United States Patent [19]

Perret

[11] **3,774,995**

[45] **Nov. 27, 1973**

[54] **REFLECTOR FOR PROJECTING OR RECEIVING RADIATION**

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[22] Filed: **May 20, 1971**

[21] Appl. No.: **145,581**

Related U.S. Application Data

[63] Continuation of Ser. No. 849,813, Aug. 13, 1969, abandoned.

[30] **Foreign Application Priority Data**

Aug. 21, 1968 Switzerland 12542/68

[52] **U.S. Cl.** **350/294,** 240/103

[51] **Int. Cl.** **G02b 5/10**

[58] **Field of Search** 350/293, 294; 240/25, 41, 35, 41.37, 103; 250/228

[56] **References Cited**

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Primary Examiner—Ronald L. Wibert
Assistant Examiner—Michael J. Tokar
Attorney—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

A reflector for projecting radiation from its focus, or for receiving radiation to focus it having a surface with sections by planes all passing through a common point located in a reference plane. Each of the sections passes through at least one straight line in the plane and are conic sections defining a first system. The sections of the surface by planes perpendicular to the reference plane are conic sections defining a second system. The vertices of the conic sections of said first system lie on at least one conic section of the second system. The conic sections of the first system define at least one chord perpendicular to the axis of its conic section and lying along the straight line corresponding to the conic section. A focus of one of the conic sections of the first system is a focus of at least one conic section of said second system so that the radiation emitted from, or received by, the focus after or before reflection by the reflector, cuts at least one plane which passes through the chord and forms an angle with the reference plane along at least one trace that defines conic sections of the same kind as those of the first system, or that defines, in the limiting case, a straight line. The trace generated by the reflector corresponding to the respective conic section of the first system and having in the reference plane the same chord as the conic section, and the vertex of such trace being a second focus of the respective conic section of the second system.

8 Claims, 21 Drawing Figures

United States Patent [19]
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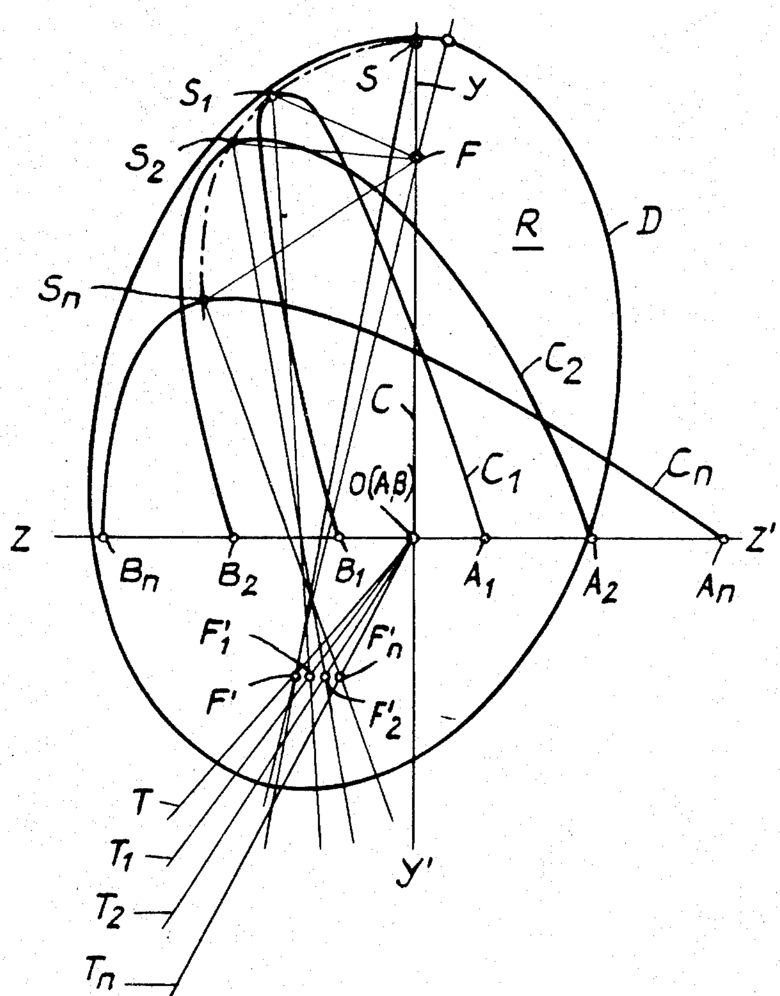
[45] Nov. 27, 1973



