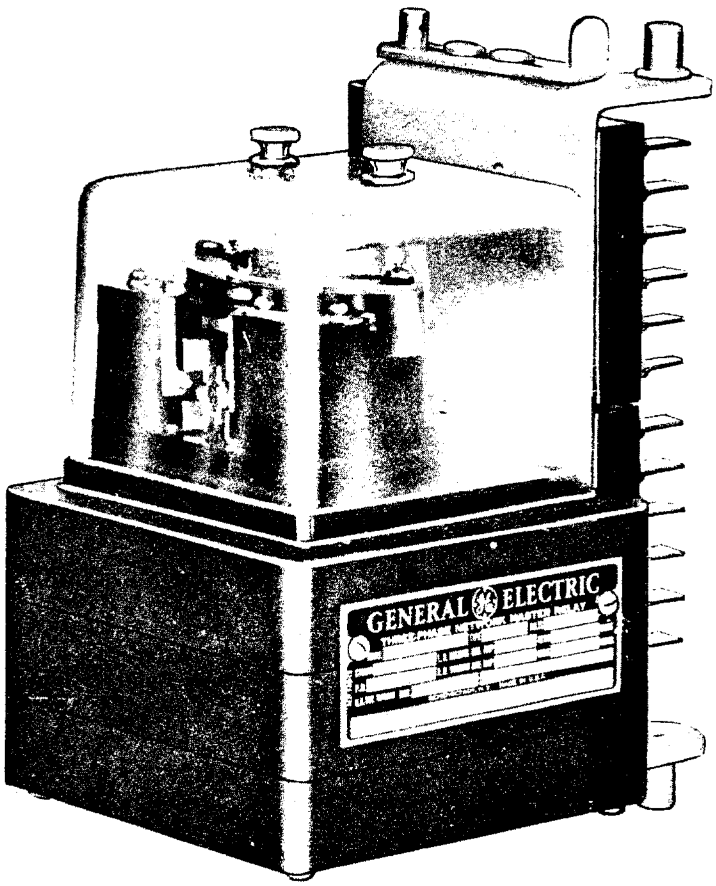
**INSTRUCTIONS**

GEI-13580E

*SUPERSEDES GEI-13580D*

# NETWORK RELAYS




## Types

## CAL15A,

## CAN11A,

## and

## PYC13B

**CONTENTS**



**POWER SYSTEMS MANAGEMENT DEPARTMENT**

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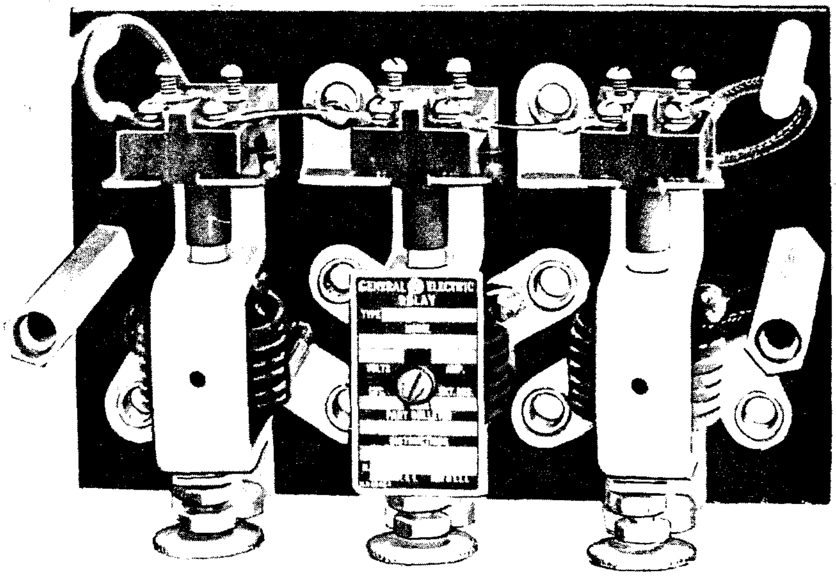


Fig. 1 Type PYC13B Relay

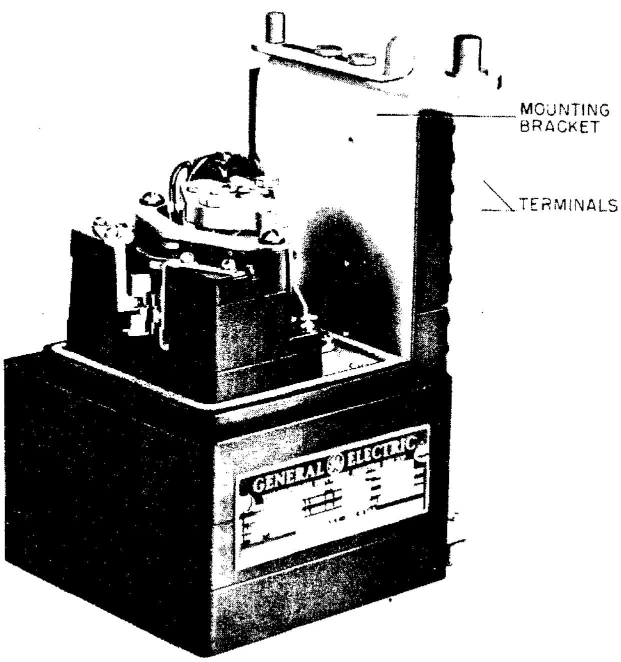


Fig. 2 Type CAN11A Relay With Cover Removed

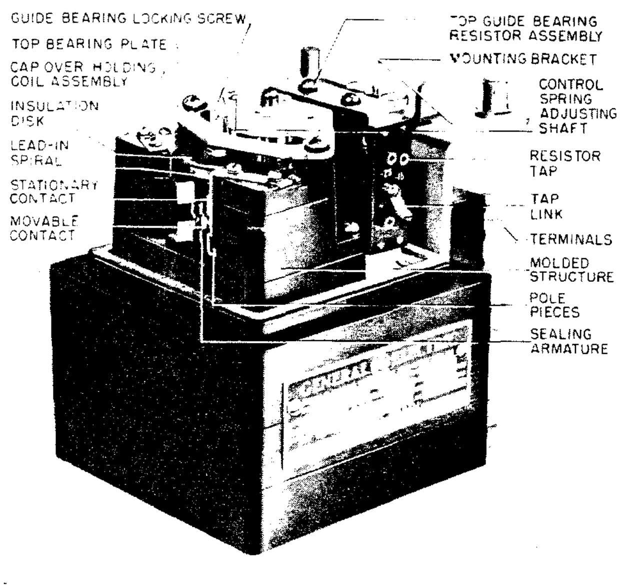


Fig. 3 Type CAL15A Relay With Cover Removed

Cover (855730) Fig. 1 (852518) Fig. 2 (858291) Fig. 3 (858290)

# NETWORK RELAYS
# TYPES CAL15A, CAN11A AND PYC13B

## DESCRIPTION

### INTRODUCTION

The Type CAN relay is a three-phase induction-cylinder relay as illustrated in Fig. 2. Facing the contact structure, the tripping contacts are on the left.

The Type CAL relay is a single-phase induction-cylinder relay shown in Fig. 3. In this relay the complete contact assembly is the same as in the Type CAN relay except the left holding coil, left stationary contact, left movable contact brush and the mechanical and electrical restraints are omitted.

A resistor and tap block assembly is mounted on the back part of the top plate to provide various phase angle characteristics.

The Type PYC Network Overcurrent Relay, Fig. 1, consists of three small plunger-type elements mounted on a Textolite* base. Each element has a set of circuit-opening contacts and all three sets are connected in series.

### APPLICATION

CAN11A

Relay Performance During Unbalanced Primary-feeder Faults

The theory of operation of the Type CAN three-phase, single-element relay with L-L connected potential coils can be readily understood by referring to Fig. 4 and Table I. In Table I comparisons are

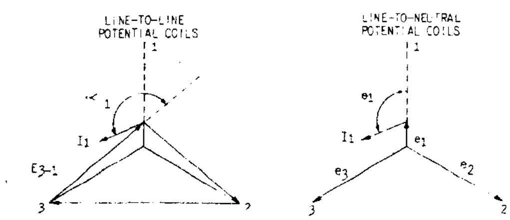


Fig. 4 Vector Diagrams For Line-to-line Fault On Primary Of Y-Y Transformer Bank, Both Neutrals Grounded

Fig. 4 (104A8503)

made at three different voltages. Fig. 4 is a vector diagram of the voltages existing at the relay for a line-to-ground primary-feeder fault on a Y-connected transformer. There is fault current ($I_1$) in only one phase of the system, and hence only one phase of the master relay.

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Other possible unbalanced primary-feeder faults are: (1) double line-to-ground faults; and (2) line-to-line faults. The actual torques for two similar relays with L-N-connected and L-L-connected potential coils are compared in Table II.

Hence, it permits more latitude in the selection of network-protector fuses without the probability of a fuse's blowing on unbalanced primary-feeder faults before the master relay trips the network protector.

The greater torque of this relay has proved particularly advantageous where higher reverse power settings are required to prevent "pumping" of the network protector during normal operation. These higher settings may actually prevent a relay with L-N potential coils from tripping during certain unbalanced primary-feeder faults. The greater torque produced by the single-element relay with L-L-connected potential coils permits greater reverse power settings without the relay failing to trip on unbalanced primary-feeder faults.

The vector diagrams in Fig. 5, 6 and 7 show the relation between the fault voltages and the currents in the two relays employing L-L or L-N potential connections.

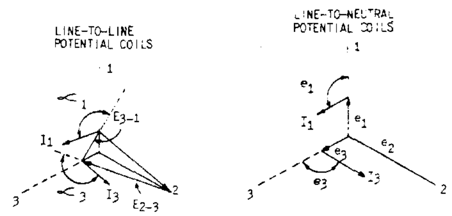



Fig. 5 Vector Diagram For Double Line-to-ground Fault On Primary Of Y-Y Transformer Bank, Both Neutrals Grounded

Fig. 5 (104A8501)

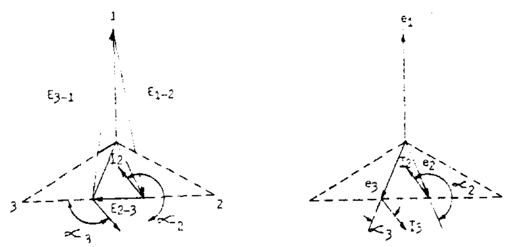


Fig. 6 Vector Diagrams For Line-to-line Fault With Y-Y Transformer Bank, Both Neutrals Grounded

Fig. 6 (104A8500)

TABLE I

Comparison of Relays for Line-to-ground Fault, Fig. 9

| Per Cent *Fault Current ($I_1$) | Per Cent Potential-coil Voltage Which Operates with $I_1$ | Angle between Fault Current and Maximum Torque Angle of Relay | † Per Cent of Normal Torque | | Ratio of Relay Torque L-L to L-N |
|---|---|---|---|---|---|
| | | | L-L Relay (Type CAN) | L-N Relay (Conventional) | |
| 200 | 10 $e_1$ | 75° | | 1.7 | 15.3 |
| 200 | 58 $E_{3-1}$ | 47° | 26 | | |
| 500 | 25 $e_1$ | 75° | | 11 | 6.1 |
| 500 | 71 $E_{3-1}$ | 55° | 67 | | |
| 1400 | 70 $e_1$ | 75° | | 81 | 1.7 |
| 1400 | 85 $E_{3-1}$ | 51° | 139 | | |

* Fault current and potential-coil voltage are stated in per cent of rated current and voltage of associated network transformer.

† Normal torque is the torque produced by the relay with all three phases energized with rated voltage and rated current at the angle of maximum torque.

TABLE II

Comparison of Master Relays for Various Types of Unbalanced Primary-feeder Faults, Fig. 10, 11, and 12. Basis: Fault Voltage Equals 25 per cent of Normal. Power-factor of Fault Current Is 75 Degrees Lagging

| Type of Fault | Transformer Primary Connection | Per Cent of Normal Torque | | Ratio of L-L to L-N Relay Torques |
|---|---|---|---|---|
| | | L-L Relay (Type CAN) | L-N Relay (Conventional) | |
| Double line-to-ground | Wye | $15.1 \frac{I}{I_n}$ | $4.2 \frac{I}{I_n}$ | 3.6 |
| Line-to-line | Wye | $24.8 \frac{I}{I_n}$ | $3.7 \frac{I}{I_n}$ | 6.7 |
| Line-to-line | Delta | $21.4 \frac{I}{I_n}$ | $3.2 \frac{I}{I_n}$ | 6.7 |

$\frac{I}{I_n}$ = Ratio of fault current to rated current of network relay.

