

Oct. 5, 1943.

E. C. BINGHAM

2,330,808

ROAD SURFACE

Filed March 7, 1941

2 Sheets-Sheet 1

Fig. 1.

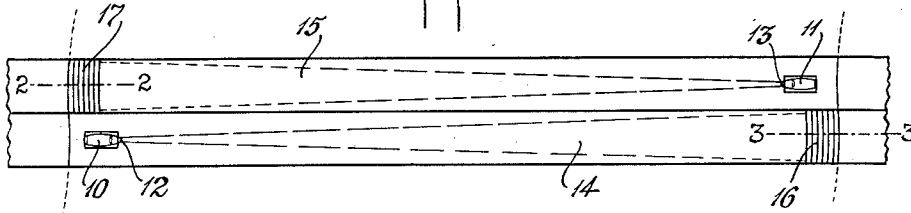


Fig. 2.

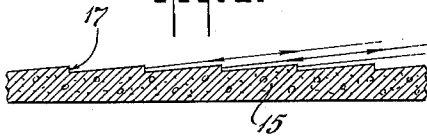


Fig. 3.

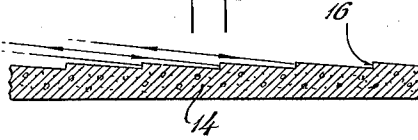


Fig. 4.

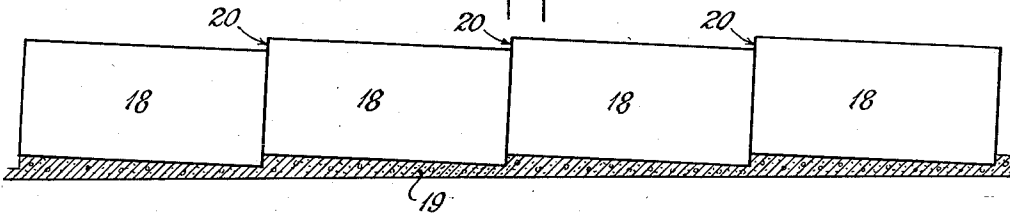


Fig. 5.

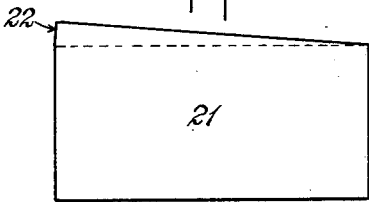


Fig. 6.

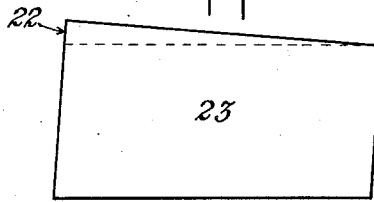
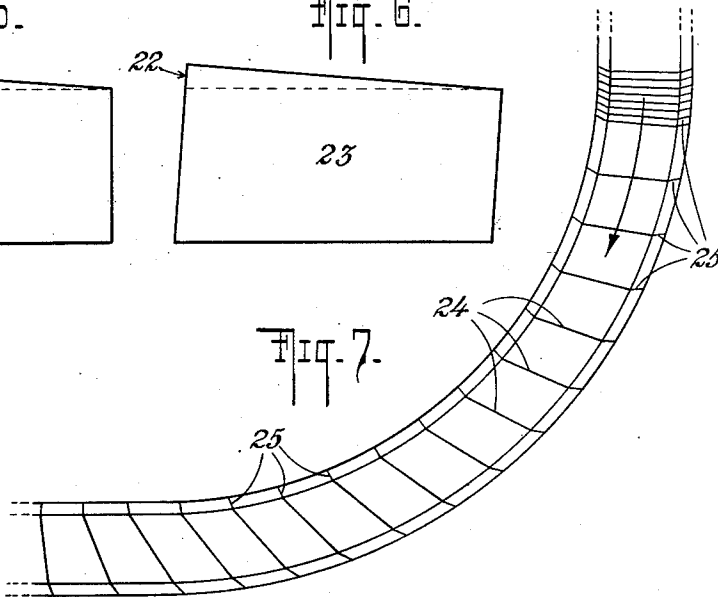


Fig. 7.



WITNESS

G. V. Rasmussen

INVENTOR

EUGENE C. BINGHAM

BY

Driesen & Schrenk,
ATTORNEYS

Oct. 5, 1943.

