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Chapter 30

CONTROL PANEL, TYPE 46

(Voltage regulator)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Control panel, Type 46	*Ref. No.* 5UC/6926
Controlled voltage phase/line	115/200*V* ± $2\frac{1}{2}$ *per cent*
Adjustment	+2 −5 *per cent*
Weight	$9\frac{1}{2}$ *lb. approx.*

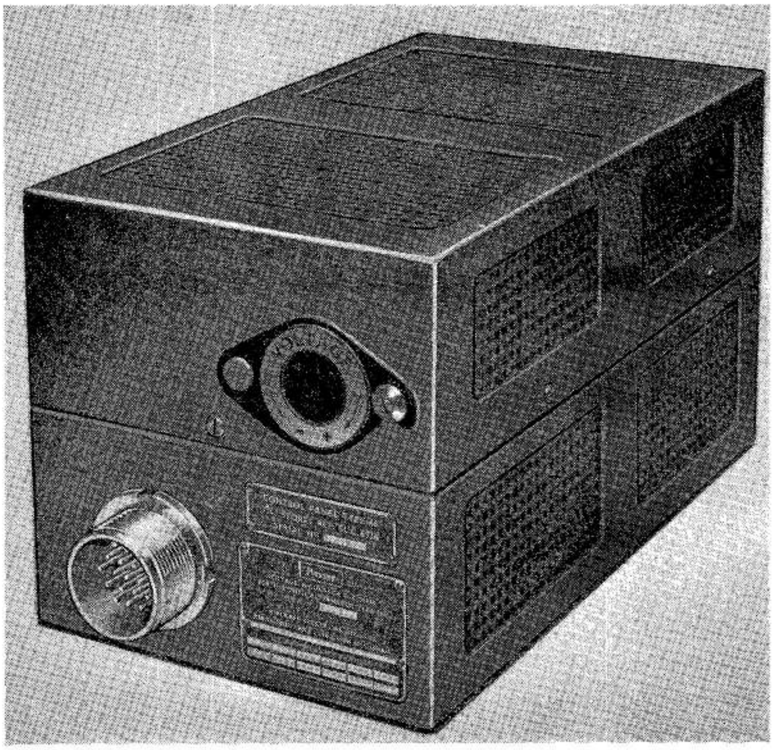


Fig. 1. Control panel, Type 46

Introduction

1. The control panel, Type 46, is designed to control the voltage output of the a.c. generator, Type 165; it is a component part of the Labinal generating system which is described in A.P.4343, Vol. 1, Sect. 2.

DESCRIPTION

General

2. The control panel comprises a rectangular alloy single deck chassis, which forms a mounting platform for the various components of the unit. The side panels of the chassis are perforated to provide ventilation. The components mounted on top of the chassis are enclosed by a ventilated cover, and access to the components which are underslung is gained by removal of the baseplate. Views of the chassis with the top cover and baseplate removed are shown in fig. 3 and 4.

3. The components fitted on top of the chassis comprise rectifier assembly MR1, the six diodes of which are mounted on cooling fins, two silicon bonded glass fabric tagboard assemblies TB1 and TB2, transformer T1, neon reference valve V1, resistor R6 and variable resistors RV1 and RV2. The tagboard assembly TB1 contains the four diodes of rectifier MR2, the three diodes comprising rectifier MR3, the single diode of rectifier MR4, and capacitors C1 and C2. The tagboard assembly TB2 contains resistors R1, R2, R3, R4, R5, R7 and R8 and thermister TH.

4. The components fitted to the underside of the chassis comprise compounding transformers TC1, TC2 and TC3, magnetic amplifier MA and inductors L1, L2 and L3. Electrical connection to the unit is made through a 19-pole UK-AN connector fitted at one end of the chassis.

Voltage reference circuit

5. The voltage reference circuit is made up of a voltage reference bridge comprising resistor R1, R2, R3, R4, R7 and RV1, and a neon reference valve V1. The sensing signal is obtained from the generator busbars and fed to the reference bridge through the 3-phase half-wave rectifier MR3, the other end of the bridge being connected to neutral. The error signal output from the reference bridge is applied to the control winding of the magnetic amplifier MA. A thermister TH is connected in the reference circuit to compensate for temperature variations within the unit. Adjustment of the voltage setting is effected by variable resistors RV1.

