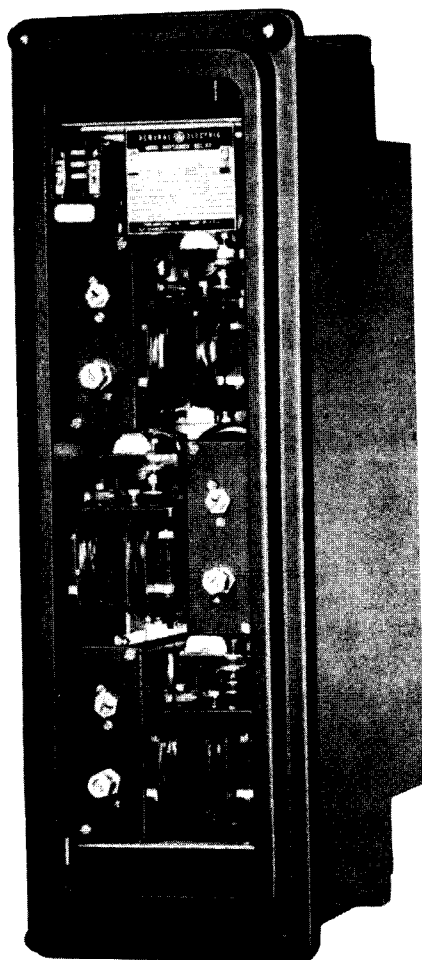




# ***INSTRUCTIONS***

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## **MHO DISTANCE RELAY TYPE CEY51A**



*GE Protection and Control  
205 Great Valley Parkway  
Malvern, PA 19355-1337*

This data is for the 3.0-ohm basic-reach tap setting. The burden for other tap settings may be calculated from the following equation:

$$B_{new} = \left( \frac{B.R.}{3} \right)^2 \times B_3 \text{ ohms}$$

where:

- $B_{new}$  = Burden at new tap setting
- B.R. = Basic reach of new tap setting
- $B_3$  ohms = Burden from Table V

POTENTIAL CIRCUITS

The maximum potential burden (with restraint tap set for 100%) imposed on each potential transformer at 120 volts and 60 cycles is listed in Table VI.

TABLE VI

CIRCUIT	R	X	P.F.	WATTS	VA
Polarizing	1300	-j680	0.89	8.7	9.8
Restraint	3200	j0	1.0	4.5	4.5

The restraint circuit burden, and hence the total relay burden, will decrease when the restraint tap setting is less than 100%.

The potential burden at tap settings less than 100% can be calculated from the following formula.

$$VA = (a + jb) \frac{\text{Tap Setting}^2}{100} + (c + jd)$$

The terms (a + jb) (c + jd), etc., represent the burdens of the mho-unit-potential circuit expressed in watts and vars with their taps on 100%. The values of these terms for 60-cycle relays are given in Table VII.

TABLE VII

CIRCUIT	TERM (Watts + j Vars)	TERM (Watts + j Vars)
Restraint	(a + jb)	(4.5 + j0)
Polarizing	(c + jd)	(8.7 - j4.5)

## CONSTRUCTION

The type CEY51A relays are assembled in a deep, large-size, double-end (L2D) drawout case having studs at both ends in the rear for external connections. The electrical connections between the relay units and the case studs are made through stationary molded inner and outer blocks, between which nests a removable connecting plug that completes the circuits. The outer blocks attached to the case have the studs for the external connections, and the inner blocks have the terminals for the internal connections.

Every circuit in the drawout case has an auxiliary brush, as shown in Figure 8, to provide adequate overlap when the connecting plug is withdrawn or inserted. Some circuits are equipped with shorting bars (see internal connections in Figure 9), and on those circuits it is especially important that the auxiliary brushes make contact, as indicated in Figure 8, with adequate pressure to prevent the opening of important interlocking circuits.

The relay mechanism is mounted in a steel framework called the cradle, and is a complete unit with all leads terminated at the inner blocks. This cradle is held firmly in the case with a latch at both top and bottom and by a guide pin at the back of the case. The connecting plug, besides making the electrical connections between the respective blocks of the cradle and case, also locks the latch in place. The cover, which is drawn to the case by thumbscrews, holds the connecting plugs in place. The target-reset mechanism is part of the cover assembly.

The relay case is suitable for either semi-flush or surface mounting on all panels up to two inches thick and appropriate hardware is available. However, panel thickness must be indicated on the relay requisition in order to make sure that proper hardware will be included.

A separate testing plug can be inserted in place of the connecting plug to test the relay in place on the panel, either from its own source of current and voltage, or from other sources. Or the relay can be drawn out and replaced by another that has been tested in the laboratory.

Figure 1A and 1B show the relay removed from its drawout case, with all major components identified. Symbols used to identify circuit components are the same as those that appear on the internal connection diagram in Figure 9.

The relay includes three similar mho subassembly elements mounted on the front of the cradle and a plate with transformers and transactors mounted on the back of the cradle.

The mho subassembly includes the four-pole unit and associated circuit components. Adjustable reactors X11, X12, X13, used in setting the angle of maximum torque, and rheostats R11, R12, R13, used in setting the basic minimum reach, can be adjusted from the front of the relay.

The transactors (TR-01-2, TR-02-3, TR-03-1) with their tap blocks are mounted on the back. The relay must be removed from its case to make the transactor (or minimum ohm) settings.

See Figure 8, Cross Section of Case and Cradle Block Showing Auxiliary Brush and Shorting Bar.

### RECEIVING, HANDLING AND STORAGE

These relays, when not included as part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of a relay, examine it for any damage sustained in transit. If injury or damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest General Electric Sales Office.

Reasonable care should be exercised in unpacking the relay in order that none of the parts are injured nor the adjustments disturbed.

If the relays are not to be installed immediately, they should be stored in their original cartons in a place that is free from moisture, dust and metallic chips. Foreign matter collected on the outside of the case may find its way inside when the cover is removed, and cause trouble in the operation of the relay.

### ACCEPTANCE TESTS

Immediately upon receipt of the relay, an inspection and acceptance test should be made to make sure that no damage has been sustained in shipment and that the relay calibrations have not been disturbed. If the examination or the test indicates that readjustment is necessary, refer to the section on **SERVICING**.

#### VISUAL INSPECTION

Check the nameplate stamping to make sure that the model number and rating of the relay agree with the requisition.

Remove the relay from its case and check that there are no broken or cracked molded parts or other signs of physical damage, and that all screws are tight.

#### MECHANICAL INSPECTION

1. It is recommended that the mechanical adjustments in Table VIII be checked.
2. There should be no noticeable friction in the rotating structure of the units.
3. Make sure control springs are not deformed and spring convolutions do not touch each other.
4. With the relay well-leveled in its upright position, the contacts of all three units must be open. The moving contacts of the units should rest against the backstop.
5. The armature and contacts of the seal-in unit should move freely when operated by hand. There should be at least 1/32 inch wipe on the seal-in contacts.
6. Check the location of the contact brushes on the cradle and case blocks against the internal connection diagram for the relay.

TABLE VIII

Check Points	MHO Units
Rotating Shaft End Play	0.010 - 0.015 inch
Contact Gap	0.030 - 0.035 inch
Contact Wipe	0.003 - 0.005 inch

ELECTRICAL CHECKS - MHO UNIT

Before any electrical checks are made on the mho units, the relay should be connected as shown in Figure 10 and be allowed to **warm up** for approximately 15 minutes with the potential circuit **alone** energized at rated voltage and the restraint taps set as shown in Table IX. The units were warmed up prior to factory adjustment, and if rechecked when cold will tend to underreach by 3% or 4%. Accurately-calibrated meters are of course essential for correct test results.

It is desirable to check the factory setting and calibrations by means of the tests described in the following sections. The mho units were carefully adjusted at the factory and it is not advisable to disturb these settings unless the following checks indicate **conclusively** that the settings have been disturbed. If readjustments are necessary, refer to the section on **SERVICING** for the recommended procedures.

(a) Control-Spring Adjustment

Be sure that the relay is level in its upright position. Leave the relay connected as shown in Figure 10 and position the restraint taps according to Table XII.

Use the following procedure in checking each unit. With the current set at 5 amperes and the voltage across the relay voltage studs at 120 volts, set the phase shifter so that the phase-angle meter reads the value shown in Table IX for the unit being tested; that is, so current lags voltage by an angle equal to the angle of maximum torque of the unit. Now reduce the voltage to the low test voltage of 2.0 volts, and reduce the current to about 2 amperes. Gradually increase the current until the contacts of the unit just close. This should occur between 2.7 and 3.3 amperes for the 1.5 ohm setting or 10.1 and 12.4 for the 0.4 ohm setting.

(b) Clutch Adjustment

The mho units include a high-set clutch between the cup-and-shaft assembly and the moving contact to prevent damage during heavy fault conditions. These clutches have been set at the factory to slip at approximately 40-60 grams applied tangentially at the moving contact. This can best be checked in the field in terms of volt-amperes by the following method.

