APPENDIX

2 VERTICAL DEFLECTION AMPLIFIER TYPE B

2.1 GENERAL

This highly sensitive Differential Amplifier provides a simple and economic way of extending the range of the general purpose oscilloscope to those regions where small signals must be examined against very high levels of interference.

The common-mode rejection of this amplifier is 10,000 : 1 ; its basic sensitivity 1 mV/cm. from DC to 100 Kc/s. It will accept a range of twelve input voltages from 1 mV/cm. to 5 V/cm. in a 1 : 2 : 5 ratio. Special stabilizing and smoothing circuits minimize both pickup noise and drift so that the maximum DC drift is not more than 5 mV per hour after the amplifier has warmed up.

The amplifier is thoroughly screened against possible electrostatic and electromagnetic interference. It is self-contained but draws its power supplies from the oscilloscope into which it is plugged. All connections are made automatically as the amplifier is pushed home.

The Differential Amplifier may also be used to advantage for single-ended inputs, within the limits of the above specifications.

2.2 OPERATION

Input Selector Switches

The maximum DC input to either channel, when the V/CM. switch is set to 50 mV/cm. or less, is about 15V in the "DC" position of S2. If the DC level of the input signal exceeds this, the selector switches should be set to "AC", when a blocking capacitor is switched into circuit. The value of this capacitor is 0.01 uf (+ 20%) and it will therefore distort low frequency input signals, though high frequency signals will not be effected. Whenever possible, the "DC" position should be used for low frequency signals.

If the DC component requires the use of a blocking capacitor, a larger capacitor may be used in series with the input in the "DC" position.

Single-Ended Inputs

For use as a conventional Vertical Deflection amplifier, the signal is taken to one input and the other is earthed by the Input Selector Switch.

Use as a Differential Amplifier

Use both inputs, taking the combined signal alone to the other. AC inputs up to 250 V peak to peak may be applied.

Full instructions for setting the common-mode rejection are given in the setting-up procedure.

Warm-Up Time

The Amplifier should be allowed half an hour after switching on to warm up before use.

2.3 CIRCUIT DESCRIPTION (Fig. 3.3)

The circuit consists of three cascaded stages of long-tailed pairs. The input stage uses two double-triode valves (V1 and V2), type ECC82, as a cascode connected long-tailed pair. The two halves of V1 are used as the input halves of the cascode coupled pairs. Both cathodes of V1 are connected by a variable potentiometer RV20. This permits the anode currents of the valves to be balanced to give equal gain and so sets the rejection of the Differential Amplifier. In order to ensure that the anode voltages are equal, the anode of V2B is taken to a coarse balance control (a variable potential divider network, set by the switch S4), whilst the anode of V2A is taken to a FINE balance control, the potentiometer RV22. These two controls are used in conjunction with one another to balance the DC levels of the anodes of V2.

The signals developed at the anodes of V2 are DC-coupled to the next long-tailed pair (V3A and V4A). The anode of V3A is taken to a preset variable resistor (RV49) (PRESET BALANCE), which again permits the anode potentials of the two

halves to be equalized. This control is adjusted during initial setting-up operations.

The signals developed at the anodes of V3A and V4A are passed via attenuator networks (R50, R52 and R51, R53) to the grids of cathode follower stages (V3B and V4B). Vertical Shift is provided by the variable potentiometer (RV57) (Y SHIFT) which varies the current through the cathode followers.

The outputs of the cathode followers are fed to the grids of V5A and V5B, and the Cathode Ray Tube Vertical Deflection Plates are connected to the anodes of V5A and V5B, which form a third long-tailed pair. The preset variable resistor (RV68) (SET GAIN) between the cathodes of V3A and V4A is used to adjust the overall gain of the amplifier by varying the amount of negative feedback between the two cathodes.

The internal triggering waveform for the timebase is also taken from the anode of V5B to the Y1, Y2 positions of the Trigger Selection Switch (S101) via R75 and C21.

