Jan. 24, 1950 K. FRANCK 2,495,320

LUMINAIRE FOR SURGICAL LIGHTING

Filed March 27, 1948 2 Sheets-Sheet 1

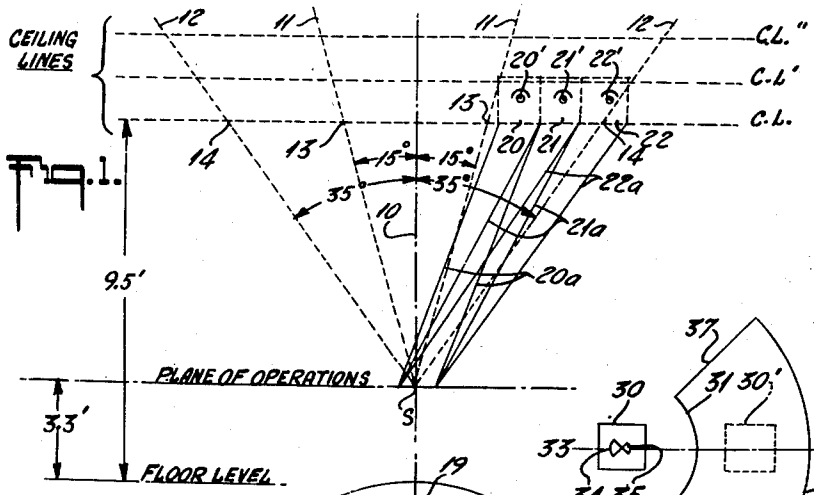


Fig. 1.

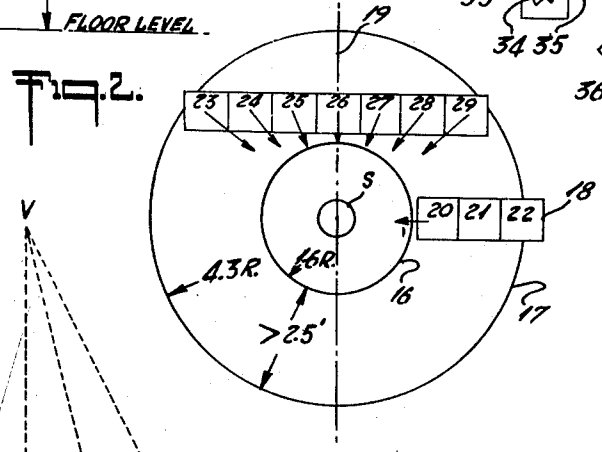


Fig. 2.

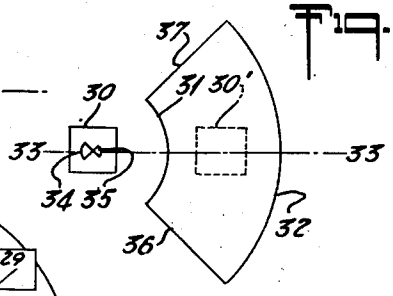


Fig. 3.

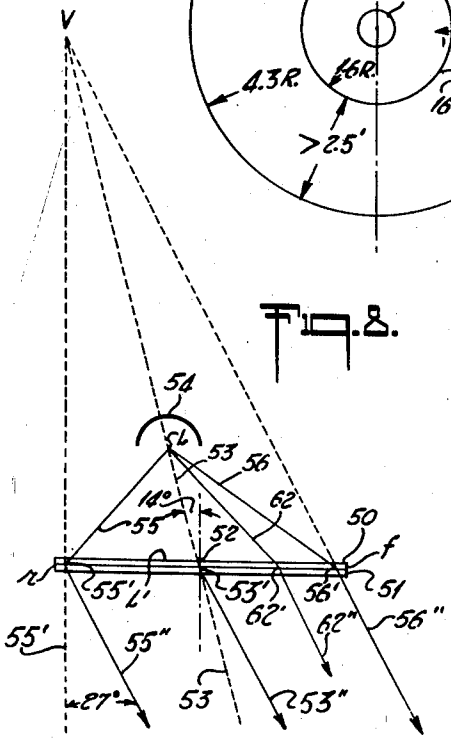


Fig. 8.

