A Simple Escapement Mechanism

It's a wrap!

Early mechanical clocks were often powered by gravity, in the form of falling weights. Even today, the pendulum and chimes in many "grandfather" clocks are still driven by falling weights, which must be wound back up to their original heights every few days. Other mechanical clocks are driven by springs. But all mechanical clocks include some sort of ***escapement*** mechanism, whose function is to control the energy the clock receives, and portion it out into small regular bits of movement. (Without an escapement, the weights on a gravity-powered clock would fall rapidly to the floor, or the spring on a spring-driven clock would rapidly unwind, possibly causing with the hands of the clock to race around the face of the dial!). The term *escapement* is associated with regulating the "escape" of energy from the weight or spring. The first known mechanical clock, and its escapement design, was a hydraulic clock attributed to a Chinese monk and mathematician, Yi Xing, around 725. The first weight-driven clock is attributed to Gerbert, a French monk who in 999 became Pope Sylvester II. Over time, many different and elaborate forms of escapements have been developed. The wrapping form of escapement you will build here is said to have actually been used in a fifteenth-century German clock.

Materials

pipette box (RAFT has these in abundance for almost no cost)
3 bamboo skewers (large diameter, approximately 3/16 in.) -- 2 cut to 9 in. and 1 cut to 7 in.
6 plastic drinking straws (diameter must be large enough to fit over bamboo skewers -- most readily available brands such as Safeway, Glad, or Solo will be OK -- straws with flexible section will work)
10 jumbo paper clips
1 regular paper clip
2 ft of light string (not heavy twine)
translucent tape (e.g., Scotch™ Magic™ Tape, or equivalent)
scissors
ruler
wire cutter (for cutting paper clip)
saw to cut bamboo skewers (e.g., band saw, sabre saw, coping saw, etc.)

Assembly

1. Use scissors to slit two of the straws along their entire length. See Figure 1

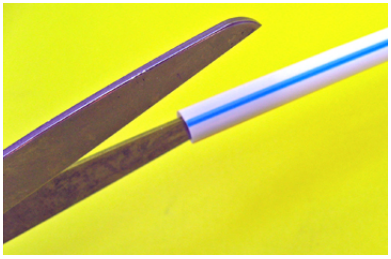

Figure 1

Figure 2

2. From one of these straws cut 3 pieces each 2 1/2 in. long. From the other straw cut 3 pieces each 2 in. long. Place a 2 in. piece around each of the 2 1/2 in. pieces to form three sleeve assemblies, as shown in Figure 2.

3. Insert the three straw sleeve assemblies in the appropriate holes in the base as shown in Figure 3.

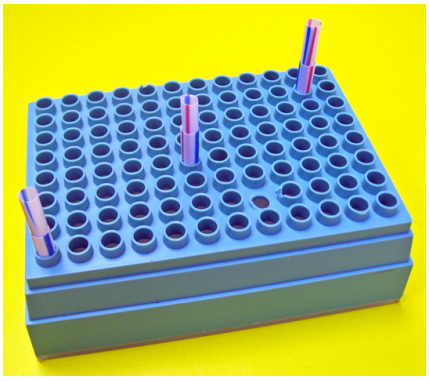

Figure 3

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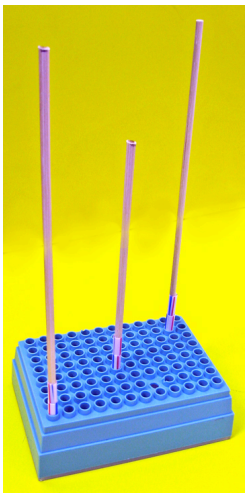


Figure 4

4. Use a saw (bandsaw, sabre saw, coping saw, etc.) to cut off the sharp ends of the bamboo skewers so that two of the remaining portions are 9 in. long, and one is 7 in. long. Insert the skewers in the appropriate straw sleeves, as shown in Figure 4. A closeup of a skewer in a sleeve is shown in Figure 5.

