



## INSTRUCTIONS

GEK-45347 A  
Insert Booklet -  
GEK-34123

### RECLOSING RELAY

TYPE NLR21U

#### INTRODUCTION

These instructions are a supplement to Instruction Book GEK-34123 which is included in this book. The combination of the two provide instructions for the NLR21U relay. All information pertinent to the NLR21U relay which is not covered by this supplement is as indicated in GEK-34123.

#### DESCRIPTION

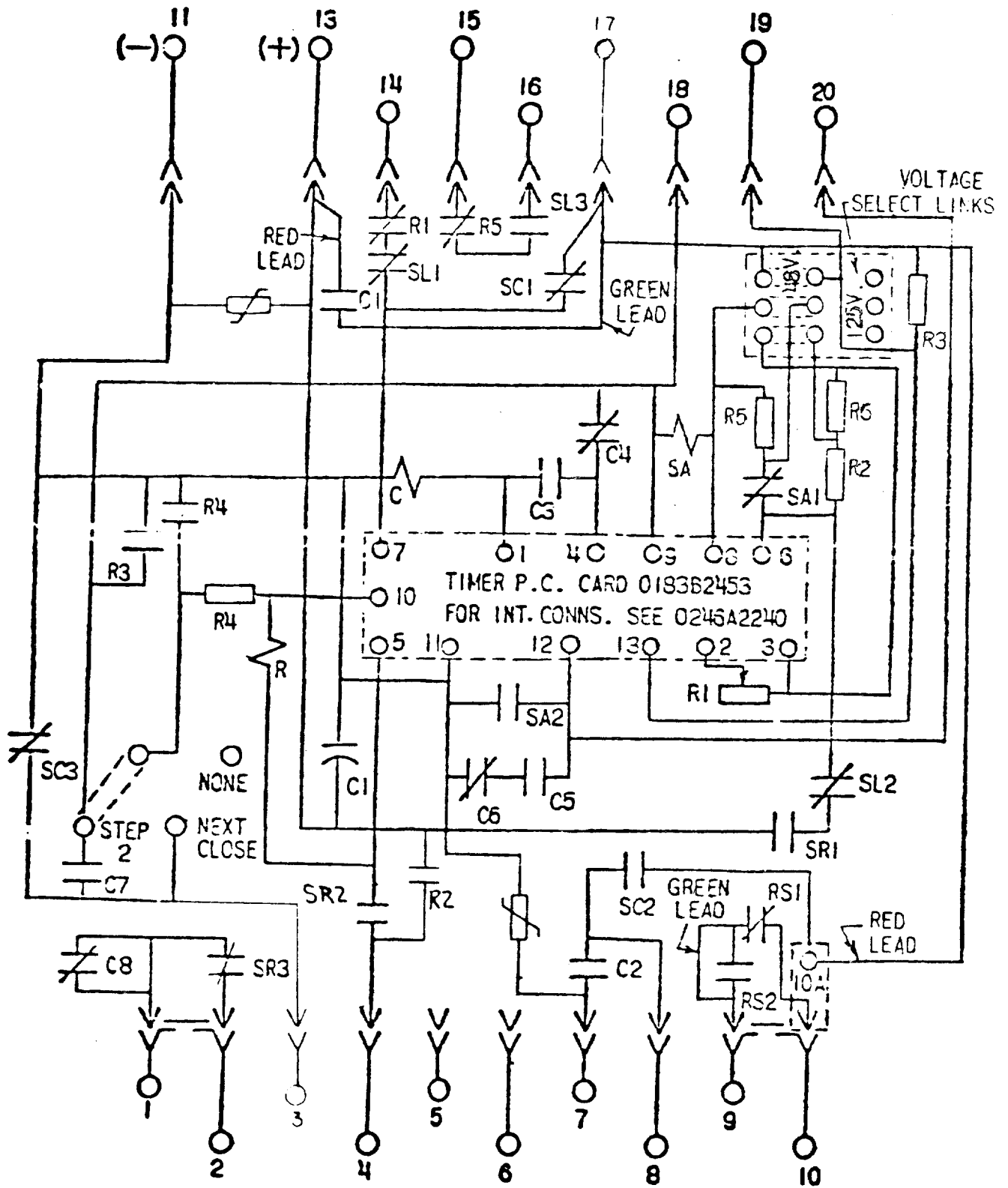
The NLR21U is similar to the NLR21A except it is a dual rated DC relay. The NLR21U relay contains rated voltage selecting links to provide means of adjusting the relay to operate on the control voltage available.

Figure 1 shows the internal connections for the NLR21U relay.

Figure 2 shows the external connections for the NLR21U relay.

*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.*



O = POST NO. ON PRINTED CIRCUIT CARD

FIG. 1 (0257A5059-0 Sh-1) Type NLR21U Internal Connections Diagram

STEPPING SWITCH CONTACTS

CONTACTS	SWITCH CONTACTS		
	RESET	STEPS 1-34 INC.	LOCKOUT
SL (⊕)	CLOSED	CLOSED	OPEN
SL (⊖)	OPEN	OPEN	CLOSED
SR (⊕)	OPEN	CLOSED	CLOSED
SR (⊖)	CLOSED	OPEN	OPEN
SC (⊕)	CLOSED BY ADJUSTABLE CAMS IN ANY 3 NON-ADJACENT STEPS		
SC (⊖)	CLOSED WHEN SC CONTACTS (⊕) ARE OPEN		
SA (⊕)	CLOSED WHEN STEPPING SW. COIL IS ENERGIZED		
SA (⊖)	OPEN WHEN STEPPING SW. COIL IS ENERGIZED		

MODEL	FORM	
12NLR21U(-)A	1	
VOLTS DC	48/125	
RESISTANCE IN OHMS		
C COIL	500	
R COIL	600	
SA COIL	70	
P1	1MFG.	
P2	2,000	
R3	620	
R11	600	
R5	100	
R6	6,000	
CAPACITANCE VALUE		
C1	1uf	

FIG. 1 (0257A5059-2 Sh-2) Type NLR21U Internal Connections Diagram

NOTE 1: USE STUD 13 CONNECTION NORMALLY FOR NON-PUMP FREE CONTROL SCHEMES SHIFT INTERNAL RED LEAD FROM 13 TO 15 WHEN USING STUD 15 DO NOT USE STEP 2 RESET POSITION.

NOTE 2: KLR21U SHOWN SET FOR INSTANTANEOUS RECLOSURE

CAM OPERATED CONTACTS	RESET STEP 0	STEPS 1-34	LOCKOUT STEP 35
SL	X		X
SR		X	
SL		X	X
SC		X	X
SR		X	X
SR		X	X
SR		X	X

DEVICE NO.	INCL. ELEM.	DESCRIPTION
52	SB	CONTROL SWITCH
74	NLR	AC CIRCUIT BREAKER
	C	AC RECLOSING RELAY
	R	CLOSING UNIT
	RS	RESETTING UNIT
	RS	CAM OPER. AUX-FUNCTION SW
	SA	ARMATURE OF STEPPING SWITCH
	SC	CLOSING CONT'S OF STEPPING SWITCH
	SL	LOCKOUT CONT'S OF STEPPING SWITCH
	SR	RESETTING CONT'S OF STEPPING SWITCH

