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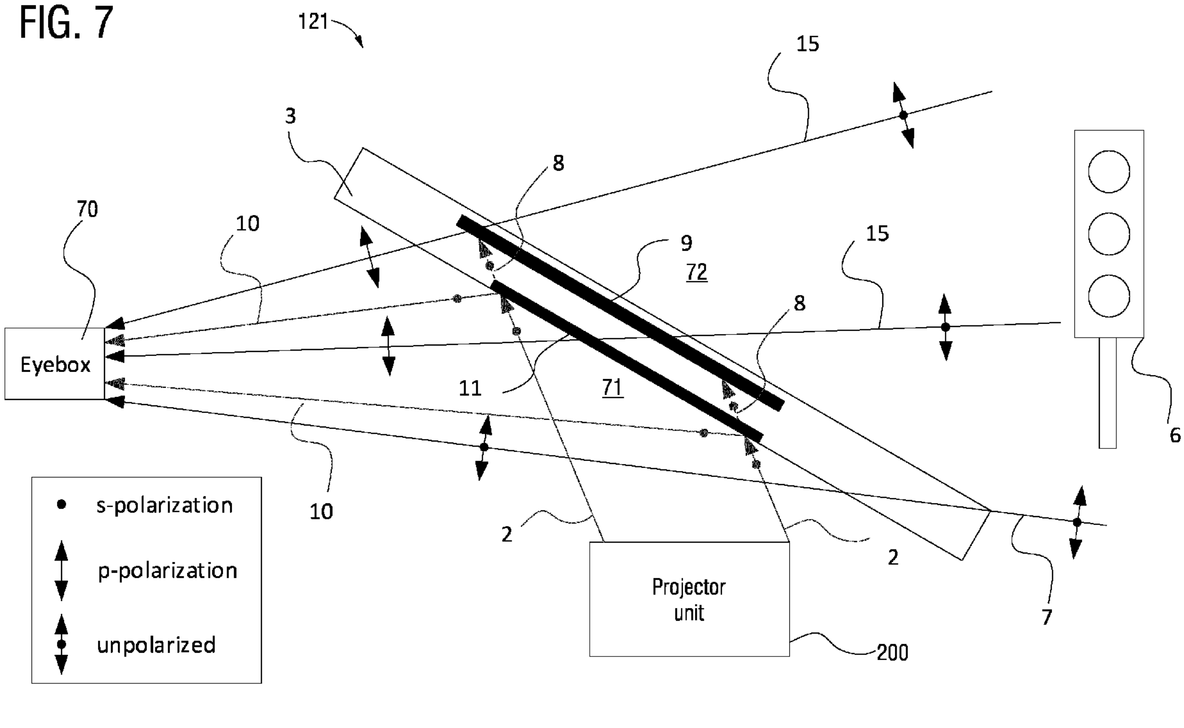
(54) **Title:** TAILORING STRAYLIGHT AT TRANSPARENT SCREEN UNIT

FIG. 7



(57) **Abstract:** Straylight (8) is reduced at a transparent screen unit (11), e.g., used for a head-up display. A polarization unit (9) is provided.

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DESCRIPTION

TAILORING STRAYLIGHT AT TRANSPARENT SCREEN UNIT

TECHNICAL FIELD

Various examples of the disclosure pertain to systems including a picture generating unit and a transparent screen unit configured to divert light associated with the picture generated by the picture generating unit to an eyebox. The transparent screen unit can support an in-plane image or a virtual image. A polarization unit is arranged adjacent to the transparent screen unit.

BACKGROUND

Transparent screen units are used in various use cases. In a first use case, a head-up display (HUDs) is used, for example, in vehicles to create a virtual image so that the driver does not have to take his eyes off the road. In contrast to a real image, which is displayed on a physical surface (e.g., a screen), the virtual image is generated on a virtual image plane, which is located behind the windscreen (i.e., in the environment of the vehicle) as seen from an eyebox. The eyebox is the area where the driver can clearly see the virtual image.

The HUD includes a projector unit. The projector unit comprises several main components, including a light source, a picture generating unit (PGU), and one or more optical elements configured to manipulate the light.

Another use case for transparent screen units is a so-called holodiffusor. Here, an image visible from the eyebox is generated in an imaging plane that is aligned with the transparent screen unit.

The holodiffusor and the HUD thus include similar hardware components; however, the imaging planes are arranged differently, as explained above.

In scenarios in which the projector unit and the eyebox are arranged at the same side of the transparent screen unit, it has been observed that under certain circumstances a fraction of the light emitted by the light source is not diverted by the transparent screen unit towards the eyebox (straylight), but rather transmitted through the transparent screen unit, e.g., towards an environment of the vehicle in the scenario of a HUD. This can be undesired for various reasons, including distractions of others in the environment.

SUMMARY

Accordingly, a need exists for advanced techniques of implementing HUDs or holodiffusors. A need exists for tailoring straylight at transparent screen units.

This need is met by the features of the independent claims. The features of the dependent claims define embodiments.

Hereinafter, various techniques using a transparent screen unit in combination with a PGU are disclosed. Such elements can be used to implement a HUD or a holodiffusor. Other use cases would be possible.

A system is disclosed. For instance, the system may implement a HUD. The system could also implement a holodiffusor.

The system includes a PGU.

The PGU is configured to generate a picture. The PGU comprises one or more light sources. For example, coherent light sources such as lasers or laser diodes can be used. Furthermore, the PGU typically includes a liquid crystal display (LCD) or micromirror device. The light beam emitted by the light source or light sources is manipulated by the display or micromirror device.

The system may optionally also include one or more optical elements that are configured to project the picture on an imaging plane, by shaping a path of the light that is associated with the picture. For example, such one or more optical elements can include one or more of the following elements: a mirror; a holographic optical element (HOE); a filter.

The PGU in combination with the one or more optical elements may be referred to as projector unit.

The system also includes a transparent screen unit. The transparent screen unit is arranged in the path of the light. The transparent screen unit is configured to divert a first part of an eyebox. The eyebox and the PGU are both arranged at a first side of the screen unit. The light incident at the transparent screen unit has a given polarization.

It is possible that the transparent screen unit in combination with the one or more optical elements shapes the path of the light. The transparent screen unit may be a flat plane; it would also be possible that the transparent screen unit has a curved surface.

For instance, the light incident at the transparent screen unit can have a linear polarization or a circular polarization. For instance, the light incident at the screen unit can have an s-polarization with respect to the transparent screen unit. It would also be possible that the given polarization is a p-polarization with respect to the transparent screen unit.

S-polarization, also known as TE (transverse electric) mode, refers to polarization where the electric field is perpendicular to the plane of incidence onto the reference plane (here the transparent screen unit). In contrast, P-polarization, also known as TM (transverse magnetic) mode, refers to polarization where the electric field is in the reference plane.

The system includes a polarization unit. The polarization unit is arranged adjacent to the transparent screen unit. The polarization unit is arranged at a second side of the screen unit that is opposite to the first side of the screen unit (at which the PGU and the eyebox are arranged). The polarization unit is arranged to filter, i.e., to not allow to pass / not allow to transmit, the given polarization of a second part of the light that passes through the transparent screen unit towards the second side.

By provisioning the polarization unit, it is possible to reduce the fraction of the light emitted by the light source of the PGU that escapes towards an environment of the transparent screen unit. The straylight can be reduced.

As a general rule, various options are conceivable for the transparent screen unit. For instance, the transparent screen unit can be a surface of a window of a vehicle. The transparent screen unit can be the inner surface of a windshield of a vehicle. The transparent screen unit could be a surface of a combiner that is arranged in the eye path of a user.