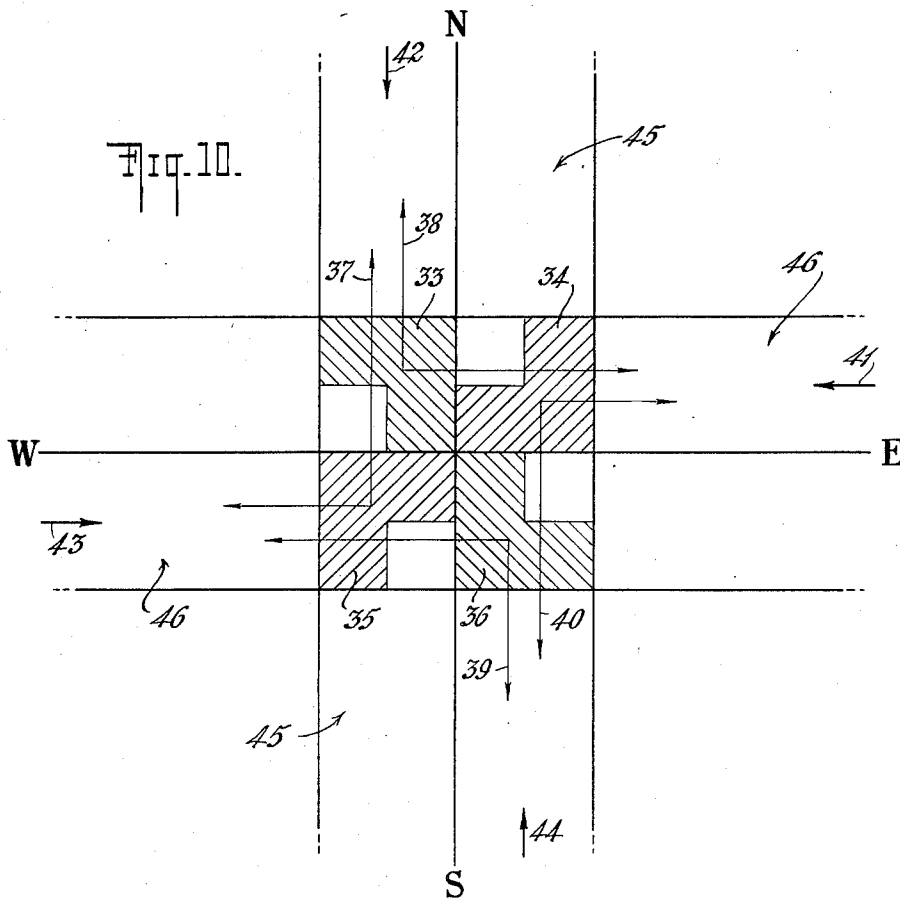
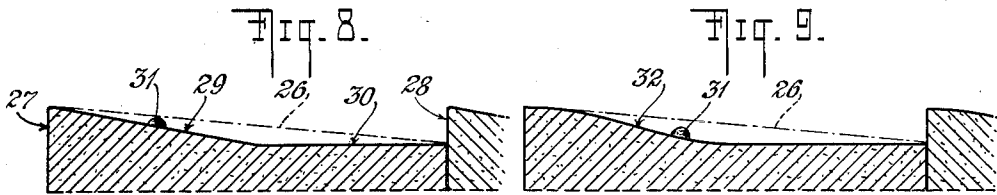
E. C. BINGHAM

2,330,808

ROAD SURFACE

Filed March 7, 1941

2 Sheets-Sheet 2



WITNESS

G. V. Rasmussen

INVENTOR

EUGENE C. BINGHAM

BY *Riesen Schenk,*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,330,808

ROAD SURFACE

Eugene C. Bingham, Easton, Pa.

Application March 7, 1941, Serial No. 382,132

12 Claims. (Cl. 94—1)

My invention relates to improvements in road surfaces and its general object is to provide an improved road surface of simple, reliable, and inexpensive construction wherewith it is possible to obtain maximum illumination thereof by the lamps of the vehicles which it carries.

The problem of properly illuminating roads to provide for safe night driving has been of pressing importance in recent years due to the increasing number of accidents which occur after dark. It has been estimated that sixty percent of the deaths on highways occur after dark although there is then only twenty-five percent as much traffic. In an attempt to alleviate this condition, it has been given a great deal of publicity of an educational nature and many suggested systems of highway lighting have been experimented with. Some of these lighting systems have proved fairly satisfactory and if their use results in a sufficiently marked drop in the casualties on those highways on which they have been installed, they will no doubt be used on an increasing number of roads. But this expansion has an obvious limitation due to the heavy expense for installation and maintenance of such lighting systems and, in all probability, will not spread beyond the important or principal highways into the secondary roads which form the greater part, by far, of the highway system of this country. Efforts in other directions to provide a less expensive solution to the problem have led to the devising of various kinds of markers to be anchored in the road and to the incorporation in suitable road binders of light reflecting material. Markers are so costly that their use, in the main, has been limited to designating functions and to defining road limits. Furthermore, known types of markers have a very low efficiency as light reflectors and they are prone to work loose from the roadway after being subjected to the strains inflicted by traffic. The use of light reflecting material in the road surfaces is inefficient and unpredictable because the positions of the particles of such material cannot be controlled.

