OCTAVE-BAND RESPONSE-SELECTION AMPLIFIER AM1/11

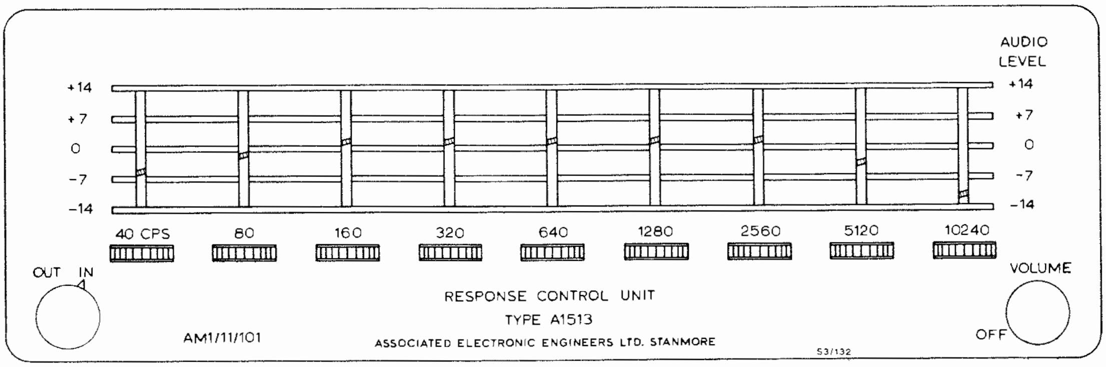

Fig. 1. AM1/11: Panel Layout

Introduction

Amplifier AM1/11 is a portable unit providing a variable frequency response which can be adjusted at octave intervals over the range from 40 Hz to 10,240 Hz. It has input and output impedances of 600 ohms and a straight-through loss of 10 dB. It can be operated from a 200/250-volt 50-Hz supply.

The amplifier was developed from a commercial design, and as the purpose for which this was intended did not require the degree of precision normally associated with response control units in the broadcasting chain, it has inherent limitations which restrict the way it may be used.

General Description

The controls are on the front panel (Fig. 1) and input and output jacks are at the rear. The controls provided comprise a switch to select a flat or variable response, a main volume control combined with on-off switch, and nine controls which vary the response at intervals of an octave from 40 Hz to 10,240 Hz.

The spindles of the octave controls are vertical, and each spindle carries an illuminated perspex cylinder with a helical stripe which is visible through a narrow slit in the front panel and indicates the setting of the control. The nine points corresponding to the settings of the nine controls provide a graphical display of the response curve of the amplifier. Horizontal calibration lines at +14 dB, +7 dB, 0, −7 dB and −14 dB are provided, but the accuracy of the indication given is not constant for all settings of the controls.

The unit measures 17½ inches wide, 5½ inches high and 7½ inches deep, and weighs 14½ lb.

Electrical Design

The amplifier consists of two sections and a power supply. The first section comprises eight parallel-connected single-stage valve amplifiers with frequency-discriminating networks in their anode circuits. The second section is a three-stage output amplifier.

Seven of the single-stage amplifiers have the same circuit configuration (Fig. 2), and a typical response curve is shown in Fig. 3. The peak frequencies of these response curves are spaced in octaves from 80 Hz to 5,120 Hz. The octave points at the ends of the range, i.e., at 40 Hz and 10,240 Hz, are covered by the eighth amplifier which has two parallel networks with separate output controls, producing response curves as shown in Fig. 4.

