The present invention relates to apparatus for demonstrating light distribution.

The intensity of luminous radiation is shown in various ways. It is more commonly shown by the candlepower distribution curves wherein the intensities are expressed in candlepower at various angles about the source, the curves being plotted in polar coordinates.

The distribution from a luminair which is symmetrical about an axis may be adequately shown by a single polar curve in which the axis of symmetry is in the zenith-nadir line. As the curve is plotted on a flat sheet and is a true representation of the distribution in a typical vertical plane, the relation of flux intensity and spatial distribution of flux is readily visualized. By the application of the usual human factors the flux distribution in the various zones is determined and a few calculations are required to determine the curves (isolux curves) for the illumination of the working plane on which the flux falls.

Where the light distribution is asymmetrical a single candlepower distribution curve does not completely show the distribution in space, and it is necessary to make at least two such curves. Asymmetric equipment may be classified according to where it is to be used either for lighting horizontal surfaces, such as in street and highway lighting, corridor lighting, outdoor overhead lighting and the like, or for lighting vertical surfaces, such as in show window lighting, picture and blackboard lighting and the like.

The performance of asymmetric unit for lighting horizontal surfaces is generally shown by one or more curves showing the candlepower readings taken in vertical planes through the zenith-nadir axis of each beam and curves showing candlepower readings taken in the surfaces of one or more cones whose axes in each case is the zenith-nadir axis of the unit. When the candlepower readings taken in the vertical planes are plotted on a flat sheet on opposite sides of a vertical axis the representation does not readily depict the spacial relation of the beams about the axis and above or below the horizontal, and it is necessary to refer to the other distribution curves for this. The plotting of the readings taken in the cone on to a flat sheet cannot disclose the entire angular distribution, and the visualization of the distribution in space requires one to combine the various curves into a mental image.

The illumination produced on a given area may also be shown by isolux curves.

While the methods above described are precise and complete and furnish the trained illuminating engineer with the information desired, they are not readily understood by the layman who must at times pass on solutions proposed for definite lighting problems.

The present invention contemplates apparatus for demonstrating lighting distributions in such a manner that a technical understanding of the usual methods employed is not necessary.

According to the present invention the light distribution curve is reproduced on a medium having a space relationship corresponding with the space relationship of the measurements taken of the actual distribution of the luminair in a single cone. In this way it is possible to see at one time more of the true relationship of the two usual photometric curves. By making a number of these curves at various apex angles on transparent cones and nesting them, the complete composite of the usual sets of curves may be readily visualized and these cones may be placed over a replica of the area to be illuminated and the illuminating effect readily demonstrated.

Where a quantity of duplicate demonstration outfits are to be made, the information may be printed on to flat transparent sheets, with suitable allowances and the flat sheets reformed under pressure into cones with no seams. Where the outfits are to be hand made, the data may be replotted on sheets which may be bent into the conical form. Such cones would have joints.

The accompanying drawing shows for purposes of illustration a set of curves for a typical street lighting unit, together with the method of and apparatus for demonstrating the light distribution from such a unit.

In this drawing: Figure 1 illustrates a typical vertical light distribution curve for a street lighting refractor designed for mounting over the curb line of the street and with the lamp mounting adjusted to give the maximum distribution at 75° above nadir;

Figures 2 and 3 are top plan and side elevational views of a 75° cone illustrating the lateral light distribution in the cone 75° above nadir and from the same unit, Figure 2 also showing in dotted lines the appearance of a flat sheet on which the photometric curve was plotted before the sheet was deformed into the cone;

Figures 4 and 5 are views similar to Figures 2 and 3, respectively, for distribution in the cone 60° above nadir;
Figures 6 and 7 are similar views for distribution in the cone 30° above nadir;

Figure 8 illustrates the nesting of the cones of Figures 3 and 7;

Figure 9 is a top plan view of the nested cones of Figure 8 placed over a representation of a street;

Figure 10 is a view illustrating the replotting of the curve of Figure 2 on a flat sector shaped sheet adapted to be bent into a cone, with the side making an angle of 75° with the vertical; and

Figures 11 and 12 are views similar to Figure 10 showing the distribution curves in the cone 60° and 30° above the nadir, replotted on to flat sector shaped sheets adapted to be formed into 60° and 30° cones.

