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Chapter 17

CONTROL PANEL, TYPE 26 (ROTAX U 1504)

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LEADING PARTICULARS

Control panel, Type 26	*Ref. No. 5UC/6030*
Output (when used with Type 108 or Type 108A inverter) —	
Voltage	*115V ± 5V a.c.*
Frequency	*400 c/s ± 2½ per cent.*
Load	*(a) 770W at 1·0 — 0·84 p.f. (lagging)*
	or (b) 650W at 1·0 — 0·95 p.f. (leading)
Output (when used with Type 112 inverter) —	
Voltage	*115V ± 4 per cent a.c.*
Frequency	*400 c/s ± 4 per cent*
Load	*200W 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.*

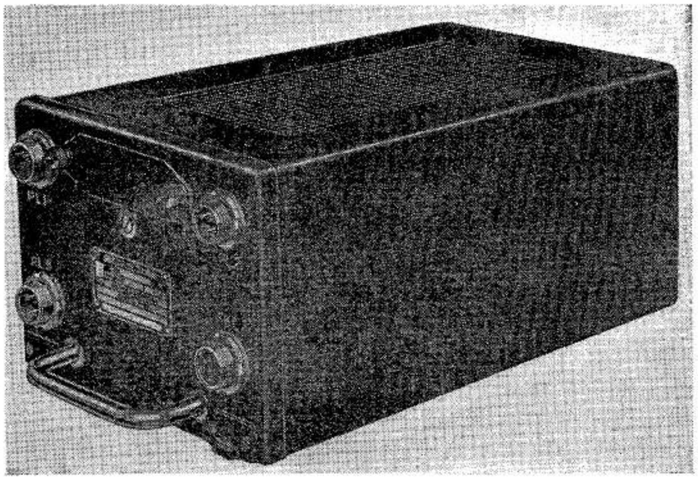


Fig. 1. Type 26 control panel

Introduction

1. The control panel, Type 26 (*fig.* 1), is designed to control the single-phase, 115-volt, 400 c/s a.c. output of inverters in the Rotax S3300 series. When used with inverter, Type 108 (S3303) or 108A (S3304) (770 watts load), the panel controls to 115V ± 5V and 400 c/s ± 2½ per cent, whilst when used with the Type 112 inverter (S3302) (200 watts load), the panel controls to 115V ± 4 per cent and 400 c/s ± 4 per cent. Trim potentiometers are provided to enable the output voltage and frequency to be readily adjusted while the panel is installed in the aircraft.

DESCRIPTION

2. The major components of the panel are mounted above and below a horizontal platform which is supported behind a vertical front plate by an angle frame. The disposition of the components is shown in fig. 2, 3 and 4. Two screwdriver operated potentiometers, one (5RV2) for trimming the voltage; the other (5RV1) for trimming the frequency (the voltage trim potentiometer being on the right) are mounted behind the front plate (*fig.* 1) and access to them is gained through two small holes, in line horizontally, which are normally concealed by a swing protection cover. Three plugs and a socket are fitted to the front plate. The components of the panel are enclosed by a box cover which is secured by two captive nuts at the rear, engaging with studs on the chassis frame. The cover is provided with grills at top and bottom to permit adequate cooling.

3. All the references used in describing the operation of the circuit correspond with those shown in the composite circuit diagram (*fig.* 5). The circuit and description cover the entire inverter and control panel system, since the panel cannot be properly understood without reference to its associated equipment. The component 1SW1 is the manual start-stop switch; the components prefixed 2 are parts of the main contactor; those prefixed 3 are parts of the starting switch; those prefixed 5 are mounted in the control panel; those prefixed 6 are mounted on the inverter, Type 112 (Rotax S3302) being shown as a typical machine for this installation.

Voltage regulation

4. The output from the inverter is taken from socket 6SK2 and enters the control panel via the two pole plug 5PL3. The external load is connected to the two pole socket 5SK1 whilst the tappings for the control panel supplies are made internally between the entry plug and load socket. Tapping A1, B1 is fed to the primary winding of transformer 5TR1, from which three outputs are taken, of which two supply the frequency sensitive circuits (*para.* 11). The output from terminals 3 and 4 of the transformer, at 17·5 V, is fed to the voltage error detecting circuit (*para.* 5).

5. The voltage error circuit consists of a barretter (5RB1) and a linear resistance (5RV2, 5RV3 and 5R3), the current flowing through each arm of the circuit being

