

(21) Application No: 1121102.6  
 (22) Date of Filing: 08.12.2011  
 (30) Priority Data:  
 (31) 102010056250 (32) 24.12.2010 (33) DE

(71) Applicant(s):  
**GM Global Technology Operations, Inc.**  
 (Incorporated in USA – Delaware)  
 PO Box 300, 300 Renaissance Center, Detroit,  
 48265–3000, United States of America

(72) Inventor(s):  
**Peter Brandt**  
**Heiko Charle**  
**Georg Bauer**

(74) Agent and/or Address for Service:  
**Adam Opel AG**  
 Intellectual Property Patents, IPC:A0–02,  
 65423 Rüsselsheim, Germany

(51) INT CL:  
**G02B 27/28** (2006.01) **B60J 3/06** (2006.01)  
**B60K 35/00** (2006.01)  
 (56) Documents Cited:  
**WO 2010/089026 A1** **US 5657161 A**  
**US 5566025 A** **US 5053755 A**  
**US 4418377 A** **US 20070217010 A1**  
 (58) Field of Search:  
 INT CL **B60J, B60K, G02B**  
 Other: **Online: EPODOC, WPI**

(54) Title of the Invention: **Vehicle having at least one instrument in a driver information system and a method for avoiding reflections of an instrument in a windshield of a vehicle**  
 Abstract Title: **Polarization of light to avoid reflections of an instrument in a windshield of a vehicle**

(57) A vehicle has driver information system 2 having at least one instrument 4, which has a front plate and an illumination device 6. At least one light-transmitting area 30 is arranged in the front plate and the illumination device 6 is arranged behind the front plate. The illumination device 6 is able to emit light through the at least one light-transmitting area 30 of the front plate 10. A polarization filter 7 is arranged between the front plate 10 and the illumination device 6. The polarization filter 7 is oriented opposite to a polarization direction of a windshield 3 of the vehicle 1 so that reflections are not transmitted to vehicle occupants 19.

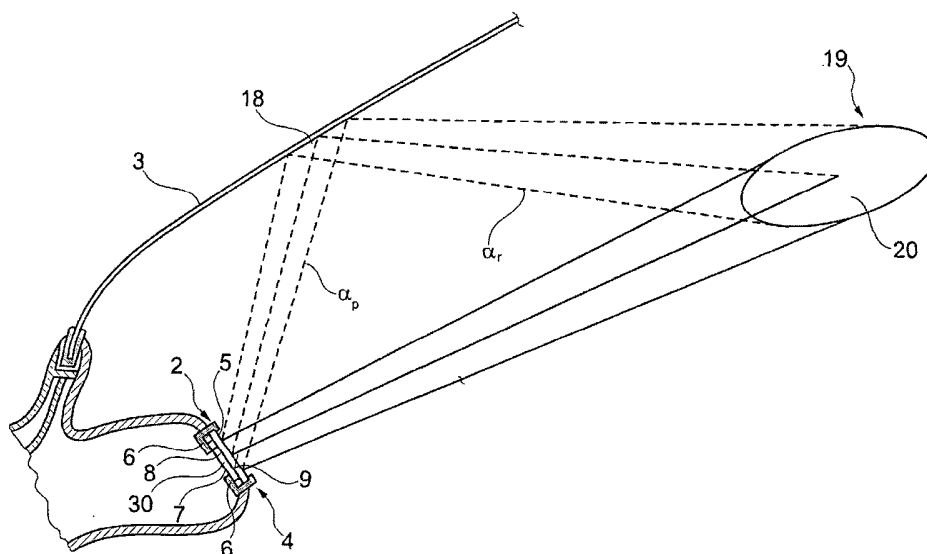


Fig. 2

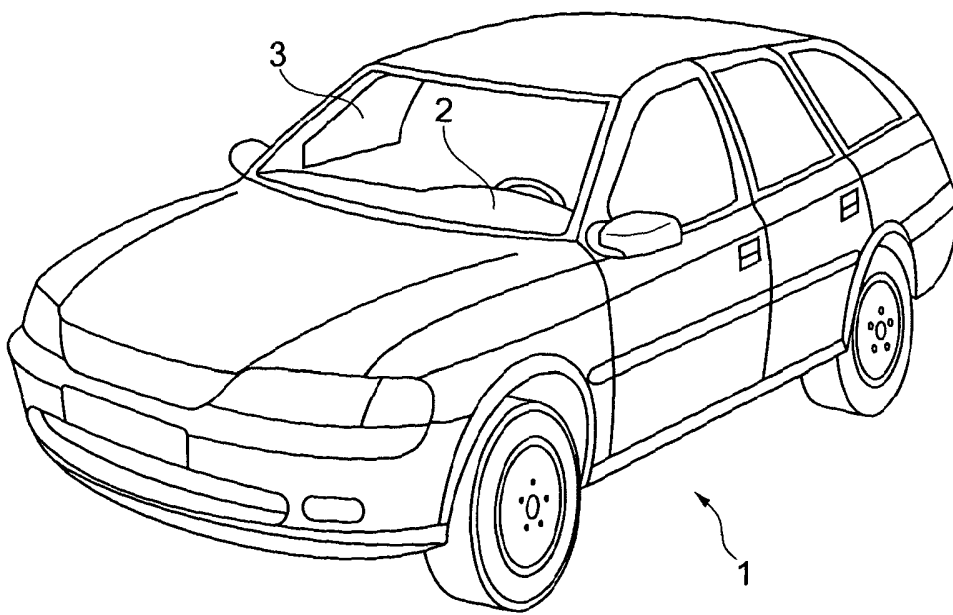
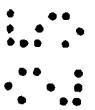


