

The Fresnel

Light for a soft wash and all the ships at sea

By Katherine Shirek Doughtie and Steve Nelson

IN 1819, the French government commissioned a thirty-four-year-old physicist named Augustin Jean Fresnel to develop an improved lens for its lighthouses. The result, still carrying its inventor's name, now hangs in theatres all over the world.

The Fresnel (pronounced *freh-nell*) is the instrument lighting designers turn to when they want a soft wash of light, a fill, or a general area special. Unlike the ellipsoidal reflector spotlight (explored in detail in "Workhorse of the Grid," January 2002), which projects a hard-edged beam that can be sharply focused, the theatrical Fresnel produces soft, diffuse light.

How it works

When you look at a theatrical Fresnel lens, you'll notice that on the front side there's an array of concentric ridges and the back side is a flat, dimpled surface. The concentric ridges enable the relatively thin, lightweight lens to manipulate light as effectively as a much heavier conventional lens.

The problem that Fresnel was asked to solve was that in the large diameters needed to project light to ships at sea, conventional plano-convex lenses (flat on one side, domed on the other) were impossibly heavy and subject to cracking under heat stress. Fresnel perfected a design that segmented a plano-convex lens into concentric circles and collapsed the segments toward the flat side



The concentric design of a Fresnel lens gives the instrument its characteristic softly focused, diffuse light.

of the lens. (See the drawing on page 24.) This theoretically gives the lens the same focusing (or converging) power of the original plano-convex lens, but drastically reduces the mass of the glass.

The theatrical Fresnel lens, it turns out, is not really able to focus light as efficiently as the plano-convex lenses upon which it is based, nor is it intended to. It is relatively crudely manufactured as one piece of cast glass. Spill—unfocused light—escapes from the edges of the segments where the glass is stepped back, so you can't get a sharp-edged beam from a theatrical Fresnel. But that was never the point. The Fresnel lighting instrument is intended as a low-cost soft-edged supplement to the more expensive and larger focusable instru-

ments. In fact, the pebbled surface is added to the back of many Fresnel lenses to make the beam even more diffuse, helping to even out any irregularities in the projected light.

Inside the Fresnel

The lens is fixed and is attached to the front end of the metal tube that makes up the instrument housing. The back end of the tube is closed. Inside, the lamp and a polished concave reflector are attached to a sliding base, or sled.

The sled can be moved back and forth inside the housing, carrying the lamp and reflector closer or farther away from the lens. This manipulates the beam from

"spotted down" (narrow and somewhat concentrated, with the lamp and reflector positioned farthest from the lens) to "flooded out" (wide and soft, when the lamp and reflector are in the most forward position).

A knob that protrudes from the flattened bottom of the instrument—or in some designs, a lever or crank at the back—allows for adjustment of the beam by moving the sled.

The light produced by the lamp filament shoots out in all directions. Some goes straight forward, a lot is absorbed by the housing, and some travels back to the reflector and is directed forward toward the lens. Light entering the back of the lens is focused into a soft-edged beam and projected onto the stage.

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Controlling the light

What a Fresnel does best is to put a soft wash of light on a large area of stage. The instrument's major drawback is that it's very difficult to shape or control the beam. You can sort of control unwanted light from a Fresnel by using *barn doors* or *snoots* (sometimes called *snoods*, *top hats* or *high hats*). Perhaps "tame" is a better word than "control," because you're working with a soft-edged field of light rather than the sharp, disciplined beam projected by a leko. It's something like herding cats. You're never completely successful.

Barn doors function something like the shutters on a leko, or ERS, instrument. These hinged metal flaps attach to the gel frame and can be used to mask light off a part of the set, or out of the audience's eyes, by pivoting any of the flaps into the light beam. The barn doors rotate around the lens so you can angle the flaps anywhere you need them.

Snoots are metal cylinders that slip in front of the lens and restrict the spread of the beam. Usually, the tube is about six inches long and looks a lot like a hat with the top sliced off (which is why they are also called top hats). Some snoots are also manufactured so that the cone can telescope in and out, thus increasing or shrinking the diameter of the snoot's aperture. Whether fixed or adjustable, they allow you to control the light and produce a round beam of light instead of one with straight, angled sides.

