMER UNIT

The time delay circuit measures the time it takes to charge a capacitor through an adjustable resistor after the initiating contact closes. Zener regulators keep the voltage across the resistor-capacitor combination constant to produce a charging time that varies directly with the resistance in the charging circuit. When the capacitor charge reaches a definite voltage level it triggers a control rectifier, by means of an unijunction, and this picks up a telephone-type unit to terminate the timing period.

The relay contains a discharge rectifier which provides a low resistance discharge path for the capacitor charge the instant that the initiating contact opens the timing circuit. This permits the timing circuit to be completely reset as soon as the telephone-type unit drops out. The maximum reset time is 20 milliseconds.

Under identical conditions the relay will repeat its operation as accurately as the relay can be set or within one percent of its original setting. An electronic timer must be used in making the time delay settings.

BURDEN

TABLE III

MAXIMUM POWER DISSIPATION IN WATTS			
Circuit	d-c Control Voltage		
	24	48	125
Operate Circuit (Stand-by)	0.2	0.9	7.0
Holding Circuit (When Energized)	1.3	4.0	10.0
Timer Circuit (When Energized)	10.7	13.1	27.5
Total	12.2	18.0	44.5

CONSTRUCTION

CASE

The NSR21H relays are assembled in a single-ended (S1) drawout case. Figures 1, 2 and 3 show the relay removed from its drawout case with all major components identified.

The case is suitable for either surface or semiflush panel mounting and an assortment of hardware is provided for either mounting. The cover attaches to the case and also carries the reset mechanism when one is required. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at the bottom only for the external connections. The electrical connections between the relay units and the case studs are made through spring-backed contact fingers mounted in stationary molded inner and outer blocks between which nests a removable connecting plug

which completes the circuits. The outer block, attached to the case, has the studs or the external connections, and 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 being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The case and cradle are so constructed that the relay cannot be inserted in the case upside down. 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 fastened to the case by thumbscrews, holds the connecting plug in place.

To draw out the relay unit, the cover is first remove and the plug drawn out. The latches are then released, and the relay unit can be easily drawn out. To replace the relay unit, the reverse order is followed.

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 unit can be drawn out and replaced by another which has been tested in the laboratory.

The cover is provided with a mechanical interlock which prevents replacing the cover unless the connecting plug is in place.

TESTING FACILITIES

All General Electric drawout case relays may easily be tested in the case by using either the XLA12A or XLA13A test plugs. The XLA12A has 20 fingers which bring both the ten relay connections and the ten outside world connections to the front of the relay for easy access. The XLA13A test plug brings only the ten relay connections to the front of the relay without disturbing the CT shorting bars. Circuits for testing the NSR relay, using one XLA12A test plug, are shown in figures 10 and 11.

For further information on the test plug, refer to Section 7332 in the General Electric Apparatus Handbook or contact the nearest General Electric Apparatus Sales Office.

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 substained 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

GENERAL

The relay should be examined and tested upon delivery to ensure that no damage has been sustained in shipment and that the relay functions properly. If the examination or acceptance tests indicate that readjustment is necessery, refer to the section on SERVICING.

The following tests may be performed as part of the installation of the relay 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 the relays.

VISUAL INSPECTION

Check the nameplate stamping to ensure that the model number agrees 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

1. The armature of the target unit should move freely when operated by hand.

2. The flag in the target unit must come into view and latch when the armature is operated by hand and should unlatch when the target release lever is operated.

3. The telephone relay units used in these relays should be checked to have a contact gap of at least ten mils and contact wipe of five mils. The contact wipe may be checked by inserting a five mil shim between the armature and pole piece and operating the armature by hand. The normally open contacts should make contact with the shim in place when the armature is operated by hand.

4. Make sure that the fingers in the relay cradle and case blocks agree with the internal connections diagram. The internal connections diagram is included here as figure 4.

CAUTION: EVERY CIRCUIT IN THE DRAWOUT CASE HAS AN AUXILIARY BRUSH. IT IS ESPECIALLY IMPORTANT ON CURRENT CIRCUITS AND OTHER CIRCUITS WITH SHORTING BARS THAT THE AUXILIARY BRUSH BE BENT HIGH ENOUGH TO ENGAGE THE CONNECTING PLUG OR TEST PLUG BEFORE THE MAIN BRUSHES DO. THIS WILL PREVENT CT SECONDARY CIRCUITS FROM BEING OPEN CIRCUITED DURING INSERTION OF THE CONNECTING PLUG. SEE FIGURE 13.

DRAWOUT CASE

Since all drawout relays in service operate in their case, it is recommended that they be tested in their case 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. Test connections in figure 10 illustrate the use of this more versatile test plug.

POWER REQUIREMENTS GENERAL

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 application of non-sinusoidal waveforms.

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 dc control power should be tested using dc 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 dc source should not contain more than 5% ripple.

