March 16, 1926.

1,577,352

M. W. CAUGHLAN

HEADLIGHT REFLECTOR

Filed May 13, 1925

2 Sheets-Sheet 1

Fig. 1.

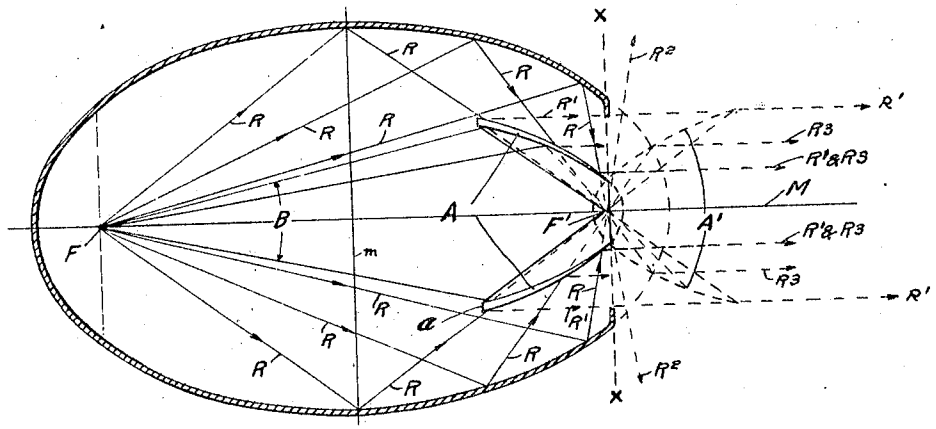
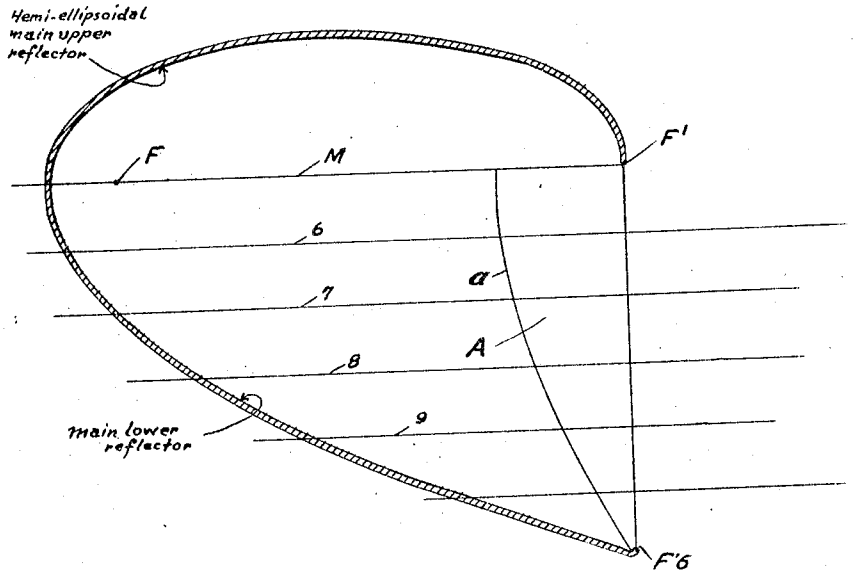


Fig. 2.



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Fig. 3.

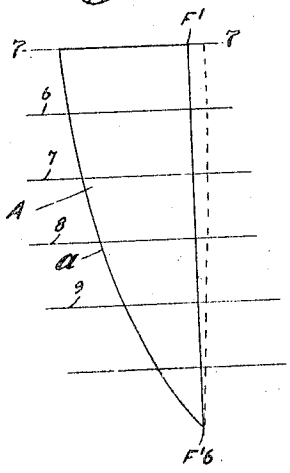


Fig. 4.

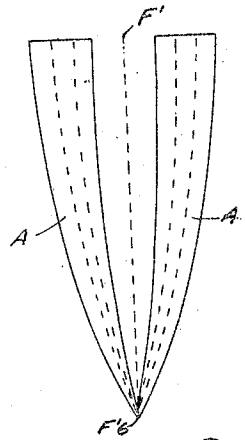


Fig. 5.

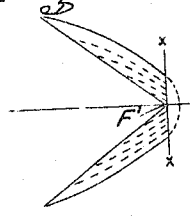


Fig. 6.

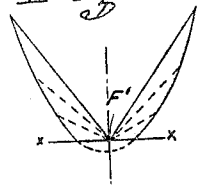


Fig. 7.

