ALSTOM

YCGF

Field Failure Relay

Operation, Maintenance and Commissioning Instructions R5628F

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OPERATION, MAINTENANCE AND COMMISSIONING INSTRUCTIONS FOR FIELD FAILURE RELAY - TYPE YCGF

The YCGF relay detects loss of field supply or reduction in the field current of a synchronous generator beyond the machine stability limit. It is basically a single phase mho relay and, when plotted on an RX diagram, its characteristic encircles the -X axis and is offset from the origin as shown in Figure 1.

The relay movement is a high speed induction cup unit with operating, restraint and bias windings. Adjustment of the ohmic values of the diameter and offset of the relay characteristic circle is provided by combinations of plugboard and potentiometer settings K_1 K_2 K_3 K_4 and K_5.

K_1 potentiometer is in the restraint circuit and provides fine adjustment of the characteristic circle diameter.

K_2 potentiometer is in the polarising circuit and should be set to coincide with the offset taps K_3 and K_4 to establish the maximum torque angle at all offset settings.

The characteristic offset is obtained by injecting voltage from the current circuit into the voltage circuit through a transactor. Taps for this transactor are brought out to plugboard K_3 K_4 and combinations of the two plug settings provide adjustment of the offset setting.

K_5 plugboard allows coarse adjustment of the characteristic circle diameter by selection of taps on an auto-V.T. in the restraint circuit.

NOTE : External and internal connections to the relay are shown in Figures 2 and 3 respectively.

CIRCLE DIAMETER

The diameter of the characteristic circle ($K_5 \times K_1$) is continuously adjustable between 5-50 ohms (phase-neutral). (5 amp relay).

OFFSET

The offset is adjustable between 0.5-4 ohms in 0.5 ohm steps (5 amp relay). The equation for the setting is :

Offset = $K_3 + K_4 = K_2$

MAXIMUM TORQUE ANGLE

The relay has a leading maximum torque angle of 90°.

ACCURACIES

Circle diameter :	$\pm$ 10% of nominal for all settings, for voltages of 25 - 110V.
Offset :	$\pm$ 10% of nominal for all taps, for voltages of 25 - 110V.
Maximum torque angle :	90° leading $\pm 5^{\circ}$ on all taps or settings.

RATINGS

5A and 110V at 50Hz.

5A and 115V at 60Hz.

1A versions of the relay are also available and the ohmic setting ranges for these are obtained by multiplying the 5A relay settings by 5.

BURDEN

The burdens imposed on the C.T. and V.T. circuits vary with the relay setting and the phase angle of the current.

	50Hz	60Hz
Maximum C.T. burden/phase	2.76 VA	2.72 VA
Maximum V.T. burden	7.33 VA	7.26 VA

C.T. REQUIREMENTS

Minimum knee point voltage $V = 1.5\, I\, (0.11 + R_L + R_{CT})$

where I = C.T. secondary current corresponding to full load rating of the generator.

R_L = loop lead resistance.

R_{CT} = C.T. secondary resistance.

RECEIVING

The relays are despatched either as part of a panel or in cartons designed to protect them from damage.

Relays should be examined immediately on receipt to ensure that no damage has been sustained in transit. If damage due to rough handling is evident, claim, at once to the Transport Company concerned and notify GEC Measurements.

HANDLING

Reasonable care should be taken in unpacking and installing the equipment so that none of the parts are damaged or the settings altered. The packing pieces and rubber bands which protect the various parts must be removed before commissioning.

STORAGE

If the relays are not installed immediately, they should be stored in their original cartons in a place free from dust and dampness. If this is difficult because the climate has high humidity i.e. over 85% peak value, a small source of heat should be provided in the storage room or container to raise the relay ambient temperature $10^{o}C$ above the outside ambient. This will prevent the humidity from exceeding 65%. In tropical applications special packing is employed.

When removing the relays from their cartons after a period of storage, care must be taken that no foreign matter can get into the relay movement to impair its correct operation.

INSTALLATION

LOCATION

The location should be dry, clean, free from dust and excessive vibrations and reasonably well illuminated to facilitate inspection.

MOUNTING

The relay should be mounted on a panel surface vertical within $\pm 5^{o}$.

All drawout cases are suitable for flush or projecting mounting. For flush mounting the case is held in position by adjustable brackets secured to the back of the case. The flange around the front of the case is held by these brackets against the panel : consequently no drilling is required on the panel for fixing screws.

DUST FILTER

A filter breather is fitted on the rear of the drawout case. This ensures that the pressures inside and outside the case remain equal without admitting dust.

COMMISSIONING

PRELIMINARY INSPECTION

Remove the relay cradle from the case and check that all packing pieces are removed and that the contacts can close. Rotate the lefthand cradle latch to the "locked" position and check that the trip circuit isolator closes. Check that terminals 5, 6 and 9, 10 on the relay case have shorting switches fitted. Replace the relay in the case.

SECONDARY WIRING CHECK

Current transformer and voltage transformer pilots should be disconnected and checked through (with a test lamp or bell) to ensure correct phase connections to the relay and then re-connected to the transformers and relay.

INSULATION CHECK

The insulation of the relay and panel wiring should be checked using a 500V Insulation Tester. Tests should be made between all circuits and earth and also between all circuits not intended to be connected together. Any deliberate earths should be removed before the test and replaced after the test.

SECONDARY INJECTION TESTS

1. TEST EQUIPMENT

   The preferred equipment to test the YCGF relay is as follows :

   1 - Phase shifting transformer 440/110V.
   1 - Voltmeter, multirange e.g. Avometer.
   1 - Ammeter, multirange e.g. Avometer.
   1 - Phase angle meter 110 volts, 1 and 5 ampere.
   2 - Variac transformers 250 volts, 2 amps.
   1 - Current control resistances, 125 ohms, 2 amps.
   1 - Interposing CT 2/10 amps (5 amp relays only).

