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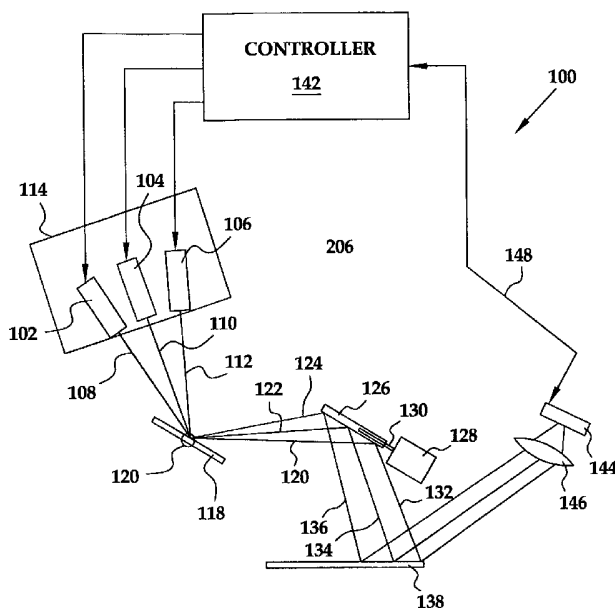
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[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR DISPLAYING INFORMATION IN AUTOMOTIVE APPLICATION USING A LASER PROJECTION DISPLAY



(57) Abstract: A method and apparatus are provided to controllably reduce power of a laser projection display (LPD) in response to detecting a variation in a viewing surface. During the operation of the LPD, a controller 142 monitors laser light being reflected from the viewing surface. Since the controller 142 "knows" the amount of power that the LPD is being instructed to deliver, it may compare the known power to the reflected laser light to determine if a foreign object may be in the path of the laser light, and therefore, affecting the magnitude of the laser light. The controller 142 responds to detecting such an event by reducing power to the lasers.

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# METHOD AND APPARATUS FOR DISPLAYING INFORMATION IN AUTOMOTIVE APPLICATION USING A LASER PROJECTION DISPLAY

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## BACKGROUND OF THE INVENTION

### 1. FIELD OF THE INVENTION

This invention relates generally to electronic displays, and, more particularly, to a laser projection display within a vehicle.

10

### 2. DESCRIPTION OF THE RELATED ART

In a vehicle, considerable information may be presented to the occupants. Some of the information relates to the operating conditions of the vehicle, such as speed, RPMs, temperature, oil pressure and the like, and is generally of substantially continuous interest and importance to at least the driver of the vehicle. Other information, may relate to more transitory events, such as alarms, warning conditions, and the like, and their importance may be high but not of continuous interest. Finally, other information may be considered entertainment, such as a radio or DVD player, and its importance may be substantially reduced, depending on other factors.

Typically, these various types of information are presented to the occupants of the vehicle using separate and distinct devices that are specifically designed for that purpose. Typically, a vehicle's speedometer and climate control have two separate displays that are located according to their importance to the driver. Moreover, these devices are typically assigned a position in the vehicle that is relatively permanent. For example, under normal operating conditions the driver of a vehicle may be most interested in the speed of his vehicle. Accordingly, the speedometer is located in a prominent position in the driver's direct field of view. At other times, however, it may be useful for the driver to have access to other more

interesting or compelling information. For example, warning information may take precedence over normal operating information, and yet, the warning information may be assigned a less prominent location. Further, entertainment type devices, such as radios and CD players, are assigned the least prominent position relative to the driver. Thus, when the driver operates the  
5 radio, his/her attention may be diverted from the primary task of driving the vehicle.

The present invention is directed to overcoming, or at least reducing, the effects of one or more of the problems set forth above.

