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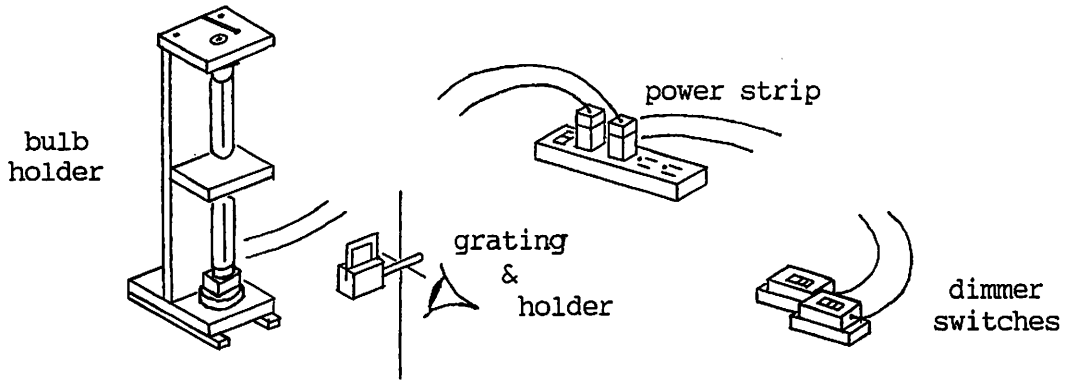
A "spectra" comparator - an excellent, old, multiuse demonstration made even better via recent technology. The added ingredients are a neodymium (bluish) light bulb and inexpensive ($10.) compact dimmer switches. It does require much first-time preparation; after that, little effort is needed. The whole set-up can cost less than $50. and can be used in physics, earth science, and chemistry classes. The diagram illustrates my set-up; you may alter as you see fit.

Warning! This is a 120 V system. Observe all safety precautions. Keep unplugged until all adjustments are made; unplug when not in use. Tape over exposed terminals or add Plexiglas covers. This apparatus was designed for experienced teachers. You must add safety features for student use, and you must supervise them. Do not exceed the wattage rating (150 W ?) of the dimmer switches.

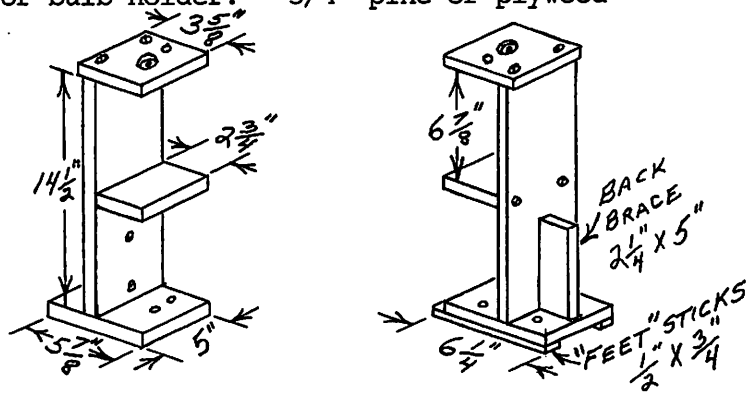
Diagram:

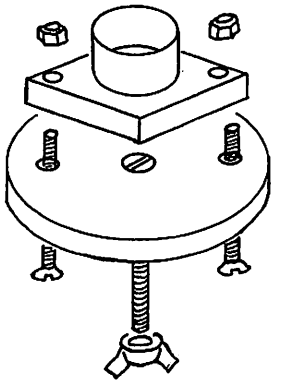


Materials: 2 med. base #9063 Leviton pony cleat lampholders, 2 RS #274-656 2-position barrier strips, 2 #TBI03 Leviton plug-in lamp dimmer switches, 3' #18 RS stranded hook-up wire, 5' #18 lamp cord wire, 2 male plugs, 6 FH bolts, 4 lock nuts, 2 wing nuts, 6 #6 x 3/4" PH screws, masking tape, 3/4" pine board or plywood, 3/8" plywood, holographic diff. grating*, right angle clamp, ring stand, power strip

* #33-0980 Holographic diffraction grating, Arbor Scientific, Ann Arbor, MI 1(800)367-6695

Plan for bulb holder: 3/4" pine or plywood





#6 x 32 lock nut

socket

2 5/8" dia., 3/8" plywood

#6 x 1" FH bolt

#8 x 1¼" FH bolt

#8 x 32 wing nut

Assembly of bulb holder: (a) Cut out the five pieces of 3/4" stock, drill, and countersink slightly for #6 x 1 5/8" dry wall screws.
(b) Mark the centers and cut out the two 2 5/8"dia. x 3/8" plywood socket bases. Drill and countersink an 11/64" hole in the centers for the 1¼" x #8 FH bolts.
(c) Center the sockets on the plywood bases and mark and drill (countersink) the two 9/64" holes for the two 1" x #6 FH bolts.
(d) Center the plywood bases on the top and bottom boards of the stand within the 2 3/4" space (should be at least a 1/16" gap front and back). Counterbore a 3/4"→1" hole, ¼" deep for more clearance. Drill the 11/64" holes in the boards for the #8 FH bolts.

