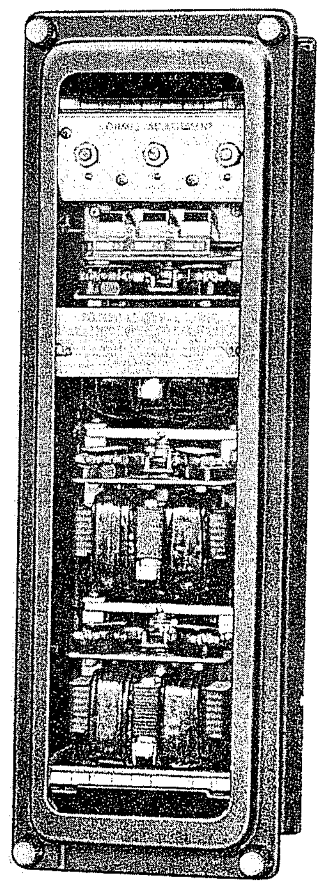
MHO BLOCKING RELAY

Type CEB13B



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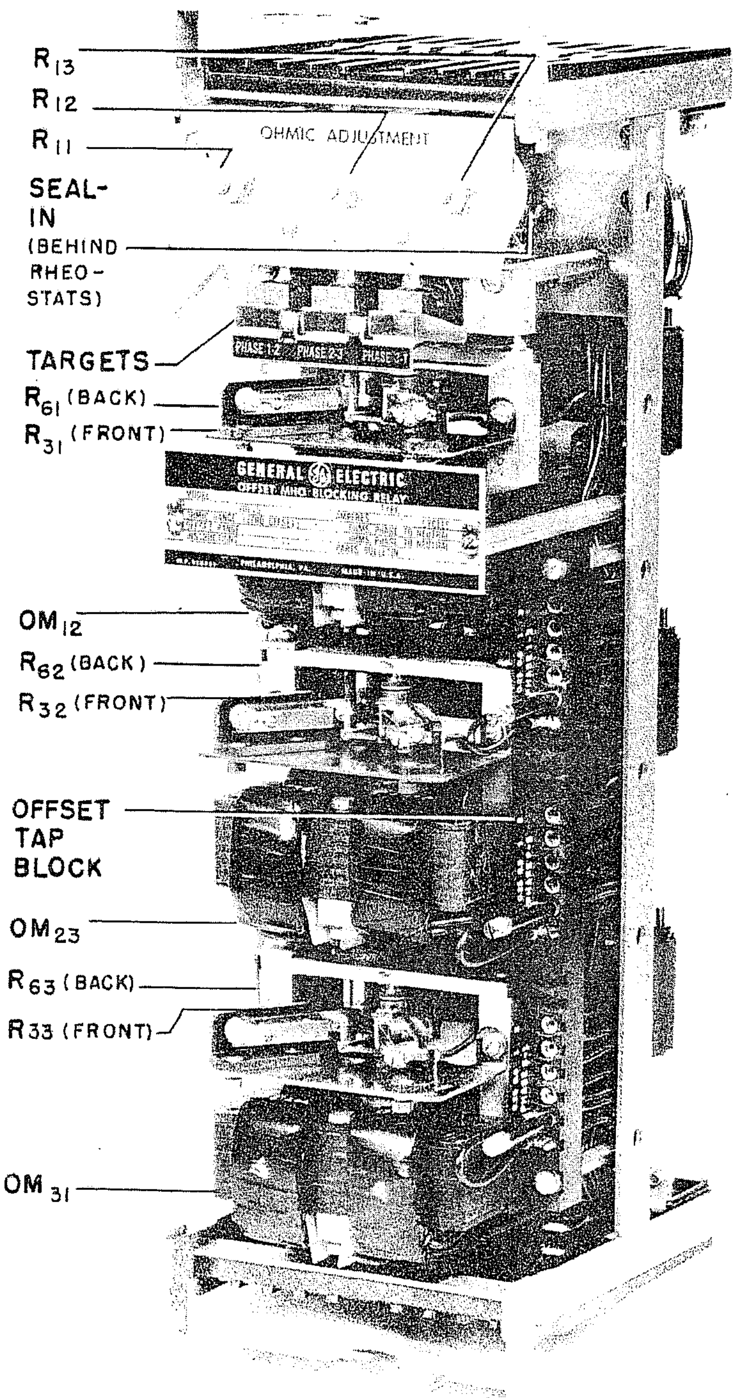
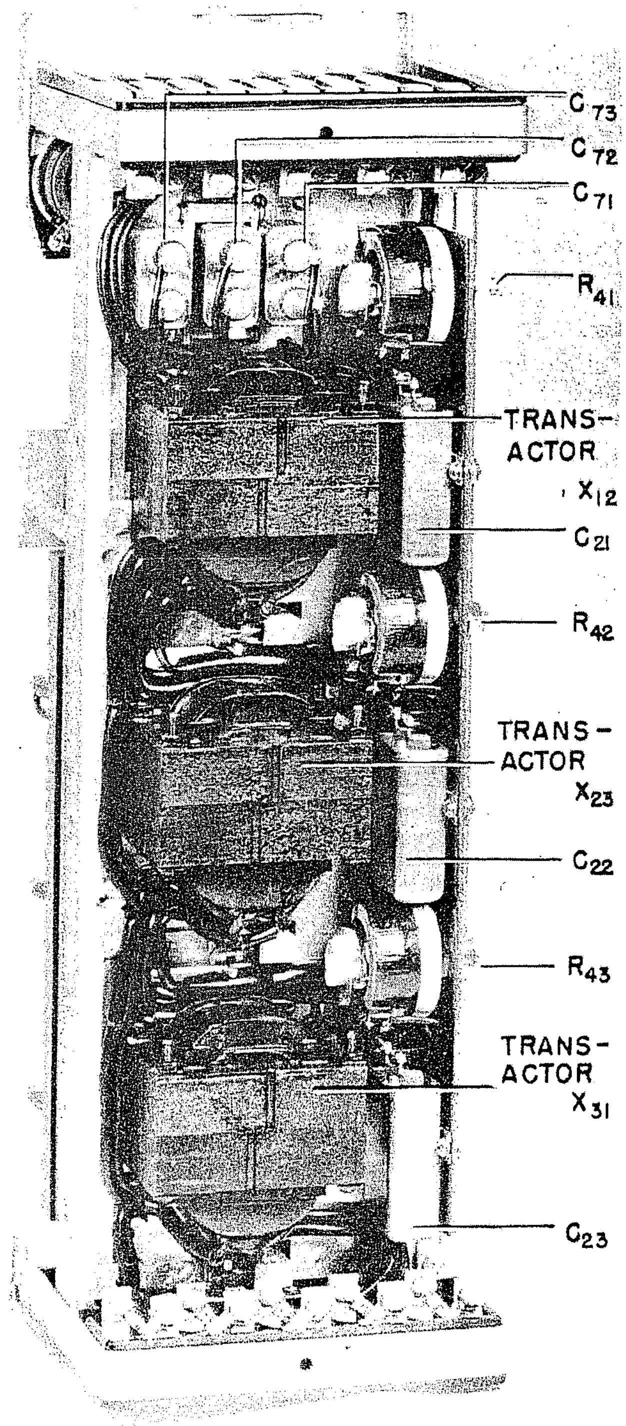


Front View



Rear View

Cover (8011765)

Fig. 1(8024904) Front View

Fig. 1(8024905) Rear View

Fig. 1 Type CEB13B Relay Removed From Case

MHO BLOCKING RELAY
TYPE CEB13B

DESCRIPTION

INTRODUCTION

The Type CEB13B relay is a three phase, offset mho blocking relay, which operates on the induction cylinder principle, providing a high steady torque acting on low inertia parts.

APPLICATION

The Type CEB13B relay may be used as the reversed third zone and carrier starting element with the Type GCX17A or 17B reactance distance relay to form a directional comparison carrier relaying terminal which is especially applicable to the protection of three terminal transmission lines. The offset mho unit of the Type CEB13B relay provides a directional type of carrier starting element. On three terminal line applications, the directional type of carrier starting element provides more latitude in the settings of the distance relays and also offers line protection in some cases where non-directional carrier starting may not.

Each of the three mho units is supplied with line-to-line voltage and the vector difference of the currents in these same two lines, (delta current). Consequently, the ohmic reach of a single unit is the same for three-phase, phase-to-phase or two-phase-to-ground faults. The ohmic reach is adjusted by means of a resistor in the restraint circuit.

Each of these type relays have phase targets and a seal-in unit, the ratings of which depend on the relay model.

The principal problem in making relay settings, when applying directional comparison carrier relaying with non-directional carrier starting to three terminal lines, is the coordination of the carrier starting element reach with the carrier stopping or tripping element reach. This coordination is complicated by infeed from the third line terminal. An internal fault close to one terminal of the line appears to be at a greater distance from the relay at the other line terminal than it actually is due to the infeed from the third line terminal. The carrier tripping element must have ample reach to see any internal fault regardless of the infeed, but also its reach must not exceed the carrier starting element, otherwise false tripping will result on external faults.