### **SUMMARY OF THE INVENTION**

10 In one aspect of the instant invention, an apparatus for displaying information in vehicle is provided. The apparatus comprises a laser projector and a viewing surface positioned to receive a variable image from the laser projector.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

15 The invention may be understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements, and in which:

Figure 1 is a stylistic block diagram of a top level view of one embodiment of the present invention;

20 Figure 2 is a stylistic view of a viewing surface shown in Figure 1;

Figures 3A and 3B depict a top view of a scanning device at various times during its operation;

Figure 4 depicts one embodiment of a vehicle dashboard employing aspects of the instant invention;

Figure 5 depicts an alternative embodiment of a vehicle dashboard employing aspects of the instant invention; and

Figure 6 depicts one embodiment of a rear seat entertainment system deployed in a vehicle employing aspects of the instant invention.

5 While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives  
10 falling within the spirit and scope of the invention as defined by the appended claims.

#### **DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS**

Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course  
15 be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for  
20 those of ordinary skill in the art having the benefit of this disclosure.

The following co-pending applications are hereby incorporated by reference herein in their entirety: Method and Apparatus for Aligning a Plurality of Lasers in an Electronic Display Device, by Mik Stern et. al.; Method and Apparatus for Controllably Reducing Power Delivered by a Laser Projection Display, by Mik Stern et. al.; Method and Apparatus for

Providing an Interface Between a Liquid Crystal Display Controller and a Laser Projection Display, by Narayan Nambudiri et. al.; A Color Laser Projection Display by Paul Dvorkis et. al.; Method and Apparatus for Capturing Images Using A Color Laser Projection Display, by Chinh Tan et. al.; Method and Apparatus for Conserving Power in a Laser Projection Display, 5 By Fred Wood et. al.; A Laser Projection Display, by Ron Goldman et. al.; Method and Apparatus for Controllably Compensating for Distortions in a Laser Projection Display, by Carl Wittenberg et. al.; and Method and Apparatus for Controllably Modulating a Laser in a Laser Projection Display, by Dmitriy Yavid et. al.

Turning now to the drawings, and specifically referring to Figure 1, a stylistic block 10 diagram of a laser projection display (LPD) 100, in accordance with one embodiment of the present invention, is shown. In the illustrated embodiment, the LPD 100 includes three lasers 102, 104, 106, each capable of emitting a beam of light 108, 110, 112 consisting of a unique color, such as red, green or blue. Those skilled in the art will appreciate that the number of lasers and the color of light emitted therefrom may be varied without departing from the spirit 15 and scope of the instant invention.

The lasers 102, 104, 106 are arranged in a common plane 114 with the beams of light 108, 110, 112 being angularly directed relative to one another to fall on a substantially common location 116 on a first scanning device, such as a first scanning mirror 118, from where they are reflected as beams of light 120, 122, 124. In the illustrated embodiment, the 20 first scanning mirror 118 oscillates on an axis 120 at a relatively high rate (e.g., about 20-30 Khz). Rotation or oscillation of the first scanning mirror 118 causes the beams of light 108, 110, 112 to be moved. That is, as the angular position of the first scanning mirror 118 alters, so to does the angle of reflection of the beams of light 120, 122, 124 from the first scanning mirror 118. Thus, as the mirror oscillates the reflected beams of light 120, 122, 124 are

scanned to produce movement of the beams of light 120, 122, 124 along one component of the two-dimensional display.

The second component of the two-dimensional display is produced by a second scanning device, such as a mirror 126. In the illustrated embodiment, the second mirror 126 is coupled to a motor 128 at a pivot point 130 so as to produce rotational or oscillating movement about an axis that is substantially orthogonal to the axis of rotation of the first mirror 118. The beams of light 120, 122, 124 are reflected off of the second mirror 126 as beams of light 132, 134, 136 and directed to a viewing surface 138. The viewing surface 138 may take on any of a variety of forms without departing from the spirit and scope of the instant invention. For example, the viewing surface 138 may be a fixed screen that may be front or back lit by the lasers 102, 104, 106 and may be contained in a housing (not shown) that is common with the LPD 100, or alternatively, the viewing surface 138 may take the form of any convenient, generally flat surface, such as a wall or screen, spaced from the LPD 100.