Fig. 1



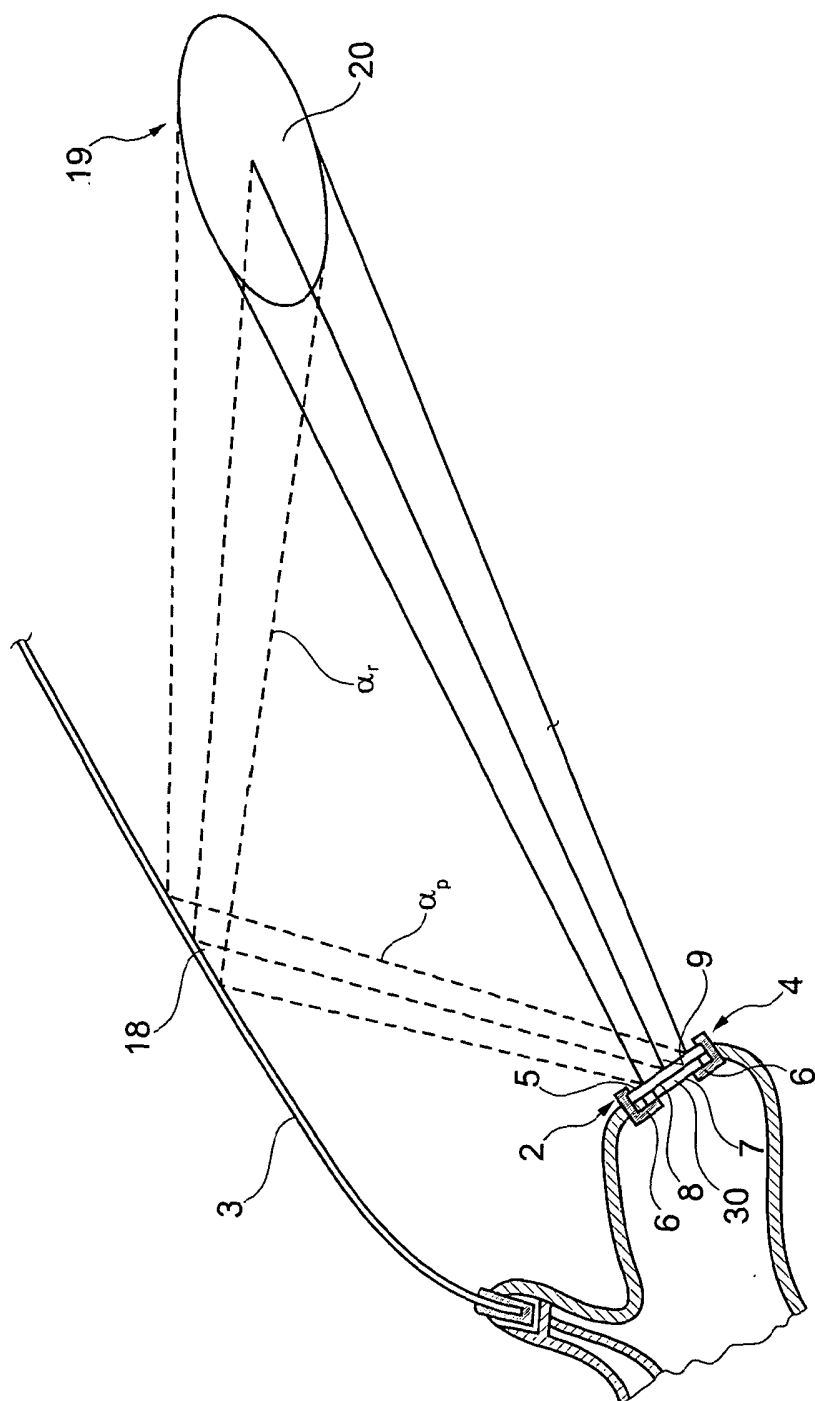


Fig. 2

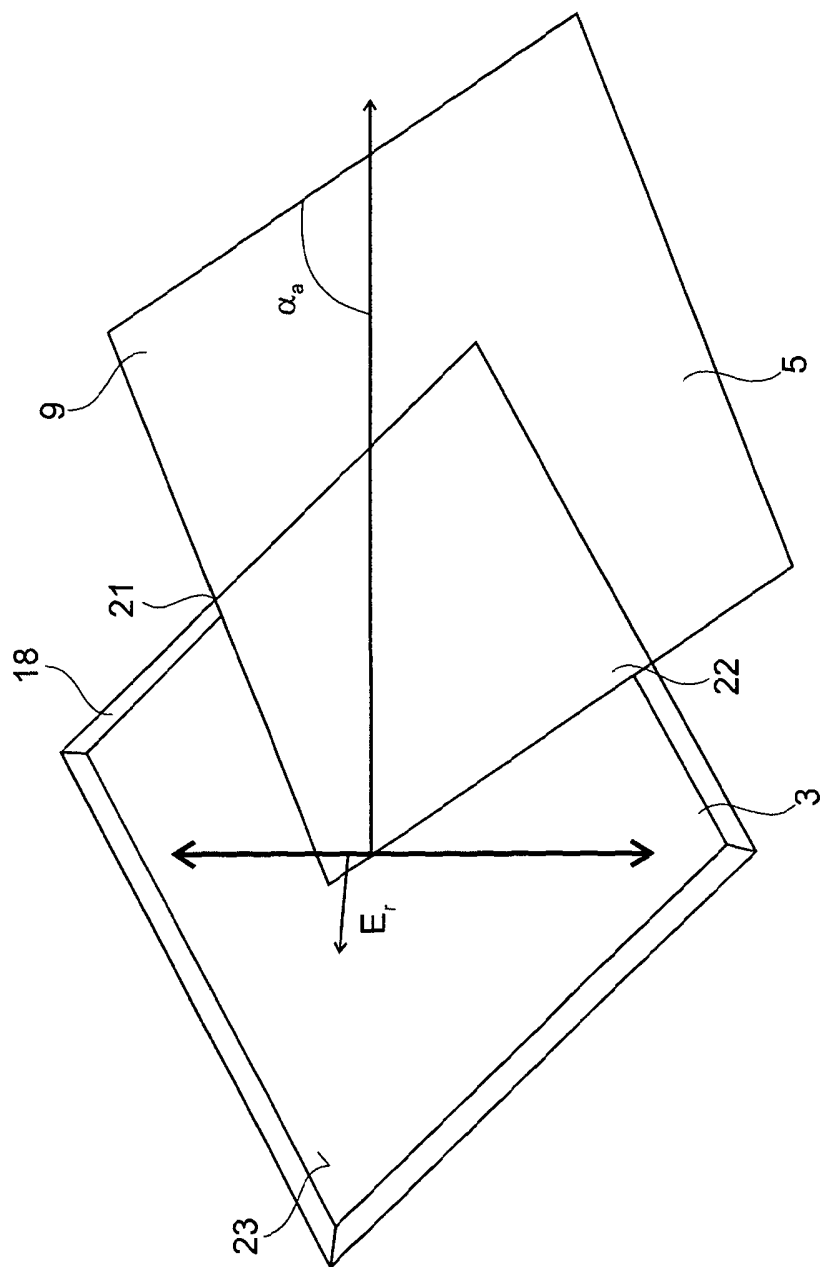


Fig. 3

$$R_p = \frac{I_p}{I_{ep}} = \frac{E_p^2}{E_{ep}^2} = \frac{\tan^2(\alpha_e - \alpha_g)}{\tan^2(\alpha_e + \alpha_g)}$$

