The ULTIMATE amplifier

by EMORY COOK and GUS JOSE

If the sentiments of Walter Mitty are sometimes yours, here's a golden opportunity to live dangerously for awhile — build this super amplifier, whose design is explained in a refreshing manner by the perpetrators.

DURING most of 1954 appeared a phenomenon that some of us 20 years ago* despaired of ever seeing. At last the hue and cry about new and amazing amplifier circuits seemed to be subsiding. Ever before, affairs were in a shocking state. Around every corner, and at the top of every pile of technical magazines, disillusionment lurked ready to leap out. Always there in black and white, sired and authored by impeccable, unimpeachable authorities, was a new feedback amplifier circuit whose characteristics put yours to shame. You just *had* to rebuild.

And then, those few blessed months of peace.

But now pilot lights in the eyes of circuit-designers and article-writers all over the world are beginning to burn again brightly. In the face of this threat, we decided that the moment had come in which to perpetrate our idea of the *Ultimate* amplifier — and this was with some assurance that it would not immediately be followed by the *Ultra-Ultimate*.**

The secret about this whole business of amplifiers is that there is no secret. The facts are few and simple, when uncluttered by adjectives and technical mysticism. Feedback in itself is no panacea for a poor design. True, it helps to cover up the frequency-response of a cheap amplifier on the test bench, but a respectable job can't be done without a well-designed amplifier comprised of the best components. Only then is the addition of feedback impressive.

Years ago feedback was a will-o'-the-wisp circuit factor. If you could connect it around a single stage of amplification you were often surprised and content. Over two stages, feedback was quite an achievement; and the greater the number of stages enclosed in the feedback loop, the more effective it was.

Even today, feedback over three stages *of amplification* is still restricted principally to the tinkering specialist. Yet here is such a circuit wired up from production parts — nothing special, just good blocking condensers, accurate resistors, and a fine output transformer.

There is a certain amplifier-design philosophy based upon the type of logic that assumes if 100 horsepower in a car is good, then 200 horsepower must be twice as good. If 20 db of feedback in an amplifier is a salubrious thing, then let us by all means have it ten times as healthy and use 40 db. Ah, yes. At this point the output impedance has been reduced by the feedback to a quantity so insignificant that the copywriters are tempted to call it "zero." Whereupon the advertising manager, let us say, rushes around discovering reasons why zero impedance is good. Here is a chain of events that all hangs from the original badly-planned logic of the horsepower analogy, preposterous enough to be evident to all.

Well, there are two possible kinds of negative feedback: *current* and *voltage* feedback. An amplifier with large amounts of *voltage feedback only* will not care whether you connect the speaker or not. The same waveform and loudness will be presented at the output terminals — the same *voltage*. An amplifier with large amounts of *current feedback* (none such is manufactured) will care very much about whether or not something is connected across its output. If no speaker (load) is attached, its output voltage will rise to an astronomical figure in the effort to force *current* through the output load which isn't there. The one maintains constant voltage across, the other constant current through the speaker. A suitable combination of the two has many advantages.

Well, why not put them together in the same amplifier? No reason why not, except that it is a lot of design trouble. The well-proportioned combination of the two produces an amplifier having a *resistive* drive without a physical resistor being involved directly, reminiscent of triode performance but a lot more husky and predictable.

It wouldn't be necessary to engage in a pedantic discussion of current, voltage and resistive drive if only it were that our amplifiers were asked to drive resistors, or resistive loads. The sad truth is — and here is a popular misconception — loudspeakers are in fact a long, long way from being resistors, or even from presenting their rated impedances to the amplifier over very much of their working ranges. Although they may bear family resemblance to resistors here and there in the frequency scale, they become resistors in series with inductors at some places, in series with condensers at others.

We can all visualize the mechanics whereby a speaker diaphragm produces sound. The cone moves in and out. But it's a lot harder to move it at some frequencies than at others. Electrically this reflects back through the voice coil, and at these frequencies the speaker is reluctant to accept as much *current* in the coil as it would for the same voltage at some other frequency. Obviously, some current feedback is needed; in a case like this the

*Oh, yes, high fidelity is 20 years old, at least. Remember Ben Olney's Stromberg karpinchoe-leather speaker, and labyrinth? Remember the Wright deCoster paracurve?

**Try to say this out loud, quickly. This was our assurance.

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