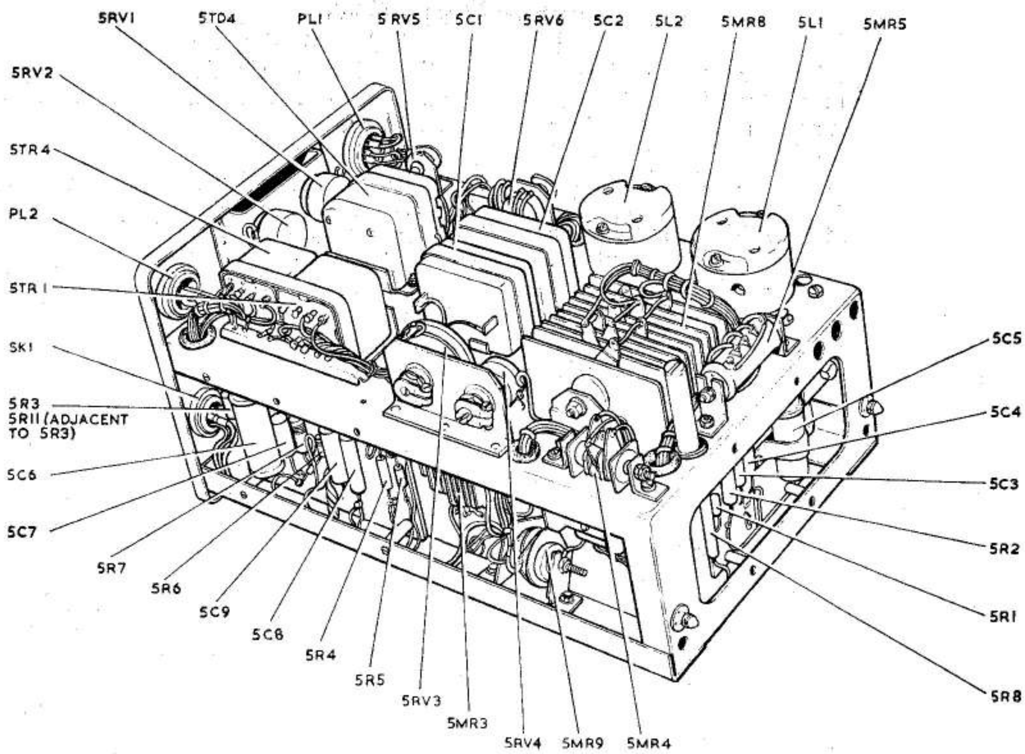


Fig. 2. Top right view (cover removed)

rectified by a full wave metal rectifier bridge (5MR3). The rectified current from the barretter is fed to the bias winding A3, A4 of transductor 5TD2 and also bias winding C1, C2 of transductor 5TD4 (*para.* 15) which is in series. The rectified output from the resistive arm is fed to control winding C3, C4 of 5TD2.

6. Whilst the inverter output voltage tends to vary with changing loads, the current passed by the barretter remains relatively constant, but that passed by the resistive arm varies in proportion to the voltage variation. The varying current (when rectified) is compared with the barretter standard by the control windings of transductor 5TD2 so that the output of this transductor varies with the inverter voltage and in the same sense. Transductor 5TD2 receives its a.c. supply from secondary 3, 4 of transformer 5TR4. The output of 5TD2 is rectified by the full wave metal rectifier bridge 5MR4 and fed to control winding A3, A4 of transductor 5TD3 which is supplied from tapping A3, B3 of the inverter output. The output of transductor 5TD3 varies inversely with the inverter output voltage.

7. The output is connected to the primary of a current step-up transformer (5TR2) and the output from this transformer is rectified (5MR6) and fed to the alternator field via pins D and E of plug 5PL1 and pins D and E of socket 6SK1. Thus any tendency of the output voltage to fall produces a corresponding rise in the alternator excitation current which restores the voltage, whilst any tendency of the output voltage to rise causes an immediate reduction of alternator excitation current which restores the voltage to normal.

8. Compounding of the alternator excitation is provided by the rectified output (5MR8) of transformer 5TR3. This is a current transformer with its primary winding in series with the inverter load, and gives an output current proportional to the load current; hence a linear increase in alternator excitation is provided for an increase in load current. The compounding current greatly reduces the component of excitation required to be supplied by the transductor output.

9. The voltage developed across the primary of the transductor output transformer (5TR2) is rectified and used as a means of providing negative feed-back to the two voltage control transductors (5TD2, 5TD3). The feed-back circuits have capacitors (5C7; 5C8 and 5C9) interposed, so that the feed-back **is** effective only during a change in transductor output. The effect of the feed-back is to damp potential hunting of the output.

10. Voltage trim is provided by the potentiometer 5RV2 in the resistive arm of the voltage error detecting circuit, which modifies the current flowing in this arm for any given applied voltage.

Frequency regulation

11. Two series tuned circuits (5L1, 5C1 and 5L2, 5C2) are fed by 10V secondary windings of transformer 5TR1 (*para.* 4). The circuits are tuned, one just above and one just below the desired control frequency of 400 c/s. The current passed by each tuned circuit is rectified by a full-wave metal rectifier bridge (two bridges comprising 5MR1), and the two rectifier outputs fed to control windings A3, A4 and C3, C4 of transductor 5TD1, the negative line of circuit 5L1, 5C1 being common with the positive line of circuit 5L2, 5C2.

12. The currents passed by the two tuned circuits are approximately equal when the inverter output is at its correct frequency, but, if the frequency tends to increase, the current passed by the circuit tuned above 400 c/s increases whilst that passed by the circuit tuned below 400 c/s decreases. If the frequency tends to drop, the current passed by the circuit tuned below 400 c/s increases, whilst that passed by the circuit tuned above 400 c/s decreases. These variations in control signals modify the main current in the transductor (which is fed by direct tapping A2, B2 from the inverter output). When the transductor output is rectified by the full-wave metal rectifier bridge 5MR2, a d.c. control signal is obtained and fed via plug 5PL1, pins B and C, to the motor control field. Thus, when the frequency

