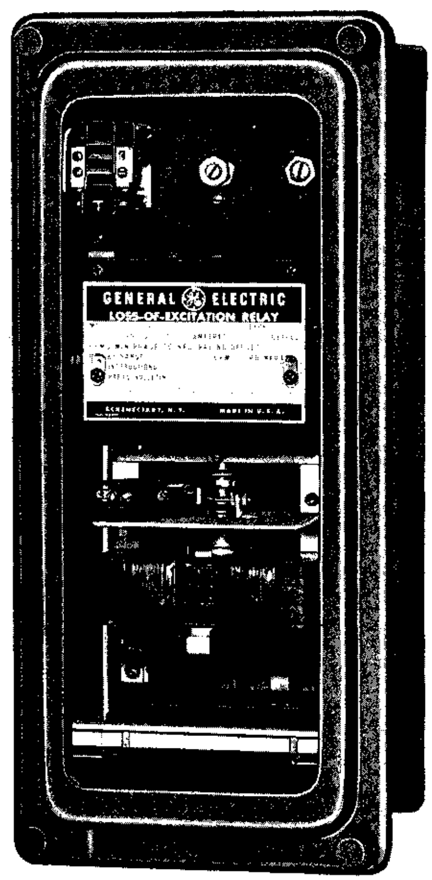
INSTRUCTIONS *Switchgear*

LOSS-OF-EXCITATION RELAY



Type CEH11A

GENERAL ELECTRIC

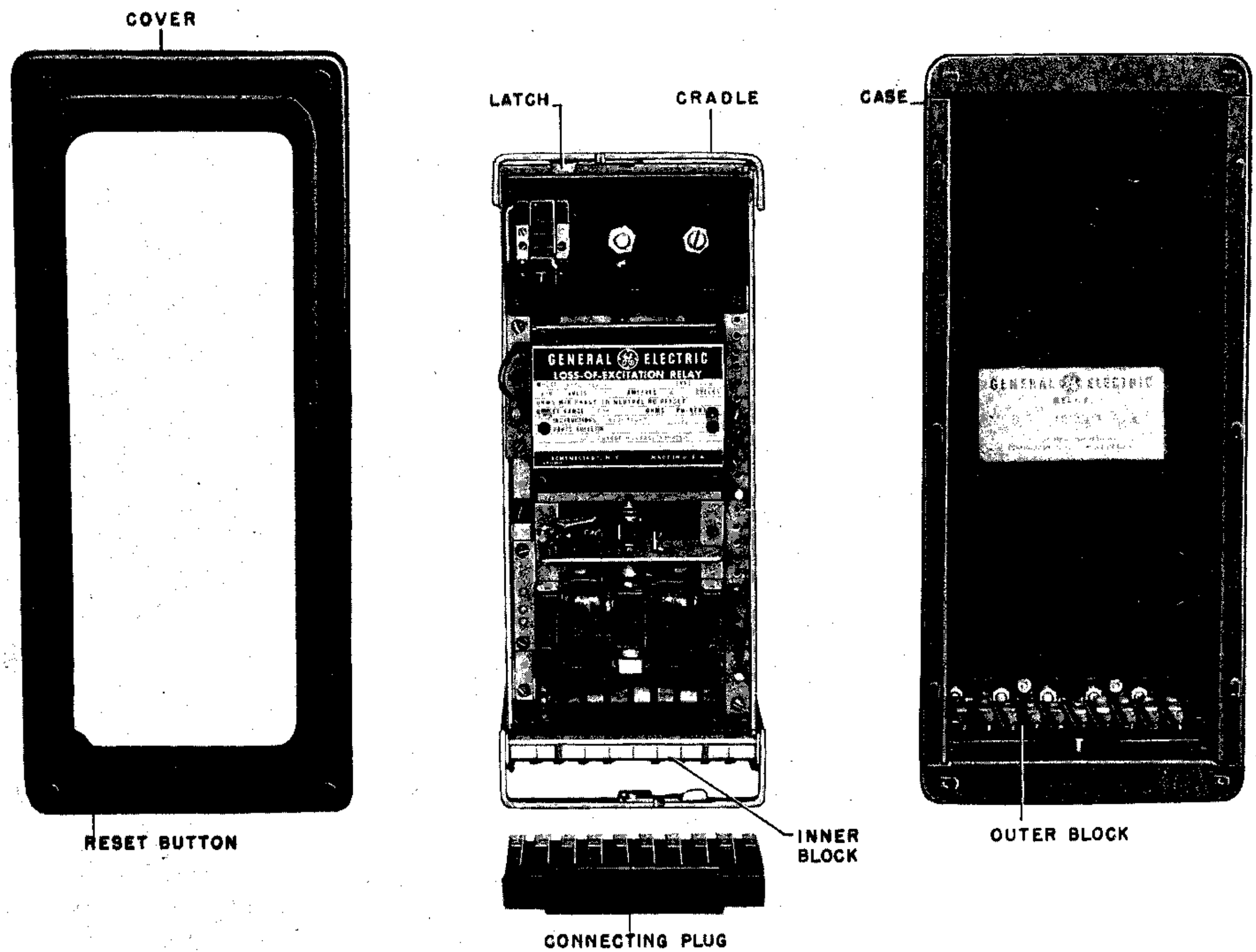


Fig. 1 The Type CEH11A Relay Partly Disassembled.

