C. N. WEEMS.

REFLECTOR FOR HEADLAMPS.

APPLICATION FILED MAR. 25, 1920.

1,398,987.

Patented Dec. 6, 1921

3 SHEETS—SHEET 1.

FIG. 1

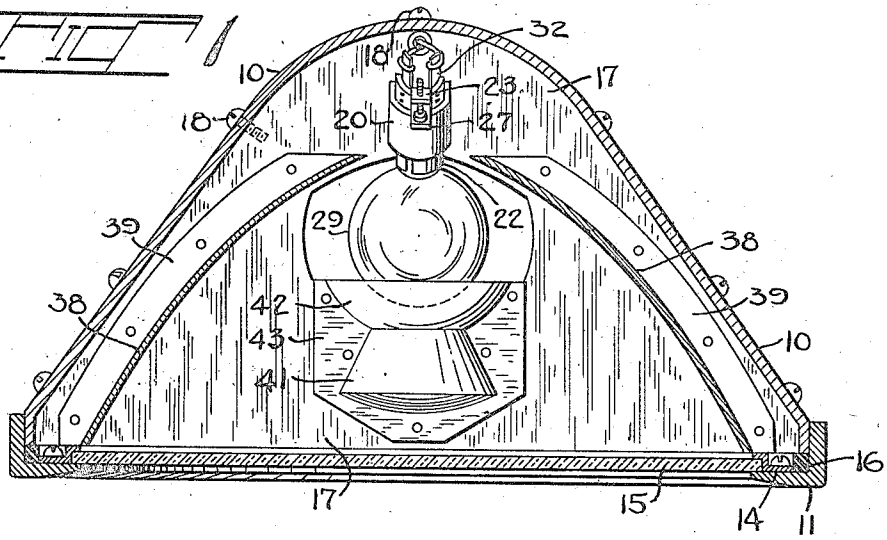
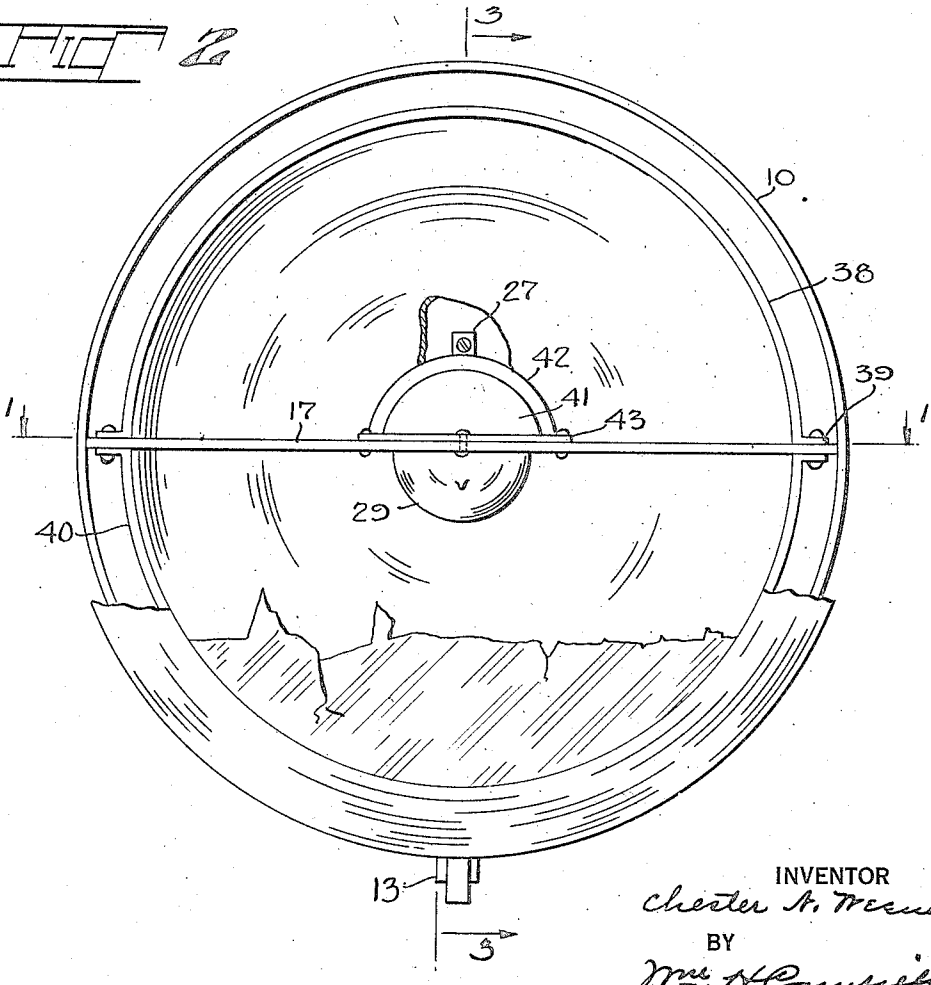


FIG. 2



INVENTOR

Chester A. Weems,

BY

Mc A Campbell.

ATTORNEY

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3 SHEETS—SHEET 2.

