Exploratorium Cookbook III

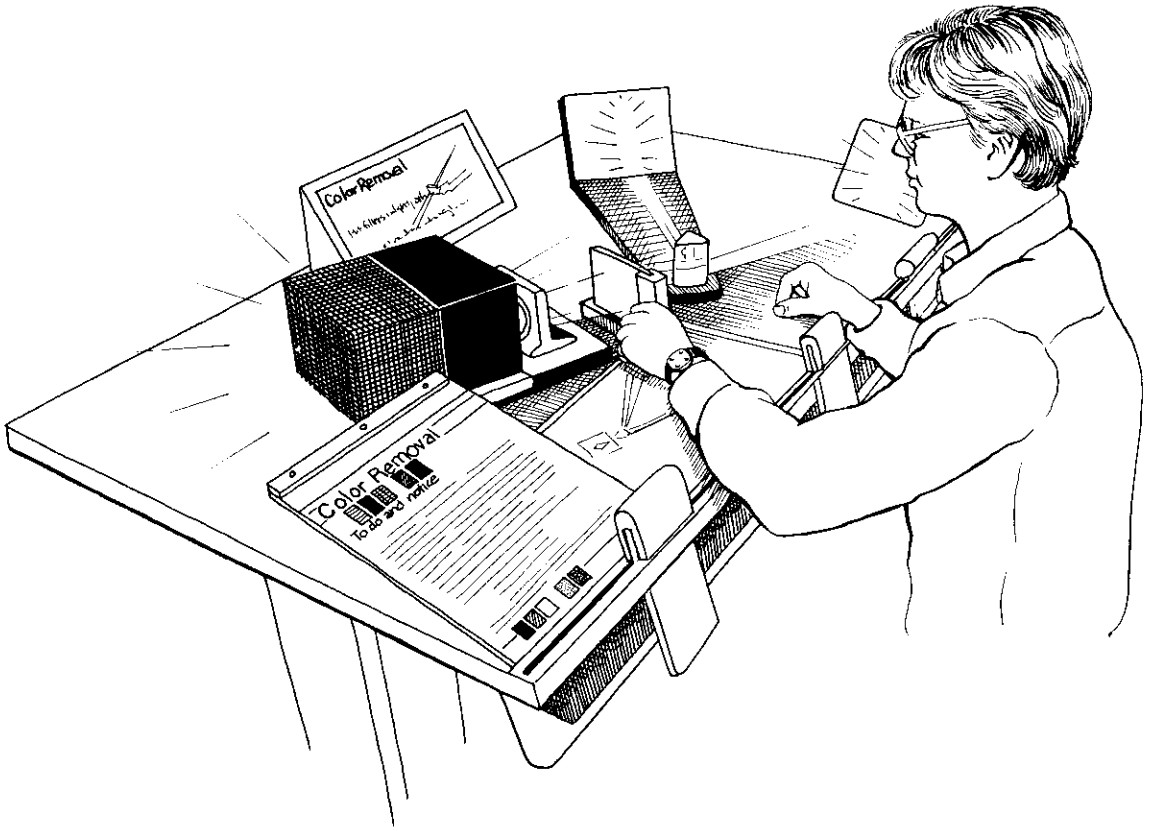
A Construction Manual for Exploratorium Exhibits

by Ron Hipschman

Print copies of the original Exploratorium Cookbook series may be purchased online at:

www.exploratorium.edu/store

Color Removal



Description

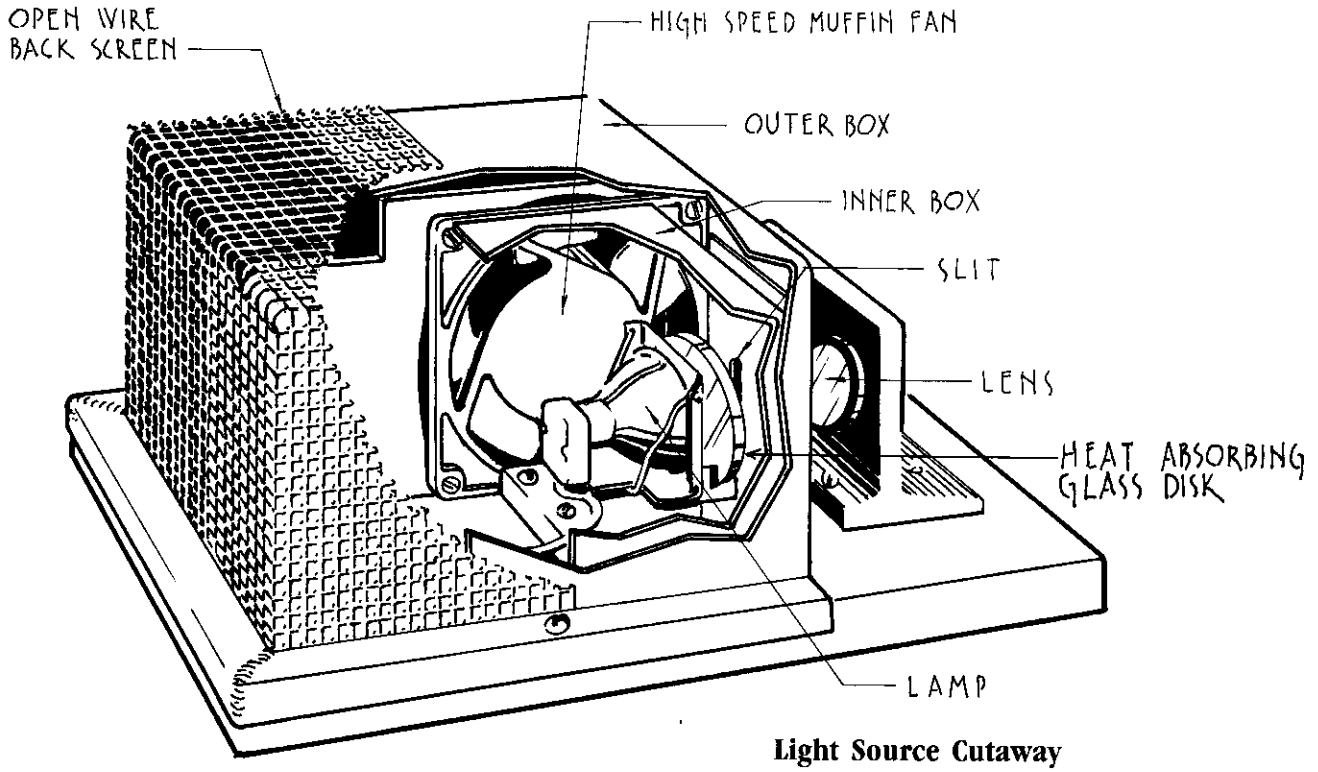
A beam of white light passes through a prism, which separates the colors and projects the resulting spectrum on a screen. The visitor can place transparent colored filters in the white light beam and watch the spectrum to find out which colors are absorbed by the filters. Also, a small portion of the white light misses the prism and is projected on a separate screen, so the visitor can compare the effects of the filters on white and separated light.

Construction

This fairly simple exhibit consists of a light source, a projection lens, the prism, and the projection screens. Our light source is a 250 watt 120 volt ENH projector lamp, a good choice for this exhibit because of its brightness and built-in reflector. The lamp is housed in a folded stainless steel sheet metal enclosure with an open wire screen back. Since the lamp gets quite hot, we've placed a high-speed muffin fan to one side of it for ventilation. The other side and top of the lamp are shielded with an angled piece of stainless, which prevents a lot of the heat from radiating to the outer enclosure. A small slit, 3/4'' high and 1/32'' wide, has been cut into the enclosure directly in front of the lamp.

An image of the slit is projected on both screens by a small lens (1-1/4'' diameter with a focal length of about 3''). This lens is mounted (glued with epoxy) into a hole cut in aluminum ''L'' angle stock and screwed down at the appropriate distance in front of the slit to form the screen images.

