SECTION 1

MISCELLANEOUS AMPLIFIERS: AM1 SERIES

RESPONSE SELECTION AMPLIFIER AM1/4

General

The AM1/4 provides variable-frequency response of three types, namely, bass cut or lift, treble cut or lift, and 'presence' lift at frequencies of about 1·4 kc/s, 2·8 kc/s or 5·6 kc/s. The normal input volume is between −10 dB and −20 dB, and with the controls set for flat response the gain is approximately zero between 600-ohm terminations.

The amplifier is constructed on a CH1/20* chassis for mounting in a studio desk, the chassis being otherwise similar to the CH1/18 and CH1/19 used in the construction of other types of audio-frequency transistor amplifiers with printed wiring. The overall dimensions are 7 in. high by 1½ in. wide by 4¼ in. deep, and the top and bottom of the front panel are drilled to take a 4BA screw for mounting purposes.

The front panel carries the continuously-variable controls for treble and bass, and two keys, one for *Presence* and the other, labelled *Response*, to by-pass the response-adjustment controls to give a flat response. A three-position switch is used to select the required *Presence* frequency.

The amplifier is an improved version of the AM1/1 (not described in Technical Instructions) which it supersedes. The more important modifications are (a) elimination of bias current from the bass control to reduce noise, (b) increase in signal handling capacity of the output stage, and (c) retention of the output stage in circuit at all times to avoid impedance and level changes.

Circuit Description (Fig. 1)

General

The circuit, shown in Fig. 1, consists of the bass-and-treble control stage, the presence network, and the output stage.

Bass and treble cut and lift are achieved by using frequency-dependent negative feedback to control the gain of the pair of transistors TR1 and TR2; these transistors are connected as a super-alpha pair as in the Line Sending Amplifier AM7/2 described in Section 7. The control circuit is that of the Baxandall tone control, modified for transistor operation.

The presence peaks are produced by passive networks coupling the first stage to the output stage.

Bass Control

The components affecting the bass response are R7, R9, C2, C3 and RV1. The reactance of C4 at low frequencies is sufficiently high to permit it and RV2 to be ignored in considering the bass control circuit. R8 becomes purely a series resistor and can also be ignored.

The incoming signal voltage is fed to the base of TR1 via C2 in parallel with part of RV1, and the negative feedback signal is fed via C3 in parallel with the rest of RV1 from the collectors of TR1 and TR2.

If the slider of RV1 is at the R7 end of its travel, the base of TR1 is effectively connected to R7, and to C3 across RV1. At very low frequencies the reactance of C3 is high compared with the resistance of RV1, and the ratio of stage output to input becomes that of (R9 + RV1) to R7, or 11 to 1. At medium and high frequencies C3 by-passes RV1, so the output-to-input ratio remains at unity. Thus the bass response is increased.

If the slider is moved to the R9 end of its travel, bass attenuation occurs in a similar manner. At intermediate positions of the bass control, both C2 and C3 affect the response, in opposition. If the bass control is set for partial lift, C2 acts to attenuate the bass at a frequency determined by its capacitance and the resistance of that part of RV1 which it by-passes. Similarly, C3 acts to lift the bass from a frequency lower than that determined by C2 and its portion of RV1.

The combined effect is then as shown by the intermediate curve in Fig. 1.1; as the frequency falls, the response first decreases slightly and then rises. A similar effect occurs with an intermediate bass attenuation setting. Ignoring these minor variations the general effect is of lift or attenuation at the rate of 6 dB per octave, acting from a variable turnover frequency.

* Connections are made through a 6-pin connector on the back of the chassis. There are no indexing studs.

Treble Control

The components affecting the treble response are R7, R8, R9, C4 and RV2. At medium and high frequencies the reactance of C2 and C3 is sufficiently low for RV1 to be considered as short-circuited, whatever its setting.

When the slider of RV2 is at the R7 end of its travel, the base of TR1 is connected through C4 to the input point of the stage. At low and medium frequencies, when the reactance of C4 is high, the base of TR1 is effectively connected to the junction of R7 and R9, and the gain is zero. As the frequency increases the reactance of C4 falls, the feedback decreases and the gain rises, that is, treble lift occurs. When the slider of RV2 is at the R9 end of its travel similar action by C4 increases the feedback, causing treble attenuation.

The frequency at which treble lift or attenuation begins is controlled by R7 or R9, R8 and C4, and is therefore fixed. The ultimate lift or attenuation is controlled by R7 or R9, R8 and RV2 and is therefore variable. Thus the slope of the response curve varies from zero at mid-position of the treble control to approximately 6 dB per octave at extreme settings, while the turnover frequency remains unaltered. (Fig. 1.1.) This type of variation therefore differs from that of the bass control.