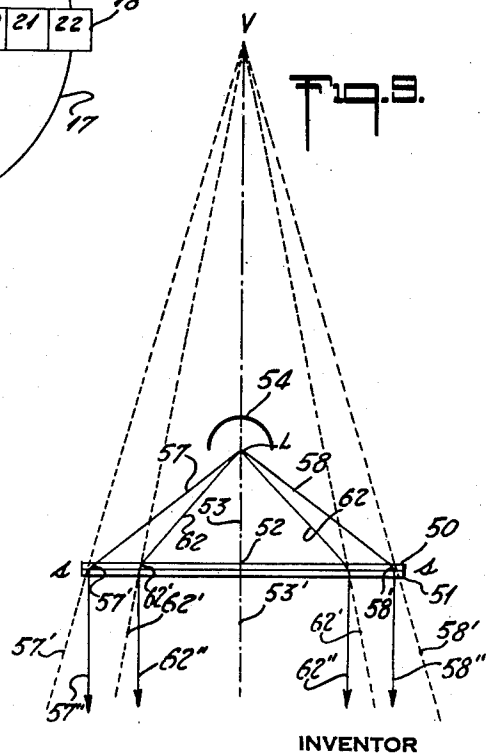


Fig. 9.

INVENTOR
KURT FRANCK
BY John W. Cole
ATTORNEY

Jan. 24, 1950 K. FRANCK 2,495,320

LUMINAIRE FOR SURGICAL LIGHTING

Filed March 27, 1948 2 Sheets-Sheet 2

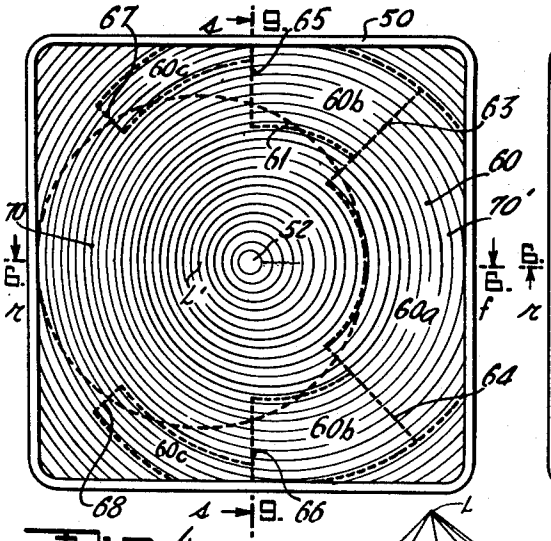


Fig. 4.

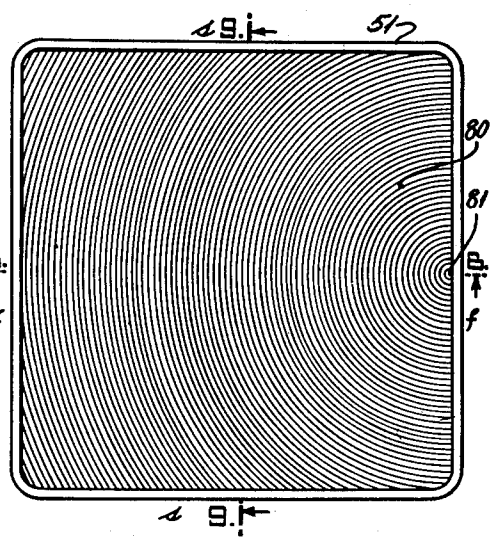


Fig. 5.

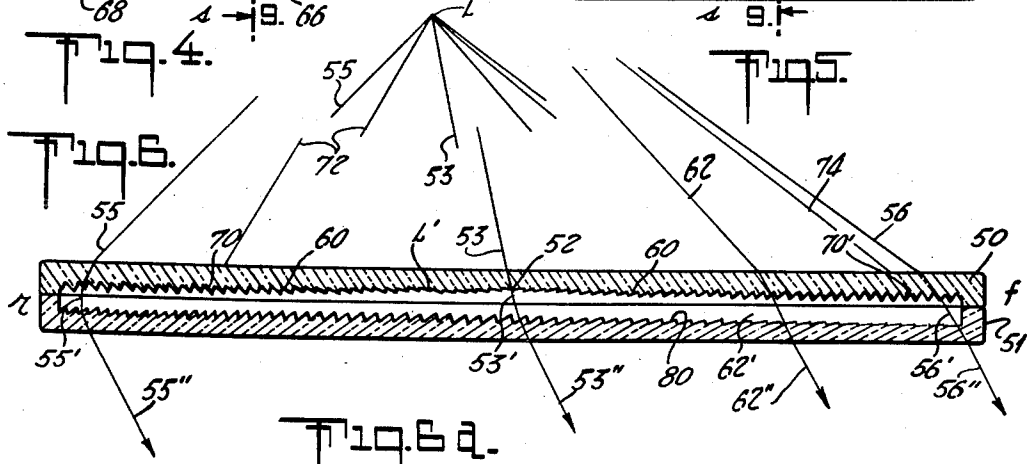


Fig. 6.