FIG 4

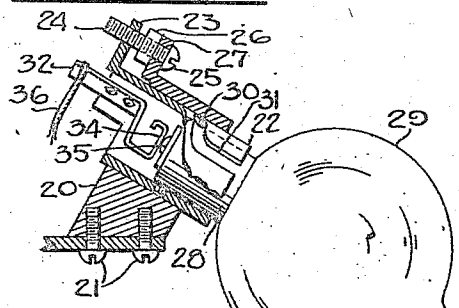


FIG 3

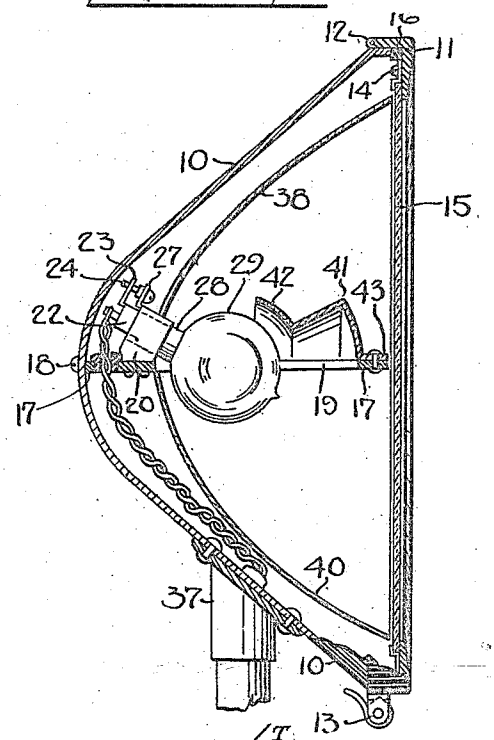
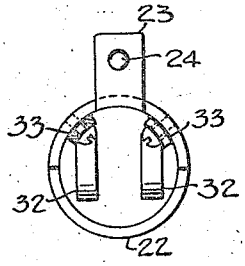


FIG 5



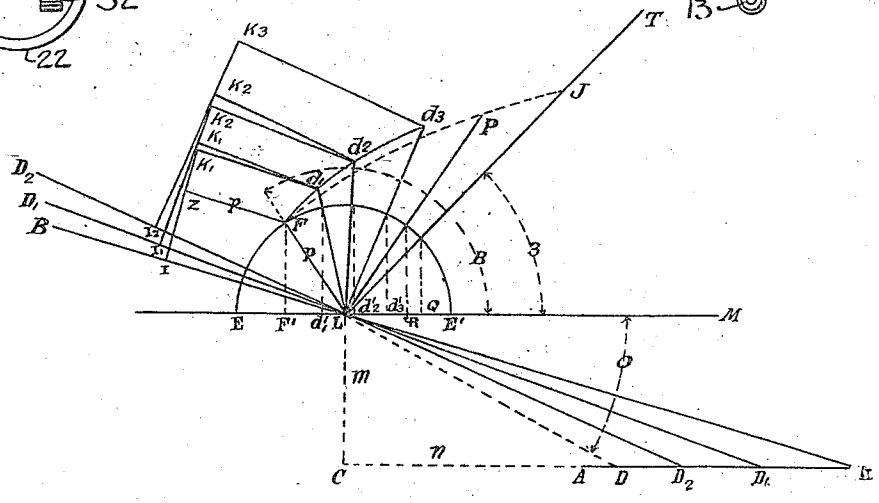


FIG 6

INVENTOR

Chester N. Weems,

BY

Mrs H Campbell

ATTORNEY

C. N. WEEMS.

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3 SHEETS—SHEET 3.

FIG 7

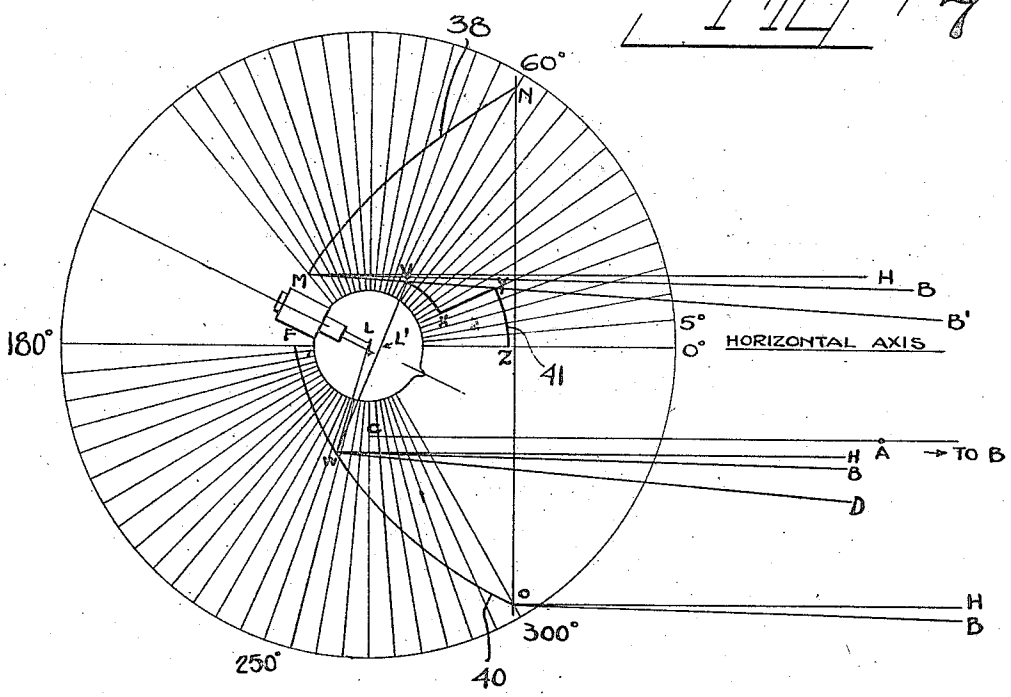
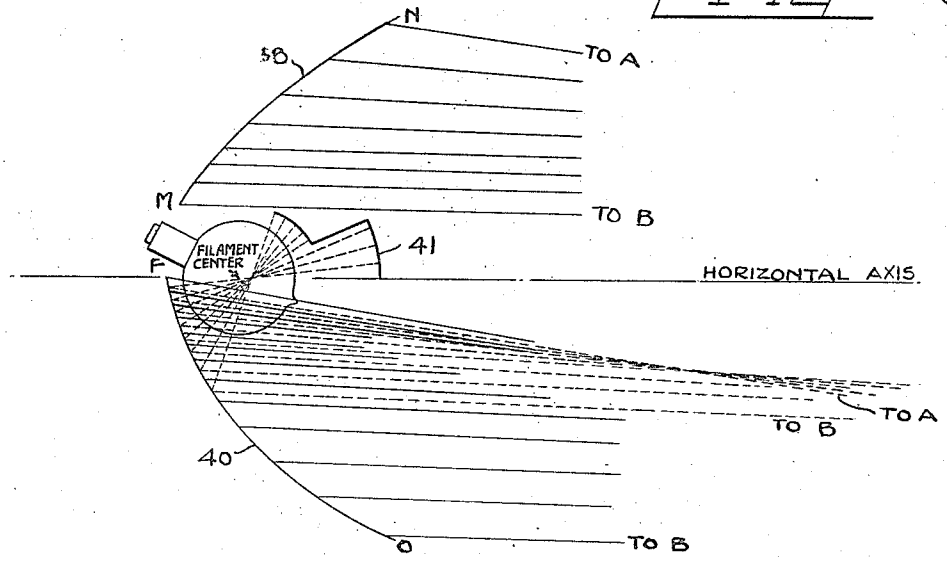