As a general rule, the polarization unit that is configured to filter a certain polarization can be configured to allow an orthogonal polarization to pass. The certain polarization can be absorbed(absorber polarizer).

Thus, said filtering of the polarization unit can be implemented by absorbing the given polarization of the second part of the light.

The polarization unit can include long-chain polymers in a substrate and aligned in a particular direction. When unpolarized light strikes this material, waves oscillating in the direction parallel to these chains are absorbed, while those oscillating perpendicular pass through. Such a scenario lends itself to implementing the polarization unit as re-configurable. Here, an electrical signal can be applied by a control circuitry to re-arrange the polymers, thereby changing the filter characteristics. The polarization unit can be operated in multiple modes. In one state, the given polarization is filtered; in another state, the given polarization is not filtered. Another option for a polarization unit is a wire-grid polarizer. A wire-grid polarizer uses microscopic parallel metallic wires to polarize light. When an unpolarized light wave encounters the wire grid, the electrical field component of the light that is parallel to the wires induces electrons in the wires to move. This, in turn, creates an electromagnetic wave that is in phase with the incident wave, effectively absorbing the parallel component of the light. The perpendicular component of the light, however, is not absorbed and thus is passes through the polarizer.

The polarization unit can be made switchable – e.g., it includes a transparent liquid crystal medium with re-orientation of the liquid crystals on-demand; and thus allows or denies a certain polarization to pass through the transparent screen.

In some scenarios, a wavelength-selective polarization unit can be employed. Here, the polarization unit is configured to selectively filter in a wavelength band. In other words, outside of the wavelength band, the filtering effect may be significantly reduced if compared to inside of the wavelength band. Thereby, a negative impact on broadband environmental light passing through the transparent screen unit from the second side towards the first side can be reduced.

For example, the wavelength band can be relatively small if compared to the wavelength band of the entire visible range. For instance, the wavelength band could be in the red regime or the green regime or the blue regime. For instance, a width of the wavelength band can be in the range of 10 nm to a 50 nm. Where multiple light sources are supported, respective wavelength bands can be defined for each light source.

The polarization unit extends, in some examples, along the transparent screen unit. The polarization unit, in some examples, is offset by a gap from the transparent screen unit. In some examples, the polarization unit and the transparent screen unit are embedded into an optical system. For instance, the polarization unit and the transparent screen unit can be embedded into a windshield of a vehicle.

A windshield oftentimes includes multiple layers, e.g., an outer layer of glass facing towards the environment, a polymer layer in-between the outer layer of glass and a further inner layer of glass. For example, the polarization unit can be implemented by a foil that is arranged in between the outer layer of glass and the inner layer of glass.

The polarization unit is, in some examples, configured to absorb the fraction of the second part of the light that has the given polarization. I.e., the polarization unit can be configured to predominantly not reflect this portion of the light. This avoids ghosting artifacts. The polarization unit can accordingly be implemented as an absorber polarization unit filter. The orthogonal polarization can pass through, i.e., is not filtered.

There are also other types of polarization units that can be used in the disclosed scenarios, e.g.: Reflection Polarizers; they may use the principle of Brewster's angle, where light that comes in at a specific angle and polarization will be completely transmitted, without reflection. Light at other angles or polarizations is partially reflected.

Another type would be a beam-splitting filter: These polarizers divide incoming unpolarized light into two beams with orthogonal polarizations. One typical example is a Wollaston Prism, which splits light into two diverging beams. Yet another type would be a birefringent polarizers: These use the property of birefringence, where a material has different refractive indices for different polarized light. The incoming light is split into its ordinary and extraordinary components, which can then be separated, for example, by a prism.

For a circular polarization, a Lambda/4 plate can be combined with a filter for linear polarization. This is based on the principle of wavelength retardation. By combining a filter for linear polarization (which could be a wire-grid polarizer, for example) with a quarter-wave plate, one can effectively transform linearly polarized light into circularly polarized light, or vice versa. The principle of wavelength retardation refers to the quarter-wave plate's ability to delay one component of the light wave relative to the other, thus changing its polarization state.

The angle of incidence of the path of light on the transparent screen unit can vary in the various disclosed examples. In some examples, the angle of incident of the path of light of the transparent screen unit is different than the Brewster angle.

The Brewster angle is the angle of incidence onto a reference plane (here the transparent screen unit) at which light with a particular polarization is perfectly transmitted through a transparent dielectric surface, with no reflection. When unpolarized light is incident at this angle, the light that is reflected from the surface is s-polarized (perpendicular to the plane of incidence), and the transmitted light is partially p-polarized (parallel to the plane of incidence). The Brewster angle can be calculated as the arctan of the fraction of the second medium to the first medium from which the light is incident.

The transparent screen unit can be implemented by a surface of the transparent optical sheet that is configured to divert the first part of the light towards the eyebox using Fresnel reflection. As a general rule, when light moves between mediums of different refractive indices, some of it is reflected (Fresnel reflection) and some is refracted or transmitted. The greater the difference in refractive indices between the two mediums, the more light is reflected and the less is transmitted.

In some scenarios, rather than relying on Fresnel reflections to divert the first part of the light towards the eyebox, it would be possible to use an HOE. An HOE, as a general rule, manipulates light based on the principles of diffraction, rather than refraction or reflection as in traditional optical elements like lenses and mirrors. HOEs are created by recording an interference pattern of light using a photosensitive medium. This interference pattern is the result of the interaction between a known reference beam of light and the object beam of light that has interacted with the scene or object of interest. Once this holographic pattern is fixed in the photosensitive medium, it can be used to diffract incoming light in a specific manner, effectively creating the optical manipulation that was originally encoded into it (diverting the light towards the eyebox in the present case).

The imaging plane can be aligned with the HOE (holodiffusor) or can be arranged offset from the HOE at the second side of the transparent screen unit (HUD).

The picture formed at the imaging plane can be perceivable from within the eyebox. It may not be perceivable or less visible from outside the eyebox.

It is possible that the system also includes a further polarization unit. The further polarization unit can be part of the projector unit. The further polarization unit is arranged in the path of light in between the PGU and the transparent screen unit. The further polarization unit is configured to filter a further polarization that is different than the given polarization.

For instance, the further polarization and the given polarization can be orthogonal. The given polarization and the further polarization can also be offset by a certain angle different than 90°. Such a scenario can be preferable if a further polarization change is induced by the light being incident at the transparent screen unit. Perfect glass would not have such an effect. But in a practical scenario, glass often has some internal stresses/imperfections which usually slightly rotate polarization of the light passing this glass. Such polarization rotation offset can be compensated, in some scenarios, by a lambda/half waveplate placed before the glass. An offset of the polarization induced by the light being incident at the transparent screen unit then corresponds to the difference between the certain angle and 90°. This maximizes the filter-effect of the polarization unit.

In some scenarios, the transparent screen unit – e.g., implemented as a HOE – can be produced from a polarizing medium – e.g., photopolymer containing liquid crystals – so the transparent screen unit can provide the screen functionality diverting the light towards the eyebox, as well as filter the given polarization of the second part of the light. In other words, the transparent screen unit and the polarization unit can be integrated with each another.

A method is disclosed. The method includes providing light associated with a picture perceivable from an eyebox. The light can be polarized. The light can be linearly polarized. The method also includes, diverting, at a transparent screen unit, a first part of the light towards the eyebox. The light incident at the transparent screen unit can be s-polarized. The method also includes filtering a second part of the light that is not diverted at the transparent screen unit using a polarization unit. For instance, the polarization unit can block or absorb or reflect s-polarized light, but allow p-polarized light to pass. The method may further include shaping the light using one or more optical elements arranged adjacent to a picture generating unit forming the picture. The method may further include pre-polarizing the light adjacent to the picture generating unit. The method may further include re-configuring the polarization unit, e.g., switching on or off the polarization unit.