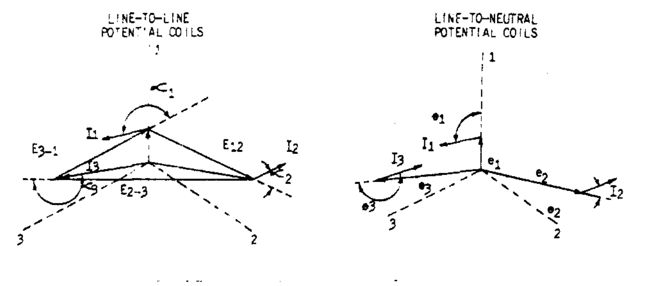



Fig. 7 Vector Diagrams For Line-to-line Fault With Y-△ Transformer Bank

Fig. 7 (104A502)

The increased torque of the new relay during unbalanced primary-feeder faults provides more positive operation and also increases the speed of operation of the relays (see Table III).

CAL15A

The Type CAL network phasing relay, Fig. 3, is used in conjunction with the Type CAN network master relay to control the closing operation of the automatic network protectors.

TABLE III

Comparative Operating Times of Similar Relays on Single Phase-to-ground Primary-feeder Faults with L-L connected and L-N connected Potential Coils. Basis: Fault Voltage Equals 25 Per Cent of Normal. Power-factor of Fault Current is 75 Degrees Lagging

| Fault Current in Per Cent of Normal | Operating Time in Seconds | |
|---|---|---|
| | L-L Relay | L-N Relay |
| 500 | 0.16 | 0.9 |

If the Type CAN relay were used alone, it might permit the protector to close under voltage conditions which would cause the power flow upon reclosure to be from the network into the transformer. The protector would, therefore, immediately open. Thereafter it would continue to reclose and open or "pump."

The conditions giving rise to such operation are illustrated in Fig. 8. This shows the voltage conditions existing with the network protector open and the current which would flow with the protector

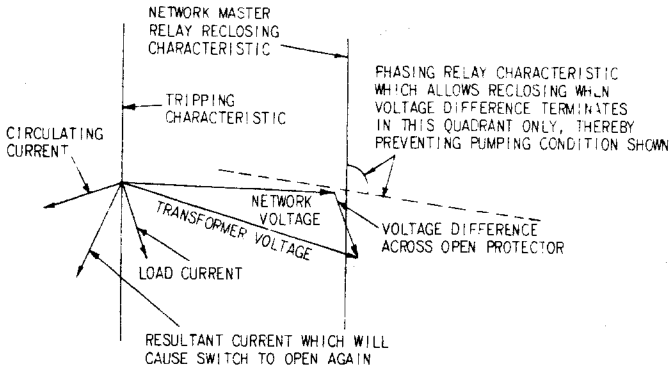



Fig. 8 Vector Diagram Of Condition That Causes Pumping

closed. The transformer voltage is shown as being higher than the network voltage and lagging it in phase angle. It will be noted that the vector of this voltage difference terminates to the right of the reclosing characteristic of the Type CAN master relay (shown in this figure in approximate form). Therefore, the Type CAN relay will close its closing contacts under these voltage conditions. If the protector were allowed to reclose, a circulating current would flow in addition to the load current due to this voltage difference. This circulating current will lag the difference voltage by a high phase angle, and the resultant current may fall on the left-hand side of the network tripping characteristics, with the result that the protector will be immediately opened. The characteristics of the Type CAL phasing relay are approximately such that its contacts will close only when the transformer voltage leads the network voltage in phase angle. Thus, when the contacts of the phasing relays are in series with the closing contacts of the Type CAN relay, closing of the network protector under the condition shown in Fig. 8 (and consequent "pumping") is prevented.

PYC13B

The Type PYC overcurrent relay is used only when it is desired to operate the network protectors nonsensitively. The PYC relay contacts are in series with the electrical restraint coil on the Type CAN network master relay.

# OPERATING CHARACTERISTICS

CAN11A

Reclosing Characteristics

A typical reclosing characteristic of the Type CAN network relay is shown plotted by polar coordinates in Fig. 10. The network voltage vector is assumed as the reference vector. For clearness, this is shown in a shortened scale, in order to enlarge the voltage scale to which the characteristics are plotted.

With the network voltage vector as reference, the vector representing the voltage difference between the voltage on the transformer side and that on the network side of the open protector is plotted to the indicated scale in its true phase-angle relation to the network voltage. If this voltage difference vector terminates to the right of the respective characteristic curves, the relay will close its closing contacts and cause the network protector to reclose. Such a vector is shown as $E_d$. If, however, the voltage difference vector terminates to the left of the respective characteristic (such as $E_{d1}$), the relay will not close its closing contacts, and the protector will remain open.

With the characteristics shown, it will be noted that the voltage difference, when in phase with the network voltage, must be 1, 1.5, or 2 volts or greater (depending on the setting) to cause reclosure. This means---if the transformer and network voltages are in phase---that the transformer voltage must be 1, 1.5, or 2 volts greater than the network voltage to cause reclosure. It is this inphase voltage difference required for reclosure which is referred to as the reclosure voltage setting of the Type CAN relay. While a setting of 1.5 volts is recommended for average conditions, this setting may be varied if desired by changing the resistors in the phasing circuit on the protector. Three settings are available by using the proper set of resistors in the phasing circuit. These settings on the 125/216-volt protectors are 1, 1-1/2, and 2 volts.

Tripping Characteristics

Typical tripping characteristics of the Type CAN network relay are shown in Fig. 11, 12 and 13. They are plotted to three different scales, with the relay arranged for sensitive operation.

As with the reclosing characteristics, the network line-to-neutral voltage is assumed as 125 volts, and the vector of this voltage is used as a reference. The current flowing through the network protector is plotted vectorially in its true phase-angle relation, in accordance with the ampere scale shown, with the origin of the current vector at the same point as the origin of the network-voltage vector. Currents, having vectors terminating to the left of the tripping characteristic will cause the relay to close its tripping contacts and the protector to open. With currents having vectors terminating to the right of the characteristics, the relay will cause the relay to close its tripping contacts and the protector to open. With currents having vectors terminating to the right of the characteristics, the relay will not close its tripping contacts, and the protector will remain closed.

Fig. 16 shows the tripping characteristic of the relay in the range of 0-7 per cent protector rating. The relay must trip on the exciting current of the network transformer. This exciting current will be relatively small and will lag the network voltage vector reversed by an angle in the order of 65 to 80 degrees. The vector of such a current is shown as $I_m$ and, since it terminates to the left of the characteristic, it is evident that the relay will close its tripping contact and cause the protector to open.

Fig. 12 shows the same characteristic in the range of 0-35 per cent of the protector rating. On systems using high-voltage primary feeders the current reversal when the feeder is de-energized at the station will be equal to the exciting current of the network transformer plus cable charging current. This cable charging current will lead the network voltage vector reversed by a very high angle, in the order of 88 to 89-1/2 degrees. In order that the relays may trip satisfactorily on all networks, it is necessary that tripping occur on currents equal to the exciting current of the transformer plus any value of charging current up to 2-1/2 times the current transformer rating. Such a current vector as shown as $I_c$ and, since this vector terminates to the left of the tripping characteristic, the relay will close its tripping contacts and cause the protector to open.

The relay, in addition to tripping under the above outline current conditions, must also trip under short circuits on the primary feeder. A short-circuit-current vector is shown as $I_{sc}$, Fig. 13. Since this vector terminates to the left of the tripping characteristic, the relay will close the tripping contacts and cause the protector to open. For clearness, this characteristic is shown only to 350 per cent, but it extends practically in a straight line from the range shown to 2000 per cent or more.

It should also be noted that the relay should not trip under short circuits on the secondary network. Such currents may range nearly as high in value as the primary short-circuit currents and may also lag the network voltage by relatively high phase angles. Such a current is shown as $I_{cs}'$, in Fig. 13. Since this vector terminates to the right of the tripping characteristic, the relay will not close its tripping contacts, and the protector will remain closed.

## CAL15A

Typical characteristics of the Type CAL phasing relay are plotted by polar co-ordinates in Fig. 9. These characteristics are shown by the curves A, B, etc., and the reclosing characteristic of the Type CAN network relay by the nearly vertical line. The network line-to-neutral voltage is assumed as 125 volts and is used as a reference vector. The characteristics are interpreted as follows.

The vector, which represents the difference in voltage between the voltage on the transformer side and that on the network side of the open protector, is plotted to the indicated voltage scale in its true phase-angle relation to the network voltage. If this voltage difference vector (as $E_{d1}$) terminates below the Type CAL relay characteristic, the contacts of this relay will remain open and the network protector will not reclose. If, however, the voltage difference vector (as $E_d$) terminates above the characteristic the relay will close its contacts and if this voltage difference vector also terminates to the right of the Type CAN relay reclosing characteristic, this relay will close its contacts and the protector will reclose.

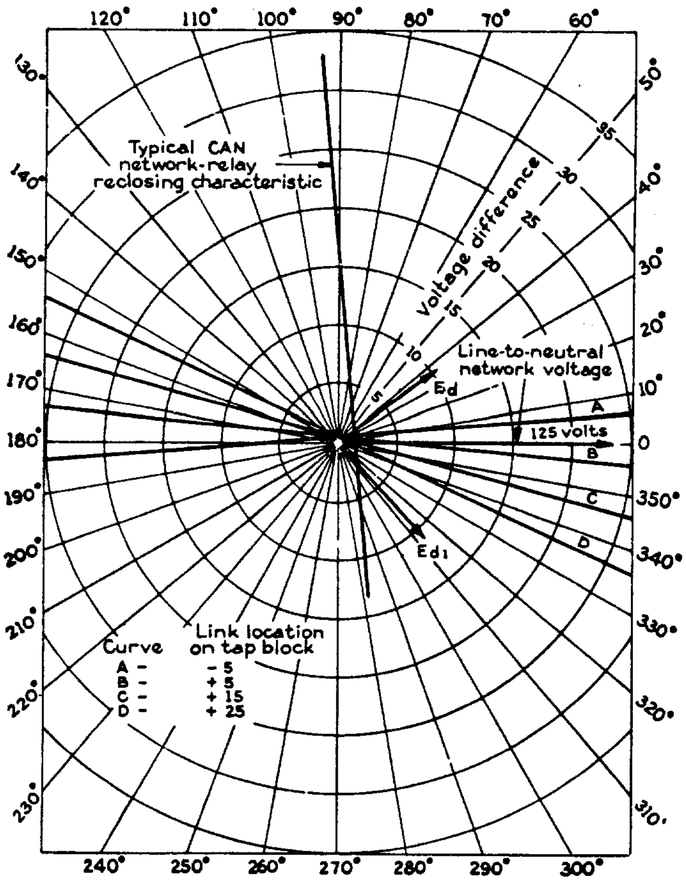



Fig. 9 (104A8508)

Fig. 9 Typical Reclosing Characteristics of Type CAL Relay

Note that with the characteristics shown the voltage difference vector leading the network voltage by 90 degrees must be 0.5 volts or greater to cause reclosure. It is this 90 degrees of out-of-phase voltage difference required for reclosure which is referred to as the reclosing voltage setting of the Type CAL relay. While a setting of 0.5 volt leading the network voltage by 90 degrees is recommended for average conditions, this setting can be varied from 0 to 1 volt with the voltage difference vector either leading or lagging the network voltage by 90 degrees.

The Type CAL phasing relay is so arranged that its characteristics may be varied from 5 degrees leading to 25 degrees lagging the network voltage. The steps are: +5 degrees, -5 degrees, -15 degrees, and -25 degrees. These positions of the characteristic are obtained by selecting the proper tap connections on the phasing-coil resistor on the rear portion of the contact plate.

To obtain the desired characteristics, connect the link from the common tap on the terminal board to any of the other four taps marked +5, -5, -15, or -25.