FIG 8



Chester N. Weems, INVENTOR

BY

Mrs H Campbell.

ATTORNEY

UNITED STATES PATENT OFFICE.

CHESTER N. WEEMS, OF LIBRARY, PENNSYLVANIA.

REFLECTOR FOR HEADLAMPS.

1,398,987. Specification of Letters Patent. Patented Dec. 6, 1921.

Original application filed June 19, 1919, Serial No. 305,292. Divided and this application filed March 25, 1920. Serial No. 368,490.

To all whom it may concern:

Be it known that I, CHESTER N. WEEMS, a citizen of the United States, and a resident of Library, county of Allegheny, and State of Pennsylvania, have invented certain new and useful Improvements in Reflectors for Headlamps, of which the following is a specification.

This invention is designed to provide reflectors for a headlamp in which the source of light, usually an electric lamp, with said associated reflectors illuminates uniformly the curved inside surface of the lower half of an imaginary horizontal cylinder whose axis coincides with the horizontal axis of the headlamp, whose radius is equal to the height at which it is proposed to place the headlamp above the ground, and which extends from a point slightly ahead of the headlamp to a distance of from 200 feet to several hundred yards ahead of the headlamp, depending upon the type of vehicle upon which the headlamp is used. For use on pleasure vehicles this imaginary cylinder would start approximately 20 feet and would extend about 200 feet ahead of the the headlamp.

In practice, a level strip, including the roadway and the ground for some distance either side, is illuminated approximately uniformly for a desired distance ahead of the vehicle, and objects in the path of the light are illuminated to a height not greater than the height of the headlamp center above the ground. Thus a low spreading beam of light is secured, no portion of which strikes above the level of the center point of the headlamp.

The invention is further designed to provide a reflector that is constructed on a curve relative to the light source, which curve has been determined mathematically, so that a given surface before the headlamp is illuminated substantially uniformly of its area, which surface is the inside curved surface of the lower half of the horizontal cylinder whose axis coincides with the horizontal axis of the headlamp.

The invention further comprises a reflector made according to a principle to be hereinafter more fully described and also embodied in the claims, and in the preferred form of lamp I employ three reflectors, the functions of these reflectors, when assembled, being to intercept and reflect to the desired field all the light flux from the electric lamp, except that light flux which falls naturally and directly to the field from the electric lamp.

In practice, the beam of light flux will be spread slightly, due to the fact that the source of light is of finite size. The theoretical field to be illuminated is selected sufficiently near to the headlamp so that the spread of the light beam in practice will not be sufficient to elevate any light rays above the horizontal plane of the headlamp, and in designing any particular headlamp I select the position of the theoretical field to be illuminated in regard to the size of the filament of the particular electric lamp which is to be used. The larger the volume of the filament, the nearer it is necessary to assume the farther limit of the theoretical field to be illuminated, because a large filament will spread the beam to a greater degree than a small filament.

A reflector made according to this invention is applicable to different forms of lights, but particularly to that form as illustrated and described in my Patent No. 1,349,642, issued Aug. 17, 1920.

The invention is illustrated in the accompanying drawings, in which Figure 1 is a section on line 1—1 in Fig. 2. Fig. 2 is a front view, broken away to more clearly illustrate the construction. Fig. 3 is a section on line 3—3 in Fig. 2. Fig. 4 is a detail section of the lamp supporting fixture. Fig. 5 is a face view of part of the structure shown in Fig. 4. Figs. 6, 7 and 8 are diagrammatic views showing the curvature of the reflectors and their correlation.

The lamp body comprises a casing 10, which is provided on the front with a lid or door 11, which is fastened in any suitable way, such as by the hinge 12 and the catch 13, the rim of the door being provided with suitable means, such as the clip 14, for holding a circular piece of clear or transparent glass 15. A snug fit is secured by means of a washer or gasket 16. A horizontal support or partition 17 is placed within the casing and has its outline fitting the inside of the casing 10 and being secured thereto by screws 18, although it will

be evident that other means of fastening these elements can be employed.

The horizontal support or partition 17 is provided with an opening 19, and in rear of the opening is mounted the lamp supporting fixture, which consists of a stationary member 20 secured by suitable means, such as the screws 21, and a movable member 22 which is arranged to slide in the fixed member, having a flange 23 into which the screw 24 is fitted. The head 25 of the screw provides for the adjustment of the parts, the screw being provided with a permanent collar 26 which fits against the rear face of the lug 27 of the fixed member 20. The movable member 22 is preferably in the form of a sleeve to receive the neck 28 of the bulb 29, and guiding lugs 30 on the base 28 of the lamp fit into slots 31 in the member 22, so that when the lamp is pushed in and then to the right, the lugs 30 are seated in the slots, the lateral portion of the slot extending a distance but little greater than the diameter of the guiding lugs almost at right angles to the main portion of the slot.

