

(12) STANDARD PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. **AU 2010308271 B2**

(54) Title
Liquid dispensing with blink detection

(51) International Patent Classification(s)
A61B 3/113 (2006.01) **A61F 9/00** (2006.01)

(21) Application No: **2010308271** (22) Date of Filing: **2010.10.19**

(87) WIPO No: **WO11/049911**

(30) Priority Data

(31) Number	(32) Date	(33) Country
12/902,575	2010.10.12	US
61/253,613	2009.10.21	US

(43) Publication Date: **2011.04.28**

(44) Accepted Journal Date: **2016.02.25**

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(56) Related Art
WO 2004/028421
US 2007/0211212
US 2008/0233053

(19) World Intellectual Property Organization
International Bureau



PCT



(10) International Publication Number
WO 2011/049911 A1

(51) International Patent Classification:
A61B 3/113 (2006.01) *A61F 9/00* (2006.01)

(21) International Application Number:

PCT/US2010/053132

(22) International Filing Date:

19 October 2010 (19.10.2010)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) Priority Data:

61/253,613	21 October 2009 (21.10.2009)	US
12/902,575	12 October 2010 (12.10.2010)	US

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ,

[Continued on next page]

(54) Title: LIQUID DISPENSING WITH BLINK DETECTION

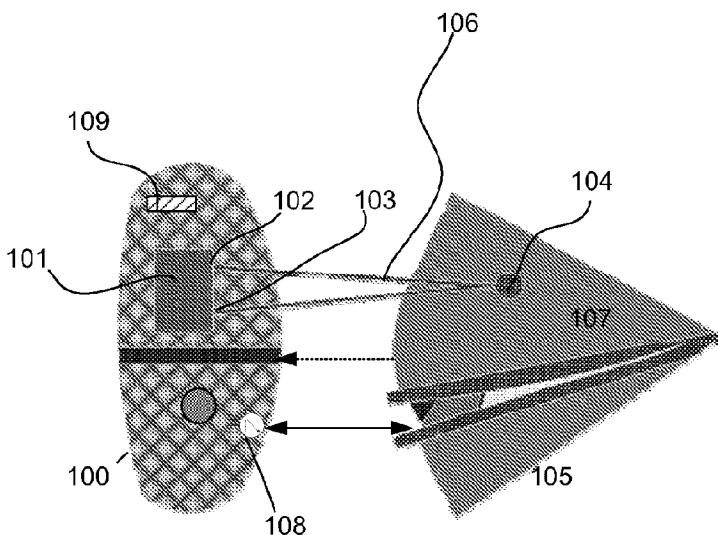


Fig. 1

(57) Abstract: This invention describes a device for dispensing liquids or mists into the eye, and, more specifically, in some embodiments, a device that dispenses a spray or mist into the eye based upon detection of a blink.

WO 2011/049911 A1



TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))

Published:

- with international search report (Art. 21(3))

LIQUID DISPENSING WITH BLINK DETECTION

RELATED APPLICATIONS

This application claims priority of U.S. Patent Application Serial
5 No. 12/902,575 filed October 12, 2010 and U.S. Provisional Patent Application Serial
No. 61/253,613 filed October 21, 2009.

FIELD OF USE

This invention describes a device for dispensing liquids or mists into the eye,
and, more specifically, in some embodiments, a device that dispenses a spray or mist
10 into the eye based upon detection of a blink.

BACKGROUND

It has been known to dispense a liquid or a mist into an eye using many
different devices. However, although many devices result with a liquid entering the
eye, the experience of getting the liquid into the eye is generally less than satisfactory.

15 Devices for self dispensing liquids typically require that a user hold the eyelids
open to fight the blink reflex. This contention inhibits easy application of the desired
fluids. Some automated devices pull down on one lid, or encapsulate the eye area to
stop the lids from closing. This touch is damaging to makeup, and can lead to
contamination of the device and the liquid entering the eye.

