AMPLIFIER AM8/9

Introduction

This amplifier is intended for use with the Goodmans *Maxim* loudspeaker at O.B. points; its compactness and low cost match the small size and low cost of the loudspeaker.

The power output into 15 ohms, with an input level of −12 dB at 1 kHz, is 10 watts at maximum sensitivity. The circuit contains an equaliser giving a boost of about 8 dB at 50 Hz. The amplifier may be operated continuously on programme peaking to 10 watts in an ambient temperature not exceeding 40 degrees C.

A power supply unit is built into the same case as the amplifier, and is stabilised to work over a mains voltage range of 200-250 volts. Terminals are provided for the connection of an external battery as an alternative source of power.

Circuit Description

Amplifier (*Fig. 8.1*)

The main circuit features of this amplifier, which operates in six stages, are set out below.

Transistor TR1 is a common-emitter amplifying stage feeding from the collector load R3 into the base of the following transistor TR2, also working as a common-emitter amplifier and feeding the signal from the collector via C5 to the base of TR3.

Negative feedback is applied from the collector of TR2 to the emitter of TR1 through a frequency-dependent network R6, R7, C3 which causes the amount of feedback to decrease gradually below about 1 kHz to give an increase in gain of 8 dB at 50 Hz. Below 50 Hz feedback is again increased by the rise in reactance of C4 which removes the shunting effect of R9; the gain therefore is reduced. D.C. feedback is also applied from R4 through R2 to the base of TR1.

TR3 amplifies the signal and passes it on from the collector load R21 to the base of TR4. The output of TR4 appears both at the base of TR5 and the base of TR6. TR5 and TR6 are complementary and give paraphase outputs at the top of R23 and R28 to drive the output pair of power transistors TR7 and TR8. TR7 and TR8 conduct alternately; thus the signal voltage at C8 swings roughly between the voltages of the positive and negative rails, and drives the loudspeaker.

Negative feedback is applied from the output through the network R16, C7 to the emitter of TR3; the input impedance, therefore, is very high.

The d.c. potential difference between the bases of TR5 and TR6, which determines the quiescent current of TR7 and TR8, can be adjusted by variable preset resistor RV2. The rise in temperature of TR7 and TR8 after switching on, however, would make the quiescent current increase, and this effect, if not corrected, could cause the destruction of the transistors. Two diodes, D1 and D2, are therefore connected in series with RV2 as shown, but are mounted together with TR7 and TR8 on a heat sink. When the temperature of the heat sink rises, that of D1 and D2 rises also, and causes their forward voltage to decrease, thus narrowing the difference of potential between the bases of TR5 and TR6. This in turn decreases the difference of potential between the bases of TR7 and TR8 and brings the quiescent current down.

The capacitor C9 reduces the a.c. potential at the top of R20 to near equality with that on the base of TR5, so that the signal current through R20 is much reduced; as far as the signal is concerned, therefore, the shunting effect of R20 and R19 across collector and base of TR5 is greatly reduced.

R24/C11 and R30/C17 are phase-shifting devices to assure the stability of the amplifier above 50 kHz.

Power Supply

The lower part of Fig. 8.1 shows the power supply, which delivers 400 mA at 45 volts. Even if the mains voltage varies, Zener diodes D7 and D8 maintain a constant voltage between the base of the power transistor TR9 and the positive line; the potential difference between the emitter and the positive line is thus also held constant, since the voltage across emitter and base is very small.

Operation and Testing

Ambient Conditions

The amplifier must always be placed so that air may circulate freely through the cabinet on all sides.

Continuous 1-kHz tone giving an output at 8 dB below 10 watts may not be applied for longer than half an hour at an ambient temperature of 40

degrees C. Tests with tone at 10 watts output must not exceed 20 minutes continuous operation at normal room temperature.