The springs 32 are secured to the inner side of the sleeve 22 and are insulated therefrom by a suitable insulation 33, these springs having contact ends 34 which fit against the contacts 35 at the end of the base 28 of the electric lamp bulb and act to complete the circuit with the lamp, and also by their spring pressure tend to hold the lamp in position, the springs 32 having the wires 36 secured thereto by soldering or other suitable means, the wires 36 extending to the outside of the casing, preferably through the supporting post 37, which is hollow and which is suitably secured to the casing of the headlamp and thereby acts as a support therefor.

The associated reflectors that coöperate to direct the beam of light in the desired direction consist of an upper reflector 38, which is preferably secured to the supporting plate or partition 17 by means of its flange 39, and a lower reflector 40 similarly secured by a similar flange, and forward reflectors 41 and 42, preferably formed of sheet metal and having a flange 43 which rests on and is preferably riveted or screwed to the partition or support 17.

It will thus be seen from this description that the lamp casing and the elements on the inside thereof are held together in a compact and stable manner, and the central support, while not essential, is preferable in providing a convenient means for supporting the reflectors 41 and 42 and also for supporting the electric bulb preferably at an angle of about twenty-five degrees to the horizontal axis of the lamp.

The reflectors 38 and 40 are the main reflectors, mounted in the usual position in rear of the electric lamp or other source of illumination, and reflectors 41 and 42, which will be hereinafter referred to as the auxiliary reflector and mentioned as one reflector, are mounted on the upper side of the supporting plate or partition 17 in front of the electric lamp. Each of these three reflectors is designed to distribute the light flux which it intercepts uniformly over the assumed field hereinbefore mentioned, to wit: the inside curved surface of the lower half of an imaginary cylinder whose radius is the distance from the ground to the horizontal axis of the lamp, in practice this radius being usually 42 inches, and the roadway, assuming level ground, will be approximately uniformly illuminated over a strip approximately 40 feet wide and 200 feet long, starting 20 feet ahead of the automobile and extending straight ahead. The ground to the sides of this strip will also be illuminated, but to a lesser degree, and objects having elevation and situated ahead of the automobile will be illuminated by the direct beam to a height of 42 inches above the ground level.

It will be understood that any two or any three of these reflectors may be employed, and, if desired, the auxiliary reflector may be omitted and the tip of the electric lamp frosted, but I prefer, however, to use them in correlation as illustrated herein. These reflectors are usually made of sheet metal polished on the inside surface.

The reflector 38 is generated by revolving a plane curve through substantially a 180 degree dihedral angle, the plane of the generating curve being at all times common to the horizontal axis of the headlamp.

In the following description the auxiliary reflector will be designated by the reference numeral 41 to indicate the two sections 41 and 42 thereof, in order to simplify the description.

The generating curve of the reflector 38 is designed in the following manner:

In Fig. 6, AB is a given line m distant and parallel to a horizontal line LM. Point A, the starting point of line AB, is distant n from a perpendicular dropped from point L on line LM to C on line AB extended. Lines LB, LD_1 and LD_2 are common to point L and intersect AB at about equal distances starting at B, and make a variable angle phi (φ) with line LM, the angle φ being considered as the angle for LB, LD_1 or LD_2, though its value for each is, of course, different. Point F is located a given distance ρ from L along the line LF, the line LF making an angle beta (β) with the line LM. F is the starting point of a curve $Fd_1d_2d_3$ which is made up of sections of parabolæ, Fd_1, d_1d_2, d_2d_3, etc. The portion of this curve Fd_1 is a small

section of a parabola whose axis is the line LB, likewise d_1d_2 is a small section of a parabola whose axis is line LD_1, and similarly with d_2d_3, the axis in the latter case being the line LD_2. In each case it will be noted that point L is the focus of the parabolic section.

The directrix of each parabolic section is indicated. For instance, the directrix of the small parabolic section Fd_1 is the line IK_1 and that for the section d_1d_2 is I_1K_2, etc. According to the laws of the parabola, the line ZF, which is a perpendicular from point F to the directrix IK_1, is equal in length to the line LF. The point d_1 is common to two parabolic sections, and the perpendiculars d_1K_1 dropped from this point to each directrix IK_1 and I_1K_2 are the same length and equal to the line Ld_1. For similar reasons the lines d_2K_2 are of the same length and equal to the line Ld_2.

Now if curve $Fd_1d_2d_3$ were a line on the surface of a reflector and a point source of light were placed at L, the light rays which strike the portion of the curve Fd_1 will all be reflected in the direction of and parallel to the axis LB. At point d_1 the direction of the curve changes, and for the distance d_1d_2 the light rays will be reflected in the direction of and parallel to the axis LD_1. It follows, of course, that the light striking the curve d_2d_3 will be reflected along the direction of and parallel to the axis LD_2.

The values represented by the lines and angles of Fig. 6 are of any values whatsoever, and if we consider the reflector curve $Fd_1d_2d_3$ very small compared with the line AB and a great distance away from the latter, we will have, with a point source of light placed at L, spots of light along the line AB, the spot at B coming from the portion of curve Fd_1, that at D_1 coming from d_1d_2, and that at D_2 coming from d_2d_3.

If now a reflector surface is generated by revolving curve $Fd_1d_2d_3$ through the 180 degrees dihedral angle above the horizontal plane through the line LM and around LM as an axis, and then a point source of light is placed at L, the spots of light at B, D_1 and D_2 referred to above will be replaced by semi-circular zones of light on the inside curved surface of the lower half of the horizontal cylinder generated by revolving the line AB about the line LM as an axis.

Now if instead of drawing the sections of the reflector curve Fd_1, d_1d_2, d_2d_3, etc., large as shown in Fig. 6, but on the other hand we draw them infinitely small and place an infinite number of such parabolic sections in the generating curve, the result in the final reflecting surface generated by revolving the curve about the line LM as explained above will be an infinite number of semi-circular zones of light on the inside curved surface of the lower half of the cylinder AB, and the space between these zones will be infinitely small, or, in other words, the light will be continuous over this illuminated surface. Such a generating curve is illustrated by the dotted curve FJ in Fig. 6 of the drawings.