The directional type of carrier starting element with its principal reach being directed away from the protected line section or in the reverse direction, simplifies the coordination problem since it is only necessary that it out reach the carrier tripping elements at the other two line terminals for all external faults. The possibility of the carrier tripping elements at the other two terminals outreaching the carrier starting element at the third terminal is therefore less likely. The carrier starting element is always offset to insure proper operation to start carrier for external faults very close to the line terminal.

The R and X diagram and the elementary diagram of Fig. 9 show the recommended carrier-distance relaying protection for three terminal line applications where the Type GCX reactance distance relay is applicable.

The Type CEB13B relay may also be used with a Type RPM timer to provide back-up protection for other line relaying. This application is shown by the elementary diagram of Fig. 11.

When the application requires a relay to be set for less than the minimum ohmic reach of the Type CEB13B relay, a secondary current transformer is required to step down the current by a suitable factor. For instance, a four ohm setting of the relay can be made to the equivalent of a 2.0 ohm relay by the use of three 5/2.5 ampere C.T.'s for each Type CEB relay. It should be remembered in this case, that the relay is energized by one-half the secondary current of the line C.T.'s, and this fact must be used when referring to operating time or accuracy data recorded as a function of current. Data recorded as a function of relay terminal voltage is not affected.

The use of the secondary step down C.T.'s reduces the minimum ohmic reach and the offset of the three units by the same factor.

The remainder of these instructions cover the operation of the relay with no reference to the use of auxiliary current transformers.

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 without the attendant high burden. Electrical insulation is also obtained. By adding the transactor secondary voltage in series with the terminal voltage and applying the vector sum to the operating unit, the effect is to offset the ohmic characteristic without changing its diameter.

Referring to Fig. 2, the characteristics at 75 and 60 degrees with zero offset are similar to the mho unit characteristic of the Type GCX relay. Curves of Fig. 2 show how the characteristic may be offset in the Type CEB relay. In the carrier-pilot relaying scheme, the connections to the Type CEB relay are reversed so that except for the offset portion OA, its zone of operation lies in the direction opposite to that of the mho unit. It thus covers the line section behind the relay location. Its normally-open contacts close to trip the breaker in third zone time for faults in this section, while its normally closed contacts open to initiate the transmission of carrier.

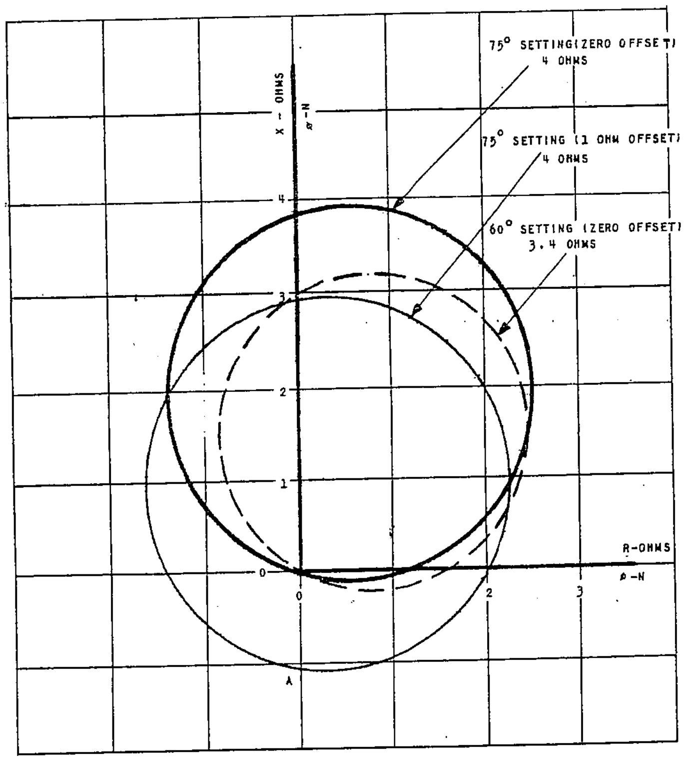


Fig. 2 Impedance Characteristics Of The Type CEB13B Relay

The characteristic circles may be expanded by reducing the effect of the restraint circuit. This is accomplished by increasing the setting of the adjustable resistor in that circuit.

When zero offset is used, the characteristic circles all pass through the origin. When one ohm offset is used, these circles continue to pass through a common point which has moved to point A in Fig. 2.

The direction of the zero offset characteristic can be adjusted from the 75 degree setting, shown by the upper heavy circle of Fig. 2, to any angle down to the 60 degree setting, shown by the dashed circle. The variation in minimum ohmic setting with this adjustment is indicated in Table I. This adjustment is made by decreasing the resistance in R_{31} plus R_{41} for the M_{1-2} unit. If no change is made in the setting of R_{61} and if offset is used, the new circle, initially at 60 degrees, for example, will be shifted along a 75 degree line. In order to have the offset along a 60 degree line, the resistance of R_{61} must be reduced.

TABLE I

MINIMUM OHMIC REACH VARIATION

Angle	Frequency	Minimum Ohmic Reach
75	60	3.92 - 4.08
60	60	3.18 - 3.68

No attempt has been made to limit the transient overreach of this relay. The directional action with 1.5 volts, phase-to-phase, is correct from 6 to 60 amperes, when no offset is used.

Fig. 2 (362A671)

RATINGS

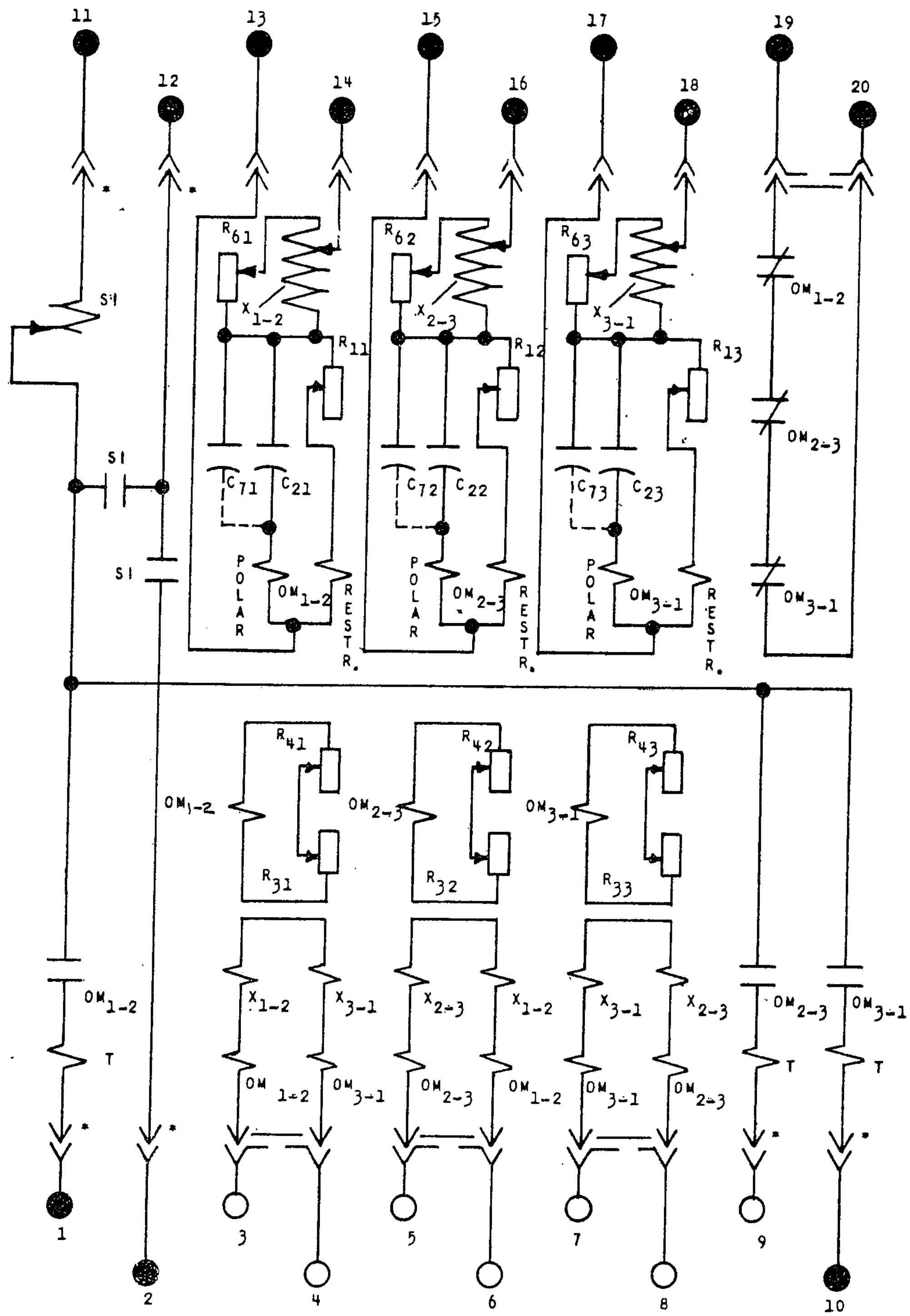
The Type CEB13 relays are available in one rating only -60 cycles, 5 amperes, 115 volts. The basic range of ohmic adjustment is 4 to 20 ohms, phase-to-neutral, when set with the factory angular adjustment.