Presence Control

The presence control is a passive network incorporated in the coupling between the bass-and-treble control stage and the output stage. R12, R13 and R14 form, with the input impedance of the output stage, a potential divider giving 6 dB loss. A tapped coil L1 and capacitors C8 and C13 are connected to the presence-frequency switch to provide a circuit which can be set to resonate at 1·4, 2·8 or 5·6 kc/s. The resonant circuit can be switched across either R12 or (R12 + R13), or can be switched out of circuit. At resonance, the impedance of a part, or the whole, of the upper half of the potential divider is reduced to a low value (the resistance of the part of the coil in circuit) and the loss of the divider is cancelled.

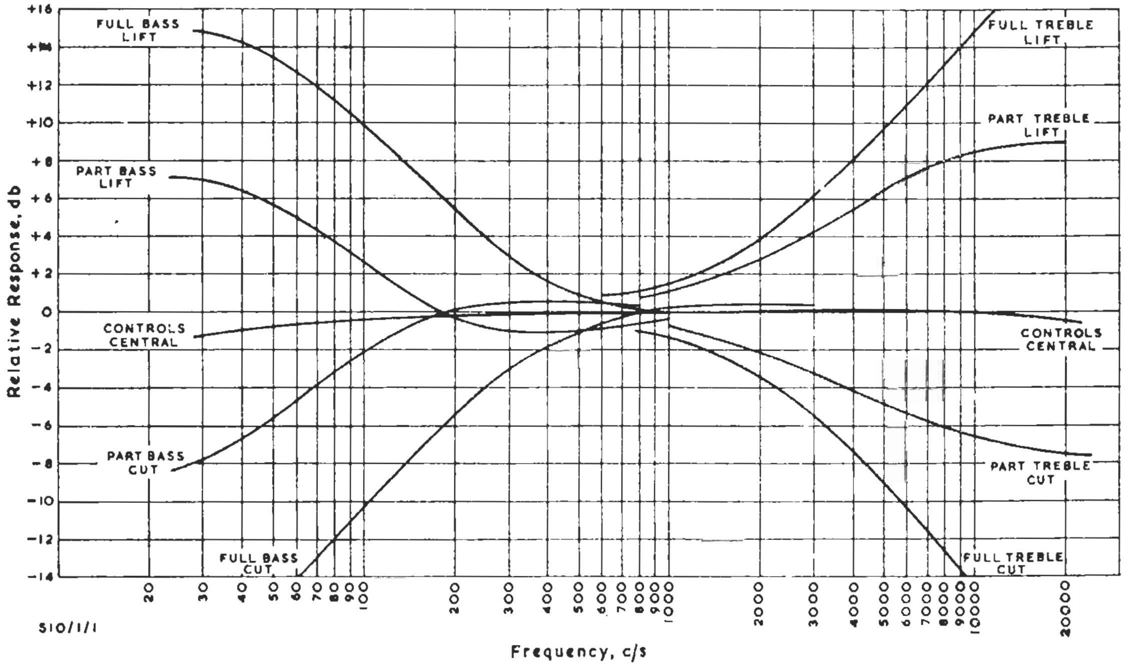

Fig. 1.1. AM1/4 Response : Treble and Bass Controls
Drawing No. DSKA 7076

The impedance variations of this network, as seen by the preceding stage, are not of importance. The treble-and-bass control stage has considerable negative voltage feedback applied under all conditions at the frequencies affected by the presence control, and its output impedance is, in consequence, small.

Output Stage

This is an amplifier stage with sufficient gain (about 12 dB) to offset the losses in the input and output transformers and the presence filter. Negative feedback is applied by means of the unby-passed emitter resistor R18, increasing the output impedance of the transistor. The amplifier output impedance is therefore equal to R17 plus the winding resistances of the output transformer, a total of approximately 600 ohms.

By-passing of Response Control Stages

When *Response* switch SA is operated to give a flat response, the output stage is fed directly from the input transformer through an attenuator. This enables the losses in the transformers to be offset, and the input and output impedances to be maintained unchanged. The amplifier can therefore be left in circuit to avoid impedance and level changes.

Performance

Response

Fig. 1.1 shows typical response curves for the extreme and mid-positions of the treble and bass controls. With components on the tolerance limits there may be a possible variation of about ±1·5 dB from the curves shown, this variation being due to a change of turnover frequency. The shape of the response curves will not change.

The mechanical mid-position of the treble and bass controls may not coincide with the position for flat response because of the departure from strict linearity of the law of the carbon element. For normal operational purposes the mechanical mid-point represents flat response, typical errors being 0·6 dB at 40 c/s and 1·5 dB at 10 kc/s.

The electrical mid-point is checked on initial test by adjusting the control to give the same output in the two positions of the *Response* key at 40 c/s for the bass control and at 8 kc/s for the treble control.