TARGET UNIT TAP SETTING

When trip coil current falls within the range of 1.0 to 4.0 amperes at minimum control voltage, the tap screw of the target unit should be set in the low ampere tap. When the trip coil current ranges from four to 30 amperes at minimum control voltage, the tap screw should be placed in the 4.0 ampere tap. The tap screw for the target unit is the screw holding the right-hand stationary contact of the target unit. To change the target unit tap setting, first remove the relay connection plugs. Then take a screw from the left-hand stationary contact and place it in the desired tap. Next, remove the screw from the other tap and place it back in the left-hand contact. This procedure is necessary to prevent the right-hand stationary contact from getting out of adjustment. Screws should never be left in both taps at the same time.

TARGET UNIT CHECK

The pickup and dropout of the target unit can be tested as follows.

1. Connect relay studs 2 and 2 (see figure 4) to a d-c source, ammeter, and load box so that the current can be controlled over a range of 0.1 to 4.0 amperes d-c.

2. Short the TU contacts by jumpering terminal 2 to the target unit tap screw.

3. Increase the current slowly until the target unit picks up. See Table IV for correct pick-up values.

4. Decrease the current slowly until the target unit drops out. See Table IV for correct drop-out values.

TABLE IV

Unit	Tap	Pick-up Amperes	Drop-out Amperes
1.0/4.0	1.0 4.0	0.75 - 0.95 3.0 - 3.90	0.05 or more 0.05 or more

RECLOSING UNIT: TIMING CHECK

1. Set the NSR VOLT SELECT link to the appropriate battery voltage; similarly adjust the TU VOLT SELECT link.

2. Assemble test setup as shown in figure 10.

3. The reset control has been set at the factory between 13 and 16 seconds.

4. Move the switch S1 to DISCHARGE position.

5. Close S2; this charges the capacitor to its normal initial conditions.

6. Open S2; reset timer.

7. Move S1 to the OPEN position.

8. Close S2; then at ten seconds, as shown on timer, move S1 to TEST position.

9. The A telephone relay should not operate.

10. Repeat steps 4, 5, 6, 7.

11. Close S2; then, after 16 seconds as shown on timer, move S1 to test position.

12. The A telephone relay should pickup.

13. This concludes the acceptance tests for the reset circuit. Proceed to the next section for timer unit (TU) tests.

RECLOSING-DELAY UNIT: TIMING CHECK

1. Set the NSR VOLT SELECT link to the appropriate battery voltage; similarly adjust the TU VOLT SELECT link.

2. Assemble the test setup as shown in figure 11.

3. Set target unit tap screw in higher tap to provide minimum impedance in STOP-timer circuit.

4. The timer-unit adjustment has been set at the factory at the fifth time setting mark. This time can be read on the nameplate.

5. Push the A telephone relay closed to time the interval.

6. The timer should indicate a time reasonably close to the labeled time. Ensure that fine tuning allows this value to be obtained more accurately.

7. This completes the acceptance tests on the timer units.

INSTALLATION PROCEDURE

INTRODUCTION

The relay should be installed in a clean, dry location, free from dust and excessive vibration, and well-lighted to facilitate inspection and testing.

The relay should be mounted on a vertical surface. The outline and panel drilling dimensions are shown in figure 14.

The internal connection diagrams for the relays are shown in figure 4. A typical connections diagram is shown in figure 7.

TEST PLUGS

The relay may be tested without removing it from the panel by using a 12XLA13A test plug. This 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. Additional information on the XLA test plugs may be obtained from the nearest General Electric Apparatus Sales Office.

ELECTRICAL TESTS AND SETTINGS

Most operating companies use different procedures for installation tests. The section under ACCEPTANCE TESTS contains all necessary tests which may be performed as part of the installation procedure. Procedures for setting the relay are discussed in the SERVICING section in this book.

SERVICING

TARGET UNIT TAP SETTING

Refer to section of this same title under ACCEPTANCE TESTS for details on changing taps.

RECLOSING UNIT: TIME ADJUSTMENT

As mentioned earlier, the relay should be tested in its case. Also, a good d-c source is necessary to achieve accurate adjustments. If these conditions are met, testing will simulate conditions the relay "sees" in service.

The reset time may be adjusted to a chosen setting by the following technique.

1. Increase or decrease the reset-timer adjustment as desired.
2. Use the circuit and steps outlined in the ACCEPTANCE TEST section to determine the reset time.
3. Fine tune the setting if necessary, and repeat step 2.

RECLOSING-DELAY UNIT: TIME ADJUSTMENT

Use the procedure outlined under ACCEPTANCE TESTS to set the timer unit. Fine tune the setting until the desired time is achieved.

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 the complete model number of the relay for which the part is required.

PERIODIC CHECKS 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.

CONTACT CLEANING

For cleaning relay 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 throughly 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.

