FUN with FRESNEL LENSES

NO. 9053

Edmund Scientific

CAUTION: The Edmund Fresnel (No. 70,533) is extremely powerful. Any combustible material, such as paper or wood, will immediately burst into flame when placed at the focal point of the lens. Reflection and glare at this point are also dangerous to the eyes. Exposure can cause retinal burns causing headaches, tearing or even blindness. Dark glasses should be worn while focusing the lens.

FUN

with

FRESNEL LENSES

Second Printing 1972
Third Printing 1973
Forth Printing 1974
Fifth Printing 1977
Sixth Printing 1978
Seventh Printing 1980
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Ninth Printing 1984
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INTRODUCTION

Say "Fresnel" (pronounced "Freh-nel") to most people and, if it rings a bell at all, they will probably think of the giant lens in a lighthouse or the lens on a spotlight that photographers use. These are Fresnel lenses---and quite expensive. Now you can buy inexpensive Fresnel lenses, made out of a plastic material called acetate butyrate. The most remarkable thing about these plastic lenses is that they appear to be absolutely flat. So, how can they be a lens?

If you look closely at one of these new plastic lenses you will see a series of concentric lines etched into the plastic. These lines are only a few thousandths of an inch apart. Each concentric line acts as part of a lens; but taken all together, they form the function of a true lens. That is, they will focus all light they gather into a single spot---sort of like a giant magnifying glass.

CLEANING: Do not wash the Fresnel lens any more than is absolutely necessary. To clean the lens, first brush it with a camel's-hair brush to remove surface dust. It is best to follow these steps:

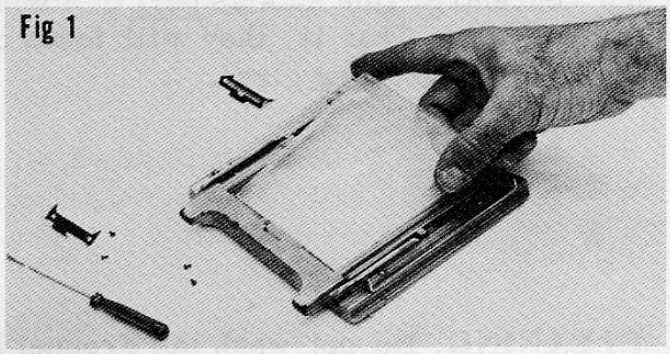
1. Brush the lens with a circular motion, following the embossed lines in the lens.
2. If fingerprints or stains are apparent after the brushing, wash the lens with a piece of absorbent cotton soaked in a mild solution of a non-gritty detergent, plus a few drops of ammonia and some warm water. Use a circular motion when washing, the same as for brushing.
3. Wash only a small portion at a time. Use a new piece of cotton frequently to prevent accumulation of gritty particles.
4. Careful. Do not let the cotton become too dry, as the lens may be scratched from a pile-up of gritty particles.
5. Rinse the lens in two changes of cool clean water.
6. Dry the lens with a large piece of clean absorbent cotton, again using a circular motion.
7. Remove any lint from the surface with the camel's hair brush.

IMAGE BRIGHTENER FOR GROUND GLASS CAMERAS

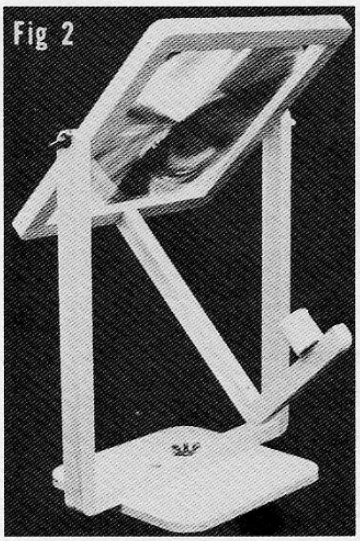
If you use a camera that employs a ground glass for focusing, such as a Speed Graphic, a view camera, or even a Rollei-type of camera, you can get a much brighter image on the ground glass by means of a Fresnel lens.

First, measure the length and width of your present ground glass. Transfer these dimensions to the Fresnel lens. Make absolutely certain that the center of the Fresnel lens will be in the center of the area you are going to cut out. A good way to cut the Fresnel is to make a sandwich.. by placing the Fresnel lens between two pieces of 1/4" plywood. The plywood will prevent splintering of the hard plastic. If you own power tools, a jigsaw, circular saw or a band saw will do a good cutting job. You can also do the job by hand. Use a finetooth coping saw for the cutting.

You will be pleasantly surprised at how much brighter the image is and how much easier it is to do the focusing. Fig. 1 shows a Fresnel lens image brightener being installed over the ground glass screen of a Speed Graphic camera. Make sure the grooved side of the Fresnel lens faces the camera lens...to prevent possible scratching of the engraved surface.



Fitting the Fresnel lens over the ground glass of a 4 x 5 camera.



A solar energy kiln. The crucible can be store-bought or made out of firebrick. An alternate method of construction is to make the projecting arm out of aluminum. If the crucible is not in place, the wood arm will burst into flame when exposed to the sun. Note the two pivot points which allow you to aim the furnace at the sun no matter what position the sun is in the sky.

THE SOLAR FURNACE

You can make a simple solar furnace with a single Fresnel lens mounted in a wooden frame as shown in Fig. 2. The base consists of a piece of 1/2" thick plywood with rounded corners. The U-shaped frame is made out of 1 x 1-1/2" wood (these dimensions are not too critical). The frame stands 18" high and is 15-1/2" wide. Drill a hole in the bottom part of the U to pass a 1/4" bolt and wing nut. The two arms are slotted at the top to accept 1/4" bolts and wing nuts which project from the mid-point of the frame.

The frame which holds the Fresnel lens is out of the same stock used to make the U-shaped frame. Cut a groove in the middle of the four pieces of wood which make up the frame to accept the Fresnel lens. The outside dimensions of the frame measure 13-1/2 x 13-1/2". The groove cut into the wood should be deep enough to accept about 1/4" of the Fresnel lens all around its periphery. Before inserting the Fresnel lens into the frame, drill two holes at the mid-point of two of the frame sections. Through these holes pass two 1/4" bolts. These bolts, tightened with wing nuts, form the axis which will allow you to tilt the Fresnel lens up or down so that it will be perpendicular to the sun. The wing nut assembly at the bottom of the base will allow you to shift the assembly from left to right.

The next step is to insert the lens into the frame grooves. Use glue and brads to

secure the four pieces of the frame together.

You are now ready to give it a try. Crumple up a sheet of newspaper, point the lens at the sun, and lo and behold...the paper will burst into flame. Be careful. You are, in effect, concentrating a disk of sunshine 13" in diameter, into an area less than an inch in diameter.

The final step in the construction of the solar furnace is the mounting of the L-shaped bracket that will hold the crucible. This bracket, also made out of the same stock used for the construction of the furnace, is fastened in place with two round-head screws to the bottom of the frame holding the Fresnel lens. The length of the bracket is determined by the focal length of the Fresnel lens---and with allowance for the height of the crucible.

The crucible can be made out of ordinary firebrick, a good grade of ceramic tile---or you can buy a small crucible, such as shown in the photograph, from a supply house specializing in products for chemistry college classes.

When you set up the furnace, make sure that the crucible is in place, otherwise you will char and burn the bracket. This furnace will develop a temperature of 2,000°F, so be careful. Do not look directly at the projected image of the sun... wear dark glasses, if you must. This hot spot is as bright as the arc in a welder's torch...and he always wears dark glasses!