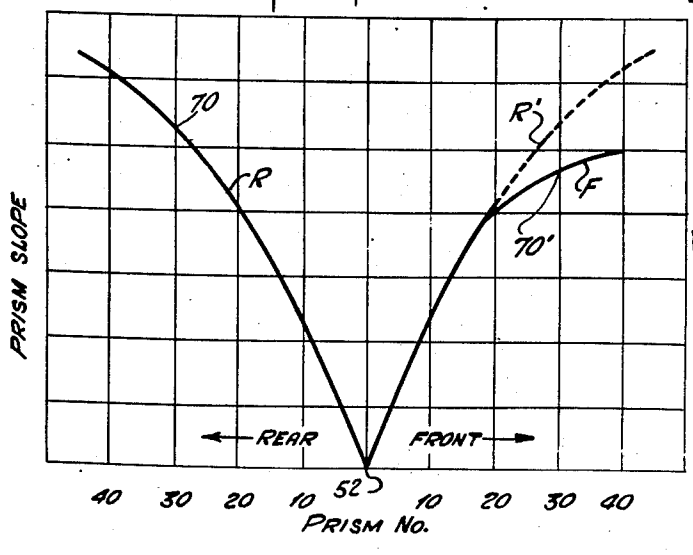


Fig. 6a.

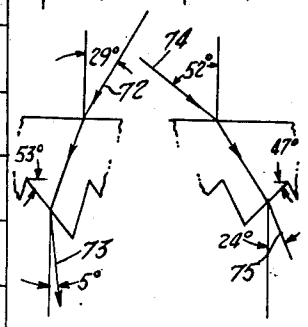


Fig. 7. Fig. 7a.

INVENTOR
KURT FRANCK
BY John M. Cole.
ATTORNEY

Patented Jan. 24, 1950

2,495,320

UNITED STATES PATENT OFFICE

2,495,320

LUMINAIRE FOR SURGICAL LIGHTING

Kurt Franck, Newark, Ohio, assignor to Holophane Company, Inc., New York, N. Y., a corporation of Delaware

Application March 27, 1948, Serial No. 17,492

17 Claims. (Cl. 240—106.1)

1

The present invention relates to luminaires for surgical lighting and more particularly to luminaires in the form of identical units of square shape adapted to be mounted at a given level in any desirable pattern.

The conditions under which surgical operations are performed are such that lighting of sufficient intensity and proper direction or directions must be available. It has been customary to provide multiple unit overhead surgical lighting systems for this purpose and the present invention contemplates improvements in such multiple unit systems.

According to the present invention, a plurality of identical luminaires are mounted above the region or spot in which the operations are to be performed, each arranged to provide a downwardly oblique beam of substantially parallel light rays projected toward the center of the spot at angles between 15° and 35° to the nadir, this optimum range being such as to avoid shadowing by the surgeon and assistants and to provide vertical illumination in the most effective region. Each luminaire has a horizontal square two-component refractor so that the units present a level lower surface and may be mounted side by side immediately adjacent one another or scattered about in the optimum ceiling region above given. Each luminaire has a point light source and spherical reflector displaced from the center of the corresponding refractor in a direction to direct a pyramidal beam of divergent rays onto the refractor and with the axis of the pyramid leaning in a direction to bring the rays towards the spot. The refractors have prismatic configurations whereby these divergent rays are first reduced in divergence to produce a beam of divergent rays with the same sloping axis and a more remote virtual source, and the rays are then brought into parallelism and bent farther to bring them onto the spot. The light sources are variably shifted relative to the refractor centers to adjust the angle of beam throw to compensate for the different angles required in the optimum ceiling region. They may also be shifted to change the orientation of the emitted beam relative to the refractor.

Inasmuch as the refractors in the arrangement above stated receive light from an offset source, the refractors are asymmetric in design and according to the present invention this asymmetry is correlated with the shape of the square plate so that the beam throw is always away from the front edge of the refractor, i. e., the edge remote from the light source. By shifting the source above the rear 90° quadrant of the refractor, the beam can be oriented in the front quadrant, and by shifting the lens 90° at a time and the source correspondingly, the beam can be sent in any direction desired. Hence the same unit may be mounted anywhere in the optimum ceiling area,

2

and by adjusting the lamp position and refractor orientation, the output of the refractor may be placed on the spot.

The accompanying drawings show, for purposes of illustrating the present invention, one embodiment in which the invention may take form, it being understood that the drawings are illustrative of the invention rather than limiting the same.

