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(54) Title: LIDAR SENSOR ASSEMBLY

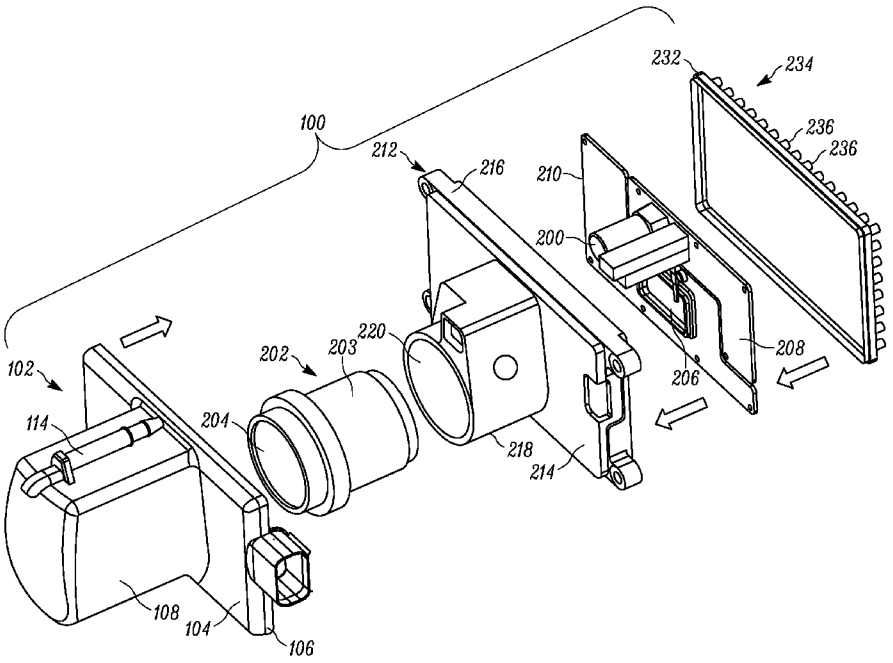

FIG. 2

(57) Abstract: A lidar sensor assembly includes a light source producing infrared light and a holder supporting the light source. A front cover is coupled to the holder and includes a window comprising a plastic allowing passage of infrared light.

[Continued on next page]

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Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*
— *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))*

Published:

— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

LIDAR SENSOR ASSEMBLY

TECHNICAL FIELD

[0001] The technical field relates generally to an assembly for housing a lidar sensor and particularly to an assembly for housing a flash lidar sensor.

BACKGROUND

[0002] With the rise in autonomous vehicles and advanced driver assistance systems, lidar sensors are increasingly being used to survey the region around a vehicle. Such lidar sensors typically use laser-generated light and one or more photodetectors to sense shapes, distances, etc. of objects and markings around the vehicle. However, laser light is often hazardous to human vision when not properly masked and/or filtered.

[0003] As such, it is desirable to present a lidar sensor assembly that provides protection for unfiltered emissions of laser light. In addition, other desirable features and characteristics will become apparent from the subsequent summary and detailed description, and the appended claims, taken in conjunction with the accompanying drawings and this background.

BRIEF SUMMARY

[0004] In one exemplary embodiment, a lidar sensor assembly includes a light source producing infrared light. The assembly also includes a holder supporting the light source. The assembly further includes a front cover coupled to the holder. The front cover includes a window comprising a plastic allowing passage of infrared light.

[0005] In another exemplary embodiment, a lidar sensor assembly includes a light source and a lens barrel having at least one lens. The assembly further includes a detector array. At least one printed circuit board ("PCB") supports the light source and the detector array. The assembly further includes a holder supporting the lens barrel and the at least one printed circuit board. The holder includes a base and a wall extending from the base to define a cavity. The holder further includes a protuberance extending from the base and defining a channel for accommodating at least a portion of the lens barrel and a duct for accommodating at least a portion of the light source. A front cover has a base and a wall extending from the base to define a void. The front cover further includes a protuberance extending from the base and defining a housing

for accommodating the protuberance of the holder. A back cover is coupled with the front cover such that the at least one PCB and the holder are sandwiched therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Other advantages of the disclosed subject matter will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0007] Figure 1 is a front perspective view of a lidar sensor assembly according to an exemplary embodiment;

[0008] Figure 2 is an exploded perspective view of the lidar sensor assembly according to an exemplary embodiment;

[0009] Figure 3 is a rear perspective view of a holder of the lidar sensor assembly according to an exemplary embodiment;

[0010] Figure 4 is a rear perspective view of the lidar sensor assembly showing a heat sync on a back cover according to an exemplary embodiment;

[0011] Figure 5 is a front perspective view of the lidar sensor assembly showing a conductor of a light source shutoff circuit according to an exemplary embodiment; and

[0012] Figure 6 is an electrical schematic diagram of the light source shutoff circuit according to an exemplary embodiment.

DETAILED DESCRIPTION

[0013] Referring to the Figures, wherein like numerals indicate like parts throughout the several views, a lidar sensor assembly 100 is shown and described herein.