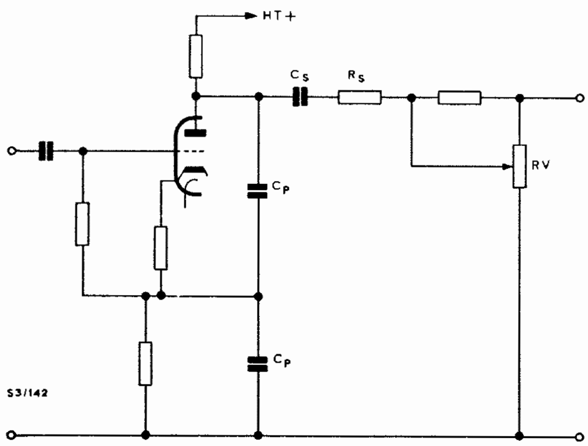

Fig. 2. AM1/11: Circuit of a Frequency-selective Stage

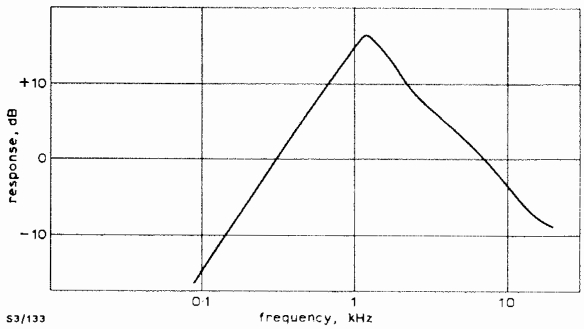

Fig. 3. AM1/11: Response of 1,280-Hz Circuit Only

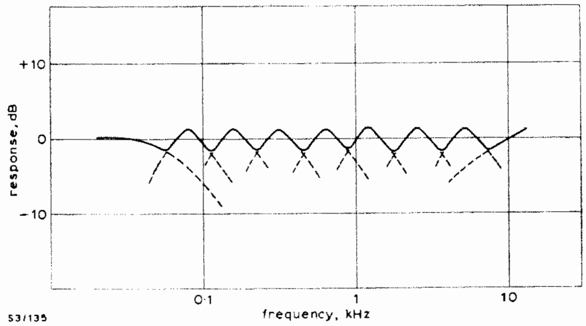

Fig. 5. AM1/11: Resultant Response with All Octave Controls Set at their Mid-points

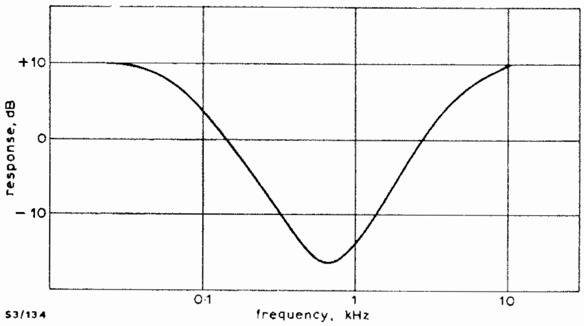

Fig. 4. AM1/11: Response of 40-Hz and 10,240-Hz Circuits Only

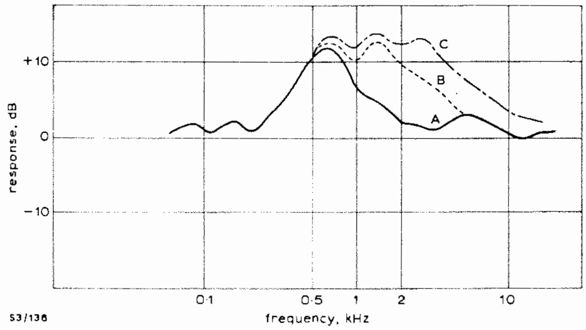

Fig. 6. AM1/11: Response (A) with 640-Hz Control at +14 dB, (B) with 640 and 1,280-Hz Controls at +14 dB, and (C) with 640, 1,280 and 2,560-Hz Controls at +14 dB. All Other Controls at '0'

The response levels off below 40 Hz and above 10,240 Hz, due to components outside the networks.

