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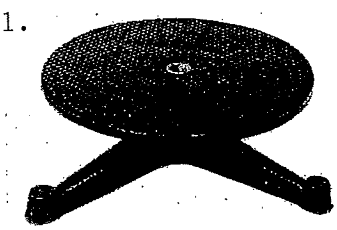
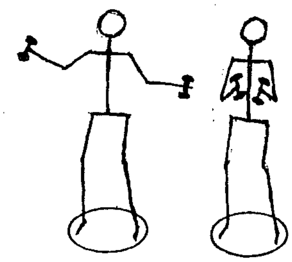
The rotating platform - was marketed by Cenco for decades in the 20th century; it was made of very heavy cast iron and rested on a tripod base (1.). It was expensive and envied by all because it worked so well; teachers and students loved it. Its primary purpose was to demonstrate conservation of angular momentum and gyroscopic phenomena using students; they could actually feel the effects (forces, velocities, etc.) involved. The heavy platform with its large moment of inertia made possible many other demonstrations via apparatus that could be attached to it. Thus, it had more than a few uses and was a valuable asset.

1.



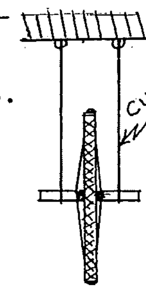
(a) Conservation of angular momentum using students: Using the equation mvr (before) = mvr (after), a student steps up onto the platform and gets a comfortable stance. The student is handed two 1 kg masses or two 2 lb. barbells. With outstretched arms, a gentle push on one arm begins the student's rotation. As the student brings the arms and masses inward, the speed of rotation increases. To slow down the spin, simply extend the arms outward again (2.). Everything happens as the equation predicts. For the students, this helps explain the customary spins of skilled figure skaters. Every student can participate; this activity was always performed during the short week before Thanksgiving.

2.



(b) Gyroscopic phenomena using students: This activity requires a "loaded-rim" bicycle wheel with handles on each end of the axle. The "load" is usually solid rubber or iron in some form to increase the moment of inertia. One of the first demos with the wheel is to suspend it from a support with string attached to each handle (3.). Start the wheel spinning quite fast and cut one of the strings. Rather than fall, it precesses, partially holding to an initial position, the beginning to understanding aerospace guidance systems like autopilots, etc. Now have a student take a stance on the platform, spin the wheel very fast, and hand it over to the student (4.). With a little experimenting, the student will learn to rotate one way, stop, and rotate the other way and change speeds, controlling the student's motion, like a programed guidance system on a missile.

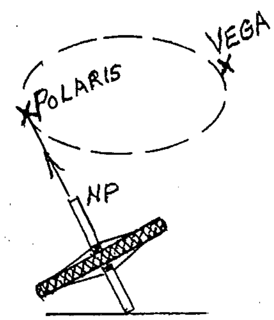
3.



4.

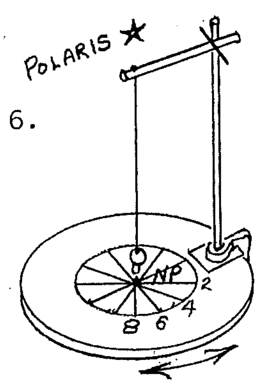
While using the wheel, spin it, set it on its axle (one handle) like a top, tilted like the earth on its axis, and watch it precess (5.). Thus, the students can learn a little astronomy, also, that the earth's north pole over time (many years) follows a circular path in the sky in which the North Star (Polaris) is only one point in the circle. Like the spinning wheel, our spinning earth "wobbles" on its axis, also.

5.



(c) The Foucault pendulum - is featured in several large-city science museums as an hourly time piece ("clock"). The pendulum keeps time by swinging over a 24 hr. dial below it and/or knocks over dowels hourly on it (6.). The dial, of course, is rotating with the earth; observers, however, tend to think that the pendulum is constantly changing the direction of its swing. The Foucault pendulum is a brilliant application of Newton's First Law on inertia. Once you start a pendulum in a certain plane (direction), it will remain in that plane until an outside force is applied to change it. Of course, the museums "cheat" a little by applying a constant, miniscule force (in different ways) to the pendulum to counter the small problem of air resistance on the bob trying to slow it down. The rotating platform is ideal to show what is really going on in a Foucault pendulum. Draw 12 equally spaced radial lines on an 8" dia. cardboard "dial"; mark them bi-hourly (2,4,6, etc. up to 24); cut out the circle and tape (masking) it in the center of the platform. Set up the simple apparatus of a table clamp, ringstand rod, right angle clamp, a 3/8" or ½" dia. dowel, nylon thread, a metal bob (lots of inertia!) with a hole through it, and a small paper clip. On one end of the thread tie a paper clip; run it up through the bob to the dowel and tie. Adjust the dowel to center the bob over the center of the platform (dial) and its best height just above the dial. Select an "hour" to start the swing;

