SECTION 3

GENERAL PURPOSE AMPLIFIER TV/A/1

Introduction

The Television Amplifier TV/A/1 is a general-purpose amplifier, having a maximum gain of 40 db. Two gain controls are provided, one coarse and one fine. The coarse control is a three-position switch, which adjusts the maximum gain to 20, 30 or 40 db. The fine control is an input attenuator, which introduces a maximum loss of 10 db. The gain is thus variable over the whole range 10–40 db. The normal output signal is 1 volt d.a.p. into a load of 75 ohms. The normal input and output impedances are 75 ohms, but the input impedance of certain models can be set to the additional values of 100 and 186 ohms.

The frequency response of the amplifier is flat within 0·1 db over the video-frequency range; in fact the frequency response is substantially flat over a much wider range. At the upper limit there is a slight rise in the response in the region of 8 Mc/s, whilst at the lower limit, the response extends to below 1 c/s. The low-frequency performance is such that the amplitude of a 50 c/s square wave does not vary by more than 5 per cent.

The unit is mounted on a 19 × 7-inch panel, suitable for bay mounting; when so mounted the unit projects through the bay. Input and output connections are made via *Musa* plugs at the rear of the unit; 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 SPS/4, connection at the amplifier being made by a four-pin plug situated at the rear of the unit.

Circuit Description (Fig. 6)

The input signal to the amplifier is fed to the network comprising R1, R2 and R3. The input impedance is 75 ohms, and the values of R1 and R2 are so chosen that the range of gain control by R2 is approximately 10 db. For certain applications, alternative values of input impedance are required; the input circuit is then modified by the introduction of switch SWC, by means of which the appropriate input impedance, 75, 100 or 186 ohms, can be selected.

The amplifier comprises two sections, each with negative feedback applied. The first section of the amplifier comprises the stages V1, V2 and V3; V1 is a triode to ensure a good signal to noise ratio. Since the feedback is controlled by the current in V3, the effect of the negative feedback is to stabilise the input voltage—V3 anode-current characteristic. Since the feedback is taken from the cathode of V3, the feedback-voltage waveform is virtually a copy of the waveform at the grid of V3, i.e. the feedback loop embraces the stages V1 and V2.

In order to achieve a substantially-flat frequency response at both high and low frequencies, the interstage time constants are staggered.* Thus V1 employs a relatively low-value anode-load resistor R5, and this ensures that the frequency response is well maintained at high frequencies compared with V2, which employs a relatively high value of anode-load. Similarly the network time constants governing the low-frequency response differ appreciably. The frequency response of V1 is thus 'wide', whilst that of V2 is 'narrow'.

The effect of the cathode-earth capacitance of V3 is to reduce the feedback voltage at high frequencies; to offset this effect, the inductor L7 is employed. A small degree of overcompensation is employed, the overall frequency response of the amplifier rising to a peak of 2 db at 8 Mc/s. Individual negative current feedback is applied to V3 by R15. This resistor provides the major portion of the bias resistance, and it is not practicable to by-pass this resistor, since, if this is done the operation of the feedback loop is upset.

The coarse gain control is effected by altering the anode-load of V3 by means of switch SWA. At the lower gain positions of the switch, 20 db and 30 db, the load resistor is sufficiently low for the effect of shunt capacitance at high frequencies to be negligible. At the highest gain position, 40 db, the effect of shunt capacitance cannot be neglected, and inductor L1 is included in series with R18 to maintain the frequency response at high frequencies.

The response at low frequencies is extended by the pseudo d.c. coupling network, C11, R24, C12, R25. Over the range of frequencies at which the reactance of C12 is negligible by comparison with

* For further details of this technique, reference should be made to Television Engineering, Volume 2, and to an article by C. F. Brocklesby 'Negative Feedback Amplifiers', *Wireless Engineer*, February, 1949.

the resistance of R24 and R25, a perfect low-frequency response can be obtained by proportioning the network values correctly. For example, at the 20 db position, the condition is

$$R20 : (R21 + R50)\ C8 = R26 : C11\ (R24 + R25)$$

In order to maintain the desired ratio of the network elements at each position of the *Gain* switch, it is thus necessary to switch the grid circuit resistor of V4. At very low frequencies, where the reactance of C12 is no longer negligible compared with the resistance of R24 and R25, the low-frequency response falls. In fact, the 'ideal' condition is not used; the components are chosen instead to correct slight deficiencies in the low frequency response in the remainder of the amplifier.

