VALVE MONO 2W BOOKSHELF AMPLIFIER

INTRODUCTION

It was decided to build this amplifier in an attempt to re-create the 'sound of the sixties'. Most domestic audio equipment from the late 1930s up to the mid-1960s was valve based and sound came from a single loudspeaker. Amplifier power was limited to between two and four watts RMS.

Almost all the components needed to build the amplifier were already in the 'junk box'. The only items that had to be bought were the chassis and the audio output transformer and this latter was needed to match the chosen output valve.

WARNING

This day and age one must issue warnings for everything. It should be pretty obvious that high voltage electricity is dangerous but even so the reader is warned that this project uses dangerously high voltages at high currents. These voltages can kill if handled carelessly. At points in this equipment voltages of almost 300v are present on unguarded components.

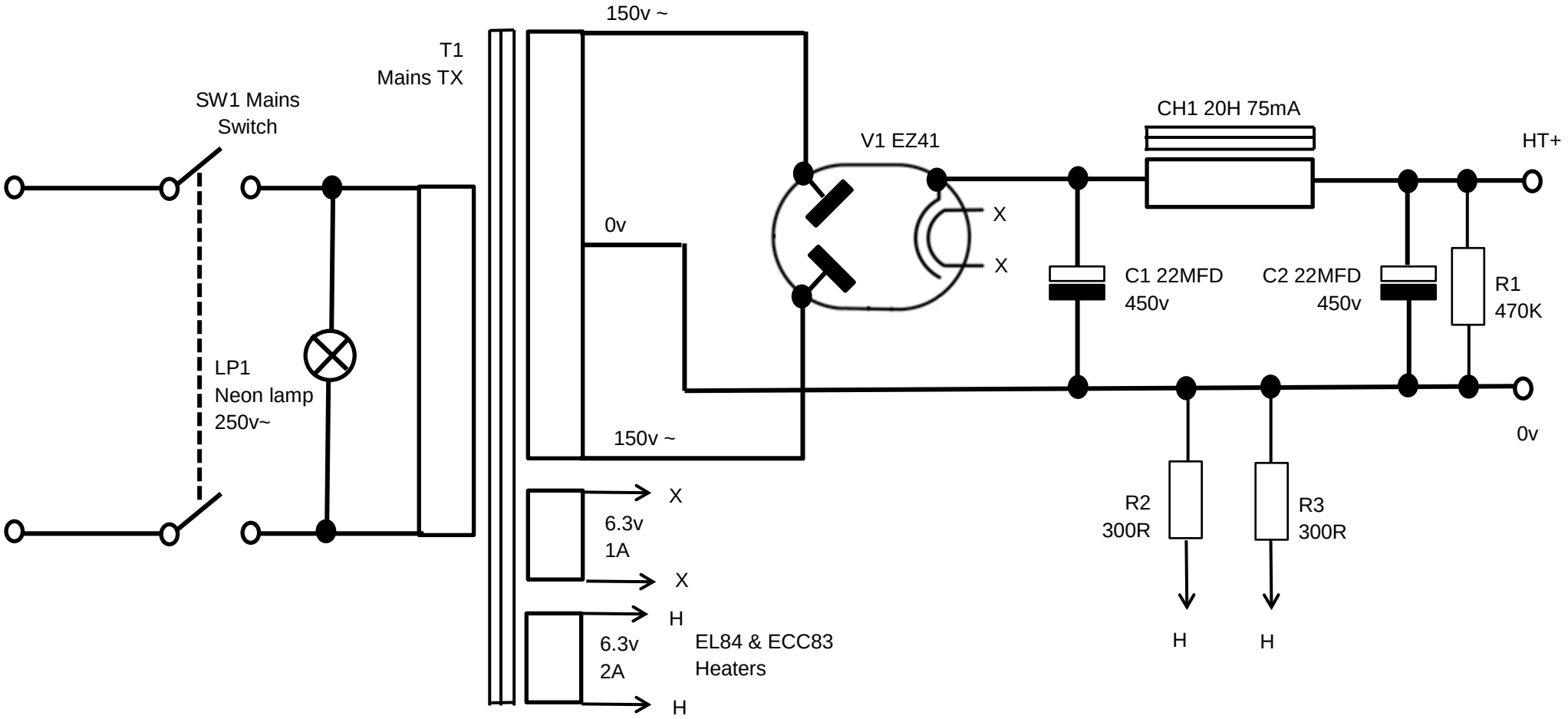
As the amplifier was to be used out of its case so that the valves could be seen glowing, care should be taken when touching the valves as these can become very hot, especially the output valve.