$$\sqrt{R(\alpha_e)}$$

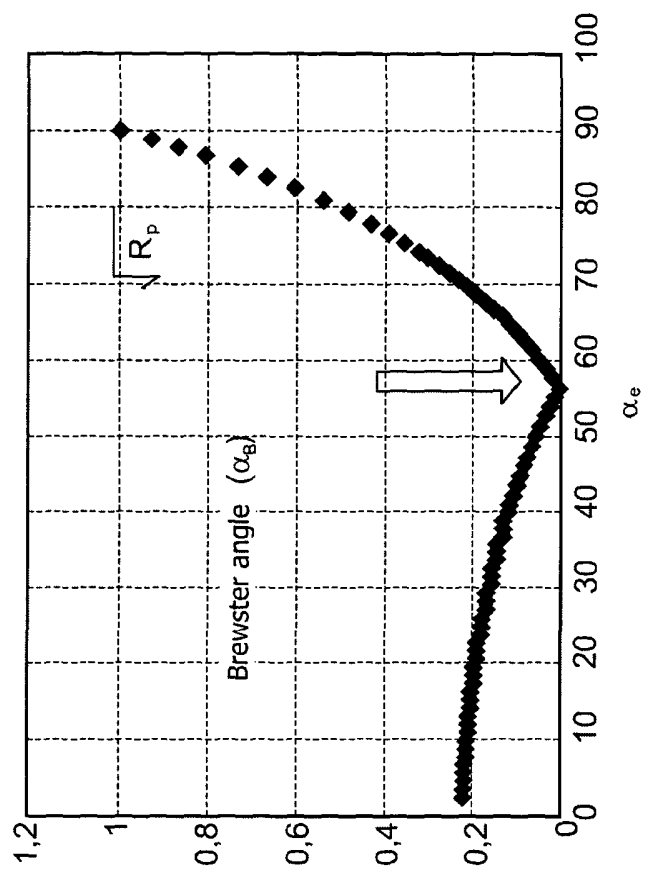


Fig. 4

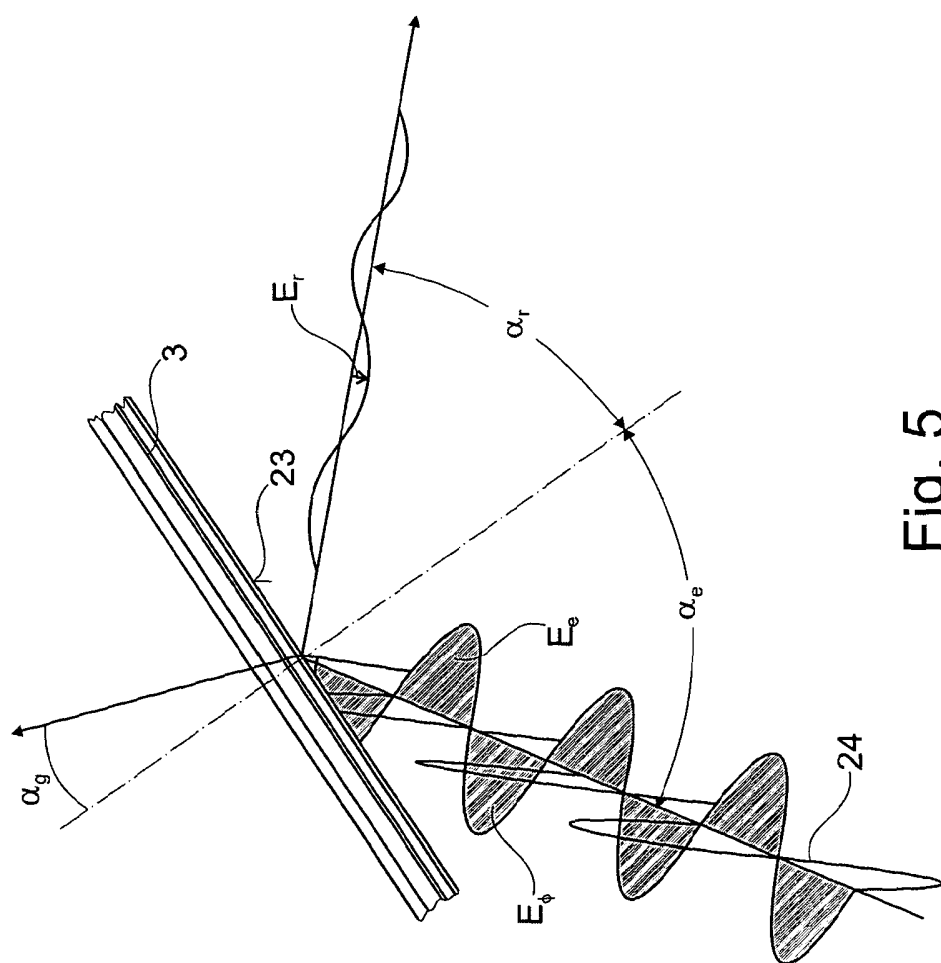


Fig. 5

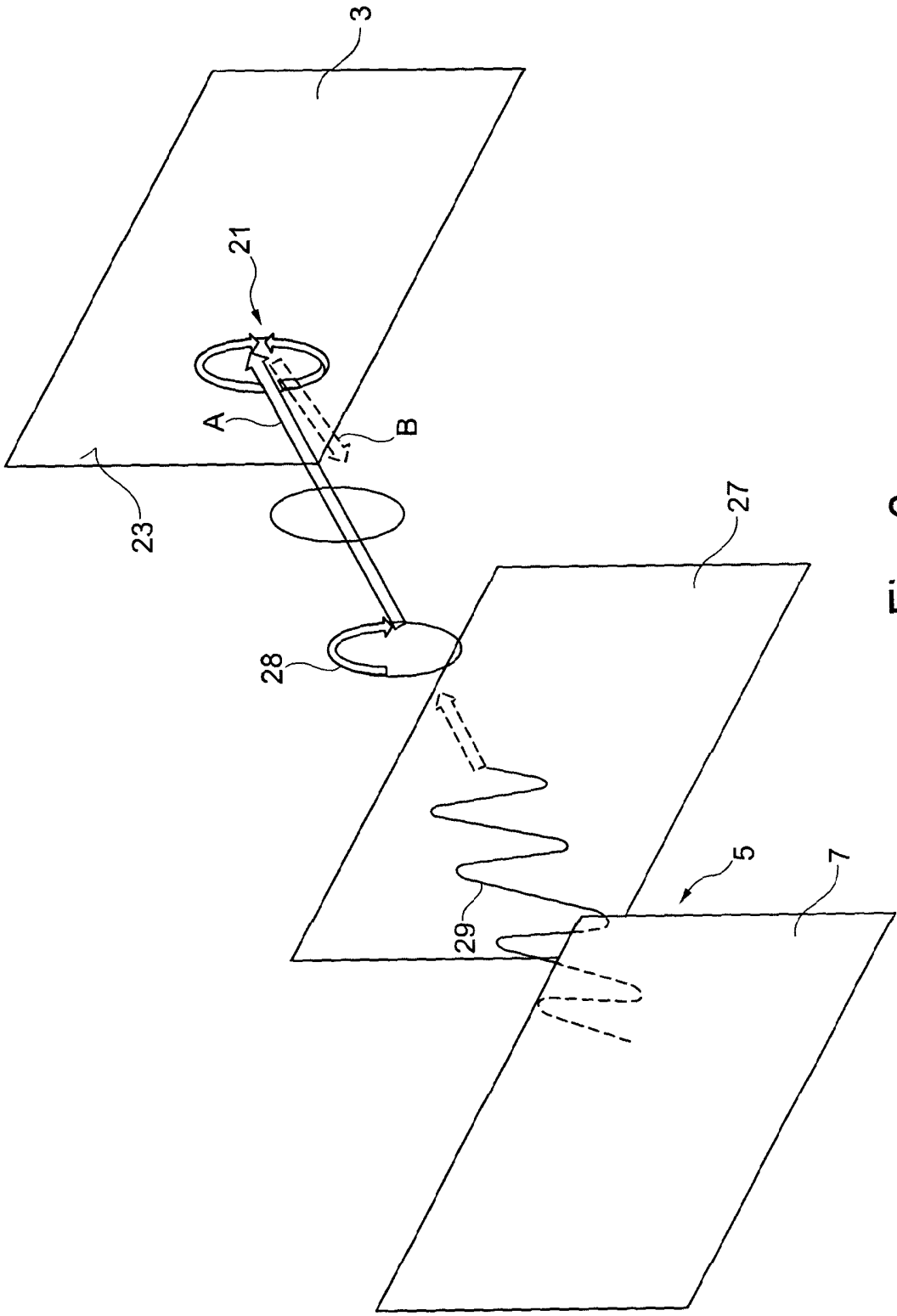


Fig. 6

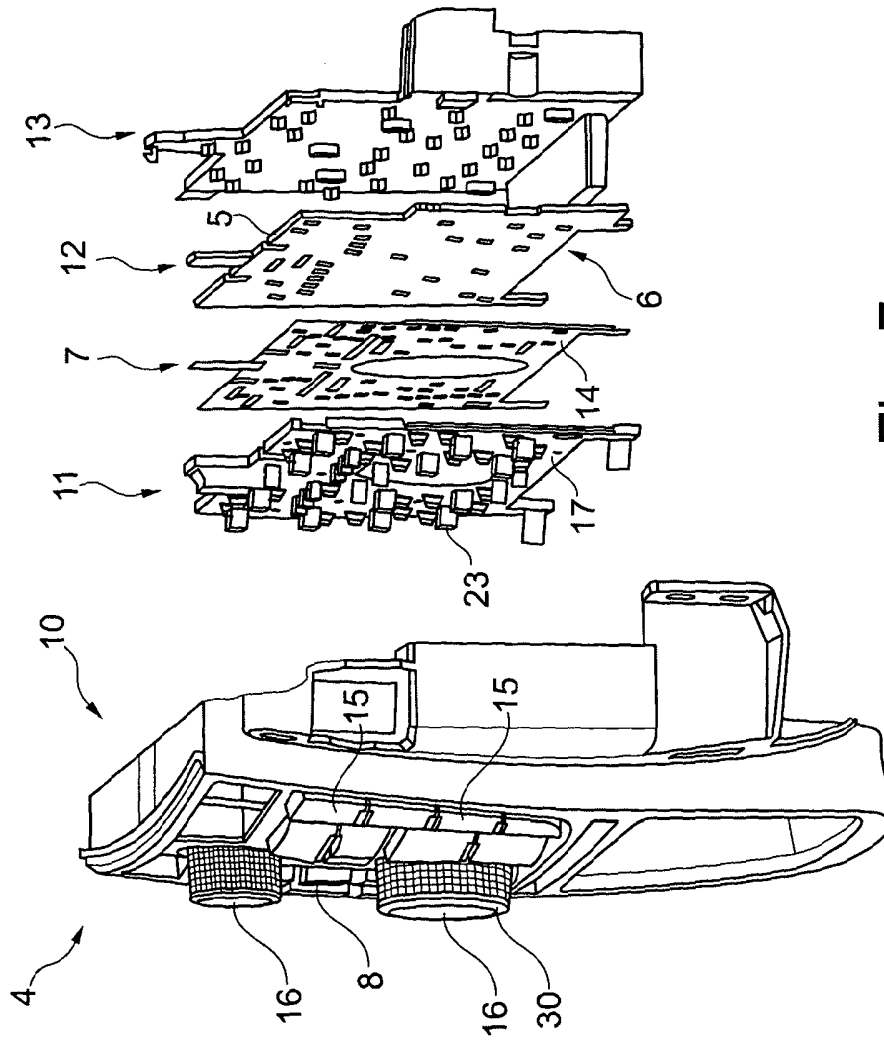


Fig. 7



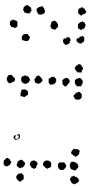
**VEHICLE HAVING AT LEAST ONE INSTRUMENT IN A DRIVER  
INFORMATION SYSTEM AND A METHOD FOR AVOIDING REFLECTIONS  
OF AN INSTRUMENT IN A WINDSHIELD OF A VEHICLE**

10    **Description**

A vehicle having at least one instrument in a driver information system is specified.

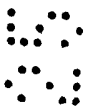
15    Like an audio device, a driver information system typically has multiple illuminated displays. In particular in darkness, these illuminated displays may reflect in the windshield. These reflections are undesirable, since they may obstruct the view of the driver, which could result in a hazard to the street traffic in particular when driving in darkness.

20    A motor vehicle with display device is known from the publication DE 10 2005 051 956 A1. In this display device, a background illumination has an extensive optical fiber body arranged on the rear side of the display screen, into which the illuminants couple light. For this purpose, the side of the optical fiber body facing toward the rear side of the display screen has a microstructure, which is oriented in such a manner that light provided for the background illumination of the display does not have any component in the direction of the windshield of the motor vehicle. In order to achieve this, a complex angled structure is arranged on the top side of the extensive optical fiber body, which is connected with high manufacturing costs, in particular because this prism-like microstructure must have exact reflection angles, so as not to emit any component of the light in the direction toward the windshield.



30

