(No Model.) 4 Sheets—Sheet 1.

W. WHEELER.

REFLECTOR.

No. 247,589. Patented Sept. 27, 1881.

Fig. 1.

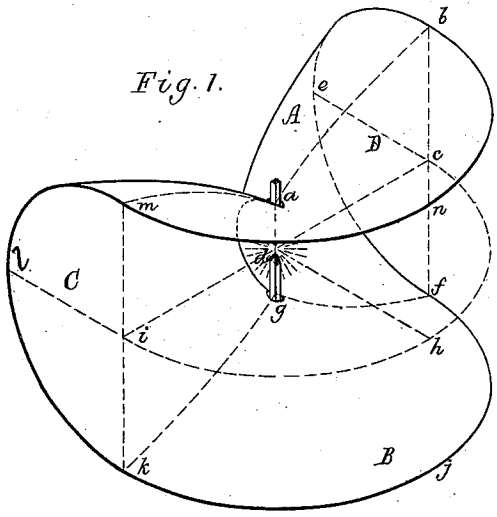
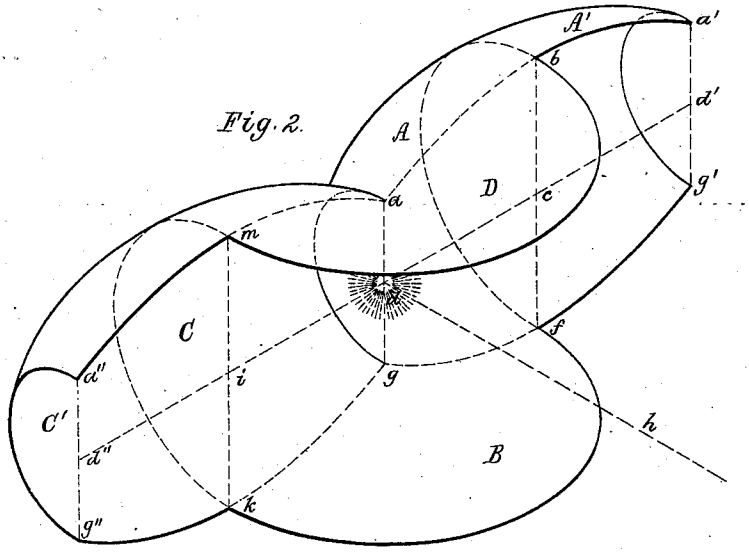


Fig. 2.



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by R. K. Eddy att'y.

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(No Model.) 4 Sheets—Sheet 2.

W. WHEELER.

REFLECTOR.

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Fig. 3.

