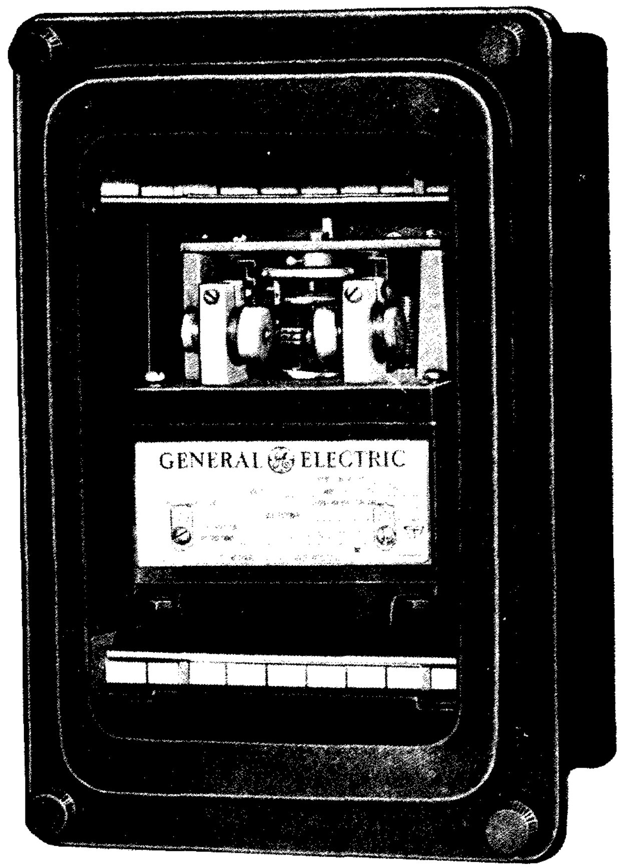
INSTRUCTIONS

GEI-12083J

POWER DIRECTIONAL RELAYS



Types

CAP15A
CAP15B

GENERAL ELECTRIC

TABLE OF CONTENTS

The Type CAP15A and Type CAP15B relays consist of one three-phase unit, with one rotor mounted on a shaft. The contact assembly consists of two electrically separate contacts, one normally-open and one normally-closed. The normally closed contacts are held closed, when the relay is not energized, by means of two spiral springs which also complete the control circuit to the moving contacts.

APPLICATION

The CAP15A relay is a three-phase induction-cylinder power directional relay. Its principal application is to perform the directional duties in directional overcurrent scheme. The recommended A-C external wiring connection for the Type CAP15A relay are shown in Figure 9, connection A. With this connection the relay has maximum torque on a balanced three-phase condition when the line current lags its unity power factor position by 40 degrees in the tripping direction. On a zero voltage phase-to-phase fault just beyond the relay terminals, the relay has maximum torque when the current lags its unity power factor position by 70 degrees in the tripping direction. Figure 2 demonstrates the directional characteristics of the preferred connection (60 degree connection). The 30 degree and 90 degree connections are also shown in Figure 9, with the corresponding angle of maximum torque for balanced conditions.

If the relay is used in an application where there is the possibility of a momentary reversal of power immediately following the clearing of a fault, and if the overcurrent relay contacts have closed, it is necessary to provide directional control to prevent false tripping. In the case of time-delay overcurrent relays, this may be done by allowing the overcurrent relays to operate only if the fault is in the protected direction. If the overcurrent relay is instantaneous in operation, discriminating control may be obtained by using the right-hand contact to control a Type HGA auxiliary relay as shown in Figure 3.

If both directional contacts are used and if a momentary reversal of power immediately following the clearing of a fault is not possible, it is still advisable to use some method of directional control. This is evident because when a fault is removed, sufficient energy will be stored in the deflected contact to cause rebound to the other contact. If only one contact is being used, the stored energy in the other contact may be substantially eliminated by reversing the contact barrel and its sleeve in the contact holder thereby using the back end as a solid stop. This is done by loosening the screw that locks the barrier in place, remove the barrel and sleeve, unscrew the sleeve from the barrel, insert the sleeve into the contact support from the inside and screw the barrel into it from the outside with the contact pointing out. When the stop is located where desired, lock in position by tightening the screw. It has been found advisable to remove the corresponding moving contact finger as well.

The Type CAP15B relay is a general purpose reverse power relay. This relay measures true watts and is practically unaffected by the reactive component of power. Because this relay is a high speed relay, it should always be used with a suitable timing relay in order to prevent undesired operations during system disturbances which cause momentary power reversals. An application of the CAP15B is shown in Figure 13.

RATINGS

12CAP15A(-)A

The 12CAP15A(-)A relays are available at voltage ratings of 115, 130, 208 and 230 volts. The current circuits are continuously rated at five amperes with frequencies available at 25, 35, 50 and 60 hertz. The targets and holding coils are available at 0.2 and 1.0 amperes d-c rating.

12CAP15B(-)A

The 12CAP15B(-)A relays are available at voltage ratings of 115, 208, and 230 volts. The current circuits are continuously rated at five amperes with frequencies available at 25, 50 and 60 hertz. The targets and holding coils are available at 0.2 and 1.0 ampere d-c rating.

CONTACT RATINGS

The contacts of both types of CAP relays can momentarily carry 30 amperes for voltages not exceeding 250 volts. However, the contacts do not have an interrupting rating. Therefore, the trip circuit must be opened by some other means.

Each stationary contact, Figure 6, is mounted on a flat spiral spring (F) backed up by a thin diaphragm (C). These are both mounted in a slightly inclined tube (A). A stainless steel ball (B) is placed into the tube before the diaphragm is assembled. When the moving contact hits the stationary contact, the energy of the former is imparted to the latter and thence to the ball, which is free to roll up the inclined tube. Thus, the moving contacts come to rest with substantially no rebound or vibration. To change the stationary contact brush, remove the contact barrel and sleeve as a complete unit after loosening the screw at the front of the contact block. Unscrew the cap (E). The contact brush can then be removed.

SHORT TIME RATINGS

The current coils of all the CAP relays have a one second rating of 220 amperes. To determine the current that can be applied for more than one second, the following equation can be used.

$I^2t = K$ $\quad$ $K = 220^2 = 48400/1$ second

$I = \sqrt{\frac{K}{t}}$ $\quad$ I = Applied current

t = Time in seconds

POTENTIAL COIL RATINGS

The potential coils of all the CAP relays are continuously rated at their nameplate voltage value.

TARGET AND HOLDING COILS

The rating for the target and holding coil are given in the following table I

TABLE I

	AMPERES A.C. OR D.C.	
FUNCTION	1 AMP	0.2 AMP
Coil Resistance	0.25 ohm D.C.	7.0 ohm D.C.
Tripping Duty	30	5
Carry Continuous	1.25*	0.5

*Determined by the control spring rating.

The 0.2 ampere coil is for use with trip coils that operate on currents ranging from 0.2 ampere to one ampere at the minimum control voltage. If this coil is used with trip coils that take one ampere or more, there is a possibility that the seven ohms resistance will reduce the tripping current to a low value and then the breaker will not trip. This coil can safely carry tripping currents as high as five amperes.

The one ampere coil should be used with trip coils provided the tripping current does not exceed 30 amperes at the maximum voltage. If the tripping current exceeds 30 amperes, an auxiliary relay must be used to control the trip-coil circuit. It must be connected in such a manner that the tripping current does not pass through the contacts or the target and holding coil of the protective relay.

When it is desirable to adopt one type of relay as standard to be used anywhere on a system, relays with the one ampere coil should be chosen. These relays should also be used when it is impossible to obtain trip coil data, but attention is called to the fact that the target may not operate if used with trip coils taking less than one ampere.

OPERATING CHARACTERISTICS

The phase angle and time characteristics of the 60 cycle relay are shown in Figures 1, 1A and 2 with the recommended connections.

BURDENS

CURRENT

The burden imposed by each current coil at five amperes is given in the table below. With standard connections, one of the three current transformers supplies two current coils in series so that the burden on that transformer will be twice the amount given below. The other two current transformers will each supply one current coil and will have a burden as given in the following table:

TYPE CAP15A			
Frequency	Volt Amps	Watts	P. F.
60	0.40	0.20	0.50
50	0.35	0.20	0.57
25	0.60	0.55	0.92
TYPE CAP15B			
60	3.6	1.8	0.50
50	3.2	1.8	0.57
25	2.6	2.4	0.92

POTENTIAL

The potential burdens per relay circuit (studs 13-14, 15-16, 17-18 and 19-20) are listed in the following table.

Relay	Frequency	Volt Amps	Watts	P. F.
CAP15A	60	5.3	1.60	0.30
	50	6.2	2.15	0.35
	25	3.5	1.85	0.53
CAP15B	60	4.7	2.35	0.50
	50	5.8	2.89	0.50
	25	3.5	1.85	0.53

CONSTRUCTION

The stator has eight laminated magnetic poles projecting inward and arranged symmetrically around a central magnetic core. The poles are fitted with current and potential coils. In the annular air gap between the coils and the central core, is the cylindrical part of the cup-like aluminum rotor, which turns freely in the air gap. The central core is fixed to the stator frame and the aluminum cup rotates carrying the moving contacts.

This construction provides a higher torque and a lower rotor inertia than the induction disk construction, and makes the relay faster and more sensitive than the disk-type relays.

The CAP relays are contained in an S2 drawout case providing a means to remove the relay from the circuitry without disconnecting any wiring.

The outline and panel drilling diagram is shown in Figure 15.

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.

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.

POWER REQUIREMENTS - GENERAL

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

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

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

ELECTRICAL TESTS

DRAWOUT RELAYS GENERAL

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

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

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

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

ACCEPTANCE TESTS

When received, the relays should be given a visual inspection to determine if any of the relay parts have been damaged in shipment.

Check the nameplate for the proper model of the relay and for the proper ratings as ordered on the requisition.

Check the fingers and shorting bars in the relay and case according to the internal connections diagram. Use Figure 4 for the 12CAP15A(-)A relay and Figure 5 for the 12CAP15B(-)A relay.

All electrical checks should be performed in the relay's case in a leveled position.

If it becomes necessary to readjust or check the calibration of the relay, refer to the section on SERVICING.

LOCATION

These relays should be installed in a location that is clean and dry, free from excessive vibration and well lighted to facilitate inspection and testing.