DISCLAIMER

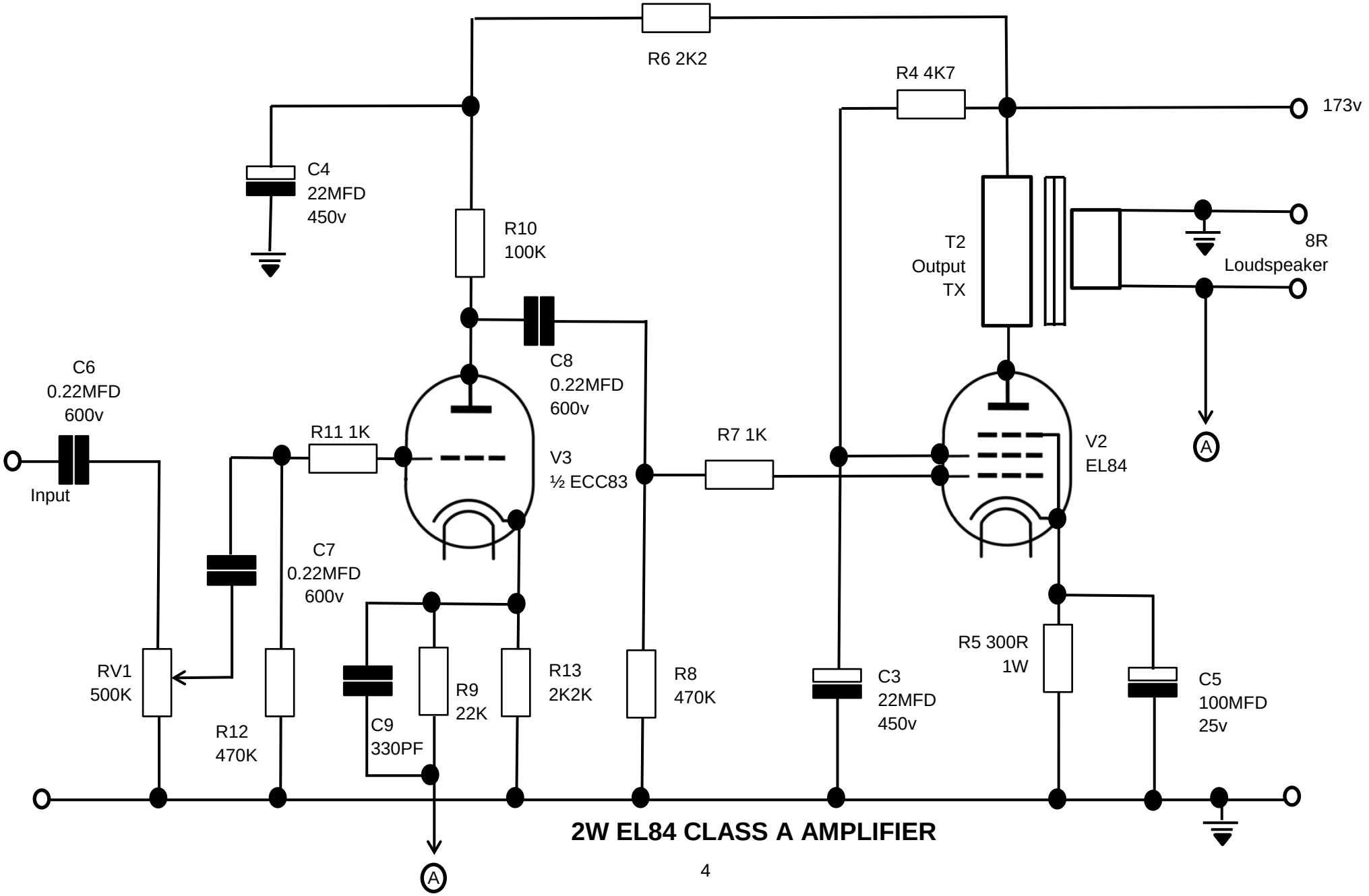
The author will accept no responsibility for any damage to persons building this equipment from this design. You build and use it at your own risk and it will be assumed that if you go ahead and build this equipment you are competent to do so and are familiar with building and using high voltage equipment. The author will also not accept any responsibility for damage to existing equipment which is connected to the constructed amplifier. You connect it at your own risk.

