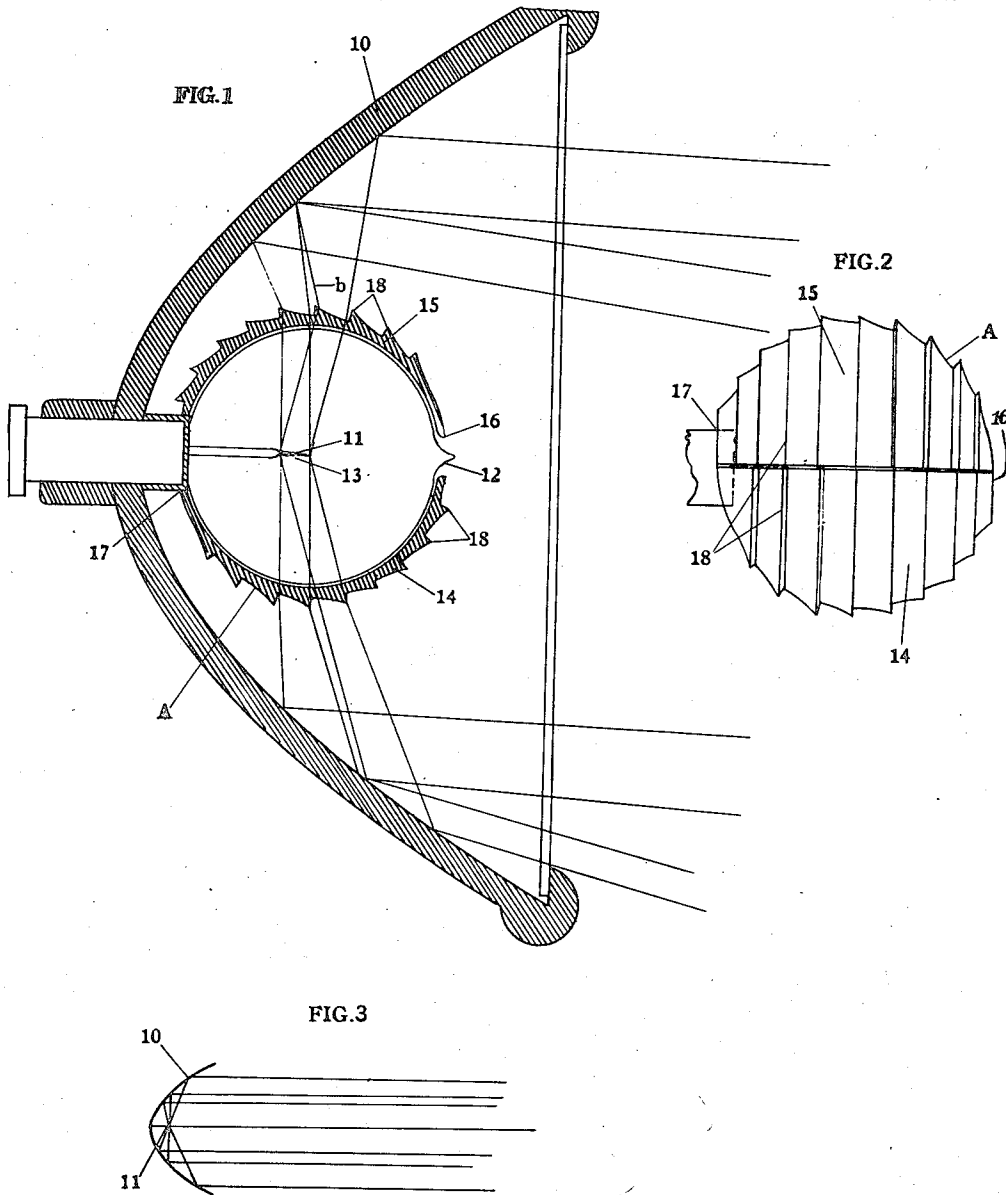


W. H. ZORGER.
ELECTRIC HEADLIGHT.
APPLICATION FILED JUNE 29, 1918.

1,348,617.

Patented Aug. 3, 1920.
4 SHEETS—SHEET 1.