Additional ranges of 2-10 ohms and 1.33 to 6.67 ohms can be obtained by the use of one auxiliary current transformer per phase, mounting externally to the relay. The ohmic setting of each unit is continuous throughout the range.

Type CEB13B relays are available with offset ranges of 0-2 and 0-4 ohms.

The one second thermal rating of the current coils is 130 amperes.

The current closing rating of the normally open contacts is 30 amperes for voltages not exceeding 250 volts. The contacts will close, carry continuously and open 0.3 ampere in circuits up to 250 volts.



OM_{1-2} - TOP UNIT

OM_{2-3} - MIDDLE UNIT

OM_{3-1} - BOTTOM UNIT

X_{1-2} - TOP TRANSACTOR

X_{2-3} - MIDDLE TRANSACTOR

X_{3-1} - BOTTOM TRANSACTOR

* - SHORT FINGER

Fig. 3 Internal Connections Of Type CEB13B Relay (Front View)

TARGET AND SEAL-IN UNIT COILS

The target and seal-in unit coil ratings are given in TABLE II. These ratings are either AC or DC.

TABLE II
TARGET COIL AND SEAL-IN UNIT COIL RATING

	Target Coil		Seal-In Unit Coil	
	0.2 Amp	2.0 Amp	0.2 Amp	2.0 Amp
Operating Range	0.2-2.0	2-30	0.2-2.0	2-30
Resistance	7	0.1	7	0.13
Carry For Tripping Duty	5	30	5	30
Carry Continuously	0.8	6	0.3	3

BURDENS

Because of the presence of the transactor in the relay, the ohmic burdens imposed upon the current and ptotential transformers are not constant, but vary somewhat with the ohmic reach, amount of offset, and current. This variation is of little importance to the current transformer, so that a formula for calculating only the potential burden will be given.

CURRENT CIRCUITS

The maximum current burden imposed on each C.T. with a practical setting at 5 amperes, 115 volts and 60 cycles is given in Table III.

TABLE III
CURRENT CIRCUIT BURDEN

R	X	Z	WATTS	VARS	VA
0.31	0.50	0.59	7.8	12.5	14.7

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

POTENTIAL COILS

The maximum potential burden imposed on each P.T. with a practical setting at 115 volts, 5 amperes and 60 cycles is given in Table IV.

TABLE IV
POTENTIAL CIRCUIT BURDEN

WATTS	VARS	VA
8.9	4.7	10.1

The potential burden is altered by changing the restraint setting in order to obtain the proper reach, as well as by changing the offset adjustment. The equations below cover the condition of minimum ohmic setting. The burden will be decreased if the ohmic setting is increased.

$W + jV$ = Volt Ampere Burden on Potential Device or Potential Transformer

E = Relay Terminal Voltage (ϕ - ϕ)
I = Relay Current
Z_L = Line-to-Neutral ohms seen by Relay $= \frac{E\phi - N}{I}$
Z_0 = Ohmic Offset Setting of Relay
θ = Power Factor Angle of Load
ϕ = Angle of Offset

$$W + jV = \frac{E^2}{Z_S}\sqrt{1 + 2\frac{Z_0}{Z_L}\cos(\phi - \theta) + \left(\frac{Z_0}{Z_L}\right)^2} \quad (1)$$

$$\text{where } Z_S = 1160 + j614 + Z_0{}^2\ (4.5 \times j74.5) \quad (2)$$

Table V lists the results for Z_S when various values of Z_0 are substituted into equation (2).

TABLE V

Z_0	Z_S
0.25	1160 + j615
0.5	1161 + j618
1	1164 + j628
2	1178 + j672
3	1200 + j744
4	1232 + j844

CONSTRUCTION AND CIRCUITRY

MHO UNIT

The relay has 3 units, each unit being an offset mho unit; i.e., it has a circular impedance characteristic similar to that of the basic mho unit except that it is offset so as to encircle the origin of the impedance diagram instead of passing through it. The schematic connections for this unit are shown in Fig. 4. The two side poles, energized with phase-to-phase voltage, produce the polarizing flux which interacts with the flux produced in the back poles energized with a percentage of the same voltage to produce the restraint torque in the relay. The flux produced in the front pole, energized with the two line currents associated with the phase-to-phase voltage used, interacts with the polarizing flux to produce the operating torque. The torque equation for zero offset at pickup is therefore:

$$T = 0 = EI\cos(\phi - \theta) - KE^2$$

where E is the phase-to-phase voltage
I is the delta current ($I_1 - I_2$)
θ is the angle of maximum torque of the relay.
ϕ is the power factor angle
K is a design constant

Dividing through by E^2 and transposing reduces the equation to:

$$Y\cos(\phi - \theta) = K$$

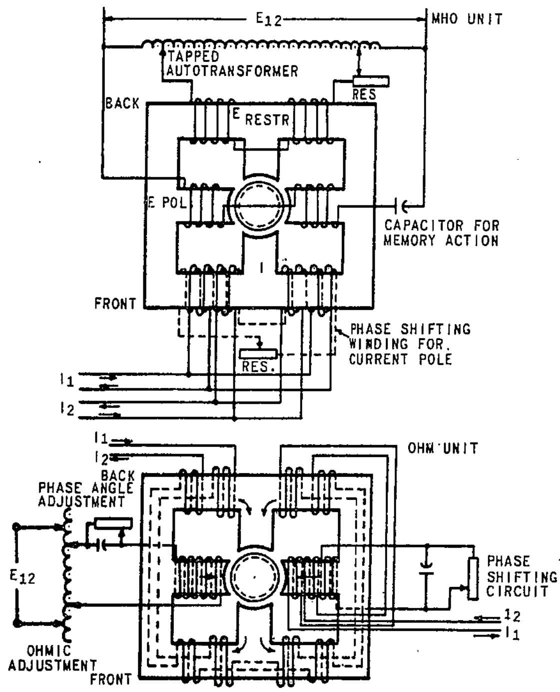


Fig. 4 Schematic Connections For MHO Unit Of Type CEB13B Relay

Fig. 4 (6305890)

Thus, the relay will pick up at a constant component of admittance at a fixed angle depending upon the maximum torque angle of the unit, hence the name mho unit.

TRANSACTOR

The relay has 3 offset mho units. The offset is provided by the voltage drop across a transactor in the current circuit in conjunction with an element which is otherwise simply a mho unit. Transactor is the name given to a reactor which has a secondary winding with a step-up ratio to provide more reactance with less burden on the current circuit. Taps on the secondary winding provide a selection of offset of 0, 1, 2, 3, and 4 for the 4 ohm transactor and 0, 0.5, 1, 1.5 and 2 ohms for the 2 ohm transactor.

CONTACTS

The contacts of the Type CEB13B relay are made of fine silver for low contact resistance and are of the ideal design of two cylinders at right angles, which provides a point contact without actually using a pointed contact. To protect the contacts from damage caused by high operating torques under short-circuit conditions, a felt clutch is provided between the shaft and the contact arm.

INSTALLATION

RECEIVING

These relays, when not included as a part of a control panel, will be shipped in cartons designed to protect them against damage. Immediately upon receipt of the relay, an examination should be made for any damage sustained during shipment. If injury or damage resulting from rough handling is evident, a claim should be filed at once with the transportation company and the nearest Sales Office of the General Electric Company notified promptly.

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

INSPECTION

Before placing a relay into service, the following mechanical adjustments should be checked and faulty conditions corrected according to instructions given under MAINTENANCE.

There should be no noticeable mechanical friction in the rotating structure of the mho units and the moving contacts should barely 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 in 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 tap plugs.

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

All contact surfaces should be clean.

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

SETTINGS

The ohmic offset of the mho unit may be varied from 0-2 or 0-4 (depending on the relay model) by changing the tap setting of the offset tap block.

The setting of each mho unit, defined as the diameter of its ohmic characteritstic, becomes equal to the ohmic reach plus the offset. The phase-to-neutral setting (with no offset) may be calculated from equations (3) and (4) when the angular settings of the operating element and the transactor are the same.

$$Z\text{ (setting)} = Z_R + Z_O \qquad (3)$$

$$Z_R = \frac{Z_L^2 + Z_O\ Z_L \cos(\theta - \phi)}{Z_O + Z_L \cos(\theta - \phi)} \qquad (4)$$

where Z_L = Desired ohmic reach at angle If the angle θ and ϕ are different.