SPECIFICATION

Input:	Stereo phono (RCA) sockets mixed to mono internally. 1v p-p will give full output. Inputs are via a 0.22MFD/600v capacitor to protect external equipment
Output:	2 - 3 Watts. The frequency response is flat from 30Hz to 20KHz. Loudspeaker connections match 4 ohm and 8 ohm speakers.
Power:	230 - 250v AC mains. Mains plug fused 3A. The amplifier is earthed.



2W EL84 CLASS A AMPLIFIER POWER SUPPLY



2W EL84 CLASS A AMPLIFIER

PARTS LIST

R1	470K ¼ W	C1	22MFD @ 450v electrolytic
R2	300R ½ W	C2	22MFD @ 450v electrolytic
R3	300R ½ W	C3	22MFD @ 450v electrolytic
R4	4.7K ¼ W	C4	22MFD @ 450v electrolytic
R5	300R 1 W	C5	100MFD @ 25v electrolytic
R6	2.2K ¼ W	C6	0.22MFD @ 600v mylar
R7	1K ¼ W	C7	0.22MFD @ 600v mylar
R8	470K ¼ W	C8	0.22MFD @ 600v mylar
R9	22K ¼ W	C9	330PF @ 100v ceramic
R10	100K ¼ W		
R11	1K ¼ W	V1	EZ40
R12	470K ¼ W	V2	EL84
R13	2.2K ¼ W	V3	ECC83
T1	0 - 250V primary, 150 - 0 - 150v @ 60mA, 0 - 6.3v @ 1A x2 secondaries		
T2	Audio output 5K primary, 0 - 4 - 8 ohm secondary	RV1	0 - 500K log scale with integral DP mains switch fitted with silver knob.
CH1	20H 75ma	SW1	
LP1	250v neon including resistor	Chassis	10"x6"x2" steel ready painted
		Speaker connector	Stereo wire-grip type
		Audio sockets	Chassis mounting phono (RCA)

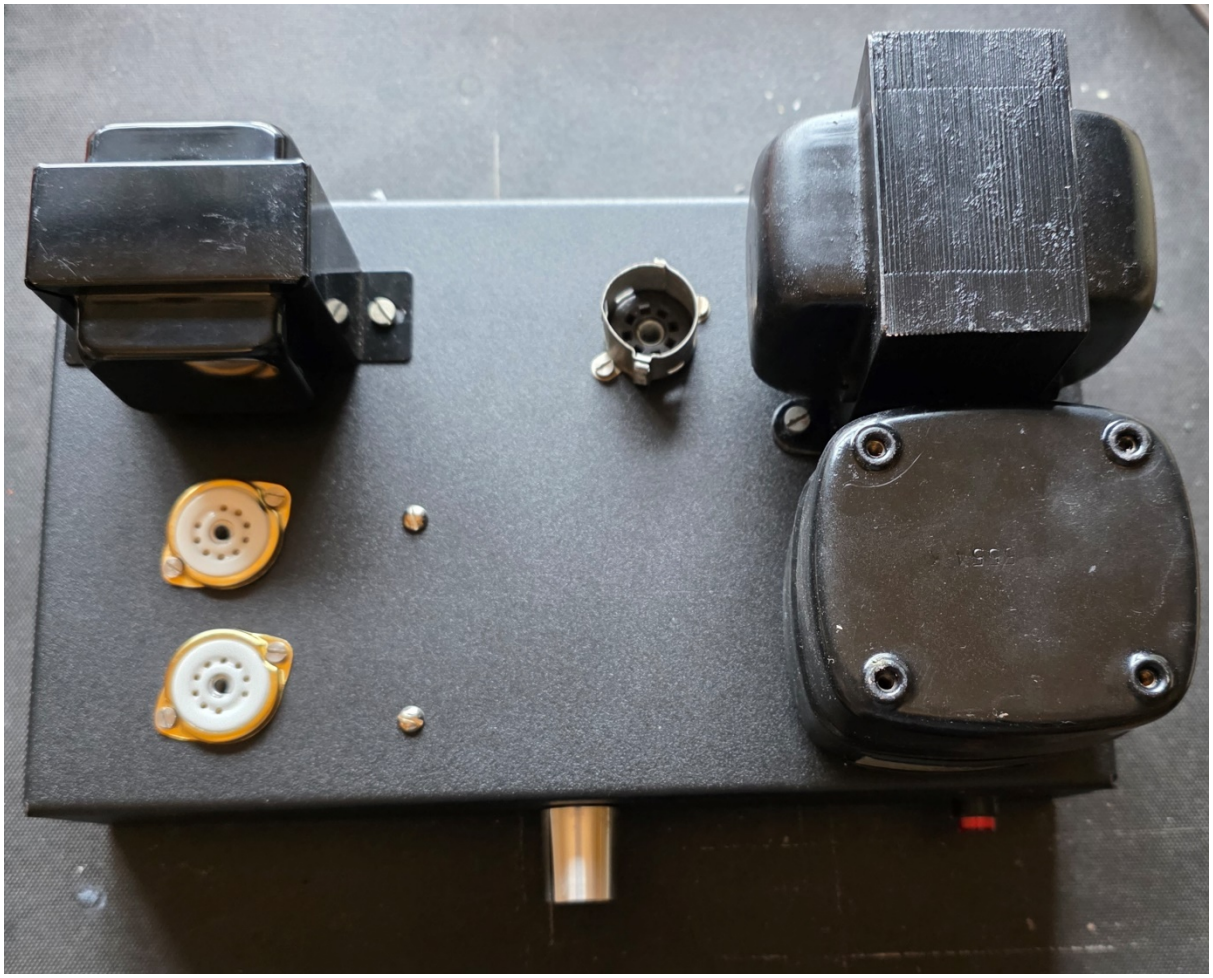
None of the parts are especially critical and different resistance and capacitor values ±20% could be substituted as available. V1 is an EZ40 as this was available. An EZ41 could also be used. T2 is matched to the EL84 output valve. A different output valve would need an output transformer to match. A mismatched output transformer could be used if a loss in performance could be accepted.