In the accompanying drawings:

Figure 1 is a diagrammatic illustration showing in a vertical plane the disposition of luminaires and operating region or spot;

Figure 2 is a diagrammatic plan view illustrating possible locations of luminaires relative to the operating region or spot;

Figure 3 is a diagram illustrating the beam throw range of the luminaire units;

Figure 4 is an inverted plan view of the upper lens plate of the two-component refractor;

Figure 5 is a top plan view of the lower lens plate of the refractor;

Figure 6 is a section taken on the lines 6—6 of Figures 4 and 5, showing the two components of the refractor joined together;

Figure 6a is a diagram illustrating variation of refracting power of the prisms in plane 6—6;

Figures 7 and 7a are enlarged sectional views showing typical prism sections; and

Figures 8 and 9 are diagrammatic views illustrating ray paths taken in the planes 6—6 and 9—9 of Figures 4 to 6.

In order to avoid shadowing of the region where the operation is being performed by the head and shoulders of the surgeon and by the attendants, it is desirable to avoid having light come from directly overhead. It has been found desirable to avoid light nearer than 15° to the vertical as such light is likely to be blocked off by the surgeon, his assistants and by instruments and the incision itself. Also, such nearly vertical light gives no appreciable illumination on vertical surfaces. While the light should come from angles greater than 15° with the nadir, there is no need of obtaining light for ordinary operational work at angles much greater than 35° with the nadir, for at this angle the vertical illumination for a given candle power value reaches its maximum. Hence, it is possible to have the beam throw range between substantially 15° and 35° against the nadir.

This optimum condition is illustrated in Figures 1 and 2, in which the ceiling lines are indicated at CL, CL' and CL'', and the spot to be illuminated at S. The vertical line 10 through the center of S forms a vertical axis for the system, and dotted lines 11—11 at 15° to the vertical and 12—12 at 35° to the vertical indicate the desirable limiting ray slopes. Lines 11 and 12 intersect the ceiling line CL at 13—13 and 14—14, respectively. They intersect the other ceiling lines at more

remote points as indicated. As the condition should be symmetrical about the vertical axis 10, the points 13—13 and 14—14 fall in two concentric circles 16 and 17, Figure 2. The diameters of these circles will of course depend in any particular instance upon the ceiling height.

The annulus formed by the circles 16 and 17 defines the limits of an area on the ceiling from which light can come to the spot S with angles of between 15° and 35° to the nadir and lighting equipment may be mounted in this annular area with the proper angle of beam throw and azimuth to direct the light toward the spot.

With a ceiling height of 9.5 feet (the lowest likely to be encountered) and the plane of operations 3.3 feet above the floor, the radii of the circles 16 and 17 are 1.6 feet and 4.3 feet, respectively, so that measured radially there is a space of over 2.5 feet between the circles. As the spot to be illuminated and the luminaires themselves must have substantial areas, it is possible to have the luminaires extend beyond the outside circle 17. This makes it possible to utilize three refractors, each one foot square, disposed side by side in a radius 18 at the ceiling surface, and when properly mounted and adjusted to have light come from the prescribed ceiling area.

Three such refractors are indicated at 20, 21 and 22 in Figures 1 and 2, with the corresponding light sources and reflectors at 20', 21' and 22'. Light rays from the refractors 20, 21 and 22 are downwardly and obliquely directed toward the spot S by means to be described hereinafter. The paths of the bounding rays are indicated by light solid lines 20*a*, 21*a* and 22*a*. It will be noted that with the luminaires indicated by the refractors 20, 21 and 22 on the right hand side of the spot S, all the light is bent so that it proceeds away from the left edge of the refractor as indicated by the adjacent short arrow, Figure 2.

Not only can refractors be placed in radial positions relative to the spot S, but they can be placed so as to be at right angles to a radius. For example, a row of refractors 23, 24, 25, 26, 27, 28 and 29 is indicated as being at right angles to the vertical line 19 through the center of the Figure 2. The refractor 26 is oriented relative to this radius the same as the refractor 20 is oriented relative to radius 18, and the downward direction of the beam is indicated by the downwardly extending arrow below the reference character 26. In the luminaires corresponding with refractors 25 and 27, however, the beams must have their azimuths changed relative to the position of the refractors as indicated by the short arrows extending downwardly from the refractors 25 and 27 toward the center of the spot S. The refractors 23, 24, 28 and 29 are farther from the center of the system and hence the azimuths of the beams from these refractors must be adjusted to a greater extent.

