D Cell Power

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So there I was, having made a Quaker Oats Box receiver with a 1S5 tube sticking out the top and 36 turns of no. 24 enamel wire wrapped around the old guy's head (Figure 1). For a B supply I knew I would need about 30 volts, and three nine-volt batteries would probably work. But that would be a tight squeeze at the bottom of the container, where there was already a 365 pF tuning cap and a D cell in a holder. Using an outboard supply, I found out the set would work with as little as 12 volts of B Battery, though at awfully low volume.

I remembered an idea I'd seen in a trade magazine years ago. Someone had powered a digital project using a single D battery to make a five-volt supply for the two or three chips he needed. Why not see what a circuit like that might do for us tube-type guys using one or two D cells? Anyway, transistors are historical by now. Any ideological purists can just turn the page!

Fig. 1. My One-tube Quaker Oats Box Receiver

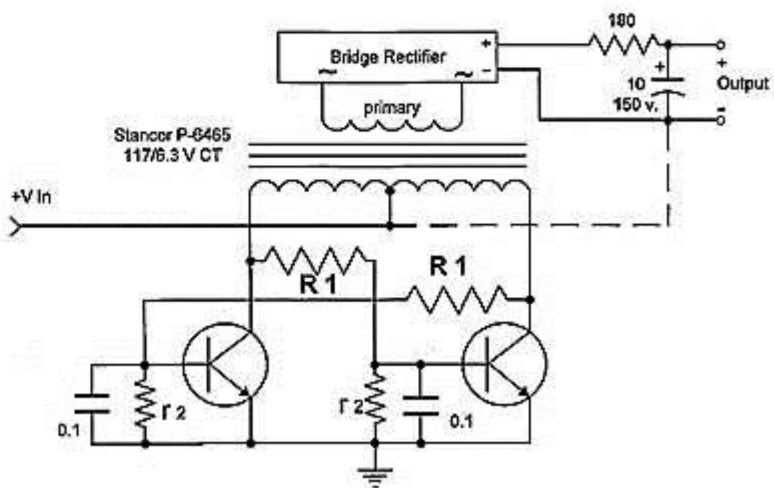

Fig. 2. The Simple Power Inverter (See Text)

Figure 2 is the circuit of a simple power inverter, making AC out of DC then rectifying the output back to DC. It works as a multivibrator, each transistor alternately conducting and switching off due to the action of the other transistor, coupled through the halves of the center-tapped transformer winding. The reversed six-volt transformer will put out tens of volts from the 117 volt primary winding, and a bridge rectifier turns that AC back into DC. Adding the connection shown as a dotted line will add the battery voltage to the rectifier output, and a simple filter can remove spikes from the bridge output.

The waveform out of the 6.3-volt one-amp transformer approximates a square wave, but varies considerably with load. The operating frequency--typically a few hundred Hertz--will rise with increasing load as the net available magnetic flux in the transformer core is used up in transferring energy. If the load gets too great, the circuit will become flux-limited, and will run at a too-high frequency; useless for our purposes.

When I breadboarded this using one of those plugboard units to make component substitution easier, I started with a pair of silicon transistors, knowing they would be forgiving of any accidental clumsy moves by the experimenter. In this circuit, the transistors have to saturate, and the voltage from collector to emitter (about half a volt) represents a loss in output, since it takes away from the voltage across each conducting half of the transformer winding.

Germanium transistors saturate at about 0.3 volt, but they can "run away" and overheat unless their base connections offer a path to ground shown by the resistors labeled r2 in the schematic. Working on the bench, I soon found that a capacitor-input filter would make the circuit take off and fibrillate no matter what the load was, so it wanted some extra resistance ahead of the capacitor.

But it does work. After a complete series of tests using both silicon and germanium transistors, I got the results shown in Figure 3. Resistance values that seemed to work best were 100 ohms for R1 when using silicon transistors and 1.5 volts (one cell); 180 ohms if using 3 volts (two cells). When using germanium units, R1 was 180 ohms for one cell and 270 ohms for two cells; R2 needed to be 510 ohms or 100 ohms, respectively.

It stands to reason that transistors with different gain would require slightly different values for R1 and/or R2, so if you breadboard a supply like this, be prepared to fool around with these values. Current drain using the parts described turned out to be about 200 mA from one cell and 350 mA using two.