Magnetic amplifier

6. The magnetic amplifier consists of a single-phase bridge arrangement of rectifier

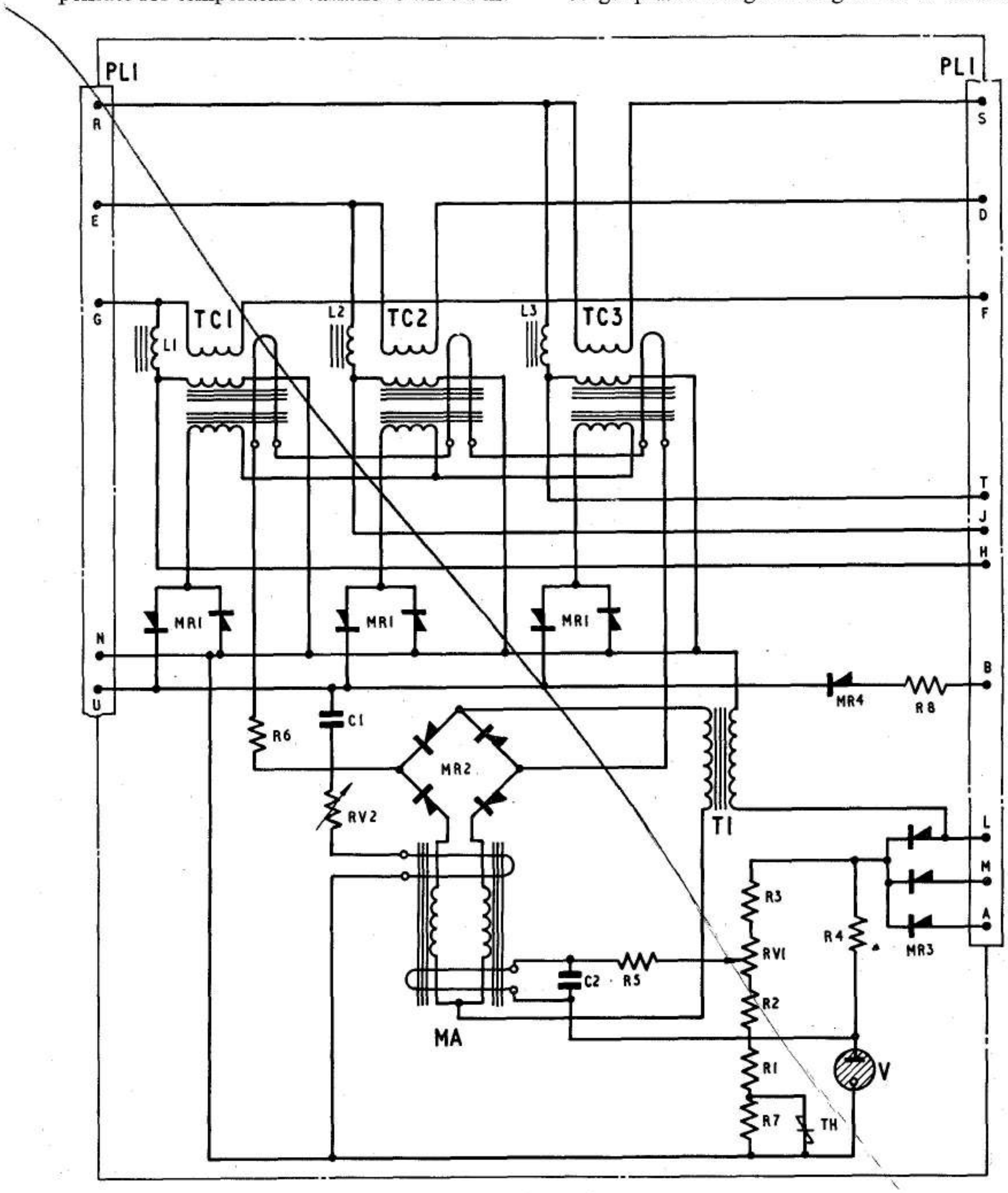
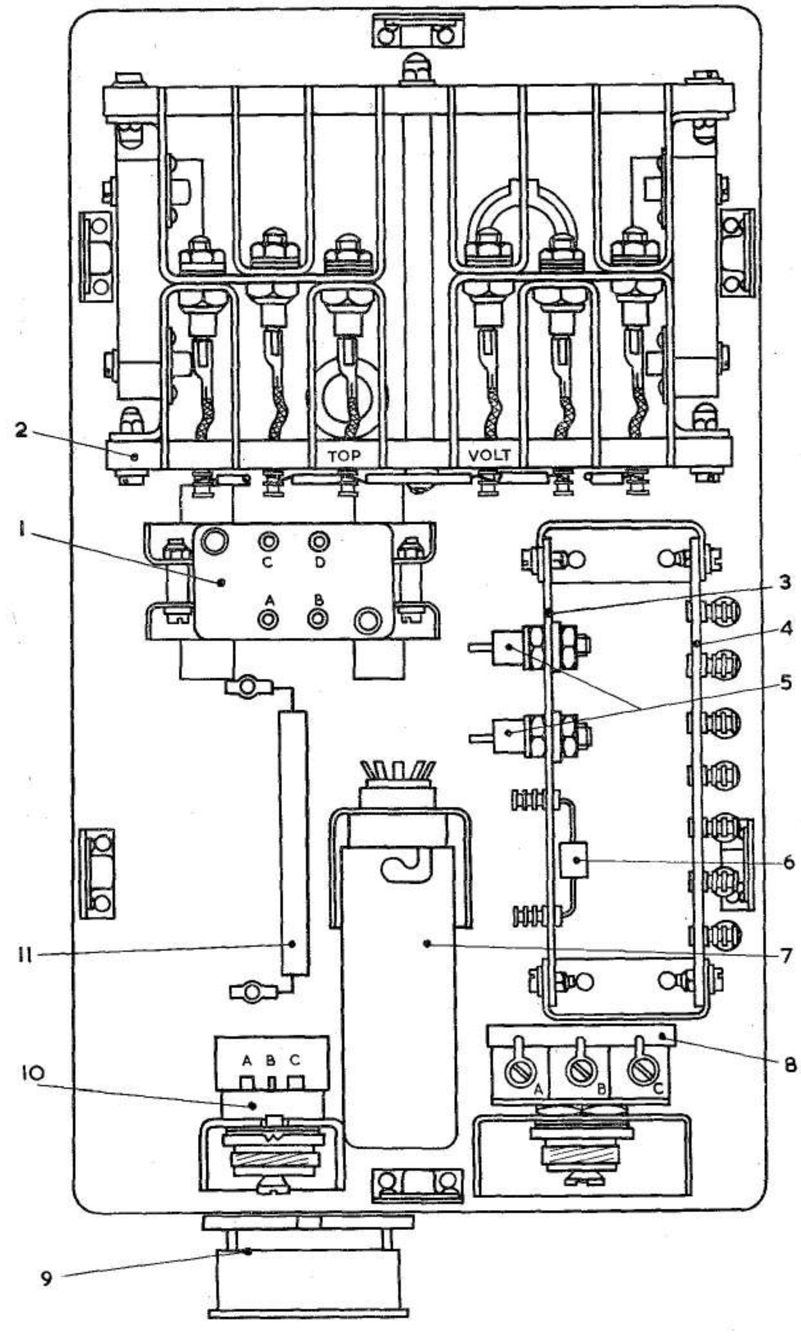