[0014] Referring to Figure 2, the lidar sensor assembly 100 of the exemplary embodiment includes a light source 200. In the exemplary embodiment, the light source 200 includes a laser transmitter (not separately shown) configured to produce a pulsed laser light output. The pulsed laser light output, in the exemplary embodiment, has a wavelength in the infrared range. More particularly, the pulsed laser light output has a wavelength of about 1064 nanometers ("nm"). The light source 200 may also include a diffusion optics (not separately shown) to diffuse the pulsed laser light output produced by the laser transmitter. The diffused, pulsed laser light output of the exemplary embodiment allows for the lidar sensor assembly 100 to operate without moving the light source 200, e.g., rotating, as is often typical in prior art lidar sensors.

[0015] The lidar sensor assembly 100 of the exemplary embodiment also includes a lens barrel 202. The lens barrel 202 includes a frame 203 supporting at least one lens 204. Of course, the lens barrel 202 may include multiple lenses 202, commonly known as "elements". The at least one lens 204 of the lens barrel 202 are configured to receive infrared light that is produced by the light source 200 and reflected off one or more objects (not shown). In the exemplary embodiment, the frame 203 has a generally cylindrical shape with threads (not separately numbered) on an exterior thereof. In the exemplary embodiment, the frame 203 is formed at least partially of aluminum. However, it should be appreciated that other materials may be utilized to form the frame 203.

[0016] The lidar sensor assembly 100 of the exemplary embodiment further includes a detector array 206 of light detecting elements (not individually shown). The detector array 206 receives infrared light focused by the at least one lens 204. The detector array 206 may be coupled to an integrated circuit (not shown), such as a readout integrated circuit ("ROIC").

[0017] The lidar sensor assembly 100 of the exemplary embodiment also includes at least one printed circuit board ("PCB") 208, 210. More particularly, the exemplary embodiment includes a first PCB 208 and a second PCB 210. The first PCB 208 supports the light source 200 while the second PCB 210 supports the detector array 206.

[0018] The lidar sensor assembly 100 further includes a holder 212. The holder 212 supports the lens barrel 202 and the at least one printed circuit board 208, 210. In the exemplary embodiment, the holder 212 includes a base 214 and a wall 216 extending from the base 214 to define a cavity 300, as shown in FIG. 3. The cavity 300 may be configured to accommodate the at least one PCB 208, 210.

[0019] Referring again to FIG. 2, the holder 212 further including a protuberance 218 extending from the base 214 and defining a channel 220. The channel 220 may accommodate at least a portion of the lens barrel 202. In the exemplary embodiment, the channel 220 defines a cylindrical shape to generally match the shape of the lens barrel 202. The protuberance 218 may include threads (not numbered) such that the threads of the frame 203 of the lens barrel 202 may be secured and supported in the channel 220.

[0020] In the exemplary embodiment, the protuberance 218 also defines a duct 222. The duct 222 is configured to accommodate at least a portion of the light source 200. In the exemplary embodiment, the duct 222 has a generally rectangular cross-section.

However, it should be appreciated that the duct 222 may be formed in any suitable shape.

[0021] Referring again to FIGS. 1 and 2, the lidar sensor assembly 100 also includes a front cover 102. The front cover 102 includes a base 104 and a wall 106 extending from the base 104 to define a void (not specifically shown). The void of the front cover 102 is configured to accommodate at least a portion of the holder 212, as described in greater detail below. In the exemplary embodiment, the front cover 102 comprises a plastic. That is, the front cover 102 is formed at least partially from plastic.

[0022] The front cover 102 further includes a protuberance 108 extending from the base 104 and defining a housing (not specifically shown). The housing is configured to accommodate the protuberance 218 of the holder 212. That is, at least a portion of the protuberance 218 of the holder 212 may fit inside the housing 102 defined by the protuberance 108 of the front cover 102. Accordingly, at least a portion of the lens barrel 202 and at least a portion of the detector array 206 may be disposed within the protuberance 108 of the front cover 102.

[0023] The lidar sensor assembly 100 further includes a back cover 232. The back cover 232 may be coupled with the front cover 102. As such, the at least one PCB 208, 210 and the holder 212 are sandwiched between the back cover 232 and the front cover 102. Likewise, the detector array 206 and the lens barrel 202 are also disposed between the back cover 232 and the front cover 102.

[0024] The lidar sensor assembly 100 may include a heat sync 234. In the exemplary embodiment, the heat sync 234 is disposed on the back cover 232, as best seen in FIG. 4. More particularly, the heat sync 234 of the exemplary embodiment includes a plurality of frustoconical projections 236 extending from an outside surface (not numbered) of the back cover 232. However, it should be appreciated that the heat sync 234 may comprise elements having different shapes (e.g., fins) and be disposed at various regions of the assembly 100.

[0025] Referring again to FIG. 1, the front cover 102 includes at least one window 110, 112. More particularly, in the exemplary embodiment, the protuberance 108 of the front cover 102 includes a first window 110 and a second window 112. The windows 110, 112 each comprise a plastic allowing passage of infrared light. For example, the windows 110, 112 may be transparent. However, in other embodiments, one or more of the windows 110, 112 may be formed of glass.

[0026] The first window 110 is situated adjacent the at least one lens 204 for allowing light to travel therethrough. Similarly, the second window 112 is situated adjacent an output (not numbered) of the light source 200, to allow light to travel therethrough.