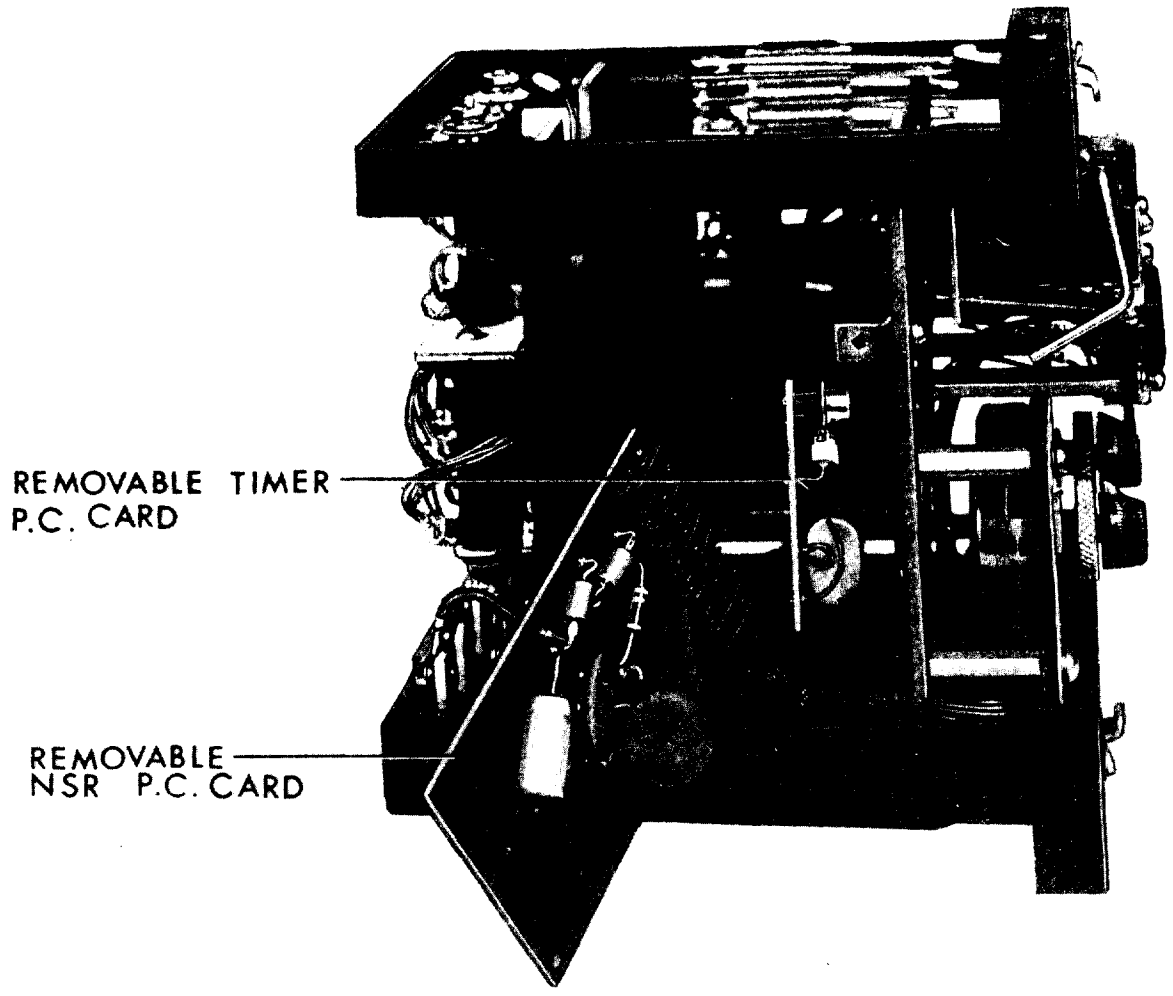


Figure No. 3 (8042601). Side View of the NSR21H Relay Highlighting the Removable Printed Circuit Cards