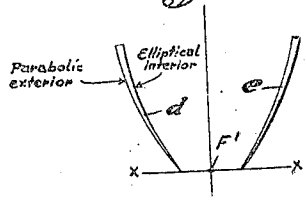
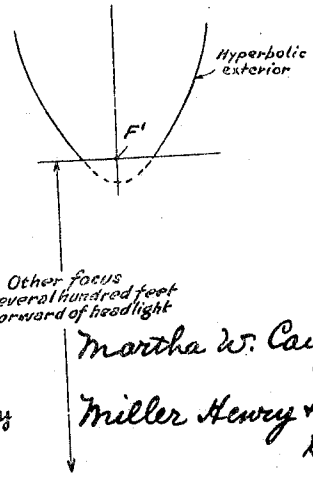


Fig. 8.



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Her Attorneys

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UNITED STATES PATENT OFFICE.

MARTHA W. CAUGHLAN, OF OAKLAND, CALIFORNIA, ASSIGNOR TO AMERICAN WOODLITE CORPORATION, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

HEADLIGHT REFLECTOR.

Application filed May 13, 1925. Serial No. 29,933.

To all whom it may concern:

Be it known that I, MARTHA W. CAUGHLAN, citizen of the United States, residing at Oakland, county of Alameda, State of California, have invented new and useful Improvements in Headlight Reflectors, of which the following is a specification.

This invention relates to reflectors for headlights such as are used on automobiles, locomotives and the like, and particularly to improvements on the structure shown in my co-pending application entitled "Compound reflector", filed January 19, 1925, Serial No. 3335.

The principal object sought in my application above referred to was the attainment of an ideal distribution of light from a reflecting surface as adapted for use in a lamp for illuminating the road with an ideal field for vehicle use, by projecting the light from one portion of a compound reflector in a concentrated and substantially horizontal beam, and from another portion of the reflector in a relatively less intense and laterally divergent and downwardly-directed beam.

To obtain these results I employed a compound reflector, within which is positioned a lamp, or other light source; the upper portion of the reflector above the horizontal plane passing through the lamp consisting of substantially a hemi-ellipsoid of revolution whose major axis passes through the lamp and one of whose foci is coincident with the lamp; and the lower portion of the reflector is formed of a series of diminishing ellipses whose major axes are parallel and in the same vertical plane as the major axis of the aforesaid ellipsoid of revolution and whose foci remote from the lamp lie on a vertical line; and whose other foci lie on a parabola passing through the lamp.

The principal object of the present invention is to provide means whereby the beam produced by the lower portion of my compound reflector above described may be still further intensified, through restricting its lateral spread, and whereby to more effectively utilize as nearly as possible the total spherical candle-power of the light source.

These objects I attain by forming preferably an auxiliary compound reflector which is herein called a condensing reflector, to be used with a light source in combination with the compound reflector of my co-pending application aforesaid, or with other reflectors, it being possible to use this auxiliary or condensing reflector in various relations to other reflectors, or with modifications of my compound reflector.

The invention consists of the parts and the construction and combination of parts as hereinafter more fully described and claimed, having reference to the accompanying drawings in which:—

Figure 1 is a sectional plan on the horizontal plane passing through the light source, showing my invention in combination with the compound reflector of my co-pending application.

Figure 2 is a side elevation of the above combination.

Figure 3 is a side elevation of my condensing reflector.

Figure 4 is a front elevation of my condensing reflector.

Figure 5 is a diagrammatic plan view of the exterior surface of my condensing reflector showing its development.

Figure 6 is another diagrammatic plan view of the same.

Figure 7 is a horizontal section on plane VII—VII, of Figure 3.

Figure 8 is similar to Figure 7, but shows the outer arc as hyperbolic instead of parabolic.

Throughout the figures, similar numerals refer to identical parts, or parts functioning in the same manner.

It will be seen by reference to Figures 1 and 2 and as particularly explained in detail in my co-pending application that above the major horizontal axis M my compound reflector is a hemi-ellipsoid of revolution about said axis, and that from said axis downward the lower main reflector is elliptical on all horizontal parallel planes. 6, 7, 8, and 9 and parabolic on all vertical planes as defined by its intersection by a vertical pencil of planes rotated about the vertical axis F′—F′$_6$. It then follows necessarily that light rays R emanating from F, the focal point of the reflector, and also the focus common to all the ellipses and parabolas involved, will be reflected on parallel horizontal planes, converging and crossing on the line F′—F′$_8$, the locus of the remote foci of all the elliptical arcs involved.