2) MHO CIRCLE CHARACTERISTIC TEST

With the equipment connected as shown in Figure 4, set the relay to the required values of circle diameter (K1K5) and offset (K3 + K4) = K2.

The outer limit of the characteristic can then be checked by first applying rated voltage to the relay and a current from the following table.

1 Ampere Relay

Circle Diameter Setting (K1K5).	26 to 50	50 to 125	125 to 250
Current to be injected (I).	1 Ampere	0.4 Amperes	0.2 Amperes

5 Ampere Relay

Circle Diameter Setting (K1K5).	5.2 to 10	10 to 25	25 to 50
Current to be injected (I).	5 Amperes	2 Amperes	1 Ampere

With the current and voltage applied to the relay, adjust the phase angle meter reading to 90^{o} leading; i.e the injected current leads the applied voltage by 90^{o}.

The voltage should then be reduced until the YCGF relay contacts close. The voltage (Vs) at which this occurs should be as follows:-

Vs = 2I [(K1K5) + (K3+K4)] within 10% accuracy.
Where I is the injected current as given in the tables above.

The inner limit of the relay characteristic can be checked in a similar manner, but the current (I) to be injected should be 2 Amperes for a 1 Ampere rated relay and 10 Amperes for a 5 Ampere rated relay.

The setting voltage (Vs) at which the relay contacts close is given by:-
Vs = 2I (K3 + K4) within $\pm$ 10% accuracy.

NOTE: The contacts will be seen to close as the voltage is raised from zero upwards.

3) MAXIMUM TORQUE ANGLE CHECK (MTA)

The voltage setting (Vs) should first be determined at the outer limit of the circle characteristic and at the nominal M.T.A. of the relay, i.e. 90^{o} lead as described above. The voltage should then be reduced a further 10%. The phase shifting transformer should then be rotated clockwise until the relay contacts open. The phase shifter should then be rotated slowly back towards the M.T.A. until the relay contacts close and a note should be made of the angle θ, at which this occurs.

This procedure should then be repeated in the opposite direction with the phase shifter being first rotated anti-clockwise to open the relay contacts. The phase shifter should then be rotated back towards M.T.A. until the relay contacts close and a note should be made of the phase angle θ_2 at which this occurs.

The maximum torque angle (MTA) of the relay should be equal to $\frac{\theta_1 + \theta_2}{2}$ within $\pm 5^{o}$ accuracy.

4) SYSTEM LOAD TEST

The relay on-load test can best be performed by first removing the relay offset and voltage restraint features. This converts the relay characteristic to a simple directional one as shown in Figure 5 (a) with a M.T.A. at 90^{o} leading.

This conversion is done as follows :

(i) Open circuit plug boards K3, K4 and K5 by removing the plug and inserting a piece of insulation of similar size into the plug hole, e.g. matchstick or p.v.c. covered wire.

(ii) Temporarily link the common sides of plug boards K3 and K4. This is done by withdrawing the relay from its case and linking the two outer connections on the back of plug boards K3 and K4 as shown on Figure 5 (b).

The relay should then be replaced in its case and with the generator supplying at least 15% of full load current, the excitation of the machine should be varied to make the load current both lead and lag the generated voltage. With leading power factors the relay contacts should close and with lagging power factors the relay contacts should open. The operating boundary of the relay can have a tolerance of 5^{o} lagging and 15^{o} leading. This takes into account the $\pm 5^{o}$ tolerance in the relay MTA and the reduction of the 180^{o} directional characteristic due to low load. This is illustrated in Figure 5(a) and should be allowed for when checking for operation of the relay.

On completion of the tests, remove the link from the plug boards K3 and K4. Remove the insulating plugs from plugboards K3, K4 and K5. Replace the standard plugs to give the required mho circle diameter and offset.

MAINTENANCE

The relay requires little maintenance as the induction cup is the only moving part and the static components need no attention. For maintenance or cleaning, the cup unit can, however, be quickly dismantled to the basic components as shown in Figure 6.

Two settings made in the Factory should NOT be disturbed. These are the position of the flat portion on the cylindrical core, which eliminates I^2 torque, and the adjuster vane on the top of the cup itself, which cancels out V^2 torque. The contact arm on the cup is also locked in position and should not be removed as this would disturb the setting of the adjuster vane.

CONTACTS

If the performance of the unit is not correct, first check that the contacts are clean and that the settings are within the limits given below. When cleaning contacts, a flexible burnishing tool should be used. This tool consists of a flexible strip of metal with an etched roughened surface resembling in effect a superfine file.

Never clean contacts with knives, files or abrasive paper or cloth. Knives and files will leave scratches which increase arcing and deterioration of the contact, while abrasive material may leave minute particles of insulating abrasive material in the contacts, and thus prevent closing.

CONTACT SETTINGS

The contact assembly, and clearances are shown in Figure 7. To set these use the following procedure.

(a) Slacken off screws A and B.

(b) Adjust leaf spring D of the horizontal contact C so that the contact just touches and lies parallel to the moulded contact block.

(c) Adjust the rounded end of the second leaf spring E to just touch the first leaf spring D.

(d) Adjust screw A until the contact tips C are 0.023"/0.020" from the moulded pads of the contact block.

(e) Adjust the front screw B until the above gap is reduced to 0.005"/0.008". Lock screw B in position by means of the locknut. Note that the contacts lie parallel with the moulded contact block when in this position.

(f) Check that the moving contact is vertical and that both upper and lower contacts operate simultaneously.

(g) Adjust the clearance between the fixed and moving contacts to 0.025"/0.035" by moving the backstop H and finally locking in position by means of screw J.

(h) The moving contact should then be adjusted to lie against the back-stop H by means of the adjuster arm G, such that the force required (at the counter-balance weight end of the cup unit paxolin arm) to close the contacts is between 3/16 and $\frac{1}{4}$ gram.

