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Chapter 18

FREQUENCY CONTROL UNIT, TYPE C.P.S.3, Mk.1

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LEADING PARTICULARS

Frequency control unit, Type C.P.S.3, Mk.1	Ref.No.5UC/7010
Regulated frequency	400c/s ± 2%
Dimension	
Length overall	10 in.
Height overall	7 in.
Width overall	5.75 in.
Weight	6.5 lb.

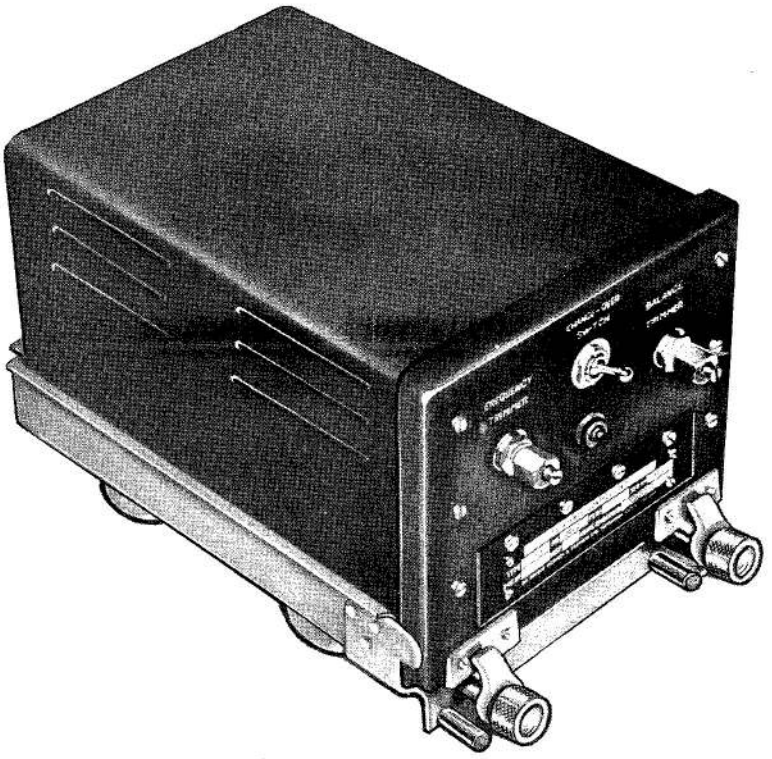

Fig.1 Frequency control unit, Type C.P.S.3, Mk.1

Introduction

1. The frequency control unit Type C.P.S.3, Mk.1 is designed for use with the turbo-alternator set, type T.G.A.-30, Mk.1. The a.c. generator output frequency is controlled by a closed loop servo system which consists of the following components:-

(1) Frequency control unit type C.P.S.3, Mk.1.

(2) Torque motor.

(3) Hydraulic servo.

(4) Feedback potentiometer.

(5) Flow control valve.

2. The frequency control unit is a separate unit, and the torque motor and feedback potentiometer are part of the hydraulic servo. The system controls the turbine speed, and therefore the a.c. generator output frequency at 400c/s ± 2%. The principle of operation and description of the turbine geared alternator, type TGA-30, Mk.1 is given in A.P.2240C, Vol.1 and Vol.6, Part 1, Sect.1, Chaps.1 and 2. These chapters contain information on the components 2, 3, 4 and 5 listed in para.1.

DESCRIPTION

General

3. The control unit (fig.1) is a completely self contained unit which, when installed is fitted into a rack designed for flexible mounting to minimise vibration. Electrical connection is made by three Mk.4 sockets.