[0027] In one exemplary embodiment, the front cover 102 is formed through an injection molding process utilizing two different plastic materials. A first material (not shown) forms the transparent plastic to form the first and/or second windows 110, 112. A second material (not shown) forms other portions of the front cover 102 which are not transparent. In other exemplary embodiments, the front cover 102 and/or portions of the front cover 102 may be formed of a metal.

[0028] The lidar sensor assembly 100 may include a fluid hose 114. The fluid hose 114 defines an opening (not numbered) for allowing a fluid to flow therefrom. For instance, the fluid may be a cleaning fluid. The opening, in the exemplary embodiment, is disposed adjacent the windows 110, 112. As such, fluid may flow out of the fluid hose 114 and onto the windows 110, 112 for cleaning the windows 110, 112. The fluid hose 114 may be connected to another hose (not shown) and/or a reservoir in which the fluid is stored.

[0029] Referring now to FIGS. 5 and 6, the lidar sensor assembly 100 may include a multi-function circuit 500. The multi-function circuit 500 is configured, as described in greater detail below, to prevent illumination of the light source 200 in response to a crack detected in the front cover 102 and/or removal of the front cover 102 from the assembly 100.

[0030] The multi-function circuit 500 includes a conductor 502 disposed at least partially within the front cover 102. In the exemplary embodiment, at least a portion of the conductor 502 is disposed in contact with the protuberance 108 of the front holder 102. The conductor 502 may be formed of any suitable conductive material, including, but not limited to, a wire and/or conductive paint.

[0031] The circuit 500 may be utilized to provide heat to the front cover 102. In the exemplary embodiment, the circuit 500 includes one or more resistive elements 600 electrically connected to the conductor 502, as shown in FIG. 6. The conductor 502 is also electrically connected to a power supply 602 configured to provide power to the circuit 500 and the resistive element 600. The resistive elements 600 emit heat when an electrical current is applied thereto. The resistive elements 600 may be formed of any suitable material, including, but not limited to, conductive paint. In the exemplary

embodiment, the resistive elements 600 are disposed proximate to at least one of the windows 110, 112. As such, the circuit 500 may be utilized to remove moisture, condensation, snow, ice, etc. from the windows 110, 112, thus allowing less obstructed passage of light through the windows 110, 112.

[0032] The circuit 500 may also be utilized to detect cracks in the front cover 102 and/or removal of the front cover 102. Still referring to FIG. 6, the circuit 500 also includes a sensor 606. The sensor 606 of the exemplary embodiment measures voltage at a point between the power supply 602 and the resistive elements 600. A processor 608 is in communication with the sensor 606 and configured to receive data from the sensor 606. The processor 608 is also in communication with the light source 200 and is configured to selectively deactivate the light source 200.

[0033] When the circuit 500 is interrupted, e.g., when a crack has occurred in the front cover 102 and breaks the conductor 502, the voltage at the sensor 606 will change, e.g., increase. The processor 608 is then notified of the change in voltage by sensing the change in voltage at the sensor 606. In response to the change in voltage, the processor 608 may deactivate the light source 200. As such, laser light from the light source 200 is not inadvertently projected through any cracks in the front cover 102.

[0034] In the exemplary embodiment, the circuit 500 also includes at least one contact 604 for electrically connecting the power source 602 to the portion (not labeled) of the conductor 502 disposed on the front cover 102 and the resistive elements 600. When the front cover 102 is removed from its connection with the holder 212 or other structure component of the assembly 100, the contact 604 will break the circuit 500, thus changing the voltage at the sensor 606. The processor 608 may then deactivate the light source 200 based on this change in voltage.

[0035] Referring again to FIG. 1, the lidar sensor assembly 100 of the exemplary embodiment also includes a connector 116. The connector 116 includes a hood 118 projecting from the front cover 102. The hood 118 is configured to mate with another connector (not shown), e.g., of a cable. The hood 118 also protects electrical contacts, including the contacts 604 described above. It should be appreciated, however, that the lidar sensor assembly 100 may be constructed without the connector 116.

[0036] The lidar sensory assembly 100 also includes a plurality of mounting tabs 120 for attaching the assembly 100 to a vehicle. In the exemplary embodiment, the assembly 100 includes four mounting tabs 120, one tab 120 extending from each corner (not numbered) of the holder 212.

[0037] The present invention has been described herein in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the invention are possible in light of the above teachings. The invention may be practiced otherwise than as specifically described within the scope of the appended claims.

CLAIMS

What is claimed is:

1. A lidar sensor assembly comprising:

a light source producing infrared light;

a holder supporting said light source; and

a front cover coupled to said holder and including a window comprising a plastic allowing passage of infrared light.

2. The lidar sensor assembly as set forth in claim 1, further comprising a shutoff circuit configured to deactivate said light source in response to a predetermined condition.

3. The lidar sensor assembly as set forth in claim 2, wherein the predetermined condition comprises a crack in said front cover.

4. The lidar sensor assembly as set forth in claim 3, wherein said shutoff circuit comprises a conductor disposed at least partially within said front cover.

5. The lidar sensor assembly as set forth in claim 4, wherein said conductor comprises a heating element disposed around at least part of a periphery of said window.

6. The lidar sensor assembly as set forth in claim 4, wherein said shutoff circuit comprises a voltage sensor configured to sense a voltage on said conductor.