Fig. 2. Wiring diagram



1 TRANSFORMER T1
2 RECTIFIER AND COOLING FIN ASSEMBLY
3 TAGBOARD ASSEMBLY NO. 1
4 TAGBOARD ASSEMBLY NO. 2
5 RECTIFIERS MR2
6 RECTIFIERS MR3
7 NEON REFERENCE VALVE CV4028
8 VARIABLE RESISTOR RV1
9 CONNECTOR UK-AN-FIX-22-14P
10 VARIABLE RESISTOR RV2
11 RESISTOR R6

Fig. 3. View with cover removed

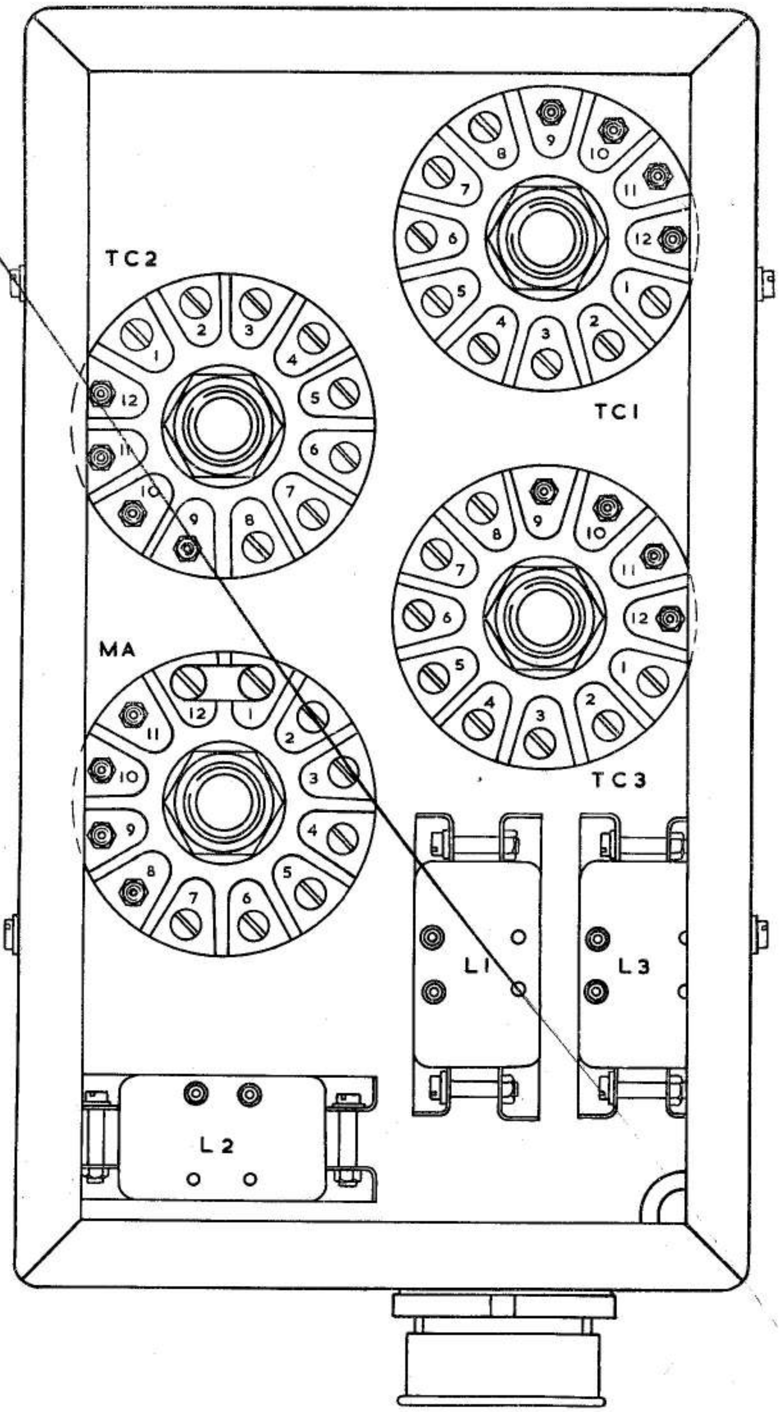


Fig. 4. View with baseplate removed

MR2 in series with the amplifier main winding and supplied from the single-phase transformer T1. The d.c. output from the rectifier bridge, which is the amplified error signal from the voltage reference circuit, is applied to the series connected saturation windings of the compounding transformers.

7. The control circuit is stabilized by the use of a transient feedback signal, derived from the rectified output to the generator field excitation circuit. This signal is applied to the second control winding of the magnetic amplifier in such a direction as to oppose the system disturbances producing the signal. Adjustment of stability is obtained by means of variable resistor RV2.