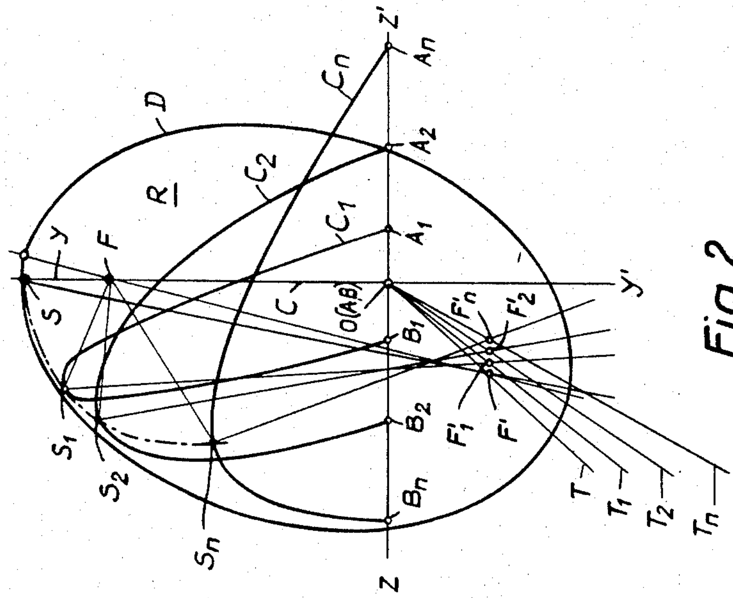


Fig. 2

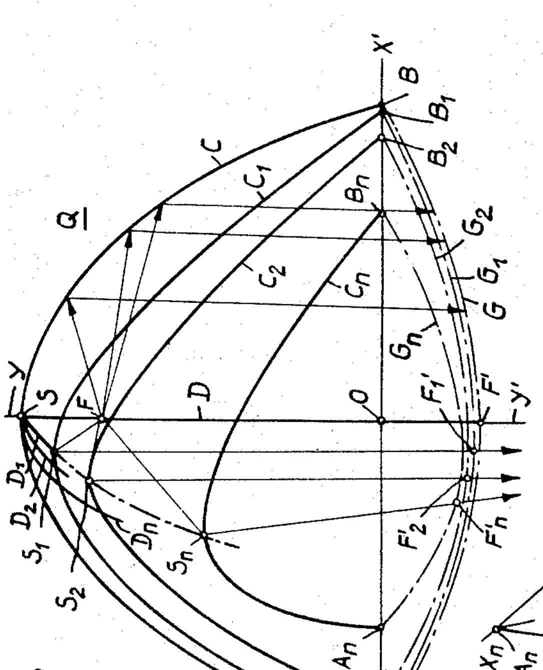


Fig. 1

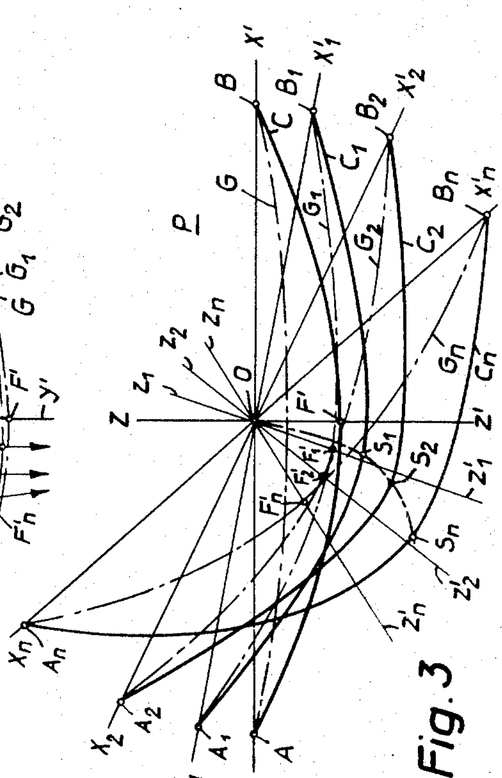


Fig. 3

