

June 13, 1939.

R. M. COOLEY ET AL

2,162,160

VISION APPARATUS

Filed Jan. 14, 1938

3 Sheets-Sheet 1

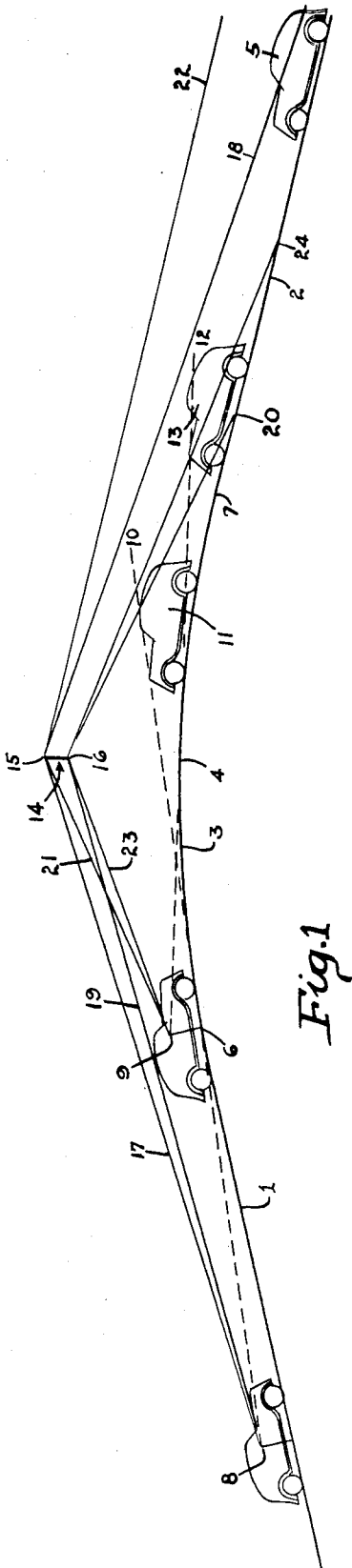


Fig. 1

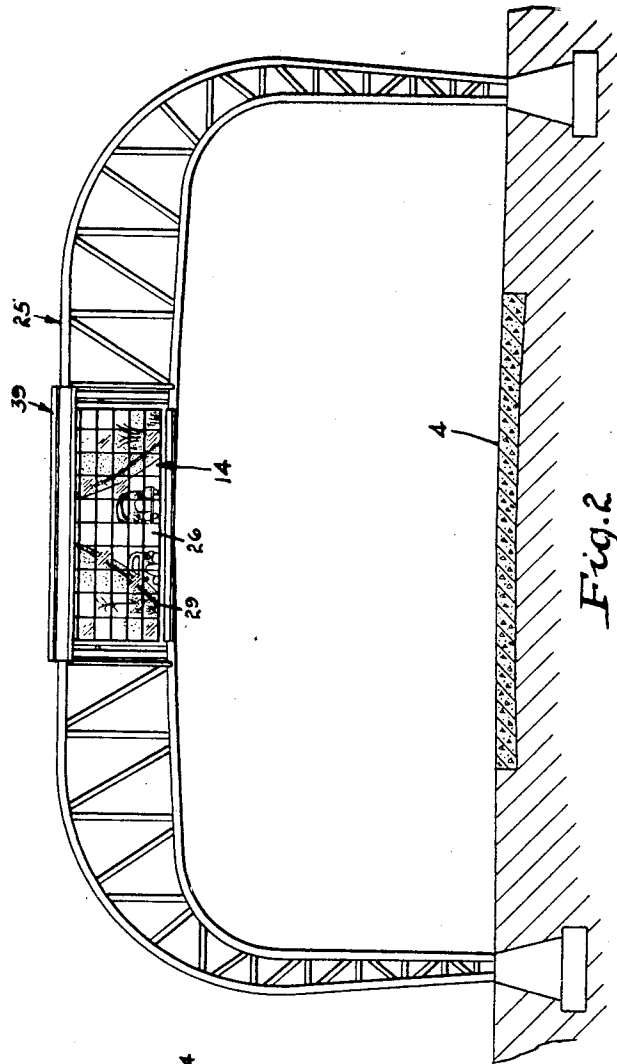


Fig. 2