Hanging the instruments

Before beginning to hang Fresnels, do a quick check to be certain the instruments are ready. Make sure that:

- The C-clamp and yoke are in good working order.
- A lamp is installed.
- The power cable is looped neatly around the yoke for safe and easy carrying.
- A safety cable is attached.
- A gel frame and gel for each instrument is at hand.

When you're hanging any lighting instrument, you need to have an eight-inch adjustable open-end wrench (also known as a crescent wrench), preferably attached to your belt or pants with a tie



A hanging Fresnel, opened to show the lamp and reflector assembly mounted on its sliding sled.

line or piece of telephone cable. You should be wearing sturdy shoes and have a good pair of leather gloves.

Once you and the instrument are in position, loosen the bolt that runs diagonally through the C-clamp so that the clamp will fit over the pipe. Hook the clamp onto the pipe, making sure that the instrument will be right side up when it is aimed in the direction of the stage. Check the clearance so the instrument has enough room to swing without hitting adjacent instruments.

Finger-tighten the bolt until it meets the pipe. Loop the safety cable around the pipe and through the yoke of the instrument, and then clip the two ends together. Use your wrench to tighten the C-clamp bolt onto the pipe. (It doesn't have to make a dent in the pipe!)

Adjust the instrument so that it's pointing in generally the right direction (upstage, downstage, stage right, stage left). Try to position the instrument as accurately as possible and make sure it's ready to be focused.

Finger-tighten the yoke knob, so the instrument is snug but can still be tilted during focus with a firm hand. Drop in the gel frame with the designated gel into the gel frame holder. Plug the instrument into the designated circuit.

If you are hanging on an onstage counterweighted batten, tell the flyman

he or she can figure on about ten pounds for each six-inch Fresnel, twelve pounds for each eight-inch instrument.

Focusing

Focusing is the time when the lighting technicians and the lighting designer work together to aim, focus, and gel all the instruments to be used in a show. Because the instrument has fewer controls, the focusing process for a Fresnel is somewhat simpler than for an ERS. For a detailed discussion of the technician's responsibilities during focusing, see "Workhorse of the Grid," *Dramatics*, January 2002.

As with focusing any instrument, the technician will position and gel the Fresnel according to the lighting designer's instructions. The beam then can be "flooded out" or "spotted down" by moving the knob or slider to position the lamp and reflector inside the instrument.

If you are using barn doors, the designer will tell you how to shutter the instrument to make cuts off scenery or architectural structures (such as the proscenium), or to create a smaller pool of light. Barn doors will never give you precise results. Do the best you can. If you need to get a different angle, the barn door should be able to rotate in the frame holder.



The position of the lamp and reflector is controlled by a knob on the instrument's undercarriage, or by a lever or crank at the back.

Once the designer is satisfied with the position and focus of the instrument, lock it down with your wrench and the yoke knobs.