Finally, seal all adjustments with varnish.

BEARINGS AND PIVOTS

Ensure that the end play in the shaft is approximately 0.015".

To inspect the bearings and pivots, first remove the contact block by loosening the fixing screws on the bridge and sliding out the block. Next remove the bridge after taking out the screws in the supporting pillars.

The cup can then be lifted out for inspection of the pivots. As the upper bearing is mounted in the bridge it can be easily examined but the lower bearing may have to be inscrewed from its holder. Cracks in the jewel bearing can be detected by exploring the bearing surface with the point of an ordinary needle.

The bearings may be cleaned with petroleum spirits which should afterwards be blown out with compressed air.

SPECIAL TOOLS

A special tool kit is available for relays. It consists of the following items :

Inspection mirror
Spring setting tool
Contact gauge and burnishing tool
Pen torch with light bending attachment
OBA-2BA ring spanner
M5/M6 ring spanner

(See publication R.5138 for full details).

RENEWAL PARTS

When ordering renewal parts, please specify the quantity required, describe the required part in detail, and give the Model Number of the relay for which they are required.

APPENDIX TO YCGF RELAY INSTRUCTIONS R.5628

The satisfactory application of the YCGF field failure relay, requires a full knowledge of the operating parameters of the machine during normal operating conditions. The maximum rotor angle at which the machine can operate within the stability limit, and whether the machine has been designed for operation under line charging conditions, that is leading power factors, are required. Once the operating conditions of the machine have been established, it is possible to determine the required offset and circle diameter for the circular characteristic of the relay from a knowledge of the machine transient and synchronous reactances.

The general practice is to use an offset setting equal to half the machine transient reactance $\left(\frac{Xd'}{2}\right)$ and a circle diameter equal to the synchronous reactance of the machine (X_S) for rotor angles up to 90°, and when the machine cannot be operated at leading power factors. Nevertheless when the machine has been designed to operate at leading power factors and it is provided with high speed, fast acting voltage regulators that permit the operation of the machine at rotor angles up to 120°, the above settings are modified to three quarters of the machine transient reactance ($\frac{3}{4}$ Xd') for the offset and half the machine synchronous reactance $\left(\frac{Xs}{2}\right)$ for the circle diameter.

The following worked example indicates the method to be used in estimating the required relay settings. The characteristics of the machine to be used are as follows :

Voltage : 11kV 3 phase, 50Hz.
Output : 30 MVA 0.8 Power Factor.
Machine transient reactance X_d' = 19%
Machine synchronous reactance X_S = 200%.
Current transformer ratio 1500/5.
Voltage transformer ratio 11000/110 volts.

TYPICAL RELAY SETTINGS ARE :

(i) For rotor angles up to 90° and no leading power factors

Offset $\frac{Xd'}{2}$ Circle diameter X_S

(ii) For rotor angles up to 120° and leading power factors

Offset $\frac{3}{4}$ Xd' Circle diameter $\frac{X_S}{2}$

Relay to be set for condition (i) above.

OFFSET SETTING

Machine transient reactance in Secondary Ohms = $\frac{19 \times 11^2}{100 \times 30} \times \frac{1500/5}{11000/110}$

= 2.3 ohms.

Required Offset Setting = $\frac{Xd'}{2}$

= $\frac{2.3}{2}$ = 1.15 ohms

Relay Setting = $K_3 + K_4$

Now, the range of plug settings available on 5 amps basis are :

K_3 plug settings 0, 0.5 and 1.0 ohms.

K_4 plug settings 0.5, 2.0 and 3.0 ohms.

Therefore, set the relay offset to the nearest ohmic value given by the sum of $K_3 + K_4$ above the required value of 1.15 ohms; that is, put K_3 = 1.0 and K_4 = 0.5 which gives a relay offset of $K_3 + K_4$ = 1.0 + 0.5,

= 1.5 ohms.

Also potentiometer K_2 in the polarising circuit of the relay must be set to the same value as $K_3 + K_4$, that is, 1.5 ohms. For this purpose, potentiometer K_2 can be adjusted from 0 to 4 ohms and is calibrated in 0.5 ohm steps.

CIRCLE DIAMETER SETTING

Machine synchronous reactance in secondary ohms = $\frac{200 \times 11^2}{100 \times 30} \times \frac{1500/5}{11000/110}$

= 24.2 ohms.

Required circle diameter = X_s

= 24.2 ohms.

Relay Setting + K1 K5

The range of plug settings available on 5 amps basis are :

K_1 potentiometer, in the restraint circuit of the relay, is the fine adjustment with a range of 0.75 to 1.0, calibrated in 0.05 steps.

K_5 is the coarse plugboard adjustment with plug positions of 6.95, 9.65, 13.4, 18.6, 25.9, 36 and 50 ohms.

Set the coarse plugboard K_5 to the nearest plug setting above the required value of 24.2 ohms, that is, 25.9 ohms. Make the fine potentiometer K_1 setting equal to $\frac{24.2}{25.9} = 0.93$

The selected settings are $K_1 = 0.93$, $K_5 = 25.9$.