Center Focus

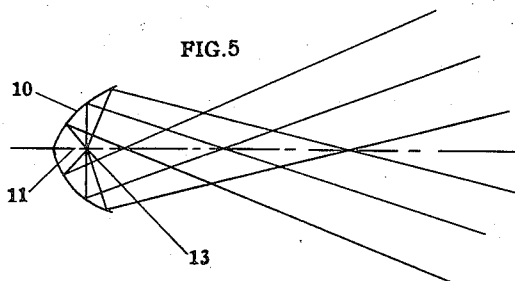
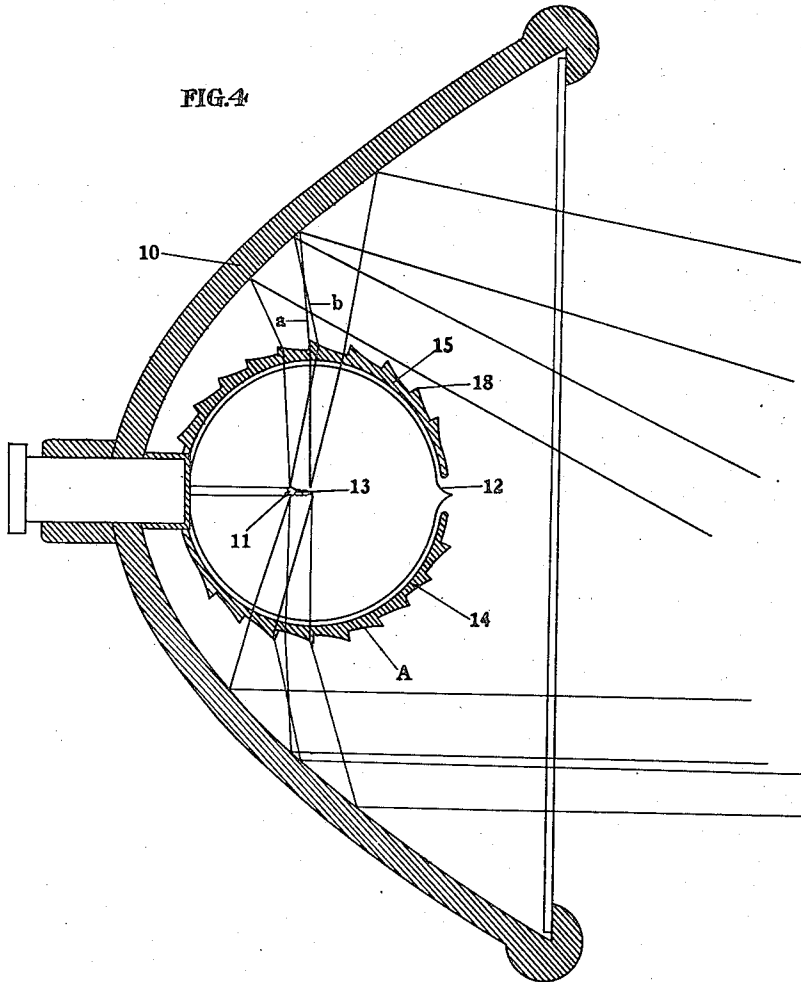
William H. Zorger,
Inventor

By
Ernest Cushman
ATTORNEYS

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4 SHEETS—SHEET 2.



William H. Zorger,
INVENTOR

Forward Focus

BY

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4 SHEETS—SHEET 3.

FIG. 6.

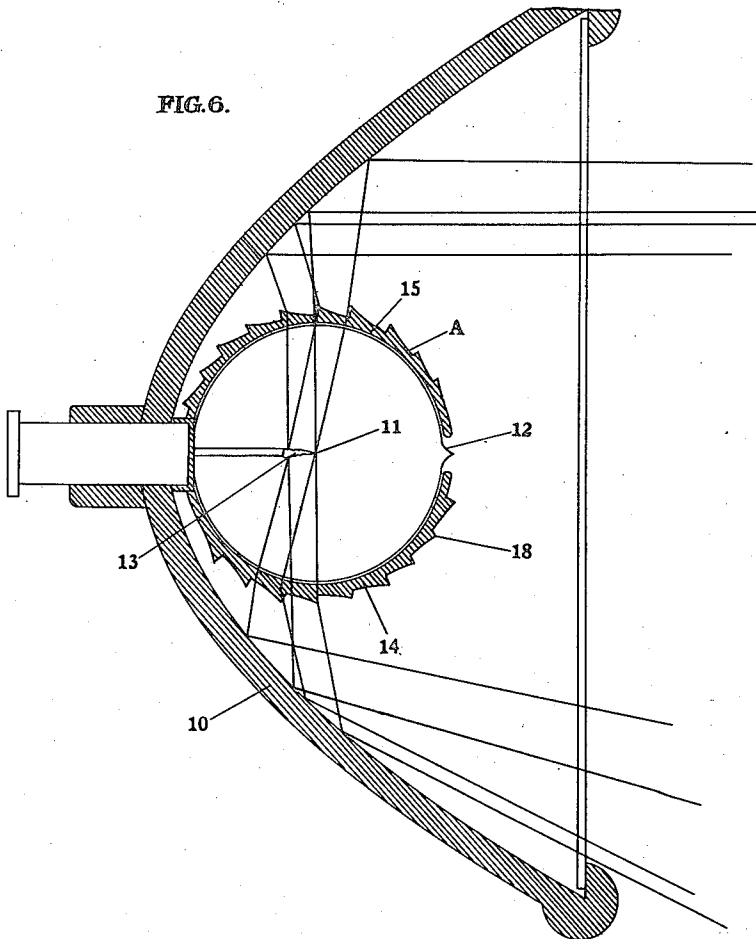
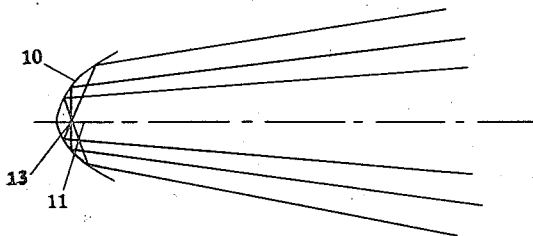