To carry out the object of my present

invention and restrict the lateral spread of some of these rays after emergence (as originally at R^2) and thereby produce a beam of greater intensity in the center field, I insert adjacent to the beam opening of the compound reflector the condensing reflector as shown in side elevation Figure 3, front elevation Figure 4, and in plan Figures 7 and 1. Figure 5, indicates in plan the diminishing parabolas of the exterior reflecting surface. Fig. 6 shows in plan, in dotted line, several of the vertical planes, with axis F'—F'_6 which form parabolic arcs on the surface of the reflector as also shown by dotted lines in Fig. 4.

Fig. 7 is a plane section on plane VII—VII, of Fig. 3, showing the exterior surface of the reflector parabolic on all parallel horizontal planes and on the interior surface elliptical on all parallel horizontal planes.

Fig. 8 shows in plan a modification of my condensing reflector in which the exterior surface is hyperbolic on all parallel horizontal planes.

The condensing reflector is preferably formed of two confronting shell like segments (*d*, *e* in Figure 7) with its interior surface consisting of arcs of a series of downwardly diminishing parallel ellipses whose major axes are parallel and lie on a central vertical plane, and whose foci lie on a vertical line F', F'_6; and its exterior surface consisting of a series of correspondingly diminishing parabolas whose axes are also parallel and lie on the same central vertical plane as the axes of the ellipses, and whose foci also lie in the same vertical line which is the locus of the foci of the ellipses. The exterior surface, however, may be formed by a series of diminishing hyperbolas, as indicated in Figure 8, with their near foci located on the above mentioned vertical line, and their remote foci removed as far forward as dictated by the length of projected beam desired.

To utilize this condensing reflector most effectively in combination with my first mentioned compound reflector, it is necessary to locate it so that the locus of its foci is coincident with the locus of the foci of the ellipses of the lower portion of the reflector as described in my co-pending case and as shown in Figures 1 and 2 of the drawing, said locus being the vertical line F', F'_6.

It can be readily seen that the interior of this reflector will function whether extended from said vertical line in a direction toward the light source, or away from it, the results obtained depending on the conics involved. That portion of the reflector outward beyond the foci, containing the vertices, and defined by a plane passing through the latus rectums of the ellipses and parabolas, is cut away along the line *o*—*o* to form an opening for the inner projected beam and is of course covered with glass in actual construction.

In locating the reflector I prefer to extend its interior surface toward the light source, as this permits of its inclusion within the contour of the reflector of my co-pending application. It will be readily seen, then, that if the interior surface is elliptical, as described, that portion of the direct light from the light source, otherwise wasted as direct light, will be reflected and strengthen the side lighting as produced by the upper hemi-ellipsoid. But more important still, if the outer surface of the inserted reflector is parabolic, then all converging rays R from the main reflector impinging thereon will be projected outwardly in parallel relation as at R′ where now they are widely divergent laterally on emission as at R^2 with a consequent loss in intensity. If this outer surface is hyperbolic, with the remote foci at a considerable distance, say two or three hundred feet, the intensity increase will be largely the same, with the rays converging to the remote foci. If the interior of the reflector is extended away from the light source, of course the interior surface would have to be parabolic, instead of elliptical.

The rays from the main reflector, to the rear of its minor axes *m*, converge on horizontal planes, crossing on the vertical straight line of foci, F', F'_6, and pass out through the opening in the inserted reflector, similarly to the rays reflected by the interior surface of the inserted reflector.

In Fig. 1, my condensing reflector A is shown in plan in combination with the main compound lower reflector of my co-pending case, and in side elevation in Fig. 2. In this latter position the interior surface only is utilized, and is parabolic on all parallel horizontal planes as in Fig. 5. I prefer, however, to position the reflector within the main projecting reflector, extending with its larger opening toward the light source F, while maintaining its focal points on the vertical line of focus F'—F'_6, as it is shown in Fig. 1, indicated as A. It is here shown as parabolic on its exterior surface and elliptical on its interior surface, with the locus of the foci of all parallel horizontal parabolic and elliptical arcs being the vertical line F'—F'_6, which is also the locus of the remote foci of all the parallel horizontal elliptical arcs in the main compound projecting reflector and also the axis of the pencil of vertical planes which will produce parabolic arcs on intersection with either the main projecting reflector or with the surface (interior and exterior) of my condensing reflector.

In Fig. 1, the rear edge *a* of the con-

densing reflector is extended back toward the source of light just far enough to intercept all rays R reflected from the main reflector from points forward of the minor axes *m* of the horizontal arcs, yet without intercepting any of these rays on their direct course from the light source. It will be readily seen that these rays R will be intercepted by the parabolic exterior of the condensing reflector and be re-reflected in parallelism, as denoted by the extensions of the rays, and parallel to the major axis of both the projecting reflector and the condensing reflector, which axes are coincident. These rays, reflected, are indicated as R'.