If in designing the reflector $Fd_1d_2d_3$, a circle EFE′ is first described through the point F with L as its center and the terminating points for the parabolic sections, that is, points F, d_1, d_2, d_3, etc., are then so located that the distances between any two adjacent perpendiculars to the line LM (or LM extended), dropped from the intersection with this circle of each focal radius from point L to these points, are equal, the amount of light on the illuminated zones on the inside of the cylinder AB would be equal. These perpendiculars meet LM at F′, d'_1, d'_2, etc. This condition is true because the amount of light flux intercepted by each parabolic section Fd_1, d_1d_2, d_2d_3, etc., is measured by the area of the spherical zone generated by the small arc on circle EFE′ subtended by the angle made by the lines from L to the ends of the small parabolic sections, assuming the circle EFE′ to be revolved about the line LM in the same manner as the curve. The areas of these spherical zones are in turn proportional to their altitudes, which are the lines $F'd'_1$, $d'_1d'_2$, $d'_2d'_3$, etc., and these altitudes, as stated above, are taken equal in length.

With the final reflector in which an infinite number of sections or steps are taken in making up the generating curve FJ there will be, therefore, on the inside curved surface of the horizontal cylinder AB an infinite number of small semi-circular zones of light, each illuminated by the same amount of light flux. Since these light zones are taken with their centers an equal distance apart, (these centers being the intersections of the axes with the line AB), the number of such light zones to be found in a unit length of cylinder AB will be constant, and as the light flux directed to each zone is equal, the illumination of zone surfaces of equal area on the inside of cylinder AB will be the same. In other words, the illumination of the inside curved surface of the lower half of the horizontal cylinder generated by revolving the line AB about the line LM as an axis will be uniform.

If in designing the curve explained above the starting point F is assumed the same as before, but if we beforehand set a definite limit for the curve, for instance, the line LT which makes an angle omega (ω) with the initial line LM, then the limit of the altitudes of the flux measuring zones on the measuring circle EFE′ will be Q, the base of a perpendicular to line LM dropped from the intersection of the line LT with the measuring circle. In such a case then we

can define one law of the final generating curve FJ made with an infinite number of parabolic sections, as follows:

As a variable point P moves along the curve from F to the curve limit J on the line LT, it must move in such a manner that the point R, which is the base of a perpendicular to line LM dropped from the intersection of the radius vector LP with the measuring circle EFE′, travels at a uniform rate from F′ to Q in the same time that D, the intersection with line AB of the variable axis corresponding to P, travels from one limit to the other of line AB at a uniform rate.

In the law just given, we have taken the conception of one axis for the curve which swings around L between the limits LB and LA while its intersection with AB travels from B to A, instead of a large number of axes having their intersections spaced equal distances along AB, as was our first conception.

Another law of the final generating curve FJ worked out above is that any increment of the curve at any point P is a section of parabola with an axis intersecting AB at the variable point D which corresponds to the variable point R, the latter in turn being dependent on P. This law is evident from the way in which the curve is built up of infinitely small parabolic sections, and it follows from this law that the length of the radius vector from L to any point P on the curve is always equal to the distance of P from the directrix of the curve at this point. The directrix of the curve at any point P is a line perpendicular to the corresponding axis for that point and is located on the opposite side of L from D. This definition comes direct from the laws of the parabola and from the fact as brought out above that any small increment of the curve FJ is an infinitely small section of parabola.

From what has preceded, curve FJ can be defined as a curve which starts at a given point F distance ρ from the focus L, the line LF making an angle beta (β) with the initial LM and is limited by a given line LT which makes an angle omega (ω) with the initial line LM. As the variable point on the curve P, moves from F to J the following conditions hold.

D moves from B to A or from A to B. If while P moves from F to J the point D moves from B to A in practice, the portions of the field of illumination farthest from the headlamp will be illuminated by light reflected from the heel of the reflector. On the other hand, if point D moves from A to B under the same circumstances, the farther portions of the field of illumination will be illuminated by light from the front part of the reflector.

R moves from F′ to Q. R moves from F′ to Q at a uniform rate as D moves from B to A at a uniform rate. That is, the ratio of F′Q to F′R is always the same as the ratio BA to BD.

In my description above I have described a reflector surface of revolution generated by a curve made up of a series of parabolic sections, the axis of each as well as the axis of revolution being angularly displaced with respect to the others. I have also described the limit of this curve which is reached when the number of parabolic sections employed in its makeup is increased to infinity. It is understood that I may employ, and that my invention includes, a reflector generated by a curve made up of a definite or limited number of parabolic sections arranged as described or generated by the limiting curve of a series of such parabolic sections when the number of such sections is increased to infinity. It is to be pointed out that in practice an approximate solution of the limiting curve only is required to secure uniform illumination on the desired field, because the source of light in practice is much larger than a point source and the spread of the beam resulting from this condition is sufficient to cause the reflector to give approximately uniform illumination when comparatively few sections of parabolae are employed in making up the generating curve of the reflector.

In the particular reflector 38 illustrated, the generating curve shown as MN on Fig. 7 starts at the point N, which is in the vertical line passing through the point O of reflector 40, and extends counter-clockwise around its focus L to the point M, being limited by the radius vector making an angle of 130° with the horizontal axis of the headlamp. With this arrangement the portion of the finished reflector 38 near point M illuminates the more distant parts of the field to be illuminated near B. (In this drawing the ground line of the field of illumination is indicated reduced, that is, projected toward the center of the headlamp. In reality this ground line is very far from the headlamp compared with the size of the headlamp). This arrangement of reflector 38 in the given case is taken in order that the lower edge of the light beam from reflector 38 inside the headlamp, M to B′, will be as high as practicable in order to facilitate the placement of the auxiliary reflector 41. If the part of the reflector 38 near M illuminated the field near A, the beam of light within the headlamp would strike at a lower angle and less room would be available for the placement of reflector 41. The point just brought out also leads to the principal reason for placing the electric lamp 29 in the peculiar position in which its base is elevated, making the center line meet the

horizontal axis at an angle of 25°. With this arrangement of electric lamp 29 the point M of the reflector 38 will be higher above the horizontal axis than if the electric lamp 29 were placed in a horizontal position and less room would be available for the placement of auxiliary reflector 41.