With a square refractor, the limiting amount of adjustment which can take place and yet have the beam bend about the "front" edge of the refractor is 90°. The refractors 23 and 29 show the limiting condition. When any refractor occupies a position outside of the quadrant (Figure 2) occupied by the refractors 23 to 29, it is still possible to have the light beam bend about the same "front" edge of the refractor as before, provided the refractor is turned to an angle of 90°. For example, a refractor placed in the area between refractors 21 and 29 in Figure 2 would be oriented the same as refractor 21. The refractor in the left quadrant of Figure 2 will be oriented 180° from refractors 20 to 22, inclusive, while refractors in the bottom quadrant of Figure 2 would be oriented 180° from those in the upper quadrant. Thus, it is apparent that square refractors may be mounted in the optimum area of the ceiling in any location desired and the refractors individually oriented so that the beam throw is toward the spot to be illuminated. The number and disposition in any installation will depend on lighting intensities and direction desired.

Figure 3 illustrates the analysis of the performance of an individual luminaire by considering reversal of the light rays, this figure being a diagrammatic top plan view showing the luminaire and possible areas to be illuminated. A square refractor is here indicated at 30 and a spot to be illuminated from the refractor by the square 30'. This square area is within the lines 31 and 32, which are arcs drawn with radii having the relation of the tangents 15° and 35°, respectively. When the light beam from the refractor 30 is shifted in the median plane 33—33 of Figure 3, the spot 30' moves back and forth along the median line 33—33 between the arcs 31 and 32. The light source may be moved not only back and forth along the line 33—33, but can be shifted about in one or the other of the quadrants 34 and 35 so as to effect a shifting of the spot 30' above and below the line 33—33. Thus, with the same position of refractor 30 and by shifting the light source in the regions 34 and 35, it is possible to place the center of this light beam from the refractor 30 at any desired position in the area between the lines 36 and 37 at 90° to one another and the arcs 31 and 32.

Figures 4 to 9, inclusive, illustrate the structure and operation of a refractor by which one can obtain any of the light distributions required to fulfill the conditions discussed above. The refractor employed is a two-component refractor having an upper lens plate 50 and a lower lens plate 51. The upper surface of the upper plate and the lower surface of the lower plate are preferably smooth. The plates are square with an outside dimension of 1 foot. In designing the refractor, it is preferable to design it to fit the conditions for the luminaire which has substantially average beam throw. When the area to be covered between the lines 36 and 37, and 31 and 32 of Figure 3 is considered, it is found that the optimum beam throw about which to design the refractor is 27°, which is 2° more than the average of 35° and 15°. When a beam throw of less than 27° is desired, the light source is shifted in one direction and when a beam throw of more than 27° is desired, the light source is shifted in the other direction. The horizontal shift is accompanied by a slight vertical shift.

Inasmuch as the beam throw is always to be in the same direction, it is possible to locate the light source with respect to the center of the prism system in such a way that part of the beam throw is obtained by the off-setting of the light source relative to the center of the prisms. The center or nodal point of the prism system of the upper plate is shown at 52, which is at the physical center of the plate 50.

In the arrangement shown, the prism design is predicated upon the placing of the light source L above the plate on a line 53 extending rearwardly in the plane 6—6 and at an angle of 14° with the vertical. The plate therefore receives light from the source L and the spherical reflector 54 about it in an oblique square pyramid

defined by ray 55 toward the rear *r*, ray 56 toward the front *f* (Figures 6 and 8), and rays 57 and 58 towards the sides *s* (Figure 9). The apex angle of the pyramid is somewhat greater than 90°.

The lower surface of the lens 50 is provided with prisms designated generally by the reference character 60, the purpose of which is to reduce the divergence of the rays with the apex L to be within a pyramid of the same base but with an apex at V (Figures 8 and 9). V becomes the virtual source for the emitted light and is located on an extension of the line 53 at a point vertically above the rear *r* of the lens plate 50. The vertex angle at V is 27° in Figure 8 and 28° in Figure 9, Rays 53, 55, 56, 57 and 58 are emitted from the upper plate as indicated at 53', 55', 56', 57' and 58', respectively.

The prisms 60 in the upper plate 50 are circular. They differ from the usual system of light concentrating prisms, having the same center or nodal point, in that the locus of the centers of the circular prisms starts at the point 52 and moves to the right along the line 6—6 of Figure 4, as indicated by the series of dots at the right of the reference character 52. The migration of these centers is very gradual so that the overlapping of one prism on the region normally occupied by the adjacent prism does not impair its refracting action. The shifting of centers makes it possible to keep the virtual source at the point V notwithstanding the obliquity of the axial ray 53.

The light source L is opposite the point L' (Figures 4, 6 and 8) of the upper lens plate. The angle of incidence of extreme ray 55 on the upper plate is about 40°, and all rays received by the plate with less angles of incidence than this ray can be efficiently handled by the circular prisms of 360° extent and deviated so as to appear to come from the virtual source V. Such prisms are those within the dotted circle 61 of Figure 4. Rays 62, at the same angle of incidence as ray 55, are the bounding rays of this cone. Such rays are emitted by the circular prisms as indicated at 62'.

