Breadboarding

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More Adventures With Transistors

It's been one of my goals in life to drive around in an old car-- but only if I didn't have to. Now that I'm so well-off, fond memories of driving cross-country in a 1947 Plymouth before the Interstate Era recently inspired me to acquire a 1948 DeSoto. This big old boat has a seven-tube Mopar radio built by Philco--a Model 802 set--and of course it has a vibrator power supply.

Now these days, vibrators are readily available, but not for car radios. The one I need is a four-pin non-synchronous unit--really just a buzzer with contacts that cycle a grounded armature between two contacts. Those are connected to a step-up transformer that has its center tap connected to the car battery voltage. Figure 1 shows the circuit.

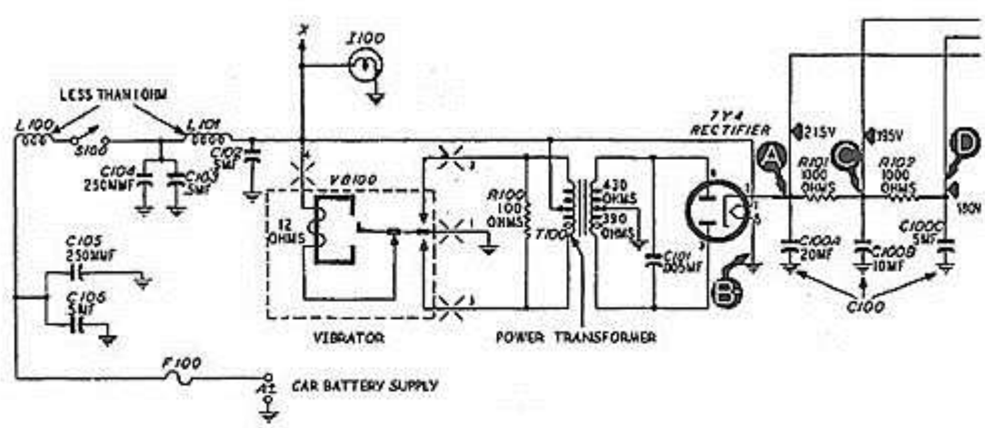

Fig. 1. Philco Model 802 Power Supply

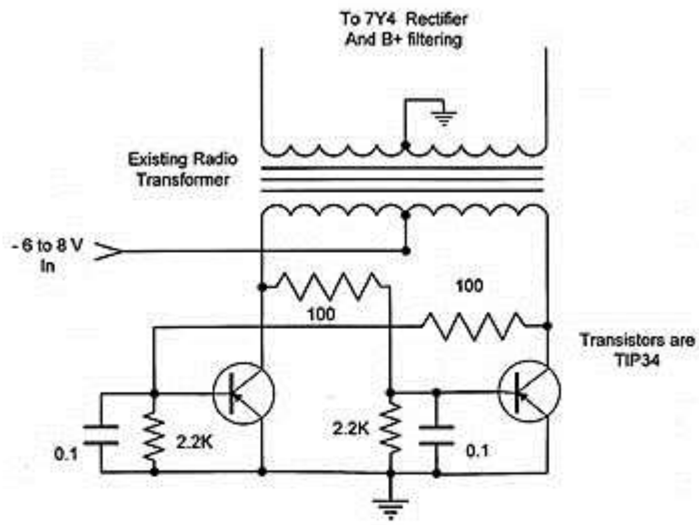

Fig. 2. Vibrator Substitute Design Starting Point

Why not replace the vibrator with a solid-state equivalent? It's a perfect opportunity to get on the bench and do some breadboarding. My DeSoto has a six-volt positive ground electrical system, but transistors come in both genders, so whatever I come up with can be made to work in a negative-ground car by choosing the right kind of transistor polarity.

I started by setting up a more powerful version of the D Cell supply I wrote about in an earlier column (1). Figure 2 shows my starting point.

I started by removing the resistor across the Philco transformer's primary. It turned out that to get enough current into the primary winding, I had to lower the base drive resistors to about 100 ohms. The transistors were pulling (or pushing) about 3 amps when in conduction.

But as the heaters in the radio tubes warmed up, load current increased and the inverter frequency rose, then took off into severe fibrillation at any supply voltage above about 3 volts. It seemed clear to me that a self-excited transistor pair was not going to serve the purpose. I thought about a separate oscillator driving the push-pull power stage, and tried changing the power transistors to NPN types operating as emitter followers (figure 3).

