6CW5 TM5 OPT SE class-A amplifier

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The article represents a brief study and some possible implementations of a simple high-quality amplifier using inexpensive vintage components.

The task was to use a vintage Electro-Voice TM5 transformer and 6CW5 valve (direct American equivalent to the European EL86) with no restrictions on schematics. It was desirable to “squeeze out” the maximum power of at least 1 - 1.5W. The main intrigue here is that the output transformer is actually not a classical tube amplifier OPT since it was designed to match high-voltage lines with a low-resistance load. Exaggerating a little, we can say that this is a transformer for a home radio broadcasting.

While OPT has a lot of taps on the primary and we have a broad choice of reflected impedance, the problem is its very low inductance. Certain schematics restrictions are imposed by the fact that the transformer will not accept DC current bias.

Therefore, the output impedance of the output cascade should be kept minimal, and the most appropriate circuit for this is a hybrid SRPP. Beside that, I decided to investigate some possible options for a spud (single-tube-per-channel) amp and to measure its real-world characteristics.

The first option (Fig. 1)

The power tube in a pentode mode, utilizing the entire primary winding of OPT where reflected impedance is 8K Ohm. The idea has been seen as very tempting, giving us the maximum inductance.

We can see right away that the scheme is far from awesome unfortunately. It turned out that 6CW5 does not work well with large voltage swings at the anode, it generates a very high second harmonic level and in addition to this fact has excessive sensitivity.