2.4 ATTENUATOR NETWORKS

The response of the Differential Amplifier to different input signal levels is controlled by a twelve-position Attenuator Switch S3A, B, C, D, E, F, G, H (MILLIVOLTS/CM.) This performs three types of operations to cover the range of input levels appropriate to each setting of the switch (1mV/cm. to 5V/cm.).

Reading round the switch anti-clockwise from 1mV/cm. to 5V/cm., the gain is first reduced in three steps down to 10mV/cm. by varying the gain of the second long-tailed pair, V3A and V4A. This is done by shunting their existing anode loads (R40 and R44) with R46, R47 and R48. The next two steps, down to 50 mV/cm., are taken by reducing the gain of the first stages, V1 and V2, in a similar manner. In this case R16 and R17 are shunted by R23 and R26 by the operation of S3E/F.

The range below 50 mV/cm. is adjusted by a two-stage balanced input attenuator operating in conjunction with S3E/F to give six further levels of attenuation, down to 5 V/cm. In these attenuators the DC balance is adjusted by means of the preset variable resistors (RV3 and RV8) (PRESET REJECTION) and the AC Balance by preset variable capacitors (C1, C4 and C9, C12).

2.5 POWER SUPPLIES

Power supplies to the Vertical Deflection Amplifier are derived from the main oscilloscope, all connections being made automatically via a power socket as the amplifier is pushed home.

A negative line at -150 V is required for the cascode coupled input stages. This is derived from a transformer (T2) connected to the 110 volt supply in the main oscilloscope. The output from the secondary is rectified by a Sen-Ter-Cell type C3B bridge, smoothed by R70 and C19, and stabilized by the neon diode (V7). The positive output is taken to chassis and the negative to the common cathode resistor (R15) of V1A and V1B.

The heater supply to the input valves (V1 and V2) is rectified and stabilized to minimize noise pickup and drift. This supply is provided from a further winding on T2 giving 16 V AC, which is rectified by four diodes (type 50A5) again arranged in a bridge circuit. The rectified voltage is smoothed by the capacitor (C20) and stabilized by a series transistor (type OC25) and a shunt Zener diode.

The heater centre tap of V1 is taken via R77 to the slider of RV78. This adjusts the relative heater voltage of each half section and so equalizes their gains.

2.6 SETTING-UP PROCEDURE

Remove the amplifier from the oscilloscope and connect the power supplies, Y-plate outputs and internal trigger output by means of extention leads. Proceed as follows:

(1) Short the grids of V3B and V4B. Adjust the Y SHIFT to centralize the trace.

(2) Transfer the short to V3A and V4A grids.

With the attenuator switch set to 1 mV/cm., adjust the PRESET BALANCE control (RV49) to centralize the trace.

(3) Remove the short between V3A and V4A grids.

Remove V2.

Connect an avometer between the anodes of V2A and V2B and adjust the coarse and fine balance controls for zero voltage difference between the anodes.

(4) Plug in V2 and allow to warm up.

Switch input selector switches to earth.

Adjust the slider potentiometer RV78 for zero voltage difference between V2A and V2B anodes. The REJECTION control should be set to its mid-position for this adjustment.

(5) Remove the avometer.

Connect the cal. voltage to both inputs, with both input selector switches set to DC.

Set the attenuator to 1 mV/cm.

Cancel the signal with the REJECTION control, and as the trace moves, re-centre with the FINE BALANCE control. (It may also be necessary to use the COARSE BALANCE control).

The DC levels should now be correctly balanced.

Setting Up the Attenuator

Plug the amplifier into the oscilloscope and proceed as follows:

(1) Apply a 2 Kc/s. squarewave (about 0.5 V peak to peak) to both Input 1 and Input 2. Switch Input 2 to "AC" and Input 1 to "EARTH".

(2) Turn the attenuator to 100 mV/cm. and adjust C4 for a flat-topped response.