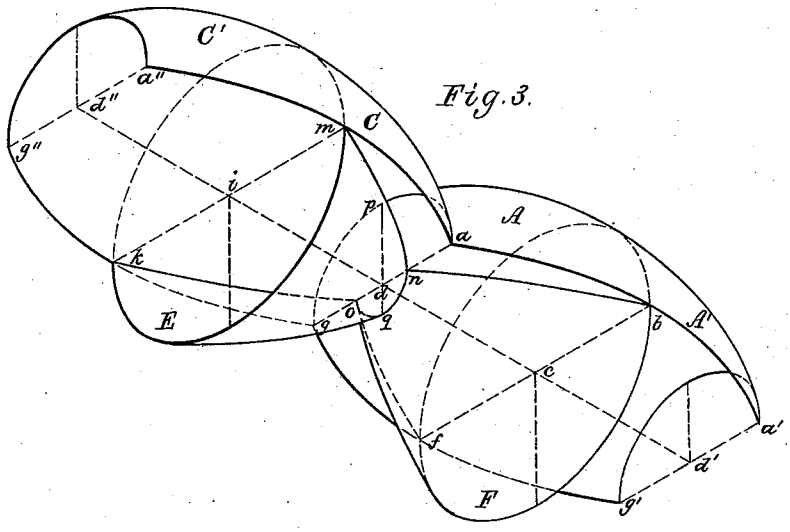
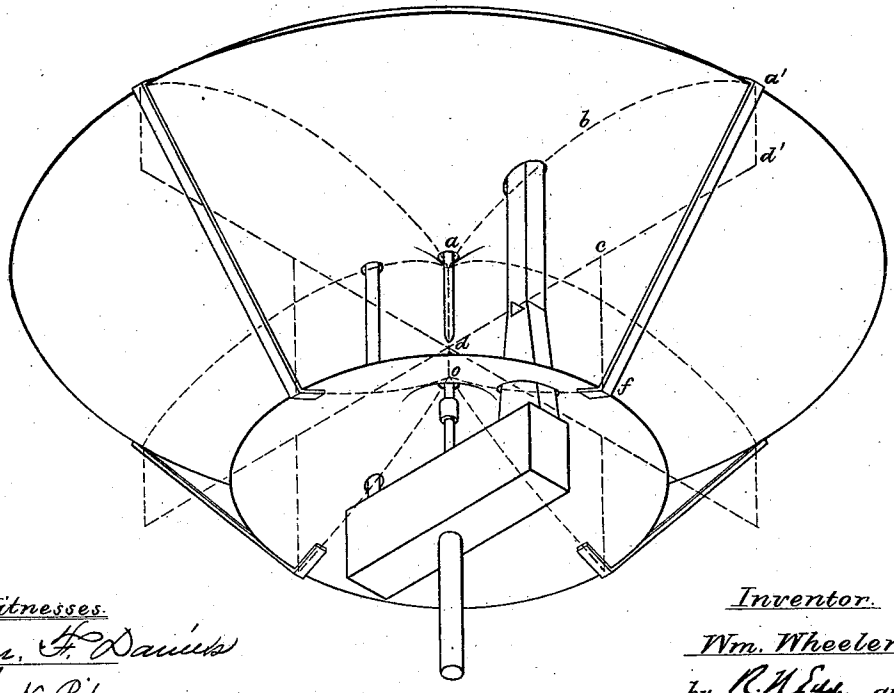


Fig. 4.



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(No Model.) 4 Sheets—Sheet 3.

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Fig. 5.

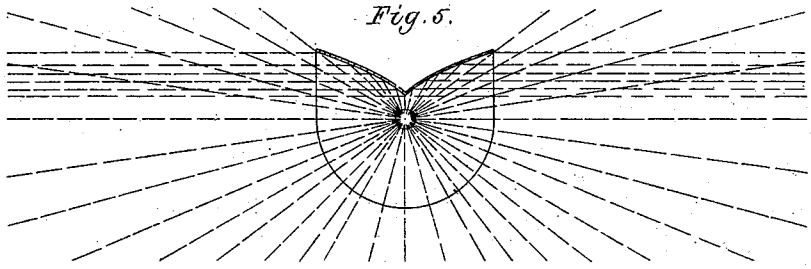


Fig. 6.

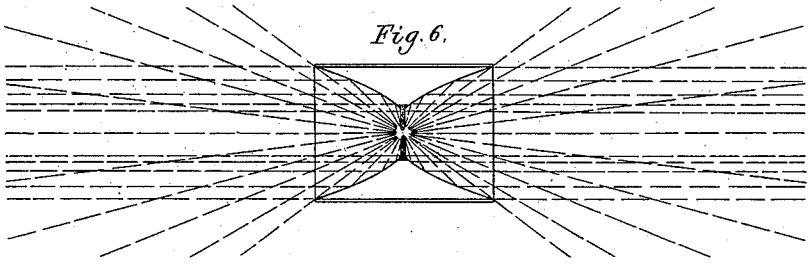


Fig. 8.

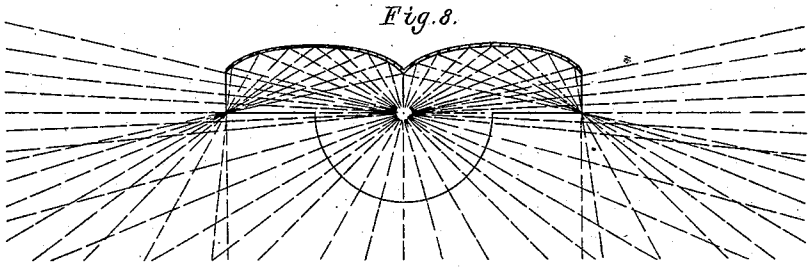


Fig. 9.