DESCRIPTION OF DEVICE	INTERNAL	OUTLINE
KLR21U	22-24325	K-6209272
NLR21U	22-5745059	K-5207272

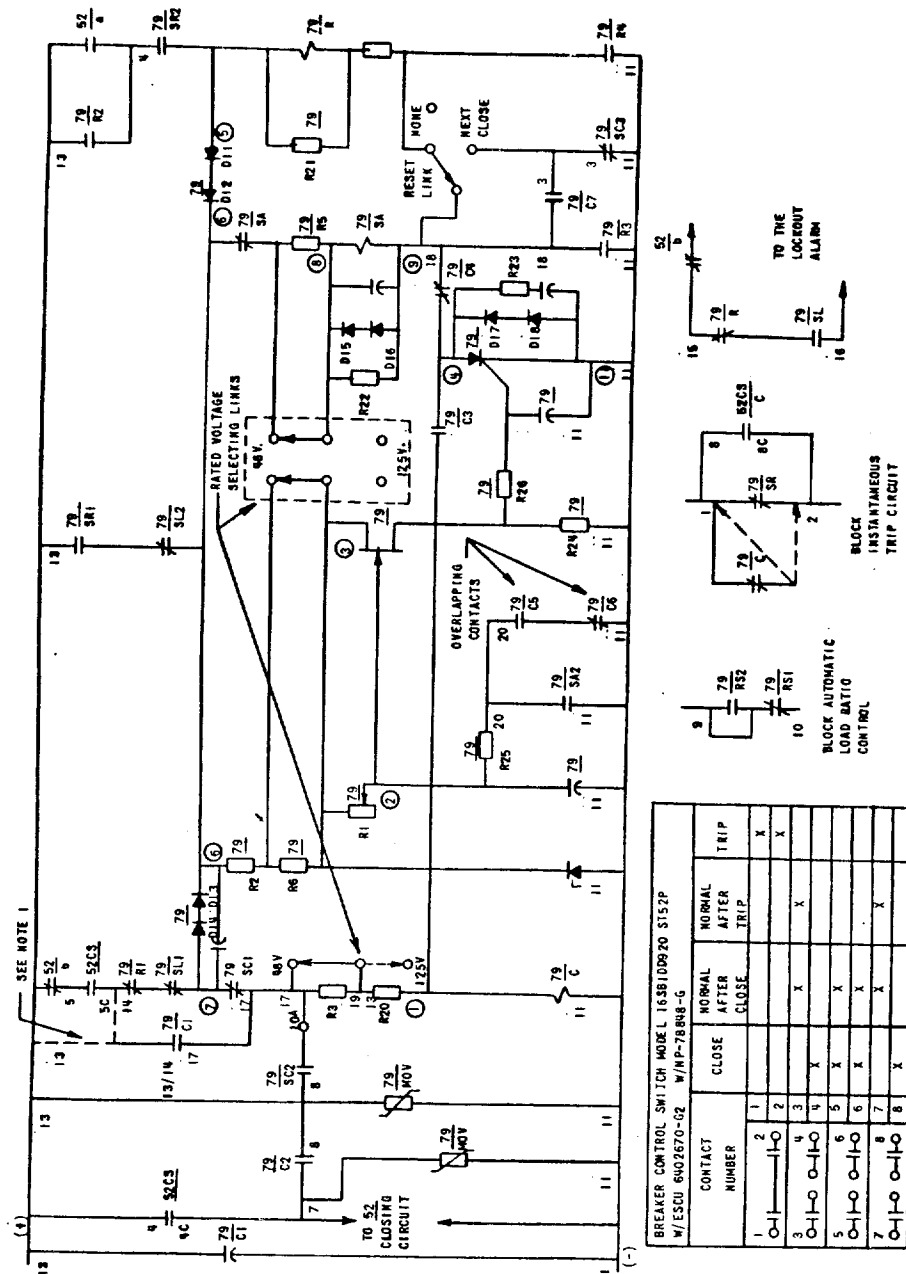


FIG. 2 (010888924-1) Type NLR21U External Connections Diagram



**INSTRUCTIONS**

GEK-34123F

RECLOSING RELAY

TYPE NLR21A

---

**GENERAL  ELECTRIC**

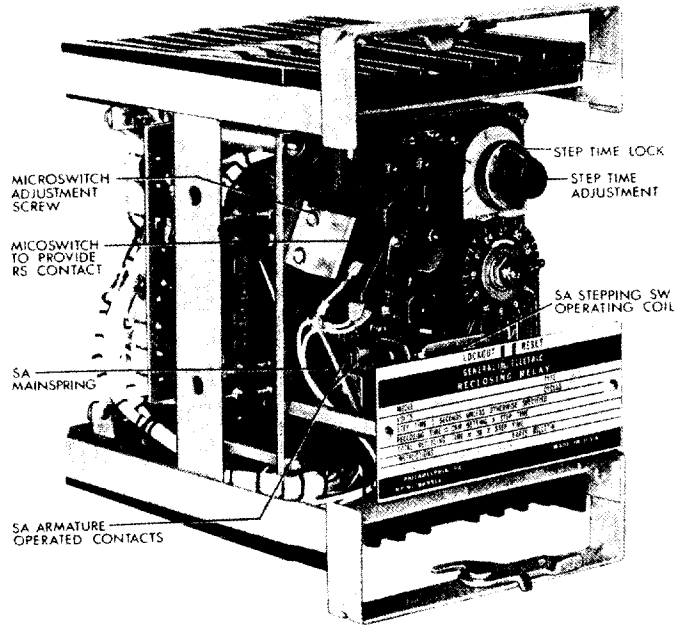


FIG. 1 (8041774) Type NLR21A Relay Removed From Case (Front View)

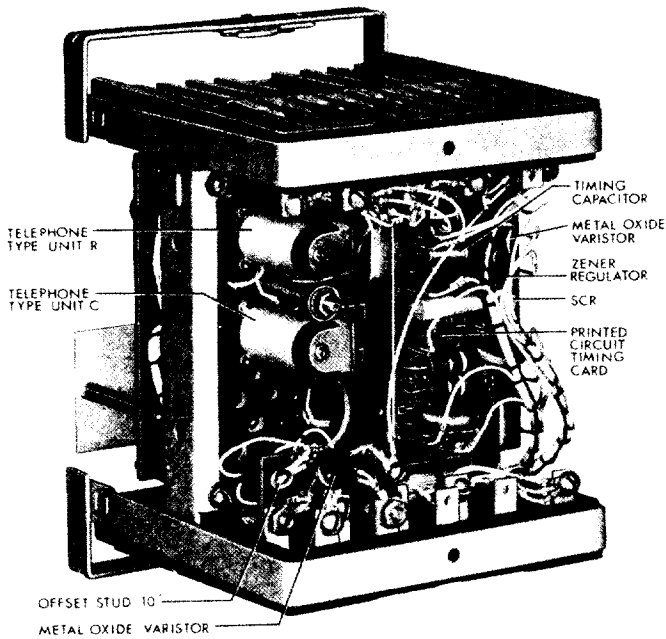


FIG. 3 (8041771)

Type NLR21A Relay Removed From Case

(Back View)

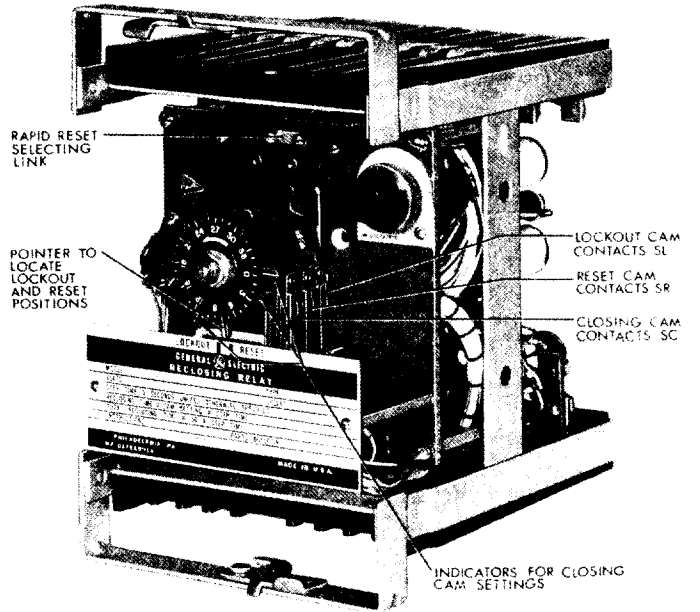


FIG. 2 (8041773)

Type NLR21A Relay Removed From Case

(Front View)

LIST OF FIGURES

	<u>PAGE</u>
<u>PHOTOGRAPHS</u>	
Fig. 1 Front View With Nameplate.....	2
Fig. 2 Front View.....	2
Fig. 3 Back View.....	2
Fig. 4 Internal Connections Diagram.....	15
Fig. 5 Outline And Panel Drilling Diagram .....	16
Fig. 6 External Connections.....	17
Fig. 7 Printed Circuit Card Internal.....	18
Fig. 8 Breaker Reclosing Circuit.....	19
Fig. 9 Breaker Reclosing And Reset Circuits.....	20
Fig. 10 Stepping Switch.....	21
Fig. 11 Test Connections.....	22
Fig. 12 Field Test Connections.....	23

CONTENTS

	<u>PAGE</u>
DESCRIPTION.....	5
APPLICATION.....	5
SETTINGS.....	8
RATINGS.....	8
SURGE WITHSTAND CAPABILITY.....	8
BURDENS.....	9
CHARACTERISTICS.....	9
TIMING CIRCUIT.....	9
MICRO SWITCH.....	9
TELEPHONE RELAY.....	9
OPERATING PRINCIPLES.....	9
INTRODUCTION.....	9
PRINTED CIRCUIT CARD.....	9
STEPPING SWITCH.....	9
OVERALL OPERATION.....	10
SELECTED RESETTING OPERATIONS.....	10
ACCEPTANCE TESTS.....	11
MECHANICAL TESTS.....	11
ELECTRICAL TESTS.....	11
INSTALLATION PROCEDURE.....	12
INTRODUCTION.....	12
MECHANICAL TESTS.....	12
ELECTRICAL TESTS.....	12
ADJUSTMENTS.....	13
INTRODUCTION.....	13
RECLOSING INTERVALS.....	13
STEP TIME.....	13
RS CONTACT AND MICRO SWITCH.....	13
PERIODIC CHECKS AND ROUTINE MAINTENANCE.....	14
CONTACT CLEANING.....	14
SERVICING.....	14
RECEIVING, HANDLING AND STORAGE.....	14
RENEWAL PARTS.....	14



RECLOSING RELAY  
TYPE NLR21A

DESCRIPTION

The Type NLR21A relay is a multi-shot reclosing relay designed to initiate multiple reclosures of a circuit breaker. The relay is generally employed to provide three shot reclosing on radial distribution circuits. It is capable of initiating one, two, or three independently adjustable reclosures of a circuit breaker with the choice of the first reclosure being either high speed or time delay. One complete cycle is adjustable in the range from 18 to 180 seconds. A quick reset feature is also available so that the relay may be adjusted to reset after a successful reclosure.

The NLR21A relay includes provisions for removing instantaneous tripping before the first reclosure, blocking automatic tap changing under load equipment, and sounding a lockout alarm. Figures 1, 2 and 3 show the front, side and back views of the relay respectively.

The Type NLR21A relay is designed for DC operation from the station battery and contains no target. One such reclosing relay per circuit breaker is generally applied. The auxiliary equipment required in addition to the NLR21A depends upon the user's reclosing philosophy. Some general factors that should be considered in the application of this relay are stated in the section entitled APPLICATION.

The Type NLR21A relay is contained in an S2 drawout case. The internal connections diagram and the outline and panel drilling diagrams are shown in Figures 4 and 5 respectively.

APPLICATION

The Type NLR21A reclosing relay is applied to reclose a circuit breaker one, two, or three times after the circuit breaker has been tripped by its protective relays. It is generally employed on radial distribution circuits. Other Type NLR relays are available for multi-shot reclosing on subtransmission and transmission circuits.

A typical external connections diagram is shown in Figure 6. All cam-operated contacts are shown with the relay in the reset position which is position #0. The adjustable closing cam is shown set for a high speed reclosure with one of the three lobes placed in the Step #0 position. With this setting, SC2 is open and SC1 and SC3 are closed in the reset position. When the relay is initiated by the closing of the breaker auxiliary switch (52/b) after a protective relay operation, the stepping switch takes an immediate step and the SC contacts reverse position. SC2 closes to provide an immediate reclosure.

Time delay reclosures are obtained by placing the SC lobes in any non-adjacent positions in steps 1 to 34 inclusive. If a high speed first reclosure is employed (first SC lobe placed in Step 0), the minimum first time delay reclosure is obtained by placing the second SC lobe in the Step #2 position, because it is the first non-adjacent position to Step #0. With this setting, the first time delay reclosure occurs after a two step time interval. If an instantaneous reclosure is not required, the minimum time delay reclosure is obtained by placing the first SC lobe in the Step #1 position. With this setting, the first reclosure occurs after one step-time interval. The time delay between steps is adjustable between 0.5 and 5.0 seconds.

The relay can be set for a maximum of three reclosures in a variety of combinations. When selecting the number of reclosures and the time delay between reclosures the following two factors should be considered.

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. ASSOCIATED PROTECTIVE RELAYS

When high speed reclosing is employed, the circuit breaker closing time should be compared with the dropout time of the protective relays that initiate the tripout. If high speed reclosing is to be successful, the protective relays that tripped the breaker obviously must reopen their contacts before the breaker recloses. Otherwise the breaker will be tripped again even if the fault has been cleared.

*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.*

The typical external connections diagram of Figure 6 indicates the use of circuit breaker control switch contacts as well as circuit breaker auxiliary switch contacts. A control switch contact, that is closed in the normal after close and close positions, is employed to prevent the breaker from being automatically reclosed when it has been tripped by the control switch. With regard to Figure 6, the following two considerations should be noted.

#### 1. PUMP FREE BREAKER CLOSING CIRCUIT

With the connections shown in Figure 6, the breaker closing circuit must be pump free. This is so because the closing signal from the relay is maintained for one time step interval during each reclosure. If the breaker closing circuit was not pump free, the maintained relay closing signal would cause the breaker to pump if it was closed into a permanent fault. The performance of the scheme with a pump free circuit breaker, when closing into a permanent fault by means of the control switch, will depend on whether the relay was initially in the reset or lockout position. For either case, the relay, set for an instantaneous reclosure, would not reclose the circuit breaker immediately.

