Chapter 22

CONTROL PANEL, PLESSEY, TYPE 21

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LEADING PARTICULARS

Control panel, Plessey, Type 21	*Ref. No.* 5UC/6460
Output line voltage	200$V \pm 4$ *per cent*
Output	2·5*kVA at* 0·8 *p.f. lagging*
Frequency	400 *c/s* $\pm$5 *per cent*

Introduction

1. The Plessey control panel, Type 21, shown in fig. 1, is used in conjunction with the Plessey inverter, Type 107, which is described in A.P.4343B, Vol. 1, Book 3, Sect. 16.

2. This control panel is capable of maintaining the output voltage at 200V$\pm$4 per cent r.m.s. values between lines. The control is achieved by magnetic power amplifiers supplied from the inverter and feeding into the alternator field through rectifiers. Pilot leads are provided enabling the voltage to be controlled at the load bus-bars.

3. The control panel is also capable of maintaining the frequency at 400 c/s $\pm$ 5 per cent. The control is again by magnetic power amplifiers, supplied from the inverter output and feeding the motor control field.

DESCRIPTION

4. Two views of this control panel are shown in fig. 2. It consists mainly of the voltage and frequency regulators, contained on separate chassis. These chassis (fig. 3 and 4) fit into recesses provided in a metal base, and each is secured in position by four bolts, one being screwed into position from the underside of the base. A vertical panel

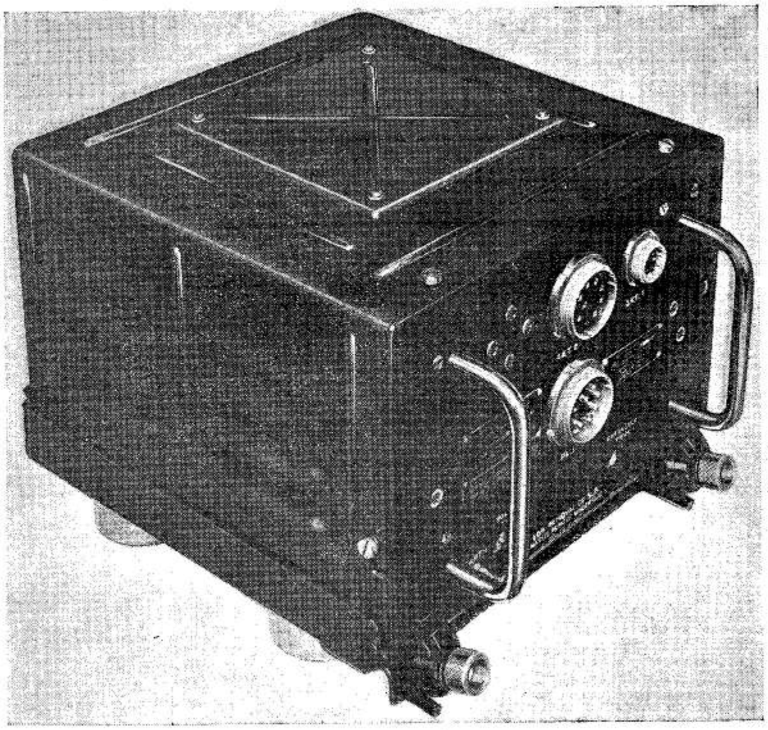


Fig. 1. Control panel, Plessey, Type 21

attached to the base carries the other items of equipment associated with the circuit, together with the input and output plugs and sockets.

5. A voltage and a frequency trim control are located at the bottom of the panel. Two handles located on each side of the front panel are provided to facilitate easy handling and carrying of the completed unit. A circuit diagram of the control panel is shown in fig. 6, and a schematic block diagram in fig. 5.

Voltage control circuit

6. The power to the transductor is supplied from the inverter through terminals 1, 2 and 3 of terminal block TBV. The output from this transductor is then fed to the primary of transformer T7 the output of which is rectified and fed to the alternator field of the inverter.

7. The voltage appearing at the load terminals is returned to the 3-phase bridge network MR.45.55 and R42.53 through terminals 4, 5 and 6 on terminal block TBV, radio interference suppressors, and pins D, E and F on output socket 2. The resultant rectified voltage appears across the resistors R35 and R33 and produces a current in the transductor (T7) winding 19-20, through the parallel resistance network consisting of R27 and R28.

8. In addition to the current in winding 19-20, another current is produced in the winding 18-20 through the series network consisting of R30, R31, RV5 and V1 resulting from the voltage appearing across R33.

9. Initially when the inverter starts, the voltage produced across R33 is insufficient to cause the voltage stabilizing tube V1 to strike; however, before the alternator voltage has completely built up the tube will strike and this results in a current being produced in winding 15-18. This current will be in opposition to that produced in winding 19-20.

10. Now since the voltage appearing across the stabilizing tube is substantially constant, the current in the winding 15-18, is proportional to the difference between the voltage across V1 and R33. The proportionate change in current is, therefore, greater than that in winding 19-20, which is proportional to the change in voltage across R35 and R33.

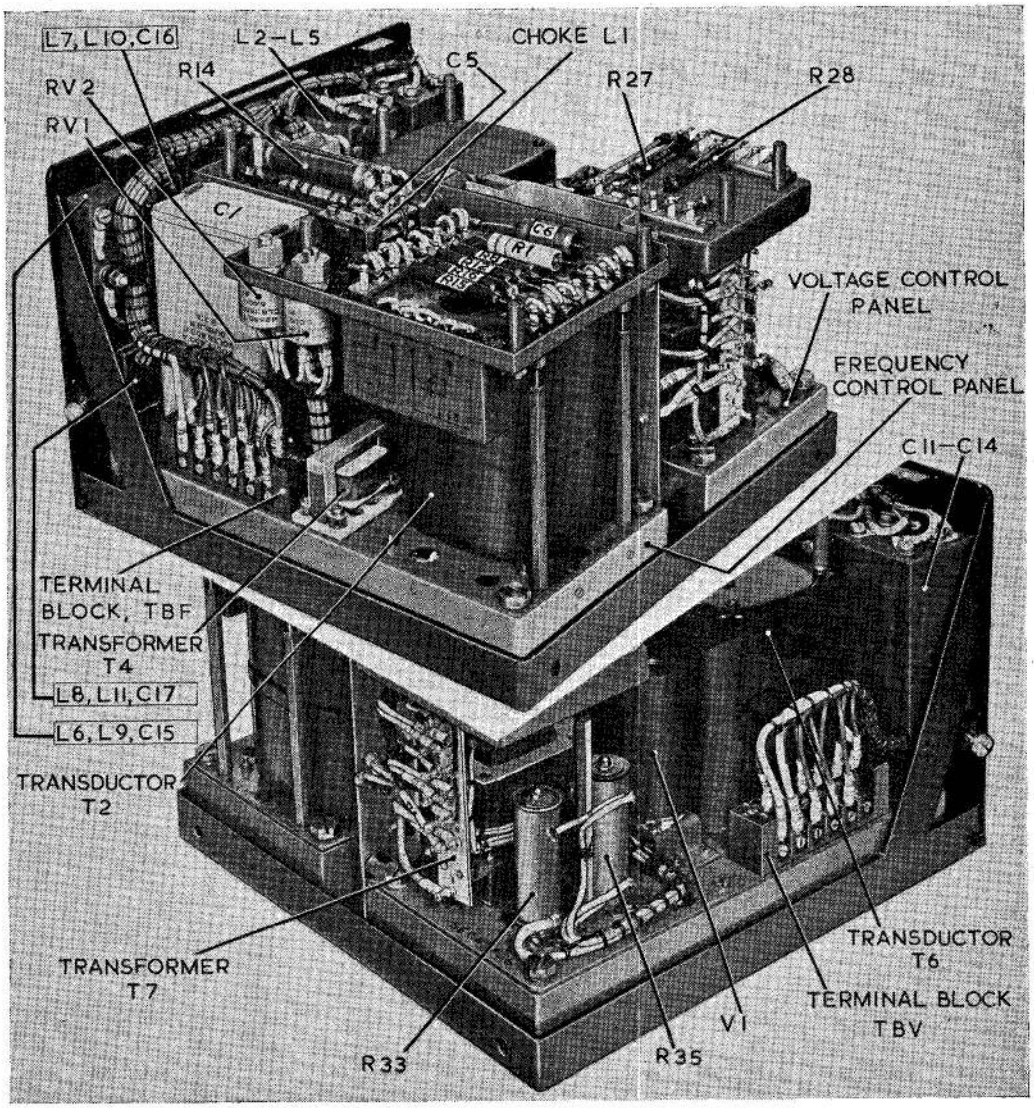


Fig. 2. View of control panel, with covers removed

11. The variable resistor RV5 therefore sets the value of the operating voltage by controlling the current level in winding 15-18.

Operation of voltage control circuit

12. A load on the machine causes the voltage to fall, and consequently the d.c. voltage appearing across R35 and R33 will fall; the resultant effect is to reduce the effective control current of the transductor. This will allow more current to flow in the a.c. winding of the transductor, the rectified voltage from the transformer T7 will be increased, and will be applied to the alternator field. The net effect is to increase the voltage to its maintaining level.

13. In order to stabilize the control a feedback path is provided from the rectified d.c. output of transformer T7, and is fed to winding 1-2 through capacitors 8, 9 and 10 in parallel, and R41. This stabilizing winding is only effective when transductor output is varying.

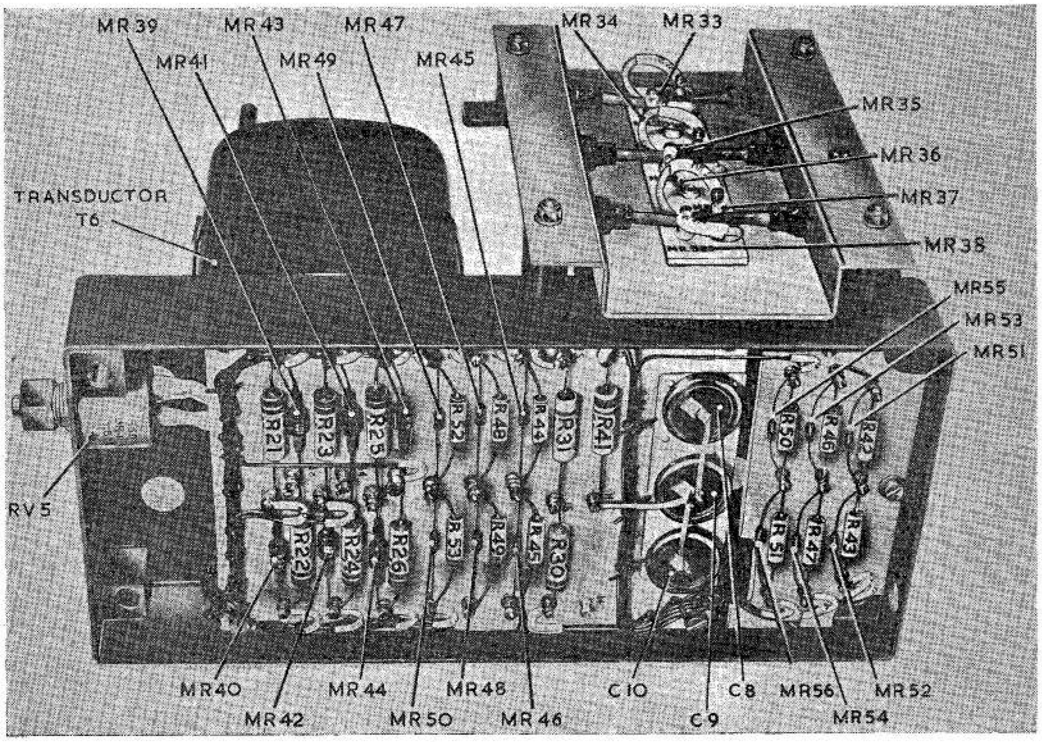


Fig. 3. View of voltage control panel

14. The controlling current to the alternator field is reasonably large, therefore regulation is assisted by the rectified output of transformer T8, which produces an output proportional to the load current.

