Light-Commutated Motor

The next device will also be a conversation piece because it has interesting features not possible without photocells for power. It is a dc motor in which the commutation is done by light (radiation). One real advantage to this method is that the friction normally present in a mechanical commutator is absent. This motor is very easy to make and requires little equipment. I will describe what worked for me and try to point out the important factors. Figure 8-3 shows one of the motors. A slightly more sophisticated version of this motor operates a set of angel chimes originally intended to run with burning candles.

The schematic drawing, Figure 8-4, explains the construction. Two solar cells are mounted on opposite sides of the cork and connected to the coil with opposite polarities. The direction of current flow through the coil is now in one direction for one cell and in the opposite direction for the other. This connection provides the required reversal of current (commutation) for each half rotation of the motor, the light coming in from only one side. The cell in the dark will always have high resistance so that it does not waste the power generated by the cell which is in the light. Note the placement of the field magnet to give the maximum torque to the windings when either one of the cells faces the light.

The bearing is glass on a steel point to give low friction. Use a

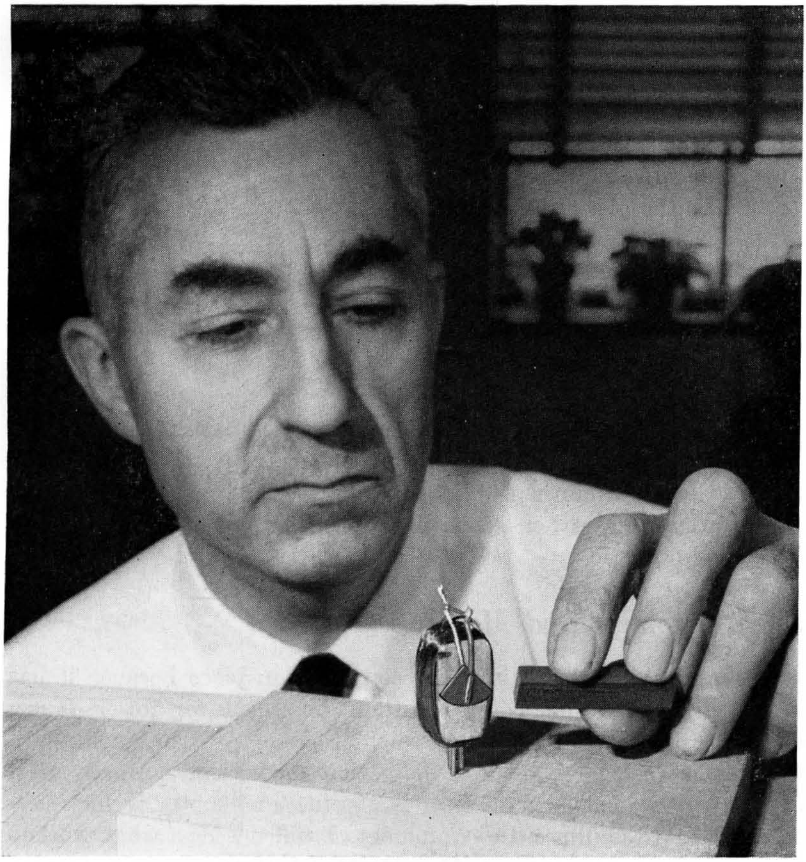

Figure 8-3. *A light-commutated motor.*

large sewing needle or sharpen a long nail. Mount it vertically in the block of wood used for a base.

Select a piece of glass tubing (the glass part of an eyedropper will do) with a hole about ⅛″ in diameter. Fire close one end. There are many ways to do this, but I found it easy to heat a piece of glass tubing in the middle and pull it apart. A little judicious heating and pulling resulted in a closed end which was not too distorted. Break the tubing about 2″ from the closed end and fire polish the broken end. This tubing, set over the point of the needle, will be the bearing. You may want to make several pieces of glass and choose the one that appears to give the least friction.

Obtain a cork stopper about 1″ in diameter on the small end. Bore a hole along its axis from one end not quite to the other end. Make the hole a snug fit for the glass tubing and push the closed end of the tubing into the cork. The cork and glass should rotate freely on the point of the needle. With a file or sandpaper, make two parallel flat sides on the cork for winding the coil, and two parallel flat sides for mounting the solar cells.

