SECTION 4

SENDING AMPLIFIERS: TV SA 1 SERIES

Introduction

The TV/SA/1 sending amplifier is also produced in variant forms that are also closely related to the parent type. The TV/SA/1A is identical electrically with the TV/SA/1, but mounted on a different chassis. The portable version, designated TV/PSA/1, has slight circuit changes. It differs mainly in construction as a self-contained equipment, complete with mains unit. Following description refers to the TV/SA/1 amplifier, and amending details for others are given later.

TV/SA/1

The TV/SA/1 provides two anti-phase outputs from a single input; the outputs can be used in combination to give a push-pull output. The input impedance is 75 ohms, whilst the output impedance can be set to one of three values, 100, 140 or 186 ohms. These are the values of the output impedance when the unit is employed in the push-pull output condition; the output impedances of each half separately are equal to half the above values. The overall maximum voltage gain is four times, when the push-pull output is fed to a matched load. A gain control is fitted, having three positions, 6, 9 and 12 db respectively, the figures referring to the gain in the push-pull output condition. With a single-sided output, the gain at each position of the switch is 6 db lower than the marked figures. The frequency response over the range 10 kc/s to 3 Mc/s is flat within 0·2 db; the 'sag' of a 50 c/s square wave input is less than 2 per cent.

The amplifier is mounted on a 19 × 7-inch panel, suitable for bay mounting. When so mounted, the unit projects through the bay. The input and single-sided output connections are made via *Musa* plugs at the rear of the unit; the push-pull output is fed via a balanced coaxial plug. Input and output monitoring plugs are mounted on the front panel of the unit. Power supplies are normally obtained from a stabilised power-supply unit, Type SPS/4, connections being made via a four-way plug at the rear of the unit.

Circuit Description

A complete circuit diagram of the amplifier is given in Fig. 7. The input is terminated by the resistors R1, R2, R3, which together give an input resistance of 75 ohms. These resistors are chosen so that at the junction of R1 and R2 the signal is 3 db below its input value, and at the junction of R2 and R3, the signal is 6 db down. As the overall maximum gain is 12 db, the *db Gain* switch can be set to give gains of 6, 9 and 12 db.

From the *db Gain* switch the signal is applied to the grid of V1, which forms one valve of the cathode-coupled pair V1, V2. These valves share a high-value common-cathode load, R7. With an input signal to V1, the cathode tends to follow the input signal, and in so doing, provides an input to V2. The anode current of V2 in responding to this input, tends to reduce the cathode voltage variation, with the result that the signal amplitude across R7 is approximately one-half of that of the signal amplitude at the grid of V1. Thus each valve behaves as if half the input signal were applied between its grid and the junction of its cathode resistor (R6 or R12) and R7, and at the anodes of V1 and V2, the signals are very nearly equal in amplitude, but in anti-phase. The gain of each valve is reduced by the individual feedback applied by R6 or R12, by about 5 db.

From the anode of V1, the signal is fed to the grid of V2, which comprises a shunt-inductance stage with a gain of about 22 db. From the anode of V3, the signal is fed to the output cathode follower, V5, which works into the load provided by its cathode chain, R33, R34 and the external load in series with one or more of R44, R49 and R50 according to the output impedance selected. The load of V5 thus varies somewhat with the output impedance selected, and although the total cathode load is comparable with the output impedance of V5 itself, the variation of gain with output impedance is minimised by the feedback path from the cathode of V5 to the grid of V3. The pre-set capacitor C10 in parallel with R17 is necessary to ensure that the frequency response remains substantially flat at high frequencies. The response would otherwise tend to rise, because of the effect of the shunt capacitance at the grid of V3, which would tend to decrease the feedback fraction at high frequencies.

The circuit of V4 and V6, fed from the anode of V2, is identical with that of V3 and V5, providing

an output in anti-phase to that at the cathode of V5.

The output from each half of the amplifier is fed to an output plug, providing a single-sided output, and to a common outlet providing a push-pull output.