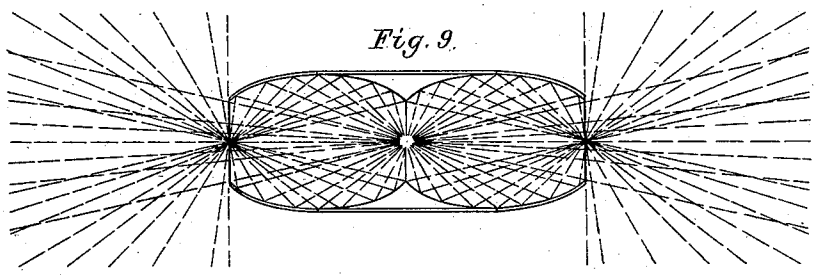


Fig. 10.

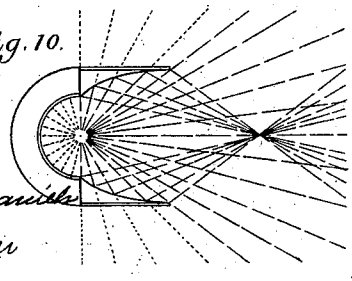
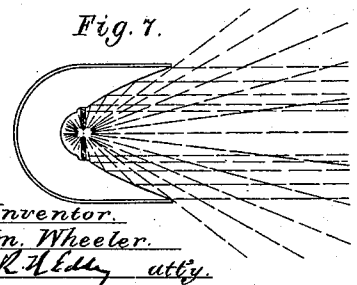


Fig. 7.



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(No Model.) 4 Sheets—Sheet 4.

W. WHEELER.

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Fig. 11.

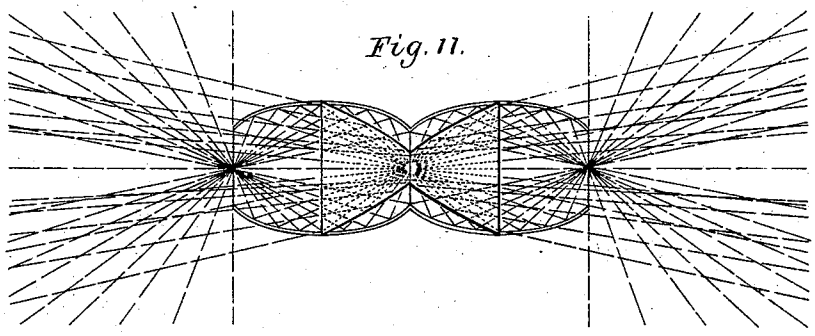


Fig. 12.

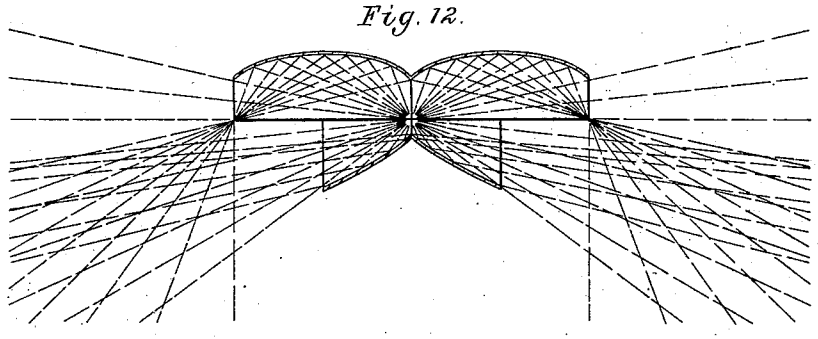
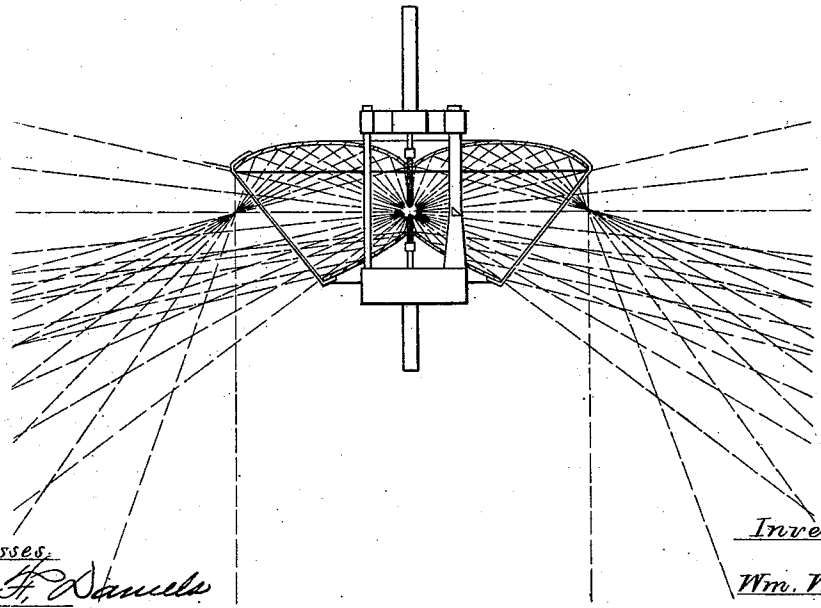