Fig. 1.2 shows the 3-dB and 6-dB peaks for each of the three resonance frequencies. With the given component tolerances, the height of the peaks should not vary by more than 1 dB. Because the resonance curves are broad, the peaks are not well defined, and the amplifier is best aligned (with the treble and bass controls set at their electrical mid-points) by adjusting L1 for equal response at 2·3 and 3·3 kc/s. It should then be checked that the peak response is at 2·8 kc/s ±5 per cent and that the other two resonances are at about 1·4 and 5·6 kc/s.

Impedances

Both the input and the output impedance are nominally 600 ohms, and the amplifier is designed to work between source and load impedances of 600 ohms, either balanced or unbalanced. When the treble control is adjusted for maximum lift the input impedance decreases slightly at high frequencies, but for all other control settings the 600-ohm impedance is maintained.

Levels

The programme volume which may be applied to the amplifier depends on the function of the response control to be applied. If, for example, the input signal is not lacking bass or treble, and the amplifier is used to increase either for a special effect, the possible signal handling capacity will not be as high as if the unit is merely used to

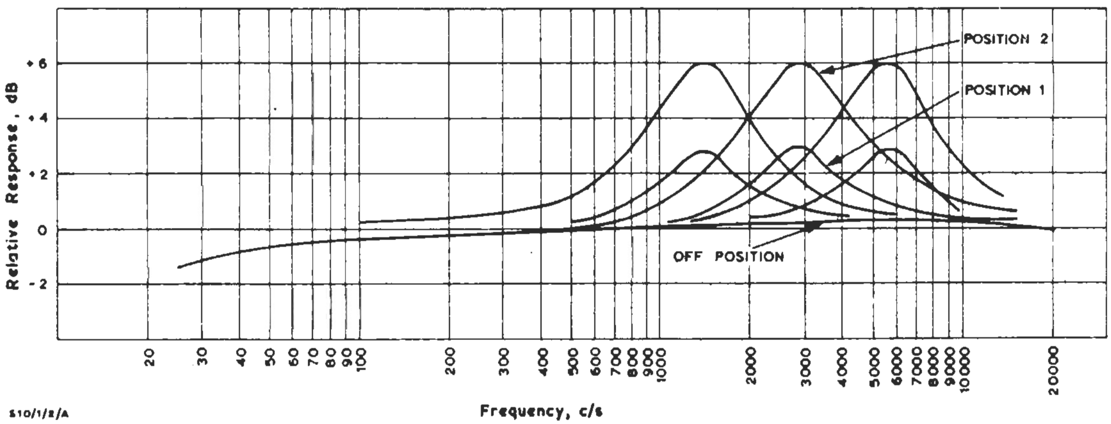

Fig. 1.2. AM1/4 Response: Presence Control
Drawing No. DSKA 7077

equalise a signal deficient in bass or treble.

The output stage, including the output transformer, controls the maximum output which can be obtained, peak clipping occurring at an output of between +10 and +12 dB. Hence if full treble or bass lift is used on a programme having a flat frequency characteristic, the maximum programme volume which may be fed to the amplifier must fall short of +12 dB by the sum of the applied lift, 8 dB (the excess of peak level over line-up level), and a suitable overload margin. This total would be not less than 22 dB.

If, however, the amplifier is used as an equaliser, the programme volume can be increased by the amount allowed above for lift, approximately 10 dB. As a general rule, therefore, the input level to the amplifier should be from —10 to —20 dB; with the noise output at about —80 dB, this will give a suitable compromise between distortion and noise.

To obtain a higher output level a push-pull output stage and a larger output transformer would be required, thus increasing the size of the amplifier.

Earthing

The amplifier case is permanently connected to the positive supply line inside the amplifier. Pin 6 of the connector is connected to this line and should be connected to programme earth by the shortest wiring practicable.

General Data

Power Requirements

Supply voltage, 24 volts d.c. from battery or stabilised supply. Total current, 31 mA.

Input Level

The test figures given below apply when the input level is —20 dB unless otherwise stated.

Impedances

Input and output impedances, 600 ohms nominal.

Insertion Gain

With all controls set for flat response and the *Response* key set to *Adj.*, the insertion gain should be zero ±1 dB at 1 kc/s between 600-ohm terminations.

Frequency Response

With all controls set for flat response, the response should not vary more than 2 dB from 40 c/s to 12 kc/s in either position of the *Response* key.

Treble and Bass Controls

At extreme settings of the treble and bass controls (presence control at *0*) the response should conform to the curves in Fig. 1.1 within ±1·5 dB.

Presence Control

With the treble and bass controls set for flat response, the *Presence* control settings should provide responses conforming to the curves in Fig. 1.2 within ±1 dB.

Noise

The peak noise volume measured on an ATM/1, switched to *PPM*, should not exceed —80 dB with the amplifier input terminated in 600 ohms and all controls set for flat response.

