

A SET OTL Amplifier

The author presents a new, improved output-transformerless amp design.

Using parts I had on hand, I presented a good-looking OTL amplifier in the May '08 issue ("Build a Hybrid SE OTL Amp," p. 34). Although it performs very well, I decided to change some basic things. The result is this new OTL amp design.

In the previous amplifier a PL509 pentode delivers the current to the speaker via an I/V converter and is assisted by a power booster in the form of a TDA7294 power op amp that also modulates the plate voltage when powering the speaker. First, this plate voltage variation of the pentode has no influence on the plate current itself, so no feedback exists. Second, the power supply voltages were a little too high for the booster and

too low for the pentode.

In the meantime, I received a bunch of 6080WA double triodes, which I decided to use to make a new SET OTL amplifier. I needed a new power supply to deliver

- a) $\pm 30\text{V}$ DC for the booster
- b) -120V DC for the triode
- c) 6.3V AC for the filaments
- d) $\pm 15\text{V}$ DC for the op amps.

* The layout of the new amplifier is basically the same as the first amplifier. The first stage is the input circuit, followed by the SE triode circuit, then the conversion circuit, and finally the booster circuit. For each of these circuits I made a complete circuit diagram plus parts lists (Figs. 1-4).

THE INPUT STAGE

The 6080WA is a sturdy double triode

with a rather low plate resistance and an even lower gain. The PL509 could be modulated straight from the line transformer, but the triode needed some more amplification (Fig. 1). I changed the original line transformer for a new Lowter model 1975, which has a balanced input. The RCA input is connected to the non-inverting input of the OPA2134 op amp that gives the $3\times$ amplified input signal to half the primary of the line transformer Tr1, so the secondary signal to the grid of the triode is six times the RCA input signal.

THE TRIODE STAGE

As you can see on the complete SET-OTL schematic (Fig. 5), the next stage is the SE triode circuit. The 6080WA



PHOTO 1: Sowter line transformer model 1975.

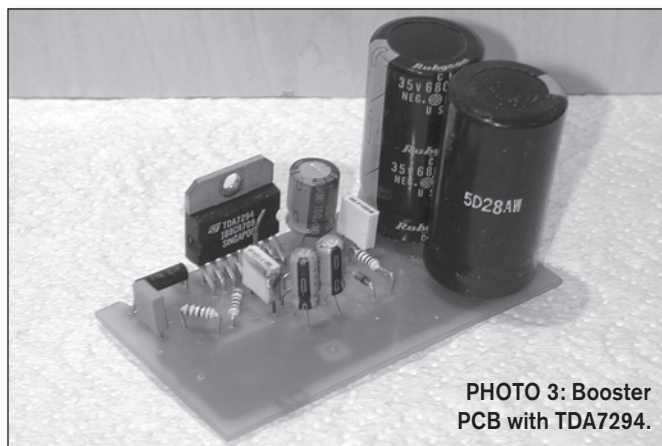


PHOTO 3: Booster PCB with TDA7294.

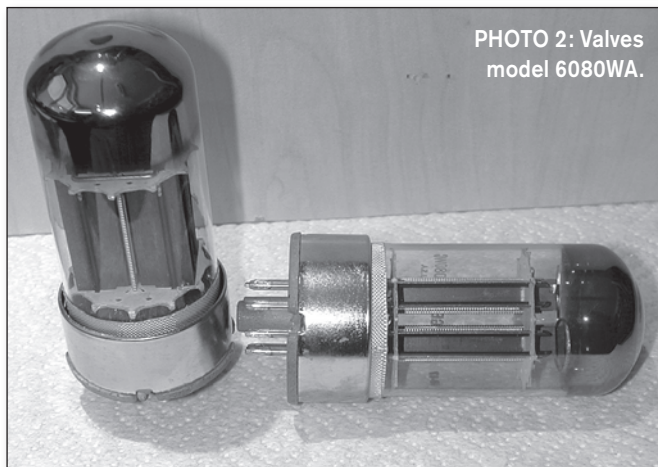


PHOTO 2: Valves model 6080WA.