Realizing the shortcomings of the methods heretofore suggested, I made a careful study of the problem to determine if a more effective and reliable solution could be devised. I found that roads having a smooth asphalt surface were least illuminated by the lights of a vehicle. This, I believe, is not due to the dark color of this type of road but to the fact that when a perfectly smooth horizontal surface is illuminated by lights striking it at a very low angle, as in the case of the light from the headlamps of an automobile,

it offers the worst possible condition for illumination, particularly so, when such a surface is wet as it is then converted into an optical surface, meaning that it gives specular reflection like any mirror. This belief is borne out by the fact that when I placed a well-planed board coated with several layers of flat-white paint upon a road surface where the lights of a vehicle could strike it, the white surface did not appear bright as I had expected but appeared to be even darker than the roadway itself due, no doubt, to the fact that the smooth coating of paint presented a better reflecting surface than did the surface of the roadway. On the other hand, a pavement covered with gravel was much more luminous than one without and it did not seem to make any difference whether the gravel was made of light material or dark, for the gravel could be covered over with an asphalt coating and yet become quite as luminous as the uncoated light colored gravel. From these observations I concluded that whether the road was made of light or dark material was not of prime importance, that smooth surfaced roads offered the worst possible condition for illumination by the lights of a vehicle and that this condition was aggravated by paint, horizontally-positioned metal or light-colored non-metallic materials which offer better reflecting surfaces to the beams of light, and that the only part of the light given out by the lamps of the vehicle that was of any use to me in driving was the part of the light that went out to the pavement and then returned to my eyes. Further research showed that while gravel and transverse ridges resulting from irregularities in the road surface increased the visibility of the road to some extent, the effect was small and insufficient to be of any material assistance to the driver. This, I found, was due to two factors. In the first place, only a very small portion of the light from the lamps of a vehicle falls on the road and such light as does fall on the road decreases so rapidly in intensity in its travel from the vehicle lamps that the light at a distance of one foot from the lamps of the vehicle is reduced to an intensity of less than one one-hundred thousandth part at a distance of three hundred and twenty feet from such lamps. As the surfaces of gravel and irregularities in the road do not concentrate the light striking it at such distance but, on the contrary, usually diffuse it in all directions, the light will spread out in all directions on returning and only a very minute part of the light will return to the eyes of the operator of the vehicle. In the second place, the lamps of a vehicle are normally

about three feet above the pavement, so that, that portion of the light which strikes the pavement at a distance of three hundred feet from the car, strikes it at the extremely low angle of about 0.5 degree. As gravel or irregularities in the road surface rarely have surfaces which approach within one-half of a degree of the vertical, it is clear that the ordinary gravel particles or the ridges formed by irregularities in the road surface do not increase greatly the visibility of the road but, on the contrary, tend to reflect the light in directions away from the operator. Furthermore, as at this angle, the light beams are just grazing the road surfaces, the pieces of gravel and irregularities near the vehicle will in all likelihood interfere with the light reaching the gravel or irregularities farther away. Thus, while the gravel or irregularities immediately in front of the vehicle may be sufficiently illuminated, the visibility will decrease so rapidly with the distance that at normal driving speed the eyes of the driver are taxed to see the highway at the more remote distances, let up say, two hundred and fifty to three hundred feet. I found, however, that by deliberately roughening or constructing the road surface in a special manner I was enabled to increase the illumination thereof to such an extent that at those parts spaced from the vehicle where light visibility is desired by the operator of the vehicle, such parts were clearly visible to the operator and the major factors which caused past difficulties were eliminated. The principle involved is based upon a conception that reflecting surfaces provided in the roadway should be so oriented in an exact position with respect to each other and to the vehicle as to return to the operator's eyes a maximum of the amount of light which falls on the road at a distance, of say, three hundred feet from the lamps of the car. I am aware that it has already been proposed to provide blocks having surfaces which are presented in opposed relation to the direction of the travel of the vehicle so as to reflect the light rays coming from the lamps of the vehicle, but so far as I am aware such blocks were so constructed that their illuminating effects were practically negligible at substantial distances from the vehicle for one or more of the reasons previously pointed out.

For a clearer understanding of the invention I have made, based on the principles and discoveries made during the course of my study of this problem, reference is made to the following description to be read in connection with the accompanying drawings, in which Fig. 1 is a plan view of a double highway constructed in accordance with the invention; Fig. 2 is an enlarged fragmentary sectional view of the highway shown in Fig. 1 taken along the line 2—2 of Fig. 1; Fig. 3 is a similar view taken along the line 3—3 of Fig. 1; Fig. 4 is a vertical sectional view of a portion of a highway built with blocks in accordance with the invention; Fig. 5 is a side elevational view of a modified form of block that may be used in the construction of the highway; Fig. 6 is a view similar to Fig. 5 showing another type of block that may be used; Fig. 7 is a plan view of a curved portion of a single-lane highway made in accordance with the invention; Figs. 8 and 9 are vertical sectional views of modified forms of paving blocks, and Fig. 10 is a plan view of the crossing of two highways, to illustrate the manner in which the invention may be utilized at such crossing.