Monitoring Facilities

Three outputs are provided for monitoring purposes. These outputs are taken in parallel with the input to the amplifier, and one with each side of the output. To avoid mismatching effects, any monitoring apparatus connected at these points should have a high input impedance.

The monitor plugs, designated *Input Mon.*, *Output Mon.* 1 and *Output Mon.* 2, respectively, project through the front panel.

Metering

The total currents for stages V3, V4, V5, V6, and V1 and V2 together, can be checked individually by means of the meter M1, mounted on the front panel. The meter reads full scale for a current of 1 mA, and is scaled 0–50. The meter resistance is built out to 500 ohms. By means of its selector switch, the meter can be connected in parallel with any of the metering resistors, R11, R27, R30, R36 and R43; additionally, the meter, in combination with R46, can be used to measure the h.t. supply voltage. The values of the current-metering resistors are such that the meter indicates the current in the circuit under test directly in milli-amperes. At the h.t. voltage position, the scale reading multiplication factor is 10.

Mechanical Construction

The unit is mounted on a 19 × 7-inch panel, suitable for bay mounting. When so mounted it projects through the bay. Behind the front panel, and at a distance of 5 in. from it, is a sub-panel secured to side panels attached to the front panel. On the sub-panel are mounted the amplifier values and components. The amplifier is enclosed by a cover which is detached from the rear and located when in place by the side panels. The cover is cut out at the rear, to give access to the input plug, output plugs and output impedance selector switch and the power supply plug. The construction of the unit can be seen from Plates X to XII.

Access to the valves from the front of the unit is through a detachable plate secured to the front panel. The plate is fitted with a handle, and is held in place by the pressure of spring mountings on two fasteners at the top and bottom centre of the plate. Additionally, handles are attached to the front panel, to assist removal and replacement of the amplifier.

The two sections of the amplifier comprising V1, V3, V5 and V2, V4 and V6 are designated the 'upper' and 'lower' sections respectively from the physical positions they occupy; the 'upper' section feeds output No. 1.

General Data

Feed Meter
Weston Type S33, 1 mA, F.S.D., scaled 0–50.

Input Single-sided Output, and Monitor plugs
P.O. coaxial plugs No. 1.

Balanced Output Plug
F. and E. balanced coaxial type P.L.284.

Power Input Plug
F. and E. Type JP-4-AB.

Valve Data

Valve	*Feed Current*	*Anode Voltage**		*Screen Voltage**		*Cathode Voltage**	
	Panel Meter Reading	*Meter Range*	*Reading*	*Meter Range*	*Reading*	*Meter Range*	*Reading*
V1(EF50)	10	480	240	480	240	480	130
V2(EF50)		480	240	480	240	480	130
V3(EF50)	6	480	205	480	205	12	1·7
V4(EF50)	6	480	205	480	205	12	1·7
V5(EF55)	40	480	270	480	270	120	25
V6(EF55)	40	480	270	480	270	120	25

Tolerances on all readings ±10%

* Measured with AVO Model 40.

Impedances

Input: Z = 75 ohms resistive.
Output: Z = 50, 75, 93 (single-sided).
Z = 100, 150, 186 (balanced).

Maximum Output

Balanced output, any output impedance, working into matched load: 8 volts d.a.p.

Balance

The two outputs should be within 10 per cent of each other in the range 10 kc/s to 3 Mc/s.

Power Consumption

H.T. 100 mA at 270 volts.
L.T. 3·1 A at 6·3 volts.

Power supplies normally obtained from a stabilised power-supply unit Type SPS/4.

Test Specification

The apparatus required comprises:

1 Video-frequency Oscillator 10 kc/s–6 Mc/s.
1 Valve Voltmeter
1 Avometer
1 Television Waveform Monitor TV/WM/1
1 Television Test Generator TV/TG/1
1 Amplifier Detector
2 50-ohm Resistors, accuracy ±5 per cent, matched to within 1 per cent
2 1,000-μF 25V Capacitors.

