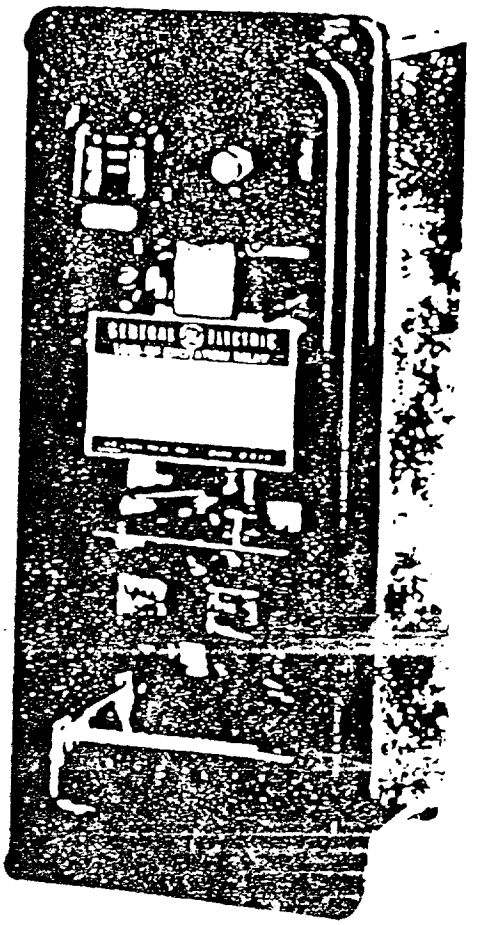
INSTRUCTIONS

GEI-31017L

SUPERSEDES GEI-31

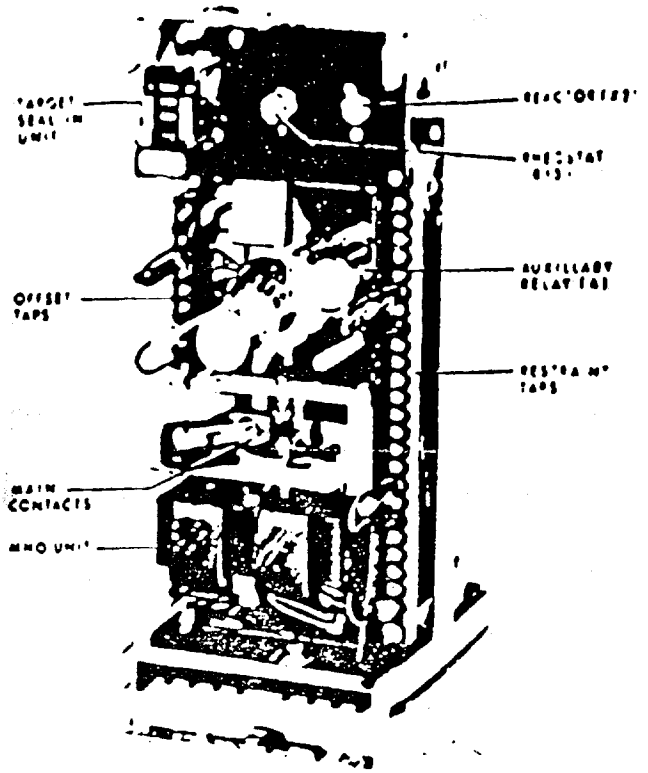
LOSS-OF-EXCITATION RELAY



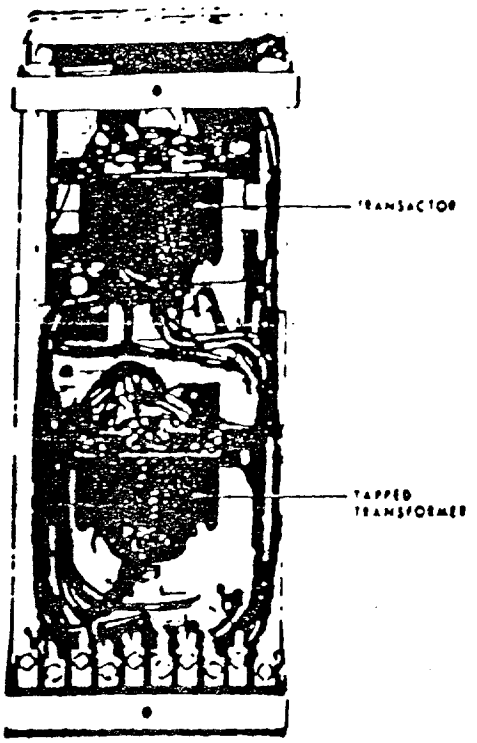
Type CEH11A3 and Up

POWER SYSTEMS MANAGEMENT DEPARTMENT

GENERAL ELECTRIC



(Front View)



(Rear View)

Fig. 1 (8034543 & 8034542) Type CEH11A Relay Removed From Case

* Denotes change since superseded issue.

LOSS-OF-EXCITATION RELAY
TYPE CEH11A

INTRODUCTION

The Type CEH11A relay is a single-phase offset mho type relay, which operates on the induction cylinder principle, providing a high steady torque acting on low inertia parts.

APPLICATION

This relay is designed to detect the loss of excitation of synchronous generators. It has sufficient selectivity not to function during system short circuits. With the suggested settings as detailed in the OPERATING CHARACTERISTICS section, the shape and location of the relay characteristics are such that maximum possible selectivity is provided against operation during power swings or loss of synchronism.

RATINGS

Two ratings are available, 115 volts, 5 amperes, 50 or 60 cycles. The basic range of the ohmic adjustment is 5 to 50 ohms, phase-to-neutral. This relay is provided with a transactor that has steps of 0, 0.5, 1.0, 2.5, and 4 ohms offset taps with two input leads to the transactor tap block. These two leads can be varied to obtain any ohmic offset up to 4 ohms in 0.5 ohm steps.

• The one second thermal rating for this relay is 150 amperes.

BURDENS

Because of the presence of a transactor in the relay, the burdens imposed upon the current and potential transformers are not constant, but vary somewhat with the ohmic reach, amount of offset, and amount and phase angle of the current.

CURRENT CIRCUITS

The maximum 60 cycle burden imposed on each current transformer is:

R	X	Z
0.33	0.46	0.56

The current burden was measured under phase-to-phase fault conditions which yield higher burden readings than balanced three-phase conditions. Also any other change caused by different conditions of offset will cause the burden to be less than indicated.

