Oct. 1, 1940. C. D. RYDER 2,216,325

PRISMATIC REFLECTING STRUCTURE

Filed April 21, 1939

FIG. 7

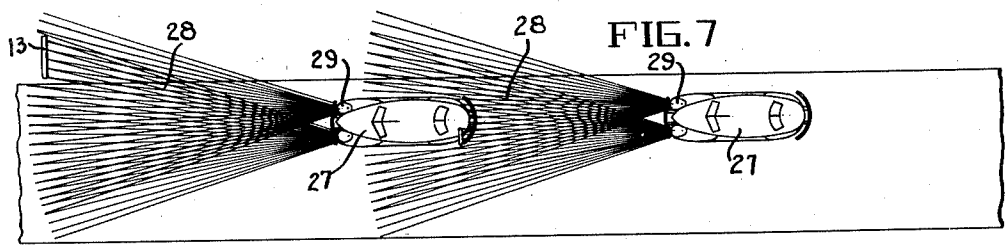

FIG. 1

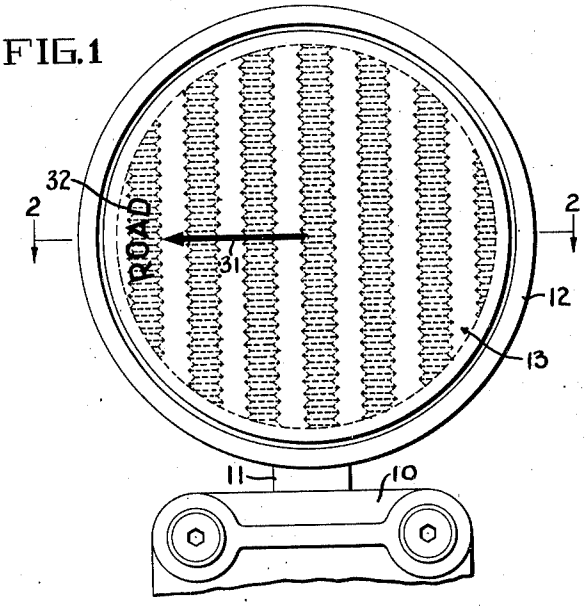

FIG. 3

FIG. 6

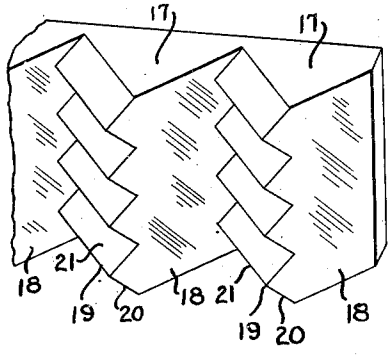

FIG. 2

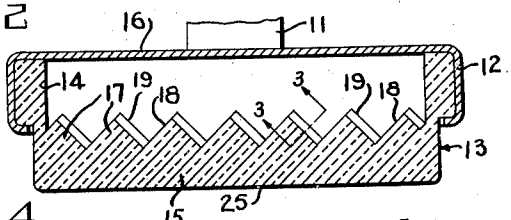

FIG. 4

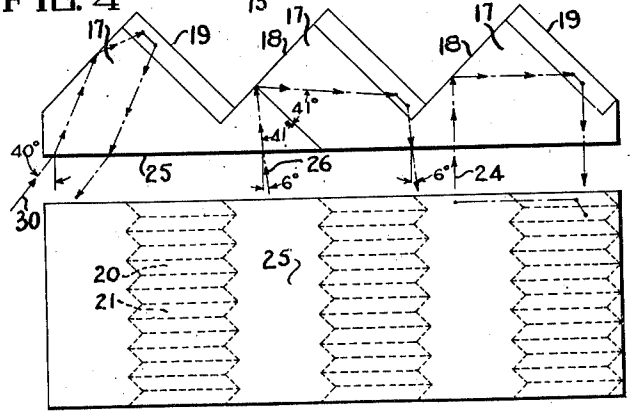

FIG. 5

INVENTOR
CHARLES D. RYDER

BY
Faulmin & Faulmin
ATTORNEYS

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PRISMATIC REFLECTING STRUCTURE

Charles D. Ryder, Covington, Ky., assignor to The National Colortype Company, Bellevue, Ky., a corporation of Kentucky

Application April 21, 1939, Serial No. 269,187

1 Claim. (Cl. 88—78)

This invention relates to reflecting devices and in particular to auto-collimating reflectors such as are used in highway safety signals or upon vehicles.