During all tests, except where otherwise specified, each of the single-sided outputs should be loaded by one of the 50-ohm resistors, connected via a 1,000-μF coupling capacitor. The output impedance switch should be set 100 ohms. In the following tests voltages are given in d.a.p., the corresponding approximate r.m.s. figures for sinusoidal waveforms are given in brackets.

1. The input impedance, measured at d.c., should be 75 ohms ± 3 per cent. Check that resistors R49 and R51 are each 20 ± 0·5 ohms, and that resistors R50, R52 are each 22 ± 0·5 ohms.
2. Switch on power supplies and allow ten minutes to elapse for the unit to warm up.
3. Check that the h.t. voltage is 270, and that the valve feeds are as given in the Valve Data Section.
4. Set the *db Gain* control to 12 db, and apply a signal at 100 kc/s from the video-frequency oscillator of amplitude 1 V (350 mV). Check that the output across each load resistor is 2 ± 0·2 V (700 ± 70 mV). Output '1' should be greater than output '2' by about 0·1 V (35 mV).
5. Adjust oscillator output until output '1' is 2 V (0·7 V) precisely. Set the *db Gain* control to 9 db, and check that the output is 1·41 ± 0·05 V (500 ± 20 mV). Set the *db Gain* control to 6 db, and check that the output is 1·0 ± 0·03 V (350 ± 10 mV).
6. Set the variable capacitors C19, C20 to minimum value. Set the *db Gain* control to 6 db, connect the valve voltmeter to output '1'. Set oscillator frequency to 100 kc/s and adjust oscillator output until valve voltmeter reads 1 V (350 mV).
7. Set oscillator frequency to 3 Mc/s, and output amplitude to the same value as that employed in (6) above. Adjust the core of L1 until the output is 1·16 V (405 mV).
8. Adjust C19 until output is 1·0 V (350 mV), and check frequency response at 10, 15, 20, 40, 60, 80, 200, 400, 600, 800 kc/s and 1, 1·5, 2·0, 2·5, 3·0, 4·0, 6·0 Mc/s. The response at any frequency between 10 kc/s and 3 Mc/s should be within 0·2 db of that at 100 kc/s; at 4 Mc/s the response should be down by 0·5 db approximately, and at 6·0 Mc/s down by 3 db approximately. If the response in the range 10 kc/s–3 Mc/s is outside the limits, repeat (6)–(8) employing a different value of L1 in (6), until the response falls within the limits.
9. Transfer valve voltmeter to output '2', and repeat (6)–(8) for this output.
10. With an output of 1·0 V (350 mV) approximately at each output, check that the outputs are equal within 10 per cent at frequencies of 10 kc/s, 100 kc/s, 500 kc/s, 1 Mc/s, 2 Mc/s and 3 Mc/s.
11. Set oscillator frequency to 100 kc/s at an amplitude of 1 V (350 mV). Set *db Gain* control to 6 db, and disconnect the load circuit from output 1. Measure the open-circuit e.m.f. E, which should be about 2 V (700 mV). Replace the load circuit and measure the output voltage V. Check that the output impedance Z, given by

$$Z = (50E/V) - 50 \text{ ohms}$$

is 50 ± 5 ohms.
12. Repeat (10) for output '2'.

13. Restore the load resistors using the *DC* and *Sym* inputs of the TV/WM/1, display the balanced output from the amplifier; with an input at 100 kc/s, check that no obvious distortion is present up to an output amplitude of 8 V (2·85 V).
14. Apply the output from the TV/TG/1 to the input of the amplifier, and set the TV/TG/1 control to *Comp W/F, Lift, Frame* 1 and *Pulse Signals*. Set TV/WM/1 to display the frame waveform; no distortion of the frame bar should be observable. If a 50 c/s square wave input is available, the 'sag' over a half cycle should be less than 2 per cent.
15. The hum and noise level in the balanced output measured on the Amp. Det. (high impedance) should be below —50 db.