Fig. 1 (8010124)

Cover (8010124)

ADC

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 other system conditions which involve large interchange of RKVA of more or less transient nature, such as system short circuits, severe synchronizing surges, or even loss of synchronism.

RATINGS

One rating is available, 115 volts, 5 amperes, 60 cycles. The basic range of the ohmic adjustment is 3 to 30 ohms, phase-to-neutral. The offset can be set by means of taps to values of 0, 1, 2, 3, and 4 ohms, phase-to-neutral.

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
0.23	0.36	0.43

The above 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 in the effected phase 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 per cent. 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.

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. 2), 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 may be supplied with either of the two current-voltage combinations.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

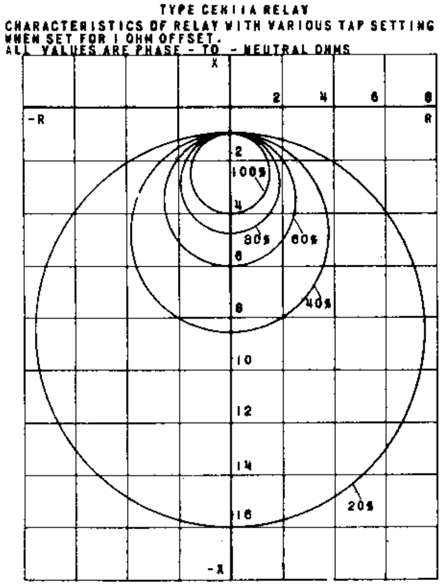


Fig. 2 Characteristics of Type CEH11A Relay Various Tap Settings, One Ohm Offset

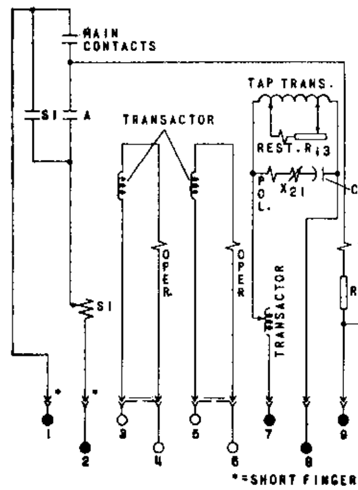


Fig. 3 Internal Connection Diagram of Type CEH11A Relay

(1) Current from two phases, and the voltage between these two phases.

(2) Current from one phase, and the phase-to-ground voltage of that phase.

The ohmic reach of the relay will be different for the two current and voltage combinations. With combination (1) the currents from the two phases are passed in opposite directions through two current coils in the relay, which produce an effect proportional to $\sqrt{3}$ times one of the currents. With combination (2) the current is passed through the two coils in a series-adding direction, which produces an effect proportional to twice the current. If the P. T. ratios are the same for both voltage sources, combination (1) will provide the relay with $\sqrt{3}$ times the voltage of the combination (2). Consequently the combination (1) will have twice the reach of combination (2).

The minimum ohmic reach of the relay is 3 ohms on a phase-to-neutral basis when the restraint is on the 100% tap. For the purpose of obtaining the same characteristics in terms of primary quantities, the restraint tap setting must be doubled if the phase-to-neutral voltage is used.

With either current and voltage combination and the proper settings, the relay operation will be the same when the generator loses excitation. Also, the relay will properly refrain from operating for any other normal or abnormal systems 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 due to a blown fuse.

CASE

The case is suitable for either surface or semi-flush panel mounting and an assortment of hardware is provided for either mounting. The cover attaches to the case and also carries the reset mechanism when one is required. Each cover screw has provision for a sealing wire.

The case has studs or screw connections at both ends or at the bottom only for the external connections. The electrical connections between the relay units and the case studs are made through spring backed contact fingers mounted in stationary molded inner and outer blocks between which nests a removable connecting plug which 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.

The relay mechanism is mounted in a steel framework called the cradle and is a complete unit with all leads being terminated at the inner block. This cradle is held firmly in the case with a latch at the top and the bottom and by a guide pin at the back of the case. The cases and cradles are so constructed that the relay cannot be inserted in the case upside down. 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 fastened to the case by thumbscrews, holds the connecting plug in place.