Z_O = Ohmic Offset

Z_R = Ohmic reach at angular setting of unit

θ = Angular setting of unit

ϕ = Angle of the Line

CHECK TESTS

CALIBRATION

To eliminate the errors which may result from possible instrument inaccuracies a test circuit has been selected which requires no instruments for checking the reach and maximum torque angles. Such a circuit is shown in Fig. 5. In Fig. 5 $R_S + X_S$ is the source impedance, S_F is the fault switch and $R_L + X_L$ 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 per cent and 1 per cent steps so that the line impedance $R_L + X_L$ may be made to appear to the relay very nearly 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.

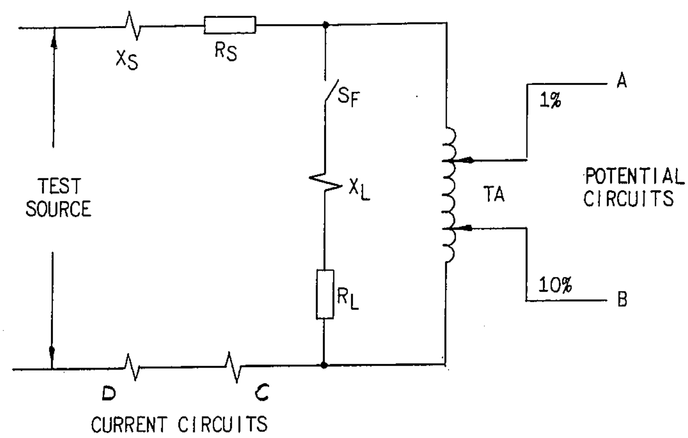


Fig. 5 Schematic Test Connections for Type CEB13B Relay

Fig. 5 (459A299)

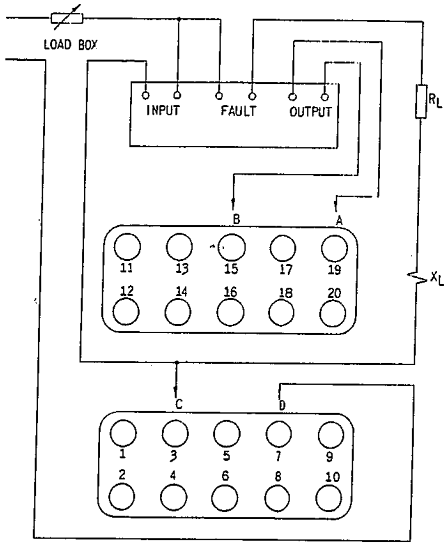
For convenience in field testing the fault switch and tapped autotransformer of Fig. 5 have been arranged in a portable test box, Cat. No. 102L201, which is particularly adapted for testing directional and distance relays. The box is provided with terminals to which the relay current and potential circuits 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 GEI-38977.

Other equipment required includes:

- Load Box
- Tapped Test Reactor
- Tapped Test Resistor
- Voltmeter
- Ammeter
- Test Plugs

To check the calibration of the mho units is is suggested that the test box Cat. 102L201; test reactor (Cat. 6054975); and test resistor (Cat. 615B546) be arranged with the type XLA test plugs as shown in Fig. 6. This circuit is similar to that shown in Fig. 5, except that the source impedance $R_S + X_S$ is replaced by the load box which controls the level of the fault current and produces the source voltage drop.

Since the reactance of the test reactor may be very accurately determined from its calibration curve, it is desirable to check relay pickup with the fault reactor alone, due account being taken of the angular difference between the line reactance, X_L, and the relay angle of maximum reach. The



TO TEST UNIT	CONNECT LEADS TO RELAY TERMINALS				JUMPER TERMINALS
	A	B	C	D	
TOP	13	14	3	5	4 & 6
MIDDLE	15	16	5	7	6 & 8
BOTTOM	17	18	7	3	8 & 4

Fig. 6 (459A298)

Fig. 6 Test Connections for Type CEB13B Relay Using the Test Box 102L201

line reactance X_L, selected should be the test reactor tap nearest above twice the mho unit reach with account being taken of the difference in angle of the test reactor impedance and the relay angle of maximum reach. Twice the relay reach at the angle of the test reactor impedance is:

$$2\ Z\,(\text{Relay}) = 2\ Z\,(\text{p-n})\cos(\theta - \phi) \quad (5)$$

where ϕ is the angle of the test reactor impedance, θ is the relay angle of maximum reach and Z p-n is actual relay reach, phase-to-neutral. The test-box autotransformer percent tap for the mho-unit pickup is given by:-

$$Z\ \text{tap} = \frac{2Z\ \text{Relay}}{Z_L}\ (100) \qquad (6)$$

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 4 ohms (p-n) minimum at a maximum torque angle of 75 degrees. In determining the reactor tap setting to use it may be assumed that the angle of the test impedance is 80 degrees. From the above, twice the relay reach at the angle of the test-reactor impedance is:-

$$2Z\ \text{Relay} = 2\ \frac{4}{1.0}\ \cos(80-75) = 7.97\ \text{ohms}$$

Therefore, use the reactor 12 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 degrees. Table VI shows the angles for each of the reactor taps.

TABLE VI

TAP	ANGLE ϕ	COS $(\theta-\phi)$
24	88	0.973
12	87	0.976
6	86	0.980
3	85	0.984
2	83	0.989
1	81	0.994
0.5	78	0.988

From Table VI it is seen that the angle of the impedance of the 12 ohms tap is 87 degrees. Therefore:

$$2Z\ \text{relay} = 2\ \frac{4}{1.0}\ \cos(87-75) = 7.82\ \text{ohms}$$

The calibration curve for the portable test reactor should again be referred to in order to determine the exact reactance of the 12 ohm tap at the current level being used. For the purpose of this illustration assume that the reactance is 12.2 ohms. Since the angle of the impedance of the 12 ohm tap is 87 degrees, the impedance of this tap may be calculated as follows:-

$$Z_L = \frac{X_L}{\cos 3} = \frac{12.2}{.9986} = 12.217$$

From this calculation, it it 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:-

$$Z\ \text{tap} = \frac{7.82}{12.2}\ \text{X}\ 100 = 64\%$$

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 12 or 6 ohm taps of the specified test reactor, impedances at 60 degrees and 30 degrees respectively will be available for checking the mho unit reach at the 60 degree and 30 degree positions. The mho-unit reach at the zero-degree position may be checked by using the calibrated test resistor alone as the line impedance. The calibrated test reactor is supplied with a data sheet which gives the exact impedance and angle for each of the combinations available. The test-box autotransformer per cent tap for pickup at a particular angle is given by:-

$$\%\ \text{tap} = \frac{2\ Z\ (\text{p-n})\cos(75^{\circ}-A)}{Z_L}$$

where "A" is the angle of the test impedance (Z_L), Z_L is the 60 degree, 30 degree or zero degree impedance value. As in the case of the previous tests, the load box which serves as a 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 angle of maximum reach of the mho unit as indicated above, there are two factors to keep in mind which affect the accuracy of the results. First, when checking the mho unit at angles of more than 30 degrees off the maximum reach position, the error becomes relatively large with phase angle error.

Second, the effect of the control spring should be considered when testing a mho unit since it can only have a perfectly circular characteristic when the control-spring torque is negligible. For any normal level of polarizing voltage, the control spring may be neglected but in testing the mho unit as indicated above it may be necessary to reduce the test box autotransformer tap setting to a point where the voltage supplied to the unit may be relatively low. This reduces the torque level since the polarizing as well as the restraint torque will be low, making the control spring torque no longer negligible. The result of the control spring at low polarizing voltage is to cause the reach of the mho unit to be reduced.

In addition to the above tests on the mho units, they may also be checked for directional action with the test box circuits as shown in Fig. 6. The fault resistor R_L may be zero and the test reactor should be set on the 0.5 ohm tap. With connections made as shown, the unit contacts should close from 6 to 60 amperes with 1.5 volts applied.

CLUTCH

The clutch on each unit should slip at a torque corresponding to approximately 50 grams applied at the contact normal to the contact arm.

CONTACTS

The relay contact circuits should be given an electrical test by closing each of the mho unit contacts by hand.

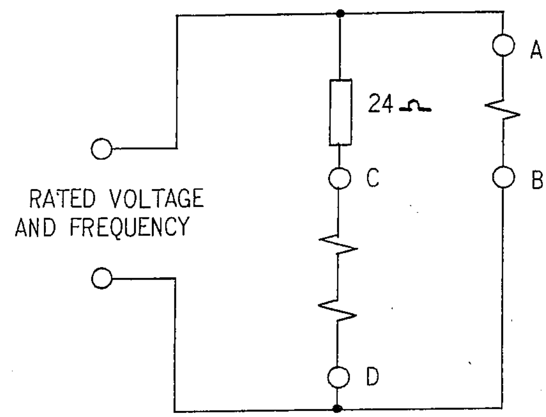
POLARITY

Connect as shown in Fig. 7. Put the offset taps in zero. Apply rated voltage at rated frequency.

