SECTION 1

STABILISED POWER-SUPPLY UNIT SPS/4

Introduction

The stabilised Power-supply Unit SPS/4 is designed to feed apparatus requiring a stabilised supply in the range 250-350 volts, with a maximum current of 230 milliamps in the range of 250-320 volts. When the output voltage required exceeds 320 volts, the maximum current which can be supplied is reduced progressively. At 350 volts it is 175 milliamps. Two 6·3-volt r.m.s. feeds are available, both rated at a maximum current of 5 amps. The unit is mounted on a 19 × 7 inch panel, suitable for a single-sided bay mounting. Power dissipation in the unit is high, and adequate ventilation must be provided. Because of ventilation requirements, the unit must not be operated when resting on a flat surface.

Circuit description

A complete circuit diagram of the unit is shown in Fig. 1. Neglecting the h.t. voltage-stabilising system, the design is conventional, utilising two valves Type UU5 in a full-wave rectifying circuit.

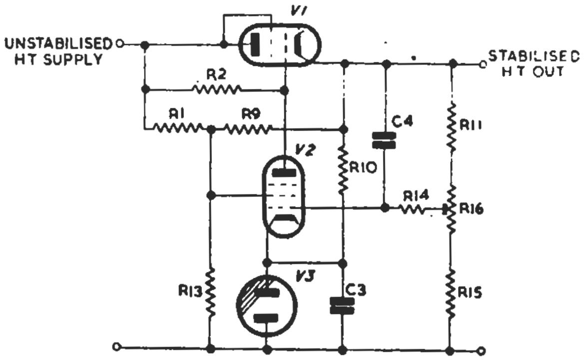

Fig 1.1. Simplified Diagram of H.T. Stabilising System

In order to assist the understanding of the operation of the h.t. voltage-stabilising system, a simplified diagram of this part of the circuit is shown in Fig. 1.1.

Essentially, the system comprises a cathode follower, V1; the external load forms the cathode load for the valve. The grid of V1 is connected with the anode of V2, so that the cathode voltage of V1 takes up a value slightly in excess of the anode voltage of V2. By virtue of the cathode-follower action of V1, the output source has an inherently low internal impedance to ensure good regulation.

The regulation of the system is, however, made to approach even further to the ideal by action of the high-gain amplifying stage V2. The control grid of V2 is fed from a potential divider connected in parallel with the external circuit; any change in the output voltage is thus communicated in an amplified form to the grid of V1, in a sense to oppose the change occurring. In this way the output impedance can be made very small indeed. The actual value can be determined as follows. If β is the attenuation factor from the output to the grid of V2, and A is the stage gain of V2, a change in the output voltage dv would cause a change in the grid potential of V1 of $-A\beta$ dv. Thus the grid-cathode potential of V1 would have changed by $(1 + A\beta)$ dv. If the corresponding change in the output current were di,

$$di = (1 + A\beta)\ dv.g_m$$

The output impedance (Ro) is given by

$$Ro = \frac{dv}{di} = \frac{1}{(1 + A\beta)g_m}$$

and the output impedance is therefore lower by a factor $(1 + A\beta)$ than it would be if the grid of V1 were held at a constant voltage.

The output voltage is stabilised against the changes in the input voltage and spurious changes in two ways. Firstly, under conditions of varying input voltage, the potentiometer formed by R1 and R13 ensures that any such change of input voltage is communicated to the screen grid of V2 and the resulting change in anode current reduces the corresponding change in the anode potential of V2. Secondly, any change in output voltage is communicated to the grid of V2, and the corresponding change in the anode potential of V2 opposes the change occurring. This action is independent of the cause of the change in output voltage and hence stabilises the output under all conditions.

In effect, V1 may be considered to have a large degree of negative feedback, so that under all conditions the cathode potential of V1 is effectively stabilised by the negative feedback action.

Since, of necessity, the potential applied to the grid of V2 is positive with respect to earth, the cathode of V2 must also be held at a positive potential, so that the grid-cathode voltage of V2 is at a negative value. The cathode potential is stabilised by the action of the gas-filled valve V3. The action of this valve also ensures that the cathode potential of V2 does not vary with the grid voltage, and the stage therefore operates at full gain, i.e. there is no negative current feedback.

The stability of the output voltage is critically dependent upon the performance of the valve V3 since the action of this valve ensures that spurious corrections of the output voltage due to variation of cathode potential are held small. If such a variation occurs, the action of the circuit is such as to minimise the change in grid-cathode potential of V2, the output voltage varying to achieve this. This is, of course, a very undesirable condition.