7. The lidar sensor assembly as set forth in claim 4, wherein said shutoff circuit includes a connector in-line with said conductor and connecting said front cover and said holder.

8. The lidar sensor assembly as set forth in claim 1, further comprising a fluid hose defining an opening adjacent said window.

9. The lidar sensor assembly as set forth in claim 1, wherein said front cover includes a base and a proturberance extending from said base.

10. The lidar sensor assembly as set forth in claim 9, wherein said protuberance of said front cover includes said window.

11. A lidar sensor assembly comprising:

a light source;

a lens barrel having at least one lens;

a detector array;

at least one printed circuit board ("PCB") supporting said light source and said detector array;

a holder supporting said lens barrel and said at least one printed circuit board;

said holder having a base and a wall extending from said base to define a cavity;

said holder further including a protuberance extending from said base and defining a channel for accommodating at least a portion of said lens barrel and a duct for accommodating at least a portion of said light source;

a front cover having a base and a wall extending from said base to define a void;

said front cover further including a proturberance extending from said base and defining a housing for accommodating said protuberance of said holder;

a back cover coupled with said front cover such that said at least one PCB and said holder are sandwiched therebetween.

12. The lidar sensor assembly as set forth in claim 11, wherein said protuberance of said front cover includes a window.

13. The lidar sensor assembly as set forth in claim 11, further comprising a shutoff circuit configured to deactivate said light source in response to a predetermined condition.

14. The lidar sensor assembly as set forth in claim 13, wherein said shutoff circuit comprises a conductor disposed at least partially within said front cover.

15. The lidar sensor assembly as set forth in claim 14, wherein said conductor comprises a heating element disposed around at least part of a periphery of said window.

16. The lidar sensor assembly as set forth in claim 14, wherein said shutoff circuit comprises a voltage sensor configured to sense a voltage on said conductor.

17. The lidar sensor assembly as set forth in claim 14, further comprising a connector in-line with said conductor and connecting said front cover and said holder.

18. The lidar sensor assembly as set forth in claim 12, wherein said window comprises a plastic allowing passage of infrared light.

19. The lidar sensor assembly as set forth in claim 11, further comprising a fluid hose defining an opening adjacent said window.