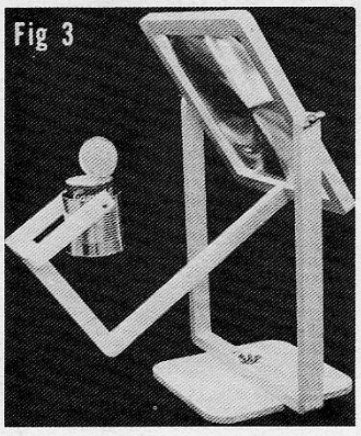
The solar furnace can produce some unusual jewelry. At about 1,500° F, powdered enamel will fuse to metal, but since some enamel colors reflect and absorb heat more than others, you will get some really exotic effects because of the difference in melting rates. You can watch this operation through dark glasses.

THE CAMP COOKER

The camp cooker is really a variation of the solar furnace. Its construction is identical except for the projecting L-shaped bracket. This bracket is somewhat longer, it measures 15" in length. At its end it has a small U-shaped yoke designed to hold an ordinary can. The can is mounted with two round-head screws. The screws should be just tight enough to allow the can to move so that it is always vertical to the ground, regardless of the tilt of the Fresnel lens and assembly.

The can shown in Fig. 3 is 3-1/4" in diameter, just wide enough to accept a slightly smaller can of soup. Fill the space between the two cans with water, paint a black spot on the outside of the larger can, and you now have the equivalent of a double boiler. A two or three minute exposure to the sun will cause the water to boil, effectively warming the contents of the inner can. Many brands now offer soups which do not require dilution with water. Of course you can use this arrangement to heat up other groceries such as franks and beans, canned corn, etc. But don't forget, open the top of the can before you start the cooking operation.

An alternate method of construction, from a safety standpoint, is to make the projecting L-shaped and U-shaped brackets out of Reynolds do-it-yourself aluminum. The aluminum will not burn if accidentally left exposed to the sun's rays. But, it will give you a nasty burn if you touch the hot surface--treat the furnace and cooker with respect and avoid an accident.



A simple variation of the solar furnace will allow you to make it into a camp cooker for heating soups, franks and beans, and other prepared canned foods. It is really a double boiler. The smaller can fits into the larger can with room to add water. Paint the front end of the large can a flat black to absorb the heat of the sun. Make sure you open the top of the inner can before starting the cooking operation. Within three minutes your meal will be ready--provided the sun is shining!

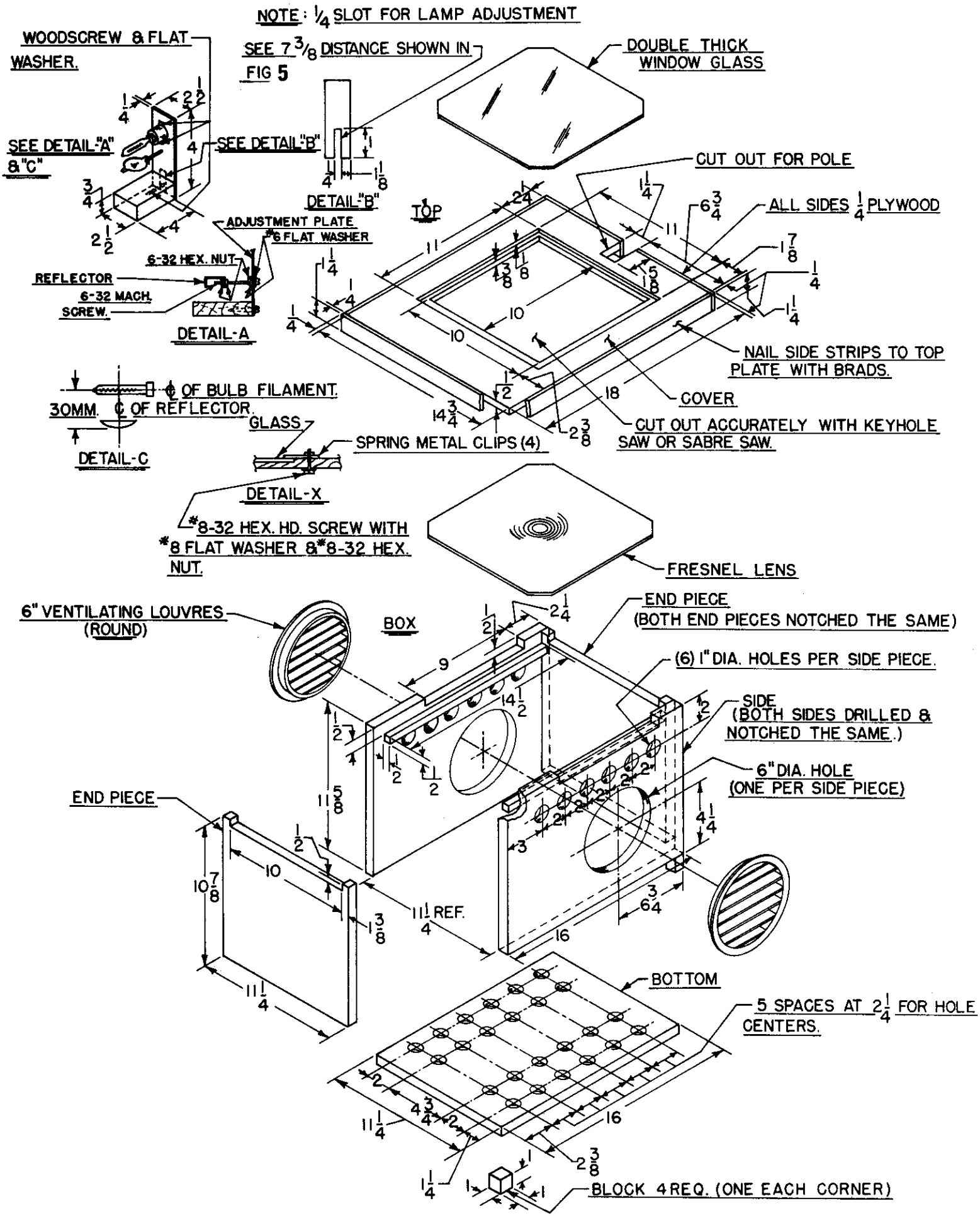
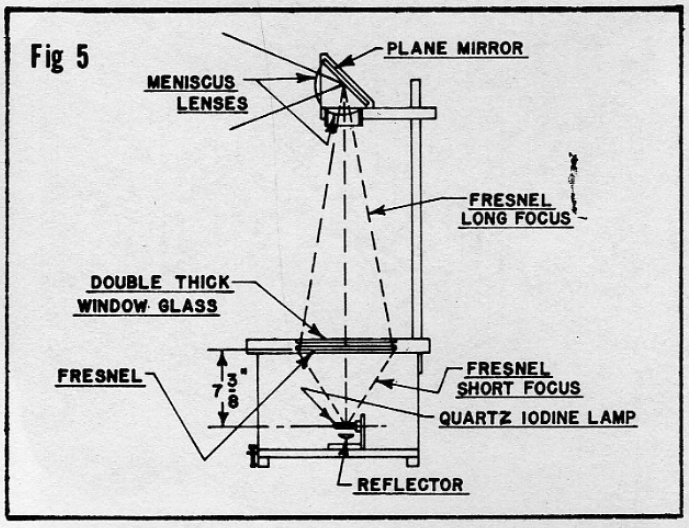

