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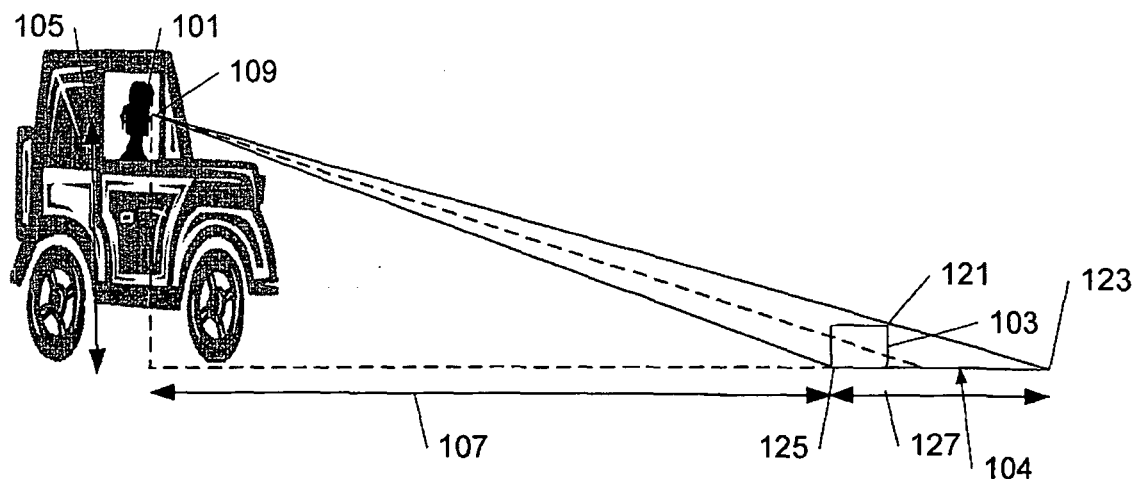
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(54) **Road element**

(57) This invention relates to a road element for influencing the behaviour of the road user, for instance a road obstacle, where said road element comprises a road print (104) being a perspective projection of a three-dimensional road element (103), where said road print is optimized for a viewer (101) within a given position from

said road print, where said road print is placed upon or integrated into the surface of the road or in close proximity to the road. The present invention further relates to a method for manufacturing a road element for influencing the behavior of a road user and to a method for reducing the speed of a vehicle on a road.



**Fig. 1a**

**Description**

**[0001]** The invention relates to a road element, such as for instance a road obstacle, for regulating the behavior of road users.

**FIELD OF THE INVENTION**

**[0002]** The increased traffic volume has put a large pressure on the existing road system, having both bothersome and dangerous effects. Bothersome due to especially traffic jams, leading the often delayed road users to speeding in order to make up for lost time. Dangerous as speeding, per se, increases the likelihood of accidents with a lethal outcome. Speeding is, however, not only associated with the increase in traffic volume, hence speeding is a general problem and common road user behaviour. Such behaviour is a considerable problem in for instance cities and where road work is being carried out as the traffic intensity and the number of soft road users is relatively larger in these areas.

**[0003]** Another problem in traffic is that many road users find it increasingly difficult to interpret message signing on roads which at times results in very dangerous situations. This could for instance be a situation where a car driver overlooks a 'No Entry' sign and drives down an exit from a motorway and thus drive in the opposite direction in the wrong roadway and thus becoming a so-called ghost driver.

**[0004]** To accommodate especially the problem of speeding, regulating traffic and regulating traffic behaviour in general, several initiatives have been taken in terms of laying down road obstacles such as for instance roundabouts, chicanes and speed bumps. Roundabouts are typically constructed to replace an intersection where two or more roads with high traffic intensity intersect. A problem with roundabouts is that the one-way traffic combined with the rounding of the roundabouts wear the tires on the vehicles unevenly. Chicanes are often placed at entrances and in areas with a permitted speed limit. Some chicanes are constructed so that traffic from only one direction can pass at a time, others are sine or arc shaped chicanes which can only be comfortably passed at a certain speed. Unidirectional chicanes are not suitable in areas with high traffic intensity as these would slow the traffic beyond the reasonable. A problem with sine or arc shaped chicanes is that they can be passed with a speed above the allowed limit.

**[0005]** Speed bumps are speed reduction devices used with the intention to ensure that road users do not exceed the speed limit deemed safe. Speed bumps can for instance be used as speed dampers on roads with a given maximum velocity or where two lanes narrows to one lane.

**[0006]** The purpose of speed bumps is typically that the discomfort when passing increases with increasing speed. This effect is obtained as a result of the curvature of the speed bump. Hence the curvature of speed bumps is constructed to give a minimum discomfort at a certain speed and there below and increasing discomfort at speed above. Speed bumps therefore have the advantage that if distributed relatively evenly over a given distance, most road users will maintain approximately the allowed speed limit within that given distance. This makes speed bumps one of the most effective speed reduction devices and due to a low construction cost, also one of the most widely used.

**[0007]** Speed bumps can, however, have undesired effects if the curvature of these speed bumps is not constructed according to the desired speed. A poorly constructed speed bump is therefore a problem for all road users as drivers and passengers may be injured and vehicles damaged when passing. Whether the curvature is constructed as intended or not, speed bumps are a problem for specific groups of road users, for instance bus drivers who risk getting back problems due to the placement of the steering wheel in front of the front suspension of the bus. Another group is emergency vehicles, for instance ambulances that have to pass road bumps very slowly in order not to impose additional injuries to the person(s) carried which in return prolongs the emergency response.

**OBJECT AND SUMMARY OF THE INVENTION**

**[0008]** It is an object of the invention to provide a device for regulating the behavior of road users by solving the above-mentioned problems.