20 The dose from the system should consistently, without great user effort,
dispense into the user's eye, not upon the eyelid or other part of the users face, and
optimally should not touch the face in a manner that damages makeup or contaminates
the device.

Some dispensing devices simulate a 'gun' and shoot a fluid in at the eye at a
25 rate calculated to beat the blink reflex, however the speed and impact of the fluid seem
to induce discomfort in the patient.

Other devices force the lids open in different manners through touching the
cheek below the lid, and the eyebrow range above the upper lid, then spray the fluid
into the eye. This forcing open of the lids is uncomfortable, and the unit itself becomes
30 large and unwieldy. Any makeup worn by the consumer is smudged during the
process and sometimes contaminates the dispenser and/or the dispensed liquid.

Misting of fluid over the entire eye or even the facial area is also feasible, but wets not only the eye, but undesirable surfaces such as the eyelid, forehead, and nose. Application of liquid to the eyelid is declared to also wet the eye by flowing into the eye, but results from this method are mixed, and the wetting of the lid itself
5 is typically undesirable.

SUMMARY

Accordingly, the present invention provides a method of dispensing a liquid into an eye, the method including the steps of:

- 10 positioning a liquid dispensing device comprising a sensor and automated dispenser proximate to the eye;
- aligning the eye with a hole or tubular cutout formed through the liquid dispensing device for the user to look through, wherein the aligning of the eye positions the sensor to detect a blink of the eye and the automated dispenser to dispense the liquid into the eye;
- 15 emitting a light beam towards the eye; sensing the light reflected off of the eye to detect the blink; and
- dispensing the liquid via the automated dispenser based on the detection of the blink.

The invention also provides an apparatus for dispensing a liquid into an eye,
20 the apparatus including:

- an emitter for emitting a light beam towards the eye;
- a detector for detecting a blink from the light reflected off of the eye;
- an automated dispenser for dispensing the liquid towards the eye based on detection of the blink;
- 25 a dispensing nozzle for dispensing the liquid into the eye
- a processor in logical communication with the detector to coordinate dispensing of the liquid towards the eye based upon the detection of the blink; and
- a hole or tubular cutout formed through the apparatus for the user to look through to align the apparatus with the eye.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a dispensing device sensing a closed eye according to some embodiments of the present invention.

5 FIG. 2 illustrates a dispensing device sensing an open eye according to some embodiments of the present invention.

FIG. 3 illustrates an eye with an alignment apparatus.

FIG. 4 illustrates an exemplary apparatus for sensing a state of an open or closed eye.

Fig. 5 illustrates a controller that may be used to implement some embodiments of the present invention.

10

DETAILED DESCRIPTION OF THE INVENTION

The present invention includes a device for dispensing a liquid or a mist into an eye. The device for dispensing a liquid or a mist into an eye includes a detection method to determine when a blink has been completed. Dispensing is timed to an

interval based upon a determination of when an eye into which the liquid will be dispensed opens and closes, such as, for example, in a consciously induced eye blink or a natural eye blink. The blink is utilized to determine whether an eye is known to be open whereby a liquid can be dispensed before the patient closes the eye.

5 In some embodiments the device includes features to minimize the need for facial contact during liquid application. Additional embodiments include alignment features to assure proper alignment of the device to the eye. For example, in some embodiments, the dispensing device includes protrusions that rest on the eyebrow, and have a small diameter hole for the user to look through. When the user is able to see
10 through the hole, proper alignment has been achieved).

 Once the device is properly aligned with an eye, opening and closing of the eye is automatically determined by a sensor. A dispensing apparatus in logical communication with the sensor is programmed to dispense a liquid or mist into the eye according to the timing of an open cycle of a blink. The alignment process coupled
15 with the blink detection eliminates the need for holding the lids open, touching the face, or contamination associated with regular facial touch. In addition, by dispensing based upon an opening motion of an eyelid, a dispenser according to the present invention, consistently wets the eye without wetting the eyelid or surrounding face.