NOTE: 1/4 SLOT FOR LAMP ADJUSTMENT
WOODSCREW & FLAT WASHER.
SEE 7 3/8 DISTANCE SHOWN IN FIG 5
DOUBLE THICK WINDOW GLASS
SEE DETAIL-"A" & "C"
SEE DETAIL-"B"
DETAIL-"B"
CUT OUT FOR POLE
TOP
ALL SIDES 1/4 PLYWOOD
ADJUSTMENT PLATE
*6 FLAT WASHER
6-32 HEX. NUT
REFLECTOR
6-32 MACH. SCREW.
DETAIL-A
NAIL SIDE STRIPS TO TOP PLATE WITH BRADS.
℄ OF BULB FILAMENT.
30MM. ℄ OF REFLECTOR.
DETAIL-C
GLASS
SPRING METAL CLIPS (4)
COVER
CUT OUT ACCURATELY WITH KEYHOLE SAW OR SABRE SAW.
DETAIL-X
*8-32 HEX. HD. SCREW WITH *8 FLAT WASHER & *8-32 HEX. NUT.
FRESNEL LENS
6" VENTILATING LOUVRES (ROUND)
BOX
END PIECE (BOTH END PIECES NOTCHED THE SAME)
(6) 1" DIA. HOLES PER SIDE PIECE.
SIDE (BOTH SIDES DRILLED & NOTCHED THE SAME.)
6" DIA. HOLE (ONE PER SIDE PIECE)
END PIECE
BOTTOM
5 SPACES AT 2 1/4 FOR HOLE CENTERS.
BLOCK 4 REQ. (ONE EACH CORNER)

Fig 4

THE OVERHEAD PROJECTOR

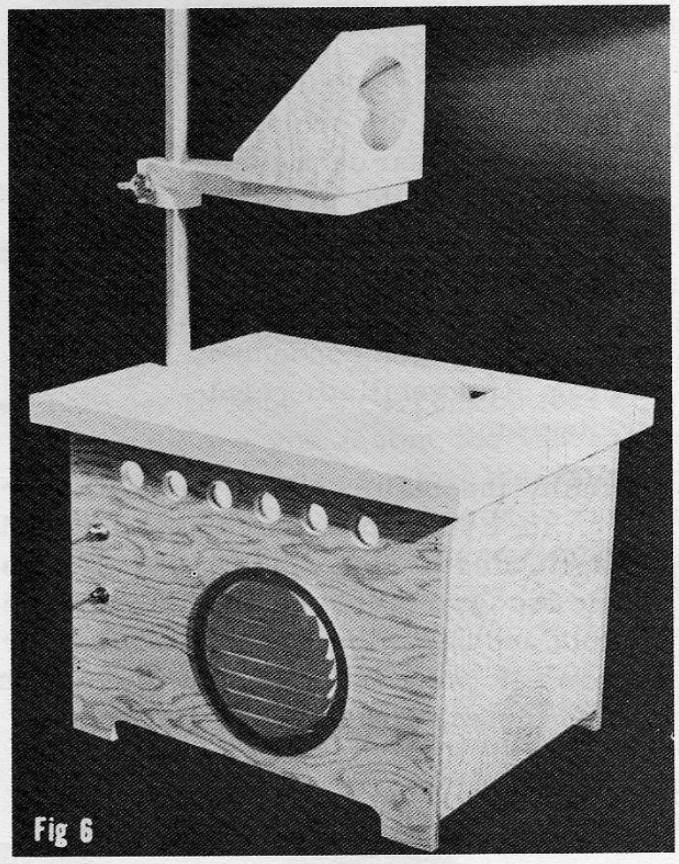
A Fresnel lens, part of Edmund Kit No. 70,966, will enable you to build a professional-style 10 x 10" overhead projector. In addition to this kit you will need a lamp, socket, motor-driven fan, mirror, switches, wood, hardware, plus wire, etc. The total, including approximately $16 for the kit, should not exceed $40. You will wind up with a projector easily worth $175, capable of showing 8 x 10" color transparencies, tracings, line drawings, and even the outlines of flat objects such as keys, coins, etc.

The first step is to make the box. (For complete construction plans, see Fig. 4.) It can be made from wood or sheet metal, painted, stained, finished plywood, etc. It is important to choose well seasoned wood as the heat is liable to warp green wood and throw the projector out of alignment. 3/4" pine makes a good working base. The box should measure 12-3/4" x 16" x 11-5/8" high. Paint all inside surfaces dead black to prevent stray reflections from the light surfaces. (Note: The construction photos were taken before the inside was painted black.)

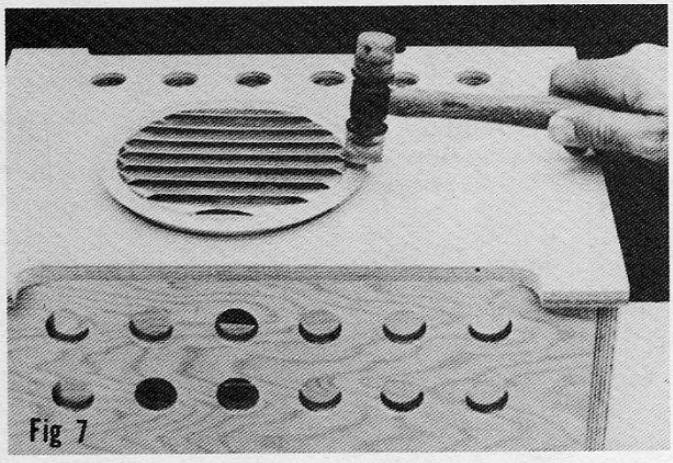


Ventilating Cooling Alignment. These are the most important items in building an overhead projector. Make sure the center of the bulb filament, the center of the Fresnel condenser and the center of the projection lenses are exactly in line. (See Fig. 5.) Check and recheck this using a try square and plumb line.

Ventilation. Four cutouts (see Fig. 6), one at each side of the box, raise the box 1-1/4" off the table to provide an air flow. Two louvers, each 6" in dia., face each other on the long side of the box. (See Fig. 7.)



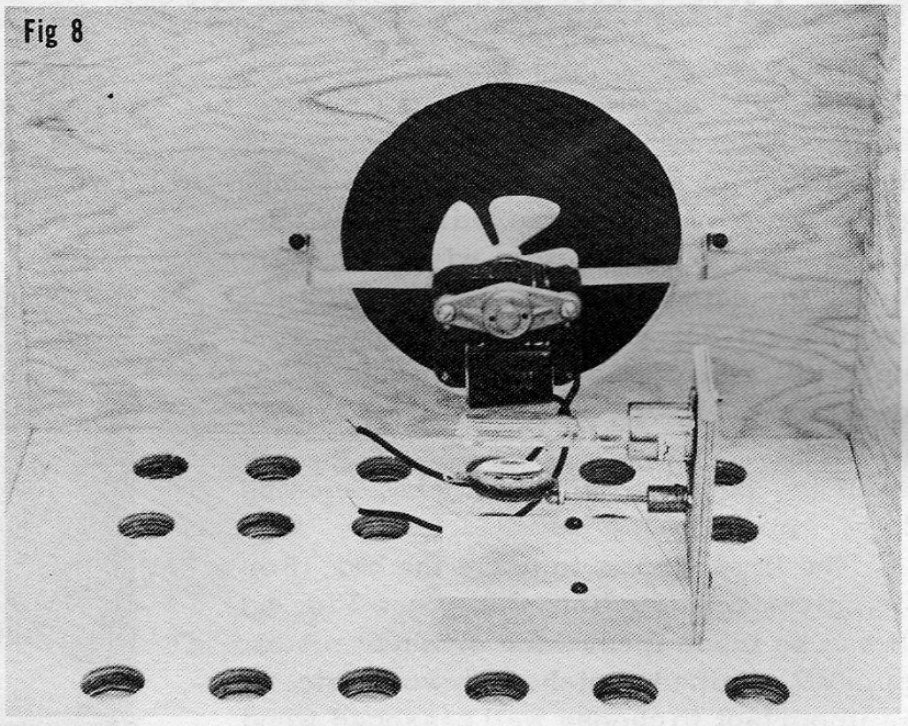
The finished overhead projector. It will accept up to 10 x 10" transparencies and specimens. Note the cut outs at the bottom for ventilation. Upper switch turns on fan, lower switch, painted red, turns on the lamp.