(3) Now switch Input 2 to "EARTH" and Input 1 to "AC". Adjust C1 for a flat-topped response.

(4) Switch Input 2 to "AC" and adjust RV3 until a straight horizontal trace is obtained (i.e. zero vertical deflection).

(5) Repeat this procedure in the 1 V/cm. position of the attenuator switch, this time adjusting C12, C9 and RV8.

Setting Up the Rejection

(1) Set Input 1 to "DC" and Input 2 to "EARTH" and feed a 1000 c/s square-wave of about 5 - 10 V amplitude into both.

(2) Set the Attenuator Switch to 5 V/cm. and display a few cycles of the squarewave on the screen to give 1 - 2 cm. vertical deflection.

(3) Now set Input 2 to "DC". Adjust the REJECTION and FINE BALANCE controls to give a straight horizontal trace.

(4) Set the Attenuator Switch to 1 mV/cm. and continue to adjust the REJECTION and FINE BALANCE controls until a satisfactory trace is obtained. This sets the common mode rejection whilst the amplifier is in its most sensitive condition. The final trace will look rather like a differentiated square wave, since some overshoot will be visible from the vertical edges of the mutually-cancelling waveforms when amplified to this extent.

2.7 SIMPLIFIED SETTING-UP PROCEDURE

Remove the screen from the amplifier and fit the amplifier in the Y2 (lower) position. Leave Y1 aperture blank.

Set REJECTION, PRESET BAL. (RV49), COARSE AND FINE BAL., to mid-positions. On 50mV/cm range, centre the trace with the Y shift control. Turn to 100mV/cm range and re-centre the trace with RV78.

Repeat the above adjustments until there is no trace movement when switching between the two ranges.

Turn to 1mV/cm and re-centre with the PRESET BAL. (RV49) control.

Repeat until there is no movement between the 10mV/cm and 1mV/cm positions.

Feed in the 1v CAL to both inputs on D.C.

Cancel the signal with the rejection control and as the trace moves, re-centre with the COARSE AND FINE BAL. controls.

AMPLIFIER TYPE 143B

Part No.	C.C.T. Ref.	Value	Description	Tolerance	Rating @ 70°C
12M	R 1	900K	HSC	1%	¼w
72M	R 2	106K	HSC	1%	¼w
17C	RV 3	10K	Potentiometer 'Preset Rejection'		
72M	R 4	106K	HSC	1%	¼w
12M	R 5	900K	HSC	1%	¼w
11M	R 6	990K	HSC	1%	¼w
71M	R 7	9.85K	HSC	1%	¼w
16C	RV 8	470	Potentiometer Preset Rejection'		
71M	R 9	9.85K	HSC	1%	¼w
11M	R10	990K	HSC	1%	¼w
10M	R11	1M	HSC	1%	¼w
10M	R12	1M	HSC	1%	¼w
S10410	R13	100K	C	10%	¼w
S10410	R14	100K	C	10%	¼w
26X	R15	82K	MO	2%	1w
23X	R16	56K	MO	2%	½w
23X	R17	56K	MO	2%	¼w
S10310	R18	10K	C	10%	¼w
127C	RV20	100	Potentiometer 'Preset Rejection'		
Y22310	R21	22K	C	10%	½w
81C	RV22	200K	Potentiometer 'Fine Bal.'		
90M	R23	94K	HSC	1%	¼w
912510	R24	1.2M	C	10%	¼w
968510	R25	6.8M	C	10%	¼w
88M	R26	23.7K	HSC	1%	¼w
S10110	R27	100	C	10%	¼w
S10110	R28	100	C	10%	¼w
S10210	R29	10K	C	10%	¼w
S10210	R30	10K	C	10%	¼w
S10210	R31	10K	C	10%	¼w
S10210	R32	10K	C	10%	¼w
S10210	R33	10K	C	10%	¼w
S10210	R34	10K	C	10%	¼w
S10210	R35	10K	C	10%	¼w
S10210	R36	10K	C	10%	¼w