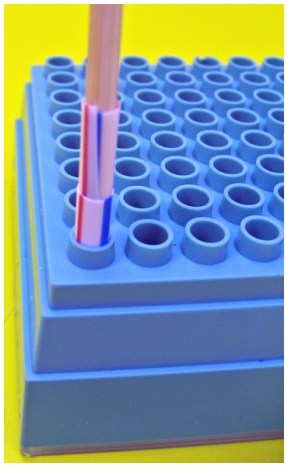


Figure 5

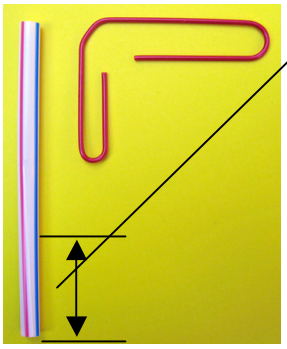


Figure 6

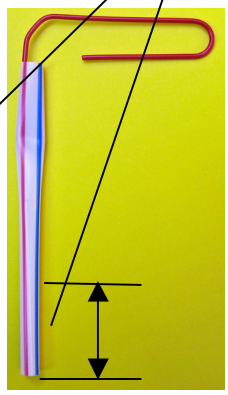


Figure 7

5. Cut a 3 1/2 in. piece from one of the remaining straws. Cut a lengthwise slit 1 1/2 in. long at one end of this piece --see Figure 6. Bend a paper clip as shown in Figure 6, and insert the smaller bent portion into the unslit end of the piece of straw as shown in Figure 7.

6. Insert the unit shown in Figure 7 into the appropriate hole in the base, as shown in Figure 8.

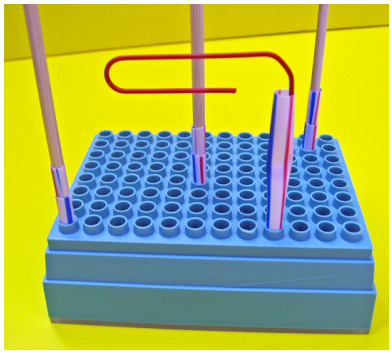
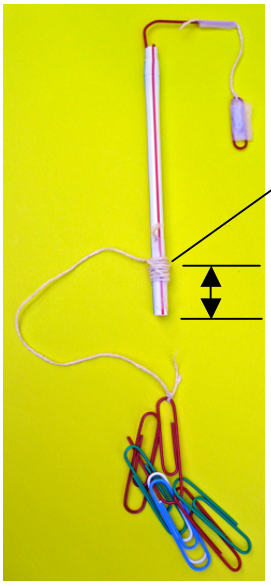


Figure 8



7. Cut one of the remaining three straws so that it is 5 in. long. Use this piece of straw, transparent tape, string and paper clips to assemble the unit shown in Figure 9 and 10. Place the unit on the central skewer so that the bottom of the inserted paper clip rests on the top of the skewer to provide a relatively low-friction bearing surface. See Figure 10 -- a transparent straw is used here to allow you to see how the paper clip rests on the skewer.