Fig. 10 (104A8570)

Fig. 11 (104A8509)

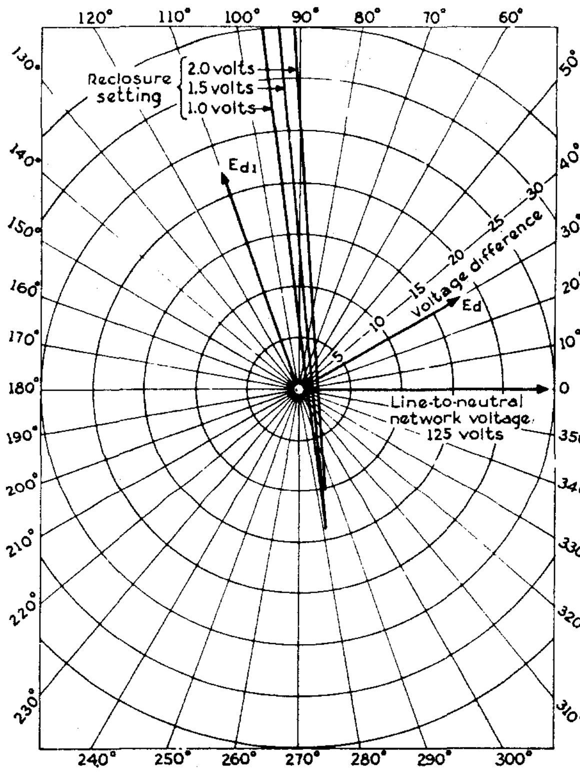



Fig. 10 Typical Reclosing Characteristics of Type CAN Relay

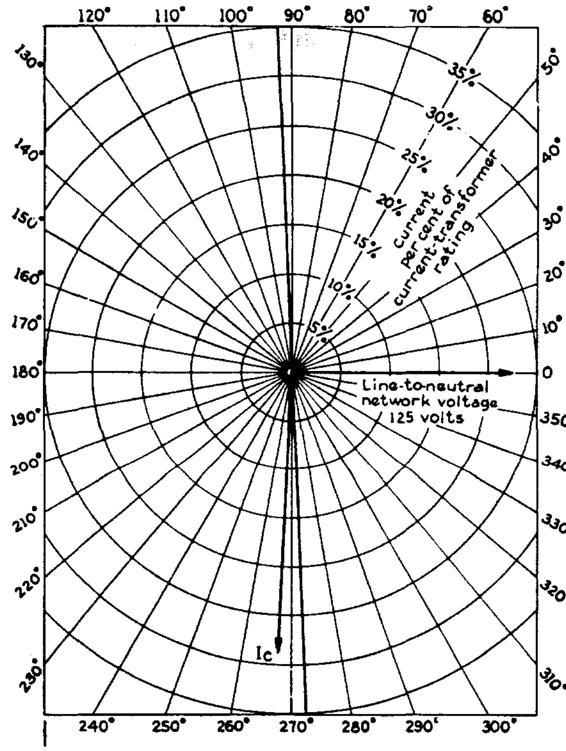



Fig. 12 Typical Sensitive-Tripping Characteristics of Type CAN Relay for Currents up to 35 Per Cent of Current-Transformer Rating

Fig. 12 (104A8507)

Fig. 13 (104A8510)

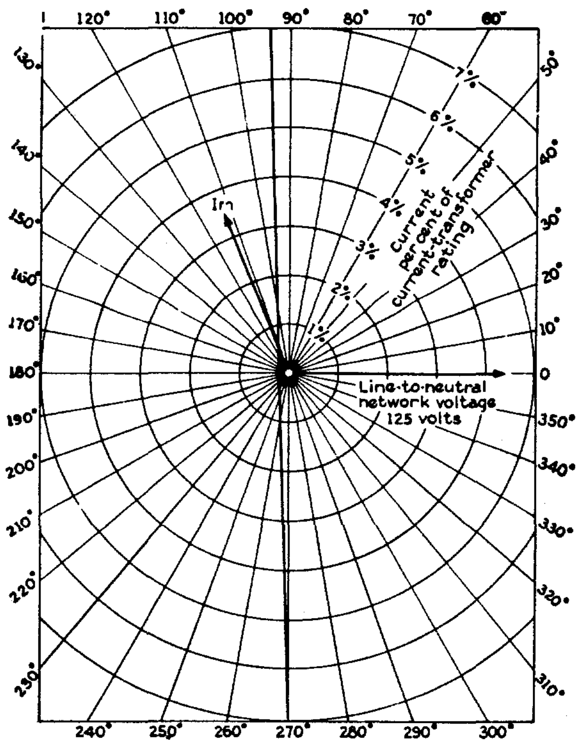



Fig. 11 Typical Sensitive-Tripping Characteristics of Type CAN Relay for Currents up to 7 Per Cent of Current-Transformer Rating

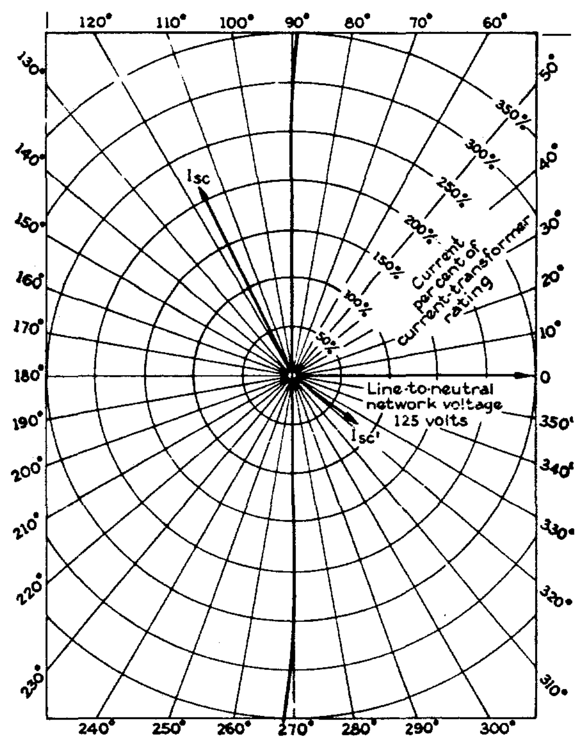



Fig. 13 Typical Sensitive-Tripping Characteristics of Type CAN Relay for Currents up to 350 Per Cent of Current-Transformer Rating

Characteristic A will provide the greatest security against "pumping" of the network protector, but may prevent reclosure under some advantageous conditions. Characteristics which are rotated in a clockwise direction from A can be used where it is found that a satisfactory operation without "pumping" obtains.

In general, characteristic B should be used in cases where two or more network transformer banks are bused directly together on the secondary, particularly if the transformers are of 10-per cent reactance. If there is a considerable length of secondary cable between transformers, characteristic D can be used.

PYC13B

The Type PYC relay consists of three plunger type overcurrent-relay elements, with single-pole, normally closed contacts, mounted on a Textolite base (see Fig. 1). The silver-to-silver contacts of the three elements are connected in series so that if an overcurrent condition exists in any one phase, the electrical restraint of the Type CAN relay will be released. An adjusting screw is provided on each element to set the pick-up between 125 per cent and 180 per cent of the protector rating. The drop-out of the relay is above 110 per cent of the protector rating.

A sheet-metal covering fastened on by two thumbscrews is placed over the entire assembly.

This relay can be readily added to the network protector, as a mounting is provided for it on the protector.

# OPERATION

CAN11A

Tripping Operation

As shown in Fig. 14A, the potential coils of the power element are connected phase-to-phase on the network side of the network protector. These coils are, therefore, energized at all times that the network is alive. The current coils are excited from the secondary of a current transformer in the phase conductor.

If current flows from the distribution transformer into the network, the relay will have a torque that tends to reotate away from the tripping contacts. If the flow of current should reverse, the direction of current flow through the relay current coils will also reverse, and the torque will tend to rotate to close the tripping contacts.

The current transformers are designed with a saturating characteristic in order that the relay may have sufficient torque to close the tripping contacts on current reversals as low as the exciting current of the network transformer and still not be damaged by high short-circuit currents.

Reclosing Operation

Fig. 14B shows the connection of one phase of the Type CAN network relay for reclosing operation. An additional winding on the current transformer, in series with a resistor, is connected across the main contacts of the protector. The current transformer thus acts as a potential transformer when the breaker is open and provides a current in the relay current coil proportional to the voltage existing across the main protector contacts. If the protector contacts are open and the transformer secondary voltage is lower than the network voltage, a current will flow through the relay current coils. This current, which is due to the voltage difference, will flow in the same direction as that flowing with the protector contacts closed and reverse current flowing. Thus, under this condition, the relay element has a torque that rotates the contacts toward the tripping position and away from the closing position. However, if the transformer voltage is of a greater magnitude than the network voltage, the flow of current through the relay current coils will be in the opposite direction, and the torque will tend to rotate the contacts toward the closing position.

CAL15A

Fig. 15 shows the schematic external connections of the Type CAL phasing relay. The potential coil is connected through a series resistor between one line conductor and ground on the network side of the network protector. This coil, therefore, is energized whenever the network is alive. The phasing coils are connected through a series resistor from the network side of the transformer side of the corresponding pole of the protector. The connections to this relay are independent of phase sequence or rotation. It can be connected to any phase of the network.

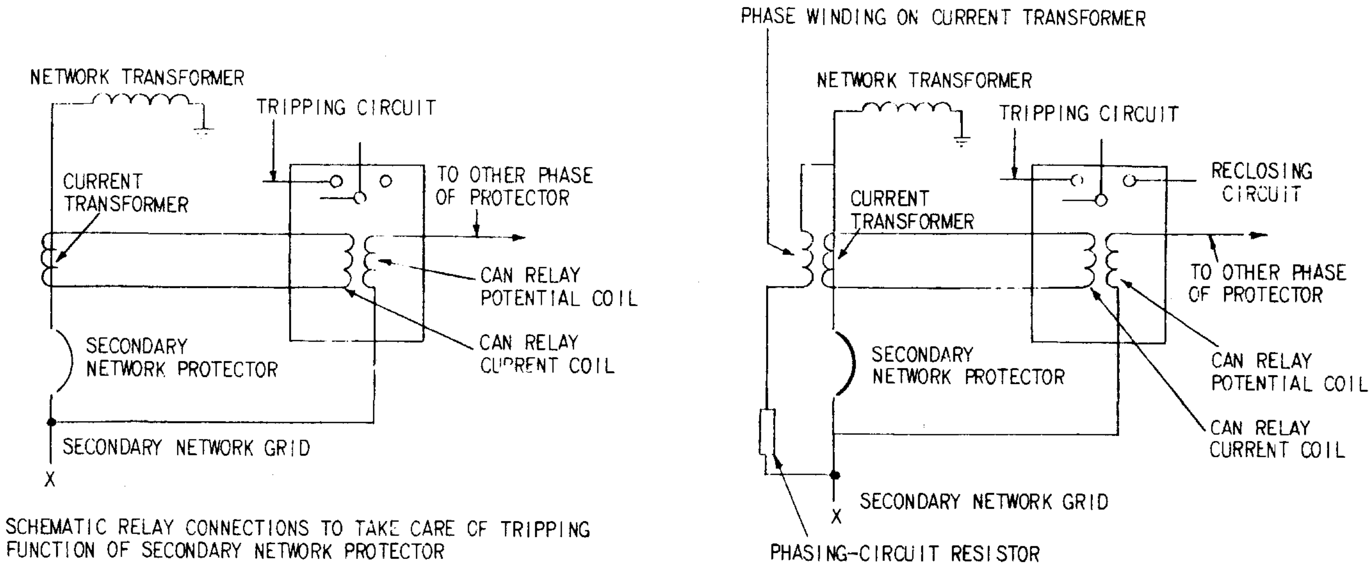
While in the reclosing operation of the Type CAN network relays the voltage conditions are checked across all three poles of the protector, it is satisfactory in the phasing relay to check across one pole only. Conditions which will cause the transformer voltage to lag the network voltage in phase angle and cause the Type CAL phasing contacts to remain open will either exist on all three phases or will exist on one phase only. In the latter case, the phase can be predetermined and the phasing relay connected to it.

With the protector open and with the voltage difference between the transformer and the network voltages lagging the network voltage by 90 degrees, a current will flow through the lower coils and tend to rotate the cylinder in a direction which would open the relay contacts. When this voltage difference reverses and leads the network voltage by 90 degrees, the direction of current flow through the lower coils reverses and, therefore, the torque tends to close the contacts. Essentially, the Type CAL relay produces a torque toward the closing contacts when the transformer voltage leads the network voltage and a torque away from the contacts when the transformer voltage lags the network voltage.