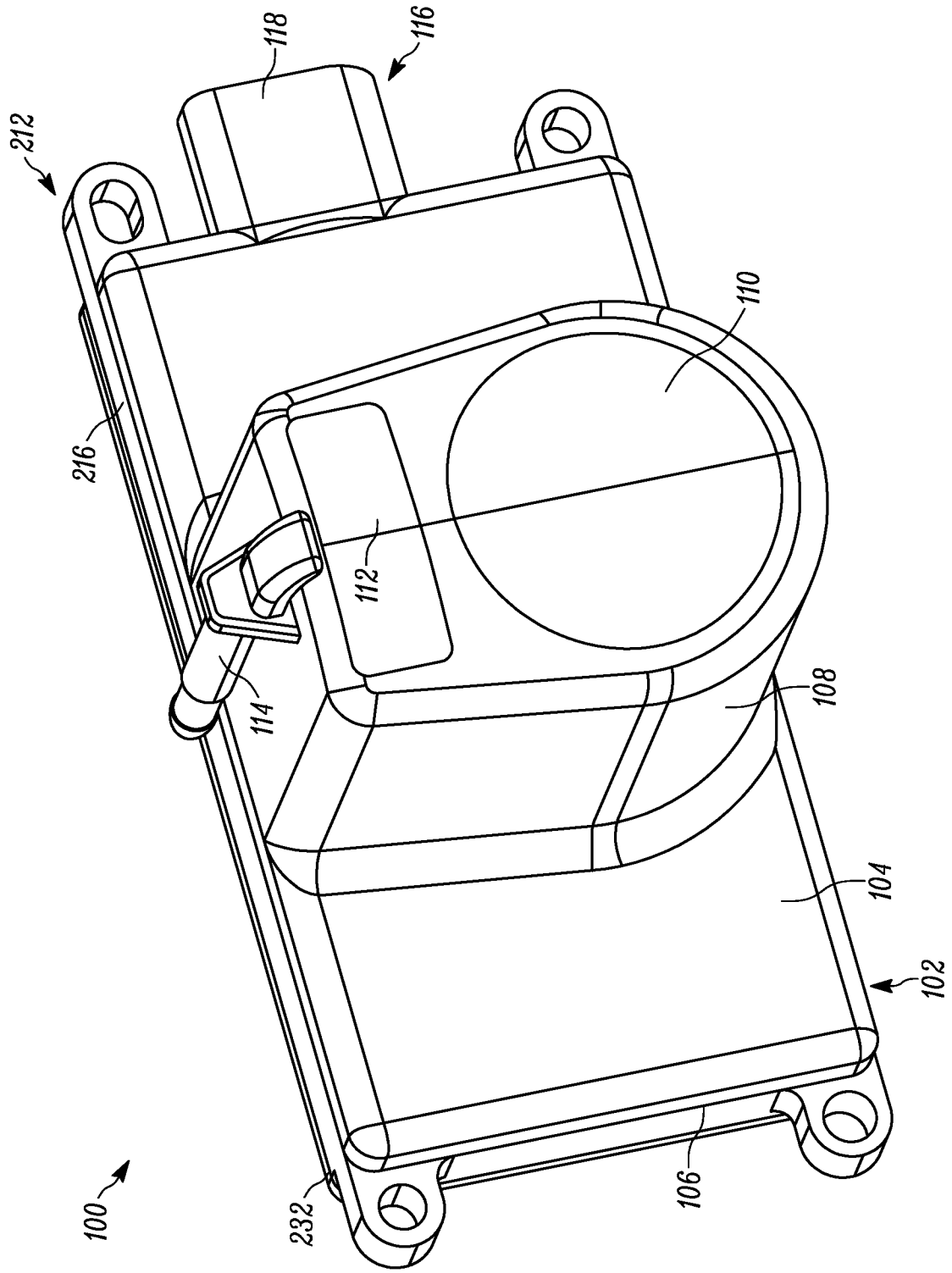

FIG. 1

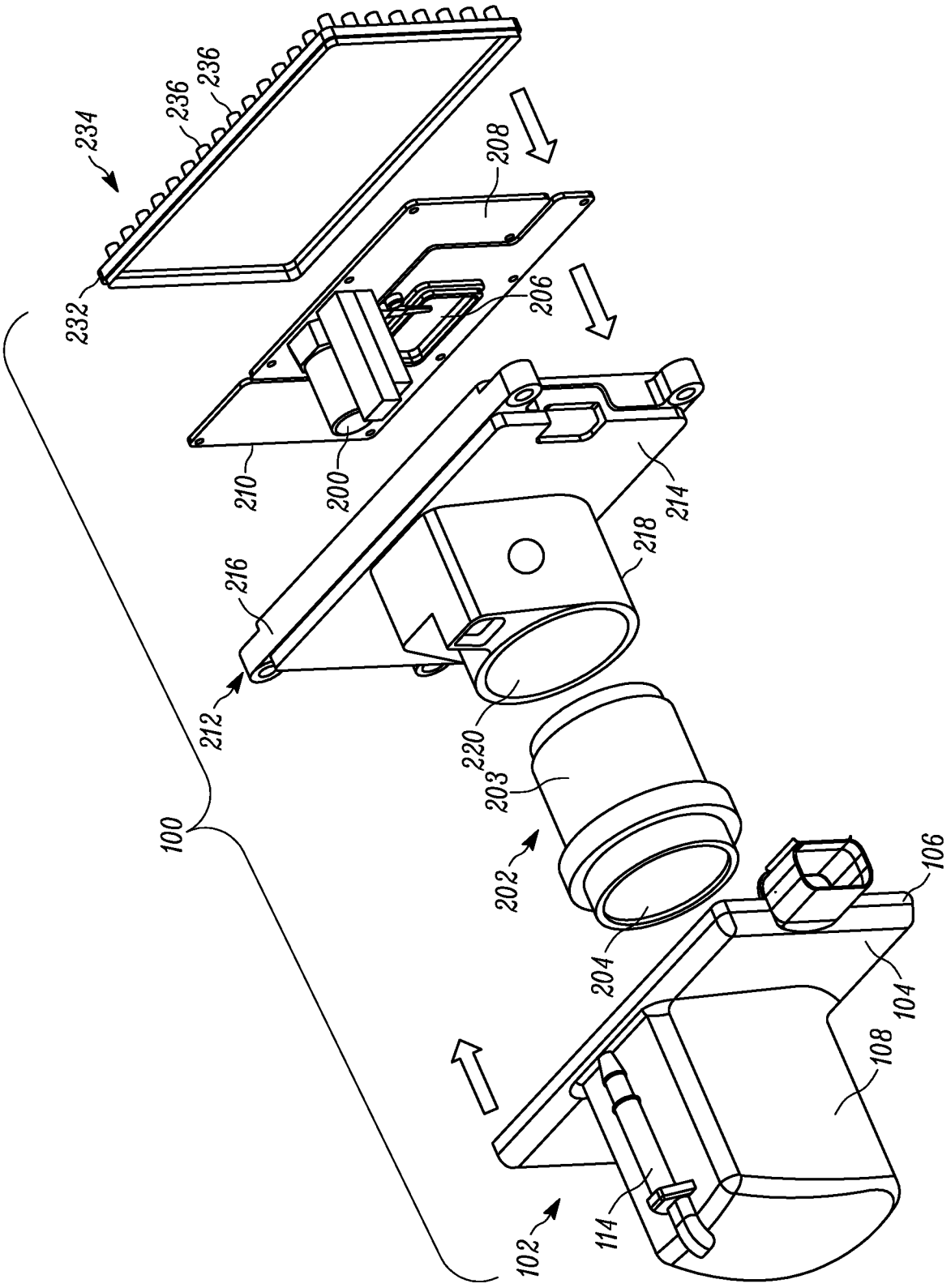
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FIG. 2

