Alternators as steppers?

A *stepper motor* differs from an ordinary motor in that it can deliver incremental motion in the form of tiny precise steps, rather than as a continuous rotation. The important advantages of a stepper motor are the precision with which you can set an output shaft position, the ability to rapidly and conveniently change the direction or the speed of your output steps, and the capability of strongly holding a zero-speed position.

Small stepping motors are widely used for such things as printer paper feeds, automobile idle controls, pen plotters, and sometimes for disk-drive head positioners. And most any old surplus electronics catalog will have lots of small steppers and all their drivers cheaply available. But what about the heavy stuff?

There are lots of good hacking uses for power stepper motors. Obvious examples include robotics, machine-tool power feeds, animation stands, plotters, sign cutters, solar pumps, and even Santa Claus machines. As you have probably noticed by now, power stepper motors are rare, horrendously expensive, hard to get, and harder to drive. Did I mention being hot and noisy?

An industrial arts teacher out of Phoenix by the name of Bob Knight stopped in the other day with what just might be a brilliant hack. Junkyard car alternators cost under $5 each, especially if you don't particularly care which model you are getting. Can you convert an alternator into a power stepper?

The needed modifications do appear to be simple and obvious. And power FET or Darlington drivers are no big deal these days.

My first response was "yes, but...," and I immediately came up with a dozen good reasons why this flat out would not work. At least not very well. Things like a wide air gap, low-frequency mechanical resonances, DC biasing, giant step sizes, all the non-optimum magnetic paths, very poor damping, backlash, slow speeds, and an efficiency that probably would be an outright joke.

On the other hand, if you pulse an alternator, there is no way you can hold onto it when you do. The kick is definitely there.

At best, I would guess that you could not get as much useful force with a car alternator as you could by using a much smaller "real" stepper motor. And the alternator would end up ridiculously slower to boot.

I'd like you to try and prove me wrong. Either as this month's contest or for a winning school lab project, experiment with a car alternator and find out exactly how useful a power stepper motor you could convert it into. Could you in fact create a $5 machine-tool power feed with one? How fast can you go? How much output force can you get? How good are the steps? What is the best computer interface?

There will be the dozen or so of our usual *Incredible Secret Money Machine* book prizes, along with a big all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all.

Okay, Fig. 4 shows you some conversion hints.

Most real stepper motors do use a permanent magnet rotor. With an alternator, you would use the field winding and slip rings as a giant electromagnet, running as much current through it as you can without overheating. This forms a group of seven shaft-attached magnets that you can rotate to a desired position by activating the stator coils.

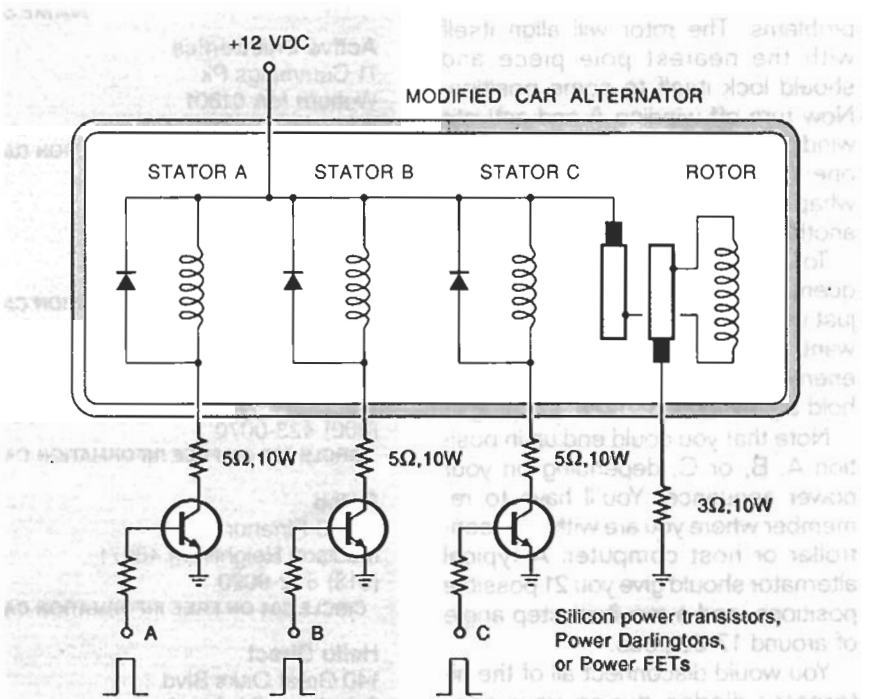

FIG. 4—CAN A CAR ALTERNATOR get converted into a $5 power stepper for a machine tool drive? Only hackers know for sure. To experiment, use the rotor as a powered electromagnet. Find the floating stator wye connection and bring it out as a power terminal. Pulse one stator winding at a time in an ABC (clockwise) or an ACB (counterclockwise) sequence. Be sure to limit stator currents.

And speaking of which, there are normally three sets of stator coils. These are usually hooked up in what is known as a three-phase *wye* circuit. For stepper use, you will want to find the floating splice where your wye connection is made and bring it out as a separate positive terminal. Which should then give you three distinct and independent winding sets.

Let's call the windings A, B, and C. Power the field via the slip rings, and pulse winding A. Keep your current down around an amp or two at first to

stator pole rather than three. Ampere turns is the name of the game here. You could also try improving the rotor flux paths and air gaps.

For further resources on power stepping in general, check out *Airpax* and *Slo-Syn* for iron, the *PCIM* and *Motion* trade journals for info, and *SGS*, *Sprague*, or else *Motorola* for drivers. One distributor that stocks a wide selection of power-electronics stuff is *Galco*. And good old *J.C. Whitney* has bunches of alternators and parts available, including some rewound 100-amp stators that go for around $18. You will find lots more on power electronics in our brand new *Hardware Hacker III* reprints. There's lots of possibilities here. Let's see what you can come up with.