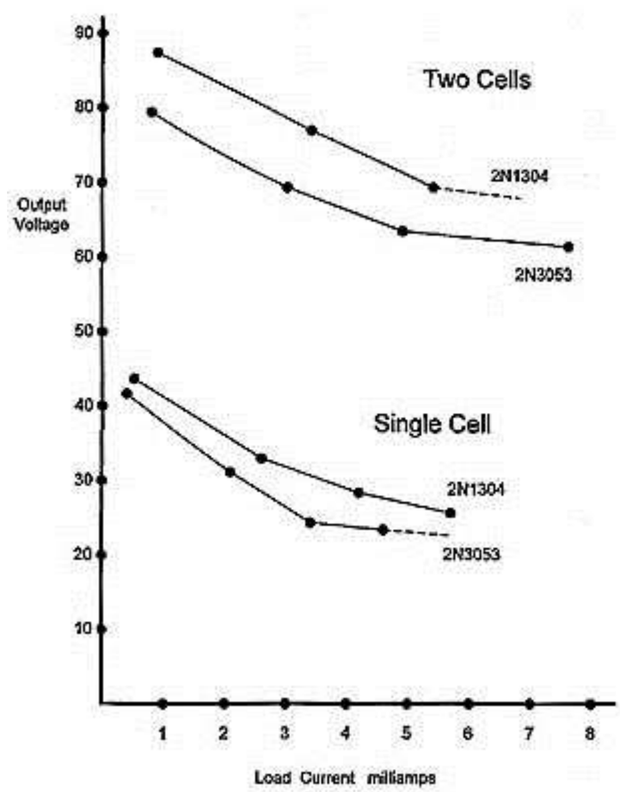

Fig. 3. Test Results With Both Silicon and Germanium Transistors

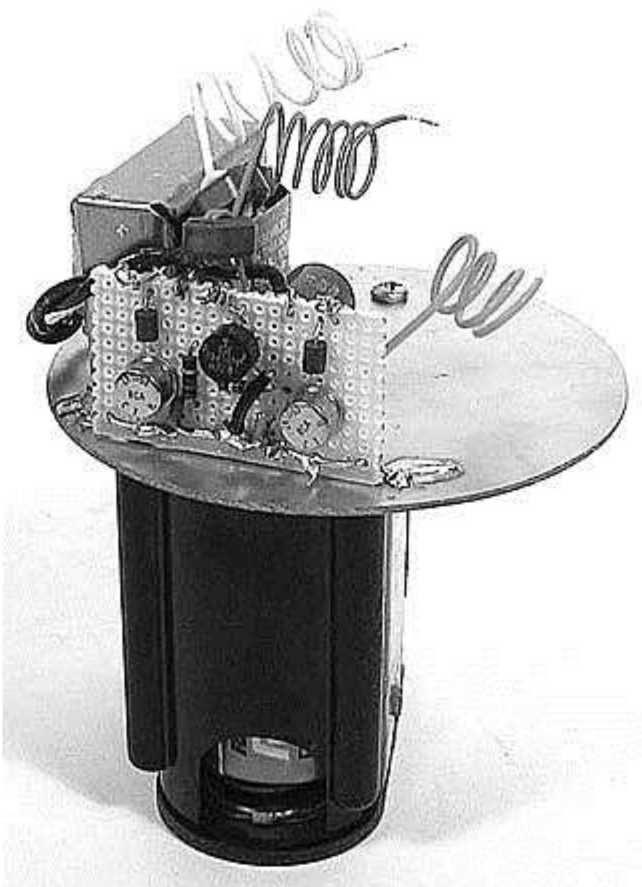

Fig. 4. Two-Cell Power Supply for a Two-Tube Receiver

Don't omit the two 0.1 uf capacitors--they suppress switching spikes that otherwise create sputtering all over the band. Further noise suppression can be had by putting little ferrite beads over the leads to the transistor collectors and over the input and output wires. There WILL be a hum note in your ear with this supply, but filtering will minimize it. If you can't stand even that, fool around with shielding the supply.

My 1S5 regenerative set needs 50 mA for its filament and less than one milliamp from the B bus, so either kind of transistor will work fine, giving out 40 to 45 volts. A fresh alkaline D cell is good for maybe 15 amp-hours, so the Quaker Oats radio ought to run for 50 or 60 hours before replacing the single battery. Looks like a receiver using two or three 199s ought to do fine using this inverter circuit running on two D cells as the whole power supply, with the B bus sitting up around 65 or 70 volts and 3 volts to run the filaments.

Improvements? This inverter works just like a vibrator (the car radio kind), so you could always go to six volts, beef up the transformer to 12 volts CT and run almost any three-dialer full of 01As with a six-volt lantern battery. For a while.

I took this idea a little farther: I found some ferrite "cup-core" coil forms on eBay and wound a new transformer, hoping for better efficiency and easier DC filtering. For the record, my cores were Fair-Rite # 5677362221, about an inch and a half in diameter and an inch high when paired up. I had to make bobbins out of fishpaper--no fun, that.

HV winding was #32, almost full, while the primary was eight feet of #28 tapped in the middle. Results with 3 volts in: the supply would deliver 10 milliamps at 55 volts with the transistors switching at about 1 kHz. Efficiency 43%, and not much difference with either silicon or germanium. Load regulation looked better with the cup-core, but the 6 volt Stancor transformer works well without all the grief.

Figure 4 shows a two-cell power supply I've made for a two-tube "Pilgrim" receiver. You can see the holder for the two D cells below the copperclad disk that will fit inside the Quaker Oats box. The perfboard holds all the parts and there's also room for the tuning capacitor on the circular base.

So, if you want to say goodbye to banks of 9 volt or AAA batteries wrapped up in a reproduction Eveready package, give this idea a try, even if you have to soil your hands with solid-state parts. Let me know your results.

References:

The Fair-Rite web site: http://www.fair-rite.com/ See if they'll sell you some bobbins!