MOUNTING

These relays should be mounted on a vertical surface by means of mounting studs or screws. One of the mounting studs or screws should be permanently grounded by a conductor not less than No. 12 B&S gage copper wire or its equivalent. The outline and panel drilling diagrams are shown in Figure 14.

CONNECTIONS

The internal connection diagrams are shown in Figures 4 and 5. The external connections diagrams are shown in Figures 9, 11, 12 and 13.

INSTALLATION TESTS

Upon installing the relay, it is necessary to know (1) that the voltages and currents go to the proper relay terminals, and (2) that none of the relay coils is open-circuited.

Item (1) may be checked easily by means of a phase-angle meter. Determination of the angle between a current and the three voltages and between a voltage and the other two currents gives all the information necessary for a complete vector diagram. The vector diagram plus a knowledge of the direction of power flow will immediately indicate whether or not the connections are correct.

The above test may be made with a wattmeter but the method is somewhat more involved than the phase-angle meter test.

Item (2) may be checked by noting that torque is available and in the correct direction upon removal of two of the three currents. Each of the three current combinations should be tested in turn. When making these tests, the phase angle of the currents should be considerably different from the angle of zero torque.

CAUTION: Every circuit in the drawout case has an auxiliary brush; this is the short one in the case (not on the cradle) which the connection plug or test plug should engage first. On every current circuit or other circuit with a shorting bar, make sure these auxiliary brushes are bent high enough to engage the connection plug or test before the main brushes in the case do, as otherwise the CT secondary circuit may be opened (where one brush touches the shorting bar) before the circuit is completed from the plug to the other main brush. See Figure 15.

OPERATION

In analyzing various connections to the Type CAP15A relay, it is convenient to consider the magnet as a group of eight wattmeter type units acting upon a single rotor, a combination of each coil and an adjacent coil being assumed to be one element.

Of course, extraneous torques are developed by combinations of coils which are not adjacent. However, the torque of an adjacent pair of poles is largely relative to that of any other pair. For instance, the torque produced by the interaction between coils B and H (part "a," Figure 7) is approximately 15 percent of that produced by coil combinations A-H, while the torque produced by combination C-H is about two percent, a negligible amount. The torques of alternate poles (e.g., A-C or B-H) being appreciable, the connections are arranged so that their torques balance out substantially to zero, a factory adjustment being provided for more accurate balance of the current torques. (See CURRENT BIAS ADJUSTMENT). Referring to the currents in part "a," Figure 7, it can be seen that the torque produced by the interaction between coils A and G is balanced by the equal and opposite torque of combination E-G is balanced by that of combination C-E.

Part "a" of Figure 7 shows schematically the currents and voltages applied to the eight coils with connections as in Figure 9, connection A. For clarity one current coil and its adjacent potential coils are isolated in part "b," Figure 7. It is observed that I_3 acts with E_{1-2} and E_{2-3}, the resulting torque being equivalent to the reaction of I_3 with the vector difference of E_{1-2} and E_{2-3} (difference because the potential coils are on opposite sides of the current coil). The vector relations are also shown in part "b." Part "c" and "d" show corresponding coil and vector relations for the other two currents, I2 and I_1. It is noted (part "e" of Figure 7) that the two remaining coil combinations produce equal and opposite torques.

Considering a potential coil and its adjacent current coil, this combination would have maximum torque when the current leads the voltage by 20 degrees. With the connections of part "a" of figure 7, it is seen that I_3 will lead $E_{1-2} - E_{2-3}$, by 20 degrees when I_3 lags its phase-to-neutral voltage by 40 degrees. Thus, with these connections, maximum torque (balanced three-phase conditions) is obtained when a current lags its phase-to-neutral voltage by 40 degrees.

ADJUSTMENTS

CUP AND STATOR

These relays are properly adjusted at the factory to obtain the desired characteristic and it is advisable not to disturb these adjustments. If for any reason it becomes necessary to remove the contact plate and rotor, the following procedure must be followed:

1. Remove the cradle from the case.

2. Remove the two screws holding the top inner block to the cradle and tilt the block up and back so that it is possible to work on the top of the relay.

3. Disconnect the four leads which go to the contact plate at the terminals in the upper and lower inner blocks and draw the loose ends out through the holes in the mounting plate.

4. Remove the two screws which secure the top bearing plate.

5. The contact plate is secured to the stator by means of three screws. The screws are located on the right-hand and left-hand sides in the front and at the middle at the rear. Remove the three screws.

6. The shaft rotor and top bearing plate will now lift out of the stator as the contact plate is raised.

7. The rotor may be removed from the shaft by loosening the two set screws which fit into V-holes in the shaft.

The two stator castings are permanently fastened together with the laminations clamped between them, and the faces of the poles and the cylindrical surfaces on these castings are then machined true about the same axis. To preserve this alignment, the large rivets in the corners should never be removed.

Use care in handling the rotor while it is out of the relay, and see that the air gap and rotor are kept clean.

In reassembly, the rotor will go into the air gap easily without forcing, if the parts are held in proper alignment.

The lower-jewel bearing should be screwed all the way in until its head engages the end of the threaded core. The upper bearing should be adjusted to allow about 1/64 inch to 1/32 inch end play to the shaft.

To check the clearance between the iron core and the inside of the rotor cup, press down on the contact arm near the shaft and thus depress the spring-mounted jewel until the cup strikes the iron. The shaft should move about 1/16 inch.

The lower jewel may be tested for fractures by exploring its surface with a fine needle. If replaced with a new jewel a new pivot should be screwed into the end of the shaft at the same time.

ACCEPTANCE TESTS

The contact gap may be adjusted by loosening slightly the same screw at the front of the contact block as mentioned previously. The screw should be loose enough only to allow the contact barrel to rotate in its sleeve.

The time curves of Figure 1-1A were taken with a contact gap of 0.018 inch. This gap may be obtained in the following manner: With the right-hand contact tube or barrel secured in place, turn the left-hand barrel in the opposite direction approximately 210 degrees or 0.6 revolutions from contact closing.Tighten the screw which secures the barrel.

Each moving contact may be removed by loosening the screw which secures it to the contact arm and sliding it from under the screw head.

HOLDING COILS

The location of each holding coil may be adjusted by loosening the mounting screw and sliding the coil either to the left or the right in a groove provided for that purpose. The holding coils are located in the factory so that there is a gap of about 0.055 inch between the pole pieces and the armature. The 0.055 inch is equivalent to 1-5/8 turns of the contact barrel.

CONTROL AND LEAD-IN SPRING

The control and lead-in springs are adjusted in the factory to close the right-hand contact when the relay is de-energized. The closing spring torque is equivalent to about 45 degrees motion of the spring adjusting ring located just under the top bearing plate. The tension of the control spring may be changed by loosening the hexagonal screw located at the rear of the adjusting-ring to the desired position.

CLUTCH - 12CAP15B(-)A

The clutch adjusting screw should be tightened as much as possible so that the clutch does not slip.

CLUTCH-12CAP15A(-)A

Connect the relay per Figure 8A. Apply rated voltage and current to the relay and set the phase angle meter for 0 degrees. The clutch should slip between 7.5 and 10 amperes. Adjust the screw and locknut located on the right side, front view of the moving contact assembly if the clutch slip is not as listed above. Clutch slip is considered acceptable if the cup assembly makes one or more revolutions. This can be determined by visually noting the movement of the u-shaped pin located at the top of the cup shaft.

SERVICING

12CAP15A(-)A

MECHANICAL ADJUSTMENTS

The clutch can be checked by connecting the relay per Figure 8A, current and voltage. With rated voltage applied, increase the current until the clutch begins to slip; this should occur between 7.5 and 10 amperes.

Check the end play which is the upper end play of the cup and moving contact assembly. This should be between 1/64 inch and 1/32 inch.

The contact gap with the relay de-energized should be 0.016-0.020 inch.

The holding coil gap should be approximately 0.055 inch (±) 0.005 inch.

Connect studs 1 and 11 to a variable d-c source. Close the left contact and the target should operate as follows.

Target Rating - Amps	Operating Current - Or Less
0.20	0.17 amps
1.00	0.85 amps

POLARITY TESTS

Complete polarity tests are made in the factory and these may be checked by connecting terminals A and C together, connecting terminals B and D through a resistor (20 ohms) and apply rated voltage to terminals C and D. With these connections, the left-hand contact (front view) should close in each of the following eight checks:

TABLE II

Current Coil		Potential Coil	
A	B	C	D
3	4	19	20
3	4	14	13
4	6	17	18
4	6	20	10
7	8	15	16
7	8	18	17
9	10	13	14
9	10	16	15

PHASE ANGLE TESTS

Connect the relay to an external circuit according to that shown in Figure 8A. With this connection, the polyphase phase angle of the relay can be checked. The angle of maximum torque with the 8A connections should be 40 degrees lead (±) five degrees. Pickup should be less than 0.025 amperes at rated voltage and frequency at the angle of maximum torque.

If a phase shifter, phase-angle meter is not available, the 12CAP15A(-)A can be rechecked or recalibrated as follows:

(a) Return the control spring to its neutral (centered between the contacts) by loosening the hex stud at the top rear of the unit, and turning the control spring adjuster to accomplish the centering.

(b) Connect the current circuit only as shown in Figure 8A. Short the potential circuits at the relay case terminals.

(c) Set the three-phase currents, balanced at 30 amperes. The moving contact should stay at its previously set neutral position or could possibly have a slight opening bias, which is acceptable. A slight adjustment of the resistors at the rear of the relay will correct for the current bias if it is not correct.

Increasing the resistance of the upper resistor will tend to open the left contact. Increasing the resistance of the lower resistor will tend to open the right-hand contact. Cross adjust the two resistors until the moving contact remains at the neutral position or with a slight opening bias. Do not leave the current on for any length of time because it will overheat the unit and result in erroneous bias conditions.

Remove the current from the relay and connect the potential circuit as shown in Figure 8A. With rated three-phase voltage applied (at rated frequency) the unit should have a slight opening bias. The core of the relay must be adjusted if this test fails. The core consists of an inner stator protruding through the base plate of the unit and secured with a locknut. The end of the core has a jewel bearing that supports the cup with minimum friction. Loosen the locknut slightly and turn the jewel screw (slotted head) to remove the potential bias. Then hold the jewel screw and lock the locknut.

Cross adjust the current and potential bias adjustments until both tests are acceptable.

The final test is to wind the control spring from its neutral position towards the opening direction. A spring windup of approximately 3/16 inch along the periphery of the spring windup adjuster is sufficient. Lock the spring adjuster in this position.