In reflector 38 illustrated the focus is L on Fig. 7. This focus corresponds to the focus L of the generating curve FJ discussed above. The focus L for reflector 38 is placed on the horizontal axis of the headlamp, at approximately the center of the filament of the electric lamp 29 used as the source of illumination.

The filament of any practical automobile electric lamp which might be used as the source of illumination in the headlamp, while small, is of finite size and only roughly approximates a point source of light. For this reason in operation the finished headlamp will give an actual beam having more spread than the theoretical or computed beam for the given headlamp. This spread for any point on the reflector, for instance, M on reflector 38, see Fig. 7, will be equal to the angle subtended at this point by the electric lamp filament. Now in the finished headlamp this spread of the actual beam for the most distant portion of the field to be illuminated must not be above the level of the headlamp, for if such is allowed, some light may strike above the horizontal axis of the headlamp and cause glare. In this headlamp the actual beam of light flux from reflector 38 is confined below the level of the headlamp by the following method:

The most distant edge of the theoretical field to be illuminated, which is assumed in designing the reflector, is taken sufficiently near to the headlamp so that the angle subtended at point M with the horizontal is as great as, or greater than, the angle subtended at point M by that portion of the electric lamp filament which is in the rear of the focus L. That is, if MH is the horizontal and MB the line from M to the distant edge of the assumed theoretical field to be illuminated, the angle HMB must be as great as the angle subtended at M by the rear half of the filament. Having designed the reflector in this manner, light coming from the rear edge of the filament to reflector 38 will not be reflected at angles above the plane level of the headlamp.

Reflector 40 is designed in the same manner as reflector 38, except that its position is inverted with respect to reflector 38 and it is placed below the horizontal plane through the center of the headlamp.

The generating curve FO on Figs. 7 and 8 for reflector 40 is computed in the same manner as that for reflector 38. The reflecting surface is generated by revolving this generating curve FO through 180° around the horizontal axis of the headlamp, this revolving of the curve taking place in the dihedral angle subtended below the horizontal plane that includes the horizontal axis of the lamp.

The generating curve FO for reflector 40 of the headlamp illustrated is assumed as starting at a point F on the horizontal axis of the headlamp, at a suitable distance in the rear of the center of the filament to clear the electric lamp 29, and is limited by the radius vector which makes an angle of 300° with the horizontal axis of the headlamp. (See Fig. 7.)

The focus of reflector 40 is placed on the horizontal axis of the headlamp at L, see Fig. 7, which is at approximately the center of the filament of the electric lamp 29. As in reflector 38, the size of the filament of the electric lamp source of light causes a spreading of the reflected light beam in reflector 40. This spread of the light beam is confined below the level of the headlamp by the following method.

The most distant edge of the theoretical field to be illuminated, which is assumed in designing the reflector, is taken sufficiently near the headlamp so that the angle subtended at point O (point O of reflector 40 and nearby portions illuminates the most distant portions of the field to be illuminated) with the horizontal is as great as, or greater than, the angle subtended at point O by that portion of the electric lamp filament which is in front of the focus L. That is, if OH is the horizontal and OB the line from O to the distant edge of the assumed theoretical field to be illuminated, the angle HOB must be as great as the angle subtended at O by the forward half of the filament. Having designed the reflector in this manner, the light coming from the front edge of the filament will not be reflected at angles above the plane level of the headlamp.

Reflector 41 of the headlamp is made from thin sheet metal and is mounted before the electric lamp source of light above the horizontal plane including the horizontal axis of the headlamp, and is reversed in position with respect to the main reflectors 38 and 40. The reflecting surface of reflector 41 is made by revolving a generating curve VXYZ on Fig. 7 about the horizontal axis of the headlamp. The generating curve VXYZ is revolved approximately through 180° of the upper dihedral angle subtended above the horizontal plane, which includes the horizontal axis of the headlamp. The intersections of this reflector by planes perpendicular to the horizontal axis at points within the reflector are substantially semi-circles, except that the semi-circles are not

carried all the way to the horizontal diameters, a small space of about one-eighth of an inch being allowed to accommodate the central supporting plate 17 in the assembled headlamp.

The lower horizontal edge of reflector 41 is provided with a horizontal flange 43, and in the assembled headlamp the reflector is mounted on the upper side of the central supporting plate 17 and is held to the central supporting plate 17 by screws, rivets or bolts which pass through the flange 43 and the central supporting plate 17.

The reflecting surface of reflector 41 is the inside surface which faces the electric lamp source of illumination. A portion of the inside surface of reflector 41 is radial in position from the electric lamp filament, and this portion is not included in the reflecting surface and is not polished.

The generating curve for reflector 41 is made up of two ellipses VX and YZ, see Fig. 7, and a straight line XY which is radial from the point L on the horizontal axis of the headlamp. The two ellipses have the same foci which are L and L′ on the horizontal axis of the headlamp. The reflecting surface is generated by the two ellipses. It is characteristic of a reflector surface generated by an ellipse that the light from a point source of light placed at one focus is focused or concentrated on the other focus. Therefore, if a point source of light is placed at focus L, all of its light flux reflected by the reflector 41 will pass through the point L′.

In describing the ellipse VX, the starting point V is assumed along the line from L to N and below the line MB′. Since the curve is all below the starting point, the reflector 41 will not interfere with the light beam from reflector 38. Also, since V is taken along the line LN, no light from the filament of the electric lamp 29 can escape to the outside of the headlamp between reflector 38 and reflector 41.

