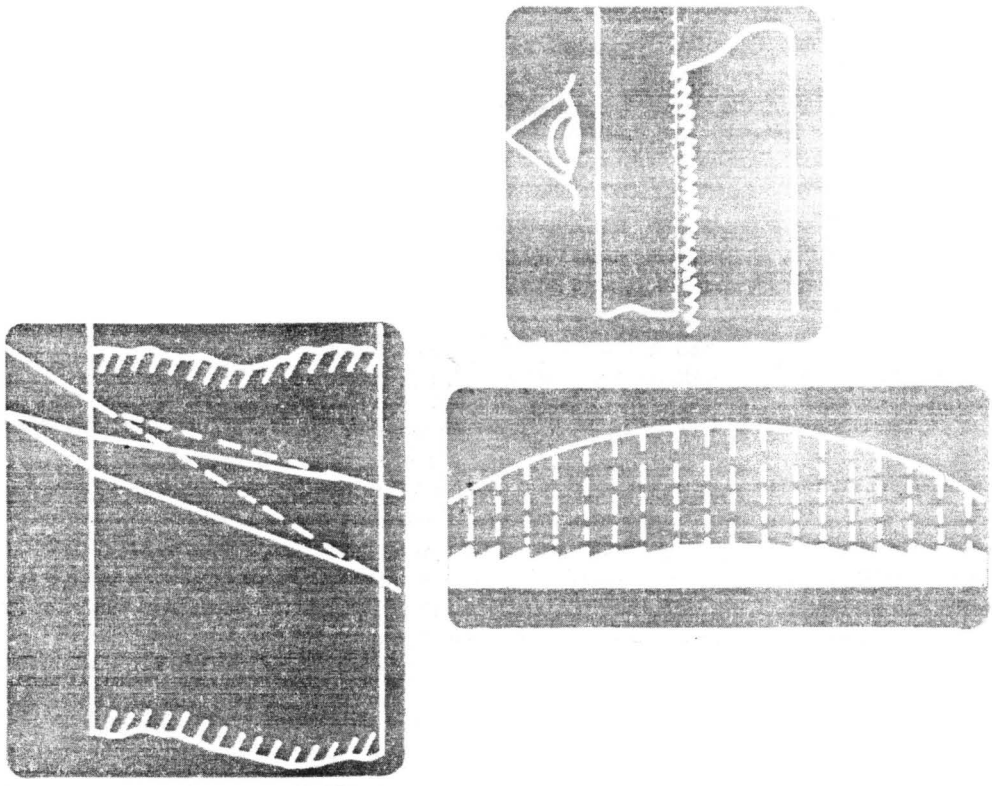

What the Camera Technician Should Know About Fresnel Screens

By J. M. Harris

Since the introduction of the Ektalite field lens to photographic applications about 1950, the use of fresnel screens to provide more uniform light distribution on ground glass finders has become widespread. Fresnel screens are often found on press and view cameras, twin-lens reflexes, and medium format SLR's. In addition, practically every 35mm SLR has a fresnel field of some kind in its finder system. Although fresnel screens never wear out and rarely need repair or replacement, there are three things that every camera technician should know about them:

1. What fresnel screens are.
2. How they should be installed.
3. How to correct for the focus shifts they cause.

THE FRESNEL PRINCIPLE

A fresnel screen is really a collapsed lens. As shown in Figure 1, the curved refracting surface of the lens has been divided into annular zones and dropped to the base. This technique produces both good and bad results. The good result is that the collapsed lens retains the focal length and general refracting characteristics of the original lens, but weighs only a fraction as much and takes up far less space. The bad result is that breaking the lens up into zones disturbs its finer optical qualities, and hence the fresnel equivalent cannot compete in resolution or image contrast with the original lens. Nevertheless the performance of a finely-divided cast acrylic fresnel lens is more than adequate for use as a light-distributing element in camera viewing systems.