Adjustment of Mains Unit

1. Remove strap between pins 1 and 3 on tagstrip TS2.
2. Connect an Avometer Model 8 (100-volt range) between pin 1 and the positive supply rail.
3. Feed power from the mains through a Variac transformer set to 225 volts and allow 3 minutes for the Zener diodes to reach a stable temperature.
4. Adjust RV3 so that the voltage reading is 45.
5. Connect a 100-ohm 20-watt resistor across the Avometer and vary the supply voltage from 195 to 255; the d.c. voltage should remain within the limits 45 $\pm$1.
6. Remove the Avometer and 100-ohm resistor and connect the former as a d.c. milliammeter (25-mA range) between pins 1 and 3.

Amplifier Adjustment

The following sequence of operations reduces the hazard of damage to transistors caused by faulty components or after any changes have been made.

1. Before the application of mains power, turn the volume control fully anticlockwise.
2. Turn RV2 fully anticlockwise.
3. Connect an Avometer Model 8 (25-volt range) between the negative end of C8 and the positive rail. The voltage reading should settle at 23 $\pm$1 within about two seconds.
4. If the observed voltage is incorrect and the current drain exceeds 50 mA, switch off immediately and examine the power amplifier circuit for faults.
5. If the current is less than 20 mA, apply the voltmeter between the junction of R12/R13 and the positive rail. Incorrect voltage at this point may be caused by a fault in the pre-amplifier, and the resultant voltage shift would be increased by the main amplifier to give a false reading at C8.
6. When the typical voltages shown on the circuit diagram have been established, adjust RV2 so that the no-signal current is 16 mA immediately the amplifier is switched on. This current will increase during the first few minutes of operation to a steady value of about 20 mA.
7. Change the milliammeter range to 500 mA and apply 1-kHz tone to give an output of 13 volts r.m.s. across a 15-ohm load, which must be capable of dissipating 10 watts continuously.
8. If the waveform observed on a cathode-ray oscilloscope is free from clipping and the direct current drawn is about 400 mA, remove the meters, re-solder the link on TS2 and reassemble the amplifier.

Performance

The expected performance of the amplifier is given below, it being assumed that the source impedance is 300 ohms and that of the load 15 ohms.

(*a*) *Gain*

With the volume control at maximum, and an input of not more than $-$12 dB at 1 kHz, the output should be 10 watts, that is, 12·3 volts or +24 dB.

(*b*) *Frequency Response*

Between 1 kHz and 15 kHz the response should be within 0 and $-$0·5 dB of the response at 1 kHz. Between 1 kHz and 20 Hz the response should follow the curve shown in Fig. 8.2 within the limits of $\pm$1 dB.