With the relay in the reset position and set for an instantaneous first reclosure, even a momentary closure of the control switch will result in a maintained close output signal from the relay. This will prevent pumping of the circuit breaker even when closing into a permanent fault. Also, in the above situation, operation of the control switch to the close position causes the relay to make an immediate step which opens contact SR3 to block instantaneous tripping. In order to reinstate the instantaneous trip circuit that has been blocked by the opening of SR3, contact (8-8C) of 52/CS, that is closed in the close position, is employed as shown in Figure 6. This contact is required only if the relay is set for an instantaneous reclosure and the SR3 contact is used to block the instantaneous trip circuit. In order to prevent a subsequent time delay reclosure from occurring, an operator should immediately place the control switch in the Trip position after the circuit breaker is tripped by the protective relays. With 52/CS in the Trip position, the relay would run to lockout but there would be no relay closing signals applied to the breaker closing circuit.

With the relay initially in the lockout position, and the circuit breaker manually closed into a faulted line, the relay would not go to reset unless the circuit breaker auxiliary 52/a switch remained closed for a time equal to or greater than one time step interval. Therefore, the relay would remain at lockout if the protective relay operating time was less than one time step. If the circuit breaker was manually closed into an unfaulted line and the relay was in the reset position and set for an instantaneous reclosure, the relay would take an immediate step and continue to step until it resets. The speed of reset would depend on the position of the reset link.

#### 2. NON PUMP FREE BREAKER CLOSING CIRCUIT

If the breaker closing circuit is not pump free, the internal red lead must be moved from stud 13 and placed on stud 14 as shown in the external connections diagram in Figure 6. With this connection, the seal-in of the C unit is supervised by the 52/b contact. When the 52/b contact opens, it drops out the C unit which, in turn, removes the closing signal from the breaker closing circuit. It should be cautioned that this connection results in a lost step after each reclosure. For example, if 6 time steps between reclosures are required (normally 30 seconds), 7 time steps must be set.

The resetting of the relay following a successful reclosure is accomplished by setting the "Rapid Reset Selecting Link." The link can be set in any one of the three following positions.

1. Step 2 Position - where the relay resets two time steps after a successful reclosure.
2. Next Close - where the relay resets after a successful reclosure but at the next reclose set point.
3. None - where the relay resets one time step after the lockout position.

With the link placed in one of the two rapid reset positions, the R unit will seal-in when the rapid reset is initiated. If the breaker should trip again during this transition period, the NLR21A relay will continue to reset since the R unit has sealed in, and will then initiate another cycle of reclosures.

In addition to the wide choice of adjustments for reclosing and resetting, the relay has output contacts as shown in Figure 6 that are normally used for the following functions.

#### 1. BLOCK INSTANTANEOUS TRIP

It is sometimes desirable to coordinate with branch circuit fuses, by blocking the instantaneous trip circuit after the first tripout and before the first reclosure. This can be accomplished by means of the SR3 contact which is closed when the NLR21A relay is in the reset position and will open on the immediate step which occurs prior to a high-speed initial reclosure. The instantaneous trip will be reinstated in the reset position. It is possible, if desired, to reinstate the instantaneous trip circuit one time step after reclosure. This may be accomplished by use of the C8 contact. This C8 contact is normally jumpered out. It can, however, be reconnected in parallel with SR3 so that instantaneous tripping, blocked by SR3, will be reinstated one time step interval after each reclosure. With this arrangement, the instantaneous trip circuit will be blocked for only one time step interval, after each subsequent reclosure.

It is also possible to reinstate the instantaneous trip circuit prior to lockout, by means of the RS switch as described in item 4 below.

#### 2. BLOCK TAP CHANGING UNDER LOAD EQUIPMENT

The cam which operates the RS contact is dimensioned to hold that contact in the operated position for four adjacent steps of the stepping switch. Thus, the RS1 contact shown closed will be closed for 4 steps and open for the remaining 32 steps of the cycle. There is a green jumper lead connected to the common point between RS1 and RS2. By shifting this jumper from stud 9 to stud 10, the RS2 contact will become the effective one and will be open for 4 steps and closed for the remaining 32 steps.

Normally, the jumper is connected to stud 9 and the cam is set so that RS1 is closed at reset, opens before the first reclosure, and recloses ahead of lockout. With this normal connection, the RS1 contact is commonly connected in the control circuit of the tap changing under load transformer to block any tap changing while the NLR21A relay is operating through its reclosing cycle, and to reinstate it before the relay reaches the lockout position. For this application the RS1 contact must be closed in reset and lockout, and the two positions prior to lockout, and the last reclosure must be initiated no later than Step #32.

#### 3. ALARM CIRCUIT

When the relay steps to the lockout position, contact SL3 in the alarm circuit will close. If the breaker is open, the 52/b switch and contact R5 will be closed and the lockout alarm circuit will be completed.

#### 4. OTHER FUNCTIONS OF THE RS CONTACT

If the RS1 contact is not required to block the tap changing under load equipment, it may be employed in place of the SR3 contact in the instantaneous trip circuit to block instantaneous tripping after, rather than prior to, the initial reclosure (either immediate or delayed). This provides two instantaneous tripouts of the breaker before shifting to time delay trip to allow clearing by the branch fuse. For this application, the RS1 contact should be closed two positions prior to the initial reclosure, and one position after the initial reclosure. Hence, two positions after the initial reclosure, the RS1 contact will open to block the instantaneous trip circuit, and it will remain open for 32 steps.

Another use for the RS1 contact would be to reinstate instantaneous tripping prior to lockout when the SR3 contact is used to block instantaneous tripping. To accomplish this, the RS1 contact would be connected in parallel with SR3, and its actuating cam would be positioned to close RS1 prior to lockout, hold it closed in the lockout position, but reopen it when the relay steps to the reset position.

The RS contact can also be used as a spare alarm contact, if the cam is set so that the contact closes between the last reclosure and lockout, and opens between lockout and reset.

SETTINGS

The Type NLR21A relay provides a wide choice of adjustments for reclosing and resetting. The choice depends upon the user's reclosing philosophy. However, the factors stated in the section entitled APPLICATION should be considered when applying the relay. The following settings are required.

1. Number of Reclosures - The number of reclosures is determined by the number of SC lobes employed on the closing cam. A maximum of three reclosures can be set on Steps 0 to 34 inclusive in any three non-adjacent positions.
2. Time Between Reclosures - The time between reclosures is determined by the position of the SC lobes and the step time. The step time is normally set at the factory for 5 seconds; but it can be adjusted in the field to provide a step time from 0.5 to 5 seconds.
3. Position of the Rapid Reset Selecting Link - The link can be set in either the STEP 2, NEXT CLOSE, or NONE position.
4. RS Contact - The adjustable cam that operates the RS switch can be adjusted to close the RS switch for any 4 adjacent steps of the stepping switch. Functions of the RS contact are noted in the section entitled APPLICATION.

RATINGS

The NLR21A is a DC operated relay with ratings of 48, 125, and 250 volts DC. Table A lists the ratings of the relay contacts.

TABLE A  
CONTACT RATINGS

RATING	CONTINUOUS CURRENT AMPS	TRIP DUTY AMPS	INTERRUPTION CURRENT AMPS	
			INDUCTIVE	NON-INDUCTIVE
48 VDC	1	30	1.0	3.0
125 VDC	1	30	0.5	1.5
250 VDC	1	30	0.25	0.75
115V 60 HZ	1	30	0.75	2.0
230V 60 HZ	1	30	0.5	1.0

The NLR21A will operate in an ambient temperature of -40°C to 60°C.

SURGE WITHSTAND CAPABILITY

The NLR21A relay will withstand the following test voltage waveform without damage to any component. The test voltage waveform consists of a high frequency damped oscillation with a frequency of 1.5 megahertz. The source has an internal impedance of 150 ohms. The initial value (zero to peak) is 2500 volts and the damping is such that the envelope of the waveform decays to half the initial value (1250 volts) in 6.0 microseconds. The test voltage is applied between the relay case and each of the relay terminals, across the input circuit (DC input), and across the closing circuit.

BURDENS

The burden of the NLR21A relay is approximately as given in Table B.

TABLE B  
BURDENS

VOLTS	FREQUENCY	RESISTANCE-OHMS MINIMUM
250	DC	1500
125	DC	400
48	DC	70

The resistance values given are the relay resistance when the stepping switch coil is energized. The stepping switch coil is energized for about 8 milliseconds when the switch steps. At other times when the timer is running the relay resistance is approximately 10 times the values given in Table B. When

the relay is in reset, it has zero burden.

### CHARACTERISTICS

The NLR21A relay will perform properly over a range of applied DC voltage from 80 to 110 percent of rated voltage. In addition to the four basic units, there is a means of selecting the relay operation after a successful reclosing.

#### TIMING CIRCUIT

The timing circuit consists of two basic units, a timer and a stepping switch.

Timer - Consists of an RC type timer which has an adjustable step time between 0.5 and 5.0 seconds. The timer will operate in ambient temperatures of -20°C to 60°C with a maximum time variation of 6 percent and down to -40°C with a maximum variation of 10 percent.

Stepping Switch - The stepping switch is a spring driven mechanism that rotates a series of cams which actuate contacts affixed to cantilever springs. There are a total of 36 steps in one complete revolution and the total time is a function of the timer. Therefore, to find the total time one has to multiply the step time by 36. Example: Step time is set for 0.5 seconds giving a total time of 18 seconds for one complete revolution.

#### MICRO SWITCH

The NLR21A contains a micro-switch that operates off an adjustable cam in the stepping switch. The selection of a normally open or closed contact may be made by moving a green wire.

#### TELEPHONE RELAY

There are two telephone type relays, one to maintain the closing signal and the other the reset signal to insure successful completion of each operation.

### OPERATING PRINCIPLES

#### INTRODUCTION

The NLR21A is basically a timing device that provides automatically reclosing signals to a circuit breaker, which has been tripped by its protective relay. Basically the NLR21A consists of a static timer and a stepping switch which serves as a memory device. There are three adjustable lobes on the outside cam (SC) on the stepping switch, which provides adjustable breaker closing signals. Two auxiliary telephone type relays insure complete breaker closing and rapid reset.

#### PRINTED CIRCUIT CARD

The printed circuit card as shown in Figure 7 basically consists of an RC timer. The time is adjustable between 0.5 and 5.0 seconds by means of a potentiometer. The RC timer, which is zener regulated by Z11, consists of R1 (the potentiometer located in the front of the relay) and C25. C25 is charged up through R1 and when C25 reaches about 55 percent of the zener voltage it fires the unijunction T11 which in turn provides a short pulse of current to flow through R24. The voltage drop across R24 is impressed on the SCR (silicon controlled rectifier) gate and turns on the SCR. D17, D18, C23, and R23 are used as snubber circuits.

The rest of the components are part of the logic of the relay and will be discussed elsewhere.

#### STEPPING SWITCH

When the SCR (SCR11 of the printed circuit card) turns on, it allows current to flow through the SA coil which operates the stepping switch armature.