4. It consists of a single deck chassis,

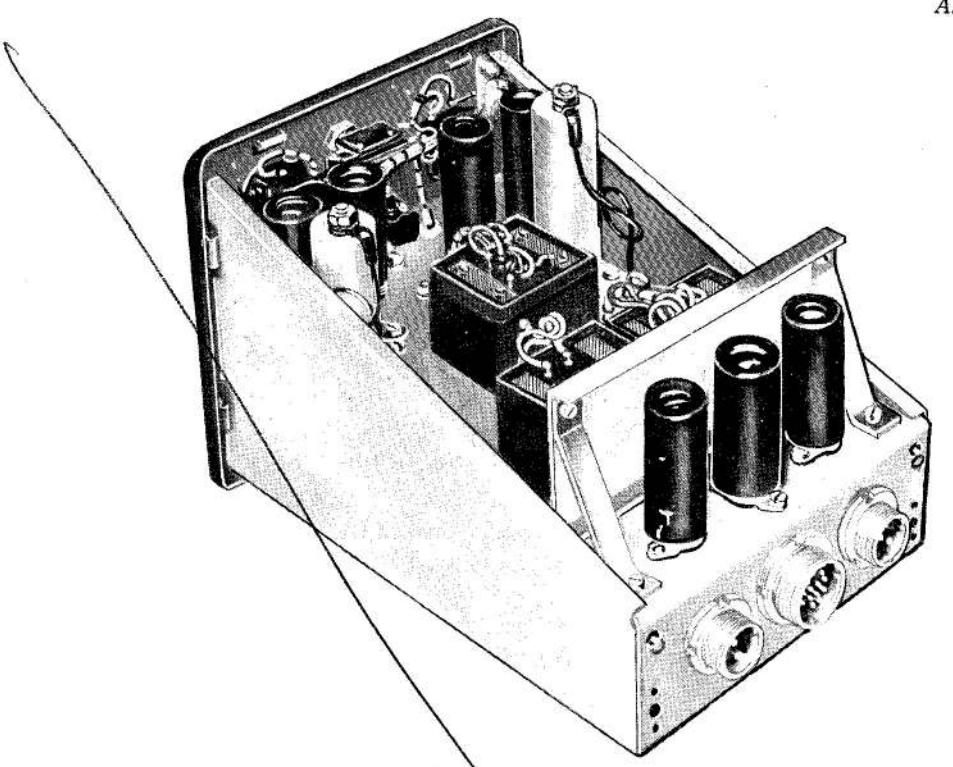

Fig.2 View from top rear, with cover removed

upon which are mounted the various components of the unit. A vertical front plate is screwed to the chassis, attached to this plate, and accessible from the front, are the frequency trimmer and balance trimmer potentiometers, the jack socket and the change over switch. The unit is enclosed in a rectangular box cover which is secured by two captive screws at the rear. A list of components in the control unit is given in Table 1.

Frequency selective circuit

5. The frequency selective circuit consists of two tuned circuits connected as a parallel-T network. The circuit containing RV1 (fig.4) being resonant at 500c/s and the other circuit at 300c/s. They are supplied from the generator output, each connected to a separate winding on the isolating transformer T2.

6. Since the voltage developed across the load of the parallel-T network is a minimum at resonant frequency, the output from each network will vary as shown in fig.4. Assuming that the output frequency of the generator is 350c/s, then the 300c/s network will allow (a) volts to be developed across its load, and the 500c/s network will develop, (b) volts across its load.

7. A variable resistor (RV1) in the 500c/s circuit enables a small adjustment to be made of the frequency at which the circuit resonates. Therefore the operating positions of the two output curves may be made to intersect at 400c/s. Subsequent

deviations in frequency will cause a differential voltage signal to be passed to the control grids of V1, the magnitude and polarity of which is dependent upon the magnitude and direction of the deviation in frequency.

Summing network and amplifiers

8. The a.c. outputs from the parallel-T networks are each restricted by a full wave bridge rectifier smoothed by capacitors C5 and C14. This smoothing still permits a degree of ripple to pass through the amplifier and performs the function of 'dithering' the relay a very small amount, and hence the pilot valve, this decreases the stiction. The rectified and smoothed outputs from the parallel-T networks are fed via the summing networks to the grids of the double triode V1. The anodes of V1 are coupled to the control grids of the pentodes V2 and V3, the anode loads of which are formed by the coils of the torque motor.