Use the connections of Figure 10 and set the phase shifter so that the phase-angle meter reads 300° at 120 volts and 5 amperes. Disconnect the No. 1 restraint tap leads from the tap block and short to stud 16, then set the

mho units for 3-ohm basic minimum reach. With the voltage across the relay studs set at 120 volts, increase the current until the clutch just slips.

This should occur between 35 and 55 amperes.

On short range 0.375/1.5 ohms (or 0.2 ohms), set the tap in 1.5 (or 0.8 ohms); clutch must not slip below 60 amperes.

TABLE IX  
OHMIC REACH ADJUSTMENT TABLE

Unit Loca- tion	Unit	Reach Tap Ohms	Res- traint Tap	Connect Lead to Relay Studs as Follows				Jumper Relay Studs	Phase Angle Meter Reads	VA-B Set At	Pickup Amps
				Lead A	Lead B	Lead C	Lead D				
Top	ø1-2	1.5	100%	14-15	13-16-17	5	7	6-8-10	300°	45V	14.6-15.4
Middle	ø2-3	1.5	100%	13-16-17	18-19-20	7	9	6-8-10	300°	45V	14.6-15.4
Bottom	ø3-1	1.5	100%	18-19-20	14-15	9	5	6-8-10	300°	45V	14.6-15.4
Top	ø1-2	0.4	50%	14-15	13-16-17	5	7	6-8-10	300°	45V	27.3-29.0
Middle	ø2-3	0.4	50%	13-16-17	18-19-20	7	9	6-8-10	300°	45V	27.3-29.0
Bottom	ø3-1	0.4	50%	18-19-20	14-15	9	5	6-8-10	300°	45V	27.3-29.0
Top	ø1-2	3.0	100%	14-15	13-16-17	5	7	6-8-10	300°	90V	14.5-15.4
Middle	ø2-3	3.0	100%	13-16-17	18-19-20	7	9	6-8-10	300°	90V	14.5-15.4
Bottom	ø3-1	3.0	100%	18-19-20	14-15	9	5	6-8-10	300°	90V	14.5-15.4
Top	ø1-2	.75	100%	14-15	13-16-17	5	7	6-8-10	300°	45V	29.1-30.6
Middle	ø2-3	.75	100%	13-16-17	18-19-20	7	9	6-8-10	300°	45V	29.1-30.6
Bottom	ø3-1	.75	100%	18-19-20	14-15	9	5	6-8-10	300°	45V	29.1-30.6

(c) Ohmic Reach

With the relay still connected as shown in Figure 10, make connections shown in Table IX and set the phase shifter so that the phase-angle meter reads the angle shown in Table IX for the unit to be checked.

Now reduce the voltage to the value shown in Table IX and increase the current gradually until the normally-open contacts of the unit just close. This should occur within the pickup limits shown in Table IX. Note that the tap screws on the transactor tap blocks are set to the position which gives the basic minimum reach shown in the table.

Note that for the test conditions, the mho units see a phase-to-phase fault of twice the basic minimum reach.

The relays are normally shipped from the factory with the basic minimum reach adjustment taps of the units (on the back of the relay) in the intermediate

setting, that is, 1.5 ohms or 0.4 ohm (the value shown in Table IX). If the units are set on either of the remaining basic minimum reach taps, the basic reach of the units will be within  $\pm 4\%$  of the tap plate marking.

(d) Angle of Maximum Torque

For checking the angle of maximum torque the connections of Figure 10 will be used with the restraint tap leads, and the voltage, set at the value shown in the upper and lower portions, respectively, of Table X for the unit to be checked. The minimum reach taps should be set to the 1.5 ohm or 0.4 ohm position.

In checking the mho units the following procedure should be used. First set the phase shifter so that the phase-angle meter reads  $330^\circ$ . Note that while the phase angle is being set, the current should be 5 amperes and the voltage at 120 volts. Now set the voltage at the value shown in Table X, and increase the current slowly until the mho unit picks up. The pickup current should be within the limits shown in the table. Now reset the phase angle at  $270^\circ$  and again check the current required to pick up the mho unit. This current should fall within the same limits as for the  $330^\circ$  check.

Note that the two angles used in the previous check, i.e.,  $330^\circ$  and  $270^\circ$ , are  $30^\circ$  away from the angle of maximum torque. An examination of the mho unit impedance characteristic in Figure 6 shows that the ohmic reach of the unit should be the same at both  $330^\circ$  and  $270^\circ$  and should be 0.866 times the reach at the angle of maximum torque.

TABLE X  
ANGLE OF MAXIMUM TORQUE ADJUSTMENT TABLE

Unit Location	Unit	Reach Tap Ohms	Restraint Tap	Connect Leads to Relay Studs as Follows				Jumper Relay Studs	$\emptyset$ -Angle Meter Reading		V <sub>A-B</sub> Set At	Pickup Amps +
				Lead A	Lead B	Lead C	Lead D		Angle of Max. Torque	Test Angles		
Top	ø1-2	1.5	100%	14-15	13-16-17	5	7	6-8-10	$300^\circ$	330 & 270	45V	16.8 - 17.8
Middle	ø2-3	1.5	100%	13-16-17	18-19-20	7	9	6-8-10	$300^\circ$	330 & 270	45V	16.8 - 17.8
Bottom	ø3-1	1.5	100%	18-19-20	14-15	9	5	6-8-10	$300^\circ$	330 & 270	45V	16.8 - 17.8
Top	ø1-2	3.0	100%	14-15	13-16-17	5	7	6-8-10	$300^\circ$	330 & 270	90V	16.8 - 17.8
Middle	ø2-3	3.0	100%	13-16-17	18-19-20	7	9	6-8-10	$300^\circ$	330 & 270	90V	16.8 - 17.8
Bottom	ø3-1	3.0	100%	18-19-20	14-15	9	5	6-8-10	$300^\circ$	330 & 270	90V	16.8 - 17.8
Top	ø1-2	0.4	50%	14-15	13-16-17	5	7	6-8-10	$300^\circ$	330 & 270	45V	31.5 - 33.5
Middle	ø2-3	0.4	50%	13-16-17	18-19-20	7	9	6-8-10	$300^\circ$	330 & 270	45V	31.5 - 33.5
Bottom	ø3-1	0.4	50%	18-19-20	14-15	9	5	6-8-10	$300^\circ$	330 & 270	45V	31.5 - 33.5
Top	ø1-2	0.75	50%	14-15	13-16-17	5	7	6-8-10	$300^\circ$	330 & 270	45V	16.8 - 17.8
Middle	ø2-3	0.75	50%	13-16-17	18-19-20	7	9	6-8-10	$300^\circ$	330 & 270	45V	16.8 - 17.8
Bottom	ø3-1	0.75	50%	18-19-20	14-15	9	5	6-8-10	$300^\circ$	330 & 270	45V	16.8 - 17.8

+ Pickup amps should be as close to equal as possible for the 330o & 270o tests.

ELECTRICAL TESTS - TARGET SEAL-IN

The target seal-in unit has an operating coil tapped at either 0.6 and 2.0 amperes, 0.2 and 2.0 amperes, or 0.2 and 0.6 amperes.

The relay is shipped from the factory with the tap screw in the lower ampere position. The operating point of the seal-in unit can be checked by connecting from DC source (+) to stud 11 of the relay and from stud 1 through an adjustable resistor and ammeter back to (-). Connect a jumper from stud 12 to stud 11 also, so that the seal-in contact will protect the mho unit contacts. Then close the mho unit contact by hand and increase the DC current until the seal-in unit operates. It should pick up at tap value or slightly lower. Do **not** attempt to interrupt the DC current by means of the mho contacts.

**INSTALLATION PROCEDURE**LOCATION

The location of the relay should be clean and dry, free from dust, excessive heat and vibration, and should be well lighted to facilitate inspection and testing.

MOUNTING

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

CONNECTIONS

The internal connections of the CEY51A relay are shown in Figure 9. An elementary diagram of typical external connections is shown in Figure 3.

VISUAL INSPECTION

Remove the relay from its case and check that there are no broken or cracked component parts and that all screws are tight.

MECHANICAL INSPECTION

Recheck the six adjustments mentioned under MECHANICAL INSPECTION in the section on **ACCEPTANCE TESTS**.

PORTABLE TEST EQUIPMENT

To eliminate the errors that may result from instrument inaccuracies, and to permit testing the mho units from a single-phase AC test source, the test circuit shown in schematic form in Figure 12 is recommended. In this figure  $R_S + jX_S$  is the source impedance, SF is the fault switch, and  $R_L + jX_L$  is the impedance of the line section for which the relay is being tested. The autotransformer TA, which is across the fault switch and line impedance, is tapped in 10% and 1% steps so that the line impedance  $R_L + jX_L$  may be made to appear to the relay very

nearly the same as the actual line on which the relay is to be used. This is necessary since it is not feasible to provide the portable test reactor  $X_L$  and the test resistor with enough taps so that the combination may be made to match any line.