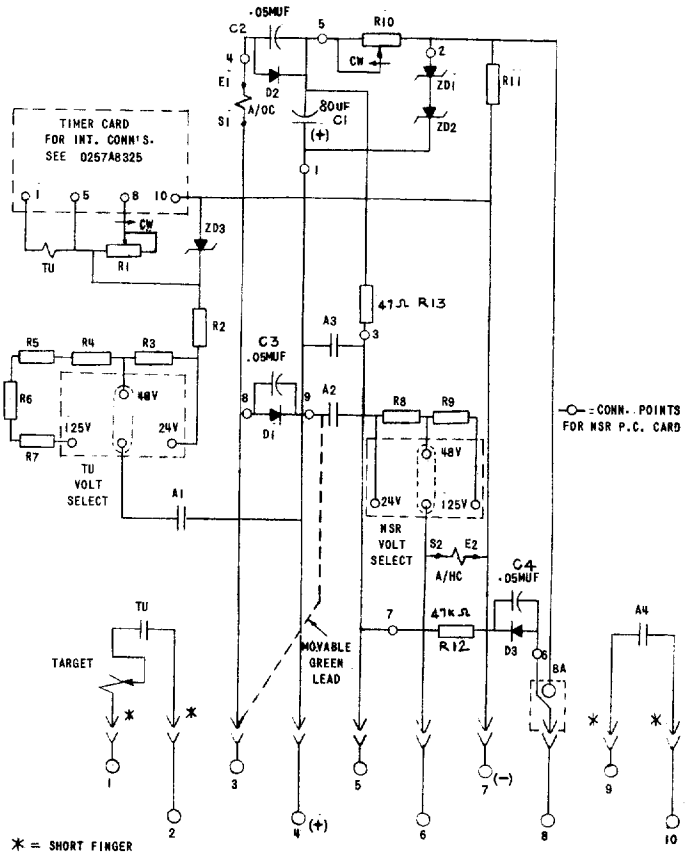


Figure No. 4 (0257A8324-1, Sheet 1). Internal Connection Diagram for NSR21H Relay (Front View)

MODEL	FORM
12NSR21H(-)A	1
VOLTS D.C.	24/48/125
RESISTANCE IN OHMS	
TU COIL	300
A/OC COIL A/HC COIL	500 500
R1	1.5M
R2	25
R3	100
R4	100
R5	100
R6	100
R7	100
R8	150
R9	1200
R10	.75M
R11	2500

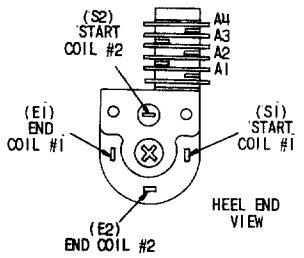


Figure No.5 (0257A8324-1, Sheet 2). Table of Values for Components in Figure 1.

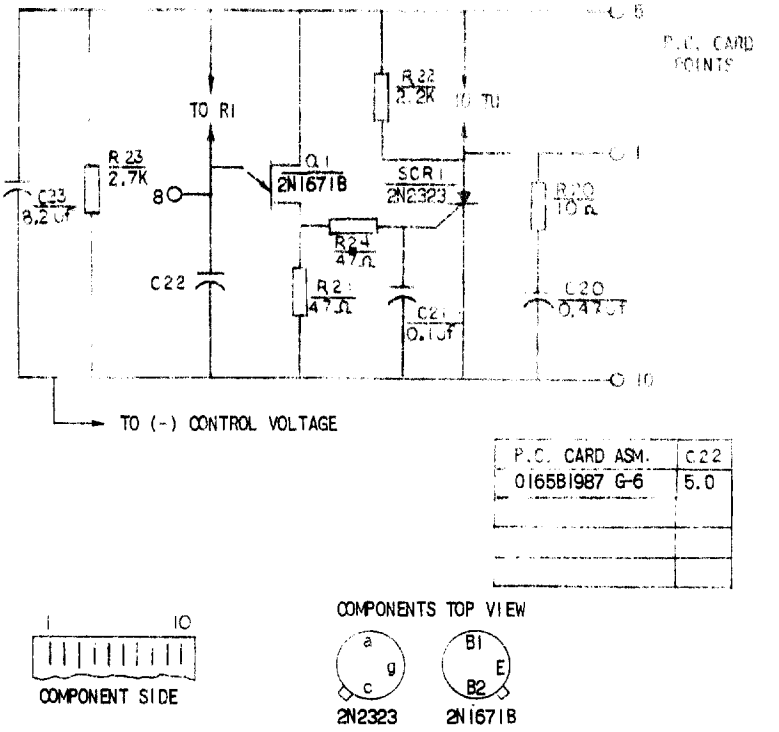


Figure No. 6 (0257A8325-1) Internal Connections of NSR21H Timer-Printed-Circuit Card