With the current circuit open (lead removed from stud 3, 5 or 7) there should be a strong torque holding the contacts open. With the current circuits restored and a card placed under the sliders of R_{11}, R_{12}, and R_{13}, the unit should operate to close its contacts. (See Fig. 1.)

OVERALL TESTS

Overall tests on current transformer polarities, relay connections and wiring can be made on the complete installation. Referring to Fig. 8, a check of the indicated phase angle meter readings will indicate that the relay is receiving the proper voltages and currents from the connections to the current and potential transformers for the conventional connections shown in Fig. 9.



TO TEST UNIT	CONNECT LEADS TO TERMINALS				JUMPER TERMINALS
	A	B	C	D	
TOP	13	14	3	5	4 & 6
MIDDLE	15	16	5	7	6 & 8
BOTTOM	17	18	7	3	8 & 4

NOTE: TEST ONE UNIT AT A TIME.

Fig. 7 Test Connections For Checking Polarity Of The CEB13B Relay

Fig. 7 (104A8525)

LOCATION AND MOUNTING

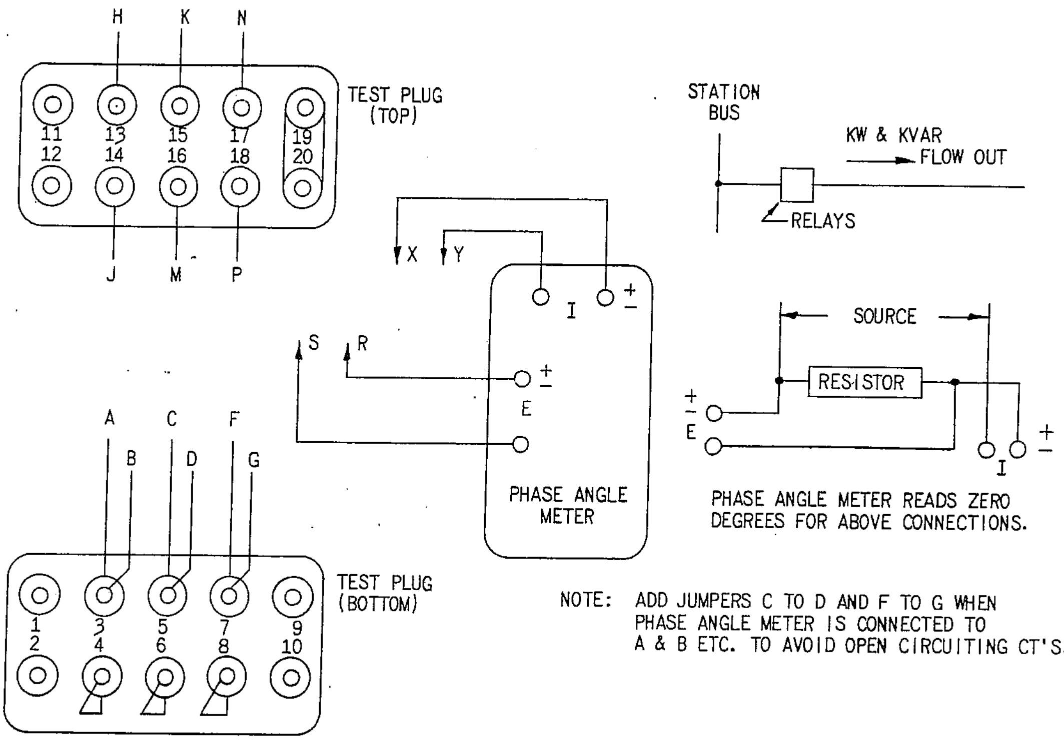
The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

The relay should be mounted on a vertical surface. The outline and panel drilling diagram is shown in Fig. 12.

CONNECTIONS

The internal connection diagram for the CEB13B relay is shown in Fig. 3. Typical wiring diagrams are given in Figs. 9 and 11.

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.



NOTE: ADD JUMPERS C TO D AND F TO G WHEN PHASE ANGLE METER IS CONNECTED TO A & B ETC. TO AVOID OPEN CIRCUITING CT'S.

CAUTION: BEFORE MAKING THESE TESTS IT IS ESSENTIAL TO ESTABLISH THAT THE KW AND KVAR METERS ARE PROPERLY CONNECTED IN THE CT AND PT CIRCUITS.

POWER FACTOR ANGLE (DEG. LEAD) →	PROPER READING FOR PHASE SEQUENCE 1-2-3							
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-360
KW AND KVAR DIRECTIONS WITH RESPECT TO THE BUS	KW OUT > KVAR IN	KVAR IN > KW OUT	KVAR IN > KW IN	KW IN > KVAR IN	KW IN > KVAR OUT	KVAR OUT > KW IN	KVAR OUT > KW OUT	KW OUT > KVAR OUT
RELAY CONNECTIONS: R TO H AND S TO J, X TO B AND Y TO A	330-15	15-60	60-105	105-150	150-195	195-240	240-285	285-330
R TO K AND S TO M, X TO D AND Y TO C	330-15	15-60	60-105	105-150	150-195	195-240	240-285	285-330
R TO N AND S TO P, X TO G AND Y TO F	330-15	15-60	60-105	105-150	150-195	195-240	240-285	285-330
	PROPER READING FOR PHASE SEQUENCE 1-3-2							
R TO H AND S TO J, X TO B AND Y TO A	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30
R TO K AND S TO M, X TO D AND Y TO C	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30
R TO N AND S TO P, X TO G AND Y TO F	30-75	75-120	120-165	165-210	210-255	255-300	300-345	345-30

THE VOLTAGE CONNECTIONS TO R AND S OF THE PHASE ANGLE METER ARE FOR THE CONDITION WHEN THE CEB13B IS USED TO START CARRIER FOR FAULTS IN THE NON-TRIPPING DIRECTION. WHEN THE CEB13B IS USED AS A BACKUP RELAY IN THE TRIPPING DIRECTION, THE CONNECTIONS TO R AND S SHOULD BE INTERCHANGED.

THE ABOVE RANGES OF PHASE ANGLE METER READINGS ARE THE ANGLES BY WHICH THE CURRENT LEADS THE VOLTAGE WITH THE DESCRIBED CONDITIONS OF POWER (KW) AND REACTIVE POWER (KVAR) FLOW WITH THE STATION BUS CONSIDERED AS THE REFERENCE IN ALL CASES.

CORRECTIONS SHOULD BE MADE FOR METER ERRORS ON LOW CURRENTS, INHERENT IN SOME PHASE ANGLE METERS.

Fig. 8 Test Connections For Checking Wiring And Transformer Polarities Of The CEB13B Installation

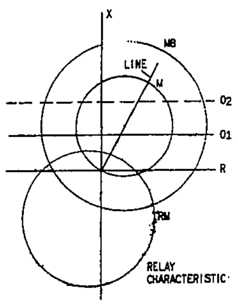
CHANNEL CUTOFF SWITCH (CCS) 16SB1DB211			
CONTACTS (HANDLE-END)		BACK VIEW	
		CHANNEL OFF	CHANNEL ON
1 1C 2C 2	1		X
	2		X
3 3C 4C 4	3		X
	4		X
5 5C 6C 6	5	X	
	6	X	
7 7C 8C 8	7		X
	8		X

CHANNEL TEST SWITCH (TS) 16SB1BB499					
CONTACTS (HANDLE-END)		BACK VIEW			
		SEND	NOR	REC.	R.S.
1 1C 2C 2	1		X		
	2		X		
3 3C 4C 4	3		X	X	X
	4	X	X	X	
SPRING RETURN TO NORMAL					

TABULATION OF DEVICES			
TYPE OR DESCRIPTION		INT. CONNS.	OUTLINE
AUX. CT-JY-4			K-4123813
BCA11AS		418A997	K-6209272
CHANNEL CUTOFF SWITCH	SB-1	16SB1DB211	116A130
CHANNEL TEST SWITCH	SB-1	16SB1BB499	116A130
CEB13B		K-6556411	K-6209276
CEB12B		K-6376686	K-6209274
CLPG12B		418A899	K-6209276
CARRIER SET 4CS12A1	125V	C-7776154	TYPICAL CARRIER SETS
CARRIER SET 4CS12A2	250V	C-7776155	
GCX17A OR GCX17B		K-6375826	K-6209276
JBCG52E (INVERSE)		418A866	K-6209276
JBCG54E (VERY INVERSE)		418A869	K-6209276
MILLIAM. DO-71 (SEMI-FLUSH)			K-8904776
MILLIAM. MOD-301 (SURFACE)			376A914
NAA22A		K-6400699	K-6209272
RPM11D	125V	K-6209282	K-6209272
RPM11D	250V	K-6400680	K-6209272
TEL. JACK			K-6400578
WHITE LAMP			K-6151144
RECTIFIER-295B233G1 FOR 21X	125V	418A964	418A964
HGA14AM BACK CONN. (IF		K-6400533	K-6400533
HGA14AL FRONT CONN.) USED		377A139	377A139
RHEOSTAT-RES. SIG. TEST			418A774

NOTE 3:-USE AUXILIARY CT'S AS SHOWN IF NECESSARY TO REDUCE REACH OF 68CB. OTHERWISE MAKE DASH CONNECTIONS.