**[0009]** This is achieved by a road element for influencing the behavior of the road user, for instance a road obstacle, where said road element comprises a road print being a perspective projection of a three-dimensional road element, where said road print is optimized for a viewer within a given position from said road print, where said road print is placed upon or integrated into the surface of the road or in close proximity of the road. Hereby a road element that would influence road users' way of driving due to high detectability and without causing discomfort when the road user passes the obstacle and without unnecessary wearing of the vehicle is provided. This is achieved due to the fact that the obstacle would appear as a 3D element on the road and the road user would therefore see the obstacle as a real obstacle and thus correct the way of driving according to the obstacle. The obstacle would on the other hand not cause discomfort and unnecessary wearing of the vehicle because it is formed as a road print being a perspective projection of a three-dimensional road element, and the vehicle can therefore just drive over the road print. The road print could be embodied by painting the projection of the 3D road element directly on the road or by printing the projection onto a print carrier

that could be placed on the road. The 3D road element could for instance be a speed bump, a chicane, a signal cone, a road sign, a road hole or the like.

[0010] In another embodiment of the road element, said given position from said road print corresponds to the driver of a vehicle moving towards the road print. Hereby a driver would see the projection of the road bump as a 3-dimensional road element when approaching the road element and thus correct his/her way of driving according to the appearance of the road element.

[0011] In another embodiment of the road element, said three-dimensional road element is a speed bump. The road user would then correct his/her way of driving according to the speed bump and as a consequence decrease the speed of driving. The road bump would not cause discomfort and unnecessary wear of the vehicle when the driver passes the road element.

[0012] In another embodiment of the road element, said road print is printed on a print carrier. Hereby it is possible to print the road print on a print carrier which could be put on the road in various places, for instance in connection with road work where the 3D road element could be formed as a warning cone that could be moved from place to place according to the progress of the road work.

[0013] In another embodiment of the road element, said road print is being inked into said print carrier. Hereby the road print could be integrated as a part of the print carrier and the road print would therefore not disappear when the surface of the print carrier is worn e.g. due to friction between the vehicles' tires and the surface.

[0014] In another embodiment of the road element, said print carrier is formed by wear-resistant material such as metal, rubber or the like. Hereby the needed maintenance for the print carrier is decreased and the lifetime of the print carrier is increased.

[0015] In another embodiment of the road element, said road print is painted on the road. Hereby a permanent road print illustrating a 3D road element is provided. This could for instance be a 3D 'No Entry' sign placed at an exit from a motorway in order to prevent drivers to become ghost drivers. Further, it is difficult for malicious persons to remove the road element.

[0016] The present invention further relates to a method for manufacturing a two-dimensional road element for influencing the behavior of a road user, said method comprises the step of transforming a three-dimensional road element into a road element by performing a perspective projection of said three-dimensional road element to a surface of the road or in close proximity of the road such that said transformation is optimised for a viewer within a given position from said road element. Hereby the same advantages as described above are achieved.

[0017] The present invention further relates to a method for reducing the speed of a vehicle on a road, where the method comprises the step of placing a road element as described above in close proximity to said road. Hereby the same advantages as described above are achieved.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In the following, preferred embodiments of the invention will be described referring to the figures, where

Figure 1 a and 1b illustrate a side view and a top view of how a print according to the present invention can be made,

Figure 2a and 2b illustrate a side view and a top view of a specific embodiment of how a print according to the present invention can be made,

Figure 3 illustrates how the length of a substantially plane print is determined,

Figure 4a and 4b illustrate proportional stretching of the plane of projection in length,

Figure 5 illustrates how the size of each projected sub mask is determined,

Figure 6a and 6b illustrate proportional stretching of the plane of projection in width,

Figure 7a and 7b illustrate a speed bump according the present invention,

Figure 8a and 8b illustrate another embodiment of the present invention.

## DESCRIPTION OF EMBODIMENTS

[0019] Figure 1a and 1b illustrate how a road print according to the present invention can be made. The figures illustrate the viewer, a road user, 101 together with a cube shaped three-dimensional object 103 which is to be transformed to

the road print 104. In figure 1a a side view of the viewer 101 and the object 103 is illustrated, and in figure 1b a top view of the viewer 101 and the object 103 is illustrated.

**[0020]** In order to perform the projection, it is first determined which viewpoint (also called central fictive viewpoint 109) the print is to be optimised for. In figure 1, the position is determined by using the distance 105 from the ground to the central fictive viewpoint 109 and the distance 107 between the central fictive viewpoint 109 and the front of the three-dimensional object 103.

**[0021]** Each point in the three-dimensional object 103 is then projected to a point on the road print 104. This is performed according to a projection line defined as a line connecting the point in the three-dimensional element to be projected and the central fictive viewpoint 109. In 1 a, it must be noticed that the points placed at the longest distance from the viewer are the points 123 being a projection of the points 121 in the cube, and the points placed at the shortest distance from the viewer are the points 125. Thereby the total length of the print 127 is the distance between the points 123 and 125. The applied projection is then a perspective projection meaning that each point has its own projection vector or projection line defined by the central fictive viewpoint and the selected point on the 3D object.

**[0022]** Since the viewer 101 has two viewpoints, a left 111 and a right 113, it is necessary to compensate by choosing the left viewpoint 111 for projecting one side 117 of the element and then choosing the right viewpoint 113 for the other side 115 of the element. The left viewpoint and the right viewpoint are defined as being on the left and the right side of the central fictive viewpoint 109 and approximately in the same vertical axis as the central fictive viewpoint 109. In figure 1b, the left viewpoint 111 has been used for the right side 117, and the right viewpoint 113 has been used for the left side 115. In another embodiment this could be different such that the left viewpoint is used for the left side and the right viewpoint is used for the right side. In figure 1b, the left boundary 137 of the road print 104 is parallel to the projection line 131 connecting the right viewpoint 113 and the point 119, and the right boundary 139 of the road print 104 is parallel to the projection line 133 connecting the left viewpoint 111 and the point 135.

**[0023]** After having described above some properties of a road print generated by a projection of a three-dimensional element, a method of generating a road print will be described in the following.

**[0024]** It can be a complex affair to perform the projection of a physical three-dimensional element. One way of doing it could be by generating a model of the physical element in a computer program and then perform the projection using the computer program according to the above-described. This would require that it is possible to generate a computer model of the element, and especially in the case of very complex elements this could be a very cumbersome process.