FIG. 7.



William H. Zorger,

Inventor

Back Focus

By

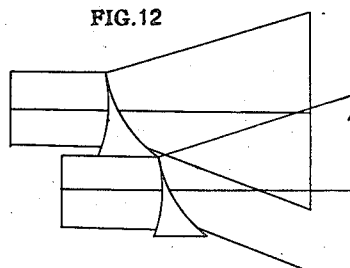
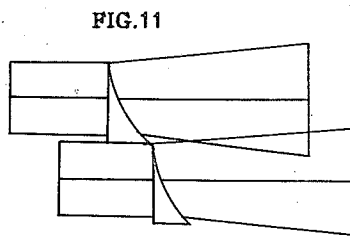
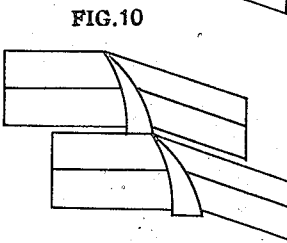
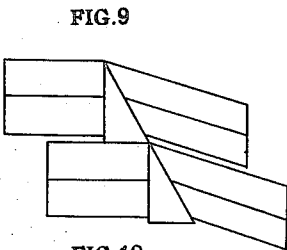
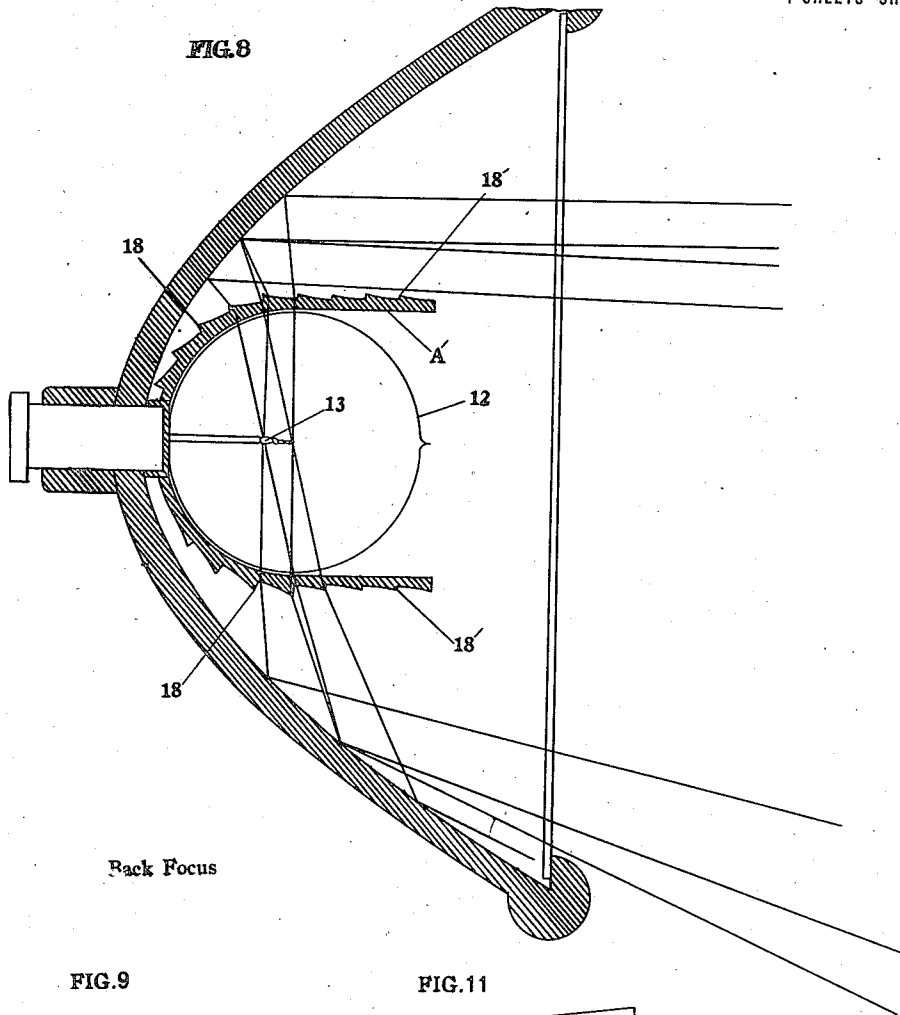
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W. H. ZORGER.
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1,348,617.