The second section of the amplifier comprises stages V4, V5 and V6. A negative feedback path from the cathode of V6 to the cathode of V4 is employed; the circuit arrangement is similar to that employed with V1–V3. In this section of the amplifier, V4 has the 'wide' response and V5 the 'narrow' response. An inductor corresponding to that employed with V3 is not necessary in the cathode circuit of V6, because V6 carries a relatively high anode current and, consequently, the total bias resistance is small, so that the shunting effect of the cathode-earth capacitance is negligible.

The anode-load of V6 is effectively the shunt-fed resistor R47 (77 ohms). Under working conditions, the external circuit may also comprise a load of 75 ohms, so that the total load of V6 is some 38 ohms. With this low value of load the standing current of V6 must of necessity be large to achieve the necessary current swing to produce the standard output of 1 volt d.a.p., and for this reason V6 is type EF55.

R.f. filters are fitted in the h.t. and l.t. leads, since the amplifier may be operated in regions of high r.f. field strengths; these filters serve to remove any interference borne by the mains-supply leads.

Monitoring Facilities

Two outputs are provided for monitoring purposes. These outputs are taken in parallel with the input to the amplifier, and with the output. To avoid mismatching effects, any monitoring equipment connected at these points should have a high input impedance. The monitor plugs, designated *Input Mon* and *Output Mon* respectively, project through the front panel of the unit.

Metering

The total current feeds for each of the four stages can be checked 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; by means of its selector switch, the meter can be connected in parallel with any of the metering resistors R7, R12, R22, R33, R39 and R46. Additionally, the meter, in combination with R49, can be used to measure the h.t. supply voltage. The values of the metering resistors R7, R12, R22, R33 and R39 have been chosen so that when metering the currents in V1 to V5, the meter indicates directly the current in milliamps. The value of R46 is such that the meter reads full scale for a current of 100 mA, so that the scale reading multiplication factor is 2. When metering the h.t. supply voltage the meter full-scale deflection corresponds to 500 volts.

Mechanical Construction

The unit is mounted on a 19-inch panel for bay mounting. Behind the front panel, and at a distance of 5½ inches from it, is a sub-panel secured to side panels attached to the front panel. On this sub-panel are mounted the amplifier valves 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 plug and power supply plug respectively.

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 general layout of the unit can be seen in Plates VIII and IX.

Valve Data

Valve	*Feed Current Panel Meter Reading*
V1 (CV417)	6·5
V2 (CV138)	8·0
V3 (CV138)	14·0
V4 (CV138)	8·0
V5 (CV138)	11·0
V6 (EF55)*	22·5

H.T. voltage 300
Tolerance on all readings ± 15%.

* Actual current in V6 (mA) is twice meter reading.

General Data

Gain Control

Reliance type TW/1, 100 ohms non-inductive wirewound (500 ohms for variable input impedance models).

Feed Meter

Weston type S33, 1 mA F.S.D. scaled 0–50.

Meter Switch

Oak type DH. 1 bank, 7 way. Non-shorting. Without flat.

Input, Output and Monitor Plugs

P.O. Co-axial Plug No. 1.

Impedances

Input: Z = 75 ohms resistive.
Output: Z = 75 ohms resistive.

Gain

Test conditions:

The gain should be measured between 75-ohm terminations at 100 kc/s with the gain control set to maximum.

The gain should be within ± 1·0 db of the selected value. The calibration of the input attenuator should be within 0·5 db of the nominal value.

Frequency Response

Apparatus required:

(1) Oscillator covering range 10 kc/s–8 Mc/s.
(2) Moullin valve voltmeter with 75-ohm input attachment, or other suitable wide-range instrument.
(3) Double-pole change-over switch (Musa type).
(4) Wide band attenuator, having a maximum attenuation exceeding 40 db.