AMPLIFIER TYPE B (continued)

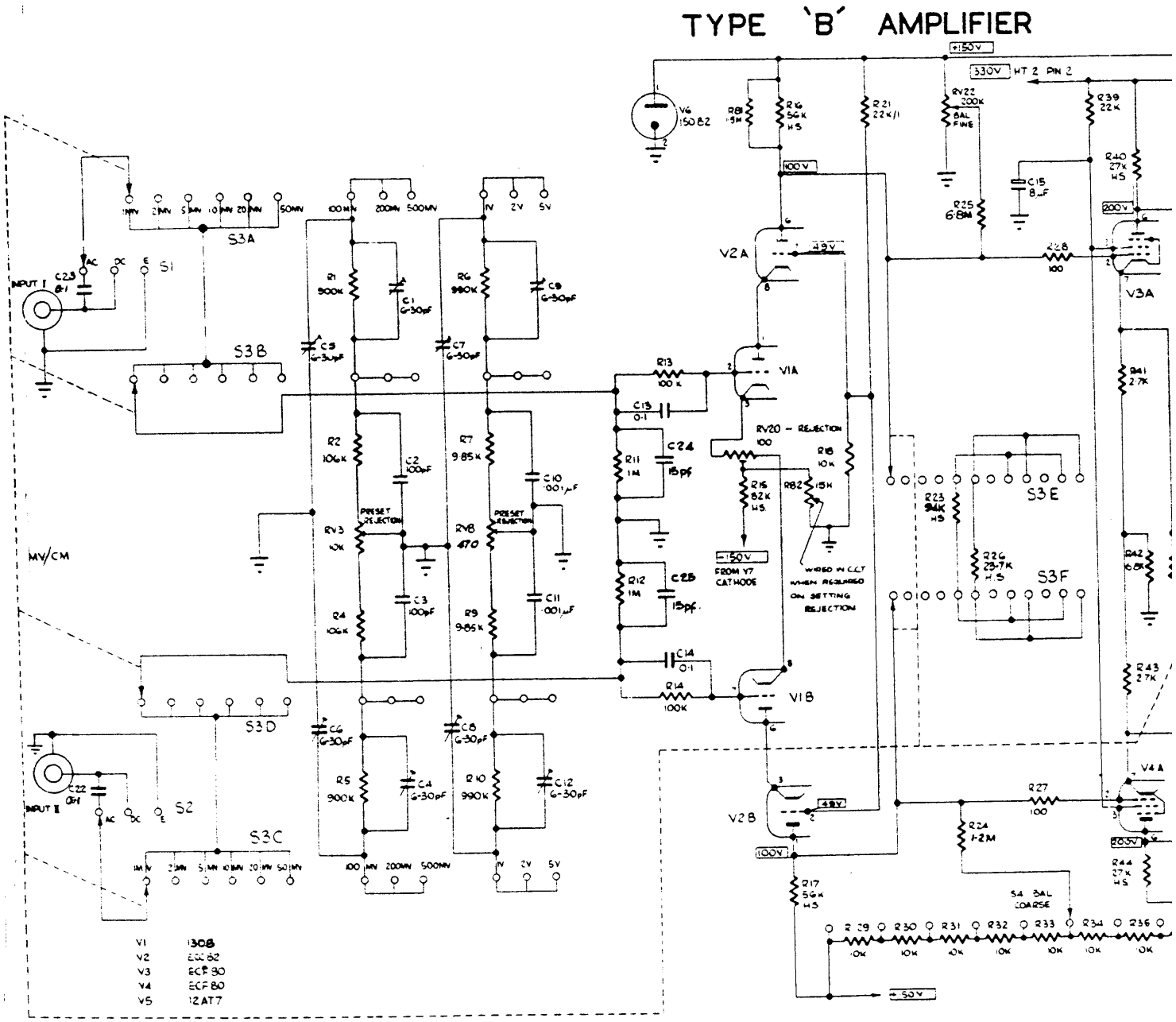
Part No.	C.C.T. Ref.	Value	Description	Tolerance	Rating @ 70°C
S10210	R37	10K	C	10%	¼w
S10210	R38	10K	C	10%	¼w
Y22310	R39	22K	C	10%	½w
24X	R40	27K	MO	2%	1w
S27210	R41	2.7K	C	10%	¼w
102L	R42	6.8K	MO	5%	2w
S27210	R43	2.7K	C	10%	¼w
24X	R44	27K	MO	2%	1w
33M	R45	4.7K	WW	5%	5w
89M	R46	42.6K	HSC	1%	¼w
91M	R47	10.65K	HSC	1%	¼w
92M	R48	4.73K	HSC	1%	¼w
18C	RV49	1M	Potentiometer 'Preset Balance'		
18M	R50	111K	HSC	1%	¼w
18M	R51	111K	HSC	1%	¼w
23X	R52	56K	MO	2%	¼w
23X	R53	56K	MO	2%	¼w
33M	R54	4.7K	WW	5%	5w
Y68210	R56	6.8K	C	10%	½w
61C	RV57	50K	Potentiometer 'Y SHIFT'		
Y68210	R58	6.8K	C	10%	½w
Y10310	R60	10K	C	10%	½w
S10110	R61	100	C	10%	¼w
156L	R62	10K	MO	5%	2w
S10110	R63	100	C	10%	½w
039310	R66	39K	C	10%	1w
039310	R67	39K	C	10%	1w
128C	RV68	5K	Potentiometer Preset 'SET GAIN'		
S33310	R69	33K	C	10%	¼w
Y68210	R70	6.8K	C	10%	½w
Y68210	R71	6.8K	C	10%	½w
S22110	R72	220	C	10%	½w
S22410	R74	220K	C	10%	¼w
S47210	R75	4.7K	C	10%	¼w
S47110	R77	470	C	10%	¼w