Between the anode load and the output control *RV* (Fig. 2) of each frequency-discriminating network is a series circuit $C_S - R_S$ which produces the rising response with increasing frequency, and effectively across the anode load are two capacitors in series C_p producing the falling response with increasing frequency. Each output control *RV* is a 500-kilohm potential divider, and since the nine circuits (Fig. 5) are all in parallel, their effective output impedance is about 50 kilohms. Operation of the control *RV* of any discriminating network affects all frequencies equally, and moves the curve for the network bodily between the maximum output, marked +14 dB, and nothing.

This method of operation results in an inequality in the form of the curves when one or more circuits are used to produce a positive or negative modification of a level response. With the *RV* controls for all octave-bands set at their mid-points, the summation of the individual curves produces a resultant as seen in Fig. 5. If, now, one of the outputs is increased a, peak is produced at the corresponding frequency and has a profile determined by the response curve of that circuit. Similarly, if the output of the adjacent circuits is increased, the peak is broadened as shown in Fig. 6. If, however, the output of a single circuit is reduced, the trough resulting is shaped by the response curves of the adjacent circuits. (Fig. 7). This trough may be sharper than a peak, and the effect of adding adjacent troughs can be quite different from adding adjacent peaks, so that the resultant curve bears little resemblance to the display on the front panel, However, for dips in the characteristic of 7 dB or less, this difference is reduced considerably.

Examples of the use of the controls to produce other variations are given in Figs. 8, 9 and 10.

Operational Use

This unit is normally used operationally to modify the frequency characteristic of the programme chain as judged subjectively. If a numerically specified

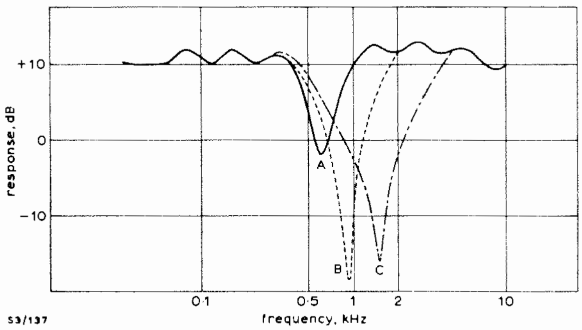

Fig. 7. AM1/11: Response (A) with 640-Hz Control at −14 dB, (B) with 640 and 1,280-Hz Controls at −14 dB, and (C) with 640, 1,280 and 2,560-Hz Controls at −14 dB. All Other Controls at +14 dB. (The shapes of the curves are similar with all other controls at '0' instead of at +14 dB)

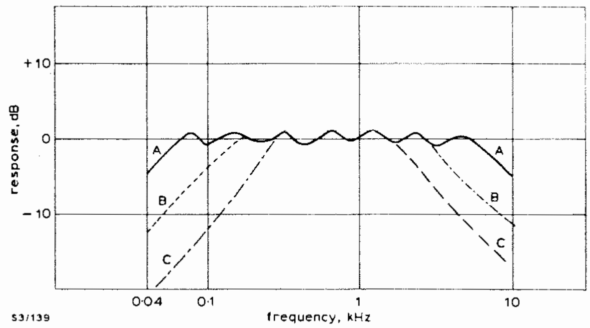

Fig. 9. AM1/11: Response (A) with 40 and 10,240-Hz Controls at −14 dB, (B) with 40, 80, 5,120 and 10,240-Hz Controls at −14 dB, and (C) with 40, 80, 160, 2,560, 5,120 and 10,240-Hz Controls at −14 dB. All Other Controls at '0'

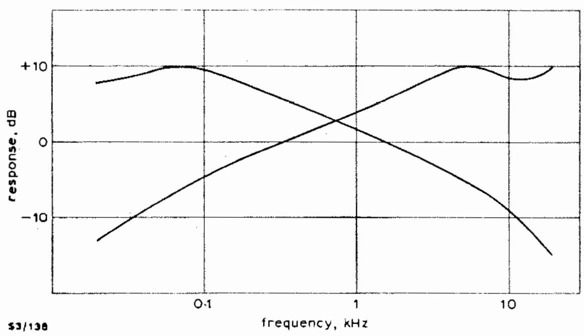

Fig. 8. AM1/11: Response with Control Settings Evenly Graduated Between +14 dB and −14 dB, from 40 Hz to 10,240 Hz and Vice Versa

