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JUNE 1, 1943.	MULTIPLE DIVERGENCE REFLECTING DEVICES	289,326
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Fig. 3

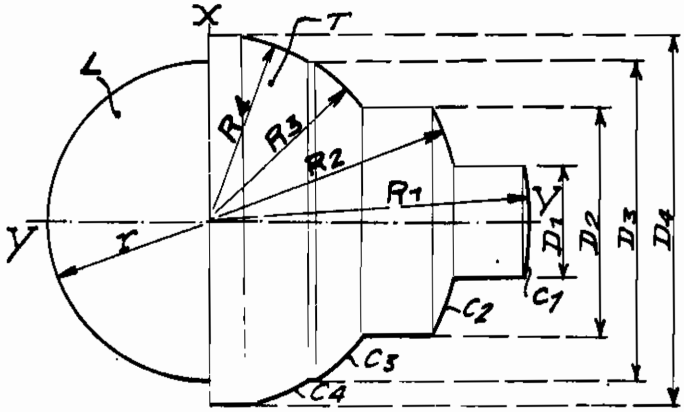
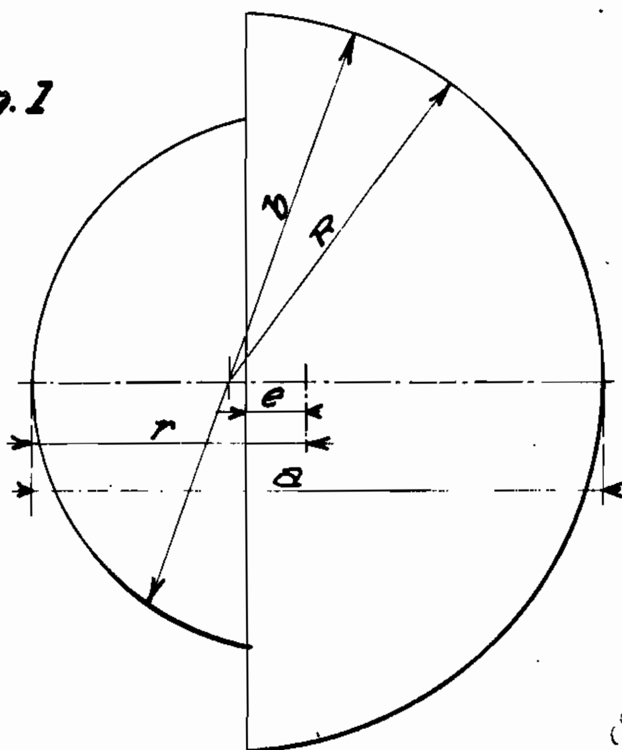


Fig. 1



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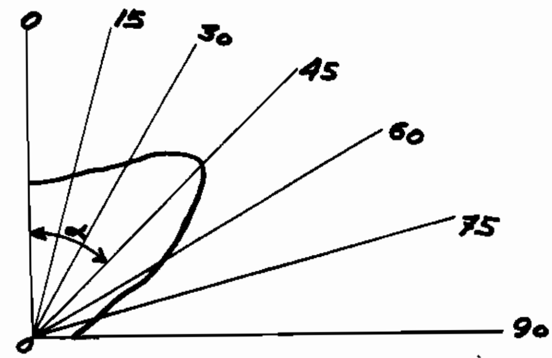


Fig. 2

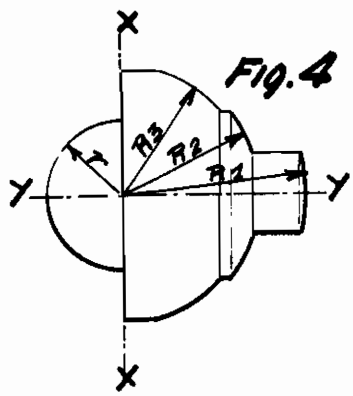


Fig. 4

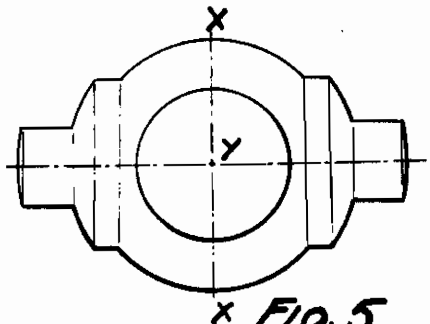
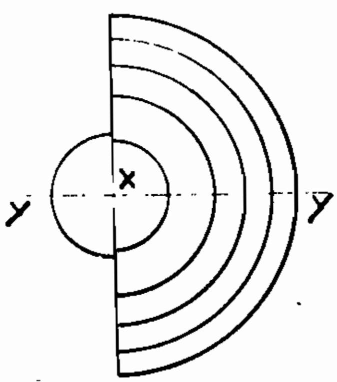