AMPLIFIER TYPE B (continued)

Part No.	C.C.T. Ref.	Value	Description	Tolerance	Rating @ 70°C
15C	RV78	1K	W/W Variable Resistor		
Y10210	R79	1K	C	10%	½w
S68410	R80	680K	C	10%	¼w
915510	R81	1.5M	C	10%	¼w
Y15310	R82	15K	C	10%	½w
16J	C 1	6-30pf	CER TRIMMER		350v
59K	C 2	100pf	SM	10%	350v
59K	C 3	100pf	SM	10%	350v
16J	C 4	6-30pf	CER TRIMMER		350v
16J	C 5	6-30pf	CER "		350v
16J	C 6	6-30pf	CER "		350v
16J	C 7	6-30pf	CER "		350v
16J	C 8	6-30pf	CER "		350v
16J1	C 9	6-30pf	CER "		350v
61K	C10	.001	SM	2%	350v
61K	C11	.001	SM	2%	350v
16J	C12	6-30pf	CER TRIMMER		350v
16K	C13	0.1	POL	20%	400v
16K	C14	0.1	POL	20%	400v
39X	C15	8	ELEC		300v
81J	C16	32	ELEC 16 + 16		300v
39X	C17	8	ELEC		300v
40X	C18	32	ELEC		300v
40X	C19	32	ELEC		300v
47X	C20	2000	ELEC 1000 + 1000		18v
16K	C21	0.1	POL	20%	400v
16K	C22	0.1	POL	20%	400v
16K	C23	0.1	POL	20%	400v
63X	C24	15pF	CER	20%	350v
63X	C25	15pF	CER	20%	350v
51J	C26	8	ELEC	-20% +50%	450v

AMPLIFIER TYPE B (continued)