Compounding transformers

8. The compounding transformers TC1, TC2 and TC3 adjust the generator field excitation current to maintain the controlled voltage at the a.c. busbars at all times. Each transformer has four windings, a current winding, a voltage winding, a secondary winding and a saturation winding. The primary side of the transformer is formed by the current and voltage windings; the current winding is connected in series with each of the generator phase lines and the voltage winding is connected between the phase and neutral points. The voltage winding is energized by a current which is in quadrature with the load current, this effect being obtained by the insertion of an inductance in series with the winding. The secondary winding output current which is proportional to the vector sum of the primary current and voltage, is rectified by MR1 and supplied to the generator exciter field. The current in the saturation winding is controlled from the voltage bridge network and adjusts the saturation point of the transformer to maintain the busbar voltage within the regulated limits.

9. The remanent flux in the generator rotor normally produces a voltage build-up on starting, but to ensure operation at all times the field is excited from the d.c. supply. The supply is permanently connected from the d.c. busbar through resistor R8 and blocking rectifier MR4 to the generator field, the current flowing is of the order of 0·12A.

OPERATION

10. The average of the three-line voltages is controlled at 200V $\pm 2\frac{1}{2}$ per cent from no load to 4kW, power factor 0·8 lagging to unity. The busbar voltage is regulated by the control of generator excitation dependent upon the load current delivered by the generator and the error between the desired line voltage and the actual line voltage. The generator field excitation current is supplied from the secondary windings of the compounding transformers rectified by MR1, this current is proportional to the vector sum of the primary current and voltage. In this manner compensation is automatically made for variations in the load power factor.

11. The voltage reference circuit compares the rectified line voltages with a constant voltage obtained at the terminal of the neon reference valve V1. The voltage difference detected across the bridge network is then applied to the control winding of the magnetic amplifier, and determines the saturation current necessary to adjust the compounding transformer.

12. If the voltage difference at the reference point is positive, the increased voltage at the control winding of the magnetic amplifier creates an increase in the saturation current of the compounding transformers, causing a decrease in the generator excitation current and a resultant decrease in the line voltage. If voltage difference at the reference point is negative, the opposite of the foregoing occurs and the line voltage is increased.

SERVICING

13. The control panel should be serviced in accordance with relevant Servicing Schedule. It should be inspected for signs of corrosion and damage to the cover, chassis components and electrical connections. Collection of dust and other foreign matter should be blown out using a jet of dry clean compressed air. Access to the inside of the control panel is obtained by removal of the top cover and the baseplate. No special instructions are required for dismantling the components from the chassis, such dismantling should only be necessary when the components require to be renewed.

TESTING

General

14. The power supplies required for tests given in para. 15 to 17 should be equivalent to those used on the particular aircraft system. For the tests given in para. 18 to 20, the control panel should be connected to a

