High-fidelity Main Amplifier

By J. Haskell

THIS UNIT PROVIDES A GOOD QUALITY 10W OUTPUT

THE increasing number of hi-fi enthusiasts who wish to start a hi-fi system from scratch will welcome this article about a hi-fi amplifier capable of providing up to 10W of good quality reproduction with negligible distortion, and good frequency response.

Circuit

The main amplifier is usually built separately and can be stored away from the control unit if desired. An obvious choice for the output section in an amplifier of good quality is a push-pull one. The output stage consists of two EL84's in push-pull, under normal or low-loading conditions as required. Distributed loading was considered but due to the lack of peak power handling this arrangement was discarded. The normal loading condition for the output valves results in a distortion figure of about 0·3% at 10W over a power response of better than 30—15,000c/s within one decibel. This response is more than adequate for even the most critical of listeners, and only very expensive speaker systems can reproduce below 30c/s at the rated output. The frequency response is 10c/s to 20kc/s ± 1dB or better.

The valves are cathode-biased under both loading conditions. A balance control is included in the cathode circuit of V2 and V3.

Low-loading

Under this loading, the distortion content at 10W is approximately 0·1% over the specified range, and is therefore more suitable for music and speech reproduction in the home than normal loading. The anode to anode load for EL84's, in normal and low-loading conditions is 8,000Ω and 6,000Ω respectively. The usual "grid stopper" resistors are included in the circuit to prevent any parasitic oscillations from taking place.

The Phase Inverter

The phase inverter circuit is designed around a high-gain double-triode valve type ECC83, the first section of which acts as a driver and the second section as the phase inverter proper. This type of circuit gives good reproduction and is quite popular, the only disadvantage being that the overall gain is slightly more than unity (1·8). Since the cathode resistors of the phase inverter are not by-passed, there is heavy negative feedback, giving good transient response and also

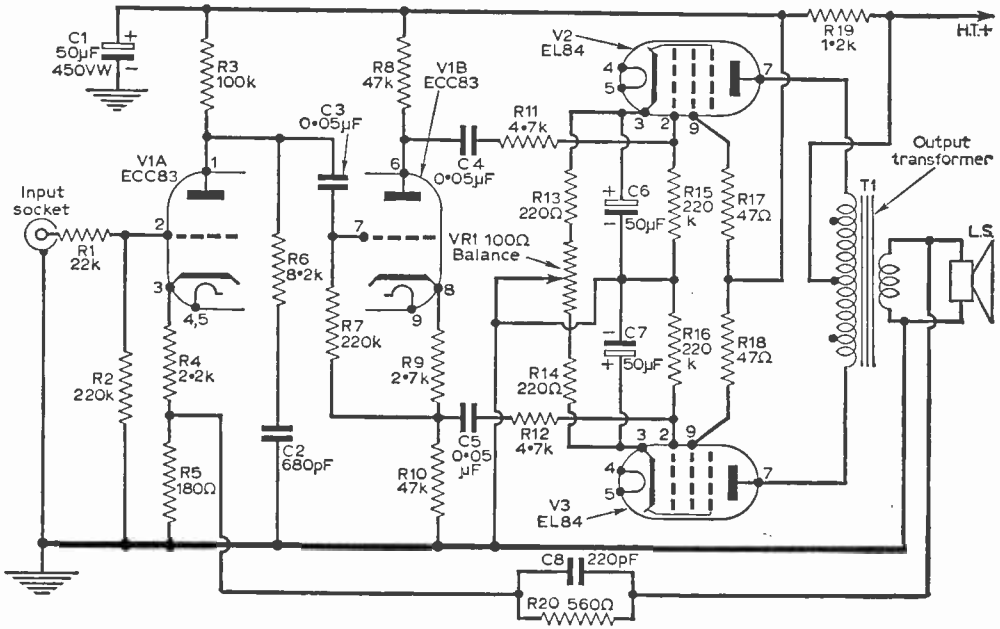

Fig. 1—The circuit diagram.

helping towards the balance of the output stage.

The output transformer was a Partridge type P3667, which has an 8k primary winding tapped at 6k. The constructor may therefore try both loadings out on the output stage, bearing in mind that resistors R13 and R14 will have to be changed as well (220Ω for normal loading and (390Ω) for low-loading conditions).

Increased Feedback

The degree of negative feedback is about 20dB, and increasing it to 30dB resulted in no instability, giving a good feedback stability margin.

An interesting feature about the driver-section is the resistor R6 and condenser C2 in series from the anode of V1A to earth. This is to prevent parasitic oscillations (rarely present in triode valves) and to provide a time constant giving good stability in the lower registers of the frequency range.