Part No.	C.C.T. Ref.	Value	Description	Tolerance	Rating @ 70°C
60F	MR1	C38	Bridge Rectifier Sentercel		
10E	MR2	4xZ570	Ferranti		
65T	MR3	MEZ12/T5	International. Rec.		
126T	TR1	OC25	Transistor Mullard		
6T	V1		Valve Brimar 13D8		
7T	V2		Valve Mullard ECC82		
10T	V3		Valve " ECF80		
10T	V4		Valve " ECF80		
13T	V5		Valve " 12AT7		
37T	V6		Valve " 15082		
37T	V7		Valve " 15082		
45S	T2		Transformer Type HL/BIF		
43D	S1		Switch 2 Pole 3 position		
43D	S2		Switch 2 Pole 3 position		
68C	S3		Attenuator Switch 8 sec. 12 pos.		
69C	S4		Balance Switch 1 Pole 11 way.		


TYPE 'B' AMPLIFIER
+150V
330V HT 2 PIN 2
V6 ECC82
R21 22K/1
RV22 200K BAL FINE
R39 22K
R40 27K H.S
C15 8µF
R25 6·8M
100V
200V
V2A
48V
R28 100
V3A
S3A
S3B
S1
INPUT I
C23 0·1
R1 500K
C1 6-30pF
R6 990K
C9 6-30pF
C5 6-30pF
C7 6-30pF
R13 100K
V1A
C13 0·1
R2 106K
C2 100pF
R7 985K
C10 ·001µF
RV3 10K
PRESET REJECTION
RV8 470
C24 15pf
RV20 — REJECTION 100
R18 10K
R11 1M
R16 82K H.S
R82 15K
-150V FROM V7 CATHODE
WIRED IN CCT WHEN REQUIRED ON SETTING REJECTION
C25 15pf
R12 1M
R4 106K
C3 100pF
R9 985K
C11 ·001µF
C14 0·1
R14 100K
V1B
S3E
R23 94K H.S
R26 28·7K H.S
S3F
R41 27K
R42 6·8K
R43 27K
MV/CM
S3D
C6 6-30pF
C8 6-30pF
V4A
S3C
INPUT II
C22 0·1
S2
R5 990K
C4 6-30pF
R10 990K
C12 6-30pF
V2B
R27 100
R24 1·2M
100V
R17 56K H.S
S4 BAL COARSE
R29 R30 R31 R32 R33 R34 R35
10K 10K 10K 10K 10K 10K 10K
-50V
V1 1308
V2 ECC82
V3 ECF80
V4 ECF80
V5 12AT7