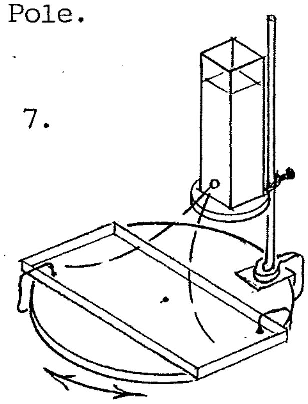
6.



carefully pull the bob straight back from the center with a moderate amplitude (not huge!). Let it swing a few times and then slowly, carefully rotate the platform by hand in the hourly direction you want. Also, show the students that the pendulum will hold its same plane of swing in the opposite direction; inertia rules! The earth simply rotates beneath the pendulum. It's easiest to understand if you picture the pendulum at the North Pole.

(d) The Coriolis effect - is important in meteorology and with simple apparatus can be nicely demonstrated on the rotating platform. The effect is the deflection of moving objects like projectiles, air currents, etc. due to an apparent force caused by the earth's rotation, to the right in the northern hemisphere, to the left in the southern. Our "projectile" is water shooting out of the bottom of a plastic container that is rotating (7.) One method is to glue a quart milk container to an acrylic base plate that can be C-clamped to a platform support on a ringstand; punch a small, 3/32" dia. hole in the container with a hot nail that can be taped (masking) over. Attach a table clamp with its rod to the rotating platform. If possible, have the punched hole very near or over the center of the platform. Clamp down a tray to collect the water, and adjust the height of the container so the stream lands in the tray. Fill the container to the top for maximum pressure at its bottom to get a good stream. When ready, remove the masking tape over the hole and rotate the platform in either direction. The effect is simple and nice to see.

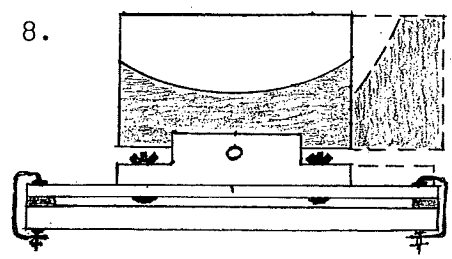
7.



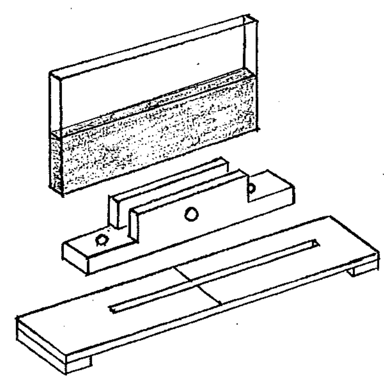
(e) Centripetal acceleration and beautiful parabolic curves - may be studied using a PSSC liquid accelerometer clamped to a rotating platform. Of course, centripetal acceleration is a quadratic relationship of velocity and radius, $a_c = v^2/r$, that will always produce a parabolic curve when graphed. This demonstration shows it as a natural (real) phenomenon. The accelerometer is a "sealed" plastic container, half filled, with ethylene glycol containing a red food dye (8.).

A recommended method of attachment to the rotating platform follows (9.) The slim container is held (clamped) in a wooden holder that is held (bolted) in a slotted board that is C-clamped to the rotating platform. The slotted board allows the accelerometer to be located in different positions to achieve different parabolas, from dead center to out on the edge of rotation. The plastic container is purchased; its holder is made of spruce with a carriage bolt and wing nut as a "clamp"; and this unit has a carriage bolt and wing nut on each end to hold it in the slotted piece of plywood (10.). The plywood has a slight "lift" glued fast under each end. Yes, a little woodshop work is required. Besides the repositioning (changing r) of the accelerometer, you can also change the speed (v) of rotation to achieve different parabolas. It is all qualitative but beautiful to see. The apparatus is durable and easy to store.