Specimen Frequency Responses

The two specimen frequency responses below were taken with the capacitors C19 and C20 at optimum and at minimum settings respectively. In each case each output was terminated in a resistive load equal to the output impedance selected. The response at left was obtained with C19, C20 optimum, and at right with C19, C20 minimum.

Response relative to that at 100 kc/s; C19, C20 optimum.	*Frequency*	*Response relative to that at 100 kc/s; C19, C20 minimum*
0 db	10 kc/s	0 db
0	500 kc/s	+0·05
0	1 Mc/s	+0·2
0	2 Mc/s	+0·6
—0·1	2·5 Mc/s	+0·9
—0·2	3 Mc/s	+1·3

Specimen Signal Levels

(a) Test conditions: 100 kc/s input at 1 V d.a.p. Output impedance 100 ohms. Each output loaded by 50 ohms. *db Gain* control at 6 db position. Voltages are d.a.p.

V1 anode	*V2 anode*	*V3 anode*	*V4 anode*	*V5 cathode*	*V6 cathode*
0·25 V	0·25 V	3·7 V	3·7 V	1·8 V	1·8 V

(b) Test Conditions: as (a), but with valves V3 and V4 removed.

V1 anode	*V2 anode*
0·8 V	0·8 V

(c) Test Conditions as (a), V5 and V6 removed:

V1 anode	*V2 anode*	*V3 anode*	*V4 anode*
0·8 V	0·8 V	10·5 V	10·5 V

TV/SA/1A

The TV/SA/1A differs from the TV/SA/1 only in the type of chassis employed. The TV/SA/1A is mounted on a standard CH/39 chassis, and succeeds the TV/SA/1.

TV/PSA/1

The TV/PSA/1 is a portable version of the TV/SA/1, and incorporates a mains unit, so that the amplifier is self contained.

The components are mounted on a chassis attached to the front panel, and the whole is enclosed in a steel case fitted with carrying handles. The front panel has two captive knurled-headed bolts which engage with threaded holes of the case to retain the panel in position. Two handles are attached to the front panel itself, so that the unit can be extracted from the case. Additionally, there is a rest socket for the mains plug to prevent damage in transit. The construction of the unit can be seen from plates XIII–XV.

The circuit of the amplifier section is closely similar to that of the TV/SA/1. Minor differences include reduced values for R19 and R21, to improve the stability of the equipment, and provision of a 150-ohm, instead of 140-ohm, position for the *Output Z* switch. The circuit diagram of the complete equipment, Fig. 8, shows a mains unit of conventional design. The associated component table differs considerably from that of Fig. 7, chiefly in equivalent-component coding and to some extent in component types.

Under conditions given in item 4 of the TV/SA/1 Test Specification (page 4.3) the TV/PSA/1 has an output voltage of 1·8 volts ± 10 per cent. Note also that, owing to the very good l.f. response, a low-amplitude l.f. oscillation is to be expected on the V5 and V6 anode currents when mains transients occur. This oscillation appears in the amplifier output.

The signal input and balanced output connections differ from those employed in the TV/SA/1; the input plug and socket are F. and E. Type PL259 and SO239 respectively, whilst the balanced output plug and socket are *Niphan* Type N660A and N662A respectively.