POTENTIAL BURDEN

The maximum potential burden at 115 volts, 5 amperes, 60 cycles is:

Watts	Vars	Volt-Amps
12.6	14.9	19.4

The potential burden will decrease as the restraint tap is decreased. The maximum burden, given above occurs with a restraint tap setting of 100 percent. The potential burden will also depend upon the angle between the voltage and current applied to the relay. Maximum potential burden occurs when the current ($I_1 - I_3$) lags the voltage (V_{1-3}) by 90 degrees (generator at zero P. F. overexcited).

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 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 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.

• Denotes change since superseded issue.

DESCRIPTION

The main unit of the CEH11A relay is an offset mho unit, i.e., it has a circular impedance characteristic on an R-X diagram (Fig. 4), similar to that of the basic mho unit except that it is offset so as not to encircle or pass through the origin of the impedance diagram. This offset is obtained by adding the voltage drop from a transactor to the voltage from the potential transformer, and applying the vector sum to the mho unit potential circuit. Transactor is the name given to a reactor which has a secondary winding with a step-up ratio so as to provide more reactance with less burden on the current circuit.

The mho unit is supplied with current from two phases, and the voltage between these two phases.

The minimum ohmic reach of the relay is 5 ohms on a phase-to-neutral basis when the restraint is on the 100% tap.

With this current and voltage combination and the proper settings, relay operation will occur when the generator loses excitation. Also, the relay will properly refrain from operating for any other normal or abnormal system conditions.

A combination target and seal-in unit is mounted at the top of the relay and is connected in series with the tripping circuits. The target is reset by a button on the bottom of the cover on the left.

The auxiliary element (A), a telephone type relay, is mounted behind the nameplate. The purpose of this auxiliary is to prevent the relay from tripping the breaker falsely due to vibration when no voltage is applied to the potential circuit, or on contact bounce if the voltage falls to zero. The operating time of this unit is 0.067 to .083 seconds.

INSTALLATION

LOCATION

The location should be clean and dry, free from dust and excessive vibration, and 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 Fig. 16.

CONNECTIONS

Internal connections are shown in Fig. 5. Typical external connection is shown schematically in Fig. 2.

• Unless mounted on a steel panel which adequately grounds the relay case, it is recommended that the case be grounded through a mounting stud or screw with a conductor not less than #12 B&S gage copper wire or its equivalent.

ADJUSTMENTS

The relay is adjusted at the factory and it is advisable not to disturb the adjustments. If for any reason they have been disturbed, the following points should be observed in restoring them.

CLUTCH ADJUSTMENT

The induction-cup units have a clutch so that the cup and shaft can slip with respect to the moving contact whenever the torque in either the opening or the closing direction becomes greater than a predetermined value. The grams to slip the clutch should be measured by holding the cup and pushing with a gram gage against the moving contact. The moving contact should slip relative to the cup at approximately 50 grams pressure. The pressure at which the clutch slips can be changed by loosening the set screw in the collar at the top of the shaft and turning the collar down, to increase the slip pressure or up, to decrease the slip pressure. The set screw should be tightened again after the clutch is set to the proper value.

CONTACT ADJUSTMENT

The stationary contact should rest against its felt backstop and should have about 1/16-3/32 inch gap.

OFFSET TAP BLOCK

The two leads to this tap block are marked L and H. By variation, any combination of ohmic offset may be obtained up to 4 ohms in 0.5 ohm steps, phase-to-neutral. As an example, placing the L lead in the 0.5 ohm tap and the H lead must be in a higher tap than the L lead to keep the offset in the proper direction.

RESTRAINT TAP BLOCK

Variation of the restraint tap setting varies the size of the ohmic characteristic. (See Fig. 4). The variation is in 1% steps up to 10% and in 10% steps up to 100%, thus providing for a restraint adjustment of 1-100% in 1% steps. The restraint coils are rated 115 volts continuously and hence should not be set above 87% when using line-to-neutral potential transformers, and with input taps set on 40 and 10.

CHECK OF CHARACTERISTIC

1. Connect as shown in Fig. 6. Allow relay potential coils to warm up by energizing at rated voltage for 15 minutes prior to testing.

2. Turn phase shifter to make angle 90 degrees (current leads voltage).

3. Set offset ohms on 4 ohms and transformer taps on 100 percent.

4. Increase current until contacts just close.

Current should be:

$$\frac{\text{Voltage across studs 7-8}}{2 \times \text{Min. ohms} + 2 \times \text{Offset}} = \frac{115}{10+8} = 6.39\text{A}$$

• Denotes change since superseded issue.

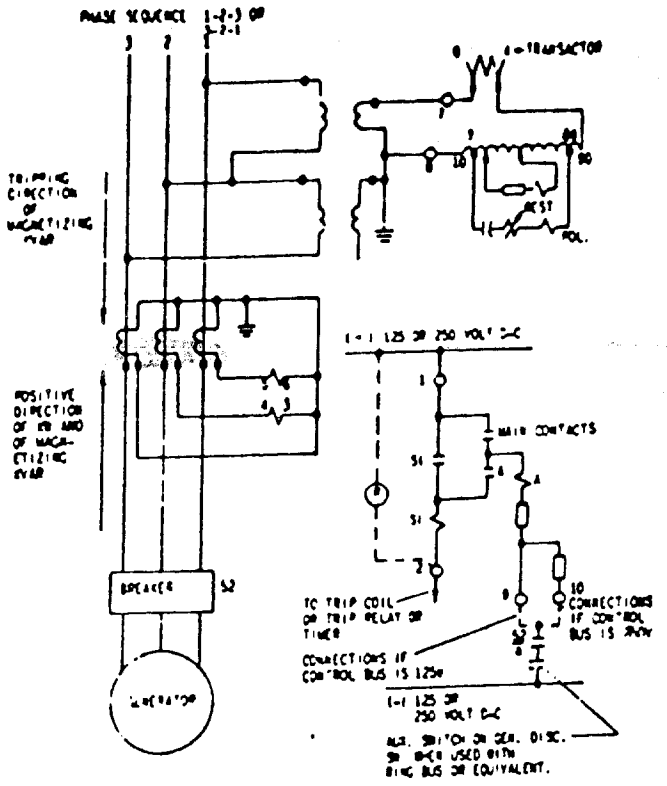


Fig. 2 (K-6375858-17 Sh. 1) External Connection Diagram For Type CEH11A Relay Using-to-line Voltage