Fig. 13.



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UNITED STATES PATENT OFFICE.

WILLIAM WHEELER, OF CONCORD, MASSACHUSETTS.

REFLECTOR.

SPECIFICATION forming part of Letters Patent No. 247,589, dated September 27, 1881.

Application filed April 4, 1881. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM WHEELER, of Concord, of the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Reflectors; and I do hereby declare the following to be a full and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

This invention is particularly designed to provide improved forms of reflectors of simple construction, to be used in combination with any suitable light-source, but especially the electric arc, for the purpose of effecting a uniform and economical lighting of a street or place; and, in general, to so direct and disperse the light emanating from any suitable source that its full illuminating power may be utilized in, or about in, the direction and within the prescribed limits of the space to be lighted.

It is evident that when a reflector is not used the light from a common street-lamp, radiating, as it does, equally in all directions, passes, in large proportion, upward into space, while another almost equally large part is intercepted by the top and bottom of the inclosing lantern, without producing any valuable result. Of the available remainder the greater part is spent in illuminating to a disproportionate excess the bed and sides of the street in the immediate vicinity of the lamp, leaving to be applied to the general thoroughfare, up and down the street, in the two directions in which the light is almost exclusively required, only a small fraction of the total lighting power expended.

In the case of the electric light now coming into use for such purposes, and which, from its excessive brilliancy and the greater space lighted thereby, is usually placed at a much greater elevation, only an extremely small percentage of its light is utilized for achieving the purpose intended. Not less than fifty per cent. of the light emitted is often totally lost, since all rays radiating upward into space above the horizontal plane of the arc, rather than in the direction in which they are required, must for that requirement be assumed to have no existence, while of the other fifty per cent. at least one-half is consumed in illuminating to a disproportionate excess the sides of the street in the immediate vicinity of the lamp within a distance up and down the street oftentimes not exceeding its width, thus leaving for the general lighting of the thoroughfare in both directions beyond the above limits less than one-fourth of the total lighting power expended.

The simple parabolic reflector concentrates into a beam of great intensity the rays emanating from any light at its focus. But the concentration is too complete. There is too little dispersion allowed. The path of illumination is made too narrow for street-lighting. The intercrossing of rays in different directions is insufficient, and there is not a sufficient adaptability of the form of the beams or pencil and their relative intensities to the form and extent of the spaces to be illuminated thereby. For these and other reasons the simple parabolic and other similar and substitute concentrators of light are poorly adapted for the general purposes of street-lighting.

The same objections apply to the combination of two simple reflectors having the rear part of each removed, the said reflectors being placed back to back, so as to have a common focus. The combination of a simple focal reflector, placed above or below the light-source, with secondary reflectors used to again reflect the light in the desired direction horizontally, involves a complication and multiplicity of parts and a waste of light, due to two reflections, and is capable of obviating only in a limited degree the objections noted in the preceding paragraph.

My invention consists, primarily, in a reflector having a continuous reflecting-surface generated by the entire or partial revolution of a conic-section curve about an ordinate of said curve, or about such and also about the axis of the curve, or, in other words, by the revolution of a single curve about an ordinate of it and successively about two different axes which pass through the focus of said curve, such focus thereby becoming the common focus of the several parts of the reflecting-surface so generated.