The noise level should not materially increase during operation of the controls.

Harmonic Distortion

With 1-kc/s tone at a level of —10 dB fed to the amplifier, the total harmonic separation of the output, measured by a FHP/3 and ATM/1, should not be less than 45 dB.

With the 1-kc/s input tone at a level of +2 dB, the harmonic separation should not be less than 40 dB.

D.C. Conditions

The following are typical voltages measured on the 25-volt range of a Model 8 Avometer relative to the positive side of the supply:

Point of Measurement	*Voltage*
Negative h.t. line	—22·6
TR2 collector	—10·0
TR2 emitter	—4·3
TR3 collector	—13·3
TR3 emitter	—7·5

W.G. 9/63: P.D.M. 7/66

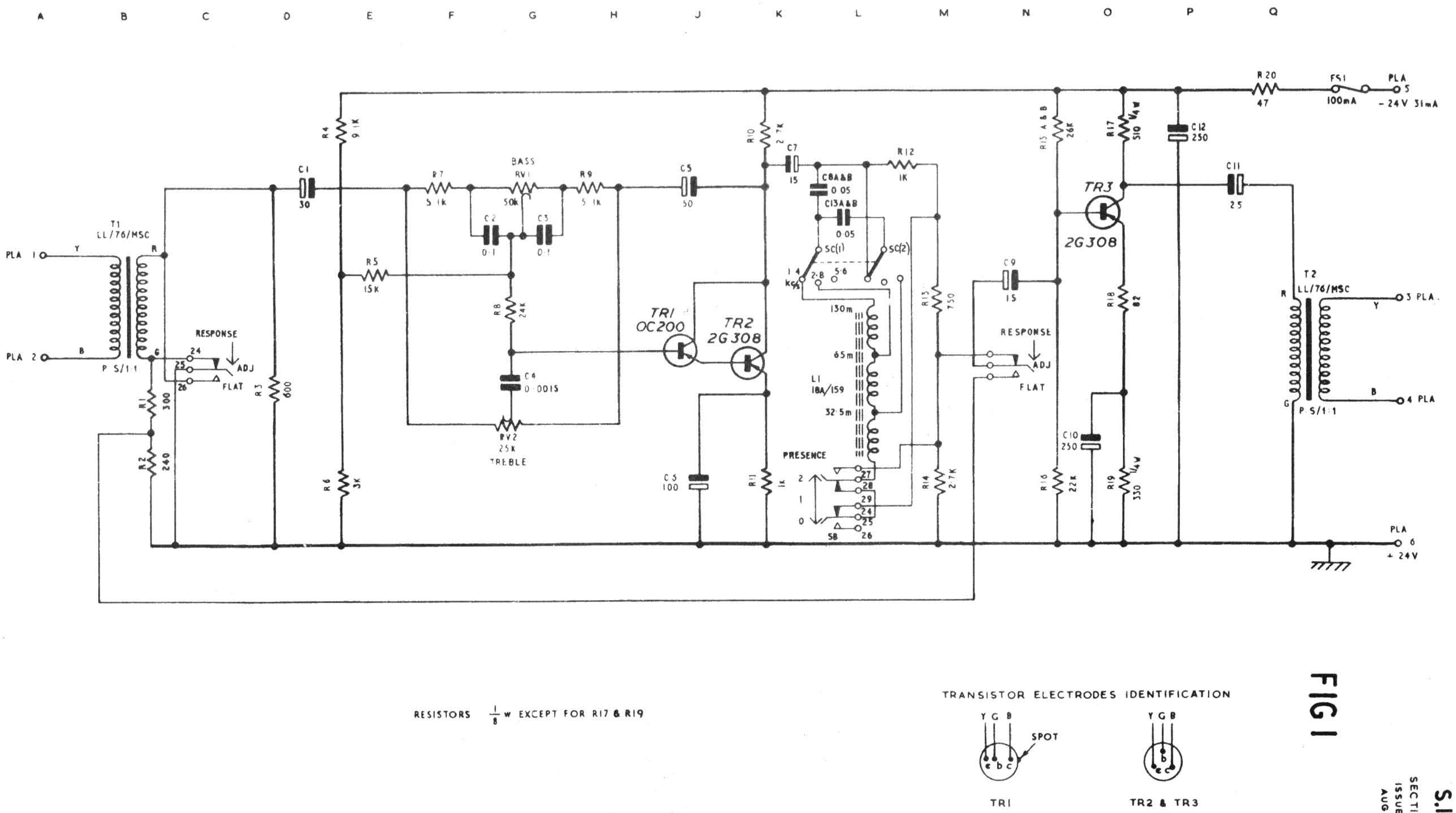

FIG 1

RESPONSE SELECTION AMPLIFIER AM1/4 : CIRCUIT