T1 was used as it was to hand. Any suitable transformer with secondaries of up to 250 - 0 - 250 at 60mA could be used. V1 could be replaced by two rectifier diodes.

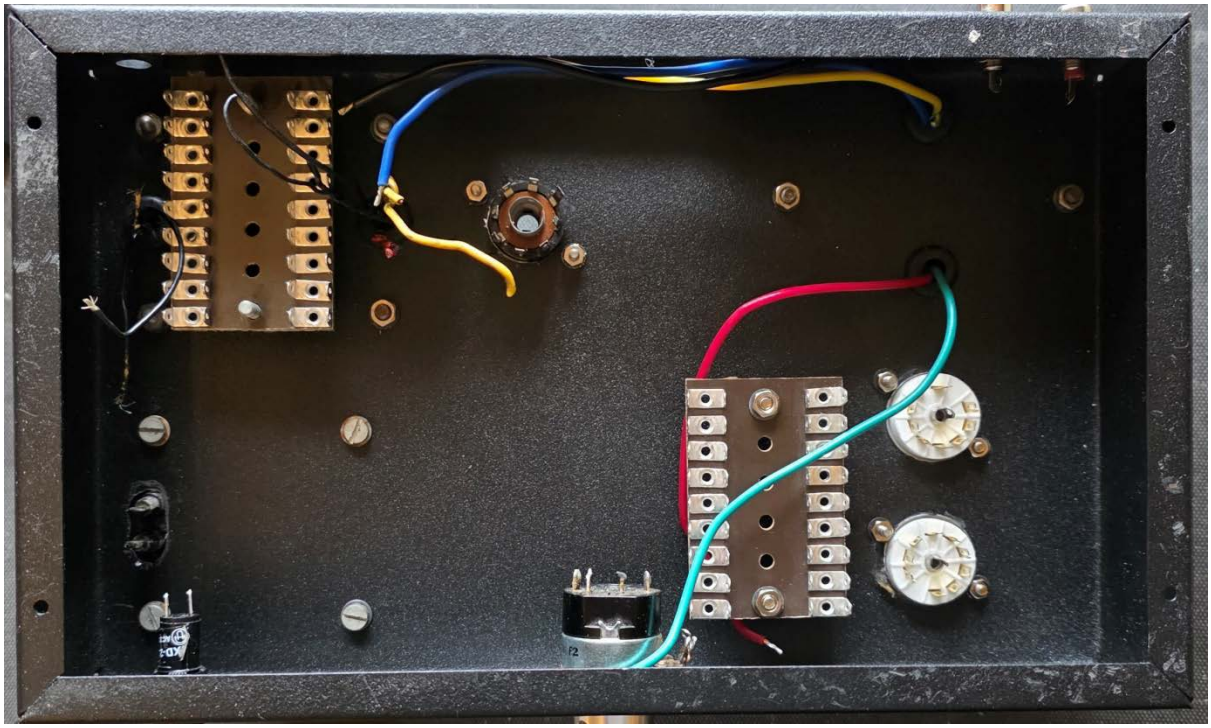
CONSTRUCTION

No great care was taken with the amplifier layout with the exception of keeping the mains transformer distant from the output transformer and arranging its core to be at 90 deg. to that of the output transformer to reduce induced hum. Similarly the smoothing choke, CH1, was arranged to minimise induced hum.

