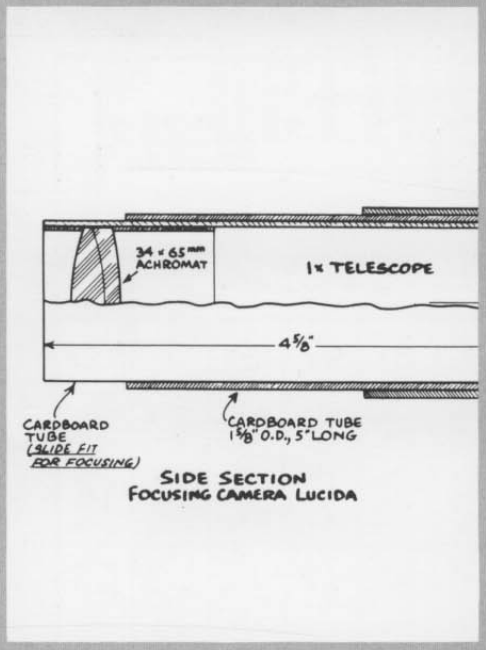

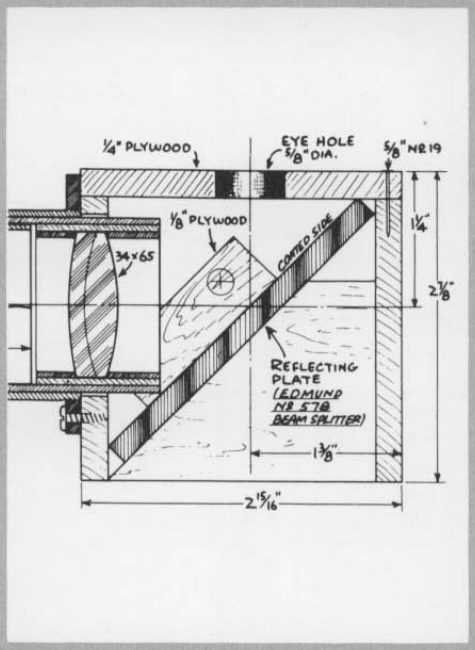

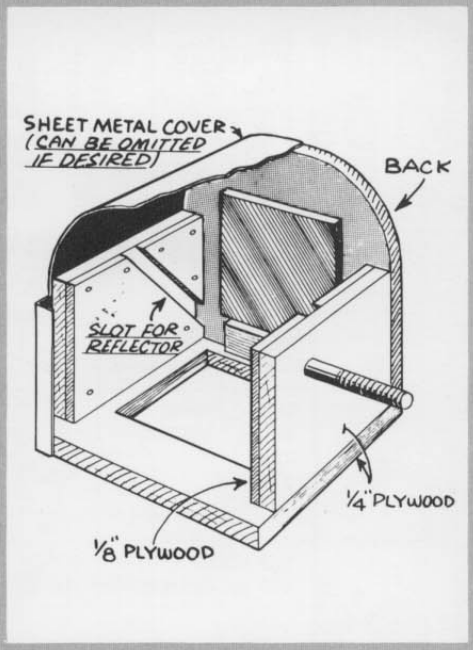

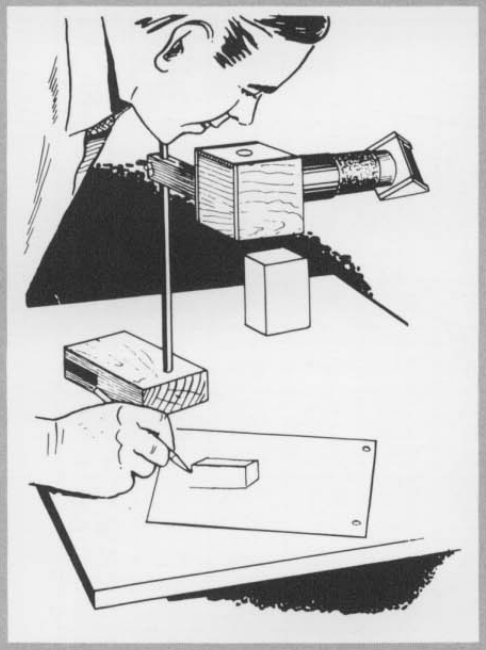

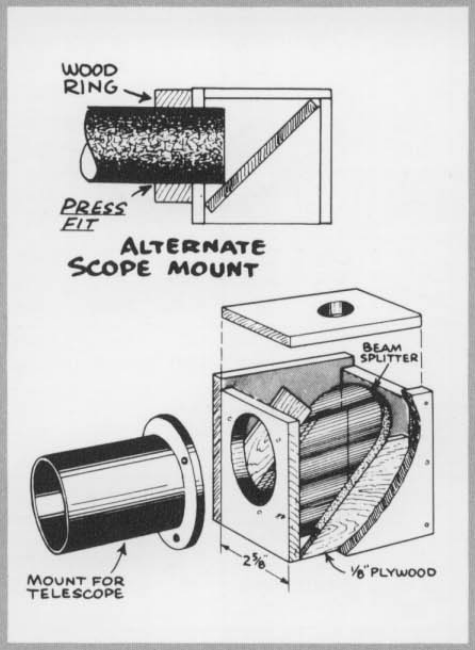

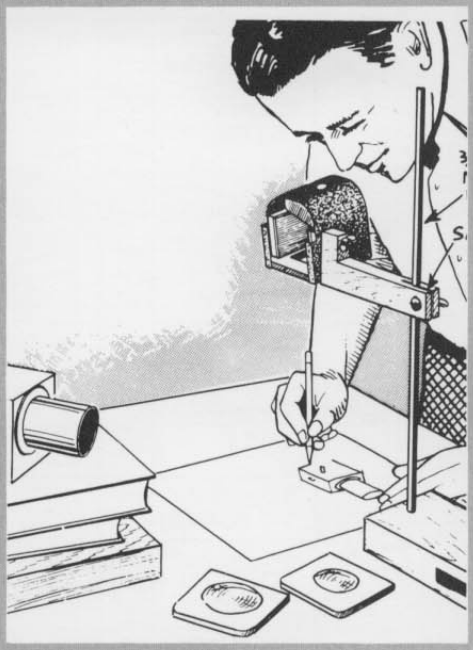

How To Build
OPTICAL DRAWING DEVICES

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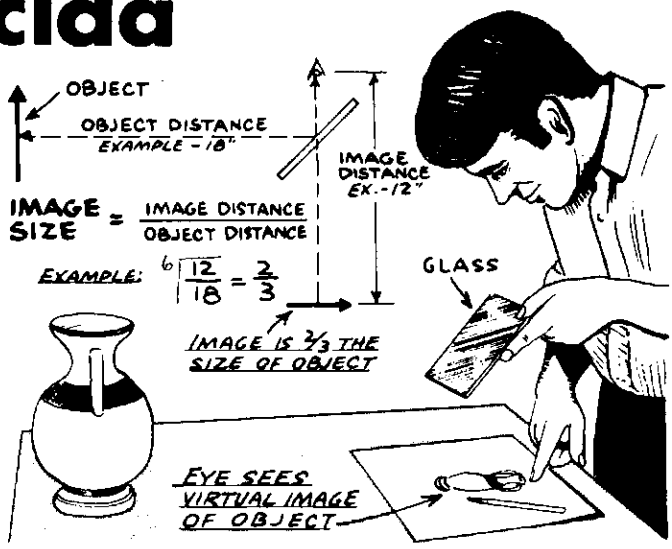
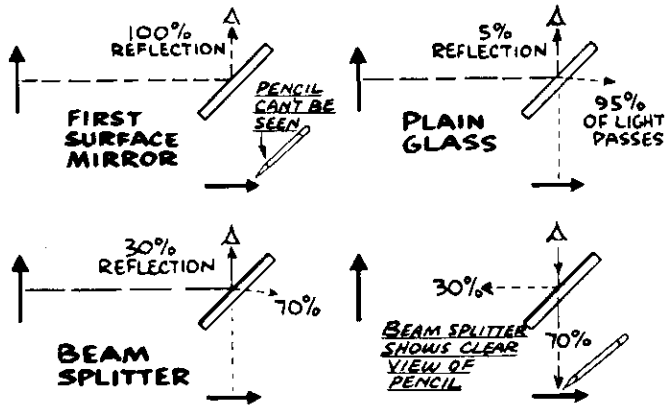
The Camera Lucida

CREDIT for the original camera lucida goes to W. H. Wollaston, English physicist, who invented it about 1804. Fig. 3H shows Wollaston's design, a "split-vision" type with a quadrilateral prism. A number of variations have been made and sold throughout the years and the "lucy" is today as popular as ever. What the lucy does is to project a virtual image of any object onto the drawing board surface, where it can be traced with a pencil. The general idea of the whole thing is right in front of your eyes every time you look out of a window--with a china-marking pencil you could draw what you see on the window glass.