PYC13B

The PYC has three plunge type current units which pickup on overcurrent.

Fig. 14 (104A8505)




SCHEMATIC RELAY CONNECTIONS TO TAKE CARE OF TRIPPING FUNCTION OF SECONDARY NETWORK PROTECTOR
(a)

SCHEMATIC RELAY CONNECTIONS TO TAKE CARE OF COMBINED CLOSING AND TRIPPING FUNCTIONS OF SECONDARY NETWORK PROTECTOR
(b)

Fig. 14 Schematic Connections of Type CAN Relay

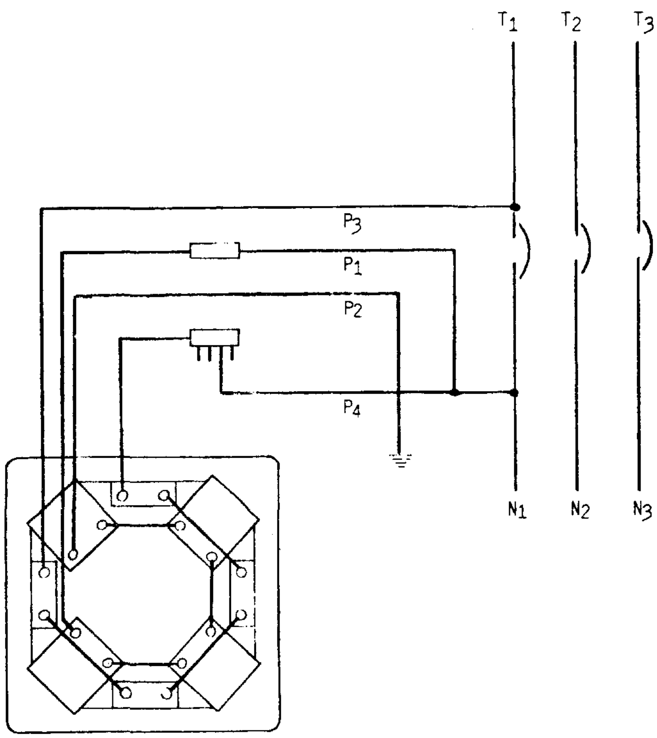



Fig. 15 Schematic Connections for Type CAL Relay

# INSTALLATION

## RECEIVING

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 the relay, an examination should be made for any damage sustained during shipment. If injury or damage resulting from rough handling is evident, a claim should be filed at once with the transportation company and the nearest Sales Office of the General Electric Company notified promptly.

Reasonable care should be exercised in unpacking the relay in order than 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.

## LOCATION AND MOUNTING

Mountings on the network protector are provided for both the Types CAN11A and CAL15A relays. The PYC13B can be readily added to the protector.

The internal connection diagrams for the three types are shown in Figs. 16, 17 and 18.

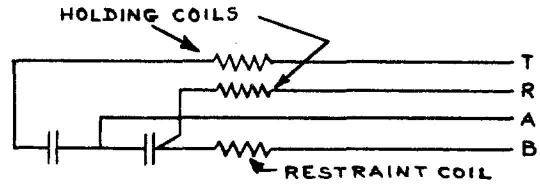



Fig. 16 (6073176)

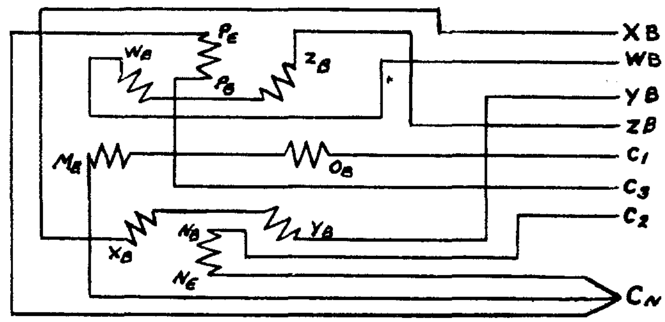



Fig. 17 Internal Connections of Type CAN11A Relay

Fig. 17 (6174086)

Fig. 18 (6174098)

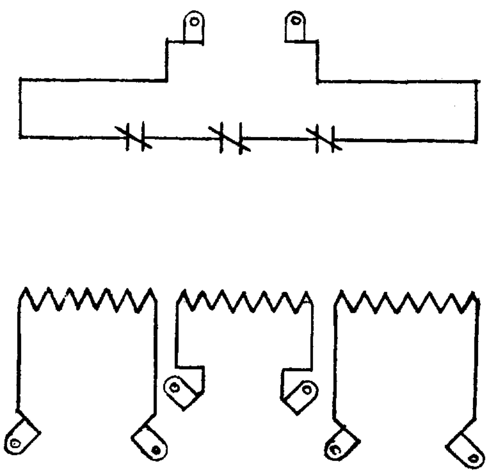


Fig. 16 Internal Connections of Type PYC13B Relay

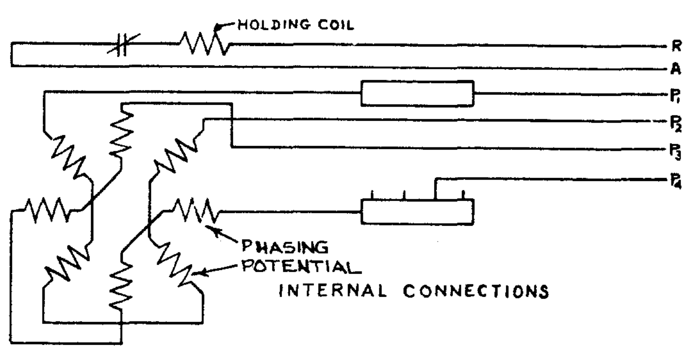



Fig. 18 Internal Connections of Type CAL15A Relay

# MAINTENANCE

## CAN11A

The relays have been thoroughly calibrated, tested, and inspected at the factory; however, before installing them it is advisable to check the points given under "INSPECTION AND MECHANICAL ADJUSTMENTS," and "CALIBRATION TESTS AND ADJUSTMENTS" to make sure that no damage has occurred in shipment.

The standard resistors for the Type CAN11A relay are for 1-1/2 volt in-phase reclosure. Resistors for 1 and 2 volt reclosure will be furnished upon request.

IMPORTANT: The correct operation of the Type CAN network master relay depends upon having currents and voltages of the correct phase sequence applied to the relay coils.

INSPECTION AND MECHANICAL ADJUSTMENTS

Inspection can be made more easily if the relay is placed in a test stand such as used for testing the relays. Always have the relay vertical.

1. Rotate the movable contacts to the left (facing the relay), by placing the thumb on the insulation disk at the top (Fig. 19), and release them. They should return to their original position against the right stationary contact with an even, steady motion.

2. The vertical end play of the main shaft should be approximately 1/32 inch. Check by placing a screw driver under the flange at the top of the pinion, at "A", Fig. 20, and lifting the main shaft. If necessary, adjust the vertical end play by raising or lowering the top guide bearing after loosening the guide bearing locking screw (Fig. 19). If this bearing fits snugly in the top plate casting, it can be raised by pressing upward on the pinion flange or lowered by tapping on its top surface.

3. There should be 1/64 inch or more vertical end play of the movable contact shaft. The bottom end of this shaft should clear the top of its bearing nut by at least 1/32 inch.

4. There should be a slight backlash for any position of the movable contacts with the proper gear mesh. Check for this slight backlash of the gears with the movable contacts to the left, to the right and in a midway position, by holding the main shaft stationary and attempting to rotate the movable contact assembly back and forth. The main shaft may be held stationary by inserting the blade of a thin screw driver in either set screw hole on the periphery of the flange at the top of the pinion.

Procedure to change the backlash of the gears. Loosen the three mounting screws, Fig. 22, about two or three turns. Move the entire contact structure in toward the pinion to increase the gear mesh or away from the pinion to decrease the gear mesh. Tighten the mounting screws. Recheck the backlash.

5. The control spring convolutions, Fig. 20, should be separated for all positions of the movable contacts. If the control spring has been damaged such at its turns touch, remove the entire molded structure (see Item 1 under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY") and try straightening the turns with a pair of tweezers. If not successful, then replace the control spring. See Item 8 under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAYS".

6. The lead-in spring (Fig. 19) should not touch either the insulating disk or the stationary parts of the molded structure. If it does, then remove the lead-in spring and either straighten it with a pair of tweezers or replace it with a new one. (See Item 2, under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAYS").

7. The mechanical restraint cap, Fig. 22, when turned, changes the minimum tripping calibration. The arm at the bottom of the mechanical restraint should engage the pin on the bottom of the movable contact gear sector when there is about 1/32 inch gap at the left-hand contacts. This should be vertified during the calibration tests on the mechanical restraint. (See Item 3A under "CALIBRATION TESTS AND ADJUSTMENTS".) The arm can be seen by looking down the front of the mechanical restraint, Fig. 22.

8. The contact travel of the CAN relay is limited by a stop pin, Fig. 19, in the top of the top plate casting. This pin should project down at least one-half the thickness of the flange at the top of the pinion on the main shaft. The projection of this pin can be adjusted by loosening its clamping nut and screwing the pin up or down as desired.

Be sure to tighten the clamping nut.

When the main shaft is moved to either extremity of its travel, the sealing armature should either be against the holding coil pole pieces, or have a clearance of only a few thousandths of an inch.

The shaft may be moved over its entire travel by placing the thumb on the insulation disk and rotating the movable contact assembly.

The two brass rivets in the sealing armature are to prevent iron-to-iron contact between the sealing armature and holding coil pole pieces, so the heads of these rivets and not the iron of the sealing armature should engage the pole pieces.

9. Contact adjustment. Hold the movable contact assembly in a central position where neither the tripping nor the closing circuits are made. The movable contact brush should be in the approximate position relative to the sealing armature as shown in Fig. 23A. Press on the back of the sealing armature, and move it away from the center post. (The movable contact brush should follow the sealing armature when the sealing armature is moved

out.) When released, the sealing armature should definitely return to its original position. Press, with a small screw driver or some other clean metal instrument, on the contact side of the brush and move it over against the sealing armature. When it is released, it should efinitely return to its original position with the free end pressing against the back side of the sealing armature. In no case should the outer end of the contact brush rub on either the top or the bottom of the sealing armature notch.

Upon closing the contacts, the movable contact brush should pass between the pole pieces of the holding coil with at least 1/64 inch clearance between the brush and each pole piece, see Fig. 23d.

To check the contact wipe, insert a 1/32 inch thick piece of pressboard or fibre at "A" in Fig. 23d. Rotate the movable contact assembly by hand until the seal-in armature hits the pressboard. The contacts should just touch, showing that there is at least 1/32 inch contact wipe. To increase the contact wipe, move the stationary contact brush to the left after loosening its two screws, "B" in Fig. 22.

Check the clearance between the back of the movable contact brush and the sealing armature, when the movable contact assembly is held at either extremity of its travel by pressing lightly on the contact side of the brush at "A" in Fig. 23d. The contacts should open 1/64 inch or more without moving the sealing armature away from the pole pieces. If the contacts do not open at least 1/64 inch, move the stationary contact brush slightly toward the holding coil housing. Recheck the contact wipe and, if necessary, increase the contact wipe by bending the free end of the movable contact brush as shown by Fig. 23b.

10. The electrical restraint relement, Fig. 20, may be checked as outlined below. (The electrical restraint is a "built-in" feature of the relay, however, and there is of course, no necessity to check it if it is not being used in the particular application.)

The end play of the restraint mechanism shaft should be at least 1/64 inch. The bottom end of this shaft should clear the top of its bottom bearing nut by at least 1/64 inch. Engaging arm at the top of the restrain mechanism should clear the top plate casting by 1/32 inch or more.

The engaging arm should clear the flange at the top of the pinion by at least .010 inch. With the right-hand contacts closed, pick up the armature of the electrical restraint by pressing down on hook attached to armature. This should definitely seal the closing contacts closed. In this position there should be only a perceptible rotational play of the movable contact shaft. The engaging surface between the flange and the arm should be approximately 1/32 inch.

The surface of the roller on the engaging pin (Fig. 20) and the inner side of the armature hook should be very smooth and well polished.

Check the tension of the returning spring after removing the relay from the stand and laying it on its left side (viewed from the front). The restraint element proper should not rotate in a counter-clockwise direction. If it does, increase the tension of the returning spring by sliding its collet counter-clockwise on the tube of the restraining element proper.