In addition, the rear side of the optical fiber body must also either be arranged at an acute angle to a reflector of the display device or the reflector must be structured corresponding to a Fresnel film. These structural measures of an extensive optical fiber body both on its front side and also of the reflector on its rear side cause substantial tool costs of the optical fiber or the reflector and increase the overall costs of this display device.



35

The object of the application is to provide a simple and cost-effective possibility for suppressing reflections of an illuminated display of a driver information system on the windshield.

- 5 This object is achieved by the subject matter of the independent claims. Advantageous refinements of the application result from the dependent claims.

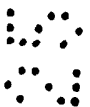
A vehicle having a driver information system is specified, the driver information system having at least one instrument. The instrument has a front plate and an illumination device, at least one light-transmitting area being arranged in the front plate. The illumination  
10 device is arranged behind the front plate and can therefore emit light through the light-transmitting area of the front plate. A polarization filter is arranged between the front plate and the illumination device, which has a polarization direction which is oriented opposite to a polarization direction of a windshield of the vehicle.

15 A reflection of the light-transmitting areas of the instrument through which light shines can thus be prevented by a suitable relationship between the polarization direction of the light emission and the polarization direction of the windshield, so that at least a reduced reflection occurs.

20 The undesired reflection in the windshield of areas of an instrument of the driver information system through which light shines can thus be provided by a suitable polarization direction of the polarized light emission of the operating elements. For example, reflections of areas through which light shines, such as operating elements of an instrument, can be  
25 avoided if the polarization filter is arranged behind the front plate having the operating elements.



30 For example, the driver information system can be implemented as a dashboard and the instrument can be implemented as a communication device, input device, playback device, measuring device, or audio device.



35 In one embodiment, the light emitted by the areas of the front plate of the instrument through which light shines is linearly polarized, so that a linearly polarizing filter can be rotated in front of the illumination device until reflections on a multilayer windshield are suppressed as substantially as possible.

In a further embodiment, it is provided that light emitted from the areas through which light shines is circularly polarized, so that a circularly polarizing filter can be rotated in front of the illumination device until reflections on a multilayer windshield are suppressed as much as possible. It is decisive that both polarization methods are advantageously oriented optimally in relation to the orientation of linearly or circularly polarizing filters in relation to a vehicle windshield.

Applying nonreflective films to the inner sides of side windows and/or even windshields can therefore be omitted. The instrument described herein advantageously utilizes the linearly or circularly polarizing properties of windshields, and a polarization direction of a polarization filter in front of the illumination device is arranged rotated inside the instrument in relation to the polarization direction of the linearly or circularly polarizing properties of the windshield in such a manner that a desired suppression of the reflection of the areas through which light shines is achieved.