To draw out the relay unit the cover is first removed, and the plug drawn out. Shorting bars are provided in the case to short the current transformer circuits. The latches are then released, and

Fig. 2 (K-6507992)

Fig. 3 (K-6375844)

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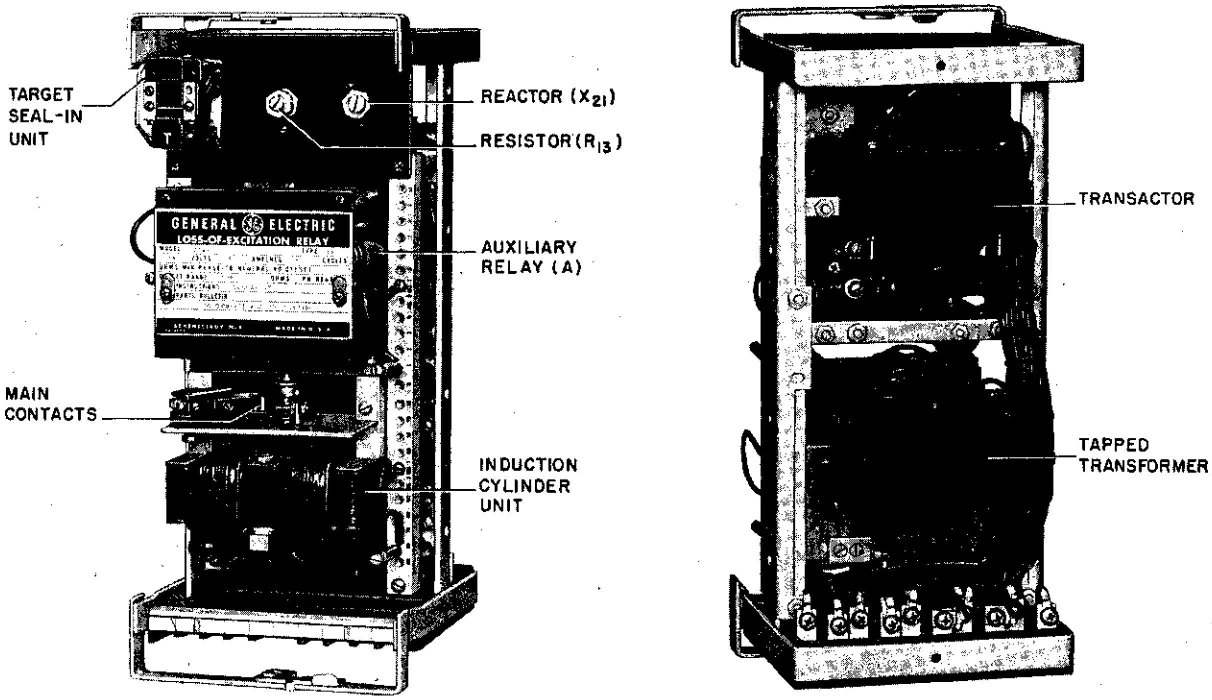

Fig. 4 Type CEH11A Relay in Cradle (Front View on Left, Rear View on Right).

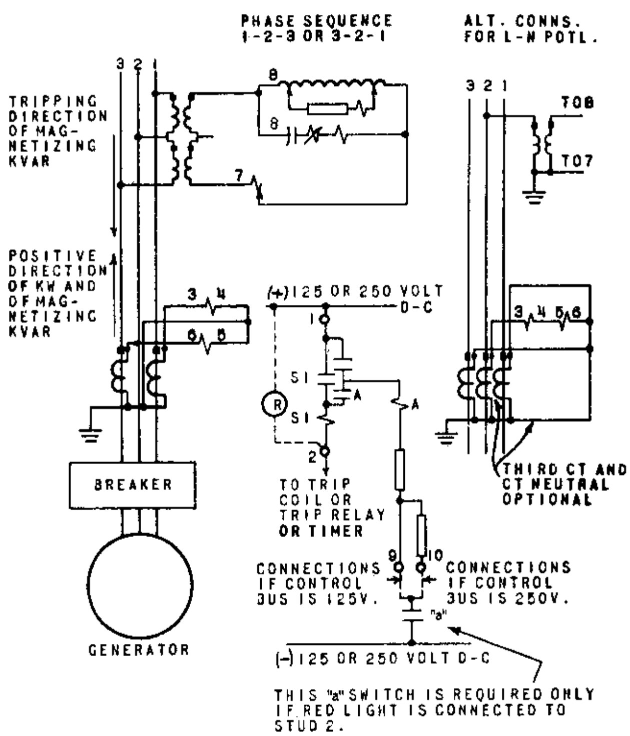

Fig. 5 External Connection Diagram for Type CEH11A Relay Using Line-To-Line Voltage

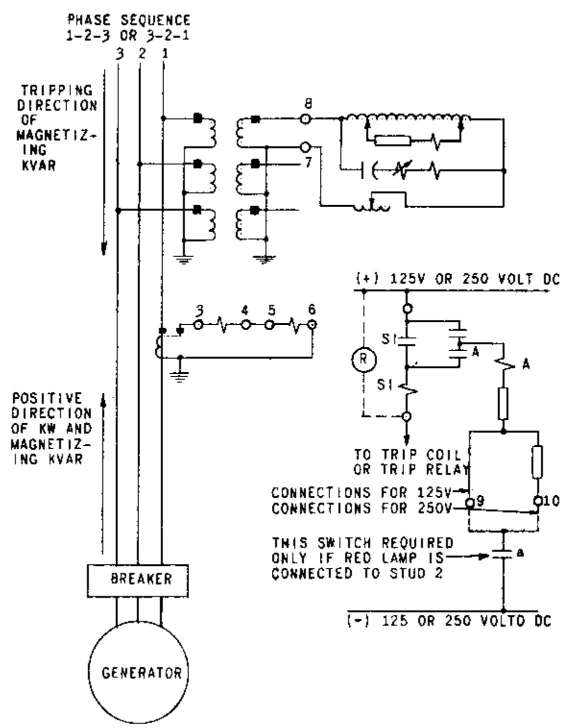

Fig. 5A External Connection Diagram for Type CEH11A Relay Using Line-To-Neutral Voltage