9. Stability of the amplifier and the system over its working range is effected by feedback signals obtained from two potentiometers which are part of the hydraulic servo. The feedback signals are of opposite polarity to the primary signals with which they combine in the summation networks. A normally closed jack socket J1 and change over switch S1, are connected in the anode circuits of V2 and V3. These are used to test the outputs of V1 and V2 which are balanced by adjustment to RV2.

Power Pack

10. A constant 350V d.c. is obtained from the power pack transformer T1 after

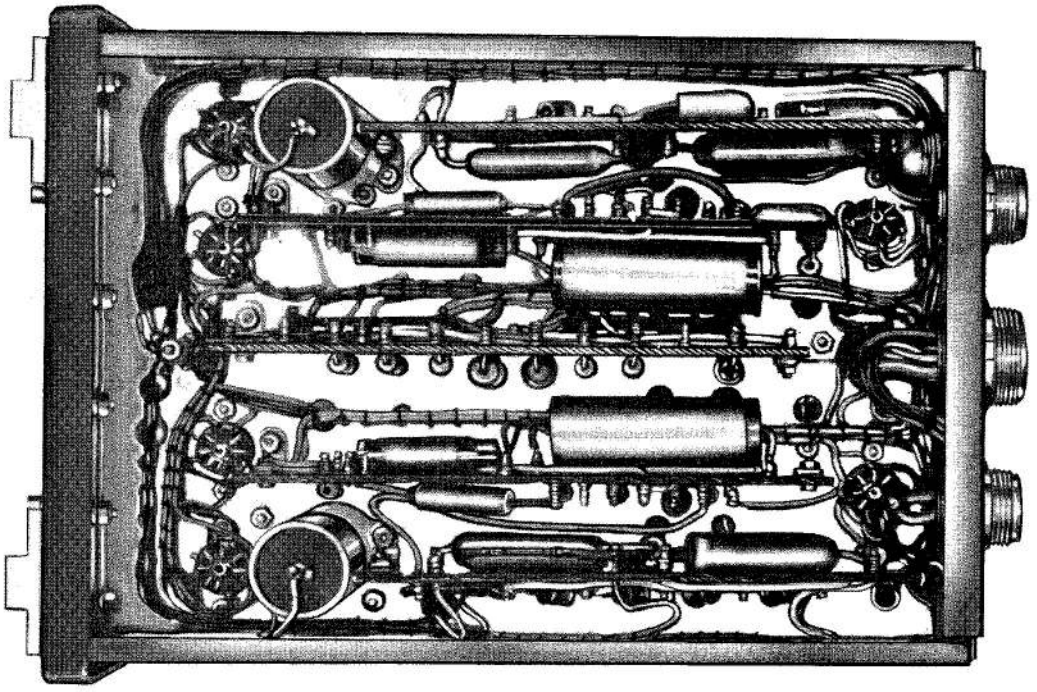

Fig.3 Underside view of control unit

full wave rectification. The rectified voltage, after smoothing, is applied across the potential divider comprising R51 and R52. This provides for a supply of 200V to the anodes of V1.

11. The valve heater circuit is supplied through Plug 2 from an external 28V d.c. supply voltage. Connected in parallel with the heaters through pins C and M on plug 1, are the two feedback potentiometers on the hydraulic servo.

Feedback

12. Operation of the air mass flow controlled by the hydraulic system results in changing d.c. feedback signals returned through pins A and F on Plug 1 to the frequency control unit. The purpose of this feedback is to prevent over correction with consequent hunting of the whole system. The feedback signals are therefore, in opposition to, and proportional to, the change of frequency control outputs signals.

13. The feedback into the 500c/s circuit of the frequency control unit is wired to give an increasing voltage as the flow controller opens. The feedback for the 300c/s circuit is wired for a decreasing voltage under similar conditions. The signals derived from the potentiometer produce changes of potential across capacitors C6 and C15, therefore the feedback signals injected into the summation network are transient.