My invention consists, secondarily, in a reflector having its upper and lower and two opposite reflecting-surfaces such as would be generated either as above described or by the

revolution of two different and unlike conic-sectional curves or combinations of such curves about a common axis, all as is hereinafter fully described.

Figures 1 to 4, inclusive, are isometric projections of different forms and modifications of my invention, showing geometrically the manner in which the reflecting-surfaces thereof are generated and proportioned. Figs. 5 to 13, inclusive, represent different sections and elevations of the same, showing also the manner in which light is reflected thereby.

In Fig. 1 the dotted line *a b* represents a parabolic curve, of which the dotted line *c d* is a part of the axis and the dotted line *a d* an ordinate thereto, passing through the focus or one-half the latus rectum of said curve. By the revolution of the said curve *a b* about the axis *c d* through the semicircular arc *b e f*, the paraboloidal surface *a b e f g*, subtending an angle of one hundred and eighty degrees at the axis of revolution, is generated, and the said generating-curve *a b* then coincides with the curve *g f*. Next, designating the generating-curve in its new position by the letters *g f*, by the revolution of said curve *g f* about the ordinate *g d* or latus rectum *g a* as an axis through a semicircular arc parallel with the arc *c h i*, the superficial sector *g f i k* of an inverted parabolic spindle subtending an angle of one hundred and eighty degrees at the axis of revolution is generated, and the generating-curve is then in the position represented by and coincides with the equal curve *g k*, and its corresponding axis *c d* is in the position represented by and coincides with the line *d i*. Next, by the revolution of the said curve *g k* about the axis *d i* through the semicircular arc *k l m*, the paraboloidal surface *g k l m a*, subtending an angle of one hundred and eighty degrees at the axis of revolution, is generated, and the generating-curve is then in the position represented by, and coincides with, the equal curve *a m*. Finally, by the revolution of said curve *a m* about the ordinate *a d* or the latus rectum *a g* as an axis through a semicircular arc parallel with the arc *i h c*, the superficial sector *a m n b* of an inverted parabolic spindle subtending an angle of one hundred and eighty degrees at the axis of revolution is generated, and the generating-curve is then returned to its original position. (Represented in the dotted curved line *a b*.)

The surfaces successively generated as above described are continuous throughout, and constitute one of the forms of the reflecting-surfaces of a reflector covered by my invention, the common focus of the several parts of said surface becoming the light-focus of the reflector so formed, all as represented by the full lines in Fig. 1.

It is to be understood that the angular amount of rotation of the generating-curve about the several axes of revolution may vary, and that some other curve or combination of curves derivable from a conic section may be used as the said generating-curve.

In Fig. 2 the line *a b a'* represents an elliptic curve, of which the line *d d'* denotes that part of the major axis included between the foci of said curve at *d* and *d'*, the line *b f* the minor axis, and the lines *a g* and *a' g'* the double ordinates through the foci. By the revolution of the said curve *a b a'* successively about the axis *d e* or *d d'* and the double ordinate *a g* in the same order of sequence and through the same arcs as has been fully described in the case represented by Fig. 1, and omitting from the surface thus generated the parts generated by the revolution of the lines *f g'* and *m a''* about the double ordinate *a g*, we obtain another form of reflector continuous throughout, covered by this invention, in which the parts A' and C' extend in wing-like projections to a greater distance from the focus than do the parts B and D, all being as represented by the full lines in said Fig. 2.

It is to be understood that the outer limits, *b* and *a'*, of the generating-curves *a b* and *a b a'* may be varied in their distance from the focus *d* both relatively to each other and to the axis *b f*, as circumstances may render desirable.

The reflectors shown in Figs. 1 and 2 may be placed in any desired and suitable position—that is to say, so that either the latus rectum *a g* or the axis *d h* shall be vertical. In the former case, for which the form represented in Fig. 1 is well adapted, the light is supposed to be placed at the side of the street or thoroughfare to be lighted thereby in the usual manner of street-lamps, with the axis *c i* parallel thereto and the mouth or aperture of the reflector facing across and longitudinally up and down said street or thoroughfare. In this position the parts A and C intercept and reflect up and down the street that large part of the whole light that would otherwise be spent in lighting to disproportionate excess a short length of houses or land immediately behind said light, while the parts B and D render useful the light that would otherwise be spent in an excessive illumination of the ground immediately below and in front of the light and in useless radiation upward into space, respectively.