The front and side portions of plate 50 receive rays at greater angles of incidence than rays 62, but as these rays are to be emitted between rays 62' and rays 56' or 58', it is not necessary to deviate them as much as rays making equal angles with the ray 53 on the other side of this ray 53. Hence, in the areas of the plate 50 outside the circle 61 it is not necessary to have prisms of as great refracting powers as the correspondingly numbered prisms toward the rear of the plate.

The variation of prism slope with respect to prism number (counting from the center) is shown in Figure 6*a*. Here, to the left of the center, the full line R shows the slope of the prisms to the rear of the center 52, while the full line F shows the slope of the prisms to the front of the center 52. The dotted line R' corresponds with the outer portion of line R. The curve F is like curve R out to where R' is shown. There is a change in refractive powers at the juncture of F and R' corresponding with circle 61, such that less steep prisms are used toward the front.

As portions of the larger radius circular prisms are inside the circle 61 and other portions outside, it becomes desirable to change the prism section in the region where the circular prisms cross the circle 61. Instead of making this change at the point of intersection, it is more convenient in the manufacture of the mould to provide prisms which approximate such a layout. The region outside the circle 61 can conveniently be divided, as indicated in Figure 4, by diagonal lines 63 and 64 on the front side of the plate, transverse lines 65 and 66, and rear diagonal lines 67 and 68. The prisms in the area 60*a* between lines 63 and 64 are formed about the same centers as the prisms of corresponding radius on the rear side of the plate but are of different refracting power as indicated in Figure 6*a*. The prisms in the region 60*b* between lines 63 and 65, and 64 and 66, respectively, and the prisms in regions 60*c* between lines 65 and 67, and 66 and 68, respectively, also have refracting powers calculated so as to bend the rays the proper amount to keep the virtual source for all rays at a point.

In Figures 4, 6 and 6*a*, the points 70 and 70' locate prism No. 30 of Figure 6*a*. These prisms have a common center and the prism slopes are 53° and 47° respectively. The point 70 is inside the circle 61, while the point 70' is outside the circle 61. Figure 7 shows the 53° prism while Figure 7*a* shows the 47° prism. A light ray such as 72 from the light source L will be refracted on entering the plate, and by the lower surface of prism 71 so as to be emitted in the direction 73 without crossing the vertical. Similarly a ray 74 from the source L, with greater angle of incidence is refracted and emitted in the direction indicated at 75. All these rays appear to come from the same virtual source and it is thus apparent that the first or upper plate places on the second or lower plate a pyramidal beam of light rays about a sloping axis of 14° with a spread of from 27° to 28°.

The purpose of the lower plate is to convert this moderately divergent sloping beam into a beam of parallel rays with a greater angle of slope. This lower plate is provided with a system of refracting prisms 80 of variant refracting power centered about a nodal point 81 at the front edge of the plate and in the plane 6—6. These prisms have variant refracting power with increase in diameter as indicated in Figure 6. At the point 81 the refracting power is zero, so that the ray 56 is emitted at 56'' without change in direction. The refracting power increases across the plate so that all the rays are bent into parallelism with the ray 56''. Hence these rays are all at an angle of substantially 27° with the vertical. These parallel rays are indicated in the Figures 6, 8 and 9 by the same reference characters used for the direct light rays with two primes added, also by lines 21*a*, Figure 1.

It is thus apparent that the direct and reflected light which falls on the upper plate has now been transformed into a beam of parallel rays emitted in a direction 27° to the vertical, and that these rays may be directed toward the spot S when the luminaire is mounted at the proper location. By shifting the light source along the line 6—6, or in the plane of Figure 8, it is possible to shift the beam one way or the other from the 27° angle as indicated at the right of Figure 1, and by shifting the light source and reflector one way or the other from the axis 6—6 and forward or back as desired, it is possible to direct the beam in any of the directions indicated in Figures 2 and 3 so that by selection of luminaire location, orientation of plate and adjustment of light source, it is possible to produce beams of parallel light of extremely high end-on candlepower for illuminating the spot desired.

Luminaires made according to the present invention have considerably higher light output in the range of adjustments than available with lens refractor combinations in which all the prisms are concentric with the focal line normal, and the beam throw and azimuth shift are obtained by shifting or offsetting the light source.

While the description herein presented is for purposes of illustration based on specific angular relations stated, it is of course to be understood that these are to be interpreted as illustrative and subject to variations as conditions may arise under which the same principles of light control may be employed.