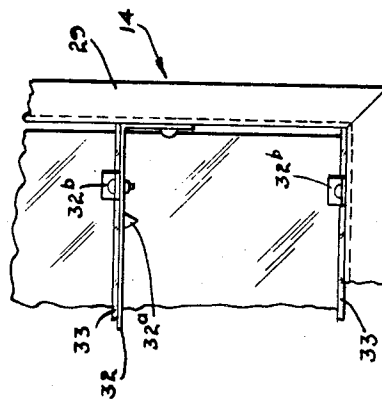


Fig. 7

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3 Sheets-Sheet 2

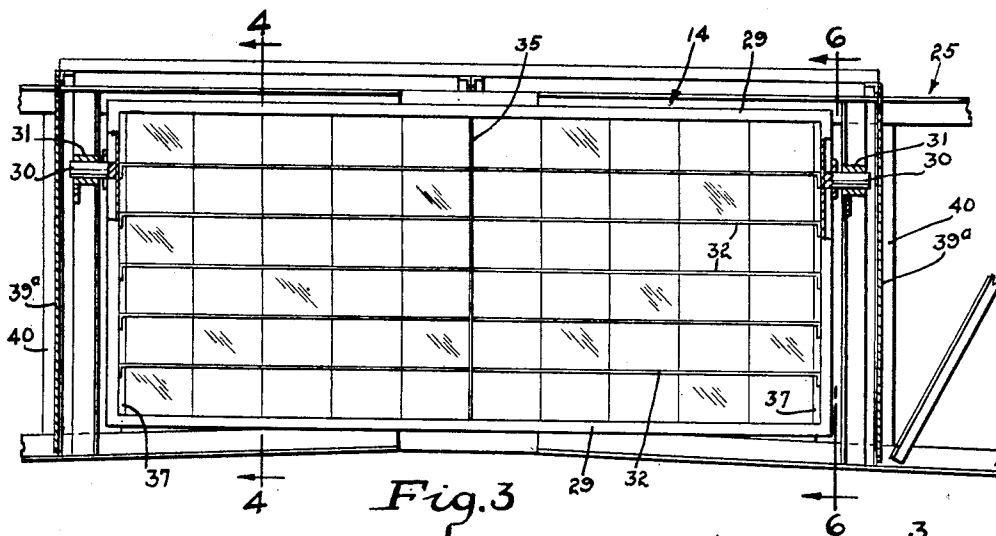
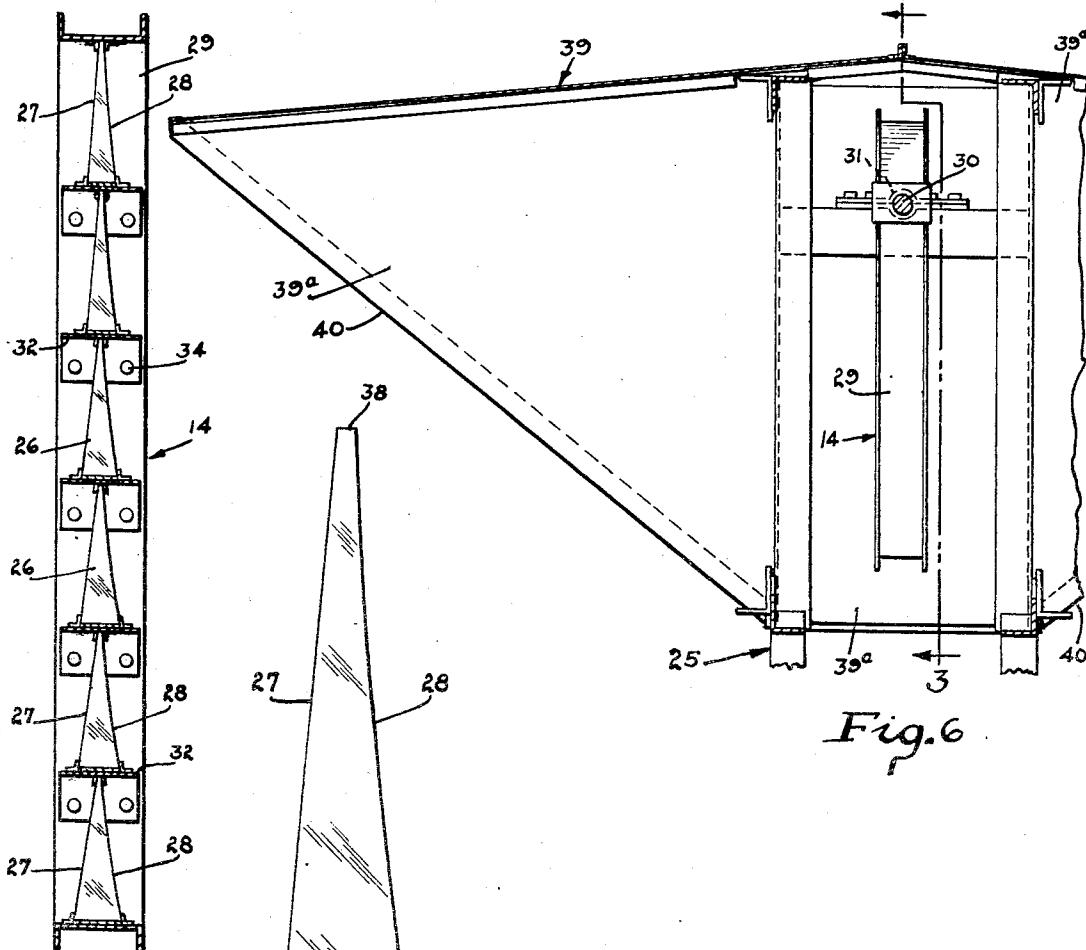