Maintenance

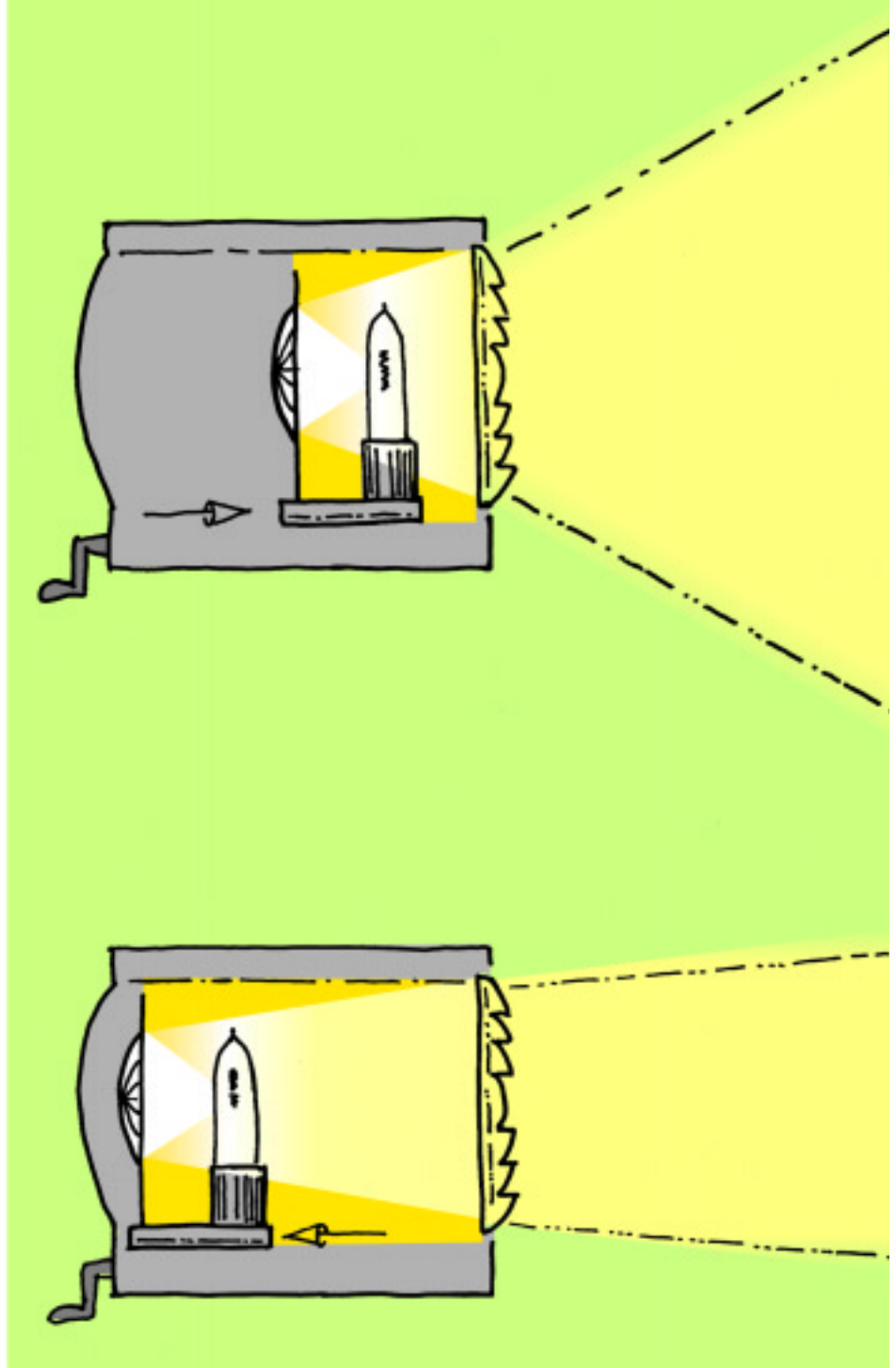
Fresnels are relatively simple, rough and tumble instruments that can get knocked around in normal use and still do yeoman work. Their light output will benefit from periodic—preferably annual—maintenance, consisting of cleaning, checking for broken, bent and worn parts, and adjusting the reflector.

To set up for maintenance, you can either rig a waist-high pipe to hang the instrument you're working on, or you can rest it on a milk crate sitting on top of a table. Either way, you'll need to have enough space to shine the instrument's beam onto a flat, light-colored surface about ten feet away. A wall, a drop, or even a musical shell section will do nicely.

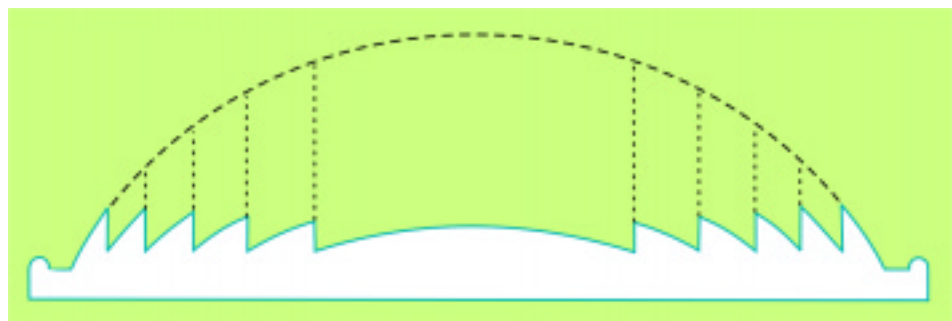
You'll need the following gear:

- An AC cable (and adapter, if necessary) for connecting the instrument to a dimmable live power source.
- Compressed air for cleaning.
- A crescent wrench.
- Tape or some other marking system.
- An indelible marking pen.
- A grease pencil.
- A pencil and notepad.