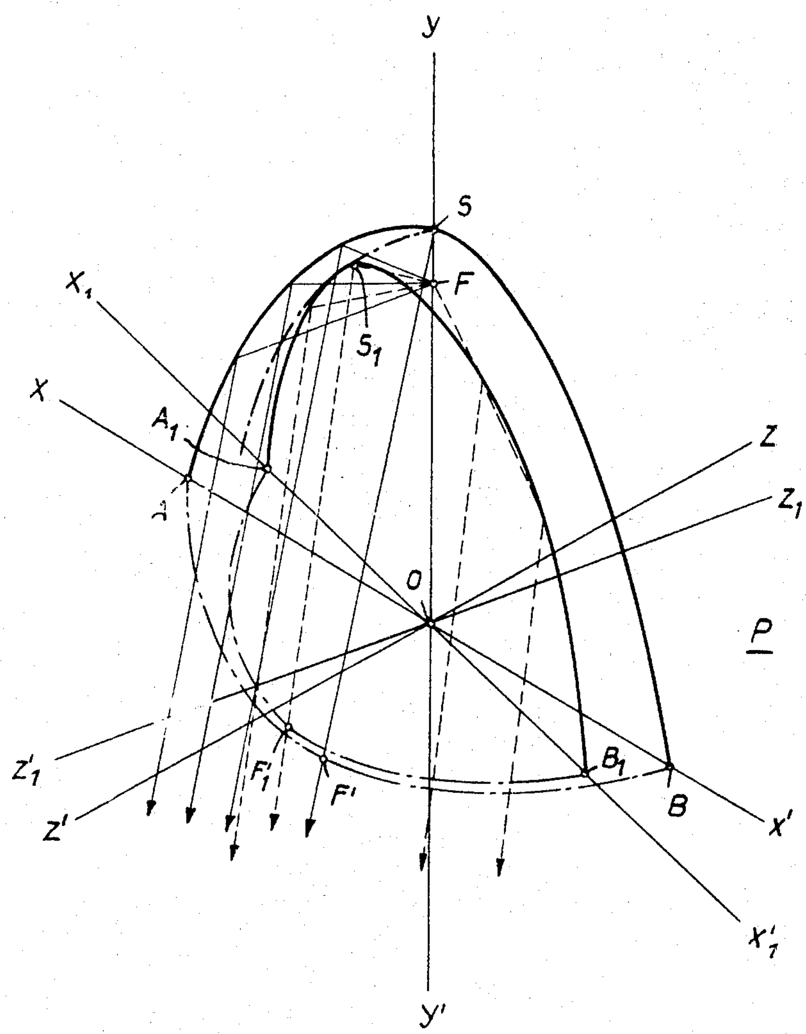


Fig. 4

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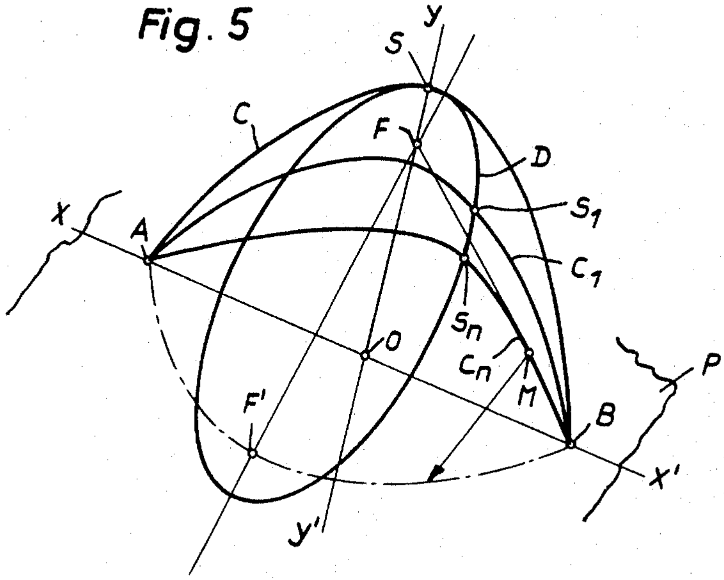
Fig. 5