LEGEND			
DEVICE NO.	DEVICE TYPE	INCL. ELEM.	DESCRIPTION
21X	RPM		TIMING RELAY
		T1	ZONE #1 TARGET
		T2	ZONE #2 TARGET
		T3	ZONE #3 TARGET
		TU	TIMING ELEMENT
		TX	AUX. FOR TIMING ELEMENT
21	GCX		REACTANCE-TYPE STEP DISTANCE RELAY
		OC	OVERCURRENT UNIT GCX17B ONLY
		M	MHO-TYPE STARTING UNIT
		O	REACTANCE-TYPE OHM UNIT
		OX	ZONE-TRANSFER AUXILIARY FOR O
		S	COORDINATING AUXILIARY RELAY
		T&SI	TARGET & SEAL-IN
		SI	SEAL-IN
52		a	CIRCUIT BREAKER-AUXILIARY SWITCH
67GB	JBCG		GROUND DIRECTIONAL OVERCURRENT RELAY
		D	DIRECTIONAL UNIT
		IOC	INSTANTANEOUS UNIT
		TOC	TIME OVERCURRENT UNIT
		T&SI	TARGET & SEAL-IN
		SI	SEAL-IN
67GC	CLPG		CARRIER GROUND DIRECTIONAL RELAY
		G1	CARRIER GROUND BLOCKING UNIT
		G2	CARRIER GROUND TRIPPING UNIT
		GD	CARRIER GROUND DIRECTIONAL UNIT
		GD1X	AUX. TO CONTINUE GROUND BLOCKING
		SI	SEAL-IN UNIT (GROUND)
		T	TARGET
68CB	CEB13		CARRIER BLOCKING RELAY
		RM	OFFSET MHO UNIT
		TR	TRANSACTOR
68SB	CEB12		OUT-OF-STEP BLOCKING RELAY
		MB	OFFSET MHO UNIT
		OB	OUT-OF-STEP BLOCKING AUXILIARY
		TR	TRANSACTOR
85	BCA		CARRIER CURRENT AUXILIARY RELAY
		R	RECEIVER RELAY OPERATING COIL
		RH	RECEIVER RELAY HOLDING COIL
		GDX	AUX. TO GD
		MX	AUX. TO M
		T	TARGET
85X	NAA		CARRIER AUXILIARY RELAY
		KX	RECLOSURE INITIATING AUXILIARY
		RA	RECEIVER ALARM UNIT
		TB	RECLOSURE BLOCKING AUXILIARY
94	HGA		AUX. FOR TRIPPING TWO CIRCUIT BREAKERS
CCS			CHANNEL CUTOFF SWITCH
TS			CHANNEL TEST SWITCH



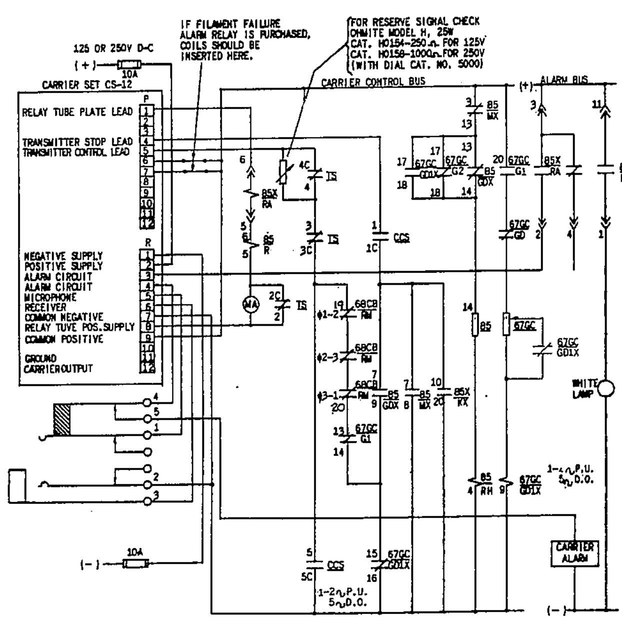


Fig. 9 Elementary Diagram for Carrier Pilot

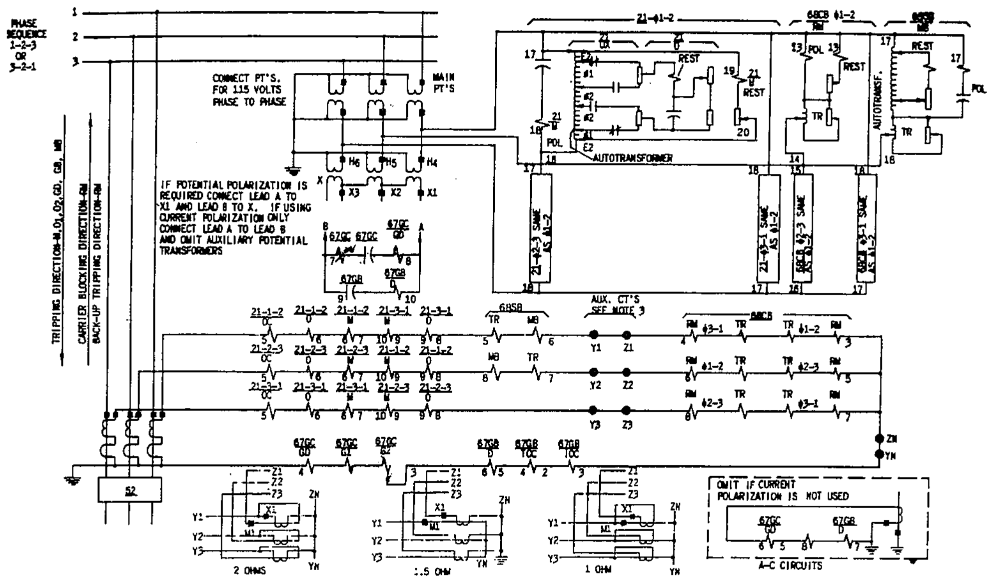


Fig. 9 (7021B83AA Sht. 1)

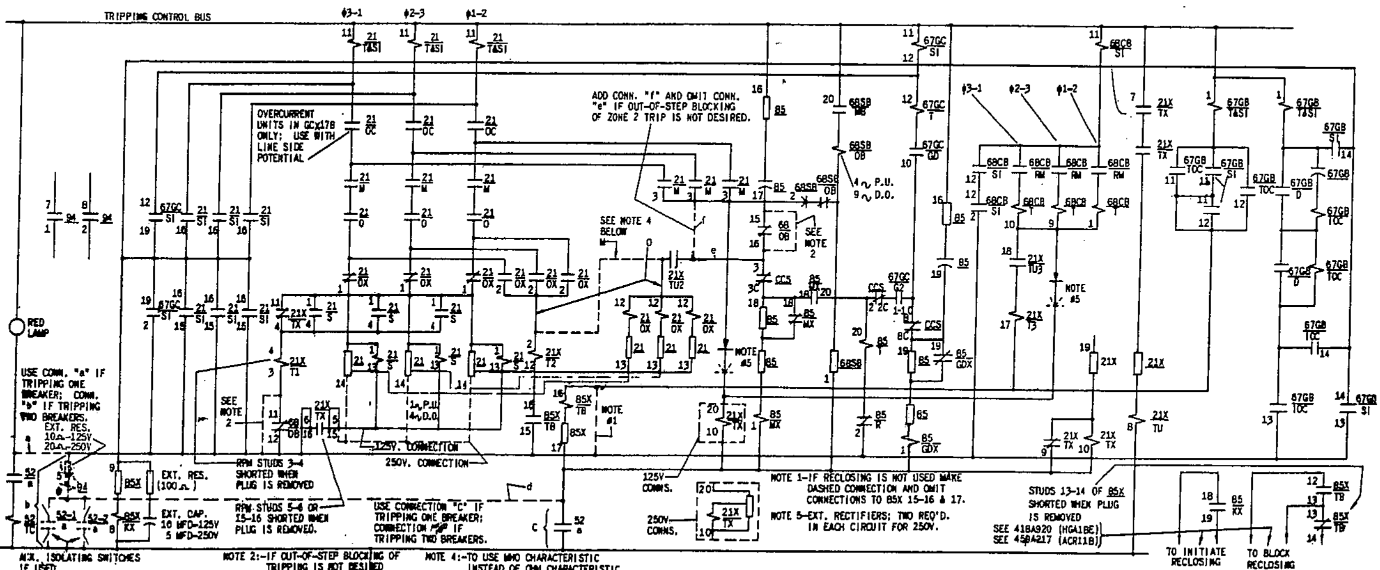


Fig. 9 (7021B83AA Sht. 2)