For convenience in field testing, the fault switch and tapped autotransformer of Figure 12 have been arranged in a portable test box, Catalog No. 102L201, which is particularly adapted for testing directional and distance relays. The box is provided with terminals to which the relay current and potential circuits, as well as the line and source impedances, may be readily connected. For a complete description of the test box, the user is referred to GET-3474.

### ELECTRICAL TESTS ON THE MHO UNITS

The manner in which reach settings are made for the mho units is briefly discussed in the **CALCULATION OF SETTINGS** section. Examples of calculations for typical settings are given in that section. It is the purpose of the electrical tests in this section to check the ohmic pickup of the mho units at the settings that have been made for a particular line section.

To check the calibration of the mho units it is suggested that the portable test box, Catalog No. 102L201; portable test reactor, Catalog No. 6054975; and test resistor, Catalog No. 6158546, be arranged with Type XLA test plugs according to Figure 13. These connections of the test box and other equipment are similar to the schematic connections shown in Figure 12, except that the Type XLA test plug connections are now included.

Use of the source impedance  $R_S + jX_S$ , simulating the conditions that would be encountered in practice, is necessary only if the relay is to be tested for overreach or contact coordination which are not normally considered necessary at the time of installation or during periodic testing. Some impedance will usually be necessary in the source connection to limit current in the fault circuit to a reasonable value, especially when a unit with a short reach setting is to be checked, and it is suggested that a reactor of suitable value be used for this purpose since this will tend to limit harmonics in the fault current.

Since the reactance of the test reactor may be very accurately determined from its calibration curve, it is desirable to check mho unit pickup with the fault reactor alone, due account being taken of the angular difference between the line reactance,  $X_L$ , and mho-unit angle of maximum reach. The line reactance  $X_L$  selected should be the test-reactor tap nearest above twice the mho-unit phase-to-neutral reach, with account being taken of the difference in angle of the test-reactor tap impedance and unit angle of maximum reach. From Figure 11 it is seen that twice the relay reach of the angle of the test reactor impedance is:

$$2Z \text{ Relay} = 200 \times \frac{Z \text{ Min.}}{\text{Tap Setting \%}} \times \text{Cos } (\emptyset - \theta)$$

where:

- $\emptyset$  = the angle of the test reactor impedance
- $\theta$  = mho unit angle of maximum reach
- Z Min = Basic minimum reach of mho units

To illustrate by an example let us consider the percent tap required on the test box autotransformer for a unit that has been factory adjusted to pick up at 3 ohms minimum and at a maximum torque angle of 60°. In determining the reactor tap setting to use, it may be assumed that the angle ( $\theta$ ) of the test reactor impedance is 80°. From the above, twice the relay reach at the angle of the test-reactor impedance is:

$$2Z \text{ relay} = 200 \times \frac{3}{100} \cos (80 - 60) = 5.64 \text{ ohms}$$

Therefore, use the reactor 6-ohm tap. Twice the relay reach at the angle of test-reactor impedance should be recalculated, using the actual angle of the reactor tap impedance rather than the assumed 80°. Table XI shows the angles for each of the reactor taps.

TABLE XI

TAP	ANGLE	COS $\theta-60$
24	88	0.883
12	87	0.891
6	86	0.899
3	85	0.906
2	83	0.921
1	81	0.934
0.5	78	0.951

From Table XI it is seen that the angle of the impedance of the 6-ohm tap is 86°. Therefore:

$$2Z \text{ relay} = 200 \times \frac{3}{100} \cos (86-60) = 5.4 \text{ ohms}$$

The calibration curve for the portable test reactor should again be referred to in order to determine the exact reactance of the 6-ohm tap at the current level being used. For the purpose of this illustration assume that the reactance is 6.1 ohms. Since the angle of the impedance of the 6-ohm tap is 86°, the impedance of this tap may be calculated as follows:

$$Z_L = \frac{XL}{\sin 86} + \frac{6.1}{0.9976} = 6.115$$

From this calculation it is seen that the reactance and the impedance may be assumed the same for this particular reactor tap. Actually the difference need only be taken into account on the reactor 3, 2, 1 and 0.5 ohm taps.

The test-box-autotransformer-tap setting required to close the mho-unit contacts with the fault switch closed is:

$$\% = \frac{5.4}{6.1} (100) = 88.5\% \text{ (use 88\% tap)}$$

Figure 7 should be checked to determine that the test current to be used is high enough to produce a characteristic at the calculated value.

If the ohmic pickup of the mho unit checks correctly according to the above, the chances are that the angle of the characteristic is correct. The angle may, however, be very easily checked by using the calibrated test resistor in combination with various reactor taps. The calibrated test-resistor taps are pre-set in such a manner that when used with the 12- and 6-ohm taps of the specified test reactor, impedances at 600 and 300 respectively will be available for checking the mho-unit reach at the 600 and 300 positions. The mho-unit ohmic reach at the zero-degree (00) position may be checked by using the calibrated test resistor alone as the line impedance. The calibrated test resistor is supplied with a data sheet that gives the exact impedance and angle for each of the combinations available. The test-box auto-transformer percent tap for pickup at a particular angle is given by:

$$\% \text{ Tap} = \frac{200 Z \text{ MIN } \cos (\phi - \theta)}{Z_L (\text{Tap Setting } \%)} \quad (100)$$

where  $\theta$  is the angle of maximum torque of the unit,  $\phi$  is the angle of the test impedance ( $Z_L$ ),  $Z$  is the 600, 300 or 00 impedance value taken from the calibrated resistor data sheet. As in the case of the previous tests, the load box that serves as the source impedance should be adjusted to allow approximately 10 amperes to flow in the fault circuit when the fault switch is closed.

When checking the mho unit at angles of more than 300 off the maximum reach position, the error becomes relatively large with phase-angle error. This is apparent from Figure 11 where it is seen, for example at the zero-degree position, that a 20 or 30 error in phase angle will cause a considerable apparent error in reach.

### OVERALL TESTS

An overall check of current transformer polarities, and connections to the relay, can be made on the complete installation by means of the test connections and tabulation in Figure 13. A check of the phase angle meter readings in the table for power factor angle and phase sequence involved will indicate whether the relay is receiving the correct voltage and currents for the conventional connections shown in Figure 3.

### INSPECTION

Before placing a relay into service, the following mechanical adjustments should be checked, and faulty conditions corrected according to instructions in the ADJUSTMENTS subsection of this section or under the MAINTENANCE section.

### TARGET AND SEAL-IN UNITS

The armature and contacts of the target and seal-in units should operate freely by hand.

There should be a screw in only one of the taps on the right-hand contact of the target and seal-in unit.

The target should reset promptly when the reset button at the bottom of the cover is operated, with the cover on the relay.

### MHO UNITS

There should be no noticeable friction in the rotating structure of the mho unit. The mho unit moving contact should just return to the backstop when the relay is de-energized and in the vertical position.

There should be approximately 0.010 - 0.015 inch end play in the shafts of the rotating structures. The lower jewel screw bearing should be screwed firmly into place and the top pivot locked in place by its set screw.

If there is reason to believe that the jewel is cracked or dirty, the screw assembly can be removed from the bottom of the unit and examined. When replacing a jewel, have the top pivot engaged in the shaft while screwing in the jewel screw.

All nuts and screws should be tight, with particular attention paid to the tap plugs.

The felt gasket on the cover should be securely cemented in place in order to keep out dust.

Determine the impedance and phase angle seen by the relays. Knowing the impedance and phase angle seen by the relay, the tap value at which the relay will just operate can be calculated. It is then only necessary to reduce the tap setting of the relay until the mho units operate, and see how close the actual tap value found checks with the calculated value. The calculated value should take into account the shorter reach of the mho unit at low currents. This effect is shown in Figure 2.

A shorter test that will check for most of the possible open circuits in the AC portion of the relay can be accomplished by disconnecting the current circuits. This can be done by removing the lower connection plug. All units should have strong torque to the right when full voltage is applied.

Replace the lower plug and open the restraint taps. All units should operate if power and reactive flow are away from the station bus and into the protected line section. If the direction of reactive power flow is into the station bus, the resultant phase angle may be such that the units will not operate.

### 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 once a year.

### CONTACT CLEANING

For cleaning fine silver 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 ensures the cleaning of the actual points of contact. Do not use knives, files, abrasive paper or cloth of any kind to clean relay contacts.

### SERVICING

If it is found during the installation or periodic tests that the mho unit calibrations are out of limits, they should be recalibrated as outlined in the following paragraphs. It is suggested that these calibrations be made in the laboratory. The circuit components listed below, which are normally considered as factory adjustments, are used in recalibrating the units. These parts may be physically located from Figure 1A and 1B. Their locations in the relay circuit are shown in the internal connection diagrams of Figure 9.