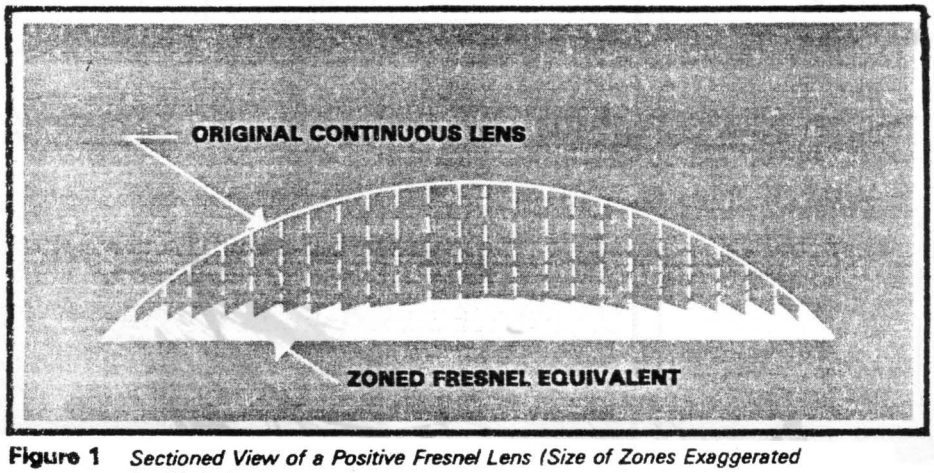

Figure 1 *Sectioned View of a Positive Fresnel Lens (Size of Zones Exaggerated for Clarity)*

The fresnel screen is usually placed nearly in the plane of the image, so that it cannot introduce any significant distortion. It intercepts the light coming from the camera lens and deflects the off-axis rays toward the optical axis just before they strike the ground glass. The result is more even illumination of the ground glass due to an increase in the apparent brightness of the outer portions of the field.

INSTALLATION

An excellent discussion of fresnel screen usage is contained in Reference 1.

The author concludes that the most desirable arrangement is that shown in Figure 2. The textured surface of the ground glass and the embossed fresnel surface are placed in contact. If this were not done, separate images would appear on the fresnel surface and the ground glass, making focusing more difficult and less definite. If the pair were turned so that the smooth surface of the ground glass faced the lens, the imaging rays would be scattered by the ground glass before entering the fresnel screen, and much of the beneficial effect of the fresnel would be lost. It is not unusual to find used press or view cameras with the fresnel screen installed backwards or on the wrong side of the ground glass. At its worst, an incorrect installation can cause both ghost imaging and an appreciable focusing error. As explained in the next section, the correct location for the ground glass/fresnel interface is not the same as that for the ground glass alone.

FOCUS SHIFT DUE TO FRESNEL SCREEN

In addition to having lenslike properties, the fresnel screen is a transparent plate of given thickness and index of refraction. Although a parallel-sided plate has no magnifying power and no effect on rays perpendicular to its surfaces, it does have an effect on converging rays such as those produced by a camera lens. Figure 3 illustrates what happens to a pair of converging rays when they are refracted by a plate of thickness t. The solid lines indicate where the rays converge after passage through the plate, and the dotted lines indicate where they would focus if the plate were not in their path. The distance e represents the amount of focus shift caused by the presence of the fresnel screen. The danger of ignoring the shift can be shown by an example: Suppose a repair person is asked to add a fresnel screen to a twin-lens reflex or a press camera. Let us say the technician understands the correct orientation for the screen and installs it as shown in Figure 2, being careful not to change the location of the ground glass relative to the lens. The problem is that now the lens must be racked out an additional distance e to focus an image point on the ground glass, but no such shift occurs when the rays meet the film. Therefore the installation of the screen, without disturbing the ground glass, will cause a hidden focusing error to occur in every subsequent photograph.

How large is the error? Analysis shows that it varies over the field, being somewhat greater at the edges than in the center.

The formula for the error at the center of the field for small apertures is:

$$e = t\left(1 - \frac{1}{n}\right)$$

Where t is the thickness of the fresnel screen and n is the index of refraction of the material from which it is made. Fresnel screens are made of acrylic plastic having an index of about 1.5. Substituting this value we get:

$$e = t\left(1 - \frac{1}{1.5}\right) = \frac{t}{3}$$

So a representative central field error would be one-third the thickness of the screen. A typical screen for a 4 x 5 camera is 70 mils thick, giving an error of 23 mils or 0.023 inch. This error is not small when compared with the depth of focus of normal lenses even at small apertures, and can cause a noticeable lack of sharpness in product photography, close-ups and copy work.