Fig. 4 (8010125) Fig. 4 (8010123) Fig. 5 (K-6375658) Fig. 5A (377A180)

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the relay unit can be easily drawn out. To replace the relay unit, the reverse order is followed.

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 unit can be drawn out and replaced by another which has been tested in the laboratory.

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. 12.

CONNECTIONS

Internal connections are shown in Fig. 3. Typical external connections are shown schematically in Fig. 5 and 5A.

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.

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 gauge 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 1/32 inch gap.

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 per cent.

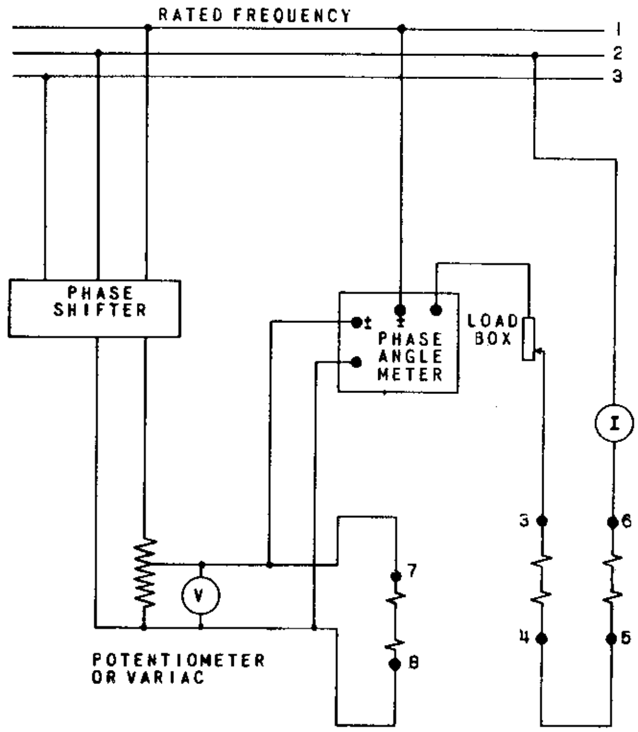

Fig. 6 Test Connections for Type CEH11A Relay

Fig. 6 (362A501)

4. Increase current until contacts just close.

Current should be

$$= \frac{\text{Voltage across studs 7-8}}{\text{2x Min. ohms + 2x Offset}} = \frac{115}{6+8} = 8.22\text{A}$$

The relay should operate within ± 5 percent of this value (7.80 to 8.62A).

5. Continue increasing current until contacts open again,

Current should be

$$= \frac{\text{Voltage across studs 7-8}}{\text{2x Offset}} = \frac{115}{8} = 14.4\text{A}.$$

The relay should operate within ± 5 percent of this value (13.7 to 15.1A).

These two values check two points on the relay characteristic at 90 degrees lead, and if both are right, indicate that both the offset ohms and the minimum ohms are right.

ADC

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

1. Calculate diameter of circle.

$$\text{Diameter} = \frac{\text{Min. Ohms}}{\text{Tap setting}} \quad (\emptyset\text{-N ohms})$$

Example: Assume 14 percent tap setting.

$$\text{Diameter} = \frac{3}{0.14} = 21.4 \text{ ohms } (\emptyset\text{-N})$$

2. Center of circle = radius + offset.

Example: Assume 2 ohms ($\emptyset$-N) offset.

$$\text{Center} = \frac{21.4}{2\,(\emptyset\text{-N})} + 2 = 10.7 + 2 = 12.7 \text{ ohms.}$$

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 $\emptyset$-N ohms as follows:

$$\emptyset\text{-N} = \frac{\text{Voltage on studs 7-8}}{2I}$$

Example: Assume I set at 5 amperes.

$$\emptyset\text{-N Ohms} = \frac{115}{2\text{x}5} = 11.5 \text{ ohms}$$

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 and maximum currents between which the relay contacts are closed.

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

$$\text{Max. I} = \frac{\text{voltage studs 7-8}}{2\text{x Offset}}$$

For example above:

$$\text{Min. I} = \frac{115}{2\,(21.4 + 2)} = \frac{115}{46.8} \quad 2.48 \text{ amps.}$$

$$\text{Max. I} = \frac{40}{2\text{x}2} = \frac{40}{4} = 10 \text{ amps}$$

Four points have now been determined on the relay characteristics. These four 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.

If the angle of maximum torque is not correct it can be corrected by adjustment of reactor (X21). 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.