- R11 -  $\emptyset$ 1-2 Unit ohmic reach adjustment
- X11 -  $\emptyset$ 1-2 Unit angle of maximum torque adjustment
- R12 -  $\emptyset$ 2-3 Unit ohmic reach adjustment
- X12 -  $\emptyset$ 2-3 Unit angle of maximum torque adjustment
- R13 -  $\emptyset$ 3-1 Unit ohmic reach adjustment
- X13 -  $\emptyset$ 3-1 Unit angle of maximum torque adjustment

**NOTE:** Before making pickup or phase-angle adjustments on the mho units, the units should be allowed to **heat** up for approximately 15 minutes energized with **rated voltage** alone and the restraint tap leads set for **100%**. Also it is important that the relay be mounted in an **upright** position so that the units are level.

### CONTROL SPRING ADJUSTMENTS

Make connections to the relay as shown in Figure 10. Set the restraint-tap leads and the basic-reach taps as shown in Table IX. Make sure that the relay is in an upright position so that the units are level. With the current set at 5 amperes and the voltage  $V_{A-B}$  at 120 volts, set the phase shifter so that the phase-angle meter reads the value shown in Table XII.

Now reduce the voltage to the test voltage value and set the current at the value shown in Table XII for the unit being adjusted. Insert the blade of a thin screwdriver into one of the slots in the edge of the spring-adjusting ring and turn the ring until the contacts of the unit just close. If the contacts were closing below the set point shown in Table XII, the adjusting ring should be turned to the right. If they were closing above the set point, the adjusting ring should be turned to the left.

With restraint tap settings and connections as per Table XIV, set the phase shifter so that the phase-angle meter reads 315°, set VAB to 45 volts and the current to pickup amperes. Adjust the appropriate reactor so that the unit just picks up. Now check the pickup current at 255°. The pickup current at both test angles should be within  $\pm 2\%$  of the value listed in the table. After the setting is made make sure the reactor lock nuts are tight.

DIRECTIONAL CHECK

With the relay connected per Figure 10, and restraint taps in 100%, allow the relay to preheat for approximately 15 minutes at rated voltage.

Set the phase-angle meter at the angle of maximum torque and reduce the voltage to 2 volts. The relay contact must close over the range of 6-60 amperes.

With the potential circuit short-circuited on itself, the contacts must remain open over the range of 0-30 amperes.

Should the MB unit fail to pass either test, the core must be adjusted. The core and coil assembly is shown in Figure 1?.

By use of a special wrench (0178A9455 Pt.1) the core may be rotated 360° in either direction without having either to hold nut "F" or to retighten any parts after the final position of the core has been determined.

The final position of the core is that position where the unit passes both the above directional check tests.

**RENEWAL PARTS**

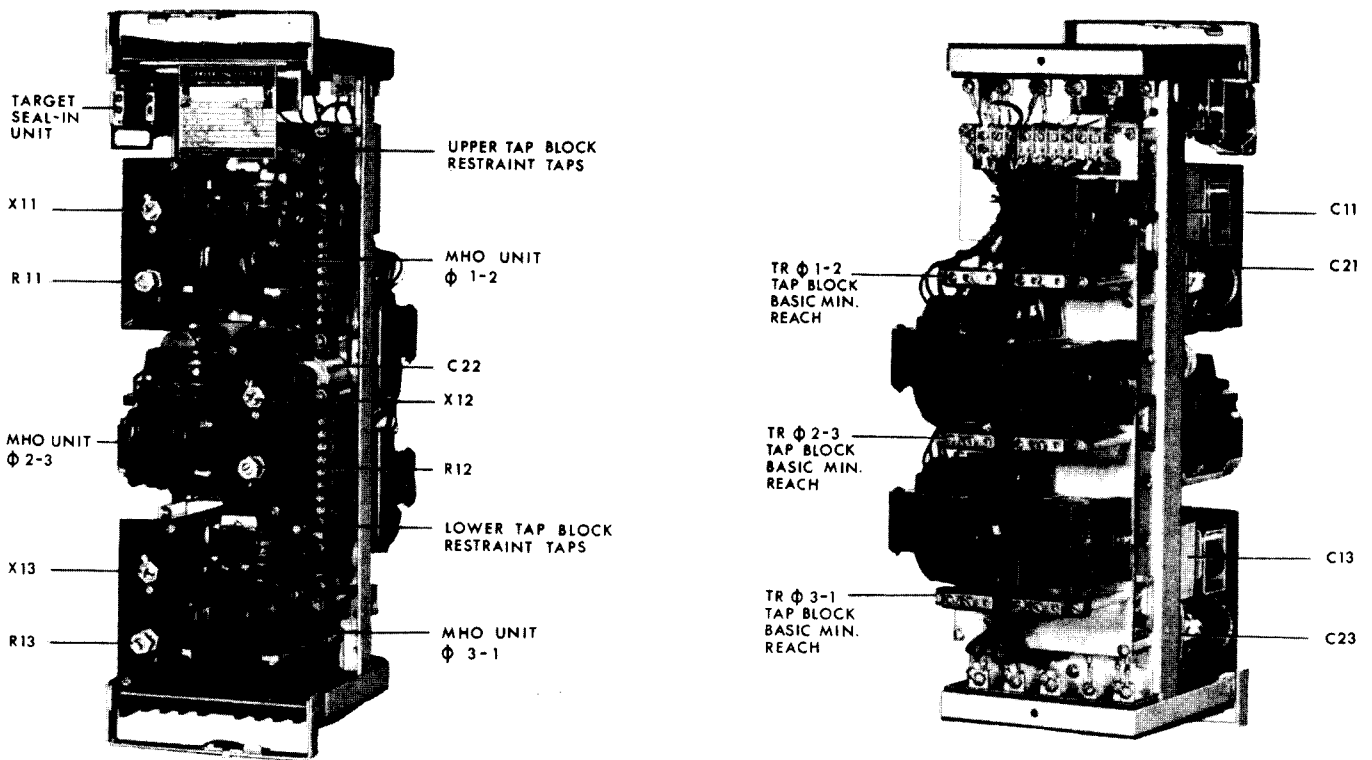
It is recommended that sufficient quantities of renewal parts be carried in stock to enable the prompt replacement of any that are worn, broken or damaged.

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

LIST OF FIGURES

- Figure 1 MHO Distance Relay Type CEY51A A. Front View (8036549) B. Back View (8036550)
- Figure 2 (0195A4989-2) Steady-State and Dynamic-Reach Curves for MHO Unit in the CEY51A Relay
- Figure 3 (0116B9309-5) Typical External-Connection Diagram for the CEY51A Relay
- Figure 4 (0195A4986-1) Schematic Connections of MHO Units in the CEY51A Relay (Top View)
- Figure 5 (0195A4987) Graphical Representation of MHO-Unit Operating Principle
- Figure 6 (0195A4988) Steady-State Impedance Characteristic of the MHO Unit in the CEY51A Relay
- Figure 7 (0195A4990-1) Average-Operating-Time Curves of the MHO Unit in the CEY51A Relay
- Figure 8 (8025039) Cross Section of Case and Cradle Block, Showing Auxiliary Brush and Shorting Bar
- Figure 9 (0178A7132-1) Internal-Connection Diagram of the CEY51A Relay (Front View)
- Figure 10 (0195A4991-1) Test Connections for Checking the Correct MHO-Unit Operation
- Figure 11 (0195A4492) Diagram Showing Reach of the MHO Units at Angle of Test Reactor
- Figure 12 (0195A4994) MHO-Unit Test Connections
- Figure 13 (0195A4993 [1]) Overall Test Connections for Checking of External Wiring to Relay
- Figure 14 (0178A7336-4) Outline and Panel-Drilling Dimensions for Relay Type CEY51A

Since the last edition, Tables IX, X, XII, XIII, and XIV have been expanded, and Figures 3 and 14 have been clarified. The drawing number of Figure 11 has been corrected.