OPERATION

14. When the a.c. generator is running

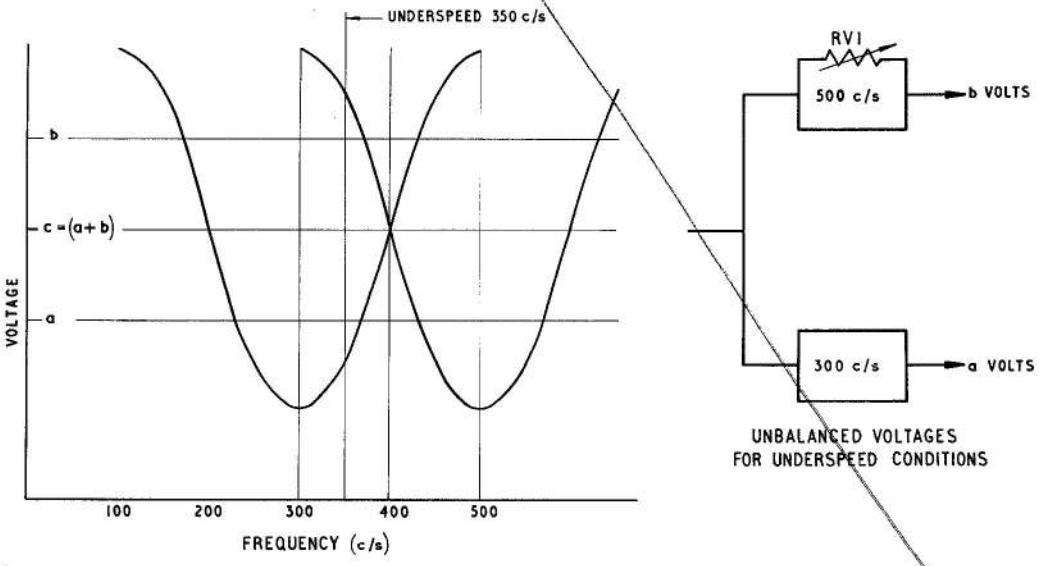

Fig.4 Parallel - T networks

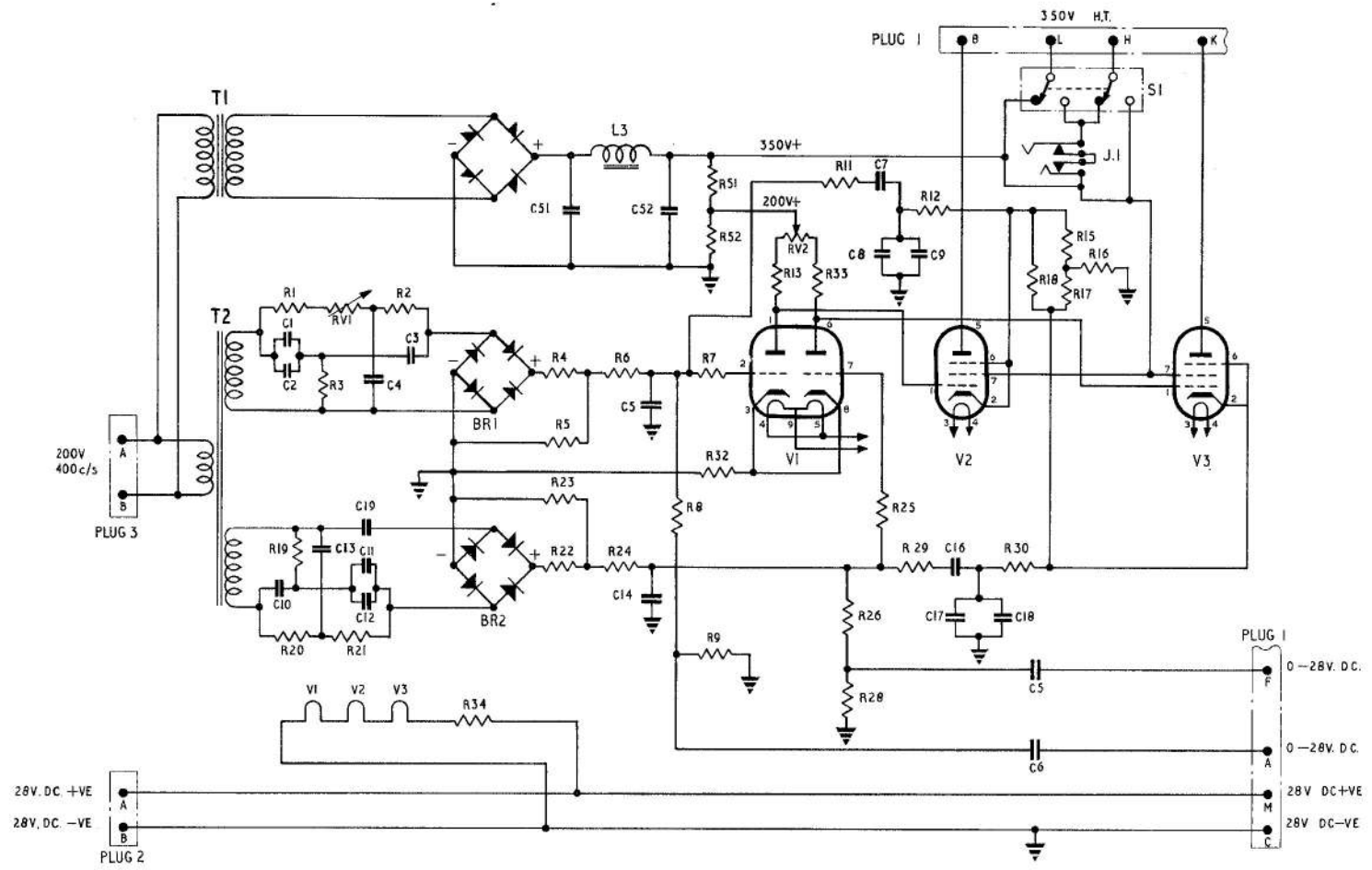

Fig.5 Circuit diagram

at the design frequency of 400c/s any changes in generator load or the airflow at the turbine inlet will cause a deviation from the design frequency. The frequency selective circuit in the frequency control unit will sense any deviation from the design frequency and will provide a differential voltage signal which is proportional to the frequency deviation.

15. This signal is fed into the summation networks and is then passed to the control grids of V1. The amplified signal, depending on whether the frequency is above or below normal, is passed from the anodes of V1 to the control grids of either V2 or V3. The signal is then transmitted through the coils of the torque motor, which are coupled to the anodes of V2 and V3 through pins B and K on Plug 1. This causes the current through one coil of the torque motor to increase, and the current through the other coil to decrease, the effective difference current will, produce proportional rotation of the torque motor spindle. The torque motor has linear characteristics, that is, movement of the motor armature is proportional to the input current applied.

16. Movement of the arm mounted on the armature spindle actuates the hydraulic servo pilot valve which permits oil pressure to act to one side or the other of the servo piston. The piston incorporates a toothed rack which operates a pinioned shaft. This shaft controls the position of the air mass flow valve, which will open or close depending on whether the deviation is below or above the design frequency. Concurrently with movement of the servo piston, the wiper arms on the feedback potentiometers move to send out a differential voltage signal which is fed back, into the summation networks of the frequency control unit.

17. Because the sense, or polarity, of the feedback signal from the potentiometers is in opposition to the signal from the frequency controller, the primary signal is progressively cancelled out as movement of the hydraulic servo continues, thus frequency control system returns to a state of equilibrium at the new conditions of load and air flow.

SERVICING

18. Servicing of this Unit will normally be restricted to the checking of electrical connections for security, and the inspection of components to see that no damage or corrosion is apparent. Where it is obvious that any component is unserviceable, it should be renewed. A list of components is given in Table 1.

ADJUSTING AND TESTING

19. The following paragraphs describe briefly the method of adjusting and testing the unit, and are not comprehensive. This chapter will be amended to include further details on these procedures as further information is available.

Balancing

20. The unit should be connected to a 28V d.c. and a 200V, 400c/s a.c. supply through plugs 2 and 3. The output connection should be made from plug 1 to a hydraulic servo unit, type H.S.1 Mk.1. A suitable milliammeter should be connected to the jack plug sockets on the front plate of the unit.