## CALIBRATION TEST AND ADJUSTMENTS

A laboratory set-up wired according to Fig. 26 is sufficient for all calibration tests. During all tests the voltage and frequency applied to the relay potential coils should agree with those values stamped on the relay nameplate. Always energize the relay at rated voltage and frequency for about 10 minutes before beginning the tests.

### 1. Potential Alone

Close switch $S_{14}$ to energize the potential coils only. The movable contacts should come to rest, at a position where the gap at the tripping contacts is about 1/16 to 1/32 inch. Switch $S_{15}$ and $V_2$ are provided to read the voltage applied to the potential coils.

### 2. Reclosing Voltage

In the standard laboratory test equipment, resistors are furnished for 1-1/2 volts reclosure only. (If desired, resistors for 1 or 2 volts reclosure, or both, may be obtained.

Close switches $S_{14}$, $S_4$, $S_5$, $S_6$, up, $S_{10}$ down and $S_{12}$ up. Then slowly vary $R_1$ to increase the reclosing voltage from a very low value until the right-hand contacts just close.

The reclosing voltage is numerically equal to the reading of the ammeter $A_1$ because $R_4$ has a resistance of one ohm. This reclosing voltage reading, is related to the actual three-phase reclosing voltage, $E_3$, as shown in the following tabulation:

When more than two volts are required across the phasing circuit, close switch $S_5$ down instead of up, and read the voltage directly at $V_1$ instead of the current in ammeter $A_1$. Table IV applies to the reading of the voltmeter $V_1$ as well.

TABLE IV

| Nominal $E_3$ | $E_1$ (and limits) |
|---|---|
| 1.0 | 1.5 (1.2-1.8) |
| 1.5 | 2.25 (1.9-2.6) |
| 2.0 | 3.0 (2.6-3.4) |

A limited adjustment of the reclosing voltage may be obtained by varying the tension of the control spring. The tension of the control spring is adjusted by turning the control spring adjusting shaft, Fig. 19, with a screw driver. Turning this shaft clockwise unwinds the control spring and, therefore, increases the reclosing voltage setting. There are stops on this control spring adjustment so that it cannot be turned far enough in either direction to damage the spring. In no case should the spring be set so that the closing contacts do not positively close when the relay is completely de-energized.

When the relay leaves the factory, the control spring is wound up 90 degrees (1-1/2 turns of the spring adjusting shaft from the zero tension stop).

With the spring unwound to the zero tension stop and the relay de-energized, the movable contact should just about touch the right-hand stationary contact.

### 3. Tripping

The tripping function is divided into two classes: sensitive and non-sensitive. For sensitive operation, very low in-phase tripping settings are used and calibration is obtained by adjustment of the mechanical restraint. The maximum in-phase reverse current setting with the mechanical restraint should not exceed three per cent of the current transformer rating. The range of adjustment obtainable with the electrical restraint is from 10 to 100 per cent of the current transformer rating.

To eliminate the necessity of handling large current through the primaries of the current transformers, a voltage is applied to the phasing circuit which produces the equivalent effect of current through the primary of the current transformers. The values of voltage or phasing winding current used for producing the effect of an equivalent primary current are given in the tables under MECHANICAL RESTRAINT and ELECTRICAL RESTRAINT sections following.

### 3a. Mechanical Restraint (Sensitive Setting)

Close switches $S_{14}$, up $S_4$ down, $S_5$, $S_6$ up, $S_9$ down and $S_{12}$ up. Then gradually increase the current by varying $R_1$ until the indicating lamp in the trip circuit lights up. The voltage applied to the phasing circuit is numerically equal to the indication of ammeter $A_1$. Refer to Table V to convert this reading into equivalent tripping current in per cent of current transformer rating.

TABLE V

| Equivalent Tripping Current in % | Voltage Applied to Phasing Circuit | | |
|---|---|---|---|
| | *1 | *1-1/2 | *2 |
| 0.2 | .70 | 1.12 | 1.54 |
| 0.5 | 1.75 | 2.80 | 3.85 |
| 0.75 | 2.62 | 4.20 | 5.80 |
| 1.0 | 3.50 | 5.60 | 7.72 |
| 1.5 | 5.25 | 8.40 | 11.60 |
| 2.0 | 7.00 | 11.20 | 15.54 |
| 2.5 | 8.75 | 14.00 | 19.25 |
| 3.0 | 10.50 | 16.80 | 23.15 |

*These figures represent the nominal reclosing voltage of the relay. For example, the first column headed "1" would be used when the resistors in the phasing circuit are those prescribed for one volt reclosure and so on, for the columns headed "1-1/2" and "2".

The relays are set at the factory to close their tripping contacts on 0.2 per cent (± 20 per cent) of the current transformer rating. To increase the setting, turn the mechanical restraint cap clockwise.

The mechanical restraint spring has a very low gradient to facilitate calibration. Approximately five turns are required to cover the range from 0.2 to 3 per cent of the current transformer rating.

In any case, when the tripping current or the voltage applied to the phasing circuit for the tripping calibration is suddenly or gradually reduced to zero, the trip contacts should open at least 1/32 inch. This verifies Item 7 under INSPECTION AND MECHANICAL ADJUSTMENTS.

### 3b. Electrical Restraint (Non-sensitive Setting)

If the relay is to operate with the electrical restraint, the mechanical restraint should be set at 0.2%. This is necessary to provide proper resetting of the latch on the electrical restraint.

Before checking the calibration of the electrical restraint element, disconnect voltmeter $V_1$.

Select the setting desired of the electrical restraint, using Table VI as a guide. This setting is controlled by the tension of the restraint element and the spring tension may be varied merely by turning the adjusting screw clockwise to increase the setting and counter-clockwise to decrease it. The adjusting screw head faces the right-hand side of the relay and is located just under the calibrated sleeve at the top of the restraint mechanism. See Fig. 20. The marks on the calibrated sleeve of the restraint mechanism are used as a guide in obtaining the setting desired. When the restraint is energized, the marks on the calibrated sleeve should line up with the pointer to get the setting given in Table VI.

The pick-up of the restraint magnet may be checked by opening all switches except $S_{14}$ and $S_2$ which should be closed up. Manually hold the relay contacts in the reclosed position and vary the potentiometer ($P_1$), or test bus, voltage from a low value until the armature picks up, which should be 180 volts or less.

Close switch $S_{14}$ and apply rated voltage and frequency to the potential coils. After the movable contacts have come to rest, close switch $S_2$ up. Then apply about three volts to the reclosing circuit (it is assumed that the resistors for 1-1/2 volts reclosure are in the phasing circuit) by closing switches $S_4$, $S_5$, $S_6$, and $S_{12}$ up and adjusting $R_1$ to obtain the three volts on the reclosing circuit. This will cause the right-hand contacts to close and pick up the electrical restraint, which in turn should definitely seal the contacts closed. If it does not, loosen the three mounting screws about one-half turn each and shift the entire electrical restraint element to the left a very small amount and recheck the operating outlined above.

The electrical restraint settings can be checked by closing switches $S_{14}$, $S_2$, $S_3$ up, $S_4$, $S_5$ down, $S_6$ up and $S_{12}$ down, and closing the right-hand contacts by hand if they are not already closed. Gradually increase the current by varying $R_1$ until the relay operates to close the left-hand contacts. The voltage applied to phasing winding equivalent to tripping current is indicated by voltmeter $V_1$. This reading is related to the per cent restraint according to Table D. A variation of $\pm$ 20 per cent may be expected when making the setting by the calibration marks. If closer calibration is required, the relay should be set for the desired value by checking the actual operation.

TABLE VI

| Mark on Calibrating Sleeve Opposite Pointer | Restraint Setting |
|---|---|
| 1 | 20% |
| 2 | 40% |
| 3 | 60% |
| 4 | 80% |
| 5 | 100% |

TABLE VII

| Equivalent Tripping Current in % | Voltage V Applied to Phasing Wind. | Current Trans. Rating Amp. |
|---|---|---|
| 100 | 138 | 800 |
| 100 | 115 | 1200 |
| 100 | 120 | 1600 |
| 100 | 125 | 2000 |
| 100 | *175 | 2500 |
| 100 | *175 | 3000 |
| 100 | 175 | ** 5 |

*These values are voltages applied to the phasing winding of the phase-shifting transformer which is used in conjunction with a standard current transformer of the rating listed.

**This is the phase-shifting transformer alone which has a 5:5 ratio.

4. Holding Coil Operation

If it is desired to check the operation of the right holding coil, close switch $S10$ up and hold the right-hand contacts closed, adjusting R until $A_3$ indicates 0.3 ampere, then open switch $S_{10}$. Close switch $S_{14}$ and apply rated voltage and frequency to the potential coils. After the movable contacts have come to rest, apply about three volts to the reclosing circuit (it is assumed that the resistors for 1-1/2 volts reclosure are used in the phasing circuit in the test setup) by closing switches $S_4$, $S_5$, $S_6$, $S_{10}$ and $S_{12}$ up, adjusting $R_1$ to obtain three volts on the reclosing circuit. (See Item 2.) This will cause the right-hand contacts to close and, as soon as they do, the sealing-in armature should definitely seal these contacts closed. There should be no sparking except at the instant the contact is made. Interrupt the holding coil current by opening S10, never at the contacts. When $S_{10}$ and $S_4$ are opened, the sealing-in armature should pull away from the pole pieces.

To check the left-hand holding coil, open all switches and hold the left-hand contacts closed. Then close switch $S_9$ up and adjust the resistor $R_2$ until the ammeter $A_2$ indicates two amperes. Then open $S_9$. Close switch $S_{14}$ and apply rated voltage and frequency to the potential coils of the relay. After the movable contacts have come to rest, close switches $S_9$ up, $S_4$ down, $S_5$, $S_6$, $S_{12}$ up and increase the current through ammeter $A_1$ until the trip (left-hand) contacts close. (See Item 3A.) This current can be varied by adjusting resistor $R_1$. As soon as the contacts make, the sealing armature should definitely seal them closed. The normal tripping current is approximately 17 amps at 216 volts, for which the contact brush will be fully wiped in. At low current values (2-6 amps) there may be contact arcing, but above 6 amps there should be no arcing. Interrupt the holding coil current by opening $S_9$, never at the contacts. When S9 and $S_4$ are opened, the sealing-in armature should pull away from the pole pieces..

The sealing-in armature may vibrate due to the fact that the holding coils are energized with alternating current.

If there is sparking at the contacts after they have closed, move the stationary contact back slightly, and if necessary, bend the free end of the movable contact brush as shown in Fig. 23 to readjust wipe to 1/32 inch, etc., and recheck electrically as outlined above.

MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY

There are no set rules as to the inspection period for the network relay. This varies with the operating company's practice. It is suggested, however, that the relays be thoroughly inspected as outlined under "INSPECTION AND MECHANICAL ADJUSTMENTS" and checked for electric calibration as outlined under "CALIBRATION TESTS AND ADJUSTMENTS" at least once a year, preferably twice a year. The inspection and electrical tests can be made either in the laboratory or in the field. It is suggested, however, that the relays be inspected and checked in the laboratory, where dirt and dust conditions are less severe and where usually more time and room are available.

In addition to making the regular inspection and electrical tests, the jewel bearing at the bottom-center of the relay should be inspected and thoroughly cleaned with a chamois dampened with Type M-6 (Cat. 291861) demand meter oil. If the jewel is defective in any way, replace the pivot in the end of the shaft as well as the jewel bearing. The pivot may be easily removed from the shaft for inspection or replacement by inserting the standard G-E meter pivot wrench (Cat. 4124390 or equivalent) through the hole from which the jewel bearing was removed. Before replacing the pivot, wipe the end of it with a chamois dampened with fresh, clean Type M-6 demand meter oil.

The pivot in the upper end of the shaft can be removed with a standard G-E meter pivot wrench after the upper guide bearing has been removed. To remove the upper guide bearing, first loosen the guide bearing locking screw (Fig. 19) and then press upward on the pinion flange. The upper guide bearing should be examined for wear and the pivot should be wiped with a chamois dampened with Type M-6 demand meter oil before it is replaced. There is no lubrication required of the upper guide bearing proper.

The contacts should also be cleaned by burnishing with burnisher supplied in the standard relay tool kit. Under no circumstances should crocus cloth, sandpaper, or emery cloth be used on fine silver contacts. Finish by wiping the contacts with a clean soft cloth and avoid touching them with the fingers.