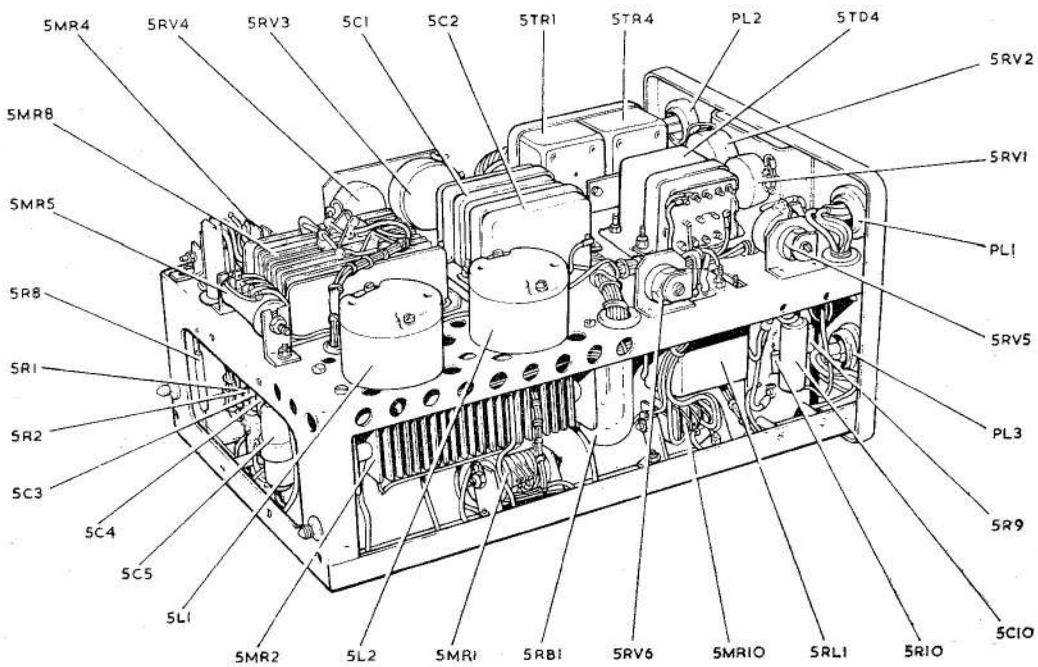


Fig. 3. Top left view (cover removed)

(i.e. motor speed) tends to fall, the control field excitation is decreased by the transductor output and the motor speed is restored. If the frequency tends to rise, there is a corresponding increase in the motor control field excitation which results in the motor slowing down.

13. Negative feedback to winding A1, A2 of the transductor (5TD1) is obtained from the rectified transductor output. Capacitor 5C5 is interposed in the feedback circuit so that the feedback only takes effect during a change of transductor output. The provision of this feedback prevents hunting of the control signal.

14. Trimming of the output frequency is achieved by adjusting potentiometer 5RV1 which, in series with resistor 5R1, is connected across the rectified output of the low frequency tuned circuit and therefore modifies the current flowing in control winding C3, C4 of the transductor. 5C3 and 5C4 are smoothing capacitors.

Protection circuit

15. The protection circuit consists of a single-phase transductor (5TD4), which is supplied from the 22V secondary (terminals 5, 6) of the transformer 5TR4, and a relay (5RL1) having two pairs of contacts. Bias winding C1, C2 of the transductor is energized in series with winding A3, A4 of 5TD2 (*para.* 5) whilst the control winding A3, A4 (of 5TD4) is energized by the rectified output of 5TR4 (when contacts 2 and 3 of the relay or the "start" contacts are closed). The output of the protection transductor is rectified and used as positive feed-back to winding A1, A2, the coil of the relay being connected in series with the winding. This direct positive feed-back gives the transductor the property of delivering either a high output or a low output, with no intermediate condition. The high transductor output energizes the relay coil whilst the low output is below the relay hold-in value and the transductor characteristic ensures that the relay invariably operates or returns to normal with a positive switching action. The output of the transductor is controlled by the signal in winding A3, A4; such that when this is in the region of the normal rectified output of 5TR4 (this output varies with the inverter output), i.e., 25V, the transductor yields high output, but if this signal rises above normal (i.e. 120 per cent) the transductor yields low output.

16. Before the system has been switched on, the relay is not energized, i.e., contacts 21–22 closed and contacts 2–3 open. A connection from the 28V d.c. inverter input to the alternator field is made via resistor 5R8 and contacts 21–22. When the system is switched on by closing the "start" contacts of the manual switch, the inverter starts up and output voltage is built up from the initial excitation of the alternator field provided by this d.c. supply. As the output voltage is built up, the voltage control transductors come into operation and an effective control component of excitation is established.

17. While the inverter output is building up, the protection transductor output is low but, as the inverter output approaches its nominal value of 115V, the transductor output rises suddenly to its high value and operates the relay, so that the supply providing the initial excitation is disconnected from the alternator field, leaving the panel excitation in control. At the same time, the main contactor is held on by a 28V supply connected via contacts 2–3 of the relay and the normally closed "off" contacts of the manual switch. The "start" contacts are allowed to open after the relay has operated, so that they do not override the protection circuit contacts.

18. The circuit protects the system against sustained overvoltage, whilst permitting momentary surges. If the control signal in winding A3, A4 rises to the equivalent of 120 per cent sustained overvoltage at the inverter output, the transductor output collapses and the relay returns to normal so that contact 2–3 open and the inverter contactor drops out. The capacitor 5C10 in the control circuit introduces a time delay such that if there is an overvoltage of 120 per cent, the capacitor charge, and therefore the signal winding A3, A4 requires time to build up and cause the inverter to be switched off. If a heavier overvoltage is sustained, the time delay is correspondingly smaller.