In Fig. 1 of the drawings, the double highway is shown with two vehicles 10 and 11 traveling in opposite directions and being provided with the usual headlamps. For the sake of simplicity, no account has been taken of the distance separating the two headlamps of each vehicle, the headlamps of the two vehicles 10 and 11 being illustrated as single units which are designated by the reference characters 12 and 13, respectively. As is usual, the lamp 12 of the vehicle 10 concentrates the light emanating therefrom so that the major portion of such light striking the highway falls upon the lane 14 of the highway, while the light from the headlamp 13 on the vehicle 11 traveling in the opposite direction is concentrated to illuminate the highway lane 15. Each of the road lanes 14 and 15 is composed of a series of transverse rows of reflecting surfaces, the rows of the highway lane 14 being indicated by the reference numeral 16 and the rows of the highway lane 15 being indicated by the numeral 17. The reflecting surfaces in each case are arranged to face the path of travel of the vehicles so that the reflecting surfaces of lane 14 will face in a direction opposite to that of the surfaces of lane 15, as will be readily evident from a comparison of Figs. 2 and 3 of the drawings. The reflecting surfaces may be formed by specially arranged or specially constructed blocks, by embossing the road surface, by inserting metal strips, etc., all of which will become hereinafter more clear. In Fig. 4 of the drawings, there is shown by way of example, a method of forming the rows of reflecting surfaces by means of bricks or blocks. Referring to Fig. 4, the blocks 18 of each row may be rectangularly-shaped and laid in slightly tilted position upon the roadbed 19 so that each brick presents an elongated rectangularly-shaped surface 20 to the view of the operator of the vehicle traveling on such highway. As the bricks or blocks 18 are tilted so that the surfaces 20 thereof in each highway section or lane is opposed to the direction of the travel of vehicles on such lane, it will be evident that the blocks 18 on one lane, say lane 14, will be tilted in a direction opposite to that of the blocks on the lane 15, compare for example, Figs. 2 and 3 of the drawings. Thus each lane of the highway is constructed of a series of rows of bricks tilted to present a plurality of reflecting surfaces 20 in opposed relation to the direction of travel of traffic on such highway lane so that beams of light from the headlights of the vehicles will strike against such surfaces. The angle of tilt of each brick is determined by the average height of the lamps of vehicles from the road surface, and by the distance from the vehicle at which it is desired to have the road illuminated. The height of the reflecting surfaces 20, which are arranged so as to be perpendicular or normal to those rays of light emanating from the headlamps of a vehicle and striking the roadway at the distance from the vehicle at which visibility is desired, is determined by the size of the blocks that it is convenient to use. For example, let it be assumed that the highway is to be constructed so that the light from a vehicle is to illuminate the road for a distance of from two hundred and fifty to three hundred feet from the vehicle. As the headlamps of the vehicle are usually positioned at about three feet above the surface of the highway, at three hundred feet from the vehicle rays of light from the headlamps would be striking the pavement at an angle with the horizontal which corresponds to the tangent

of three over three hundred or approximately zero degrees, thirty-four minutes. This angle will be equal to the angle between the face of the surfaces 20 and the vertical, when the former are positioned so that they are normal to those beams of light reaching from the headlamp at a distance of three hundred feet and therefore in position to reflect the light back to the vehicle. In other words, in order that a maximum of the light from the headlamps of the vehicle be reflected back to the eyes of the operator from a distance of three hundred feet, the angle which each surface 20 makes with the vertical should be equal to the angle which the top surface of the brick or block 19 makes with the horizontal and should be approximately one-half of a degree. For the sake of simplicity, it is here assumed that the line from the lamp of a vehicle to the pavement at three hundred feet is coincident with the line taken by the light in returning from the pavement to the operator of the vehicle. Thus none of the light will strike the top surfaces of the blocks at this distance but will all shine directly on the opposed reflecting surfaces 20 of the blocks. In order that there may be no interference with the light rays striking each surface 20 (see Fig. 4) at the considered distance, the height of the latter is in the same ratio to the length between the bottom of one reflecting surface and the next, as the height of the vehicle lamp (three feet) is to the distance of such surface 20 from the car (three hundred feet). Thus if the length of the blocks is one inch, the height of the reflecting surface 20 which can be illuminated from the headlamp of the car at three hundred feet will be 0.01 inch, while if the length of the block is made two feet, the corresponding height of the surface 20 will be 0.24 inch. Thus even if the surfaces 20 are two feet apart, the height of such surfaces which are usable as reflectors is only one-quarter of an inch. It will be understood that with effective or usable reflecting surfaces one-quarter inch in height, for illuminating distances of three hundred feet, the distance of two feet is to be taken as a minimum, for, of course, the distances between such surfaces can be greater than two feet depending upon the degree of illumination of the roadway desired. At distances greater than two feet the height of the surfaces 20 can, of course, also be correspondingly greater and since the wave length of light is of the order of a ten-thousandth of an inch, it is not at all necessary for the reflectors to be large and conspicuous and may be reduced to less than one-quarter of an inch. In either case, whether the distance between reflectors is less than or greater than two feet, the light reflected should be constant, it being understood that when the distances between reflectors are less than two feet, the effective or usable reflecting surfaces will be correspondingly reduced. The factor determining the maximum distance might be the riding quality of the highway and the factor determining the minimum distance would in theory be the wave-length of light, of the order of a ten-thousandth of an inch, but in practice it might well depend upon the feasibility of constructing a large number of reflectors having the required reflecting properties over a long period of time.