The second mirror 126 oscillates or rotates at a relatively slow rate, as compared to the rate of the first mirror 118 (e.g., 60 hz). Thus, it will be appreciated that, as shown in Figure 2, the beams of light 132, 134, 136 generally follow a path 140 on the display surface 138. Those skilled in the art will appreciate that the path 140 is similar in shape and concept to a raster scan commonly employed in cathode ray tube televisions and computer monitors.

While the instant invention is described herein in the context of an embodiment that employs separate first and second scanning mirrors 118, 126, those skilled in the art will appreciate that a similar path 140 may be produced by using a single mirror. The single mirror would be capable of being moved about two axis of rotation to provide the fast and slow oscillating movements along two orthogonal axes.

As is apparent from Figure 1, owing to the angular positioning of the lasers 102, 104, 106, even though the lasers 102, 104, 106 have been arranged mechanically and optically to deliver the beams of light 108, 110, 112 within the same plane 114 and at the same point (on the rotational axis 120) on the mirror 118), each has a different angle of reflection, which causes the beams of light 120, 122, 124 to diverge. A controller 142 is provided to controllably energize the lasers 102, 104, 106 to effectively cause the beams of light 120, 122, 124 to be collinear, such that they may be reflected off of the second mirror 126 and delivered to the same point on the viewing surface 138 relatively independent of the distance of the viewing surface 138 from the second mirror 126.

Turning now to Figures 3A and 3B, the operation of the controller 142 to cause the beams of light 120, 122, 124 to be collinear is discussed. To simplify the discussion, only two lasers 102, 104 are illustrated in Figure 3, but those skilled in the art will appreciate that the concepts discussed herein may be extended to three or more lasers without departing from the spirit and scope of the instant invention. As shown in Figure 3A, if the lasers 102, 104 are energized simultaneously, the reflected beams of light 120, 122 diverge. However, as shown in Figure 3B, if the lasers 102, 104 are energized at slightly different times, then the beams of light 120, 122 can be made to follow a single, common path (i.e., the beams of light 120, 122 are collinear). For example, if the laser 102 is energized at a first time  $t_1$ , then the mirror 118 will be at a first position, as represented by the solid lines, and the beam of light 108 will reflect off of the mirror 118 as the beam of light 120. Subsequently, if the laser 104 is energized at a second time  $t_2$ , then the mirror 118 will be at a second position, as represented by the dashed lines, and the beam of light 110 will reflect off of the mirror 118 as the beam of light 122. By precisely controlling the time  $t_2$ , the mirror 118 will be in a position to

accurately reflect the beam of light 122 along substantially the same path as the beam of light 120.

Thus, through the operation of the controller 142, the beams of light 120, 122 are substantially collinear, but are slightly displaced in time. That is, the beams of light 120, 122 will now both be projected onto substantially the same point on the display surface 138, but at slightly different times. However, owing to the persistence of the human eye, the variation in timing is not detectable. That is, in the case of the three laser system described in Figure 1, each of the lasers 102, 104, 106 will controllably deliver laser light of a unique color and intensity to substantially the same point on the viewing surface 132 within a relatively short window of time. The human eye will not detect the three separate colors, but rather will perceive a blending of the three light beams such that a consistent and desired hue appears at that point on the viewing surface. Those skilled in the art will appreciate that this process may be repeated numerous times along the path 140 to recreate a picture on the viewing surface 132.

Returning to Figure 1, a photodetector 144 is arranged to receive laser light reflected from the viewing surface 138. The photodetector 144 may take any of a variety of forms, including a single photosensitive element or a plurality of photosensitive elements arranged in a grid. In some embodiments, it may be useful to include a mechanical/optical system 146 to focus the reflected laser light onto the photodetector 144.