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COMPONENT TABLE: FIG. 7

Comp.	Loc.	Type	Tolerance per cent
C1	B4	T.C.C. CP47S/PVC 500V	20
C2	B7	T.C.C. CP47S/PVC 500V	20
C3	C3	Plessey CE809/1 450V	−20 +50
C4	C8	Plessey CE809/1 450V	−20 +50
C5	D5	T.C.C. CP37N/PVC 350V	20
C6	D7	T.C.C. CP37N/PVC 350V	20
C7	F5	Plessey CE17043/1	
C8	F5	Plessey CE17043/1	
C9	E8	Plessey CE811/1 450V	−20 +50
C10	E3	Plessey CE811/1 450V	−20 +50
C11	F7	T.C.C. CP37N/PVC 350V	20
C12	F3	T.C.C. CP37N/PVC 350V	20
C13	F4	Plessey CE809/1 450V	−20 +50
C14	G6	Plessey CE809/1 450V	−20 +50
C15	J4	T.C.C. CP37N/PVC 350V	20
C16	J6	T.C.C. CP37N/PVC 350V	20
C17	F4	T.C.C. SCE77L/PVC 350V	−20 +50
C18	F6	T.C.C. SCE77L/PVC 350V	−20 +50
C19	D4	Mullard (3-30 pF) E7876 75V	
C20	D7	Mullard (3-30 pF) E7876 75V	
C21	H4	Plessey CE17028/1 12V	−20 +100
C22	H6	Plessey CE17028/1 12V	−20 +100
L1	F3	Neosid 351/8BA/200 mod. to EG8769 Det. 20	
L2	F8		
R1	A4	Erie 100 1W	2
R2	A4	Erie 100 1W	2
R3	A5	Erie 100 1W	2
R4	C3	Erie 9 0·25W	10
R5	B4	Erie 9 0·25W	10
R6	C4	Erie 108 0·5W	2
R7	C5	Dubilier BTB 1W	10
R8	C3	Erie 108 0·5W	2
R9	C2	Dubilier BTB 1W	10
R11	D1	Erie 108 1W (±0·5Ω)	
R12	C6	Erie 108 1W	2
R13	C6	Erie 9 0·25W	10
R14	C7	Erie 9 0·25W	10
R15	C8	Erie 108 0·5W	2
R16	C9	Dubilier BTB 1W	10
R17	D4	Erie 108 1W	2
R18	D6	Erie 108 1W	2
R19	E5	Erie 9 0·25W	10
R20	E3	Erie 9 0·25W	10
R21	E5	Erie 9 0·25W	10
R22	E7	Erie 9 0·25W	10
R23	E5	Erie 9 0·25W	10
R24	E6	Erie 9 0·25W	10
R25	F2	Erie 108 0·5W	2
R26	F2	Dubilier BTB 1W	10
R27	F1	Erie 108 0·5W (±0·5Ω)	
R28	F8	Erie 108 0·5W	2
R29	F9	Dubilier BTB 1W	10
R30	F9	Erie 108 0·5W (±0·5Ω)	
R31	G4	Erie 9 0·25W	10
R32	G3	Erie 9 0·25W	10
R33	G4	Erie 108 0·5W	2
R34	G5	Erie 100 1W	2
R35	H3	Erie 9 0·25W	10
R36	H1	Erie 108 0·5W (±0·5Ω)	
R37	G5	Erie 100 1W	2
R38	G6	Erie 108 0·5W	2
R39	G6	Erie 9 0·25W	10
R40	G7	Erie 9 0·25W	10
R41	F8	Erie 9 0·25W	10
R42	H8	Erie 9 0·25W	10
R43	H9	Erie 108 0·5W (±0·5Ω)	
R44	I4	Erie 108 0·5W	2
R45	I6	Erie 108 0·5W	2
R46	I3	Erie 100 1W	2
R48	F3	Erie 9 0·25W	10
R49	I4	Erie 108 0·5W	2
R50	I5	Erie 108 0·5W (±0·5Ω)	
R51	I6	Erie 108 0·5W	2
R52	I6	Erie 108 0·5W (±0·5Ω)	