INSPECTION

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

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

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 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 under a microscope, or the surface of the jewel explored with the point of a fine needle. When replacing a jewel, have the top pivot engaged in the shaft while screwing 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.

The contact surfaces should be clean.

If possible, the relay contact circuits should be given an electrical test in place by closing each of the mho unit contacts successively by hand and allowing tripping current to pass through the contacts and the target and seal-in element. The target should drop promptly.

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.

ELECTRICAL TEST

The polarity of the relay can be checked by making the connections shown in Fig. 6. 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.

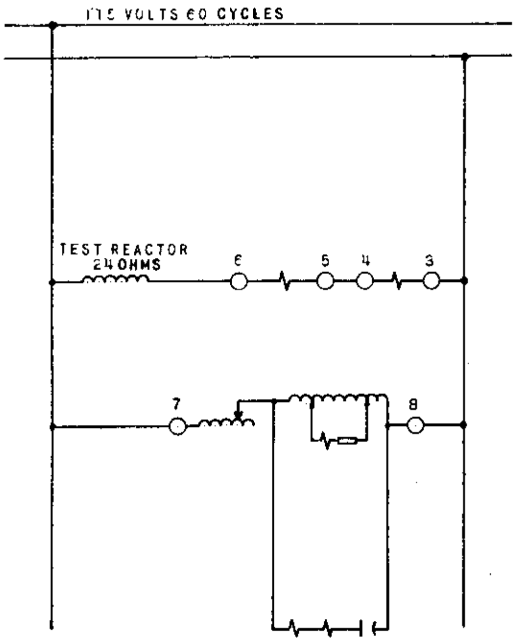

Fig. 7 Characteristics of Type CEH11A Relay 14 Percent Tap Setting, 2 Ohm Offset

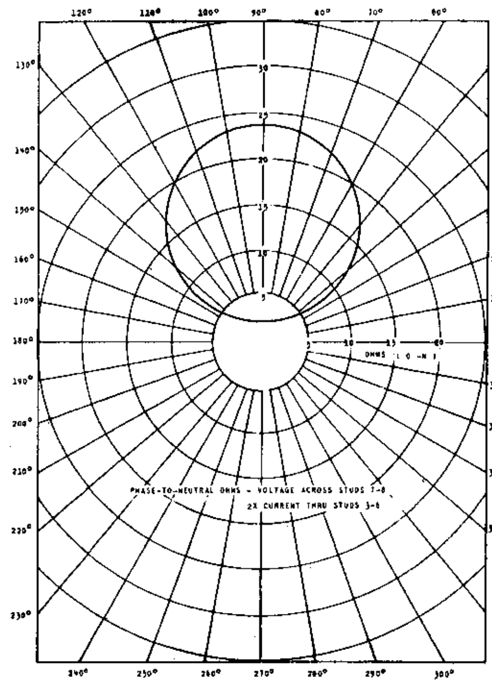

Fig. 8 Polarity Test for Type CEH11A Relay

Fig. 7 (362A500)

Fig. 8 (362A502)

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

1. Connect the relay as shown in Fig. 9.
2. Set the test box as follows:

   S_1 switch - open
   S_2 - trip position
   S_3 - V vault position
   S_4 - closed

   Arc resistor-zero tap
3. Set the test reactor on the 24 ohm tap.
4. Set the relay restraint tap on 35 percent and the offset tap on 2 ohms.
5. 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.
6. Determine the maximum test box dial setting that will cause the mho unit contacts to close. The dial setting should be between 83 and 93.
7. 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 resistor with a maximum tap of 24 ohms is used. If the calculated dial setting, using the 24 ohm tap, is between 100 percent and 200 percent, 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 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 equations:

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

$$\text{Max. dial setting} = \frac{200 \sin \theta \left(\frac{300}{TR} + \text{offset ohms}\right)}{X}$$

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 the power factor of any of the taps above 3 ohms have a power factor angle of 83 degrees or more.

INSTALLATION TEST

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

With the relay in its case and all connections jumpered through on the test block except the trip circuit, the relay contacts should be open for all values of lagging power factor.

With the restraint taps open and the offset ohms set at zero, the contacts of the relay should close when the power factor goes through unity into the leading power factor quadrant.

With the restraint taps set for 5 and any offset ohms setting, the relay contacts should close when the power factor angle is leading enough to cross the relay characteristic shown in Fig. 10.

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OPERATING CHARACTERISTICS

The offset mho unit is similar to the basic mho unit with the addition of a transactor. The transactor is an air gap reactor with a secondary winding for obtaining the desired voltage at a given primary current. It also provides electrical isolation between the current and potential circuits. By adding the transactor-secondary voltage in series with terminal voltage of the potential transformer and applying the vector sum to the mho unit potential circuit, the effect is to offset the ohmic characteristic without changing its diameter.