It will be evident from the foregoing that if the blocks 18 in the road are laid in the manner described, none of the light from the lamp of the vehicle will strike the long slope or top surfaces of the blocks but will strike the reflecting surfaces 20 perpendicularly to the direction of its travel and will be reflected therefrom back to the eyes

of the operator. Any light coming from the opposite direction, as from the lamps of a vehicle traveling in the opposite direction will, however, strike the sloping top surfaces of the bricks and will be reflected away from the lamp of the vehicle from which it emanates. It will thus appear that the driver of the vehicle will see clearly illuminated only that half of the road on which he is driving, while the other lane of the road for traffic in the opposite direction will appear to be substantially dark and unilluminated.

The optical quality of the reflecting surfaces 20 of the blocks is of as great importance as is the proper placing of each block in order to obtain what may be properly described as the focusing of the light. The reflecting surface 20 of each block should not only be true in shape and smooth but it should also have a highly polished surface for the best effect. The reason for this is that the wave length of light is so small that even a large number of minute irregularities in the reflecting surface will reflect the light in all directions with the result that the reflected light will be highly diffused and will not return to the operator. In this connection, glazed bricks provide exterior surfaces which are highly effective as reflectors. Equally effective results are attained by providing on the reflecting surfaces 20 strips of chromium-plated metal or coats of material having high reflective qualities, such as, aluminum paint or paint containing metal flakes or mica provided that it dries to a glossy surface. Even a dark colored asphaltum or plastic material may be utilized providing it is glossy and does not attract dirt. Preferably also, in view of the fact that the light from the lamps of a vehicle spreads out in all directions along an arcuate front, the rows of blocks should be arcuately arranged in order to reflect back the maximum amount of light to the driver. This method of arranging the bricks is illustrated in Fig. 1 of the drawings where the rows 16 and 17 are illustrated as having a slight curvature, the dotted line extensions of the rows at the ends of such figure indicating more clearly the different horizontal curvatures of the rows in the two lanes 14 and 15 of the highway. The curvature of the rows, under the conditions described, would for a twenty foot pavement correspond approximately to a deviation from a straight line of nearly five inches. While I have by the foregoing description indicated that the reflecting surfaces should be flat, for best results the surfaces should also be arcuately shaped so that the curved rows of reflecting surfaces present approximately spherical segments.

Instead of making the blocks of a rectangular form, as is illustrated in Fig. 4 of the drawings, the blocks may be made with a longitudinal section of such trapezoidal form as to provide a small reflecting surface arranged at the correct angle for maximum reflection under the conditions desired. Such a brick or block is designated 21 in Fig. 5 of the drawings, the reflecting face 22 thereof being formed at one end of the brick and being smooth and glazed or painted to increase its reflecting qualities. Blocks of this type may be readily laid in rows on a flat surface with the reflecting surfaces properly positioned to reflect a maximum of the light back to the eyes of the operator and with a minimum of expense and trouble. The blocks can be made also with the end faces thereof parallelly arranged with respect to the reflecting surface, as is illustrated by the block designated 23 in Fig. 6 of the drawings, so that when such blocks are laid upon the roadway

there is an interlocking condition between the blocks.