The first focus of the ellipse VX is assumed at L, which is at the center of the electric lamp filament. The second focus L′ is located as follows:

A line VW is drawn from V, striking the reflector 40 at a point W at such an angle that if the line VW represented a ray of light traveling from V, this ray would be reflected by reflector 40 to point B of the field to be illuminated. The point is found by trial. It is known from the laws of reflector 40 that a ray of light from L, the focus of reflector 40, which strikes W will be reflected to a certain portion of the field of illumination, which we will call D and which may readily be determined by calculation from the mathematical principles used in computing the focus of the generating curve for reflector 40. After a trial position is selected for point W, an angle BWD is laid off above line WD equal to angle LWV. If line VW represents a ray of light traveling toward W, it is known that this ray will be reflected by reflector 40 along the line WB, because we know that the angle of incidence of line LW to reflector 40 is equal to the angle of reflection of line WD, and since the angles LWV and BWD are laid off equal, the angle of incidence for VW and of reflection for WB must be equal with reference to reflector 40. Next a measurement of WB is made to determine whether this line is parallel with either line MB or OB, and if found so, the line WB, if extended, will strike the point B of the field to be illuminated, and W is the desired point on the generating curve of reflector 40. It is to be remembered that point B of the field to be illuminated is a great distance from the headlamp compared to the size of the headlamp.

Having found point W on reflector 40, the second focus for ellipse VX is taken at L′, the intersection of line VW and the horizontal axis of the headlamp.

The ellipse VX is drawn to X with foci L and L′. The point X is placed a distance from the center line of the electric lamp 29 slightly greater than half the diameter of the bulb. Both ellipses VX and YZ are limited at their low points X and Z in this same manner in order that, with the finished reflector 41 assembled in the headlamp, the electric lamp 29 can be placed and withdrawn through the face of the headlamp without interference from reflector 41.

The ellipse YZ is drawn from an assumed starting point Z on line XZ to the radial line XY, meeting this limiting line in Y.

If it were not for interference with the placing of the electric lamp 29 by the completed reflector 41 in the assembled headlamp, a reflector generated by an ellipse made by continuing VX to the horizontal axis or central supporting plate 17 would be satisfactory and the offset ellipse YZ would be unnecessary. As a matter of fact, the reflector 41 may be designed by a generating curve composed only of the ellipse VX extended downward as just described, provided it is made detachable to accommodate the placing of the electric lamp 29, and it is understood that I may employ such an arrangement of reflector 41 in the headlamp.

Since the reflecting surface of reflector 41 is generated by the curves VX and YZ, all light from L striking the said reflecting surface will be reflected by reflector 41 to the portion FW of reflector 40. This light from V, as pointed out above, strikes through L′ to W, and as we travel along the ellipse toward X and from Y to Z, the re-

flected light rays from reflector 41 will strike through L′ to the reflector 40, coming nearer and nearer to F. These rays also pass nearer to L, the focus of reflector 40, until from point Z on reflector 41 the reflected ray travels through L′ and L to point F on reflector 40, and from point F it is reflected to point A of the field to be illuminated, it being seen from Fig. 8 that light rays striking through L to point F are reflected to A, the nearest point of the field to be illuminated. It can readily be seen then that following the generating curve of reflector 41 from V to X, Y and Z, the light reflected from reflector 41 strikes reflector 40 and then is again reflected gradually over the field to be illuminated from its distant edge B to its nearest edge A.

The effect of reflector 41 with a point source of light at L can be conceived, also, as though originating a point source of light at L′, which influences or energizes from an illumination point of view the portion FW only of reflector 40. This point L′ is an apparent point of light or the image of point source L and acts on reflector 40 from F to W exactly as a point source of light placed at L′. Now L′ in this character of a point source of light is taken just sufficiently ahead of L, the true focus of reflector 40, to spread the beam of F to W all the way from B to A of the field of illumination. Since reflector 40 is designed to illuminate the given field approximately uniformly, if the point light source is placed at L it will also illuminate this field approximately uniformly from light from the apparent point light source L′ which energizes only the portion FW of reflector 40. Reflector 41, therefore, receives light from a point source placed at its focus L and reflects it to reflector 40 in such a manner that it is again reflected so as to illuminate the field to be illuminated in an approximately uniform manner.

In actual operation the filament of the electric lamp source of illumination will be reflected by reflector 41 as an image in the vicinty of the secondary focus L′. This image will be the same size as the real filament and will energize the portion FW only of reflector 40. Now the image filament at point L′ is as far from portion FW of reflector 40 as the real filament, and being of the same size will cause no more spread of the light beam from reflector 40 than does the real filament. To insure against light from reflector 41 striking reflector 40 and being directed at angles above the horizontal level of the headlamp, the most distant edge of the assumed theoretical field to be illuminated by reflector 41 is taken sufficiently near the headlamp so that the angle subtended at W (on reflector 40) with the horizontal (angle BWH) will be as great as the angle subtended at W by the forward half of the image of the filament originated at L′ by reflector 41.

The curvature of the reffectors 38 and 40 in an intersecting plane including the axis of revolution might be defined in a particular case as the limit of a series of connected parabolic sections having a common focus and whose axes are progressively angularly displaced from the axis of revolution, by which I mean that the axes are successively angularly displaced from the axis of revolution in regular order, each succeeding axis being displaced from the axis of revolution through a greater angle than the preceding one.

I do not claim as part of my invention in this case the particular structure of headlamp illustrated in the drawings and which features a horizontal supporting plate or partition to which the several reffectors are attached, but my invention refers more particularly to the curvatures of the reflectors employed and to the peculiar combinations of such reflectors in relation to the light source and to each other, and it is understood that any two or all three of these reflectors may be employed, and if desired, the auxiliary reflector may be omitted and the tip of the electric lamp frosted, but I prefer, however, to use them in correlation as herein described.

I claim:

1. A reflector of revolution whose curvature in an intersecting plane including the axis of revolution is a curve made up of a connected series of parabolic sections whose axes are angularly displaced with respect to each other.

2. A reflector of revolution whose curvature in an intersecting plane including the axis of revolution is a curve which is the limit of a series of connected parabolic sections having a common focus and whose axes are progressively angularly displaced from the axis of revolution.