 In the following sections detailed descriptions of embodiments of the invention
20 will be given. The description of both preferred and alternative embodiments are exemplary embodiments only, and it is understood that to those skilled in the art that variations, modifications and alterations may be apparent. It is therefore to be understood that said exemplary embodiments do not limit the scope of the underlying invention.

25 Referring now to Fig. 1, a liquid dispensing device 100 includes one or more electronic sensors 101 capable of sensing an open state or a closed state of an eye 105. In some embodiments, the one or more sensors 101 include an emitter 102 and a detector 103. The emitter 102 emits a beam 106 which reflects off of a reflecting point 104 and back to the detector 103. As illustrated in Fig. 1, the reflecting point 104 is on
30 the eyelid 107 of the eye. The beam 106 may include, for example one or more of: infra red light, visible light, ultrasonic wavelengths, or other wavelengths.

 A processor, 109 may receive input from one or both of the emitter and the emitter 102 and the detector 103. Executable software may cause the processor to be

functional to calculate an amount of reflection of the beam 106. The software may be stored in a digital storage that is in logical communication with the processor. In some embodiments, the storage may be inherent with a microcontroller including the processor. A first range of an amount of reflection may correlate with a closed eye state, and a second amount of reflection may correlate with an open eye state.

In another aspect, a proximity sensor 108 may also include an emitter and a detector, and may be positioned such that a reflected beam may be used for the processor 109 to determine a relative distance between the liquid dispensing device 100 and a surface, such as the surface of an eye 105.

10

Referring now to Fig. 2, an open eye 105 provides for a reflecting point 104 on an open portion 203 of the eye 105, as opposed to the eyelid 107. The open portion of the eye 203 can include, for example, reflection of off the sclera or other portion of the eye. In some embodiments, a wavelength of an emitted beam is correlated with physical characteristics of the reflecting point 104. Reflection of the emitter beam 106 off of the eyelid will reflect back with a first set of reflection characteristics and reflection off of the open portion of the eye 203 with a second set of reflection characteristics. The reflection characteristics will be sensed by the detector 103.

In another aspect, of the present invention, alignment of the eye 105 with the liquid dispensing device 100 may be facilitated by a focal point of the emitter 102 being aligned with a predetermined portion of the eye, such as, for example: the sclera, iris, and pupil of the eye. Alignment can be accomplished, for example, via a line of sight 201. In some embodiments, when a pupil 202 is aligned with the line of sight 201, the sensor 101 is also properly aligned to sense an open state and a closed state of the eye 105. For example, in some embodiments, a device body includes the sensor 101 and dispenser such that when a patient aligns to a tubular cutout in the body which forms the line of sight 201 in the dispensing device, a position of the liquid dispensing device 100 creates a coaxial alignment between the line of sight and the center of the tube. The alignment establishes an angular and X-Y location of the pupil relative to the dispensing device 100.

30

In some embodiments, a line of sight can be combined with a positioning device which includes one or more alignment legs which press against the face and/or forehead.

In addition, in some embodiments, an audible signaling device may be included within a sensor or I electrical communication with the sensor. When the sensor measures a distance of the device from the eye the audible signaling device may signal (perhaps by click, tone, sound, or vibration,) that it is within an acceptable Z positional
5 range from the eye for an optimal dose. It is expected that this range will be relatively wide (in the 2-5 mm range) so any of the sensors noted above as able to detect the blink could also be used to detect a distance from the eye to the dispensing device 100.

Referring now to Fig. 3, a dispensing nozzle 301 will dispense a liquid via sprays 302 or mist (not illustrated) when the sensor 101 senses that the eye 105 is in an
10 open state. The open state is determined by the nature of the beam 106 sensed by the detector 103. Preferred embodiments, dispense a liquid spray 302 based upon timing that indicates that the eyelid 107 is involved in an opening cycle. Dispensing sprays 302 during an opening cycle of an eye can be accomplished such that the patient cannot physically blink to close the eye before the liquid is dispensed. The spray may
15 be a liquid stream or a mist.

