THE COMPENSATED NEMESIS

Free translation of part of an article of Pierre Johannet in L'Audiophile
http://www.asrr.org/biblioteca/Revue%20Audiophile/fichiers2/26/nemesis.html

« The evolution towards the compensated Nemesis »

The problem of class A amplifiers that use a single actif output device, be it Monotriode, be it MOSFET, is the DC current that runs through the primary winding of the output transformer.
This (inevitable) continuous current creates a permanent magnetic field in the magnetic core. Without gap, the core would saturate. The gap effectively prevents saturation, but at the same time reduces the primary inductance of the transformer and with it its performance at low and very low frequencies.

As a mitigating measure an immediate solution comes to our mind : use a compensating winding to annul the average continuous flux of the transformer.

Comment :
This apparently simple solution hides a nasty trap. We must not feed the compensating winding with a low impedance voltage source, but with a high impedance current source.
Actually, in the case of the low impedance voltage source, the compensating winding would behave as under short circuit and it would cancel the AC signal injected in the primary.

In the case of the Nemesis, it is very easy to feed a compensating winding by means of a second 2SK135, biased by the same circuit as the first 2SK135 but without signal. We end up with schematic figure 3.

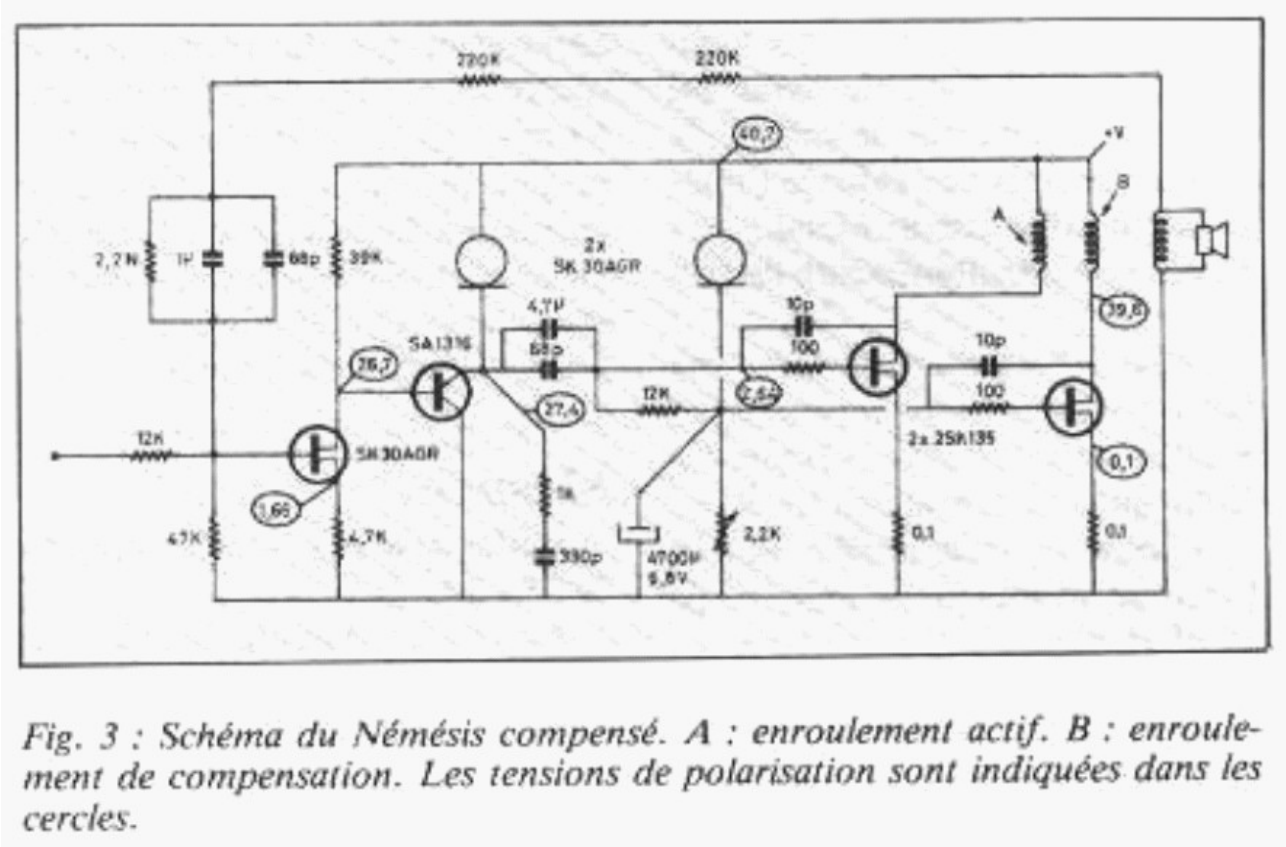

Fig. 3 : Schéma du Némésis compensé. A : enroulement actif. B : enroulement de compensation. Les tensions de polarisation sont indiquées dans les cercles.

Few comments to be made to this schematic where after all only one 2SK135 has been added.
The problem of the output transformer nevertheless needs a closer look.
The power supply is identical to the one of the Super Nemesis (fig. 3bis).