19. When contacts 2–3 open, breaking the 28V d.c. supply to the main contactor, the 28V potential is presented across them

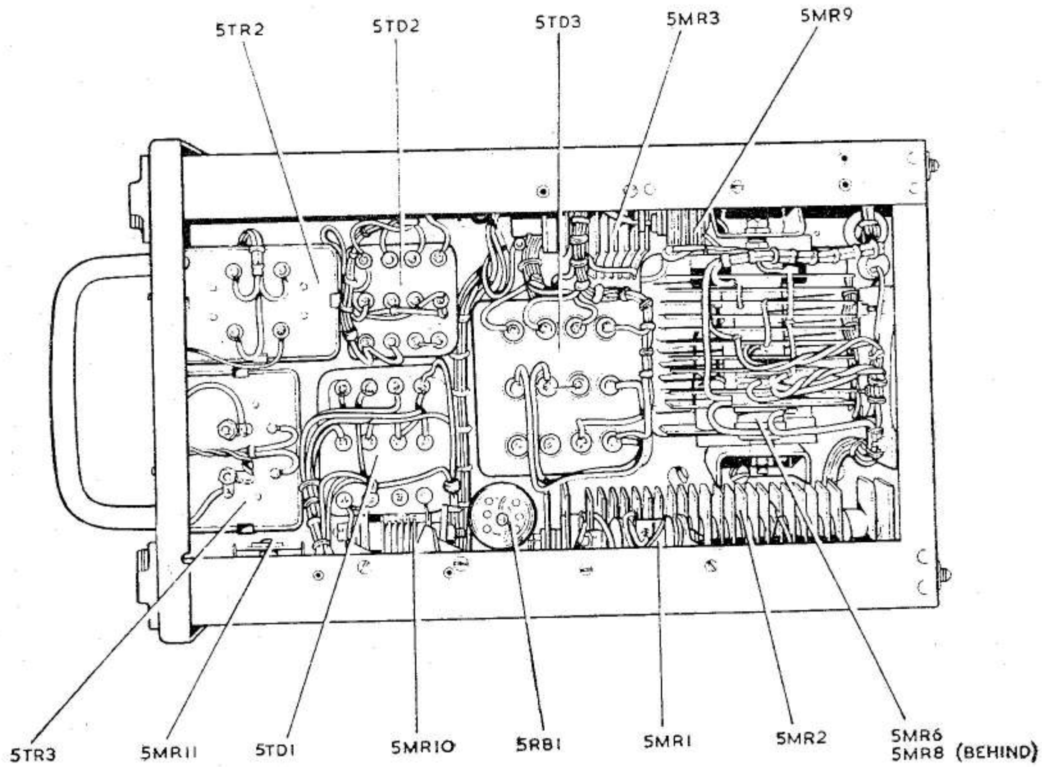


Fig. 4. Underneath view (cover removed)

which assists the action of the control signal. This ensures that the low output of the transductor is retained when the inverter output dies after switch off and passes through normal operating values, so that the system cannot switch itself on at this point. When the relay returns to normal, contacts 21–22 close, resetting the initial excitation connection to the alternator field in preparation for the next start.

OPERATION

20. To start the system, move the switch lever to the "start" position. This will initiate the starting cycle of the inverter. The switch should be held over for a few seconds in order to allow the inverter output voltage to build up and the control panel relay to operate. The switch should not be maintained in the "start" position longer than is necessary to ensure that the contactor holds in as this will render the protection circuit ineffective.

21. To switch off the system, move the switch lever to the "off" position. This will break the 28V control supply and the main contactor will drop out.

22. In the event of the protection circuit switching off the system, no attempt to restart should be made without first investigating the cause of the overvoltage.

INSTALLATION

23. The control panel is designed to be secured on a standard tray mounting EL. 39463, for chassis 12·5 in. long by 8·0 in. wide, with flexible mounting.

Electrical connections

24. There are three plugs and one socket mounted on the front plate of the panel for electrical connection, viz.,

5PL1. Six-pole miniature plug for connection to inverter control circuits. (*Ref. No.* 10*H*/0560080).

5PL2. Three-pole miniature plug for protection circuit connections (*Ref. No.* 10*H*/0560060) requiring mating socket (*Ref. No.* 10*H*/0560100).

5PL3. Two-pole miniature plug for connection to inverter output (*Ref. No.* 10*H*/0560050) requiring mating socket (*Ref. No.* 10*H*/0560090).

5SK1. Two-pole miniature socket for connection to load (Ref. No. 10*H*/0560230) requiring mating plug (Ref. No. 10*H*/0560270).

SERVICING

25. Little servicing can be undertaken while this control panel is installed in an aircraft. It is sufficient to inspect the unit for security of mounting and condition of electrical connections. Ensure also that the ventilation grill is clean and free from obstruction.

Trimming

26. Switch on the system and, after allowing about ten minutes for the output to settle, check the output voltage and frequency. Voltage error should be trimmed out by use of the right-hand potentiometer under the swing protection cover (rotate clockwise to increase voltage) and frequency error should be trimmed out by use of the left-hand potentiometer (rotate clockwise to increase frequency). If it is found to be impossible to bring the output within tolerance using the trim potentiometers, or if the control of the panel is suspected for any other reason, the control panel should be removed from the aircraft as unserviceable.