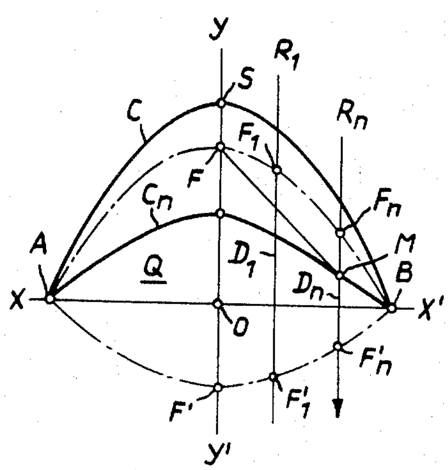


Fig. 6

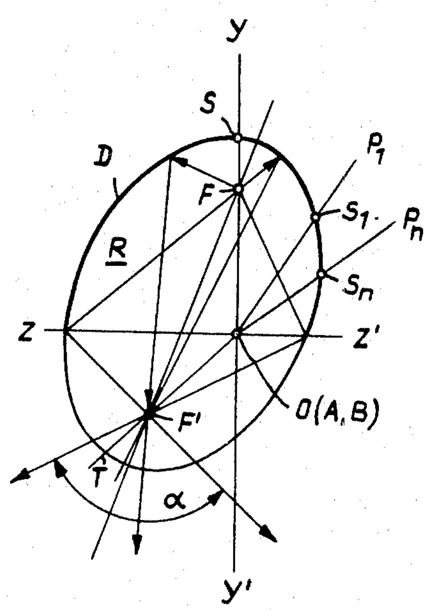


Fig. 7

Fig. 8

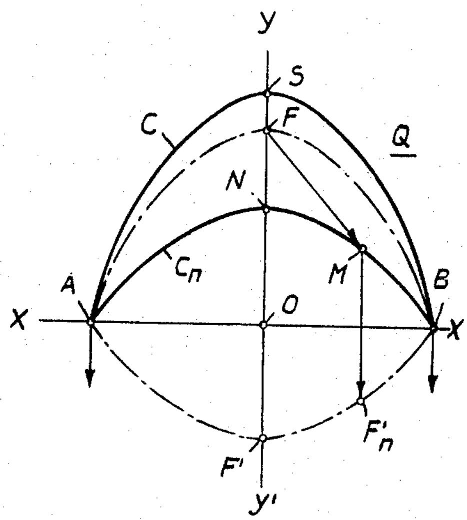
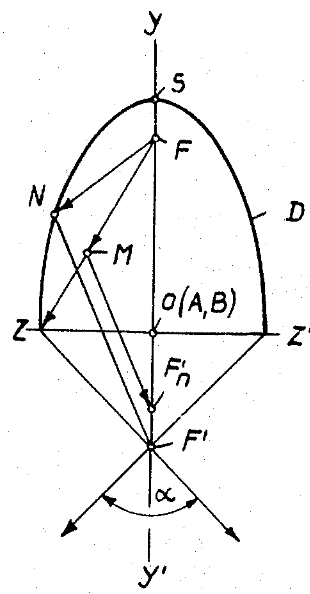


Fig. 9



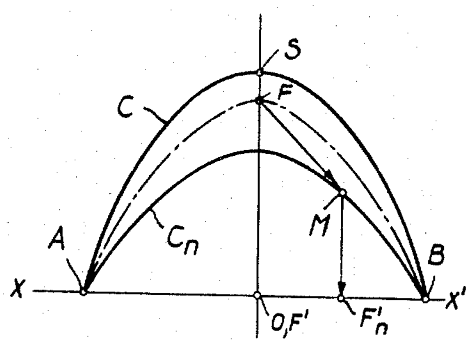


Fig. 10

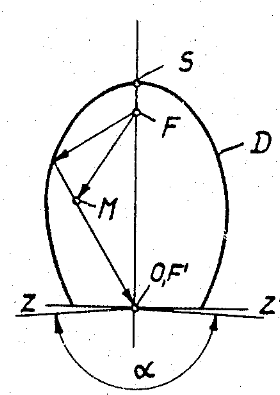


Fig. 11

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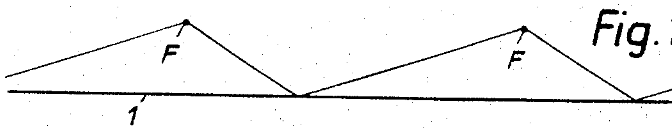