The internal connections to the transactor secondary are of such polarity that the offset is in the direction to move the center of the circle away from the origin. Fig. 11 shows the effect of changing the offset tap when the restraint tap is left at 100 percent. This shows that the diameter of the characteristic does not change with the offset, but that the center of the circle is moved away from the origin by the value of the offset tap. Fig. 1 shows the effect of changing the restraint tap when the offset tap is set on 1 ohm. The diameter of the circle in phase-to-neutral secondary ohms is equal to $\frac{300}{\text{restraint tap \%}}$. In other words, the diameter is 3 ohms if the restraint tap is 100, or 7.5 if the restraint tap is 40.

The offset tap should be the nearest tap to one half X_d', the direct axis transient reactance of the machine in secondary phase-to-neutral ohms. The

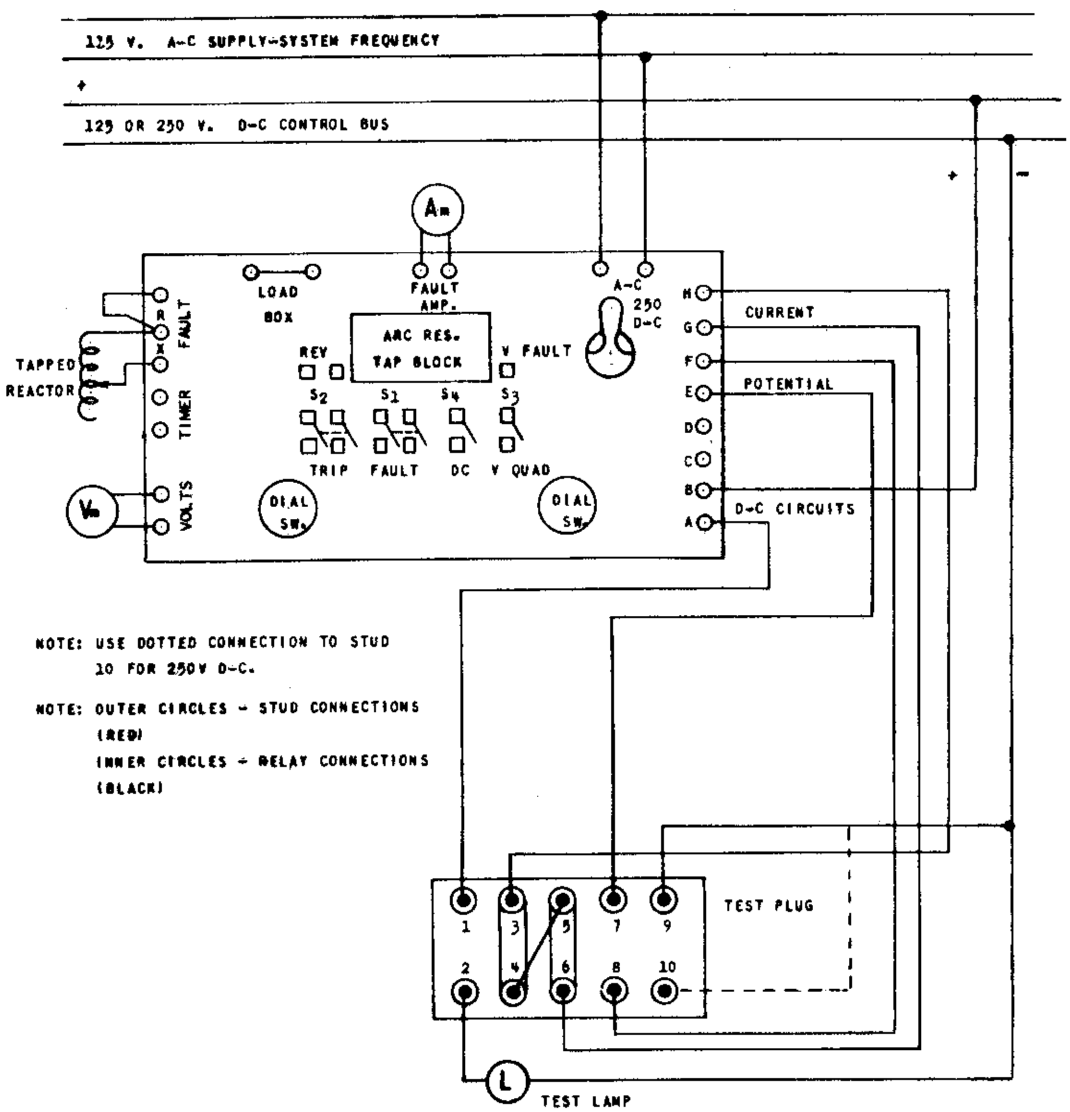

Fig. 9 Test Connections for Type CEH11A Relay Using Portable Test Box 6052978.