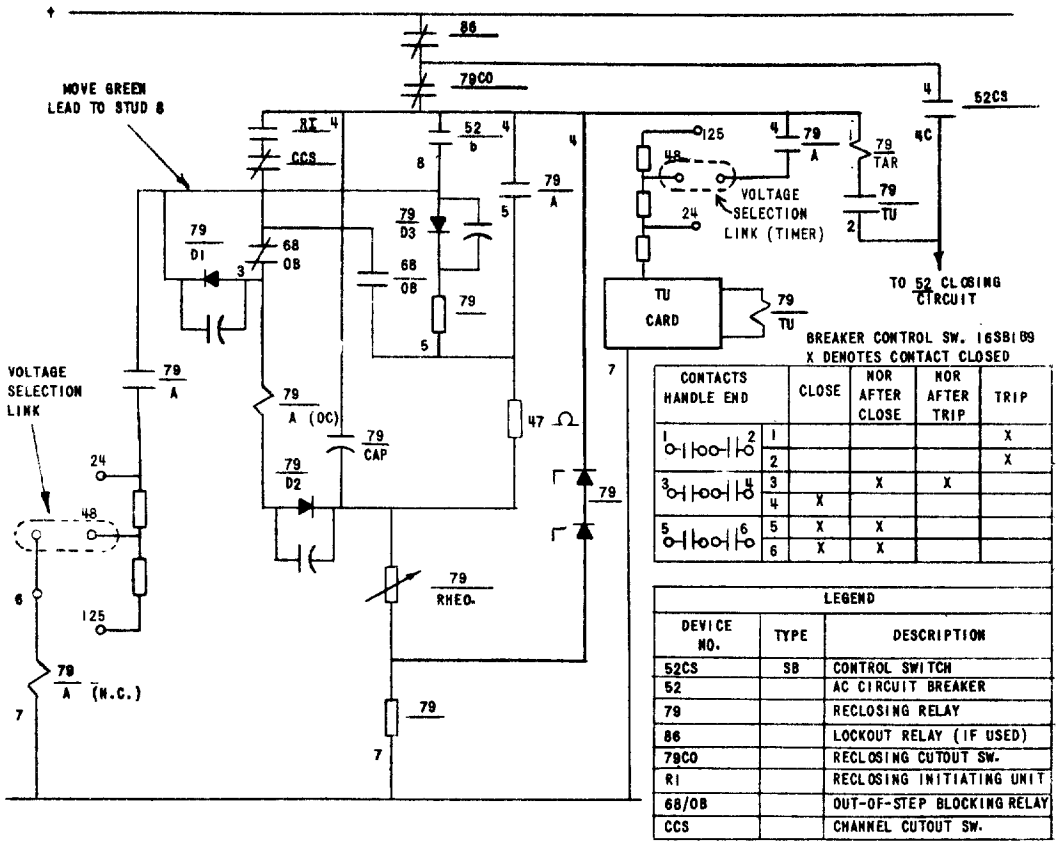


Figure No. 7 (0257A8354-0). Typical External Connections for Reclose Initiated by RI

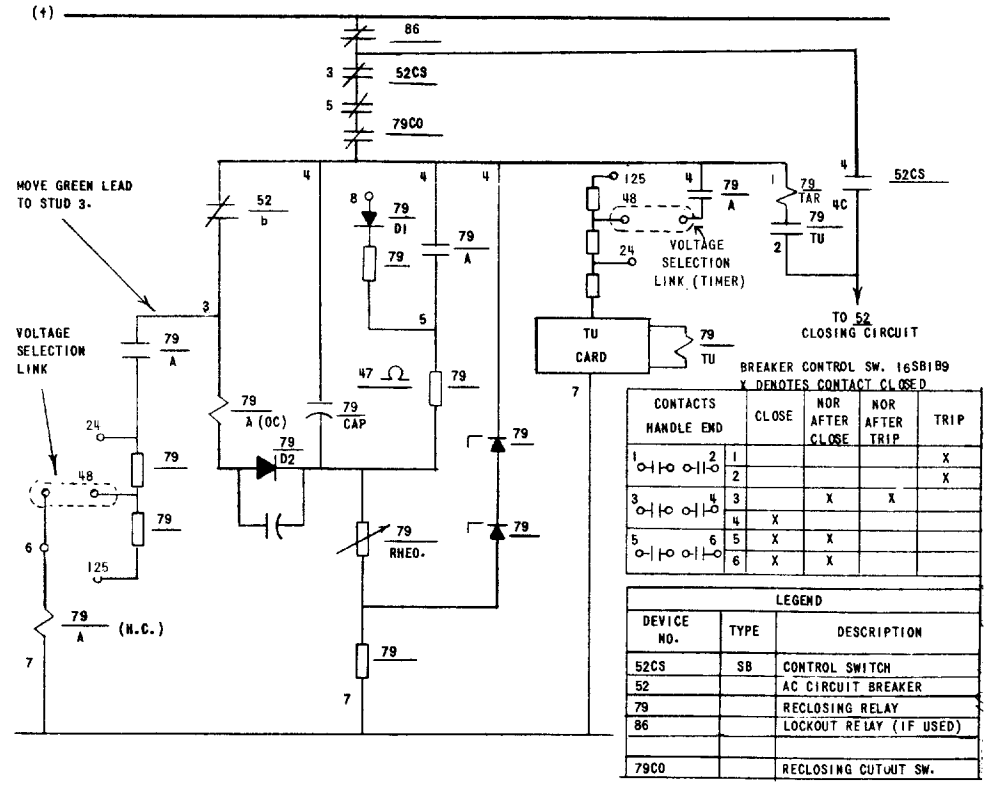


Figure No. 8 (0257A8357-0). Typical External Connections for Reclose Initiated by 52/b.