One object of this invention is to provide an auto-collimating reflector having a wider angular range of auto-collimation for rays incident from one side of the direction of approach than from the other side.

Another object is to provide an auto-collimating reflector having a relatively narrow range of self-reflection on one side thereof and a relatively wide angle of self-reflection upon the other side thereof relatively to the direction of approach of the vehicle carrying the light source.

Another object is to provide a prismatic reflecting device consisting of a plurality of 90 degree prisms formed on the back surface of a transparent plate, alternate surfaces of these prisms being further divided into 90 degree prisms running at right angles to the main prisms whereby the device will have a greater self-reflecting range from one side of the direction of approach than from the other side thereof, thereby adapting the device to the lighting conditions encountered when the device is placed at the side of a road and is illuminated by an approaching vehicle.

Another object is to provide a prismatic reflector of the type previously described wherein the prisms are formed integral with the transparent plate, and preferably of a synthetic material other than glass, and preferably a synthetic resin or other plastic substance.

In the drawing:

Figure 1 is a front elevation of a prismatic reflector according to one embodiment of the invention.

Figure 2 is a horizontal section taken along the line 2—2 in Figure 1.

Figure 3 is a section through one of the elemental prisms taken along the line 3—3 in Figure 2.

Figure 4 is a diagrammatic view similar to a portion of Figure 2, but showing the path of typical rays within the structure.

Figure 5 is a view similar to Figure 4 but taken at right angles thereto.

Figure 6 is a perspective view looking toward the rearward side of the prismatic reflector shown in Figures 1 to 5, inclusive.

Figure 7 is a diagrammatic view illustrating the operation of the device when used as a highway signal and illuminated by an approaching vehicle by means of the light projected from the headlights thereof.

In general, the device of this invention consists of a plate of transparent material having small right-angled prisms formed on the back surface thereof. Alternate surfaces of these prisms are further divided into right angled prisms running perpendicularly to the main prisms. The prismatic reflector of the invention operates upon the principle of total reflection, in such a manner that light incident upon the device is reflected back to the source through a fairly wide range of angles on one side of the direction of approach of a vehicle, but through a relatively narrow angular range on the other side thereof.

In the use of devices of this character, such as for highway signals or upon vehicles, the device is usually located at the side of the road, hence as the vehicle with its headlights approaches the device the rays of light will sweep through a relatively wide angle to one side of the direction of approach, but will sweep through but a very tiny angle on the other side thereof. The device of the present invention is so constructed and arranged that the rays incident upon it will be reflected back to the source, that is, to the approaching vehicle, not only when the vehicle is at a considerable distance, but also almost up to the time when the vehicle passes the device. This construction eliminates the defect in previous devices which reflected back the rays through a relatively narrow angle on each side of the direction of approach. Thus in prior devices the provision of even a relatively narrow angle of operability on the side away from the road was unnecessary and wasteful, whereas the narrow angle on the side toward the road was inadequate in that the device ceased to reflect back the rays as the vehicle came within a short distance of the device. The device of the present invention therefore adapts itself perfectly to the actual conditions of illumination existing in actual practice.

Referring to the drawing in detail, Figure 1 shows the device according to one embodiment of the invention as mounted upon a support 10 having a pillar 11 rising therefrom and terminating in a casing 12 which receives the optical part of the device, generally designated 13.

The optical part 13 consists of a flange-like portion 14 held within the annular casing 12 and serving to space the forward portion 15 away from the rear wall 16 of the casing 12.

The rearward surface of the forward portion

15 is formed with prisms 17 having plane surfaces 18 alternately arranged with prismatic surfaces 19, the latter in turn being formed with prismatic surfaces 20 alternating with prismatic surfaces 21. The tiny prisms 19 are therefore at right angles or perpendicular to the main prisms 17. In order to facilitate total reflection within the prisms 17 and 19, the surfaces thereof are formed at right angles, thereby constituting right angle prisms.

The optical action of the device is shown by tracing the paths of rays incident at different angles, as shown in Figures 4 and 5. In the right hand prism 17 (Figure 4) the ray 24 is incident upon the front surface 25 of the device perpendicularly. The ray 26 passes through the front portion 15 without deviation until it strikes the surface 18 of the prism 17, from which surface it is reflected to the opposite surface having the tiny prisms 19, the right-angled surfaces of which by total reflection cause the ray 24 to emerge parallel to its entering direction. In this case, when the incident rays are perpendicular to the front surface 25 of the device, all of the reflection takes place within the critical angle for total reflection and the device functions perfectly for all rays entering the structure perpendicular to its front face 15. This condition, however, rarely exists in practice due to the changing angles of the rays from vehicle headlights as the vehicle approaches the device.