The photodetector 144 is coupled to the controller 142 via a line 148. Signals indicative of the magnitude of the reflected laser light detected by the photodetector 144 may be communicated to the controller 142 over the line 148. In some instances, such as when the photodetector 144 is composed of a grid or an array of photosensors or photosensitive elements, it may be useful to also convey information regarding the location of the reflected

laser light. As discussed in more detail in conjunction with Figure 4, the controller 142 may use the information regarding the magnitude of the reflected laser light to generally determine if conditions within the transmission path of the lasers have changed, such as by being interrupted by a person or object. The controller 142 may use information regarding such an event to determine if the viewing surface has been touched. That is, the viewing screen may be rendered “touch sensitive,” and thus, may provide a form of feedback from an operator.

The controller 142 may display a pushbutton or other accessible icon on the viewing surface, and if the controller 142 detects that the portion of the viewing surface displaying the pushbutton has been touched, then the controller 142 may take a responsive action. For example, the controller 142 may display an icon labeled “headlights,” and if the controller 142 detects that a user has touched the “headlights” icon, the controller may turn on the headlights. Similarly, numerous other functions may implemented by way of appropriately configured or labeled icons displayed on the viewing surface.

The viewing surface 138 may take any of a variety of forms, and may be either frontlit or backlit. One embodiment of a vehicle dashboard employing aspects of the instant invention is shown in Figure 4. In the illustrated embodiment, an LPD 400 is positioned to display one or more images on a windshield 402 and/or on an instrument panel 404. The LPD 400 projects an image that is at least partially reflected via a mirror 405 upwards onto an interior surface of the windshield 402. In some embodiments, the interior surface of the windshield 402 may have a region 406 that is treated to enhance the visibility of the image seen by the driver of the vehicle. For example, the region 406 may have a reflective material applied thereto so that at least a portion of the laser light transmitted by the LPD 400 will be reflected off the windshield 402 and be visible to the driver. In this manner, the LPD 400 may be used to produce a “heads up” display for presenting information to the driver of the vehicle.

At least a portion of the display projected by the LPD 400 may pass through or around the mirror 405 to reach a rear surface of an instrument panel 404. In the illustrated embodiment, the instrument panel may be constructed or formed from a material that may be backlit by the LPD 400 and viewed by the driver of the vehicle. That is, at least a portion of the laser light striking a rear surface of the instrument panel 404 will pass therethrough and be visible on a front surface of the instrument panel 404.

Those skilled in the art will appreciate that a variety of icons or images may be displayed on the windshield 402 and/or the instrument panel 404 to convey information to the driver of the vehicle and to provide an interface that allows the driver to control the operation of the vehicle or subsystems contained therein, or to modify the appearance and location of information and/or icons displayed on the instrument panel 404 or the windshield 402. The driver may arrange the instruments displayed on his/her dashboard according to personal preference, such as by selecting one of a series of preselected arrangements, or by customizing the appearance of the instruments. For example, the location of an instrument may be modified by a "drag and drop" operation. The driver may select an instrument by touching the instrument panel where the instrument is displayed and then dragging his finger to a new, more desirable location.

Additionally, the controller 142 may be programmed with a preselected or customizable priority scheme regarding the location and brightness of certain instruments/information. That is, under normal operating conditions it may be useful to display the vehicle speed in a prominent location on the instrument panel 404 or windshield 402. However, if certain conditions are detected, then the controller 142 may, at least temporarily, reorganize the display to feature new, significant information. For example, if the outside temperature is detected to have fallen to the freezing point, it may be beneficial to display this information

prominently on the instrument panel 404 or windshield 402 to better gain the attention of the driver. Warning information regarding the condition of the vehicle may be treated similarly. For example, information regarding an overheating engine may be displayed with a large, bright or even flashing icon.