In one embodiment, the polarization direction of the polarized light display is oriented opposite to the polarization direction of a windshield of the vehicle. In the case of linear polarization, the polarization directions can thus be rotated by  $90^\circ$  to one another and therefore any mirror image on the windshield is extinguished. In the case of circular polarization, a rotational direction reversal can occur upon the reflection on a multilayer windshield, attenuation up to complete cancellation of the reflection being able to occur depending on the intensity of the light reflected with rotational direction reversal.

In the case of linear polarization, only the polarization filter for the light-transmitting areas, which is newly integrated into the instrument, must form a polarized light display, which is rotated by  $90^\circ$  in relation to the polarization direction of the linear polarization of the windshield. If a polarization filter does not meet this requirement from the beginning, an extinguishing angle can advantageously be detected by a polarization measurement filter, using which the angle difference is ascertained to correct the orientation of the polarization filter.

In the case of such a correction of the polarization directions, it is to be considered that both the driver and also the passenger are not restricted in the visibility of areas through which light shines. In addition, it is necessary for the visibility when using polarized sunglasses to also be unrestrictedly possible through the correction of the linear polarization direction of the polarization filter. Corresponding experiments have shown that an optimi-

zation between these three requirements, firstly suppression of reflections in the windshield, secondly visibility for driver and passenger, and thirdly recognizability of the linearly polarized light emission of the areas even using polarized sunglasses, can be successfully achieved.

5

The illumination device can be installed on a circuit board. This has the advantage of simple activation and deactivation of the illumination device via the preinstalled components of the circuit board.

- 10 The polarization filter integrated in the instrument can be a transparent plastic film having linearly or circularly oriented molecular chains. Such a polarization filter is arranged appropriately oriented in front of the illumination device, which can have a background illumination, whose light source is arranged on side edges of the circuit board, and reflectors on the circuit board being irradiated by the edge-side light source. The light is thus advantageously deflected in the direction of the light-transmitting areas of the front plate and through the polarization filter.
- 15

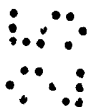
In a further embodiment, it is provided that the illumination device has a plurality of light-emitting diodes distributed on the circuit board. The distribution and number of the light-emitting diodes on the circuit board corresponds to the distribution and number of the light-transmitting areas of the front plate. An individual illumination, and its brightness, of each operating element and each display surface of the front plate, for example, can therefore be set.

- 20
- 25 In one embodiment, the front plate has operating elements, which can have light of the illumination device shine through them. These operating elements can be knobs, buttons, or dials, for example. The light-transmitting areas can be arranged in the operating element itself and/or on the edge of the operating element, in order to light through and/or illuminate the knob.



30

In a further exemplary embodiment, the instrument also has a pressure-sensitive mat, which is arranged behind the front plate. In this exemplary embodiment, the pressure-sensitive mat is arranged between the front plate and the polarization filter.



- 35 The instrument can be an input device, a playback device, a measuring device, or an audio device.

A method for avoiding reflections from an illuminated instrument of a driver information system in a windshield of a vehicle is also specified. A vehicle having a windshield and a driver information system having at least one instrument is provided. The instrument has, arranged one behind another, a front plate having at least one light-transparent area and an illumination device. An extinguishing angle is ascertained by rotating a polarization direction of a polarization filter in front of the front plate having light-transmitting areas, through which light shines, until the reflection of the at least one unpolarized light-transmitting area is extinguished on the windshield. A polarization filter is adapted and installed in the instrument at the ascertained extinguishing angle between the front plate and the illumination device.

After such an extinguishing angle is ascertained, it applies to an entire series of vehicles or to a special vehicle type, so that the extinguishing angle and therefore the manufacturing of instruments are advantageously not to be adapted individually for each individual vehicle, but rather the entire series of the vehicle type can be equipped with the appropriately adapted instrument.

The ascertainment of the extinction angle is performed by means of a linearly or circularly polarized polarization measurement filter, which is rotated in relation to the unpolarized light emission of the light-transmitting areas until the rotated polarization direction of the polarization measurement filter is opposite to the polarization direction of the linearly or circularly polarized mirror image on the windshield and therefore the mirror image is attenuated or disappears entirely.

25



30

The extinguishing angle can be ascertained in consideration of the visibility of the polarized light emission of the light-transmitting operating elements to the driver and passenger. Furthermore, it is possible to ascertain the extinguishing angle in consideration of the visibility of the polarized light emission of the operating elements to the driver having polarized sunglasses.



The application will be explained in greater detail on the basis of the appended drawings.

Figure 1 shows a schematic view of a vehicle;

35

Figure 2 shows a part of the vehicle shown in Figure 1 having driver information system and instrument;

5 Figure 3 shows a schematic outline of the superposition of a polarized light emission of operating elements or display surfaces of the instrument and the polarized light of the windshield;

10 Figure 4 shows the Fresnel formula for a linear polarization and reflection on a glass surface and a graph of the dependence of the reflection on the angle of incidence;

Figure 5 shows the polarization by reflection on a glass surface;

15 Figure 6 shows a schematic outline of circularly polarized light of a polarizing film and the interaction with a windshield;

Figure 7 shows a schematic outline of a communication playback device having integrated polarization film to reduce reflections on a windshield of the vehicle shown in Figure 1.

20

Figure 1 shows an example of a vehicle 1 having a driver information system 2 and a windshield 3. An instrument is arranged in the driver information system 2, whose polarized light emissions of operating elements and display surfaces can no longer reflect in the linearly polarizing windshield 3.

25



30



Figure 2 shows a part of the vehicle 1 shown in Figure 1 having a cross-section through the driver information system 2, the instrument 4, and the windshield 3. The instrument 4 is implemented in the exemplary embodiment shown as a communication playback device. The driver information system 2 is a dashboard in the exemplary embodiment shown, which does not have an optical screen in the direction toward the windshield 3, so that a mirror image 18 of illuminated operating elements 8 can be projected on the windshield 3 in particular when traveling at night, which could irritate vehicle occupants 19, of which an ellipse 20 is symbolically shown here.