A manual control of the output voltage is provided by R16. By varying the position of the slider, the standing voltage applied to the grid of V2 can be varied with consequent variation of the value of the stabilised output. Since alteration of the position of the slider of R16 will also affect the feedback fraction, the range of control must be limited. Otherwise the output impedance of the unit, and hence the regulation, would vary appreciably with the setting of R16.

In the actual circuit (Fig. 1), valve V1 shown in Fig. 1.1, is, in fact, two valves (V3 and V4) connected in parallel. These valves are Type 12E1, a valve specially designed for this type of application, being capable of passing high anode currents at a low anode-cathode voltage. This ensures that the input voltage to the regulating system can be kept to a reasonably low value, and also ensures that the power dissipated in the valves is kept to a low value. The valve is of the aligned-grid tetrode type, but in this circuit is used triode-connected. The mutual conductance is high (about 12 mA per volt) which ensures an inherently low output impedance.

Two other features of the design of the regulating system are worthy of mention. The screen of the control valve V2 (Fig. 1.1) is fed from a network connected to the input and output sides of the system. The values of the resistors R1, R9 and R13 are proportioned so that the amount of hum from the input side fed to the screen of V2 when amplified and fed to the grid of V1 opposes the effect of the hum at the anode of V1 on the output and in this way the hum output voltage is appreciably reduced. This system is not fully effective in dealing with the higher frequency components of the hum output, and for this reason capacitor C4 and resistor R14 are introduced. By virtue of C4, these frequency components are fed to the grid of V5 with little attenuation, and the system operates at full gain to reduce the magnitudes of these components. The value of C4 is somewhat critical; if made too large it has the effect of delaying recovery after surges in the output voltage, since any change in potential at the grid of V5 is conditioned by the charging and discharging of C4.

Resistors of R3, R4, R5, R6, R7, R8 and R12 are low-value resistors included in circuit to prevent the occurrence of parasitic oscillations.

Metering Facilities

Two meters, mounted on the front panel, are provided. Meter M1 is a milli-ammeter reading 250 mA full scale, and indicates the total output current, including that of the control system potential divider and meter M2. Meter M2 is a voltmeter, reading 500 volts full scale, indicating the output voltage.

Input and Output Connections

Mains input and power output connections are made by multi-way plugs and sockets at the rear of the unit. The mains input plug is a four-way type, with a threaded flange, to which is screwed a locking ring on the input socket. Output connections are made via a ten-way socket, also at the rear of the unit.

Mechanical Construction

The unit is mounted on a 19-inch panel. Behind this front panel and at a distance of 5 inches from it, is a second panel secured to side panels, attached in turn to the front panel. On this second panel are mounted the major components. The unit is enclosed by a cover, detachable from the rear, which is located in use by the side panels. The cover is cut out at the rear to give access to the sub panel carrying the input and output connectors, and the output voltage control, R16. Additionally, the panel is cut out on the left-hand side (viewed from front) to give access to the mains transformer input-voltage adjusting panel.

Access to the valves from the front of the unit is given by a detachable plate, secured to the front panel by two catches, each attached to a handle projecting through the plate.

Valve Data

Valve	*Type*
V1, V2	UU5
V3, V4	12E1
V5	EF50
V6	85A1

General Data

Output Voltage Control	Colvern type CLR 4001/95, 50 k Ω
Current Meter	Weston model S33, 0-250 mA.
Voltmeter	Weston model S33, 0-500 V.

Test Specification

1. The output voltage control should vary the output from 250-350 V minimum range.

2. With the chassis of the unit connected to h.t. negative, the hum level measured on a high-impedance oscillograph should not exceed 12·5 mV p-p at any voltage between 250 and 320 at an output current from 0 to 230 mA. At 350 V the hum should not exceed 12·5 mV p-p at an output current of 175 mA.

3. With the output voltage set to 300, the output voltage should not vary by more than 3 V between no load and full load.

4. With an output voltage of 300, load current of 230 mA, and nominal 230 V a.c. input, the output voltage should not vary by more than 3 V for changes in the a.c. input of 20 per cent.

5. Sudden changes of 10 per cent. in the input mains voltage should produce transient changes in the output of not more than 40 mV p-p at any value of load current.