Table 1

Circuit component details

Cct. Ref.	Description	Value	Part No.	Ref. No.
1SW1	Switch		D10006	5CW/6876
2RL1	Contactor		D9105	
2R1	Resistor	68 Ω	In contactor	
2R2	Resistor	68 Ω	In contactor	
3RL1	Starting switch, Type 1A, No. 5		U2005/1	5CW/5016
3R1	Resistor	0·065 Ω	In starting switch	
3R2	Resistor	32 Ω	In starting switch	
5C1	Capacitor	0·36μF		5UC/6312
5C2	Capacitor	0·56μF		5UC/6382
5C3	Tantalum capacitor	16μF		5UC/6403
5C4	Tantalum capacitor	16μF		5UC/6403
5C5	Tantalum capacitor	40μF		5UC/6402
5C6	Capacitor	2μF		5UC/6399
5C7	Tantalum capacitor	4μF		5UC/6398
5C8	Tantalum capacitor	12μF		5UC/6397
5C9	Tantalum capacitor	12μF		5UC/6397
5C10	Tantalum capacitor	80μF		5UC/6389
5L1	Inductor	450mH at max.	F3601/1	5UC/6535
5L2	Inductor	450mH at max.	F3601/1	5UC/6535
5MR1	Rectifier			5UC/6405
5MR2	Rectifier			5UC/6396
5MR3	Rectifier			5UC/6394
5MR4	Rectifier			5UC/6387
5MR5	Rectifier			5UC/6388
5MR6	Rectifier			5UC/6385

Table 1 — *continued*

Circuit component details

Cct. Ref.	Description	Value	Part No.	Ref. No.
5MR8	Rectifier			5UC/6386
5MR9	Rectifier			5UC/6395
5MR10	Rectifier			5UC/6387
5MR11	Rectifier			5UC/
5R1	Resistor	56 Ω		10W/0113225
5R2	Resistor	10K		5UC/6459
5R3	Resistor	68 Ω		10W/0113292
5R4	Resistor	4·3K		10W/0113335
5R5	Resistor	330 Ω		10W/0113243
5R6	Resistor	510 Ω		5UC/6400
5R7	Resistor	100 Ω		5UC/6401
5R8	Resistor	18 Ω		5UC/6584
5R9	Resistor	270 Ω		10W/0113241
5R10	Resistor	270 Ω		10W/0113241
5R11	Resistor	68 Ω		10W/0113227
5RB1	Non-linear resistor			◄ 5UC/7379 ►
5RL1	Relay			5UC/6579
5RV1	Variable resistor	100 Ω		5UC/6375
5RV2	Variable resistor	25 Ω		5UC/6376
5RV3	Variable resistor	75 Ω		5UC/6384
5RV4	Variable resistor	200 Ω		5UC/6383
5RV5	Variable resistor	500 Ω		5UC/6377
5RV6	Variable resistor	25 Ω		5UC/
5TD1	Transductor		P4807	5UC/6308
5TD2	Transductor		P4804	5UC/6407
5TD3	Transductor		P1002	5UC/6408
5TD4	Transductor		P5102	5UC/6406
5TR1	Transformer		P5004	5UC/6379
5TR2	Transformer		P5203	5UC/6391
5TR3	Transformer		P5202	5UC/6390
5TR4	Transformer		P5005	5UC/6380
6C1	Capacitor	2·0μF	In inverter	
6C2	Capacitor	0·005μF	In inverter	
6C3	Capacitor	0·005μF	In inverter	
6R1	Resistor	25 Ω	In inverter	
6RV1	Variable resistor	25 Ω	In inverter	