HI-POTENTIAL TESTS

Hipot all studs to case (ground) and between circuits at two times rated voltage plus 1,000 volts for one minute.

SERVICING

12CAP15B(-)A

MECHANICAL ADJUSTMENTS

1. The vertical end play of the shaft should be between 1/64 inch and 1/32 inch.

2. The clearance between (a) the back of the silver contact mounted on the flat spiral in either contact barrel and (b) the diaphragm behind it, should be 0.004 inch to 0.009 inch. This wipe should be measured by moving contact arm over until it just touches the stationary contact to be measured. Then, holding contact arm in this position, rotate barrel until the back of contact touches diaphragm. Rotating barrel 45 degrees corresponds to 0.004 inch while 105 degrees is the equivalent of 0.009 inch.

3. Contact gap should be 0.018 inch. This should be adjusted in the following manner: While the contact arm is parallel to the sides of the relay, turn the contact barrels until both contacts are just made (use neon lamp). Tighten the clamping screw, locking the right-hand contact barrel. Back off the left-hand contact barrel 0.57 revolution (210 degrees) and tighten its clamping screw.

4. The holding coil gaps should be 0.055 inch which should be set with a gauge.

5. Control Spring Preliminary Adjustment - With the relay de-energized, the control springs should be at their neutral positions thus holding the contact arm approximately in the middle of travel so that both contacts are open.

6. Clutch Adjustment - Turn the clutch screw all the way in and lock.

POLARITY TESTS

Complete polarity tests are made in the factory and these may be checked by connecting terminals A and C together, connecting terminals B and D through a resistor (20 ohms) and apply rated voltage to terminals C and D. With these connections, the left-hand contact (front view) should close in each of the following eight checks:

Current Coil		Potential Coil	
A	B	C	D
3	4	19	20
3	4	14	13
5	6	17	18
5	6	20	19
7	8	15	16
7	8	18	17
9	10	13	14
9	10	16	15

PHASE ANGLE TESTS

Connect the relay per Figure 8A for the current circuits and Figure 8B for the potential circuits.

Adjust the four variable resistors so that the left contacts just close at 120 degrees and 300 degrees (i.e., maximum torque at 30 degrees lead). All resistors should be adjusted to have approximately the same ohms. Use rated voltage and frequency, and five amperes.

With the above connections and adjustment, the relay is at unity power factor on a three-phase basis when the phase-angle meter reads 30 degrees.

CORE ADJUSTMENT

With zero current in the current coils and rated voltage and frequency across the potential coils, adjust the position of the relay core until the moving contact will remain in between the two stationary contacts without touching either.

PICKUP ADJUSTMENT

With 0.025 ampere in each current coil, rated voltage on each potential coil, and the phase angle set for 30 degrees (maximum torque angle), adjust the upper control spring by turning the adjusting ring in a counterclockwise direction until the left contact will just close.

HOLDING COIL CHECK (WHEN USED)

All checks should be made with the relay stator de-energized. To test the right rear holding coil, close the left contact by hand and run rated holding-coil current through this circuit (Studs 1-11). The holding coil should hold the left contact closed. To check the left rear holding coil, hold the contact arm so that the right contacts are just closed. Apply rated holding-coil current to this circuit (Studs 2-12). It should be possible to feel a pull on the contact arm in the direction to close the right contacts still more.

TARGET CHECK (WHEN USED)

Connect Studs 1 and 11 to a variable source of d-c power. The currents required to trip the target should be equal to or less than the value listed below.

Target Rating - Amps	Operating Current - Amps
1.0	0.85 or less
0.2	0.17 or less

Operate the target a few times. The target should not drop due to light shock of the relay cradle. Make sure the target can be easily reset with the relay in the case and the cover on tightly.

HI-POTENTIAL TEST

Hipot the relay circuit at two times rated relay voltage plus 1,000 volts, 60 Hz for one minute as listed below.

1. All studs to case (ground)

2. Between all combinations of circuits.

RENEWAL PARTS

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

When ordering renewal parts, address the nearest Sales Office of the General Electric Company, specify quantity required, name of the part wanted, and the complete model number of the relay for which the part is required.

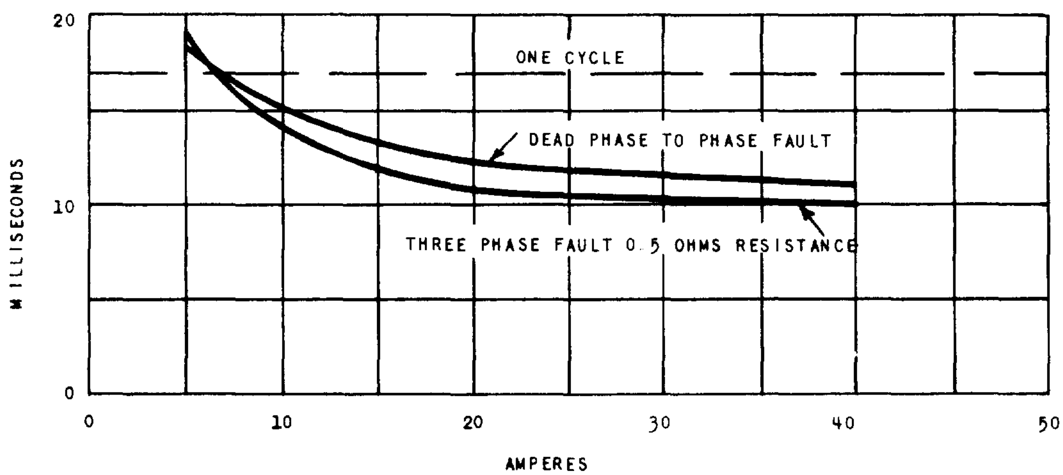


Figure 1 (0362A0611-0). AVERAGE OPERATING TIME CHARACTERISTICS OF THE TYPE CAP15A(-)A RELAY

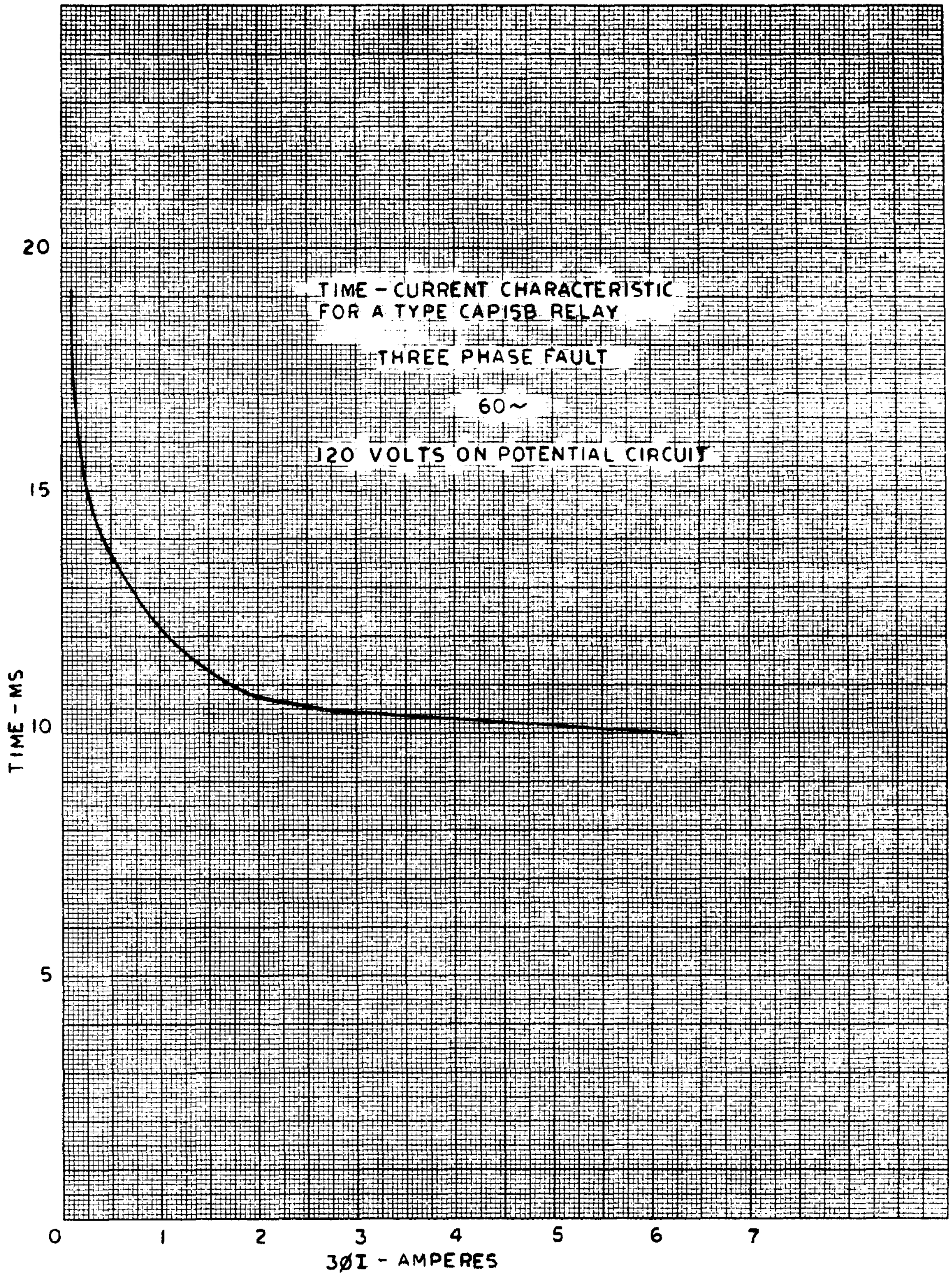
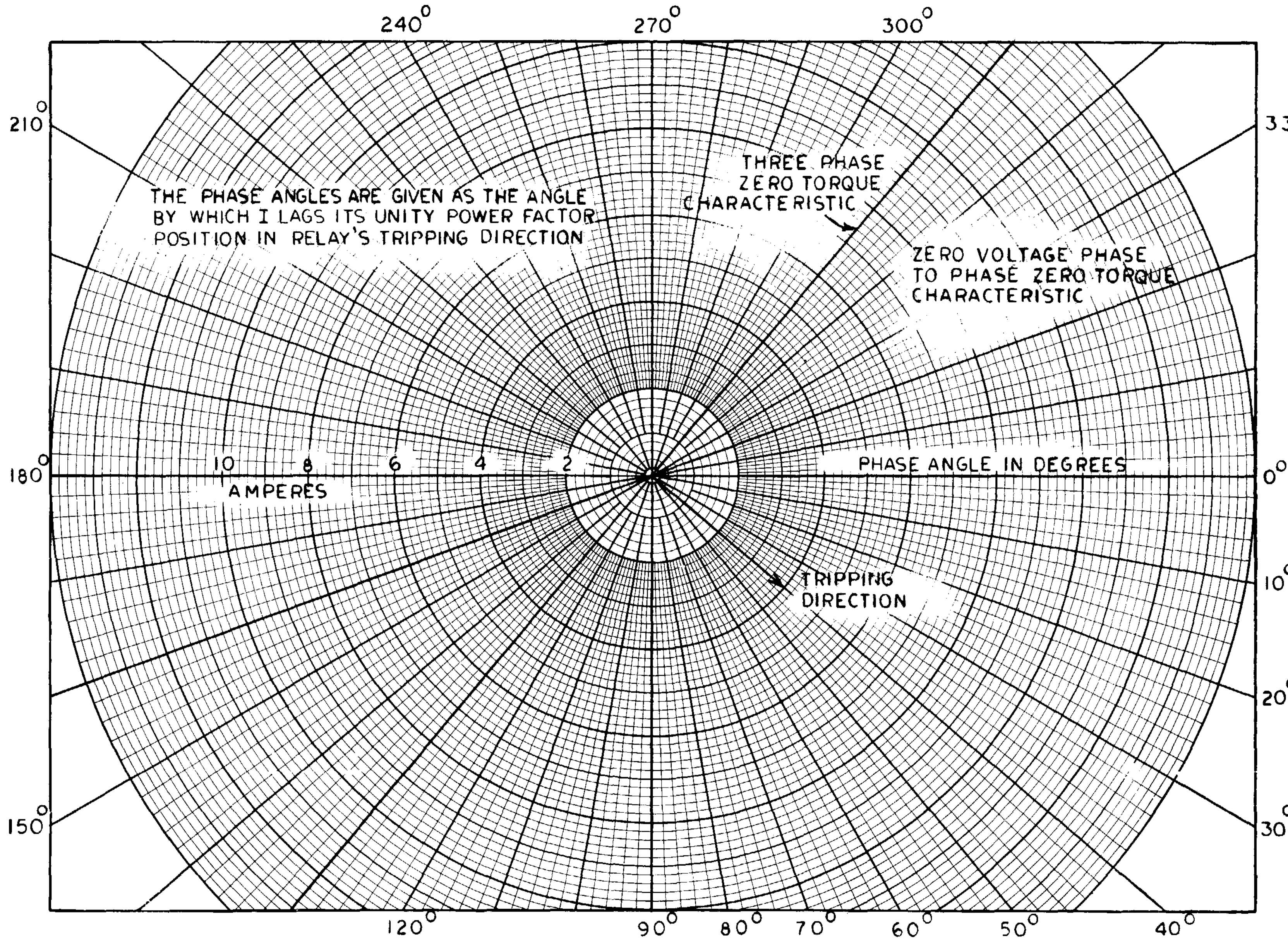
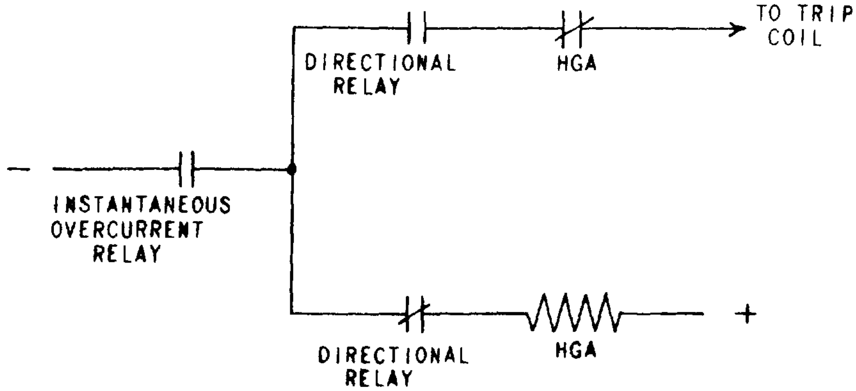