Patented Aug. 3, 1920.
4 SHEETS—SHEET 4.



William H. Zorger,
Inventor

By

Aug. C. Burkhardt
ATTORNEYS.

UNITED STATES PATENT OFFICE.

WILLIAM H. ZORGER, OF CHAMPAIGN, ILLINOIS.

ELECTRIC HEADLIGHT.

1,348,617.

Specification of Letters Patent.

Patented Aug. 3, 1920.

Continuation in part of application Serial No. 169,824, filed May 21, 1917. This application filed June 29, 1918. Serial No. 242,536.

To all whom it may concern:

Be it known that I, WILLIAM H. ZORGER, a citizen of the United States, residing at Champaign, in the county of Champaign and State of Illinois, have invented new and useful Improvements in Electric Headlights, of which the following is a specification.

My invention relates to lamps and particularly to headlights for use on automobiles, trolley cars, locomotives and the like.

The present application is a continuation in part of an application Serial No. 169,824, filed by me May 21, 1917.

It is usual, in head lights for automobiles and the like, to position the source of illumination a slight distance in front of, or back of the focal center of the convex or parabolic reflecting surface, so as to cause spreading of the reflected light rays and thus obtain the desired illumination over a relatively long range of the road-bed over which the vehicle, carrying the lights, is traveling, and also to obtain a lateral spreading of the light so as to illuminate the entire width of the road and areas along the sides thereof. When a source of light is back of the focal center of the reflecting surface, that is in "back focus," the rays reflected by the reflecting surface diverge and those rays reflected from the upper half of the reflector will be upwardly inclined. In forward focusing, the rays emanating from the reflector converge and then diverge and those rays falling on the lower half of the reflector will be upwardly inclined. This practice, in the past, has been objectionable in that the upwardly inclined rays result in what is popularly termed "glare," which is a source of annoyance and positive danger to operators of vehicles and pedestrians, and in addition the maximum efficiency of the lamp is not obtained as those light rays thrown upwardly are wasted.

The present invention has as its purpose to provide a lamp in which a lens is interposed between the reflecting surface and the source of illumination, which lens so transposes the rays of light passing therethrough that these rays will be diffused and merge into each other and will fall into the reflecting surface to be reflected therefrom in the desired direction, and more particularly the lens will transpose the light rays which would cause "glare," if the lens were not present, so that these rays will be re-

flected downwardly, laterally and horizontally and in such manner that lines of varying luminosity are not present.

Further objects of my invention are to provide a lamp wherein is obtained the maximum efficiency from the source of illumination by preventing loss of those light rays which would cause glare, and using these rays to the best advantage; to throw the downwardly inclined rays so that there will be sufficient divergence to cause illumination of a considerable stretch or longitudinal range of the road over which the vehicle is traveling; to obtain proper lateral illumination so that objects on either side of the path along which the vehicle is traveling may be clearly seen; and to provide a lamp which will throw a beam of light which is of even intensity and which is devoid of dark patches which would cause dark lines on the road.

In accordance with the present invention, my improved lens consists in one form, Figures 1 and 2, of a shell, for convenience of application made in two parts, an upper and lower, the cylinders or prisms on the upper half running at right angles to the antero-posterior diameter of the shell and, with the lens in position, at right angles to the axis of the reflector.

Since the prismatic elements have their bases away from the reflector in the lower half of my lens, when the source of light is in real focus, they will produce such a transposition of the rays as to cause them to be reflected at the same angle and inclination as if they were coming from the reflector with the bulb or source of light $\frac{1}{4}$ th inch, more or less, back of the true focal point.