In another aspect, a liquid spray 302 may be dispensed based upon a range of distance of the proximity sensor from the eye 105.

Referring now to Fig. 4, an example of a sensing device used to detect an open state and a closed state of an eyelid is illustrated. During laboratory tests, the
20 exemplary sensor 301 was connected to an oscilloscope (not shown) and positioned proximate to the eye. In some experiments, the sensor was positioned approximately 6 millimeters from the eye. The oscilloscope recorded that that the sensor 301 successfully provided a logic signal indicating that the sensor 301 accurately detected an open state versus a closed state of an eye. The detector 401 included an emitter 402
25 and a detector 403. The sensor accurately detected transition from a first state of an eye, such as an open eyelid state to a second state of an eye, such as a closed eyelid state.

According to the present invention, the detector 401 is placed in logical communication with an automated dispensing unit capable of dispensing a
30 predetermined amount of a liquid into the eye. Dispensing units are currently known and available which can receive an electrical signal based upon the logic of a sensing device 101 and activates the dispensing of a dose of liquid into an eye positioned proximate to the dispensing unit. For example, an automated dispenser may include an

electrically powered pump which dispenses a pulsatile liquid dose of a medicament into an eye. The electrically powered pump will respond quickly enough to allow a pulsatile dose to enter the eye before the eye can respond to the entry of the liquid into the eye.

5 Referring now to Fig. 5 a controller 500 is illustrated that may be used in some embodiments of the present invention. The controller 600 includes a processor 610, which may include one or more processor components coupled to a communication device 620. In some embodiments, a controller 600 can be used to receive a logical indication that an eye is in a first state or a second state and transmit energy to liquid
10 dispenser at a time appropriate to dispense a liquid or mist into the eye, based upon the transition from a first state to a second state.

The controller can include one or more processors, coupled to a communication device configured to communicate energy via a communication channel. The communication device may be used to electronically control, for example, one or more
15 of: timing of liquid dispensing; an amount of liquid dispensed; duration of a dispensing motion, tracking a number of dispensing actions, tracking chronological dispensing patterns or other actions related to the dispensing.

The processor 410 is also in communication with a storage device 630. The storage device 430 may comprise any appropriate information storage device,
20 including combinations of magnetic storage devices (*e.g.*, magnetic tape and hard disk drives), optical storage devices, and/or semiconductor memory devices such as Random Access Memory (RAM) devices and Read Only Memory (ROM) devices.

The storage device 430 can store a program 440 for controlling the processor 410. The processor 410 performs instructions of the program 440, and thereby
25 operates in accordance with the present invention. For example, the processor 410 may receive information descriptive of liquid to be dispensed, dispensing amounts, dispensing patterns, and the like.

Conclusion

The present invention, as described above and as further defined by the claims below, provides methods of providing a liquid dispenser with blink detecting mechanisms.

CLAIMS

1. A method of dispensing a liquid into an eye, the method including the steps of:
positioning a liquid dispensing device comprising a sensor and automated dispenser proximate to the eye;
aligning the eye with a hole or tubular cutout formed through the liquid dispensing device for the user to look through such that coaxial agreement is established between the line of sight of the eye and the central axis of the hole or tubular cutout, wherein the aligning of the eye positions the sensor to detect a blink of the eye and the automated dispenser to dispense the liquid into the eye;
emitting a light beam towards the eye; sensing the light reflected off of the eye to detect the blink; and
dispensing the liquid via the automated dispenser based on the detection of the blink.
2. The method of claim 1 wherein the sensor includes an emitter capable of emitting light of a predetermined wavelength towards the eye.
3. The method of claim 1 or claim 2, wherein the sensor additionally includes a detector capable of detecting characteristics of the light reflected off of the eye.
4. The method of claim 3 wherein the sensor generates a logic signal indicating if the eye is in an open state or closed state.
5. The method of any preceding claim, wherein the eye is aligned with the hole or tubular cutout of the apparatus via an alignment fixture.
6. The method of any preceding claim additionally including inputting a dosing amount into a controller and dispensing the dosing amount based upon the detection of the blink.
7. The method of any preceding claim wherein the dispensing of the liquid via the automated dispenser occurs when the eye is in an open state.
8. An apparatus for dispensing a liquid into an eye, the apparatus including:
an emitter for emitting a light beam towards the eye;
a detector for detecting a blink from the light reflected off of the eye;