Frequency control circuit

15. Power to the transductor T2 is fed from the inverter output through terminals 1, 2 and 3 of terminal block TBF and power to transductor T12 is fed from terminals 2 and 3 of terminal block TBF through transformer T4.

16. A frequency sensing network consisting of resistors R14, R15 and R16 together with capacitors C3, C4 and C7 arranged in a parallel "T" configuration, produces a voltage across the bridge rectifier MR19-22. This voltage is dependent upon frequency, and is designed to operate at frequencies around 400 cycles/sec. A filter consisting of L1, C5 and C6 reduces the effect of harmonics generated from the 400 cycle supply voltage.

17. The rectified voltage produced from MR19-22 is balanced against the voltage produced from the bridge rectifier MR23-26.

18. Transformers T10 and T1 are fed from terminals 1, 2 and 3 of terminal block TBF and form an adding circuit, the output of T1 being proportional to the average of the three line voltages. A proportion of T1 output voltage picked off RV4 is fed to bridge rectifier MR 23-26, where it is compared with the frequency sensitive output of bridge MR 19-22 to provide a frequency error signal to control magnetic amplifier T12. Adjustment of RV4 will set the voltage to be balanced, which therefore, sets the operating frequency.

19. The bias windings 3-4 of transductor T12 and winding 17-20, of T2, are fed from the three-phase bridge MR45-MR50 of the voltage control panel, the bias level of each being set by RV2 and RV1 respectively.

20. The output of T12 is rectified and fed into the control winding 15, 16 of transductor T2. The output of the latter transductor is rectified and fed to the motor regulating field of the inverter motor.

Operation of frequency control circuit

21. A sudden load appearing across the output terminals will cause the speed of the

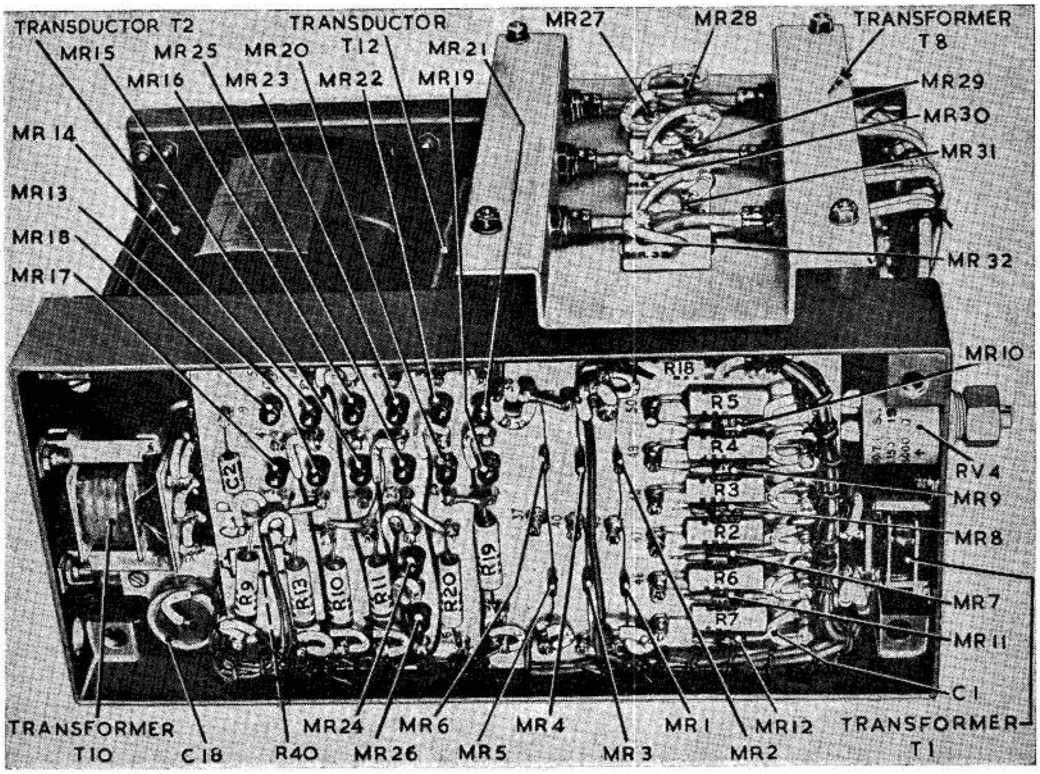


Fig. 4. View of frequency control panel

motor to fall, the frequency decreases and is followed by a change in voltage appearing on the output of the bridge rectifier MR19-22. This results in a change in the current flowing in the winding 13-14 of transductor T12.

22. The change of input to T12, causes a change of input current to winding 15-16 of T2 in a manner such as to reduce the motor regulating field current. The result is that the speed of the motor increases.

23. To stabilize the system the voltage developed in the feedback winding of the motor is fed back into the winding 15-16 of transductor T12 through resistor R18. In both cases the feedback is transient only.

24. The output of the inverter is taken to the output socket 2, through pins A, B and C and associated radio suppressors. The neutral line is taken to pin J.

25. A test socket SKT.1 is provided in order to check the voltage output.

INSTALLATION

26. The control panel is normally fitted to an anti-vibration mounting.

27. The connecting plugs and sockets used are Plessey type.

SERVICING

28. The control panel should be checked for security of mounting and connecting cables and plugs inspected to ensure that there is no damage and that the connections are in satisfactory condition.

Testing

29. Details of tests which may be applied to verify the serviceability of the panel will be found in Appendix A to this chapter.

Note . . .

It is important that the sensing leads are connected to the load bus-bars, otherwise the control panel will not function satisfactorily.