Fig. 13

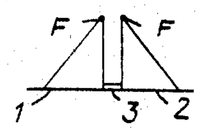

Fig. 15

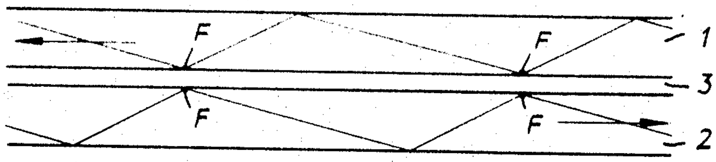

Fig. 12

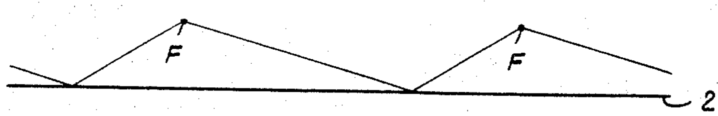

Fig. 14

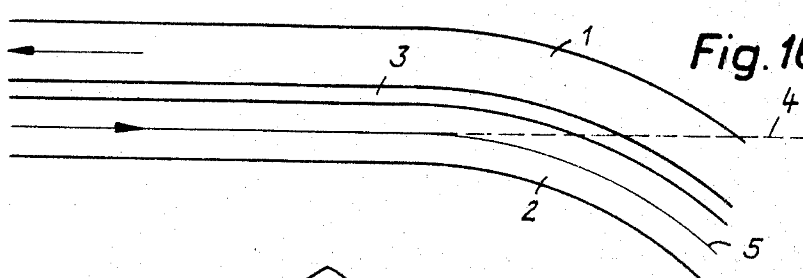

Fig. 16

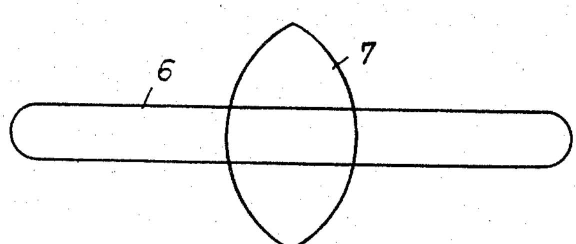

Fig. 17

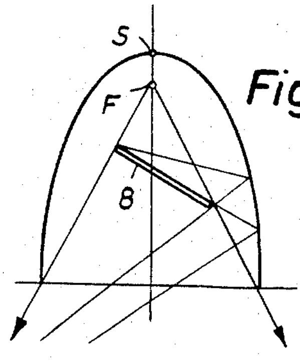

Fig. 18

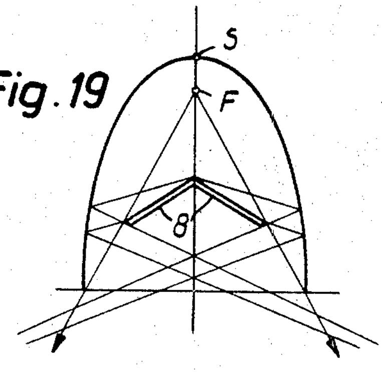

Fig. 19

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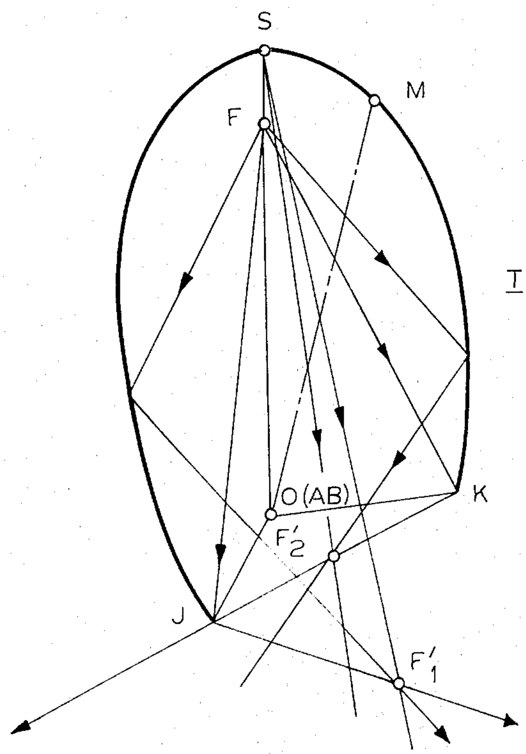

FIG. 20

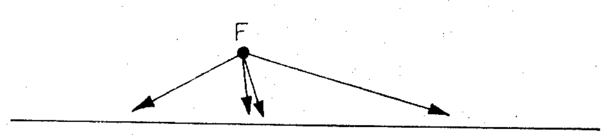

FIG. 21

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REFLECTOR FOR PROJECTING OR RECEIVING RADIATION

This application is a Streamlined Continuation of Application Ser. No. 849,813 filed Aug. 13, 1969 now abandoned.

SUMMARY OF THE INVENTION

An object of the invention is to provide a reflector for projecting or receiving radiation, to cast, for example, a beam of light, the reflector enabling the projection of a beam in the form of a strip of light well defined and of various shapes, such as i impossible with reflectors of the prior art.

BRIEF DESCRIPTION OF THE DRAWINGS is

Several embodiments of the invention will be described, with reference to the Figures of the accompanying drawings, wherein:

FIG. 1 is a front view showing the geometry of a reflector of a first embodiment of the invention.

FIG. 2 is a side view of the reflector shown in FIG. 1.

FIG. 3 is a top view of the reflector shown in FIG. 1.

FIG. 4 is a perspective view of the reflector shown in FIG. 1.

FIG. 5 is a perspective view showing the geometry of a reflector of a second embodiment of the invention.

FIG. 6 is a front view of the second embodiment.

FIG. 7 is a side view of the second embodiment.

FIG. 8 is a front view showing the geometry of a reflector of a third embodiment of the invention.

FIG. 9 is a side view of the third embodiment.

FIG. 10 is a front view showing the geometry of a reflector of a fourth embodiment of the invention.

FIG. 11 is a side view of the fourth embodiment.

FIG. 12 is a top view showing the reflector of the invention used to light a road.

FIGS. 13 and 14 are side views of the application shown in FIG. 12.

FIG. 15 is an end-on view of the application shown in FIG. 12.

FIG. 16 is a top view showing the reflector of the invention used to light a sharp curve in the road.

FIG. 17 schematically shows the two kinds of fields produced by these embodiments of the invention.

FIGS. 18 and 19 are simplified views of fifth and sixth embodiments of the invention.

FIGS. 20 and 21 are simplified views of a seventh embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The reflector shown in FIGS. 1 to 4 has a reflecting surface geometrically defined in the following manner.