Fig. 5

Fig. 6

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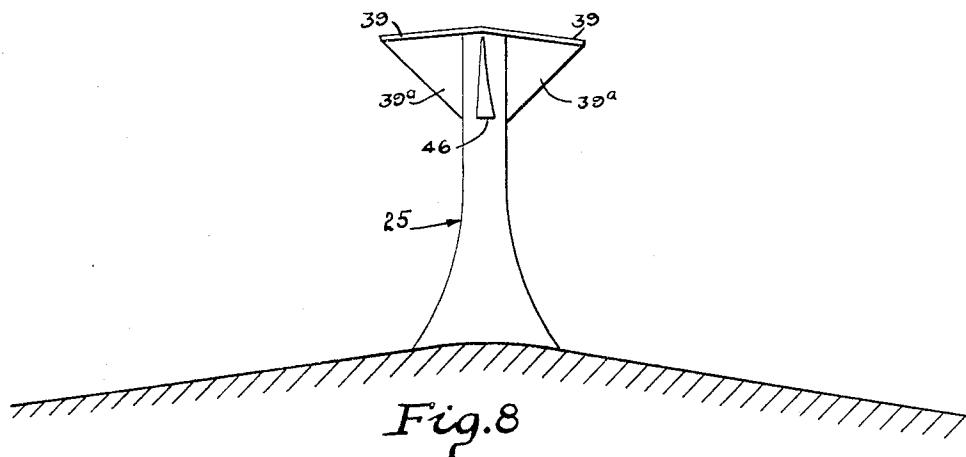
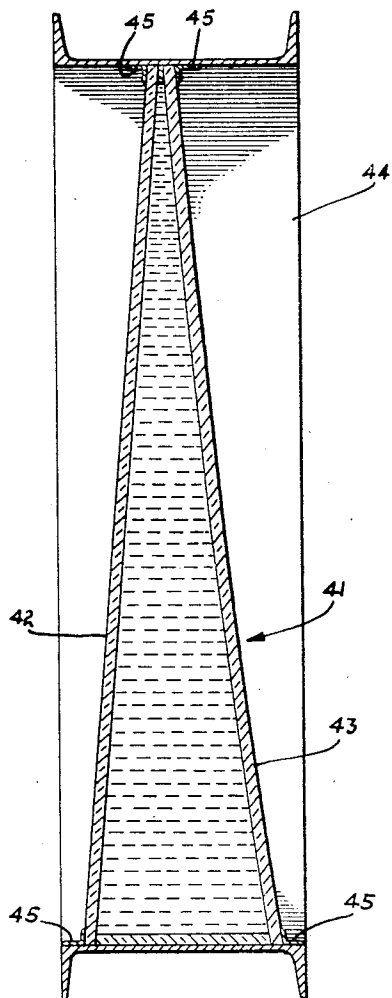
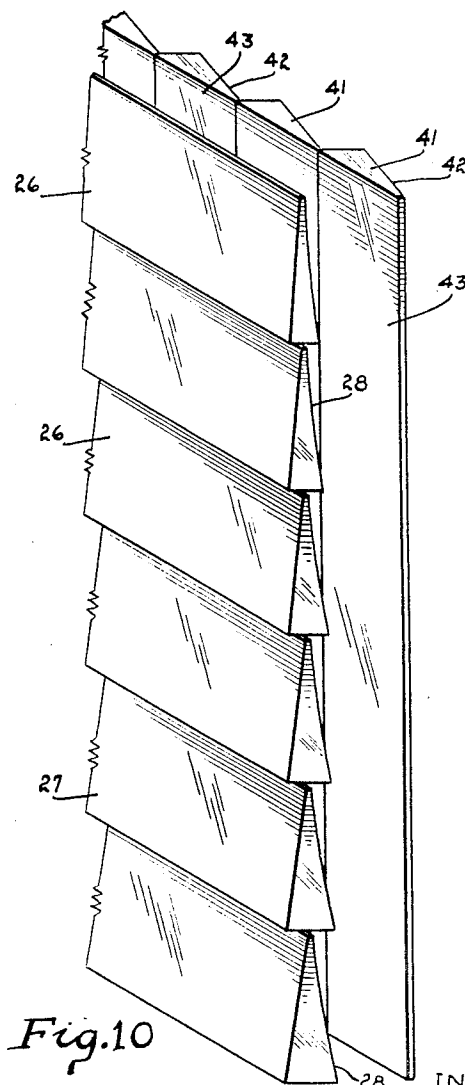
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3 Sheets-Sheet 3



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2,162,160

VISION APPARATUS

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Application January 14, 1938, Serial No. 185,048

23 Claims. (Cl. §8—1)

The present invention is an apparatus for im-
proving vehicular highways and has for an ob-
ject the improvement of highway visibility at
the crests of hills along straight or slightly
curved sections of highways.