To determine the best wire size, we need to know something about the acceptable resistance of the winding. We determine this from considering what the solar cells can deliver. In reasonably strong light, your cells should be able to deliver about 10 milliamperes of current at about 0.3 volt. If these estimates are correct, the proper resistance load is

$$\frac{E}{I} = \frac{0.3}{0.01} = 30 \text{ ohms.}$$

Note that this load is computed for different conditions from those used for the pendulum. What we want now is the most turns we can

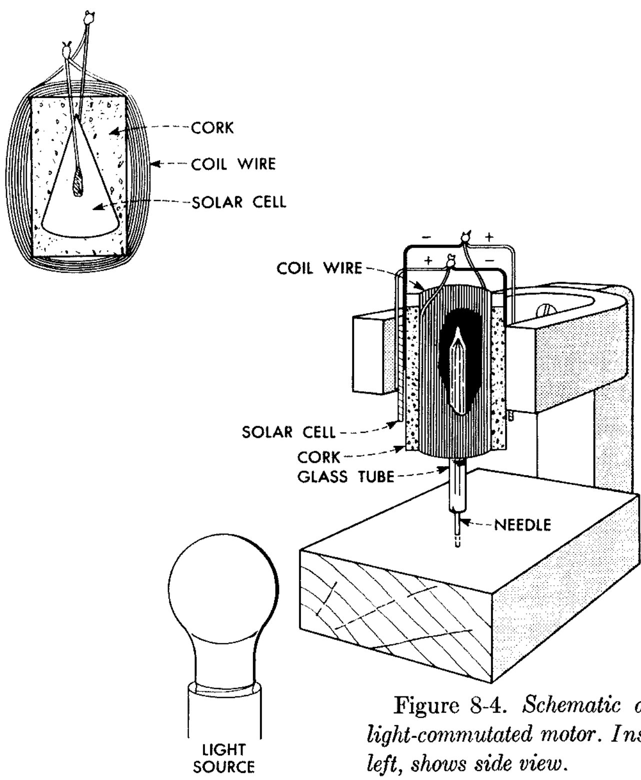

Figure 8-4. *Schematic drawing of light-commutated motor. Insert, upper left, shows side view.*

get in the space available on the cork for 30 ohms of wire. I used 350 turns of No. 31 Formex wire and the resistance was about right. This is not critical. To hold the windings in place, use household cement.

Select two of your cells that will deliver the most current and mount them with the same type of cement on the two remaining faces. Connect their terminals to the coil ends as previously described.

All you need now is a field magnet. A horseshoe magnet (or two bar magnets, one on either side and properly poled) would be excellent. The motor will operate on only one magnet as shown in Figure 8-3, but two will produce better results. An ordinary pair of pliers can be used for a field magnet. These can be magnetized, as described for the pendulum plunger, by wrapping bell wire on the handles and connecting the terminal ends of the wire momentarily to an automobile battery. Be sure to wind each handle of the pliers so that the ends are of opposite polarities. Two large files when given the car battery treatment can be used.

Although makeshift magnets will operate the motor, a really good field magnet will illustrate an important and fascinating property of direct current motors. With a strong magnet, the motor will operate on comparatively little light, but only slightly faster on very strong light. But if the field magnets are now slowly withdrawn, thereby *weakening* the field, the motor will first *increase* in speed before stopping. Before illustrating this to your friends, consult any standard text on direct-current motors for the explanation if it is not already understood.

Your motor should run well on sunlight or with a 100-watt lamp placed close to it. The light must come from only one side in a direction approximately perpendicular to the field of the magnet. In demonstrating this motor, you can show that it will reverse directions if you introduce the light from the opposite side, or reverse the position of the field magnets.

You may have to give the motor a slight push to start it as there are two dead spots where there is no torque. If you want to put on three windings and three cells, you can make a motor that will always start. The windings may be separate or you can keep the resistance down by interconnecting them. I leave this problem to you with the assurance that it is possible and has been done.

Radio Receiver

This project is a very simple solar-powered radio. Here, as in all of these demonstrations, the project has been simplified to a bare minimum for reasonable operation. The radio receiver described