Exploratorium Cookbook II

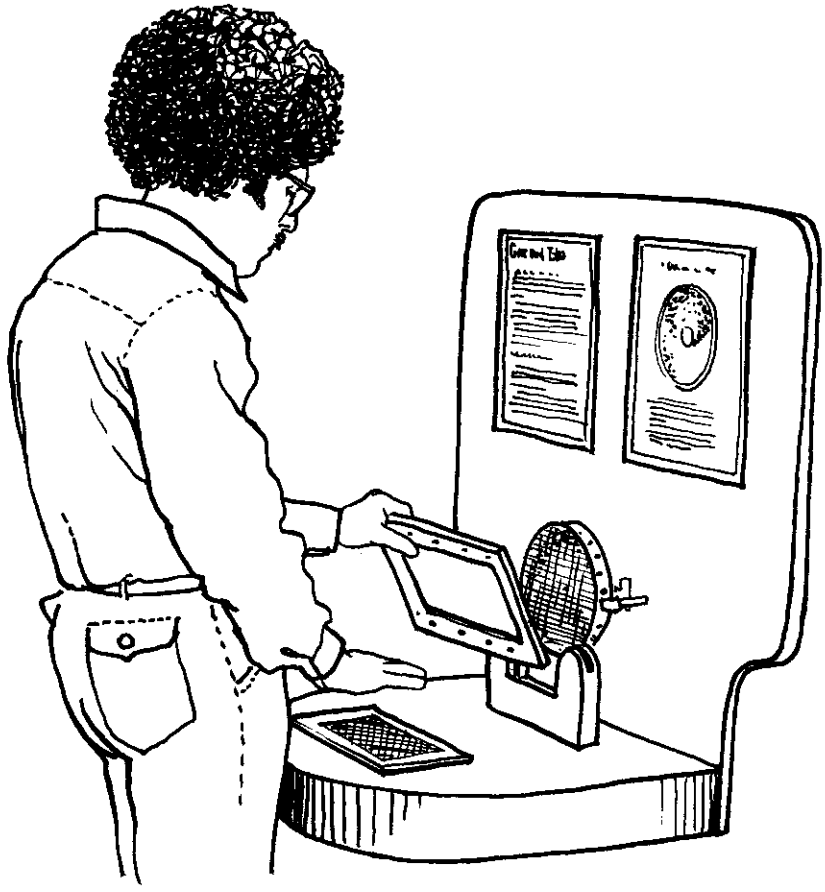
A Construction Manual for Exploratorium Exhibits