From the foregoing, it will be understood that the height of the surfaces is determined by a number of considerations among which may be added convenience and expense of production, ease of riding and effects of wear. Thus the user has a wide latitude of choice, but after the center of area of greatest illumination and such other considerations are determined upon, the angle of the reflecting surface for each block is fixed. If the upper surface of the blocks are true, the reflecting surfaces do not need to be as much as one-eighth of an inch in height but under actual operating conditions no noise or discomfort has been noticed in riding over samples with reflectors a quarter of an inch in height. Of course, instead of utilizing blocks, the same effects can be obtained in macadam and concrete roads by either working the road surfacing material when it is soft in some appropriate fashion, as by rollers or other tools or machines, to emboss upon the road surface a fundamental surface configuration provided with reflecting surfaces which can be made better reflecting by means of paint, or setting or driving into the joints or body of the pavement where feasible, reflecting strips of the desired configuration. As visibility of the highway depends upon contrast, there is no need for a middle line at night because the pavement in the reverse direction will appear black. This is due to the fact that the light from an oncoming vehicle strikes the sloping surfaces of the pavement between the reflecting surfaces and will be reflected away from the eyes of the observer. Should it be desired, however, to mark lines between two or more lanes in the same direction, this could be managed by simply leaving out the reflecting feature from a six inch strip which would then appear dark by contrast, or, the horizontal curvature of the end portions of the rows of reflectors could be increased so as to bring the gleam in the strip closer to the car. This feature is best illustrated in Fig. 7 of the drawings, in which the transversely extending lines 24 indicate the arrangement of the rows of reflectors which are so arranged as to provide the maximum amount of reflection for the vehicle traveling in the direction of the arrow and the shorter lines designated by the numerals 25, 25 indicate reflecting surfaces so positioned at the sides of the road as to bring the gleam of such reflectors closer to the car, it being understood that the closely placed lines at the upper end of Fig. 7 represent more truly the relation of the surfaces to one another while the more widely spaced lines indicate generally the directions of the rows on the several portions of the curve. The sides of the road, at a given angle, will thus appear brighter than the body thereof and by such contrast will clearly indicate the limits of the road. If the sides of the roadway are raised, as in the case of curbing, the upper surfaces of the raised sides should be provided with reflecting surfaces and the inside walls of the raised sides should preferably be constructed to present inclined outer surfaces arranged to deflect the beams of light from the vehicle by double reflection where necessary, thereby providing a more marked contrast as between the roadway and the edges thereof. In connection with Fig. 7, it should be noted also that since the speeds of vehicles are reduced when going around curves the distance for brighter illumination can be reduced by increasing the angle of inclination from the vertical of the re-

flecting surfaces at such curved portions of the road. The horizontal radius of curvature of the rows may also be considerably decreased at the curves of the roadway and the rows of reflectors diverge from one another to an extent depending upon the curve to make the pavement of the curve visible to the operator for as great a distance as possible. Furthermore, where it is desirable that road signs be placed for the convenience of the traveler, as at intersections, it has been found that by removing the reflecting surfaces at the portion of the road where the letters or designating signs are needed, such characters will appear black and in sharp contrast against the light background produced by the lights of a vehicle, thereby providing a clearly distinguishable sign for the convenience of the operator of the vehicle. As such signs can be placed in the middle of the roadway where they will be the most conspicuous, the attention of the operator can be maintained on the highway itself.

In view of the fact that at distances of three hundred feet from the vehicle the beams of light do not strike the road surface at an appreciable angle but just graze this surface, any imperfections in the surface or particles resting thereon may tend to interfere with the beams properly striking or reaching the reflecting surfaces. In order to obviate any possibility of this occurrence, the top surfaces of the bricks may be configured in the manner illustrated in Fig. 8 of the drawings. In this figure, the dotted line designated by the numeral 26 indicates the path of the beams of light from the headlamps of a vehicle at a distance of three hundred feet from the vehicle. The upper surface of the block or road, intermediate the two reflector surfaces 27, 28, is formed to provide a relatively steep surface portion 29 immediately in back of the reflector surface 27 and a substantially horizontally disposed surface portion 30 extending up to the reflector surface 28. Thus as these surface portions are substantially below the path of travel of the light beams 26 from the vehicle, any particles or bodies such as the particle designated 31 in Fig. 6 of the drawings, will not interfere with the light striking the reflecting surface 28. The increase in the angle of the non-reflecting face or top surface of the brick has two further advantages, in that, in the manufacture of the brick blocks, it is a matter of convenience not to have the maximum angle of precision to the bottom of the trough. On the other hand, a gradual increase in the angle of the reflecting surface with the vertical has the effect of increasing the visibility of the highway at distances nearer than three hundred feet, which is highly advantageous. Instead of configuring the blocks or road surface in the manner illustrated in Fig. 6, they may be given other forms capable of accomplishing the desired results, as for example, a form such as is indicated by the reference numeral 32 in Fig. 9 of the drawings. Also, instead of providing only a single reflecting surface on the blocks hereinabove described, each block may be provided with a plurality of reflecting surfaces arranged one behind the other, it being understood that the features of construction of the above described blocks will be duplicated in such compound blocks by the number of reflecting surfaces provided thereon. At intersections of a highway, the reflecting surfaces can be laid so as to indicate the approach of vehicles coming from other directions. This is illustrated in Fig. 10 of the drawings, which shows a typical intersection of two high-

