

The Filter Wizard
issue 6: One giant squeak for Mankind
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Anniversaries, eh? Today, easy access to historical information on the web makes every date significant for some reason. By the time you read this, the media froth about the first Moon landing (July 20th, 1969) will probably have settled down. But it did make me think: what was *I* doing then, electronically speaking? What formative things were happening, starting to make today's me?

At the tender age of eleven (and what does *that* mean? Eleven is a prime number, so it's pretty resistant to arithmetical damage) I was transitioning from the worlds of Meccano and of chemistry experiments (sorry about the burn marks and the smell, Mum) to a world of soldering irons and electricity (er, sorry about the burn marks and the smell, Dad).

Dad was a keen electronics hobbyist, but sometimes he didn't "get" something on a project he was attempting. He was more of a refrigeration and aircon guy. We had a home-made freezer with a throbbing compressor from a 1930's Frigidaire; gauges with trembling needles like you'd see in a black-and-white sci-fi film. Every time we recharged it with R12 the hole in the ozone layer above South London got a little bigger...little did we know.

So I started stepping in to have a go with the darkroom timers, the phone bill calculators and the drill speed controllers – how hard could all this electronics stuff be, anyhow? Good early apps experience, obviously. Practical Electronics was regular reading, and I was particularly taken by the May 1969 issue because it included a design for an electronically controlled Meccano model.

For fun, though, I've decided to look at another circuit from that issue. I never built it at the time, but would have been interested because it had an audio use, and I was already getting into audio by then. Mostly repairing old record players and valve radios, discovering the joy of the dried-out electrolytic capacitor.

The article is called "Phase Splitter – Frequency Doubler". It's built with pnp germanium transistors, and that already felt a bit dated even in 1969, when circuits using silicon transistors and articles on "integrated circuits" were appearing in the magazines. Here's the circuit diagram, scanned from my own copy:

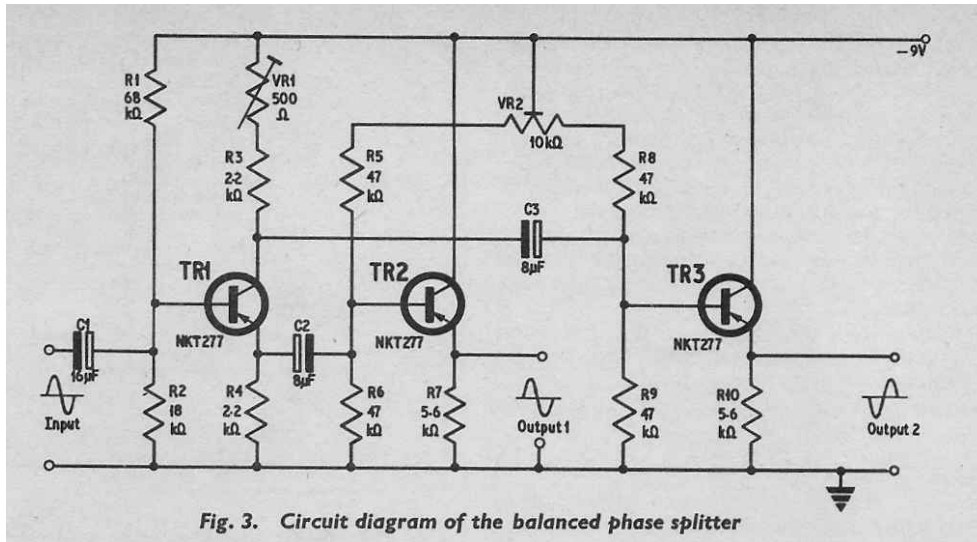


figure 1 (not fig. 3!) – the original circuit from Practical Electronics

I spent some time last year looking at discrete radio circuits and AM detectors, and the hissy, band-limited voice recordings from the Apollo recordings reminded me that the program’s electronics engineers were at the bleeding edge of 60s radio technology.

It’s a simple idea to buffer the two, antiphase outputs from the emitter and collector of a transistor (or valve, even) as TR1 is used here. You can turn this circuit into a “winner takes all” full-wave rectifier by connecting the buffered outputs together, and that’s a useful bonus. It’s hardly sophisticated stuff; out there in the real world in 1969, Barrie Gilbert – the Master Wizard of BJTs – was already publishing seminal papers on the beautiful properties of bipolar transistors.

Without a ready supply of old ‘geraniums’, I thought it would be fun to simulate this circuit. Having failed to locate information on the transistor – an expert in these old devices wonders if it might be a misprint for NKT227 – I adapted a germanium transistor SPICE model from the LTSpice user group. Here is figure 1 entered into LTSpice:

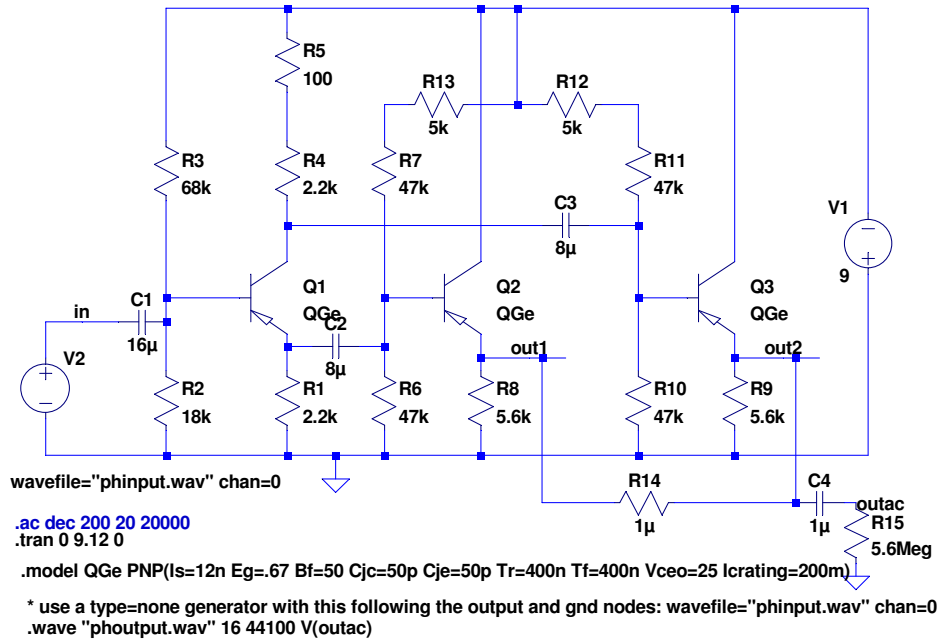


figure 2: the circuit captured as an LTSpice schematic

The trim pots are replaced with resistors; I quickly found that the correct setting of VR2 (now R12+R13) for DC balance between Q2 and Q3 emitters was exactly half-way – as expected, because in simulation the two devices are identical. But VR1 (now R5) had to be wound almost to minimum to balance the AC gains. And here's what happens with a sinewave input, and the emitters of Q2 and Q3 shorted together:

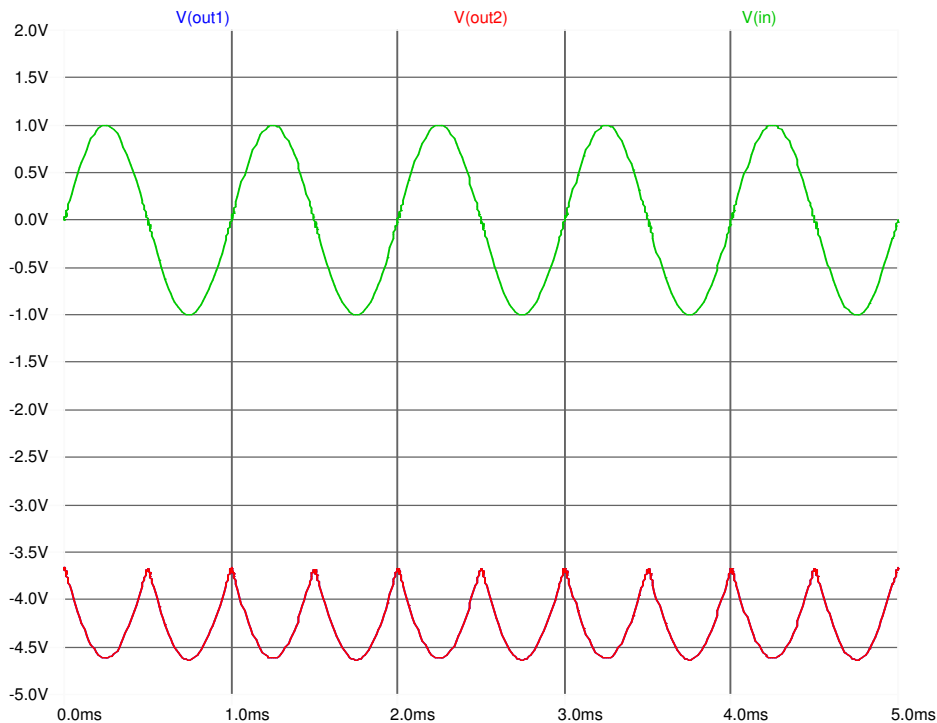


figure 3: 2Vpp 1kHz sinewave into the circuit (green) and output (red)

This shows clearly that the circuit acts as a full-wave rectifier – it's not that bad, even at low signal levels. The poor ft of the transistors shows up above a few kHz, though (the response at Q1's collector rolls off much earlier than at the emitter). What would have particularly interested me was the article's promise that the doubling capability of such a rectifier could be used to generate 'Pinky and Perky' voices. Now, if you're young or not British (just like in the case of the BBC Micro in a previous column) you may not have heard of these piggy puppets. Their amusing squeaky voices were achieved by playing back dialogue recordings at higher tape speed (helium being much too expensive). Putting a voice signal through a circuit which "doubles the frequency" to recreate that effect – I would have wanted to try that.

LTSpice allows you to play back a wav file through a voltage generator, and write circuit node voltages back out to wav files (hint: strip off big DC offsets!). So I prepared a nicely band-limited voice excerpt (don't want to get aliasing when all these harmonic components are generated and sampled back to a wav file) and sat back to wait for LTSpice to cough up some nostalgia.

Sad to say, when I tried this out, the result was hardly 'Pinky and Perky', but much closer to what I'd expect these days when passing a complicated signal through a system with a strong even-order non-linearity. The output signal clearly does have a component at twice the original frequency, but voice sounds muddy and distorted, as if a slightly squeakier person was speaking through a kazoo. Not lively and exciting, as Pinky and Perky used to be! So it wasn't one giant squeak for mankind after all, but still would have been an interesting small step for a boy. What cool stuff did *you* make that year? - Kendall