**[0025]** Alternatively, it could be performed in a more simple and cost effective way illustrated by figure 2a and 2b. Here a plane of projection 201 has been generated between the viewer 203 and the road print 205, where the plane of projection 201 is a two-dimensional plane to which the three-dimensional element 207 has been projected. In a specific embodiment, the plane of projection can easily be generated by taking a photo of the three-dimensional element 207 from a predefined point in the line of sight 209 defined between the viewpoint 211 and the three-dimensional element 207, or it can be generated by using a combination of 2 photos taken from each of the viewpoints 213 and 217 and projected onto the plane 201.

**[0026]** The plane of projection 201 is then projected to the road print 205, similar to the method of projecting the three-dimensional element, by projecting each point in the plane of projection 201 to a point on the road print 205 according to a projection line connecting the viewpoint 211 and the point on the plane. Again, since the viewer has two viewpoints, a left and a right eye, it is necessary to compensate by choosing the left viewpoint for projecting one side of the plane and then choosing the right viewpoint for the other side of the plane. In figure 2b, the left viewpoint 213 has been used for the right side 219 and the right viewpoint 217 has been used for the left side 215.

**[0027]** In the following, it is described how the projection can be performed by stretching the plane of projection in both width and length according to determined boundaries.

**[0028]** In figure 3, it is illustrated how much the plane of projection is to be stretched in length. The plane of projection is illustrated by 301 when the plane of projection is projected to the road print 303, the points on the print being placed at the longest distance from the viewer are the points 305 being a projection of the points 307 in the plane of projection 301. The points being placed at the shortest distance from the viewer are the points 309. Thereby the total length of the print is the distance between the points 305 and 309. Having determined the length boundaries 305 and 309, the print can be generated by stretching the plane of projection in such a way that the point 307 is placed at the point 305. The stretching could be performed in a simple linear way; however, this would distort the element which is to be illustrated by the print making the illusion to be obtained by the print less effective.

**[0029]** In figure 4a and 4b proportional stretching is introduced, which, compared to the linear stretching described above, results in less distortion in the element, which is to be illustrated by the road print. The plane of projection 401 is divided into equally sized sub masks 402, 404 and 406, and for each sub mask a top point 405 and a bottom point 403 is defined. The top point 405 and the bottom point 403 are then projected to the print in order to define the length of the sub mask; thereafter each sub mask is stretched similar to the method described in connection with figure 3.

**[0030]** In figure 4b, the plane of projection is shown from an angle perpendicular to the plane of projection, and it is illustrated how the road print can be generated by stretching the plane of projection. The plane of projection is first

illustrated in 411; then a number of sub masks are defined as shown in 413. Each sub mask is calculated, and finally the projected print 415 is obtained by stretching each sub mask depending on the angle between the line of sight and the road print. The sub masks having the longest distance to the viewpoint are stretched the most since the angle between the surface and the line from the viewpoint to the top sub mask is the smallest. In theory, the optimal projection would be to divide the plane of projection into an infinite number of sub masks, however, testing has shown that dividing the plane of projection into sub masks having a height being approximately 5-10% of the total height of the plane of projection results in quite a good improvement of the projection compared to linear stretching or orthogonal projection in a 3D-Computer Aided Design program.

**[0031]** Using figure 5, it is explained how the size of each projected sub mask is determined and thereby how much each sub mask should be stretched. The figure illustrates the viewer 501 with the central fictive viewpoint 502 and the plane of projection 503. The plane of projection has been horizontally divided into a number of sub masks n1 -> nN, where n1 is the first sub mask and nN is the final sub mask in the plane of projection 503. First the angles A1->AN must be determined which can be done according to the following formula:

$$\angle A_n = A \tan \left( \frac{VH - nn \times c \times \sin(90 - A0)}{V0 + nn \times c \times \cos(90 - A0)} \right)$$

where nn is the sub mask number and An is the angle between the projection line and the projection surface 505, the projection line being defined between the central fictive viewpoint 502 and the top point of the sub mask nn. V0 is the ground distance 507 between the central fictive viewpoint 502 and the bottom projection point 509 of the plane of projection 503. A0 is the angle between the projection line and the projection surface 505, the projection line being defined between the central fictive viewpoint 502 and the bottom point of the sub mask n1. VH is the upright distance 511 from the projection surface 505 to the central fictive viewpoint 502. After having determined the angles A1->AN, the length of each projected sub mask V1->VN can be determined by the following:

$$V_n = \frac{VH}{\left( \frac{VH - nn \times c \times \sin(90 - A0)}{V0 + nn \times c \times \cos(90 - A0)} \right)} - \frac{VH}{\left( \frac{VH - (nn - 1) \times c \times \sin(90 - A0)}{V0 + (nn - 1) \times c \times \cos(90 - A0)} \right)}$$

where Vn is the length of the n'th projected sub mask. Having determined V1->VN each sub mask n1->nN can be stretched accordingly.

**[0032]** In figure 6a and 6b, the left width boundary 601 and the right width boundary 603 of the print are illustrated. The left width boundary 601 is defined as being parallel to the projection line 605 from the first viewpoint to the left corner point of the object in the plane of projection; and the right width boundary 603 is defined as being parallel to the projection line 607 from the second viewpoint, being different from the first viewpoint, to the right corner point of the object in the plane of projection, where the first and second viewpoint are either the left or right eye. Having defined the left and the right boundaries and the print having been stretched in length, the print can now be stretched in width according to the defined boundaries. In figure 6b, the print having been stretched in length is illustrated in 611 being divided in a number of vertical sub masks, and in 613 it is illustrated how each sub mask is stretched proportionally. Again, the stretching could be performed linear, but by using proportional stretching it results in less distortion in the element, which is to be illustrated by the print.