5           Turning now to Figure 5, an alternative embodiment of a layout for the LPD 400 is shown. In this embodiment, the LPD 400 is located so that both the instrument panel 404 and the windshield 402 are frontlit. The LPD 400 may also be used to display images for an entertainment system 500 viewable by the occupants of the rear seat of the vehicle. A mirror 502 may be positioned to receive at least a portion of the laser light projected by the LPD 400  
10 and reflect it onto a rear surface of a backlit screen 504. The LPD 400 may then be used to display movies, television programs, games, videophone images, or the like.

Figure 6 illustrates an alternative entertainment system 600 in which the LPD 400 is positioned to project a display on a first and second frontlit screen 601, 602. The screens 601, 602 may be located on a rear surface of the front driver and passenger seats. In this manner,  
15 the LPD 400 may display movies, television programs, games, videophone images, or the like on the screens 601, 602. Moreover, the same or different images may be displayed on the two screens 601, 602. The first scanning mirror 118 (see Fig 1) of the LPD 400 may be configured to scan laser light horizontally (and vertically) across both of the screens 601, 602. The controller 142 may be programmed to turn off the lasers during the time that the mirror 118 is  
20 directed to the region between the screens 601, 602, thereby producing two separate images on the two screens 601, 602. The two images may use a common source so that both images are identical, or they may use separate sources to produce two unrelated images. For example, the screen 601 may be used to display a movie, while the screen 602 may be used to display a video game.

Unless specifically stated otherwise, or as is apparent from the discussion, terms such as “processing” or “computing” or “calculating” or “determining” or “displaying” or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical, electronic quantities within the computer system’s registers and memories into other data similarly represented as physical quantities within the computer system’s memories or registers or other such information storage, transmission or display devices.

Those skilled in the art will appreciate that the various system layers, routines, or modules illustrated in the various embodiments herein may be executable control units. The control units may include a microprocessor, a microcontroller, a digital signal processor, a processor card (including one or more microprocessors or controllers), or other control or computing devices. The storage devices referred to in this discussion may include one or more machine-readable storage media for storing data and instructions. The storage media may include different forms of memory including semiconductor memory devices such as dynamic or static random access memories (DRAMs or SRAMs), erasable and programmable read-only memories (EPROMs), electrically erasable and programmable read-only memories (EEPROMs) and flash memories; magnetic disks such as fixed, floppy, removable disks; other magnetic media including tape; and optical media such as compact disks (CDs) or digital video disks (DVDs). Instructions that make up the various software layers, routines, or modules in the various systems may be stored in respective storage devices. The instructions when executed by the control units cause the corresponding system to perform programmed acts.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the

details of construction or design herein shown, other than as described in the claims below. Consequently, processing circuitry required to implement and use the described system may be implemented in application specific integrated circuits, software-driven processing circuitry, firmware, programmable logic devices, hardware, discrete components or arrangements of the  
5 above components as would be understood by one of ordinary skill in the art with the benefit of this disclosure. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

**CLAIMS**

**WE CLAIM:**

1. An apparatus for displaying information in vehicle, comprising:  
5 a laser projector;  
a viewing surface positioned to receive a variable image from the laser projector.