It is to be understood that the features mentioned above and those yet to be explained below may be used not only in the respective combinations indicated, but also in other combinations or in isolation without departing from the scope of the invention. For instance, the method can be implemented by the system disclosed above.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A schematically illustrates a projector unit according to reference implementations.

FIG. 1B schematically illustrates an example implementation of the projector unit including a reflective Liquid Crystal on Silicon display.

FIG. 2 schematically illustrates a HUD according to reference implementations, wherein a windshield is used as a reflection component provided for Fresnel reflections, thereby implementing an augmented reality (AR) display.

FIG. 3 schematically illustrates a HUD according to reference implementations, wherein an HOE attached to or embedded into a windshield is used as a reflection component, thereby implementing an AR display.

FIG. 4 schematically illustrates a holodiffusor according to reference implementations, wherein an HOE attached to or embedded into a windshield is used as a reflection component, thereby implementing an in-plane transparent display.

FIG. 5 schematically illustrates a HUD including a polarization unit according to examples, wherein a windshield is used as a reflection component provided for Fresnel reflections, thereby implementing an AR display.

FIG. 6 schematically illustrates a projector unit according to examples.

FIG. 7 schematically illustrates a HUD including a polarization unit according to examples, wherein an HOE attached to or embedded into a windshield is used as a reflection component, thereby implementing an AR display.

FIG. 8 schematically illustrates a holodiffusor comprising a polarization unit according to examples, wherein an HOE attached to or embedded into a windshield is used as a reflection component, thereby implementing an in-plane transparent display.

DETAILED DESCRIPTION

In the following, embodiments of the invention will be described in detail with reference to the accompanying drawings. It is to be understood that the following description of embodiments is not to be taken in a limiting sense. The scope of the invention is not intended to be limited by the embodiments described hereinafter or by the drawings, which are taken to be illustrative only.

Hereinafter, concepts of reducing or eliminating straylight that would otherwise pass through a transparent screen unit of a HUD or holodiffusor are disclosed.

FIG. 1A schematically illustrates a prior art implementation of a projector unit 1. The projector unit 1 includes a PGU 12 and one or more optical components 13 arranged in a light path of light 2.

In an example, the PGU 12 may include a Liquid Crystal on Silicon (LCoS) display configured to reflect incident light and modulate, in a pixel-by-pixel fashion, an amplitude of the light so that image information is carried by the reflected light.

An example implementation of the PGU 12 by a LCoS display 811 is provided below in connection with FIG. 1B. However, it should be understood that various configurations of the PGU 12 using an LCoS projector are conceivable, and the example provided hereinafter as non-limiting. In the specific example of FIG. 1B, a light source 801 emits light 802 that may be polarized, e.g., p-polarized. It would also be possible that the light 802 is unpolarized. A polarizing beam splitter 810 can divert the light having a given linear polarization (e.g., p-polarized) towards the reflective LCoS display 811 (light 803). If the light 802 emitted by the light source is already p-polarized, then substantially the entire light 802 emitted by the light source is directed towards the LCoS display 811. The reflective LCoS display 811 includes a reflective surface coated with liquid crystal material. When a voltage is applied to the liquid crystals in this material, their orientation changes, altering the polarization of light reflected off the surface. The LCoS display 811 then switches the polarization of the incident light 803 in a pixelated manner, so that image information to be displayed is encoded. The polarization state can be transferred to brightness information by using a polarization filter. Thus, the reflected, polarized light 804 (e.g., s-polarized) carrying the image information can propagate through the polarization beam splitter. If the light 804 also includes a component being p-polarized, this component is filtered out by the polarizing beam splitter 810.Thus, the light 2 leaving the PGU 12 has a certain polarization, in the illustrated example an s-polarization. A brightness or gray value modulation can be achieved by switching in time domain at a time scale that cannot be discriminated by human vision. For instance, an 8-bit grayscale image can be built-up sequentially over 8 bitplanes. For a color image, the process can be repeated, e.g., three times for three color channels (typically, red, green, and blue).

FIG. 2 schematically illustrates a system 100 according to the prior art. The system 100 implements a HUD. The system 100 uses a windshield 3 of a vehicle to divert a part 5 of the light 2. A transparent screen unit 4 (with respect to which a first side 71 and a second side 72 are defined) is implemented by an inner surface of the transparent optical sheet implemented by the windshield 3. The part 5 of the light 2 is diverted using Fresnel reflections.

In this configuration, the s-polarization of the light 2 is diverted much more efficiently than the p-polarization. If the projector unit 1 incudes one or more HOEs as optical components 13 (cf. FIG. 1A), the HOEs are also more efficient for s-polarization.

Therefore, the projector unit 1 emits the light 2 with s-polarization only (cf. FIG. 2), but in reality, due to the current state of art in polarizers manufacturing, it may also include a p-polarization component.

An angle of incidence 79 of the light 2 onto the transparent screen unit 4 is shown. In the prior art it is stated that preferably this angle of incidence shall be the Brewster angle. However, the angle of incidence 79 can be different than the Brewster angle.

The transparent screen unit does not reflect the light 2 in full to the eyebox. A first part 5 of the light 2 is diverted to the eyebox 70; while a second part 8 of the light 2 passes through the windshield to the environment. This part 8 of the light 2 that is not diverted by the transparent screen unit towards the eyebox 70 (i.e., passes through the transparent screen unit) is labelled straylight. The system 100 thus suffers from the straylight 8 escaping to the environment.

Also illustrated in FIG. 2 is environmental light 7 entering from the environment 6. Typically, the environmental light 7 is unpolarized.

Hereinafter, techniques will be described that enable to reduce the amount of straylight 8 escaping to the environment, while limiting reduction of environmental light 7 reaching the eyebox 70.

FIG. 3 schematically illustrates a system 101 according to the prior art. The system 101 implements a HUD and generally corresponds to the system 100. In FIG. 3, however, the transparent screen unit 11 is implemented by an HOE, e.g., a volume HOE. This scenario employs diffraction to divert the light.

The HOE-based transparent screen unit 11 has a higher efficiency for diverting the first part 10 of the light 2 towards the eyebox 70 for incident s-polarized light 2. The part 10 of the light 2 after diffraction is called first-order component. The straylight 8 that goes through the HOE without diffraction is the zero-order component.

Hereinafter, techniques will be described that enable to reduce the amount of straylight 8 escaping to the environment, while limiting reduction of environmental light 7 reaching the eyebox 70.

FIG. 4 schematically illustrates a system 102 according to the prior art. The system 102 implements a holodiffusor. The system 102 generally corresponds to the system 101. in FIG. 4, however, the transparent screen unit 17 is implemented as a HOE diffusor (here referred to as a diffusor or holodiffusor). In FIG. 4, the imaging plane is aligned with the transparent screen unit 17 (while in FIG. 2 and FIG. 3 the imaging plane is offset towards the second side 72). The diffusor-based transparent screen unit 11 has a higher efficiency for diverting the first part 10 of the light 2 towards the eyebox 70 for incident s-polarized light 2. However, as illustrated in FIG. 4, typically the incident light 2 is unpolarized for the holodiffusor configuration. The imaging plane, in the holodiffusor configuration illustrated in of FIG. 3 (but not in the scenarios of FIG. 2 and FIG. 3) is aligned with the HOE-based transparent screen unit 17. The zero-order straylight 8 escapes to the environment, as explained in connection with FIG. 3.