Fig. 5

Fig. 6



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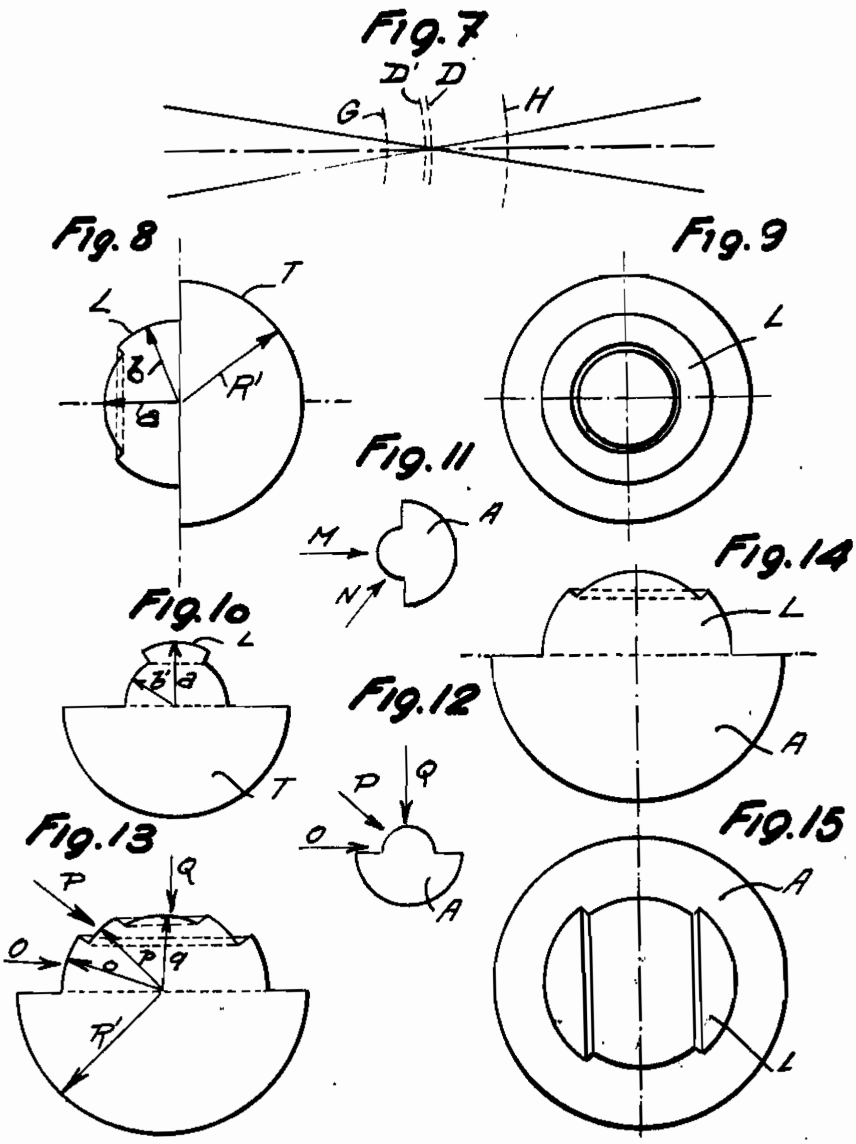

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ALIEN PROPERTY CUSTODIAN

MULTIPLE DIVERGENCE REFLECTING DEVICES

André Garbarini, Courbevoie, France; vested in the Alien Property Custodian

Application filed August 9, 1939

The present invention relates to self-collimating devices as are chiefly used for making visible road signalling or advertising apparatus when the light rays emitted by the headlights of a vehicle strike said devices.

As it is well known, said devices are essentially constituted by two spherical elements assembled together along their base and one of which receives the light rays and causes them to converge on the other, the rear face of which is silvered and therefore acts as a reflector.