Consider a plane P and therein a point O through which an axis YY' passes perpendicular to the plane P. Two mutually perpendicular axes XX' and ZZ' are drawn in this plane to pass through O. These two axes can be rotated about the point O so that the axis XX' successively assumes the positions X1X'1, X2X'2, . . . XnX'n while the axis ZZ' successively assumes the positions Z1Z'1, Z2Z'2 . . . ZnZ'n. A segment AB of the axis XX', with O as its center, is similarly moved, taking the positions A1B1, A2B2 . . . , AnBn.

Two points S and F are chosen along the axis YY', S being the vertex of a conic section C passing through A and B, its axis SFO located along YY', F being a focus of the conic section, and AOB one of the chords of the conic section perpendicular to its axis SFO. This conic section is located in a plane Q perpendicular to plane P and containing the axes XX' and YY'.

In a plane R containing the axes ZZ' and YY', and therefore perpendicular to XX', there is drawn a second conic section D of which S is one of its points and F one of its foci. The major axis of this conic section located in the plane R passes through a second focus F'.

The two conic sections C and D are the basic conic sections of two systems of conic sections, the conic sections of either system being of the same kind, and the two systems together constituting a reflecting surface generated in a manner to be described and of which each point reflects, in accordance with certain laws, any radiation emanating from, or to be directed towards, the focus F.

In the embodiment shown in FIGS. 1 to 4, the basic conic section C of the first system is a parabola having the vertex S, the focus F, and the axis SFO, passing through A and B, and having AB as a chord perpendicular to the axis SFO at O along YY'. The basic conic section D of the second system is an ellipse having foci F and F' located in the plane R, a point on ellipse passes through S.

In the first system, consider a parabola AF'B located outside of the reflecting surface and having the chord AOB in common with the parabola C. The parabola AF'B is located in a plane T perpendicular to the plane R and making a given dihedral angle with the plane P along the axis XX'.

It can be shown that the rays of radiation coming from the focus F and impinging on the reflecting surface of the parabola C are reflected as a collimated beam to the parabola AF'B (called the reflection parabola, for reasons that will be apparent) to pass respectively through planes perpendicular to the plane R along XX'. The second focus F' of the ellipse D is the vertex of the reflection parabola.

The combination is now rotated about the axis YY', with the points O, F, and S of this axis and the plane P remaining stationary. As the rotation proceeds there are drawn parabolas C1, C2 . . . , Cn of which the vertices S1, S2 . . . , Sn are successively spaced along the ellipse D, which turns with the plane R, in a manner synchronously with the rotation of the combination. The resulting curve S, S1, S2 . . . , Sn is shown in FIGS. 1 to 4. The points A1 and B1, A2 and B2 . . . , An and Bn are positioned respectively along the axes X1X'1, X2X'2 . . . , XnX'n.

The same is true of plane T, which follows the rotation of the parabola AF'B and is consequently moved successively into the planes T1, T2 . . . , Tn that respectively contain the reflection parabolas A1F' 1B1, A2F'2B2 . . . , AnF'nBn, of which the vertices F'1, F'2 . . . , F'n are the foci of the ellipses obtained by the rotation of the ellipse D. Each of the planes T, T1 . . . , Tn makes the same dihedral angle with the reference plane P along a respective chord AB, A1B1 . . . , AnBn. Rays emanating from, or received by, the focus F trace on the planes T, T1 . . . , Tn respective imaginary lines G, G1 . . . , Gn that are conic sections of the same kind as those of the first system, each imaginary line being defined by the radiation reflected by that conic section of the first system of which the chord AB, A1B1 . . . , AnBn is common to the imaginary line. These imaginary lines are identical with the reflection parabolas AF'B, A1F'1B1 . . . , AnF'nBn, and their vertices F', F'1 . . . , F'n are therefore the second foci of the ellipse D, D1 . . . , Dn.

For all of the parabolas comprised in the reflecting surface, a ray of radiation emanating from, or received by, the focus F and impinging on any point of one of these parabolas passes in each case through the reflection parabola having the same chord as that parabola. Between these two parabolic curves the radiation is collimated. The same holds true on the side of the reflection parabola remote from the parabolas C, C1 . . . , Cn.

In the case of light emanating from the focus F, the rays impinging on one of the parabolas (C, C1 . . . , Cn) of the reflector are reflected as a collimated beam towards the corresponding reflection parabola and they continue as a collimated beam on the far side of this parabola. If they impinge on a plane perpendicular to YY', there is obtained a luminous curved line.

For each parabola of the reflector there is on this plane a corresponding luminous line. Since successive parabolas of the reflector are infinitesimally close together, so are the successive luminous lines on the projection plane, the sum of these lines therefore constituting a continuous illuminated band elongated in the direction of the axes ZZ', Z1Z'1, Z2Z'2 . . . , ZnZ'n, and consequently having a longitudinal direction. Owing to the incurvature of the reflector, the band is curved as a function of the manner in which the reflector is designed. In the lateral direction the band is relatively narrow, because the rays are parallel. It is more or less wide depending on the size of the reflector and the volume of the light source.