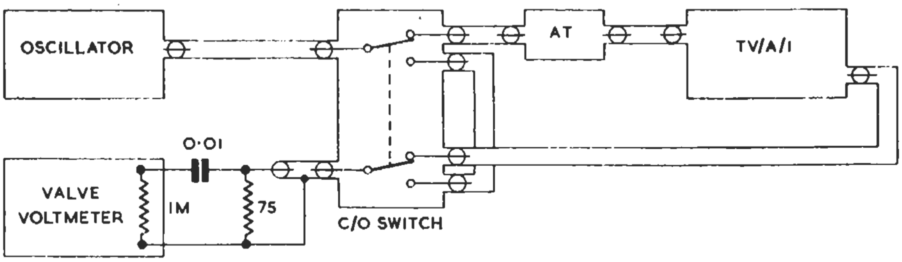


Fig. 3.1. TV/A/1: Arrangement of Apparatus for Medium- and High-frequency Response Test

(5) Test Generator TV/TG/1 with power supply.
(6) Waveform Monitor TV/WM/1.

Normal Working Levels

Input: 40 db to 10 db relative to 1 volt d.a.p.
Output: 1 volt d.a.p.
Maximum Output: 1·2 volt d.a.p.

Power Consumption

H.T. 92 mA at 300 volts.
L.T. 2·5 A at 6·3 volts.
Power supply normally obtained from Stabilised Power-supply Unit SPS/4.

Test Data

Input and Output Impedances

The input and output resistances measured at d.c. should be 75 ohms ± 2% and 77 ± 2% respectively. With the variable input impedance models, the input resistance measured at d.c. should be within 2% of the input impedance selected.

Medium and High Frequencies

Test conditions:

The apparatus in (1) to (3) above should be set up as shown in Fig. 3.1.

The response should be taken as follows:

(*a*) Set change-over switch so that the valve voltmeter is connected to the output of the oscillator. Set oscillator frequency to 100 kc/s. and adjust output until the valve voltmeter indicates 0·35 volt r.m.s. Set *Gain* control to 20 db and the attenuator to 15 db.

(*b*) Throw changeover switch and adjust the *Input Attenuator* control until the valve voltmeter again reads 0·35 volt r.m.s.

(*c*) Adjust oscillator frequency to 3 Mc/s, set changeover switch so that the valve voltmeter is connected to the oscillator output; adjust oscillator output to 0·35 volt r.m.s.

(*d*) Throw changeover switch and observe valve voltmeter reading; it should not change by more than ± 1% (0·1 db). In the event of failure to satisfy this test, adjust the core of L7 until equality is obtained.

(*e*) Repeat procedure indicated in (*c*) and (*d*) above at frequencies of 10 kc/s, 20 kc/s, 50 kc/s, 250 kc/s, and at 250 kc/s intervals to 5 Mc/s and then at 500 kc/s intervals to 8 Mc/s. The valve voltmeter reading should not differ by more than 1% in either position of the changeover switch from 10 kc/s to 4 Mc/s, rising to a peak not exceeding 25% (2·0 db) at 8 Mc/s.

(*f*) Repeat (*a*)–(*e*) at maximum and minimum settings of the *Input Attenuator* control, adjusting the external attenuator at each setting to preserve the overall (attenuator + amplifier) gain at 100 kc/s at unity. The change of gain at 3 Mc/s should not exceed 1% (0·1 db). The setting of the core of L7 should not be altered.

(*g*) Repeat (*a*)–(*e*) with the *Gain* control set to 30 db, and the external attenuator set to introduce a loss of 25 db. The setting of the core of L7 should not be altered.

(*h*) Repeat (*a*)–(*e*) with the *Gain* control set to 40 db and the external attenuator set to introduce a loss of 35 db. In the event of the valve voltmeter readings in (*d*) differing by more than 1% (0·1 db), adjust the core of L1 for equality. The resulting response in (*e*) should be within 1% (0·1 db) from 10 kc/s to 3 Mc/s, and should not fall by more than 3% (0·5 db) at 5 Mc/s.