After drilling the chassis, the various hardware components were fitted. The tag board beneath the mains transformer was supported by 4BA standoffs and these had to be fitted using countersunk bolts before the mains transformer was fitted.



The above chassis view of the completed mechanical assembly. The power supply components are to the right and the amplifier components are to the left.



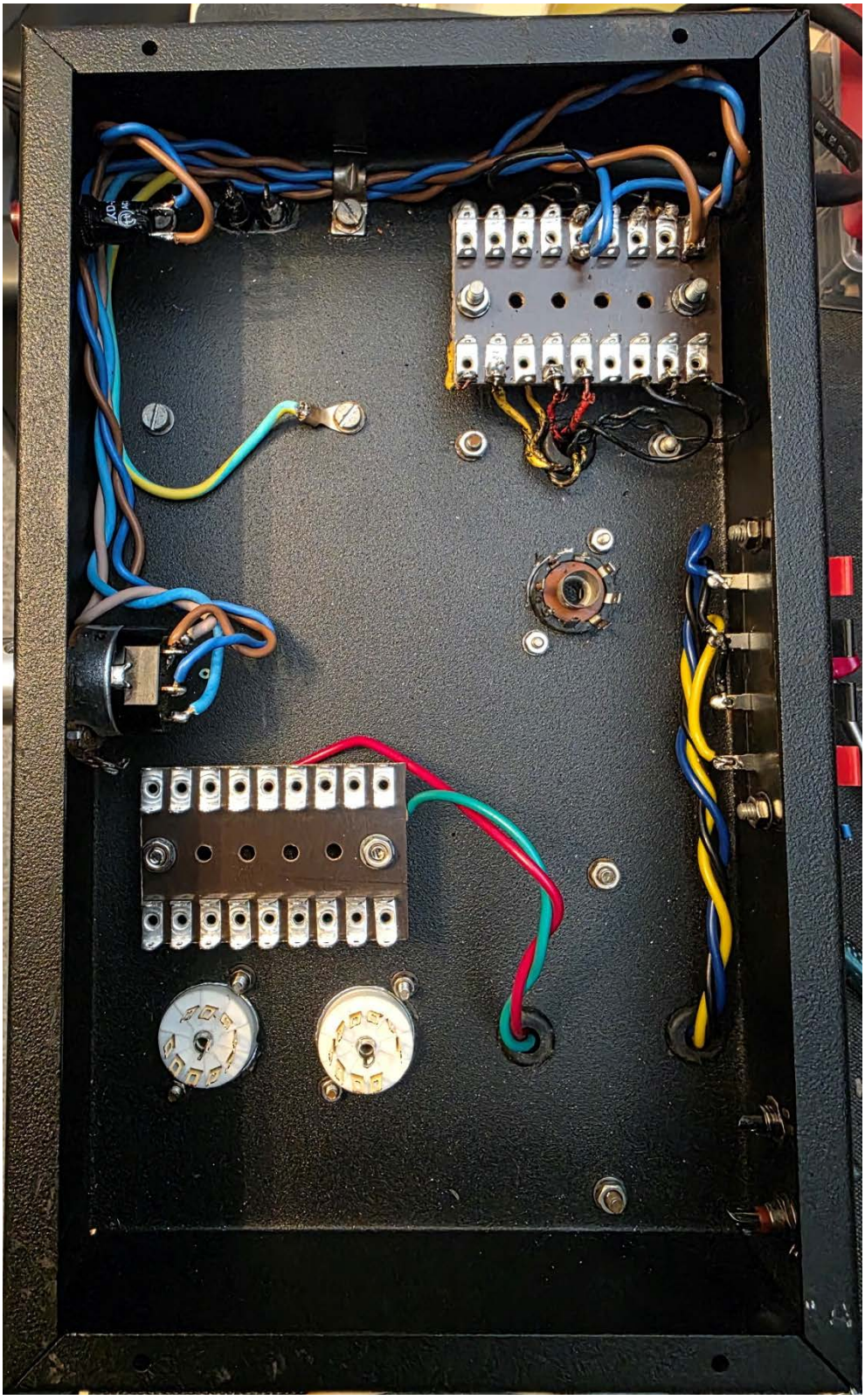
The below chassis view of the mechanical construction. The wires from the mains transformer, top left, and the output transformer, top right are also shown.