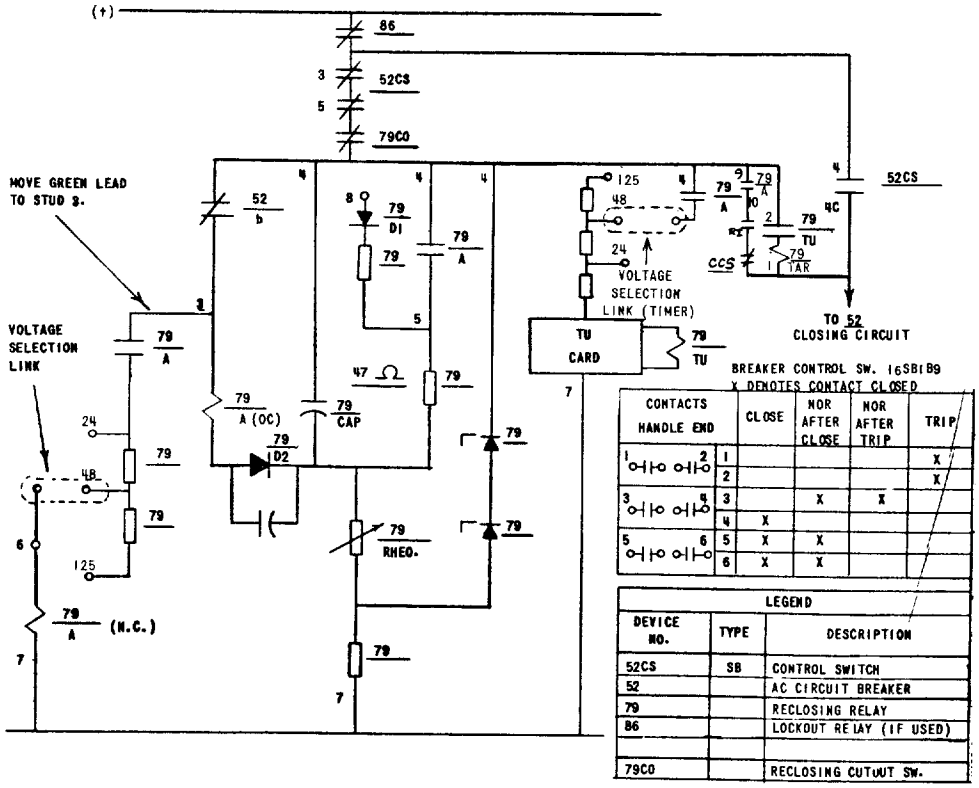


Figure No. 9 (0257A8353-0). Typical External Connections for Reclose Initiated by 52/b, Time Delay By-Passed by RI.

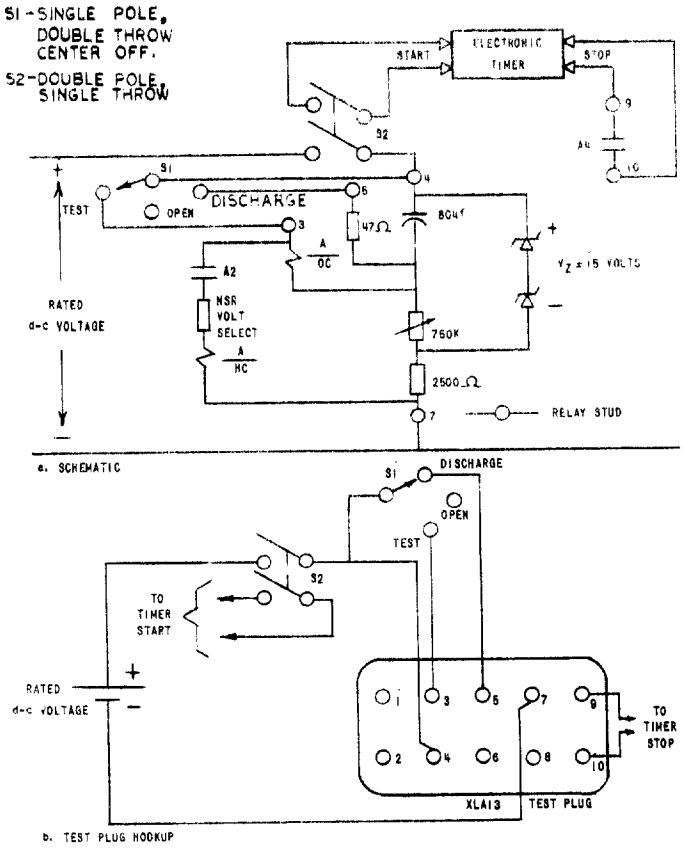


Figure No. 10 (0257A8345-1) Test Connections for Reset Time Calibration and Check.