The ability to use these square plates in any location and arrangement desired makes it possible to employ layouts in which the edges of the plates are parallel or at right angles to one another. This makes it possible to utilize other fixtures for general lighting arrangement in the same rectangular system. It also makes it possible to use the units one at a time or in groups in radial arrangements with respect to the vertical axis of the entire system. Such an arrangement is shown and its characteristics described in application of Henry L. Logan for patent for Surgical lighting, Serial No. 17,401, filed March 27, 1948.

The above discussion is specifically directed toward luminaires with point sources and refractors with circular prisms. Certain features may be employed with rectilinear sources and rectilinear prisms. The prism slopes may typically have asymmetric relations on the front and rear of the plate of the same nature as those discussed with respect to Figures 6, 6*a* and 8.

Since it is obvious that the invention may be embodied in other forms and constructions within the scope of the claims, I wish it to be understood that the particular form shown is but one of these forms, and various modifications and changes being possible, I do not otherwise limit myself in any way with respect thereto.

What is claimed is:

1. A multiple unit lighting system for building up high intensities of both horizontal and vertical illumination in a work region of substantial horizontal and vertical dimension, comprising a plurality of luminaires mounted above the work region and angularly displaced from a vertical axis through its center at angles not less than substantially 15° and not greater than substantially 35°, the luminaires each comprising a horizontal, square, two-component refractor, a point light source above the refractor, and a specular concentric reflector above the source, the refractors being at a common level and with their edges in parallel and right angular relationship with one another, the light sources being offset from the centers of the corresponding refractors so that the refractors intercept an oblique pyramid of light leaning rearwardly from said vertical axis, the first components of the refractors having light concentrating prisms and on opposite sides of a vertical plane at right angles to the direction of offset being transversely asymmetric with the front and side regions receiving more oblique direct light than the rear regions and being of less refracting power than the rear regions; the second components of the refractors being symmetric about the center of the forward edges of the second components and having concentric prisms of refracting power to reduce the divergence to substantially zero and bend the rays forwardly.

2. A luminaire comprising a point light source, a substantially square horizontal lens plate below the source with its center offset from a vertical axis through the source so as to be closer the source at the near end of the plate than at the opposite or remote end whereby the marginal portion of the plate adjacent said remote end receives rays at greater angles of incidence than those of any rays on the near end, the lens plate carrying a first system of prisms occupying a generally circular area and of increasing refracting powers about a substantially point locus offset from the vertical axis through the source toward said remote end, extending all the way to the near end of the plate and for the same distance from the vertical axis through the source toward the remote end of the plate so that all the prisms in said circular area receive light with angles of incidence not greater than the maximum angle of incidence at the near end of the plate, the marginal portion of the lens plate outside said generally circular area carrying a second system of arcuate prisms for controlling light of correspondingly increased angles of incidence, its prisms being of less rapidly increasing refracting power than prisms of corresponding radius in the first system.

3. A luminaire comprising a horizontal lens plate and a point light source above the plate, the plate being provided with circular prisms centering generally about a region laterally offset forwardly from a vertical line through the source, the prisms having increasing refracting power with increase in radius, their centers shifting forwardly with increase in radius and the refracting power of the forward prisms of larger radius being less than the refracting power of the rearward prisms of the same radius, all said prisms having refracting powers to so refract the light from the source that all the rays appear to come from a virtual source above the plate and in an extension of the line interconnecting the center of the smaller prisms and the real source.

4. In combination, a point light source, a flat, first lens plate having circular prisms with variant lineal displacement of their centers from a point spaced from the normal to the plate passing through the source and variant refracting power from prism to prism to reduce the divergence of rays emitted therefrom so that they have varying angles of obliquity to the plate and appear to come from a virtual point source, and a second flat lens plate close to the light emitting side of the first plate having circular prisms of variant refracting power with the least power opposite the most oblique rays from the first plate and the greatest refracting power opposite the least oblique rays from the first plate.

5. In combination, a light source and flat refractor for producing a light beam in a direction oblique to the plane of the refractor, the refractor having two parts, each refractor part being provided with circular light deviating prisms, those on the first refractor part reducing the convergence of direct light rays impinging thereon, those on the second refractor part further reducing the convergence of the rays directed thereon by the first part, the prisms in the first refractor part centering about a nodal region offset from the normal to the refractor through the source and of variant refracting power from prism to prism to effect partial concentration about an oblique axis, the prisms of the second refractor part centering about a nodal region

further offset in the same direction and being of variant refracting power from prism to prism to effect further concentration about a more oblique axis.