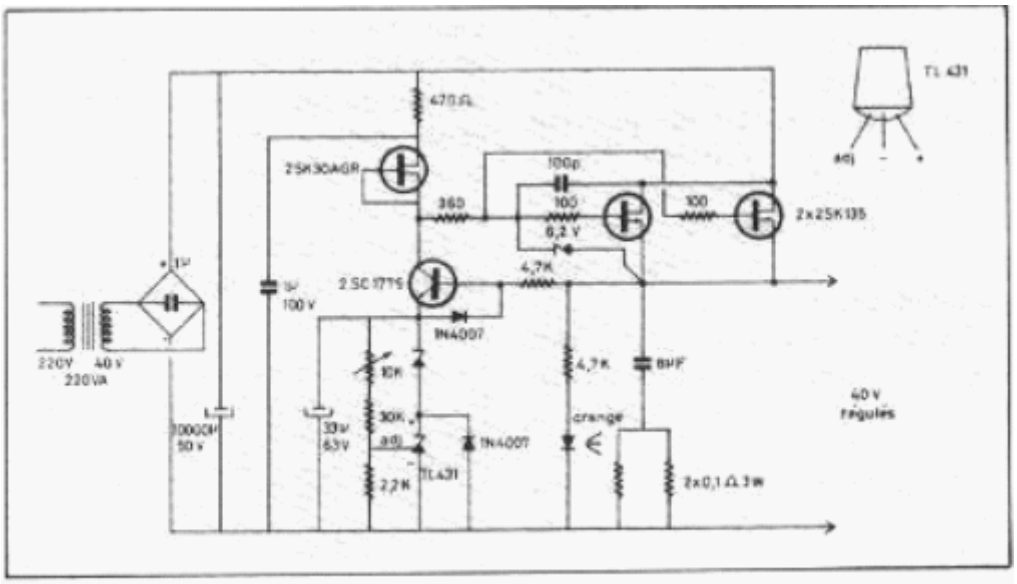

Fig. 3 bis : Alimentation régulée ajustable.

The output transformer
Both the Nemesis and the Super Nemesis use a Tango output transformer with a primary impedance of 64 Ohm. For the Nemesis, the secondary impedance is 8 ohm, whereas for the Super Nemesis 16 ohm has been chosen after trials.
The voltage relation primary–secondary is only 2 (square root of 64/16 = 2). Or, in a former article, that dealt with the interest of inductive connection with the speakers (something that seems to have been intensively read by the cable manufacturers...) we had shown the interest of using transformers from “Metalymphy” (Toroid cores mains transformers. Note by translator) as output transformers.

Actually these transformers have an interesting bandwidth for hifi use. cf. Fig 4.

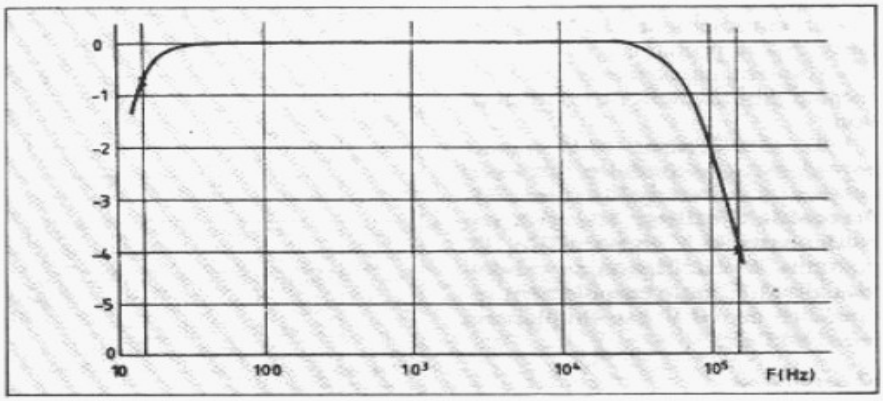

Fig. 4 : Bande passante du transformateur Metalimphy 330 VA. 2×33 volts sur rapport 1-1 (10 watts).

This wide bandwidth is not a desirable quality for a mains transformer. Numerous parasites present in the sector may be carried further down towards our precious equipment...
Often, transformers of lesser performance may be more satisfying for power supplies.

Nevertheless, in a carefully designed power supply with muscled filtering, toroid transformers remain perfectly usable.

The transformer chosen for this project is a Metalymphy 330VA, 2x 115V / 2x 40V.
As used for output transformers, in Ohm units this would correspond to 73Ω / 9.7Ω, in other words close to the used Tango transformer.

Hence we may use: one primary winding 115V as primary winding for the signal; the second 115V winding for compensation; one of the 40V windings as secondary winding (trial has shown that it is detrimental to use both secondary windings in parallel, as this produces circulating currents. The second winding is simply left open.

Adjustments
The sole required adjustment consists in setting the bias current to 650mA via Vr1, with the help of a voltmeter measuring a voltage drop of 65mV through the source resistance of 0.1Ω. The measurement must be repeated after thermal stabilization after 1hour. The two power transistors, the one carrying the signal and the one used for the compensation must be mounted close to each other on the heat sink.

Measurements
They are presented in the figures 5 to 14.
http://www.asrr.org/biblioteca/Revue%20Audiophile/fichiers2/26/nemesis.html
Bandwidth is considerably improved towards low frequencies.

Subjective aspects
Comparing to the Super Nemesis, the gain in the low and very low frequencies is remarkable, and it is the whole spectrum of frequencies that benefits from this improvement, as can often be experienced when a system is being optimized. Read further down the listening comments of the team of “L'Audiophile”.

Later developments
Given the large power reserves of the output transformer, it was tempting to increase the output power. The power supply could be raised to a B+ of 45V without problem. This could lead to 30W effective output power. The trial lead to deceiving results: The sound passed from typical “Monotriode” to “Transistor” in the bad sense of term.
In itself the trial was extremely revealing. It showed how critical B+ and bias settings are in such simple designs. To analyze the problem we proceeded in two steps, a subjective adjustment and a theoretical analysis of the problem.

The subjective adjustment
It consisted simply in varying the B+ and the bias current for best musical results. We thus reached B+ 40V bias 650mA. This limits the output power to 15W (highly musical...)

Theoretical analysis
…....