FIG. 5 illustrates schematically illustrates a system 120. The system 120 is a modification of the system 100 (cf. FIG. 2). The system 120 further includes a polarization unit 9 that is arranged adjacent to and extends along the transparent screen unit 4. The polarization unit 9 is embedded into the windshield 3. The polarization unit 9 is configured to filter – specifically, absorb – the s-polarization of the straylight 8 that would otherwise escape to the environment. Thus, the straylight 8 is reduced.

The environmental light 7,15 – incident from the environment 6 – passes through the windshield 3. The environmental light 15 which goes through the polarization unit 9 is filtered and only the p-polarized part reaches the eyebox 70 (p-polarization passes through the polarization unit 9). However, the environmental light 7 which is outside of the area of the polarization unit 9 passes through the windshield 3 unaffected and thus remains unpolarized. Therefore, the environmental light 15 has a smaller brightness than the environmental light 7. To limit this effect, the polarization unit 9 can be wavelength selective to preferentially filter the light emitted by the projector unit 200.

In order to prevent the straylight 8 from reaching the second side 72 of the windshield 3, the polarization unit 9 acts as a filter. To ensure that the straylight 8 is polarized in this case, the projector unit 200 (generally corresponding to the projector unit 1, cf. FIG. 1A) further includes a further polarization unit 14 in-between the PGU 12 and the one or more optical components 13. See FIG. 6. The polarization unit 14 ensures that the light 2 exiting the projector unit 200 is for example s-polarized. Here, the polarization unit 9 can be implemented to allow p-polarization to pass, thereby truncating the s-polarized straylight 8.

The further polarization unit 14 is generally optional. Sometimes, the PGU 12 may already be configured to provide the light 2 polarized (cf. FIG. 1A).

FIG. 7 schematically illustrates a system 121. The system 121 is a modification of the system 101 (cf. FIG. 3). The system 121 also includes the polarization unit 9, as previously explained in connection with FIG. 5.

FIG. 8 schematically illustrates a system 122. The system 122 is a modification of the system 102 (cf. FIG. 4). The system 122 also includes the polarization unit 9, as previously explained in connection with FIG. 5.

The drawings show a specific implementation to the windshield of the car. However, similar techniques can be readily applied to other optical setups, e.g., other types of windows including front, back or side wide of a car, a glass roof of a car, a transparent display of a vending machine, etc..

Above, scenarios have been disclosed in which the polarization unit 9 statically filters the S-polarization of the straylight 8. In some scenarios, the polarization unit 9 can be a re-configurable polarization unit 9. The polarization unit 9 can be reconfigured between a first state and a second state. The polarization unit can be configured to filter the given polarization, e.g., the S-polarization, only in the first state, but not in the second state. For instance, such re-configurable polarization unit can be implemented by a liquid crystal panel. Here, long-chain polymers can be rotated in the plane by up to 90° by applying a voltage. Such a scenario enables to selectively enable the straylight to escape, depending on the operating state. Although the invention has been shown and described with respect to certain preferred embodiments, equivalents and modifications will occur to others skilled in the art upon the reading and understanding of the specification. The present invention includes all such equivalents and modifications and is limited only by the scope of the appended claims.

While above scenarios have been disclosed in which the angle of incidence of the light path at the transparent screen unit is different than the Brewster angle, it would also be possible that the angle of incidence of the light path is equal to the Brewster angle.

For illustration, while various scenarios have been disclosed in the context of a windshield of a vehicle, similar techniques can also be used for other windows or setups associated with any transparent screen unit.

For further illustration, scenarios have been discussed in which the projector unit provides S-polarized light 2. In variations, the projector unit can provide, e.g., P-polarized light. In such scenarios, the polarization unit that is arranged adjacent to the transparent screen unit can be respectively configured to filter such polarization.

Further, scenarios are conceivable in which the projector unit provides unpolarized light. In such a scenario, two-cross polarization units can be arranged in an optical system or optical block including the transparent screen unit, sandwiching the transparent screen unit therebetween. In a variant, it would be possible that a carrier material (e.g., a photopolymer including liquid crystals) of an HOE (cf. FIG. 7 and FIG. 8) polarizes the transmitted light.

Further, the techniques disclosed herein can be combined with electrochromic glass and/or other switchable materials, e.g., switchable privacy filters.

C L A I M S

1. A system (120, 121, 122), comprising:

- a picture generating unit (12) configured to generate a picture,

- one or more optical elements (13) configured to project the picture on an imaging plane by shaping a path of light (2) associated with the picture,

- a transparent screen unit (4, 11, 17) arranged in the path of light and configured to divert a first part (5, 10) of the light (2) towards an eyebox (70), the eyebox (70) and the picture generating unit (12) both being arranged at a first side (71) of the transparent screen unit (4, 11, 17), the light (2) incident at the transparent screen unit (4, 11, 17) having a given polarization, and

- a polarization unit (9) arranged adjacent to the transparent screen unit (4, 11, 17) at a second side (72) of the transparent screen unit (4, 11, 17) opposite to the first side (71) and configured to filter the given polarization of a second part (8) of the light (2) passing through the transparent screen unit (4, 11, 17) towards the second side.

2. The system of claim 1,

wherein the given polarization is an s-polarization with respect to the transparent screen unit (4, 11, 17).

3. The system of claim 1 or 2,

wherein the polarization unit (9) extends along the transparent screen unit (4, 11, 17) and is offset by a gap from the transparent screen unit.

4. The system of any one of the preceding claims,

wherein the polarization unit (9) is configured to absorb the given polarization.

5. The system of any one of the preceding claims,

wherein the polarization unit (9) is configured to not filter a further polarization that is orthogonal to the given polarization.

6. The system of any one of the preceding claims,

wherein an angle of incidence of the path of light at the transparent screen unit is different than the Brewster angle.

7. The system of any one of claims 1 to 6,
wherein the transparent screen unit (4) is a surface of a transparent optical sheet, thereby configured to divert the first part (5) of the light (2) towards the eyebox (70) using Fresnel reflection.

8. The system of any one of claims 1 to 6,
wherein the transparent screen unit (11, 17) is a holographic optical element.

9. The system of claim 8,
wherein the imaging plane is aligned with the transparent screen unit (17).

10. The system of claim 8,
wherein imaging plane is arranged offset from the transparent screen unit (11) at the second side (72).

11. The system of any one of the preceding claims, further comprising:
- a further polarization unit (14) arranged in the path of light in-between the picture generating unit (12) and the transparent screen unit (4, 11, 17) and configured to filter a further polarization that is different than the given polarization.

12. The system of any one of the preceding claims,
wherein the polarization unit (9) is configured to filter the given polarization of the second part (8) of the light (2) in a wavelength band.

13. The system of any one of the preceding claims,
wherein the polarization unit (9) is re-configurable between a first state and a second state, the polarization unit being configured to filter the given polarization in the first state and configured to not filter the given polarization in the second state.

14. The system of any one of the preceding claims,

wherein the polarization unit (9) is re-configurable to filter the part of the given polarization in the first state and to not filter the given polarization in the second state.

15. The system of any one of the preceding claims,
wherein the polarization unit (9) is integrated with the transparent screen unit (4, 11, 17).

16. The system of any one of the preceding claims,
wherein the picture generating unit (12) comprises a reflective Liquid Crystal on Silicon display.

17. A method, comprising:
- providing light associated with a picture perceivable from an eyebox,
- diverting, at a transparent screen unit, a first part of the light towards the eye-box, and
- filtering a second part of the light that is not diverted at the transparent screen unit using a polarization unit.