The armature movement opens one "SA" contact and closes another "SA" contact as shown in Figs. 8, 9, and 10. The opening of the SA contact turns the SCR off and the closing of SA contact completely discharges the capacitor C25, located on the printed circuit card, to reset the timing circuit. When the armature picks up it also raises the driving spring enough to clear the next tooth on the ratchet wheel and the driving spring snaps into the next notch. When the SCR is turned off by the SA contact the armature coil is de-energized and its main spring rotates the ratchet wheel 10 degrees. At this point the timer starts timing again and it will rotate the stepping switch ratchet wheel another 10 degrees after

another time interval has elapsed. All stepping switch operations will have the same time interval.

The ratchet wheel of the stepping switch is solidly connected to a cam shaft which contains three main cams. (SC, SL, SR). The two cams nearest the ratchet wheel (shown in Fig. 10) have only one lobe each and therefore raise their associated contact operating springs only during one step interval for each revolution of the ratchet wheel. A third cam (not shown in Fig. 10) has 3 adjustable lobes and these lobes may be set to raise their associated contact operating springs on any desired step. When the adjustable cam lobes raise their contact operating springs they close two "SC" contacts shown in Fig. 8, and one of these supplies the breaker closing signal. Since the adjustable cam lobes can be set to close the "SC" contact on any step of the ratchet wheel they can provide a breaker closing signal at reset (an instantaneous breaker reclosing signal) and - or on any subsequent step until the lockout position is reached which is 35 steps after reset. The schematic diagram Fig. 10 shows the ratchet wheel in the lockout position. In this position the (SL) lockout cam opens its SL contacts to open up the breaker closing circuit and the timing circuit (which prevents any further operation of the stepping switch until the breaker is manually closed as explained later) and closes an SL contact to ring an alarm. When the stepping switch armature coil is energized again, the switch steps from lockout to the reset position (as explained later).

The lockout cam (SL) has 3 contacts, one normally open and 2 normally closed.

The reset cam (SR) has 3 contacts, one normally open and 2 normally closed.

The adjustable cam (SC) close has 3 contacts, two normally open and 1 normally closed.

An additional adjustable auxiliary cam operates a micro switch to provide the "RS" contact. The auxiliary cam is held by friction and is released by loosening the locknut on the cam shaft. The cam shaft must be firmly held when loosening or tightening the lock nut. When the lock nut is loose the auxiliary cam can be easily moved to any position and the lock nut re-tightened. The "RS" contact can be lead either a "N.O." or a "N.C." contact as desired by moving the green (see figure 4). The cam is dimensioned to hold the switch in one position for 6 steps and in the other position for 30 steps.

One "SR" contact is connected to studs 1 and 2 to be used to block instantaneous tripping during the reclosing cycle if desired.

#### OVERALL OPERATION

Fig. 8 shows the NLR breaker reclosing circuit with the NLR in the reset position and set for instantaneous first reclosure. In the reset position the SL contacts are closed, but the SR contacts are open so there is no circuit connecting the timer to power until the breaker (152) trips and closes its N.C. auxiliary switch. This energizes the breaker closing circuit and the "C" relay coil thru the preclosed SC contact and the timing circuit thru the blocking diodes D13 and D14. The "C" relay steps the stepping switch once immediately and seals in to maintain the closing signal for one step interval. The instantaneous step is to prevent pumping the breaker if control power is lost and then returns and also to open the instantaneous trip blocking contact (1-2). The "C" relay maintains the closing signal to prevent a second closing impulse if the breaker trips during the step time interval. At the end of the first time interval the "C" relay is shorted out by the SCR and drops out. Its overlapping contacts discharge the capacitor C25 to reset the timing circuit. When the "C" relay picks up the stepping switch closes its "SR" contacts at once and then the timer continues to run whether the breaker is open or closed since both the SR and SL contacts are closed and they provide a circuit to the timer. After the "C" relay drops out the stepping switch continues with equal elapsed time between steps until its ratchet reaches the step in which the lobe on the adjustable cam again closes the SC contact. At this point if the breaker is open the NLR will close it and if the breaker is closed no closing signal will be given to the breaker closing circuit due to the blocking diode shown in Fig. 8. In either case, the stepping switch steps on with equal elapsed time steps to the next reclosing cam location and then closes the breaker if it is open as described above. The stepping switch steps on to the lockout position where the SL contacts open to deenergize the timer and stepping switch and a SL contact closes to sound the alarm if the breaker is open.

#### SELECTED RESETTING OPERATIONS

Step two position - Figure 9 shows the reset circuit. The link is in the step two position. This means that the NLR relay will reset two step time intervals after any automatic breaker reclosure. After the NLR relay has reclosed the breaker as described above the breaker closes its normally open auxiliary switch shown in Fig. 9. The "SCR" is always turned off by the time the breaker closes and at the start of the next step time interval is turned on by the timer. As the connections are shown in 4C when the SCR is turned on one step time after the breaker has been reclosed there is no circuit energizing the "R" relay coil because the "C" relay N.C. contact is still open. The next time the SCR is turned on the "R" relay coil

is energized thru the N.O. breaker auxiliary switch, the SR contact, the step two reset link, the "C" relay N.C. contact and the SCR to the negative side of power. The R relay together with its parallel resistor, R21 draw enough current to keep the SCR turned on. The R relay seals in and the stepping switch armature picks up again as soon as it drops open. Thus the stepping switch runs without any delay and "homes" to the reset position where the NLR finds all connections to the plug bus open. The SR contacts open as "S" steps into the reset position and the R relay now drops out and closes its N.C. contact in the breaker closing circuit. The NLR relay is reset and waiting for the breaker to trip. The maximum reset time of the NLR relay after the "R" relay is energized is one to two seconds.

Next Close Position - With the reset link in the next close position "R" can be energized only when the NLR ratchet wheel has reached the step when the next reclosing signal is given. If the breaker is open, the NLR relay recloses it as described above but if the breaker is closed then the "R" relay is energized and seals in to reset the NLR. The SC contact opens but the R relay seals in around it to maintain the circuit until the NLR is reset.

None Position - If the "NONE" position of the Reset Link is selected the NLR will not reset until the lockout position is reached. Then if the breaker is found closed or if the breaker is open and later is manually closed the timing circuit is energized thru the breaker N.O. auxiliary switch, the SR contact, and the blocking diodes D11 and D12. If the breaker remains closed for one step time interval then the timer turns the SCR on to step the stepping switch one step to the reset position which turns everything off. If the breaker trips during this step time interval then the NLR remains in the lockout position and sounds the alarm.

#### ACCEPTANCE TESTS

##### MECHANICAL TESTS

Operate the telephone-type relay units and the stepping switch manually to check that all operate smoothly without binds.

##### ELECTRICAL TESTS

With the NLR relay in the lockout position connect rated voltage to the NLR relay as follows.

For DC operated relays connect plus to stud 13 and minus to stud 11.

Check that there is no relay operation.

Note that indicating pointer points to lockout line on the nameplate.

Connect a jumper between studs 13 and 4 and note that the stepping switch steps once after a 5 second interval (or one step time interval if other than 5 seconds) and stays in the reset position. Note that indicator points to reset. With the stepping switch still in reset position, with jumper between studs 13 and 4, the reset link in the NONE position, connect indicating lights to NLR as shown in Figure 11. Jumper stud 13 to stud 14 momentarily (1/2 second or less), or one step time if NLR is set for delayed reclose.

If NLR relay is set for instantaneous reclose the stepping switch steps instantaneously once. Then it delays two step time intervals before stepping again.

Note that relay runs in 5 second steps (or step time if it is other than 5 seconds) through all positions to reset.

Note that indicating light 1-2 lights when SA is in reset position and goes out on the first step (instantaneous or otherwise) and stays out until reset is again reached.

Note that indicating light (studs 9-10) lights when the auxiliary cam does not touch the microswitch operating button.

If the NLR relay is set for instantaneous first reclosure note that the indicating light (7-8) is energized for 5 seconds (or step time) starting as soon as jumper 13-14 was connected.

Note that the indicating light 15-16 is energized during the 5 second (or step time) lockout to reset interval.

Move the reset link to the "step 2" position. Then jumper studs 13 to 14 again removing the jumper as soon as light (7-8) comes on.

Note that 10 seconds (or 2 times step time) after the jumper was removed between studs 13 and 14 the NLR relay begins its rapid reset. Also note that indicating lights 7-8 and 15-16 are not energized during this rapid test.

Next remove the 13-4 jumper and move the reset link to the "next close" position and again jumper studs 13 and 14 momentarily. Replace the 13-4 jumper after one step. Note that when the position is reached where the adjustable cam lobe operates its contacts to supply the next closing impulse that rapid reset begins and continues to reset.

## INSTALLATION PROCEDURE

### INTRODUCTION

The location should be clean and dry, 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 diagram is shown in figure 5.

The internal connection diagram is shown in Figure 4. Refer to Figure 6 for typical external connections.

The 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. Additional information on the XLA test plugs may be obtained from GEI-25372.

### MECHANICAL TESTS

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.

Check that adjustable cam lobes are set in proper positions to provide breaker reclosing impulses at the desired times. A lobe in the zero position will provide an immediate reclosing impulse when the NLR relay is in the reset position and the breaker trips. A second lobe in position 3 will provide a second reclosing impulse 3 times the step time interval (or 15 seconds) after the first breaker trip when the NLR is set for the standard step time. Likewise a third lobe in position 9 will provide a reclosing impulse  $9 \times 5$  (or step time) or 45 seconds after the first breaker trip.

Set reset link in position to provide desired time delay before rapid reset.

### ELECTRICAL TESTS

Make connections to NLR relay as shown in Fig. 12. With NLR relay in lockout position, close S2 and check that stepping switch steps to reset after approximately 5 seconds (or one step time interval) and remains in the reset position. Note that indicating light 3 turns on at reset and indicating light 4 turns off.

Open S2 and close S1 and check that NLR relay initiates reclosing impulses (shown by indicating light 1 turning on) at desired intervals. Also check that stepping switch stops in lockout. Also check that the auxiliary cam (see Fig. 1) operates the micro switch to open (or close) the "RS" contact on the desired step as shown by indicating light 2. Adjust auxiliary cam if necessary as described in section on adjustments. Note that indicating light 3 turns off after first step.

Close S2 and after NLR has reset close S1 and note that the stepping switch starts its rapid reset after the desired time interval after the closing impulse.

If adjustments are necessary check the section on "ADJUSTMENTS" for instructions.



ADJUSTMENTSINTRODUCTION

The following adjustments may be made in any order, but due to a physical interference the adjustable SC cams cannot be set on adjacent positions. To obtain a setting such as 0-5-5 seconds it is recommended that the step time be set to 2.5 seconds and the reclosing interval set to the zero, two, and four time dial positions.

RECLOSING INTERVALS

In order to change the time intervals between reclosing impulses, proceed as follows.

Loosen the locknut and run it back to the end of the cam shaft. HOLD THE DIAL FIRMLY WITH ONE HAND WHILE LOOSENING THE NUT TO LIMIT THE STRAIN ON THE CAM SHAFT. Pull the indicating dial forward far enough to permit moving the adjustable cam (SC) rings. Then slide the rings which hold the contact operating lobes forward until the lobes are out of the locating sockets. Now the rings can be rotated to locate the three lobes in the desired locations. After changing the setting of one lobe be sure all lobes are in the desired positions.