an automated dispenser for dispensing the liquid towards the eye based on detection of the blink;

a dispensing nozzle for dispensing the liquid into the eye;

a processor in logical communication with the detector to coordinate dispensing of the liquid towards the eye based upon the detection of the blink; and

a hole or tubular cutout formed through the apparatus for the user to look through to align the apparatus with the eye such that coaxial agreement is established between the line of sight of the eye and the central axis of the hole or tubular cutout.

9. The apparatus of claim 8 additionally including a digital storage storing executable software operative with the processor to cause the processor to coordinate the dispensing of the liquid towards the eye based upon the detection of the blink.

10. The apparatus of claim 8 or claim 9 additionally including a proximity sensor in logical communication with the processor to determine whether the apparatus is within a suitable distance from the surface of the eye.

11. The apparatus of any one of claims 8 to 10 additionally including a dispensing nozzle in fluid communication with the automated dispenser and functional to dispense the liquid via a spray.

12. The apparatus of any one of claims 8 to 10 additionally including a dispensing nozzle in fluid communication with the automated dispenser and functional to dispense the liquid via a mist.

13. The apparatus of claim 10 additionally including an audible signaling device in electrical communication with the proximity sensor, said audible signaling device capable of emitting an audible signal based upon a signal from the proximity sensor that the apparatus is within a suitable distance from the surface of the eye.

14. The apparatus of any one of claims 8 to 13, wherein the processor is functional to receive a signal from the detector indicating the eye is in an open state and to send a logical signal to the automated dispenser based upon receipt of the signal indicating the eye is in an open state.

15. The apparatus of claim 14 wherein the automated dispenser dispenses the liquid based upon the receipt of the signal from the processor indicating the eye is in the open state.