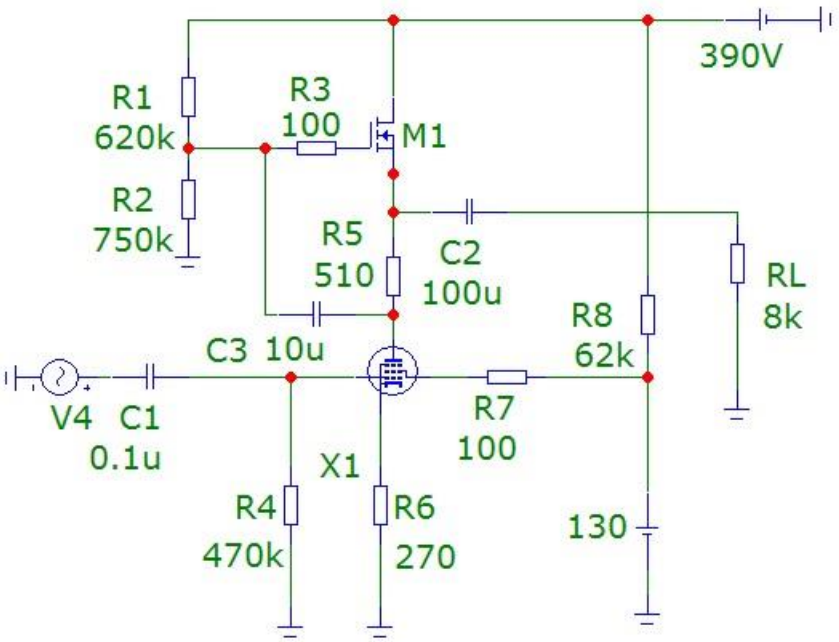

Figure 1

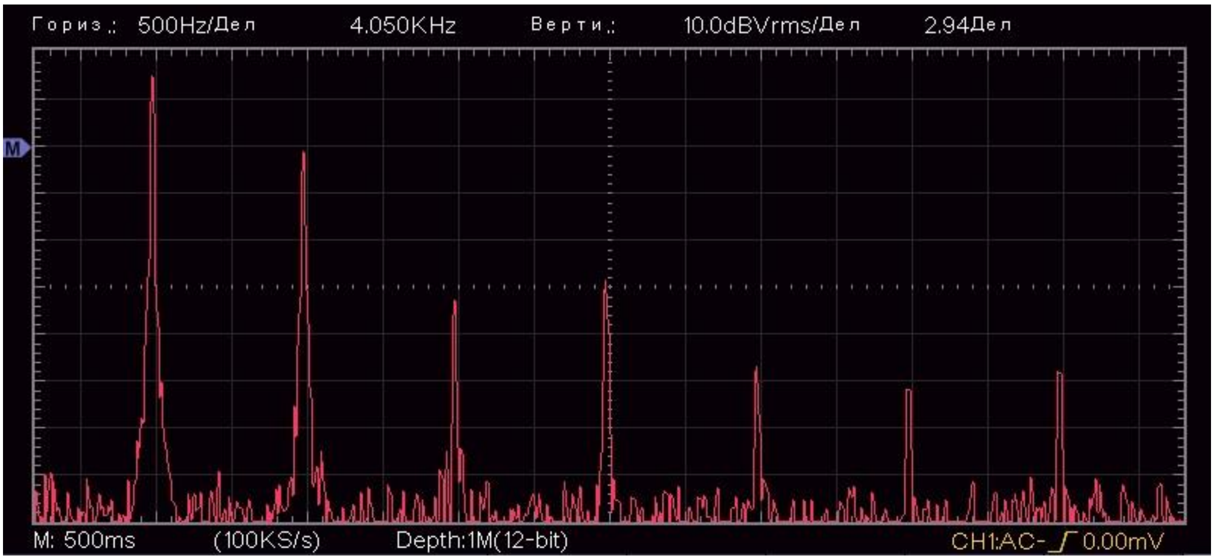

Figure 1

The second option (Fig. 3)

Taking into account previous experience, with a heavy heart, I decided to switch to a reduced impedance winding of 4k Ohm, trying to preserve the output power while reducing the voltage swing at the anode. The decrease of the inductance turned out to be not so terrible finally due to the very low output resistance of the source follower. And besides that, to get a little more “triode” out of the pentode by introducing a local NF on the second grid. The criterion for choosing the feedback depth was not to get maximum linearity but rather the desired input sensitivity of 0.7Vrms.

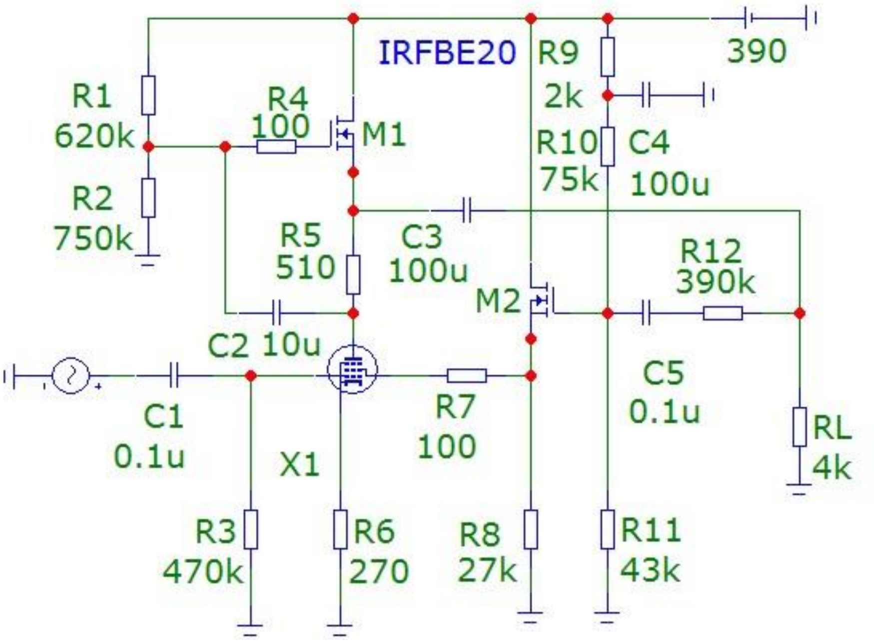

Figure 2

This turned out to be a vital scheme in general, and it might be of interest to pentode sound lovers while represents the shortest possible path for a signal amplification. The cascade distortion spectrum is shown in Figure 4