LIST OF ILLUSTRATIONS

FIG. NO.	TITLE	DRAWING NUMBER
1	Characteristics of type YCGF Relay	S77398Z09.010
2	External connection diagram for YCGF Relay	677392Z0094
3	Wiring Diagram for field failure relay type YCGF	677392Z0071
4	Circuit diagram for secondary injection tests	677392Z0095
5 (a)	YCGF relay characteristic with off-set and restraint features removed	
5 (b)	Top view of YCGF relay showing temporary shorting link and insulating strips for load test	677392Z0096
6	Exploded view of induction cup unit	PUB55/1063
7	Contact assembly	PUB/3528/7

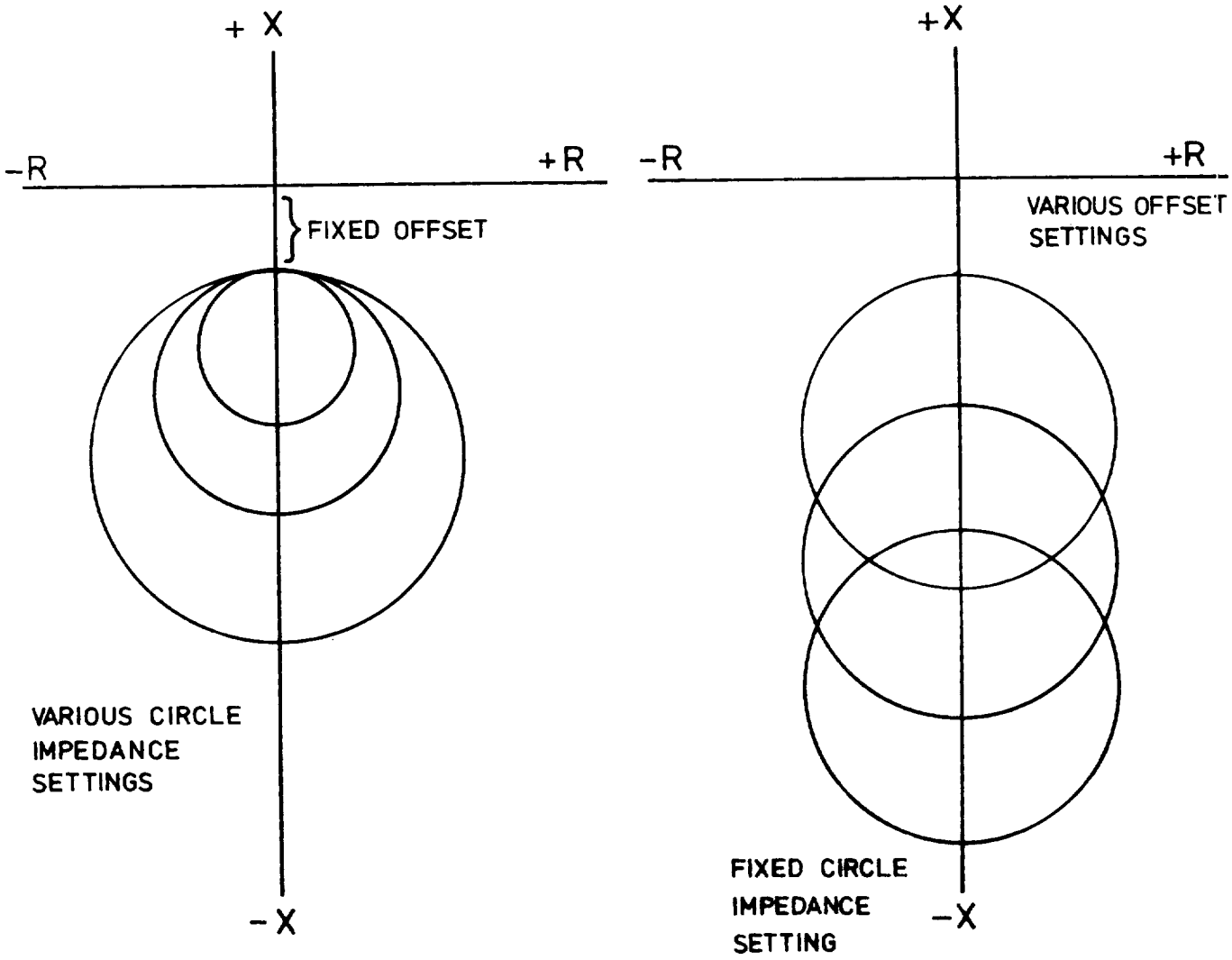


Figure 1

CHARACTERISTICS OF TYPE YCGF RELAY

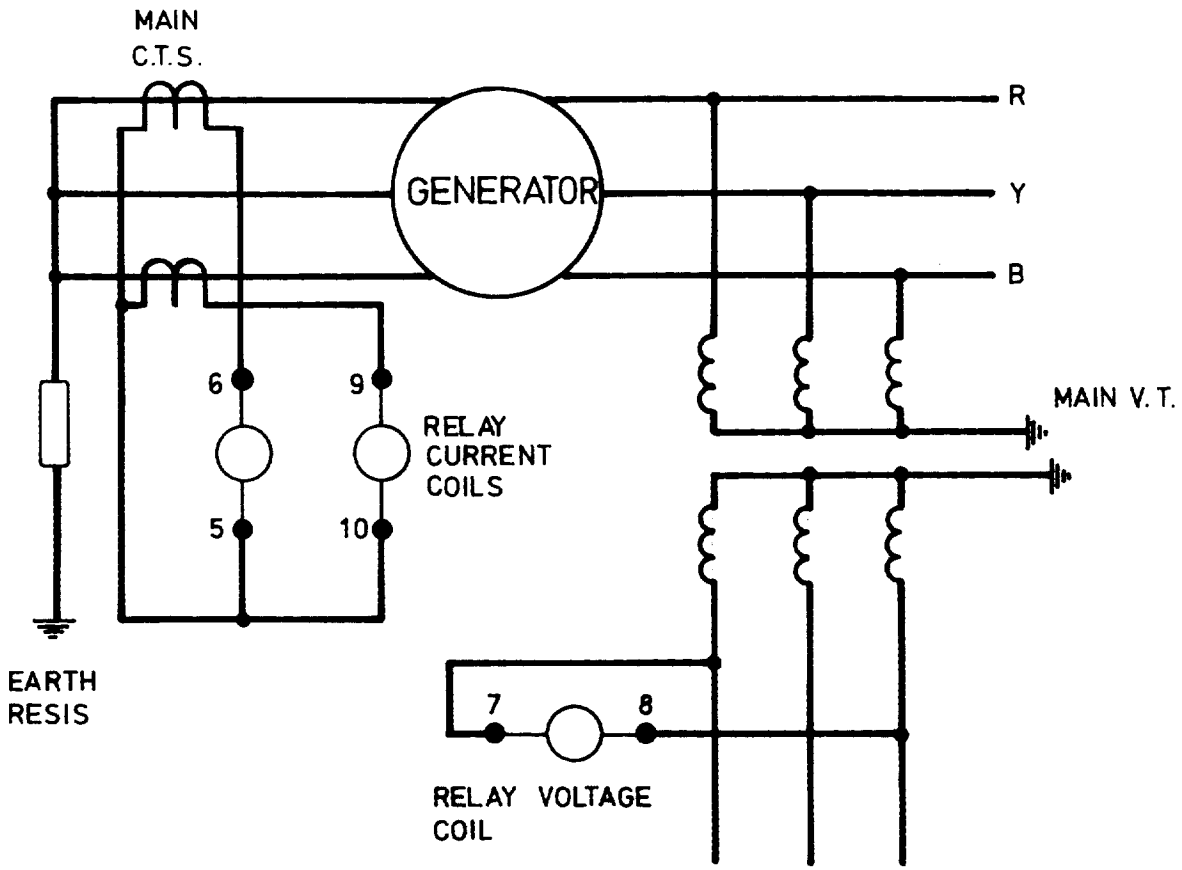
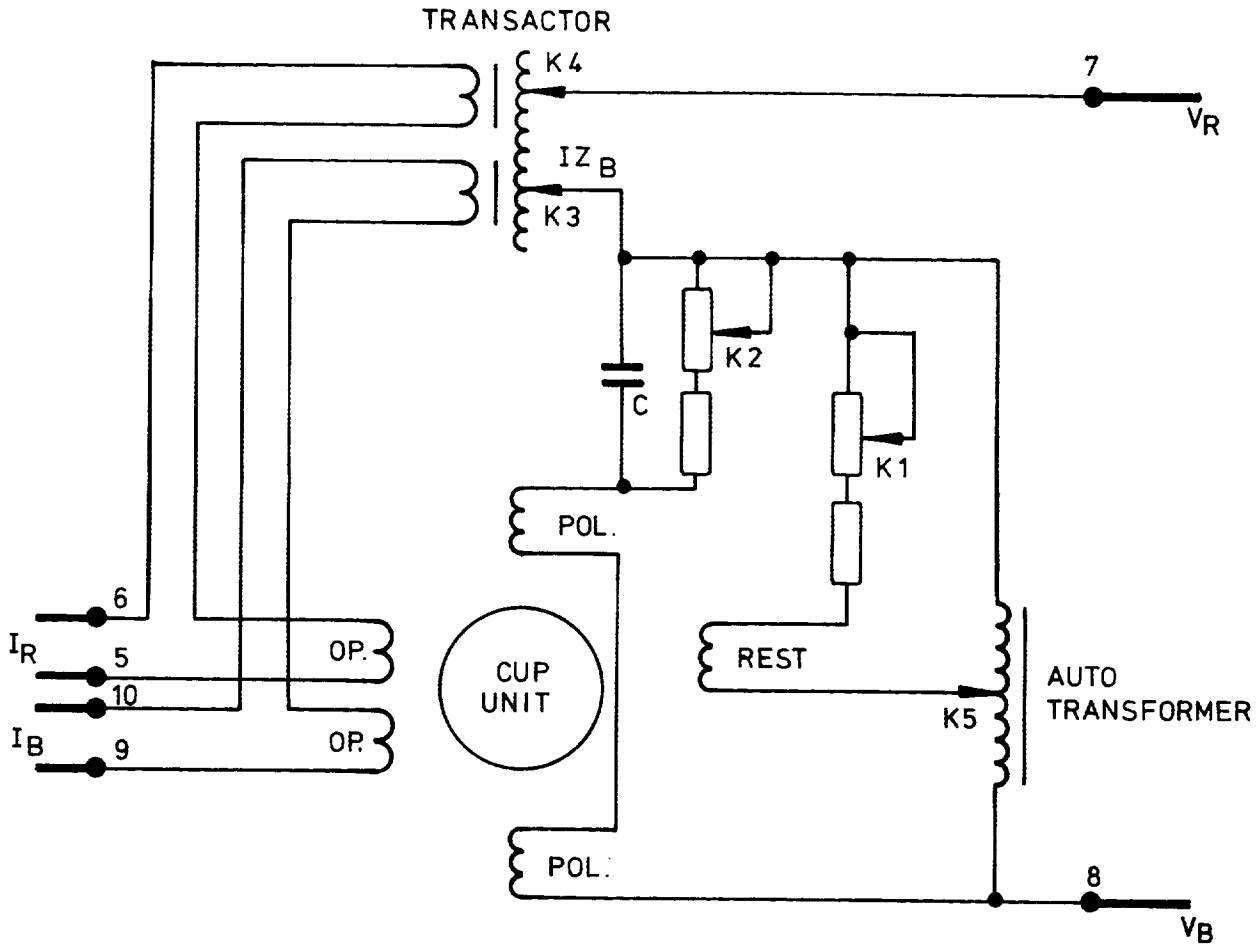


Figure 2
EXTERNAL CONNECTION DIAGRAM FOR YCGF RELAY



POL. – POLARISING COIL
OP. – OPERATING COIL
REST – RESTRAINT COIL

RELAY CASE TERMINALS SHOWN THUS :– ● WITH ASSOCIATED NUMBER.