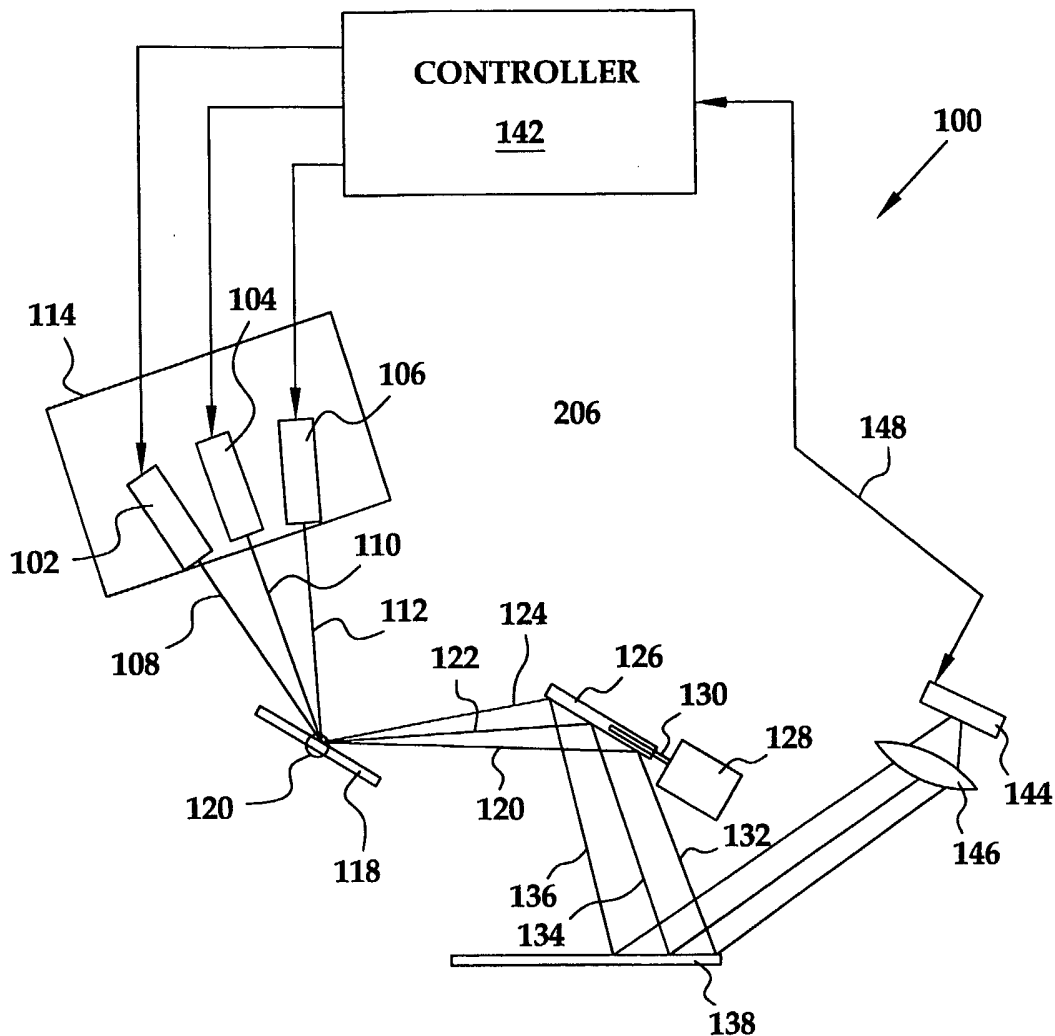


FIGURE 1

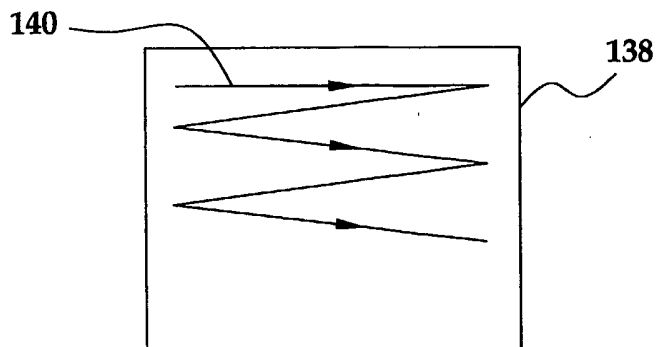