The first stage in the construction was to connect the flying leads from the transformers. The mains transformer was ex-equipment and had short leads, so these were soldered to the top left tag board to allow easy, future connection. The loudspeaker wires were connected to the connector at the top centre. Lastly the mains lead was connected to the switch bottom centre and wired to the mains indicator and the transformer primary via the tag board.

Once these connections were made, the wiring was checked for shorts and for correct continuity and then checked for correct voltages appearing at the transformer terminals.

The layout is shown in the photograph below. The amplifier is earthed via one of the smoothing choke bolts and this also acts as the common chassis connection. Another smoothing choke bolt is used to anchor the clamp for the mains wiring.

There is no fuse fitted inside the amplifier. The mains plug is fused instead.



The under chassis first stage wiring. The red and green wires are not yet connected.

After checking the mains wiring, twisted pair wiring was used to connect the valve heaters. The transformer used had two separate 6.3v heater windings. One, the red pair, was used for the HT rectifier (EZ40) and the yellow pair was used for the EL84 and ECC83 valves. The heaters for these latter valves were connected to chassis via 300R resistors to make, in effect, a centre-tapped heater supply.

The heater wiring was checked by temporarily placing the valves in their sockets.

The next stage was to wire the HT circuitry to the EZ40 valve base, smoothing choke and smoothing capacitors, which were mounted on a small tag board fastened at the earth connection. The HT circuit was tested and found to be about 200v with no load.

Working methodically the EL84 output stage was wired to the amplifier tag board next to the white B9A valve bases. After testing the output stage, the remainder of the circuit was constructed. (See the photograph below.)