The embodiment shown in FIGS. **5** to **7** constitutes that particular case of the reflector just described in which there is no rotation about the axis YY'. The axes X1X'1, X2X'2 . . . , XnX'n are one with the axis XX', and the plane R remains stationary, as do the basic conic section D, the focus F', and the reflection parabola AF'B. The illuminated band is rectilinear and dissymetrical in the direction of its length with respect to the plane Q.

In this embodiment, each of the planes P1 . . . , Pn passing through AB contains a respective parabola C1 . . . , Cn of which the vertices S1 . . . , Sn are all located on the ellipse D. Each of the planes R1 . . . , Rn parallel to the plane R contains a respective ellipse D1 . . . , Dn having the corresponding foci F1 and F'1 . . . , Fn and F'n, the foci F1 . . . , Fn being located along a parabola AFB and in a respective plane R1 . . . , Rn and the foci F'1 . . . , F'n being located on the reflection parabola AF'B (imaginary line G) and in a respective plane R1 . . . , Rn. The axes, foci (F), and vertices (S, S1 . . . , Sn) of the parabola all lie in the plane of the ellipse D; and the vertex S and focus F of the parabola C are respectively common with the vertex and foci of the ellipse D.

If a source of radiation is positioned at the focus F, the rays impinge on all points of the reflecting surface and are reflected in the following manner. For a point M of the parabola Cn and of the ellipse Dn, the reflected ray is returned in the plane Dn to a point on the reflection parabola AF'B. This holds true for all of the rays reflected by the parabola Cn, these rays being parallel and passing through the reflection parabola AF'B. This is true for any parabola. In the plane R (the plane of FIG. **7**), all of the rays coming from the focus F and reflected onto the ellipse D must pass through the second focus F'. If the reflector is limited to the part positioned above the horizonal plane containing the axis ZZ' (FIG. **7**), the light leaving the reflector forms a dihedral defining an included angle α.

The embodiment shown in FIGS. **8** and **9** constitutes a particular case of the preceding embodiment in which the axis FF' of the ellipse D coincides with the axis YY' and therefore passes through the point O of the axis XX'. The reflection parabola AF'B is in the plane Q (the plane of FIG. **8**). The illuminated band is symmetrical with respect to the plane Q, and for a reflector limited to that part located above the horizontal plane containing the axis ZZ', the dihedral coming from the reflection parabola has an included angle α, which can be varied as desired in dependence on the position of the focus F and of the reflection parabola.

The embodiment shown in FIGS. **10** and **11** is a special case of the embodiment shown in FIGS. **8** and **9**, since the second focus F' of the ellipse D is identical with the point O of the axis XX'. The reflection parabola AF'B therefore passes through O and becomes a straight line. This embodiment relates to a limiting case; for a reflector restricted to that part located above the horizontal plane containing the axis ZZ', the dihedral formed by the reflected rays has a theoretical included angle of 180°, the rays forming the illuminated band being straight lines parallel to AOB.

In each of the embodiments just described, we know for each point of the reflector the direction taken by a ray coming from the focus F and impinging on this point.

The reflector of the invention can be used, for example, to light a highway, as shown in FIGS. **12** to **15.** The highway has two parallel lanes **1** and **2**, separated by a center strip **3**, each lane carrying motor traffic in a different direction. The reflectors, which are indicated simply by their focus F, are positioned at a suitable height above the lanes **1** and **2.** The lighting can be so designed that reflectors of one lane illuminate only that lane and not the other. It is possible to obtain an illuminated strip that is well defined along its sides and so adjusted as to cover only its lane, without any rays being reflected onto the adjacent lane, there to cause dazzle. The lighting can be symmetrical in the direction of the traffic or, as shown, asymmetrical. In the latter case, the reflectors are designed to reflect a longer beam in the direction of the traffic than in the opposite direction, which substantially reduces glare on the lane.

At a sharp curve in the road (see FIG. **16**), the illumination along the inner lane **2** may spread onto the outer lane **1** and consequently cause glare. This problem can be solved by producing a curved lighted strip adapted to the particular highway, using the first embodiment, which produces a curved illuminated strip, as previously explained. A reflector positioned above the lane **2** at the beginning of the curve produces, instead of an illuminated strip having the axis **4**, an illuminated strip having the curved axis **5** that follows the curved lane.

It has been explained in connection with the several embodiments of the invention that the rays reflected by any one of the parabolas of the reflecting surface are mutually parallel. Those rays coming from the parabola at the vertex of a reflector are reflected straight from the latter onto the illuminated strip, and those coming from the parabolas constituting the edge of the reflecting surface are sent to the extremities of the strip.