When tightening the locknut, back pressure must be exerted on the dial in the counterclockwise direction. This can be accomplished by stepping the stepping switch until the lockout/reset indicator on the dial is at nine o'clock. With your fingers on the dial and your thumb against the indicator, exert a force (counterclockwise) greater than the force necessary to tighten the locknut. The locknut is normally tightened to 25 inch/pounds at the factory.

Failure to do this will result in a bent latching spring which will make the stepping switch sloppy and make the relay inoperative.

After the dial is tightened correctly, return the stepping switch to zero (immediate reclosure position) and note that the brush that activates the front row of contacts (SC) is setting approximately in the center of the lobe cam. If this is correct then the dial was held properly while it was being tightened.

If the brush is resting near the rear of the lobe cam where it might take two steps to ride off, then the back pressure on the dial was insufficient as the locknut was tightened.

Stepping dials that are incorrectly held as they are tightened will result in the relay taking three or more steps as each reclosure occurs which will further result in loss of time between lobe settings.

STEP TIME

To adjust the step time loosen the locknut on the rheostat (see Fig. 1) and turn the rheostat counter clockwise to decrease the step time interval. Connect the relay as shown in Fig. 12, connect the "reset" link to the "NONE" position, and close the S1 switch momentarily (1/2 second or less). The stepping switch will run with time delay steps to the lockout position and stop. Then by closing switch S2 it will move on to reset after one step time interval. By timing the 35 steps and adjusting the rheostat to produce the correct total time the step time interval can be set very accurately. After setting the step time lock the rheostat and place the reset link in the position which will provide the desired reset time.

RS CONTACT AND MICRO SWITCH

The "RS" contact connected to studs 9 and 10 is a micro switch contact operated by the auxiliary cam (see Fig. 1). The micro switch operating button is depressed in all but 4 steps of the 36 steps which make up one revolution of the cam shaft of the stepping switch. By loosening the locknut on the end of the cam shaft slightly, the auxiliary cam can be rotated to permit the micro switch button snap to its extended position on any desired step. The stepping switch armature can be depressed manually to step the switch to check that the "RS" contact operates on the desired step. By holding the stepping switch armature in the depressed position, the cam shaft can be rotated in counterclockwise direction without any steps to speed up the check of the "RS" contact setting.

The contact connected to studs 9 and 10 closes when the micro switch operating button is released and opens 6 to 8 steps later. By moving the green lead connected to stud 9 to stud 10 the contact operation can be reversed (i.e. opens when microswitch button is released and closes 6 to 8 steps later.)

If, for any reason, the micro switch mounting or the stepping switch mounting has been disturbed the location of the micro switch with respect to its operating cam must be rechecked. Loosen the screws holding the micro switch bracket enough to permit the bracket to be moved slightly in either direction. By moving the bracket locate the micro switch so that the distance between the micro switch case and the cam when the button is fully depressed is 0.025 to 0.045 inches.

When the micro switch is properly positioned the cam will depress the button one step after the "reset" position and the button should snap out 4 to 6 steps before the "lockout" position. With the one step between "lockout" and "reset" this gives a total of 6 to 8 steps when the micro switch is closed.

#### 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 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.

#### SERVICING

Should servicing of the relay become necessary, follow the test procedures as explained in the ACCEPTANCE and ADJUSTMENT sections. Telephone relay contact cleaning is located in the section titled PERIODIC CHECKS AND ROUTINE MAINTENANCE. Also, see section on RENEWAL PARTS for servicing printed circuit cards.

#### 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.

#### 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.

Should a printed circuit card become inoperative, it is recommended that this card be replaced with a spare. In most instances, the user will be anxious to return the equipment to service as soon as possible and the insertion of a spare card represents the most expeditious means of accomplishing this. The faulty card can then be returned to the factory for repair or replacement.

Although it is not generally recommended, it is possible with the proper equipment and trained personnel to repair cards in the field. This means that a trouble-shooting program must isolate the specific component on the card which has failed. By referring to the internal connection diagram for the card, it is possible to trace through the card circuit by signal checking and, hence determine which component has failed. This, however, may be time consuming and if the card is being checked in place in its unit, as is recommended, will extend the outage time of the equipment.

CAUTION: GREAT CARE MUST BE TAKEN IN REPLACING COMPONENTS ON PRINTED CIRCUIT CARDS. SPECIAL SOLDERING EQUIPMENT SUITABLE FOR USE ON THE DELICATE SOLID-STATE COMPONENTS MUST BE USED AND, EVEN THEN, CARE MUST BE TAKEN NOT TO CAUSE THERMAL DAMAGE TO THE COMPONENTS, AND NOT TO DAMAGE OR BRIDGE OVER THE PRINTED CIRCUIT BUSES. THE REPAIRED AREA MUST BE RECOVERED WITH A SUITABLE HIGH-DI-ELECTRIC PLASTIC COATING TO PREVENT POSSIBLE BREAKDOWNS ACROSS THE PRINTED CIRCUIT BUSES DUE TO MOISTURE OR DUST.

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.

Since the last edition, Figures 11 and 12 have been revised.