Cleaning. Open up the body of the



When the sled is in the forward position, carrying the lamp and reflector close to the lens, the Fresnel is "flooded out" and produces a wide beam (top drawing). "Spotted down," with the sled moved to the back of the instrument, it throws a tighter beam. The diagram below illustrates Augustin Fresnel's inspiration that he could make a much thinner, lighter lens by segmenting the arc of a plano-convex lens.



instrument. The innards of most Fresnels are accessed through the front of the instrument by releasing a screw-locked or spring-loaded knob at the top or side of the lens and opening the hinged lens mount.

Use compressed air to blow out the dust, working carefully around the lamp itself. If the air doesn't get the lens and reflector adequately clean, use an ammonia and water solution on a lint-free cloth to clean them. Clean any accumulated gunk off the sled path.

Inspection and repair. While you're cleaning the instrument, you may notice elements that you need to repair or adjust. It's always helpful to have a few old instruments around to cannibalize parts from. If you can't make every instrument perfect, be sure to keep notes of what instruments have cracked lenses or sticky focus assemblies, so you don't keep hanging flawed instruments in critical positions.

Here are some items to look for:

- C-clamp. Run the C-clamp bolt in and out to make sure you can work it easily with your fingers. If it's difficult or impossible to turn without a wrench, replace it, or replace the whole C-clamp.
- Sled. Loosen the lamp sled knob under (or at the back of) the instrument. Run the carriage back and forth. If it sticks, clean the accumulated dirt and gunk out of the sled path. Adding a little dry graphite lubricant (the type used on door locks) to the sliding surfaces on the sled path will usually help. If the control knob screws in and out with difficulty, its threads are probably stripped; replace it.
- The lens. Look for cracks on the side of the lens. Small edge cracks will eventually develop into big cracks that break the lens. You may as well replace it now. The lens may be held in place by a retaining ring or by clamps that attach to the inside of the mount with screws. If you don't have a replacement lens on hand, order one and mark the instrument so you can find it when the replacement arrives.
- The reflector. The distance between the reflector and the lamp is theoretically not adjustable. However,

heat and normal wear and tear will deform the reflector and move it out of position. (It should be perpendicular to the sled.) It's easy to tell if a Fresnel has a misaligned reflector without even opening the instrument: it will have poor light output compared to its peers, or you will see two overlapping pools of light, or two pools of differing diameters on top of each other.

To adjust reflector alignment, hang the Fresnel on a pipe and point it at a flat white surface about ten feet away. (You should do this procedure *after* cleaning and other maintenance tasks, since it is easy to accidentally move the reflector while noodling around inside the instrument.) *With the lamp off*, reach inside and adjust the reflector until it looks approximately straight and centered. (Most Fresnel reflectors are mounted on easily bendable supports.) *Fresnel lamps operate at more than 2000 degrees Fahrenheit. Do not attempt to adjust the reflector with the lamp on!*

When the reflector looks fairly straight (and this is by nature a pretty imprecise operation) plug into a dimmable power source, close the lens, and run the dimmer up to check the beam. Let the lamp cool and repeat as necessary.

Tweaking the reflector alignment will not make an instrument with a badly deformed reflector or substantial damage to the reflector surface work much better. In those cases, the reflector needs to be replaced.

- Wiring. Check that the wiring connections at the lamp base are solid and insulation is intact. If your old Fresnel has asbestos insulation (gray-white fibrous insulation from lamp to plug), either retire the instrument or find out from the manufacturer or your local dealer how to safely replace the cord. Do not use an asbestos-insulated Fresnel.

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The first installment in this occasional series on lighting fundamentals, which covered the ellipsoidal reflector spotlight, ran in January 2002.