FIG. 1A
(PRIOR ART)

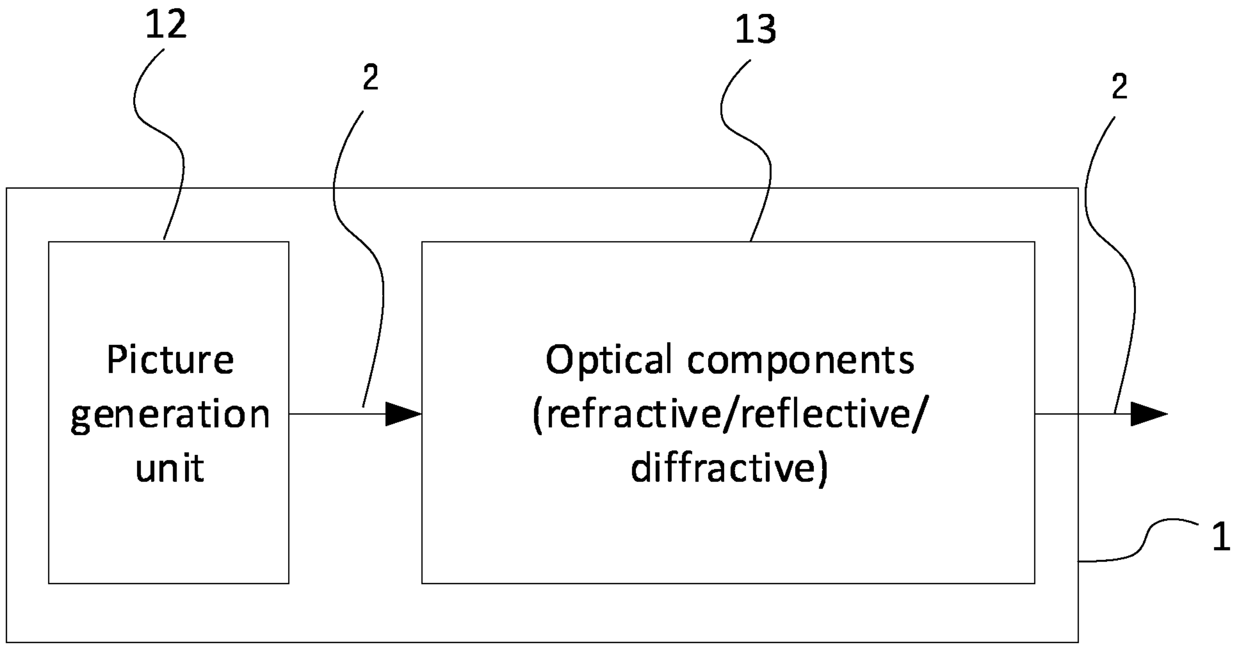
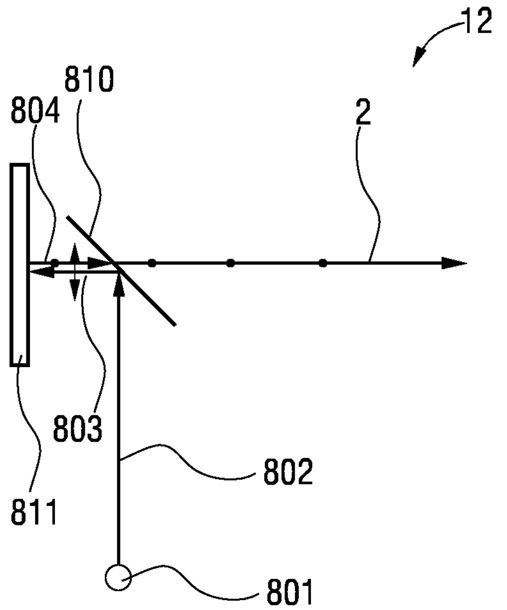


FIG. 1B



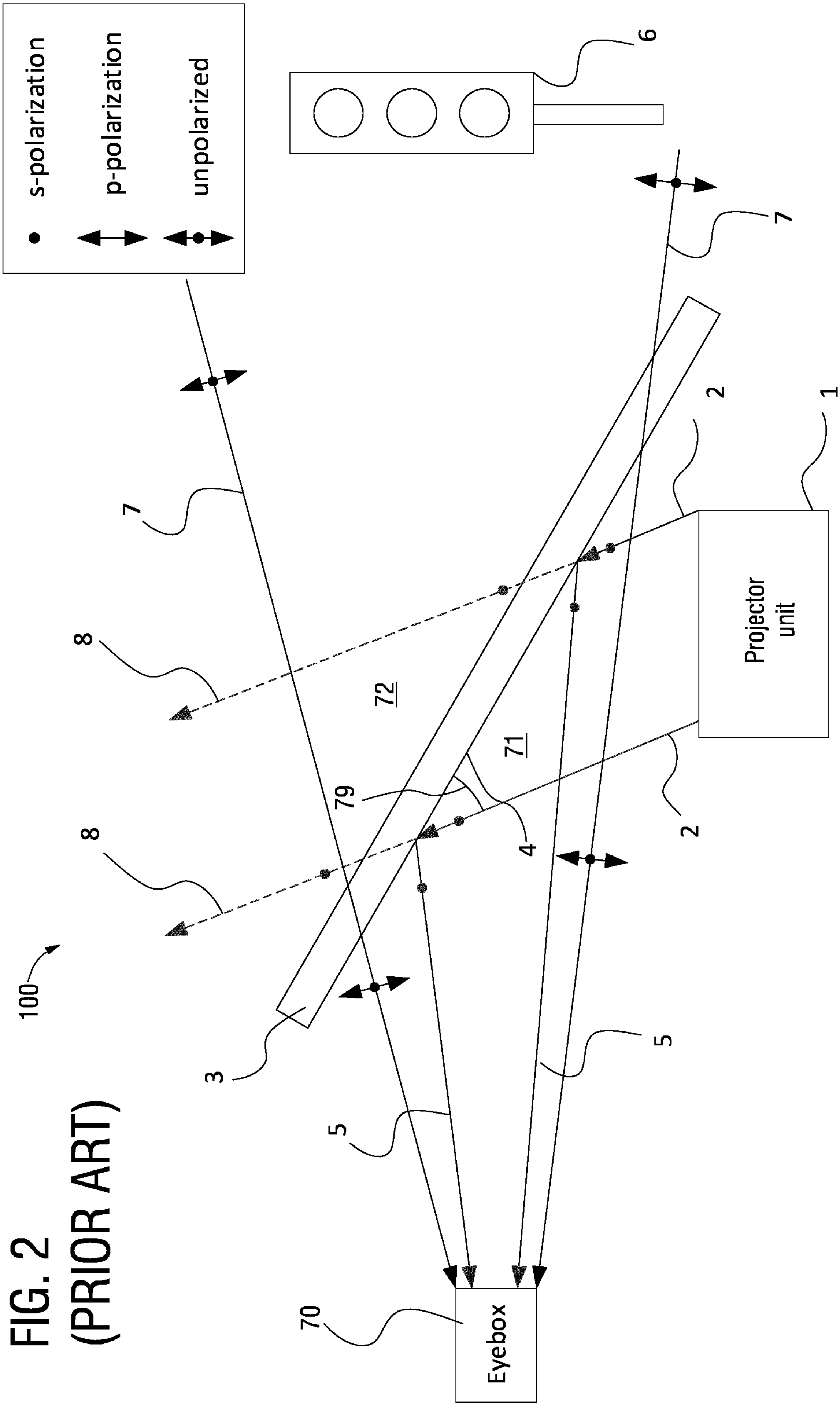


FIG. 2
(PRIOR ART)