By so arranging the prismatic elements of the same width and basic strength in the upper and lower halves of this lens, and by reversing their bases two exact half cones of light are produced when the source of light is in real focus. The upper half cone is formed by crossed rays the same as if the bulb were forward of the true focal point, as shown in Fig. 5, while the lower half cone is formed by rays spreading apparently from the reflector wall. The upper half cone is formed by rays crossing so that the right side of the upper half cone is formed of rays from the left half of the reflector and the left side from the right side of the reflector. All rays forming the lower half

cone are directly reflected from the reflector wall and never cross.

This crossing of the rays forming the upper half cone, and direct spreading of those forming the lower half, causes a mixture or light diffusion on the road bed.

If the source of illumination is in "forward focus," it is not necessary that the rays of light emanating from the upper half of the reflecting surface be interfered with as practically none of these rays are projected above a horizontal, but it is desired to transpose the rays which fall onto the lower half of the reflector, so that they appear to come from a source of illumination set in the focal center or slightly back thereof, which will cause them to be thrown forward from the lower half of the reflector horizontally or declined a little below the horizontal. If the source of illumination is in back focus, it is not necessary that the rays from the lower half of the reflector be interfered with, but the upper half of the rays are transposed so that they will so fall onto the upper half of the reflector as to be reflected thereby horizontally or declined a little below the horizontal. It is pointed out, however, that it is desirable to transpose all of the rays falling on the reflecting surface, for the reasons that from a practical standpoint, the source of illumination is not confined to a single point, but is extended over a considerable distance, so that light rays are propagated therefrom at different focal distances, and the reflecting surfaces of the usual reflectors for head lights are very faulty in construction in that their surfaces are uneven. To transpose all of the rays which would otherwise fall on the parabolic surface, I construct my improved lens so that it will surround the source of illumination, the cylinder sections on the top and bottom of the lens being absolutely disposed so that the upper cylinders will bend the rays passing therethrough in the direction toward the back of the reflector, and the lower cylinders will bend the rays passing therethrough so as to fall farther front on the reflecting surface.

By providing a lens having a plurality of cylinder segments or sections, the light rays passing therethrough are not only transposed, but they are spread out so that the rays transposed by one cylinder will cross with and merge into the rays transposed by other cylinders. In the case of light passing through a series of prisms, the light rays are transposed to the extent that they are bent, but the rays from the several prisms do not merge or cross each other, so that there are intervening dark lines or patches between the beams, and these dark lines, where prisms are used, are a source of annoyance and prevent proper illumina-

tion. The light rays passing through sectional cylinders are focused, the rays passing through different fields of the cylinders being refracted in different degrees.

Due to the wide range of dispersion in a vertical plane when the light rays are transposed by the use of my improved lens, and since the rays from the several cylinders merge into each other, a long range of the road is illuminated; there are no upwardly inclined rays to cause "glare;" lateral illumination is not interfered with; the efficiency of the lamp is increased; the area illuminated varies gradually in luminosity; and a striped effect on the road surface is not produced.

The above and other objects of my invention are obtained in the structures described in the following specification and illustrated in the accompanying drawings, and wherein:

Fig. 1 is a vertical sectional view taken centrally through a head light in which one embodiment of my invention is embodied, and in this figure the source of illumination is shown as being set in "center focus."

Fig. 2 is a side elevational view of one form of my improved lens or shell.

Fig. 3 is a diagrammatical view showing the reflection of light rays from a parabolic reflecting surface when my improvement is not employed and the source of illumination is in "center focus."

Fig. 4 is a view similar to Fig. 1, except that the source of illumination is in "forward focus."

Fig. 5 is a view similar to Fig. 3, except that the source of illumination is in "forward focus."

Fig. 6 is a view similar to Fig. 1, except that the light is in "back focus."

Fig. 7 is a view similar to Fig. 3, with the source of illumination in "back focus."

Fig. 8 is a vertical sectional view taken centrally through a head light to which another form of my invention is applied, the source of illumination being in "back focus."

Figs. 9, 10, 11 and 12, respectively, are diagrammatical views illustrating the transposition of light rays on passing through a prism having plain faces, a curved prism, a plano-concave cylinder, and a double-concave cylinder.

In the drawings, the numeral 10 designates the reflector, which may be parabolic in curvature and 11 designates the focal center of the reflecting surface, that is the position which the filament would occupy were it set in real focus so that the rays would emanate in parallelism from the head light. The means for producing illumination, in the present instance, is shown as comprising an electric filament lamp having a glass globe 12 and a filament 13, which filament,

as in actual practice, is illustrated as being of such length or size that the rays proceed from it from different points, thus striking the reflector at varying angles and being more or less divergent. It is, of course, understood that my invention may be applied to head lights of various types.