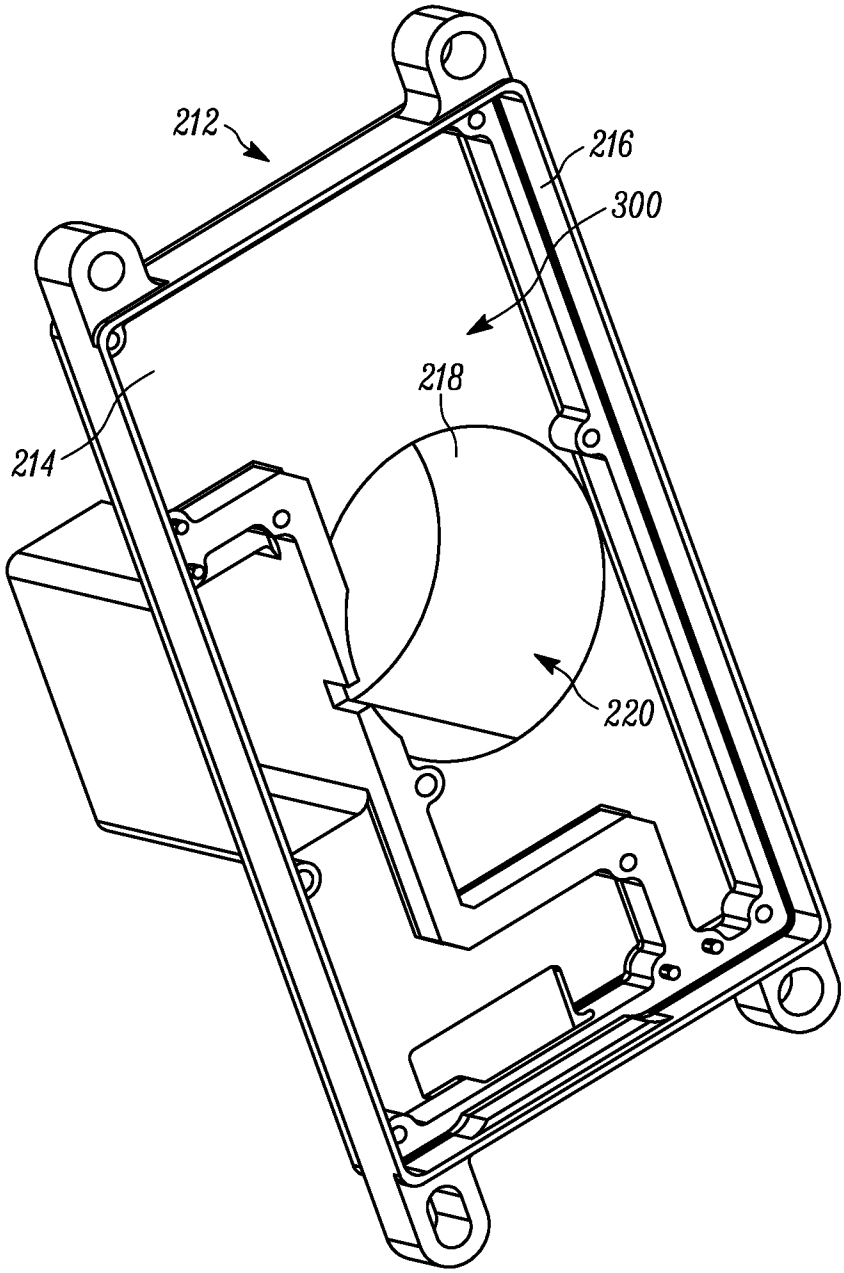

FIG. 3

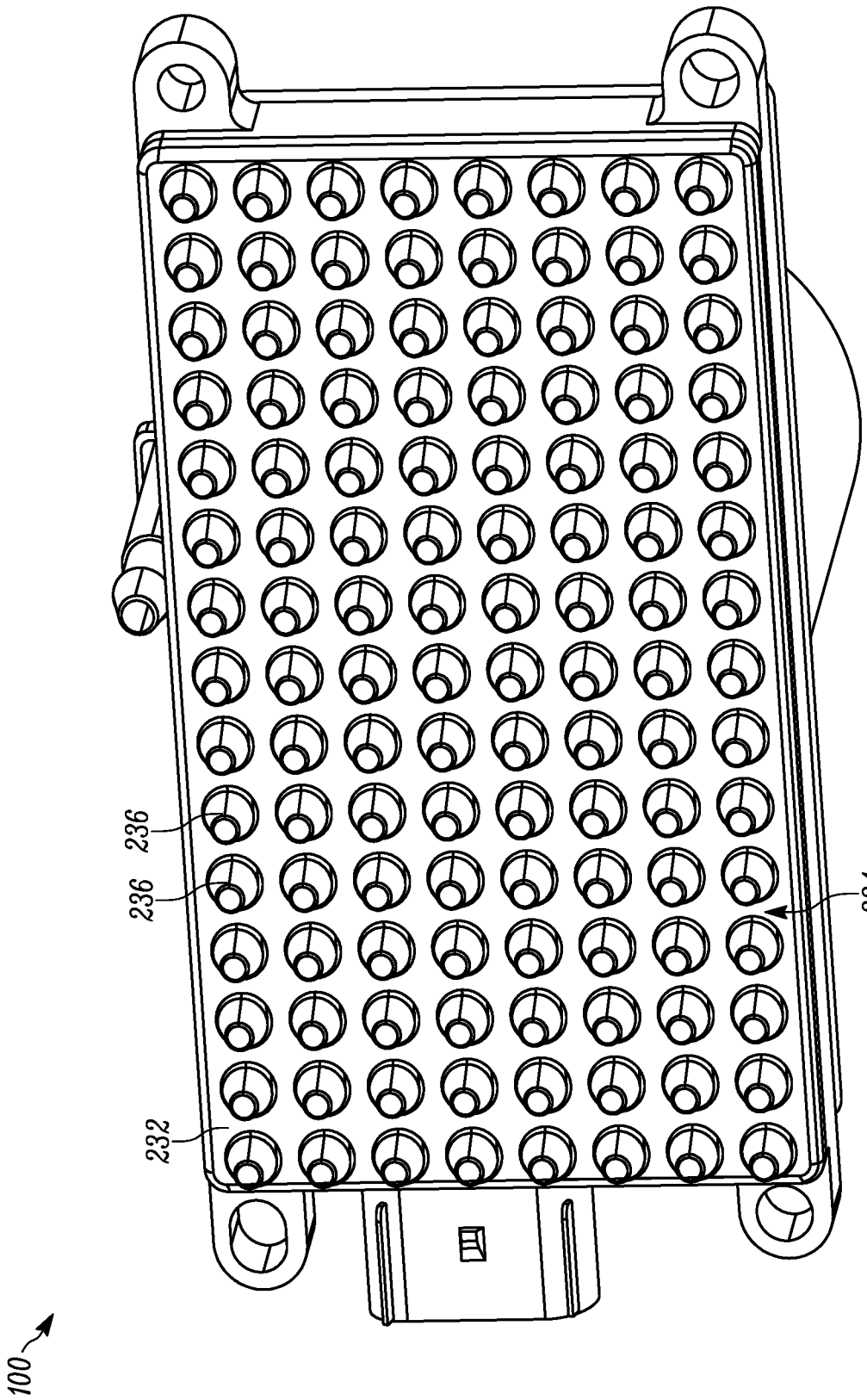

FIG. 4

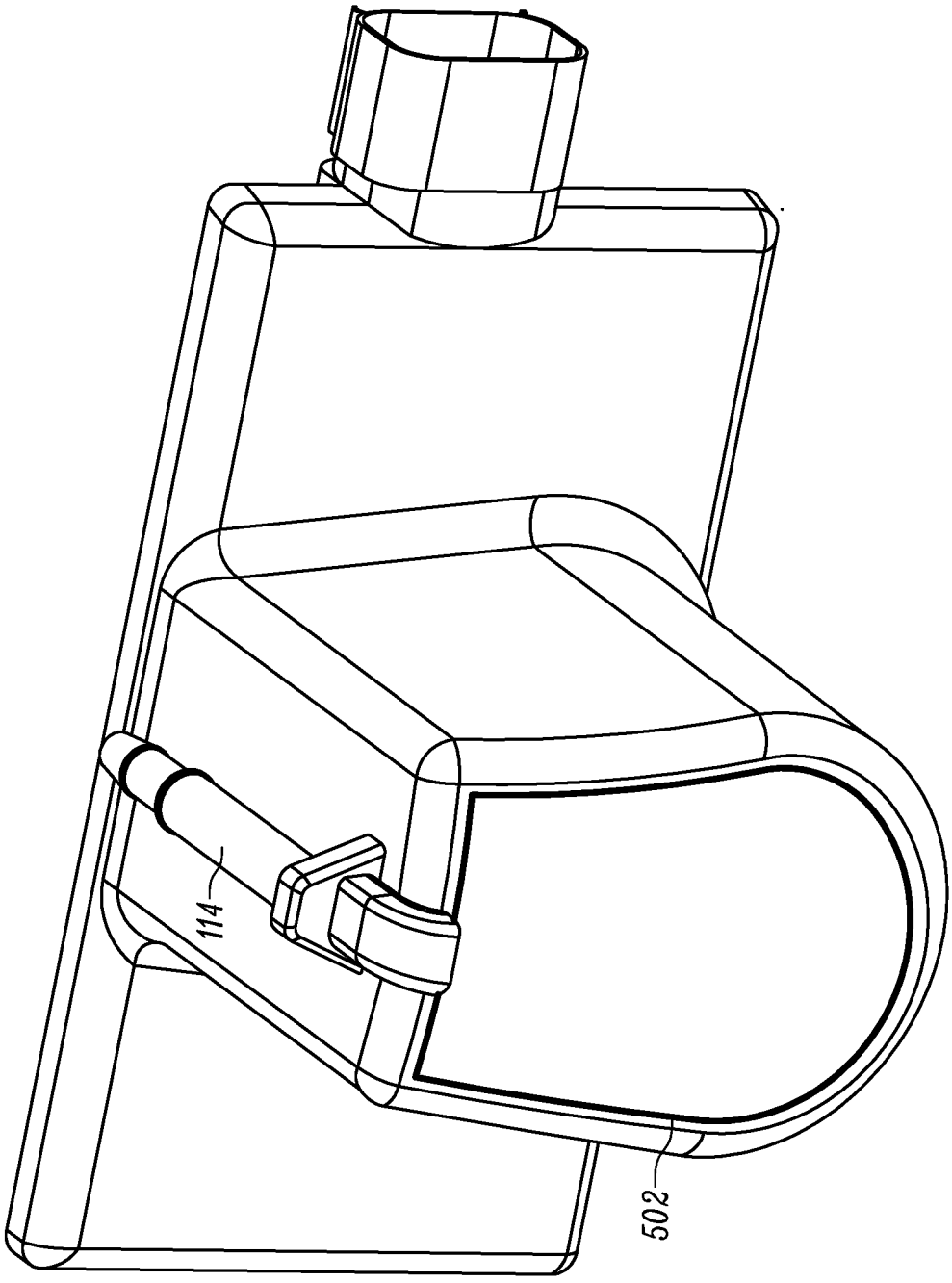

FIG. 5

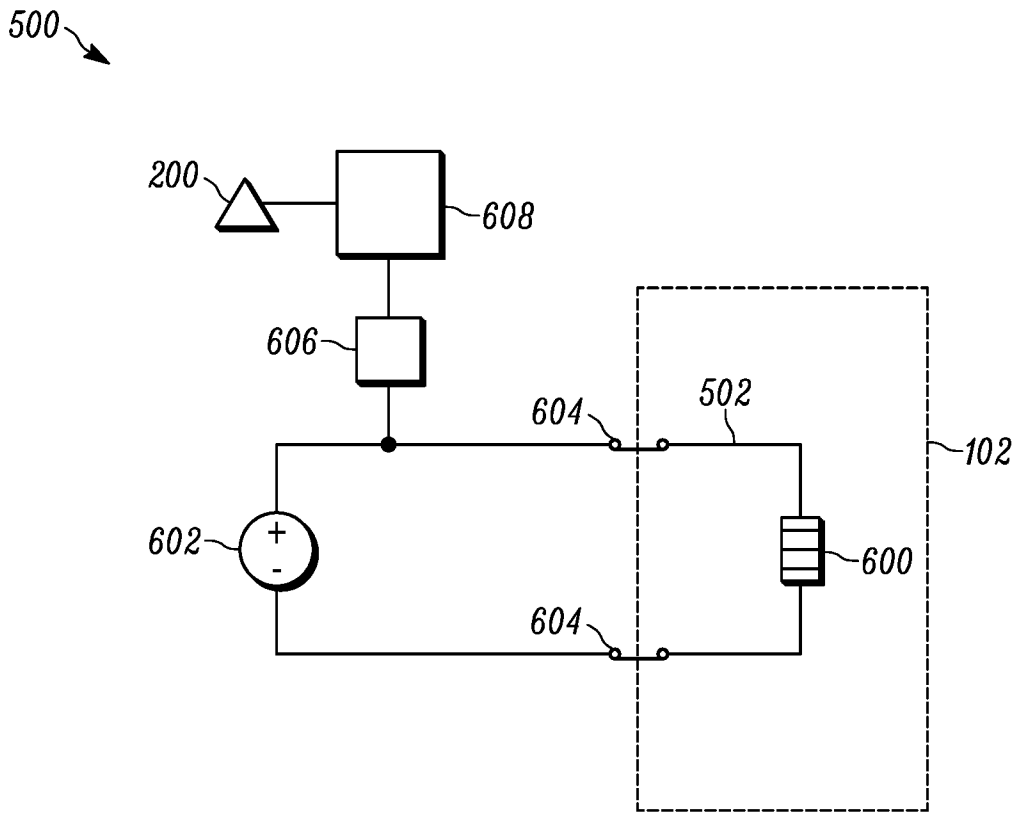

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/039006

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01S7/481 G01S7/497 G01S17/10
ADD. G01S17/89

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)
G01S

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.
X Y	US 2005/205672 A1 (ANDO TAKAMASA [JP] ET AL) 22 September 2005 (2005-09-22) abstract; figure 1 paragraphs [0033], [0035], [0038] paragraphs [0039], [0055], [0056] paragraphs [0058], [0060], [0061] paragraph [0066] -----	1-4,6,7 5