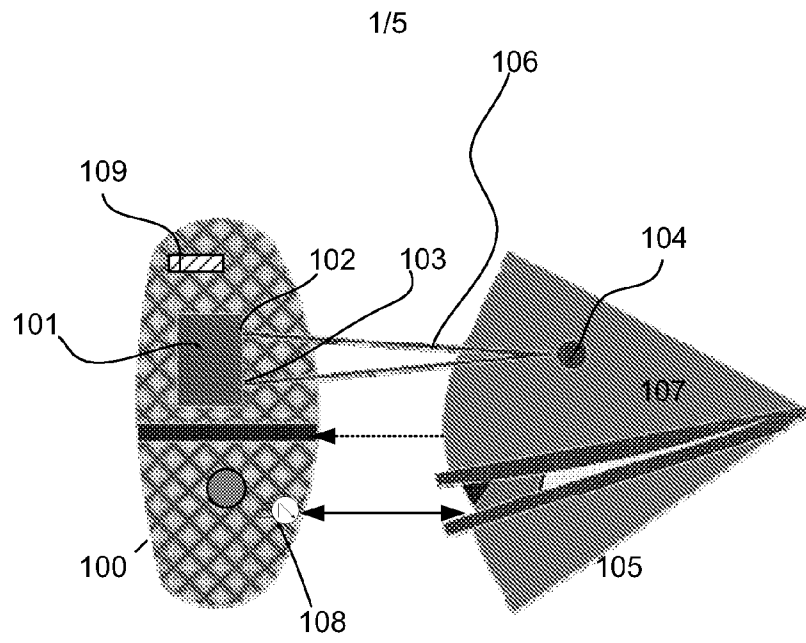


Fig. 1

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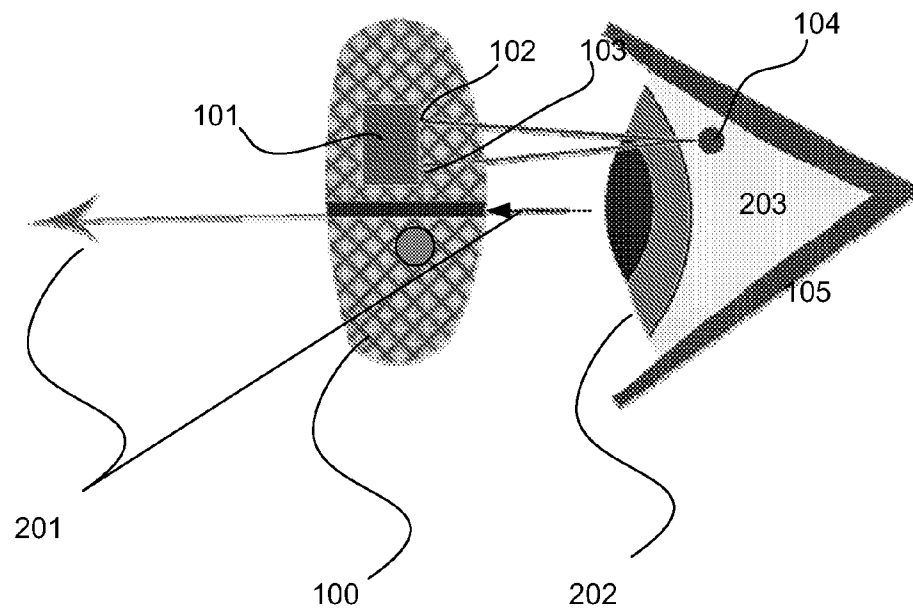


Fig. 2

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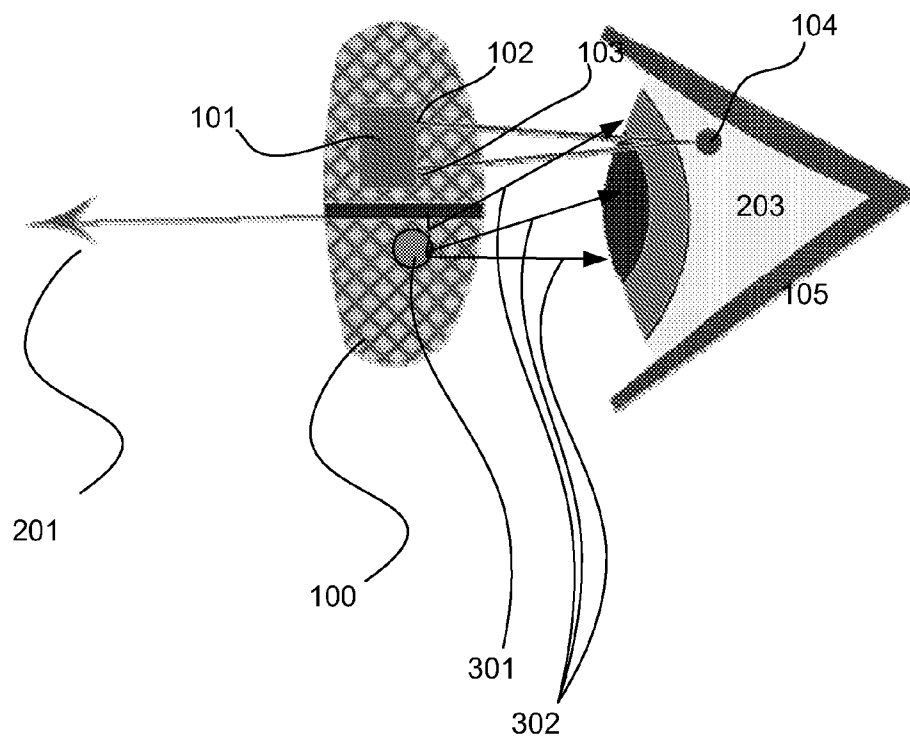