Relaying with Types GCX17 and CEB13B Relays

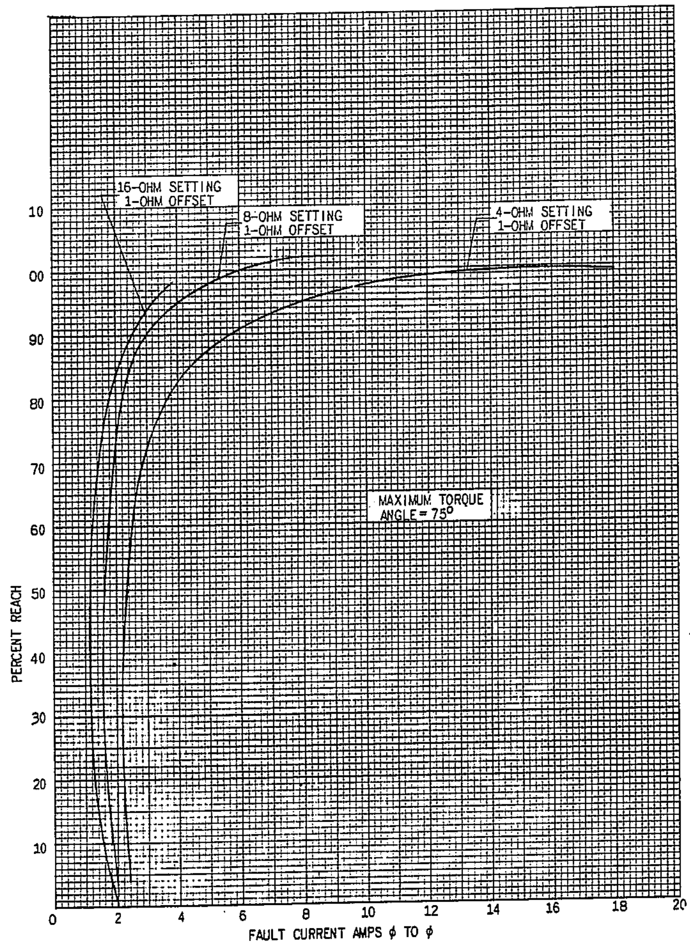


Fig. 10 Accuracy Curves For Type CEB13B Relay At The Maximum Torque Angle And One Ohm Offset

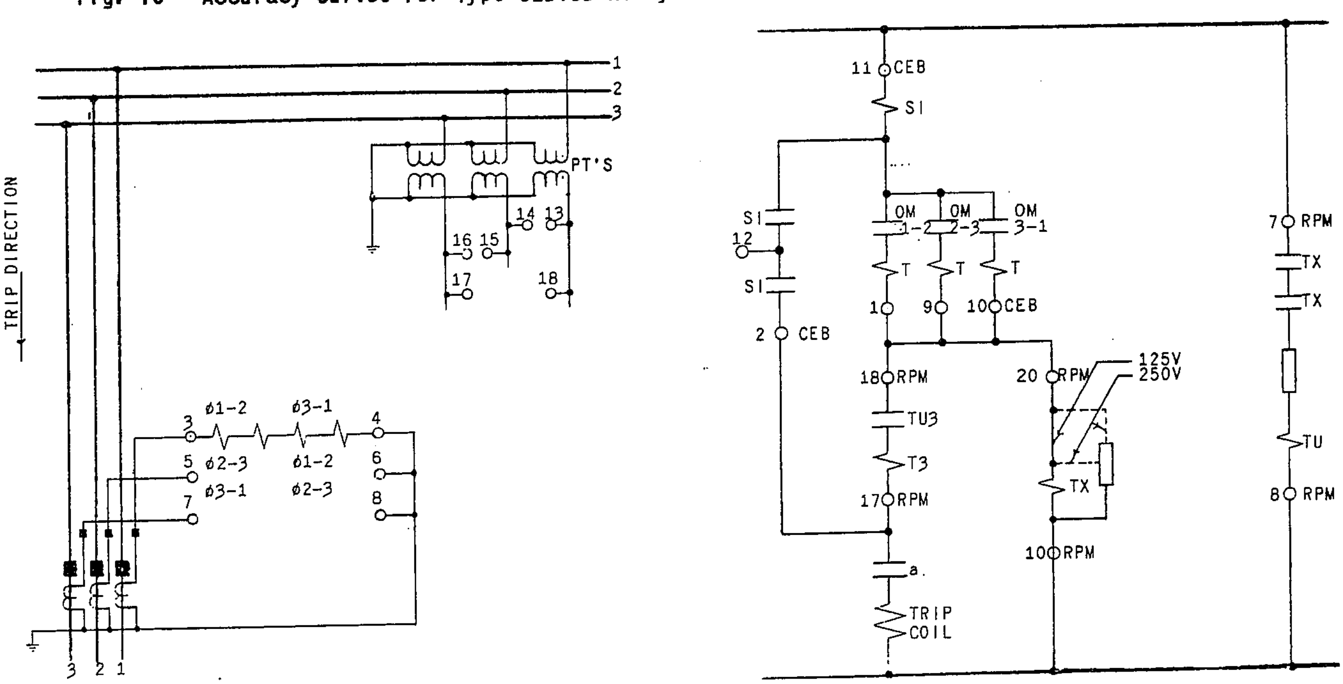


Fig. 11 External Connections For Type CEB13B Relay With Type RPM Timer In A Backup Application

Fig. 12 (K-6209276)

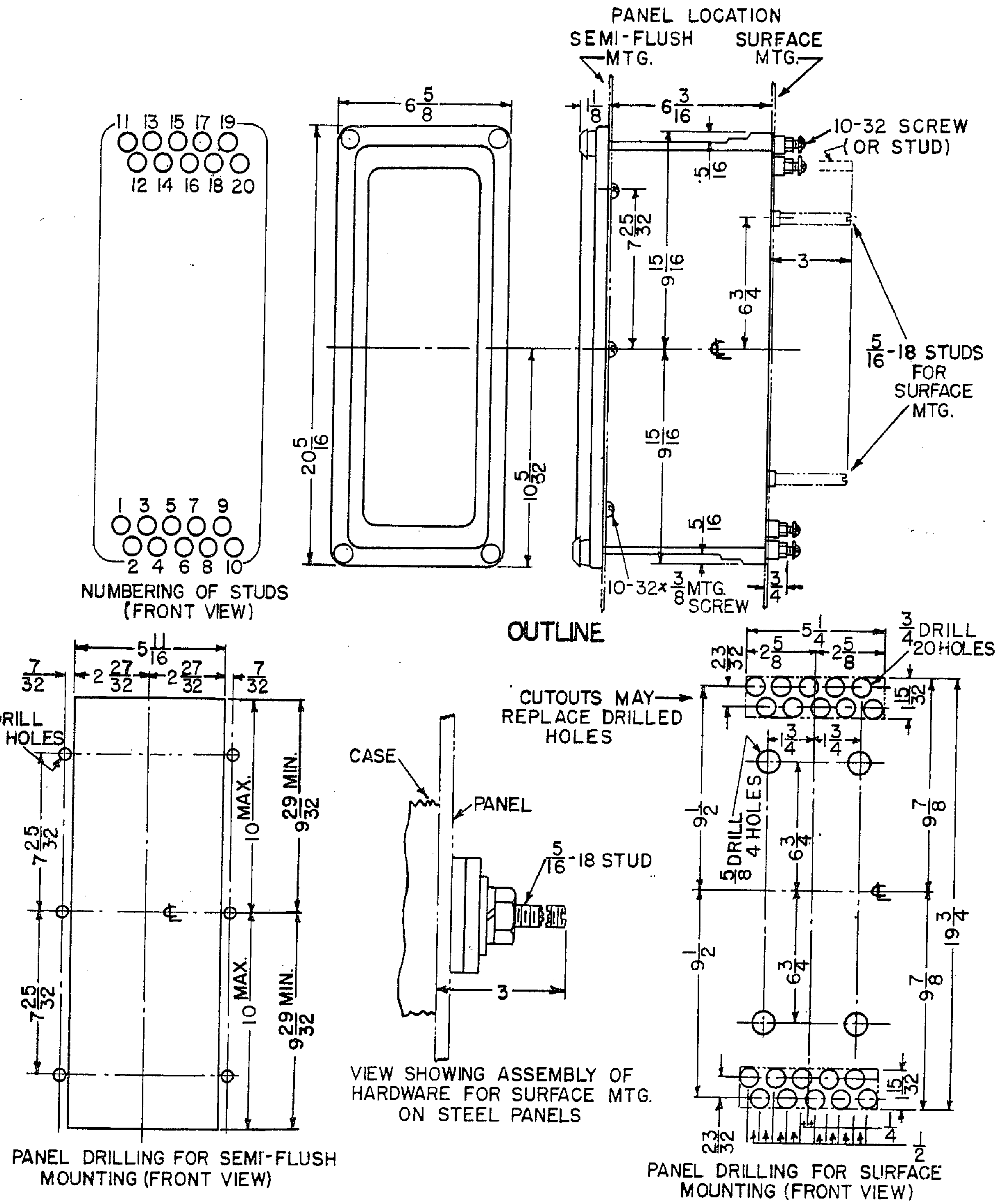


Fig. 12 Outline and Panel Drilling Dimensions Diagram for Type CEB13B Relay

MAINTENANCE

PERIODIC TESTS

FIELD TESTS

The relay should receive a periodic mechanical inspection with an electrical test to check the reach of each of the units at one point on the circle diagram. For this inspection and these tests refer to the INSTALLATION SECTION of this book.