Explanation: Why the extra work to make a swivel socket base? You want the straight filament out front for best viewing; this rarely happens when one of these bulbs is screwed into its socket. Thus, you must swivel the bulb and socket for proper alignment. Later, remember to leave enough slack in the wire leads for the swivel action.

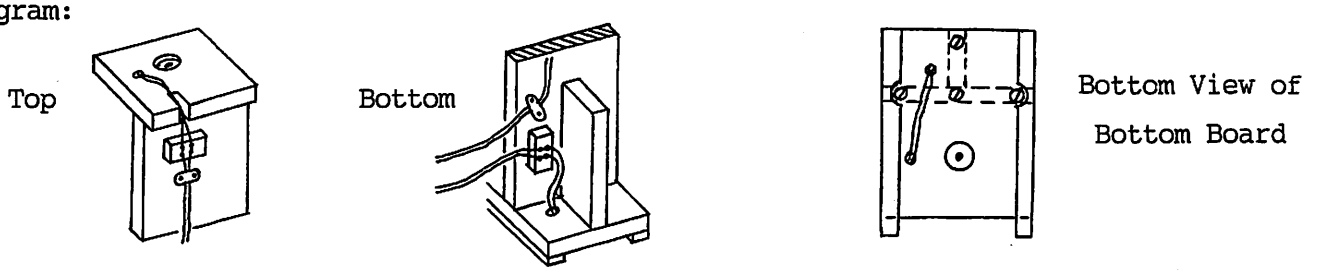
(e) If you know the diameter of two #18 RS stranded hook-up wires going to the sockets, you can drill the wire holes in the top and bottom boards.

(f) Drill two 3/32" holes for each RS barrier strip in the vertical board top and bottom, for #6 x 3/4" PH screws. Attach strips to board.

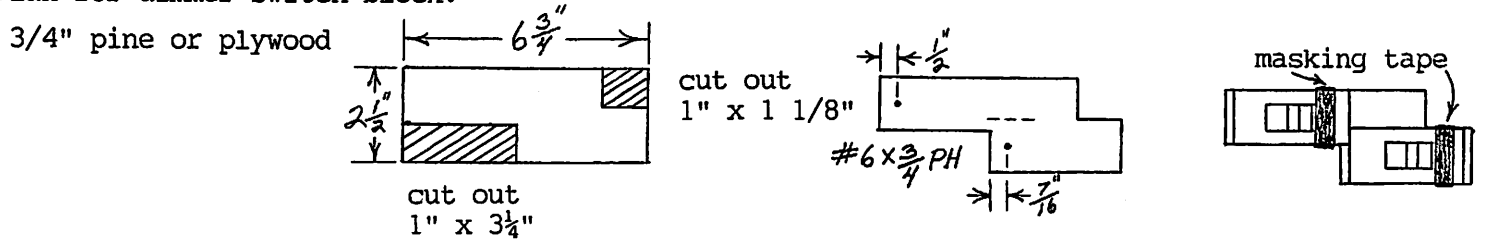
(g) Final assembly. Glue is not recommended. Predrill and screw everything together. If you have made any mistakes, you can back out the screws, take things apart, and make corrections. If glued, you can't. Finally, add "feet" sticks with glue and brads for bottom clearance.

(h) Wire sockets to strips using the #18 RS hook-up wire and leaving enough slack for swiveling. Wire #18 lamp cord to strips and use staples and/or strain releases where necessary. Add male plugs to cords.

Wiring diagram:



Plan for dimmer switch block:



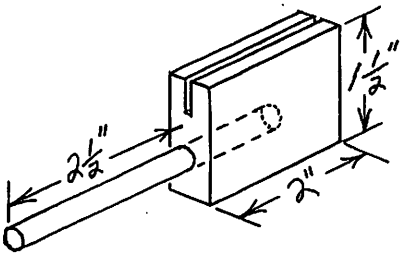
Assembly of dimmer switch block: (a) Cut out block and drill 3/32" holes for #6 x 3/4" PH screws to anchor switches.

(b) Carefully grind off top of screws so they slide into switches, and screw into wood block until switch fits snugly.

(c) Finally, use masking tape to "strap" lower end of switches to the block. Plug switch cords into power strip and bulb holder cords into switch cords.

Plan for grating holder: 3/4" pine

3/8" dowel,
3½" long



groove is
1/8" wide, 3/8" deep

Assembly of grating holder: (a) Cut groove first. If groove is too narrow for grating, cut groove wider with a second pass over table saw. (If groove is too wide for a snug fit, add a strip(s) of masking tape to grating frame until a snug fit is reached.)

(b) Cut block to size; then drill a 3/8" hole, 1" deep in one end of block for dowel. Glue dowel in block.

Operation: Turn on the power strip and move the switches until both bulbs light. With the switches close at hand, look through the grating to see the two spectra. I chose to totally shut down the neodymium bulb and study the regular, clear bulb first. I found that by dimming it, the strong yellow region dimmed rapidly, allowing the orange region to show itself better, like, for example, a yellow star evolving into an orange star as it expands and cools. Play around with it, and you will learn more (stellar evolution?).