Fig. 3

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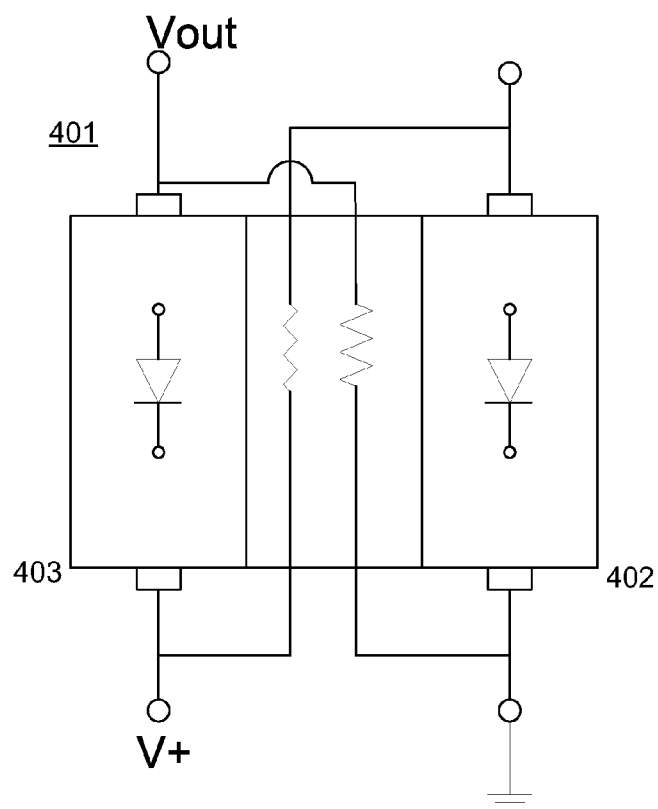


Fig. 4

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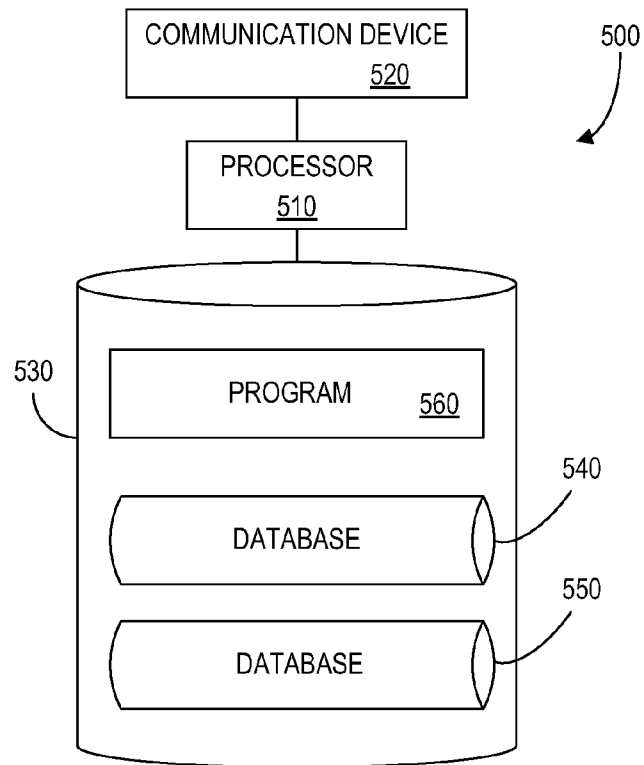


FIG. 5