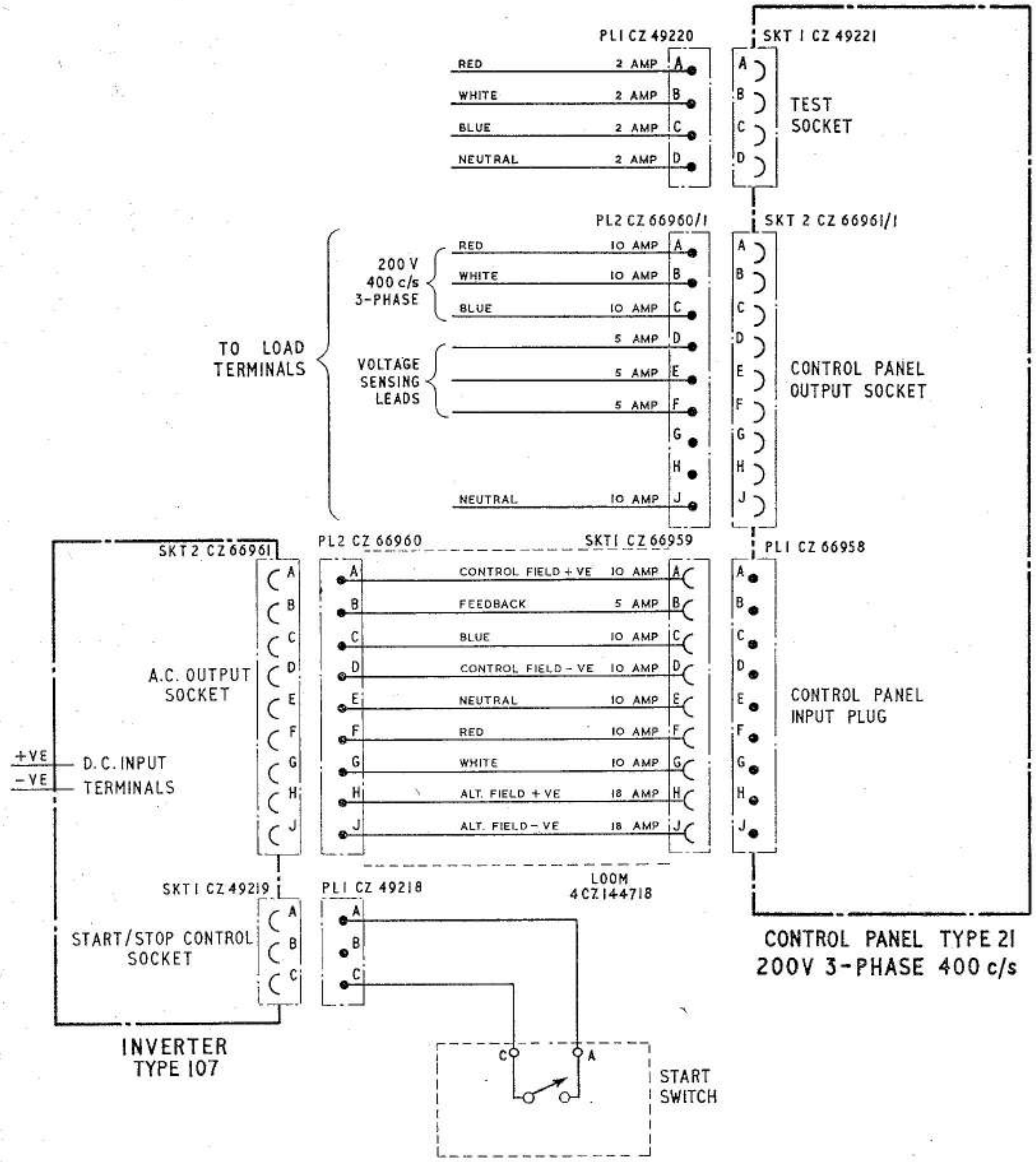
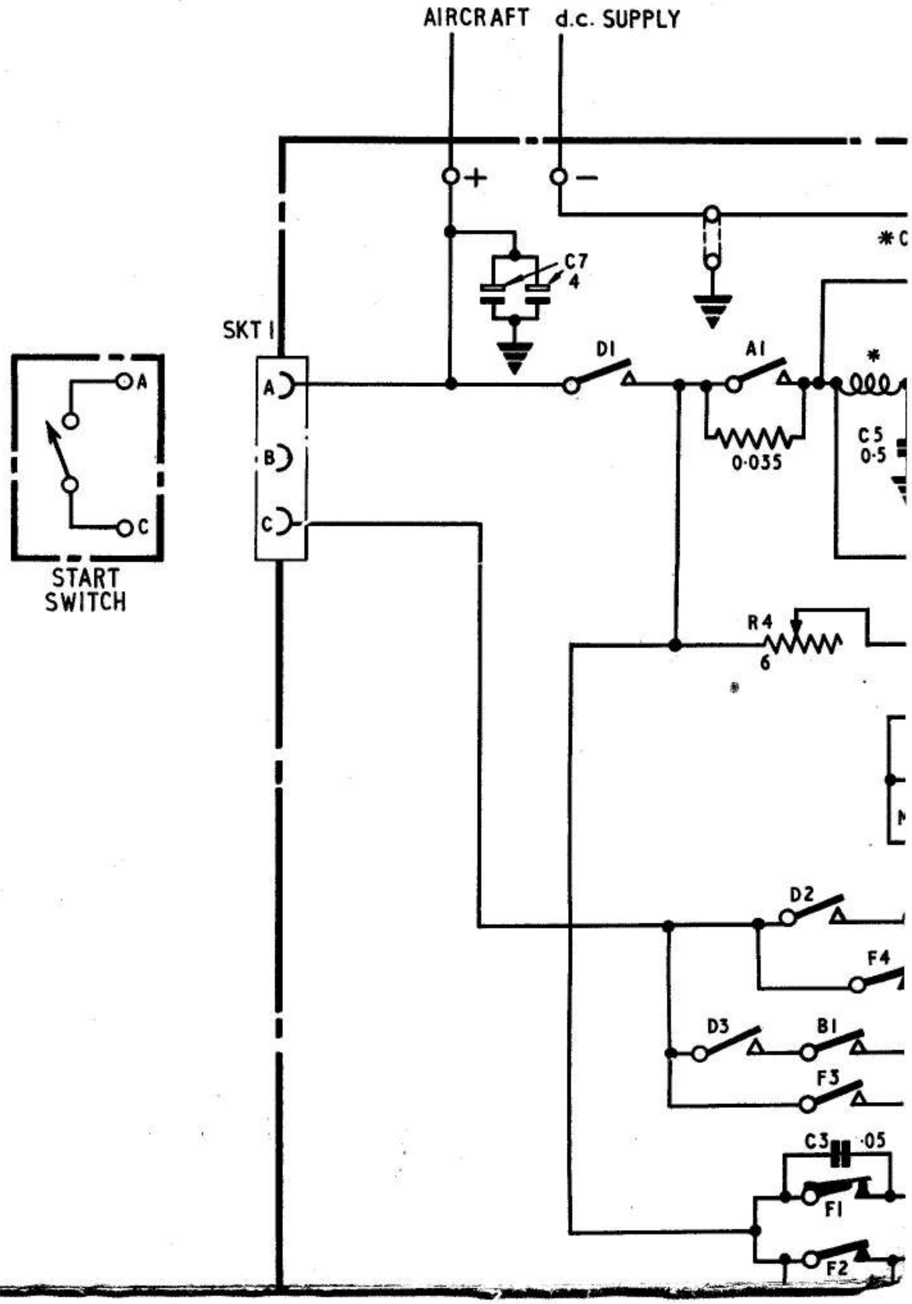
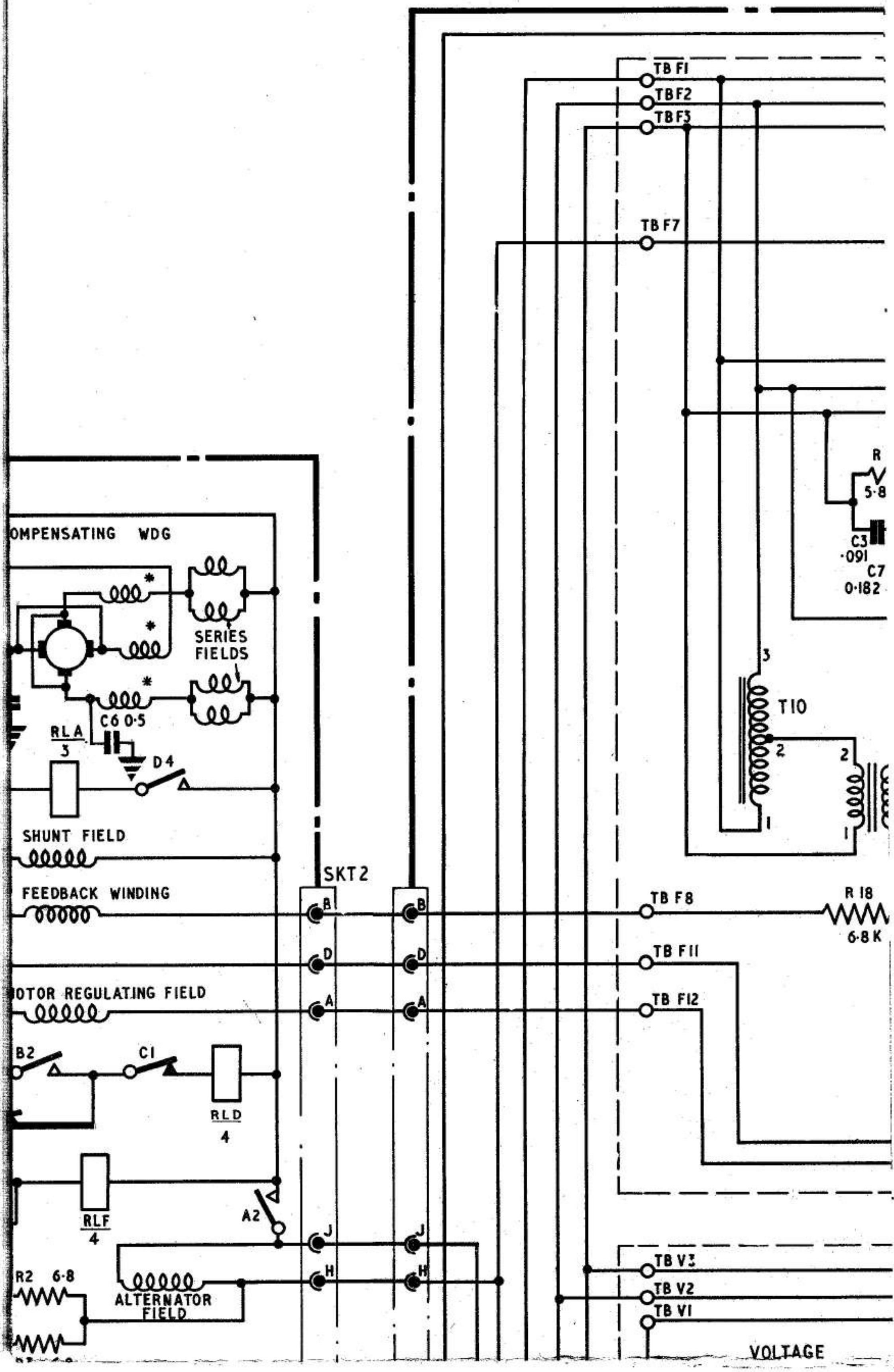
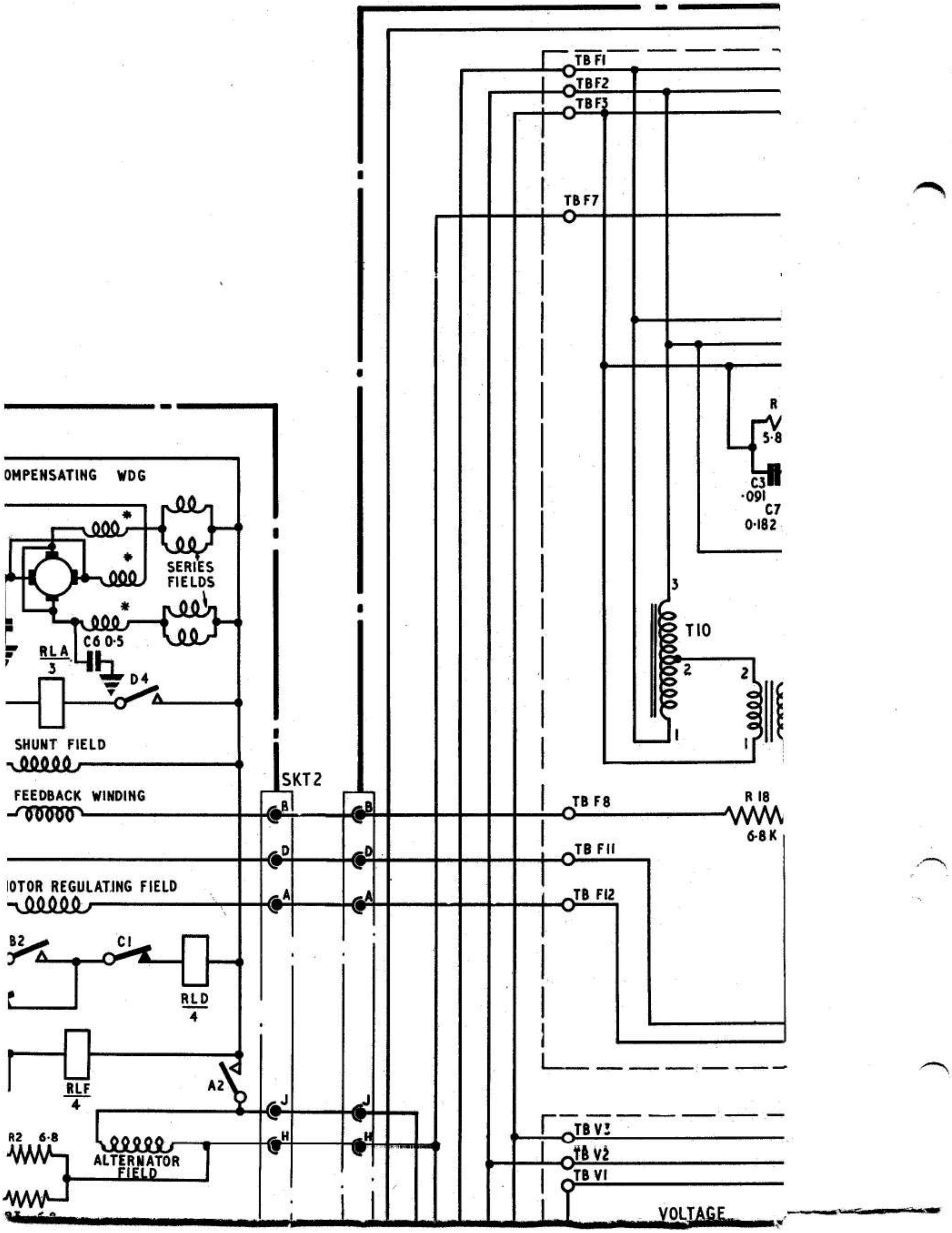