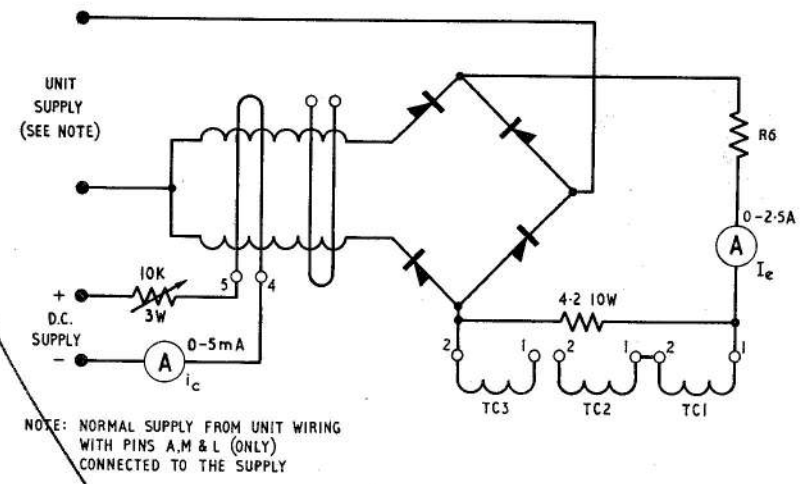


Fig. 5. Magnetic amplifier test circuit

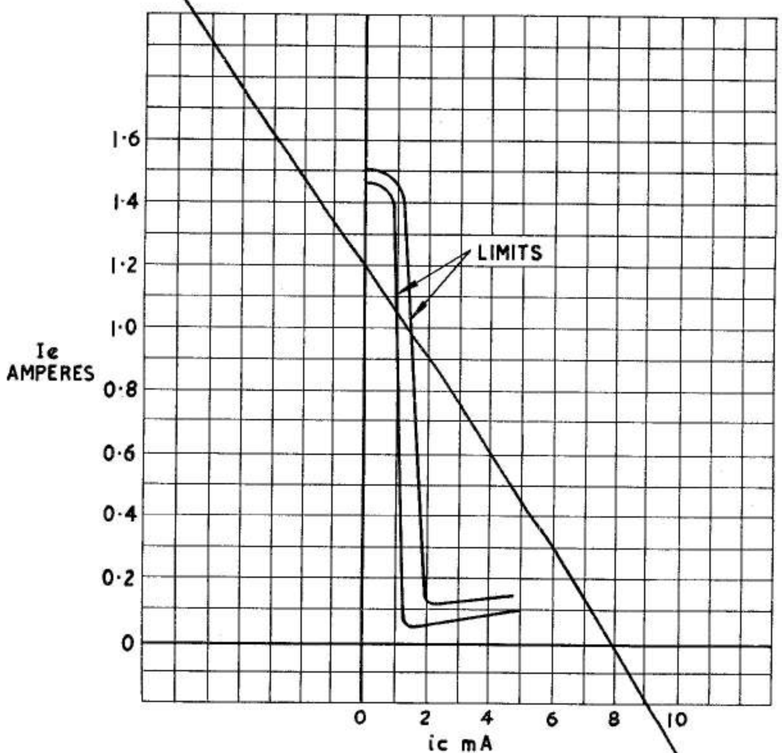


Fig. 6. Magnetic amplifier control characteristic

test circuit using the generator and frequency regulator with which it is normally associated when installed. The generator should be driven by a variable speed test set, and its output should be connected to a 3-phase, 4-wire star-connected load bank adjustable for 0 to 6kW in 1kW steps.

Compounding transformers characteristic

15. Connect the control panel to the test circuit as shown in fig. 7. Ensure that the input supply voltage, frequency and phase rotation is correct. Switch on the load in 1kW increments over the range 0 to 5kW taking readings of the load current and the excitation current at each step. The characteristic obtained should be within limits specified in fig. 8. Switch off supply and disconnect the load.

Note . . .

The period when the 5kW load is on should not exceed 2 min.

Voltage reference

16. With the circuit connected as for the test given in para. 15 and the supply switches closed, apply a short circuit between pins H, J and T of the UK-AN connector and ensure that the excitation current Iex goes to zero.