The following instructions are intended as a guide for making repairs on the relays if required. Always inspect and adjust contacts, gear mesh, etc., after repairing and reassembling any parts of the contact structure.

1. Removing and replacing contacts. Either stationary contact can be removed by removing the two supporting screws, B in Fig. 22.

The movable contacts can be removed after removing the contact structure from the relay, which can be done by unscrewing the three mounting screws and the four contact screws shown in Fig. 22. Remove the auxiliary shaft bearing plate and the lead-in spring supporting screw located just behind left holding coil housing, then lift out the movable contact assembly. Take out the screw at the back of the movable contact molded part and lift out the contact brush and the armatures as shown in Fig. 24. In reassembling, the sealing armatures (right-hand one, front view, marked "R") should be placed in the same relative position they occupied within the contact supporting member (observed carefully in the 4th step of the disassembly, Fig. 24D). Then reverse the disassembly procedure as illustrated in Fig. 24. Replace movable contact assembly and bearing plate to the molded contact structure. Check the contacts to be sure that the armature does not bind and that it returns against the center post Fig. 23. Also, the contact brushes should move with the armature when the armatures are moved away from the center post; and that the free end of each contact brush pulls against the inner side of its armature.

To reassemble the complete contact structure, hold the movable contacts to the right, and turn the main shaft of the directional units clockwise (top view) as far as possible. Place the contact structure in position. It may be necessary to rotate the movable contacts slightly to get the gears to mesh. Hold the contact structure in place and move the contacts over their complete travel to see that both contacts can be closed. If they cannot, pull the contact structure forward about 1/16 inch and slip the gears one tooth in the proper direction. When both contacts can be made, start the contact screws A and the mounting screws, Fig. 22 and then proceed with inspection and adjustments.

2. Replacing the lead-in spring or other parts of the movable contact structure. First, remove the movable contact assembly as outlined under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY", Item 1. Then take off the nut at the top of the movable contact assembly shaft and lift off the insulating disk. Remove the screw at the back of the movable contact molding, then remove the contact brushes and, finally, the lead-in spring (Figs. 19 and 7).

To reassemble the lead-in spring, reverse this procedure and then replace the movable contact assembly, put on the auxiliary shaft bearing plate and hold the guard for the outer end of the lead-in spring in place on the molded structure with the finger, and see that the lead-in spring does not rub against the insulation disk or against the molded structure. If it does, use a pair of tweezers to straighten the lead-in spring, so that it will rub on any part.

Before tightening the nut on the top of the shaft of the movable contact assembly, check to see that the movable contact brushes are centrally aligned in the gap between the pole pieces. If the brushes are too low, then screw up the nut on the bottom of the movable contact auxiliary shaft. If they are too high, screw this nut down. Check the clearance between the top of the bottom bearing nut and the bottom of the shaft (should be at least 1/32 inch) and then tighten the top nut and make a final check.

Reassemble the complete contact structure as outlined under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY", Item 1.

This same general procedure may be followed in replacing other parts of the movable contact assembly.

3. Removing and replacing holding coil. First remove the entire contact structure and the movable contact assembly, as outlined under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY", Item 1.

On the underside of the molded structure are two flat-headed screws, one for each holding coil assembly. Remove the proper screw and pull the molded cap straight up and off the holding coil housing. The entire holding coil assembly, Fig. 21 can then be removed. Remove the stationary contact brush and bend up the terminals of the holding coil leads. Pry off the bottom holding coil pole piece and slide the coil down over the core. To reassemble the coil, reverse the above procedure. The molded cap and block are cut out to receive the pole pieces; when replacing them, be sure that the pole pieces fit into the proper grooves.

4. To remove the mechanical restraint, Fig. 23, first remove the contact structure, as outlined under "MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY", Item 1. On the under side of the molded structure, there is a screw that holds the mechanical restraint in place and after this has been removed the mechanical restraint can be lifted off. To further disassemble the mechanical restraint, that is, to remove the spring, pull off the cap. To reassemble, reverse the above procedure.

5. The bottom bearing for the movable contact assembly can be removed with a socket wrench after the movable contact assembly has been removed.

6. Removing or Installing the Electrical Restraint. To remove the electrical restraint, take out the three mounting screws and the two lead terminal screws, shown in Fig. 20, and lift it off. Reverse this procedure to reassemble the electrical restraint.

After removing the electrical restraint assembly as outlined above, the coil and laminations may be removed by taking out the screws that hold the laminated structure to the bracket. The coil cannot be removed from the iron. When replacing a coil, it is necessary to replace the iron laminations as well.

To remove the restraint element proper from its bracket, remove the upper bearing nut and disconnect the outer end of the returning spring.

When reassembling the electrical restraint, follow the adjustments given in Item 11 under INSPECTION AND MECHANICAL ADJUSTMENTS to obtain the proper operation.

7. Replacing the pinion and control spring, Fig. 20. First remove the entire contact structure and electrical restraint as outlined under MAINTENANCE OF THE TYPE CAN NETWORK MASTER RELAY, Item 1. Turn the control spring adjusting shaft in clockwise direction until the zero tension stop is reached. Then unsolder the outer end of the control spring from its mounting. Unfasten the six leads coming through the top plate in order that they can be slipped through the holes of the plate when it is removed. Remove the two set screws from the pinion flange and the four flatheaded screws holding the top plate to the directional element. Remove the upper guide bearing, Fig. 23, after first backing off its locking screw. Pry the top plate loose, attempting to lift all four sides as evenly as possible. When the top plate is loose, lift it and the pinion assembly straight up and off of the main shaft. Remove the pinion assembly and slide the control spring off the end of the pinion.

To reassemble, replace the control spring on pinion and then lower both the pinion assembly and top plate over the top of main shaft while feeding the six contact leads back through the proper holes. Gently tap the top plate into engagement with the directional element. Tap all four sides down evenly. Fasten top plate to the directional element by the four flathead screws. Place the set screws in the pinion flange and be sure they fit into the recesses near top of main shaft before tightening. Check for correct vertical end play of the main shaft as outlined under MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY, Item 2.

Tighten the top guide bearing locking screw. Form the outer end of control spring around its mounting and solder. Adjust the control spring by turning the collet until the right-hand (facing front of relay) engaging surface of the pinion flange is approximately 1/8 inch from the stop pin. If necessary, carefully arrange the control spring with a pair of tweezers such that its convolutions will not touch over the entire travel of the main shaft. Replace the contact structure and then turn the control spring adjusting shaft 1-1/2 turns in counterclockwise direction, upon which the right-hand contacts should close with the relay upright and vertical.

8. Replacing control spring adjusting gears. Replace the complete top plate if either gear is damaged.

9. Replacing the directional element of the relay. When reassembling the relay, be very careful to thoroughly clean the element and not damage the rotor when putting it back. The terminal leads are marked and the internal wiring diagram Fig. 17 must be followed when replacing the terminals in the terminal block.

First remove the terminal guard, Fig. 25, unscrew the terminal blocks, and the mounting plate. Remove the stationary contact structure from the relay as outlined under MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY, Item 1. Loosen the six leads coming through the top plate in order that they may be slipped through the holes in the plate. Loosen the electrical restraint and the small terminal block on the right-hand side of the relay. Remove the top guide bearing. Remove the four flathead screws holding the plate to the directional element. Pry the top plate loose, attempting to lift all four sides as evenly as possible. When the top plate is loose, lift it straight up. The entire shaft assembly will lift out with the top plate.

## CAL15A

A resistor and tap block assembly is mounted on the back part of the top plate to provide various phase angle characteristics.

### INSPECTION AND MECHANICAL ADJUSTMENT

The inspection and mechanical adjustments for the Type CAL relay are the same as those for the Type CAN relay, with the following exception:

Item 9. Same as for the right-hand contacts of the Type CAN relay. The Type CAL relay does not have contacts on the left-hand side.

Item 10. Same as for the right-hand contacts of the Type CAN relay. The rated holding coil currents 0.3 ampere and is indicated by ammeter $A_3$ and controlled by $R_3$ when switch $S_{11}$ is closed upward. Always open the circuit at $S_{11}$-- never at the contacts.

### CALIBRATION TESTS AND ADJUSTMENTS

Use laboratory set-up wired according to Fig. 26.

During all tests, the voltage and frequency applied to the relay potential coils should agree with those values stamped on the relay nameplate. Always energize the potential coils at rated voltage and frequency for about 10 minutes before starting tests.

This relay differs from the Type CAN in that the contacts may or may not be open on potential alone, depending upon the calibration. The relays as sent out from the factory, are calibrated to close their contacts at from .4 to .6 volt (on the phasing coil) 90 degrees leading the network voltage. This adjustment is recommended for the usual conditions.

Calibration for Closing Contacts with Phasing Voltage 90 Degrees Leading the Network Voltage

Energize the potential coils by closing $S_7$ and $S_{14}$, adjusting the voltage by $P_2$ to that given on the relay nameplate, and allow the movable contacts to come to rest. Then close $S_{11}$, $S_{12}$ and $S_6$ down with $S_8$ up. Vary $R_1$ to control the phasing voltage.

The phasing voltage is numerically equal to the indication of ammeter $A_1$ as reactor X has one ohm reactance and a high power factor angle. As received from the factory, the relay should operate to close its contacts at from 0.4 to 0.6 volt.

This setting may be changed from zero to one volt leading by varying the tension on the control spring. Decreasing the tension (turning the adjusting shaft clockwise) increases the phasing voltage at 90 degrees leading, at which the relay will close its contacts. Increasing the tension (turning adjusting shaft counter-clockwise) will decrease the phasing voltage required to close the contacts. Never should the spring tension be decreased to the point where the contacts will not positively close when the relay is completely de-energized.

Calibration for Opening Contacts with Phasing Voltage 90 Degrees Lagging the Network Voltage

The arrangement of switches is the same as above except S-8 is closed down. The contacts do not open on potential alone. To increase the phasing voltage required to open the contacts, increase the spring tension. The range of adjustment obtainable here is from zero to one volt phasing voltage. A stop prevents the control spring being wound up to a point where it will be damaged.

Phase Angle Position of Reclosing Characteristics

The resistor and tap block arrangement on the back part of the top plate is provided for obtaining various positions of the phase angle characteristic. Table VIII shows the phase angles obtained with various tap link positions.

TABLE VIII

| Phase Characteristic Position - Degrees | Link Location Right Block |
|---|---|
| + 5 deg lead | + 5 |
| * - 5 deg lag | - 5 |
| - 15 deg lag | - 15 |
| - 25 deg lag | - 25 |

* Standard Factory Setting

If very close settings are desired, when changing from one tap to another, the relay should be recalibrated by changing the tension on the control spring; however, in ordinary practice, this may not be necessary.

MAINTENANCE OF TYPE CAL NETWORK PHASING RELAY

The instructions for the maintenance and making repairs on the Type CAL relay are the same as those covered under MAINTENANCE OF TYPE CAN NETWORK MASTER RELAY, except for the following:

Removal of Resistor and Tap Block Assembly

Tag the four leads coming up through the top plate connected to the left-hand resistor and the common and +5 tap on the right-hand tap block. Unsolder these leads. Removal of the two round head screws located on top of this assembly will now permit its complete removal.

This procedure is reversed when replacing the resistor and tap block assembly. The link on the resistor tap block must be in the proper location before this relay is put into service.

The internal connection diagram Fig. 18 should be followed when reassembling the terminal leads.

## PYC13B

INSPECTION

The six coil leads and the two contact leads from the three elements should be soldered securely to the terminals on the base.

The moving contact on each element should have enough tension always to insure a good electrical contact with its stationary contact when the element is de-energized.

With the elements de-energized, the insulating pusher should clear the moving contact by at least 1/32 inch on each element.

Raise the plunger by hand and the contacts should open at least 1/32 inch.

The knurled-edge circular nut on which the plunger rests, should be clamped tight by the locking nuts to prevent it from turning due to vibration.

LABORATORY TESTING PROCEDURE

All Type PYC relays used with network relays are rated 5 amperes. The relays are adjusted at the factory to pick up between 125 and 180 per cent of rated, and to drop out above 110 per cent. For this, only a current source adjustable from about 5 to 10 amps is needed.

The pick-up of these relays may be adjusted by raising or lowering the knurled-edge circular nut on which the plunger rests. The drop-out may be adjusted by raising or lowering the round-head screw, on top of contact block, which acts as a stop for the movable contact brush.