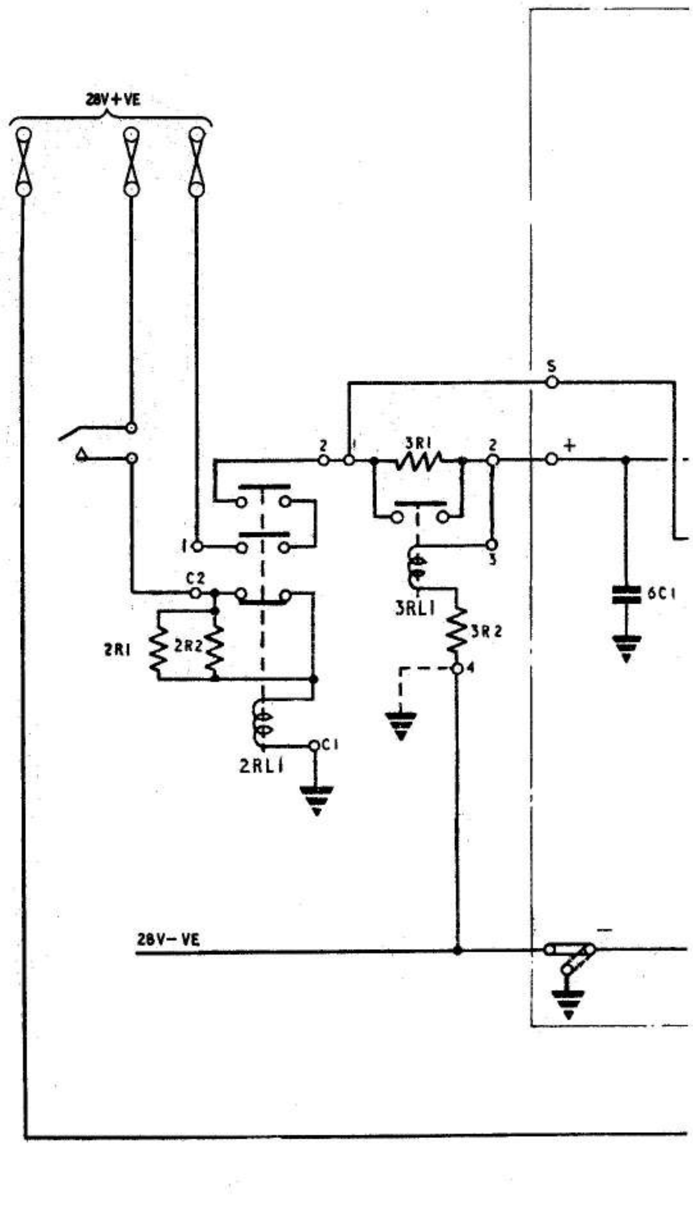
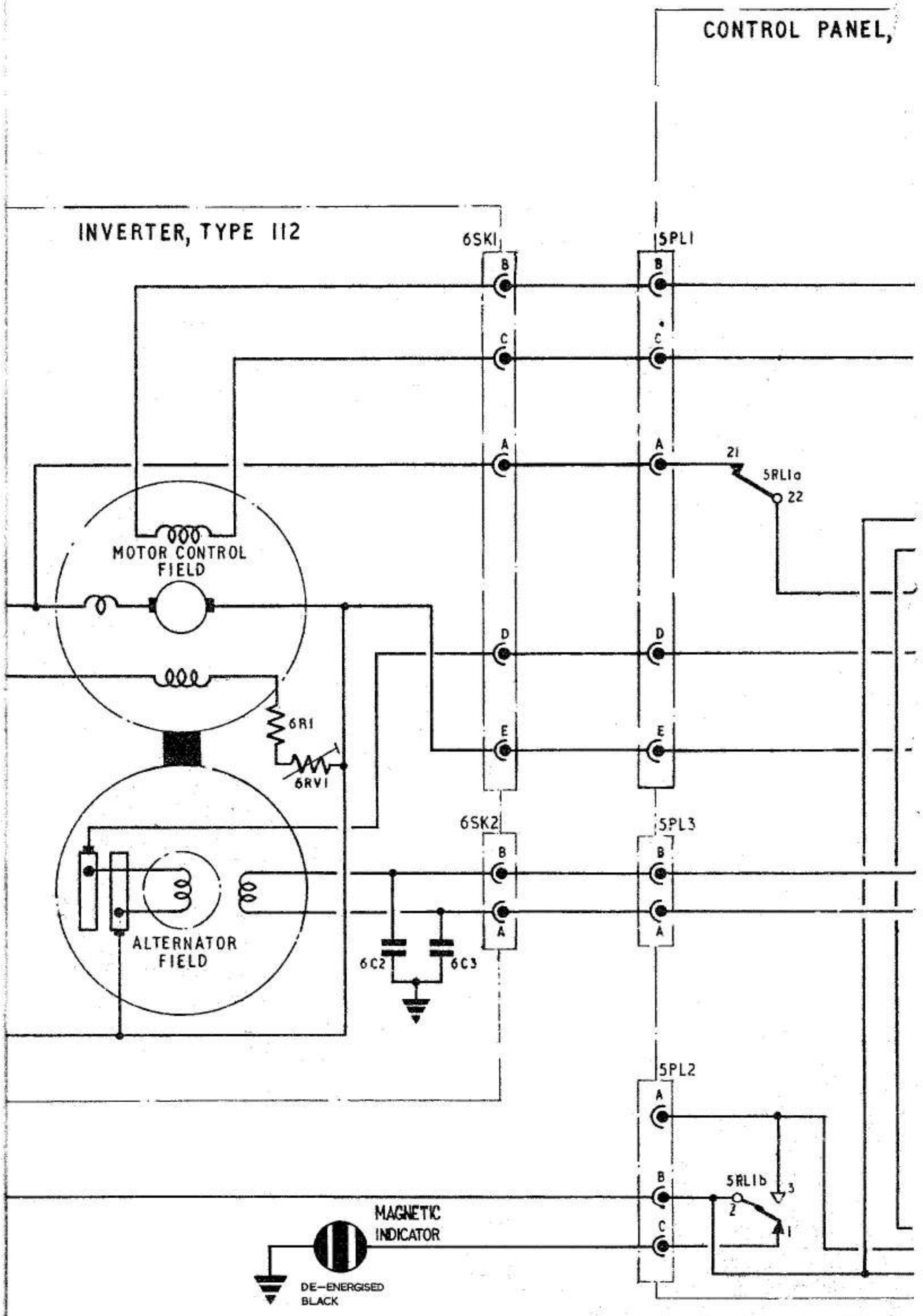
