



(11)

EP 3 435 011 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.01.2019 Bulletin 2019/05

(51) Int Cl.:
F25D 21/02 (2006.01)

(21) Application number: **17183083.9**

(22) Date of filing: **25.07.2017**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Vestel Elektronik Sanayi ve Ticaret A.S.
45030 Manisa (TR)**

(72) Inventor: **ÜNVER,, Burak
45030 Manisa (TR)**

(74) Representative: **Flint, Adam
Page White & Farrer
Bedford House
John Street
London WC1N 2BF (GB)**

(54) **AN APPARATUS AND METHOD FOR DETECTING FREEZING OF A SUBSTANCE**

(57) An apparatus (100) for detecting freezing of a substance (114) has a container (104) which contains a substance (114) which has a freezing temperature below which the substance (114) is solid and above which the substance (114) is liquid. The apparatus (100) also has a light source (108) connected to the container (104). An actuator (102) moves the container (104). A light detection component (110) is arranged to detect light emitted by the light source (108). The arrangement is such that, when the container (104) is driven to move by the actuator (102), the amount of light detected by the light detection component (110) varies depending on whether the substance (114) in the container (104) is in a solid state or a liquid state.

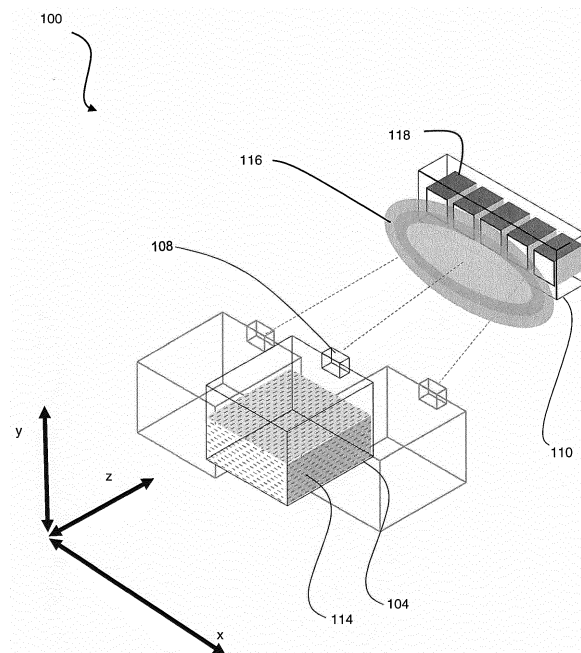


Figure 2A

EP 3 435 011 A1

Description

Technical Field

[0001] The present disclosure relates to an apparatus and method for detecting freezing of a substance.

Background

[0002] So-called frost-free refrigeration apparatus, such as freezers and refrigerators and the like, employ various complex methods for preventing a build up of ice. One example of such a method is periodically heating the freezer or refrigerator to melt any ice that may have formed inside. This process can be wasteful and inefficient.

Summary

[0003] According to a first aspect disclosed herein, there is provided an apparatus for detecting freezing of a substance, the apparatus comprising:

a container, the container containing a substance which has a freezing temperature below which the substance is solid and above which the substance is liquid;

a light source connected to the container;

an actuator, the actuator being arranged to move the container; and

a light detection component; the light detection component being arranged to detect light emitted by the light source;

the arrangement being such that, when the container is driven to move by the actuator, the amount of light detected by the light detection component varies depending on whether the substance in the container is in a solid state or a liquid state.

[0004] In an example, the light detection component comprises at least one light dependent resistor.

[0005] In an example, the apparatus comprises an electric motor for driving the actuator to vibrate the container.

[0006] In an example, the apparatus comprises a heating element, the arrangement being such that the heating element is triggered to heat when the amount of light detected by the light detection component indicates that the substance in the container is in a solid state.

[0007] In an example, there is provided refrigeration apparatus comprising apparatus as described above. The refrigeration apparatus may be for example a refrigerator or a freezer.

[0008] According to a second aspect disclosed herein, there is provided a method for detecting freezing of a substance, the method comprising:

driving a container to move by an actuator, the con-

tainer containing a substance which has a freezing temperature below which the substance is solid and above which the substances is liquid; and detecting, by a light detection component, light from a light source, the light source being connected to the container; wherein the amount of light detected by the light detection component varies depending on whether the substance in the container is in a solid state or a liquid state.

[0009] In an example, the light detection component comprises at least one light dependent resistor.

[0010] In an example, the method comprises driving the actuator by an electric motor to vibrate the container.

[0011] In an example, the method comprises triggering a heating element to heat when the amount of light detected by the light detection component indicates that the substance in the container is in a solid state.

[0012] In an example, the method is carried out by a refrigeration apparatus the refrigeration apparatus may be for example a refrigerator or a freezer.

[0013] In an example the substance is water which in its liquid state is water or steam and in its solid state is ice.