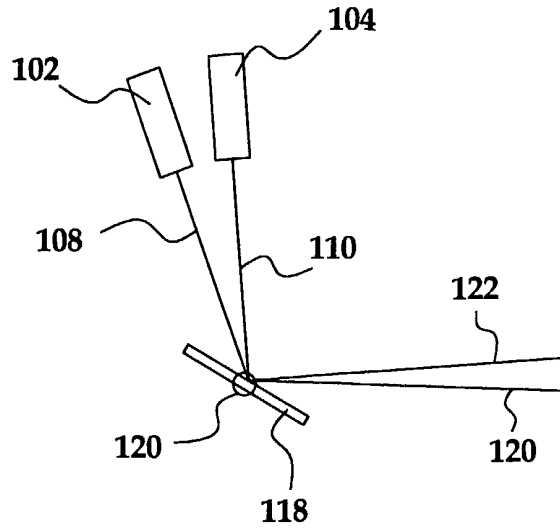
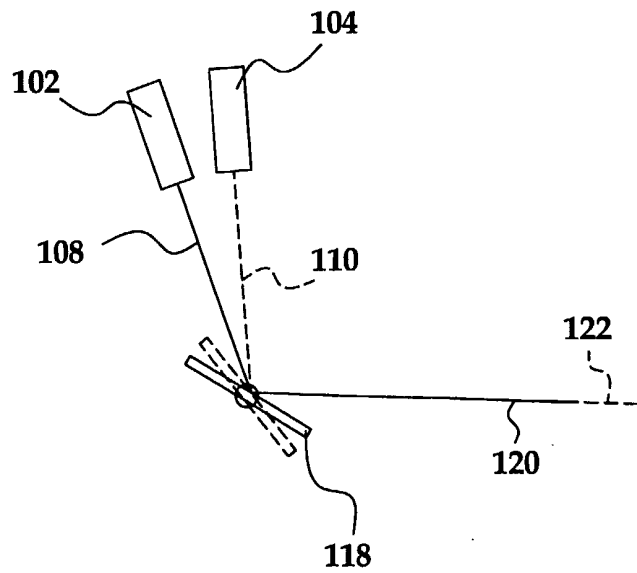