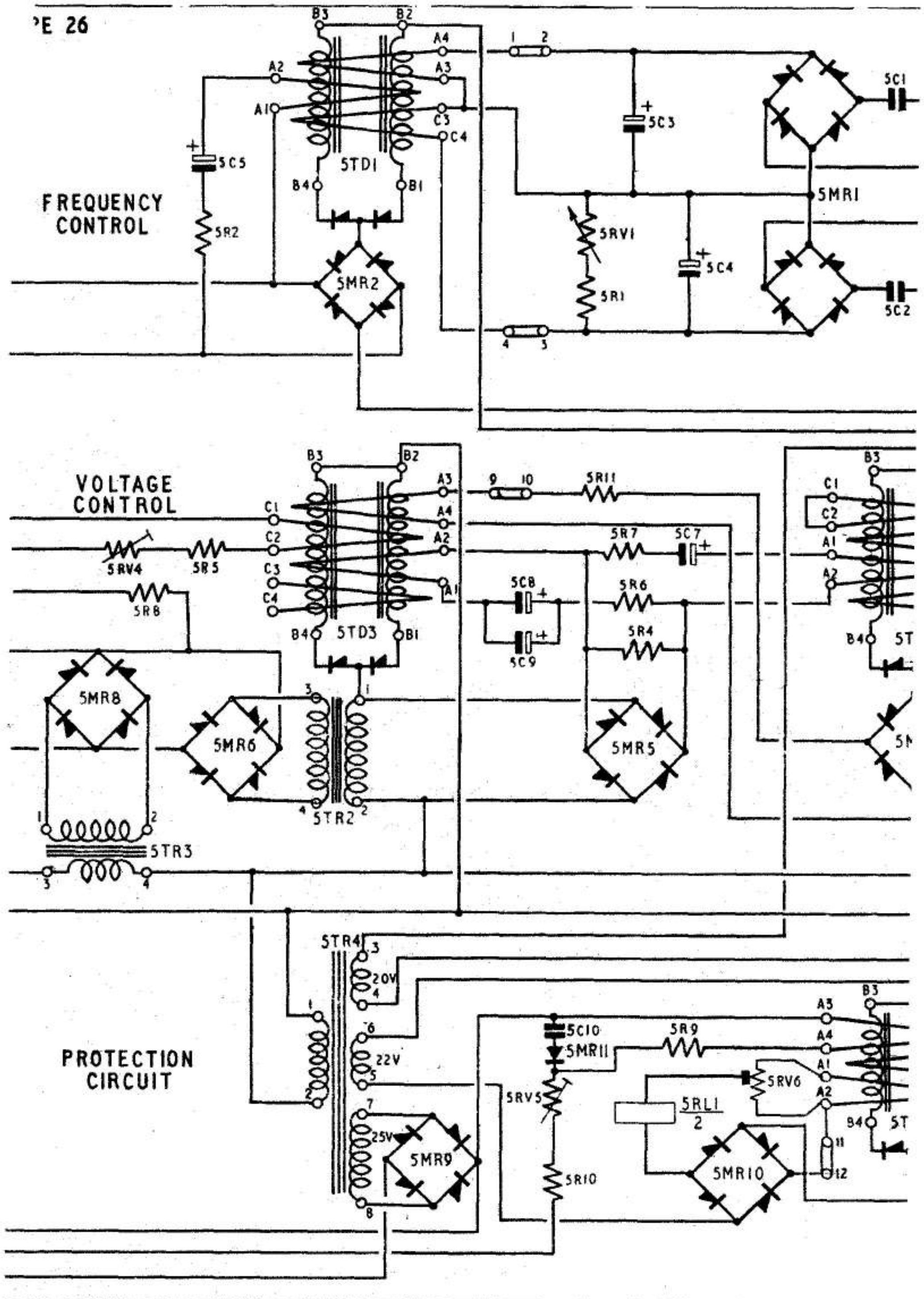