Figure 1A (0257A8580-0). AVERAGE OPERATING TIME CHARACTERISTICS OF THE TYPE CAP15B(-)A RELAY

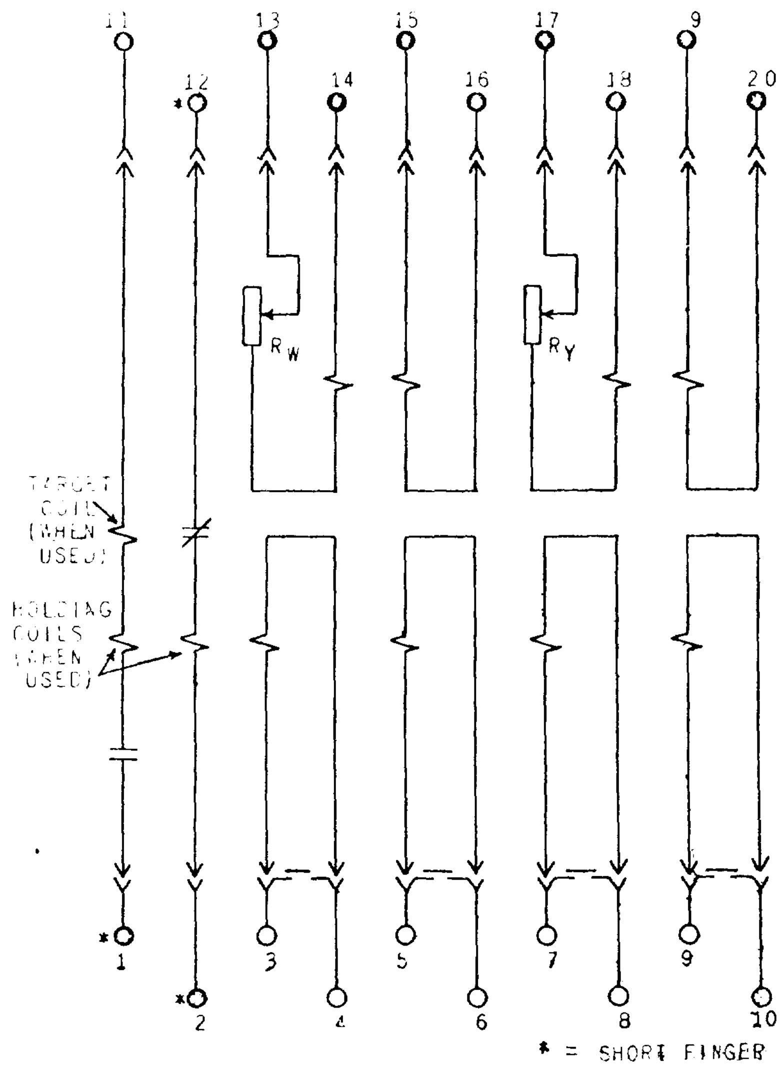


PHASE ANGLE CHARACTERISTICS OF
CAPI5A RELAY-60 DEGREE CONNECTION

Figure 2 (0257A8582-0). PHASE ANGLE CHARACTERISTICS OF THE CAP15A RELAY - 60 DEGREE CONNECTIONS



* Figure 3 (0362A0607 [1]) CIRCUIT DIAGRAM OF A TYPE CAP RELAY OPERATING WITH A TYPE HGA DELAY



* Figure 4 (K-6174667 [4]) INTERNAL CONNECTIONS DIAGRAM OF THE CAP15A RELAY (FRONT VIEW)

* Revised since last issue

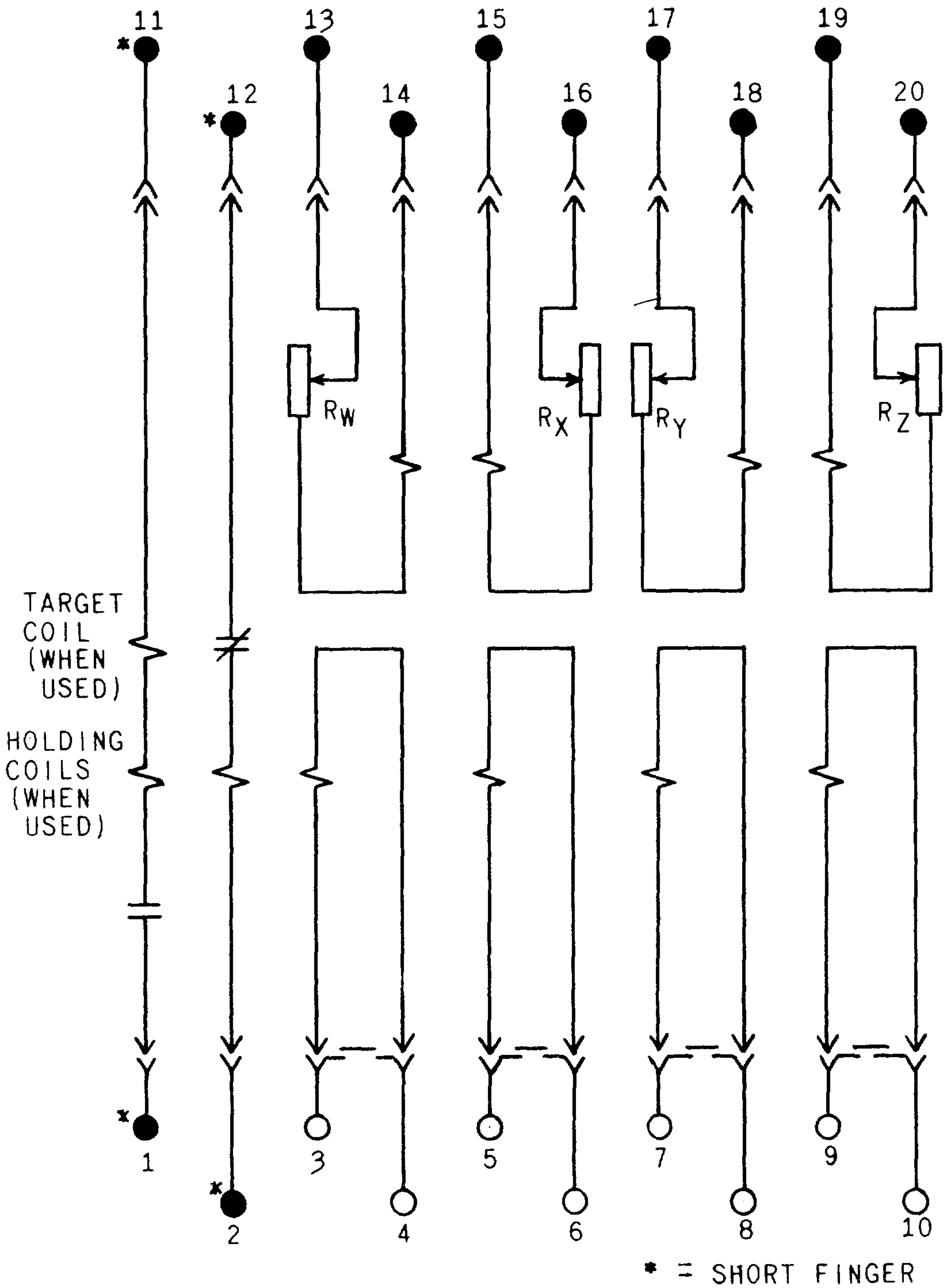


Figure 5 (K-6154196 [3]) INTERNAL CONNECTIONS DIAGRAM OF THE CAP15B RELAY (FRONT VIEW)