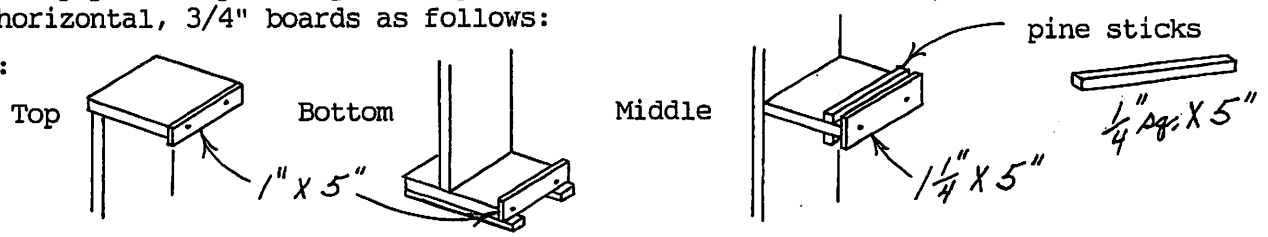
Now adjust the clear bulb to its best appearing continuous spectrum and turn up the neodymium bulb to its best appearing spectrum. I found not only the two prominent dark absorption bands in the yellow region but a faint dark band in the green region, as well. Again, play with the switches and learn more.

Note: Special thanks to Adam J. Beehler, Depart. of Physics, U. of Utah, Salt Lake City, UT for his article in the March 2010 TPT on the neodymium light bulb and its absorption bands. It resulted in my "spectra" comparator. Neat!

Addendum: Also, the design of this apparatus lends itself to other interesting investigations if you modify it slightly. For example, you may want to compare the light (colors) emitted by a soft white, 60 W incandescent bulb vs a "60 W" (13 W) fluorescent "twist" bulb (CFL). (Or you may want to show your students that a CFL really has mercury in it.)

The modification required is four "grooves" to hold the two cardboard masks in place. This is simply done by adding three pieces of 1/8" masonite or heavy cardboard to the front of the horizontal, 3/4" boards as follows:

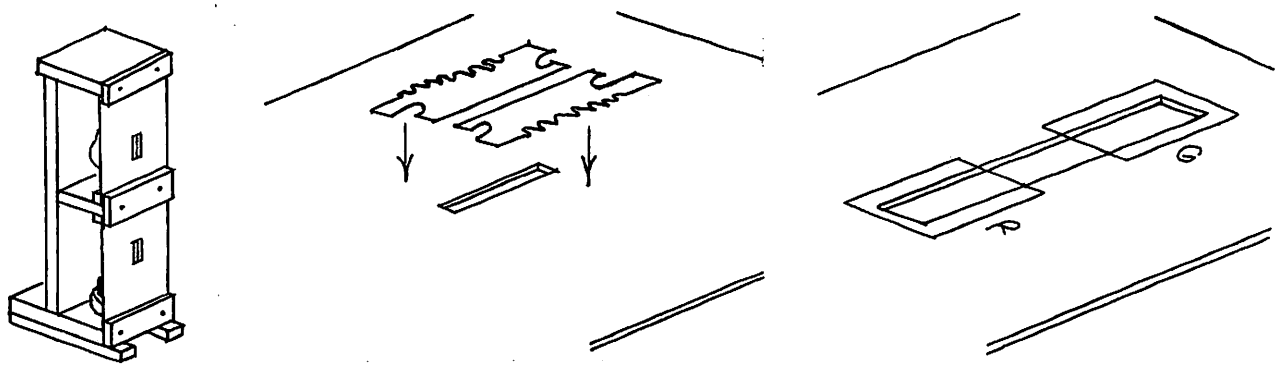
Diagram:



Glue, nail, or screw the pieces on. Glue down the two pine sticks leaving a loose space for the cardboard's thickness.

For the above comparison, two cardboard masks with a single slit in each are required. Each mask is easily made with a small sheet of cardboard, 5" x 6 13/16". With the bulbs in place, locate the best position for the light to pass through the slit to the grating and your eye. Cut a vertical slit 1¼" x 3/16" in the cardboard. Take a double-edged razor blade, carefully snap it in two (or use two single-edged blades) and tape down each cutting edge, facing each other and less than 2 mm apart, over the cardboard slit.

Diagram:



Finally, slide in the masks, turn on the bulbs, adjust the switches, and observe the spectra. The bright-line spectrum of mercury, especially its famous green line, "the standard", is impressive.

Another interesting comparison may be viewed with a mask made with colored filters; I chose red and green. (See diagram above.) Cut one long slit (2½" x ½") in the cardboard; tape down a small piece of red filter (7/8") on top and green (7/8") on the bottom. The "open" (no filter) center gap (3/4") allows for the continuous spectrum to be compared to the two different, "filtered" gaps above and below. Use the clear, incandescent, straight-filament bulb as the source; adjust the brightness with the dimmer switch. This investigation with colored filters may lead to other ideas for comparison. Use your imagination and have more physics "fun"!