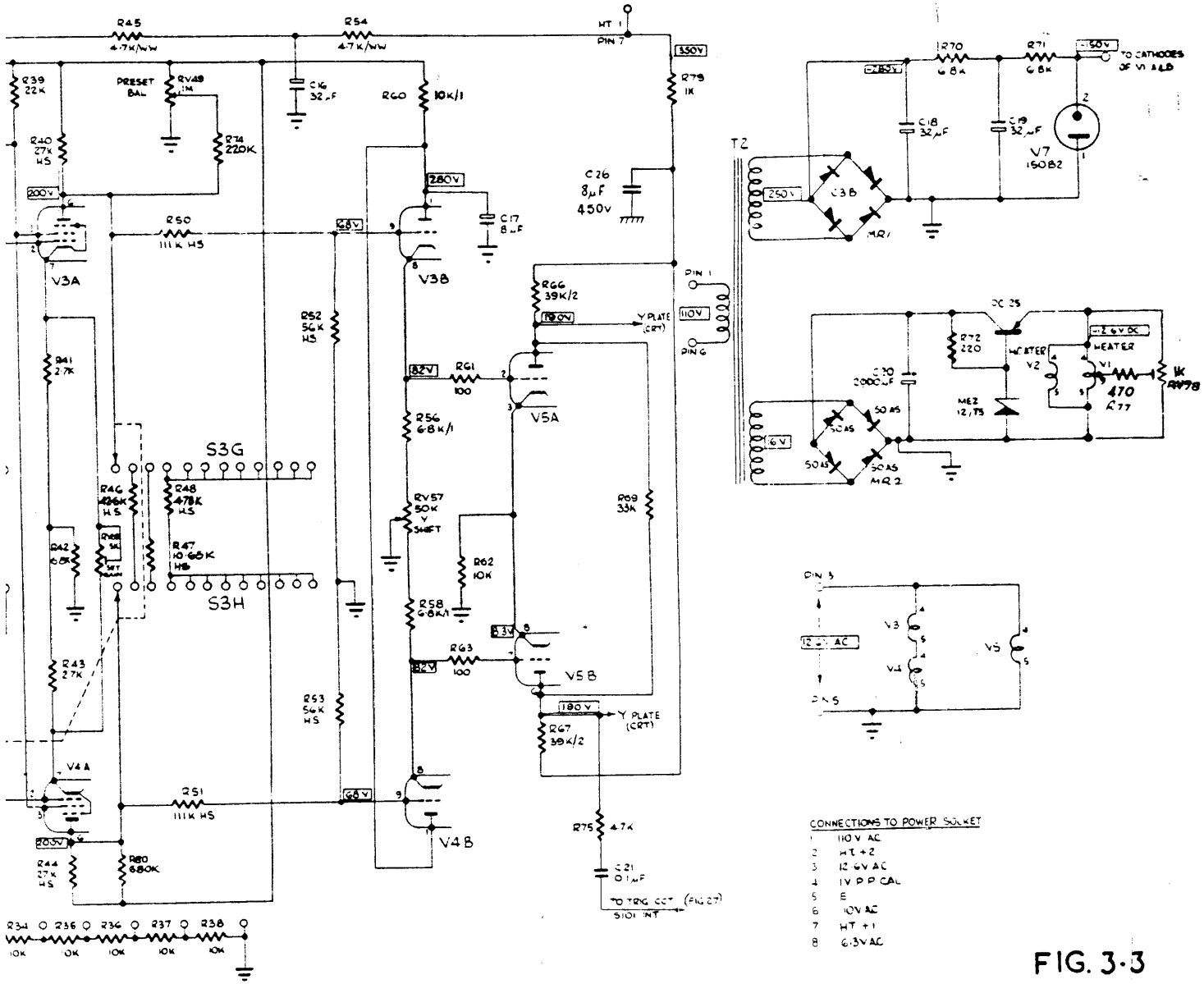
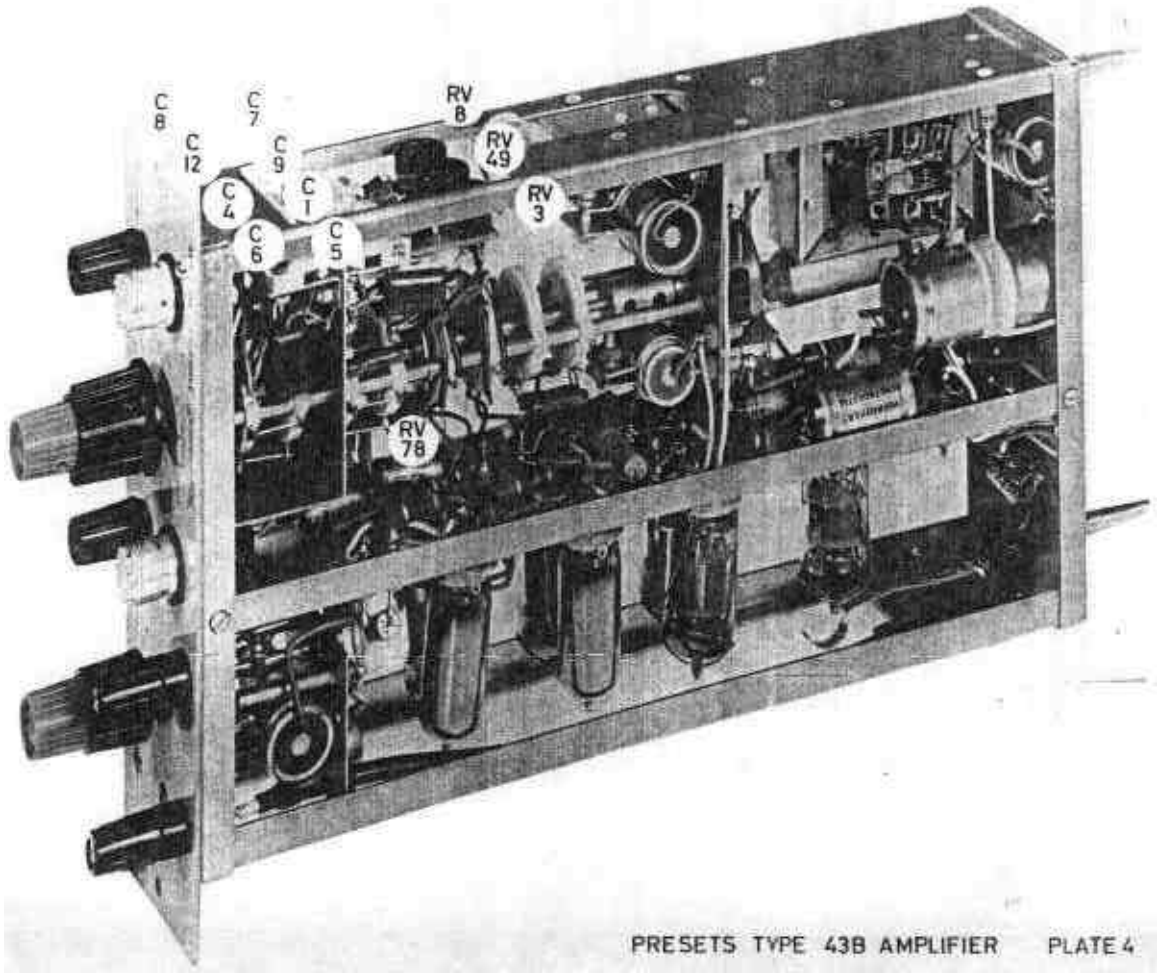