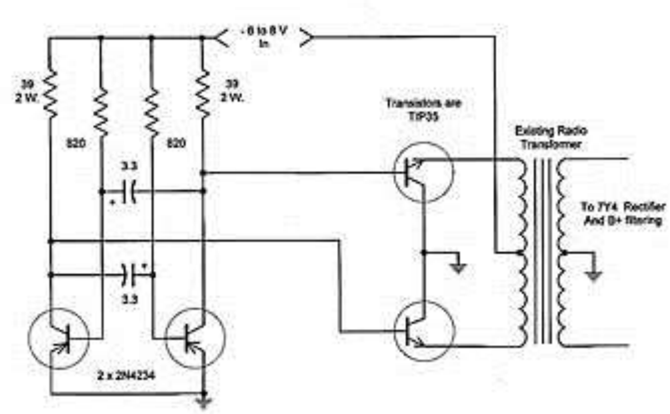

Fig. 3. Multivibrator Plus NPN Power Stage

I breadboarded a free-running multivibrator using medium-power PNP transistors, and selected the coupling capacitors to get it running at about 200 Hz, a bit above the rated 115 Hz where car radio vibrators commonly run. You'll note the NPN power transistors can connect directly to the flip-flop collectors, making for a pretty simple circuit. Best of all, the collectors get grounded, so no insulators are needed to interfere with heat flow. Another advantage of this circuit is supposed to be that base drive current for the power transistors is added to emitter current in the transformer primary windings.

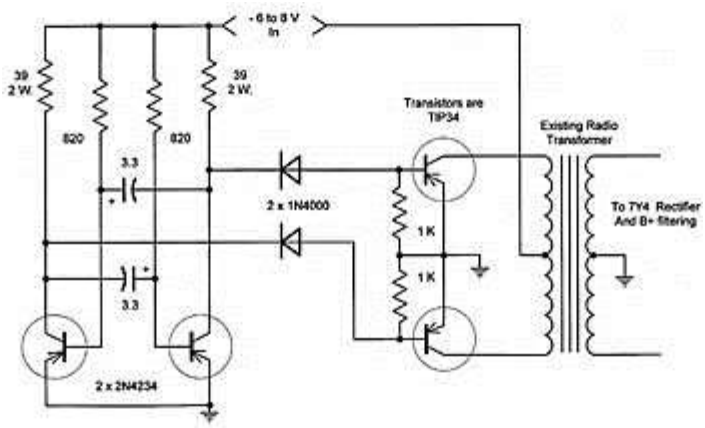

Fig. 4. Final Circuit for Vibrator Substitute

When I set this one up, it worked well and the drive frequency stayed pretty constant at about 200 Hz, but the power transistors got very hot indeed at a supply voltage of 7 volts. In a six-volt car, it's not uncommon for system voltage to get up around 8 volts, so I needed my vibrator eliminator to operate safely there.

I had been working with the idea of building my circuit into the shape of a standard vibrator once I got it working to my satisfaction. But the bodacious heating of the power stage made me decide to mount the output transistors directly to one of the radio side panels for better heat dissipation. The final configuration I chose uses PNP output transistors with the multivibrator driver, and I used a copper strip about an inch wide and seven inches long between the transistors and the radio cover plate to help with the heat transfer. Figure 4 is the schematic and Figure 5 is a photo of the parts arrangement I ended with.

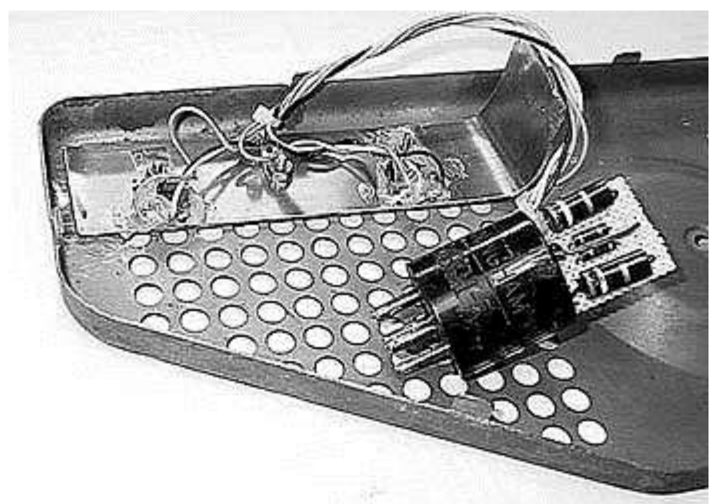

Fig. 5. The Final Parts Arrangement

The flip-flop circuit is built on a piece of perfboard epoxied into an old four-pin tube base that fits into the vibrator socket, and wires lead from the plug to the parts mounted on the cover plate. The goop on the power transistor leads is RTV for insulation. The one K resistors from base to emitter are there for insurance against thermal runaway.

If you want to try this idea and you have a negative ground vehicle, all that's needed is to select comparable NPN transistors of similar ratings. And if you have a car with a 12 volt system and the radio uses a vibrator--not uncommon in the late '50s--you'll be able to increase the value of all the resistors.

Start by doubling all their values. Load current will be less, so the transistors will run cooler. In any case, make sure the current rating of the power transistors you use is more than the load current, and their collector-emitter "breakdown" voltage ought to be three or four times the battery voltage you have.

Reference

(1.)"D Cell Power", *Old Timer's Bulletin*, October 2006, Vol.47, No. 4, p.39