**[0033]** It has been described how the projection is first performed according to a central fictive viewpoint after which the left side is compensated for to the right eye and the right side is compensated to the left eye resulting in a projection where the right side is a perspective projection optimised to the left eye and vice versa. This could also be performed in a similar way such that a projection is obtained where the right side is a perspective projection optimised to the right eye and vice versa. Further, the object to be projected could be fully projected by each eye, and then afterwards the two projections could be divided in two parts and combined such that a projection is obtained where the right side is a perspective projection to one eye and the left side is optimised to the other eye. In this case, the projections could be divided in two halves at a centreline, and afterwards the left half of one projection is combined with the right half from the other projection resulting in a single projection.

**[0034]** Figure 7 illustrates an embodiment of a road element 701 according to the present invention. The road element 701 is a projection of a curved speed bump with dark 702 and bright 703 squares. Figure 7a illustrates the road element seen from above and figure 7b illustrates the road element as seen by a driver approaching the speed bump. The road

element 701 is made by using linear stretching both in depth and in width by stretching the left part 713 and the right part 715 according to the left and right viewpoint. The distance between the dash-dotted lines 704 illustrates that the length stretching is linear, meaning that each sub mask 705 of the plane of projection has been stretched equally.

[0035] Figure 7b illustrates how the road print of figure 7a is intended to be intercepted as a three-dimensional road bump by a driver having two viewpoints. The driver would therefore automatically adapt his/her way of driving according to the road element because s/he would intercept the three-dimensional road bump as a real road bump.

[0036] Figure 8 illustrates an embodiment of a road element 801 according to the present invention where the road element illustrates a three-dimensional stop cone with the word "stop" 802 at the front side. Further, the road 803 is illustrated in dotted lines. Figure 8a illustrates the road element seen from above, and figure 8b illustrates the road element as seen by a driver. The road element 801 is, in this embodiment, made by using proportional stretching both in width and in depth as described above. The dash-dotted lines 809 illustrate that the lower sub mask 811 of the plane of projection has been stretched less and then the stretch increases to a maximum at the top sub mask 813. As mentioned earlier, this is because the angle between the surface and the line from the viewpoint to the sub mask is largest at the lower sub mask and then decreases to a minimum at the top sub mask.

[0037] Figure 8b illustrates how the road print of figure 8a is intended to be intercepted as a three-dimensional stop cone bump by a driver having two viewpoints. The driver would easily see and register the stop cone since it for the driver would appear to be placed in the middle of the road. The driver would therefore adjust his/her way of driving according to the road element.

[0038] The road element according to the present invention could be painted directly onto the road and/or pavement and thus be considered a permanent road element. The road element could, however, in another embodiment be painted onto a print carrier making it possible to place the road element at various places, for instance as warning signs in connection with road constructions sites where the road element often needs to be replaced according to the progress of the road work.

[0039] It is to be understood that the illustrated embodiments serve as illustrating examples only, and that a person skilled in the art would be able to construct a various number of embodiments within the scope of the claims.

## Claims

1. A road element for influencing the behavior of the road user, for instance a road obstacle, **characterized in that** said road element comprises a road print being a perspective projection of a three-dimensional element, where said road print is optimized for a viewer within a given position from said road print, where said road print is placed upon or integrated into the surface of the road or in close proximity to the road
2. A road element according to claim 1 **characterized in that** said given position from said road print corresponds to the driver of a vehicle moving towards the road print.
3. A road element according to any of the preceding claims 1-2 **characterized in that** said three-dimensional road element is a speed bump.
4. A road element according to any of the preceding claims 1-3 **characterized in that** said road print is printed on a print carrier.
5. A road element according to claim 4 **characterized in that** said road print is inked into said print carrier.
6. A road element according to any of the preceding claims 4-5 **characterized in that** said print carrier is formed by wear-resistant material.
7. A road element according to any of the claims 1-3 **characterized in that** said road print is painted on the road.
8. A method for manufacturing a two-dimensional road element for influencing the behavior of a road user, said method comprises the step of: - transforming a three-dimensional road element into a road element by performing a perspective projection of said three-dimensional road element to a surface of the road or in close proximity to the road such that said transformation is optimised for a viewer within a given position from said road element.
9. A method for reducing the speed of a vehicle on a road, where the method comprises the step of placing a road element according to any of the preceding claims 1-7 in close proximity to said road.

