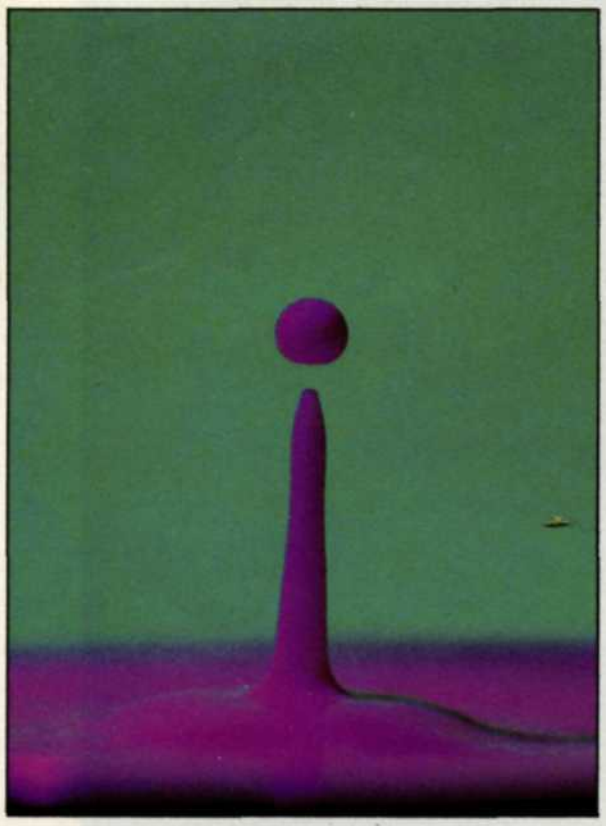
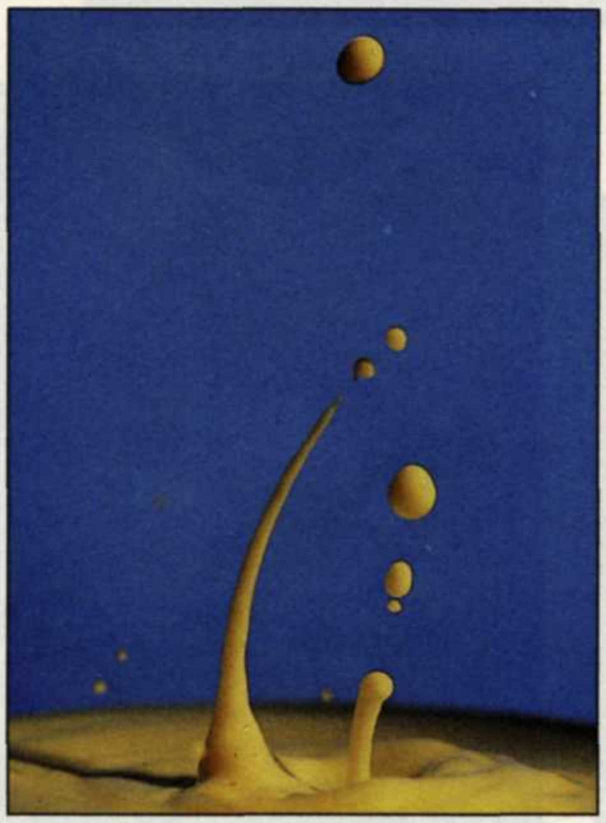
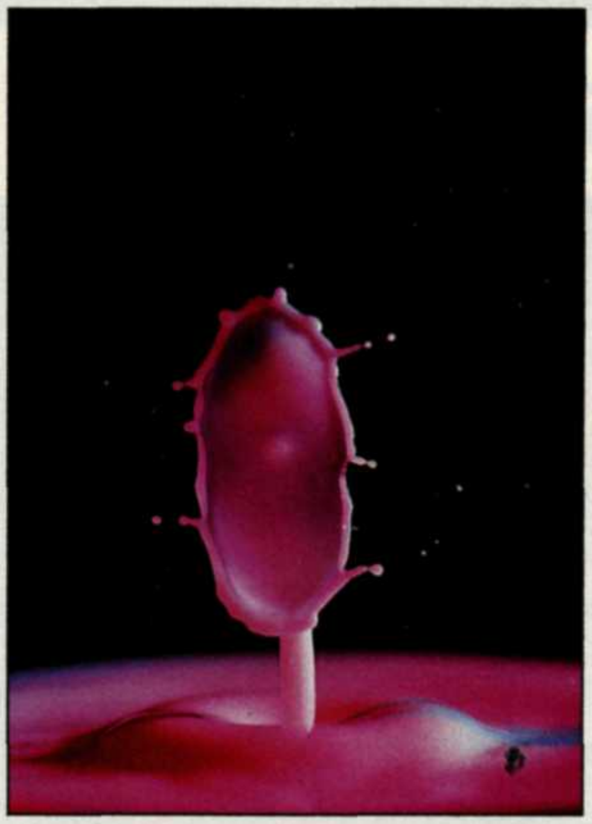
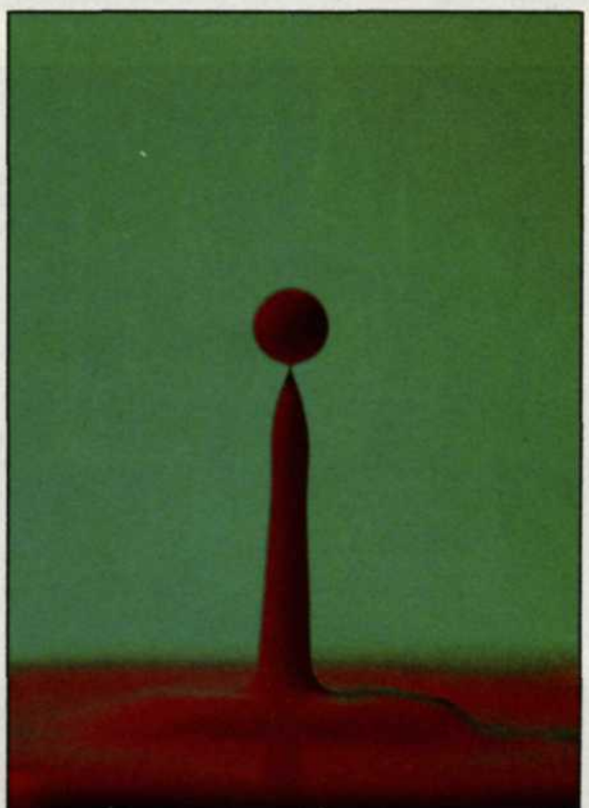




Build a Synchronizing Flash Trigger

Here's a Simple Project for Great High-Speed Results

One of the many things photography has done is allow us to see things that happen too fast for the eye to catch. In the 1880's Eadweard Muybridge used a camera—a series of cameras, to be exact—to prove that a trotting horse does occassionally have all four feet off the ground. Before Muybridge, no one had ever "seen" exactly how a horse runs, since any event that occurs in less than a tenth of a second appears to the eye as a blur. In old paintings we see horses caught in mid-stride with all four legs extended—a posture that never really occurs at all.

Although the shutter speeds of up 1/2000 second that Muybridge used in his motion experiments were astounding in his day, in today's world, where we see flash exposures as fast as a millionth of a second, Muybridge's work could hardly even be considered high-speed photography.

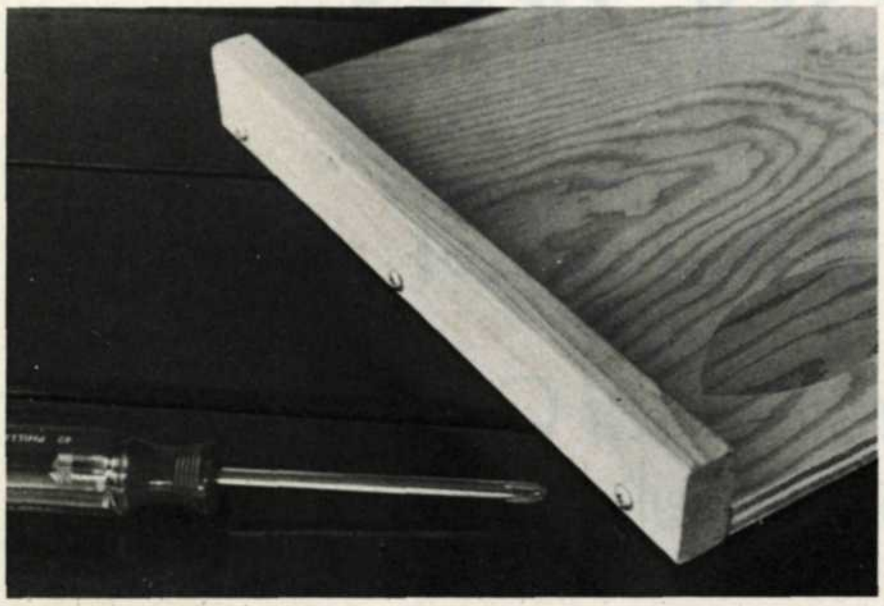
It wasn't until the 1930's, when Dr. Harold E. Edgerton developed the electronic strobe, that truly high-speed photography evolved. One of his earliest and most famous subjects was a drop of milk falling into a saucer. Edgerton used a flash exposure of about a millionth of a second, but as you can see from the accompanying photographs, the common electronic flash, with speeds that reach about 1/50,000 second, is sufficiently fast to freeze the motion.