Low Frequencies

Test conditions:

Connect TV/TG/1 to input of TV/A/1, and waveform monitor *DC* input to the output. Set TV/TG/1 to *Complete Waveform, Pulse Signals, Frame* 1 and zero lift, and observe frame waveform.

The amplitude of a frame bar should not vary by more than 5%

Transient Response

Test conditions:

As for Low Frequencies above.

Connect 75-ohm resistor to waveform monitor *Mon* plug.

Set TV/TG/1 to *Line Waveform, Spike* 1, and zero lift.

Set Waveform Monitor to observe line pulse at maximum expansion.

Check that any overshoot is not measurably greater than that of the generator.

Noise

Test conditions:

No input to TV/A/1.

Connect output to *AC* input of TV/WM/1, and connect 75-ohm resistor to *DC* plug of the TV/WM/1.

The high-frequency noise should not exceed 4·5 mV d.a.p.

Hum

Test conditions:

No input to TV/A/1.

Output terminated in 75-ohms, and connected to Amp. Det. high-impedance input. The hum level should not exceed —57 db.

G.G.J. 0555.

COMPONENT TABLE: FIG. 6

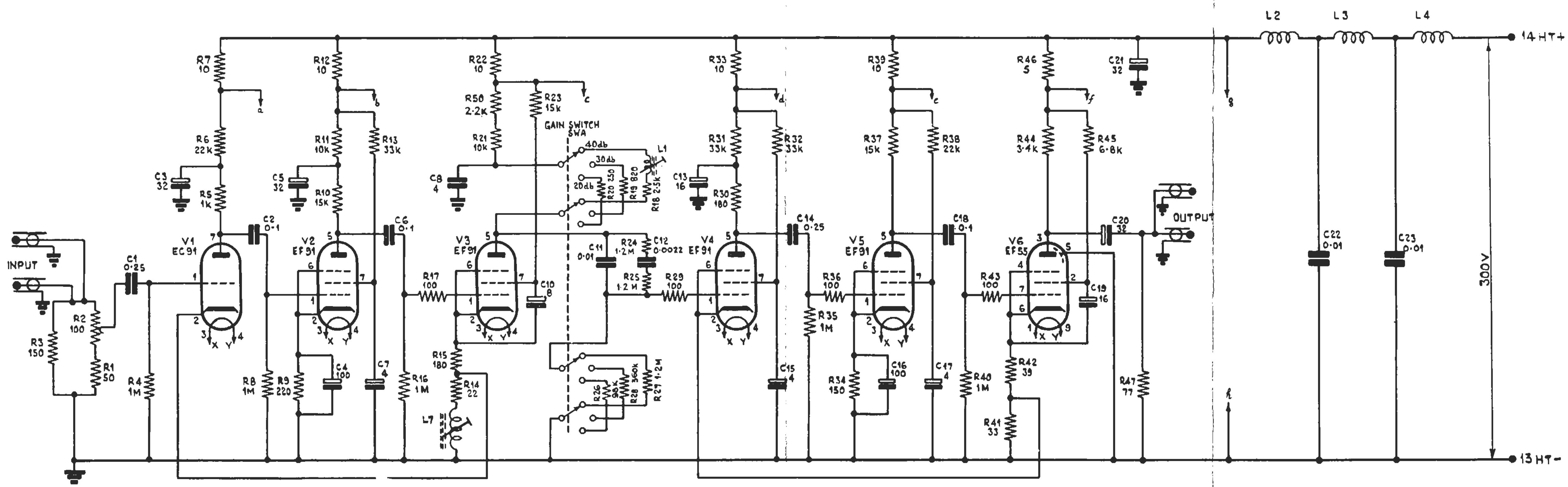
Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	B4	T.C.C. CP46S/PVC		R8	C5	Erie 108 0·5W	2
C2	D3	T.C.C. CP37N/PVC		R9	D5	Erie 109 0·25W	2
C3	B3	T.C.C. CE13PE		R10	D3	Erie 100 1W	2
C4	D5	T.C.C. CE18B/PVC 12V		R11	D2	Erie 100 1W	2
C5	D3	T.C.C. CE13PE 350V		R12	D1	Erie 109 0·25W	5
C6	E3	T.C.C. CP46S/PVC	20	R13	E2	Erie 100 1W	2
C7	E5	T.C.C. SCE79PE/PVC		R14	F5	Erie 100 1W	1
		450V		R15	F5	Erie 109 0·25W	1
C8	F3	Muirhead 239/AT/IM	1	R16	E5	Erie 108 0·5W	2
C10	G4	T.C.C. SCE74PE/PVC		R17	E4	Erie 109 0·25W	2