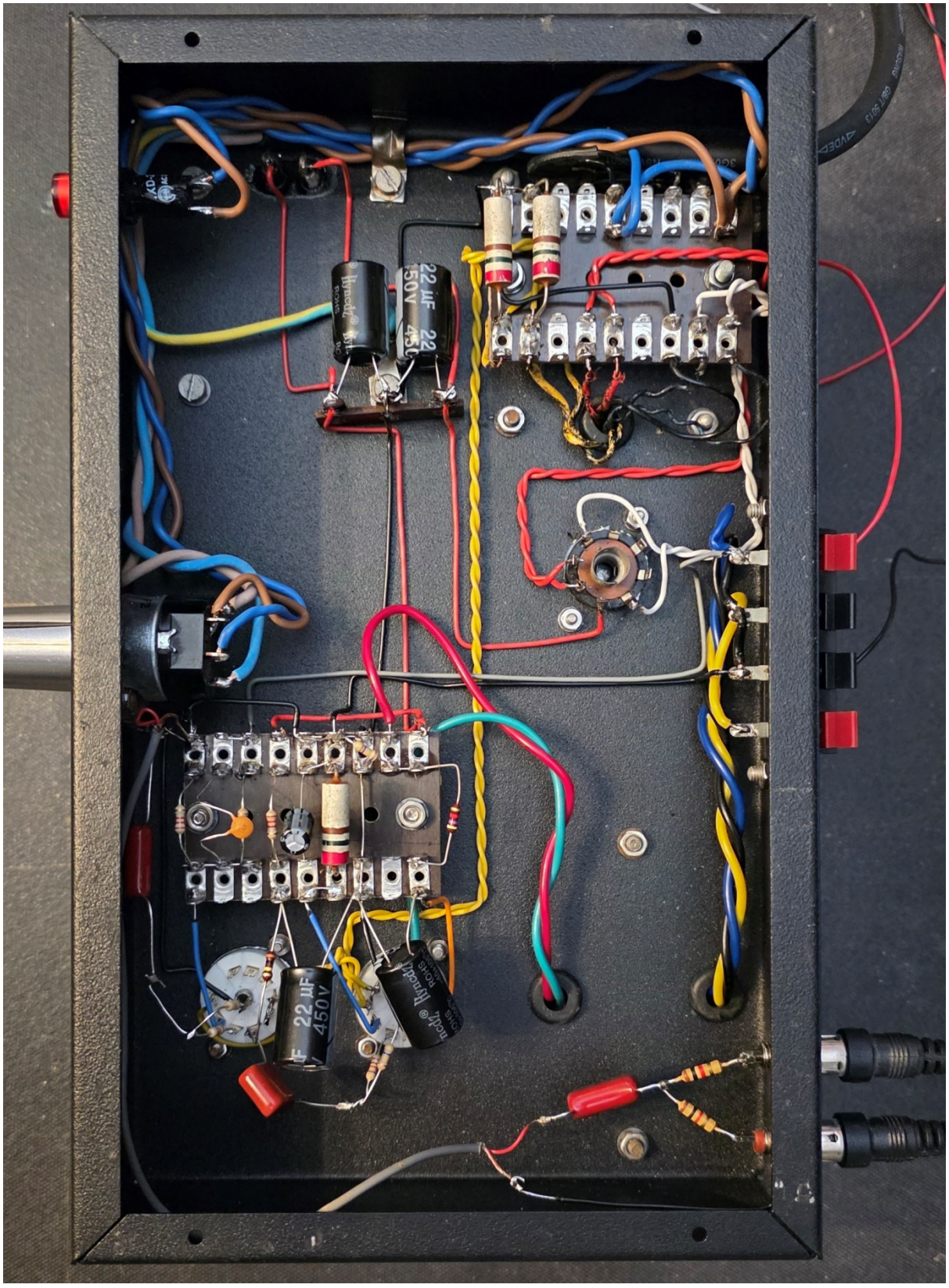
Satisfyingly the amplifier worked first time!

The output is about 2 watts with the given HT voltage (173v on load) and the EL84 cathode bias resistor. Lowering this bias resistor to increase the EL84 standing current had no effect on the amplifier performance and so the design value of 300R was not changed. The standing current through the EL84 was about 17mA. The power output is more than sufficient for the man cave.

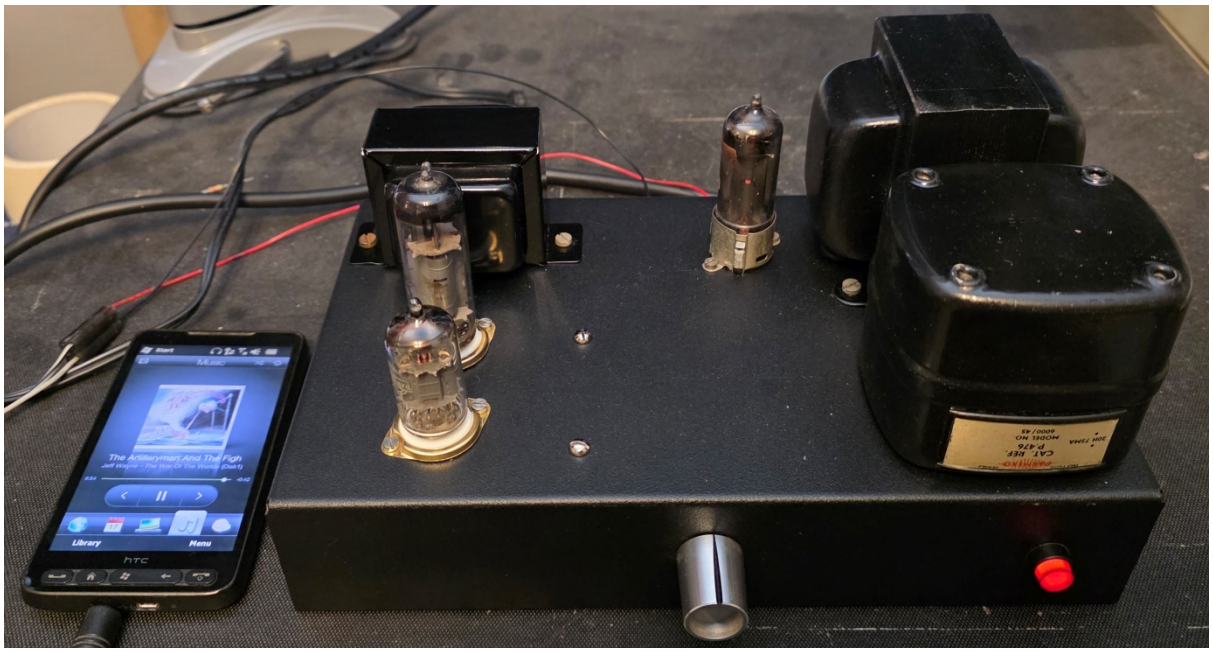
A 1v input at 1KHz can be handled before distortion appears and this appears to be even harmonic distortion. The frequency response was shown to be flat between 30Hz to 20Khz. Below 30Hz severe distortion rapidly sets in (probably due to the design of the output transformer) and above 20KHz gain drops significantly, which is no detriment.