These known apparatus are either concentric or eccentric, that is to say the elements of which they are made have either a common center or two different centers. The ratio of their radii may have any value, or it may correspond to the formula

$$R=\frac{r}{n-1}$$

in which R and r are the radii in question and n is the index of refraction of the matter of which the device is made.

These devices have certain drawbacks. When the radii comply with the above formula, the luminosity at infinity is satisfactory, but when the distance from the edvice decreases, the luminosity becomes practically zero, due to the fact that the very small divergence of the device does not enable the rays that strike it to be returned into the observer's eye, which does not coincide with the light source.

In auto-collimating devices of the eccentric type, such as shown by Fig. 1 of the appended drawings, distance a is smaller than distance b. Now, the divergence of the light beam depends solely upon the value of the sum of the radii R and r, or, in the present case, this value minus e, e designating the eccentricity, that is to say the distance between the centers of the spherical elements. If distance a is correctly determined for an operation of the device at infinity, the incident ray will be reflected with a very small divergence, which is satisfactory for visibility at long distance. As the vehicle which illuminates the signal is coming nearer thereto, the incident ray is reflected with a divergence smaller than that corresponding to a greater distance. Therefore, the reflected rays are no longer visible for the driver and passengers of the vehicle. The device has thus become inoperative.

Fig. 2 of the appended drawings is a diagram illustrating this phenomenon. It shows a curve of operation for different angles to the incident ray with respect to a normal and for a uniform divergence ranging approximately from 10 to $\frac{15}{1000}$. This curve shows that the luminosity is maximum for an angle of incidence α corresponding to a certain distance from the vehicle to the reflecting device. Now, if the signal is illuminated under an angle equal to α, this means that the light source, headlight of the vehicle for instance, is close to the device and the distance from the observer's eye and the light source is no longer negligible as compared to the distance from the signal to the light source. As the divergence necessary for making it possible to see the signal should be, not 10 or $\frac{15}{1000}$, but about $\frac{1}{10}$, that is to say approximately ten times the actual value, the devices of the type above mentioned, as they are now made, are not satisfactory since they are designed with divergences as low as the first mentioned values. Practically, the light beam striking the reflecting devices will be reflected onto the light source alone. In other words, the divergence decreases when the angle of the incident ray with respect to the normal decreases. Now, an interesting working of the device, for practical purposes, would call for an inverse condition.

The object of the present invention is to provide self-collimating devices which avoid the above mentioned drawbacks.

According to an essential feature of the present invention, both of the light concentrating and light reflecting elements are spherical but at least one of them is of multiple structure, that is to say includes portions of different radii, respectively.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Figs. 1 and 2 are explanatory views relating to the prior art, as above mentioned;

Fig. 3 is a diagrammatical view of a first embodiment of the present invention;

Fig. 4 is a vertical sectional view of a modification of this embodiment;

Fig. 5 is a front view corresponding to Fig. 4;

Fig. 6 is a plan view corresponding to Figs. 4 and 5;

Fig. 7 is a diagrammatical view illustrating the principle of a second embodiment of the present invention;

Fig. 8 is a vertical sectional view of said second embodiment;

Fig. 9 is a front view corresponding to said Fig. 8;

Fig. 10 is a vertical sectional view of a modification;

Figs. 11 and 12 are explanatory diagrams showing two different positions of the device according to the invention;

Fig. 13 is a vertical section of still another modification;

Fig. 14 is a vertical section of still another modification;

Fig. 15 is a plan view corresponding to said Fig. 14.

In the embodiment illustrated by Fig. 3, the device or apparatus according to the invention includes a front spherical lens L, the radius of which is r, and a rear reflecting element T the reflecting faces C1, C2, C3 and C4 of which have decreasing respective radii R1, R2, R3 and R4, respectively. The apparatus has the shape of a body of revolution about axis Y—Y.

When the signals are to be seen from a great distance at different angles, the spherical surfaces of Fig. 3 are advantageously replaced by tore-shaped surfaces which are obtained by revolving the profile of Fig. 3, not about axis Y—Y but about axis X—X, and through an angle of 180°. In this way, I obtain a self-collimating device such as shown by Figs. 4, 5 and 6.