Fig. 5. Block schematic diagram

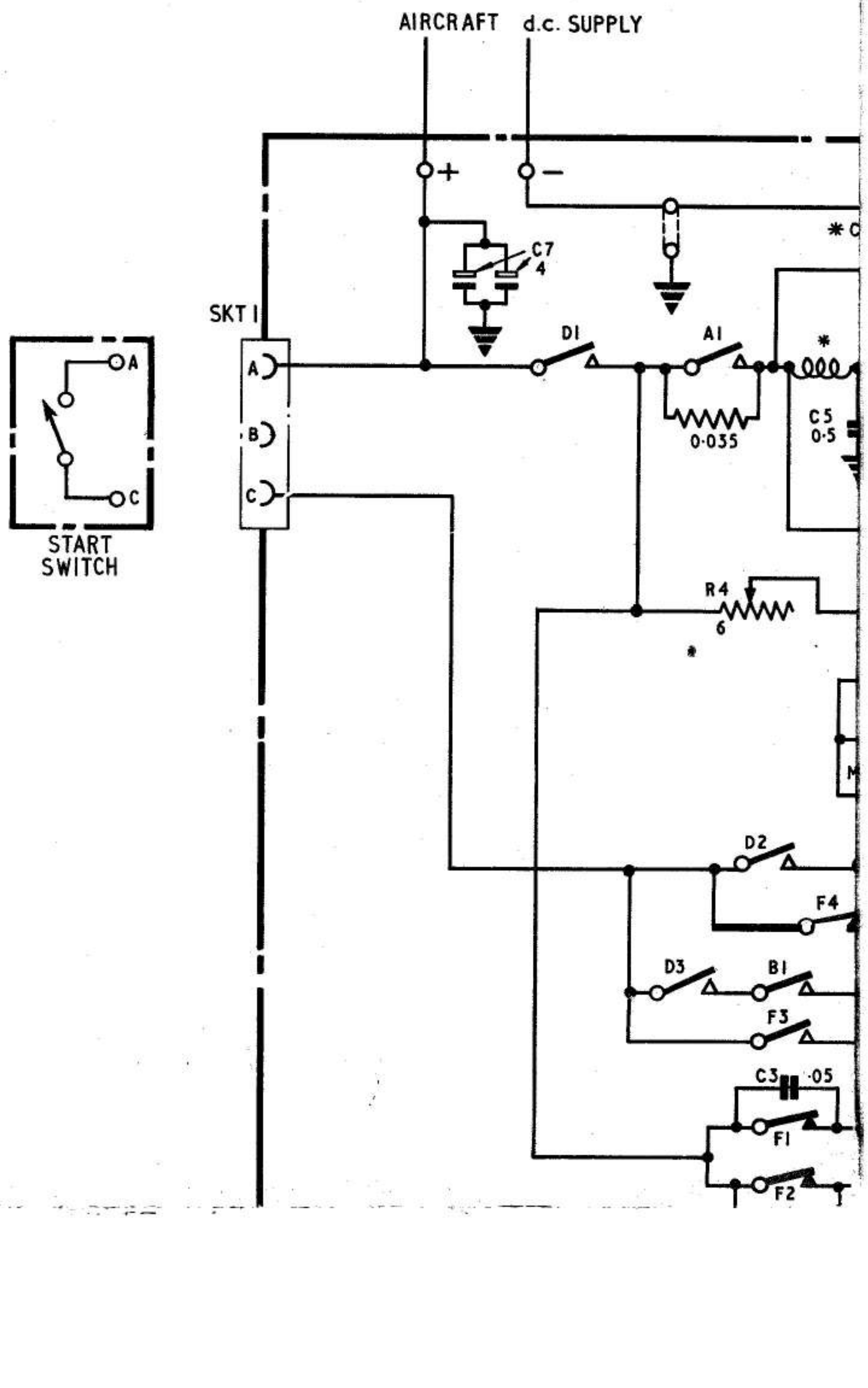

AIRCRAFT d.c. SUPPLY
+
−
C7
4
SKT I
A
B
C
START
SWITCH
D1
A1
0·035
C5
0·5
R4
6
D2
F4
D3
B1
F3
C3
·05
F1
F2

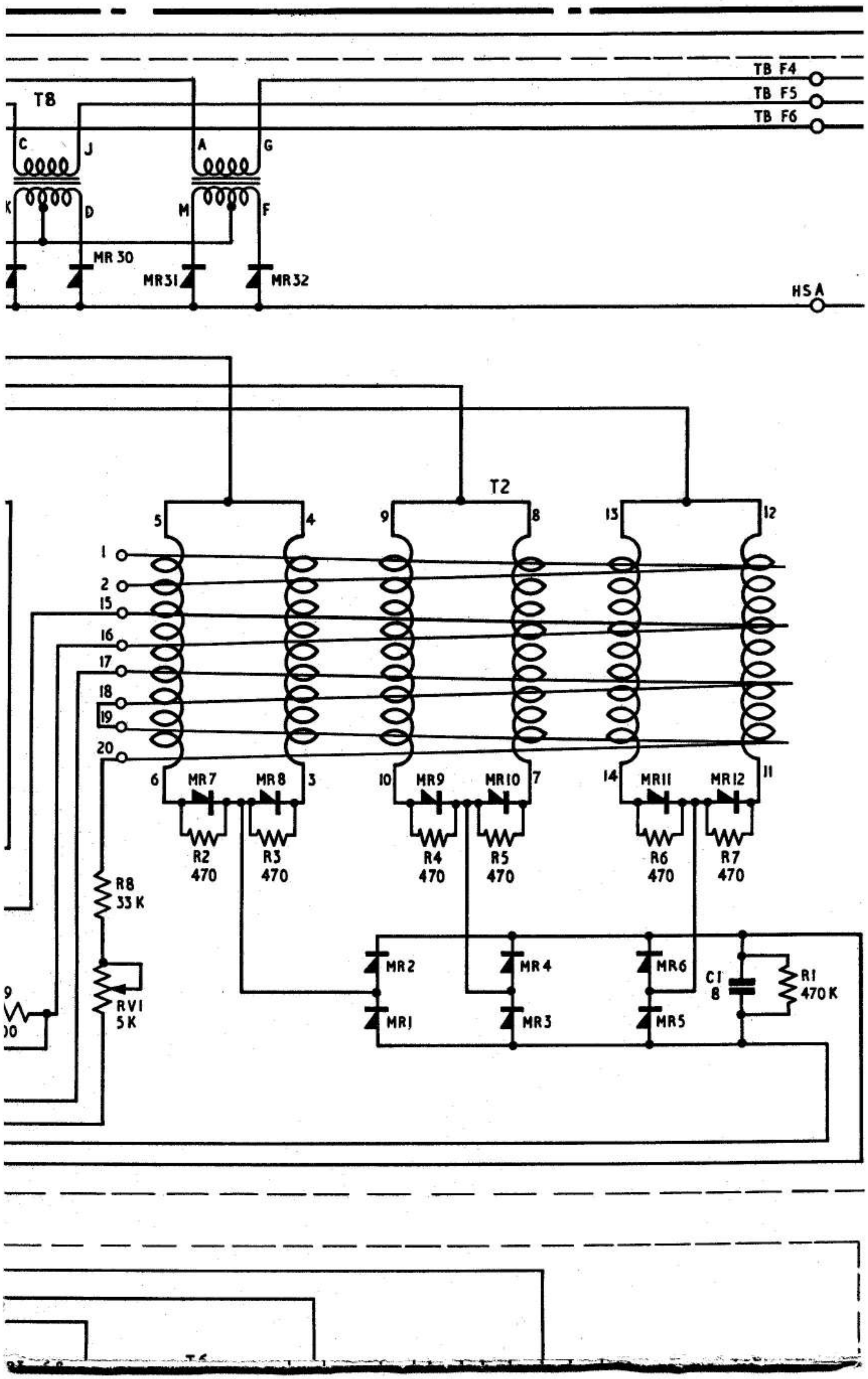


TB F1
TB F2
TB F3
TB F7
COMPENSATING WDG
SERIES FIELDS
C6 0·5
RLA 3
D4
SHUNT FIELD
FEEDBACK WINDING
MOTOR REGULATING FIELD
B2
C1
RLD 4
RLF 4
A2
R2 6·8
ALTERNATOR FIELD
SKT2
T10
C3 ·091
C7 0·182
5·8
TB F8
R 18 6·8K
TB F11
TB F12
TB V3
TB V2
TB V1
VOLTAGE

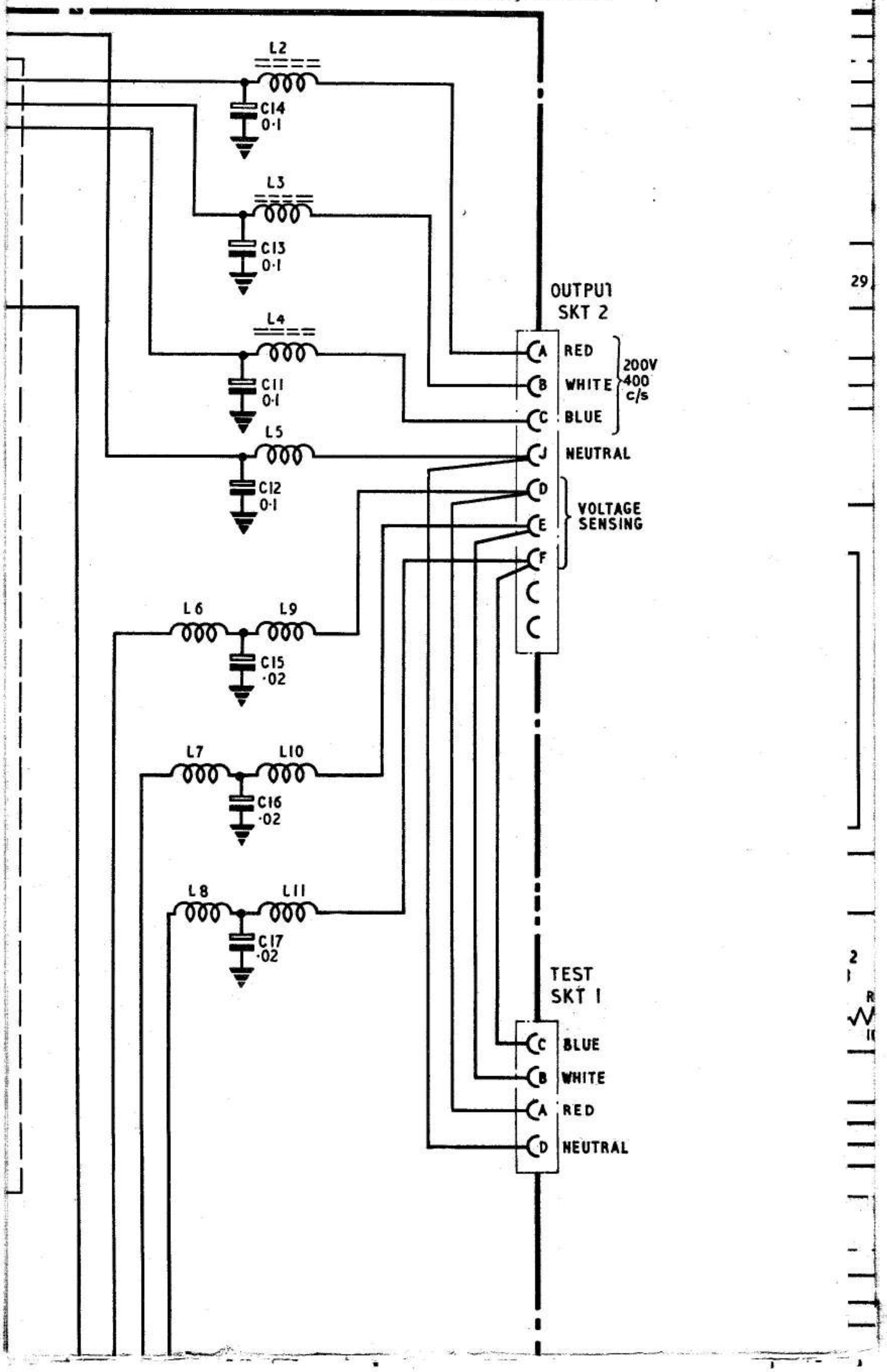


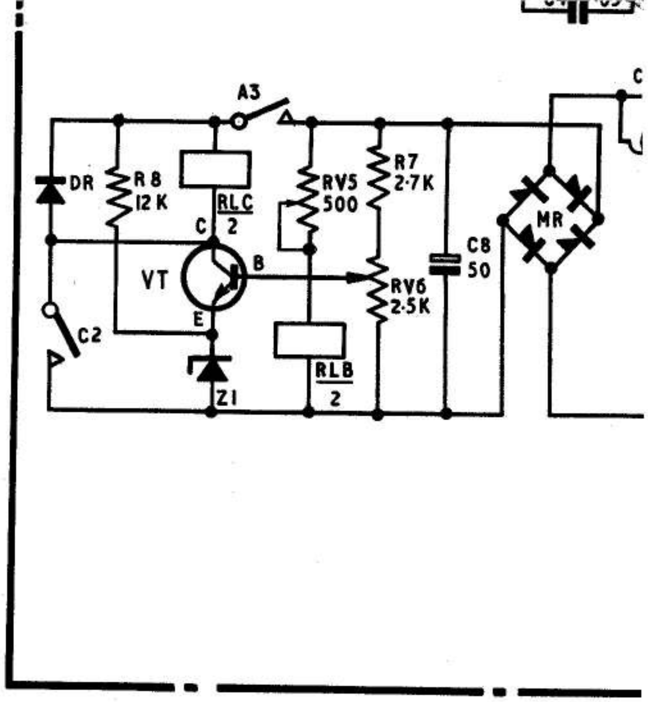
TB F1
TB F2
TB F3
TB F7
R
5·8
C3
·091
C7
0·182
3
T10
2
2
1
1
OMPENSATING WDG
SERIES FIELDS
C6 0·5
RLA
3
D4
SHUNT FIELD
SKT2
FEEDBACK WINDING
B
D
A
J
H
TB F8
R 18
6·8 K
TB F11
IOTOR REGULATING FIELD
TB F12
B2
C1
RLD
4
RLF
4
A2
R2 6·8
ALTERNATOR FIELD
TB V3
TB V2
TB V1
VOLTAGE