In fact, the main problem with doing this experiment is not freezing the action, but rather timing the exposure so you catch the drop in the right position. Since the event takes place faster than the photographer can react, the exposure must somehow be tripped by the subject itself. Muybridge strung a trip-string across the horse's path to set off his series of cameras. For the milkdrop experiment we need a precise electronic timer coupled with a photoelectric switch.

What follows are instructions for building a simple electronic "trip-string" and a platform for setting up the milkdrop experiment. The instructions are divided into three parts: (1) construction of the drop tower, (2) assembly of the electronics, and (3) final assembly and testing.

By Jack W. Drafahl, Jr. and Patrick Rice

Synchronizing Flash Trigger



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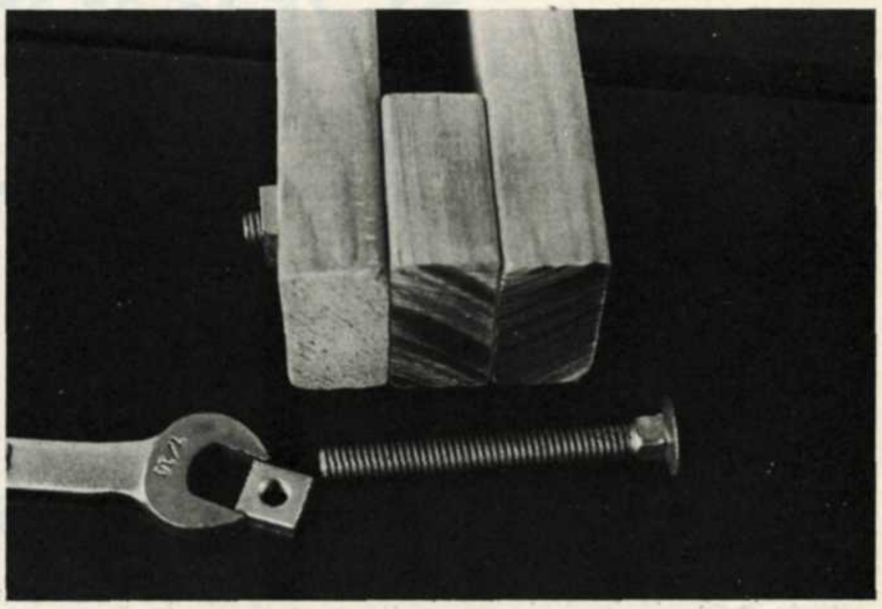

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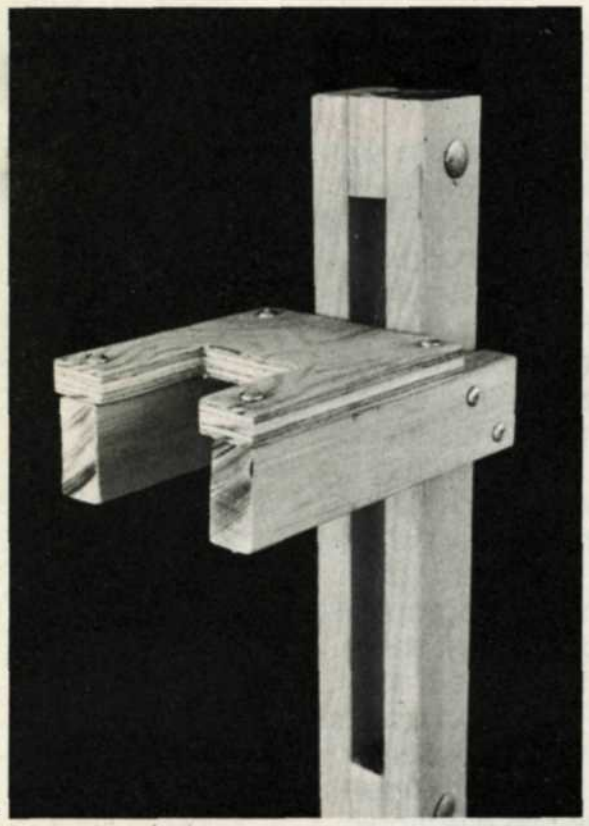

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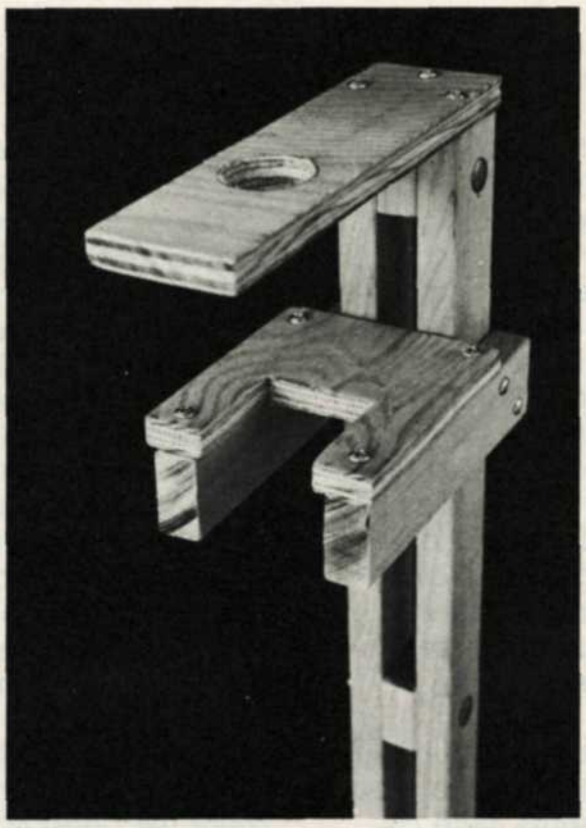

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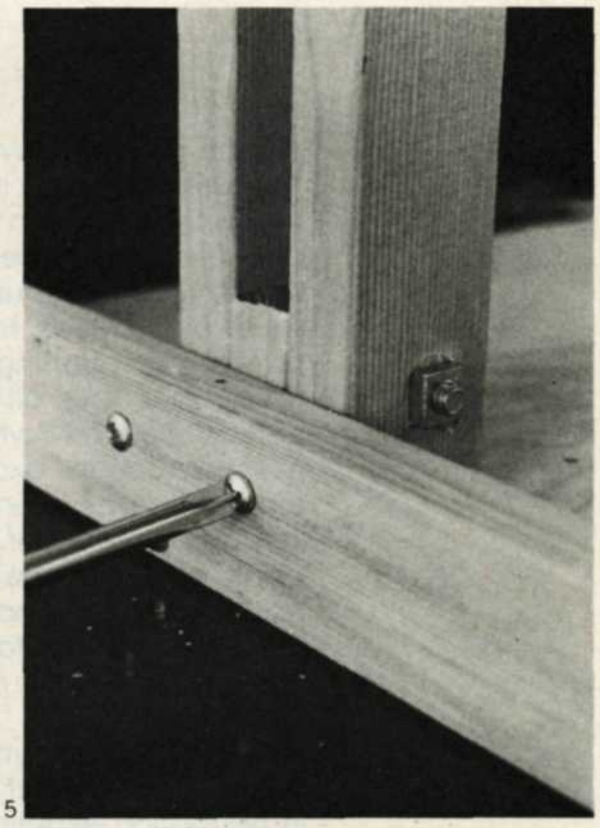

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Construction of the Drop Tower

The drop tower can be built out of a variety of materials such as metal, plexiglass, or wood. We chose wood because ordinary shop tools are all that's necessary to work with it.

MATERIALS:
6½-foot length of 1×2-inch wood
Small sheet of ½-inch plywood
Three ¼×½-inch carriage bolts
Three ¼-inch square nuts
Sixteen 1½-inch oval-head sheet-metal screws
1½-inch flat-head wood screw
Plastic film can

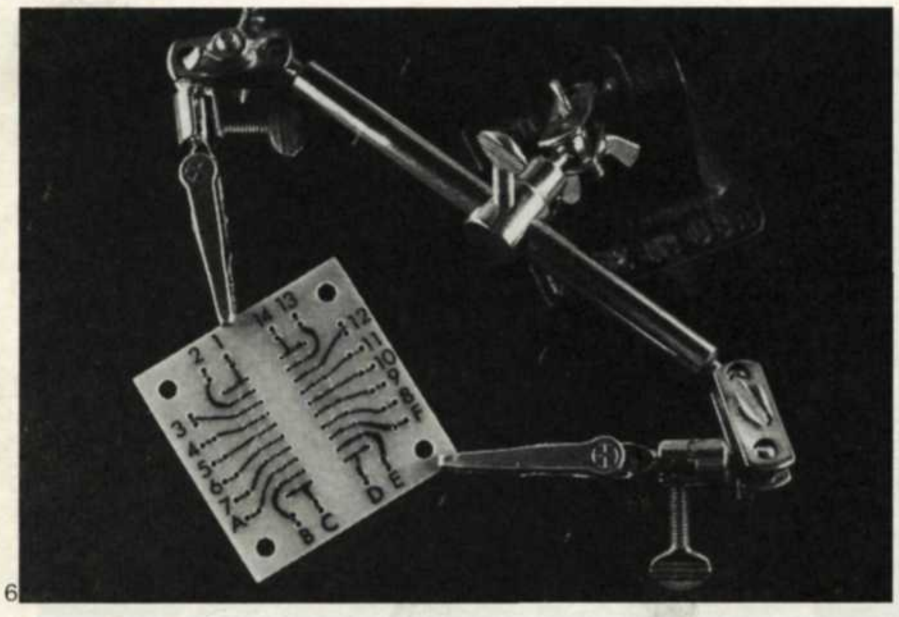
TOOLS:
Circular hand saw
Jigsaw
Drill with the following bits: ¼-inch, 3/16-inch, ⅝-inch, and 5/16-inch
Phillips screw driver
7/16-inch open-end wrench
Tape measure
Pencil