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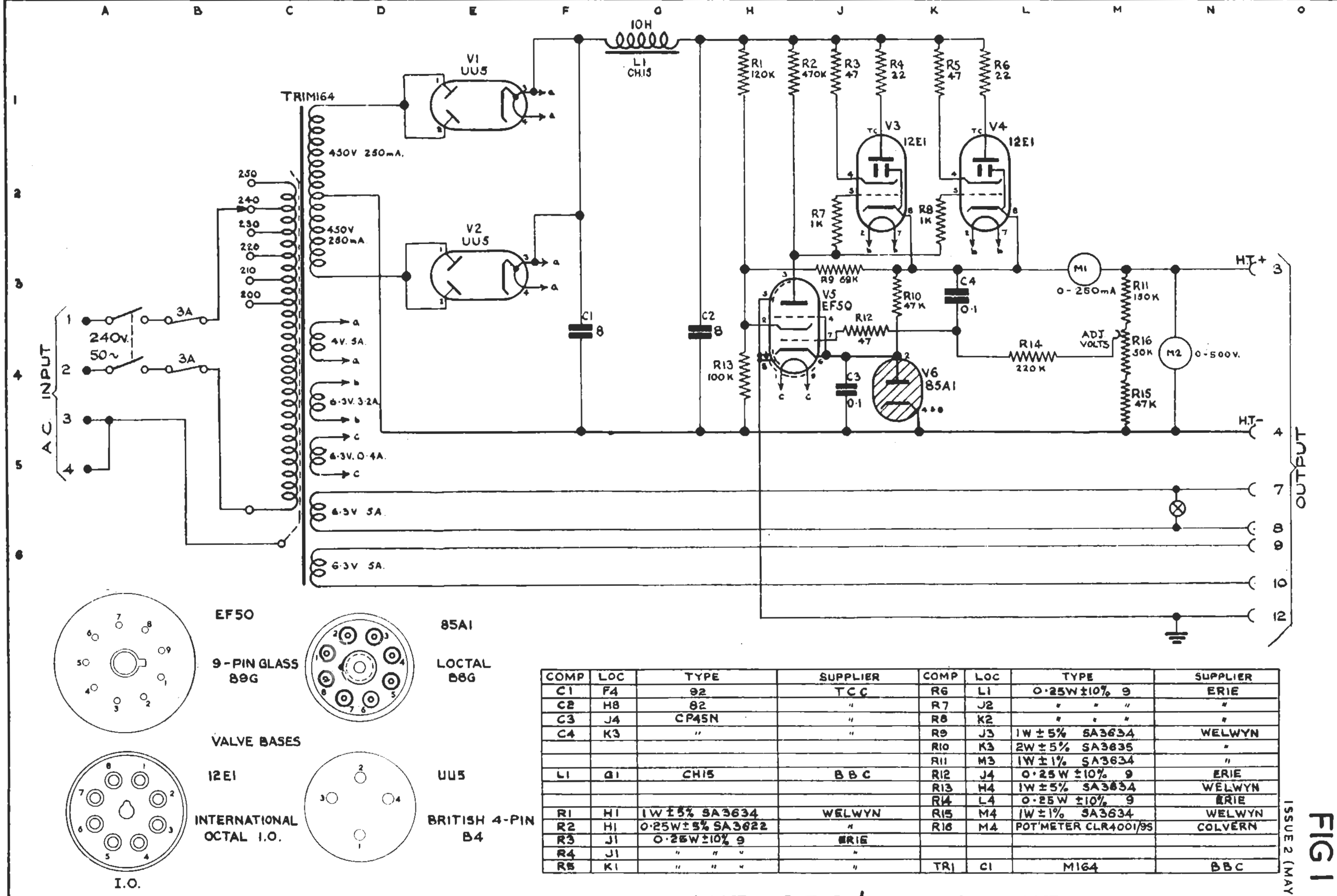

COMP	LOC	TYPE	SUPPLIER	COMP	LOC	TYPE	SUPPLIER
C1	F4	92	TCC	R6	L1	0·25W ±10% 9	ERIE
C2	H8	82	"	R7	J2	" " "	"
C3	J4	CP45N	"	R8	K2	" " "	"
C4	K3	"	"	R9	J3	1W ± 5% SA3634	WELWYN
				R10	K3	2W ± 5% SA3635	"
				R11	M3	1W ± 1% SA3634	"
L1	G1	CH15	BBC	R12	J4	0·25W ±10% 9	ERIE
				R13	H4	1W ± 5% SA3634	WELWYN
				R14	L4	0·25W ±10% 9	ERIE
R1	H1	1W ±5% SA3634	WELWYN	R15	M4	1W ± 1% SA3634	WELWYN
R2	H1	0·25W ± 5% SA3622	"	R16	M4	POT'METER CLR4001/95	COLVERN
R3	J1	0·25W ±10% 9	ERIE				
R4	J1	" " "	"				
R5	K1	" " "	"	TR1	C1	M164	BBC

STABILISED POWER SUPPLY UNIT SPS/4: CIRCUIT

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FIG 1

V4