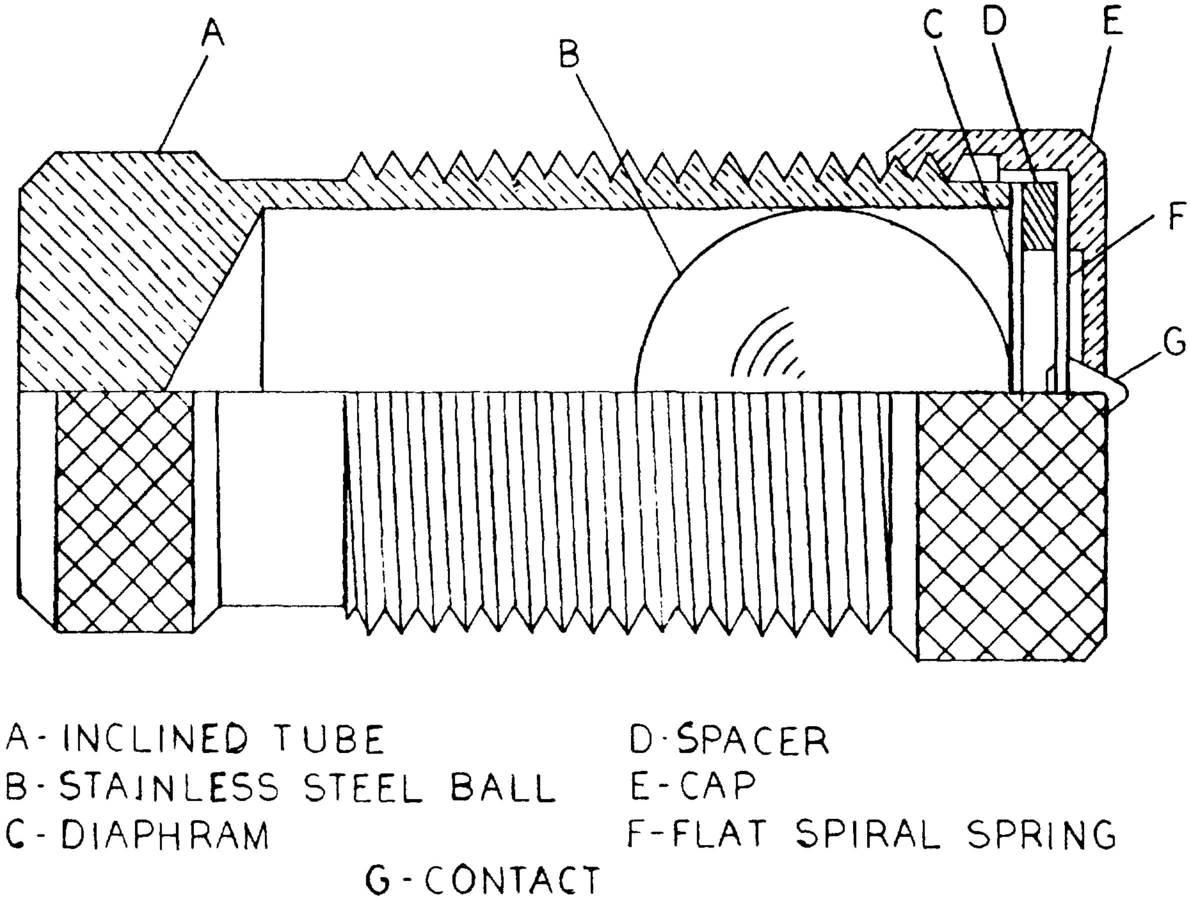


Figure 6 K-6077069 [4]) STATIONARY CONTACT ASSEMBLY

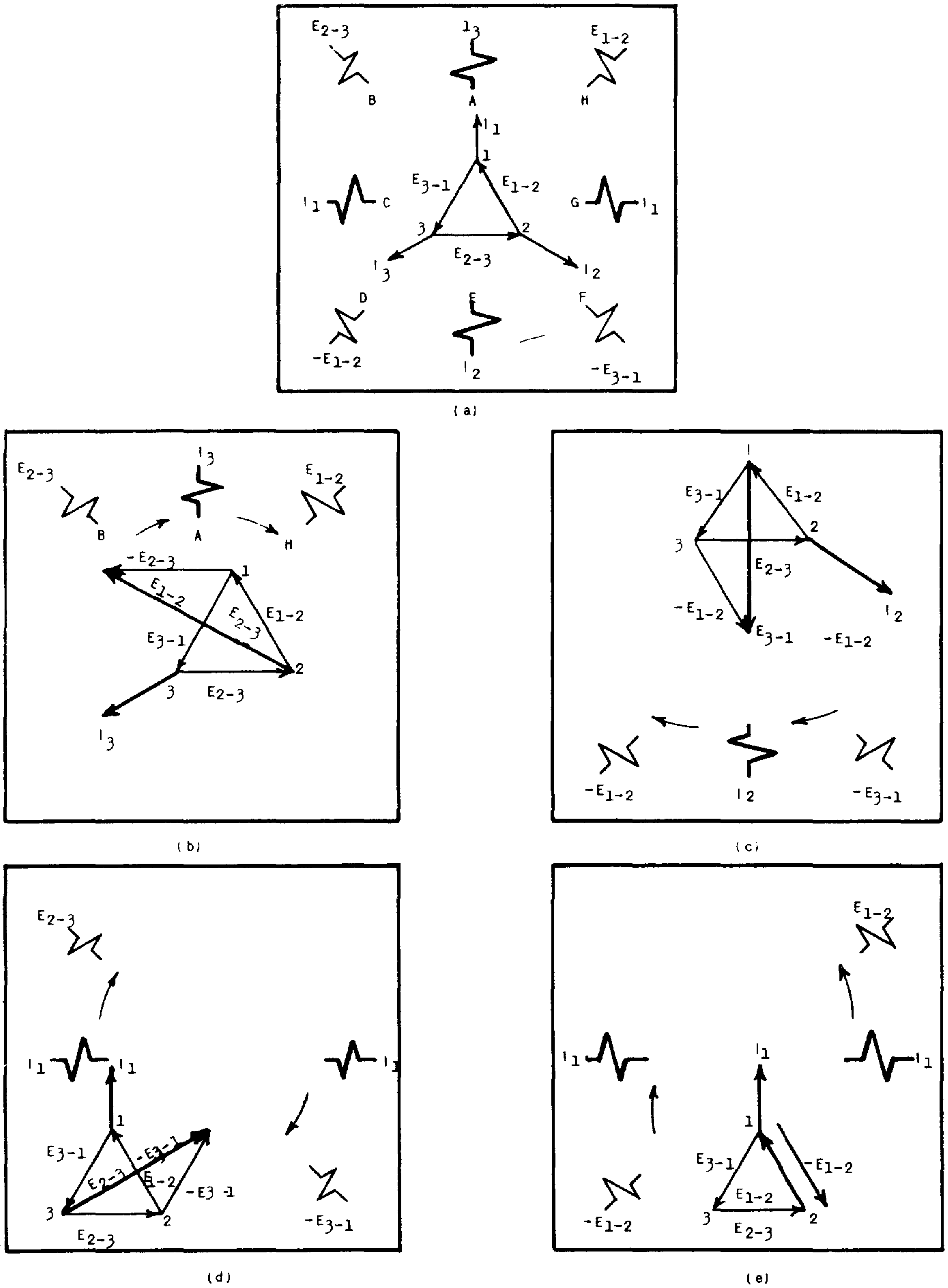
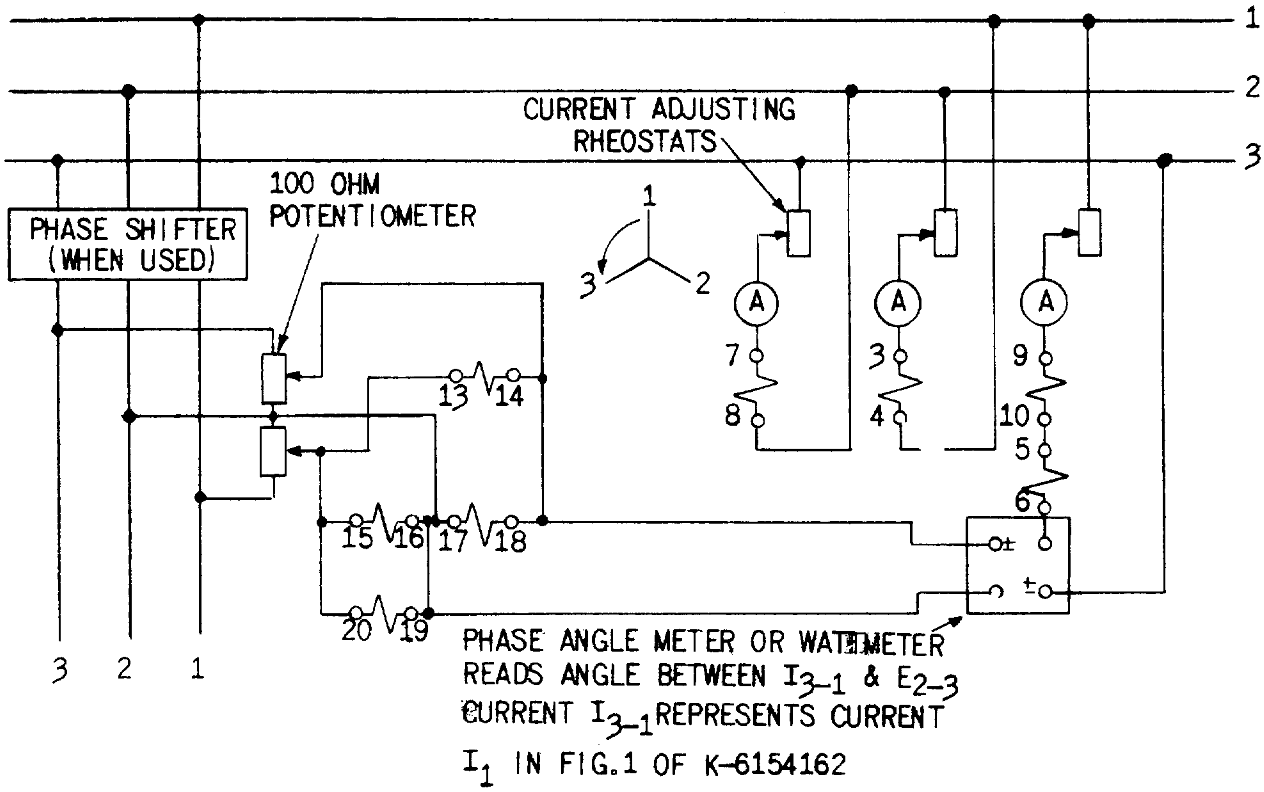
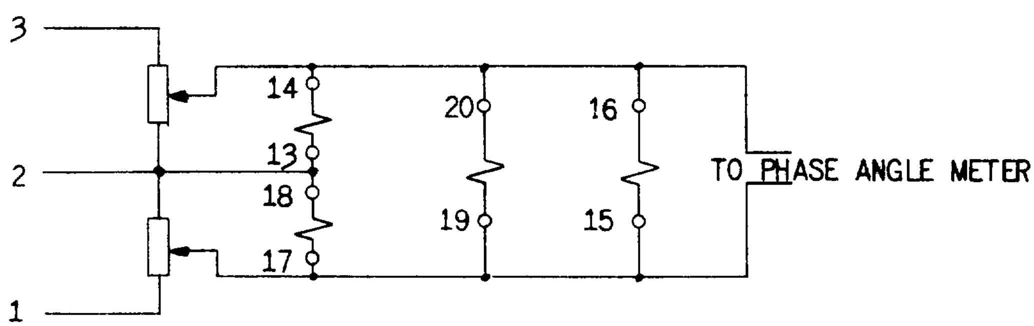