To begin, cut all the wood components. First cut the 6½-foot length of 1×2 into these sizes:
Two pieces 24 inches long
Two pieces 6 inches long
Three pieces 1½ inches long
One piece 12 inches long

Cut the plywood into these sizes:
One piece 12×16 inches
One piece 4½×4 inches
One piece 2¼×8 inches

1. Begin the assembly of the drop tower with the base. Take the 12×16-inch plywood sheet and attach the 12-inch length of 1×2 to one of the sides of the plywood using the drill with the 3/16-inch bit. Drill the holes about half the depth of the screw and then insert the screws.

2. Next, construct the tower itself. Place one of the 1½-inch pieces of 1×2 between the two 24-inch lengths at one end, hold together firmly, and using the ¼-inch bit, drill completely through the three pieces.



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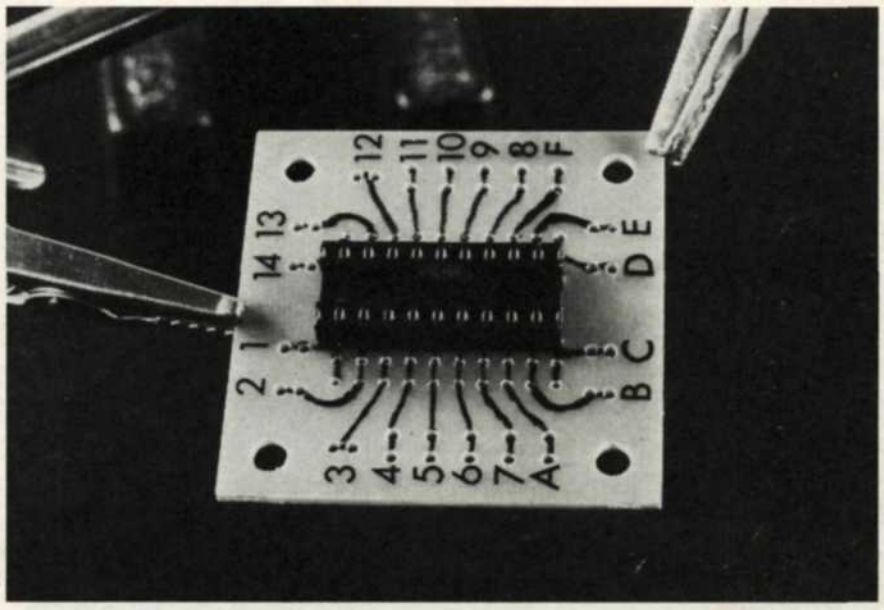

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Insert the carriage bolt and tighten the nut. Repeat this procedure on the other end and in the middle of the tower structure.

3. The electronics platform is assembled as follows:

Take the 4×4½-inch piece of plywood, and with a pencil and tape measure mark out a 2×2-inch segment centered along one of the 4-inch sides. Cut the segment out with a jigsaw.

Take one of the 6-inch 1×2's and attach it 4 inches down from the top of the tower on the outside, perpendicular to the tower. Use the 3/16-inch bit and drill through the 6-inch piece and a quarter of an inch into the tower.

Insert a sheet metal screw; drill a second hole and insert another screw. Repeat this procedure on the opposite side.

Attach the plywood piece with the 2-inch opening facing outward. Use the 3/16-inch bit. Place a screw at each corner.

On the right side of the platform brace, drill a 5/8-inch hole (not shown) to within a quarter inch of going through the other side.

Change to a 5/16-inch bit and drill completly through. This hole will hold the timing control (potentiometer).

4. For the milk container platform, take the 2¼×8-inch piece of plywood and mark with a pencil a point 5¼-inches up the center length of the plywood. Using the film can as a template draw a circle around the pencil mark. Use the jigsaw to cut the circle out just inside the line. Attach this platform to the top of the tower using the 3/16-inch bit in the drill and three sheet metal screws.

5. To complete the assembly of the tower, drill two holes through the base back-support three quarters of an inch on either side of the midpoint. Screw two screws through the holes and into the tower structure. Screw the flat-head wood screw through the bottom of the baseboard and into the bottom of the 1½-inch 1×2 piece at the base of the tower structure. Paint the tower flat black.

Electronics Assembly

The electronics for this project may look complicated, but if each step is followed in the order described, assembly is simple. If you feel that you would be totally inept at soldering these small pieces together, you might enlist the help of a friend who has more of a background in electronics than you.

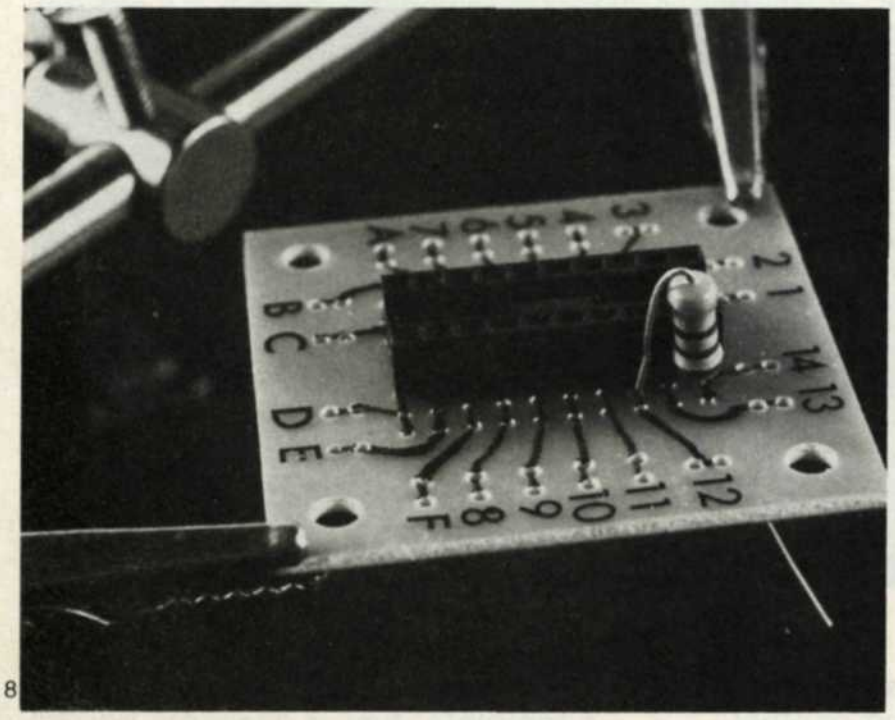
MATERIALS (All part numbers are for Radio Shack parts):
10 K ohm resistor (271-1335)
3.3 K ohm resistor (271-1328)
Two 1.8 K ohm resistors (271-1324)
680 ohm resistor (271-0021)
2.2 megohm resistor (271-061)
.1 capacitor (272-135)
.05 capacitor (272-134)
.005 capacitor (272-130)
20-pin IC board (276-159)
20-pin socket (276-1991)
8-pin socket (276-1995)
Dual timer No.556 (276-1728)
Red LED (276-041)
Green LED (276-022)
AA Battery Pack (270-391)
2 megohm variable resistor (271-093)
Photo transistor (276-130)
Opto-isolator MOC 3010 electronic switch (276-136)
Wire, black and white
Light bulb, 5 to 6 volt
PC sync chord (from a camera store)

The total cost of the electronic parts is approximately $20.

TOOLS:
Soldering Iron
Solder
Heat shrink
Electrician's helper

6. Label the front and back of the circuit board. Connect the holes on the front of the board with a marking pen to correspond to the back of the board.