A. Front View (8036549)

B. Back View (8036550)

Figure 1 MHO Distance Relay Type CEY51A

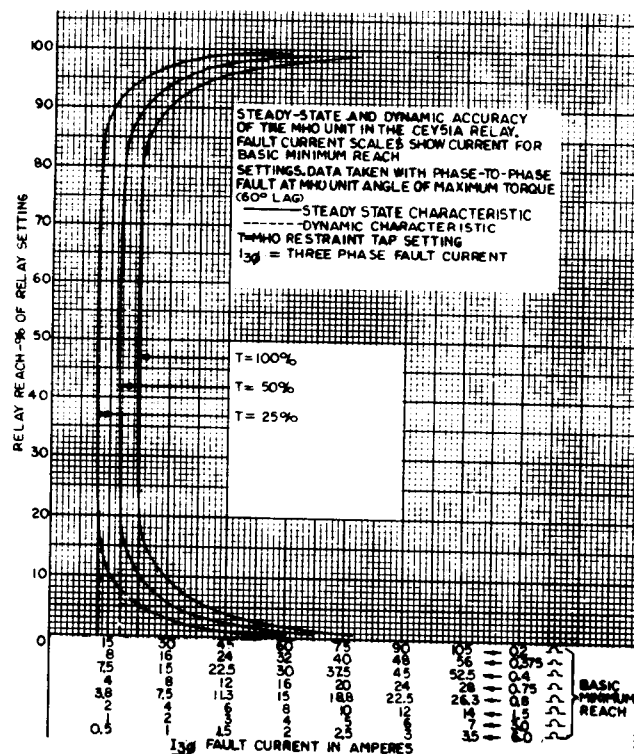
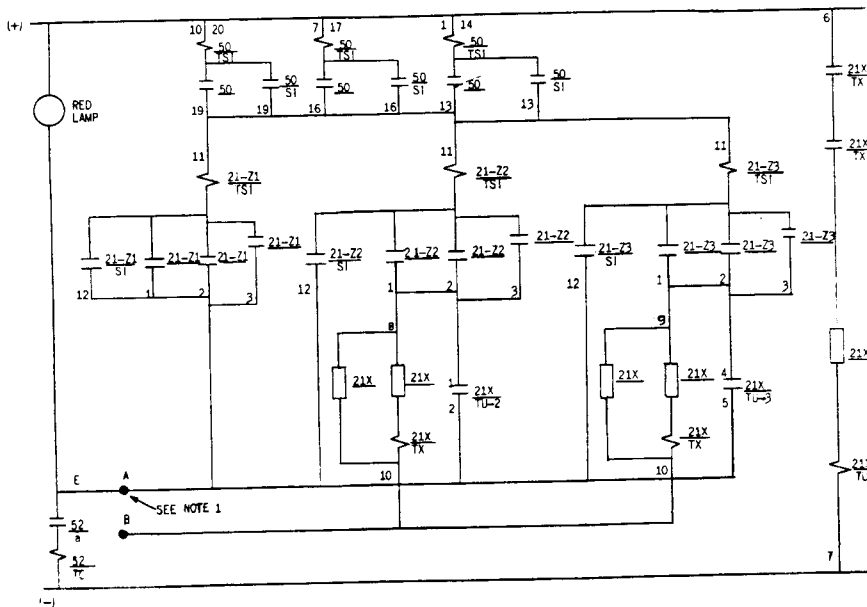
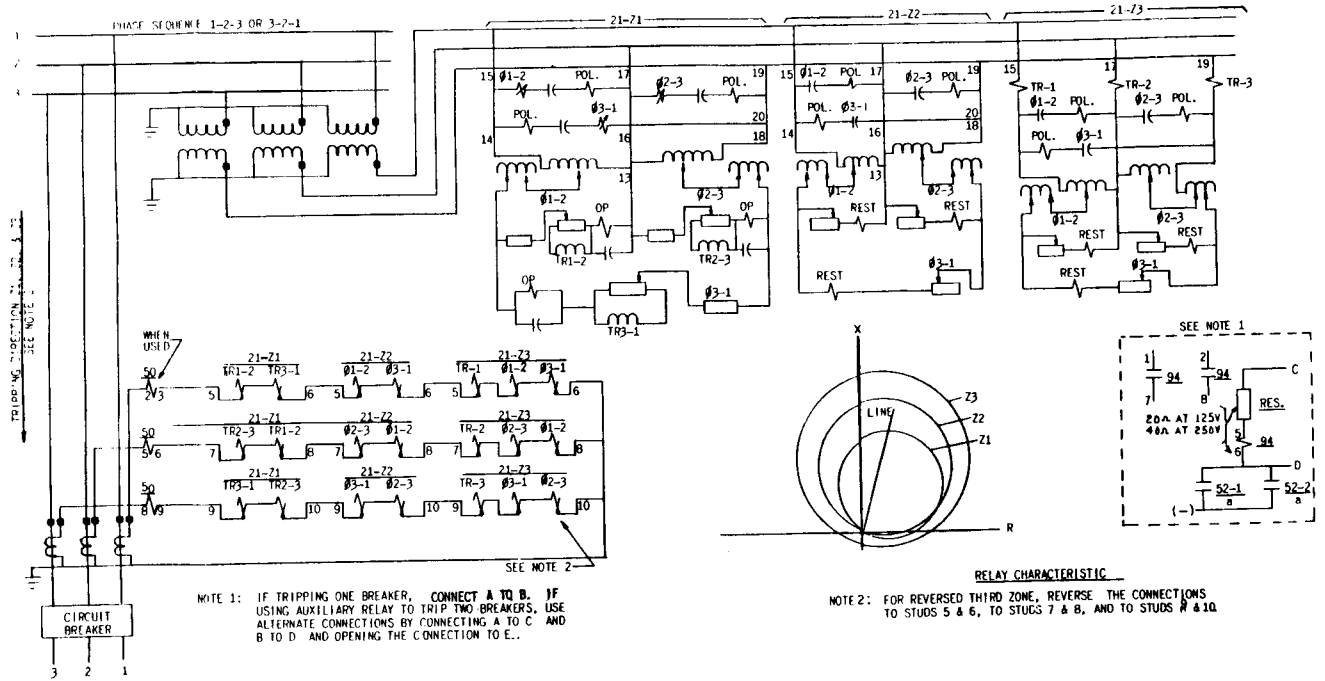


Figure 2 (0195A4989-2) Steady-State and Dynamic-Reach Curves for MHO Unit in the CEY51A Relay



LEGEND

DEVICE NO.	DEVICE TYPE	INCL. ELEM.	DESCRIPTION
21-21	CEY51A	3	PHASE-1ST ZONE WMO RELAY
		4	PHASE 1-2 UNIT ETC.
		TR-1	PHASE 1-2 TRANSACTOR ETC.
		T & S1	TARGET & SEAL-IN UNIT
21-22	CEY52A	3	PHASE-2ND ZONE WMO RELAY
		4	PHASE 1-2 UNIT ETC.
		T & S1	TARGET & SEAL-IN UNIT
21-23	CEY52A	3	PHASE-3RD ZONE OFFSET WMO RELAY
		4	PHASE 1-2 UNIT ETC.
		TR-1	PHASE 1 TRANSACTOR ETC.
		T & S1	TARGET & SEAL-IN UNIT
21X	RPM210		TIMING RELAY
		TU	TIMING UNIT
		TX	AUXILIARY TO TIMING UNIT
50	PJC31C		INSTANTANEOUS PHASE FAULT DET.
		T & S1	TARGET & SEAL-IN UNIT
94	HGA14		AUXILIARY TRIPPING RELAY

TABULATION OF DEVICES

TYPE OR DESCRIPTION	INTERNAL CONNS.	OUTLINE
CEY51A	0178A7132	0168A7336
CEY52A	0178A7133	0178A7336
CEY52A	0178A7134	0178A7336
RPM210	0127A9440	K-6209271
PJC31C	K-6375726	K-6209272
HGA14AM (BACK CONNS.)	K-8400533	K-8400533
HGA14AL (FRONT CONNS.)	377A139	377A139