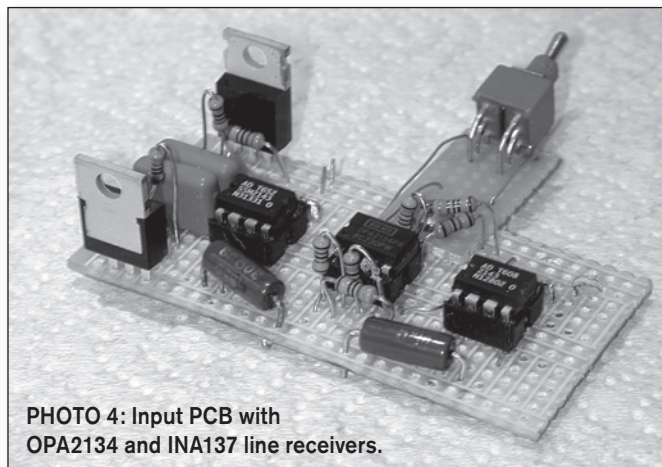


PHOTO 4: Input PCB with OPA2134 and INA137 line receivers.

consists of two triodes, each with a plate current of 100mA DC. With both triodes connected in parallel, the plate current is very sensitive to plate voltage variations. Stabilization of the plate current is a must and could easily be done by a simple constant current source (CCS) in the cathode line. The 15Ω resistor in each cathode line equalizes the plate currents within 5%. This CCS not only stabilizes the total plate current to 200mA, but nicely filters the residual ripple of the power supply as well. The output of the CCS is grounded for AC by $2 \times 470\mu\text{F}$ Elcos (C2-3).

Through resistor R5 the grids of the triode get a negative bias voltage, which is filtered to ground by C1 (470nF). Resistor R3 prevents resonating of the line transformer at higher frequencies.

Zener ZD12 gives a stable 12V DC to the ten-turn trimmer P1, so you can preset the plate current to 200mA DC.

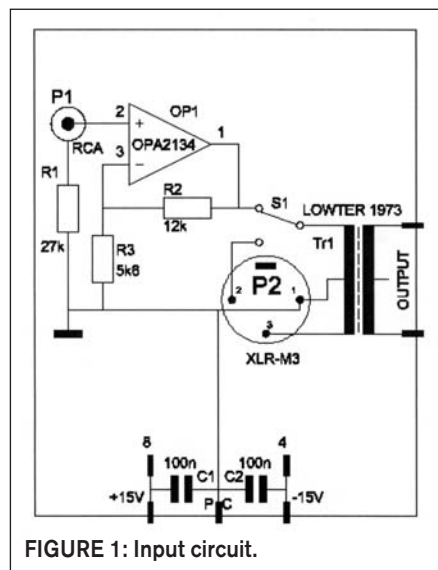


FIGURE 1: Input circuit.

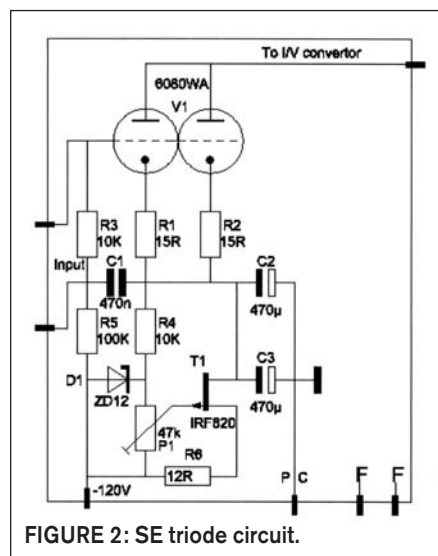


FIGURE 2: SE triode circuit.

The CCS circuit works very well; when varying the AC mains voltage with a Variac, the plate current didn't move.

THE I/V CONVERSION STAGE

The plate current of the triode flows through resistor R1 to the positive speaker terminal. With a DC current of 200mA, the input of the INA 137 line receiver is offset by 5.4V DC, and,

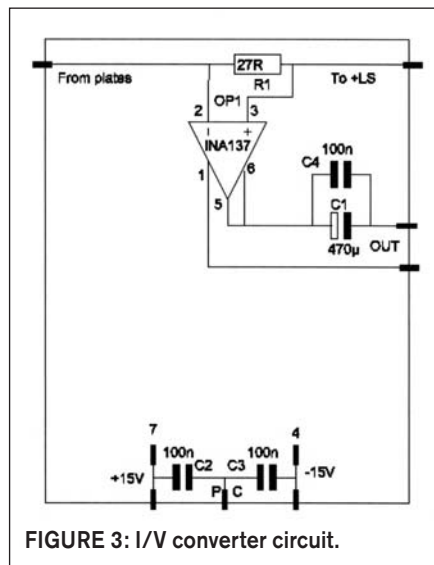


FIGURE 3: I/V converter circuit.