35

In order to avoid this, the polarization direction  $\alpha_P$  of a polarized light emission 9 is oriented opposite to a polarization direction  $\alpha_R$  of the windshield 3 of the vehicle, in that a

polarization filter is integrated in the instrument 4, which is rotated opposite to the orientation of the polarization direction  $\alpha_R$  of the windshield 3 in such a manner that the annoying reflections on the linearly polarizing windshield 3 are suppressed at least for the driver.

- 5 During the setting of the optimum reflection-free polarization direction  $\alpha_P$  of the polarized light emission 9 in relation to the polarization direction  $\alpha_R$  of the windshield 3, however, it is taken into consideration that the polarized light emission 9 is still clearly recognized through sunglasses having vertically polarizing sunglasses lenses, and both driver and also a passenger can still recognize the polarized light emission 9. For this purpose, fol-  
 10 lowing Figures 3 to 6 show the fundamental requirements of this antireflection treatment of the windshield 3.

Figure 3 shows a schematic outline of the superposition of the polarized light emission of the operating element and the linearly polarized light of the windshield 3, the intensity  $E_R$   
 15 of the reflection being given by a Fresnel formula shown in Figure 4 and the intensity  $E_R$  being a function of an angle of incidence on the windshield 3. The polarization direction  $\alpha_R$ , as shown in Figure 3, is given by the direction of extension of a polarization film having long-chain molecules, the light effects being extinguished in the area of a superposition 21  
 20 of the polarization direction of the polarized light emissions with the polarization direction of the mirror image on the windshield 3, which is shown here by a black non-illuminated surface 22.

Figure 4 shows the Fresnel formula for a linear polarization in the case of reflection on a glass surface having a graph of the dependence of the reflections  $R_P$  on an angle of inci-  
 25 dence  $\alpha_E$ . This diagram shows that at a so-called Brewster angle ( $\alpha_B$ ), the reflection of a glass surface goes toward zero in the case of an angle of incidence of approximately  $57^\circ$ . I.e., the light which is emitted at a Brewster angle onto a glass surface is completely absorbed and no longer reflected by the glass. However, this would mean that the operating  
 30 elements of an instrument are to be oriented at a fixed angle such as the Brewster angle in relation to the windshield, in order to prevent a mirror image or a reflection of the operating elements on the windshield. For this purpose, either the display screen or the windshield would correspondingly be oriented according to the Brewster angle, which is not the foundation of this application, however. Rather, the next figure, Figure 5, shows the foun-  
 35 dation of this application.

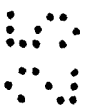


Figure 5 shows the polarization by reflection on the glass surface of a windshield 3. The component oriented parallel to the surface 23 of the windshield 3, having the intensity  $E_{\parallel}$ , is completely absorbed by the reflection surface. The intensity  $E_R$  of the reflected light is therefore zero if the light angle of incidence  $\alpha_e$  is equal to the Brewster angle of  $57.3^\circ$ . An arbitrary illumination beam 24, which is incident at an angle of incidence  $\alpha_e$  on the surface 23 of the windshield 3, is linearly polarized and emitted at a reflection angle  $\alpha_R$  having a reduced intensity  $E_R$ . However, in contrast, if already polarized light is oriented onto the surface 23 of the windshield 3, through the linear polarization of the windshield 3, with suitable orientation of the polarization of the polarized light display, the mirror image is attenuated by superposition of the two polarization directions, and even completely extinguished at  $90^\circ$  between the polarization directions.

Figure 6 shows a schematic outline of an illumination device, which shines through a circularly polarized intermediate film 27, and the interaction with a windshield 3. For this purpose, the circularly polarized intermediate film 27 is irradiated with linearly polarized light 29 from an illumination source 5 via a polarization filter 7.

Circularly polarized light 28, which is incident in the arrow direction A on the windshield 3, is reflected with reversal of the circulation on the windshield 3 in the arrow direction B and interferes with the incident circularly polarized light 28, so that with suitable rotation of the circularly polarized intermediate film 27, superposition 21 and extinguishing of the reflection of the images of operating elements of the front plate on the windshield 3 is possible, without additional measures, such as antireflection layers, being required on the windshield 3.

25

Figure 7 shows a perspective exploded schematic outline of an instrument 4 having integrated polarization filter 7 in the form of a polarization film 14 for reducing reflections on a windshield of the vehicle 1 shown in Figure 1. The instrument 4 is a communication playback device and is arranged in a driver information system of the vehicle 1. The instrument 4 has a front plate 10. Operating elements 8 in the form of push switches 15, rocker switches, sliding switches, and/or rotating knobs 16 and display surfaces are arranged in the front plate 10, the operating elements 8 cooperating with a pressure-sensitive mat 11 arranged behind the front plate 10. The front plate 10 also has light-transmitting areas 30, which are arranged in and on the edge of the operating elements 8, in order to be able to shine light from an illumination direction 6 of the instrument 4 through them.

35





The pressure-sensitive mat 11 has switch pins 25, which protrude from a rubber-elastic semitransparent mat 17, and which cooperate with the operating elements 8. Furthermore, the pressure-sensitive mat 11 has openings, through which light can fall on the light-transmitting areas 30 of the operating elements 8 and display surfaces of the front plate 10. A polarization filter 7 made of a polarization film 14 is arranged behind the pressure-sensitive mat 11. The illumination device 6 is arranged on a circuit board 12 behind the polarization filter 7.

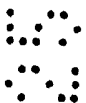
The circuit board 12 has a plurality of light-emitting diodes, which form an illumination source 5. The number and the distribution of the light-emitting diodes corresponds to the number and the distribution of the light-transmitting areas 30 on the front plate 10. The polarization direction of the polarization film 14 is oriented opposite to a polarization direction of the polarizing windshield, so that the polarizing light emission of the light-transmitting areas 30 of the operating elements 8 and the display surfaces of the instrument 4 is no longer reflected in the windshield.