Installing the six-in. louvers in the sides of the projector. If you cut two 6" dia. holes, all you need do is just tap them in place as the louvers have built-in grips.

In addition a series of 1" diameter holes near the top of the box also provide ventilation. A fan mounted opposite one of the louvers provides a forced draft (see Fig. 8). The Quartz Iodine lamp is rated at 500 watts and produces quite a large amount of heat plus intense light. Try not to look at the bulb filament when adjusting the projector; if necessary, wear dark glasses. Never run the projector without the cooling fan or blower. If you do this, the intense heat from the bulb will ruin the Fresnel condenser. See Fig. 9 for ventilating cooling diagram.

Fig 8



Inside view showing the installation of the lamp, fan, and cut-out for the ventilating louver. After correct placement of parts was ascertained, they were removed and the inside of the box painted a flat black. This is important to avoid degrading the projected image.

Build the bulb, socket, and reflector holder in 1 unit and wire to switches and fan according to diagram (Fig. 10). Always handle the Quartz Iodine bulb with a piece of cloth and never touch the glass with your fingers. If you do, clean the glass with alcohol or lens cleaner before lighting.

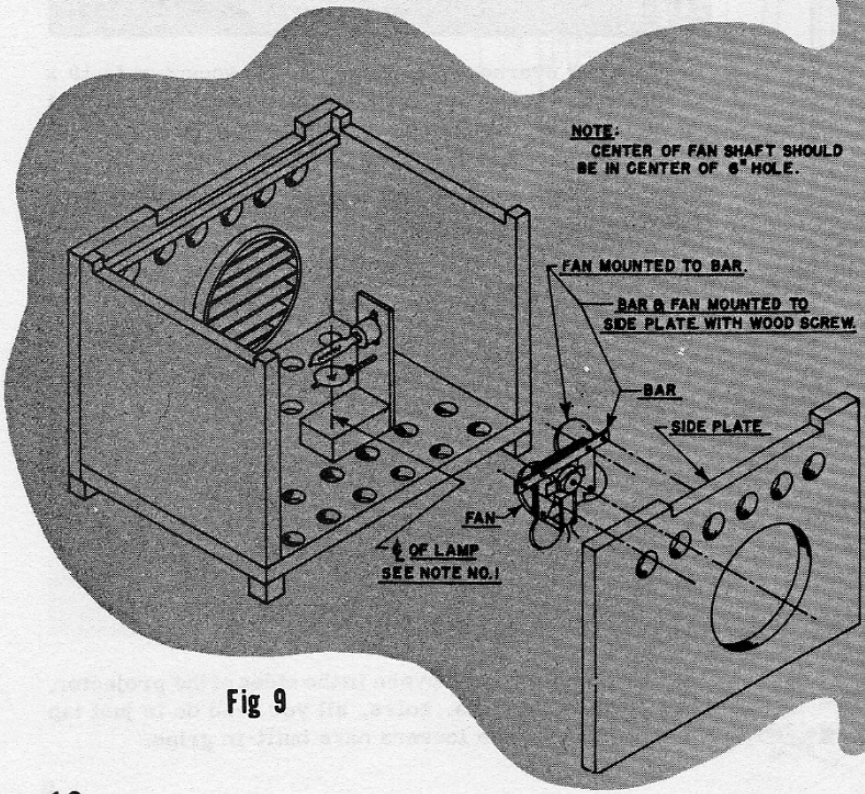


Fig 9

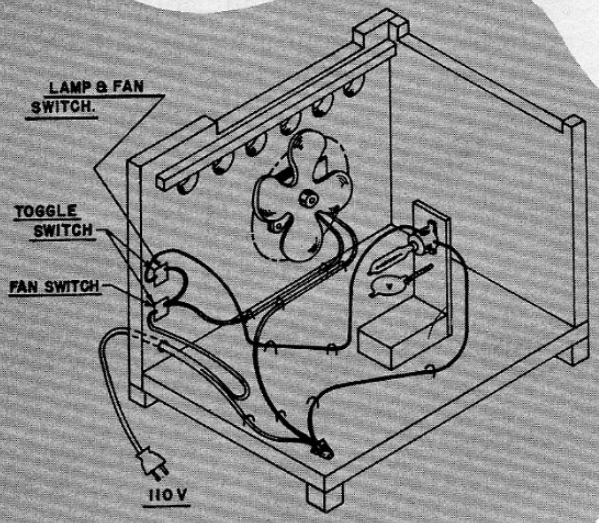
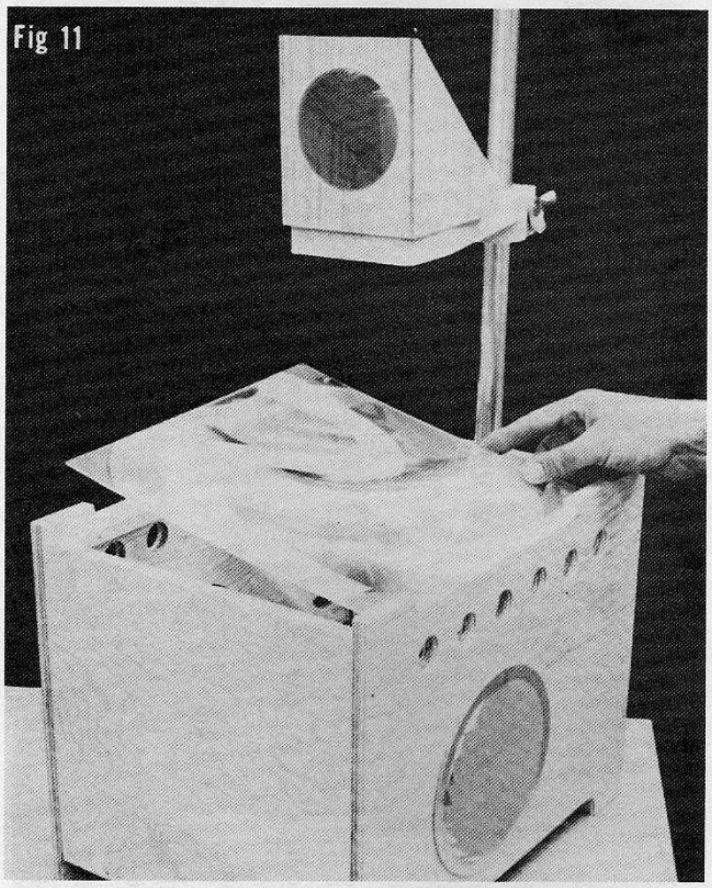


Fig 10

NOTE-1
CENTER OF FRESNEL LENS MUST BE ON A DIRECT LINE FROM CENTER OF LAMP FILAMENT.
ALSO SEE FIG. 5 FOR LAMP DISTANCE FROM FRESNEL LENS.