K 5 — MHO CIRCLE DIAMETER COARSE ADJUSTMENT
K 1 — MHO CIRCLE DIAMETER FINE ADJUSTMENT
K 3 & K4 — MHO CIRCLE DIAMETER OFFSET ADJUSTMENT
K 2 — POLARISING CIRCUIT PHASE ANGLE TRIMMER

Figure 3
WIRING DIAGRAM FOR FIELD FAILURE RELAY TYPE YCGF

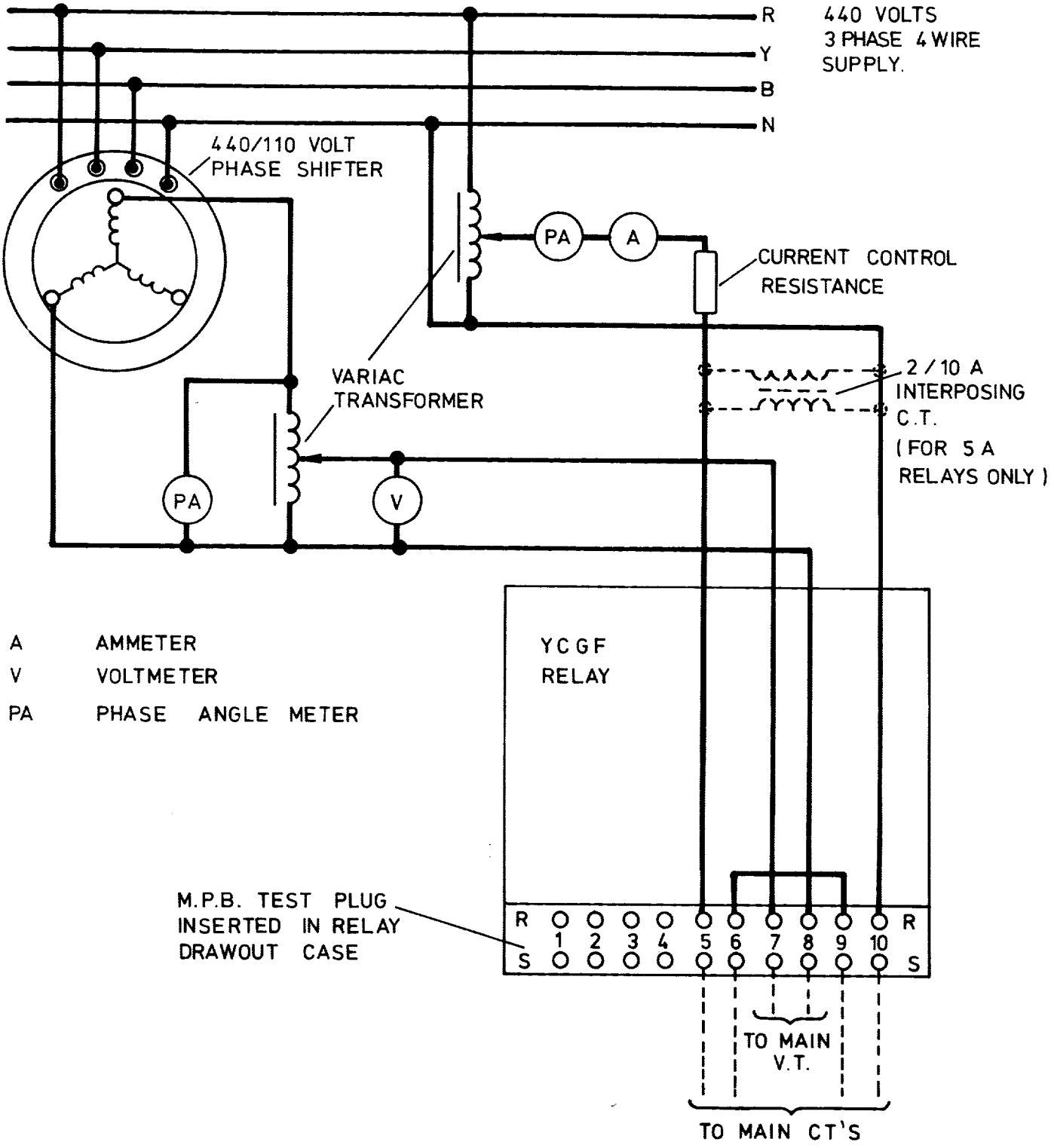
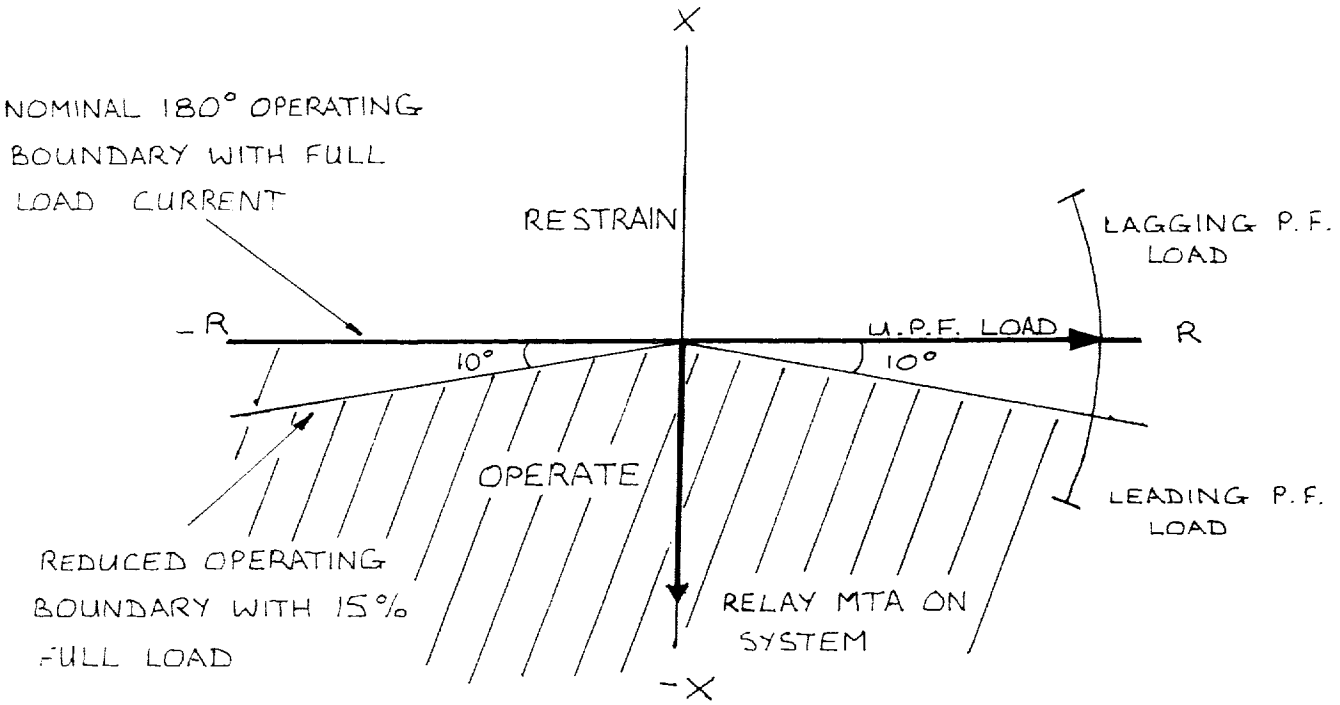