Many serviceable highways over rolling terrain
include sections at which the actual visibility
along straight or slightly curved sections of the
highway is an insufficient minimum of only two
hundred to three hundred feet, due to an inter-
vening hillcrest. Such highway sections present
traffic hazards, for experience has shown that a
minimum visibility of one thousand feet is neces-
sary for safe movement of traffic at speeds of
fifty miles per hour or over.

The only method heretofore available for the
removal of such traffic hazards due to insufficient
minimum visibility has been the regrading or re-
locating of the road-bed, but this method has
involved so much expense that many road-beds
have remained unchanged, with the result that
a constant toll of lives has been taken and a
constant loss of property incurred.

According to the present invention a light re-
fracting apparatus is positioned at or near the
crest of a convex vertical curve at grade changes
so that the driver of a vehicle approaching such
crest from one direction has a view of the ve-
hicular movements beyond such crest. The light
refracting device is positioned so that the driver
of a vehicle approaching such a crest will have
a composite view of the highway ahead of the
vehicle which is equivalent to a direct view along
said highway.

According to the present invention a highway
may be designed so as to have rolling grades over
ridges with a minimum of excavation so as to
provide as little as two hundred feet direct vision.
With a highway thus constructed additional visi-
bility is provided by means of a sight refracting
apparatus positioned over or closely adjacent the
roadway so that the highway on one approach
to the crest which is normally not visible from
the other approach of the crest is made possible
by means of the refracting apparatus.

It is, therefore, an object of the present inven-
tion to provide a highway construction apparatus
for use with a highway for supplementing in-
adequate direct vision at such crests at which the
minimum visibility would otherwise be insuffi-
cient. A particular object of the invention is to
provide an apparatus whereby direct vision for
an inadequate or insufficient minimum distance
along a highway is supplemented with an indirect
view of a related extended portion of the highway

in an amount sufficient to render the highway
relatively free of hazard due to inadequate vision.

It is a further object of the invention to provide
an optical apparatus whereby an extended por-
tion of highway along one approach to a hill may
be viewed from a position or series of positions on
another approach of said hill.

It is also an object of the invention to provide
a light refracting apparatus for use in conjunc-
tion with a highway whereby an extended por-
tion of said highway along one approach of a
sharp rise may be viewed from a position or se-
ries of positions on another approach of said
rise.

It is a further object of the invention to provide
a glass prism apparatus for use in conjunction
with a highway for deflecting a line of sight
over a hillcrest on said highway.

It is a further object of the invention to provide
a vision deflecting apparatus having at least one
concave cylindrical surface for use in conjunction
with highway construction.

It is a further object of the invention to provide
an improved highway apparatus in which direct
vision is supplemented with indirect vision by
way of a light refracting prismatic device.

Other and further objects of the invention will
be apparent from the description of the invention,
and from the drawings of the various apparatus
used in carrying out the invention.

Like characters designate corresponding ele-
ments in all of the figures illustrating the in-
vention.

Figure 1 is a schematic elevation of the inven-
tion illustrating the theory of operation of the
invention.

Figure 2 is an elevation partly in section of an
illustrative embodiment of the invention.

Figure 3 is a fragmentary detail partly in sec-
tion of the light refractive device shown in Fig-
ure 2.

Figure 4 is an elevation partly in section along
the lines 4—4 of Figure 3.

Figure 5 is an end elevation of one of the light
refracting elements used in the device shown in
Figures 1 and 5.

Figure 6 is an elevation partly in section along
the lines 6—6 of Figure 3.

Figure 7 is a fragmentary enlargement showing
the manner of mounting the light refracting de-
vices.

Figure 8 is a schematic view in elevation of a
modification of the invention.

Figure 9 is an enlarged detail of the light re-
fracting device shown in Figure 8.

Figure 10 is an isometric view partly in section, with some parts removed, showing an auxiliary prismatic horizontal deflecting device used in conjunction with a prismatic device such as that shown in Figures 2-4.