MAKING THE TOP

Your hardware store will cut you a piece of double thick window glass for the stage. This should be larger than the 10 x 10" hole in the top (see Fig. 11). Cut the wood top so the glass will be even with the top of the wood, then use metal clips to hold the glass in place. (See Fig. 4.) When cutting the 10 x 10" hole in the top, make sure the edges are neat and sharp. Use a keyhole saw or sabre saw and file smooth. If the edge is jagged, your screen image will have a jagged frame. If you can't get it accurate enough to suit, cut a sharp mask 10 x 10" out of cardboard and place this between the glass and wood. Fasten the top to the box with wood screws, then these can be removed to change bulbs or adjusting.



The Fresnel condenser lens consists of two Fresnel lenses cemented together. One lens has a short focal length, the other a long focal length. The side with the short focal length should face the lamp. The top of the Fresnel lens should be protected with a sheet of double-thickness window glass about 1" larger all around. Separate the glass from the Fresnel with a thin lining of felt around the edges.

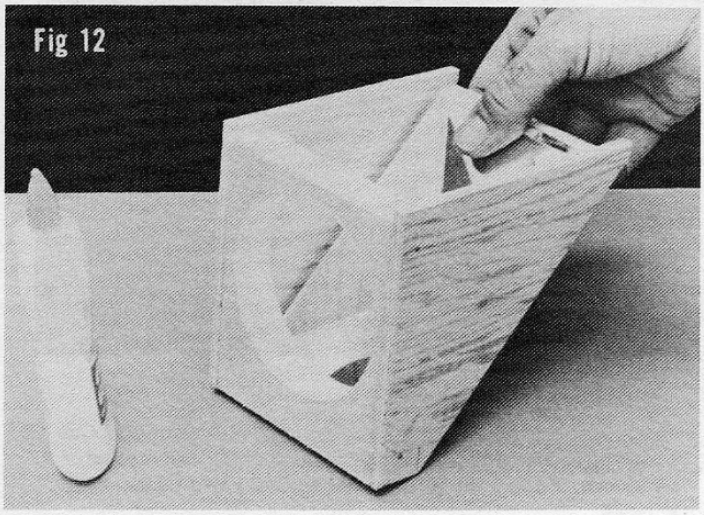
PLASTIC FRESNEL CONDENSER

This is actually a double plastic lens cemented together. One lens has a long focus, the other a short focus. The short focus lens must face the light bulb. These lenses are not marked, therefore, it will be necessary to try one side; if this does not work, try the other. If the long focus faces the bulb, the image on the screen will be a round circle instead of a square. Reverse the lens and all will be forgiven.

BUILDING THE HEAD

Alignment of the lenses so that they are at absolute right angles to each other, with the mirror at an exact angle, is a must in order to achieve correct optical alignment. Before you fasten the lenses permanently to the wood, clean the inside lens surfaces carefully. The outside surfaces can be cleaned after permanent mounting. If you use household cement, be sure to use it sparingly and be careful it does not get on the lens surface. The mirror should be cemented to the wood; cleaned; then the wood is nailed or cemented in place. (See Fig. 12.) Paint the inside of the lens head a dead black before "locking" up.

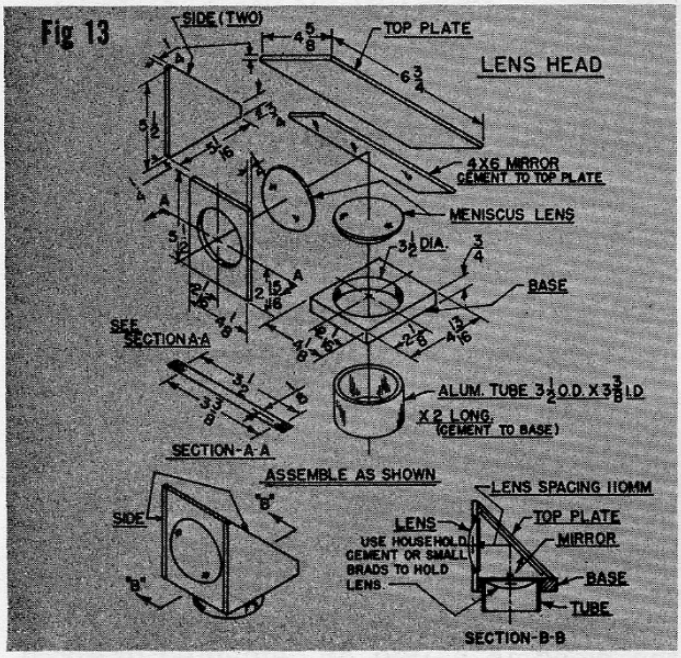
The lens assembly consists of two meniscus lenses, and a 4 x 6" mirror, mounted as shown in a 1/4" plywood box. After checking for optical alignment, remove all components and paint the inside of the triangular box a flat black.

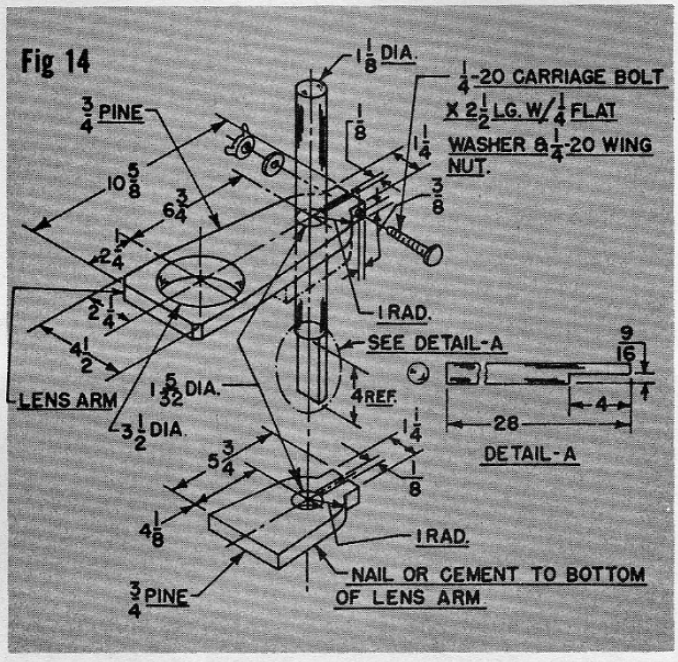


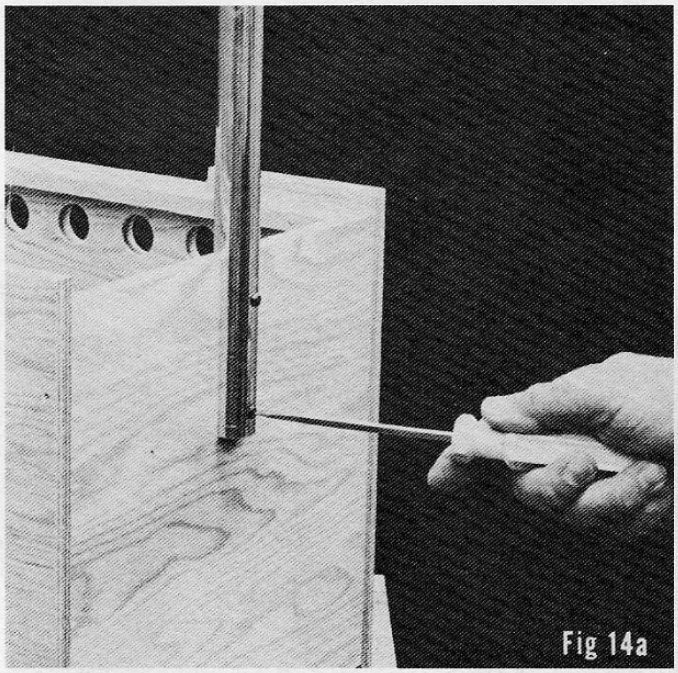
The tube that fits into the bottom of the lens head is for swiveling the lens head. For safety after inserting in the hole of the lens arm, put several rubber bands around the tube to prevent the head from coming off when carrying and moving, Fig. 13. If a larger size tube is available it can be split and pulled into correct outer diameter.