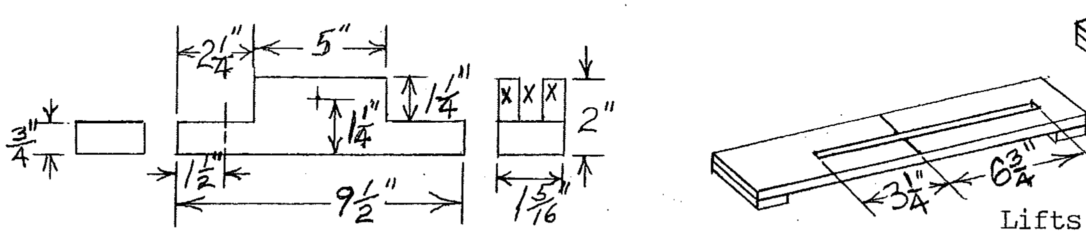
8.



9.



10.



X Each space is 7/16" wide.

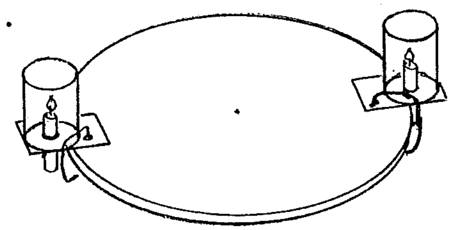
Holder cut from 2" x 4" spruce.
All ¼" dia. bolt holes.

Lifts are 1" x 3" x ¼".
16½" x 3" x 3/8" plywood with ¼" wide slot for 1½" x ¼" x 20 carriage bolts with wing nuts.

(f) The candle flame paradox - is an old, but excellent, teaching demonstration based on the fact that a candle's flame is warmer, thus lighter, than air at room temperature. (Did you ever see a normal candle flame tip or fall over?) Although only one flame is necessary, this demo is usually performed with two, one on each side. Aesthetics? However, it is more dramatic with two flames, so two are recommended (11.)

Because candles and holders come in all shapes and sizes, I suggest the following for ease of operation and storage. Lighting the candles and shielding the flames have always been this demo's biggest problems; my candle holder solves both. I recommend 3/4" dia. candles. Some woodshop skills are necessary for construction. Follow the diagram (12.) The acrylic cylinder is 2½" O.D. The pine "donut" is a ½" thick. The base "plate" is ¼" thick masonite or plywood. The thumb screw holds the candle and adjusts its height as the candle burns down. 2 screws hold the cylinder to the "donut" and allow for wax clean-up when removed. Requires a little effort to make but lasts forever!

11.



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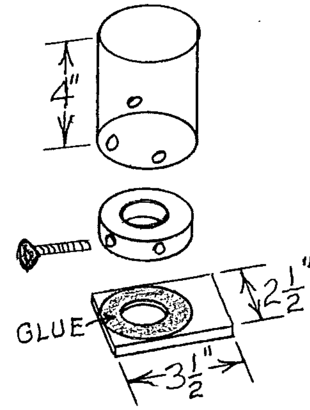

Presentation: Attach the holders with C-clamps (11.) Light the candles <u>outside</u> the cylinder, <u>push</u> them up through the <u>bottom</u> of the holders, and <u>set</u> them with the thumb screws. Rotate the platform moderately and observe the flames. In which direction do they "point"? Did you expect the flames to point outward? But why inward instead? Seems that the trapped, heavier (more dense) air in the cylinder moved to the outside (off on a tangent) pushing (floating) the lighter candle flame toward the center. So everything is behaving as it should. Thus, the cylinder serves two purposes; it shields the flame from blowing out while rotating and traps the air inside to act on the flame. Do you appreciate a candle flame a little more now? It is a little heat generator (furnace) besides being a light source.

<u>Warning:</u> The Cenco rotating platform has a design flaw that must be corrected. The top plate can slip down the center shaft and rub on the tripod base; it needs a set screw to prevent it (13.) Automatically, a slight space is created that allows dust and dirt to reach the ball bearings and their race (track). A covering ring (alum. plate?) must be machined and installed (14.) Also, I found that the ball bearings ran best when <u>dry</u> (no grease). A very light oil might be applied if the platform must be stored in high humidity to prevent rust. Clean the bearings with Coleman's white gas occasionally. The platform is indestructible if properly cared for.

13.

14.