Fig. 5 represents a horizontal section of the reflector shown in Fig. 1; Fig. 6, a front elevation, and Fig. 7 a side elevation, of the same, the broken lines in said figures representing the course of the rays as radiated from the light-source and reflected from the above-described surfaces in accordance with the well-known property of surfaces generated by the revolution of conic-sectional curves.

When the axis *d h* is made vertical, for which position the form of reflector represented in Fig. 2 is especially adapted, the light is supposed to be placed high above the middle of the street or thoroughfare to be lighted thereby, with the axis *c i* parallel thereto and the mouth or aperture of the reflector facing directly downward and up and down said street or thoroughfare. In this position the additional wings A' and C' intercept and reflect downward at different angles into the street those rays that

would otherwise pass out and upward through large semicircular apertures at the sides or ends of the reflector, to be lost in space, while the said parts B and D now prevent the light from passing out laterally over and against the houses and lands immediately adjoining and throw it down into the street, where it is required.

Fig. 8 represents a vertical section of the reflector shown in Fig. 2 in the position just described; Fig. 9, an elevation or plan as seen from below, and Fig. 10 an end elevation of the same, the broken and dotted lines in said figures representing the course of the rays as radiated from the light-source and reflected from the above-described surfaces in accordance with the well-known property of conic-sectional curves.

Fig. 3 represents in a double form a reflector having the upper parts, A A′ and C C′, the same as the corresponding parts shown and described in and in reference to Fig. 2, and the opposite or lower parts, E and F, hyperboloidal reflectors of one hundred and eighty degrees, having with said upper parts their common focus in *d* and their common axis in *c i*. The said parts E and F intercept that light radiating downward at more than a certain angle measured from the axis *c i*, and cause it to pass out at lesser angles with said axis in lines radiating from the secondary foci *d′* and *d″*, whereby said light is made effective at a greater distance from the source, but always below the horizontal plane of said source. By means of this combination of the upper ellipsoidal reflector and the shorter hyperboloidal reflector below two valuable results are secured: First, the rays that would otherwise be expended in lighting to a disproportionate excess the immediate vicinity below and beside the lamp are distributed as desired and made available at a greater distance; and, second, the rays that would otherwise be lost in space above are reflected downward at different angles through the secondary foci *d′* and *d″*, and that part intercepted by the projecting wings A′ and C′ utilized in imparting a moderate and normal degree of illumination to that space immediately below and beside the lamp from which the direct rays are cut off, as described, by the reflectors E and F.

Fig. 11 is a plan view of the reflector shown in Fig. 3, as seen from below, and Fig. 12 represents a vertical section of the same, the broken and dotted lines in said figures exhibiting the course of the light-source, and reflected from the surfaces of the said combination of reflectors.

It is to be understood that between the two quadrantal parts of both the ellipsoidal reflecting-surface *c c′* and the hyperboloidal surface E—generated by the revolution of their respective curves about their common axis *d d″*—may be inserted sectors of surfaces generated by the revolution of said curves through any suitable angle about their common vertical ordinates *p q*, produced through the focus *d*, whereby the width of the aperture of said reflectors may be increased, substantially as described in reference to and shown in Fig. 1. Thus the form and character of the pencil of rays emanating from a reflector formed by the revolution of variously combined curves about variously combined axes of revolution, as herein described, may be adapted to the form and extent of the place to be illuminated.

Fig. 4 represents a reflector in two parts, the upper one of which has a reflecting-surface, such as would be generated by the revolution of the elliptic curve *a b a′* about the ordinate *a d*, while the lower one has such a reflecting-surface as would be generated by the revolution of the hyperbolic curve *o f* about the ordinate *o d*, the said curves having the focus *d* and the axis *d d′* in common. At the said focus *d* the light-source is maintained. By means of this special combination equal illumination is effected in directions laterally. All or any desired part of the light radiated upward is reflected downward in directions in which it will be most effective, that part intercepted by the outer part of the upper reflector, when sufficiently extended, being so reflected as to impart a normal degree of illumination to the space immediately below the lamp, from which the direct rays are cut off by the lower reflector in a manner similar to that already described with reference to Fig. 3.