7. Insert and solder the 20-pin socket (271-1991) to the board. Remove pin 3 before inserting.



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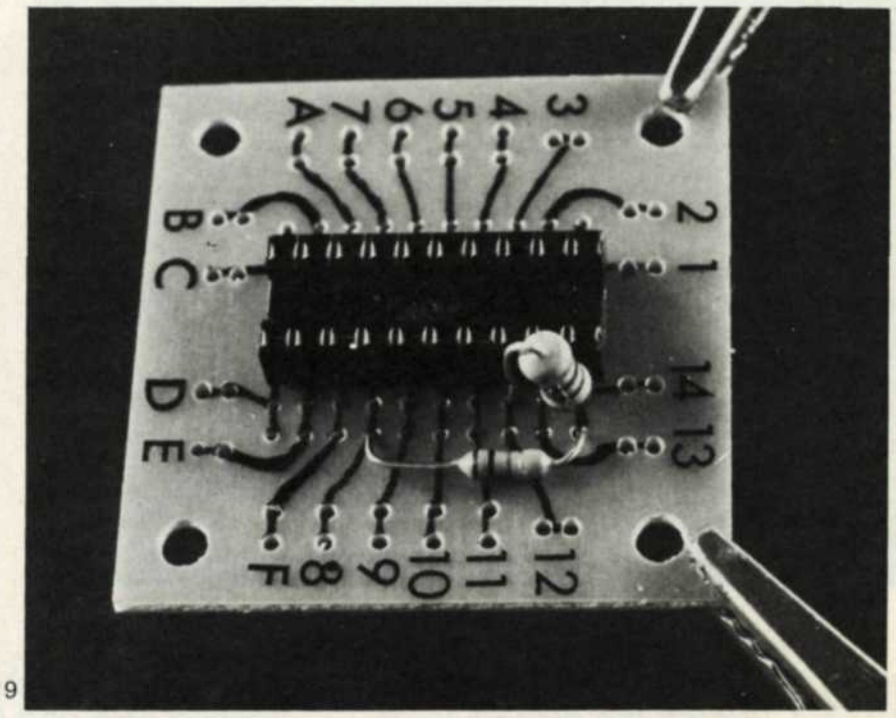

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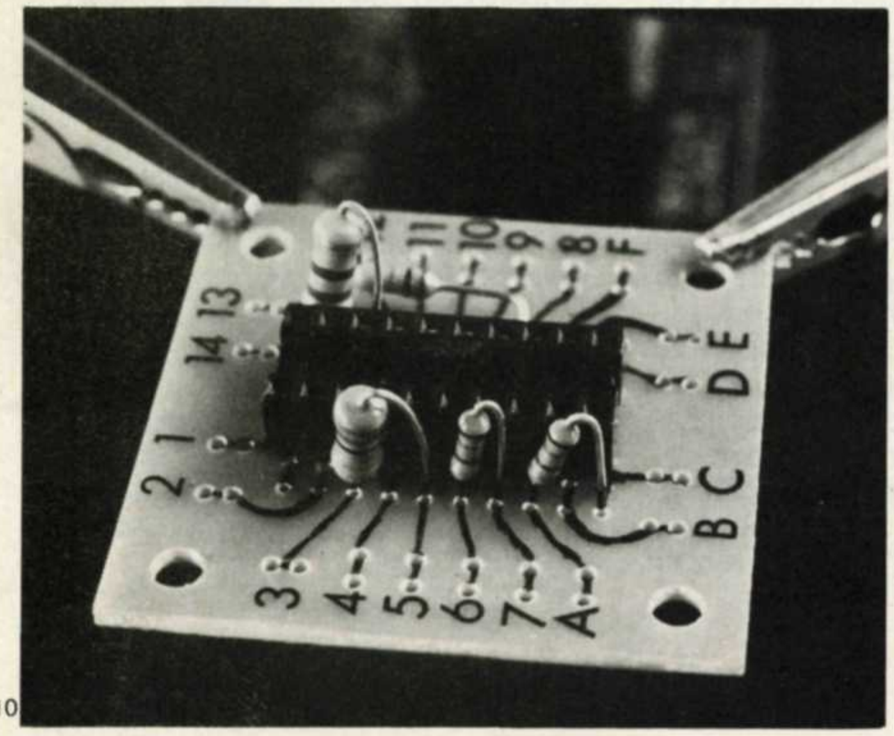

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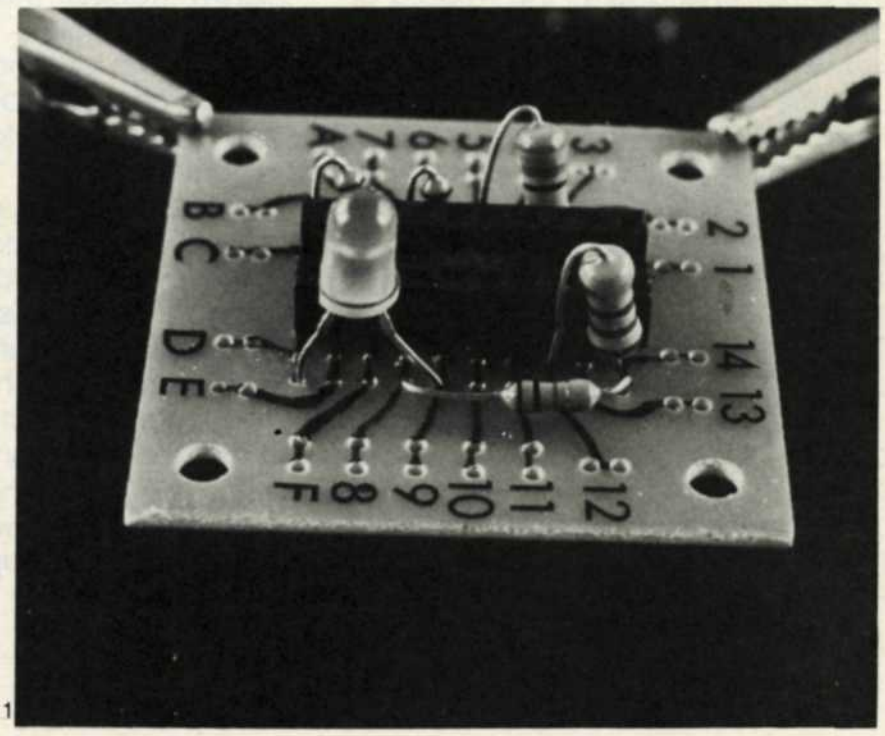

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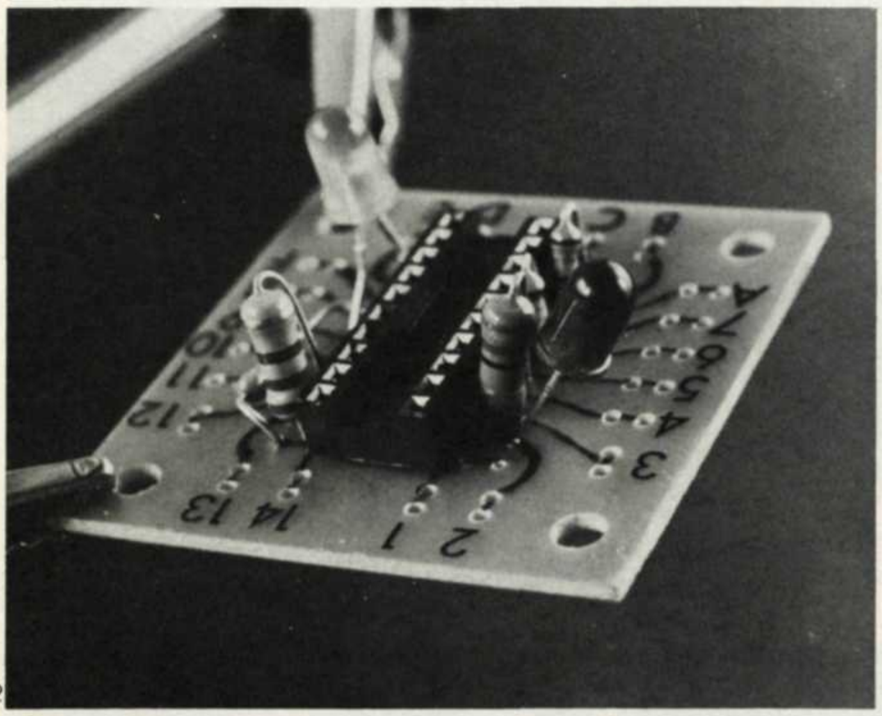
Electronics Assembly

8. Solder the 2.2 megohm resistor (271-061) from pin 14 to pin 12.
9. Solder the 10 K ohm resistor (271-1335) from pin 14 to pin 8.
10. Solder the 680 ohm resistor (271-0021) from pin 3 to pin 5. Solder one 1.8 K ohm resistor (271-1324) from pin 6 to pin 7. Solder the other 1.8 K ohm resistor (271-1324) from pin A to pin C.
11. Solder the green LED (276-022) from pin 9 to pin D, with the short lead or flat side to pin D.
12. Solder the red LED (276-041) from pin 3 to pin 4, with the short lead or flat side to pin 3.
13. Apply shrink-fit insulation to the .1 capacitor (272-135) and solder it from pin 2 to pin 7.
14. Solder the .05 capacitor (272-134) from pin 12 to pin E, and the .005 capacitor (272-130) from pin 5 to pin 8.
15. Solder five jumper wires:
Pin 12 to pin 13
Pin 7 to pin E
Pin 1 to pin 2
Pin 4 to pin 14
Pin 10 to pin 14
Solder the battery holder (270-391) red wire to pin 10, black to pin E (not shown).
16. Solder the 2.2 megohm resistor (271-061) to the center post on the 2 megohm pot (271-093). Solder an 8-