by Ron Hipschman and the Exploratorium staff

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

www.exploratorium.edu/store

Give And Take

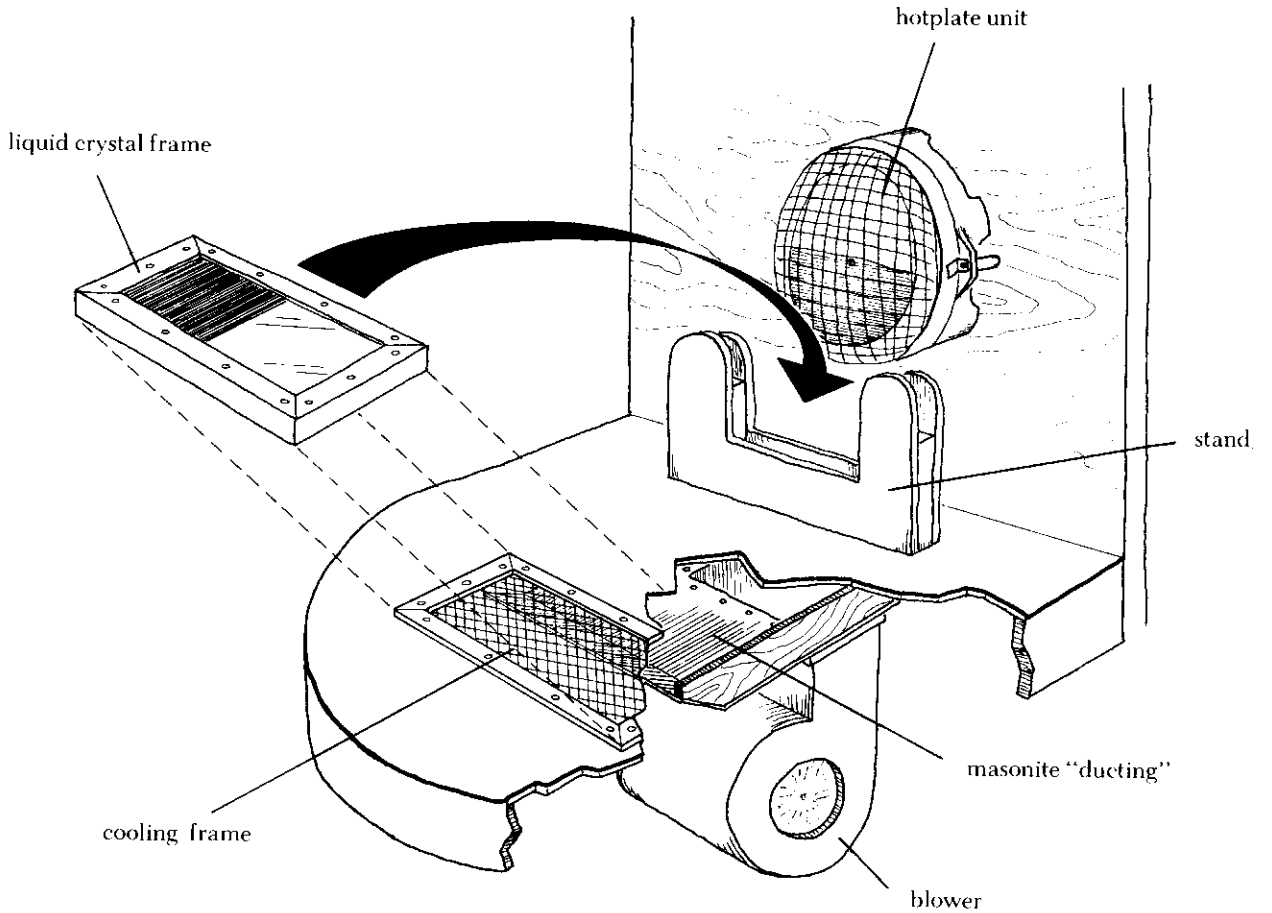


Description

This exhibit demonstrates that good emitters (givers) of heat are good absorbers (takers) of heat. The visitor places his/her hand near a hotplate on top of which is a piece of metal with one side painted black and the other side polished to a high shine. It is noticed that the black surface gives off more heat than the silver surface. A piece of heat sensitive liquid crystal material, on the back of which is glued a similar piece of thin silver/black metal, is placed in front of the hotplate. It is noticed that the black painted portion absorbes more heat by the changing color of the liquid crystal.

Construction

This exhibit is very simple to construct. The hotplate is of the common variety found in many appliance stores. We stepped down the voltage to the hotplate to 37 volts with a transformer (Any voltage çlose to this will work). This keeps the plate at a reasonable temperature. The thermostat in the hotplate was removed to allow the hotplate to remain on constantly. A thin piece of stainless steel is cut into a circle, polished, and one half painted with flat black spray paint. This plate is bolted through an existing hole in the center of the hotplate. Over the hotplate is placed a screen cover to keep people from burning themselves.



This cover is made by gluing the screen (1/4" holes) with green structural epoxy into a 1" slice of aluminum tube big enough to cover the hotplate. This whole assembly is then bolted onto the backboard of the exhibit (which also holds the graphics). The wires are routed along the back of the exhibit inside of split PVC pipe to the transformer beneath the exhibit table.

The table is made of plywood and covered with black formica for durability. The transformer is mounted under the table along with a blower used to cool the liquid crystals after use. The air from the blower is directed through a rectangular hole in the table top by masonite "ducting". Note that the air system only blows air AT the opening and is not a closed system which would cause the liquid crystal frame to be blown off of the table! Over the hole is mounted an aluminum frame which holds the liquid crystals in place while cooling, and a screen which keeps the liquid crystal frame from dropping through the hole. A stand made of aluminum to hold the liquid crystal frame in front of the hotplate is bolted to the top of the table.

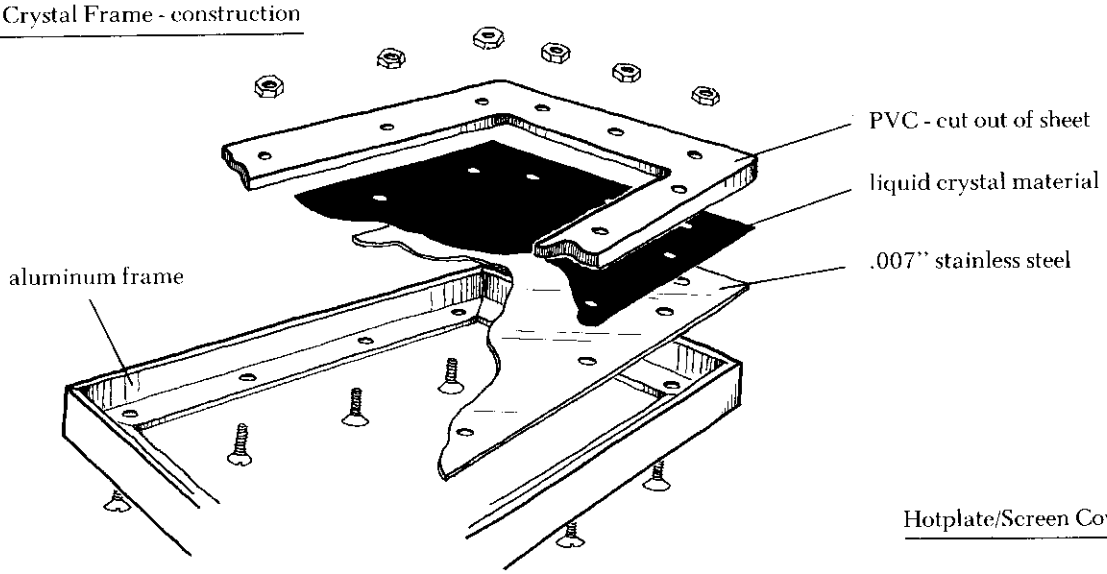
The liquid crystal frame consists of the parts shown in the diagram. The liquid crystal material is glued to the .007" stainless steel shim stock with contact cement. The liquid crystal material is available from:

Davis Liquid Crystals, Inc.
14722 Wicks Blvd.
San Leandro, CA 94577
(415) 351-2295

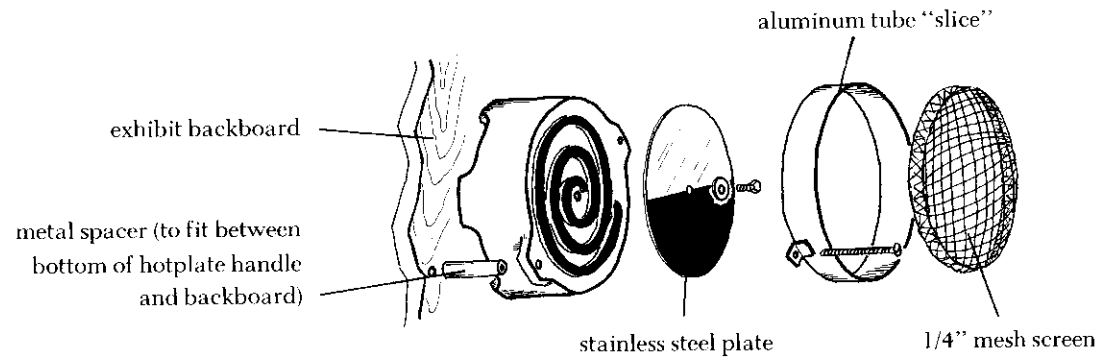
Critique and Speculation

If the shim stock is too thin, the material will be pushed in and destroyed. If the shim stock is too thick, heat will not be transmitted through it fast enough (stainless steel has poor

Liquid Crystal Frame - construction



Hotplate/Screen Cover - Construction



heat conductivity). One must find a happy medium and .007" shim stock is working for us (.001" didn't).

Additions and Changes (1990)

The orientation of the black paint on the hot plate with respect to the black paint on the panel is important. In our exhibit, the bottom half of the hot plate is black and the left half of the panel is black. When the panel is held up to the hot plate, the visitor can see every possible combination of emitters and receivers.

Related Exploratorium Exhibits

HEAT RADIATION

Hot Spot
Low Frequency Light

Exploratorium Exhibit Graphics

To do and notice:

Hold your hand in front of the hot plate, one half of which is black and the other half shiny. Notice that the black half radiates more heat to your hand than the shiny half.

Hold the frame, which has metal on one side and heat sensitive liquid crystal material on the other, in front of the hot plate with the heat sensitive side toward you.

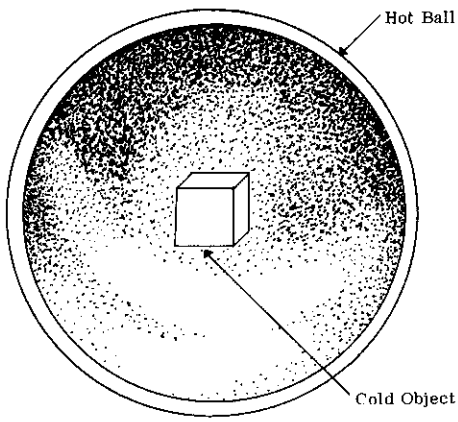
Notice that if you have the black half of the frame facing the black part of the plate it heats more quickly than any other arrangement, for example, shiny against shiny or black against shiny.

What is going on:

This exhibit shows that good absorbers (takers) of heat, i.e. black objects, are good emitters (givers) of heat, and that poor absorbers, i.e. shiny mirrors, are also poor emitters of heat.

Hot coffee in a thermos would cool off much more quickly if the walls of the insides of the thermos bottle weren't shiny. And a car with a black top sitting in the sun heats up much more quickly than a car with a white top.

A``thought experiment´´



The hot hollow ball will radiate to the cool object at its center, gradually warming it up. If the object did not then radiate back as much heat as it absorbed, it would get hotter and hotter and hotter, which does not make sense.

One must therefore conclude that a good absorber, such as a fuzzy black object, is also a good emitter of heat, and that a poor absorber,such as a white or shiny object, is also a poor emitter of heat.

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