Fig. 13 represents a vertical section of the reflector shown in Fig. 4, with a side elevation of the electric lamp shown in combination therewith, the broken lines showing the course of the light-rays as radiated from their source and reflected from the surfaces generated as above explained.

Among the superior advantages of the ellipsoidal reflectors described above is the noticeable fact that every part of the space illuminated receives its portion of light from and through at least two different foci of such reflector, while with the combination of the ellipsoidal with the hyperboloidal forms nearly every illumined part of the field is lighted from and through three different foci of the reflector, whereby is effected the result due to a group or chandelier of lights at and around each lamp. The intercrossing of rays as from a multiplied number of sources thus effected is productive of the brilliant, uniform, diffusive, and tempered light most to be desired in artificial illumination.

A simple method of manufacturing reflectors having surfaces such as would be generated by the revolution of a curve upon two or more different axes successively, as in the cases represented by Figs. 1 and 2, or by the revolution of two different curves about the same axis, as in case shown in Figs. 3 and 4, is described as follows:

The form shown in Fig. 1 consists of four parts, comprising two pairs of the corresponding parts A C and B D, respectively. To form the like parts A and C a sheet of suitable material is shaped by spinning, stamping, ham-

mering, molding, or otherwise into a paraboloid similar to an ordinary parabolic reflector and its ends cut in vertical planes intersecting the axis of the focus and aperture. It is next to be cut into two halves by a plane passing through the axis, whereby we obtain the two like parts A and C. The parts B and D are similarly made from one piece of suitable material, formed into a suitable shape, with a cross-section corresponding to two curves, *b a* and *m a*, in the positions shown. It is next cut into two halves in a plane passing through the latus rectum of the generating-curve, whereby we have formed the two like parts B and D. Said parts A, C, B, and D are next to be joined together in the positions shown, whereby a continuous surface throughout will be formed. They may be of metal polished on the inside; or the metal form may constitute a case to be lined with small plain pieces of silvered glass suitably arranged in regular series; or the reflector may be of glass silvered on the back side and the silver coating duly protected by varnish and a thin metal covering. The reflector shown in Fig. 2 may be formed in like manner as has been described above, the additional parts A′ and C′ being duplications of the parts A and C and joined thereto in the positions shown. The various parts of the combination represented in Fig. 3 may be similarly formed and joined. It is evident, however, that the junction of the upper and lower parts (said parts being constructed upon entirely different curves) does not give a continuous surface between the two; hence they are joined by suitable connections at the points of contact *b*, *f*, *k*, and *m* and by other proper devices.

In the combination shown in Fig. 4 the upper and lower parts of this reflector, being separated from each other, are to be joined by the rods *a′ f*, &c., as shown, or by any other suitable devices.

Again, the simple form of reflector represented in Fig. 1 may be formed of sheet metal entire by spinning, using suitable cores and models for the guidance of the metal plate and forming-tool, as in the turning-lathe for irregular forms.

Any of the reflectors above described may be used in combination with suitable lantern-bodies or otherwise.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A reflector having a continuous reflecting-surface such as would be generated by the partial revolution of a conic-sectional curve on its latus rectum and by the partial revolution of such curve on its prolate axis at one or each terminus of the partial revolution on the latus rectum, the axes of revolution intersecting each other in the focus of the curve, and all being substantially as set forth.

2. A reflector having a continuous reflecting-surface such as would be generated by the revolution of a conic-sectional curve about its axis and latus rectum successively, the length of said curve being varied during different parts of its revolution, substantially as set forth.

3. A reflector consisting of two opposite parts, of which the reflecting-surfaces are such as would be generated, respectively, by the revolution of two different conic sections having a common focus about their common axis, substantially as set forth.

4. A reflector of two parts having reflecting-surfaces of such forms as would be generated, respectively, by the revolution of two different conic sections each about two or more axes of revolution successively, said axes being common to both curves and intersecting each other in the common focus thereof, substantially as set forth.

5. A reflector of two parts having reflecting-surfaces of such forms as would be generated, respectively, by the revolution of two different conic sections having a common focus about their common latus rectum, substantially as set forth.

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Witnesses:
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