On the other hand, assuming the device to be placed upon the right hand side of the road, relatively to an approaching vehicle, it is highly unlikely that any rays will be incident upon the front surface 25 at any considerable angle to the right of the device. However, assuming such a ray to approach at an angle of approximately 6 degrees from the normal to the front face 25, this ray 26 is the widest angle ray which will give complete total reflection from that direction, assuming the index of refraction to be about 1.52, whereupon the critical angle relatively to the reflecting surface of the prism (surface 18) will be in the neighborhood of 41 or 42 degrees. In other words, if this critical angle is 41 degrees, the ray of light inside the transparent material strikes the reflecting surface 18 forty-one degrees from its normal or perpendicular. This makes the ray 26 incline 4 degrees from the normal to the front surface 25 and this would give an angle of approximately 6 degrees from the normal to the front face for the entering ray. A greater angle than this angle would permit some of the light to pass through the surface 18, hence total reflection would not be obtained. Unless there was a slight curve in the road prior to reaching the location of the device, the condition shown in the middle of Figure 4 would not ordinarily exist.

As shown in Figure 7, however, when a vehicle 27 approaches the device 13 mounted at the right hand side of the road, the rays 28 given off by the headlights 29 sweep through a relatively wide angle to the left of the direction of approach, as indicated by Figure 7. The optical action under these conditions is shown by the behavior of the ray 30 in the left hand prism of Figure 4. This ray 30 is shown as striking the front surface 25 at an angle of 40 degrees, whereupon the angle of the ray 30 after entering the portion 15 would be inclined about 25½ degrees to the normal to the front face 25. The ray 30, under these conditions, strikes the prism surface 18 at a large angle with the normal or perpendicular to that surface, or well beyond the critical angle. It is thus evident that the device has a large angular range to the left and a very small angular range to the right. Vertically the device has a range of about 37 degrees above and below the horizontal plane. If, however, the device should be erected upon the left hand side of the road, in this case the prismatic reflecting elements must be reversed. This is done merely by turning them 180 degrees so that the arrangement is the reverse of that shown in Figure 4. The device may be provided with an indicating element such as an arrow 31 and a word or message 32. Thus the arrow 31 will indicate the direction and will point toward the road, whereas the word 32 will indicate the object or location which it is desired to point out or against which danger the operator of the approaching vehicle is warned.

In summation, therefore, the present invention provides an auto-collimating prismatic reflector having a very wide auto-collimating range to one side of the device and a relatively narrow range to the other side thereof, thus accommodating the device to the actual conditions encountered along a highway. It will be evident that the device may be employed not only as a stationary sign along the highway but also as a warning indicator upon the front or rear ends of vehicles to notify the operator of an approaching vehicle of their presence in case the lights or the parked vehicle are not in operation. On the other hand, the relatively narrow angle of operability on the side away from the road is adequate for all practical conditions because rays do not approach the device through a greater angle than this. On the other hand, the provision of the wide angle of auto-collimating effectiveness on the side of the device toward the road gives the device a much greater efficiency and causes it to be self-luminant in appearance almost up to the time the vehicle passes it.

It will be obvious that the device may be combined with colored elements or made of colored material in whole or in part, so as to give a colored appearance. The device is also preferably made from synthetic plastic material in order to be substantially indestructible.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claim.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

An auto-collimating reflector comprising a solid transparent refracting body having a smooth front face upon which rays from a source of light are adapted to impinge, the rear surface of said reflector being formed of contiguous right angle major prisms, the adjacent corresponding sides of the prisms being formed alternately of a multiplicity of contiguous minor right angle prisms and smooth plane surfaces, said minor prisms having their longitudinal axes perpendicular to the longitudinal axes of the major prisms, said smooth plane surfaces being of substantial width throughout their length and interposed between the sides formed of said minor prisms and having the opposed ends of said minor prisms contiguous with the smooth surfaces and separated by said smooth surfaces, said reflector having a wide angular range of reflection for light rays incident upon the front face of the reflector to one side of the normal and a small angular range of reflection for light rays incident upon said front face to the other side of the normal.

CHARLES D. RYDER.