Figure 7 (K-6178877-3). SCHEMATIC DIAGRAMS OF THE CAP15A RELAY



(A) CAP15A TEST CONNECTIONS



(B) CAP15B POTENTIAL CONNECTIONS
CURRENT CONNECTIONS SAME AS (A) ABOVE

Figure 8 (K-6154165-4). LABORATORY TESTING DIAGRAM FOR THE CAP15A AND CAP15B RELAYS

CON-NEC-TION NO.	CONNECTION	CONNECTIONS TO C.T.'S	POTENTIAL TRANSFORMER SEE FIG.5	POTENTIAL CONNECTIONS		MAX.TORQUE OCCURS (BALANCED 3φ CONDITIONS) WHEN A CURRENT LAGS ITS PHASE-TO-NEUTRAL VOLTAGE BY DEG.		DIRECTION OF POWER FLOW TO CLOSE TRIP CONTACTS (TERMINALS (1-11) L.H. CONTACTS FRONT VIEW
				INTERCONNECTION OF RELAY TERMINALS	CONNECTIONS TO POTENTIAL TRANSFORMERS	50 & 60 CYC.	25 CYC.	
A	60 DEG.	FIG.1	2 IN OPEN DELTA OR 3 IN Y-Y (SEE NOTE 1)	FIG.2		40 DEG.	30 DEG.	ARROW Y FIG.1
B	90 DEG. (QUADRATURE)	FIG.1	2 IN OPEN DELTA OR 3 IN Y-Y (SEE NOTE 1)	FIG.3	PHASE 1-d) PHASE 2-f) FIG.3 PHASE 3-e)	70 DEG.	60 DEG.	ARROW Y FIG.1
C	30 DEG. (ADJACENT)	FIG.1	2 IN OPEN DELTA OR 3 IN Y-Y (SEE NOTE 1)	FIG.3	PHASE 1-e) PHASE 2-d) FIG.3 PHASE 3-f)	10 DEG.	0 DEG.	ARROW X FIG.1
D	90 DEG. (QUADRATURE)	FIG.1	Y-Y (SEE NOTE 2)	FIG.4		70 DEG.	60 DEG.	ARROW X FIG.1
E	NOTE 3 90 DEG. (QUADRATURE)	FIG.1	2 IN OPEN DELTA (SEE NOTE 1)	FIG.2		70 DEG.	60 DEG.	ARROW Y FIG.1

NOTE 1: POTENTIAL COILS CONNECTED TO DELTA VOLTAGES.
NOTE 2: POTENTIAL COILS CONNECTED TO WYE VOLTAGES.
NOTE 3: CURRENT FROM WYE SIDE OF POWER TRANSFORMER. POTENTIAL FROM DELTA SIDE. WYE SIDE LEADING DELTA SIDE BY 30°.

FOR CONNECTION OF TYPE CAP15B RELAY SEE K-6154163.

NOTE: ALL CONNECTIONS SHOWN FOR PHASE SEQUENCE 1-2-3. FOR PHASE SEQUENCE 3-2-1 INTERCHANGE CONNECTION FROM PHASE 1 AND 3 IN BOTH THE CURRENT AND POTENTIAL CIRCUITS.

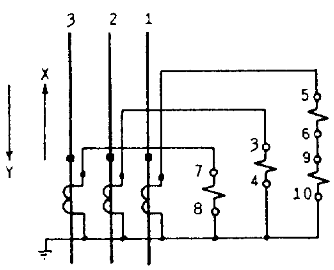


FIG.1

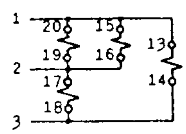


FIG.2

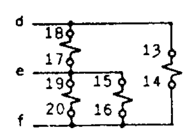


FIG.3

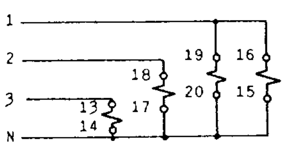
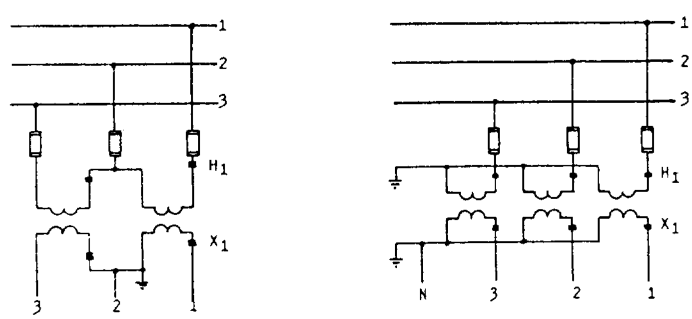