Brief Description of the Drawings

[0014] To assist understanding of the present disclosure and to show how embodiments may be put into effect, reference is made by way of example to the accompanying drawings in which:

Figure 1 shows schematically a side view of a first example of apparatus for detecting freezing of a substance; and

Figures 2A and 2B show schematically perspective views of the apparatus of Figure 1 in use.

Detailed Description

[0015] As mentioned previously, refrigeration apparatus, such as for example frost-free freezers and refrigerators and the like, prevent a build-up of ice, particularly on for example the heat exchanger, using relatively complex or inefficient methods. One such method is periodically heating a heater that is located on or near the heat exchanger to melt any ice that may have formed. Often these methods are wasteful, particularly if heaters are used excessively, and inefficient. These methods have no regard for whether ice has actually formed, and simply periodically heat the heat exchanger regardless.

[0016] According to examples described herein, an apparatus is arranged to detect the freezing of a substance, which may be for example water/ice. The apparatus comprises a container. The container contains a substance which has a freezing temperature below which the substance is solid and above which the substance is a liquid.

The apparatus also has a light source. The light source is connected to the container. The light source may be connected directly to the container, for example by being mounted on or attached to the container. Alternatively, the light source may be connected indirectly to the container. The apparatus also comprises an actuator. The actuator is arranged to move the container. Further, the apparatus comprises a light detection component. The light detection component being arranged to detect light emitted by the light source. The apparatus is arranged such that, when the container is driven to move by the actuator, the amount of light detected by the light detection component varies depending on whether the substance in the container is in a solid state or a liquid state. Such apparatus may be used in a refrigeration apparatus, such as a refrigerator or a freezer or the like. Such apparatus may also be used in other applications where it may be useful to determine or detect that a substance has solidified.

[0017] Figure 1 schematically shows a side view of an example of an apparatus 100 for detecting that a substance has solidified. An actuator 102 is movable so as to drive a container 104 to move. In this example, the actuator 102 is connected to the container 104 by a rod 106. However, other components and methods may be used to cause the actuator 102 to drive the container 104 to move. A light source 108 is connected to the container 104. In this example, the light source 108 is shown directly connected to the container 104. Alternatively, the light source may be mounted indirectly to the container 104, for example by some linkage or the like. The light source 108 is arranged to emit light. The light source 108 may be for example an LED (light emitting diode). A light detector 110 is located so as to receive light emitted by the light source 108.

[0018] In use, a motor 112 moves the actuator 102 which causes the container 104 to move. In one example, the movement of the container 104 is a reciprocating or vibrational movement. This may be for example a back and forth movement of the container 104 or a side to side movement of the container 104 or both.

[0019] When the substance 114 is in a liquid state at the time the container 104 is driven to move, the substance 114 will move with the container 104 but will also tend to move within the container 104, typically in a somewhat irregular manner, i.e. the liquid substance 114 will tend to "slosh" around within the container 104. This additional movement of the liquid substance 114 in the container 104 tends to add an additional movement to the container 104 move. The additional movement caused by the liquid substance 114 may occur at the time when the actuator 102 is driving the container 104 to move. Additionally or alternatively, the additional movement caused by the liquid substance 114 in the container 104 may cause the container 104 to continue to move after the actuator 102 has stopped driving the container 104 to move.

[0020] In contrast, when the substance 112 is a solid,

the movement of the container 104 will practically only be driven by the movement of the actuator 102.

[0021] Accordingly, the movement of the container 104 will be more irregular or chaotic when the substance 112 is in a liquid state than when the substance 112 is in a solid state.

[0022] The light source 108 is connected to the container 104. Therefore, when the container 104 is driven to move, the light source 108 also moves. A light detector 110 is arranged to receive light from the light source 108. The nature of the light signal detected by the light detector 110 will be indicative of the motion of the light source 108, and therefore of motion of the container 104.

[0023] Figure 2A shows a perspective view of the apparatus 100 of Figure 1 in use when the substance 114 is in a liquid state. The apparatus 100 is arranged such that a light signal from the light source 108 is detected by the light detector 110. When the substance 114 is in a liquid state at a time the container 104 is driven to move by an actuator 102, the liquid substance 114 will tend to move with the container 104 but will also move around in an irregular manner within the container 114, i.e. the liquid substance 114 will slosh around within the container 104, as described above. The additional movement caused by the liquid substance 114 will cause movement of the container 104, and therefore the movement of the light source 108, to be somewhat irregular or even chaotic. At this time, in one example the light detector 110 will receive a more irregular or chaotic light signal from the light source 108. The light signal will therefore be more spread out in space, typically with an irregular side to side movement which is superimposed on the more regular side to side movement brought about by the reciprocating movement of container 104 and light source 108. This is illustrated schematically in Figure 2A by an extended oval light pattern 116 which is received at the light detector 110.