		450V		R18	H3	Erie 109 0·25W	1
C11	G4	T.C.C. SM3N	2	R19	H3	Erie 109 0·25W	1
C12	H4	T.C.C. M3N	20	R20	G3	Erie 109 0·25W	1
C13	H3	T.C.C. CE61PE 350V		R21	F2	Welwyn C25 2W	1
C14	K3	T.C.C. CP47S/PVC		R22	F1	Erie 109 0·25W	5
C15	J5	T.C.C. SCE79PE/PVC		R23	G2	Erie 100 1W	2
		450V		R24	H3	Welwyn C23 0·75W	1
C16	L5	T.C.C. CE18B/PVC 12V		R25	H4	Welwyn C23 0·75W	1
C17	L5	T.C.C. SCE79PE/PVC		R26	G5	Erie 109 0·25W	1
		450V		R27	H5	Welwyn C23 0·75W	1
C18	L3	T.C.C. CP37N/PVC		R28	H5	Erie 109 0·25W	2
C19	N4	T.C.C. CE61PE 350V		R29	H4	Erie 109 0·25W	1
C20	N3	T.C.C. CE13PE 350V		R30	J3	Erie 109 0·25W	1
C21	N1	B.E.C. CE811/1 450V		R31	J2	Painton P302 6W	5
C22	P4	T.C.C. M3N	20	R32	J2	Erie 100 1W	2
C23	Q4	T.C.C. M3N	20	R33	J1	Erie 109 0·25W	5
C24	Q8	T.C.C. CSM20N	5	R34	K5	Erie 109 0·25W	2
				R35	K4	Erie 108 0·5W	2
L1	H2	EA 8026 DET 43		R36	K4	Erie 109 0·25W	2
L2	P1	EA 8026 DET 44		R37	K2	Erie 100 1W	2
L3	Q1	EA 8026 DET 45		R38	L2	Erie 100 1W	2
L4	R1	EA 8026 DET 46		R39	K1	Erie 109 0·25W	5
L5	R8	EA 8026 DET 47		R40	M5	Erie 108 0·5W	2
L7	F6	EA 8026 DET 49		R41	M5	Erie 108 0·5W	1
				R42	M5	Erie 108 0·5W	1
R1 *	B5	Erie 108 0·5W	1	R43	M4	Erie 109 0·25W	2
R2 *	B4	Reliance TW/1/8S/W	5	R44†	M2	Painton P301 4·5W	5
R3 *	A5	Erie 109 0·25W	1	R45	N2	Dubilier BTB 1W	10
R4	B5	Erie 108 0·5W	2	R46	M1	Erie 109 0·25W	5
R5	C3	Painton P301 4·5W	5			(two in parallel)	
R6	C2	Erie 100 1W	2	R47	N5	Erie 108 0·5W	1
R7	C1	Erie 109 0·25W	5	R49	G9	Erie 100 1W	1

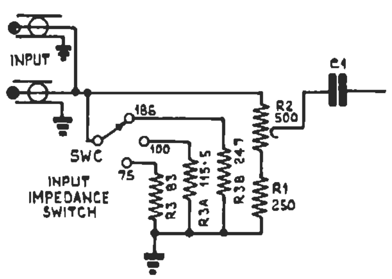
Notes: *For variable input impedance arrangement, same types are employed.
†Two (6·8k) in parallel.