FIG.4



POTENTIAL TRANSFORMERS CONNECTED IN OPEN DELTA

POTENTIAL TRANSFORMERS CONNECTED IN Y-Y

FIG.5

Figure 9 (0264B0406 Sh.1 [1] & Sh.2 [2]) EXTERNAL CONNECTIONS FOR THE CAP15A RELAY

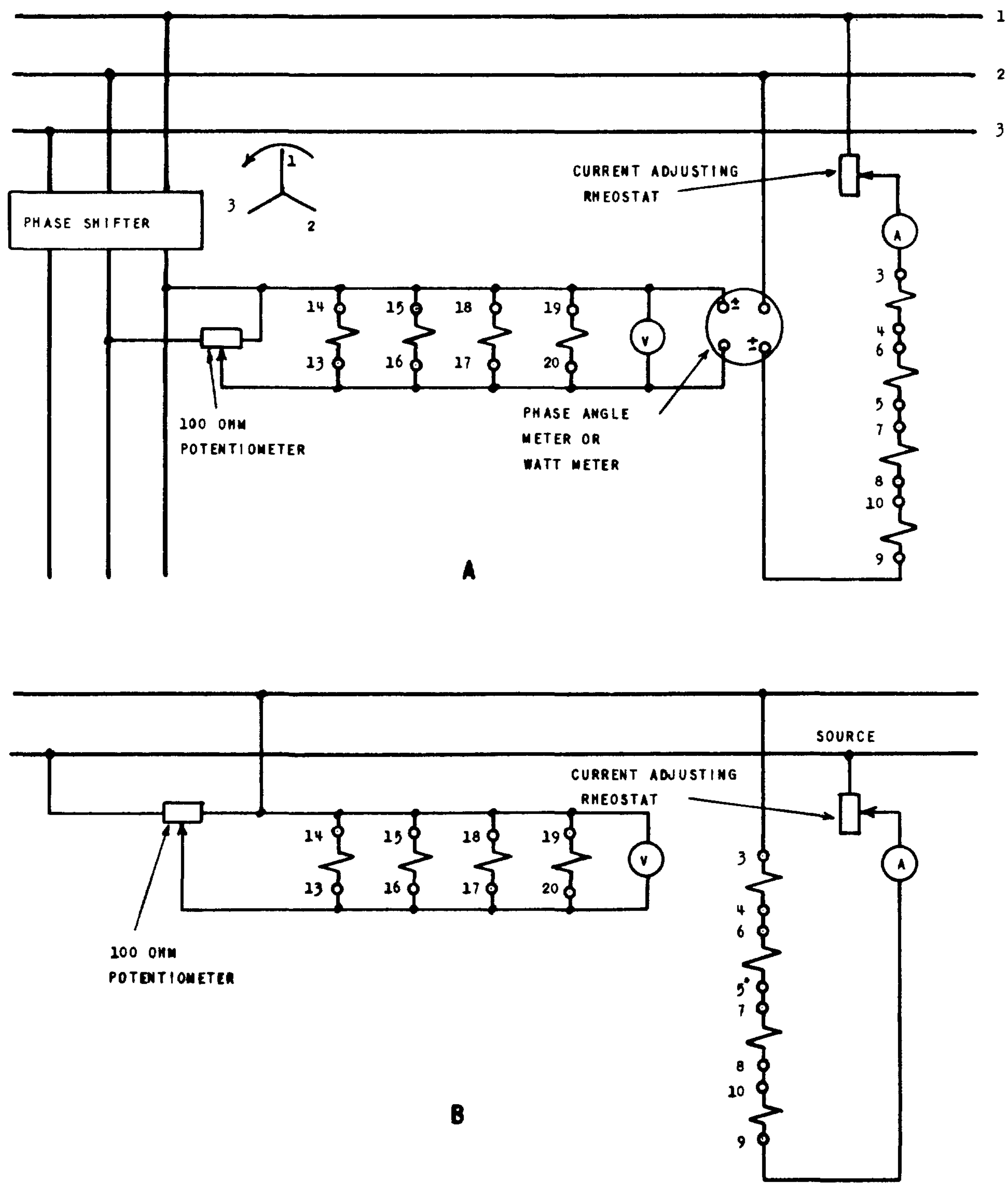
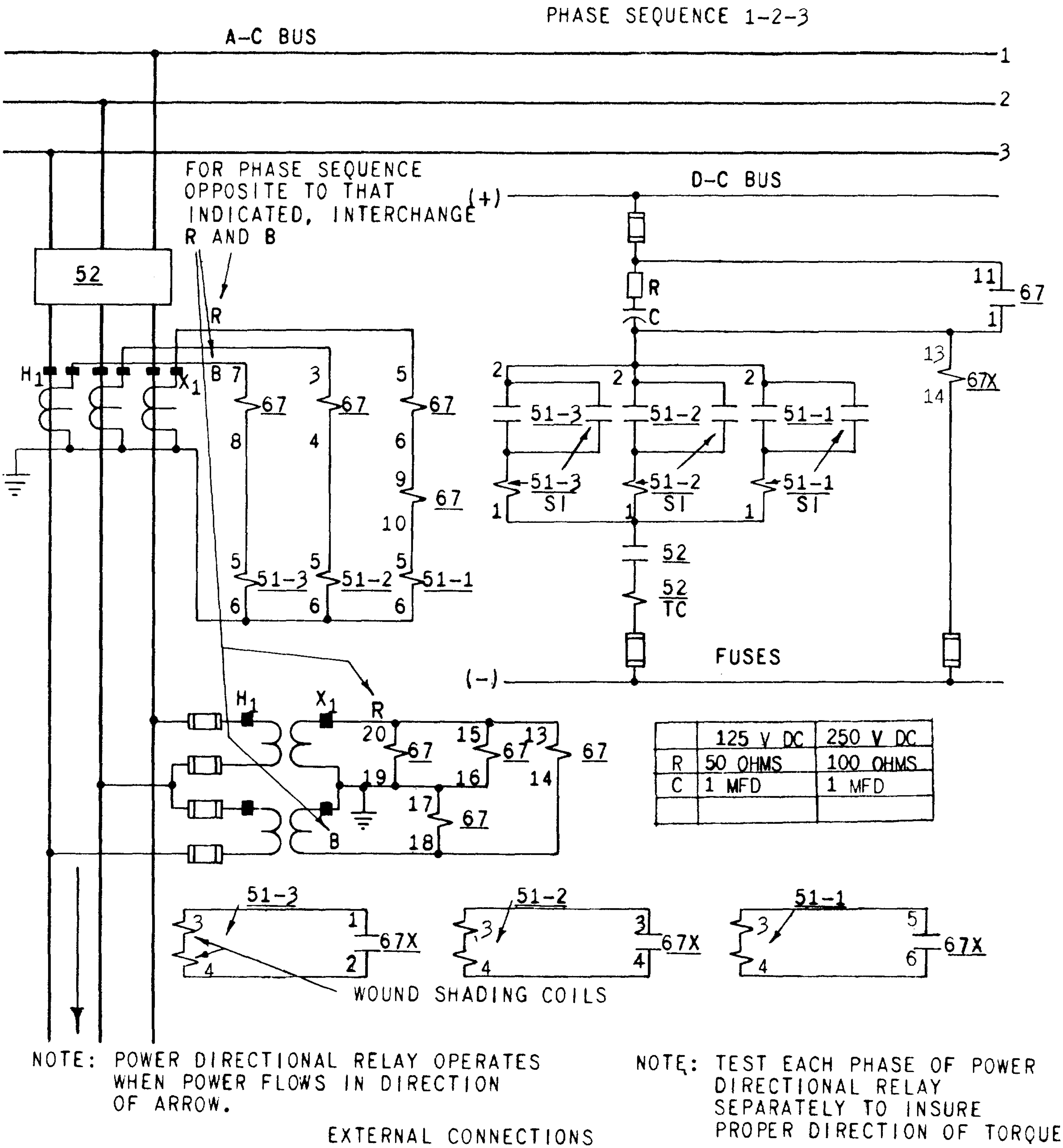


Figure 10 (K-6154164 [2]) EXTERNAL CONNECTION TESTING DIAGRAMS FOR THE CAP15A AND CAP15B RELAYS



	125 V DC	250 V DC
R	50 OHMS	100 OHMS
C	1 MFD	1 MFD

Figure 11 (K-6154168 [5]) EXTERNAL CONNECTIONS OF THE CAP15A RELAY FOR DIRECTIONAL OVERCURRENT PROTECTION

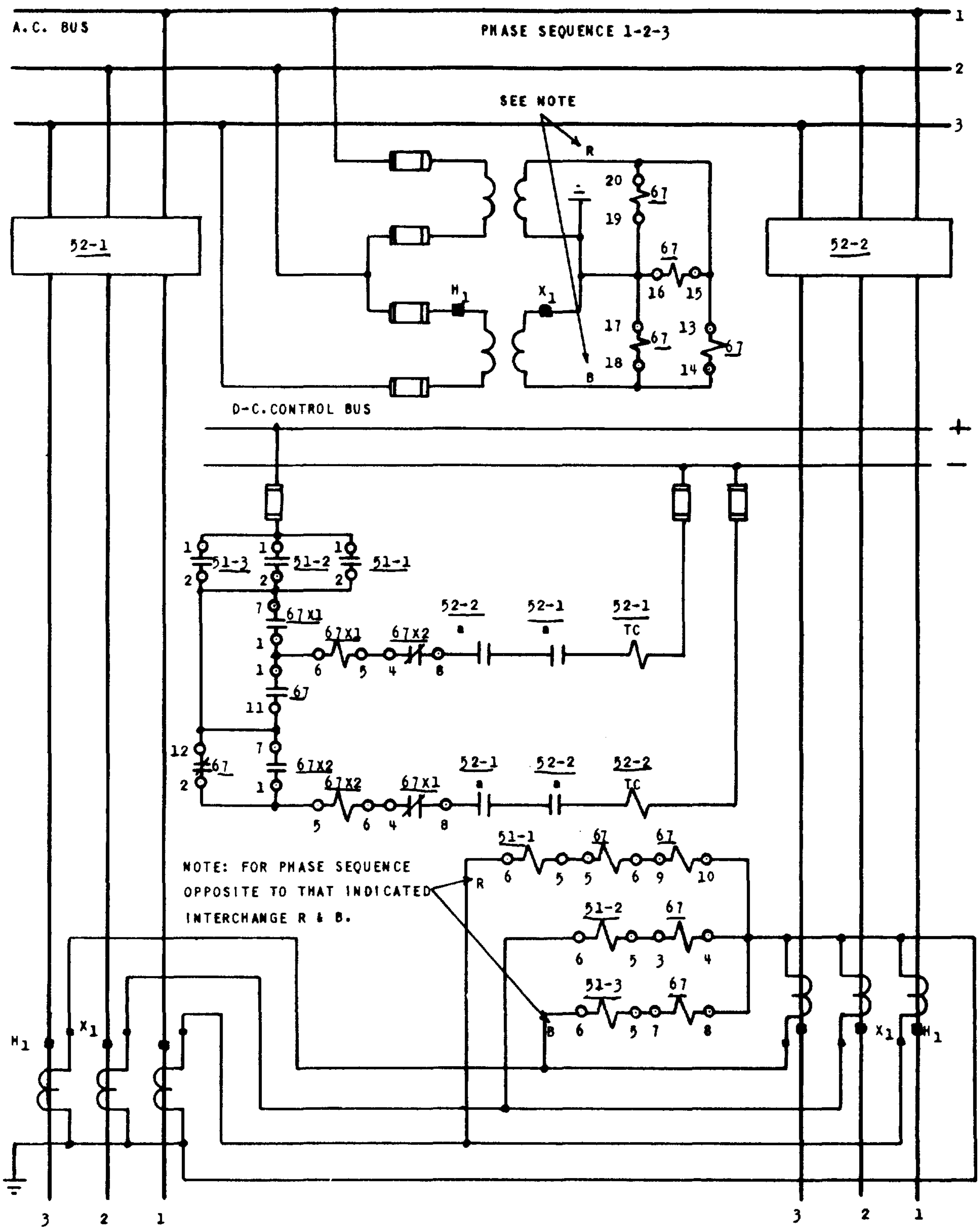


Figure 12 (K-6154166 [4]) EXTERNAL CONNECTIONS OF THE CAP15A RELAY FOR BALANCE-POWER PROTECTION OF TWO PARALLEL INCOMING LINES. NON-AUTOMATIC FOR SINGLE LINE OPERATION