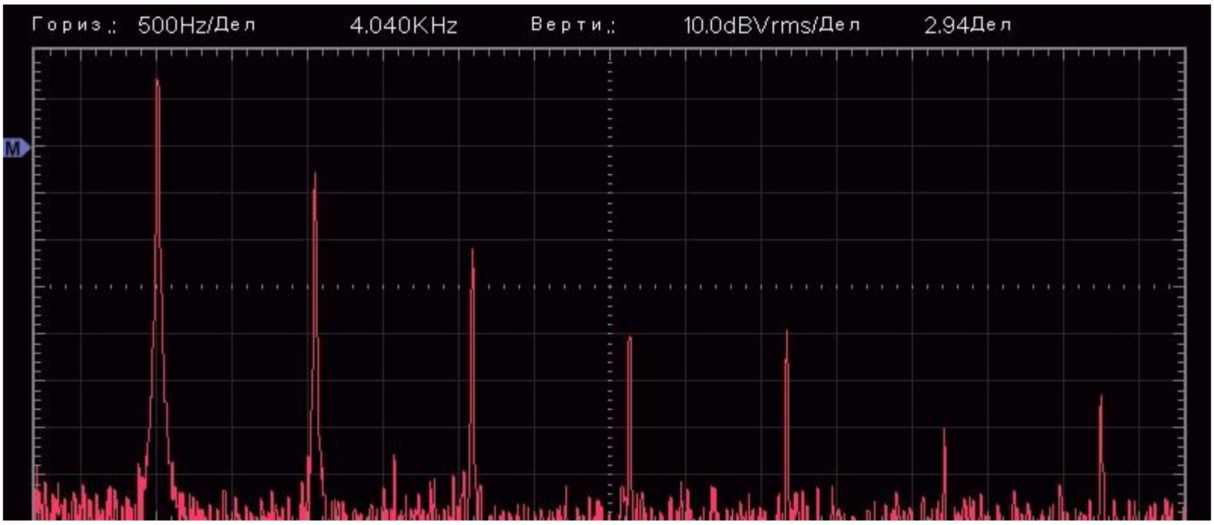

Figure 4

The third option (Fig. 5)

Experiments with the depth of negative feedback have shown that the maximum linearity can be achieved in triode mode. Actually, the “price” for increasing linearity will be a decrease in sensitivity, which implies the introduction of the second cascade inevitably.

This is, definitely, a design minus. At the same time, two cascades mutual compensation of even harmonics will bring us a bonus.

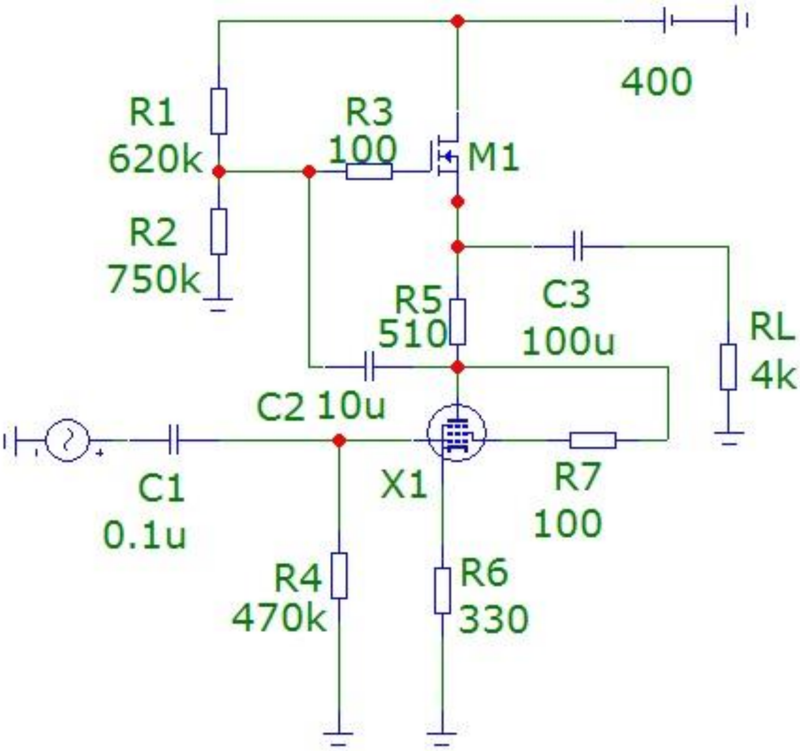

Figure 5

The distortion spectrum of the cascade is shown in Figure 6. This schema of the cascade can be considered as the best.