A rear wall 13 of the instrument 4 is arranged behind the circuit board 12 and forms an instrument housing with the front plate 10. The polarization filter 7 is therefore arranged inside the instrument housing, so that an antireflection film on the outer side of the front plate 10 can be omitted.



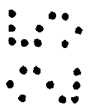
## List of reference numerals

	1	vehicle
	2	driver information system
5	3	windshield
	4	instrument
	5	illumination source
	6	illumination device
	7	polarization filter
10	8	operating element
	9	polarized light emission
	10	front plate
	11	pressure-sensitive mat
	12	circuit board
15	13	rear wall
	14	polarization film
	15	push switch
	16	rotating knob
	17	rubber-elastic mat
20	18	mirror image
	19	vehicle occupant
	20	ellipse
	21	superposition
	22	nonilluminated surface
25	23	surface
	24	illumination beam
	25	switch pin
	27	circularly polarized intermediate film
	28	circularly polarized light
30	29	linearly polarized light
	30	light-transmitting area



## Patent Claims

1. A vehicle having a driver information system (2), the driver information system (2) having at least one instrument (4), which has a front plate (10) and an illumination device (6), at least one light-transmitting area (30) being arranged in the front plate (10), and the illumination device (6) being arranged behind the front plate (10), the illumination device (6) being able to emit light through the at least one light-transmitting area (30) of the front plate (10),  
 wherein a polarization filter (7) is arranged between the front plate (10) and the illumination device (6), and the polarization filter (7) is oriented opposite to a polarization direction of a windshield (3) of the vehicle (1).
2. The vehicle according to Claim 1, wherein the polarization filter (7) is a transparent plastic film having linearly oriented molecular chains or a transparent plastic film having circularly oriented molecular chains.
3. The vehicle according to one of the preceding claims, wherein the illumination device (6) is installed on a circuit board (12).
4. The vehicle according to Claim 3, wherein the illumination device (6) has background illumination, whose light source is arranged on side edges of the circuit board (12) and irradiates reflectors on the circuit board (12).
5. The vehicle according to one of the preceding claims, wherein the illumination device (6) has a plurality of light-emitting diodes, which are arranged distributed behind the front plate (10).
6. The vehicle according to Claim 5, wherein the distribution and number of the light-emitting diodes on the circuit board (12) corresponds to the distribution and number of the light-transmitting areas (30) of the front plate (10).
7. The vehicle according to Claim 6, wherein the instrument (4) also has a pressure-sensitive mat (11), which is arranged between the circuit board (12) and the polarization filter (7).

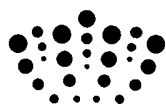


8. The vehicle according to one of the preceding claims, wherein the polarization direction of a polarized light emission (9) through the light-transmitting area (30) of the front plate (10) is oriented opposite to the polarization direction of the windshield (3) of the vehicle (1), so that an intensity of the reflection of the light-transmitting area in the windshield (3) is minimized.
9. The vehicle according to one of the preceding claims, wherein the front plate (10) has operating elements (8), through which light of the illumination device (6) may shine.
10. The vehicle according to one of the preceding claims, wherein the instrument (4) is an input device, a playback device, a measuring device, or an audio device.
11. A method for avoiding reflections from an illuminated instrument (4) of a driver information system (2) in a windshield (3) of a vehicle (1), which has the following method steps:
- providing the vehicle (1) with a windshield (3) and a driver information system (2) having an instrument (4), the instrument (4) having a front plate (10) having at least one light-transmitting area (30) and an illumination device (6) arranged behind the front plate (10);
  - ascertaining an extinguishing angle with rotation of a polarization direction of a polarization filter (7) in front of the front plate (10) having light-transmitting areas (30) through which light shines, until the mirror image of the at least one unpolarized light-transmitting area is extinguished on the windshield (3);
  - adapting and installing a polarization filter (7) at the ascertained extinguishing angle between the front plate (10) and the illumination device (6) in the instrument (4).
12. The method according to Claim 9, wherein the extinguishing angle is ascertained in consideration of the visibility of the polarized light emission (9) of the light-transmitting area to driver and passenger.
13. The method according to one of Claims 8 to 11, wherein the extinguishing angle is ascertained for the use of a linear polarization filter (7), or an extinguishing rota-



tional angle is ascertained for the use of a circularly polarized intermediate film (27).





**Application No:** GB1121102.6

**Examiner:** Mr Conal Clynych

**Claims searched:** 1-10

**Date of search:** 5 April 2012

## Patents Act 1977: Search Report under Section 17

### Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-6 & 11-13 at least	US2007/217010 A1 (LIPPEY BARRET) see paragraphs 5-6 & 22-23 and figures 1 & 4-5 especially
X	1-6 & 11-13 at least	US5566025 A (BOSCH GMBH ROBERT) see figure 3 and polarisation filters 11 & 9 especially
X	1-6 & 11-13 at least	US5053755 A (HUGHES AIRCRAFT CO) see column 2, lines 34-63, column 3, lines 15-24 & the figures
X	1-6 & 11-13 especially	US4418377 A (NISSAN MOTOR) see figures 1-3 and column 2, lines 14-24 especially
X	1-6 & 11-13 especially	US5657161 A (NORTHROP GRUMMAN CORP) see the figures and column 2, lines 1-21 especially
A	-	WO2010/089026 A1 (GM GLOBAL TECH OPERATIONS INC) see figure 3 especially

### Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

### Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>X</sup> :

Worldwide search of patent documents classified in the following areas of the IPC

B60J; B60K; G02B

The following online and other databases have been used in the preparation of this search report

Online: EPODOC, WPI



**International Classification:**

<b>Subclass</b>	<b>Subgroup</b>	<b>Valid From</b>
G02B	0027/28	01/01/2006
B60J	0003/06	01/01/2006
B60K	0035/00	01/01/2006