as in this configuration, the gain of the line receiver is $\frac{1}{2} \times$ the output to the following booster stage with a DC component of 2.7V, which is blocked by C1 (470μF). A rather high value for the booster has a low input resistance. Say that the plate current of the triode varies $\pm 100\text{mA}$, then the INA137 line receiver outputs a signal of 2.7Vp-p to the booster input. Being a line receiver,

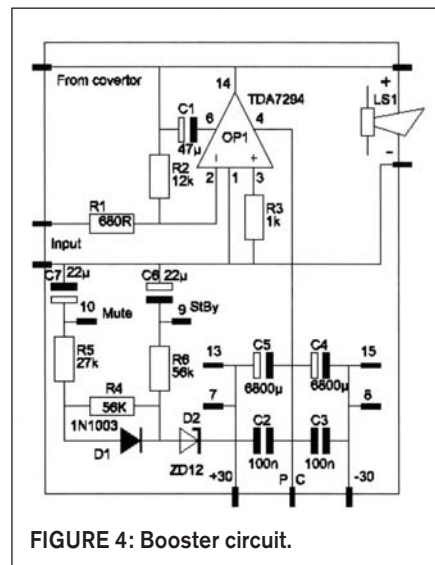


FIGURE 4: Booster circuit.

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FIGURE 5: SET-OTL schematic.

FIGURE 6: OTL power supply.

FIGURE 6: OTL power supply.



PHOTO 5: 19" housing.



PHOTO 6: Inside the amp.

ations. So there is a strong feedback from the signal to the speaker to the triode current and hence the booster input signal.

Since the output of the booster TDA7294 is an exact copy of the triode plate current variations, the amplifier acts like one big triode. Changing the gain of the TDA7294 will change the sensitivity and sound of the amp. Increasing the gain gives more sensitivity and less triode sound. With less gain the triode needs to deliver more signal to the booster so the amp has lower gain, more triode sound, and a little more distraction (mostly second harmonics). The sound is absolutely fantastic, and it seems that there is a solid grip on the speaker as well. I was really very surprised with the improvement over the first OTL amplifier.

POWER SUPPLY

There is not much to say about the power supply, which you can make from standard parts. But it is important to know that the triode plate current flows to the +30V, and to avoid too much ripple the -30V supply should be part of the -120V supply as well. This is easy to do by just adding -90V to the -30V booster power supply.

I used a 220VA transformer to deliver $2 \times 22V$ AC for the $\pm 30V$ booster voltage plus $2 \times 22V$ AC that, with the addition of 12V AC from the filament transformer, delivers the -90V—the positive side is connected to the -30V to make the -120V supply. If you fancy a delayed switch of the -120V for the triode, John Broskie of Glassware Audio Design can supply you with a nice switch.

SUMMARY

We took the following measurement at the output pins with an 8Ω speaker load:

Bandwidth at -0.5dB 25Hz to 45kHz

Bandwidth at -0.1dB 50Hz to 40kHz
Distortion at an output of 1W 0.6% second harmonics only.

Noise on speaker with no input connected about 2mV AC and 8mV DC.

ax

POWER SUPPLY PARTS LIST

Br1, Br2	bridge, 400V 2A
C1	6800 μ , Elco 40V
C2	6800 μ , 40V
C3, C4	10mF, Elco 50V
Tr1	80Va, 2×12 sec
Tr2	220Va. $4 \times 22V$ AC sec

INPUT CIRCUIT PARTS LIST

C1, C2	100n, poly 100V
Op1	OPA2134, op amp
P1	RCA, socket
R1	27k
R2	12k
R3	5k6
S1	switch, DpDt
Tr1	Lowter 1973, line transformer

TRIODE CIRCUIT PARTS LIST

C1	470n, poly 100V
C2	470 μ , Elco 250V
C3	470 μ , 250V
D1	ZD12, zener 12V
P1	47k, trimmer 10 turn
R1, R2	15R
R3, R4	10k
R5	100k
R6	12R
T1	IRF820, MOSFET 400V
V1	6080WA, double triode

BOOSTER CIRCUIT PARTS LIST

C1	47 μ , Elco 40V
C2, C3	100n, poly 100V
C4, C5	6800 μ , Elco 40V
C6, C7	22 μ , Elco 40V
D1	1N1003
D2	ZD123, zener 12V
LS1	connector, to LS
OP1	TDA7294, power chip
R1	680R
R2	12k
R3	1k
R4, R6	56k
R5	27k

CONVERSION CIRCUIT PARTS LIST

C1	470 μ , Elco 40V
C2-4	100n, poly 100V
OP1	INA137, line receiver
R1	27R, 2W

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