The prism is epoxied to a triangular 1/2'' thick aluminum base. Our base allows the visitor to rotate the prism and has detents that give a tactile ''click'' when the prism is in optimal alignment. The prism has faces 40mm square and is made of SF 10 heavy flint glass. These are available from:



Light Source Cutaway

Karl Lambrecht Corporation
4204 N. Lincoln Avenue
Chicago, Illinois 60618
telephone: (312) 472-5442
order cat. no. 33 6675

or:

Klinger Scientific Corp.
83-45 Parsons Blvd.
Jamaica, New York 11432
telephone: (212) 657-0335
order cat. no. 33 6675 (same as above!)

The prism is mounted about 11" in front of the lens and situated such that most of the white light passes through it, with a little light slipping by one side. The two screens are mounted 18" from the prism and situated so that one catches the spectrum from the prism and the other gets the white light that slips by. The screens are tilted back 30 degrees from the vertical for better visibility.

We screwed to the table a small block of wood shaped like our filters; it indicates where the filters are to be placed in the optical path. The filters are of a few different types: colored plexiglas; theatrical gels and acetates sandwiched between clear plexiglas; and a glass dichroic filter in a plexiglas sandwich. They all have hardwood handles, which remind people that they are not expendable. Although we've found that the filters do wander around the museum to other exhibits, we have not found it necessary to tie them down. They are stored in slots at the front of the exhibit, so that the colored material sticks out underneath the front edge of the table; a rear-lit strip of white plexiglas, placed behind the filters under the table, lets people see what colors they are selecting.

Critique and Speculation

The prism in our exhibit is the object of quite a lot of abuse and has gotten badly chipped on the corners. Because it's right out there in the open, kids try to take it, and this seems to be the cause of most of the damage. A better housing—one that would protect the prism and yet not hide it—could probably be designed. The filters should be replaced when necessary, as scratches in them tend to diffuse the light instead of transmitting it straight along the optical path.

Related Exploratorium Exhibits

Color Separation

Holier than Thou; Blue Sky; Benham's Disc; Bird in Cage; Hot Light; Low Frequency Light; Patterns of Scattered Light; Pinball Machine; Rainbow Edges in Your Eye; Rainbow Edges in a Lens; Bubbles; Soap Film Painting; Color Sum; Color Temperatures; Glow Wheel; Polaroid Projector; Rotating Light.

Color Mixing

Aurora; Color TV & Magnet.. 'olored Shadows; Lumen Illusion; Distilled Light.

Refraction

Disappearing Glass Rods; Bathroom Window Optics; Critical Angle; Leyes Photos; Conversation Piece; Glass Bead Rainbow; Multiple Lens Box; Water Sphere Lens; Water Waves; Image Relay; C the Light; String Analogy; Sun Painting; Convection Currents; Image Quality; Laser Demonstration; Air Reed; Rotating Light; Prism Tree.

Color

Bridge Light; Electromagnetic Spectrum; Iron Sparks; Recollections; Argon Candle; Solar Signature; Another Way of Seeing.

Colors, Complementary

Aurora; Blue Sky; Color Reversal; Colored Shadows; Distilled Light; Benham's Disc; Color Sum; Bird in Cage.

Exploratorium Exhibit Graphics

Color Removal

White light is a mixture of all the colors of the rainbow. Most colors are made up of some mixture of rainbow colors.

To do and notice

Remove any filters from the path of the white light and turn the prism until it lines up with its triangular base. Notice the rainbow colors on the back screen. The prism spreads out the colors that make up white light.

Notice that the white light that misses the prism shines on the front screen.

Place a colored filter between the light source and the prism. Compare the colors that are left in the rainbow to the color shining on the front screen.

Look through the same filter at the screens. Notice that the colors that you see don't change.

What's going on

White light contains all the colors of the rainbow. Each filter blocks or partially blocks some of these colors. The prism spreads out the remaining colors, letting you see only the rainbow colors that pass through the filter. The color on the front screen shows you what these colors look like when they are mixed together.

The colors that you see will be the same whether you put the filter between the prism and the light source, between the prism and the screen, or between the screen and your eyes. Changing the position of the filter doesn't change the color of the light that reaches your eyes, and that's what determines what you see.

The colored filters on the table contain organic dyes that absorb certain colors of light and allow other colors to pass through. An interference filter, on the other hand, absorbs little or no light—it reflects certain colors and lets others pass through.

Table of Contents for Cookbooks I, II, and III