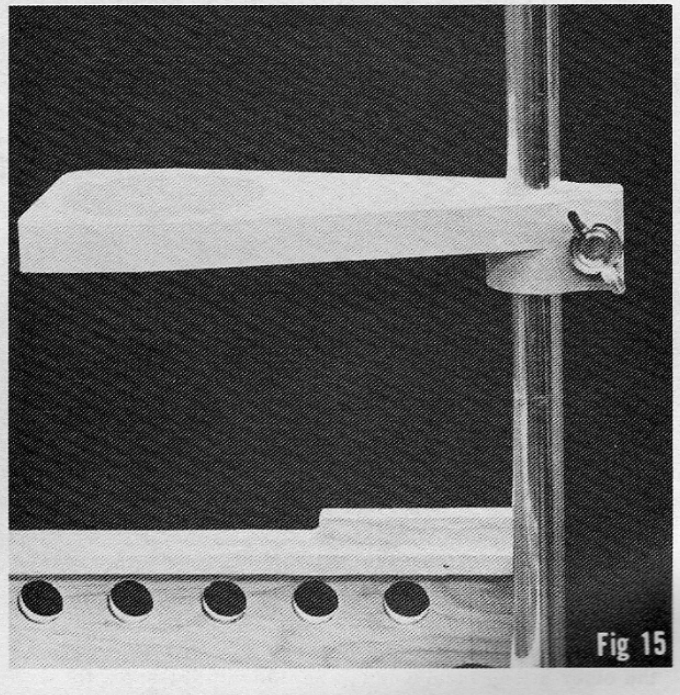
MAKING THE ARM AND POST

Be sure to drill the holes in the arm before cutting the slot, Fig. 14 and 14-A. The post can be 1-1/8" wood dowel or Reynolds 1-1/4" O. D. aluminum. If the latter is used, the hole in the lens arm must be made 1-1/4" dia. After assembly, a light coating of wax will allow easier up and down movement of the arm and head, Fig. 15.







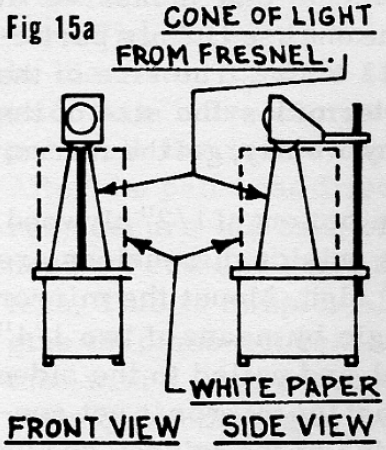


Mounting the post that supports the lens assembly. Cut away the bottom four inches so as to get a half-cylinder as shown. Fasten the post to the box with two round-head screws.

Close-up of the support for the projection lens assembly. Note the double thickness at the end drilled out to pass a 1/4" bolt and wingnut. Tightening the wingnut closes the slot in the end of the support and keeps the support in the desired position without slipping.

CHECKING ALIGNMENT

Fig 15a



An easy way to see if your optical system is centered and aligned is to switch your projector on with nothing on the stage and put out the room lights. Take a piece of white paper or white cardboard, approximately the size or a little smaller than the distance between the stage and the lens when in focus. Stand the paper or cardboard on its edge in the middle of the system. This will show a cone of light from the condenser on the white paper. The cone should come to the exact center of the lens. Do this from the side and front of the projector. If the cone does not point to the center of the lens, viewing from the side and front, move the Fresnel lens until it does. (See Fig. 15A.)

TESTING THE PROJECTOR

Select a projection distance of approximately 12 feet from lens to screen. Switch on the projector, the screen image should be a well lighted square approximately 8' x 8'. The edges of the square should be sharp when in focus.

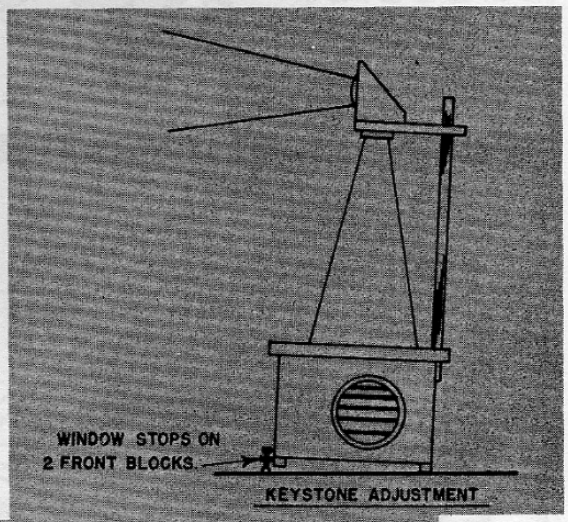
ADJUSTING FOR PROJECTION DISTANCE

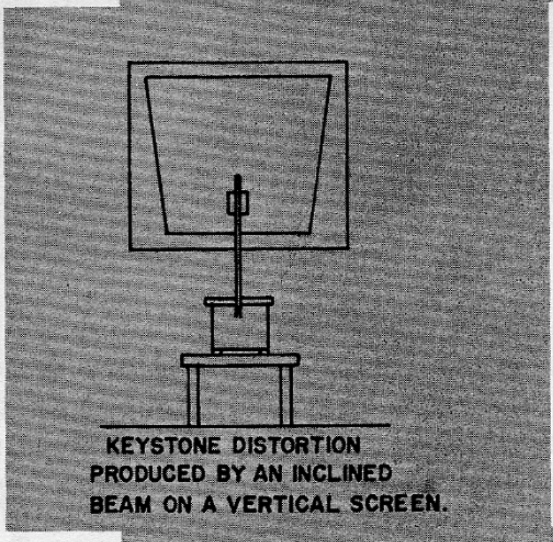
If the edges are blue, this means the lamp is too close to the screen. If the edges appear brown, the lamp is too far away. When the edges are not colored, the lamp is adjusted for the 12 foot distance. If you change this distance drastically, you will have to repeat the above. The metal reflector must always be at the same distance from the bulb (30 mms from the center of reflector to the center of the filament of the Quartz Iodine lamp; see Fig. 4.).