Figure 9

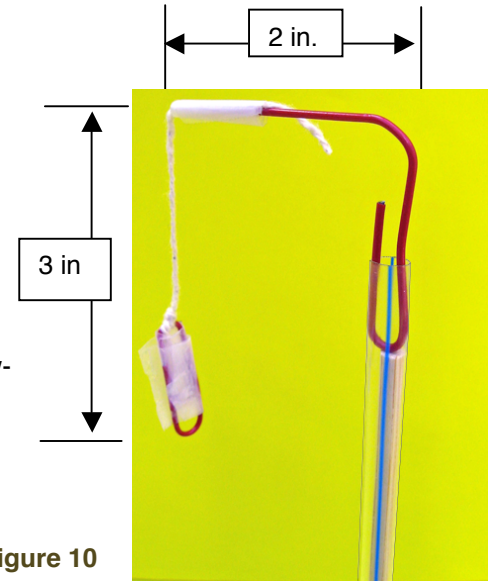


Figure 10

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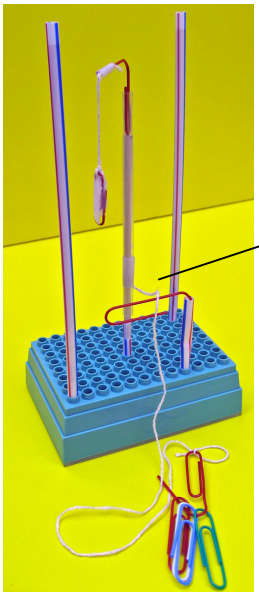
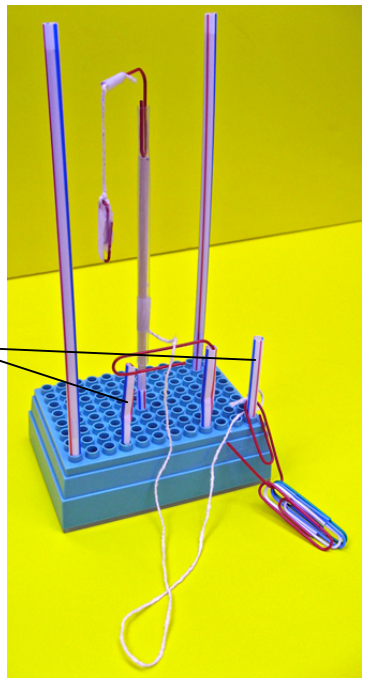


8. Place the remaining two full-length straws over the outer skewers. The assembly should now be as shown Figure 11.

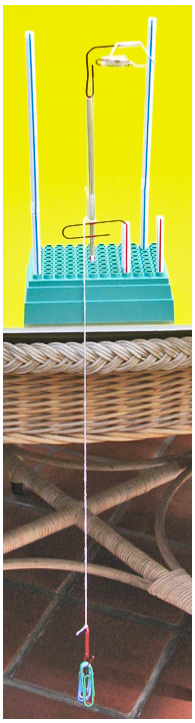
Figure 11



9. Lastly, cut two 3 1/2 in. pieces from the remaining straw supply, slit them lengthwise, and place them in the appropriate holes in the base, as shown in Figure 12. One provides a place to hang the paper clip weight assembly when not in use. When placed behind the paper clip "arm," the other will prevent the arm from rotating in toward the center skewer.

Figure 12

To Do and Notice



Wind up the string on the center straw. Place the base at the edge of a table, and let the paper clips hang over the edge so that when the paper clips are released, they pull on the string and rotate the straw. See Figure 13.

Figure 13

As the straw rotates, the string with the small paper clip at the end will wrap itself around one of the outside straws, unwrap itself, and then whirl around to repeat the process at the other straw. See Figure 14.

Figure 14

What's Going On

The series of starts and stops caused by the wrap-arounds provides the controlled release of energy and the marking of regular intervals of time that are characteristic of an escapement.

Going Further

There are several variables that can be investigated, including the number of jumbo paper clips used as the driving weight, the number small paper clips used for the swinging weight, the length of the string from which the small paper clip is hanging, etc.

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Credit
This "wrapping" escapement was adapted from a version in Bernie Zubrowski's ***Clocks***, noted in the References section below.

References

• Zubrowski, Bernie, **Clocks**, Harpercollins, 1988. See *The Swinging Escapement*, beginning on page 80.
• Macaulay, David, **The Way Things Work**, Houghton Mifflin, 1988. See *Mechanical Clocks and Watches*, p. 46.

On-line References for "Escapements"

Several of these sites have animations of escapements. I could not find a picture or description of the escapement we built today.

Escapements in motion:
www.geocities.com/mvhw/escapement.html

www.horologia.co.uk/escapements.html

Good definitions and pictures:
http://en.wikipedia.org/wiki/Escapement

www.gutenberg.org/etext/17021

www.answers.com/topic/escapement

www.brockengineering.com/mechanism/

http://www.roymech.co.uk/Useful_Tables/Cams_Springs/Escapements.html

Beautiful pictures of clocks and escapements:
www.horloger.net/06/escapements.htm

Books about Clock Escapements:

Practical Clock Escapements Book
By Laurie Penman

The Escapements Book
By F. J. Britton

Clock and Watch Escapement Mechanics
By Mark Headrick

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