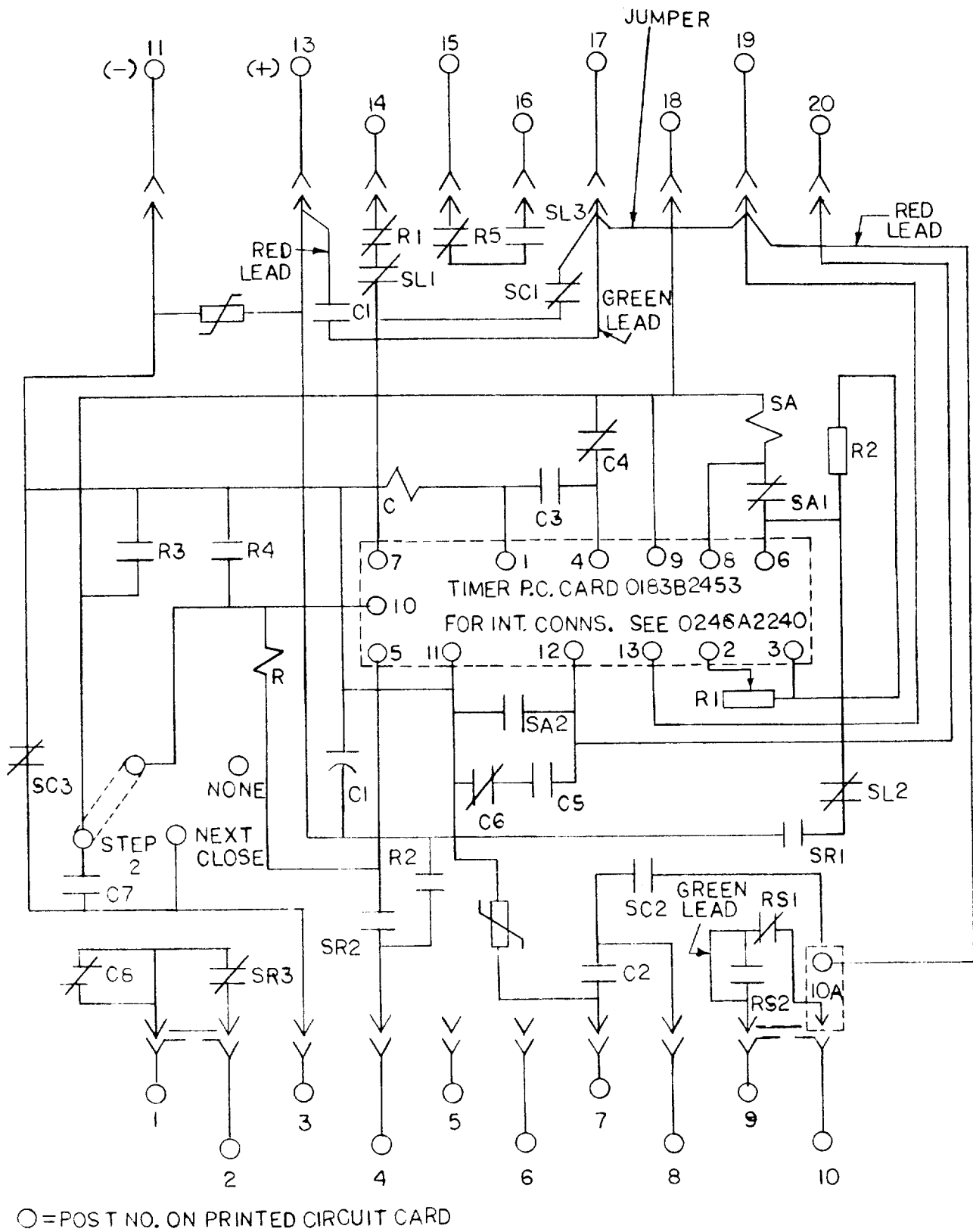


Figure 4 (0246A3325 Sh.1 |3|) Type NLR21A Relay Internal Connections Diagram

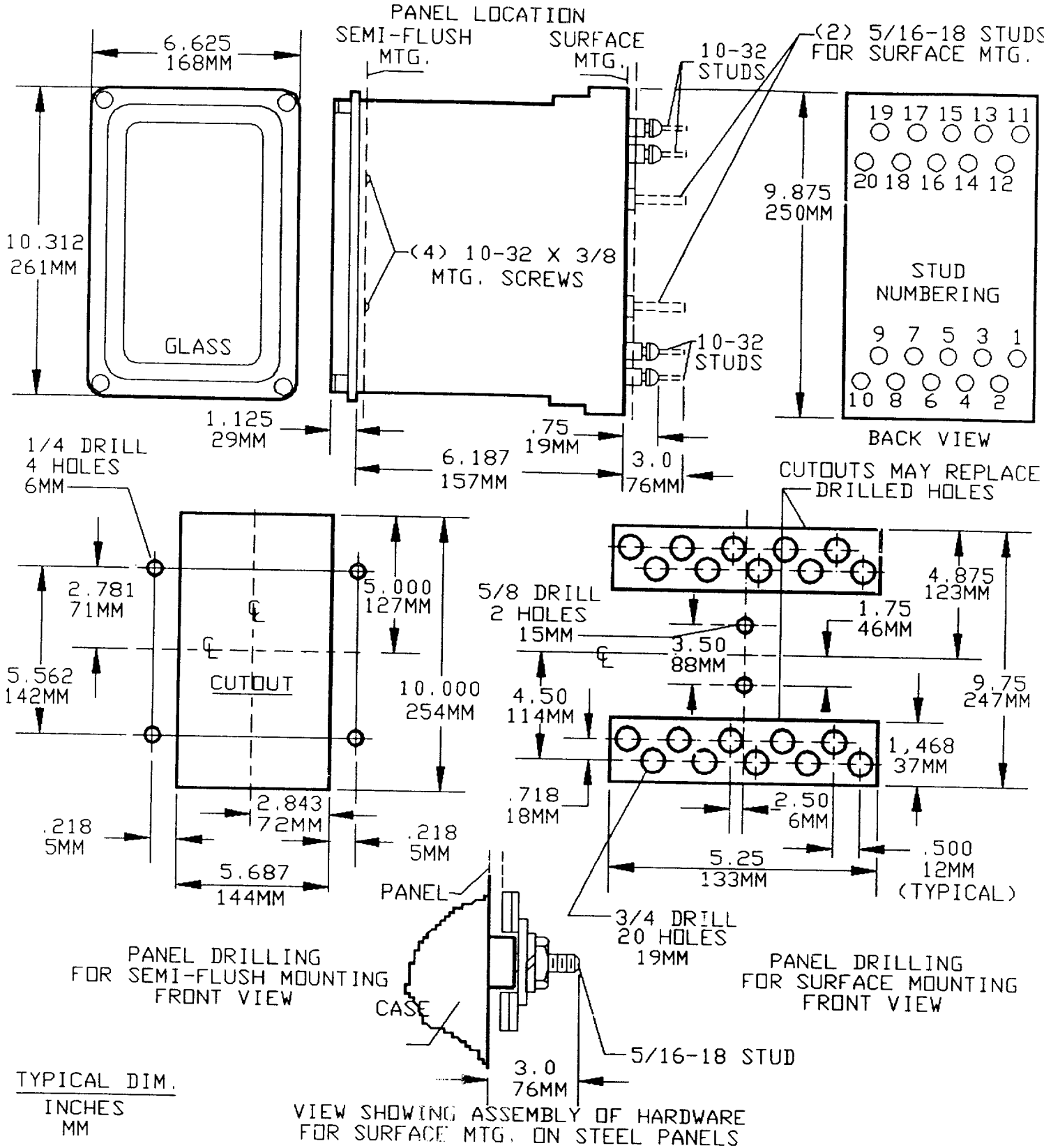
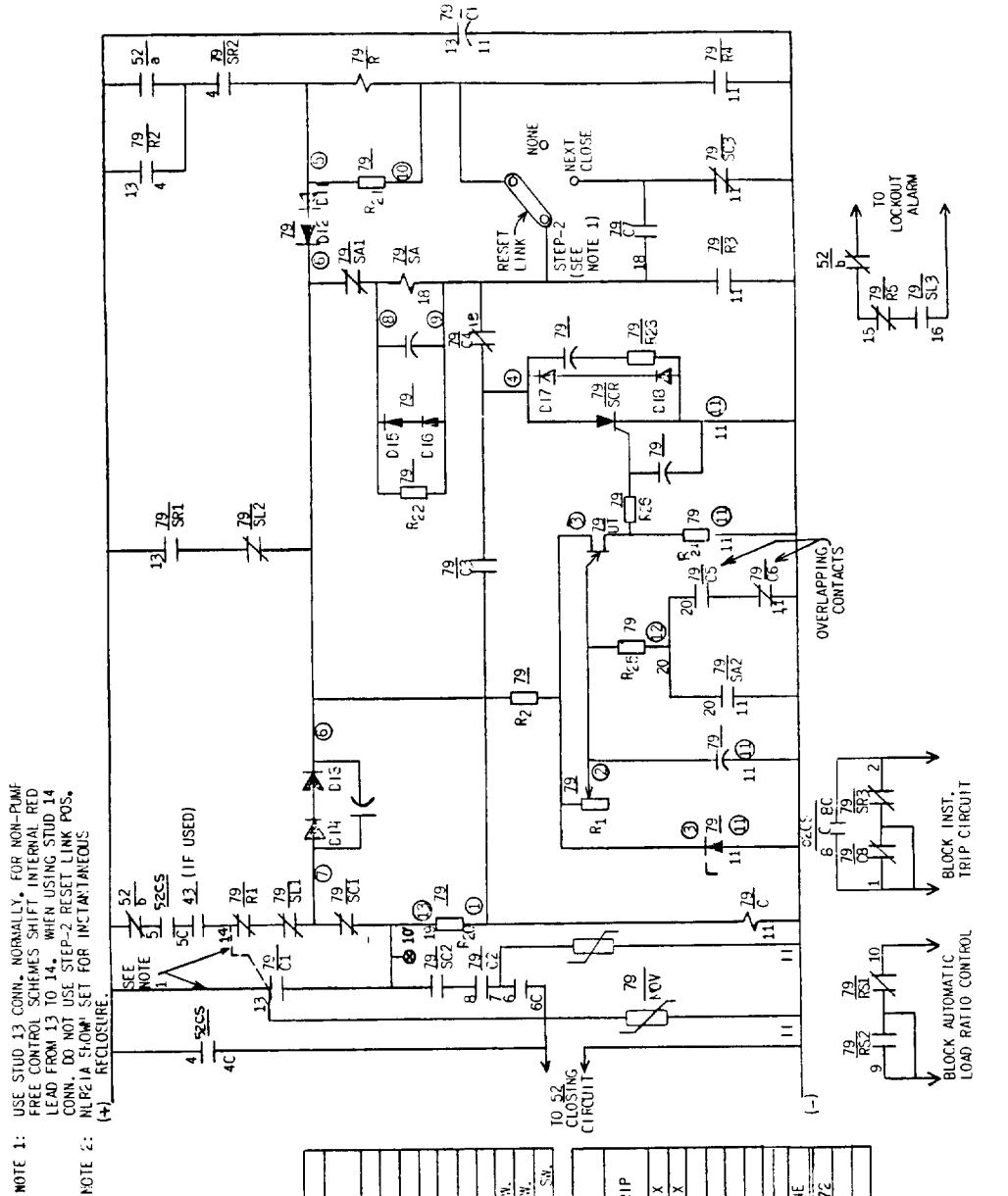


Figure 5 (K-6209272 [7]) Outline and Panel Drilling Diagram



NOTE 1: USE STUD 13 CONN. NORMALLY. FOR NON-PUMP FREE CONTROL SCHEMES SHIFT INTERNAL RED LEAD FROM 13 TO 14. WHEN USING STUD 14 CONN. DO NOT USE STEP-2 RESET LINK POS. NLR21A SLOW SET FOR INSTANTANEOUS RECLOSURE.

NOTE 2: (+)

OPERATED CONTACTS	RESET STEP #0	STEPS 1-34	LOCKOUT STEP 35
SL			X
SR		X	
SR		X	X
SL		X	
SC		X	
RS		X	
RS		X	

DEVICE NO.	INCL. TYPE	DESCRIPTION
52CS	CP	CONTROL SWITCH
79	NR	AC CLOSING RELAY
	C	CLOSING UNIT
	R	RESETTING UNIT
	P	220V OPER. AUX-FUNCTION SW.
	SA	ARMATURE OF STEPPING SW.
	SC	CLOSING COILS OF STEPPING SW.
	SL	LOCKOUT COILS OF STEPPING SW.
	SR	RESET COILS OF STEPPING SW.

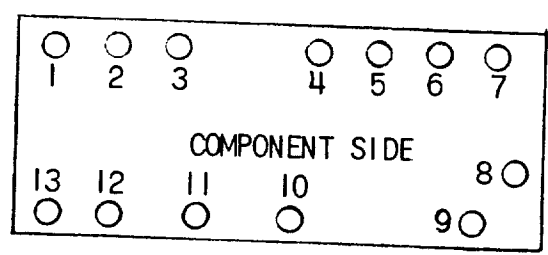
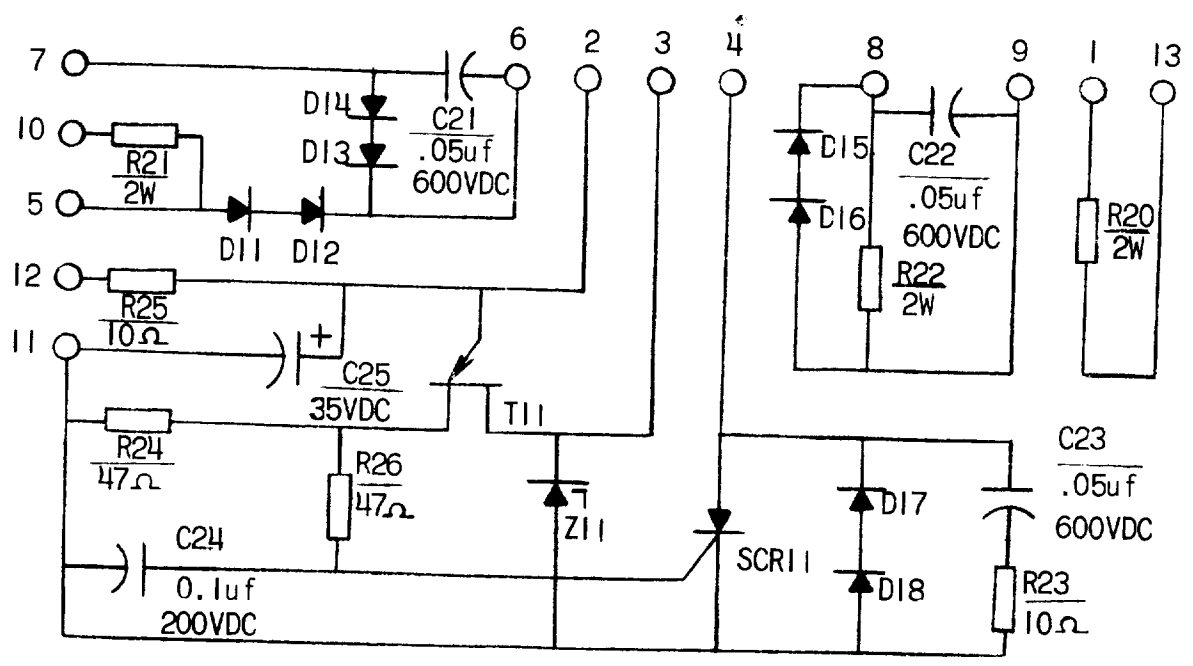
CONTACT NUMBER	CLOSE	TRIP
1	X	
2		X
3	X	
4	X	
5	X	
6	X	
7	X	
8	X	
9	X	
10	X	
11	X	
12	X	
13	X	
14	X	
15	X	
16	X	
17	X	
18	X	
19	X	
20	X	
21	X	
22	X	
23	X	
24	X	
25	X	
26	X	
27	X	
28	X	
29	X	
30	X	
31	X	
32	X	
33	X	
34	X	
35	X	
36	X	
37	X	
38	X	
39	X	
40	X	
41	X	
42	X	
43	X	
44	X	
45	X	
46	X	
47	X	
48	X	
49	X	
50	X	
51	X	
52	X	
53	X	
54	X	
55	X	
56	X	
57	X	
58	X	
59	X	
60	X	
61	X	
62	X	
63	X	
64	X	
65	X	
66	X	
67	X	
68	X	
69	X	
70	X	
71	X	
72	X	
73	X	
74	X	
75	X	
76	X	
77	X	
78	X	
79	X	
80	X	
81	X	
82	X	
83	X	
84	X	
85	X	
86	X	
87	X	
88	X	
89	X	
90	X	
91	X	
92	X	
93	X	
94	X	
95	X	
96	X	
97	X	
98	X	
99	X	
100	X	

DEBR. OF DEVICE INT. CONNS. OUTLINE  
 NLR21A & PLELIC C-245525 K-6265272

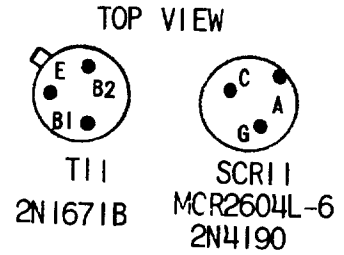
⑥ - NUMBERS IN CIRCLES ARE TERMINAL POINTS ON PRINTED CIRCUIT CARD.