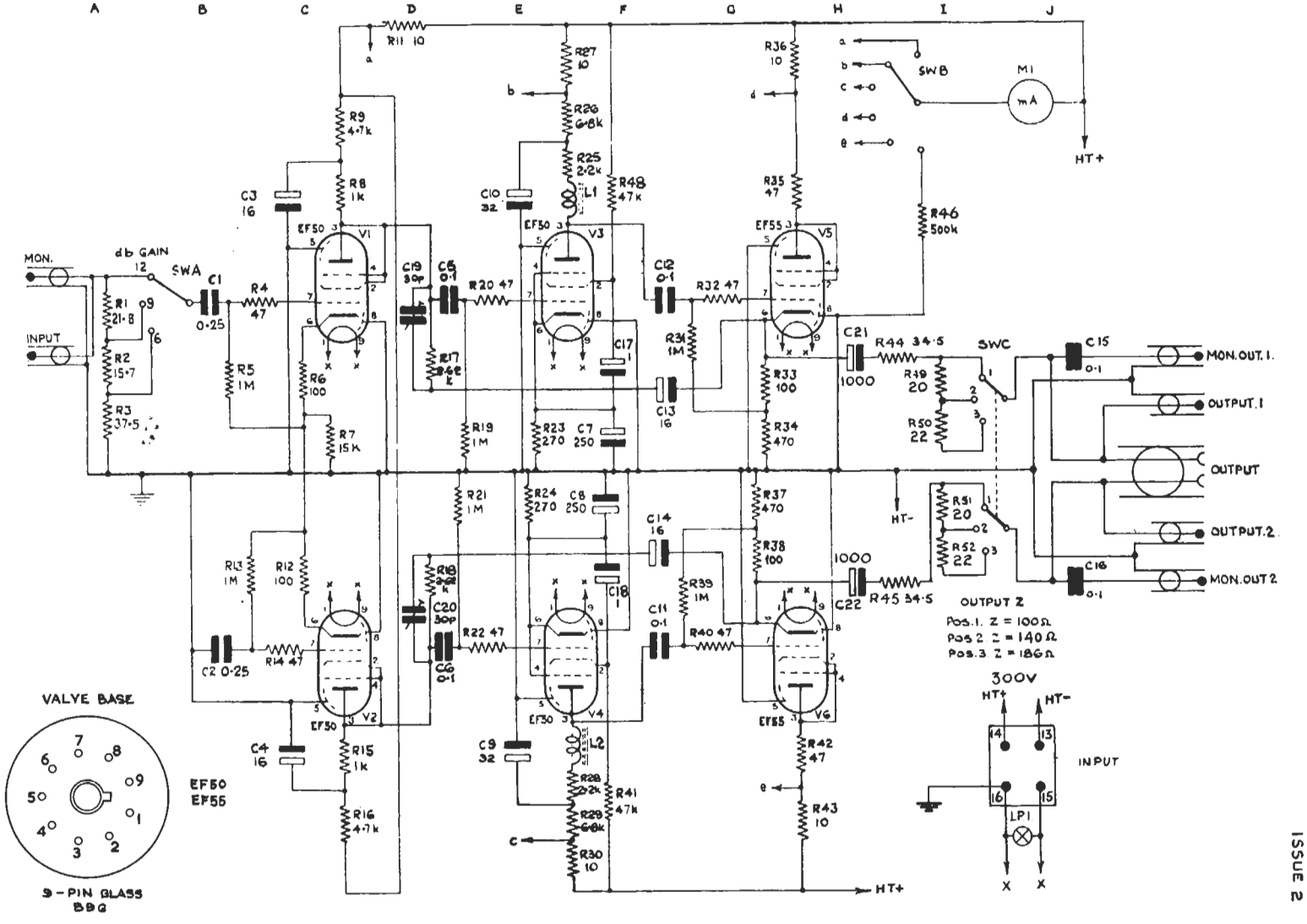

FIG. 7
ISSUE 2

TELEVISION SENDING AMPLIFIERS TV/SA/1, TV/SA/1A CIRCUIT

V2

COMPONENT TABLE: FIG. 8

Comp.	Loc.	Type	Tolerance per cent
C1	B3	T.C.C. CP47S/PVC 500V	20
C2	B7	T.C.C. CP47S/PVC 500V	20
C3	C2	Plessey CE809/1 450V	−20 +50
C4	C8	Plessey CE809/1 450V	−20 +50
C5	E4	T.C.C. CP37N/PVC 350V	20
C6	D7	T.C.C. CP37N/PVC 350V	20
C7	F5	2 x T.C.C. CE18B 12V	−20 +50
C8	F5	2 x T.C.C. CE18B 12V	−20 +50
C9	E8	B.E.C. CE511/15 with ins. sleeving	
C10	E2	B.E.C. CE511/15 with ins. sleeving	
C11	G7	T.C.C. CP37N/PVC 350V	20
C12	F3	T.C.C. CP37N/PVC 350V	20
C13	F4	Plessey CE809/1 450V	−20 +50
C14	F6	Plessey CE809/1 450V	−20 +50
C15	H4	T.C.C. CE41C 25V	−20 +50
C16	H6	T.C.C. CE41C 25V	−20 +50
C17	J4	T.C.C. CP37N/PVC 350V	20
C18	J6	T.C.C. CP37N/PVC 350V	20
C19	I8	2 x Plessey CE809/1 450V	−20 +50
C20	J8	T.C.C. 82 500V	15
C21	F4	T.C.C. SCE77L/PVC 350V	−20 +50
C22	F6	T.C.C. SCE77L/PVC 350V	−20 +50
C23	D4	Mullard E7876 75V	
C24	D7	Mullard E7876 75V	
L1	I8	BBC CH18	
L2	F3	BBC EB8253 Det. 19	
L3	F8	BBC EB8253 Det. 19	
R1	A3	Erie 100 1W	2
R2	A4	Erie 100 1W	2
R3	A5	Erie 100 1W	2
R4	C3	Erie 9 0·25W	10