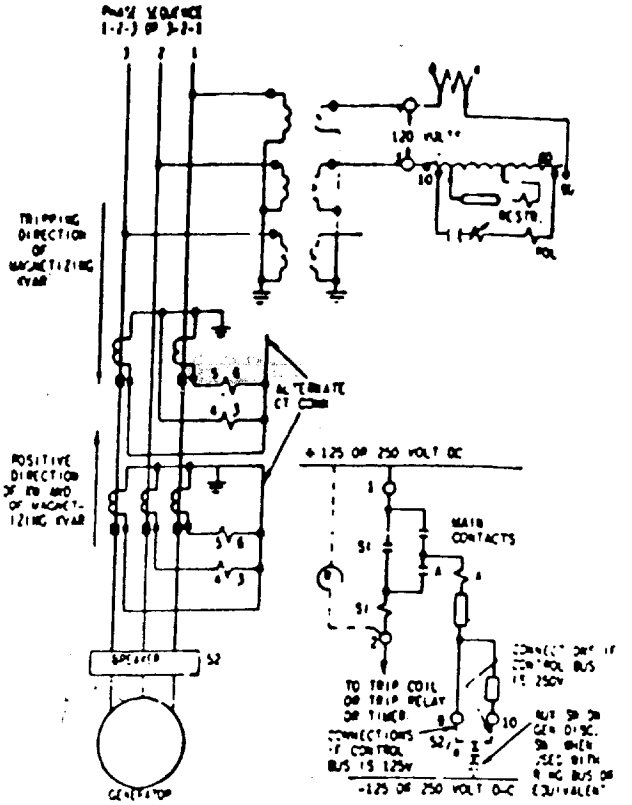


Fig. 3 (6375858-2 Sh. 2) External Connection Diagram For Type CEH11A Relay Using Wye-Wye Potential Transformers

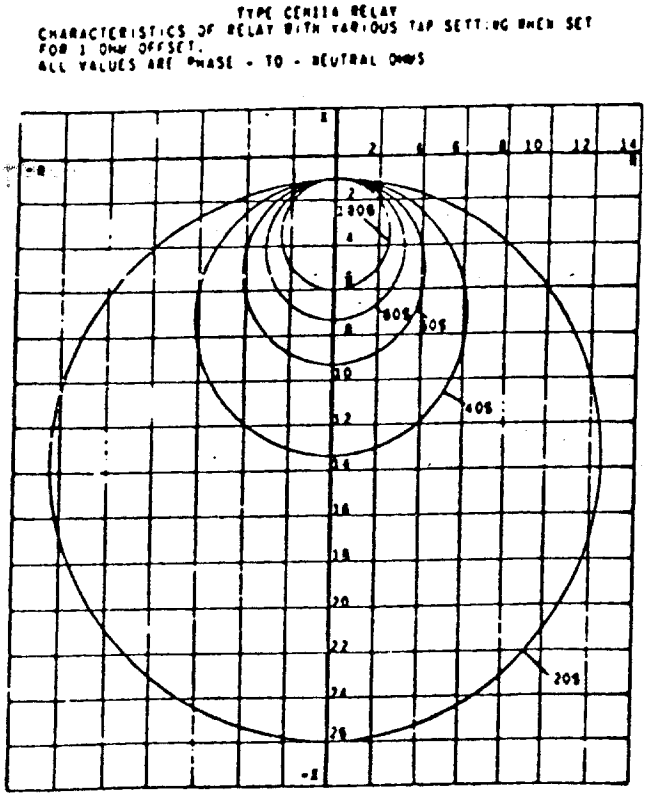


Fig. 4 (402A978-0) Characteristics Of Type CEH11A Relay At Various Restraint Tap Settings. One Ohm Offset. All Valves Phase-to-Neutral

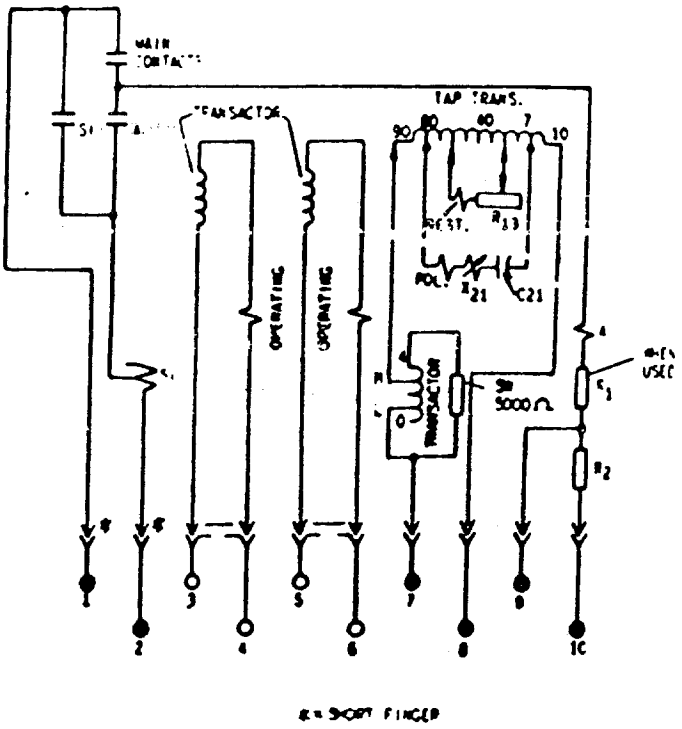


Fig. 5 (402A981-5) Internal Connection Diagram Of Type CEH11A Relay

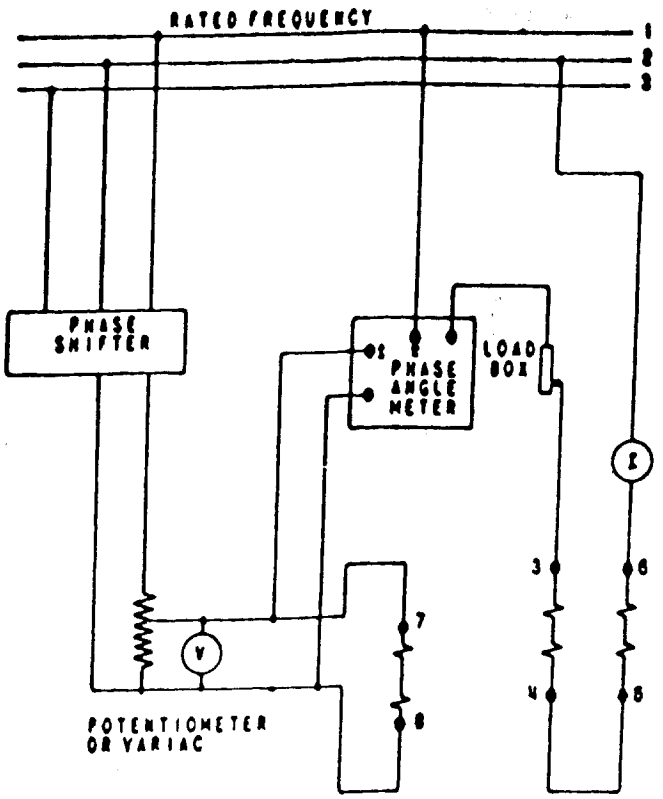


Fig. 6 (362A501-3) Test Connections For Type CEH11A Relay

The relay should operate within ± 5 percent of this value (6.06 to 6.71).