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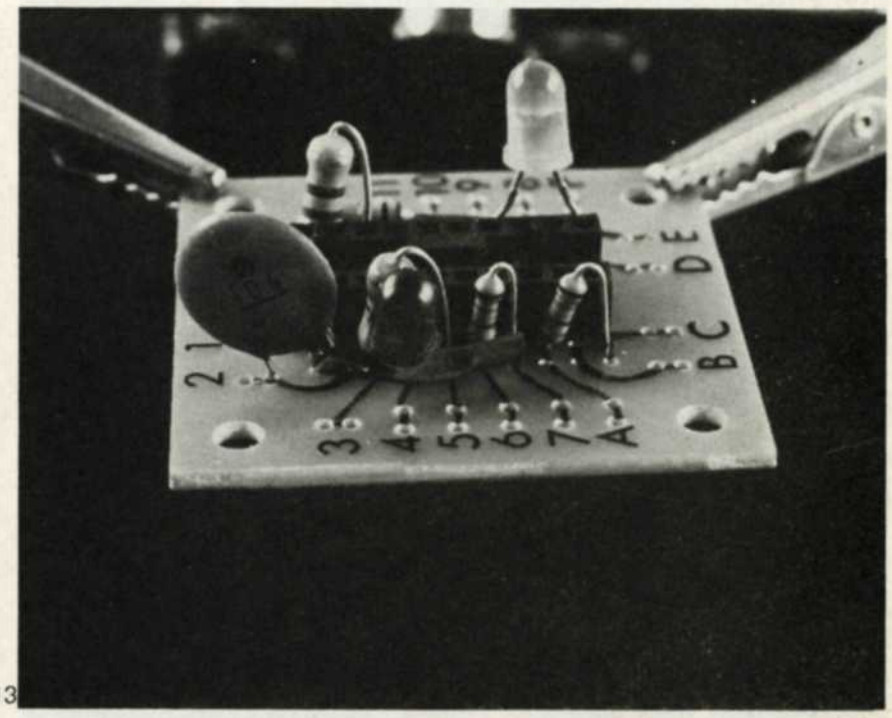

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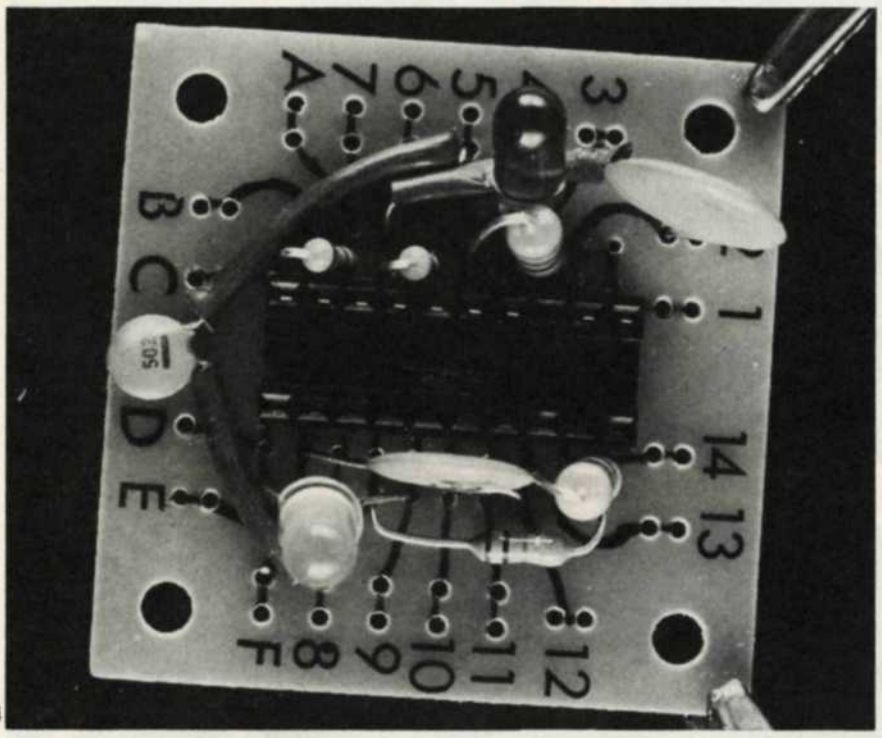

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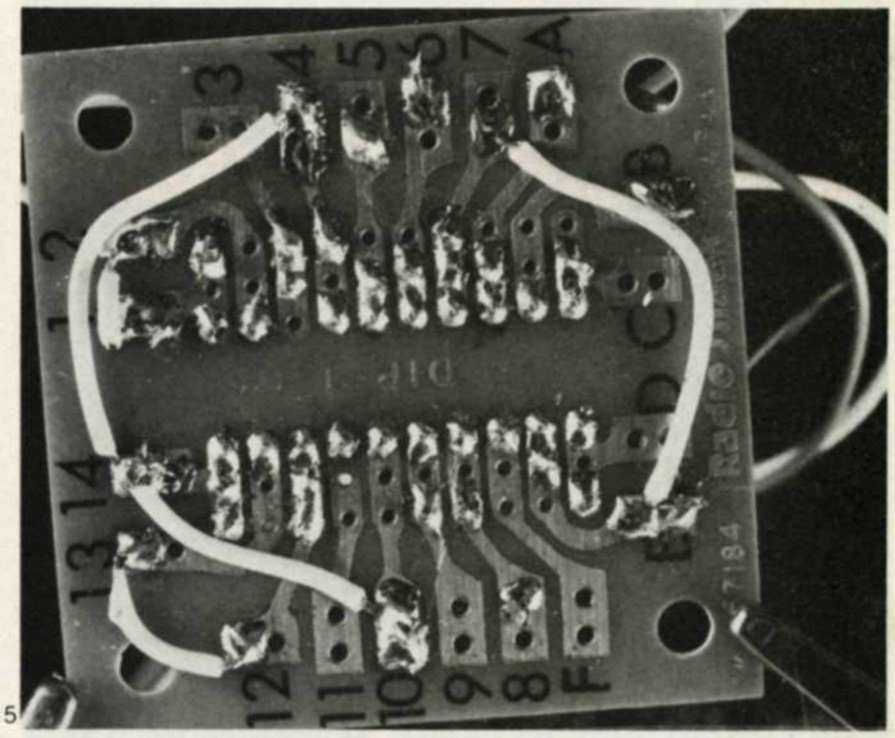

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inch wire from the end of the resistor to pin 4. Solder another 8-inch wire from the left post of the pot to pin 1. The right post is not used.

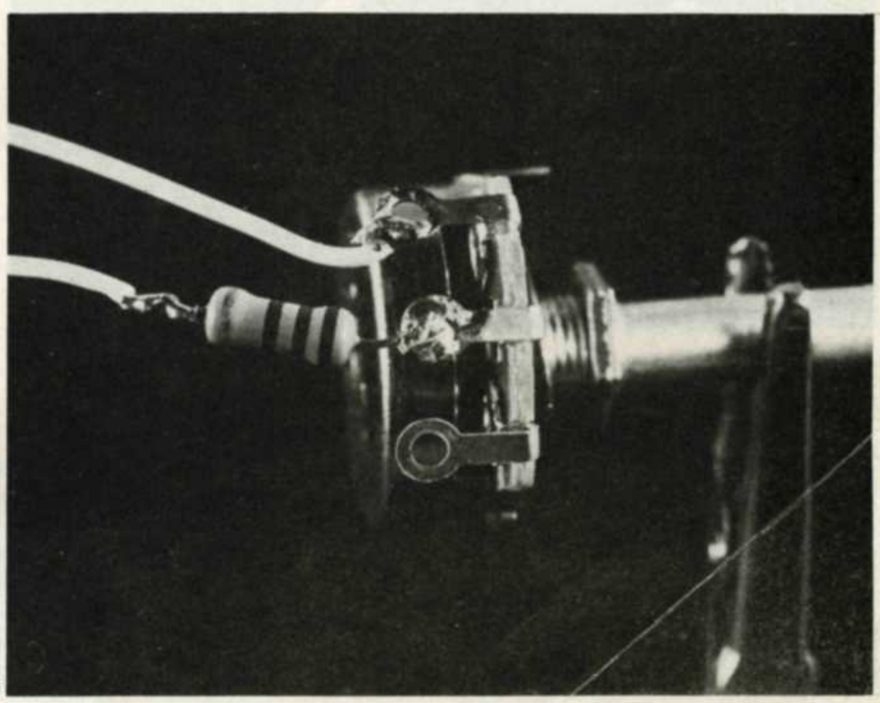
17. Solder wires to the photo transistor (276-130) as follows:

Solder 5 feet of white wire to pin B (positive sync wire).
Solder 5 feet of black wire to pin A (negative sync wire).

18. Solder the 5-6-volt lamp to pin 10 and pin E using 8 inches of wire.

At this point double check steps 6-18.