Fig. 9 (K-6556478)

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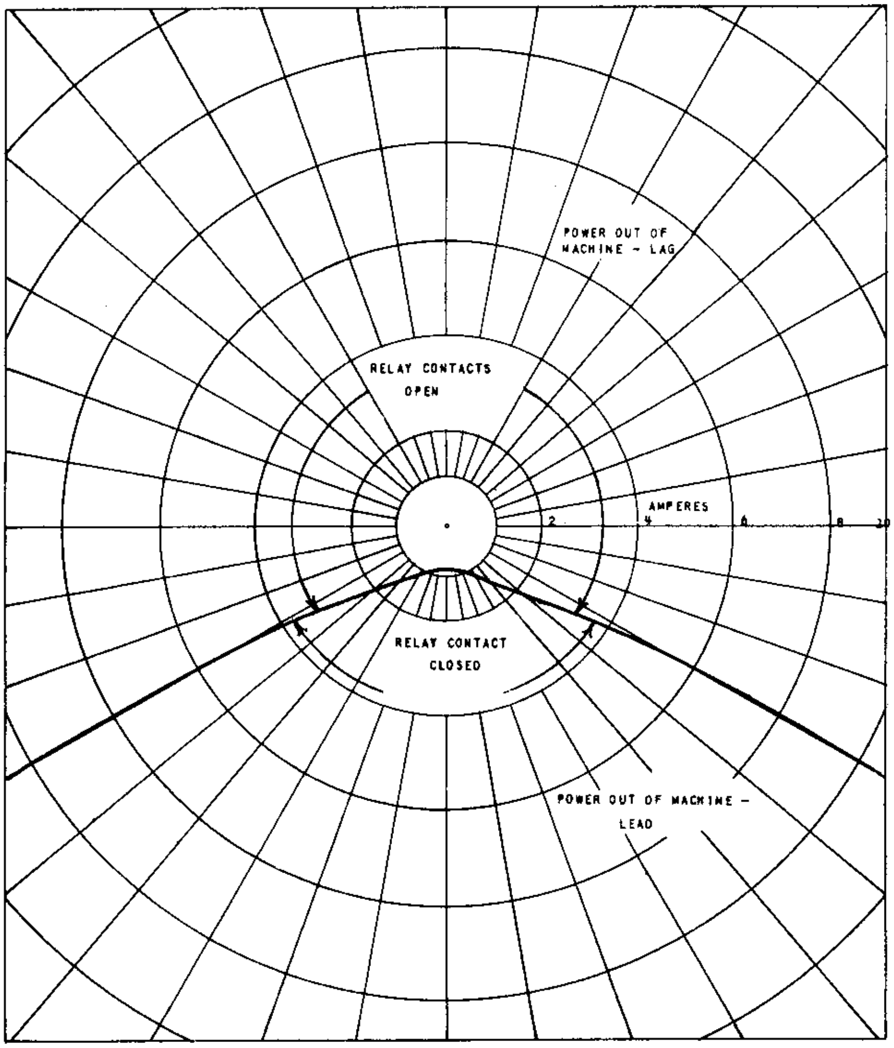

Fig. 10 Characteristics of Type CEH11A Relay. Five Percent Tap Setting, Any Ohm Offset

offset tap should never be set for less than 1 ohm offset. If one half X_d' is less than 0.5 ohms use the 1 ohm offset tap.

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 $\times \dfrac{\text{CT ratio}}{\text{PT ratio}}$.

EXAMPLE OF CALCULATIONS

Information Required

Transient reactance, percent, per unit, or primary ohms X'_d
Synchronous reactance, percent, per unit, or primary ohms X_d
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

Fig. 10 (K-6556477)

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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 nearest tap (of 1, 2, 3, or 4 ohms) = 1 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 = 22.8 ohm sec.
Desired tap = 300/ (desired diameter) = 300/22.8 = 13.2% tap
Use next lower tap = 13% tap

Note: The restraint tap setting would be doubled if phase-to-neutral voltage and one current is used, for the reasons outlined in the DESCRIPTION.

For the 13% setting.

Connect upper No. 1 lead on tap 3
Connect lower No. 1 lead on tap 10

The No. 2 taps are not used in the CEH relay.

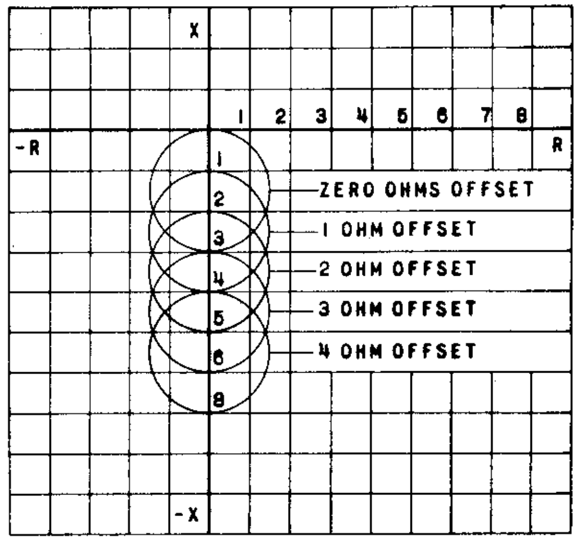

Fig. 11 Characteristics of Type CEH11A Relay. 100 Percent Tap Setting, Various Valves of Offset.

Fig. 11 (K-6507981)

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. Sometimes an ordinary file cannot reach the actual points of contact because of some obstruction from some other part of the relay.

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 directly in place by removing the appropriate screws.