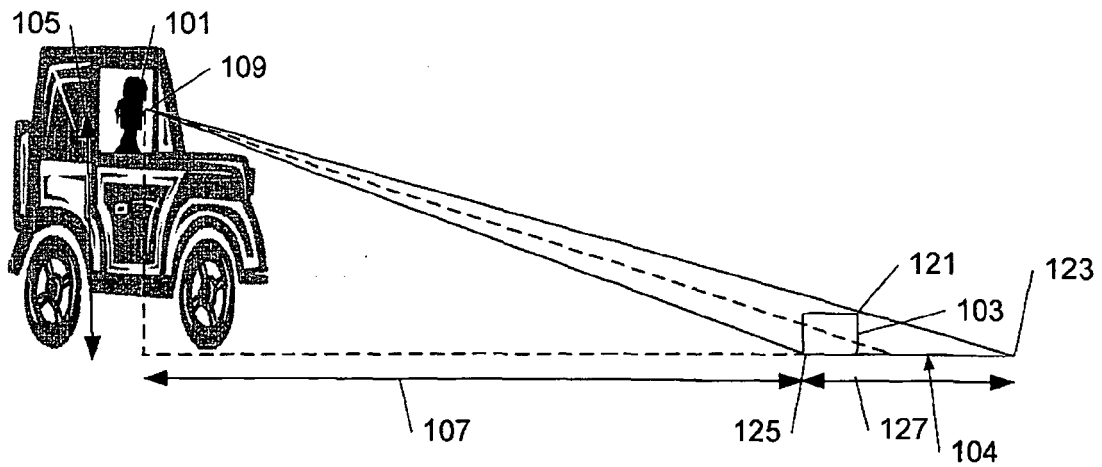


Fig. 1a

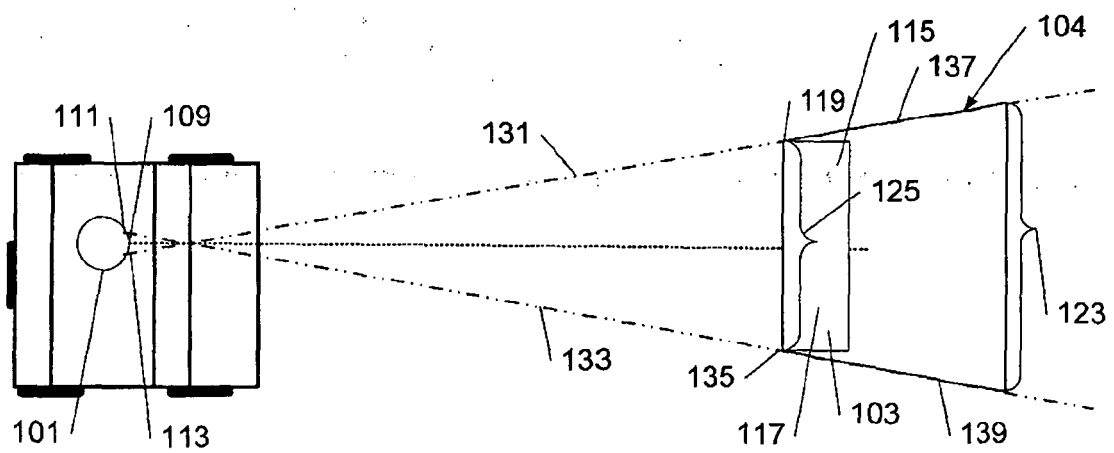
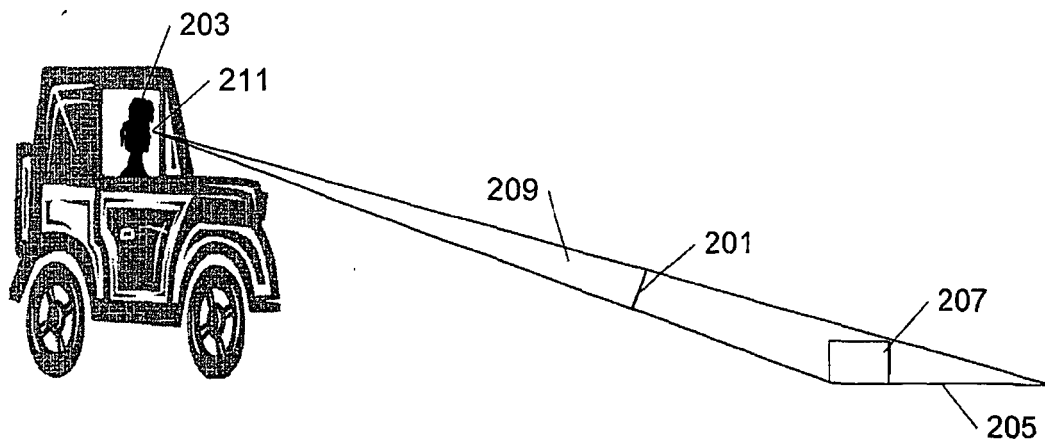
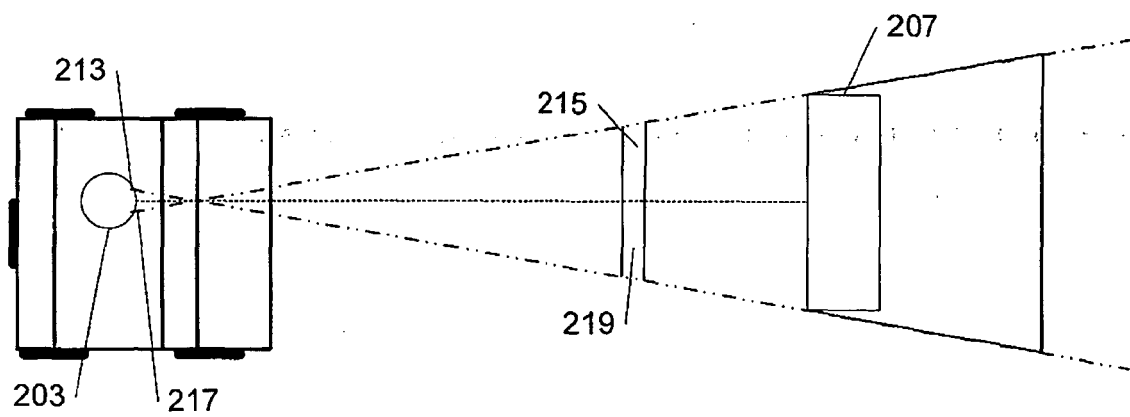