AIRCRAFT d.c. SUPPLY
+
−
C7
4
SKT I
A
B
C
START
SWITCH
D1
A1
0·035
C5
0·5
R4
6
D2
F4
D3
B1
F3
C3
·05
F1
F2



T8
C
J
K
D
MR 30
A
G
M
F
MR31
MR32
TB F4
TB F5
TB F6
HS A
T2
5
4
9
8
13
12
1
2
15
16
17
18
19
20
6
3
10
7
14
11
MR7
MR8
MR9
MR10
MR11
MR12
R2 470
R3 470
R4 470
R5 470
R6 470
R7 470
R8 33 K
RV1 5 K
MR2
MR1
MR4
MR3
MR6
MR5
C1 8
R1 470 K


L2
C14
0·1
L3
C13
0·1
L4
C11
0·1
L5
C12
0·1
OUTPUT
SKT 2
A RED
B WHITE
C BLUE
200V
400
c/s
J NEUTRAL
D
E
F
VOLTAGE
SENSING
L6
L9
C15
·02
L7
L10
C16
·02
L8
L11
C17
·02
TEST
SKT 1
C BLUE
B WHITE
A RED
D NEUTRAL
29



INVERTER TYPE 107

Fig. 6

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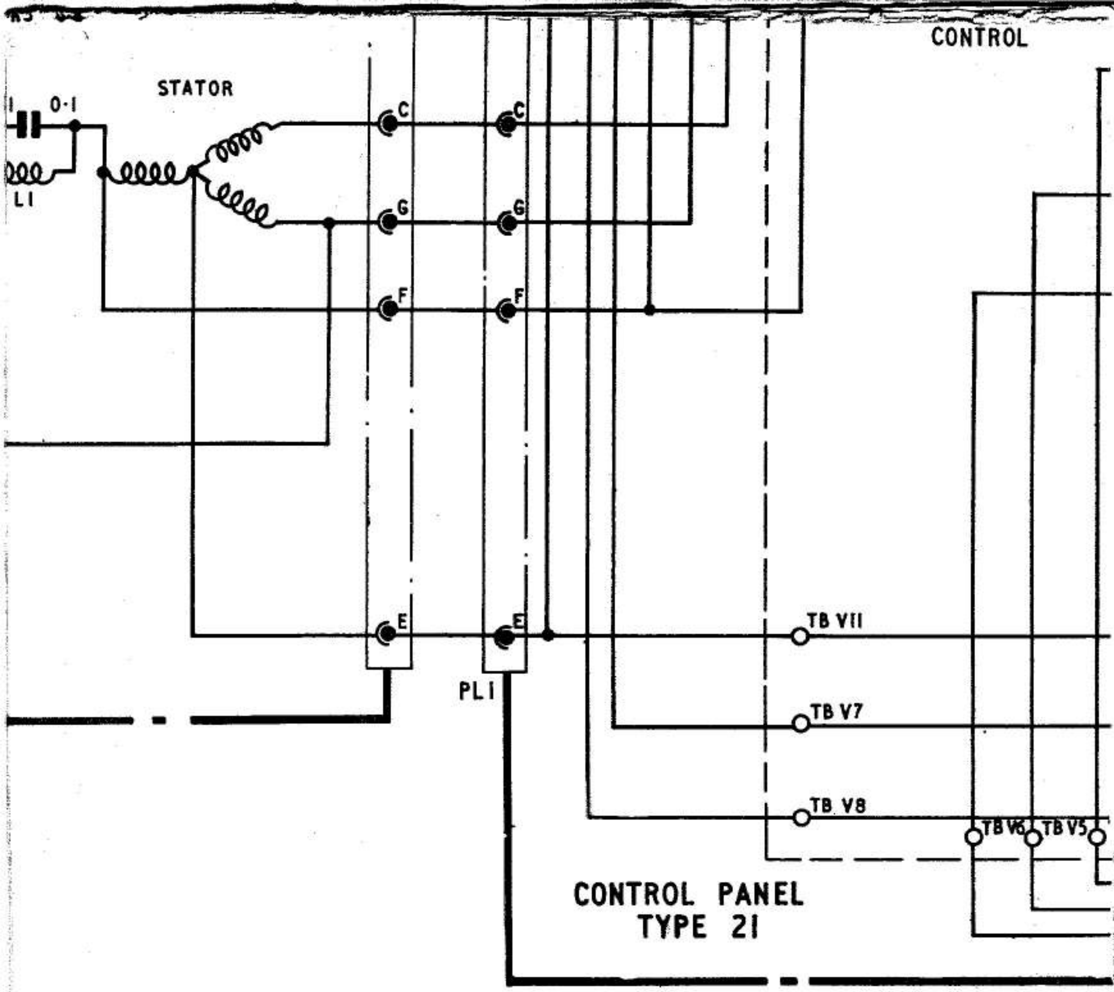
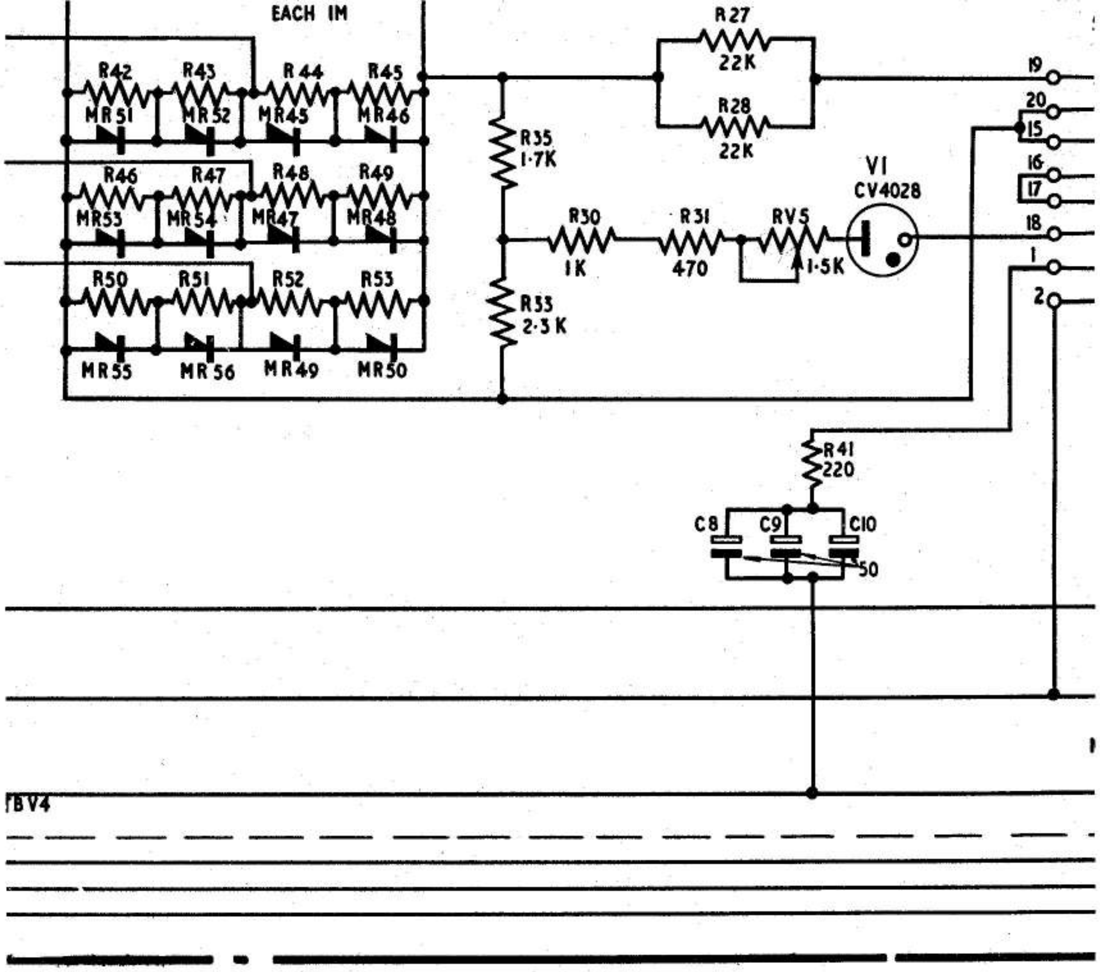