It should be emphasized that the focus shift is due only to the fresnel screen acting as a parallel-sided plate. The lens characteristics caused by the embossed surface have negligible effect on the image focus and are not involved in creating the error.

AVOIDING THE FOCUSING ERROR

Once the nature and size of the focus shift are understood, the solution to the problem is simple. All that is necessary when installing a fresnel screen is to move the ground glass *away* from the lens by a distance equal to one-third the screen's thickness. This will compensate for the focus shift in the center of the field, where the need for accurate focusing is greatest. The fresnel surface should contact the ground surface as shown in Figure 2.

Reference

1. Stroebel, Leslie. *View Camera Technique*, 2nd Ed., Hastings House, 1973.

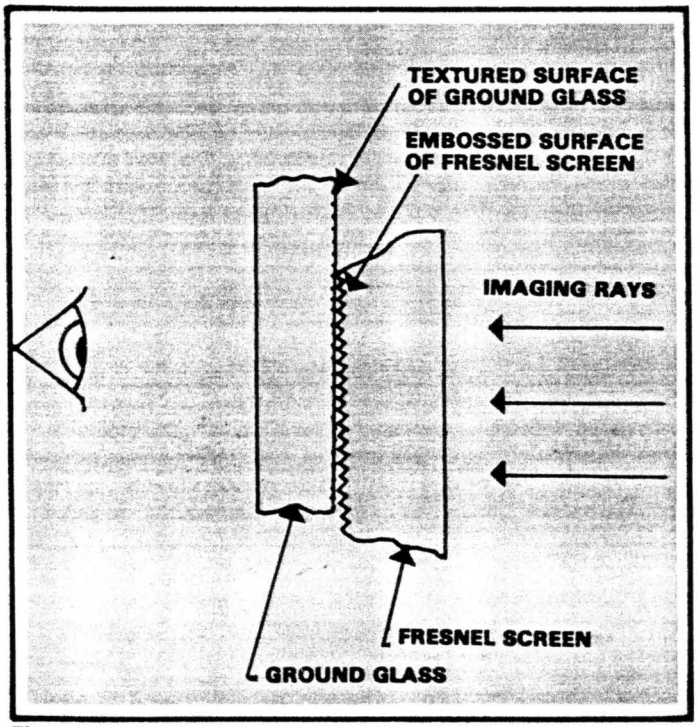

Figure 2 *Correct Orientation of Fresnel Screen and Ground Glass*

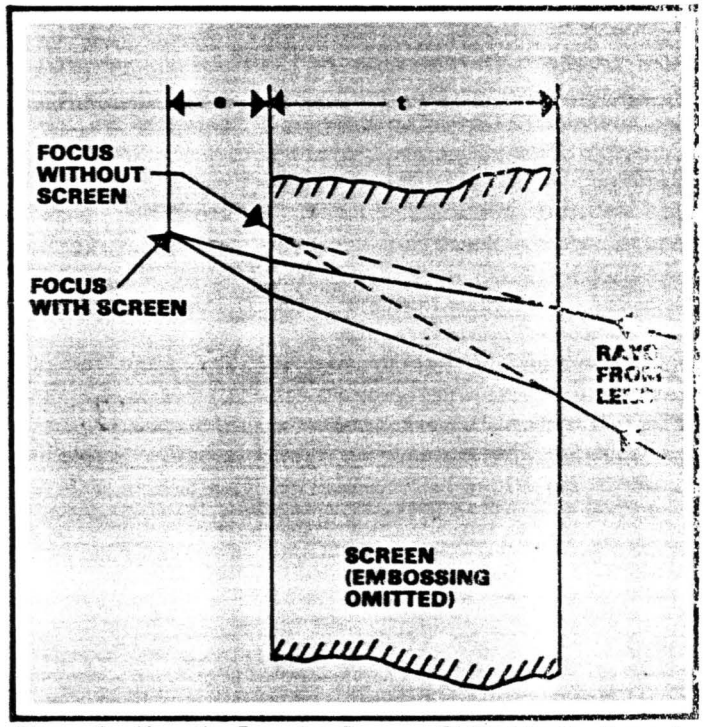

Figure 3 *How the Focusing Rays are Shifted by the Fresnel Screen*