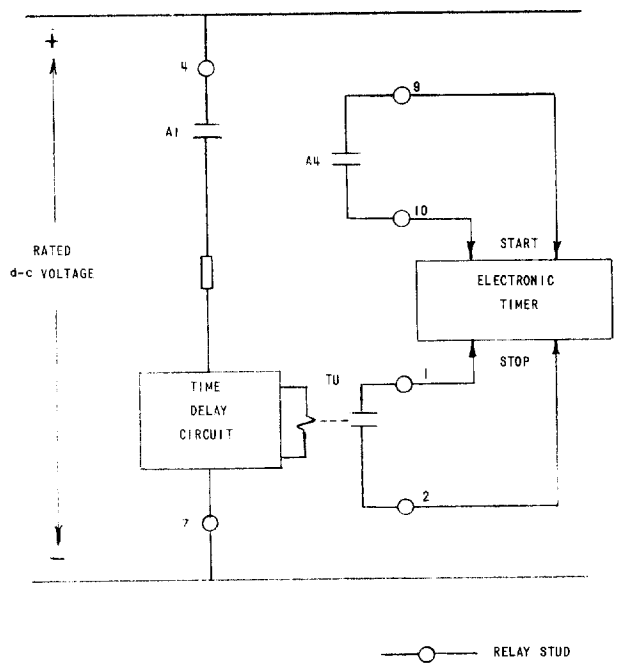


Figure No. 11 (0257A8344-0) Test Connections for Time Delay Calibration and Check.

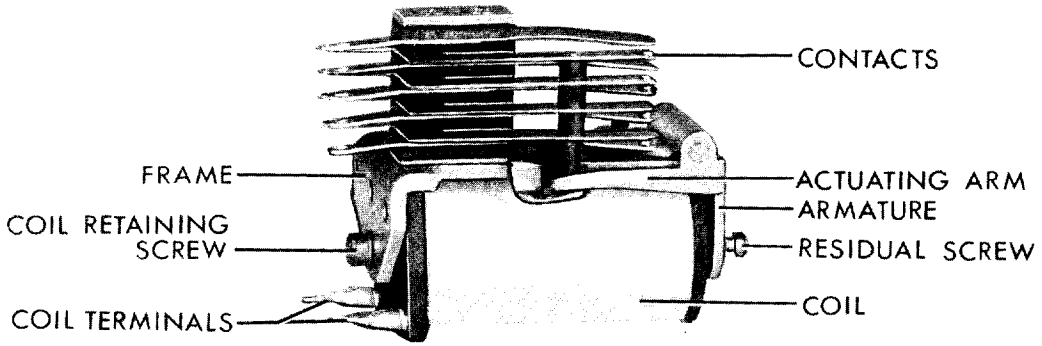
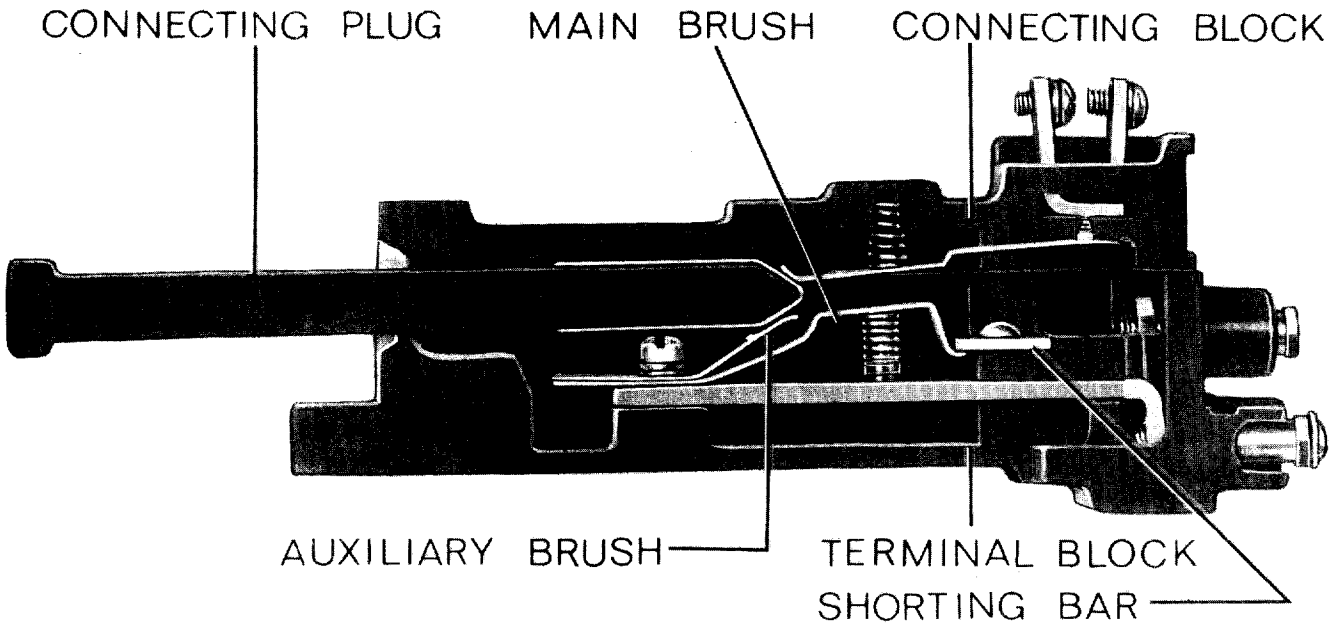