To check any particular setting required for a specific application, proceed as follows:

1. Calculate diameter of circle.

$$\text{Diameter} = \frac{\text{Min. Ohms}}{\text{Tap Setting}} \ (\text{ø - N ohms})$$

Example: Assume 23 percent tap setting.

$$\text{Diameter} = \frac{5}{0.23} = 21.7 \text{ ohms (ø-N ohms)}$$

2. Center of circle = radius + offset.

Example: Assume 2 ohms (ø - N) offset

$$\text{Center} = \frac{21.7}{2} + 2 = 10.85 + 2 = 12.85 \text{ ohms}$$

3. Draw relay characteristic on polar paper with center at 90 degrees lead using distance from origin and diameter calculated above. (See Fig. 7).

4. Set current in current coils at any test value.

I. Calculate ø - N ohms as follows:

$$\text{Ohms (ø - N)} = \frac{\text{Voltage on studs 7-8}}{21}$$

Example: Assume I set at 5 amperes.

$$\text{ø - N Ohms} = \frac{115}{3X5} = 11.5 \text{ ohms. (Points A and B)}$$

5. Turn phase shifter and determine the two angles between which the contacts of the relay are closed. These should check with the angles at which the relay characteristic, drawn in step 3 above, crosses the impedance calculated for the test current I in step 4 above.

6. Set phase shifter for 90 degrees lead and determine the minimum current for which the relay contacts are closed.

$$\text{Min. I} = \frac{\text{Voltage studs 7-8}}{2 \text{ (Diameter + Offset)}} \text{ (for Point C)}$$

For example above:

$$\text{Min. I} = \frac{115}{2 \ (21.7 + 2)} = \frac{115}{43.8} = 2.63 \text{ amps}$$

Three points have now been determined on the relay characteristic. These three points should be enough to show the relay characteristic is the proper size and has the correct angle of maximum torque. If more points are desired repeat step 4 above using* a different value of test current. During these checks endeavor to keep the test current in the order of 20 amperes or less. The maximum current under abnormal conditions is limited by the generator impedance and will usually be less than 20 amperes.

If the angle of maximum torque is not correct it can be corrected by adjustment of reactor (X_{21}). If the diameter of the circle is not correct for the particular tap setting, it can be corrected by adjustment of resistor (R_{13}).

There is no adjustment on the offset, the offset taps are determined by the turns of the transactor.

ALTERNATE CHECK OF CHARACTERISTIC

If no phase shifter is available, the relay characteristic may be checked at the points shown in Fig. 8. The test connections are shown in Fig. 10.

Apply a low current and gradually increase the current until the contacts close. Increase the current further until the contacts reopen. The higher currents should be removed quickly as they will be several times the relay rating of 5 amperes.

** For connections for test 1, the points on the R-X diagram of the relay characteristic will be:

$$R = \frac{0.5V}{2 I_{\text{pick-up}}} = \frac{0.25V}{I_{\text{pick-up}}}$$

$$X = \frac{-0.866V}{2 I_{\text{pick-up}}} = \frac{0.433V}{I_{\text{pick-up}}}$$

** For test 2, the points on the R-X diagram will be:

* Denotes change since superseded issue.

$$R = \frac{-0.5V}{2I_{pick\text{-}up}} = \frac{0.25V}{I_{pick\text{-}up}}$$

$$X = \frac{-0.866V}{2I_{pick\text{-}up}} = \frac{0.433V}{I_{pick\text{-}up}}$$

INSPECTION

Before placing a relay in service the following mechanical adjustments should be checked, and faulty conditions corrected:

The armature and contacts of the target and seal-in unit 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.

There should be no noticeable mechanical friction in the rotating structure of the units, and the moving contacts should return to the right when the relay is de-energized.

There should be approximately 1/64 inch end play in the shaft of the rotating structure. The lower jewel screw bearing should be screwed firmly into place, and the top pivot locked in place by its set screw.

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

If possible, the relay contact circuit should be given an electrical test in place by closing the mho unit contacts by hand and allowing tripping current to pass through the contacts and the target and seal-in unit.

The rotating structure of the mho unit is not balanced, so that any slight torque caused by a tilt of the shaft when the relay is installed ready for operation should be compensated using the control spring adjusting arm at the top rear of the unit. First, loosen the set screw on the front of the top pivot support and rotate the control spring adjusting arm so as to return the moving contact arm to the right-hand backstop. The control spring should hold the contacts definitely open. Once the proper adjustment has been made, the set screw should be tightened allowing approximately 1/64 inch end play in the shaft.

CAUTION: Every circuit in the drawout case has an auxiliary brush. It is especially important on current circuits and other circuits with shorting bars that the auxiliary brush be bent high enough to engage the connecting plug or test plug before the main brushes do. This will prevent CT secondary circuits from being opened.

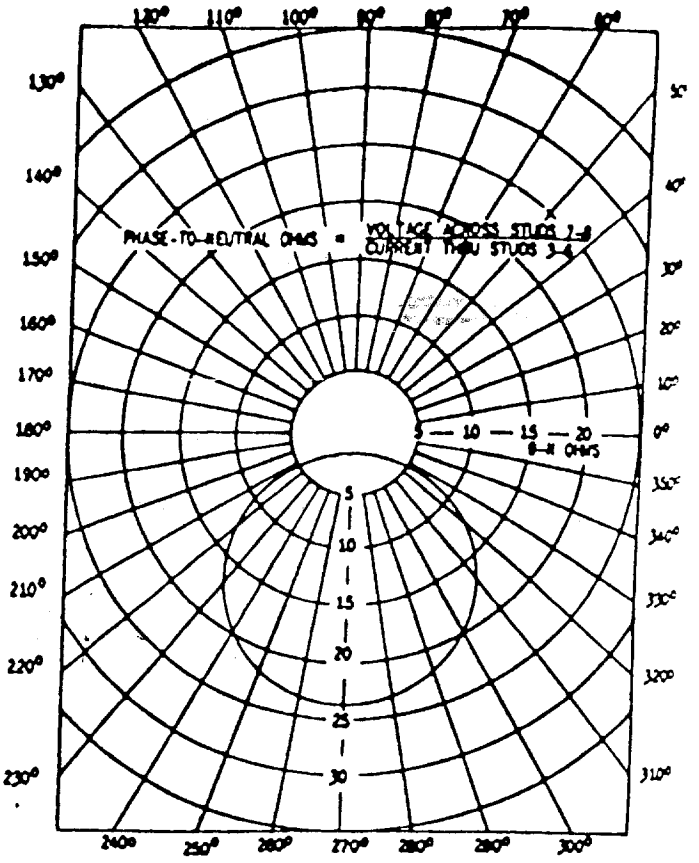


Fig. 7 (402A977-1) Characteristics Of Type CEH11A Relay With 2-Ohm (Phase-to-Neutral) Offset And 25 Percent Tap Setting