6. A lens plate for reducing the divergence of light rays from a point source and transmitting them obliquely from the side opposite the source in directions which radiate in all azimuths from a virtual source at a point more remote from the plate than the real source and to the rear of the real source, said plate having a series of eccentrically disposed circular prisms of variant refracting power from prism to prism with the centers of successive prisms shifted forward along a radial line in amounts less than prism width.

7. A luminaire for producing a downwardly and forwardly directed light beam in a selected azimuthal range, comprising a square, horizontally-disposed lens plate, a concentrated light source and concentric specular reflector above the central area of the lens plate and within the rear quadrant, so that the lens plate receives downwardly divergent light in a rearwardly leaning oblique pyramidal region with the source as an apex, the lens plate having circular light concentrating prisms having variable refracting power from the center of the lens plate toward the edges so as to variably reduce the divergence of the emitted light, the prisms in the quadrant of the lens plate between diagonals and under the source having greater refracting power than at least the outermost portion of those in the opposite quadrant, the prisms in each of said quadrants being symmetrical on the opposite sides of a vertical plane bisecting the quadrants whereby the emitted light is forwardly and obliquely directed and the azimuth direction of the oblique beam is determined by the position of the source relative to the bisecting plane.

8. A luminaire as claimed in claim 7, wherein the outermost prisms in the quadrants intermediate the first mentioned quadrants have refracting powers intermediate the refracting powers of the corresponding prisms of the first mentioned quadrants.

9. A luminaire as claimed in claim 7, wherein the centers of the circular prisms are successively displaced from the center of the plate along the bisecting plane in the direction away from the quadrants having the greatest refracting power.

10. A luminaire as claimed in claim 7, wherein the outermost prisms in the quadrants intermediate the first mentioned quadrants have refracting powers intermediate the refracting powers of the corresponding prisms of the first mentioned quadrants, and wherein the centers of the circular prisms are successively displaced from the center of the plate along the bisecting plane in the direction away from the quadrant having the greatest refracting power.

11. A luminaire as claimed in claim 7, wherein the upper surface of the lens plate is smooth.

12. A luminaire as claimed in claim 7, having a second refracting plate below the first and of the same size and shape, the second plate having circular light condensing prisms centered about an axis passing through the bisecting plane and the edge of the plates remote from the quadrant having the greatest refracting power.

13. A luminaire comprising a square, two component, horizontally disposed, flat refractor and a substantially point light source disposed relative to the refractor so that the refractor intercepts direct light in a rearwardly sloping, oblique pyramid, the first component of said refractor having circular prisms of variant refractive power from prism to prism which reduce the divergence of emitted light rays in all azimuths so that they are in an oblique pyramid and appear to come from a virtual source in a line extending through the center of the refractor and the true source, the second component of the refractor having circular prisms of increasing refracting power from the center of its front edge toward its side and rear edges which reduce the divergence to substantially zero so as to emit the rays parallel to one another with greater angle of obliquity in said vertical median plane.

14. A luminaire as claimed in claim 13, wherein the refracting power of the circular prisms of this second component vary from zero at the center of the prism to a maximum at the remote corners of the component.

15. A luminaire as claimed in claim 13, wherein the refracting power of the outermost circular prisms in the rear quadrant of the first component is greater than that of the prisms in the front quadrant.

16. A luminaire for producing a downwardly and forwardly directed beam of divergent light, comprising a horizontally disposed lens plate, a light source above the central area of the plate so that the lens plate in a transverse vertical plane through the source receives downwardly divergent light in an isosceles triangle and in a rearwardly leaning scalene triangle both with the source as an apex, the lens plate within the limits of the isosceles triangle having light concentrating prisms with variable refracting power increasing each way from the plate center for variably reducing the divergence of the emitted light so that it appears to come from a virtual source above and rearwardly of the real source and within the limits of the scalene triangle having light concentrating prisms of variably refracting power less than that of prisms at corresponding distances from the center of the plate and such as to variably reduce the divergence of the emitted light so that it appears to come from the same virtual source.

17. A luminaire comprising a two-component, horizontally disposed, flat refractor and a light source disposed above and to the rear of a vertical line through the center of the refractor so that the front margin of the refractor receives light at greater angles of incidence than any light received to the rear of the refractor center, the upper refractor part having prisms of increasing refracting power each side of the center thereof such that the light emitted from the upper part appears to come from a virtual source above and to the rear of the real source, the lower refractor part having a system of prisms of increasing refracting power from the front to the rear such that the divergent beam from the first refractor part is concentrated into parallelism at a greater angle of obliquity than the line connecting the real source and the center of the refractor.

KURT FRANCK.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,740,229	Dorey	Dec. 17, 1929
2,089,693	English	Aug. 10, 1937
2,310,810	Rolph	Feb. 9, 1943