## MAINTENANCE OF TYPE PYC RELAY

It is suggested that during periodic inspection of the protector and the other relays, the contacts of this relay be examined. Also all locknuts should be checked.

The moving and stationary contacts are each held in place by one screw located on the underside of the contact block. To remove either contact, back off its supporting screw.

Recommended procedure for removal and disassembly of any element. Remove contact leads from top side of contact block. Unsolder coil lead connections to terminals in base. Back off two flathead screws supporting the element on its base. Back off the roundhead screw supporting the contact block on the field piece and lift out insulating pusher. Loosen the locknut on the knurled-edge circular nut supporting the plunger and remove the circular nut; the plunger will then drop out. Loosen the locknut clamping the rectangular piece of brass at bottom of field piece. Swing this brass piece around toward front of element and remove the brass plunger guide; the pole piece will then drop out. The coil can then be removed from the field piece.

To reassemble, reverse the above procedure.

Before installing this relay in the protector, remove the short-circuiting links in the protector. These links must always be replaced when the Type PYC relay is removed, otherwise the Type CCN relay will not function as its current coil circuits would be open.

# TESTING EQUIPMENT

## FOR TYPES CAL, CAN & PYC NETWORK RELAYS

The following lists of equipment cover all necessary equipment except wire, panel and hardware required to build a laboratory testing outfit. In the majority of the cases each utility has its own standards for arrangement of testing equipment; therefore, only the material is listed. (Refer to Fig. 26 for connections.)

The equipment is for 216 volts, 60 cycles, (phase-to-phase) Type CAN relays; 125 volts, 60 cycles (phase-to-netural) Type CAL relays, and 5 ampere 60 cycle Type PYC relays.

| Item | Quan. | Cat. No. | DESCRIPTION & RATING |
|---|---|---|---|
| 1 | 1 | DL-3887725 G1 | Resistor, 1 ohm ± 2% (R in Fig. 26). |
| 2 | 1 | Model 9T11Y9624 | Reactor, 1 ohm ± 2% (X in Fig. 26). |
| 3 | 3 | L-6193064 G3 | Current Transformers 1600 amp (See Fig. 26). |
| | 3 | QFK-238C172G5 | Resistor for 1.5 volt reclosure (R in Fig. 26). |
| 4 | 1 | DL-6052823 G3 | Jack and terminal arrangement for Type CAN relay. |
| 5 | 1 | DL-6052823 G4 | Jack and terminal arrangement of Type CAL relay. |
| 6 | 4 | V-6057565 | Spacers for mounting Items 4 & 5. |
| 7 | 3 | | Clear Neon lamp Type S-14, 2 watt, 105-125 volt, medium screw base. |
| 8 | 3 | 50715 | Sockets for Item 7. |
| 9 | 1 | M-6019741 G2 | Base for overcurrent PCY relay. (If desired for convenient mounting). |
| 10 | 2 | K89-1D | Type LP-1, 30 amp S.P.S.T. switches ($S_2$ and $S_7$ in Fig. 26.) |
| 11 | 6 | K89-25D | Type LP-1, 30 amp S.P.D.T. switches ($S_6$ $S_9$, $S_{10}$, $S_{11}$, $S_{12}$ and $S_{15}$ in Fig. 26.) |
| 12 | 2 | K-89-26D | Type LP-1, 30 amp D. P.D.T. switch, ($S_4$ and $S_8$ in Fig. 26.) |
| 13 | 2 | K89-3D | Type LP-1, 30 amp T.P.S.T. switch ($S_{14}$ and $S_3$ in Fig. 26.) |
| 14 | 1 | K89-27D | Type LP-1, 30 amp T.P.D.T. switch ($S_5$ in Fig. 26.) |
| 15 | 2 | 8AP9VBF | Type AP-9 voltmeter, 0-150, 0-300 volt scales ($V_1$ and $V_2$ in Fig. 26.) Needed for $V_1$ only when testing the electrical restraint.) |
| 16 | 1 | | Type AP-9 ammeter 0-5 ampere scale, ($A_2$ in Fig. 26). |
| 17 | 1 | 8AP9AAC | Type AP-9 ammeter, 0-2 amp scale ($A_1$ in Fig. 26.) |
| 18 | 1 | | Type AP-9 voltmeter, 0-7.5 and 20.0 volt scales ($V_1$ in Fig. 26.) |
| 19 | 1 | | Type AS-5 ammeter, 0-0.5 amp scale ($A_3$ in Fig. 26.) |
| 20 | 1 | *1503 | Slide wire resistor, 630 ohms, 1 amp ($R_3$ in Fig. 26.) |
| 21 | 5 | *1408 (or equivalent) | Slide wire resistor, 110 ohms, 3.3 amp ($P_1$, $P_2$, $R_1$, $R_2$ in Fig. 26.) |
| 22 | 1 | *1405 | Slide wire resistor 440 ohms, 1.6 amp ($R_1$ in Fig. 26.) |

*Cat. No. for J. G. Biddle Co. (Phila., Pa.) slide wire resistors.

Items 1 to 8 inclusive are of a special nature, therefore it is necessary to use the equipment listed.

Any satisfactory equipment may be used for Items 10 to 22 inclusive. The quantity of Item 16 may be reduced, of course, to one of the meter is relocated or if a transfer switch is used. The potentiometers $P_2$ and $P_3$ will be unnecessary if the test bus voltage can be controlled.

The phasing and overcurrent relays, Types CAL15A and PYC13B respectively, may be tested with the equipment used to test Types CAL12A, CCN12B and PYC13B relays. (Instructions GEI-8374.) If such equipment is available, only those items associated with the Type CAN11A relay are necessary.

The minimum amount of laboratory testing equipment required to test the CAL and CAN (not the PYC, however) network relays satisfactorily are Items 1, 2, 3, 4, 5, 6 and 8 in conjunction with the proper ammeters to cover the range. No minimum recommendations are made regarding switches and variable resistance shown in Fig. 26.

## RENEWAL PARTS

When major repairs are necessary it is recommended that the relay be sent to the factory. Interchangeable renewal parts are available and the design of the relay is such that ordinary repairs are easily made.

If the part bulletin is not available, give a detailed description of the part or parts and all the data appearing on the nameplate. Address your request to the nearest sales office of the General Electric Company.

Fig. 19 (8002848)

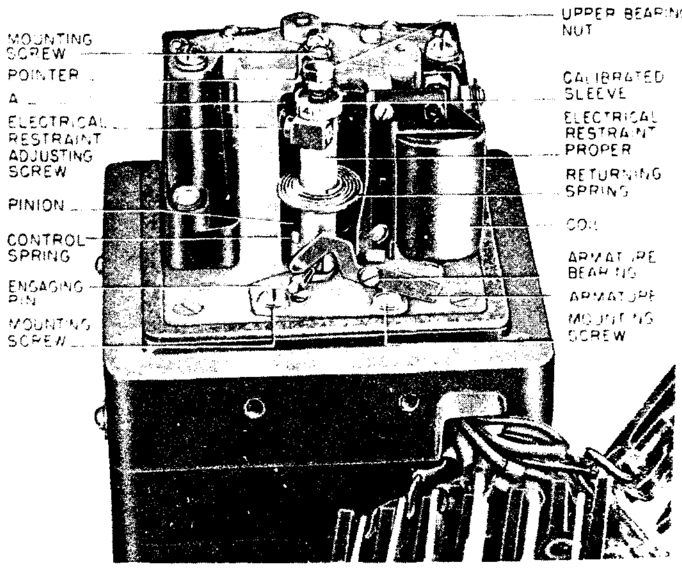



Fig. 20 Top Plate Assembly Showing Electrical Restraint of Type CAN11A Relay

Fig. 20 (8002849)

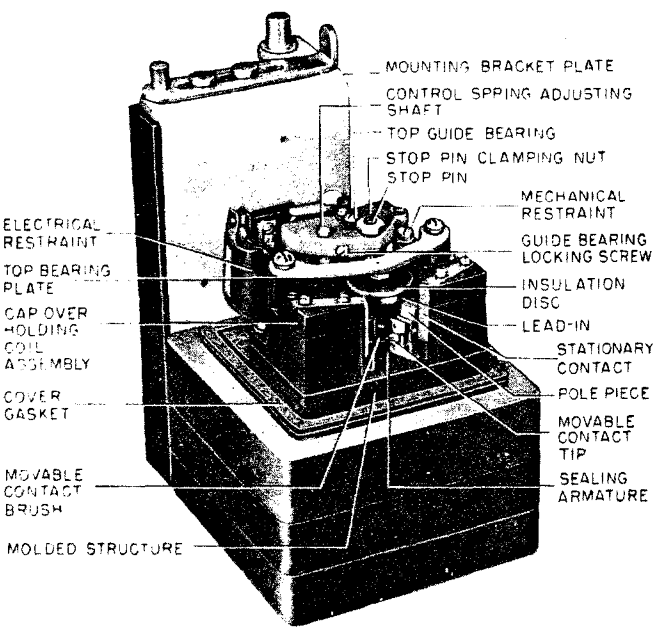



Fig. 19 Type CAN11A Relay with Top Plate Assembly Parts Identified

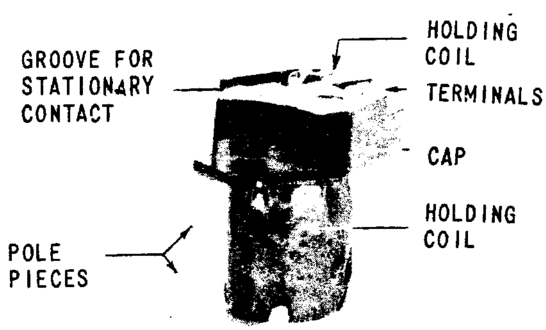
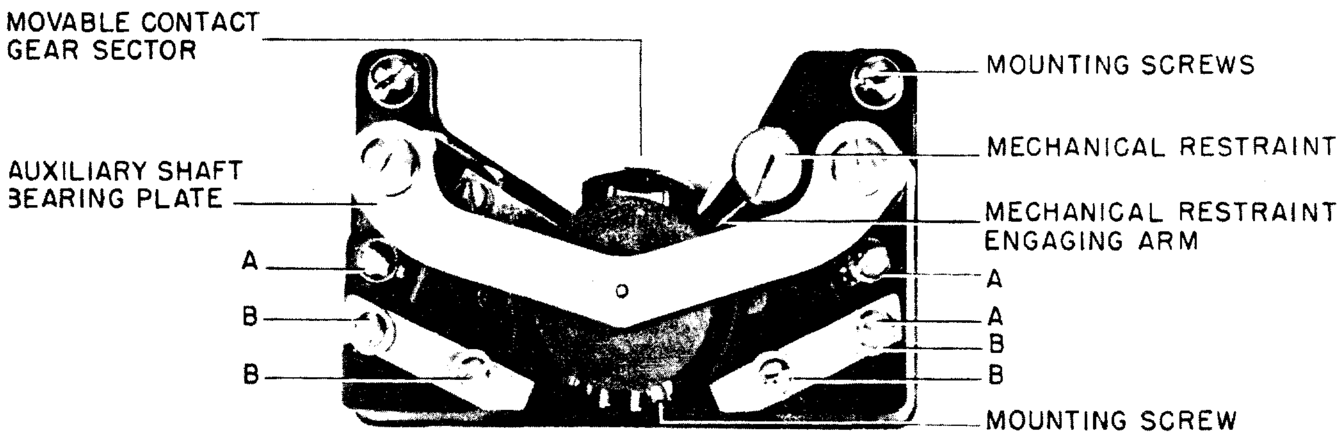



Fig. 21 Holding Coil Assembly for Types CAL and CAN Relays




A - Contact Screws to be backed off several turns before entire molded structure can be removed.

B - Screws to be backed off before Stationary Contacts can be removed.