IMAGE SIZE. The simplest lucy is a plain piece of glass, Fig. 1. Looking at the glass, you can see the object by reflection, and your eye will form a virtual image on any surface below the glass. You are also able to look directly through the glass at the drawing board and pencil. The image size is in direct ratio to image distance-object distance, as shown in Fig. 1 example.

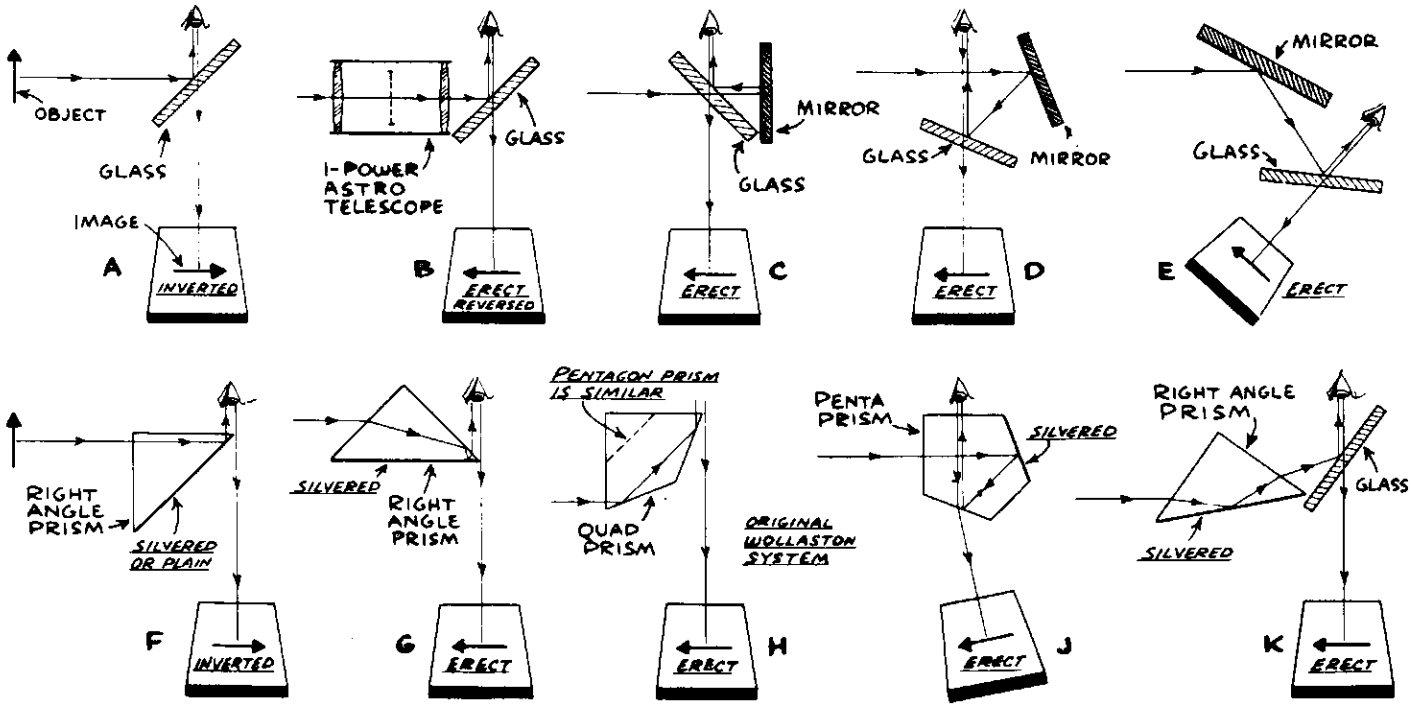


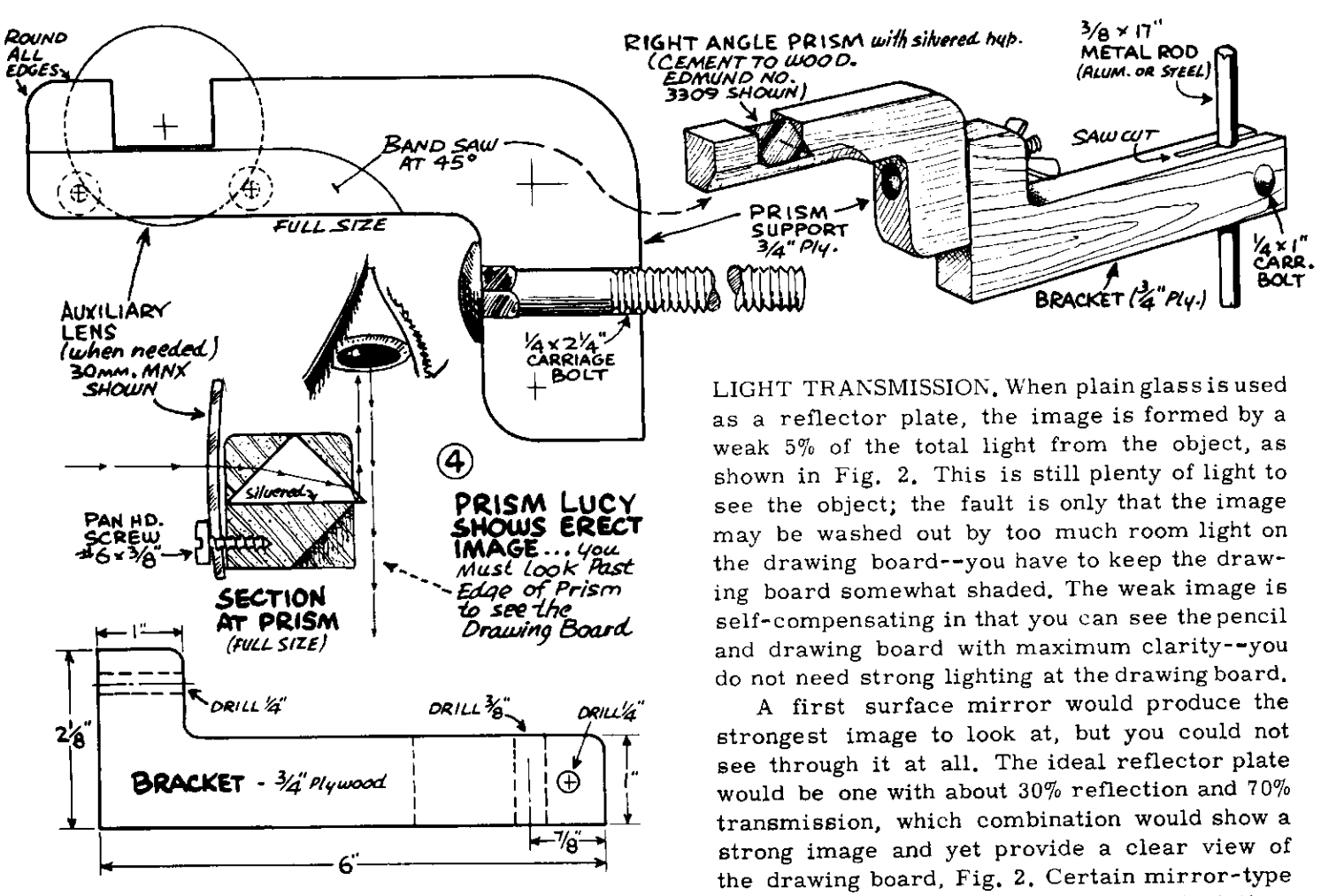
① SIMPLE EXPERIMENT SHOWS HOW THE REFLECTING "LUCY" WORKS



② LIGHT TRANSMISSION

③ OPTICAL SYSTEMS



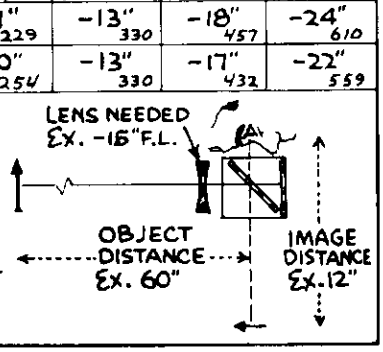


⑤ AUXILIARY LENSES

OBJECT DISTANCE	IMAGE DISTANCE (EYE TO DRAWING)				
	8"	10"	12"	16"	20"
4"	+8" 203mm	+7" 178mm	+6" 152mm	+5" 127mm	+5" 127mm
6"	+24" 610	+15" 381	+12" 305	+10" 254	+8" 203
8"	NO LENS	+40" 1016	+24" 610	+16" 406	+13" 330
10"	-40" 1016	NO LENS	+60" 1524	+26" 660	+20" 508
12"	-24" 610	-60" 1524	NO LENS	+48" 1219	+30" 762
14"	-18" 457	-35" 889	-84" 2134	+112" 2845	+47" 1194
16"	-16" 406	-27" 686	-48" 1219	NO LENS	+80" 2032
20"	-13" 330	-20" 508	-30" 762	-80" 2032	NO LENS
25"	-12" 305	-17" 432	-23" 584	-44" 1118	-100" 2540
40"	-10" 254	-13" 330	-17" 432	-27" 686	-40" 1016
60"	-9" 229	-12" 305	-15" Ex. 381	-22" 559	-30" 762
10 FT.	-8" 203	-11" 229	-13" 330	-18" 457	-24" 610
20 FT. OR MORE	-8" 203	-10" 254	-13" 330	-17" 432	-22" 559

ADJUST LUCY TO YOUR BEST NEAR VISION (EYE TO DRAWING)

Then, in table, FIND CORRECTIVE LENS YOU MAY NEED TO SEE THE OBJECT CLEARLY.



LIGHT TRANSMISSION. When plain glass is used as a reflector plate, the image is formed by a weak 5% of the total light from the object, as shown in Fig. 2. This is still plenty of light to see the object; the fault is only that the image may be washed out by too much room light on the drawing board--you have to keep the drawing board somewhat shaded. The weak image is self-compensating in that you can see the pencil and drawing board with maximum clarity--you do not need strong lighting at the drawing board.