Close tolerance resistors should be used for the anode and cathode loads of the phase inverter, as well as in the grid resistors and stoppers of the output valves. The two coupling condensers, C4, C5 should have no leakage since any D.C. on the output valve grids will result in distortion.

The Power Supply

(Fig. 1). Valve V5, used in the prototype, was a 5Y3, though an EZ81 may also be used. In this case, the rectifier winding will be 6·3V at 1A. If additional current is not required for a radio tuner, 10mA for a pre-amplifier is available. An EZ80 may be used instead of the EZ81, and

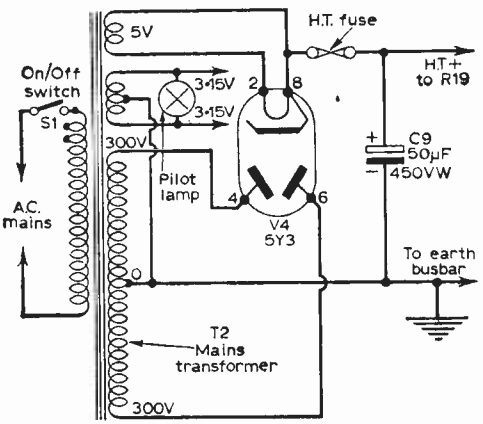

Fig. 2—The circuit of the power supply.

a common heater winding can then be used for all the valves. It should be noted that on no account should more than 90mA be drawn from an EZ80. Two resistors must be included in the anode circuit of the rectifier; the values for the EZ81 are 190Ω per anode, and for the EZ80 216Ω per anode. Under normal loading conditions the amplifier requires about 80mA of H.T. current, and 60mA under low-loading.

Since a smoothing choke was not used, a large smoothing condenser was required to supply the extra voltage on peak drives of the output stage.

COMPONENTS LIST

Resistors (all ½W unless otherwise stated)

R1	22k	R4	2·2k
R2	220k	R5	180Ω ±5%
R3	100k	R6	8·2k
R7	220k (may be increased to 1M for H.F. stability)		
R8	47k ±2%	R11	4·7k
R9	2·7k	R12	4·7k
R10	47k ±2%		
R13, R14	220Ω (for normal loading) or 390Ω (for low loading) (R13 and R14 are both 5% 3W)		
R15	220k	R18	47Ω
R16	220k	R19	1·2k 1W
R17	47Ω		
VR1	100 w.w. potentiometer		

Capacitors

C1, C9	50μF 450V elec.
C2	680pF
C3	0·05μF 600VI } low leakage types
C4	0·05μF 600V } low leakage types
C5	0·05μF
C6	50μF elec.
C7	50μF elec.
C8	220pF ±5% (for 3·75Ω speaker)

Valves:

V1	ECC83	V3	EL84
V2	EL84	V4	5Y3

Mains transformer

Primary: 200-220-240V
Secondaries: 300-0-300V, 60 or 80mA (see text)
3·15-0-3·15V, 2A
Winding to suit heater of V5

Output transformer:
Partridge P3667

Chassis:
12in. x 9in. x 2½in. approximately.
Pilot lamp, wire, solder, bolts, sockets, etc.

The possible change in line voltage is only 0·5%. Adequate decoupling of the stage is also assured.

Feedback

The values of R5 and R20 govern the degree of voltage fed back, and the values used in the prototype were 560Ω and 180Ω respectively, giving about 20dB of feedback. Constructors who wish to increase the feedback may do so by decreasing the value of R20 slightly. Resistors R8 and R10 should be good quality components of ±2% tolerance. Lack of balance here or in the output stage itself will result in unnecessarily high second harmonic distortion, owing to incomplete cancellation of the distorted anti-phase wave forms. A condenser in parallel with the feedback loop resistor promotes a phase shift opposite to that of the output transformer at the high frequency resonance of this component, and thus prevents the feedback from becoming positive at this frequency. If the output transformer is different from the one specified, it may be necessary slightly to modify the value of this component. The optimum value is best found by trial and error. Best results