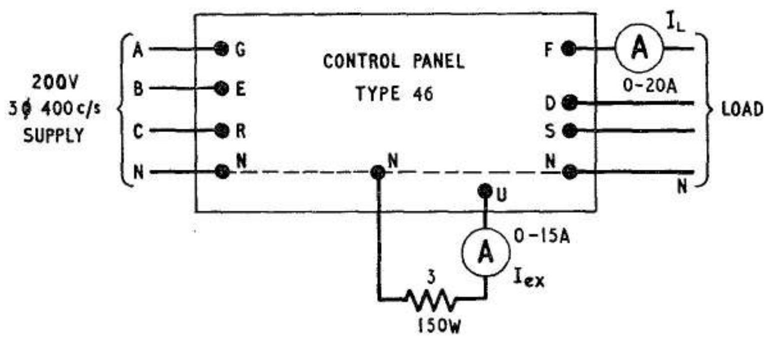


Fig. 7. Compounding transformers test circuit

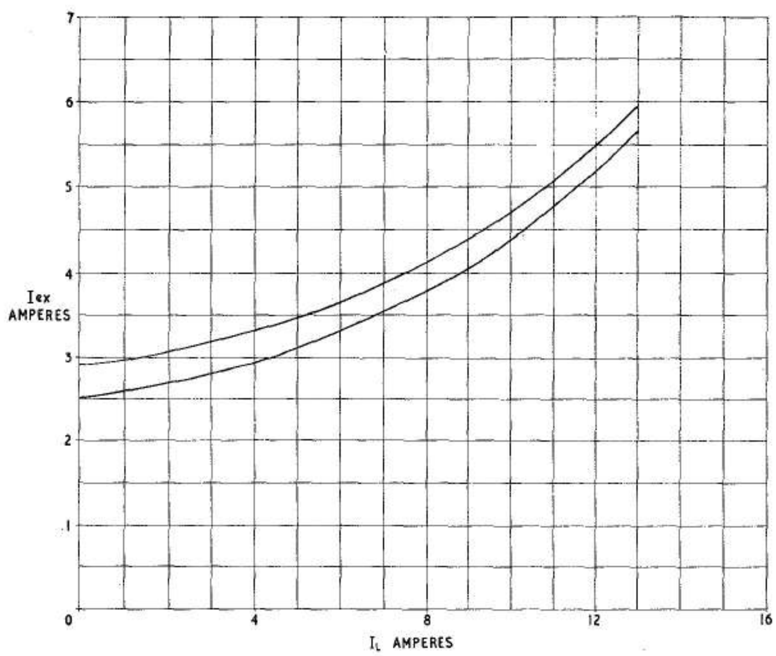


Fig. 8. Compounding transformers control characteristic

Switch off the supply, connect pins A, M and L to the 3-phase supply source. Rotate variable resistor RV1 fully counter-clockwise. Close the supply switches, and rotate RV1 clockwise. The excitation current Iex should rise from zero reaching a maximum value at approximately the mid-point of the travel of RV1, and then reduce. Switch off the supplies and disconnect the control panel from the test circuit. Apply a 28V d.c. supply through a 0·150mA meter to pins B (+ve) and U (−ve) and check that the current is within the range 0·11 to 0·13A.

Magnetic amplifier characteristic

17. Connect the control panel to the test circuit as shown in fig. 5. Disconnect the wiring from terminal 2 of the compounding transformer TC2. Disconnect the magnetic amplifier control winding at terminals 2, 4 and 5. Connect a 3V max. d.c. supply through the variable resistor and ammeter to terminals 4 (−ve) and 5 (+ve). Vary the control winding current Ic over the range 0 to 5mA in at least five increments, taking readings of output and control current at each step. The characteristic obtained should be within the limits specified in fig. 6. Disconnect the supplies and reconnect the internal wiring as per the circuit diagram fig. 2.

Stability and regulation tests

18. Connect the control panel in circuit with its associated system components. Run the generator at 4700 rev/min. on no load, and check that the phase rotation is correct. Adjust variable resistor RV2 until "hunting" commences, this is indicated by rapid oscillations of the output voltage and frequency meters. Adjust RV2 until oscillation ceases, then rotate in a clockwise direction by approx. 10 degrees to ensure a safety margin of system stability.

19. Adjust the output voltage to 200V by means of variable resistor RV1, after ensuring that adjustment over the range 165 to 260V is obtainable. Run the generator over the following input speed ranges at the given load conditions. The controlled voltage should remain within the limits of 195 to 205V and stability should be maintained.

Load	Speed range
1kW, u.p.f.	4700-8000-4700
1kVA, 0·8 p.f. lag	4700-8000-4700
2kW u.p.f.	4700-8000-4700
2kVA, 0·8 p.f. lag	4700-8000-4700
3kW, u.p.f.	4700-8000-4700
3kVA, 0·8 p.f. lag	4700-8000-4700
4kW, u.p.f.	5500-8000-5500
4kVA, 0·8 p.f. lag	5500-8000-5500

20. Should "hunting" occur at any point, adjustment should be made to variable resistor RV2 until "hunting" ceases. Repeat the regulation test after any such adjustment.

Insulation resistance tests

21. Check the insulation resistance between pins N, U, and B on the UK-AN connector and the frame using a 250V insulation resistance tester. Check the insulation resistance between all other pins of the UK-AN connector and frame using a 500V insulation resistance tester. The minimum permissible reading obtained for each test should be not less than 5 megohms.