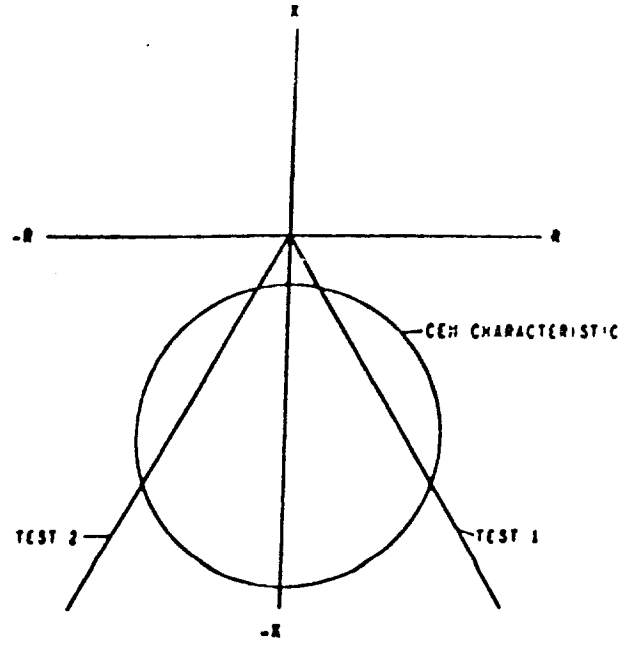


Fig. 8 (402A993-0) Test Points To Determine Type CEH11A Relay Characteristics

ELECTRICAL TEST

The polarity of the relay can be checked by making the connections shown in Fig. 11. With these connections the mho unit contacts should close when the restraint taps are on 10 percent and open when the restraint taps are on 100 percent, using the zero offset tap in each case.

A check of the relay reach can be made as follows:

1. Connect the relay as shown in Fig. 13.

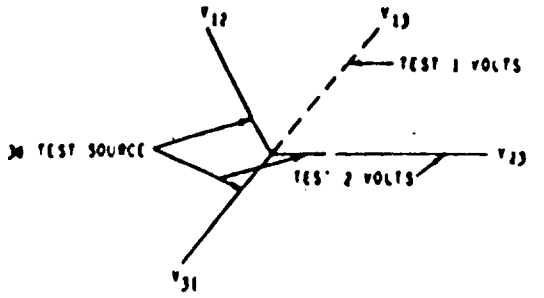
2. Set the test reactor on the 24 ohm tap.

3. Set the relay restraint tap on 55 percent and the offset tap on 2 ohms.

4. Determine the minimum test box dial setting that will cause the mho unit contacts to close. The dial setting should be between 15 and 19.

5. Determine the maximum test box dial setting that will cause the mho unit contacts to close. The dial setting should be between 87 and 97.

6. The minimum and maximum test box dial settings, between which the mho unit contacts should close, can be determined for any relay setting by the following equations. However, for low restraint setting of the mho unit the calculated dial setting will be over 100 percent if a test reactor with a maximum tap of 24 ohms is used. If the calculated dial setting, using the 24 ohm test reactor can be used by putting current through only one of the two current circuits (either circuit 3-4 or 5-6 can



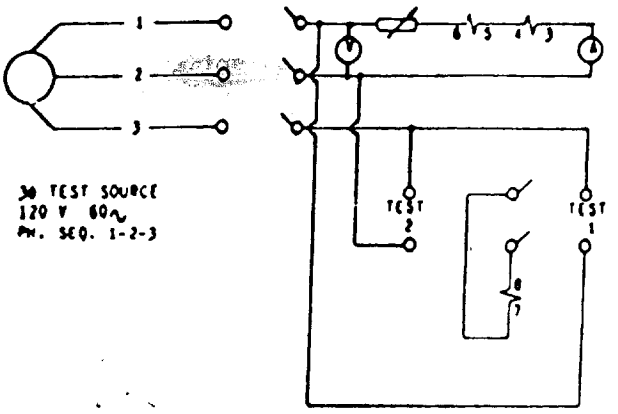
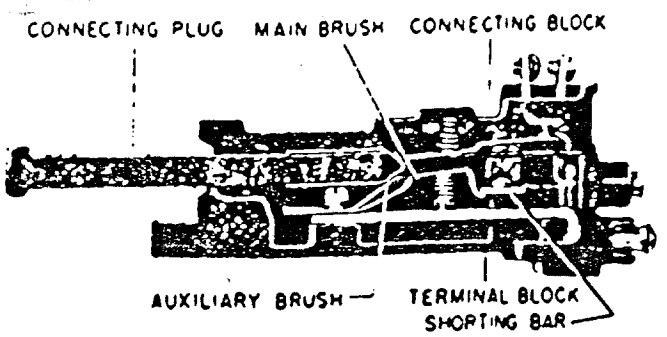


Fig. 10 (402A994-0) Test Connections For Determining Characteristics Of Type CEH11A Relay



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

Fig. 9 (8025039) Cross Section Of Dravout Case Showing Position Of Auxiliary Brush And Shorting Bar