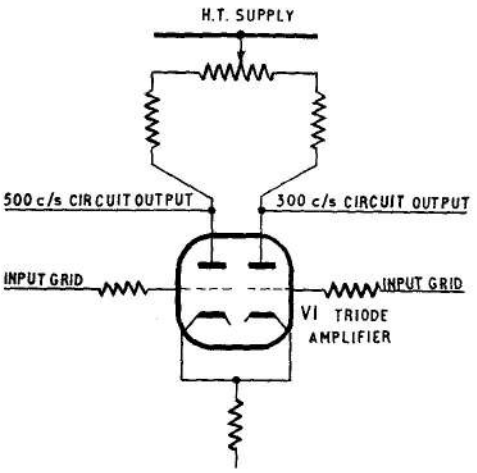

Fig.6 Triode amplifier

21. Switch on the supplies and allow the controller to warm up for 10 minutes. Connect together the grids of the triode amplifier V1, this prevents the differential output from the frequency selective circuit from affecting the balance adjustment, and ensures that the influence on both grids is identical. Adjust the balance trimmer RV2 so that the output from the pentodes V2 and V3 is similar. A reading of 8 to 11mA should be obtained. The change-over switch should be operated to connect the meter in each output circuit as R.V.2 is adjusted, so that the same reading is observed for both circuits. Remove the connection between the grids of V.1.

22. Ensure that the supply frequency is 400c/s. With the milliammeter connected in each output circuit, by operation of the change-over switch as in the previous para., adjust the frequency trimmer RV1, so that the outputs are again balanced.

TABLE 1

List of Components

Item	No.off	Ref.No.	Rating	Type
Capacitors				
C1	1	Z.123475	560pF,	350V
C2	1	Z.124214	2700pF,	350V
C3, C12	2	Z.123514	820pF,	350V
C4	1	Z.124265	3900pF,	350V
C5, C14	2	Z.115625	0.01μF,	350V
C6, C15	2	Z.115572	2μF,	150V
C8, C17	2	Z.115595	0.02μF,	350V
C9, C18	2	Z.115596	0.05μF,	350V
C10	1	Z.124334	5600pF,	350V
C11	1	Z.123376	390pF,	350V
C13	1	Z.124353	6800pF,	350V
C19	1	Z.124700	0.001μF,	350V
C51, C52	2	Z.115186	1μF,	400V
C7, C16	2	Z.115552	0.01μF,	350V

TABLE 1 (Contd.)

Item	No.off	Ref.No.	Rating	Type
Fixed resistors				
R1	1	Z.216107	75 k ohm,	½W
R2, R5, R21	3	Z.216734	390 k ohm,	½W
R3, R19	2	Z.216112	82 k ohm,	½W
R4, R22	2	Z.216718	180 k ohm,	½W
R6, R8, R11				
R24, R26, R29,	6	Z.216756	1 M ohm,	½W
R9, R28	2	Z.216722	220 k ohm,	½W
R7, R12, R25, R30	4	Z.216122	100 k ohm,	½W
R13, R33,	2	Z.216053	27 k ohm,	¾W
R15, R17	2	Z.215344	6.8 k ohm,	1W
R16	1	Z.215243	1 k ohm,	¾W
R18	1	Z.215273	1.8 k ohm,	¾W
R20	1	Z.216117	91 k ohm,	½W
R32	1	Z.215303	3.3 k ohm,	¾W
R34	1	Z.243049	33 ohm,	4½W
R51	1	Z.244122	18 k ohm,	6W
R52	1	Z.244150	47 k ohm,	6W
R23	1	Z.216738	480 k ohm,	½W
Variable resistors				
RV1, RV2	2	Z.272412	50 k ohm,	2½W
Valves				
V1	1	CV.4003		Double triode.
V2, V3	2	CV.4014		HF. pentode.
Rectifiers				
Power pack	4			40 AS Silicon rectifiers.
BR1, BR2	8			30 AS Silicon rectifiers.
Transformers				
T1	1			Ferguson 100191
T2	1			Ferguson 100190