ways 45 and 46, each of which, may be built in two lanes in the manner previously described. In the area of intersection, there are provided four L-shaped portions 33, 34, 35 and 36 in which the rows of reflecting surfaces are arranged so that they reflect the light beams from vehicles traveling in the various directions on such roads in the manner indicated by the right angled arrows 37, 38, 39 and 40. Since, in Fig. 10, the roads 45 and 46 cross at right angles the reflecting surfaces are set at an angle of forty-five degrees to the traffic lanes, as is indicated by the cross hatchings in the L-shaped portions 33, 34, 35 and 36. Thus beams of light from a vehicle traveling in the direction of the arrow 41 will be reflected by the reflecting surfaces in the L-shaped portion 34 in the direction of arrow 40 to warn the operator traveling in the direction of arrow 44 of such vehicle's approach to the intersection. At the same time, the beams of such vehicle will be reflected by the reflecting surfaces in the L-shaped portion 33 in the direction of arrow 38 to warn the operator traveling in the direction of the arrow 42. Similarly, operators traveling in the directions of arrows 41 and 43 will be warned of the approach of an operator traveling in the direction of arrow 41, operators traveling in the directions of arrows 42 and 44 will be warned of the approach of an operator traveling in the direction of arrow 43, and operators traveling in the directions of arrows 41 and 43 will be warned of the approach of an operator traveling in the direction of arrow 44. The reflected light thus serves to warn vehicles approaching the intersection well in advance, but in the absence of cars approaching the intersection all of these panels will remain dark because they are placed at the wrong angle to return light to the driver. The L-shaped form of the portions 33, 34, 35 and 36 indicate more clearly to the operator the direction of approach of a vehicle on the cross highway without diverting his attention from the highway and is especially advantageous if the road is made blind by buildings, shrubbery, signs, etc. Of course, if the two highways meet at an angle other than ninety degrees, the reflecting surfaces will be arranged so as to reflect the light into the other sections of the road in the manner indicated to forewarn the driver of the approach of a car from another section of the roadway.

I claim:

1. A road surface of such smoothness as to offer no material interference to the passage of a vehicle thereover and capable of being relatively brightly illuminated at substantial distances by a light source carried by the vehicle, said road surface comprising a series of reflecting surfaces arranged to face the path of travel of vehicles thereon, said reflecting surfaces being substantially normal to light beams from such vehicles and disposed from the vertical at an angle whose tangent is the ratio of a predetermined height of a source of light positioned above the road surface at a predetermined substantial distance from and in front of such reflecting surface to the horizontal distance between such light source and the reflecting surface, whereby such reflecting surfaces provided in a substantially level section of roadway so as to be illuminated as aforesaid at a distance of about three hundred feet from a vehicle on such roadway section and having lamps positioned at about three feet above the roadway will be disposed at an angle of approximately one-half a degree from the vertical.

2. A road surface of such smoothness as to offer no material interference to the passage of a vehicle thereover and capable of being relatively brightly illuminated at substantial distances by a light source carried by the vehicle, said road surface comprising a series of reflecting surfaces arranged to face the path of travel of vehicles thereon, said reflecting surfaces being substantially normal to light beams from such vehicles and departing from the vertical at an angle whose tangent is the ratio of a predetermined height of a source of light positioned above the road surface at a predetermined substantial distance from and in front of such reflecting surface to the horizontal distance between such light source and the reflecting surface, whereby such reflecting surfaces provided in a substantially level section of roadway so as to be illuminated as aforesaid at a distance of about three hundred feet from a vehicle on such roadway section and having lamps positioned at about three feet above the roadway, will be disposed at an angle of approximately one-half a degree from the vertical, and said reflectors being spaced from each other longitudinally by a distance at least equal to the quotient obtained by dividing the height of that portion of the reflecting surfaces to be illuminated by the given ratio.

3. A road surface such as defined in claim 1, in which said reflecting surfaces are arranged in rows extending transversely of the roadway and in which the reflecting surfaces of each row are for the major portion at least disposed at an angle other than ninety degrees to the longitudinal central line of the roadway.