RECALIBRATION TESTS

Pickup

The pick-up current at maximum torque is determined from the equation:

$$I = \frac{E}{2Z} \qquad (7)$$

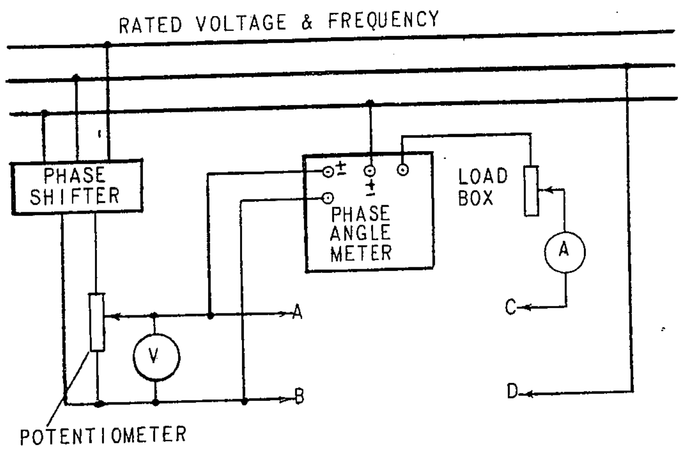
(using the connections of Fig. 13) where E is the relay terminal voltage and Z is the required ohmic reach, phase to neutral.

The procedure in making the pickup adjustment should be:

1. Determine the required diameter of the impedance characteristic circle. This equals the sum of the desired backward reach (offset) and the desired forward reach.

2. With zero offset, adjust the reach to the diameter which has been determined; this means setting pick-up current according to equation (7) above. Pick-up current is adjusted by varying the restraint circuit resistors, R_{11}, R_{12}, or R_{13}. (See Fig. 1.)

3. Set the offset tap plug in the appropriate tap.



TO TEST UNIT	CONNECT LEADS TO TERMINAL				JUMPER TERMINALS
	A	B	C	D	
1-2	13	14	3	5	4 & 6
2-3	15	16	5	7	6 & 8
3-1	17	18	7	3	8 & 4

Fig. 13 Test Connections For Type CEB13B Relay

Fig. 13 (6400773)

Angle of Maximum Torque

If it is necessary to change the maximum torque angle of the units, this is done by changing the resistance of R_{31} plus R_{41} for unit M_{1-2} etc. An increase in this resistance will increase the maximum torque angle. In making this adjustment the relay should be connected according to Fig. 13 so the maximum torque angle can be checked after each adjustment.

Transactor Adjustment

The angular setting of the transactor for the M_{1-2} unit can be changed to match any change in the angular setting of the operating element by means of the resistance R_{61}. The test circuit of Fig. 13 should be used and two ohmic characteristic curves similar to Fig. 2 plotted, one with offset, and one without offset. Draw the best circle approximating each of the curves and mark the position of their centers. A line joining the centers gives the angle of the offset. To decrease the angle, turn R_{61} to the left.

When checking the ohmic characteristic curve in the offset direction, apply sufficiently low voltages so that excessive currents are not necessary to cause the unit to pick up. High currents not only cause the unit to overheat but give erroneous results due to transactor saturation (saturation occures at approximately 60 amperes). For example, with the one quarter ohmic offset tap, transactor saturation makes it impossible for the unit to operate at the angle of maximum offset reach if the voltage is greater than approximately 25 volts.

SERVICING

INSTALLATION OF RENEWAL PARTS

All stationary contact parts can be installed directly in place by removing the appropriate screws.

The jewel screw can be removed from each unit by means of an offset screw driver or an end wrench. When turning a jewel screw into 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.

To replace a moving contact arm, control spring, or clutch friction washers from the two lower units, or the clutch friction washers from the top unit, require more time and care.

By removing the middle unit from the relay, the unit becomes accessible, and at the same time provides access to the bottom unit. The top unit can be made accessible by removing the two screws holding the front of the molded inner block to the top of the cradle and tilting up the front of the inner block.

To remove the middle unit: dismount the tap block and swing it outside of the cradle. This permits access to the four splices of the current leads to the unit. Open these splices, tagging all leads carefully. Trace each of the four leads from the polarizing and restraining coils to their points of connections, tagging carefully. Remove the lead from the stationary contact block, and the lead from stud two. Pull the four potential leads and the moving contact lead (to stud two) through to the front of the relay. Remove the four screws holding the unit's mounting plate to the cradle strap and draw the unit from the cradle with R_{42} still mounted to its top bearing support.

When removing 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 (with its rheostat still mounted on the right side) should be pried straight up off its dowel pins, taking the upper pivot and spring adjusting arm with it. Exercise caution 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.

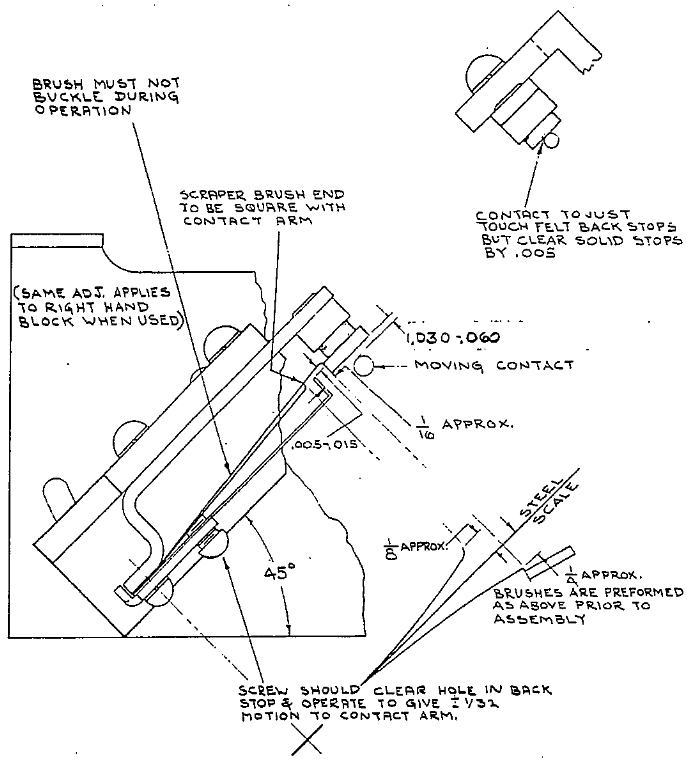


Fig. 14 Contact Adjustment Diagram of Type CEB13B Relay

Fig. 14 (365A400)

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

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 structure will then slide off the shaft.

To reassemble, reverse the procedure. Considerable care is necessary in soldering the spiral springs so that neighboring turns do not touch. Do all forming of the spirals near the mounting post and do not make any bend sharper than 1/32 inch radius. A stamp on the back of the upper contact support and one of its supporting posts indicates the proper position of the support on the dowels.

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 throughly. 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 is included in the standard relay tool kit obtainable from the factory.

CONTACT ADJUSTMENT

The contacts should have .030 inch to .060 inch gap. Refer to Fig. 14 for further dimensions. If the stationary contact is replaced, the following precautions should be observed. The brush should be carefully formed so that the silver contact meets its backstop simultaneously along their entire line of contact. The contact brush along with the 0.003 inch scraper brush in front of it should be formed so that the contact brush has the minimum initial tension which will bring the wipe within the above limits. The adjusting screw for the brushes should not be used for more than one-eighth of a turn of effective adjustment.

SPRING ADJUSTMENT

Before the control spring of each unit can be adjusted, the ohmic adjustment rheostats must be at their maximum value (full counterclockwise rotation). With the circuit of Fig. 13, apply 6 amperes and 1.15 volts at the angle of maximum torque (285° current leading voltage), adjust the control spring so that the left contacts will just close.

CLUTCH ADJUSTMENT

The clutch on each unit is adjusted by means of the steel collar at the upper end of the rotating shaft. The clutch should slip at a torque corresponding to approximately 50 grams applied at the contact normal to the contact arm. To adjust the clutch, loosen the set screw in the collar, rotate the collar on the shaft through the number of half turns (there is a groove for the set screw on the shaft) necessary to obtain the correct pressure. Moving the collar down increases the clutch pressure. Then lock in place by means of the set screw which should be inserted into the hole of the collar which is in front of the groove in the shaft.

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. If possible, give the General Electric Company requisition number on which the relay was furnished. For a listing of renewal parts refer to GEF-3936.

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