In Figure 1 the vertical distribution through one of the beams of the street lighting unit designed for curb mounting and producing lateral light distribution in two directions with the maximum beam at 75° above nadir is indicated at 10. In Figure 2 the full line curve 11 is the usual candlepower curve showing readings taken in a 75° cone about the vertical axis of Figure 1. The curves 10 and 11 shown in Figures 1 and 2 are typical curves ordinarily used for the purposes of illustrating light distribution. The sectors are selected so that the Sector (Somewhat less than 360° in extent) is just sufficient to form the

surface of a cone with an apex angle of 150° when the edge 28 and slot 27 are brought together. The sector is then provided with "de-

gresive" markings and radial lines extending from the edge so that the curve may be plotted using these new radial lines as the angular ordinates and the curve fits results. When the slitted sheet 24 is formed into a cone the diameter is lessened and the angular relation of all parts of the curve about the axis of the cone is restored to what they were in Figure 2, and when the cone is viewed from above it looks the same as in Figure 2 or Figure 9, except for the slits and joint.

Figure 11 shows a slitted sheet 29 similar to the sheet 24, and the same reference characters 25-28 with a prime added are applied. The angle 25°-28° is so chosen that the cone formed has an apex angle of 120° and the diameter is selected so that the height of the cone formed is the same as for the cone formed from the sheet 24. The curve 16a plotted on sheet 29 is plotted in the same way as the curve 16, the observations having been made in a cone at 60° to the axis. The sheet 30 of Figure 12 is worked up in the same way for the light distribution in a cone at 30° to the axis and the curve 26a obtained. When the cones formed out of the sheets of Figures 10, 11 and 12 are turned the same as in Figure 9, except for the joints between the edges of the sectors.

It will, of course, be understood that the showing made is merely illustrative of the application of the present invention. It may readily be employed in various forms of lighting equipment, and the curves reproduced may be those which apply to the particular case in hand.

What is claimed is:

1. A device for demonstrating light distribution from a luminair in a cone at a predetermined angle to the axis of the luminair comprising a transparent sheet of material formed into the surface of a cone of corresponding angle and bearing thereon indicia adapted to represent a photometric curve of the distribution to be demonstrated.

2. A device for demonstrating light distribution from a luminair in a cone at a predetermined angle to the axis of the luminair comprising a transparent sheet of material formed into the surface of a cone of corresponding angle and bearing thereon indicia adapted to represent a photometric curve of the distribution to be demonstrated, and a representation of the working plane on which the light in said conical region is to fall, the representation being made at the same scale as the height of the cone, and adapted to be placed in position to form a base for the cone.

3. A device demonstrating light distribution from a luminair comprising a plurality of cones adapted to be coaxially nested, the cones being formed of transparent sheet material and of the same height, each cone bearing indicia constituting a plot showing the light intensities of the luminair at angles to its axis corresponding with the vertex angle of the cone, all the plots being at the same scale and the cones being adapted to be oriented angularly to bring the corresponding radial lines into alignment with the light intensity.

4. A device demonstrating light distribution from a luminair comprising a plurality of cones adapted to be coaxially nested, the cones being formed of transparent sheet material and of the same height, each cone bearing indicia constituting a plot showing the light intensities of the
luminair at angles to its axis corresponding with the vertex angle of the cone, all the plots being at the same scale and the cones being adapted to be oriented angularly to bring the corresponding radial planes into registry, and a representation of the working plane on which the light in said conical region is to fall, the representation being made at the same scale as the heights of the cones, and placed in position to form a base for the cones.

5. A device for demonstrating light distribution in three dimensional space which comprises a plurality of transparent three dimensional bodies of thin cross section each occupying a region in said space and bearing indicia adapted to represent a candlepower distribution curve in the region occupied corresponding with the light intensity in the corresponding region about the luminair, the bodies being adapted to be nested together and oriented to bring corresponding radial planes into registry and the various curves being visible through the nested bodies.

STUART R. WILLIAMS.