The present invention and a road construction in which it is used is illustrated in Figure 1 in which the road profile comprises grades 1 and 2, connected by a vertical curve 3 which begins at point 6 and continues over crest 4 to point 7. While exact dimensions have not been used in Figure 1 the vertical scale is exaggerated to roughly five times the horizontal scale. The grades 1 and 2 are each five per cent, that is to say, five feet change in elevation per hundred feet, and they are joined by a vertical curve of approximately four hundred feet in length.

Eye level is taken at any point approximately five feet above road grade and vehicles are assumed to be eight feet tall. It is to be understood, of course, that these constants are merely illustrative. Other constants may obviously be used if desired, and the road grades, etc., are, of course, dependent upon the specific installation in question.

In Figure 1 eye level points are illustrated at positions 8 and 9, these being assumed as the eye level of persons in vehicles at such points. Position 9 is a point beyond which an extended portion of the road soon becomes visible. The refracting device is designed so that the vision afforded by it is effective up to points 9, at which point the vision afforded is no longer necessary on account of the direct vision available. The points 8 and 9 are not definitely fixed but generally define the limiting positions between which the refracting device is necessary and effective. These limits may be increased or decreased if desired, by varying the size and optical constants of the refracting device 14. From the position 8 the line of sight 8-10 intersects the highway at or near point 6 and thus all portions of the road beyond this point are not visible. A vehicle of approximately eight feet in height becomes visible from the position 8 when it reaches the position 11 on the crest.

Similarly, the sight line 9-12 from the position 9 intersects the highway at crest 4. Hence the roadway on the other side of the crest from point 9 is invisible and a vehicle of approximately eight feet in height does not become visible until it reaches position 13.

It has been discovered that a minimum of from eight hundred to one thousand feet of roadway must be visible in advance of a vehicle moving at the rate of approximately fifty miles per hour in order to provide safe driving conditions. When, as in Figure 1, the portion of the road directly visible is less than this required minimum, a traffic hazard exists. The present invention provides for a supplemental view of a portion of the road in addition to that by direct vision. This is done by way of a light refractory apparatus generally designated 14, by which the line of sight from, for instance positions 8 and 9, is refracted so as to intersect portions of the roadway so that a vehicle approaching the crest will always be visible first by way of the light refracting device 14 and then as the vehicle passes from the field of view of the light refracting device by direct vision. There is no point along the highway at which there is inadequate vision or what might be termed a "blind spot".

In Figure 1 the lines of sight from position 8 are shown as traversing the upper portion 15 and

lower portion 16 of the light refracting device 14. I have discovered that for satisfactory results the light deflecting power at the upper range 15 of the device must be from two to seven degrees, preferably about four degrees, less than the light deflecting power at the bottom portion 16 of the prism. Small changes in grade and short vertical curves require a greater field of vision, and hence a greater difference in light deflecting power between the top and the bottom of the refracting device than do relatively more abrupt changes in grade and longer vertical curves. Deflection of the line of sight through the prism 14 may also be expressed as a grade change. According to this nomenclature the deflection at the bottom of the prism is from two to seven, preferably four per cent (or two to seven, preferably four feet per hundred) greater than that at the top of the prism. A light refracting device in which the light deflecting power increases gradually and uniformly from that required at the top of the device to that required at the bottom of the device, is used at 14.

We have also discovered that for satisfactory results it is undesirable optically to reduce the horizontal dimension of a vehicle viewed through the light refracting device, and that it is undesirable optically to reduce the vertical dimension to much less than one-third normal. For best results the width of the light refracting device is a major fraction of the road width, that is to say, from one-half to three-quarters of road width, preferably slightly more than one-half of the road width. Of course, a light refracting device of full road width may be used if desired, but this serves merely to give added panoramic effect.

A panoramic view is desirable in order to provide safe driving conditions in locations where there is a slight change in alignment at or beyond the crest, or a vital traffic point or intersection beyond the crest.

In the diagram Figure 1 the line of sight 17 from point 8 through the upper portion 15 of the light refracting device 14 is deflected along 15-18 so as to view an oncoming vehicle 5. The effect of the light refracting device 14 is to make visible a point 5 which is spaced from crest 4 a distance equal to the distance from position 8 to crest 4. The total distance from position 8 to position 5 is the minimum safe visibility for a predetermined speed, and may be increased or decreased as desired. The line of sight from 8 to point 5 by way of the device 14 is across the top 15 of the device, and the minimum safe distance 8-5, therefore, determines the height of the device 14. The line of sight 19 from point 8 through the bottom 16 of the refracting device 14 is deflected until it intersects the highway as at point 20. It will be noted that the line 16-20 thus intersects a vehicle at the position 11, which as previously explained, is the position at which the vehicle becomes visible by direct vision along the line 8-10. Thus, as the image of the top of vehicle 11 passes downwardly, out of the field of view of light refracting device 14, the same top becomes visible along the line of sight 8-10 and there is accordingly no instant during the travel of the vehicle 11 that it is completely out of view from point 8.