In the illustrative disclosure of the embodiment of my invention shown in Figs. 1, 2, 4 and 6, my improved lens "A," which is interposed between the bulb 12 and reflector 10, is divided in the horizontal plane, where all the cylinders intersect, into two halves, 14, 15, for the purpose of manufacture and ready application to the bulb or source of light, and has the same internal radius of curvature as the bulb 12, so as to closely fit both halves thereof. The forward end of each semi-spherical part is notched as at 16 to receive the tip of the bulb 12 and the other end has a notch 17 to accommodate the socket of the bulb. The parts 14 and 15 of the lens may be attached to the tip and socket of the bulb in any suitable manner.

Each half 14 and 15 of the lens has on its external surface, sectional cylinders 18 with their axes extending transversely across or at right angles to the anterior-posterior diameter of the shell, and the base of each cylinder abuts the apex of the next succeeding cylinder. The cylinder sections on the upper half 15 of the lens have their bases facing toward the reflecting surface 10, and the sections of the lower part 14 have their bases facing away from the reflector 10. In the illustrative disclosure of Figs. 1, 2, 4 and 6, the sections 18 of the lenses 14 and 15 are double-concave cylinders, but it is evident that the particular form of cylinder section may be varied, it being only necessary that these sections be such as to transpose the light rays and cause them to spread sufficiently so that they will cross or merge into each other to prevent dark patches. In Figs. 1, 2, 4 and 6 of the drawings, the forward end of the lens is provided with cylinder segments, but these segments are not necessary, as the rays passing therethrough would fall outside of the reflecting surfaces if the lens were not present.

In Fig. 1 of the drawings, I have shown my improved lens applied to a lamp, in which a source of illumination is positioned at "center focus," the "center focus" being designated by the numeral 11. If it were possible to confine the source of illumination to a center point, the rays from the source of illumination striking on the reflecting surface would be thrown forward in parallel lines, as shown in Fig. 3, but in actual practice the source of illumination is relatively large, so that while the center of the source of illumination may be in "center focus," the forward tip thereof is in "forward focus," and the rear end is in "back focus."

The rays from the forward end of the light, and which strike the lower half of the reflecting surface, would be reflected upwardly and forwardly, and would tend to cause glare, while the rays striking the upper portion of the reflecting surface and emanating from the inner portion of the light, which is in "back focus," would be thrown upwardly and cause glare. The manner in which the rays striking the lower half of the reflecting surface are reflected when the light is in "forward focus" is clearly shown in Fig. 5, while the manner in which the rays striking the upper half of the reflecting surface when the source of illumination is in "back focus" is clearly shown in Fig. 7.

By interposing between the lower half of the reflector 10 and the source of illumination shown in Fig. 1, the lens 14, having the bases of the cylinder sections 18 facing away from the reflecting surface, the rays passing through these sections are transposed or bent, so as to fall on the reflecting surface and be reflected thereby in a forwardly and downwardly direction, and those rays which emanate from the tip of the filament 13, that is, from that portion of the light in "forward focus," are so transposed as that they appear to come from a "back focus." By interposing the lens 15 between the upper half of the reflector and the source of illumination, the rays emanating from that portion of the source of illumination lying in "back focus," are transposed or bent in a direction toward the reflecting surface, so as to fall thereon at such angles as to be reflected thereby in a forwardly and downwardly direction and thus these rays appear to come from a "forward focus." It will thus be seen that by surrounding the source of illumination with a lens having on one of its surfaces similar sections, the sections on the top and bottom portions of the lens being oppositely disposed, the rays emanating from all portions of the source of illumination are transposed in such a manner that "glare" is substantially eliminated.

My cylinders are cut with just enough basic strength to give a half cone of light having a spread of approximately four feet in twenty feet, when the source of light is in center or real focus, so, that when the bulb is moved forward into forward focus the rays from the lower half of the reflector, which would have an upward inclination, are brought into parallel forming virtually a "spot light" of the lower half of the reflector, while the rays passing through the upper half of the lens are given a wider distribution forming an enlarged half cone from the upper half. This spot light effect can only be obtained with the source of light either forward or back of real focus by constructing a lens which completely surrounds the bulb or source of light.

In Fig. 6 the source of illumination 13 is set in "back focus," and in this position of the bulb the rays from the upper half of the reflector would ordinarily as shown in Fig. 7, be inclined upwardly from the reflector and would cause glare if the lens were not interposed. The upper half of my lens causes these rays to strike the reflector at a different angle bringing them to horizontal and practically parallel producing a "spot light" effect from the upper half, while the lower half produces a larger and wider half cone of light.