Figure No. 12 (8040228). Typical Static-Timer, Output Unit



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

Figure No. 13 (8025039). Drawout Case - Contact Assembly Cutaway.

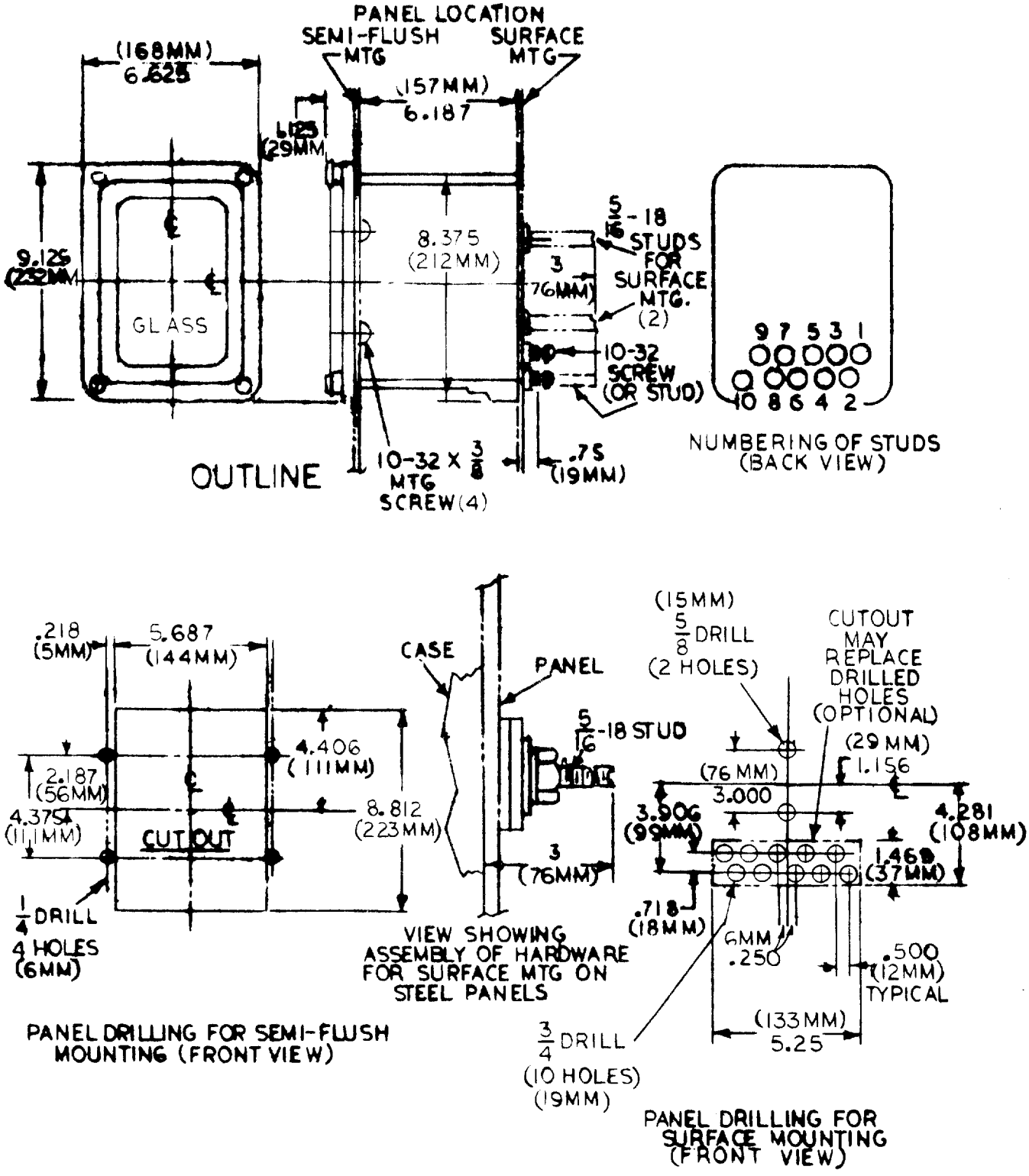


Figure No. 14 (K-6209271-6). Outline and Panel Drilling Dimensions for NSR21H Relay.

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