NUMBERS ON CONTACTS (79/R1, 79/SC1, ETC) ARE ARBITRARILY ASSIGNED FOR IDENTIFICATION PURPOSES.

Figure 6 (0165B2631 [2]) Type NLR21A Relay External Connections Diagram



CONNECTOR LOCATION ON PRINTED CIRCUIT CARD



NOTE: ALL RESISTORS 1/2 WATT ±10% UNLESS OTHERWISE NOTED.  
ALL DIODES 1N5061 UNLESS OTHERWISE NOTED.

DRAWING NO.	GROUP NUMBER				
	1	2	3	4	5
0183B2453					
	RESISTANCE VALUE IN OHMS				
R21	8200	3900	1500	8200	1000
R22	8200	3900	1500	8200	1000
R20	2200	1000	390	2200	240
	ZENER DIODE, TRANSISTOR OR SCR NOMENCLATURE				
SCR11	2N4190	MCR-2604L-6	MCR-2604L-6	2N4190	MCR-2604L-6
Z11	1N965A	1N965A	1N965A	1N965A	1N965A
T11	2N1671B	2N1671B	2N1671B	2N1671B	2N1671B
	CAPACITANCE VALUE				
C25	8.2uf	8.2uf	8.2uf	15uf	8.2uf

FIG. 7 (0246A2240-2) Printed Circuit Card Type NLR21 Relay

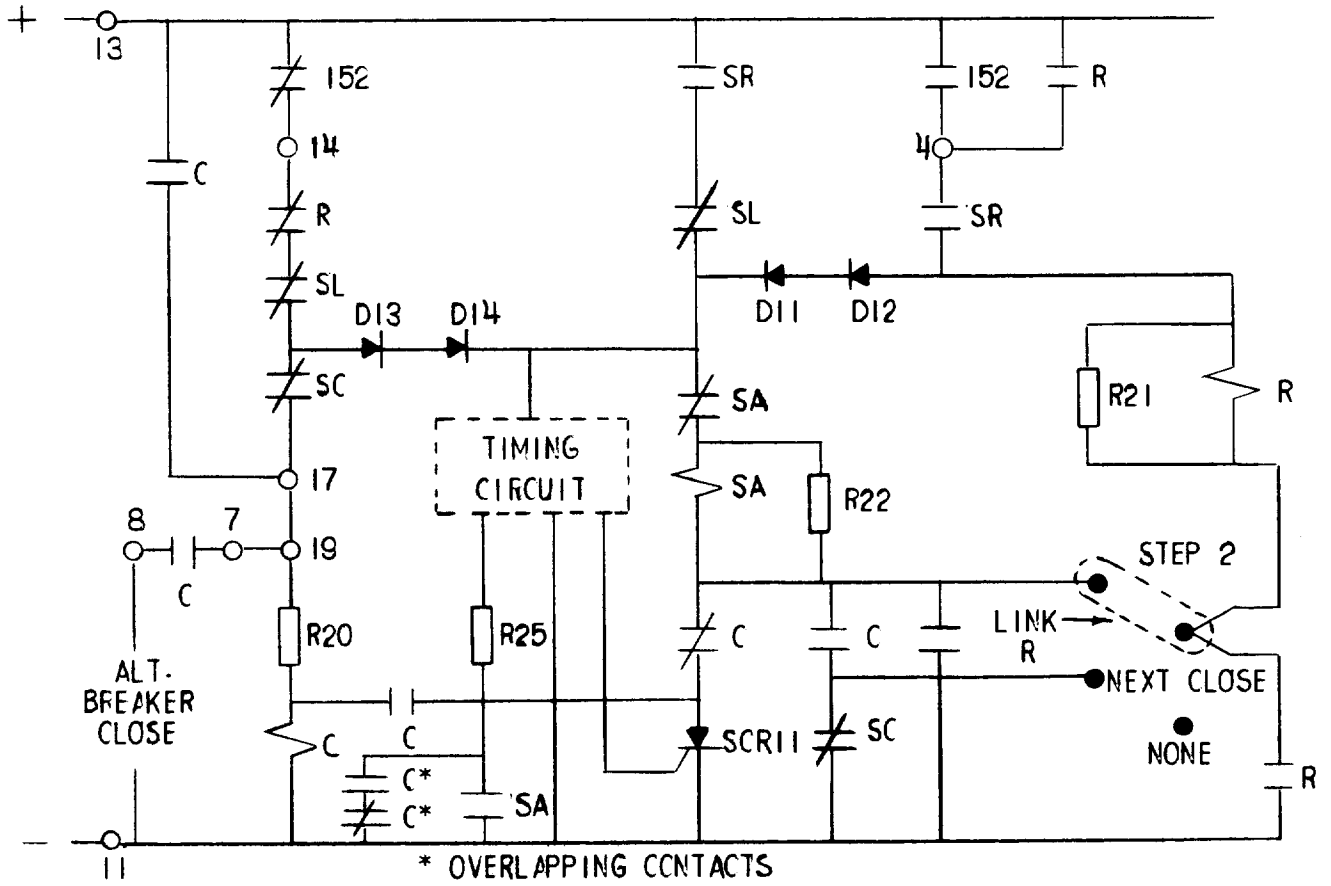
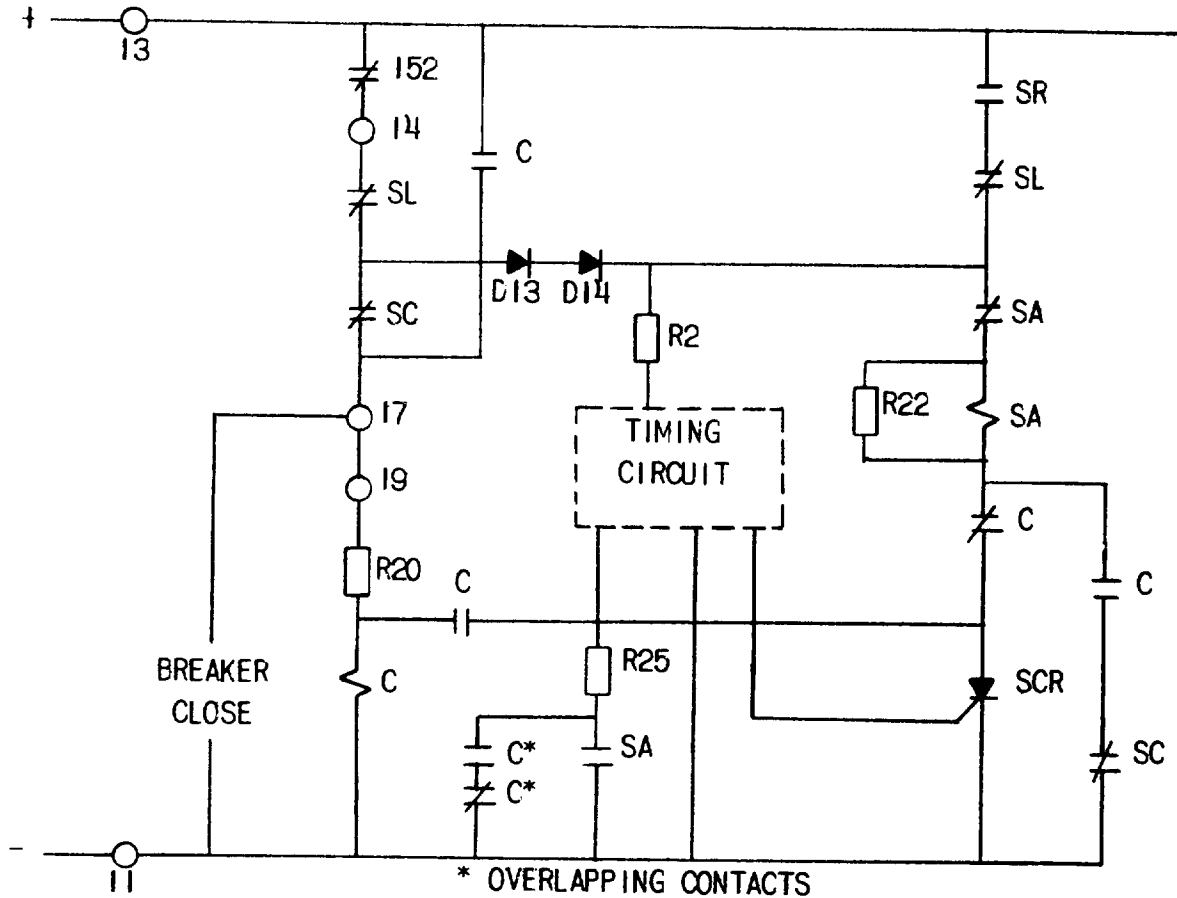


FIG. 8 (0246A6854-0) Breaker Reclosing Circuit With Contact Shown As They Are In Reset Position For Instantaneous First Reclosure





CAM OPERATED CONTACTS	RESET	STEPS 11-34 INCL	LOCKOUT
SL $\neq$	CLOSED	CLOSED	OPEN
SL $\neq$	OPEN	OPEN	CLOSED
SR $\neq$	OPEN	CLOSED	CLOSED
SR $\neq$	CLOSED	OPEN	OPEN
SC $\perp$	OPEN WHEN SC $\neq$ CONT. IS CLOSED		
SC $\neq$	ADJUSTABLE TO CLOSE ON ANY 3 STEPS		