4. A road surface of such smoothness as to offer no material interference to the passage of a vehicle thereover and capable of being relatively brightly illuminated at substantial distances by a light source carried by the vehicle, the said road surface comprising a series of reflecting surfaces, each of which departs from the vertical at an angle whose tangent is substantially the ratio of a predetermined height of a source of light positioned above the road surface at a predetermined substantial distance from and in front of such reflecting surface to the horizontal distance between such light source and the reflecting surface, whereby such reflecting surfaces provided in a substantially level section of roadway so as to be illuminated as aforesaid at a distance of about three hundred feet from a vehicle on such roadway section and having lamps positioned at about three feet above the roadway, will be disposed at an angle of approximately one-half a degree from the vertical, said reflecting surfaces being substantially normal to light beams from such predetermined source and the road surface between reflecting surfaces having a height less than that of said reflecting surfaces and a length at least as great as the quotient obtained by dividing the height of that portion of the reflecting surface to be illuminated by the given ratio.

5. A road surface such as defined in claim 4, in which the road surface between longitudinally arranged reflecting surfaces extends from the bottom of one of such surfaces to the top of an adjacent reflecting surface.

6. A road surface such as defined in claim 1, in which said reflecting surfaces have a height greater than the portion thereof to be illuminated at the aforesaid predetermined distance where relatively bright illumination is desired.

7. A road surface of such smoothness as to of-

fer no material interference to the passage of a vehicle thereover and capable of being relatively brightly illuminated at substantial distances by a light source carried by the vehicle, said road surface comprising a plurality of blocks, each having a reflecting surface departing from the vertical at an angle whose tangent is substantially the ratio of a predetermined height of a source of light positioned above the road surface at a predetermined substantial distance from and in front of such reflecting surface to the horizontal distance between such light source and the reflecting surface, whereby in a substantially level section of roadway to be illuminated as aforesaid at a distance of about three hundred feet from a vehicle on such roadway section and having lamps positioned at about three feet above the roadway, such reflecting surfaces will be disposed at an angle of approximately one-half a degree from the vertical, said reflecting surfaces being substantially normal to light beams from such predetermined source and each of said blocks in the region of its reflecting surface being higher from the horizontal than the remaining portions thereof.

8. A road surface of such smoothness as to offer no material interference to the passage of vehicles thereover and capable of being relatively brightly illuminated at substantial distances by light sources carried by the vehicles, said road surface comprising a plurality of reflecting surfaces each departing from the vertical at an angle whose tangent is substantially the ratio of a predetermined height of a source of light positioned above the road surface at a predetermined substantial distance from and in front of such reflecting surface to the horizontal distance between such light source and the reflecting surface, whereby when such reflecting surfaces are to be illuminated from a light source positioned at a horizontal distance of about three hundred feet from such surfaces and at a height of about three feet above the road surface, such reflecting surfaces are disposed at an angle of approximately one-half a degree from the vertical, said reflecting surfaces being substantially normal to light beams from such predetermined source and being arranged in a plurality of groups of rows, the rows of one group being disposed at an angle to the rows in another group.

9. A paving block having a sectional area of irregular form and having an upstanding surface of good reflective quality disposed at such angle to the vertical as to be substantially normal to light beams from a source of light positioned above said block and at a predetermined, sub-

stantial distance from and in front of such reflecting surface, the top surface of said block meeting said reflecting surface at the top edge of the latter and being disposed at an angle to the horizontal.

10. A road surface such as claimed in claim 1, in which said reflecting surfaces are arranged in arcuately shaped rows extending transversely of the roadway and are each arcuately shaped so that each row of such surfaces present a substantially spherical segmental reflecting surface to the light from the vehicle.

11. A highway for the normal travel of a vehicle at night, comprising a series of upstanding surfaces of good reflective quality arranged to be contacted by light originating on the vehicle, said reflecting surfaces extending generally in a direction transversely of said highway and being inclined from the vertical at such angle as to be substantially normal to light beams emanating from the vehicle at a predetermined, substantial distance from and in front of such surfaces, said reflecting surfaces being spaced longitudinally in the direction of the highway by surface portions each extending from the top edge of a preceding reflecting surface to below the next succeeding reflecting surface and having sufficient length to permit the light from the vehicle at such predetermined distance to contact sufficient of said reflecting surfaces in the aggregate to illuminate a portion of the highway bearing said reflecting surfaces sufficiently to define such portion relatively clearly.

12. A highway for the normal passage of a vehicle at night under the illumination of its own lights, comprising a plurality of reflecting surfaces of good reflecting quality, said reflecting surfaces extending transversely of the highway and projecting upwardly in a general vertical direction above the average height of the highway so as to be illuminated by the lighting means carried by the vehicle, said reflecting surfaces having sufficient of the aggregate reflecting area thereof disposed at such angle to the vertical as to be substantially normal to light beams from the vehicle when the latter is positioned at about 250 to 300 feet from and in front of such surfaces and being spaced longitudinally along the highway by surface portions each extending from the top edge of a preceding reflecting surface to below the next succeeding reflecting surface and having sufficient length to enable the light from the vehicle at the stated distances to clearly define the portion of the highway having such surfaces under average night driving conditions.

EUGENE C. BINGHAM.