Figure 4

CIRCUIT DIAGRAM FOR SECONDARY INJECTION TESTS



* NOTE : THESE ANGLES MAY VARY BY ± 5° WITH RELAY MTA TOLERANCES

Figure 5(a)
YCGF RELAY CHARACTERISTIC WITH OFFSET AND RESTRAINT FEATURES REMOVED.

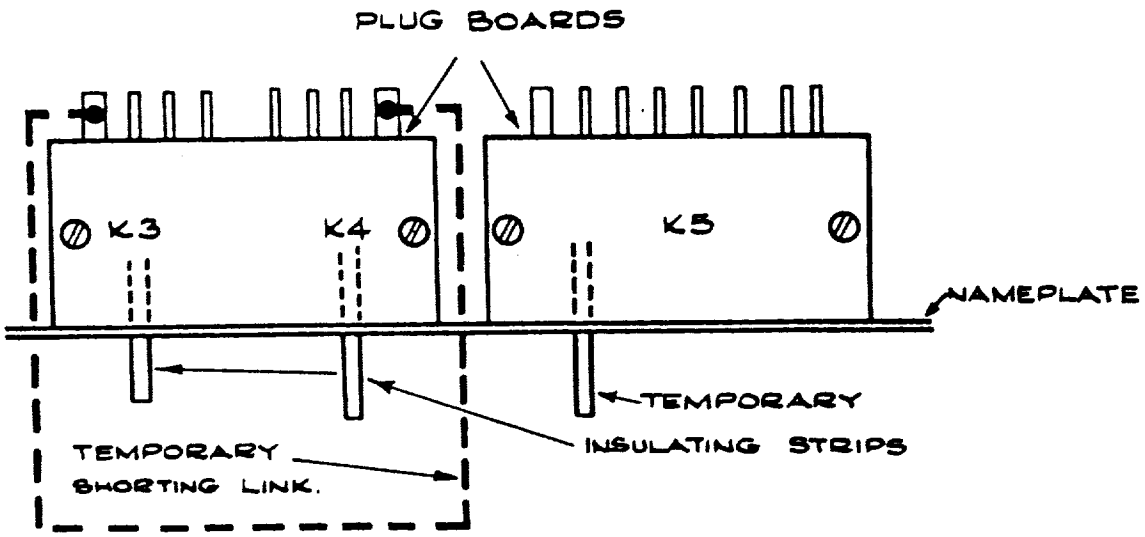


FIG 5(b) TOP VIEW OF Y.C.G.F. RELAY SHOWING TEMPORARY SHORTING LINK & INSULATING STRIPS FOR LOAD TEST.