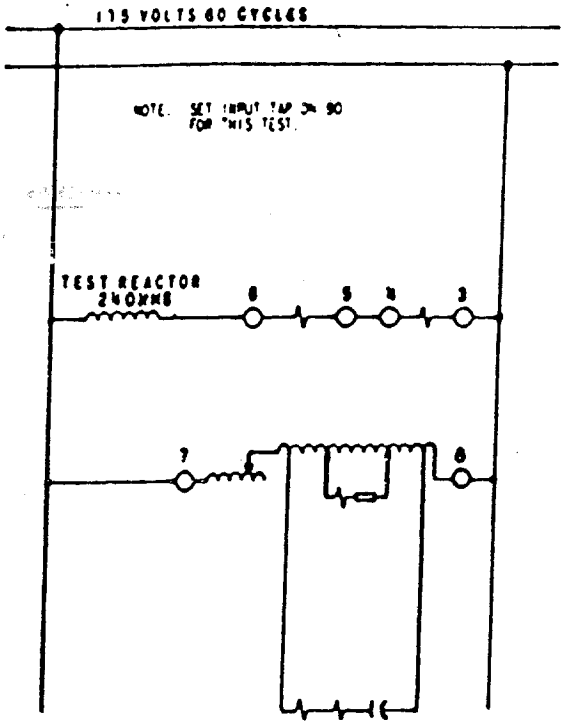


Fig. 11 (362A502-1) Polarity Test For Type CEH11A Relay

be used). When only one of the two current circuits is used the test box dial setting will be one half the value calculated from the following equation:

$$\text{Min. dial setting} = \frac{200 \sin \theta \ (\text{offset ohms})}{X}$$

$$\text{Max. dial setting} = 200 \sin \theta \ \frac{\frac{500}{TR} + \text{offset ohms}}{X}$$

Where θ = the power factor angle of the test reactor

X = actual reactance of reactor

TR = restraint tap setting of relay

If the test reactor 6054975 G1 is used, the term sin θ can be assumed to be unity, as any of the taps above 3 ohms have a power factor angle of 83 degrees or more.

INSTALLATION TESTS

When relay is installed and the generator is running, the following tests should be made to check the overall connections.

To avoid an undesirable drop in system voltage due to operation far into the underexcited region, this installation check is made with relay potential reversed as shown in Fig. 12, and with the restraint reduced to zero or 5%. The reversal of potential inverts the operating characteristic from its normal position, and the reduction of restraint increases the diameter of the characteristics. Fig. 15 shows these effects, and also the characteristic with zero restraint and zero offset.

With zero restraint, zero offset, and power out of the generator, the relay contacts should be closed for all values of lagging power factor (overexcited), and open for all values of leading power factor (underexcited). For this polarity test, it is not necessary to change the field from the unity power factor condition any farther than enough to open and close the relay contacts.

If the relay with potential reversed by the t plug operates opposite to the direction descrit for this polarity test, it will trip falsely at hea loads if placed in service by means of the connecti plug.

With 5% restraint and the value of offset chos for the installation being checked, the relay contac should close as the excitation is increased fro the unity power factor condition sufficiently cross the corresponding relay characteristic Fig. 15 into the more lagging (overexcited) are

OPERATING CHARACTERISTICS

The offset mho unit is similar to the basic m unit with the addition of a transactor. The tran actor is an air gap reactor with a secondary windi for obtaining the desired voltage at a given prima current. It also provides electrical isolation b tween the current and potential circuits. By addi the transactor-secondary voltage in series wi terminal voltage of the potential transformer ar applying the vector sum to the mho unit potenti circuit, the effect is to offset the ohmic character istic without changing its diameter.

The internal connections to the transacto secondary are of such polarity that the offset is the direction to move the center of the circle awa from the origin. Fig. 15 shows the effect of chang ing the offset tap when the restraint tap is left a 100 percent. This shows that the diameter of th characteristic does not change with the offset, b that the center of the circle is moved away from th origin by the value of the offset tap. Fig. 4 show the effect of changing the restraint tap when th offset tap is set on 1 ohm. The diameter of th circle in phase-to-neutral secondary ohms is equa to $\frac{500}{\text{restraint tap \%}}$. In other words, the dia meter is 5 ohms if the restraint tap is 100, or 12. if the restraint tap is 40.

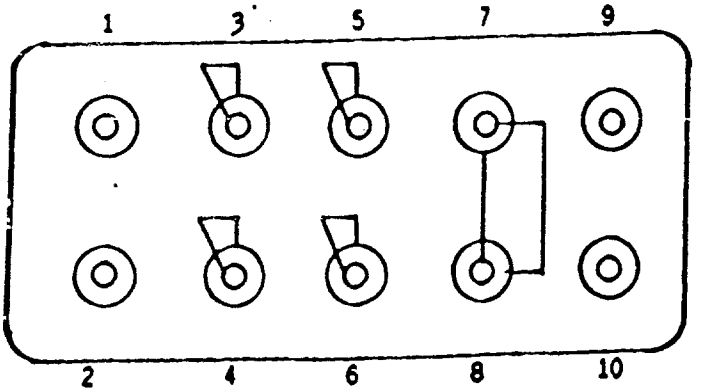


Fig. 12 (0127A9516-0) Test Plug Connections To Reverse Potential On Polarizing And Restraint Circuits

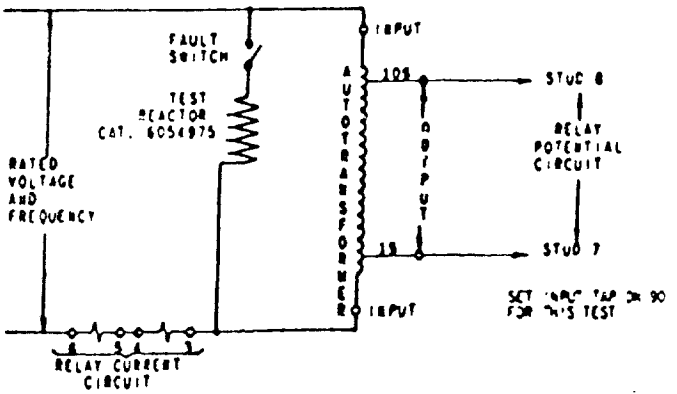


Fig. 13 (402A959-1) Test Connections For Type CEH11A Relay Using Test Box 102L201

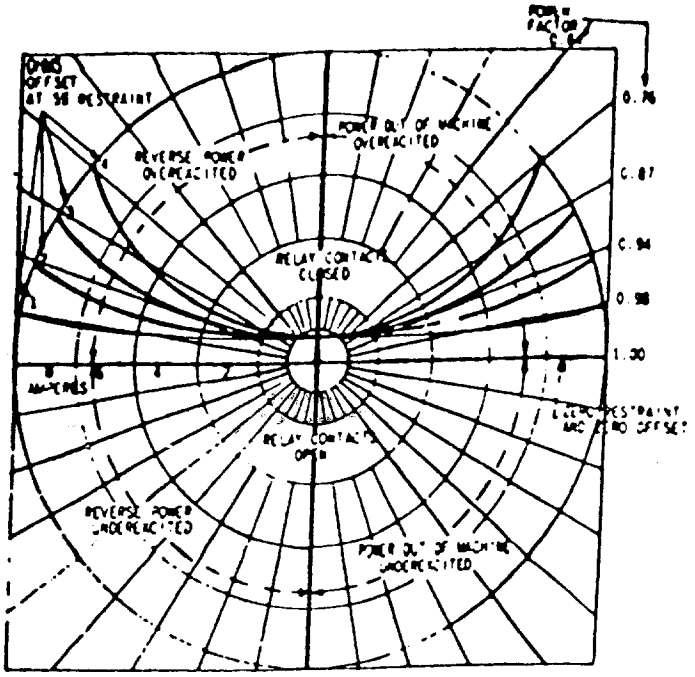


Fig. 14 (402A924-1 Sh. 2) Characteristics Of Type CEH11A Relay With Potential Reversed And Five Percent Tap Setting