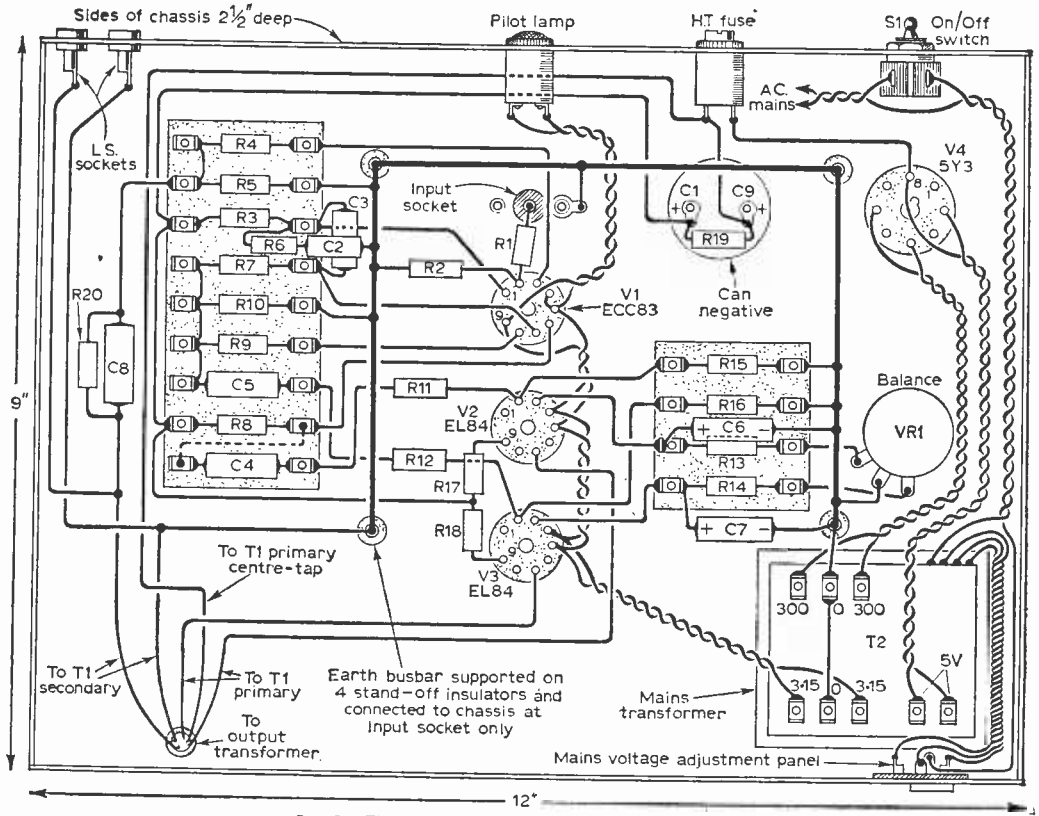

Fig. 3—The complete underchassis wiring diagram.

will be obtained if this amplifier is used in conjunction with the pre-amplifier designed by the author (June issue, 1961), as this was used with the prototype. The basic sensitivity is about 600mV and any high quality pre-amp capable of this output may be used.

Assembly

The components are first mounted on the group boards as shown in Fig. 3. When resistors R8 and R10, R15 and R18 are being soldered, a heat shunt should be used. Only one wire goes beneath the group boards, this is from C3 to R6 and is shown dotted in Fig. 3. When the group boards are assembled, they may be bolted into place with a spacer located between the board and the chassis, to allow for the wiring underneath.

All earth connections are soldered to the busbar, which may be held insulated from the chassis by means of two tagstrips: this busbar should be earthed to chassis at the input socket only.

An output socket may be included if desired, and should be insulated from chassis if possible.

Wiring

The heater and power supply should be wired in first. Tightly twisted wires are used for all A.C. circuits, and this wiring should be kept away from signal circuits and positioned as close to the chassis as possible.

Feedback

For negative feedfack to take place, the amplifier output secondary winding must be correctly phased in relation to the input. If in phase with the input, violent oscillations will take place, which may damage a high-grade speaker suspension; hence, it is best to use a low-grade speaker to secure the correct phase relation.

Output Stage Balance

The output stage is next balanced and is a very simple procedure. The balance control VR1 should be slotted with a file for screwdriver adjustment only. Before switching on, check for an H.T. short with the meter. After switching on, if positive feedback occurs, then switch off immediately and reverse the anode connections on the output transformer primary. After about thirty seconds the set should have warmed up and a very slight hum only should be present (the hum level is approximately 80dB below full output).

A D.C. voltmeter is next connected across the anodes of the EL84's and the balance control VR1 is adjusted until no reading is obtained (ignore random fluctuations). The valves are now balanced from the D.C. aspect, which is usually the same for signal input. If a balance cannot be obtained, the valves should be switched over and the procedure carried out again: if a balance is still not obtained, then the valves should be checked for emission. Usually a balance is easily obtained. ■