3. A reflector of revolution whose surface is composed of connected zones, the curvatures of the zones in an intersecting plane including the axis of revolution being parobolic sections having a substantially common focus but the axes of which parabolic sections are progressively angularly displaced from the axis of revolution, and the areas of which zones are such that each zone intercepts a substantially equal amount of light flux from a light source placed at the common focus.

4. A reflector of revolution whose surface is composed of a series of zones, the zone surfaces having a substantially common focus, the curvatures of the zones in an intersecting plane including the axis of revolution being parabolic sections whose foci coincide with the said common focus of the

zones and whose axes are progressively angularly displaced from the axis of revolution in such a manner that they intersect the central points of successive and equal lengths on the line in the field to be illuminated, which is parallel to the axis of revolution in the said intersecting plane, and the areas of which zones are such that each zone intercepts a substantially equal amount of light flux from a light source placed at the common focus of the zones.

5. In a headlamp, a reflector whose reflecting surface is generated by a plane curve rotated about an axis, and which plane curve is a series of conic section portions whose axes are progressively angularly displaced from the axis of revolution.

6. In a headlamp a combination of two reflectors of revolution, one being a reflector whose curvature in an intersecting plane including the axis of revolution is a curve made up of a series of parabolic sections whose axes are progressively angularly displaced from the axis of revolution, and the other reflector being an ellipsoidal portion placed on the opposite side of the light source and so positioned as to reflect light from the light source onto the first reflector.

7. In a headlamp, a combination of three reflectors and a light source, one reflector being located above and in the rear of the light source and having a surface of revolution whose curvature in an intersecting plane including the axis of revolution is a curve composed of a series of parabolic sections whose axes are progressively angularly displaced from the axis of revolution, a second reflector located in the rear of and below the light source and having a surface of revolution whose curvature in an intersecting plane including the axis of revolution is a curve composed of a series of parabolic sections whose axes are progressively angularly displaced from the axis of revolution, and a third reflector of revolution composed of ellipsoidal portions placed in front of the light source and positioned so as to reflect light from the light source onto the reflector located below and in the rear of the light source.

8. A reflector of revolution whose curvature in an intersecting plane including the axis of revolution is a curve made up of a connected series of parabolic sections having a common focus and whose axes are progressively angularly displaced from the axis of revolution in such a manner that they intersect equally spaced points on the line in the field to be illuminated which is parallel to the axis of revolution in the said intersecting plane, and which parabolic sections are of such lengths that the arcs on any small measuring circle having the common focus as a center, subtended by the radius vectors from the common focus to the extremeities of the parabolic sections, have projections of equal length on the axis of revolution.

9. A reflector of revolution whose curvature in an intersecting plane including the axis of revolution is a curve which is the limit of a connected series of parabolic sections having a common focus and whose axes are progressively angularly displaced from the axis of revolution in such a manner that they intersect equally spaced points on the line in the field to be illuminated which is parallel to the axis of revolution in the said intersecting plane, and which parabolic sections are of such lengths that the arcs on any small measuring circle having the common focus as a center, subtended by the radius vectors from the common focus to the extremities of the parabolic sections, have projections of equal length on the axis of revolution.

10. In a headlamp, a combination of two reflectors of revolution, one being a reflector whose surface is composed of a series of zones whose curvatures in an intersecting plane including the axis of revolution are parabolic sections having a common focus and whose axes are progressively angularly displaced from the axis of revolution in such a manner that they intersect equally spaced points on the line in the field to be illuminated that is parallel to the axis of revolution in the said intersecting plane, and the areas of which zones are such that each zone intercepts a substantially equal amount of light flux from the light source placed at the common focus of the zones, and the other reflector being an ellipsoidal reflector placed on the opposite side of the light source and having one focus at the center of the light source, and so positioned as to reflect light from the light source to the first reflector.

11. In a headlamp, a combination of two reflectors of revolution in which one reflector is an ellipsoidal reflector placed in reversed position ahead of the light source and arranged to project an image of the light source at a point adjacent to the light source, and in which combination the other reflector is placed in the rear of the light source and has a surface composed of a series of connected zones having a common focus and having curvatures in the intersecting plane including the axis of revolution which are parabolic sections whose foci coincide with the common focus of the zones, and whose axes are progressively angularly displaced from the axis of revolution in such a manner that they intersect equally spaced points on the line in the field to be illuminated which is parallel to the axis of revolution in the said intersecting plane, and the areas of which zones are such that each zone intercepts a substantially equal amount of light flux from the light source which is placed at the com-

mon focus of the zones, and which reflector is arranged to receive light from the light source and also to receive light from the said image of the light source.

12. In a headlamp, a light source, a front reflector of revolution reversed in position and placed in front of and above the level of the light source, and which front reflector has a reflecting surface of ellipsoidal portions having common foci, and which surface is arranged with respect to the light source so that it projects an image of the light source at a point substantially adjacent to the light source, and a rear reflector of revolution placed in the rear of and below the level of the light source and having a reflecting surface composed of a series of connected zones having a common focus at the center of the light source, and which zones have curvatures in the intersecting plane including the axis of revolution which are parabolic sections having a common focus at the said common focus of the zones, and the axes of which parabolic sections are progressively angularly displaced from the axis of revolution in such a manner that they intersect equally spaced points on the line in the field to be illuminated which is parallel to the axis of revolution in the said intersecting plane, and the areas of which zones are such that each zone intercepts a substantially equal amount of light flux from the light source, and which front reflector and rear reflector are arranged on a common axis of revolution which passes through the center of the light source, and which rear reflector receives light from the light source and from the said image of the light source and reflects the light so received through the face of the headlamp in a beam that illuminates uniformly a semi-cylindrical surface outside the headlamp which is parallel to and concentric with the axis of revolution of the reflectors.

In testimony that I claim the foregoing, I have hereto set my hand, this 22nd day of March, 1920.

CHESTER N. WEEMS.