The jewel screw can be removed from the unit by means of an offset screw driver or an end wrench. When turning a jewel screw in place, special precautions should be taken to prevent damage to the phosphor bronze bearing surface, at the top of the shaft, as the shaft is raised by the jewel screw.

If it is necessary to remove the shaft structure, the outer turn of the spiral spring should first be unsoldered from its slot in the supporting post mounted on the adjusting arm. Then, after removing the two screws holding the top bearing support to the supporting posts, on either side of the unit, the top bearing support should be pried straight up off its dowel pins, taking the upper pivot and sprint adjusting arm with it. Exercise caution so that the pivot does not mar the bearing surface inside the shaft and that the dowel pins are not bent. With the top bearing support placed aside, the entire cup and shaft with its clutch and contact assembly can be withdrawn from the magnetic structure of the unit. In order to disengage the moving contact from the stationary contact structure, the stationary contact structure can be dismounted from the two posts at the sides of the unit and worked free of the moving contact.

CAUTION: Ease the cup out very gently to avoid scratches in the soft aluminum surface. Protect the parts from dust and chips while disassembled.

ADC

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

To reassemble, reverse the above procedure.

Considerable care is necessary in soldering the spiral spring so that neighboring turns do not touch. Do all forming of the spiral near the mounting post and do not make any bends sharper than 1/32 inch radius.

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 part wanted, and give complete nameplate data, including serial number. If possible, give the General Electric Company requisition number on which the relay was furnished.

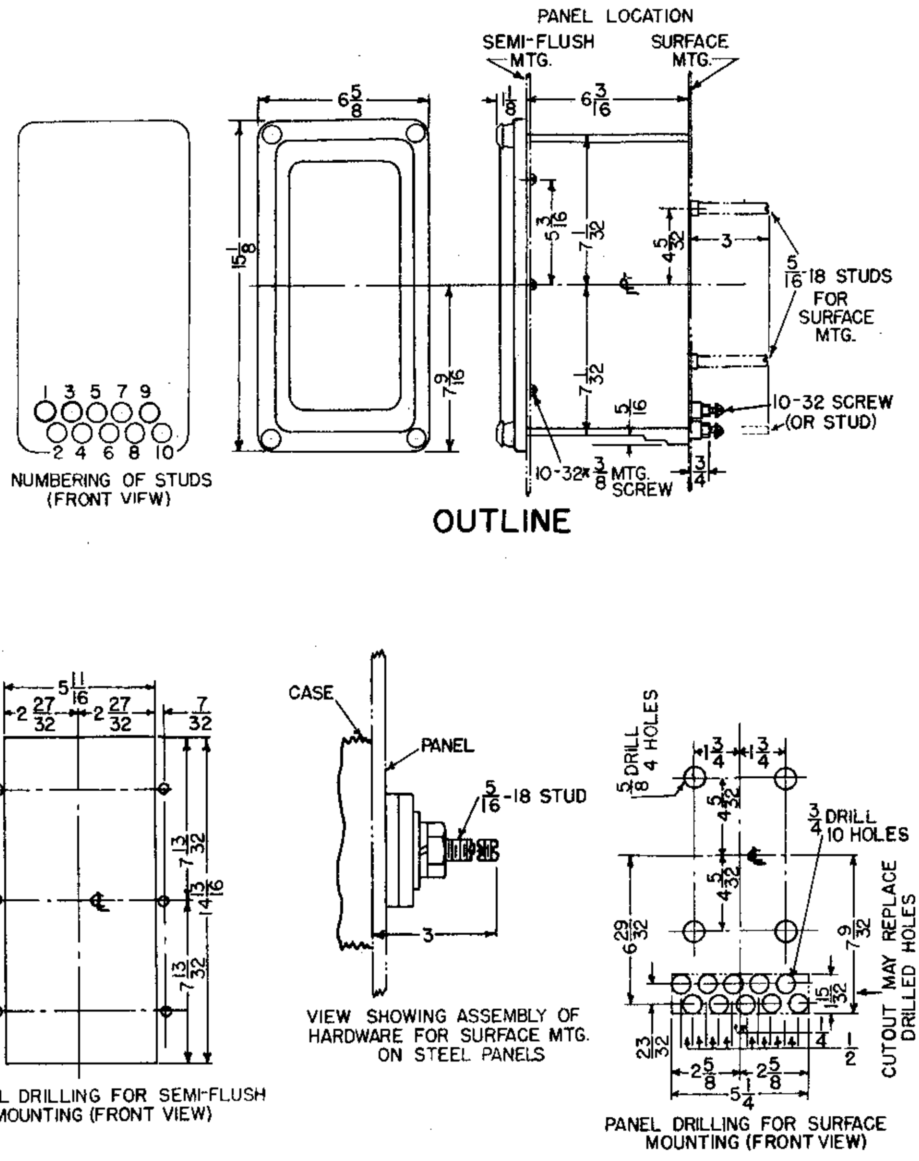

Fig. 12 Outline and Panel Drilling Dimensions for Type CEH11A Relay

Fig. 12 (K-6209273)

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