A first surface mirror would produce the strongest image to look at, but you could not see through it at all. The ideal reflector plate would be one with about 30% reflection and 70% transmission, which combination would show a strong image and yet provide a clear view of the drawing board, Fig. 2. Certain mirror-type beam splitters have the desired characteristics, such as Edmund No. 578. The interference coating is practically invisible; the coated side is the side which shows a single reflection when touched lightly with the tip of your fingernail.

OPTICAL SYSTEMS. There are two general optical systems for the camera lucida. Examples A to E in Fig. 3 are reflecting lucys. The other --and original--system makes use of a prism. The simplest example of this is shown at F in Fig. 3. Like the reflector plate, the object is seen by reflection. However, the drawing must be viewed by looking past the edge of the prism. This splitting of the vision requires the eye to be fairly close to the prism to prevent loss of field. Wollaston's original system was a quad prism, as shown at H, Fig. 3; present-day instruments are usually made with a simple right angle prism, as at G. The prism itself need be no larger than 1/4 to 3/8 inch clear face; larger prisms contribute nothing. Most of the better-quality manufactured lucys use the right angle prism, arranged on a pivot so that both inverted and upright views can be obtained. Several small auxiliary lenses are supplied with most instruments to provide for larger-than-life drawings, and also to correct the accommodation of the eye if needed. No lens is needed if drawing is same size as object.