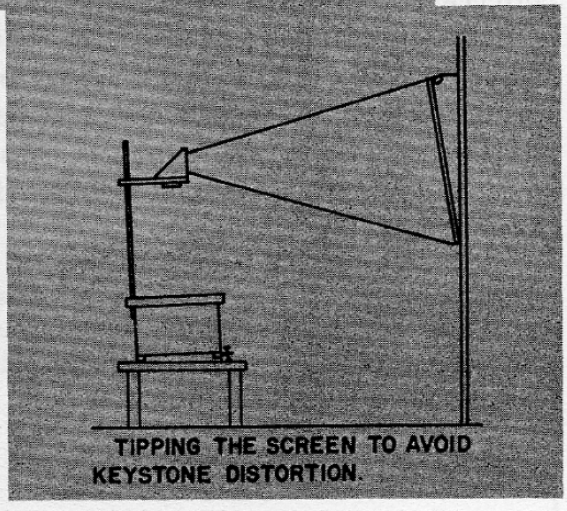
KEYSTONE EFFECT

When the projector is not square with the screen, a keystone effect will take place. Fig. 16 shows several ways to correct this. Overhead projectors should stand between 2 and 3 feet from the floor.

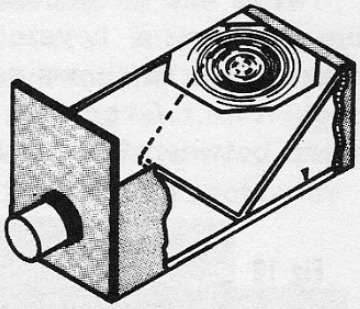
Fig 16







A CAMERA OBSCURA



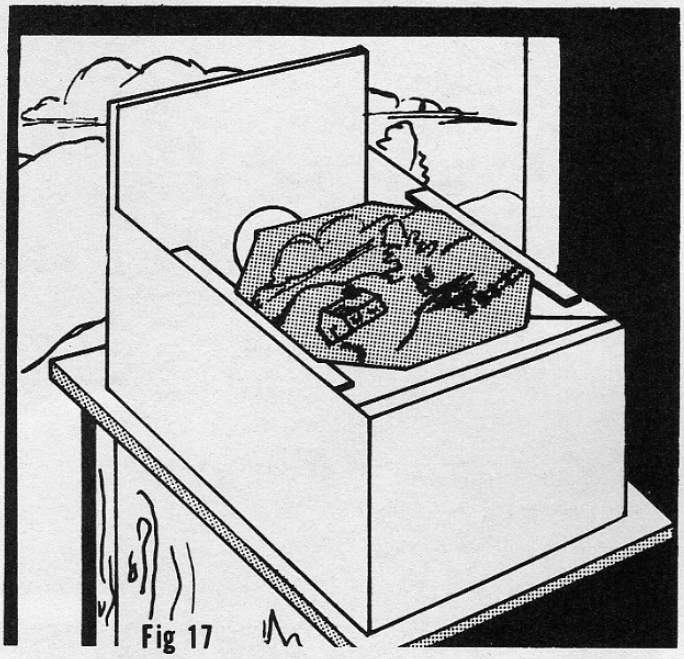


Fig 17

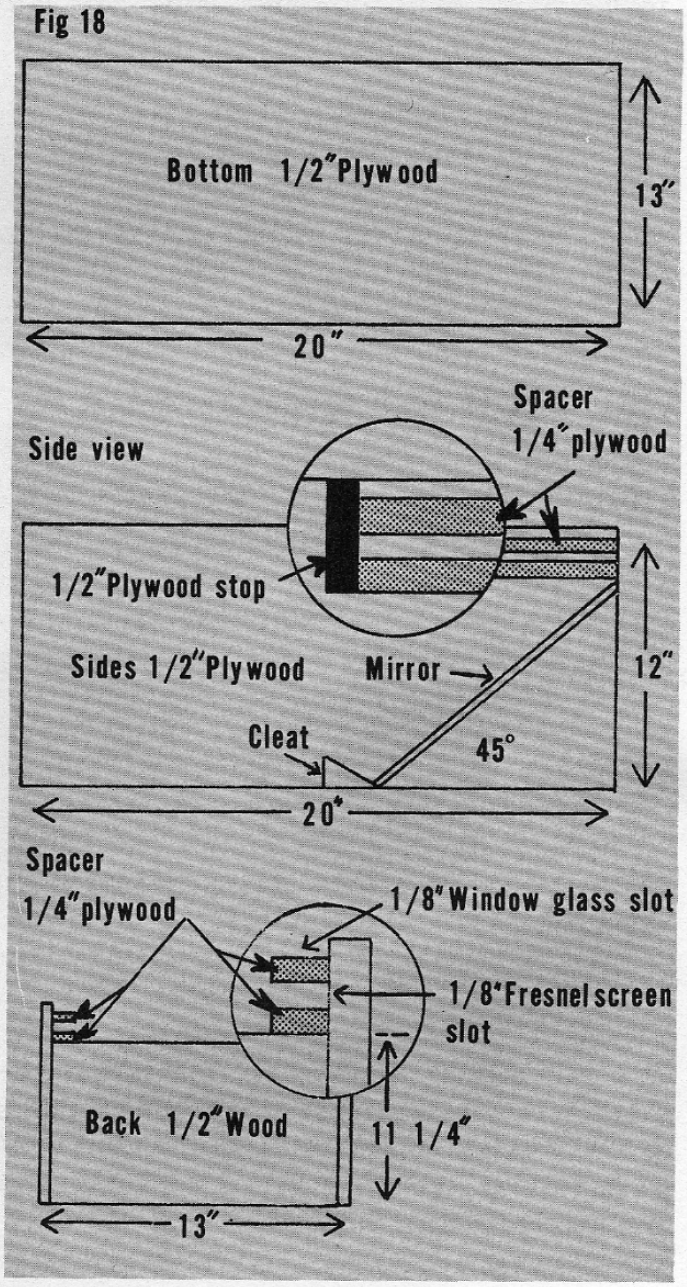
A camera obscura is a fascinating optical device (see Fig. 17). Make it for a child and he will enjoy hours of pleasure with it. But don't think it's just a toy. Professionals us it for making sketches, landscapes, and portraits. Thomas Jefferson had a small one at his home in Monticello. His guests were fascinated by the magic view of the landscape which they were able to view in a darkened room. Jefferson's camera obscura was a small one, yielding an image of about 5 x 5".

You will need a projection lens, a lens tube, focusing sleeve and a special 12 x 12" plastic Fresnel lens. The only other items you will need to build the camera are plywood, glue, and nails, plus a mirror which you can buy at the five-and-ten.

The first step is to buy a mirror at the five-and-ten. Get one that measures at least 10 x 12". The one used in this particular camera is 12 x 15". The size of the mirror really determines the size of the box and that is why we say, get the mirror first.

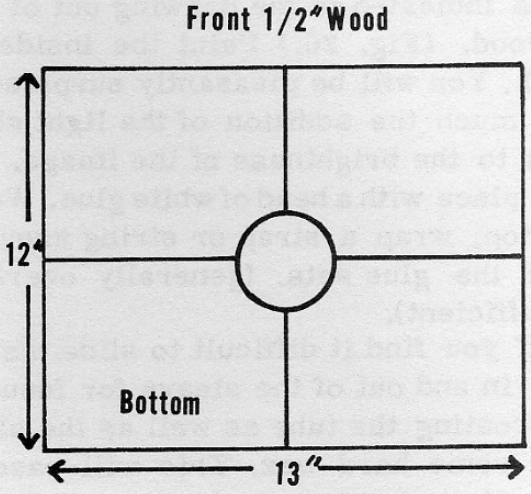
Next, make the box out of 1/2" plywood. (See Fig. 18.) Its outside dimensions are 13 x 20" and 12" high. Mount the mirror at an exact 45° angle by means of two 1/4" thick cleats glued and nailed to the sides of the box. Note that the mirror is not centered, the short side of the mirror should rest against the back of the box.