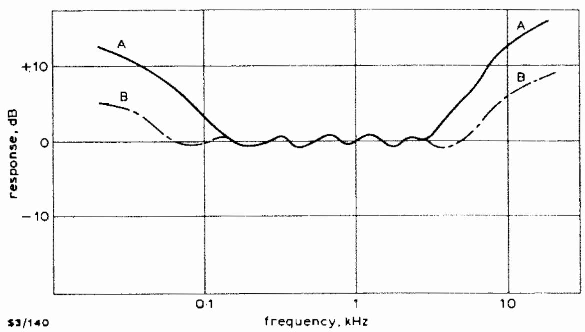

Fig. 10. AM1/11: Response with 40-Hz and 10,240-Hz Controls (A) at +14 dB and (B) at +7 dB. All Other Controls at '0'

amount of correction is required, the setting up of the controls must be carried out with the aid of frequency-response measuring equipment.

Circuit Description (Fig. 11)

The amplifier has a balanced input and output and operates between 600-ohm impedances. It can accept an input voltage level of +10 dB*, and has zero gain in the equalised condition with all gain controls at maximum. With the response controls in the mid or '0' position there is an overall loss of about 10 dB, and this applies also when the variable response section is switched out of circuit.

The signal is taken via the input transformer and an attenuator to one bank of the *In/Out* selector-switch, and from there either to the inputs of all the frequency-selective circuits in parallel, or through another attenuator to the input of the output amplifier. The gain of the first section, up to the input of the output amplifier, with all controls at maximum, is −10 dB.

The paralleled outputs of the frequency-selective circuits are taken to the second bank of the *In/Out* switch and thence to the output amplifier. This amplifier has a conventional three-stage valve circuit with negative feedback between the first and second stages via C40, R64, R61 and R62. There is additional feedback from the undecoupled bias resistor R66 in the second stage, and also from a tertiary winding on the output transformer connected into the cathode circuit of the output valve. The

*The corresponding programme volume is of course +2 dB.

three stages have a total gain of about 26 dB.

An h.t. supply at 250 volts is obtained from a full-wave rectifier with resistance-capacitance smoothing, for all valves except the output stage. This has a 210-volt supply obtained by the addition of a further *RC* smoothing network to the 250-volt h.t. supply.

There is a hum-balancing control across the 6·3-volt heater circuit. The slider of the control is taken to a voltage-divider across the main h.t. line to provide a 13-volt bias to the heaters; this serves to reduce the heater-cathode voltage of 80 volts which would otherwise exist on V1 to V4A.

General Specification

Input impedance	600 ohms
Output impedance	600 ohms
Maximum input voltage level with all controls at maximum	+10 dB
Gain with all controls at +14 dB	0 dB
Gain with all controls at '0', or with equaliser out of circuit	−10·5 dB
Total harmonic distortion at all control settings and with input voltage level of +10 dB	<1%
Noise volume measured on ATM/1 between 600/600 ohms with equaliser in circuit and all controls at maximum	−60 dB

Valve Data

All voltages measured using Avometer Model 8 on lowest practicable range.

Supplies

H.T.1 (V1—V6), 250 volts.
H.T.2 (V7), 210 volts.
Heaters, 6·3 volts.

Test Voltages

Measured from cathode to earth.