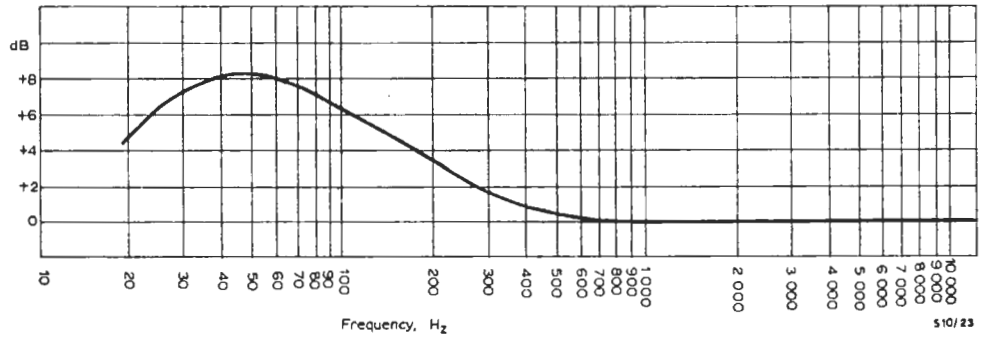

Fig. 8.2. Amplifier AM8/9: Frequency Response

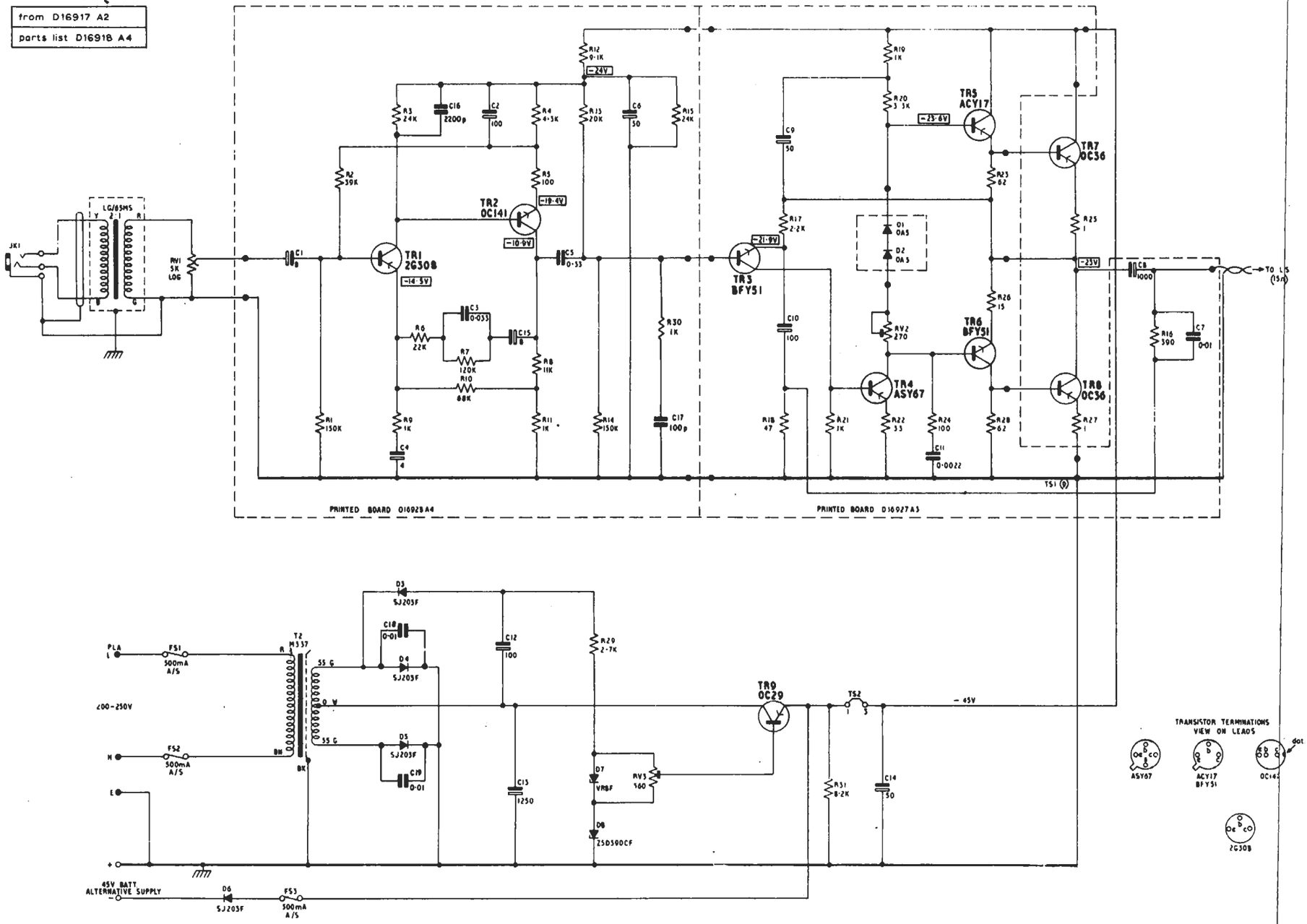

Fig. 8.1. Amplifier AM8/9: Circuit

(*c*) *Noise*

The noise output, which is mostly hum, should not exceed —45 dB on a T.P.M. peaking to 6, at any setting of the volume control.

(*d*) *Stability*

No tendency to self-oscillation should be evident with any combination of resistive and capacitive load in the range

$R = 15\ \Omega$ to ∞
$C = 0$ to $0{\cdot}1\ \mu F$

(*e*) *Operation from External D.C. Supply*

The rated maximum output of 10 watts should be obtained with an external d.c. supply of 45 volts connected to the appropriate terminals.

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