Fig. 22 Type CAN Relay Contact Structure

Fig. 22 (853800)

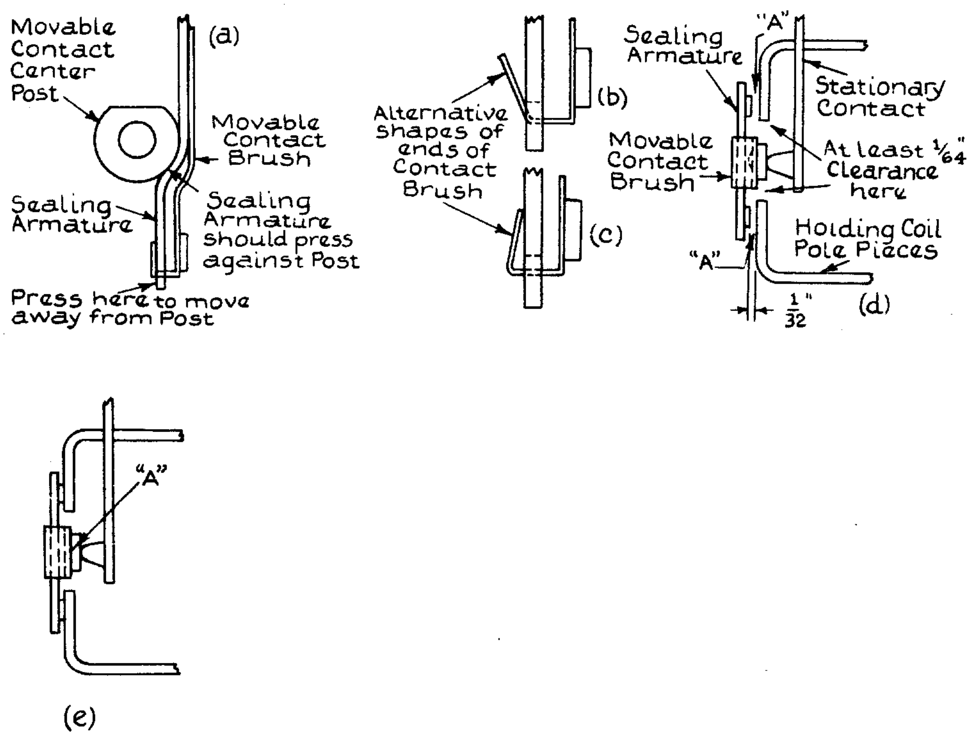
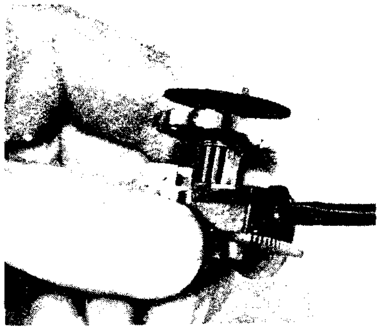


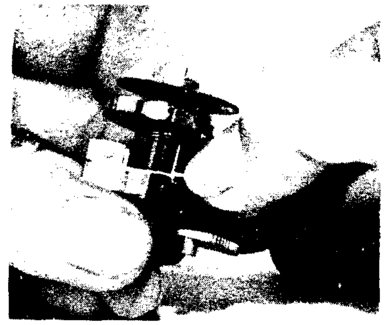

Fig. 23 Type CAN Relay Contact Structure

Fig. 23



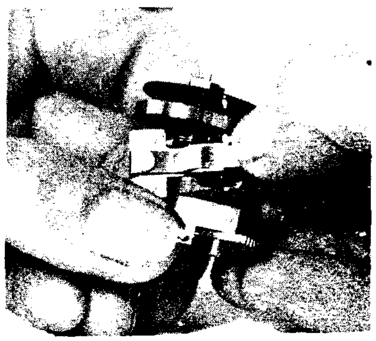
(A) Removal Of Screw Holding Contact Assembly In Place

(A-854892A)



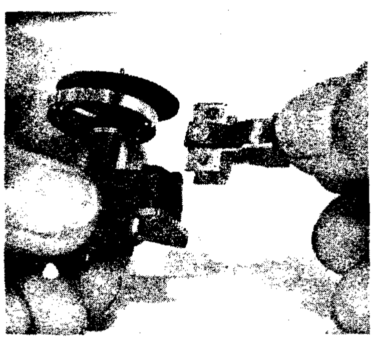
(B) Position Of Fingers To Remove Contact Assembly

(B-854893)



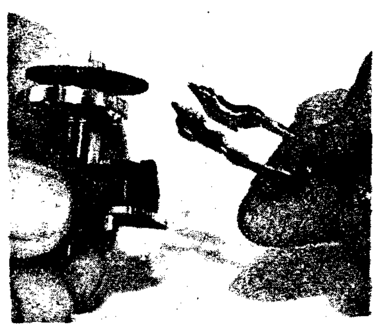
(C) Contact Assembly Removed From Recess In Compound But Not From Shaft

(C-854894)



(D) Contact Assembly Removed Entirely From Shaft

(D-854895)



(E) Contact Assembly Turned Over To Show Details

(E-854896)

Fig. 24 Removal Of Movable Contacts Of Type CAN Relay

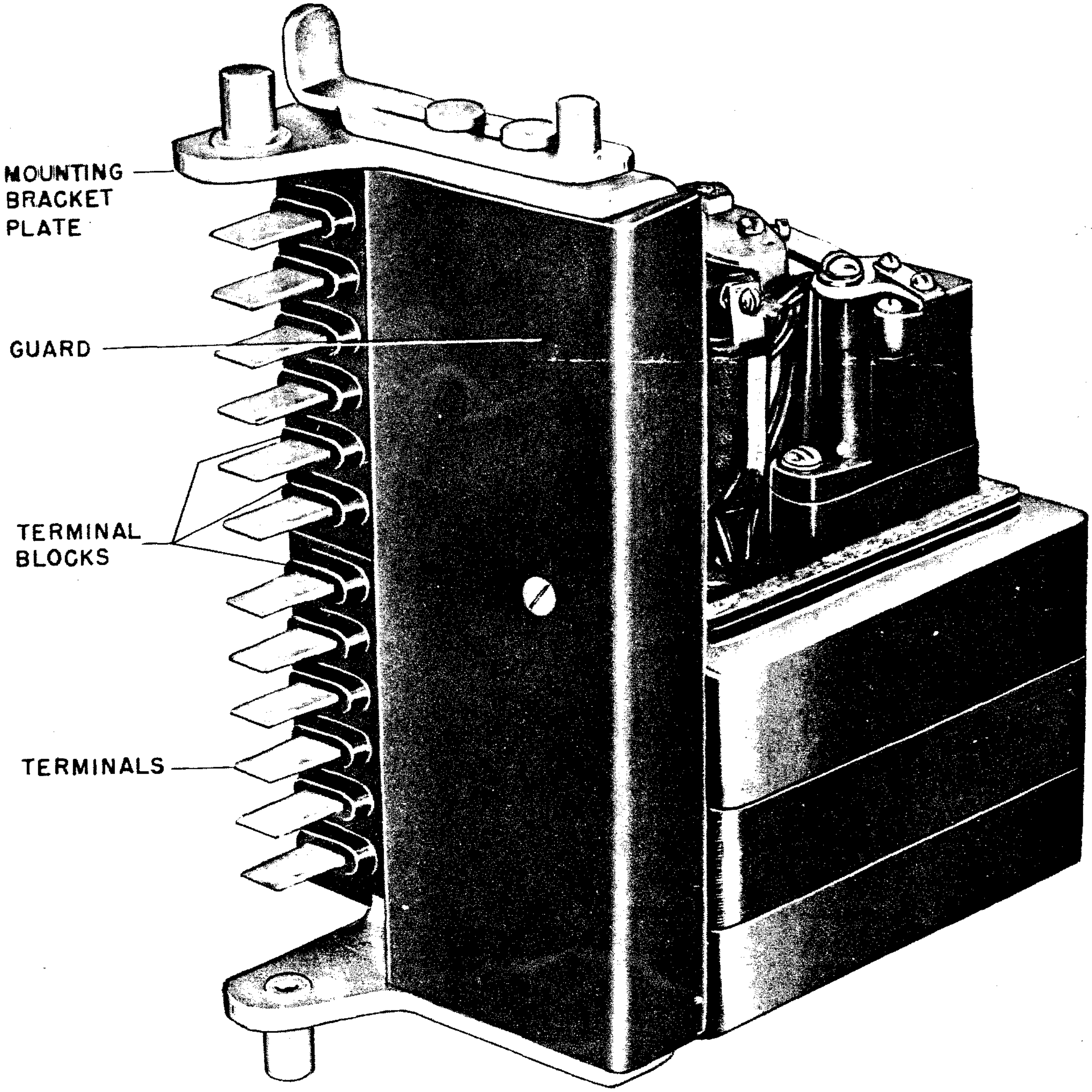



Fig. 25 Type CAN Network Master Relay Showing Position of Back Plate and Terminals

Fig. 26 (K-6154880)

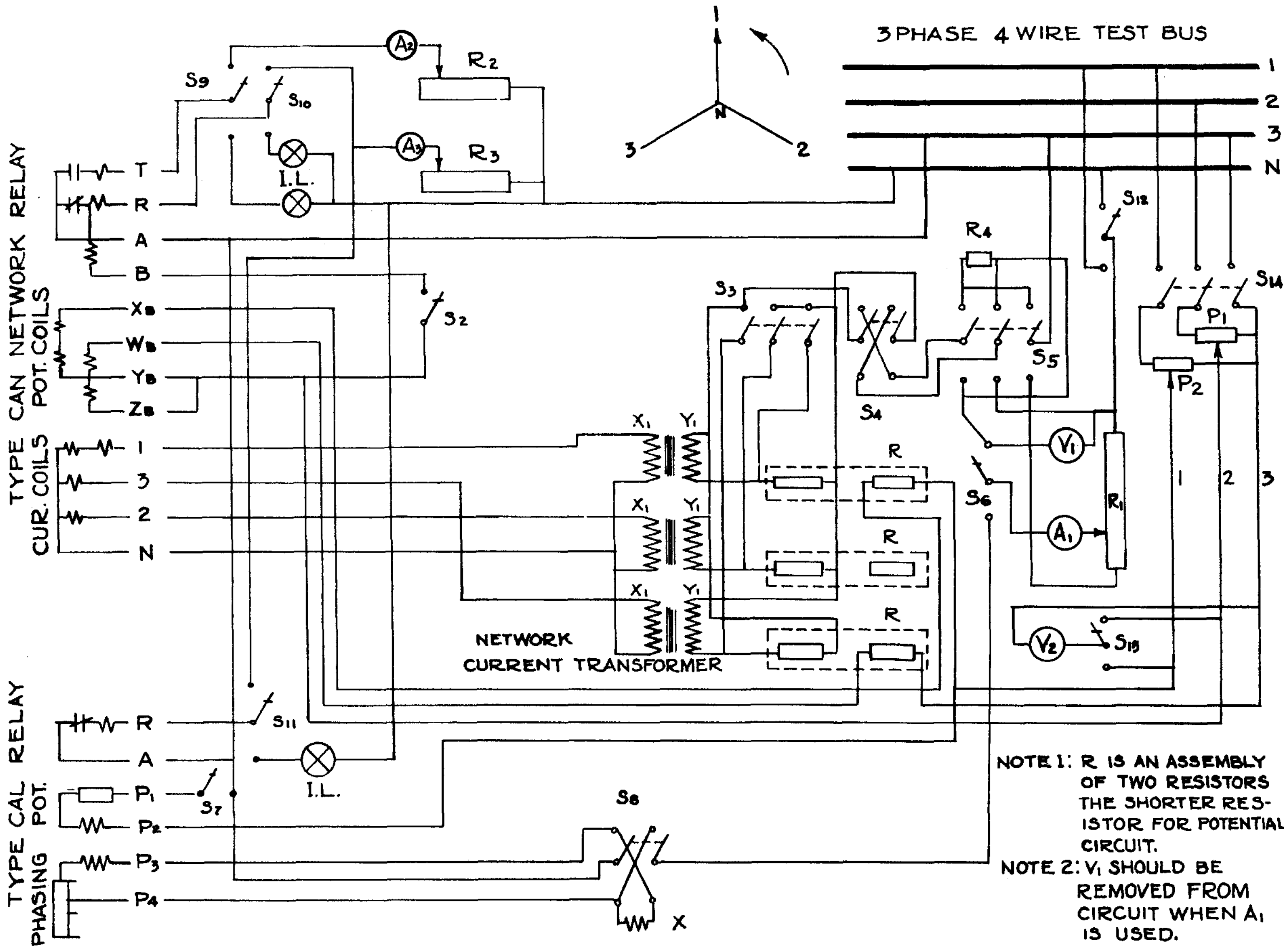



Fig. 26 Laboratory Test Connections for Types CAL and CAN Relays