Fig 18



Cut a hole in the exact center of the front of the box for the focusing sleeve. (See Fig. 19.) This hole should be 3-5/8" in diameter. Cement the focusing sleeve into this hole. Remove the mirror and paint all the inside surfaces a flat black. After the paint has dried, replace the mirror, secure the back of the box with flat-head screws and start the assembly of the lens. This is simple. All you need do is to glue the plano-convex lens (supplied) to the tube with a good grade of cement, such as 3M's Super Strength. Run a bead of cement around the inside of the tube, set the lens in place and add more cement to the outside. Paint the inside of the tube flat black before cementing the lens in place. If you desire, a lens shade made out of a sheet of photographic album paper may be added. It will help you get a brighter image.

The Fresnel lens should be installed with the etched or grooved side facing the lens mounted in the cardboard tube. In addition, you will need a sheet of double-thickness window glass to cover and protect the Fresnel screen. A glazier or hardware store will cut this to size for you. Cost should be about one dollar. The glass will provide a good working surface for making tracings and drawings.



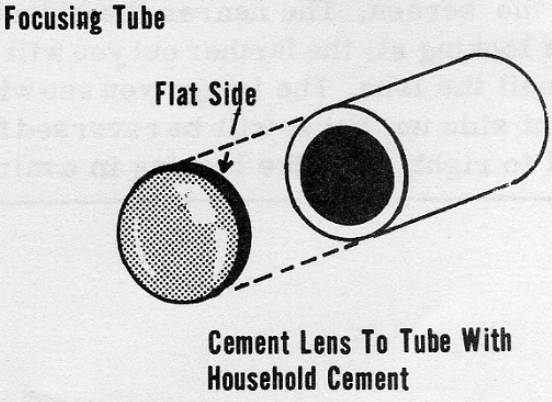
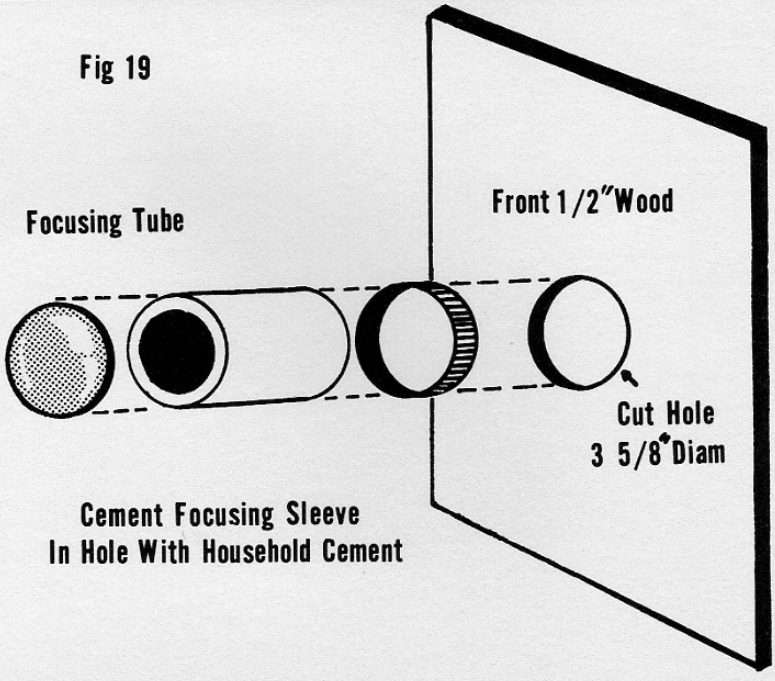
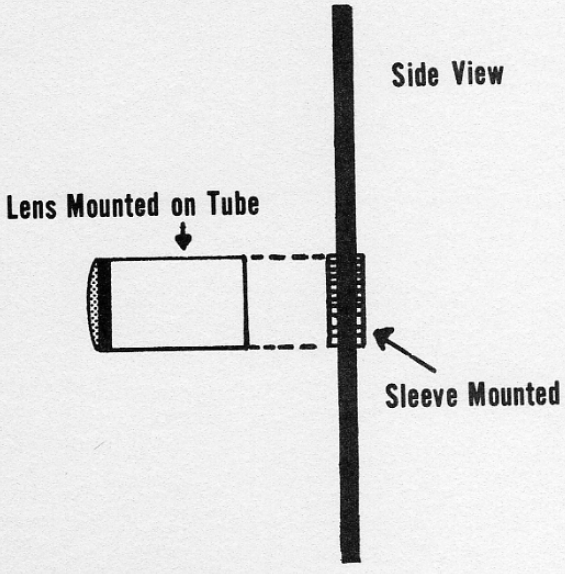


Fig 19

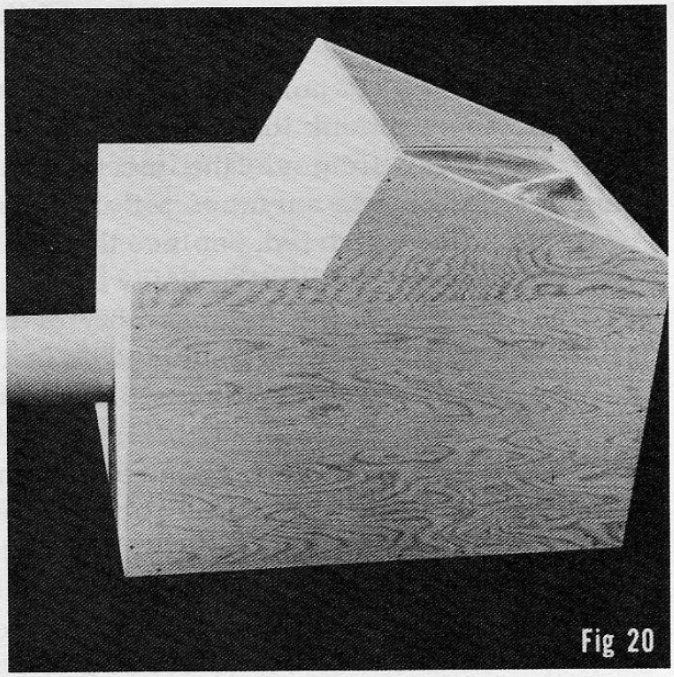




The last step in construction is the making of the triangular-shaped light shield. Cut it as shown to the dimensions indicated in the drawing out of 1/2" plywood. (Fig. 20.) Paint the inside flat black. You will be pleasantly surprised at how much the addition of the light shield adds to the brightness of the image. Glue it in place with a bead of white glue. Weight the top, wrap a strap or string around it until the glue sets. (generally overnight is sufficient).

If you find it difficult to slide the lens tube in and out of the sleeve for focusing, try coating the tube as well as the sleeve with some hard wax. This will ease the operation.

The best way to use the camera obscura is by pointing it out of a window. The darker the room the brighter the image will be on the screen. The nearer the object you are looking at, the farther out you will have to pull the lens. The image you see will be right side up, but it will be reversed from left to right, just like looking in a mirror.



The finished camera obscura. To focus, move the cardboard lens assembly in and out with a twisting motion. Use some wax to ease the operation. The sloping shield in front of the Fresnel screen helps to make a brighter image on the screen. All internal surfaces, as well as the inside of shield should be painted flat black.