HOMEMADE PRISM LUCY. The homemade prism lucy is a very simple project in plywood construction, as shown in Fig. 4. The prism must have a sharp edge since it is this area you use to see the object. The prism overhangs the wood support by about 1/8 in. to eliminate any possible interference of your sight line past the edge of the prism. In use, you must anchor your eye in a fixed position, because the image will move if you move your head. This is the main reason a small prism is used--it confines your eye. The prism specified is a bit large, which fault can be corrected with 1/8 in. strips of masking tape applied to either side of the prism surface facing your eye. Two screws in the front of the prism support provide a mounting for 30mm diameter auxiliary lenses.

AUXILIARY LENSES. Short focal length lenses are used as magnifiers, allowing you to draw objects larger than life size. The long f.l. positive lenses and all of the negative lenses are used mainly for spectacle correction, which may or may not be needed. In general, if you are a young person with normal eyes, your ability to focus your eyes near or far (accommodation) will be excellent and you will be able to work at various object distances without discomfort. Most persons over 45 will do best with a corrective lens. The exact f.l. of this is non-critical; anything within 25% of the calculated values in Fig. 5 will do the trick. The whole idea is simply that you can see the drawing okay at some near distance, say 16 inches. The specified corrective lens will then bring the object into the same range.

REFLECTING LUCY. This construction is popular because it eliminates the slight annoyance of split-vision. A poor feature is that auxiliary lenses must be 2-1/2 or 3-in. diameter to maintain the field. Fig. 6 design has the reflector plate supported by wooden sidepieces, the whole pivoted on screws to provide a tilt adjustment which is useful when you want a view looking down on an object. The revolving eye turret has two holes, the smaller being best to anchor your eye and so prevent image movement.