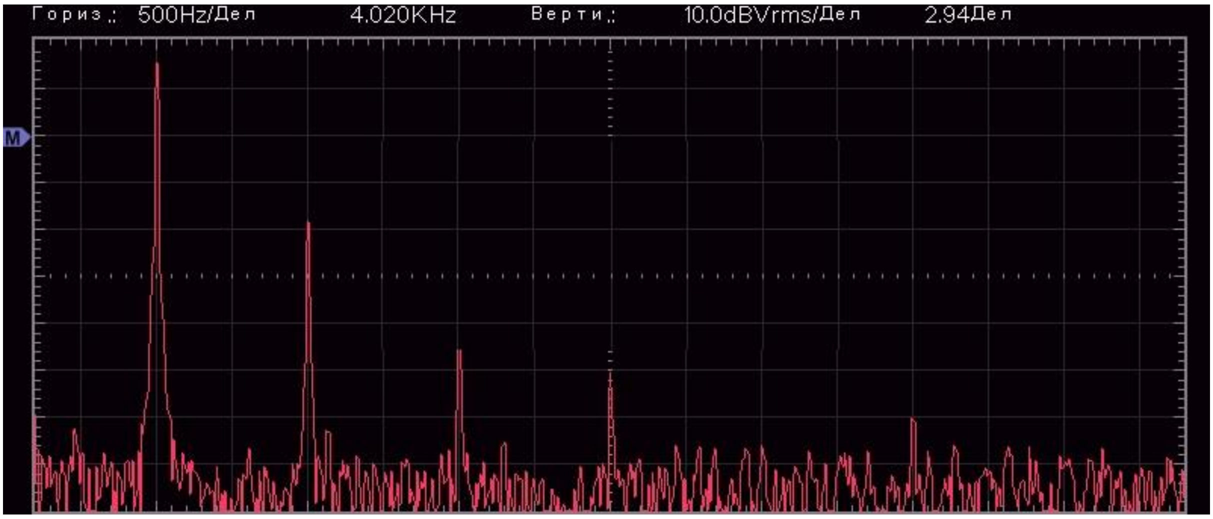

Figure 6

Final amplifier circuit diagram (Fig.7)

6GU7 tube turned out to be a good candidate for a driver stage. The resistive load provides required amplification, the second harmonic is dominating in the distortion spectrum. A fixed bias is applied for the driver and makes it possible to eliminate a large value electrolytic capacitor from the cathode using a high-quality film capacitor in the grid circuit instead. Light load of the driver will not lead to a degradation in the stability over time.

The output stage uses automatic bias, which stabilizes the DC mode of the loaded lamp. In this circuit, the auto-bias resistor does not significantly affect the gain of the stage.