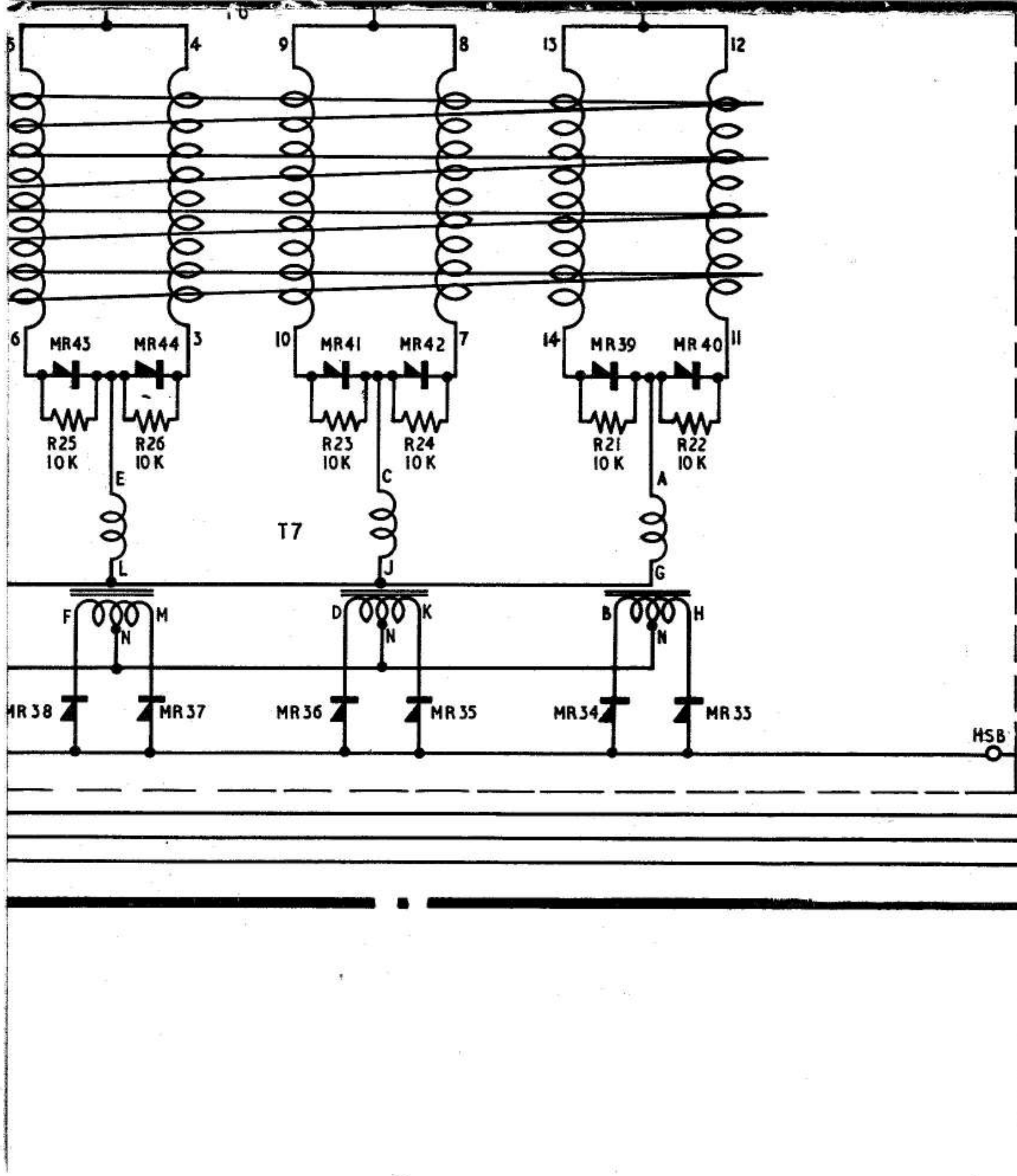
Circuit diag

3/64 C&P

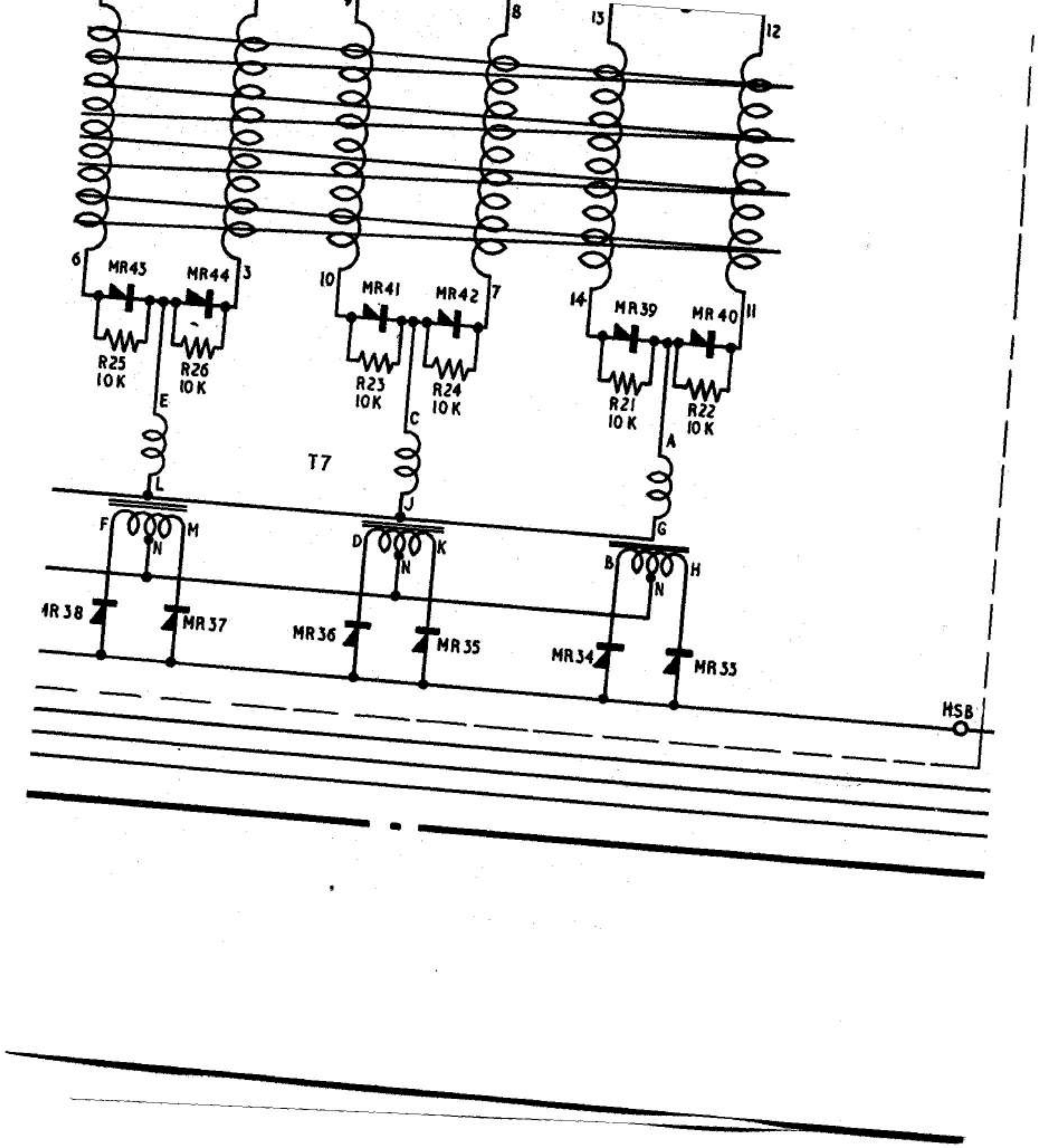


gram of control panel and inverter

R E S T R I C T E D



5
4
9
8
13
12
6
MR43
MR44
3
10
MR41
MR42
7
14
MR39
MR40
11
R25
10K
R26
10K
R23
10K
R24
10K
R21
10K
R22
10K
E
C
A
T7
L
J
G
F
M
D
K
B
H
N
N
N
MR38
MR37
MR36
MR35
MR34
MR33
HSB



6
3
10
7
14
11
8
13
12
MR43
MR44
MR41
MR42
MR39
MR40
R25
10 K
R26
10 K
R23
10 K
R24
10 K
R21
10 K
R22
10 K
E
C
A
T7
L
J
G
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M
N
D
K
B
H
MR 38
MR 37
MR 36
MR 35
MR 34
MR 33
HSB

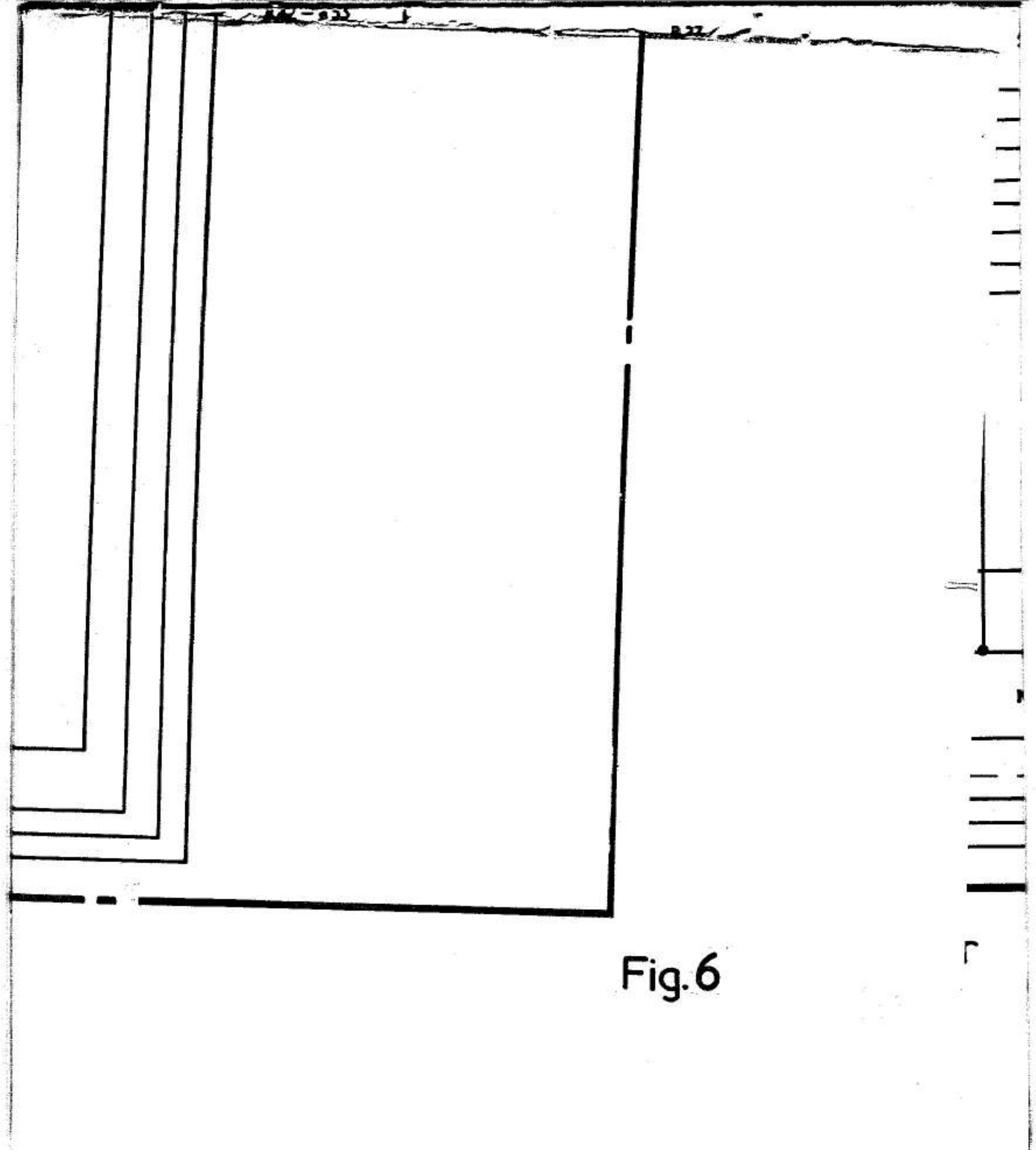

Fig. 6

Appendix 1

CONTROL PANEL, TYPE 26A (ROTAX U1507)

LEADING PARITCULARS

Control panel, Type 26A	*Ref. No.* 5*UC*/6541
Output (*when used with Type* 108 *or Type* 108*A inverter*)—	
Voltage	115*V* ±5*V a.c.*
Frequency	400 *c/s* ± 2½ *per cent*
Load	... (*a*) 770*W at* 1·0–0·84 *p.f.* (*lagging*) *or* (*b*) 650*W at* 1·0–0·95 *p.f.* (*leading*)
Output (*when used with Type* 112 *inverter*)—	
Voltage	115*V* ± 4 *per cent a.c.*
Frequency	400 *c/s* ± 4 *per cent*
Load	... 200*W at* 0·8 *p.f.* (*lagging*)
Operating temperature range	−65 *deg. C to* + 70 *deg. C*
Overall dimensions—	
Length	14·10 *in.*
Width	7·91 *in.*
Height	5·89 *in.*
Weight	... 17 *lb.*

1. The control panel, Type 26A (Rotax U1507) is similar to Type 26 (Rotax U1504), but incorporates certain higher temperature rated components to enable the control panel to be operated in temperatures up to +70 deg. C. The components concerned are capacitor 5C5 (value unchanged, but Part No. altered), also rectifiers 5MR1, 5MR3, 5MR5 and 5MR9, whose Part Nos. are altered. The internal connections of the panel are unchanged.