FIG 6

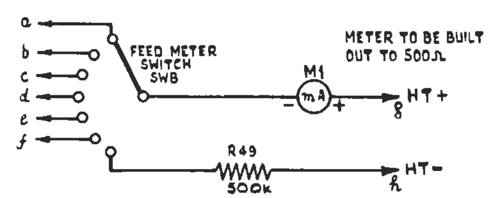
ISSUE 2

V2

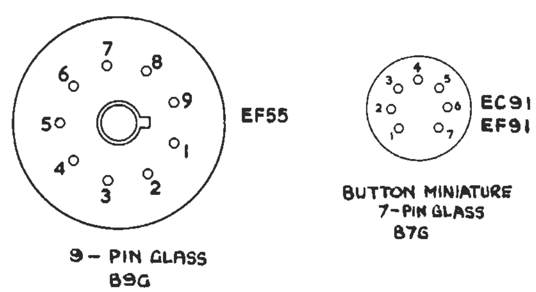


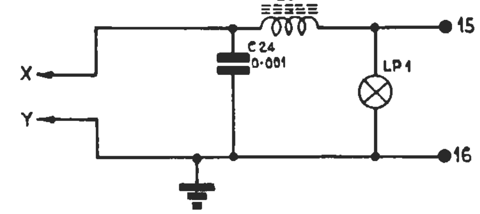


ALTERNATIVE INPUT ARRANGEMENT FOR VARIABLE INPUT IMPEDANCE.