X	US 2016/223663 A1 (SCHMALENBERG PAUL DONALD [US] ET AL) 4 August 2016 (2016-08-04) figures 1, 2 paragraphs [0004], [0015], [0021] paragraph [0033] - paragraph [0035] ----- -/--	1,2

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 September 2018	21/11/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Knoll, Bernhard

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/039006

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2016/073144 A1 (ILLINOIS TOOL WORKS [US]) 12 May 2016 (2016-05-12) abstract; figure 2 paragraph [0004] - paragraph [0007] paragraphs [0042], [0043] -----	5

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/039006

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-7

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7

   controlling the light source

   ---

2. claim: 8

   cleaning the transmission window

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3. claims: 9-19

   designing a volume-efficient housing

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2018/039006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005205672 A1	22-09-2005	CN 1670471 A	21-09-2005
		DE 102005011844 A1	13-10-2005
		JP 4305231 B2	29-07-2009
		JP 2005265439 A	29-09-2005
		US 2005205672 A1	22-09-2005
US 2016223663 A1	04-08-2016	JP 2016145817 A	12-08-2016
		US 2016223663 A1	04-08-2016
WO 2016073144 A1	12-05-2016	CN 107076852 A	18-08-2017
		EP 3215869 A1	13-09-2017
		JP 2018505383 A	22-02-2018
		KR 20170078700 A	07-07-2017
		US 2017334397 A1	23-11-2017
		WO 2016073144 A1	12-05-2016