Appendix 2

CONTROL PANEL, TYPE 26B (ROTAX U1509)

LEADING PARTICULARS

Control panel, Type 26B	*Ref. No.* 5UC/6969
Output (when used with Type 108 *or Type* 108*A inverter)*—	
Voltage	115*V* ± 5*V a.c.*
Frequency	400 *c/s* ± $2\frac{1}{2}$ *per cent*
Load	(*a*) 770*W at* 1·0–0·84 *p.f.* (*lagging*) *or* (*b*) 650*W at* 1·0–0·95 *p.f.* (*leading*)
Output (when used with Type 112 *inverter)*—	
Voltage	115*V* ± 4 *per cent a.c.*
Frequency	400 *c/s* ± 4 *per cent*
Load	200*W at* 0·8 *p.f.* (*lagging*)
Operating temperature range	–40 *deg. C to* +50 *deg. C*
Overall dimensions—	
Length	14·10 *in.*
Width	7·91 *in.*
Height	5·89 *in.*
Weight	17 *lb.*

1. ◄ The control panel, Type 26B (Rotax U1509) is similar to Type 26 (Rotax U1504) but incorporates a change in the control of relay 5RL1. A full circuit diagram is given in fig. 1. ►

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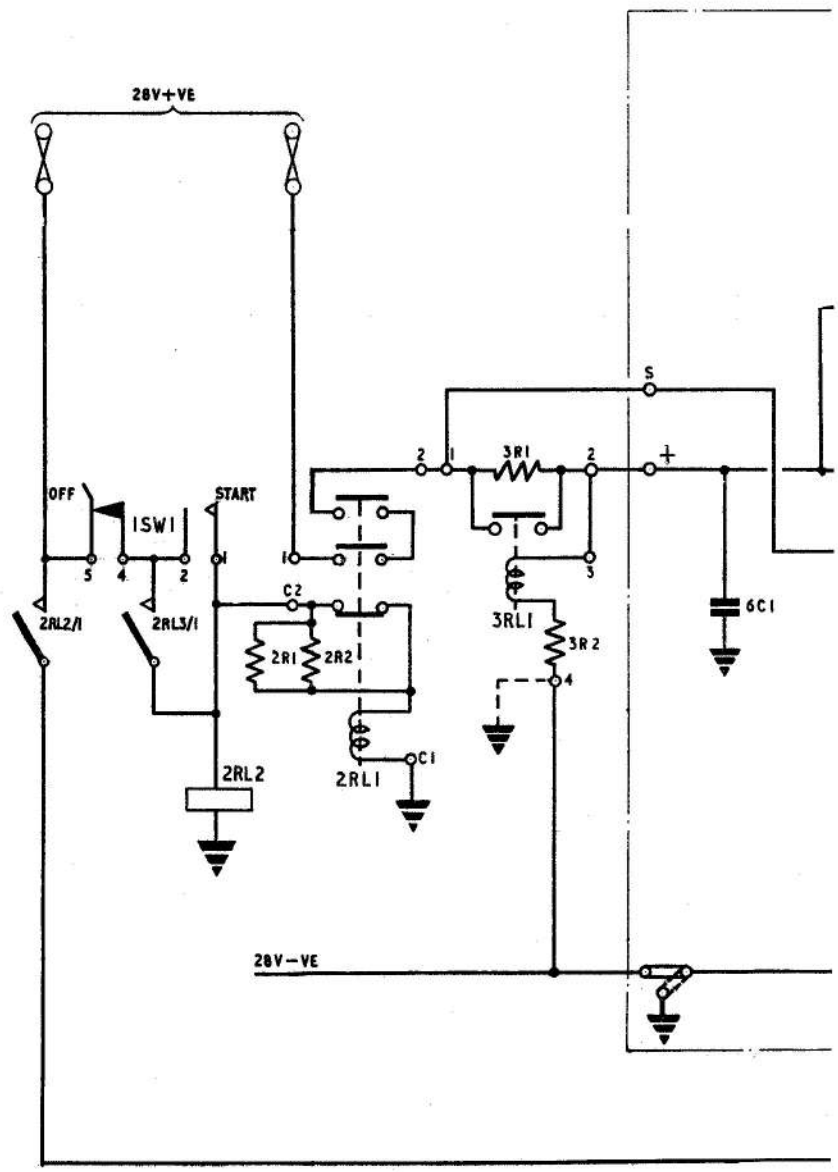
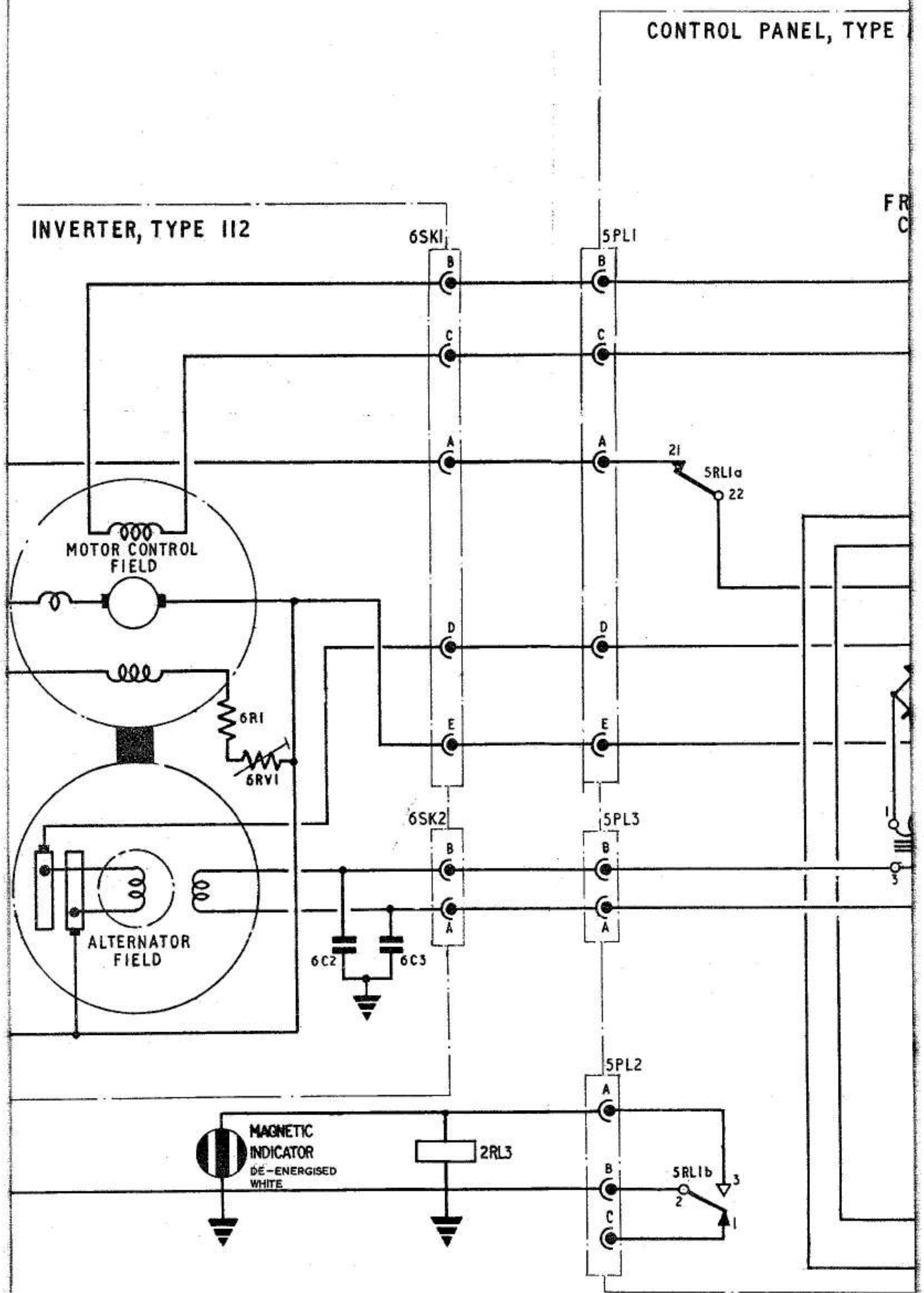
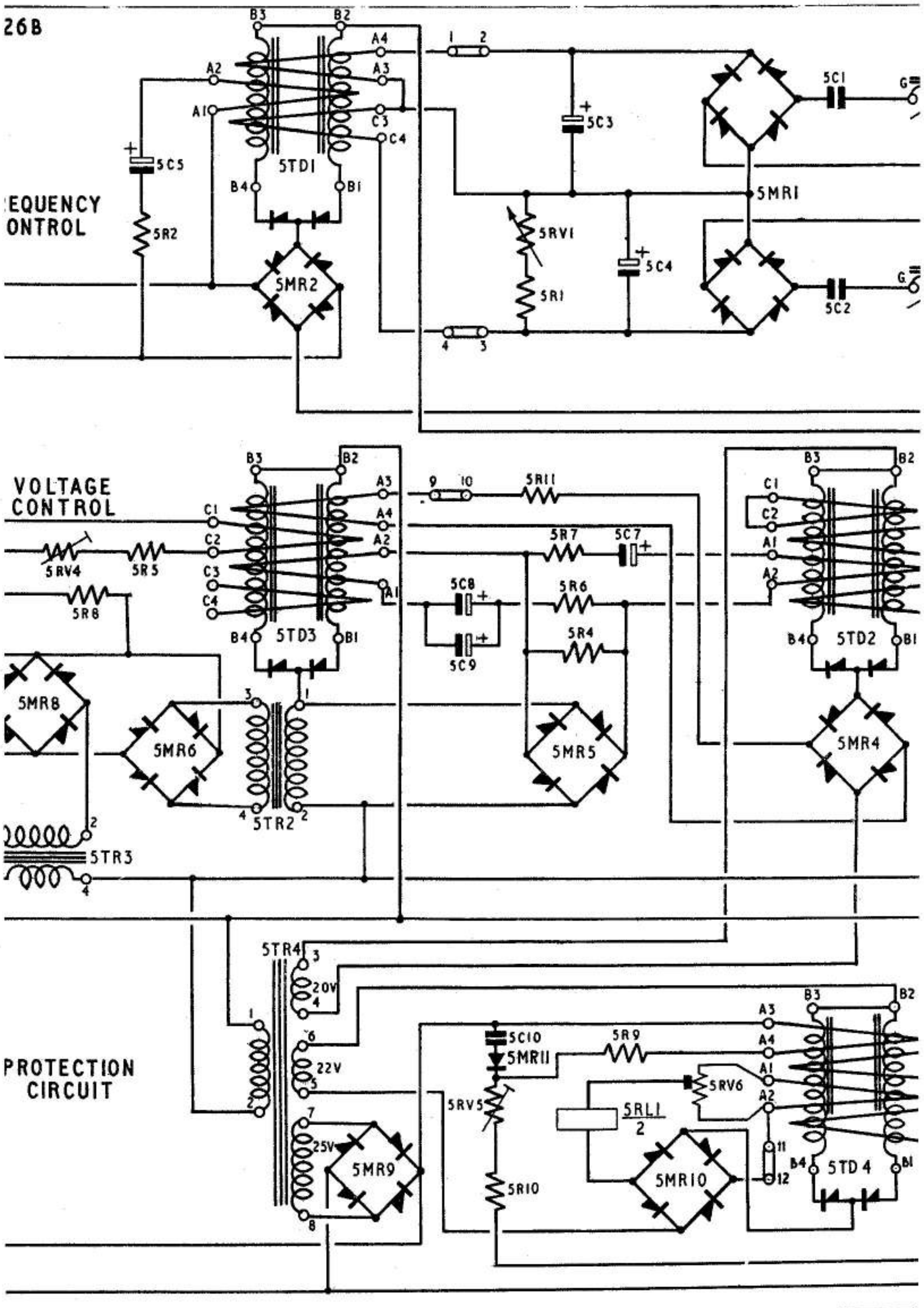