R5	B4	Erie 9 0·25W	10
R6	C4	Erie 108 0·5W	2
R7	C5	Dubilier BTB 1W	10
R8	C2	Erie 108 0·5W	2
R9	C2	Dubilier BTB 1W	10
R10	C1	Painton P301 4·5W	
R11	D1	Erie 108 0·5W	2
R12	C6	Erie 108 0·5W	2
R13	C6	Erie 9 0·25W	10
R14	C7	Erie 9 0·25W	10
R15	D8	Erie 108 0·5W	2
R16	D8	Dubilier BTB 1W	10
R17	D4	Erie 108 0·5W	2
R18	D6	Erie 108 0·5W	2
R19	E5	Erie 9 0·25W	10
R20	E3	Erie 9 0·25W	10
R21	E5	Erie 9 0·25W	10
R22	E7	Erie 9 0·25W	10
R23	E5	Erie 9 0·25W	10
R24	E5	Erie 9 0·25W	10
R25	E2	Erie 108 0·5W	2
R26	F2	Dubilier BTB 1W	10
R27	F1	Erie 108 0·5W	2
R28	F8	Erie 108 0·5W	2
R29	F8	Dubilier BTB 1W	10
R30	F9	Erie 108 0·5W	2
R31	G4	Erie 9 0·25W	10
R32	G3	Erie 9 0·25W	10
R33	G4	Erie 108 0·5W	2
R34	H5	Erie 100 1W	2
R35	H2	Erie 9 0·25W	10
R36	H1	Erie 108 0·5W	2
R37	G5	Erie 100 1W	2
R38	G6	Erie 108 0·5W	2
R39	G6	Erie 9 0·25W	10
R40	G7	Erie 9 0·25W	10
R41	F8	Erie 9 0·25W	10
R42	H8	Erie 9 0·25W	10
R43	G8	Erie 108 0·5W	2
R44	I4	Erie 108 0·5W	2
R45	I4	Erie 108 0·5W	2
R46	I5	Erie 108 0·5W	2
R47	I6	Erie 108 0·5W	2
R48	I6	Erie 108 0·5W	2
R49	I5	Erie 108 0·5W	2
R50	I2	See note (Fig. 8)	
R51	I3	Erie 100 1W	2
R52	F2	Erie 9 0·25W	10
T1	K7	BBC M.171	