19. Remove two end pins from the 8-pin socket (276-1995), making it into a 6-pin socket. Notch the opposite end of the



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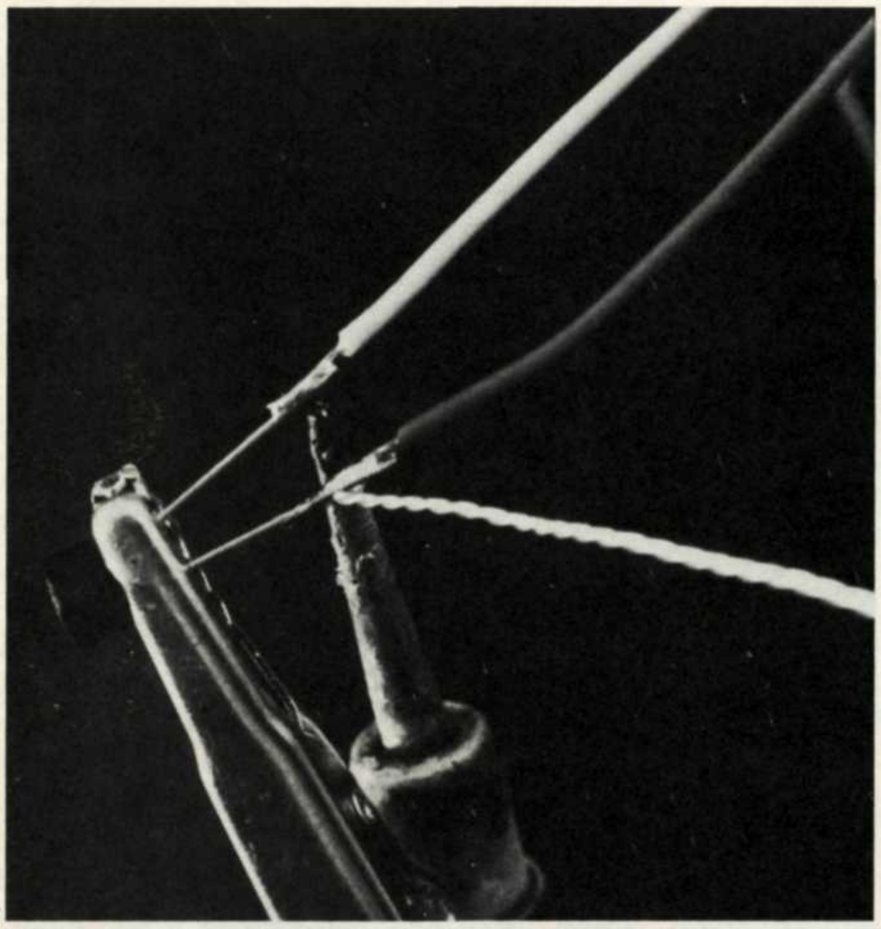

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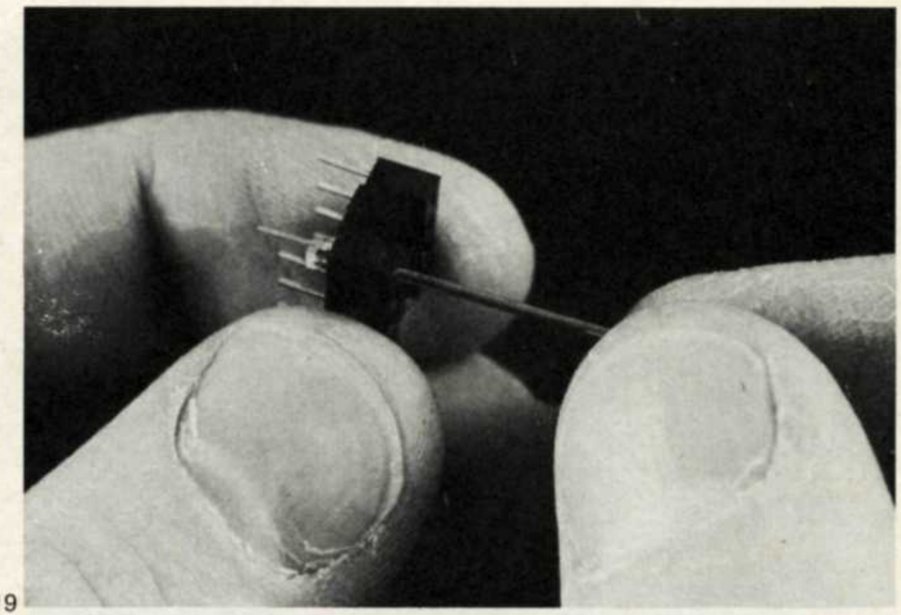

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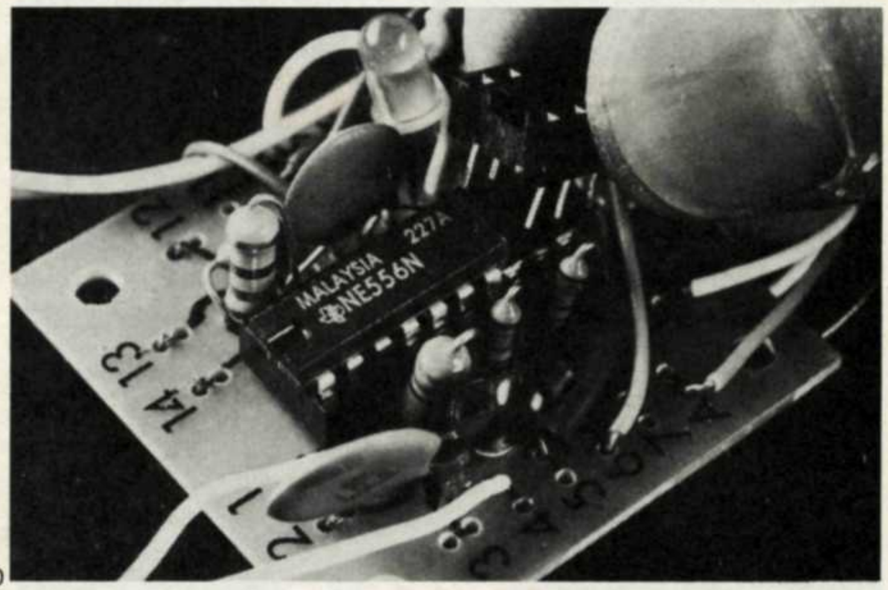

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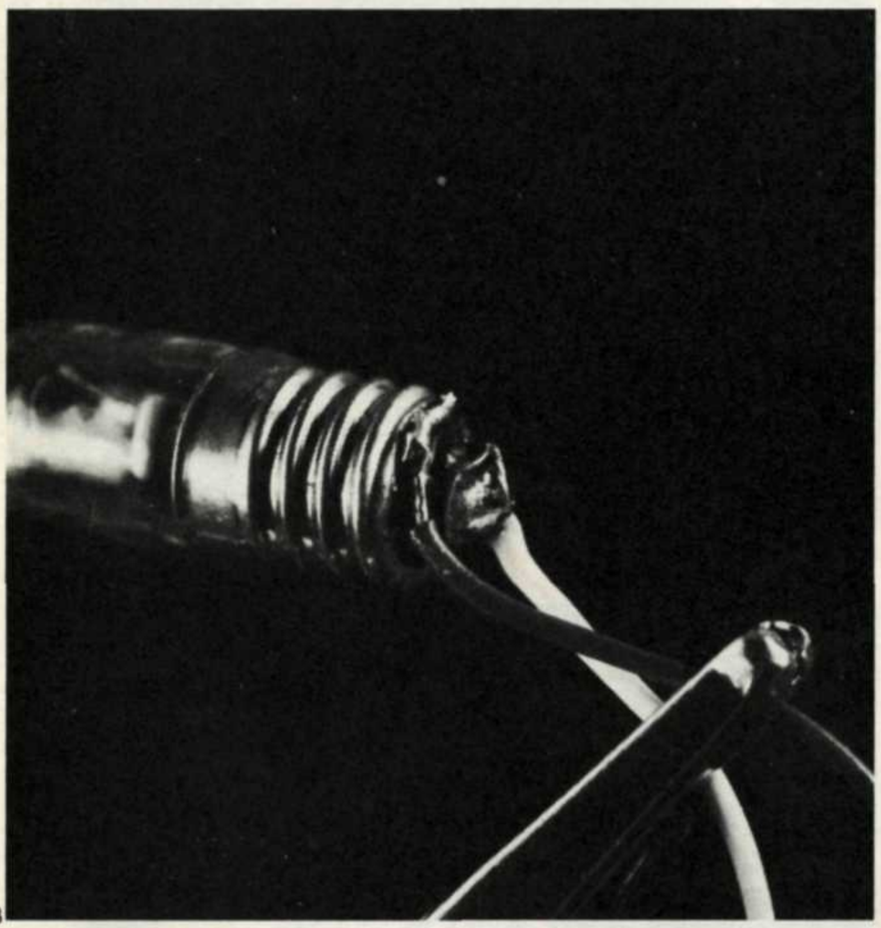