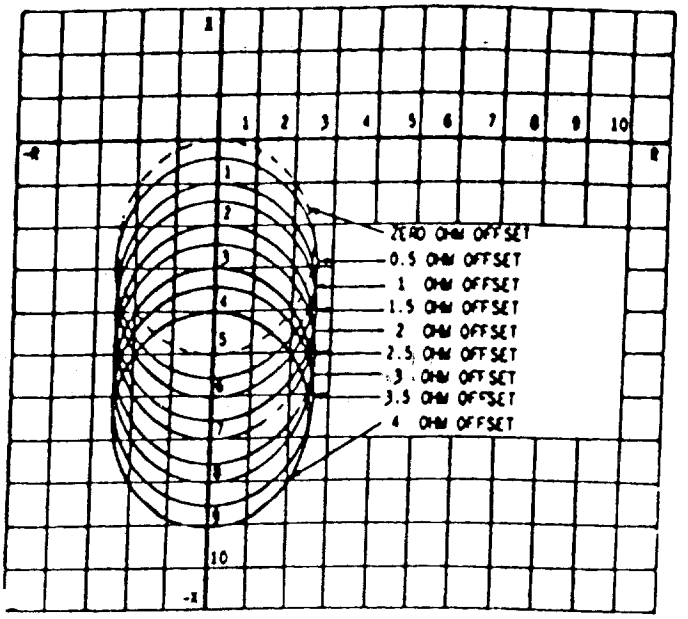


Fig. 15 (402A974-2) Characteristics Of Type CEH11A Relay, 100 Percent Tap Setting. Various Values Of Offset.

For a generator directly connected to a bus, the offset tap should be the next higher tap to one half X_d', the direct axis transient reactance of the machine in secondary phase-to-neutral ohms. This insures that the CEH will not trip on a bus fault even under out-of-step conditions. The offset tap should never be set for less than 0.5 ohm offset. If one half X_d' is less than 0.25 ohms use the 0.5 ohm offset tap.

In unit generator-transformer set-ups no offset is required since the electrical center will be outside the relay characteristic for a bus fault.

The restraint tap should be such as to make the diameter of the circle equal to X_d - offset, where X_d is the direct axis synchronous reactance of the machine in secondary phase-to-neutral ohms.

Secondary ohms is equal to primary ohms $\times \frac{\text{CT ratio}}{\text{PT ratio}}$

EXAMPLE OF CALCULATIONS

Information Required

Transient reactance X_d', in percent, per unit, or primary ohms (saturated transient reactance, also known as "rated voltage" transient reactance, should be used).

Synchronous reactance X_d in percent, per unit, or primary ohms.

Base kva of per cent or per unit reactances, equals generator rating in kva (not kw).

Base kv of per cent or per unit reactances, equals generator rating in kv.

CT Ratio
PT Ratio

Sample Calculation

Transient reactance X_d' = 13.8% = 13.8/100 or 0.138 per unit

Synchronous reactance X_d = 114% = 114/100 or 1.14 per unit

Base kva = 62500 kva

Base mva = Base kva/1000 = 62.5 mva

Base kv = 14 kv

Base ohms = $kv^2/mva = 14^2/62.5 = 3.13$ ohms pri.

CT ratio 4000/5 A = 800:1

PT ratio 14,400/120V = 120:1

Base ohms sec = Base ohms pri X (CT ratio/PT ratio) = 3.13 X 800/120 = 20.9 ohms sec.

Transient reactance (sec) X_d' = per unit reactance X base ohms sec. = 0.138 X 20.9 = 2.88 ohms sec.

Desired offset (sec) = Transient reactance X 1/2 = 2.88 X 1/2 = 1.44 ohms sec.

Use next higher tap combination = 1.5 ohm sec.

Synchronous reactance (sec.) X_d = per unit reactance X base ohms sec. = 1.14 X 20.9 = 23.8 ohm sec.

Desired diameter = Syn. reactance minus offset used = 23.8 - 1.5 = 22.3 ohm sec.

Desired tap = 500/ (desired diameter) = 500/22.3 = 22.4% tap

Use next lower tap = 22% tap

For the 22% setting.

Connect upper No. 1 lead on tap 2

Connect lower No. 1 lead on tap 20

For 1.5 ohm offset setting, connect L lead on ohmic tap 1.0.

Connect H lead on ohmic tap 2.5. The no. 2 taps are not used in the CEH relay.

MAINTENANCE

PERIODIC INSPECTION

The relay should receive a check such as described under INSPECTION at least every six months with enough of an electrical test to determine that the units and the target and seal-in will operate and trip the breaker. Frequent calibration tests are not necessary because the calibration of this relay does not change appreciably with time.

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 corroded material will be removed rapidly and thoroughly. The flexibility of the tool insures the cleaning of the actual points of contact.

Fine silver contacts should not be cleaned with knives, files, or abrasive paper or cloth. Knives or files may leave scratches which increase arcing and deterioration of the contacts. Abrasive paper or cloth may leave minute particles of insulating abrasive material in the contacts and thus prevent closing.

The burnishing tool described above can be obtained from the factory.

INSTALLATION OF RENEWAL PARTS

All stationary contacts can be installed direc in place by means of the appropriate scre

The jewel screw can be removed from the u by means of an offset screwdriver or an end wren When turning a jewel screw in place, make su there is some end play .010" to 1/64" to prev damage to the bearing surface of the phosph bronze washer in the top of the shaft, as the shaft raised by the jewel screw.

If it is necessary to remove the shaft structur the outer turn of the spiral spring should first unsoldered from its slot in the supporting pc mounted on the adjusting arm. Then, after r moving the two screws holding the top beari support to the supporting posts, on either side the unit, the top bearing support should be pri straight up off its dowel pins, taking the upp pivot and spring adjusting arm with it. Exerci caution so that the pivot does not mar the bari surface inside the top of the shaft and that the dow pins are not bent. With the top bearing suppc placed aside, the entire cup and shaft with its clut and contact assembly can be withdrawn from t magnetic structure of the unit. In order to dis engage the moving contact from the stationary co tact structure, the stationary contact structure c be dismounted from the two posts at the sides of t unit and worked free of the moving contact.