[0024] Figure 2B shows a perspective view of the apparatus of Figure 1 in use when the substance 114 is in a solid state. When the substance 114 is in a solid state at a time the container 104 is driven to move by an actuator 102, the solid substance 114 will not tend to move within the container 104. The container 104 will therefore move largely according to the driving movement of the actuator 102, i.e. in a generally regular manner. Therefore, the light source 108 will also tend to move in the same regular manner as the container 104. At this time, the light detector 110 therefore receive a regular light signal from the light source 108. This is illustrated schematically in Figure 2B by a circular or slightly oval light pattern 116 which is received at the light detector 110.

[0025] The light detector may be or include at least one light-dependent resistor (LDR) 118. Figures 1 and 2 show the light detector 110 including a plurality of LDRs 118 arranged in a row. An LDR is a variable resistor for which the resistance changes in accordance with the light intensity which falls upon it.

[0026] Figure 3 shows an example electrical arrange-

ment 300 for triggering a heating element 302 to heat an environment when a substance has solidified. The electric arrangement 300 comprises at least one LDR 304 which receives a light signal from a light source, and a reference resistor 306 for providing a reference for comparison of the light signal detected by an LDR 118/304. The arrangement 300 further comprises a power supply 308 to power the heating element 302, and a switch 310, which may be a transistor such as a MOFSET (metal oxide semiconductor field effect transistor), to enable/disable the heating element 302.

[0027] When the substance 114 in the container 104 is a liquid, the container 104 and thus the light source 108 attached to the container 104 move irregularly. In such a case, at least some of the light from the light source 108 that is incident on the detector 110 may fall outside the bounds of the light detector 110. Alternatively or additionally, if there are plural LDRs 118, the light that is incident on the detector 110 will tend to spread over a larger number of LDRs 118/304. In any event, as a consequence, the resistance of the or each LDR 118/304 is somewhat low when compared with the resistance of the reference resistor 306. Therefore the switch 310 will not switch on the heating element 302.

[0028] On the other hand, when the substance 114 in the container 104 is in a solid state, the container 104, and thus the light source 108 attached to the container 104, move regularly. The light signal from the light source 108 will therefore be less spread out and will fall within the bounds of the light detector 110 as a whole and/or any particular LDR 118 receiving light will receive a higher intensity of light. As a consequence, the resistance of the LDR 118/304 receiving light is high when compared against the resistance of the reference resistor 306. The switch 310 will therefore switch on the heating element 302.

[0029] The electrical arrangement 300 avoids the need for a microcontroller to detect that a substance has solidified and to control operation of a heater. The electric arrangement 300 may be part of an electric circuit used within a refrigeration apparatus. In particular, the heater 302 is located and arranged to reduce or prevent build up of ice on one or more specific components in a refrigeration apparatus, such as the heat exchanger of a refrigeration apparatus.

[0030] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are envisaged. Any feature described in relation to any one example or embodiment may be used alone or in combination with other features. In addition, any feature described in relation to any one example or embodiment may also be used in combination with one or more features of any other of the examples or embodiments, or any combination of any other of the examples or embodiments. Furthermore, equivalents and modifications not described herein may also be employed within the scope of the invention, which is defined in the claims.

Claims

1. An apparatus (100) for detecting freezing of a substance (114), the apparatus (100) comprising:

a container (104) the container (104) containing a substance (114) which has a freezing temperature below which the substance (114) is solid and above which the substance (114) is liquid; a light source (108) connected to the container (104);

an actuator (102), the actuator (102) being arranged to move the container (104); and a light detection component (110); the light detection component (110) being arranged to detect light emitted by the light source (108); the arrangement being such that, when the container (104) is driven to move by the actuator (102), the amount of light detected by the light detection component (110) varies depending on whether the substance (114) in the container (104) is in a solid state or a liquid state.

2. An apparatus (100) according to claim 1, wherein the light detection component (110) comprises at least one light dependent resistor (304).

3. An apparatus (100) according to any of claims 1 or 2, comprising an electric motor (112) for driving the actuator (102) to vibrate the container (104).

4. An apparatus (100) according to any of claims 1 to 3, comprising a heating element (302), the arrangement being such that the heating element (302) is triggered to heat when the amount of light detected by the light detection component (110) indicates that the substance (114) in the container (104) is in a solid state.

5. An apparatus (100) according to any of claims 1 to 4, wherein the substance (114) is water which in its liquid state is water or steam and in its solid state is ice.

6. A refrigeration apparatus comprising apparatus (100) according to any of claims 1 to 5.

7. A method for detecting freezing of a substance (114), the method comprising:

driving a container (104) to move by an actuator (102), the container (104) containing a substance (114) which has a freezing temperature below which the substance (114) is solid and above which the substance (114) is liquid; and detecting, by a light detection component (110), light from a light source (108), the light source (108) being connected to the container (104);

wherein the amount of light detected by the light detection component (110) varies depending on whether the substance (114) in the container (104) is in a solid state or a liquid state.