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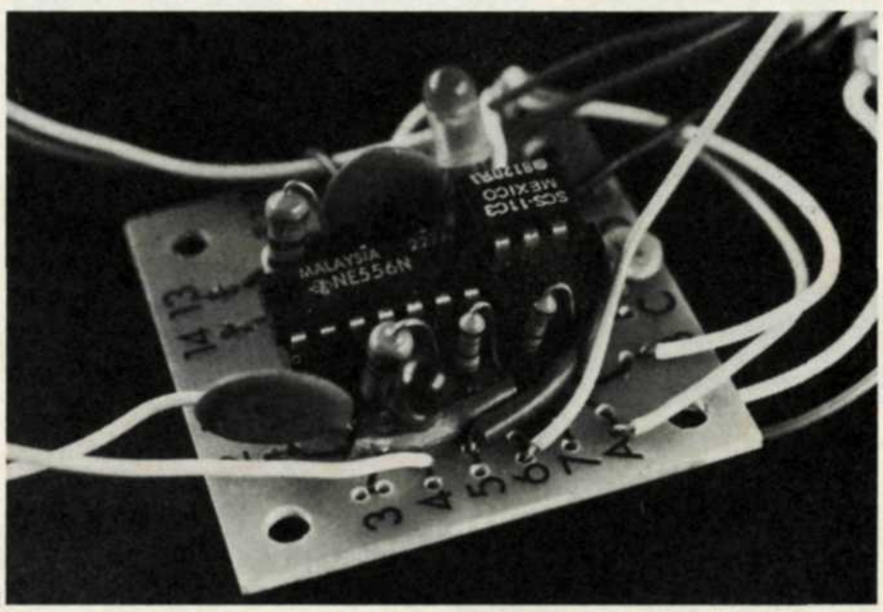

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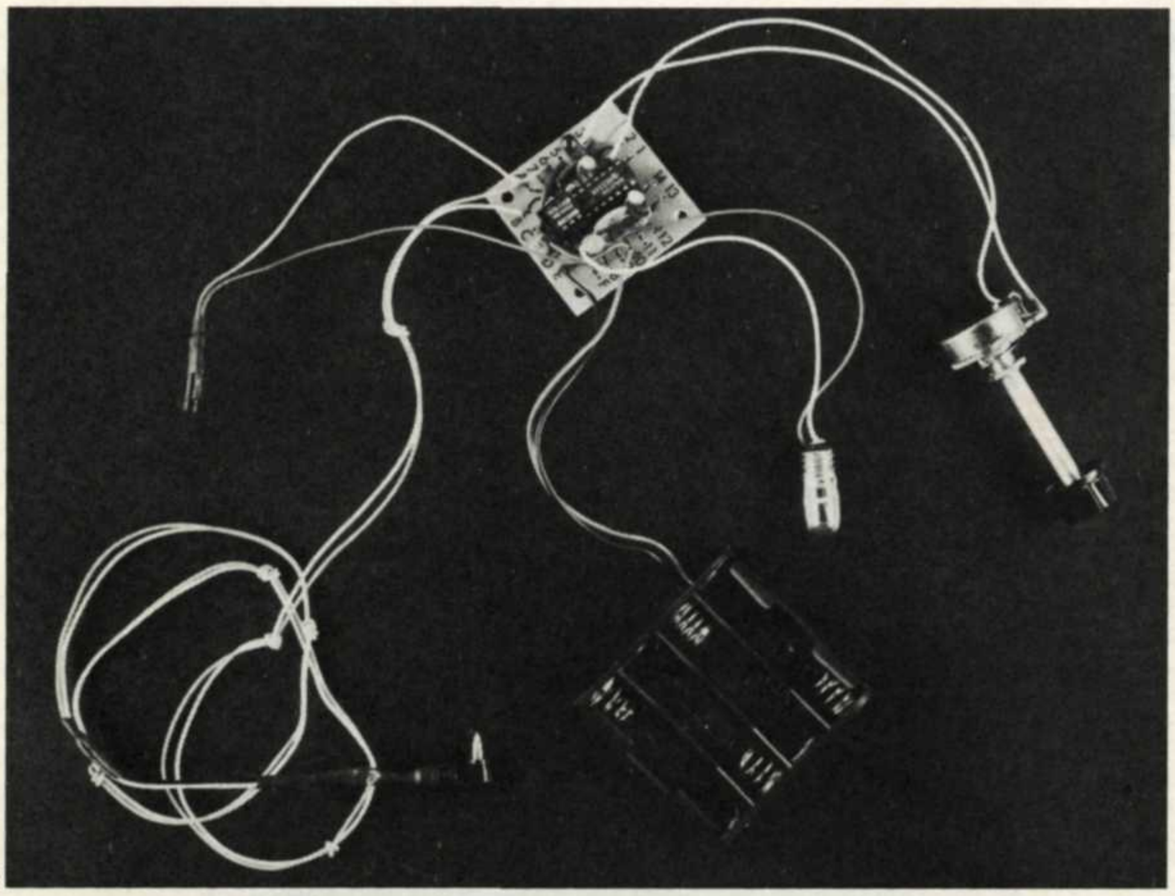
socket as shown in photo 20.
20. Insert the 556 timer (276-1728) into the 20-pin socket so that the rectangular notch on the timer is between pin 1 and pin 14 on the board. Insert the modified 8-pin socket (276-1995) into the remaining six pins. This socket-to-socket technique elevates the next part above the 556 timer for easy removal. If this stacked socket is not used the two parts that fit in the 20-pin socket fit so tightly they are almost impossible to insert or remove.

21. Insert the opto-isolator (276-136) so that the dot on the top of the part is towards pin D on the board.
22. Solder the white wire from pin B to the positive wire of a PC sync cord, and the black wire from pin A to the negative wire of the PC cord.



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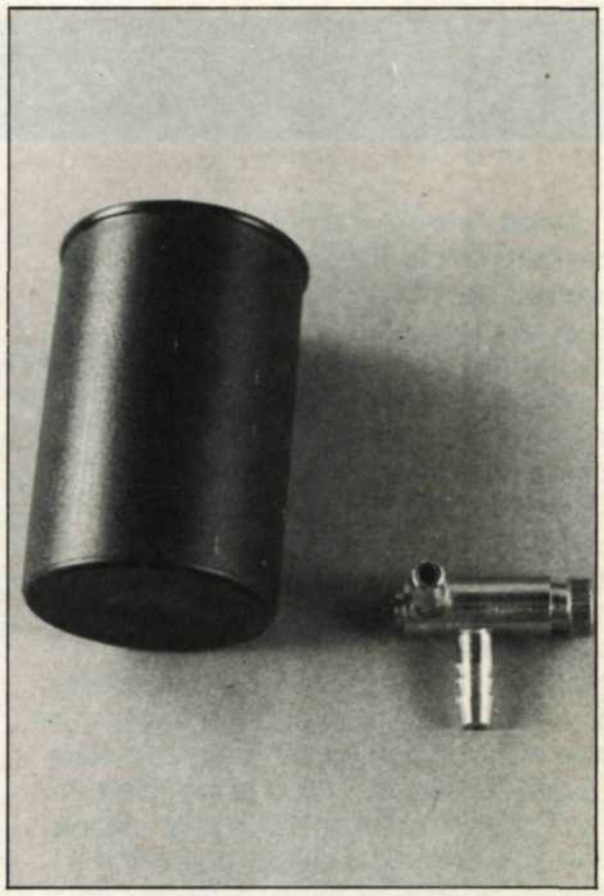

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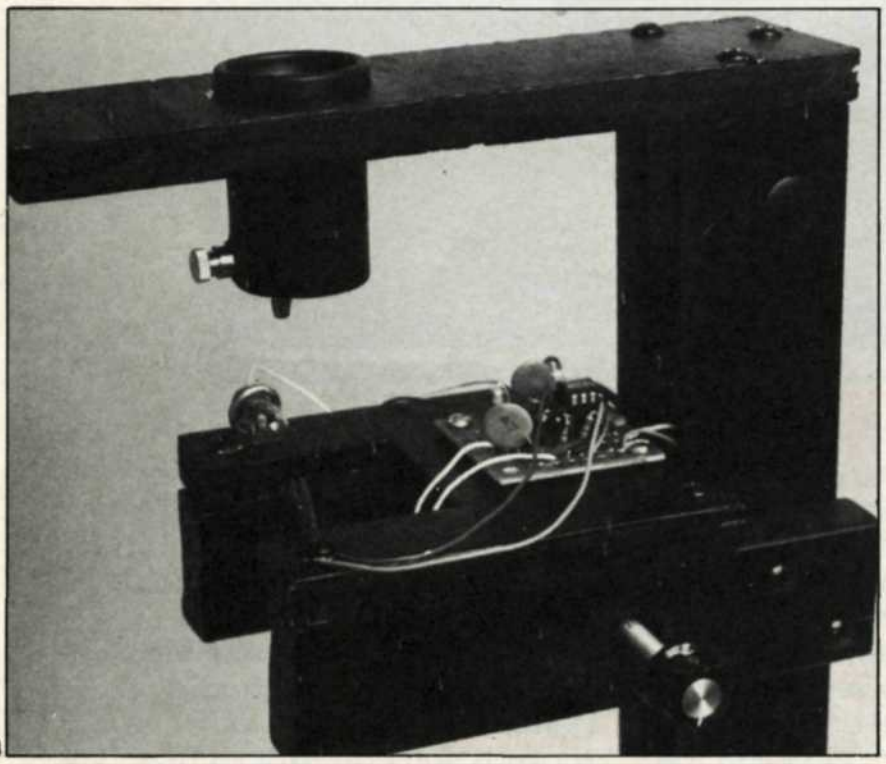

