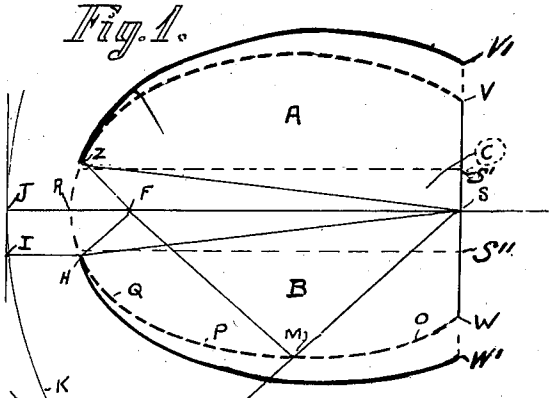
April 20, 1937. M. W. CAUGHLAN 2,077,740

REFLECTING SURFACE

Filed March 30, 1934

Fig. 1.



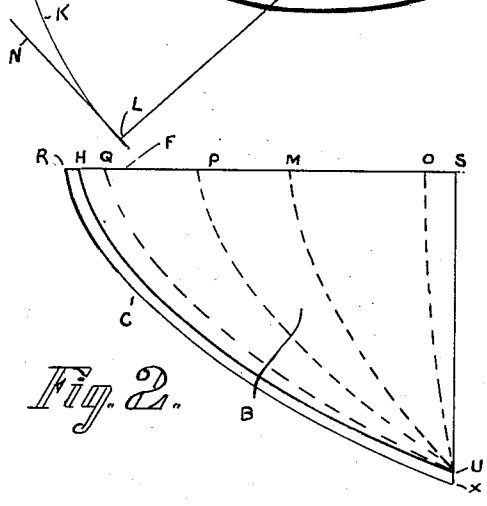


Fig. 2.

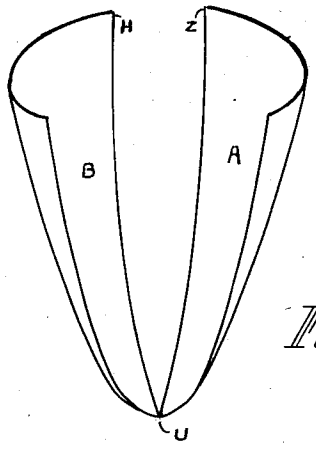


Fig. 3.

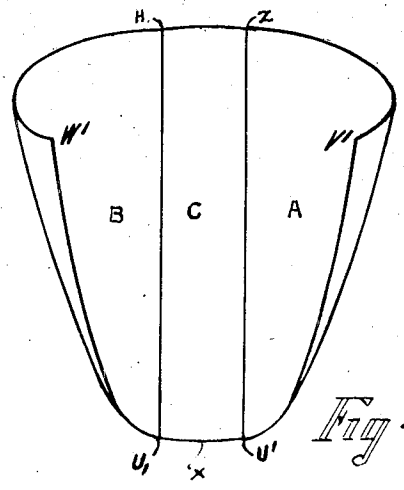


Fig 4.

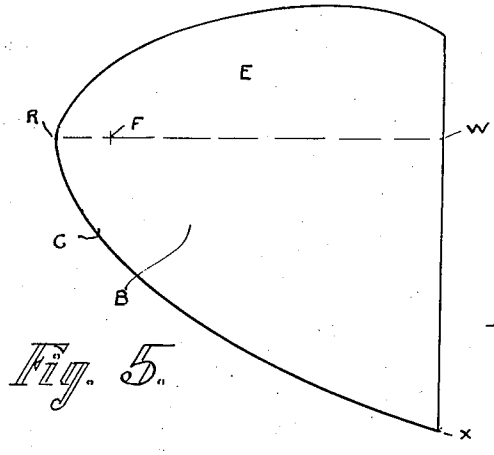


Fig. 5.

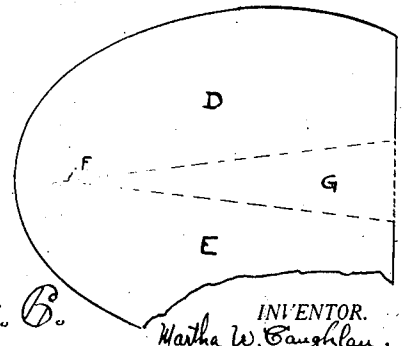


Fig. 6.

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Patented Apr. 20, 1937 2,077,740

UNITED STATES PATENT OFFICE

2,077,740

REFLECTING SURFACE

Martha W. Caughlan, San Francisco, Calif.

Application March 30, 1934, Serial No. 718,229

2 Claims. (Cl. 240—41.37)

My invention has for its object an improved reflector surface upon which the rays of a single light source are reflected but once and projected forward therefrom as a beam of light to secure the illumination of a road or other object or surface.

An object of my invention is the projection forward by my reflector of the most intense illumination within a predetermined area wherein selected relative intensities are attained.

A further object is a reflected beam wherein the requisite reflected light intensity on the side portions is secured while the central portion of the illuminated area is more intensely lighted.