Figure 3 (0116B9309-5) Typical External-Connection the CEY51A Relay

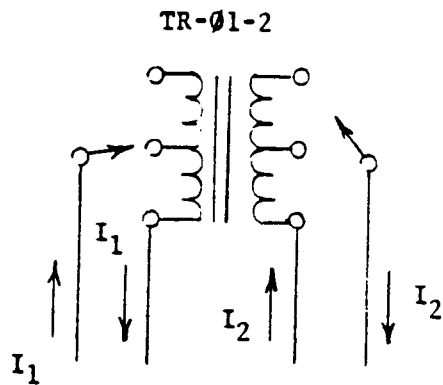
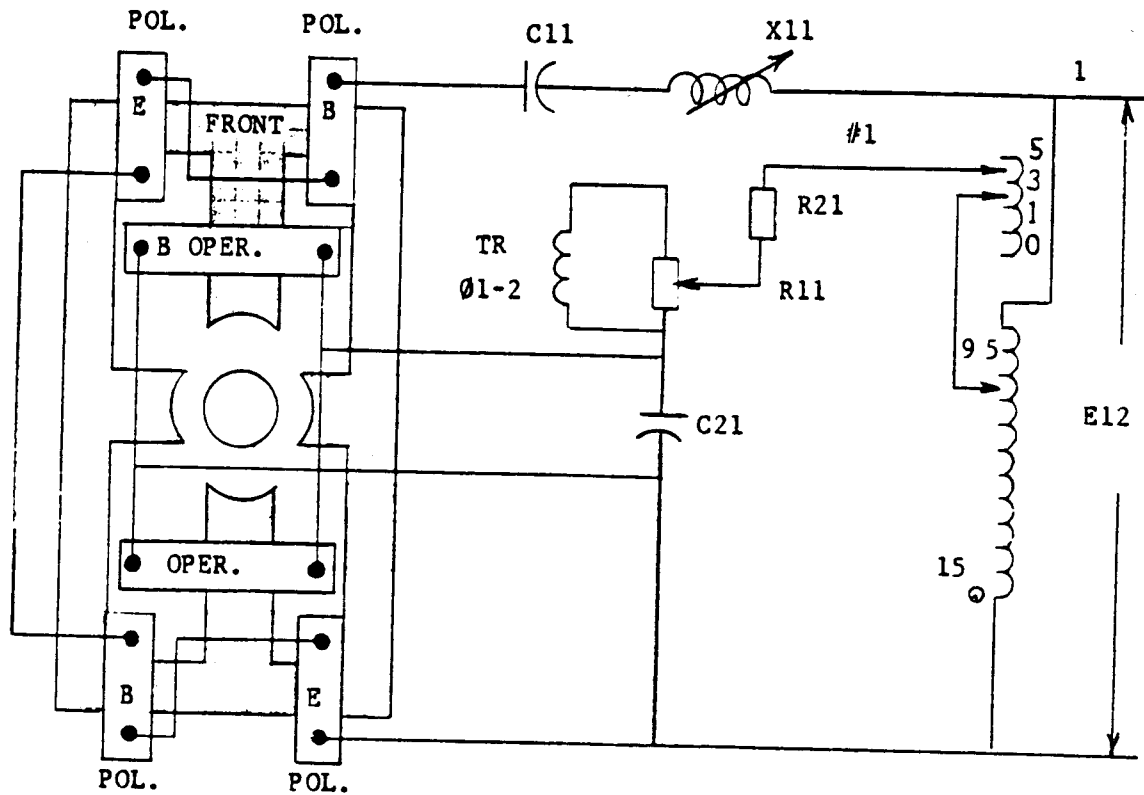


Figure 4 (0195A4986-1) Schematic Connections of MHO Units in the CEY51A Relay (Top View)

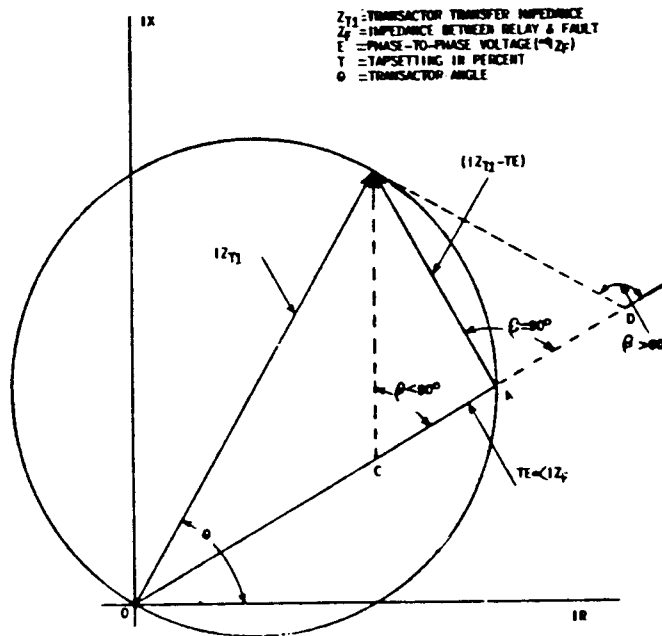


Figure 5 (0195A4987) Graphical Representation of MHO-Unit Operating Principle

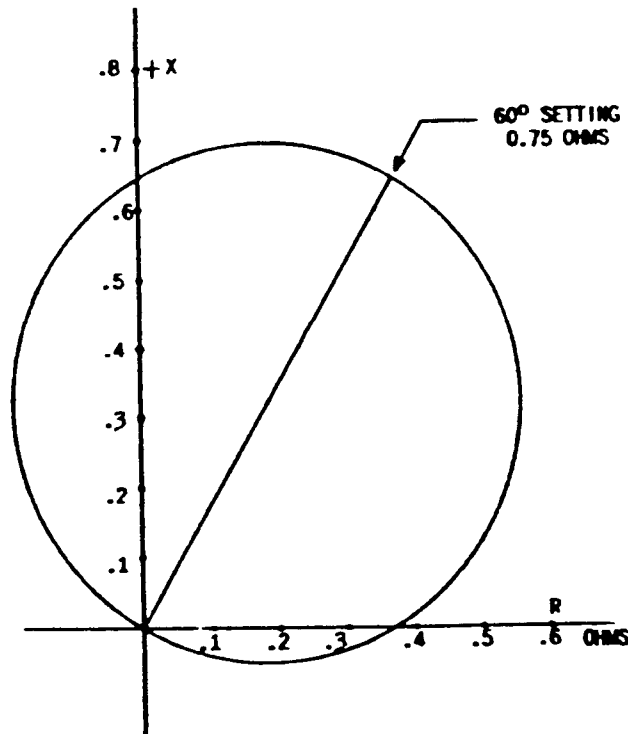


Figure 6 (0195A4988) Steady-State Impedance Characteristic of the MHO Unit in the CEY51A Relay

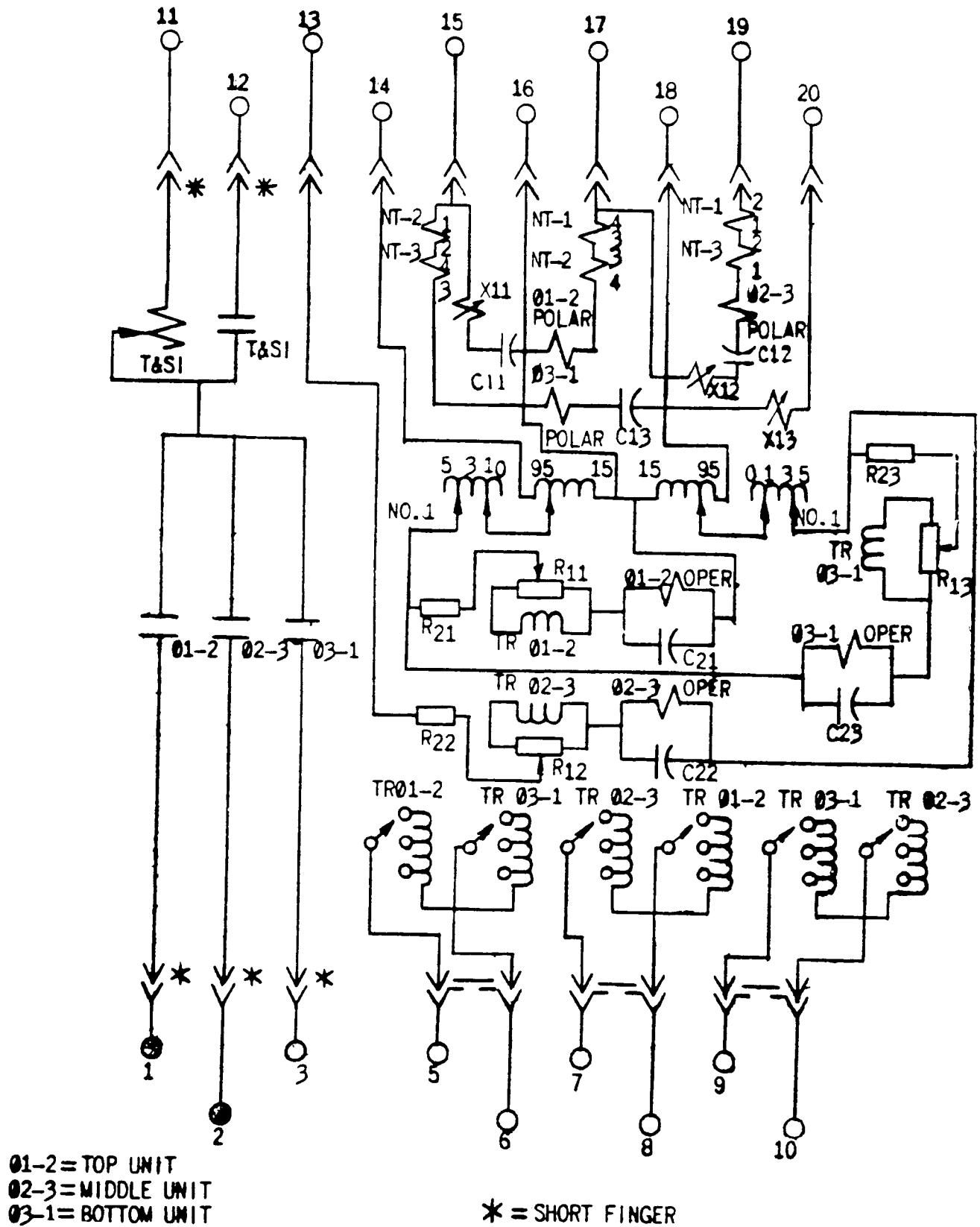
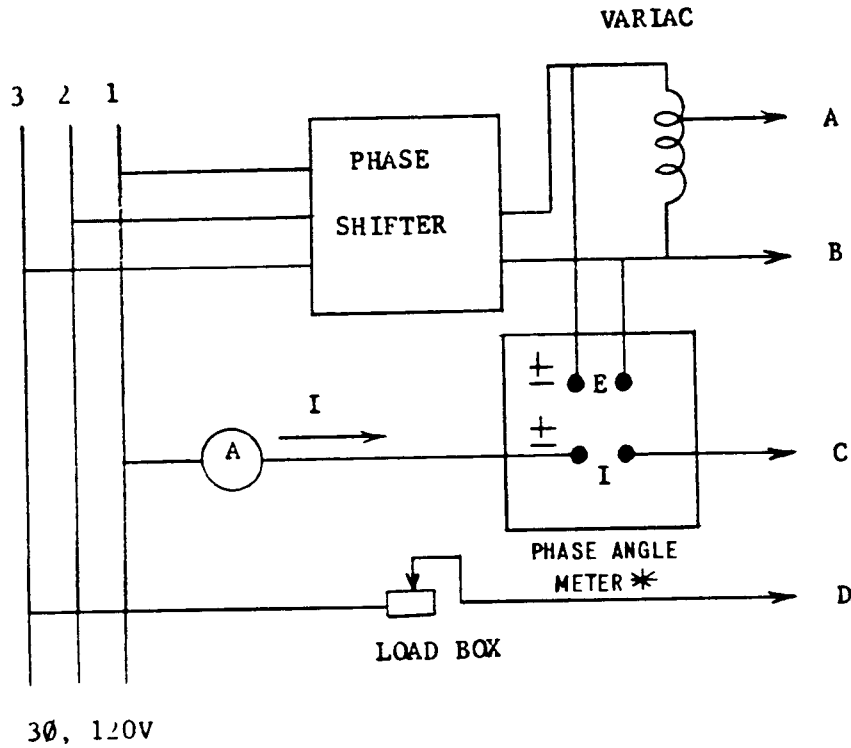