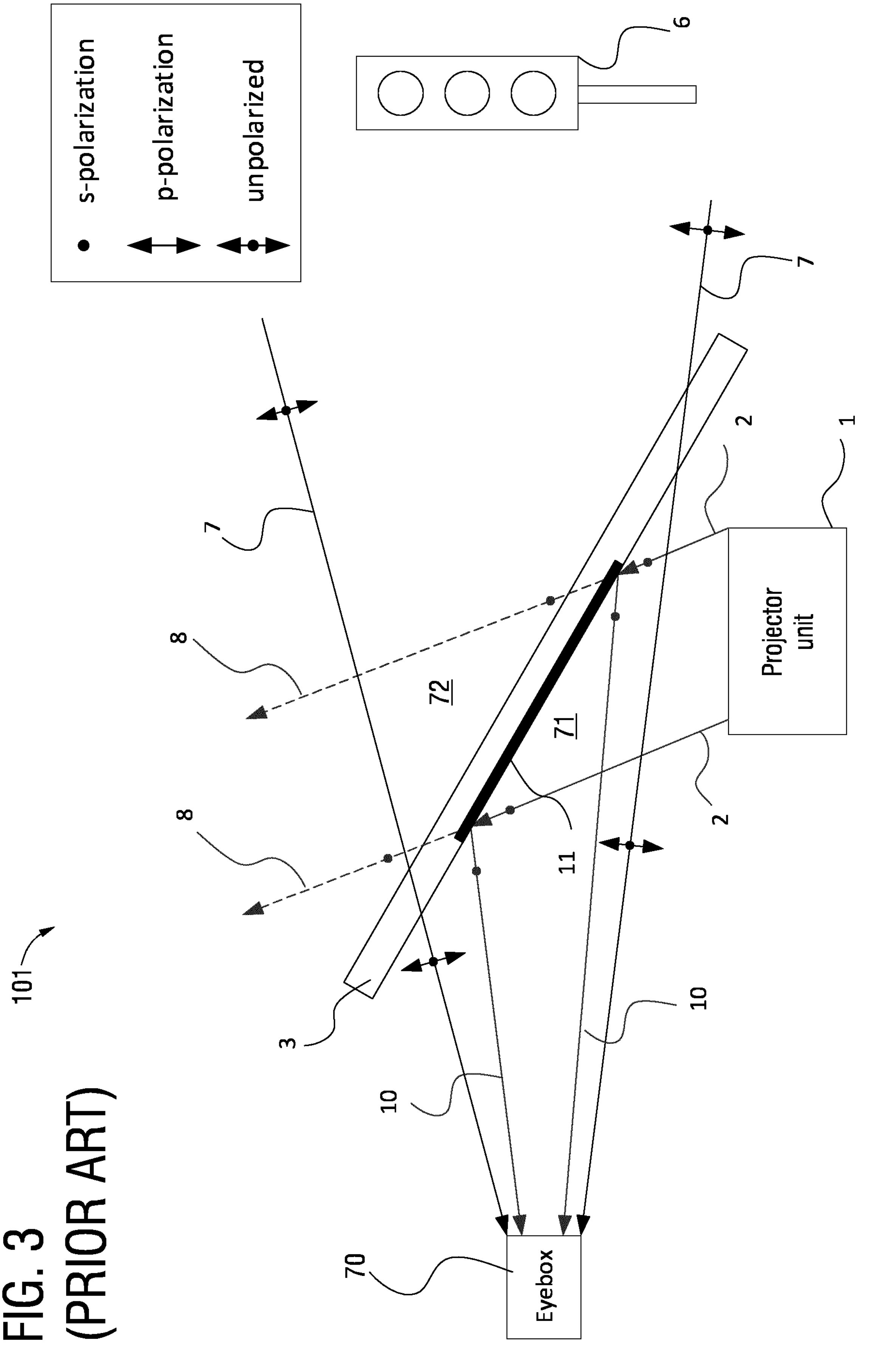


FIG. 3
(PRIOR ART)

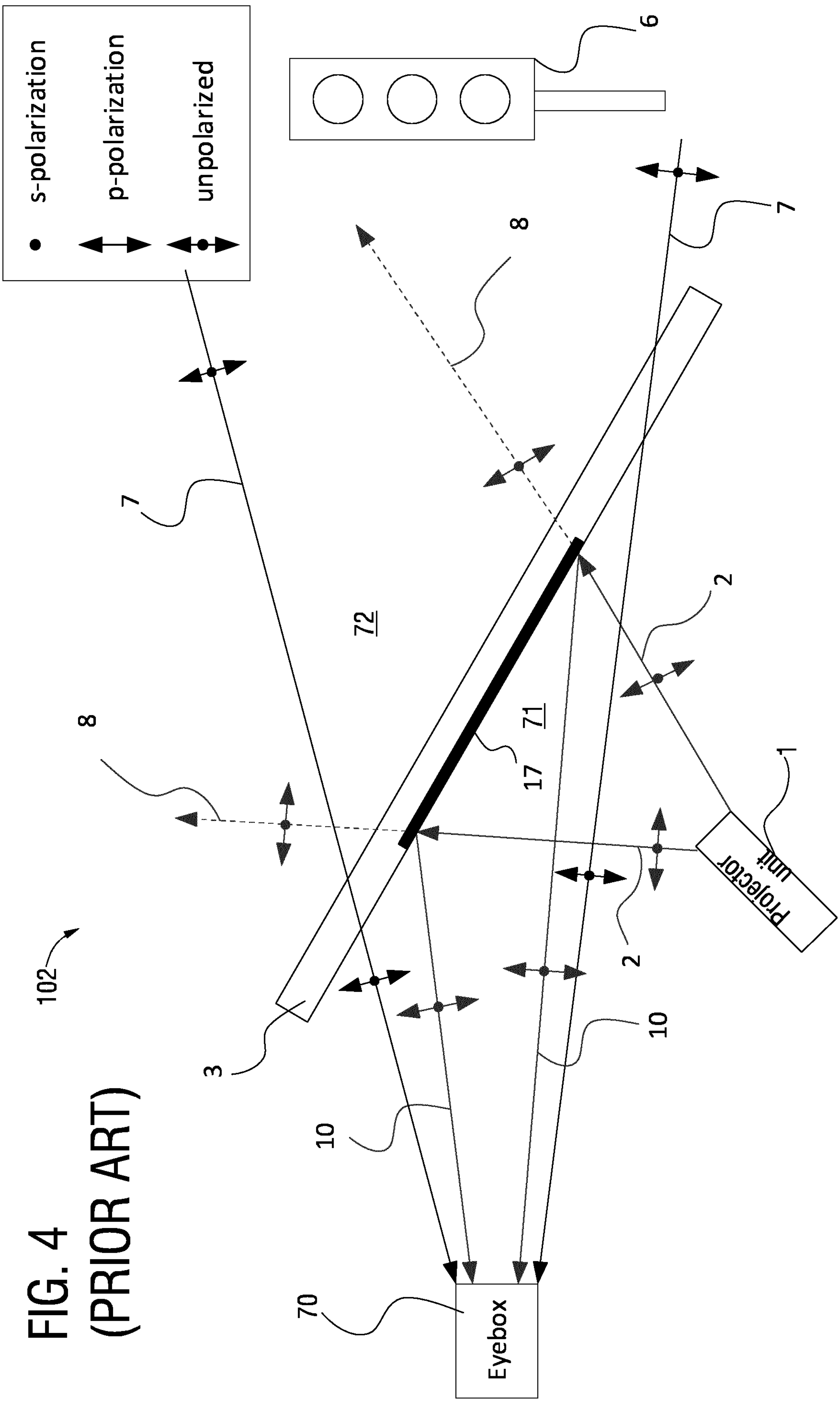


FIG. 4
(PRIOR ART)