The interior surface of the condensing reflector is elliptical on all parallel horizontal planes, the light source F being at one (the inner) focus common to all the parallel elliptical arcs involved, just as it is common to all the elliptical arcs involved in the co-pending application. The other or remote foci all lie on the vertical line F'—F'_6 as does also the locus of the remote foci of the elliptical arcs in the co-pending case. Thus it will be seen that all direct light from the light source within the angle B, excepting the small portion lost through the opening in the reflector, will be reflected in parallelism through a vertical plane, and converging on horizontal planes, crossing on the line of foci F'—F'_6, thus reflecting nearly 100% of the spherical candle power used.

If the exterior surface in position A of the condensing reflector be changed from parabolic to hyperbolic, as indicated in Fig. 8, the condensing results will be substantially the same, for the other foci of the hyperbolas could be placed 200 feet, or any distance desired out in front of the lamp.

Of course it will be understood that the condensing reflector A can be extended within the main reflector beyond the limit shown in the attached drawings if desired. If extended beyond the point *a* shown in Fig. 1, the result will be that the exterior surface will intercept rays reflected from points to the rear of the minor axis *m*, of the main reflector, and that additional rays from the light source will be intercepted by the interior surface of the condensing reflector. This may be desirable, as the exterior surface of the reflector will then project in parallelism the more powerful rays from points on the main reflector nearer the light source, and also the interior elliptical surface, being of relatively small minor axes, will materially reduce the lateral devergence at present given by the main reflector.

The lateral spread of the rays produced by the lower portion of the main compound reflector as described in the co-pending application may be also or further restricted by parting the main reflector on its central vertical longitudinal plane and opening the beam aperture the desired amount by pivoting the two halves of the reflector on a vertical axis of rotation passing through the light source as indicated in Figure 9 of the drawings.

I claim:

1. In a headlight having a main reflector and a light source, an auxiliary condensing reflector arranged to receive light from the main reflector at one end and to emit light through the other end, said condensing reflector being positioned in front of the source of light and having an outer convex reflecting surface and an inner concave reflecting surface, said convex reflecting surface being parabolic on parallel horizontal planes and said concave reflecting surface being elliptical on parallel horizontal planes.

2. In a headlight having a main reflector and a light source, an auxiliary condensing reflector arranged to receive light from the main reflector at one end and to emit light through the other end, said condensing reflector being positioned in front of the source of light and having an outer convex reflecting surface and an inner concave reflecting surface, said convex reflecting surface being parabolic on parallel horizontal planes and said concave reflecting surface being elliptical on parallel horizontal planes and the foci of the parallel ellipses and parabolas being on a common locus.

3. In a headlight having a main reflector and a light source, an auxiliary condensing reflector arranged to receive light from the main reflector at one end and to emit light through the other end, said condensing reflector being positioned in front of the source of light and having interior and exterior reflecting surfaces, the interior surfaces forming in horizontal parallel sections a series of downwardly diminishing elliptical arcs, and the exterior surfaces in similar sections a series of downwardly diminishing parabolic arcs.

4. In a structure as defined in claim 3, all the major axes of elliptical and parabolic arcs being parallel on a vertical central plane and the foci of all the elliptical and parabolic arcs vertically superimposed.

5. In a headlight having a main reflector and a light source, an auxiliary condensing reflector arranged to receive light from the main reflector at one end and to emit light through the other end, said condensing reflector being positioned in front of the source of light and having a reflecting surface whose horizontal parallel sections form a downwardly diminishing series of parabolas with axes parallel on a vertical plane, foci on a vertical line, and vertices on the arc of a parabola.

6. In a structure as defined in claim 3, the foci of the elliptical and parabolic arcs being vertically superimposed and the vertices of all the arcs lying on a parabolic arc.

7. In a headlight having a main reflector and a light source, an auxiliary condensing reflector arranged to receive light from the main reflector at one end and to emit light through the other end, said condensing reflector having interior and exterior reflecting surfaces, the interior surfaces forming in horizontal parallel sections a series of downwardly diminishing elliptical arcs, and the exterior surfaces in similar sections a series of downwardly diminishing parabolic arcs, the foci of all the elliptical and parabolic arcs being vertically superimposed, and the surface intersections of either interior or exterior surfaces forming parabolic curves with a plane revolved about the superimposed foci.

MARTHA W. CAUGHLAN.