From point 9 a line of sight 21 through the upper portion 15 of the light refracting device 14 is deflected along the line 15-22 and a portion of the road beyond car 5 is, therefore, visible from point 9 at the top of the view through the light

refracting device 14, while the line of sight 23 through the bottom of device 14 is deflected so that it intersects the grade 2 at point 24. Since the line 16-24 intersects vehicle 13 there is no time at which that vehicle is completely out of sight from point 9 as it approaches the crest. As a sight point is moved from position 9 to the crest 4 the whole field of view through device 14 gradually recedes from crest 4 down grade 2 and the direct view at all times provides the necessary supplementary vision necessary for safe visibility.

Additional illustrative intermediate points between position 8 and the crest 4 would demonstrate that at every point along the slope the light refracting device 14 supplements direct vision in an amount sufficient to provide safe vehicular movement and a vehicle approaching the crest from the opposite direction is always in view either through the light refracting device 14, or directly. Device 14 is optically similar, and hence vehicles 11 and 13 approaching crest 4 from the right are provided the same visibility of the vehicles represented by positions 8 and 9, approaching the crest 4 from the left. It will thus be seen that by this method and apparatus, an additional view of the roadway and traffic thereon, in an amount sufficient for safe driving at relatively high speeds, is provided, even though the distance directly visible along the roadway is inadequate because of intervening hillcrests.

A preferred embodiment of the light refracting device which is illustrative of the manner in which the invention is carried out is shown in Figures 2 through 7. It consists of a prismatic device generally designated 14 which is supported above or closely adjacent the hillcrest 4 by a structure generally designated 25. The light refracting device 14 consists of a plurality of horizontal rows of glass prisms 26, the rows being arranged vertically one over the other as shown in Figures 3 and 4. The prisms thus comprise a Fresnel-type cylindrical lens in that each prism has one plane face 27 and one cylindrical face 28, the radius and center of the cylinder defined face 28 being constant for all of the lenses in one device. All of the prisms in a horizontal row have the same optical constants. It is to be understood that both faces 27 and 28 of the prism may be made cylindrical if desired, but for convenience of manufacture it is preferable to grind and polish one face 27 as a plane and the other face 28 as a cylinder.

The prisms are mounted in rows in frame 29 which is preferably constructed of steel channels. The frame is provided with trunnions 30 near its upper side which are pivoted in bearings 31 in structure 25. This permits the frame and prisms to move slightly in a heavy wind. Slight movement does not affect the optical functioning of the prismatic device 14.

The individual prisms of each row are preferably mounted upon aluminum strips 32 from which the prisms are separated by a thin gasket of cork 33. Lateral movements of the prism is prevented at the top by downwardly punched ears 32a and at the bottom by angle brackets 32b (see Figure 7).

Aluminum strips 32 are bent over at the ends and attached to the frame 29 by bolts 34. If desired, a vertical tension rod 35 may be provided at one or more places in the panel of prisms so as to prevent sideways bending of the aluminum strips 32. It is desirable to leave an end clearance 37 of about one-half inch so as to provide

for differential expansion of the glass and steel composite.

There are ten prisms in each row, as shown in Figure 3, but any number of prisms may be used as desired. For instance, random lengths which are so cut as to remove flaws may be used.

In the construction shown in Figures 3 and 4 there are six rows of prisms and this likewise is merely illustrative of one manner of constructing the prism arrangement since a different number of various sized prisms may be used if desired.

In one specific construction the prisms are eight inches high by twelve inches wide, and one-fourth of an inch thick at the top edge 38. The bottom thickness of the prisms increases slightly for successively lower rows of prisms, as shown in Figure 4. In this specific construction the radius is 654 inches about one center for all of the prisms in the panel. This radius determines the width of the base of the prism for each row. The exact thickness of the top edge, and of the prisms is not a critical factor and hence no attempt is made to hold the thickness of the prism to close tolerance. The radius and the difference between the top and bottom dimensions is important.

It has been found desirable to provide the prism frame with a sun or light shade 39 which is supported above the frame by bracket 40 as shown in Figure 6. The shade also serves to protect the lenses from the elements. It is also desirable to provide a side panel 39a, which acts in the same capacity as shade 39.

It is to be understood that the prisms in optical device 14 may be composed of any desired light refracting material such as synthetic resins, plastic or other transparent materials. A particularly useful composition in this connection are the vinyl resins and the like.