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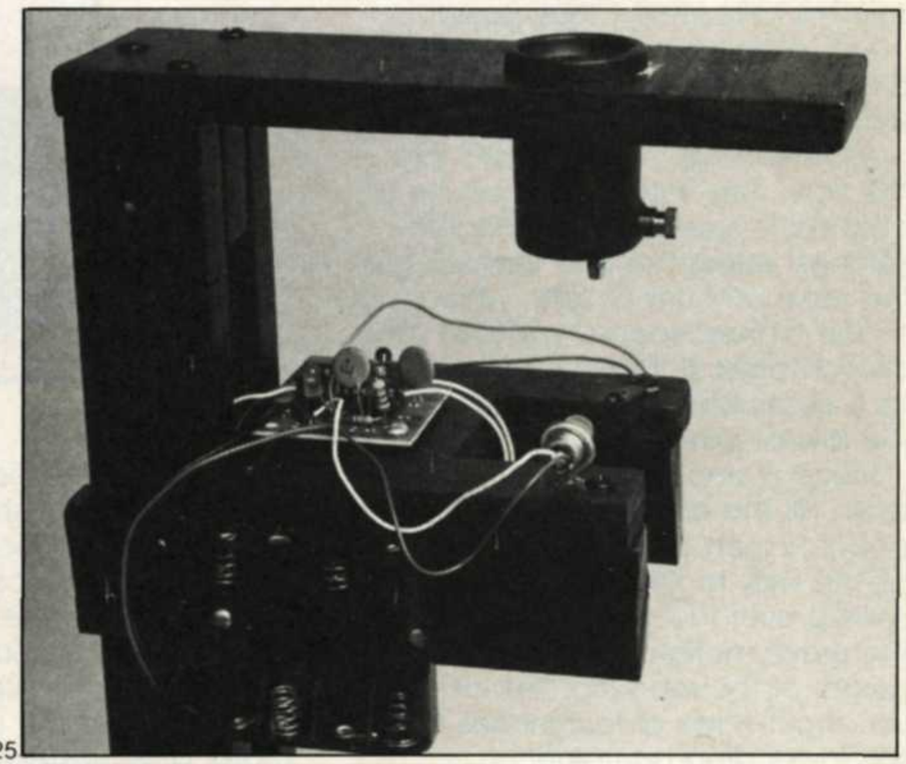

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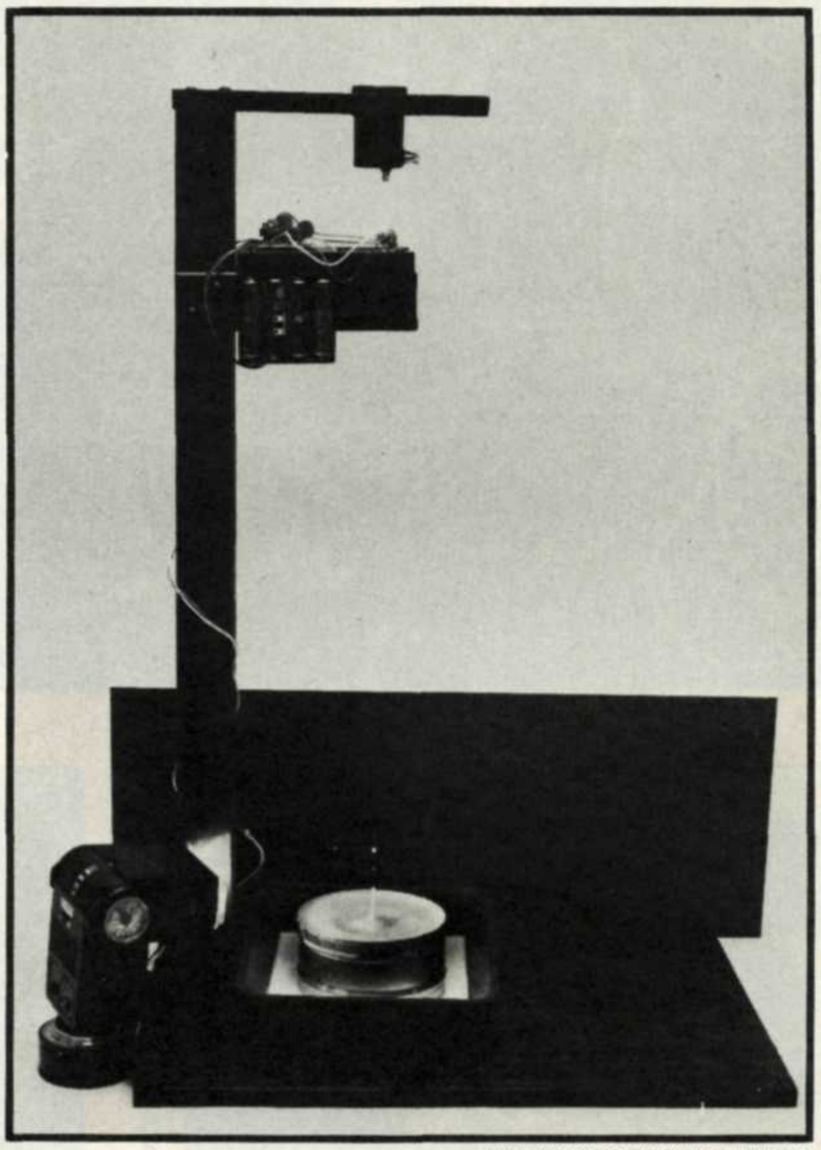
Final Assembly and Testing

23. The drop container is made from a film can and an aquarium air valve as shown in the photo. The film can and valve are seated into the hole of the upper level.
24. Mount the circuit board on the second stage of the drop tower with two screws. Mount the light bulb on one side of the second stage opening and the photo transistor on the opposite side. They should be pointed directly at each other about one inch apart. Insert the 2-megohm pot into the hole on the side of the second stage, and secure it with the nut provided.
25. Mount the battery pack on the opposite side of the second stage. Wrap the two remaining sync wires around the tower column and route them through the base.

Basic Check of the System



ALL PHOTOS BY THE AUTHORS

Insert four AA batteries into the battery pack. The 5-volt lightbulb should be lit. If not, check the bulb. The red LED should also be on. If not, move the photo-transistor to achieve better alignment. The red LED is the alignment indicator lamp. Pass a pencil between the photo-transistor and the 5-volt lamp. The green LED should blink. The green LED is the firing signal check lamp. If the red LED is on but the green LED does not blink when the pencil is passed through the trigger, check the position of the opto-isolator to make sure it is not in backwards (step 21). Also check to see that you have the correct part. If neither LED lights, check the 556 timer (step 20) to see if it is in the correct position. A review of steps 6 to 22 is the best way to correct the problems if they persist.

Assuming all the electronics work, a trial milkdrop is in order. Pour a small amount of milk into the top container. Plug the sync cord into the flash. The flash used must be an automatic type. If it has variable settings, select the one that will give the least amount of light, which is also the highest speed, 1/40,000 second or faster. If it has a vari-power, as is available on the Vivitar 283, use the lowest power setting.

Place a small container under the drop. Fill the container with milk to about ¼ inch of the top. Do not fill it all the way to the top because milk spilling over the side will dampen the wave motion and restrict the height of the rebound. Set the flash up about three of four inches from the lower drop container.

Open the valve on the upper drop container slowly so that it takes several seconds for a drop to form. Turn off the room lights. Watch for the position of the drop when the flash fires. It may be in mid-air. Turn the pot on the drop tower after each drop until the desired time delay is accomplished. Set up the camera and focus on the milk drops. Set the shutter speed to B and attach a cable release. Just before a drop falls, open the shutter until the flash fires, and then close the shutter. Make several exposures using various f-stops. Adjust the pot to get variations of drops crashing into the container below. A second slave flash, filters, food dyes, color backgrounds, etc., all add to the creative part of the milkdrop experiment.

A more automated version of this setup requires the use of a winder or motor drive. Instead of plugging the sync wire into the flash, the sync wire can be inserted into the winder. The milk drop signal could fire the camera, which would fire the flash and advance the film. By varying the pot between each shot, an entire sequence of falling milkdrops can be documented on one roll of film.

Three changes are necessary to the electronics before the sync can be hooked up directly to the camera. First, remove the 2.2 megohm resistor in step 16 and solder the wire directly to the center post. Second, remove the opto-isolator number 276-136 in step 21 and replace it with opto-isolator number 276-134. Third, change the PC plug to a type of jack that will fit your motor drive or winder.

The milkdrop experiment recalls the famous series of shots by Dr. Edgerton, but there are many other subjects you can explore using your flash trigger. For a sophisticated extrapolation of our simple setup, see Stephen Dalton's beautiful shots of birds and flying insects in his book *Caught in Motion.*

And don't think this project is too much for you to handle. It has been attempted by an average photographer with basic knowledge of woodworking and no knowledge of electronics. By following the instructions given, he was able to complete the project with no problems, and some of the resulting photos are shown in this article. ■