Fig.1

PP9221 8952/371475 2/64 C & P



Composite ci
RESTR



'cuit diagram
ICTED

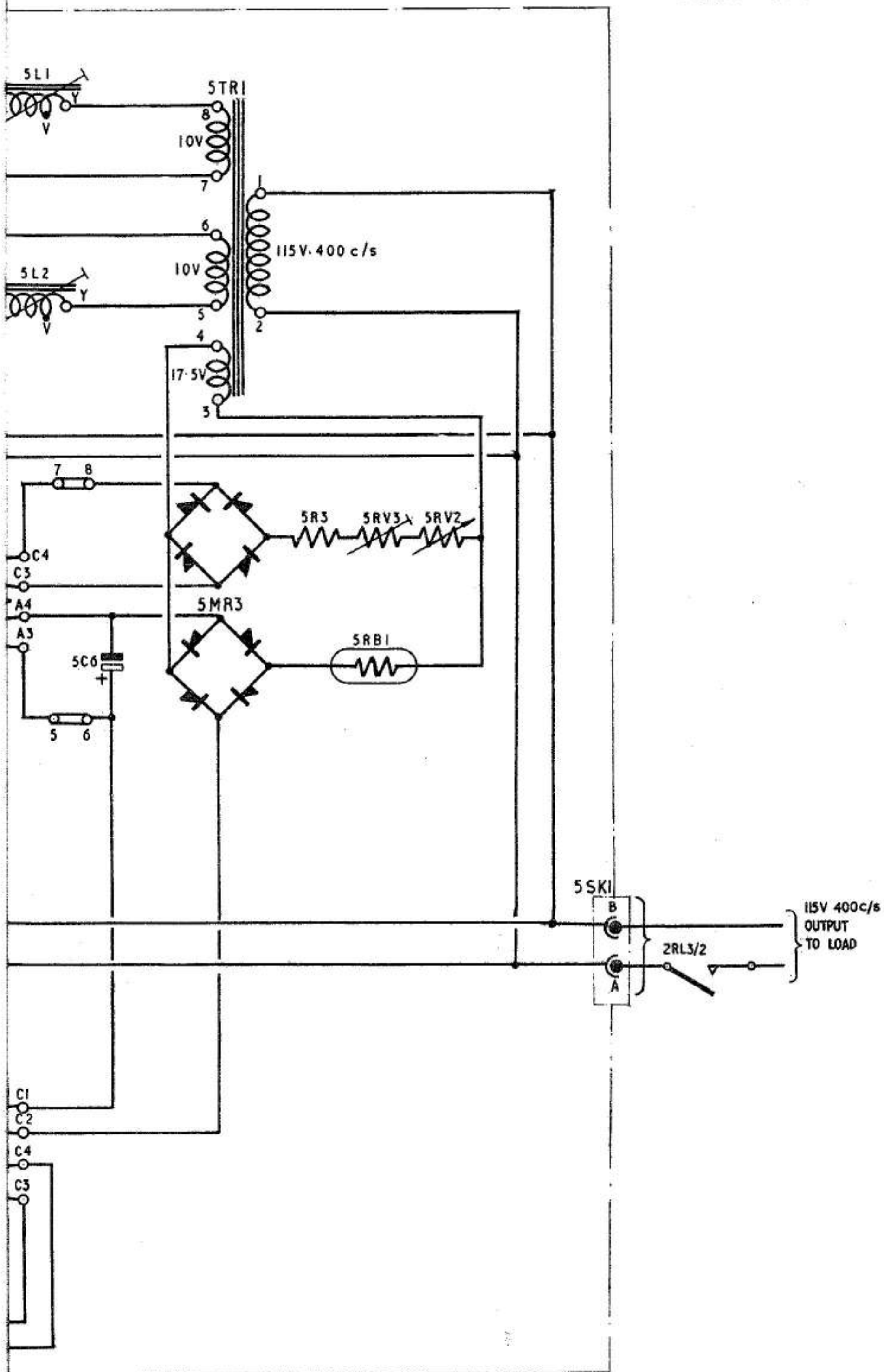

5L1
Y
V
5TR1
8
10V
7
1
6
115V-400 c/s
10V
5L2
Y
V
5
2
4
17·5V
3
7 8
5R3
5RV3
5RV2
C4
C3
A4
5MR3
A3
5C6
+
5RB1
5 6
5SK1
B
A
115V 400c/s
OUTPUT
TO LOAD
2RL3/2
C1
C2
C4
C3

Fig.1

Appendix A

STANDARD SERVICEABILITY TEST

for

CONTROL PANEL, PLESSEY, TYPE 21

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

1. The tests detailed in this Appendix may be applied to the control panel as a pre-installation test, or at any time when its serviceability is suspect.

Test equipment

2. The following test equipment is required; for the R.A.F. items (1) to (7) and for the R.N., where the control panel is tested without the inverter test rig, items (4) to (12).

Item	Instruments	Ref. No.	Description	Qty.
(1)		5G/564	Inverter test rig	1
(2)		5QP/10610	Test meter, Type D (or equivalent)	1
(3)		5G/1621	Insulation resistance tester, Type A	1
(4)	M1	5Q/234	Voltmeter 0–40V d.c.	1
(5)	M2	5Q/25091	Ammeter 0–10A d.c.	1
(6)	M3	5Q/25060	Ammeter 0–500 mA d.c.	1
(7)		5Q/154	Frequency meter 0–500 c/s, 115V	1
(8)		5UB/6821	Slave inverter, Plessey, Type 107	1
(9)		5G/3723	3-phase balance reactive load	1
(10)		5G/4019	Rheostat	1
(11)		0557/A.P. 48A	Multimeter (complete with shunts) or Multimeter Type 1 (5QP/16411)	1
(12)		0557/A.P. 12924	Insulation resistance tester, 500V	1

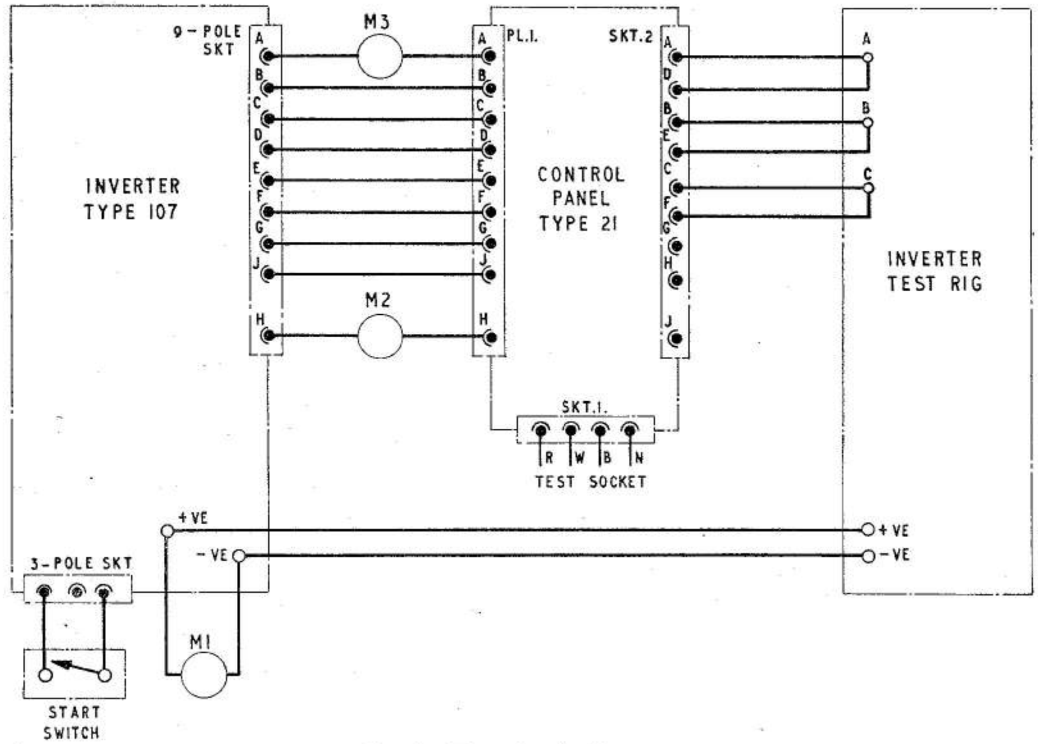


Fig. 1. Test circuit diagram

General

3. For test purposes the control panel should be connected in circuit with its associated inverter, Plessey, Type 107, variable 25-29V d.c. input and a balanced 3-phase load capable of dissipating the maximum inverter output, as shown in fig. 1.

TEST PROCEDURE

Note . . .

(1) *The inverter test rig provides for a balanced resistive load, but a balanced reactive load is being provisioned for R.N. use only. Instructions therefore, are given in this Appendix both for resistive and reactive loads (unity to 0·8 p.f. lagging).*

(2) *Frequency meter (5Q/154) is rated at 115V and must only be connected between any phase and neutral at test SKT1 for the purpose of checking frequency.*

Trimmer setting and checking

4. Insert the voltmeter (M1) across the positive and negative terminals of the inverter, and connect ammeters (M2) and (M3) between the inverter and control panel, as shown in fig. 1.

5. Switch on the equipment with the input power supply to the inverter set to 27V d.c. and, by adjusting potentiometers RV4 and RV5 on the control panel, set the output voltage and frequency to 200V and 400 c/s respectively. Allow the voltage output and frequency to stabilize, adjusting the trimmer as necessary. Switch in a load of 2kW or 2·5kVA at 0·8 p.f., and run the inverter for half-an-hour on an input of 27V d.c.

6. Switch off the load and reset the input voltage 27V d.c. Maintain the frequency at 400 c/s and check that the output voltage can be varied from 190 to 210V, by adjusting potentiometer RV5; clockwise adjustment will give an increase in voltage.

7. Set the input voltage to 200V a.c. and check that the output frequency can be varied from 370 to 430 c/s by adjusting potentiometer RV4.

8. Increase the inverter supply voltage to 29V d.c. and, by means of potentiometer RV4, set the output frequency to 408 c/s. Lock RV4 in this position.

9. Switch on full load, reduce the inverter supply voltage to 25V d.c. and, by adjusting potentiometer RV5, set the output voltage to 205V. Lock RV5 in this position.

10. Using the multimeter, measure the voltage at the test socket SKT1 between pins A-D, B-D, C-D. This phase voltage (line to neutral) in each instance should be 115V.

Starting test

Note . . .

The d.c. supply voltage must be set to such a value that the input is 25V when the equipment is running.

11. With the equipment still at normal running temperature, switch on the supply first on no-load and then on full load. Check that the control panel takes over control of output voltage and frequency after the running-up period. If the control panel fails to operate, the fault should be investigated and remedied before proceeding further.

Regulation test

12. Run the equipment for 15 min. with the supply voltage at 25V d.c. at full load. During this run check that:—

(1) The phase currents are equal.

(2) The difference between the highest and lowest line/line voltages is not greater than 2V, when measured at test socket SKT1 (pins A-B, B-C, and C-A).

Note . . .

It is important that the same instrument is used for all line voltage measurements.

13. After 15 min. running time check that the control panel and inverter voltage and current measurements conform to the following conditions:—

(1) Inverter input current is 150A.

(2) Alternator field current is 8A (max.).

(3) Motor regulator field current is 150mA (min.).

14. Switch off the load and adjust the input voltage to 29V d.c. and again check that the voltage and current measurements conform to the following conditions:—

(1) Inverter input current is 40A (max.).

(2) Alternator field current is 4A (max.).

(3) Motor regulator field current is 450mA (max.).

15. During the regulation test given in para. 12 to 14, check that the output voltages are within the limits 195 to 205V and that the frequency is within the limits 392 to 408 c/s.

Insulation resistance test

16. Using the multimeter set at the 20 megohm range, measure the insulation resistance between each pin on the 9-pole plug and socket to the frame. The reading should not be less than 20 megohms in each instance.

Note . . .

The low voltage test described in para. 16 *is designed to protect the semi-conductors from complete breakdown at* 500*V, should a fault be on the control panel; therefore if the minimum reading in para.* 16 *is not obtained, the fault should be investigated and rectified before proceeding with para.* 17.

17. Using a 500V insulation resistance tester, check the insulation resistance between each pin of the 9-pole plug and socket and the frame. The minimum permissible reading should not be less than 5 megohms.

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