Fig. 1b

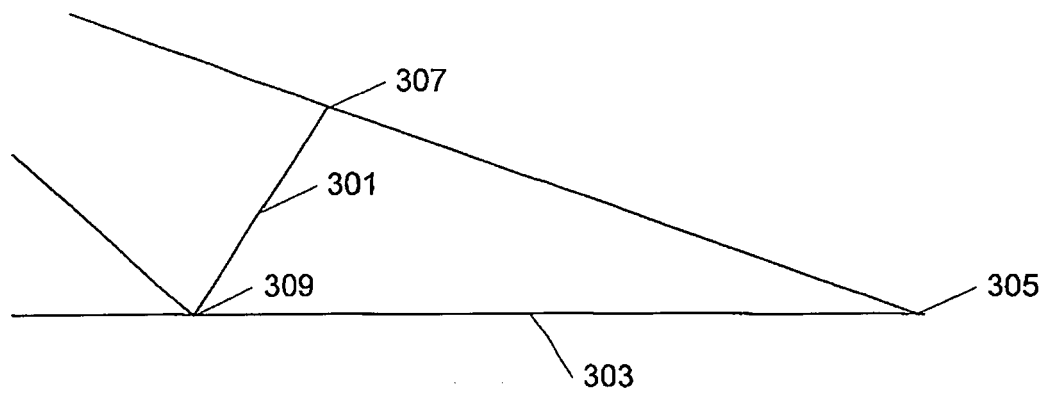


**Fig. 2a**

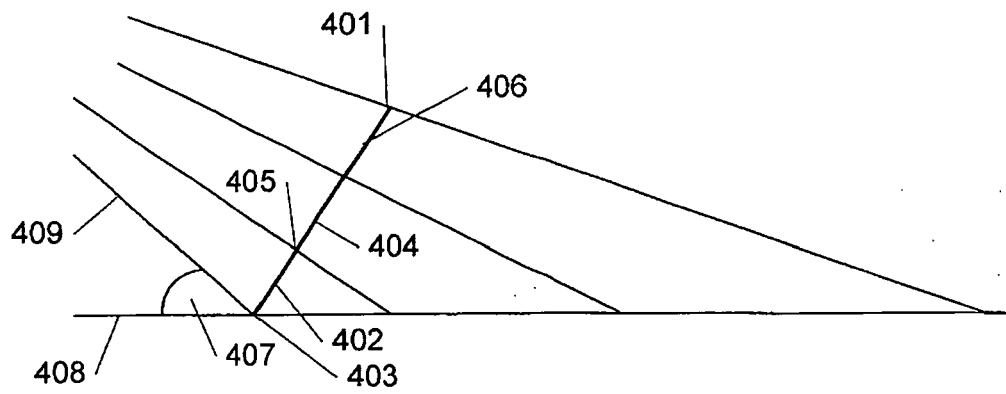


**Fig. 2b**

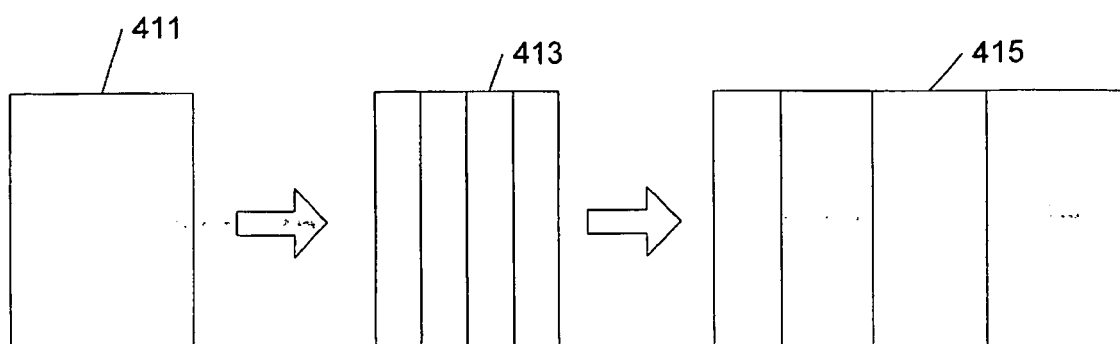




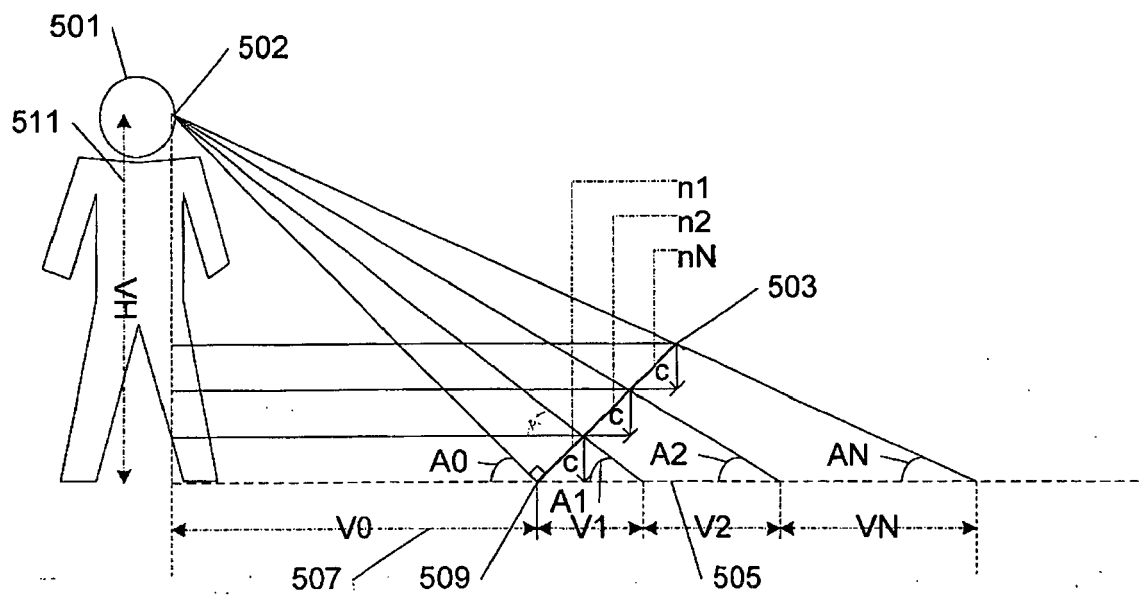
**Fig. 3**



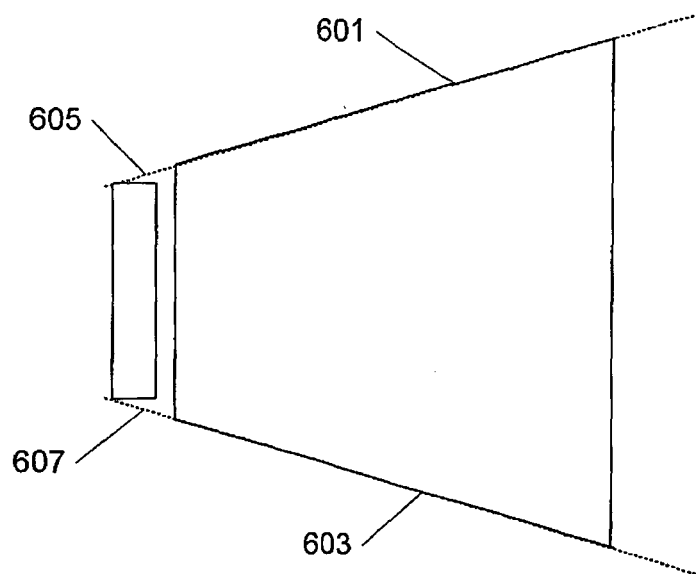