A further object is such a reflector mounted on a vehicle and wherein the reflected beam will illuminate an area positioned below a horizontal plane through the light source of said reflector.

A further object is, in a vehicle headlight employing my reflector, the securing of a longer focal length from the proximate surface of the reflector to the light source center, thus securing a greater tolerance in the constructing and positioning of the illuminating element. My invention is particularly adapted to automobile headlights.

Other objects will appear from the drawing and specification following.

These objects I attain by forming my reflecting surface preferably to conform with a plurality of quantic surfaces having a common focal point and which surfaces where they merge into one another may have common tangents.

By referring to the accompanying drawing and description which disclose a preferred form my invention will be more clearly understood.

In the drawing Figure 1 is a plan illustrating how certain of the lower portions are formed. Figure 2 is a side elevation of certain of the surfaces formed according to Figure 1. Figure 3 is a front view of two of the lower surface forms in their partial spaced position. Figure 4 is the same as Figure 3 but with the surface portions spaced in their final position and with a constant paraboloid portion in place therebetween. Figure 5 is a side view of a finished surface form. Figure 6 is a fragmentary plan view of the form of Figure 5. Figures 3 and 4 are looking into the reflector surfaces, while Figures 2, 5 and 6 are of form portions which are in effect complements of reflector portions, or they may be considered exterior views of very thin metal portions whose inner surfaces are reflecting.

The lower portion of my reflector comprises two portions of the same quantic surface which are displaced from each other and which two portions are generally indicated by the letters A and B, and between these is located a segment of a different quantic surface indicated generally by the letter C.

In a similar manner the upper portion is preferably formed as an ellipsoidal surface in two portions of the same ellipsoid and these are then displaced from each other about the focus F, while between these is located a segment swept from the focus F. These three upper surfaces are indicated generally and respectively by the letters D, E, G.

The final position of the several surfaces is such that they all have one common focus F, and are symmetrical about a vertical central plane through F, S. All of the common boundaries of the several portions have common tangents.

In order that the manner in which my reflecting surface is constructed may be understood I shall first describe forms or dies on which the said surface may be constructed, as by spinning, pressing, casting or machining; the said dies being the complement of the several surface portions of my reflector in their final and integral position.

We may first construct a die or form portion with a surface as follows:

Referring particularly to Figure 1, choose any point F which is to be the light source and also a focus common to all the curved surfaces of my final reflector; also a second point at S and draw F, S, J. Select a point H distant from the line F, J, and draw J, I, such that H, I=F, H. The point H will then lie on a paraboloid of revolution whose focus is F and whose directrix plane is perpendicular to the paper through line J, I, and whose axis is J, S. With S as a center describe the circular arc J, K, L. Position M on L, S, such that L, M=F, M. It follows that the point M will lie upon another paraboloid of revolution whose focus is F and whose directrix plane perpendicular to the paper will contain the line L, N. Determine other points O, P, Q, in the same manner. All of these points H, Q, P, M, O, will be points on an ellipse whose foci are F and S, because they lie on a curve such that the sum of the distances to each of the foci is a constant: that is, J, S=L, S. Moreover, each of the said points will also lie upon some paraboloid of revolution whose focus is F and whose directrix is tangent to the arc J, K, L.

There will be an infinite number of such paraboloids having the common focus F, and all passing through the point U of Figs. 2 and 3. Viewing this Fig. 2 when the paraboloid insert has been introduced and the side portions are in their final positions, the point S will have been

divided into the two points S^1 and S^{11}, and the point U into the two points U_1 and U^1.

Pass now a pencil of planes through the line S, U. One of these planes through H will cut from one—and only one of these paraboloids—the parabola H, U, whose axis is H, S. Likewise from such paraboloids the pencil of planes through Q, P, M and O, there will be cut the parabolas QU, PU, MU, and OU. An infinity of such paraboloidal cuts will produce parabolas having the common point U and reflecting from the common focus F. Such infinite number of these parabolas will form the concave surface whose upper edge will be the ellipse H, Q, P, M, O and whose lower portion in side view will be shown in Figure 2.

Now cut the figure with the vertical plane V, W, U, of Figures 1 and 2, and reject the portion to the right. Locate Z on the ellipse such that ZF=FH, and draw ZS. Pass vertical planes through ZS and HS and reject all that portion between ZSU and HSU. There will then remain two symmetrical portions A and B; ZU and HU being congruent parabolas, and every point on each of which surface portions will reflect light rays but once from the light source F in lines through the aperture VWU, because by construction every point on their surfaces is on one of a family of paraboloids of revolution whose axes rotate through F.

These two portions A and B are now to be pivoted about a vertical axis through F so that the lines that passed through HS and ZS will then be substantially parallel with the axis FS. These new positions are now shown at ZV^1 and HW^1 of Fig. 1 and at ZU^1 and HU_1 of Fig. 4.