Figure 9 (0178A7132-1) Internal-Connection Diagram of the CEY51A Relay (Front View)



\* = PHASE ANGLE METER READS THE ANGLE THAT THE CURRENT LEADS THE VOLTAGE.

UNIT LOCATION	UNIT	CONNECT LEAD TO RELAY STUDS AS FOLLOWS				JUMPER RELAY STUDS
		LEAD A	LEAD B	LEAD C	LEAD D	
TOP	01-2	14-15	13-16-17	5	7	6-8-10
MIDDLE	02-3	13-16-17	18-19-20	7	9	6-8-10
BOTTOM	03-1	18-19-20	14-15	9	5	6-8-10

Figure 10 (0195A4991-1) Test Connections for Checking the Correct MHO-Unit Operation

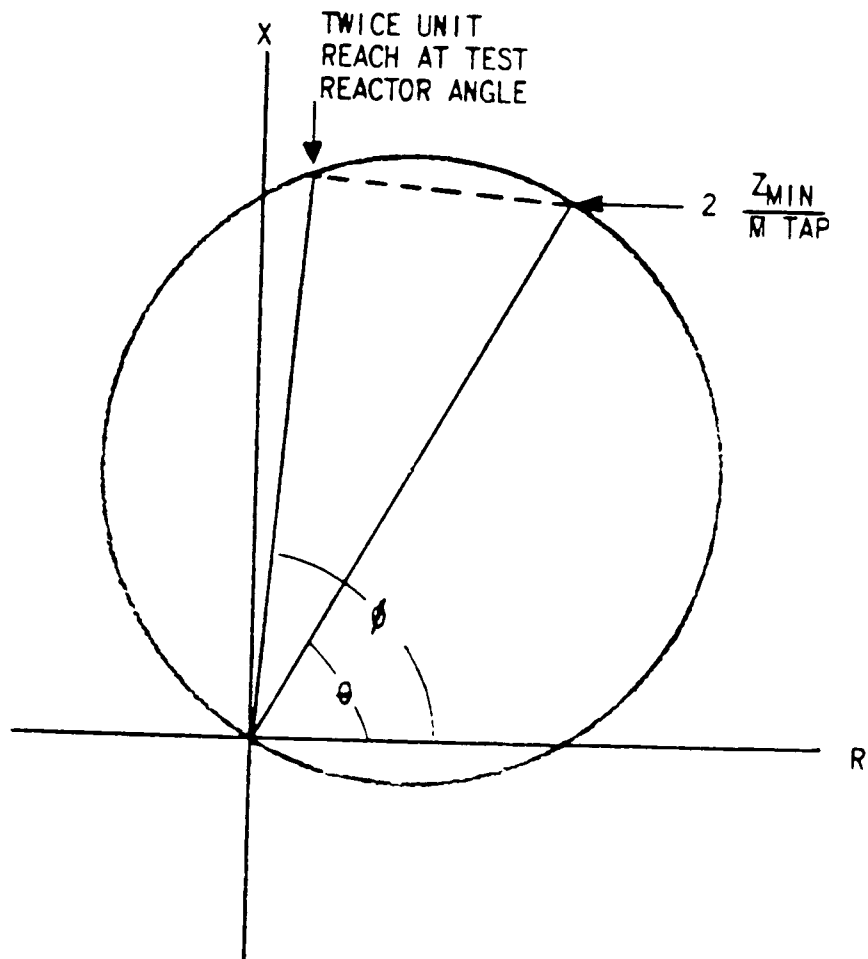
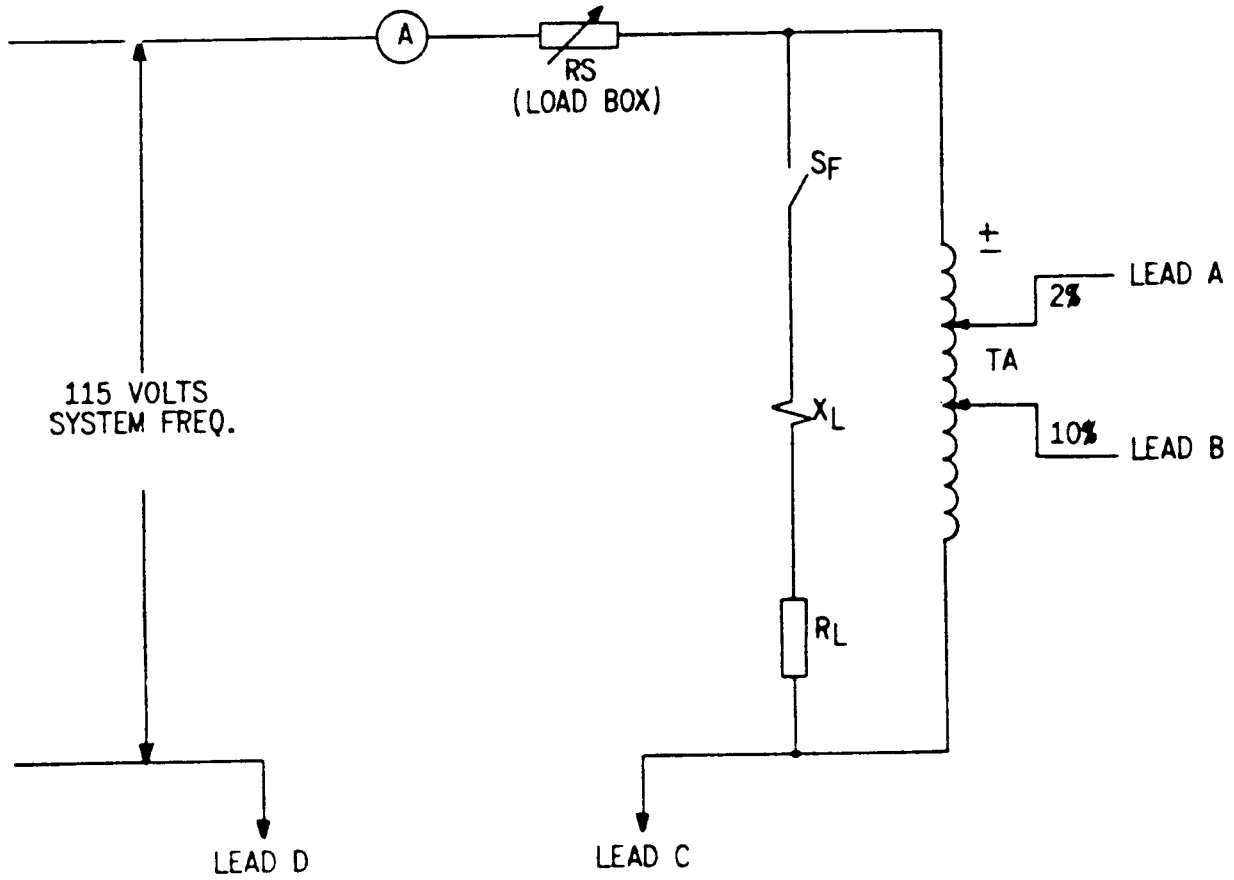
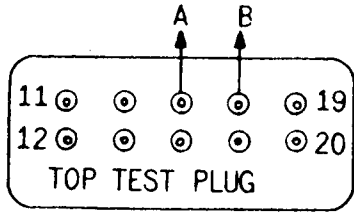