A modification of the invention is shown in Figures 8 and 9. In this device the prism arrangement consists of a glass-walled, liquid-filled vessel, generally designated 41, having a wall 42 of plane plate glass and a second wall 43 of plate glass curved so as to form a segment of a cylinder. The glass plates are fixed to a circumscribing frame 44 by means of brackets 45 and the enclosed vessel thus formed is filled with a water-white, non-freezing liquid such as a mixture of methonal and a solution of calcium chloride. The lower member of the frame 44 is constructed so as to be especially rigid in order to reduce deflection to a minimum such that after the glass is set and the vessel loaded with liquid there will be no sagging, torque or twist strains. It is also preferable to mount the structure 44 on structure 25 by three points so that the optical unit is not stressed due to uneven deflection of structure 25 when loaded. The whole device is suspended above the road at a hillcrest, as shown at 46 in Figure 8, and provided with sun or light shades 39-39a. The operation of this modification of the invention is analogous to that shown in Figures 2 through 7.

It is to be understood that in the modification shown in Figure 9, two cylindrically curved side-wall glasses may be used instead of one cylindrical and one plane side-wall glass as shown, and the liquid filling may be of a freezable type if the device is not subjected to freezing temperatures.

While the method and apparatus of the present invention has been illustrated in several specific embodiments, it is obvious that there are many modifications that may be made within

the spirit of the invention, and it is the intention to cover such modifications.

It is particularly to be understood that specific dimensions, constants, grades, deflection angles, etc. are merely illustrative and are not to be considered as limitations of the invention.

A horizontal deflection of the light rays through the refractive device 14 may be accomplished by a set of vertically disposed plano-surfaced prisms used in conjunction with device 14. By this means the entire vision through the device 14 is given any desired horizontal deflection up to the angularity at which prismatic aberration is experienced.

This modification which is shown in Figure 10 includes a series of vertically disposed prisms 41, each of which has a plane face 42 and a second plane face 43 angularly disposed with respect to each other. The orientation of the prisms and their angularity is such as to produce a sight deflection corresponding with the horizontal change in direction of the road. By this means additional vision can be provided at hillcrests even though the highway bends at the hillcrest.

The vertically disposed prisms 41 may be used separately, if desired, to provide a view of a roadway where a vital traffic point is caused by horizontal deflection of the road. In such an installation the sight deflecting device 14 is omitted.

It is obvious that many variations may be made in the details of the present structure without departing from the spirit of the invention.

We claim as our invention:

1. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising light transmitting refractor means for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, and means for mounting said apparatus in a superior position with respect to the highway near said hazard.

2. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising light transmitting prism means for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, and means for mounting said apparatus in a superior position with respect to the highway near said hazard.

3. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising light transmitting refractor means having one plane face and one cylindrically formed face curved toward said plane face, for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, and means for mounting said apparatus in a superior position with respect to the highway near said hazard.

4. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard

such as a convex vertical grade change, comprising light transmitting refractor means having one plane face and one cylindrical face curved toward said plane face and a liquid filling between said faces, for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, and means for mounting said apparatus in a superior position with respect to the highway near said hazard.

5. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising light transmitting refractor means of solid glass having one plane face and one cylindrically formed face curved toward said plane face for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, and means for mounting said apparatus in a superior position with respect to the highway near said hazard.

6. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising light transmitting refractor means of glass and having a width of approximately one half of the width of said highway for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, and means for mounting said apparatus in a superior position with respect to the highway near said hazard.

7. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum by a hazard such as a convex vertical grade change comprising solid glass plano-concave light transmitting prism lens means, means for mounting said lens means in a superior position near said hazard, said means being oriented to deflect rays from viewing points along said highway downwardly at said hazard in the general direction of said highway beyond said hazard, whereby a view of said highway beyond said hazard provided which view has a normal width and a diminished vertical dimension.

8. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising glass prism light transmitting refractor means of plano-concave cross-section having an optically effective width of not substantially less than one-quarter of the highway width, and means for mounting said apparatus in a superior position with respect to said highway near said hazard.

9. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising a lens made up of a plurality of individual solid light transmitting prismatic elements each having one plane face and one cylindrically shaped face, the radii of the cylindrically shaped faces being equal for all of the prismatic elements of the lens, and means for mounting said apparatus in a superior position with respect to said highway near said hazard.

10. A vision apparatus for improving the safety of a highway along which visibility is restricted

to an insufficient minimum distance by a hazard such as a convex vertical grade change, means for supporting said apparatus in a superior position with respect to said highway at said hazard, said apparatus comprising solid sight deflecting means having opposed light transmitting faces inclined toward each other to provide thick and thin prism sections, the inclinations of opposed faces being increased from the top to the bottom of said sight deflecting means so as to provide a sight deflection through the bottom portion of said sight deflecting means which is from approximately one-half to approximately seven and one-half degrees greater than the sight deflection through the thin section, the change in angularity of said faces being gradual so that the change in deflection is gradual.

11. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising a plurality of glass prisms assembled one above the other, said prisms having at least one cylindrical surface, the radii of the cylindrical surfaces and the centers thereof being the same for all of the prisms in said apparatus, frame means for holding said prisms assembled and means for mounting said apparatus in a superior position with respect to said highway near said hazard.

12. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising a prismatic light refracting device having a plurality of glass prisms, each of which has at least one concave light transmitting face, the surfaces of each of said prisms being oriented with respect to each other to give a light deflecting power for each of the prisms which gradually increases from the thin section of the prism to the thick section of the prism, said prisms being arranged in a plurality of vertically disposed horizontal rows, the variation in light deflecting ability from the top to the bottom of the prisms in each row being constant for all of the prisms in that row, the successive rows being arranged so that the sight of deflection at the top of the prisms of each successively lower row is substantially the same as that at the bottom of the prism at the next higher row, and means for mounting said vision apparatus in a superior position with respect to the highway near said hazard.

13. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change and/or a change in alignment, comprising means for refracting light horizontally and means for refracting the same light vertically, and means for supporting said apparatus in a superior position with respect to the highway at said hazard.

14. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change and/or a change in alignment, comprising horizontally arranged prism means for horizontally refracting light rays and vertically arranged prism means adjacent said horizontal prism means for vertically refracting the same light rays, and means for supporting said apparatus in a superior position with respect to the highway at said hazard.

15. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard

such as a convex vertical grade change and/or a change in alignment, comprising light transmitting refractor means for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard, a light shade for said refractor means, and means for mounting said refractor means in a superior position with respect to said highway near said hazard.

16. An apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, comprising a frame means for mounting said frame in a superior position with respect to said highway near said hazard, said frame being provided with a plurality of horizontal rows of prisms mounted one above the other in said frame, the prisms being formed to produce a uniform downward deflection for all rays entering the frame in a horizontal plane, and an increasing downward deflection for rays of successively lower horizontal planes.

17. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a visibility limiting hazard such as a convex vertical grade change, comprising light transmitting refractor means formed for mounting in a superior position with respect to the highway near said hazard for providing an image of the highway beyond said hazard from viewing points along the approach toward said hazard.

18. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change which apparatus is adapted to be mounted in a superior position with respect to the highway near said hazard, comprising light transmitting prism means for refracting light rays through an angle from viewing points along said highway in one direction from said hazard to fields of view including said highway in the other direction from said hazard.

19. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, which apparatus is adapted to be mounted in a superior position with respect to said highway near said hazard, comprising glass prism light transmitting refractor means of plano-convex cross-section having an optically effective width of not less than one quarter of the highway width.

20. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, which apparatus is adapted to be supported in a superior position with respect to said highway at said hazard comprising solid light deflecting means having opposed light transmitting faces inclined towards each other to provide thick and thin prism sections, the inclination of the opposed faces being increased from the top to the bottom of said light deflecting means so as to provide a deflection through the bottom portion of said light deflecting means which is from approximately one-half to approximately seven and one-half degrees greater than the light deflection through the upper section, the change of angularity of said faces being gradual so that the change in deflection is gradual.

21. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a hazard such as a convex vertical grade change, which apparatus is adapted to be mounted in a superior position with respect to said highway near said hazard, comprising a plurality of glass prisms assembled one above the other, said prisms having at least one cylindrical surface, the radii of the cylindrical surfaces and the centers thereof being the same for all of the prisms in said apparatus, and frame means for holding said prisms assembled.

22. A vision apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum distance by a lens such as a convex vertical grade change, which apparatus is adapted to be mounted in a superior position with respect to said highway near said hazard, comprising a prismatic light refracting device having a plurality of glass prisms, each of which has at least one concave light transmitting face, the surfaces of each of said prisms being oriented with respect to each other to give a light deflecting power for each of the prisms which

gradually increases from the thick section of the prism to the thin section of the prism, said prisms being arranged in a plurality of vertically disposed horizontal rows, the variation in light deflecting ability from the top to the bottom of the prisms in each row being constant for all of the prisms in that row, the successive rows being arranged so that the light deflection at the top of the prisms of each successively lower row is substantially the same as that at the bottom of the prism at the next higher row.

23. An apparatus for improving the safety of a highway along which visibility is restricted to an insufficient minimum by a hazard such as a convex vertical grade change, comprising a frame formed for mounting in a superior position with respect to said highway near said hazard, a plurality of horizontal rows of prisms mounted one above the other in said frame, the prisms being formed to produce a uniform downward deflection for all rays entering the frame in a horizontal plane and an increasing downward deflection for rays of successively lower horizontal planes.

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