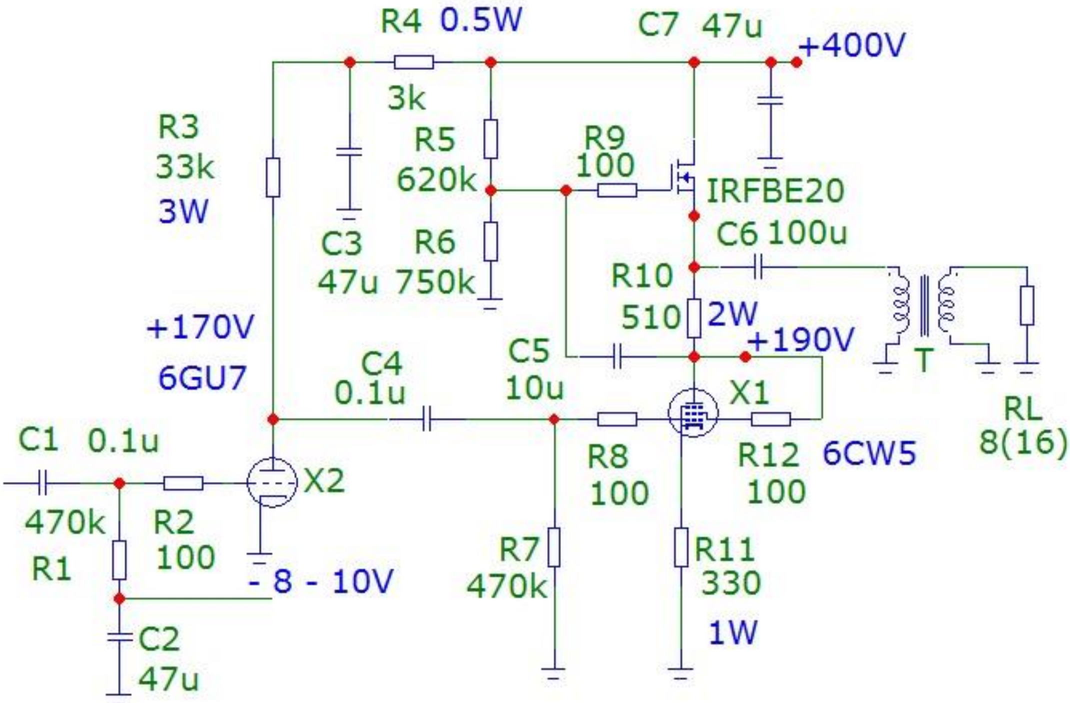

Figure 7

The amplifier has no negative feedback.

It has the parameters:

Input sensitivity	~ 0.7Vrms
Output power	- 1.5W
Frequency response @1.5W	- 40Hz÷23kHz, +0 ÷ -2Db
THD @1.5W	- 1.9%

The distortion spectrum of the amplifier is shown in Figure 8.

As seen, the nature of the distortions and their decreasing with decreasing of output power well describes the classical SE amplifier.

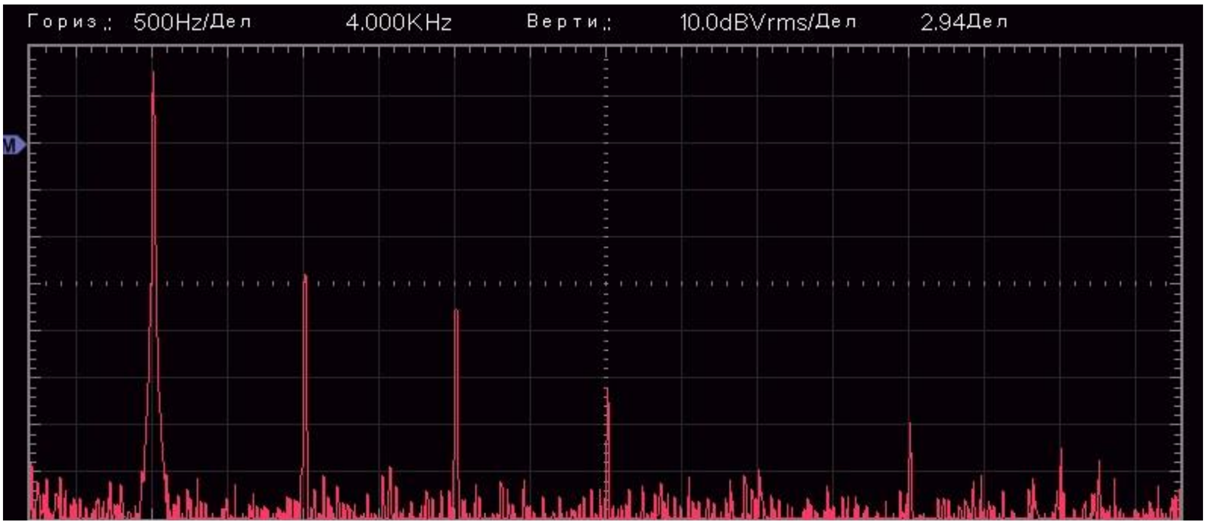

Figure 8

The diagram shows ehe OPT connection in a classical manner. There are no restrictions on turning it into an autotransformer matching headphones on primary winding taps.