LIST OF DEVICES		
DEVICE NO.	DEVICE TYPE	DESCRIPTION
67	CAP15B	POWER RELAY
62	IAV51M	TIME OVERVOLTAGE RELAY

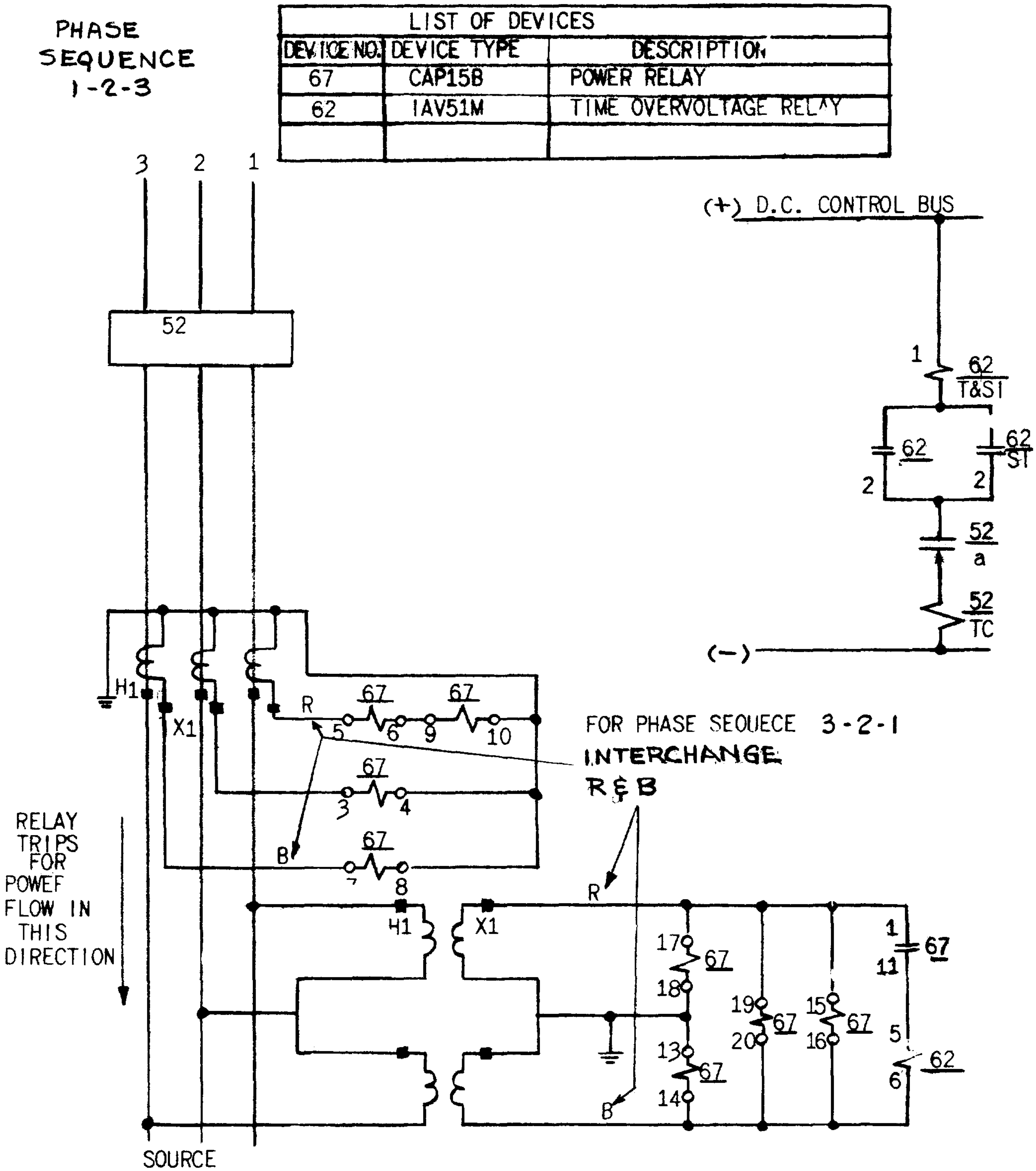
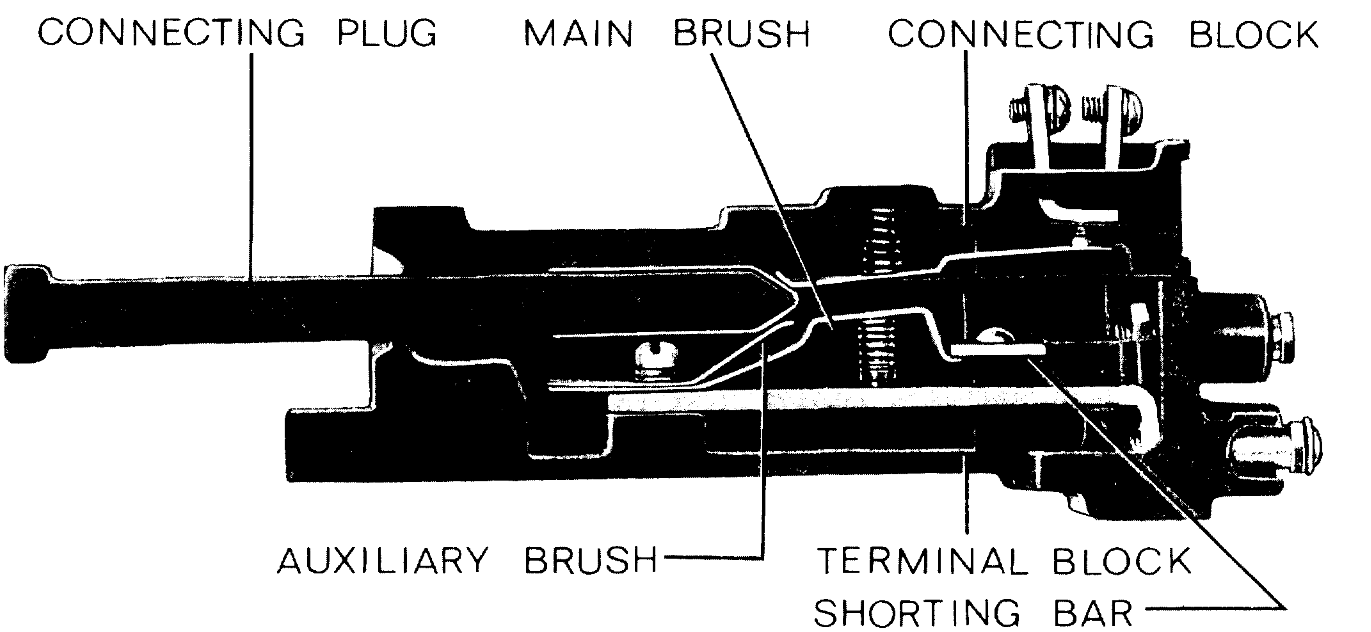


Figure 13 (0127A9459-3). EXTERNAL CONNECTIONS FOR THE CAP15B RELAY WHEN USED TO PROTECT AN ALTERNATOR



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

Figure 14 (8025039). CROSS SECTIONAL VIEW OF THE CASE AND CRADLE BLOCKS SHOWING THE SHORTING BAR

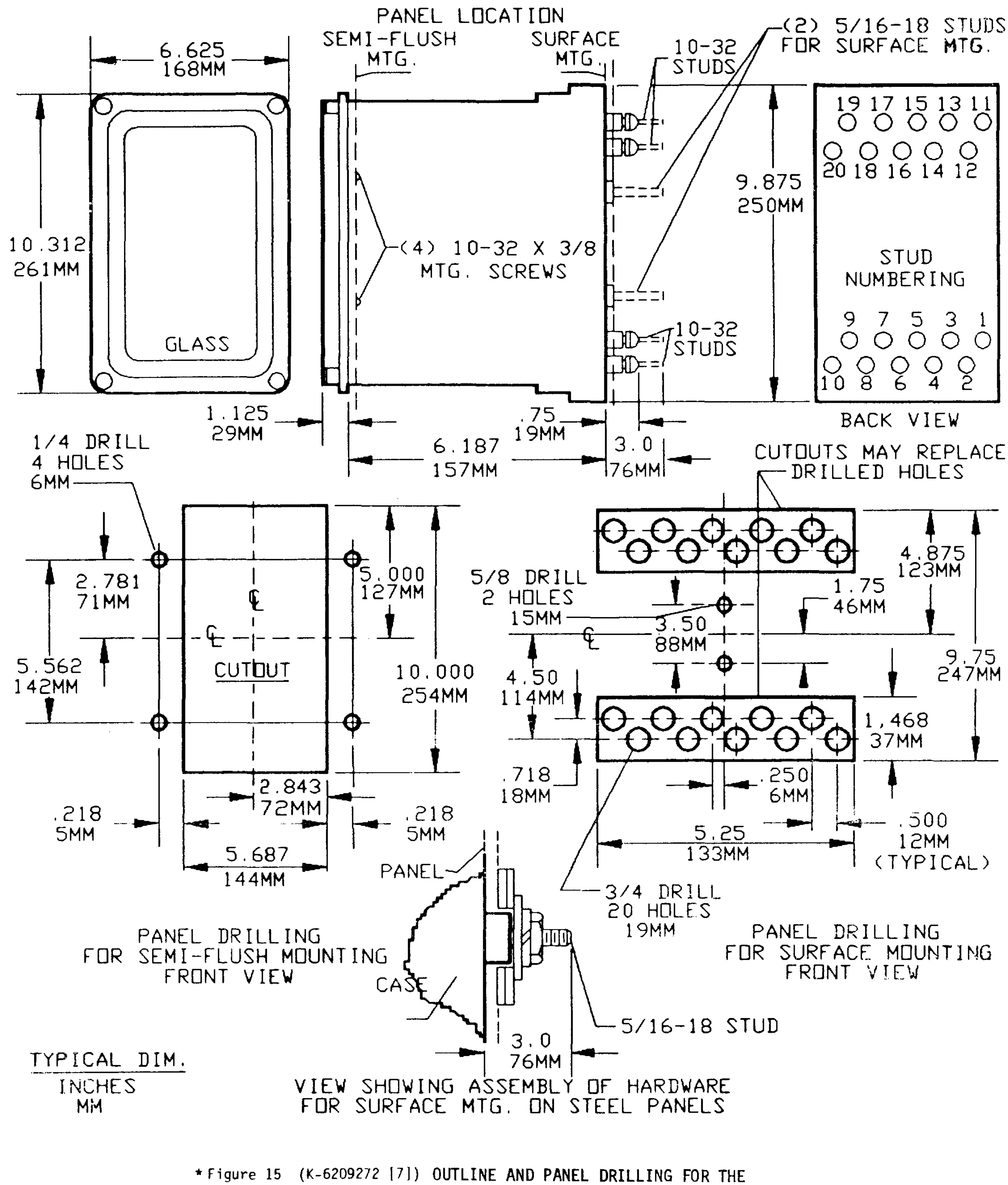


*Figure 15 (K-6209272 [7]) OUTLINE AND PANEL DRILLING FOR THE CAP15A AND CAP15B RELAYS

* Revised since last issue