Fig. 5

PP9221 8952/371475 2/64 C&P



Composite
RES



circuit diagram
TRICTED

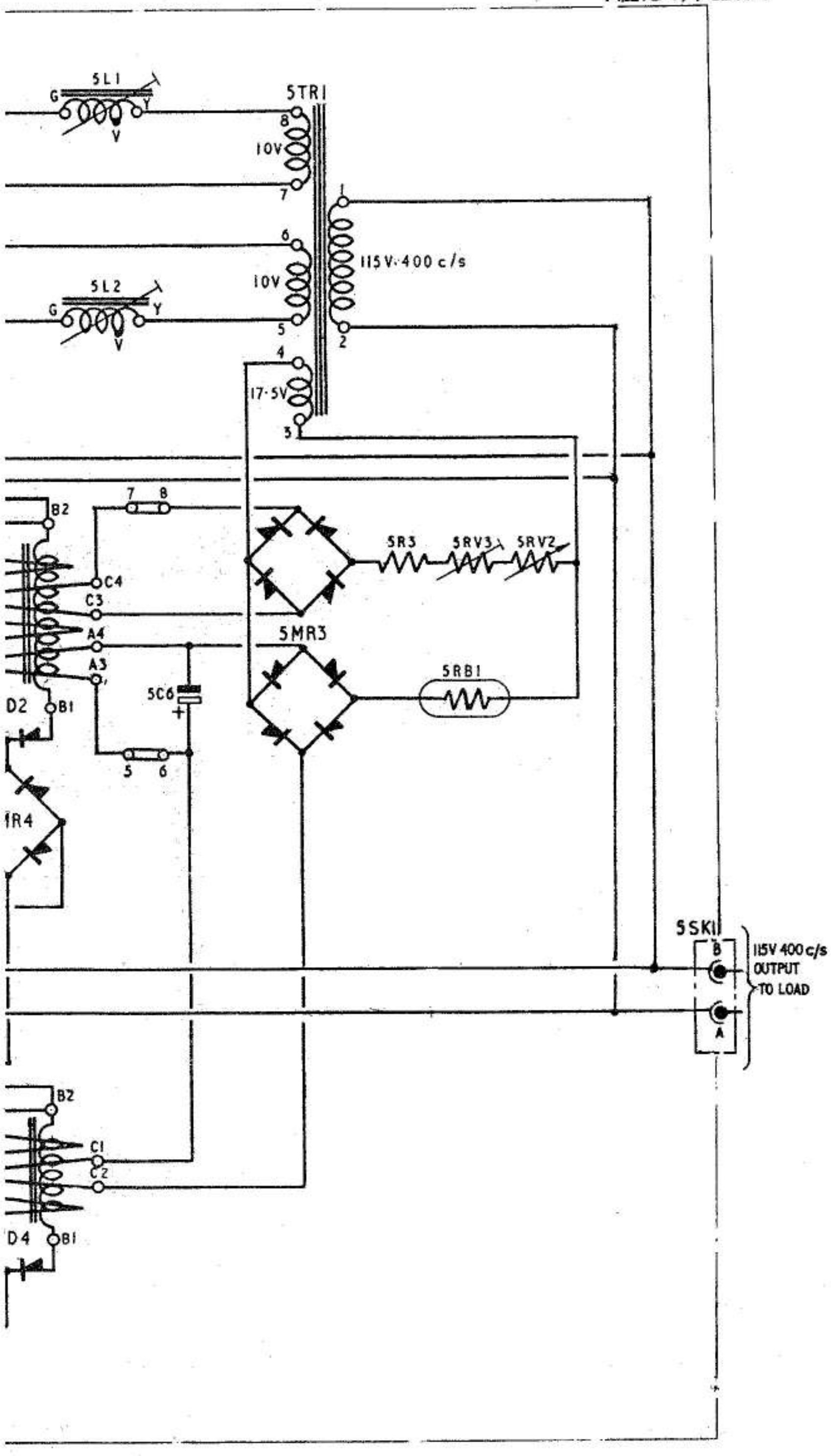

5L1
G
V
Y
5TR1
8
10V
7
1
6
115V-400 c/s
10V
5L2
5
2
4
17·5V
3
B2
7
8
5R3
5RV3
5RV2
C4
C3
A4
5MR3
A3
5C6
5RB1
D2
B1
5
6
MR4
5SK1
B
A
115V 400 c/s
OUTPUT
TO LOAD
B2
C1
C2
D4
B1

Fig.5

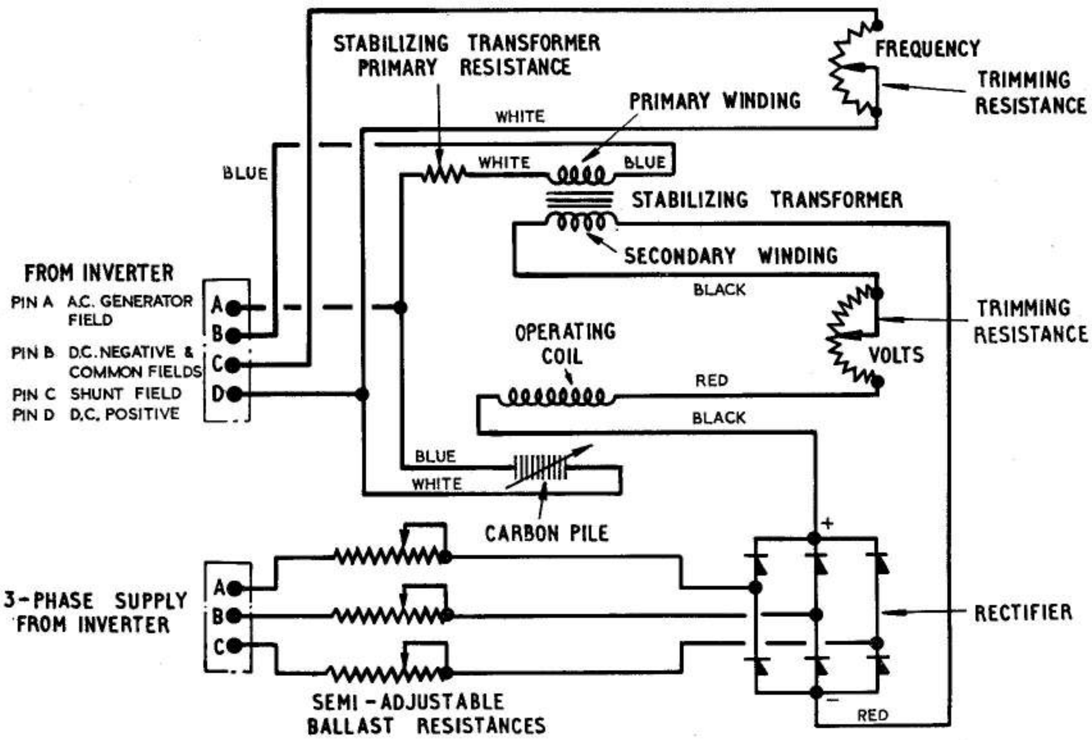


Fig. 3. Internal circuit diagram

the stabilizing transformer is used, and it acts as a feed back unit for smoothing the operation of the regulator coil. Under these conditions the direct current surge from the inverter motor passes through the transformer primary resistance and winding to the secondary winding, and then to the regulator coil.

SERVICING

9. Little servicing is necessary apart from ensuring that all the items are securely held in position. Limited adjustment to the voltage level of the voltage regulator and to the frequency of the inverter output may be made by adjusting the voltage and frequency trimming resistances respectively. This is done by turning the trimming studs in the necessary direction.

10. Adjusting and testing instructions for the automatic voltage regulator will be found in Book 1, Sect. 1 of this publication, and testing of the control panel in conjunction with the Type 102A inverter will be found in Book 3, Sect. 16.

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