**Fig. 4a**



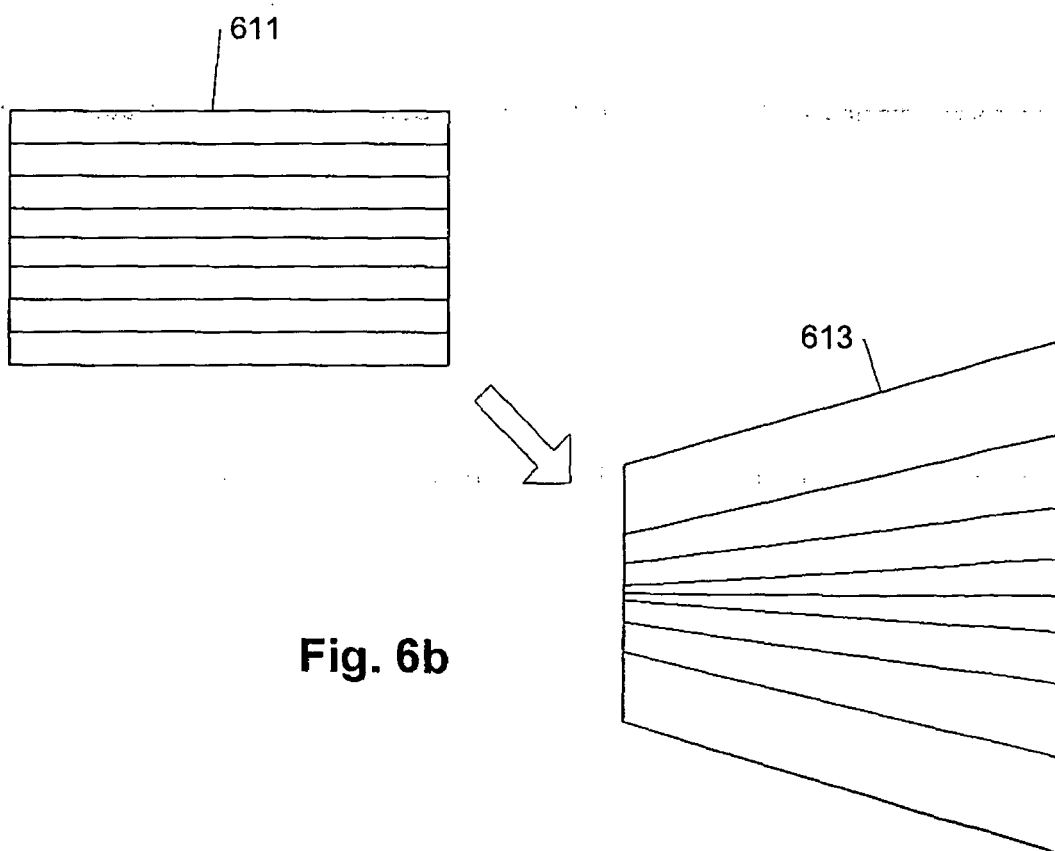
**Fig. 4b**



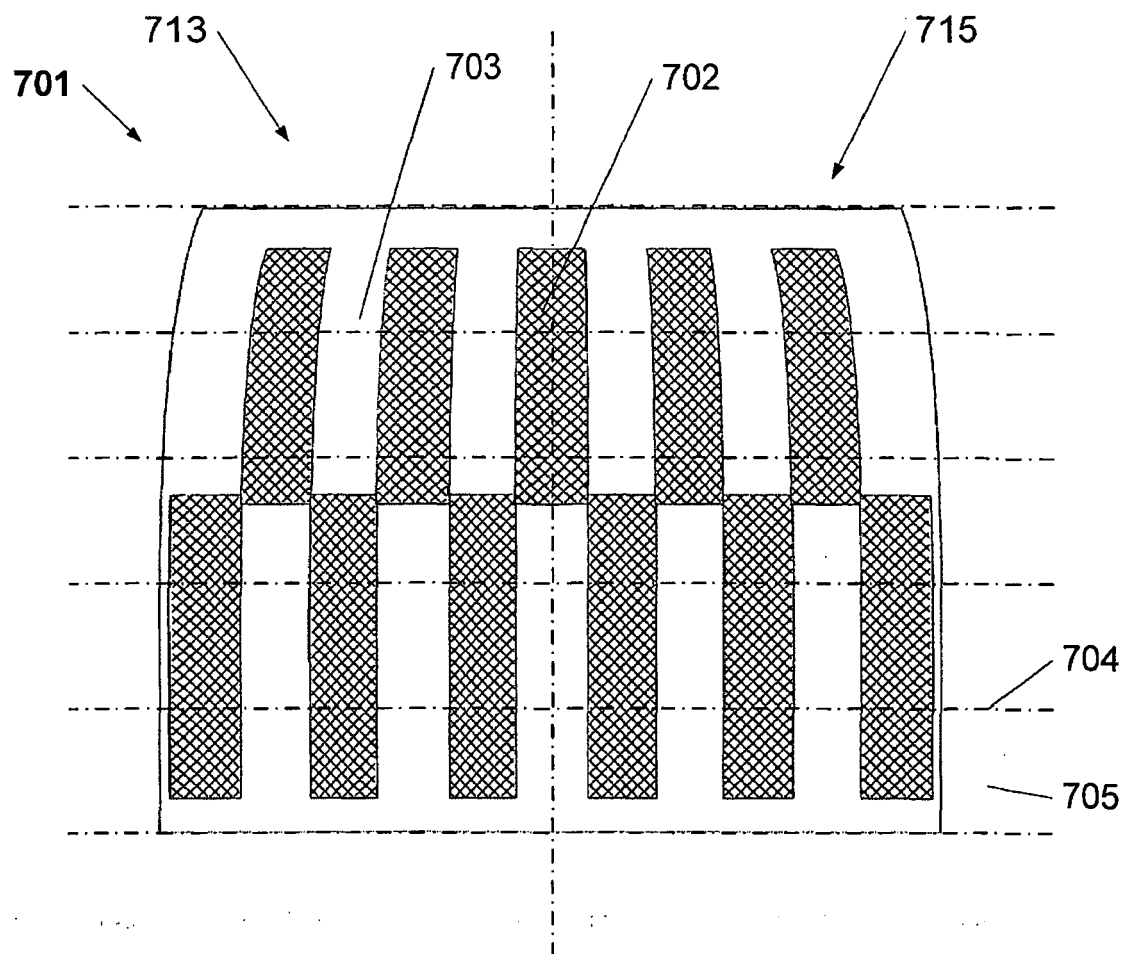
**Fig. 5**



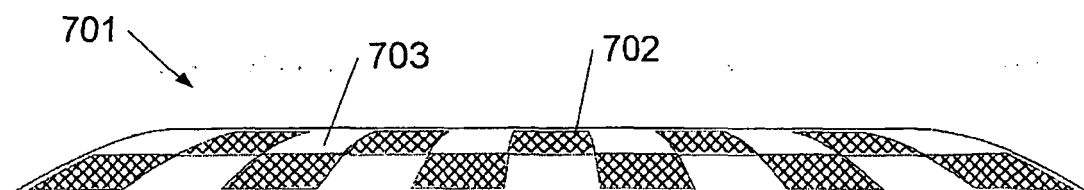
**Fig. 6a**



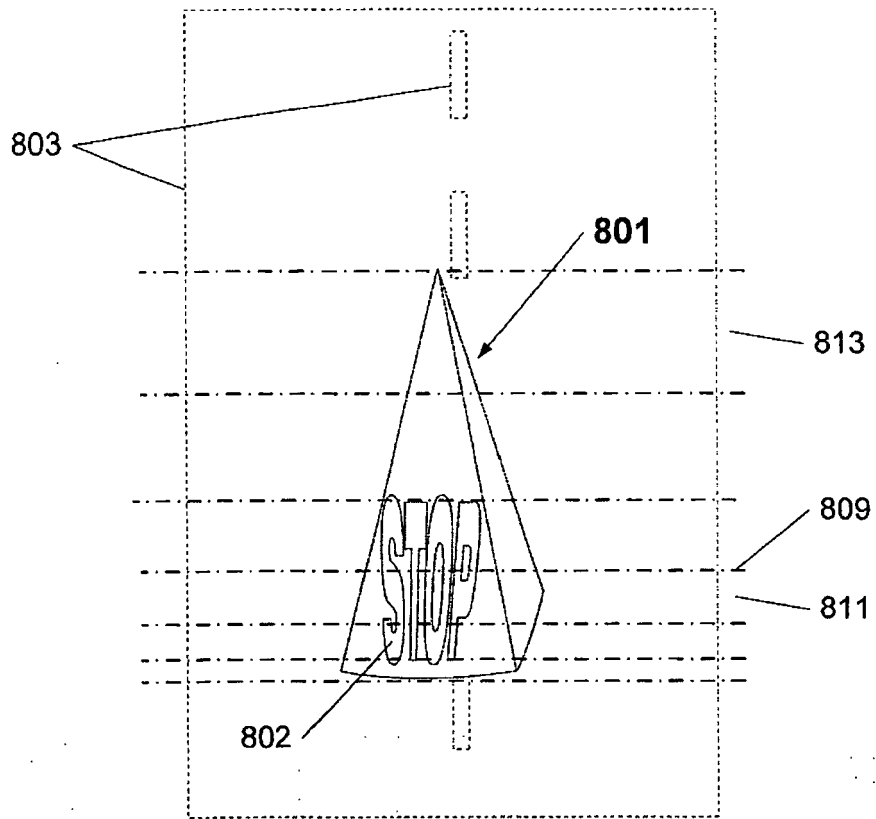