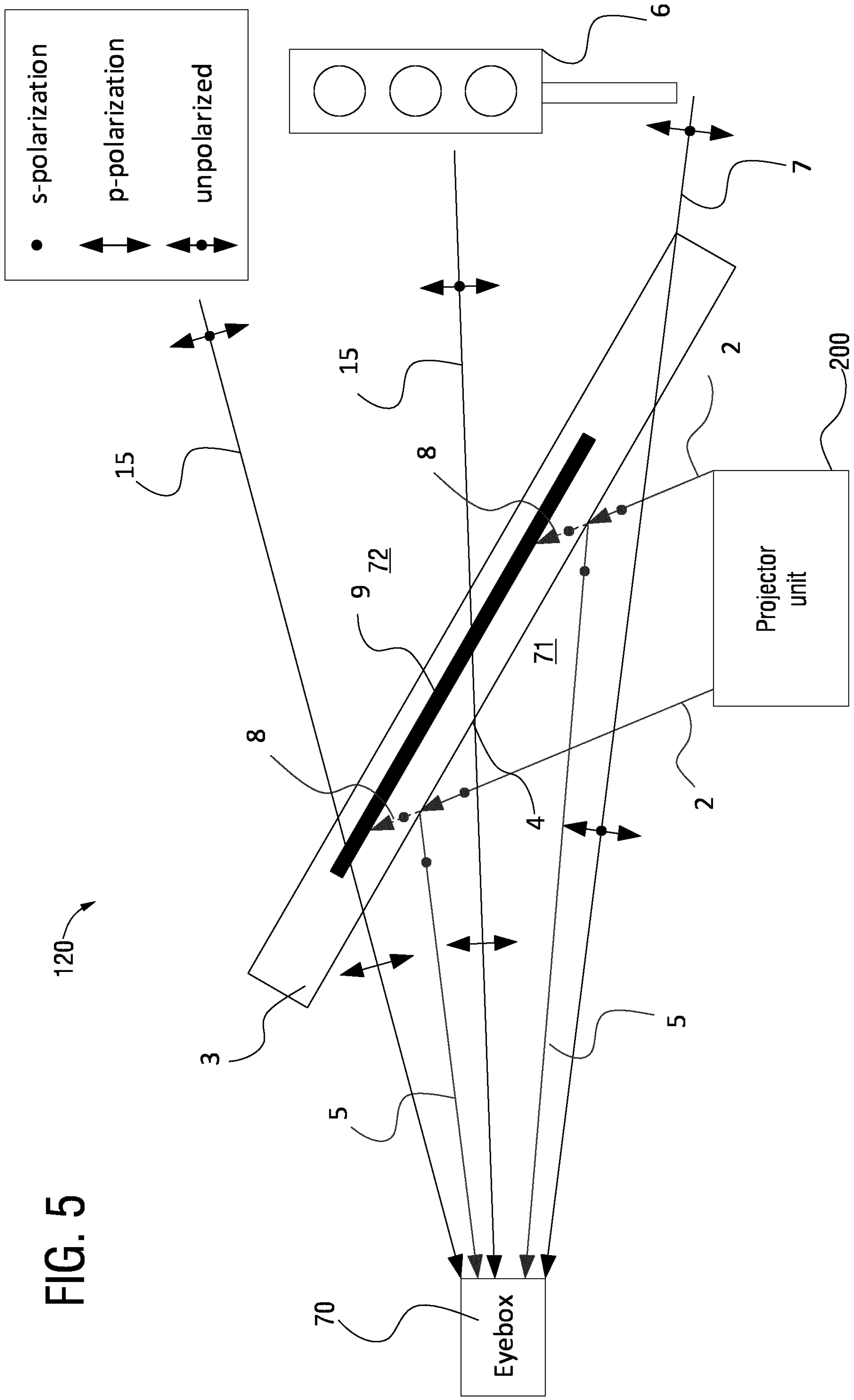
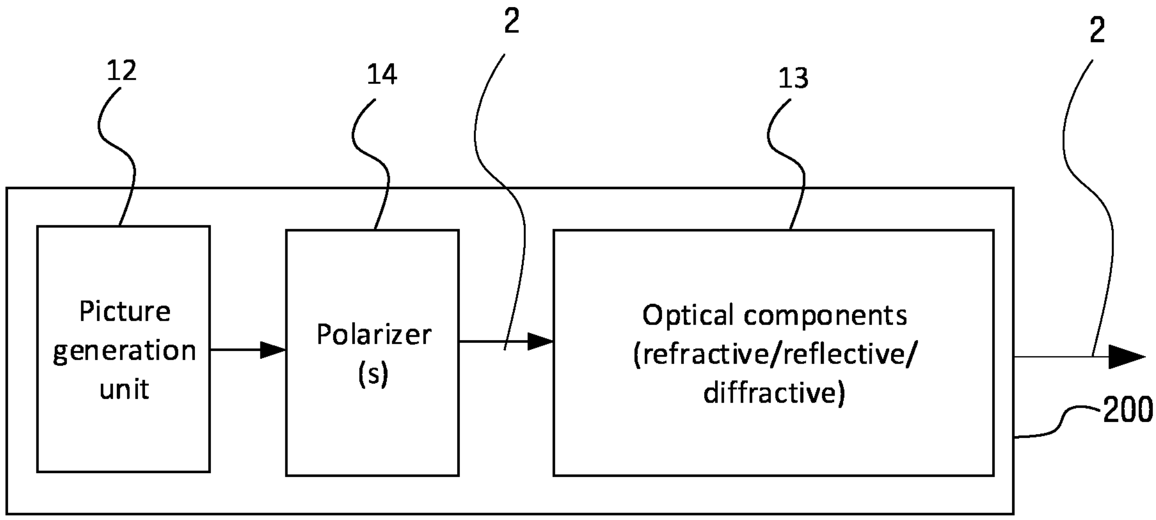

s-polarization
p-polarization
unpolarized
6
7
15
15
2
200
8
72
9
71
Projector unit
8
4
2
120
3
5
5
5
70
Eyebox

FIG. 5

FIG. 6


12
14
2
13
2
Picture generation unit
Polarizer (s)
Optical components (refractive/reflective/ diffractive)
200

