Stan's Safari 4

IN WHICH STAN CURTIS FINDS HIMSELF TRAPPED IN THE SWAMP OF AMPLIFICATION (WHERE HE MIGHT BE FOR SOME TIME!)

Having finished my last article, I thought I'd put the ghosts of valve amplifiers past to rest, but it was not to be. In the days that followed I found myself digging out a number of old work-books, and was startled to discover just how many such amplifiers I had designed in my younger days.

One in particular stood out. It consisted of a huge radio transmitter valve mounted behind a modified Vent-Axia kitchen fan, which attempted to counteract the heating effects of the several amperes of current flowing through this high voltage single-ended Class A stage. The rest of this ludicrously simple amplifier comprised no more than a substantial output transformer, a single valve driver stage, and a handful of passive components. And that was it. With an output potential comfortably above 100watts, it sounded simply magnificent to my ears and was the best valve amplifier I ever built. Maybe it wasn't very carbon friendly by today's sensibilities, but I was certainly up for building another pair until I found I hadn't retained the transformer design notes. And so it came to pass that I was once again able to avoid the dark side and return to the slightly saner world of solid state amplification.

Over the next pages I will try to take the reader through some of the problem areas of transistor amplifiers and the considerations that enter the designer's mind. What I am not going to do is supply a step-by-step lesson in amplifier design, as this will go over the heads of many readers, and probably generate too many challenges from armchair theoreticians for my liking. Instead I will highlight some of the things that can screw up the 'perfect' transmission of a music signal through an amplifier, while asking the question: "do they screw up the signal enough to cause concern?" The history of hi-fi is littered with the discovery of 'problems' that may have the capability to degrade the signal, so some designers then go off on a quest of outstanding single-mindedness to bring us a product completely free of that particular ill. Yet perhaps nobody else was actually finding that particular problem interfering with their listening pleasure.

For me the art of amplifier design is to look at all the areas of potential degradation; establish which are relevant to the product brief; and then reduce them to a level where they cease to be noticed, thereby avoiding the costs needed to produce a notionally 'perfect' amplifier. Other than to satisfy engineering ego, there's absolutely no point in reducing a distortion or coloration below the level at which it creates an audible effect, especially if it is going to add cost or complexity to the finished product.

When designing Rotel's products many years ago, I called this approach the 'Balanced Design Concept' and it's a philosophy I still adhere to. Some have suggested it is all that remains of a 1960s hippy work ethic of doing no more than is needed, but I prefer to see it as a Yorkshireman's pride in spending no more brass than is necessary.

The majority of us own transistor amplifiers, and some of us actually believe the stories of design originality spun by the manufacturers. Yet in many respects audio amplifier design has largely stood still over the last 40 years. Now I know this is an extraordinary statement, but consider the facts. The earliest transistor amplifiers used inter-stage transformers, had very limited output powers and were none too reliable. Then in 1956 Dr. Hung Chang Lin of RCA Laboratories published a simple and elegant circuit of a directly coupled quasi-complementary amplifier – an amplifier which can justifiably claim to be the grandfather of almost every one made today. (Incidentally RCA continued to help drive the design of audio amplifiers, notably producing a seminal booklet in the early 1960s entitled something like *The RCA High Fidelity Amplifier Circuits Manual*. As I recall, Julian Vereker used its contents as a basis for the first Naim amplifiers; he was not alone in finding inspiration in those pages.)

For some years most transistor designs followed a similar topology to the Lin design, an early UK example being the singularly awful sounding Leak *Stereo 30*. Then at some stage a variant appeared that replaced the single transistor input stage with a differential stage: the classic 'long-tailed pair'.

I'm not sure which designer made the first such audio amplifier, but I never saw one before the mid-1960s, and I'm pretty sure that they were based upon the circuit topology of Bob Widlar's 1965 Fairchild *µA709* integrated circuit. Widlar was a circuit design genius, and his *709* and the later ubiquitous *741* model actually incorporated most of the design structure (the 'Operational Amplifier' topology) which are found in today's amplifier designs. For sure there have been detail improvements – such as the many possible alternative output stages, fully complementary input and driver stages, alternative output devices (MOSFETs etc.) – but the essential core design of most amplifiers is the same. Now obviously you can view this outcome in two ways.