The reflector of the invention can be designed to give various kinds of strips: long, short, straight, and curved to the left or to the right; and pairs of reflecting half surface can be combined as desired to provide a series of combinations and of various kinds of illuminated strips. Moreover, these reflectors can be composed of several elements having the same focus F but different reflecting parabolas. One condition, however, is essential: the parabola joining the two reflecting half surfaces must be a parabola common to these two surfaces.

Such a reflector (FIG. **20**) is constituted by two different half surfaces JS and KS, each of which possesses the characteristics claimed, but which reflect the rays emitted from the common focus F along different parabolic traces in the plane T. The surface JS reflects the radiation along a parabolic trace having the chord AB passing through a focus F′**1**, and the surface KS reflects the rays along a parabolic trace having also the chord AB, but passing through a focus F′**2**. The surface JS ensures the lighting in one direction and the surface KS in the opposite direction (FIG. **21**). The two half surfaces JS and KS are joined by a common parabola passing through the vertex S of the reflector, and through points A and B, lying in a plane perpendicular to that of FIG. **20**, and passing through the common focus F and point O.

The embodiments described do have one defect: there are formed two illuminated fields, as shown in FIG. **17**. The first field **6**, corresponding to the desired field formed by reflection, constitutes a strip having a given width quite well defined; the second field **7**, formed by direct radiation from the source at the focus F, constitutes a double ogive perpendicular to the strip **6** and corresponding to the opening of the reflector. The field **7** extends beyond the field **6** and uselessly intensifies the lighting in front of the reflector. This defect can be prevented by mounting within the reflector a reflecting plate **8** having one (FIG. **18**) or two (FIG. **19**) surfaces, for directing the rays coming from the focus F towards one, or both, of the reflecting half surfaces, so that the rays are reflected towards one, or both, of the extremities of the lighted strip. The plate **8** must be so shaped and positioned that it intercepts as many as possible of the rays transmitted towards the field **7** without interfering with the rays reflected towards the field **6**. It is apparent that the solution to the defect is more or less complete depending on the volume of the light source.

The reflector of the invention can also be used to light streets, city squares, sport grounds, and ski trails, or used in projectors for motion pictures and television, in flashlights and other hand lamps, and in automobile headlights. It is also useful for spreading sound as a kind of sheet-like beam.

In the embodiments described, the first system of conic sections consist of parabolas, and the basic conic section of the second system is an ellipse. In accordance with the invention, the reflecting surfaces can be defined by other conic sections — such as parabolas, hyperbolas, and ellipses — either for the first or the second system.

Although the preferred embodiments of the invention have been described, the scope of, and the breadth of protection afforded to, the invention are limited solely by the appended claims.

I claim:

1. A reflector for projecting or receiving radiation comprising a smooth and continuous surface defined by a first system and a second system; said first system comprising an infinite number of conic sections of a first type lying in an infinite number of planes passing through at least one straight line, each of said conic sections of said first type intersecting said at least one straight line at two points thereof, said two points defining the end points of said at least one straight line, said at least one straight line having at the midpoint thereof between said end points a common point in a reference plane, said at least on straight line lying in said reference plane; said second system comprising an infinite number of conic sections of a second type different from said first type lying in an infinite number of planes perpendicular to said at least one straight line; the vertices of each of said conic sections of said first system lying on at least one of said conic sections of said second system; one of said conic sections of said first system having a focus coincident with a focus of at least one of said conic sections of said second system; said conic sections of said first system defining at least one chord in said reference plane, said at least one chord being coincident with said at least one straight line and being perpendicular to the axes of each of said conic sections of said first system; said reference plane forming a transverse cut across said surface and thereby limiting an opening into said surface; the inner face of said surface forming the reflector surface of said reflector.

2. A reflector as claimed in claim **1**, wherein said first system of conic sections and said second system of conic sections are rotated about an axis passing through said common point and perpendicular to said reference plane.

3. A reflector as claimed in claim **1**, wherein each of said conic sections of said second system have a second focus, said second foci forming at least one radiation trace corresponding to a conic section of the same type as said first system of conic sections, said conic section of each said radiation trace defining a chord coincident which said at least one straight line, said conic section of said at least one radiation trace being in a plane at an angle to said reference plane and perpendicular to said conic sections of said second system.

4. A reflector as claimed in claim **3**, wherein said at least one straight line comprises a single straight line.

5. A reflector as claimed in claim **4**, wherein said conic sections of said second system are ellipses, one of said ellipses having an axis passing through said common point.

6. A reflector as claimed in claim **5**, wherein said second focus of said one ellipse coincides with said common point.

7. A reflector as claimed in claim **4**, wherein said conic sections of said first system are parabolas, and said conic sections of said second system are ellipses.

8. A reflector as claimed in claim **4**, wherein said surface comprises two differing sections joined together along a common conic section and having a common focus.

* * * * *