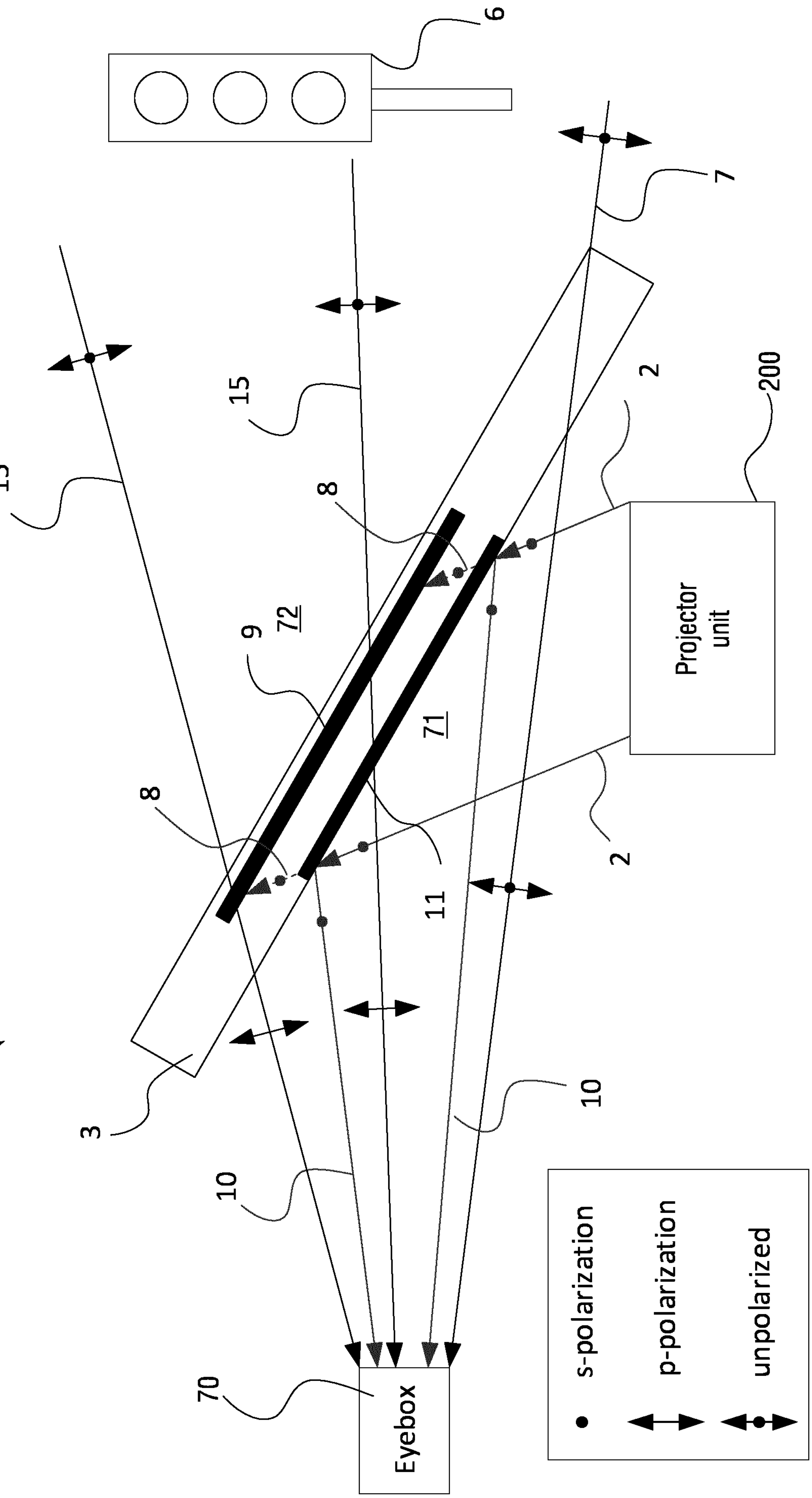
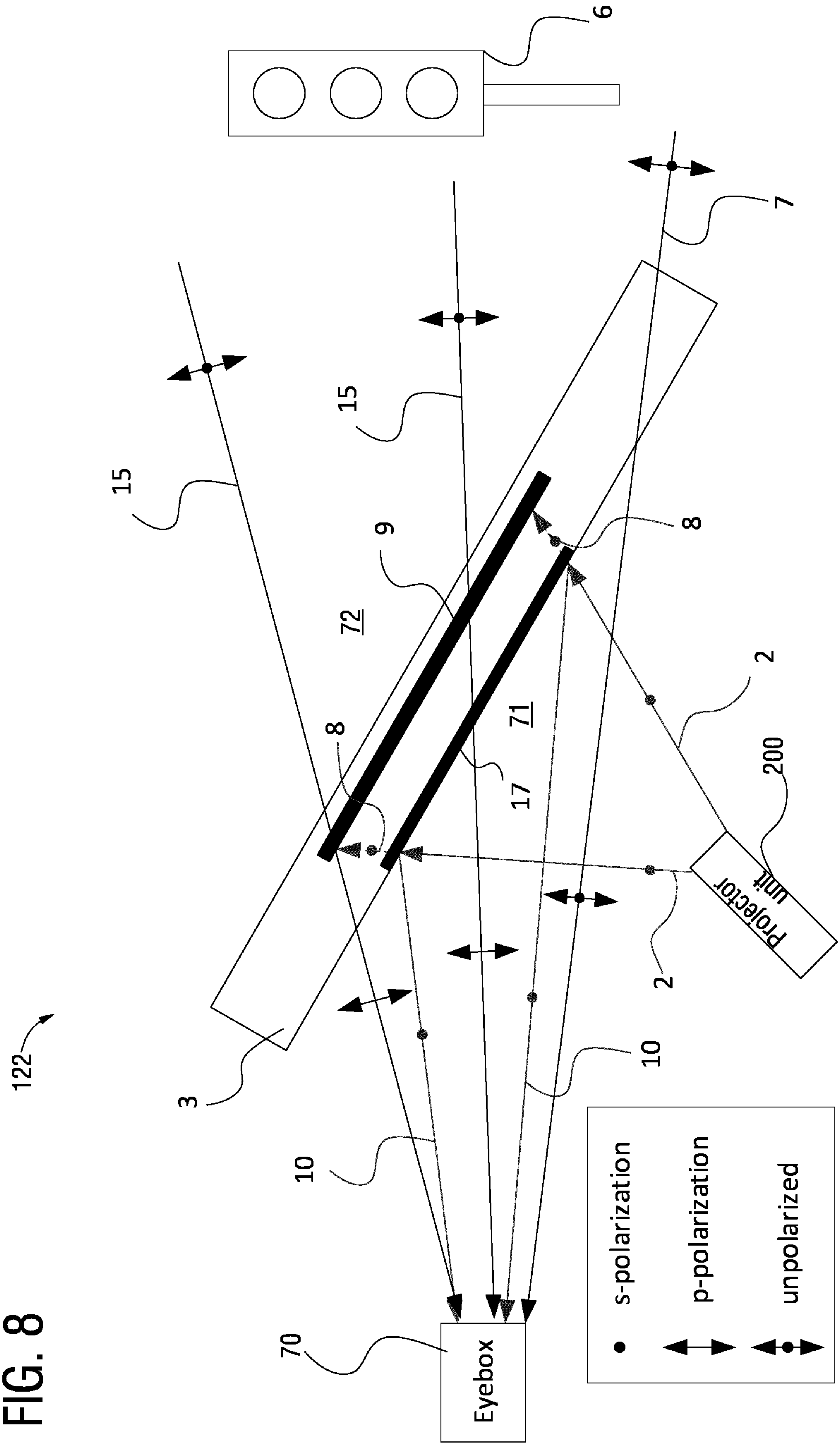

6
7
15
15
2
2
200
Projector unit
8
8
9
72
71
11
10
10
10
3
121
70
Eyebox
s-polarization
p-polarization
unpolarized

FIG. 7

FIG. 8


6
7
15
15
15
9
8
8
72
71
2
2
200
Projector unit
17
122
3
10
10
10
70
Eyebox
s-polarization
p-polarization
unpolarized

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/064667

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B27/01
ADD. G02B27/28

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)
G02B

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 practicable, 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.
A	US 2023/013999 A1 (PANKRATZ STEPHAN J [US]) 19 January 2023 (2023-01-19) paragraphs [0016] - [0020]; figures 1-2 -----	1-17
A	WO 2022/028938 A1 (CONTINENTAL AUTOMOTIVE GMBH [DE]) 10 February 2022 (2022-02-10) page 6, line 21 - page 7, line 30; figures 1-2 -----	1-17
A	KR 101 397 046 B1 (LG ELECTRONICS INC [KR]) 20 May 2014 (2014-05-20) claim 7; figure 6 -----	1-17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2024	03/09/2024

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/064667

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