Now cut the single paraboloid of revolution whose focus is F and which was passed through H and U and which is to be rotated about F such that its axis formerly through F and parallel with HS, is now to be coincident with FS, by vertical planes through ZS^1 and HS_{11} parallel with the axis FS. These cuts will be parabolas identical with parabolas HU and ZU and also with parabolas HU_1 and ZU^1, and the paraboloid surface segment C which results will merge into the surfaces A and B with no critical points, the common tangents to the surfaces C and A being coincident along the parabola ZU^1; likewise the common tangents to the surfaces C and B will be coincident along the parabola HU_1.

These three surface portions A, B, and C, now form a concave multiple curved surface which will reflect but once every ray of light originating at F upon the concave lower surface of my reflector and will be projected through the aperture $W^1\ U_1 \times U^1\ V^1$ of Fig. 4.

Referring to Figures 5 and 6, the upper portion E is a segment of an ellipsoid formed by rotating about its major axis the complete ellipse whose foci are F and S and passing through the points H, Q, P, M, O and W. Take one half of this ellipsoid by cutting it in the plane of the paper and again cut the upper half by a central vertical plane through the foci. These quarters of said ellipsoid are now pivoted about the focus F into the full line positions of Figure 6 as shown at D and E. Their last cut surfaces are trimmed and joined between the focus and the proximate vertex, and the wedge-shaped space between the dotted lines is to be filled in by sweeping a surface between the dotted lines to merge with the ellipsoidal segments D and E while utilizing F at all times as a center and focus. Its forward portion is likewise to be cut by plane VWU and that portion to the right rejected.

The interior of the complete surface which is complementary at every point to the surfaces of the forms or dies described above and composed of the quantic portions A, B, C, D, E, G, when properly polished, silvered or otherwise prepared for reflection, will constitute one form of my reflector surface, every portion of which is smoothly curved and every differential element of which has the focal point of its curvature at the light source F. All rays of light originating at F will reflect but once on my surface and will be projected through the frontal aperture $W^1\ U_1 \times U^1\ V^1$ of Fig. 4.

The method described above of producing certain parts or surface portions is further set forth in my Patent No. 1,735,377, issued November 12, 1929, and a different method by which certain of the surface portions may be produced is set forth in my Patent No. 1,781,436, issued November 11, 1930. Reference is also made to my Patent No. 1,756,084, issued April 29, 1930; and also to my Patent No. 1,577,352, issued March 16, 1926. This invention is distinguished in that the surface portions are in combination and have a common focus which has been done before, but herein they have the added condition that the lines of jointure between adjacent surfaces have coincident tangents.

It will now be apparent to those familiar with optics and with the mathematics of conic sections and their properties, that in place of employing parabolas cut from paraboloids of revolution to form the surface portions A and B, these side elements or portions may be formed from hyperboloids of revolution passing through the chain of elliptical points such as H, Q, P, M, O, W, and all having the common focus F and having a common surface point at U. Also that a pencil of planes about the line SU, will then cut hyperbolas, selected points from an infinite number of which will form a surface portion. Two such portions in lieu of A and B are then to be joined by a segment of a hyperboloid through arcs HU_1 and ZU^1.

Likewise the surface portions may be generated from ellipsoids of revolution having one common focus F, and having a common surface point at U. The pencil of planes in such case cutting ellipses, selected points from an infinite number of which will form the surface portions in lieu of A and B, while the inset portion C will now be a segment from but one of these ellipsoids of revolution. In these several cases the top may be formed in the same manner as described. The several figures of my drawing herein apply equally to these described variations.

These are but variations of my inventive concept and I desire to be understood as claiming all such.

The requirements of the law are in some cases such as to require a light beam with a sidewise divergence downward from the central horizontal plane in the light field which may readily be attained by constructing the portion C, wider at the bottom than at the top; as well known. Thus, by machining the die of the inset portion C through 184° instead of the 180° shown in the drawing, a tilting downward of 2° of the beam portions from the segments A and B on each side may be obtained.

Where I have employed the term "quantic" I desire it to be understood that it is defined as an algebraic function of two or more variables.

I claim:

1. A reflector surface having a conoidal portion comprised between two substantially parallel planes, and adjacent thereto a right portion and a left portion, which portions are spaced apart throughout their length by said conoidal portion, said right and left portions formed of successively diminishing elliptic arcs, all of said portions having a common proximate focal point and the intersections of the respective portions having common tangents, said conoidal portion having an open conic curve in vertical section and is different from the curvatures of the right and left portions.

2. A reflector surface having a conoidal portion comprised between two substantially parallel planes and adjacent thereto a right portion and a left portion, which portions are spaced apart throughout their length by said conoidal portion, said right and left portions formed of successively diminishing elliptic arcs, all of said portions having a common proximate focal point and the intersections of the respective portions having common tangents, and an upper reflecting portion formed of two ellipsoidal surfaces with a proximate focus common to said common focal point and whose remote foci respectively lie in said intersections, and wherein between said ellipsoidal surfaces a further surface portion is swept from the common focal point.

MARTHA W. CAUGHLAN.