VALVE BASES





TELEVISION AMPLIFIER TV/A/1: CIRCUIT

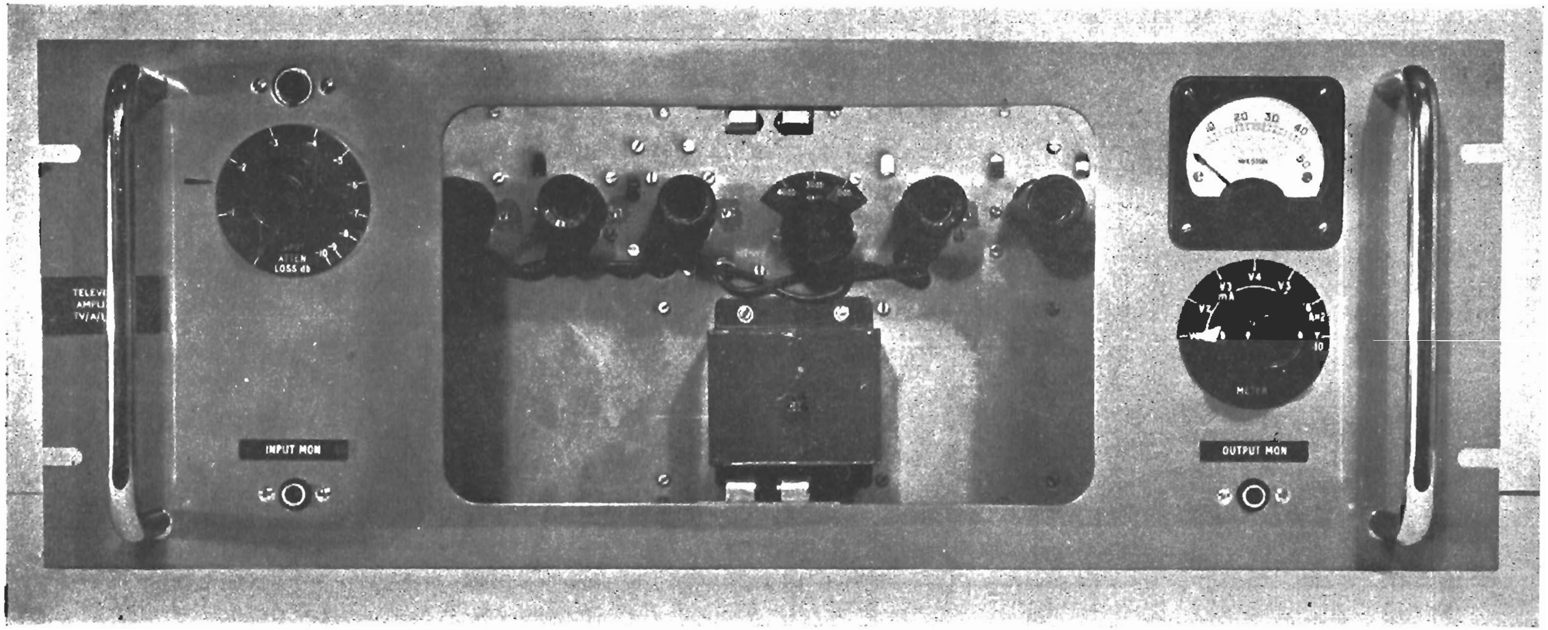


PLATE VIII. Television Amplifier TV/A/1. Front View with Cover Plate removed

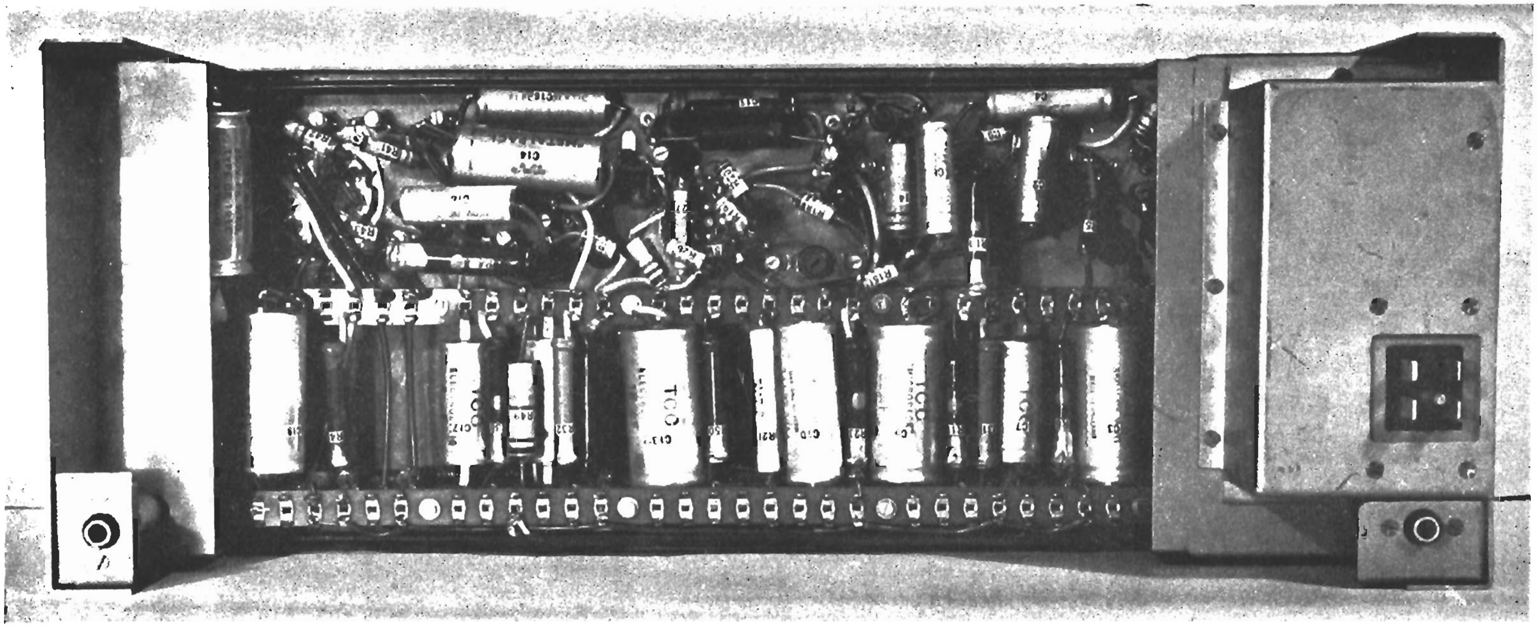


PLATE IX. Television Amplifier TV/A/1. Rear View with Cover removed