The sound output is very good, considering that the valves and most components were from the 'junk box', meaning that they were salvaged from other equipment and stored for over 50 years. The tone is not as clinical as from modern equipment using the same loudspeaker. Bass and treble sound good despite there being no controls to alter. Heavy metal music sounds nicely fractured at the high frequency end, enhancing the sound.

Hum is negligible even with the volume control turned to maximum and one's ear close to the loudspeaker.



The completed below chassis wiring. Note the stereo inputs are mixed to a mono signal using the two 1K resistors.



The finished amplifier, shown working on the work bench. The audio input is from the old mobile phone to the left.

The amplifier was designed as a bookshelf system to be used in the man cave. As such it was decided not to case the amplifier as the glow of the valves enhances (in the author's opinion) the look. The valves run very hot and can burn unwary fingers. They are also fragile when in their sockets. The uncased amplifier should not be used, therefore, in a domestic environment where children abound!

ADDENDUM

Paralleling R13 (the triode cathode resistor) with a large value electrolytic capacitor increases the gain markedly at the expense of increased distortion. This option might be considered for a guitar practice amplifier. Performing this modification removes the negative feedback via R9 and C9 from the output transformer, hence the increase in gain.

As one section of the ECC83 valve is unused Baxendale treble and bass controls could be added utilising the unused valve section. These were not necessary in the original design.

This design could be used for a stereo amplifier on a larger chassis. The power supply section has enough capacity for another EL84 output stage and the unused triode in the ECC83 can be used to supply input to the extra EL84. RV1 would need to be swapped for a dual control. As dual volume controls with an integral mains switch are uncommon and hard to acquire a separate mains switch will be needed.

More audio power output, if necessary, could be obtained by replacing the mains transformer with one which delivers a 250v - 0v - 250v secondary at 100mA. If the EZ40 rectifier is replaced by a bridge rectifier, a mains transformer with a single 0v - 250v 100mA could be used. The smoothing choke is rated at 75mA and to limit the maximum current through it a cathode resistor of no less than 180R should be used for the EL84s with this higher voltage for the stereo amplifier.

The amplifier was found to work exceptionally well when coupled to a Sony Walkman D-NE711 CD player. This is a high end Walkman and offers a line out option rather than the headphone output of mobile phones, minidisc players or other CD players. The quality of the audio output using this input device was dependent on the quality of the CD used. Commercial CDs produced outstanding audio quality. CDs with mp3 tracks, burned at 320bps using a PC were also of excellent quality.

The amplifier shown working in low light conditions so that the glow from the valves can be seen.

After using this amplifier for a few weeks it can be said that it has performed excellently and the components used are well within design parameters. There is plenty enough volume to fill a room 3m x 3.2m. There is little, if any, observed distortion to the ear and the output rivals a relatively modern, dedicated bookshelf hifi system.

From the author's perspective this amplifier has more 'soul' than the current crop of integrated circuit bookshelf amplifiers. The sight of the glowing thermionic valves is redolent of the late 1950s and early 1960s. Although a bass and treble tone control system could be added it has proved unnecessary. This has now become the 'go to' man

cave amplifier, replacing an Amazon Echo Dot and a Sony CMT-M100MD plus Raspberry Pi Rune Audio system.