R45
4·7K/WW
R54
4·7K/WW
HT 1
PIN 7
350V
R79
1K
R39
22K
PRESET
BAL
RV49
1M
R40
27K
HS
R74
220K
200V
C16
32µF
R60
10K/1
280V
C17
8µF
C26
8µF
450V
R50
111K HS
68V
V3A
V3B
R66
39K/2
190V
Y PLATE
(CRT)
PIN 1
110V
PIN 6
R52
56K
HS
82V
R61
100
V5A
R56
6·8K/1
R41
2·7K
S3G
S3H
R46
426K
HS
R48
478K
HS
R47
10·65K
HS
RV57
50K
Y
SHIFT
R69
33K
R42
6·8K
R62
10K
R58
6·8K/1
83V
R63
100
V5B
180V
Y PLATE
(CRT)
R67
39K/2
R53
56K
HS
R43
2·7K
V4A
V4B
R51
111K HS
68V
R75
4·7K
C21
0·1µF
TO TRG CCT (FIG 27)
SIOI INT
R44
27K
HS
R80
680K
R34
10K
R35
10K
R36
10K
R37
10K
R38
10K
T2
R70
6·8K
R71
6·8K
-150V
TO CATHODES
OF V1 & 2
-280V
C18
32µF
C19
32µF
V7
150B2
250V
C38
MR1
DC 35
R72
220
HEATER
V2
HEATER
V1
-2·6V DC
1K
RV78
470
R77
C30
2000µF
50 A5
MR2
6V
MEZ
12/75
PIN 5
12·6V AC
V3
V4
V5
PIN 5
CONNECTIONS TO POWER SOCKET
1 110V AC
2 HT +2
3 12·6V AC
4 1V P P CAL
5 E
6 10V AC
7 HT +1
8 6·3V AC

FIG. 3·3



PRESETS TYPE 43B AMPLIFIER PLATE 4