Figure 11 (0195A4992) Diagram Showing Reach of the MHO Units at Angle of Test Reactor

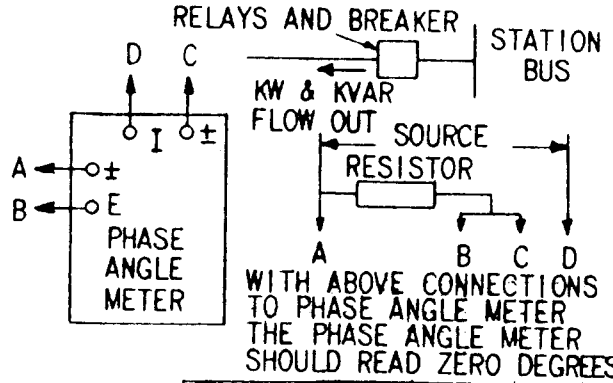


UNIT LOCATION	UNIT	CONNECT LEAD TO RELAY STUDS AS FOLLOWS				JUMPER RELAY STUDS
		LEAD A	LEAD B	LEAD C	LEAD D	
TOP	Ø 1-2	14-15	13-16-17	5	7	6-8-10
MIDDLE	Ø 2-3	13-16-17	18-19-20	7	9	6-8-10
BOTTOM	Ø 3-1	18-19-20	14-15	9	5	6-8-10

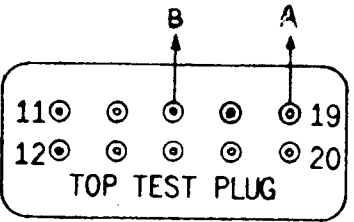
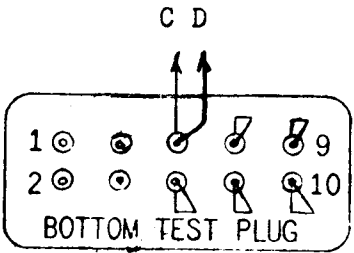
Figure 12 (0195A4994) Mho-Unit Test Connections



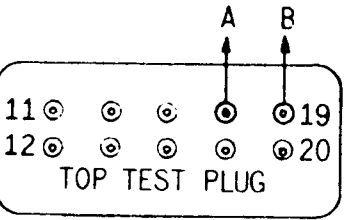
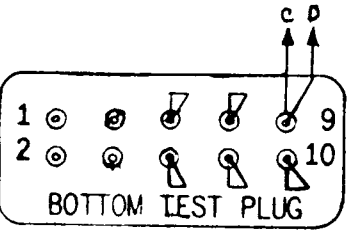
(a)  
CONNECTIONS TO PHASE ANGLE METER TO CHECK PHASE 1 CURRENT AND PHASE 1-2 VOLTAGE.



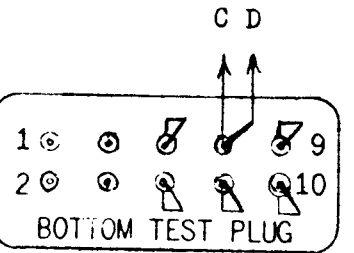
WITH ABOVE CONNECTIONS TO PHASE ANGLE METER THE PHASE ANGLE METER SHOULD READ ZERO DEGREES



(b)  
CONNECTIONS TO PHASE ANGLE METER TO CHECK PHASE 3 CURRENT AND PHASE 3-1 VOLTAGE.



(c)  
CONNECTIONS TO PHASE ANGLE METER TO CHECK PHASE 2 CURRENT AND PHASE 2-3 VOLTAGE.



POWER FACTOR ANGLE (DEGREES LEAD)	0-45		45-90		90-135		135-180		180-225		225-270		270-315		315-360	
	KW OUT	KVAR IN	KVAR IN	KW IN	KW IN	KVAR IN	KVAR IN	KW IN	KVAR IN	KVAR IN	KW IN	KVAR IN	KW OUT	KVAR OUT	KW OUT	KVAR OUT
PHASE SEQUENCE	30-15	15-60	60-105	105-150	150-195	195-240	240-285	285-330	330-15	15-60	60-105	105-150	150-195	195-240	240-285	285-330
(a) 1-2-3	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30
(b) 1-2-3	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30
(c) 1-2-3	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30

Figure 13 (0195A4993 [1]) Overall Test Connections for Checking of External Wiring to Relay

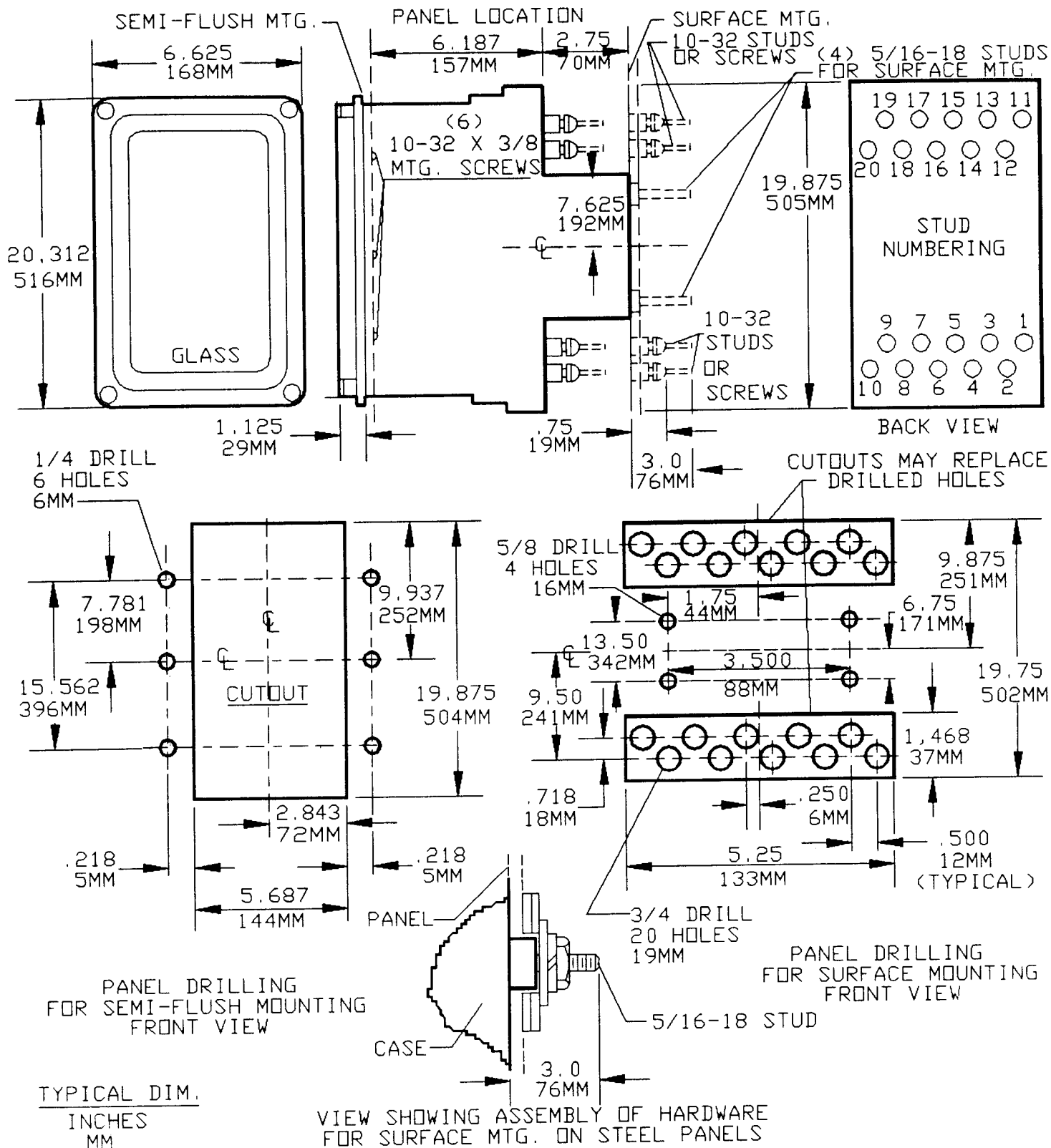


Figure 14 (0178A7336 [6]) Outline and Panel-Drilling Dimensions for Relay Type CEY51A

## ***Protection and Control***

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(1/95) (1000)

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