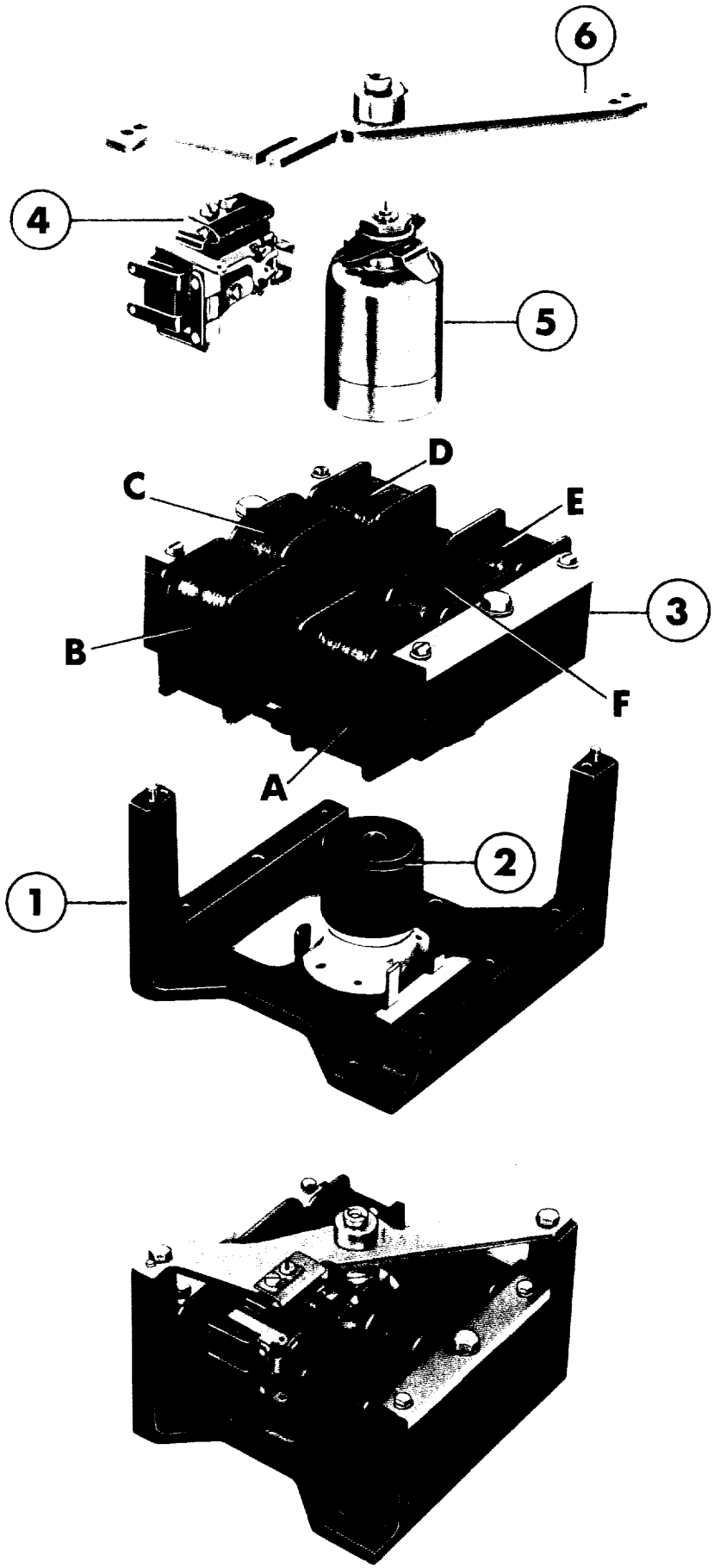


Figure 6 INDUCTION CUP UNIT

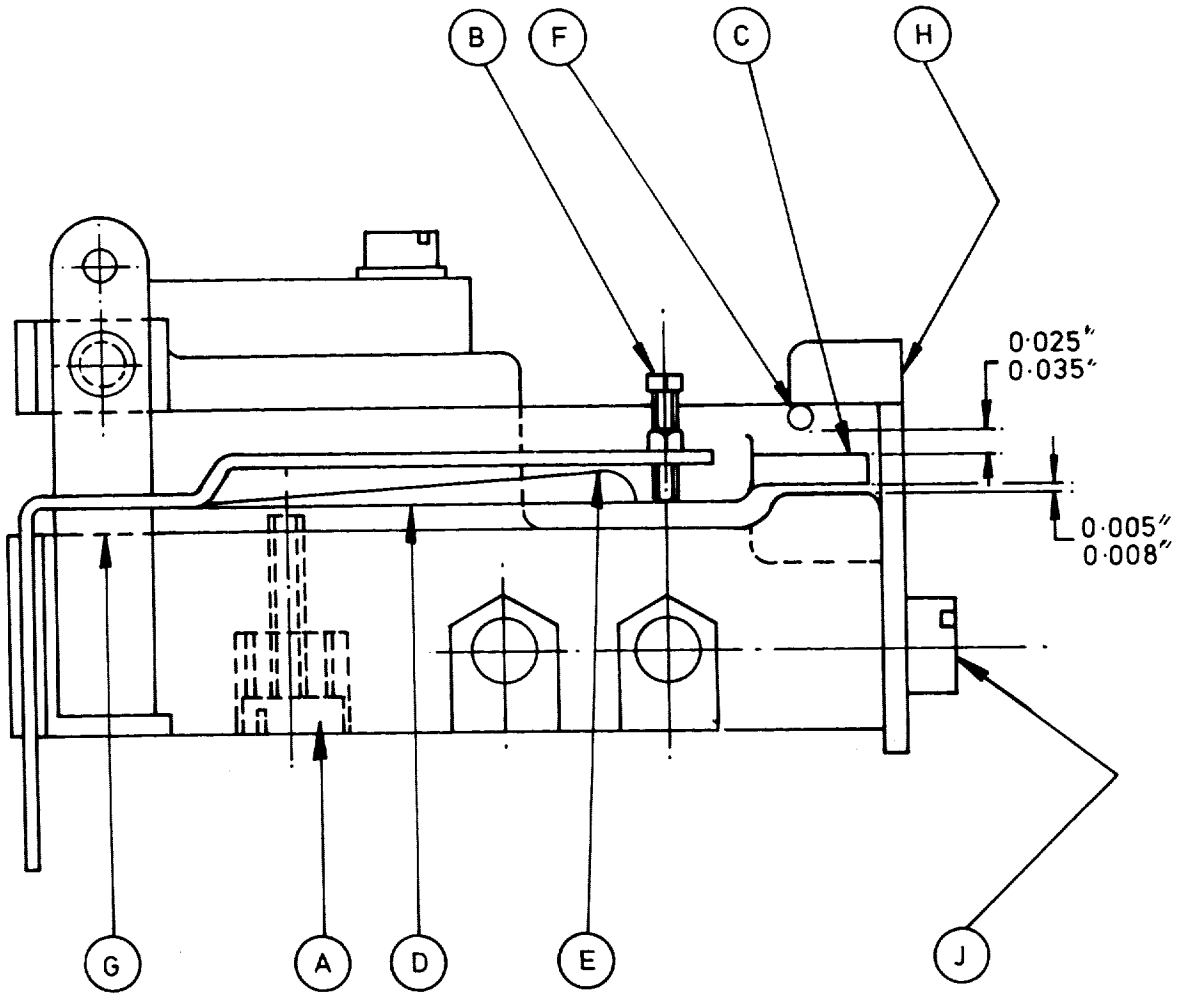


Figure 7

CONTACT ASSEMBLY