V1A&B	V2A&B	V3A&B	V4A
80	80	80	80
V4B	**V6A**	**V6B**	**V7**
1·7	4·3	1·2	2

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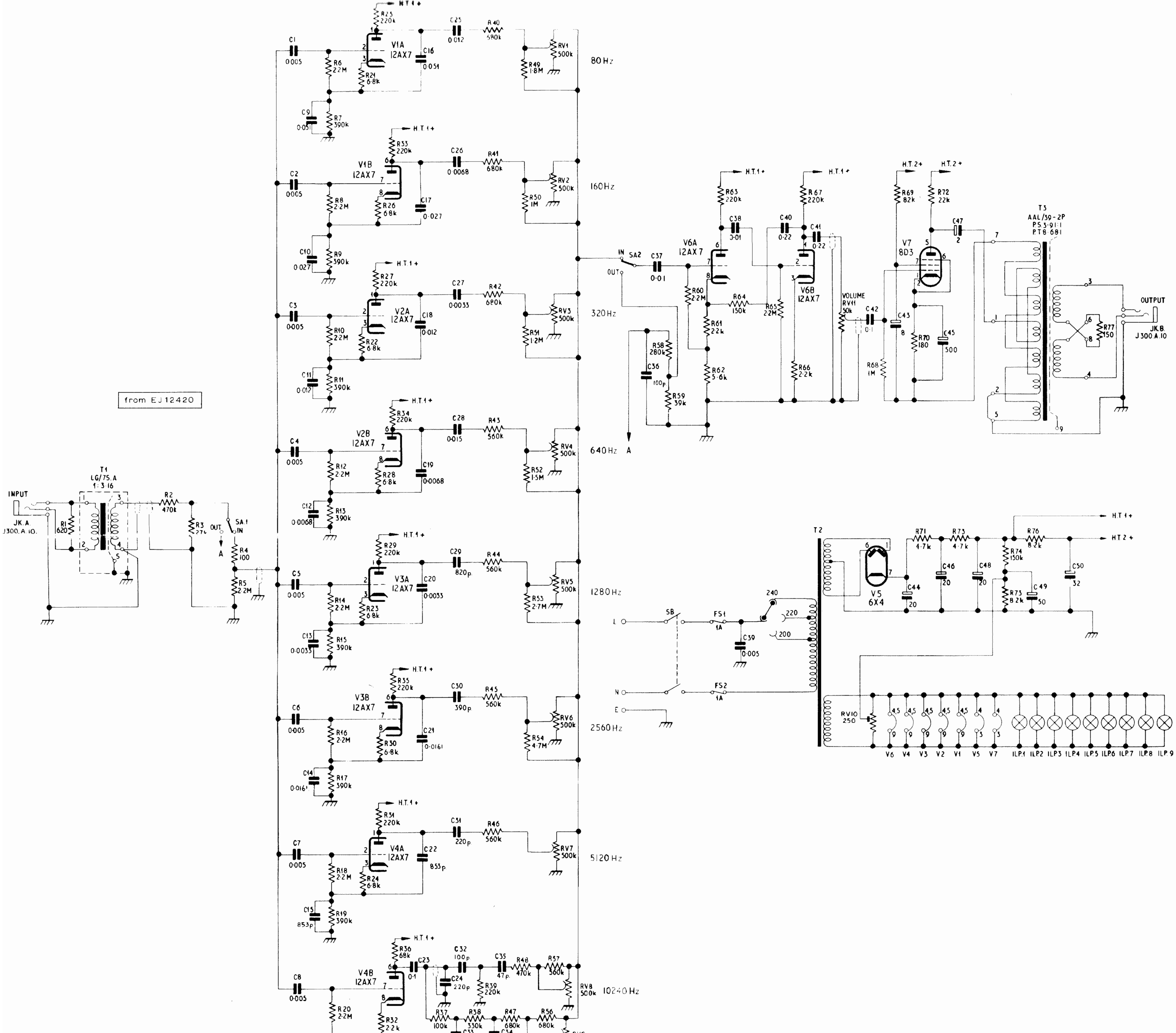

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Fig. 11 AM1/11: Circuit