FIGURE 2



**FIGURE 3A**



**FIGURE 3B**

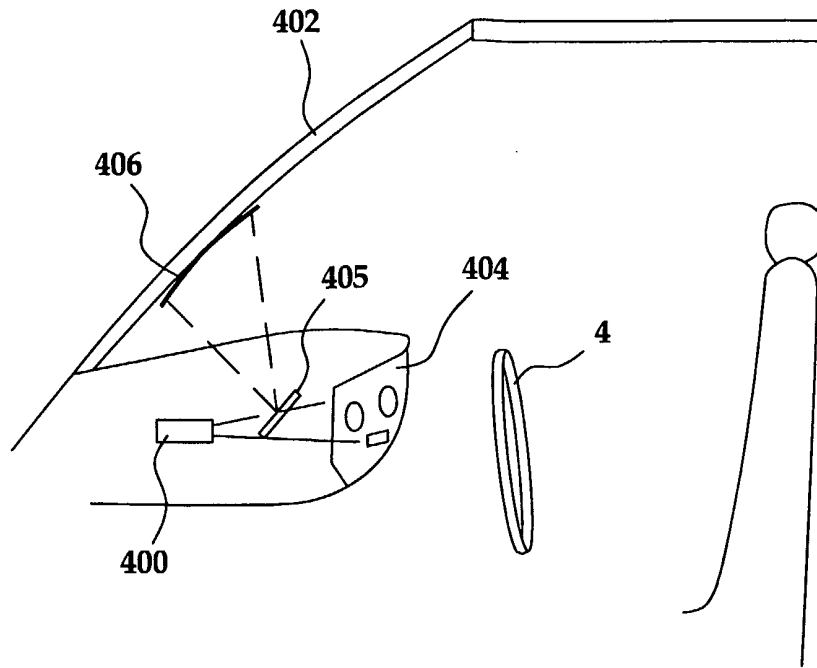


FIGURE 4

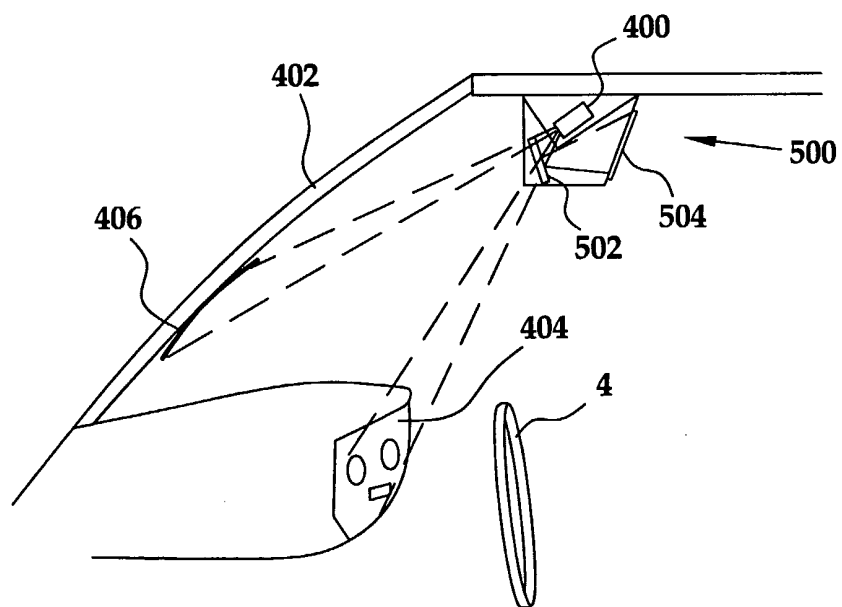
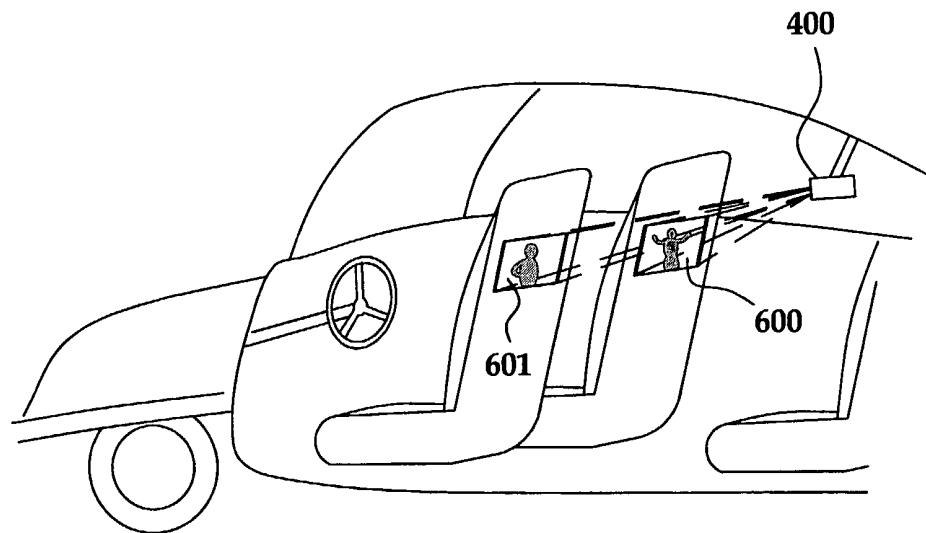


FIGURE 5



**FIGURE 6**

# INTERNATIONAL SEARCH REPORT

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**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 H04N9/31

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 H04N G03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/193651 A1 (EGLE FRANK) 16 October 2003 (2003-10-16) the whole document	1
X	US 5 864 432 A (DETER ET AL) 26 January 1999 (1999-01-26) column 11, line 48 - line 65	1
X	US 5 802 222 A (RASCH ET AL) 1 September 1998 (1998-09-01) column 11, line 51 - line 63 column 12, line 7 - line 11 column 18, line 44 - line 61	1

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
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- \*O\* document referring to an oral disclosure, use, exhibition or other means
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Date of the actual completion of the international search

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Name and mailing address of the ISA

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## INTERNATIONAL SEARCH REPORT

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