I am thus enabled to get three different effects from having my lens completely surround the source of light, viz., 1st., two beautiful half cones of light with the circle down and flat side up, the upper half cone formed by crossed rays with its apex beginning to form at the lens, the same half cone as is formed with the bulb about $\frac{1}{8}$ th inch forward of the focal center of the reflector as is shown in Fig. 5. 2nd., a downwardly directed half cone of light from the upper half of the reflector and a spot light from the lower half, and 3rd., a downwardly directed half cone of light from the lower half of the reflector and a spot light from the upper half.

By the arrangement described I obtain two equal half cones of light, thus giving more road bed illumination than the plain glass front with the source of light in real focus; and with the source of light $\frac{1}{8}$ th inch forward or back of the real focal center of the reflector I obtain a spot light beam from the respective half of the reflector that will give great distance ahead of the driver, with as much light, with an enlarged cone from the other half, as can be obtained from any plain glass front.

When the bulb is set forward the upper half cone enlarges and the lower half contracts concentrating the light from the lower half of the reflector. When the bulb is pulled or set back of the real focal center the lower half cone enlarges while the upper half contracts thus keeping half the light concentrated in a forward beam which gives the greatest possible distance.

It is, of course, evident that while I have described my improved lens, shown in Figs. 1 to 7, as comprising two parts, these parts may be integral with each other. When the lens is made in two parts, these parts may be secured about the globe in any suitable manner. If desired, the sectional cylinders may be formed integral with the bulb of the electric filament lamp.

In Fig. 8, I have illustrated my improved lens A^1 as comprising a shell, one half or end of which is spherical so as to closely receive the bulb, and the other half of the shell is cylindrical and extends forward of the headlight. The spherical and cylindri-

cal portions are provided with sectional cylinders 18 and 18^1 , respectively. The cylinder sections 18 on the spherical portion of the lens A^1 are arranged and constructed similarly to the sections on the lens illustrated in the preceding figures. The cylindrical portion of the lens A^1 has its inside surface plain and the ridges on the outside are curved inwardly on the arc of any desired circle, thus making the segments 18^1 plano-concave cylinder sections. The lens is provided with the cylindrical portion, so as to intercept and transpose those rays which would just fall out of the reflecting surface if the lens were not present, without interfering with the rays which emanate from the source of light in the horizontal plane.

It is evident that the shapes and forms, the basic or diopter strengths and the widths of the cylinder sections 18 and 18^1 of my improved lens A or A^1 may be varied to suit varying conditions, such as the size of the bulb to be surrounded; the shape and size of the reflecting surface; and the desired spread of the rays and distribution of the light upon the road surface. By way of example, the spherical portion of the lens A^1 shown in Fig. 8 may have an internal radius of $1\frac{1}{8}$ inches, and while the outer surfaces of the cylinders 18 may be of any desired arc they are preferably plain, making each ridge or segment, a section of a plano-concave cylinder. The inside of the cylindrical portion of the lens A^1 is preferably plain, while the outside surface of each cylinder is curved on an arc of 1 inch radius, the bases of the cylinders being about .02 of an inch in depth. It is, of course, evident that the outer surfaces of the cylinder section 18^1 on the spherical portion of the lens A^1 may be curved on the arc of a circle, thus making each section the section of a double-concave cylinder as shown in Fig. 8. Both the inside and the outside surfaces of the segments 18^1 on the cylindrical portion of the lens A^1 may be curved on the arc of any desired circle, thus forming a double-concave cylinder. The cylinder sections 18 and 18^1 may be concavo-convex, in which instance the radii of the outside surfaces would differ from the radius of the inside curve of the cylinders. Concavo-convex cylinders are not preferable, as they make a very heavy, clumsy construction. Minus cylinders are used to best advantage as the rays will be spread, so that rays passing through one section 18 will merge with those of another section without focusing and crossing the rays from any one before they fall on the reflecting surface. Any desired degree of diffusion may be obtained simply by varying the radius of curvature of the cylinder segments.

I am aware that it is broadly known to in-

terpose a lens between the source of illumination and the reflecting surface of a reflector, the lens having a plurality of prisms which are curved. It is pointed out, however, that with the use of prisms which are triangular in cross-section, or by the use of curved prisms, in which the inner and outer surfaces are curved on the same arc, the rays passing through the prisms are merely bent or transposed, and they are not spread or diffused so that the rays from one prism will merge into the rays passing through an adjacent prism. As previously pointed out, the advantage of using cylinder segments is that the rays passing through the various segments will merge into each other, resulting in equal diffusion of light and an absence of dark lines and patches. From Figs. 4 and 6 it will be seen that the rays *a* and *b*, passing through different cylinder segments 18, cross before they fall on the reflector 10. To graphically show the different ways in which prisms and cylinder segments function, I have illustrated in Figs. 9 and 10 the action of prisms or rays of light passing therethrough and in Figs. 11 and 12 the action of cylinder segments.