**Fig. 6b**



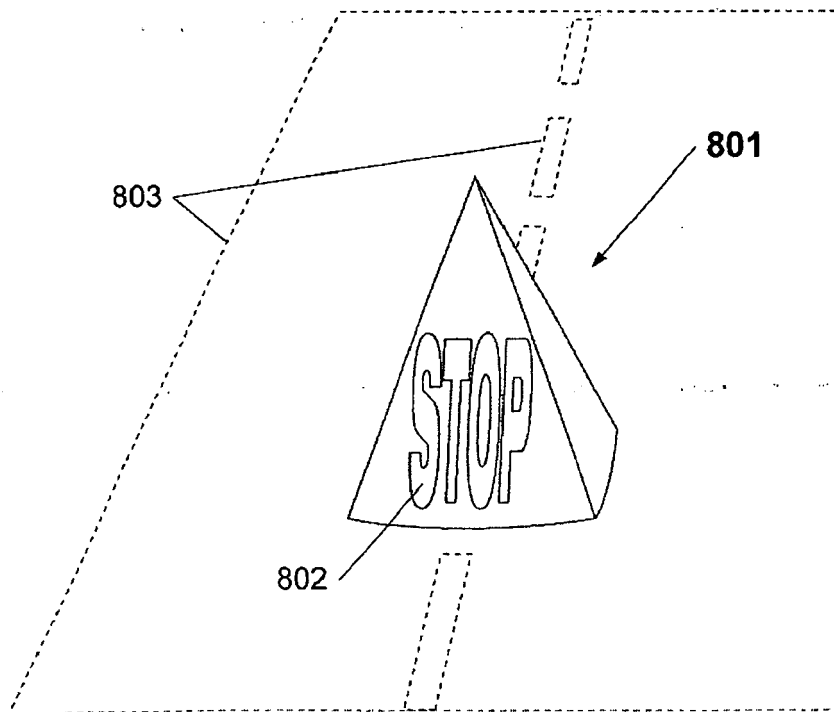
**Fig. 7a**



**Fig. 7b**



**Fig. 8a**



**Fig. 8b**



European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 07 00 0553

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