CAUTION: Ease the cup out very gently to avo scratches in the soft aluminum surface. Prote the parts from dust and chips while disassemble

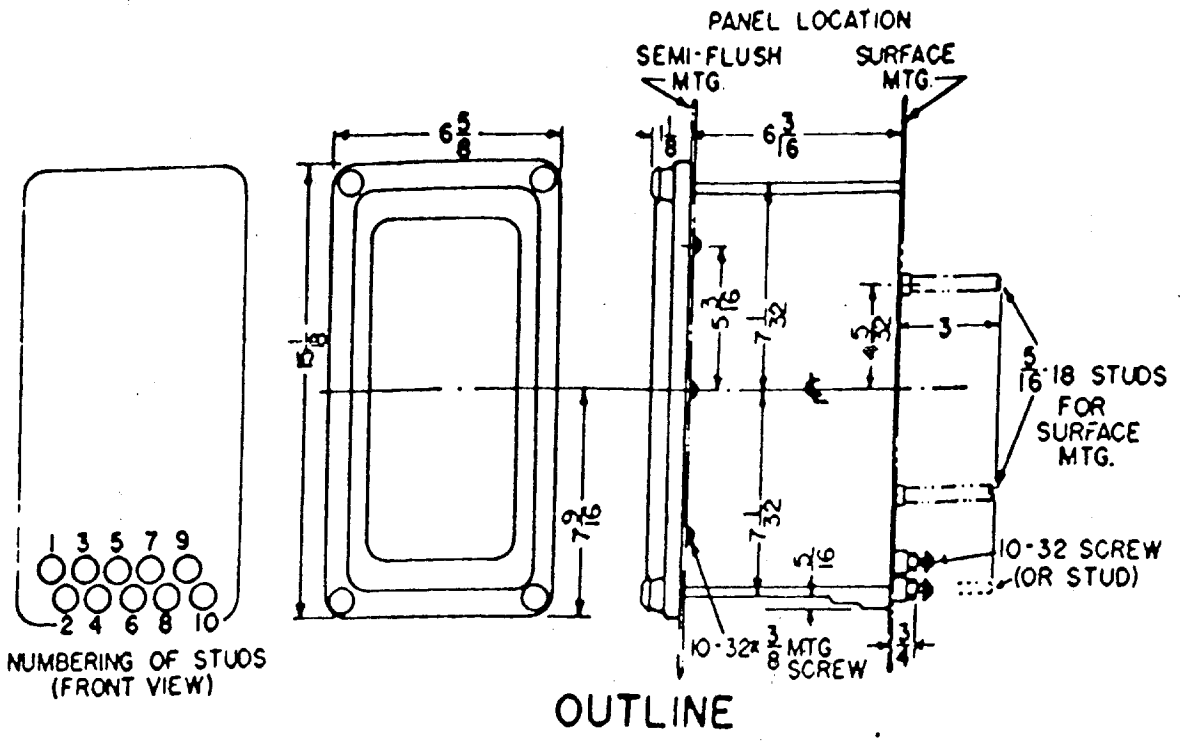
Loosen the set screw in the steel collar at t top of the shaft and remove the collar. The vario parts of the clutch and contact will then slide off t shaft.

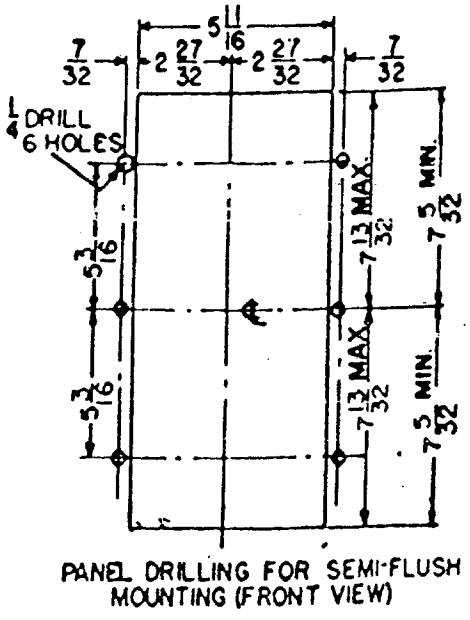
To reassemble, reverse the above procedur Considerable care is necessary in soldering t spiral spring so that neighboring turns do not touc Do all forming of the spiral near the mounting po and do not make any bends sharper than 1/32 inc radius.

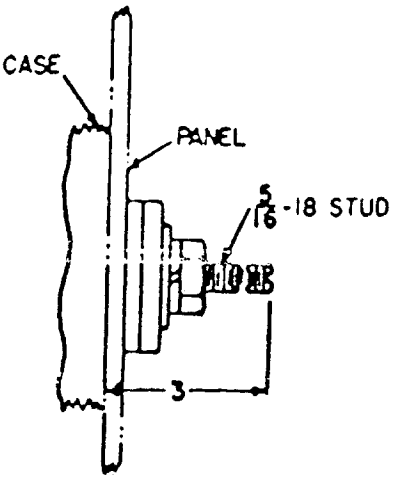
RENEWAL PARTS

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

When ordering renewal parts, address th nearest Sales Office of the General Electric Com pany, specify quantity required, name of part wanted and give complete nameplate data. If possible, giv the General Electric Company requisition number o which the relay was furnished. Refer to Pa Publication GEF-3803.







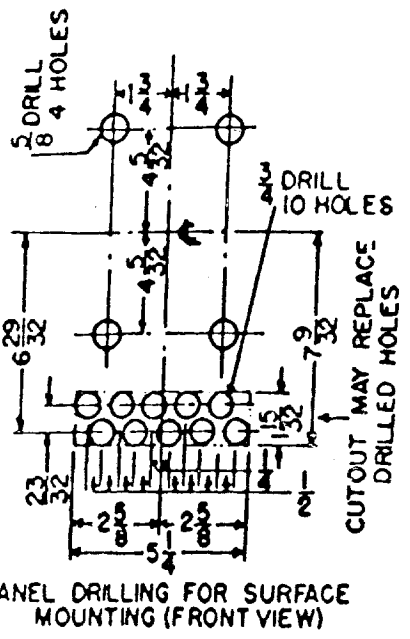


Fig. 16 (6209273-2) Outline And Panel Drilling Dimensions For Type CEH11A Relay