In Figs. 9 and 10 it will be noted that the rays on passing through the prisms are merely bent, and they are not diffused; that is, the refracted rays are substantially in parallelism with each other. Due to the fact that the light rays passing through prism section do not spread appreciably, the beam will be filled with dark patches, which are a source of annoyance. It is to be noted that a curved prism will not diffuse rays of light passing therethrough for, the outer and inner surfaces of a prism are taken on the same radius and therefore all rays will strike the inner and outer surfaces at the same angle. A curved prism will bend the rays but will not spread them.

In Figs. 11 and 12 the light rays are shown as passing through cylinder segments. In Fig. 11 the segments are plano-concave, and in Fig. 12 they are double-concave, but in both instances the action is similar, in that the refracted rays are diffused or spread. The rays passing through one cylinder segment will merge and cross the rays passing through the adjacent cylinder, so that all dark patches are eliminated and an even distribution of the light is obtained.

It will be seen that a lens, constructed in accordance with my invention, will merge the light rays refracted by the several cylinders so that a beam of even luminosity is obtained. It is of great advantage to interpose the lens between the entire reflecting surface and the source of illumination, for by so doing the source may be adjusted in any one of three focuses, namely, center, back and forward, without "glare" being present in any of these positions. Further-

more, my improved lens will eliminate "glare" which might arise from faulty construction of the reflecting surface or be due to the length of the source of illumination. The use of the lens results in great diffusion near the car and a wide spreading of the light.

It will be noted that since my improved lens closely fits the bulb 12, the cylinders may be relatively light in construction and this is especially true as they are some distance away from the reflecting surface and therefore, sufficient spreading of the rays is obtained before the rays strike this surface. The rays reflected by the reflector 10 will pass outside of the lens so as not to be absorbed thereby.

It is obvious that my invention is susceptible to various changes and modifications which would be within the spirit of the invention without departing from the scope of the following claims.

I claim:

1. In a headlight, the combination of a reflecting surface, a source of illumination, and a lens consisting of a cylindrical shell, divided through its horizontal plane into upper and lower halves, surrounding the source of light and having on its outer surface prismatic elements of the same width and basic strength, the bases of said elements on the upper half of the lens being directed toward the reflector and the bases of the prisms on the lower half being directed away from the reflector, all said prisms intersecting at the horizontal center of the cylinder and extending at right angles to the antero-posterior diameter of said shell and at right angles to the axis of the reflector, whereby when the source of light is in center focus with the reflector there will be produced two half cones of light of practically the same size and shape, the upper half cone consisting of crossed rays while the lower half cone consists of directly divergent rays, all said rays being directed downwardly.

2. In a headlight, the combination of a reflecting surface, a source of illumination, and a tubular lens, arranged about the source of light, within the reflector, and having a spherical rear portion and a cylindrical body, divided through its horizontal plane into upper and lower halves, the outer surface of such lens having transversely arranged prisms of a desired width and basic strength, the prisms of both the upper and lower halves of the lens being of the same width and basic strength, the prisms on the upper half having their bases directed toward the reflector while the bases of the prisms on the lower half are directed away from the reflector, and all said prisms being arranged at right angles to the antero-posterior diameter of the lens, whereby when the source of light is in center focus with the reflector

there will be produced two half cones of light, the upper half cone consisting of crossed rays and the lower half cone of directly divergent rays, all of said rays being
5 directed downward.

3. In a headlight, the combination of a reflecting surface having a center focus, a source of illumination, and means interposed between the source of illumination and the
10 reflecting surface to produce two downwardly directed equal half cones of light when the source of light is in center focus, and to produce an enlarged half cone of light by one half of the reflecting surface
15 and a "spot light" effect by the other half of the reflector surface when the source of light is forward or in rear of center focus.

4. A lens for headlights consisting of a

hollow shell adapted to surround an electric light bulb and having on its exterior transversely extending prisms, the prisms of the
20 upper half of said shell being reversely arranged to those of the lower half, whereby when said shell is placed about a light bulb within a reflector having a center focus, two
25 downwardly directed equal half cones of light will be produced when the light is in center focus and an enlarged half cone produced by one half of the reflecting surface and a "spot light" effect by the other half
30 of the reflecting surface when the lamp is forward or in rear of center focus.

In testimony whereof I have hereunto set my hand.

WILLIAM H. ZORGER.