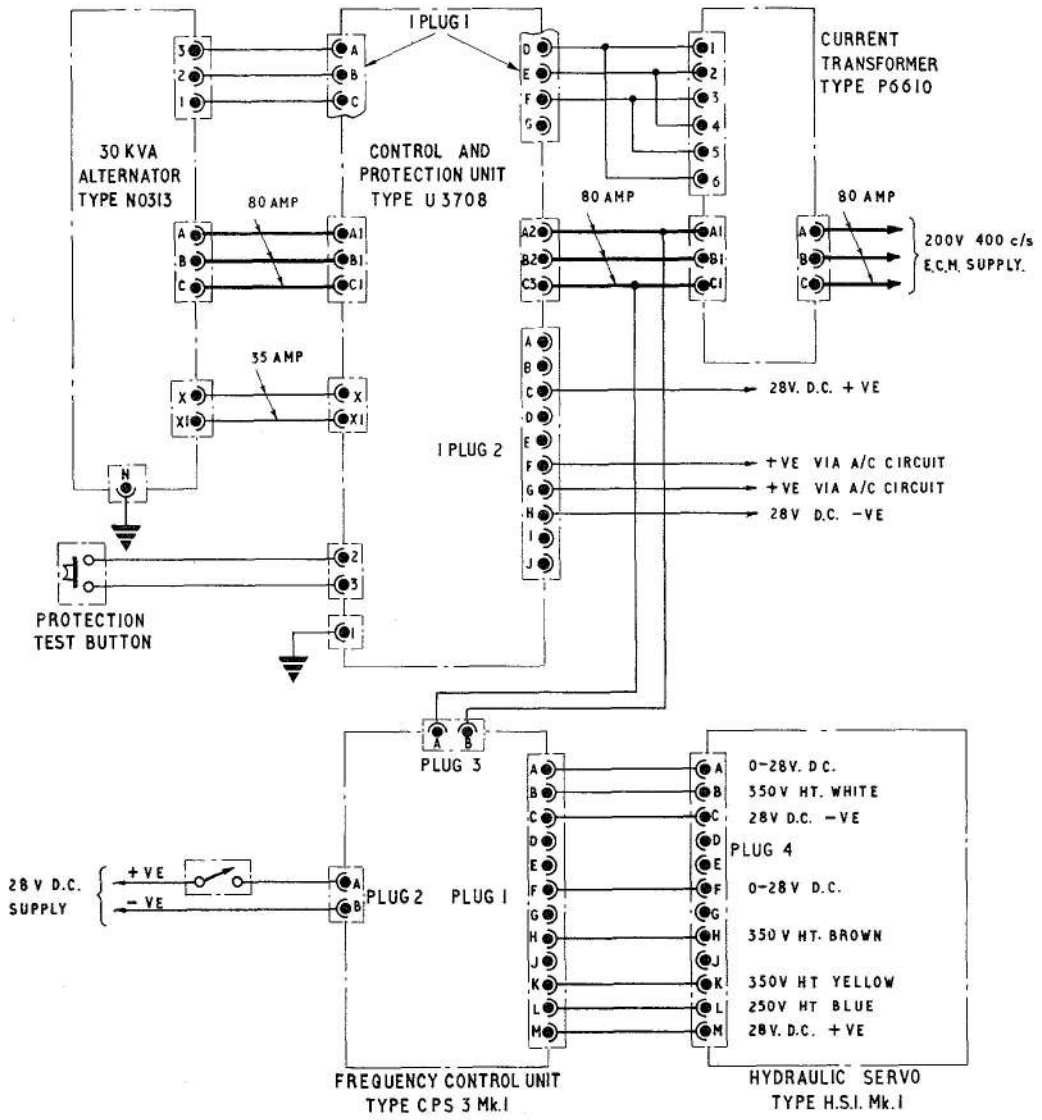

Fig.7 Block wiring diagram

TABLE 1 (Contd.)

Item	No.off	Ref.No.	Rating	Type
Choke				
L3	1			Ferguson 100192
Switch				
S1	1	10F/2487		2 pole, 2 way
Jack				
J1	1	10H/1049		Midget, self starting
Plugs				
1	1	Z.560150		12 pole
2	1	Z.560050		2 pole
3	1	Z.560555		2 pole