**LEGEND**  
 152-POWER CIRCUIT BREAKER  
 -RELAY STUDS

FIG. 9 (0246A6915) Breaker Reclosing Schematic Diagram And Reset Circuits

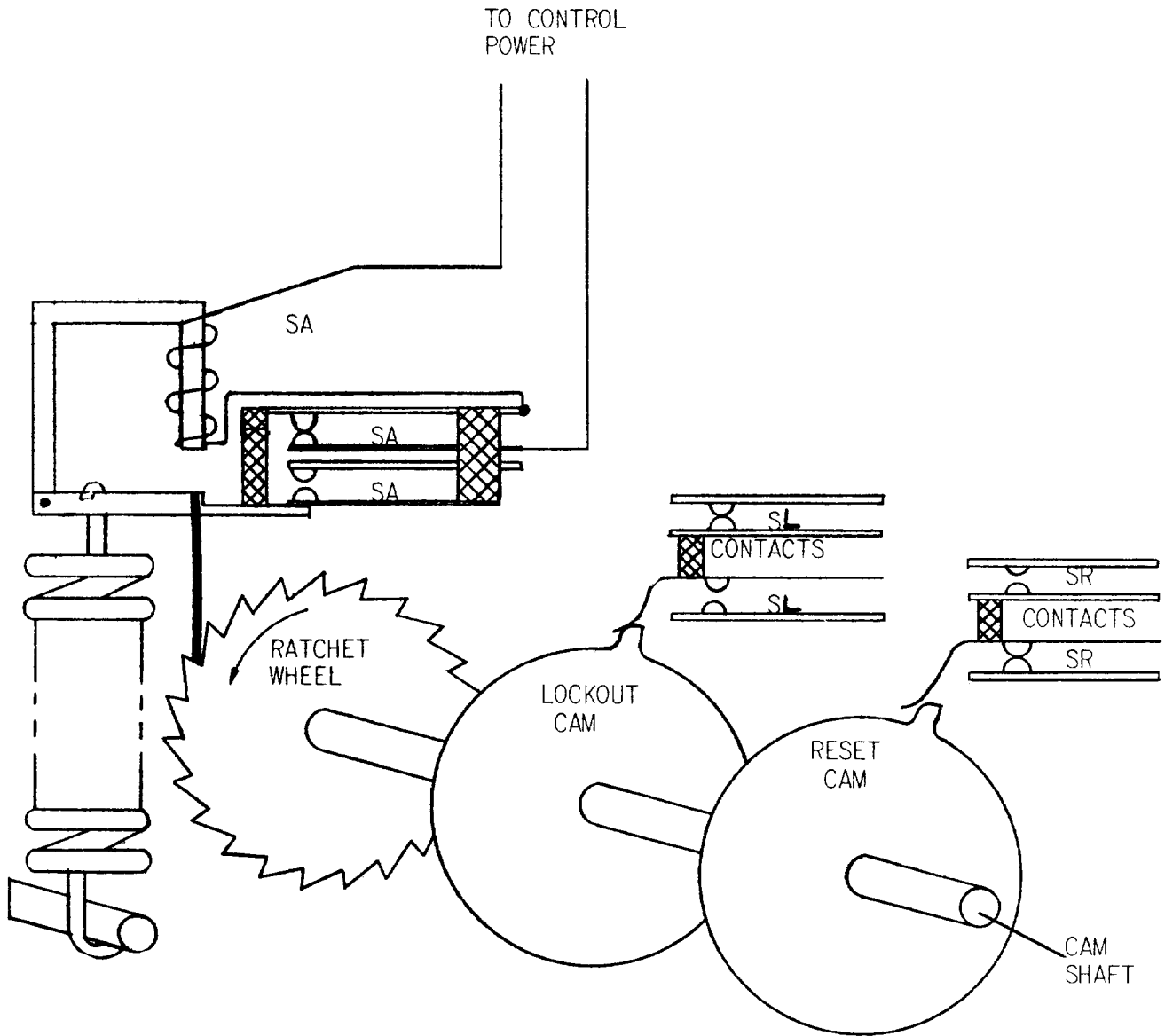


FIG. 10 (0178A9144-0) Stepping Switch For NLR Relay

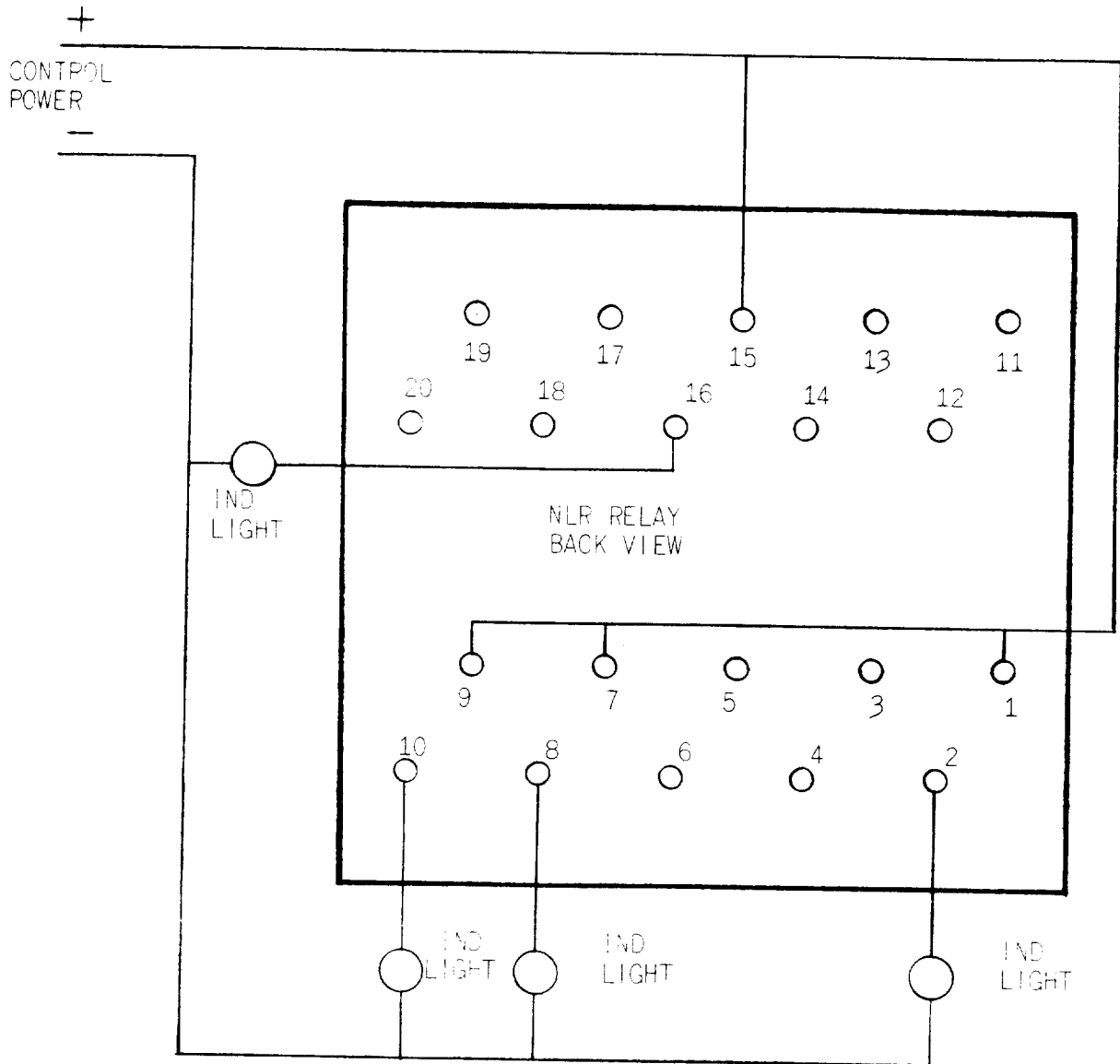


FIG. 11 (0178A9142 [1]) Test Connections for the NLR Type Relay

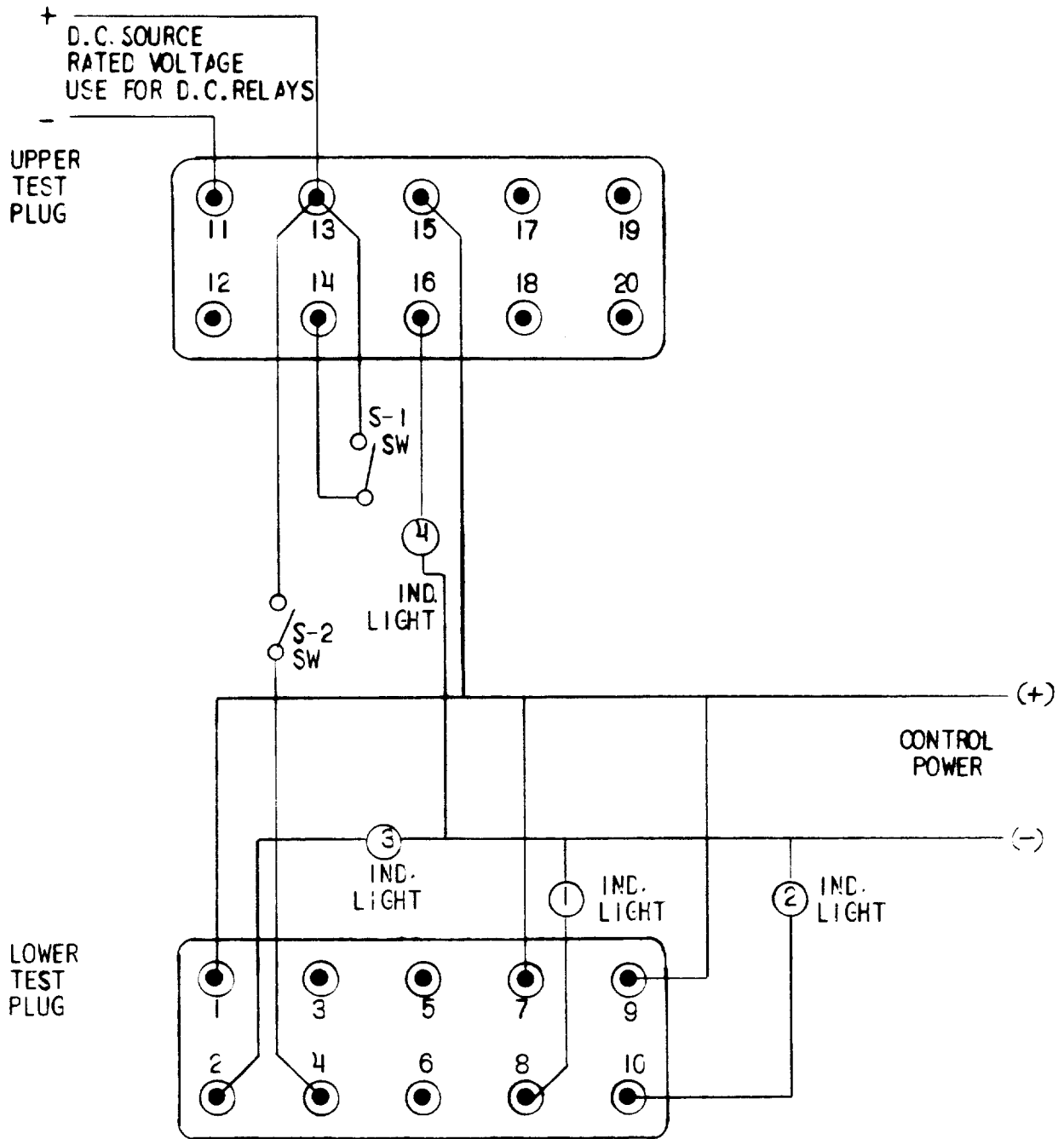


FIG.12 (0246A6857 [1]) Field Test Connections for the NLR Type Relay