According to the invention, the radii of reflective surfaces C1, C2, C3, C4 are given by the following formulas:

$$R_1=K_1\frac{r}{n-1};\ R_2=K_2\frac{r}{n-1};\ R_3=K_3\frac{r}{n-1};\ R_4=K_4\frac{r}{n-1}$$

coefficient K ranging practically from 0.65 to 0.90 and depending upon the conditions of utilization of the apparatus.

On the other hand, these formulas show that the devices according to the invention have, over those used prior to said invention, the advantage of substantially reducing the space occupied by the apparatus, that is to say of corresponding, for a greatly higher efficiency, to a substantially smaller volume and therefore a considerably lower cost.

Of course, the number of reflecting portions, their arrangement, the values of the radii of curvature and other particular data can vary within a great range without departing from the principle of the invention.

Figs. 7 to 15 relate to another embodiment of the invention. The principle is illustrated by Fig. 7. It will be readily understood that a very little divergent beam corresponds to the reflecting surface being located at the point of convergence D of the rays received by the front lens. The divergence of the apparatus may be made more or less important by modifying the position of the reflector, as shown in dotted lines, the divergence being practically proportional to the value of the variation of position. It should be noted that, in position D, the divergence would be zero, so that the reflector practically never occupies this position, but that shown at D', slightly ahead of D. Positions G and H correspond respectively to positions of the reflector in front of, and behind, said position D', respectively, these positions G and H corresponding to a substantial divergence of the reflected beam.

Figs. 8 and 9 show, in section and plan view respectively, an arrangement according to this embodiment of the invention. The front and rear elements of this device are concentric and the reflecting portion T has a single curvature, while the front lens L is made of several portions consisting of spherical or ellipsoid-shaped annular elements.

The radius R' of the reflecting surface T is therefore chosen in such manner as to correspond to a reflected beam of very small divergence, received by the central portion of the front lens L, of radius a. If the obliquity of the incident beam increases, so that it comes to impinge upon the portion of the front lens the radius of which is b, the point of convergence is modified, being ahead of the surface of the reflector, at a distance therefrom equal to a value proportional to the divergence that is chosen.

Fig. 10 is a sectional view of a modification in which the radius of the central portion of the front lens L is greater than the radius of the marginal portion, in opposition to the arrangement of the preceding embodiment. In this case, the point of convergence for the light rays that have struck the marginal portion is located behind the surface of the reflector.

As shown by Fig. 11, apparatus such as those shown by Figs. 8 and 10 reflect with a very small divergence an incident beam of direction M, but with a substantial divergence a light beam of direction N.

Fig. 12 shows the case of an apparatus which, instead of being disposed as shown by Fig. 11, is to be placed substantially at the level of the ground, for instance to indicate the axis of a road or to signal a turn, or again as a signalling element for aircrafts. In this case, the incident beam of direction O must be reflected without divergence; the incident beam of direction P is to be reflected with a substantial divergence and the incident beam of direction Q is to be reflected with a considerable divergençe. Whatever be the shape of the front lens, whether it is a sphere, an ellipsoid, or the like, or a combination of such elements, the parts corresponding to reflection without divergence or with but a very small divergence will be calculated in such manner as to give the image of a remote source of light at a point very close to the reflecting surface. For the beams of more important divergence, the front elements are, on the contrary, arranged in such manner as to give the image of the source ahead of, or behind the reflecting surface, and at a distance thereof proportional to the necessary divergence.

Fig. 13 shows an example of a device intended to be horizontally disposed, as shown by Fig. 12. In this case, the front lens has three different divergences obtained by means of spherical portions of radius o (o=a), p, q, corresponding respectively to increasing divergences.

It should also be noted that the surfaces of the front lens are not necessarily solids of revolution but may be constituted by revolution of a given profile, as shown by Figs. 14 and 15, which show an apparatus intended to work in the vertical position.

Instead of being applied directly on the rear face of the reflecting element, the coating which ensures reflection (silvering or the like) can be separated from the apparatus by a fluorescent layer, and of course, in this case, the apparatus must be made of a matter which is transparent to invisible rays, whereby, if it is illuminated by a source of rays of this type, the visibility is ensured by the fluorescence of the layer which is located in front of the reflecting layer.

Of course, the devices according to the invention can be made of glass, synthetic resins or other compositions of matter and, broadly speaking, any suitable material.

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