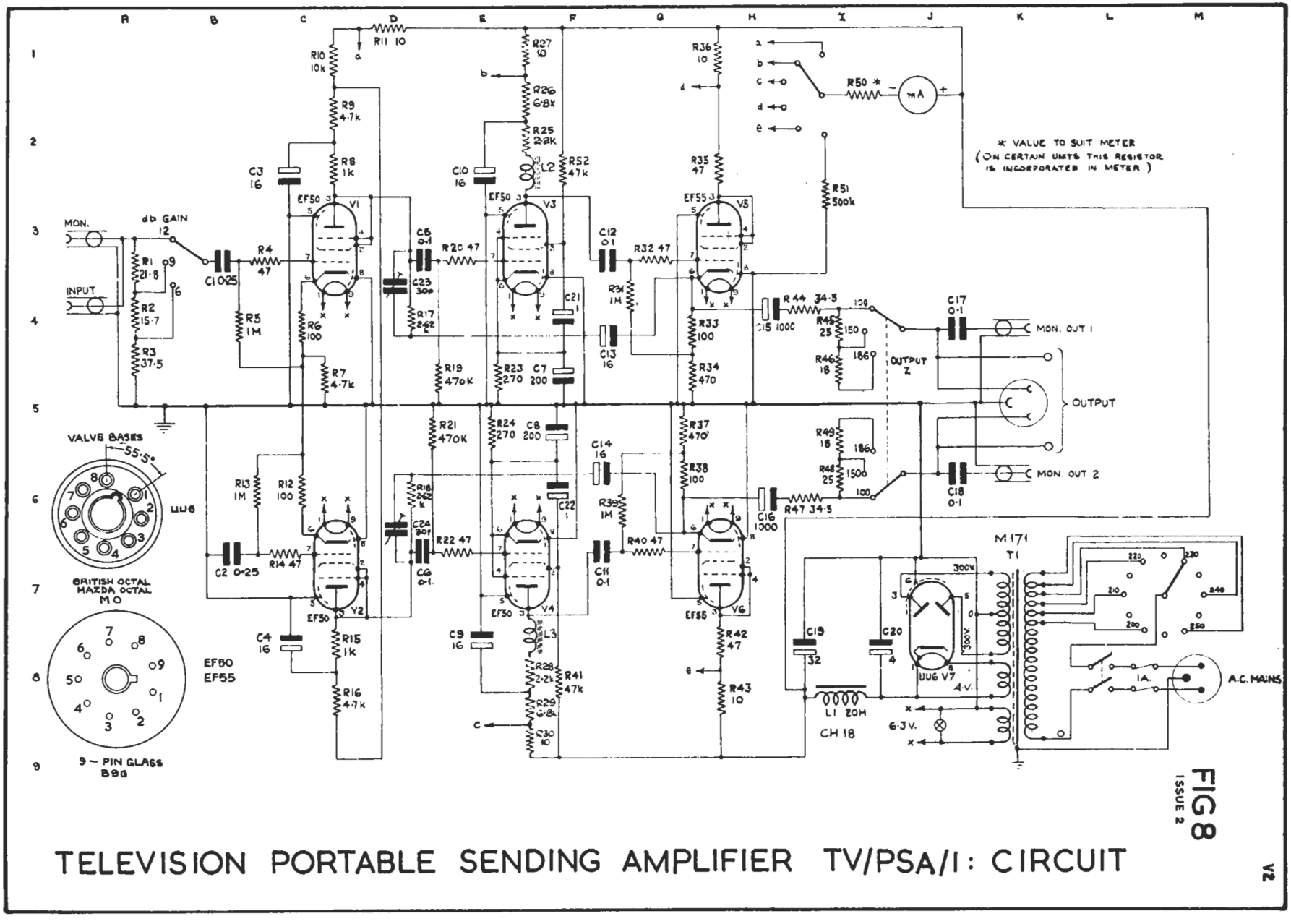

FIG 8
ISSUE 2

TELEVISION PORTABLE SENDING AMPLIFIER TV/PSA/1: CIRCUIT

V2