5

8. A method according to claim 7, wherein the light detection component (110) comprises at least one light dependent resistor.
9. A method according to claim 7 or claim 8, further comprising driving the actuator (102) by an electric motor 112 to vibrate the container (104). 10
10. A method according to any of claims 7 to 9, further comprising triggering a heating element (302) to heat when the amount of light detected by the light detection component (110) indicates that the substance (114) in the container (104) is in a solid state. 15
11. A method according to any of claims 7 to 10, wherein the substance (114) is water which in its liquid state is water or steam and in its solid state is ice. 20
12. A method according to any of claims 7 to 11, the method being carried out in a refrigeration apparatus. 25

30

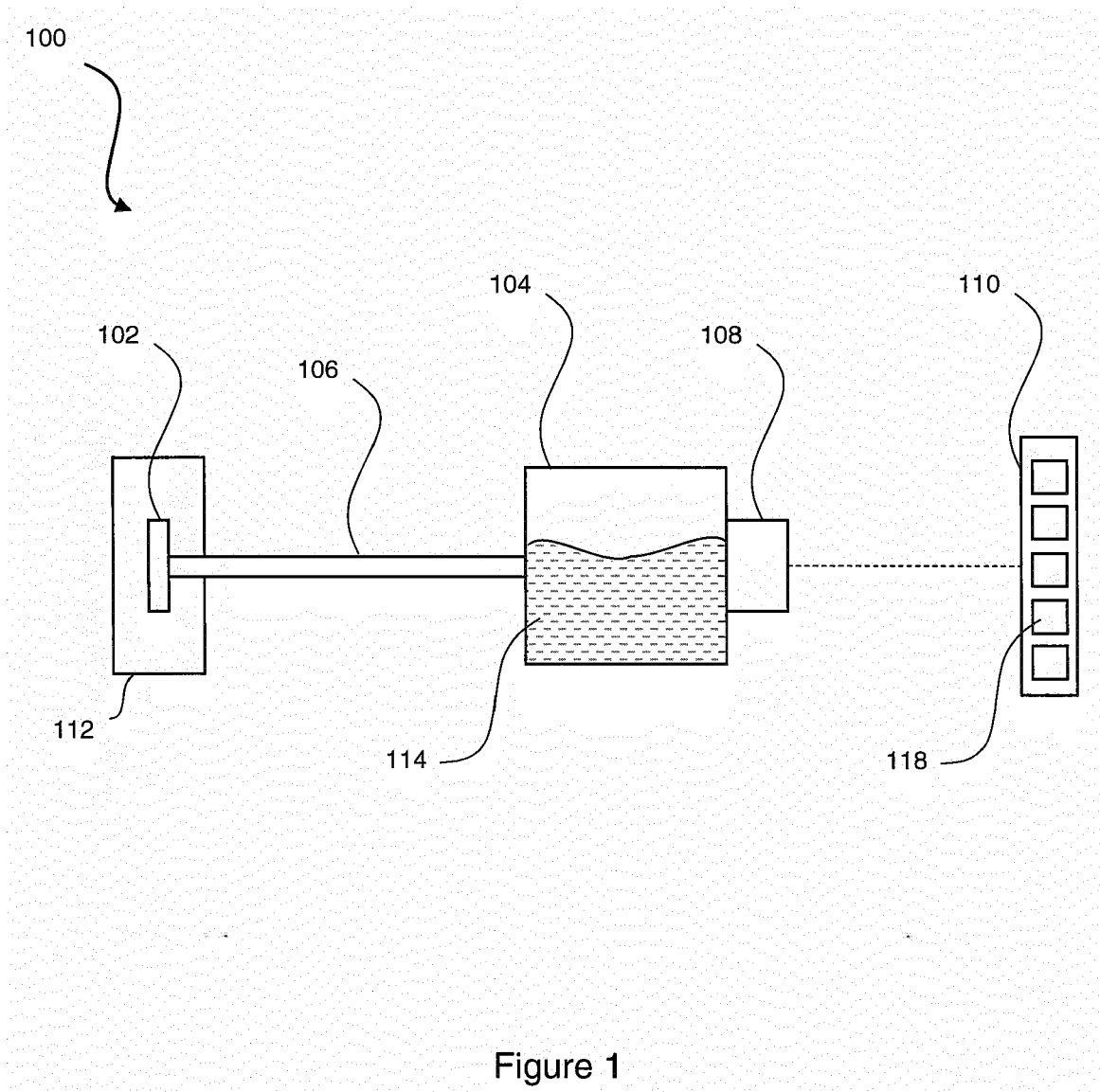
35

40

45

50

55



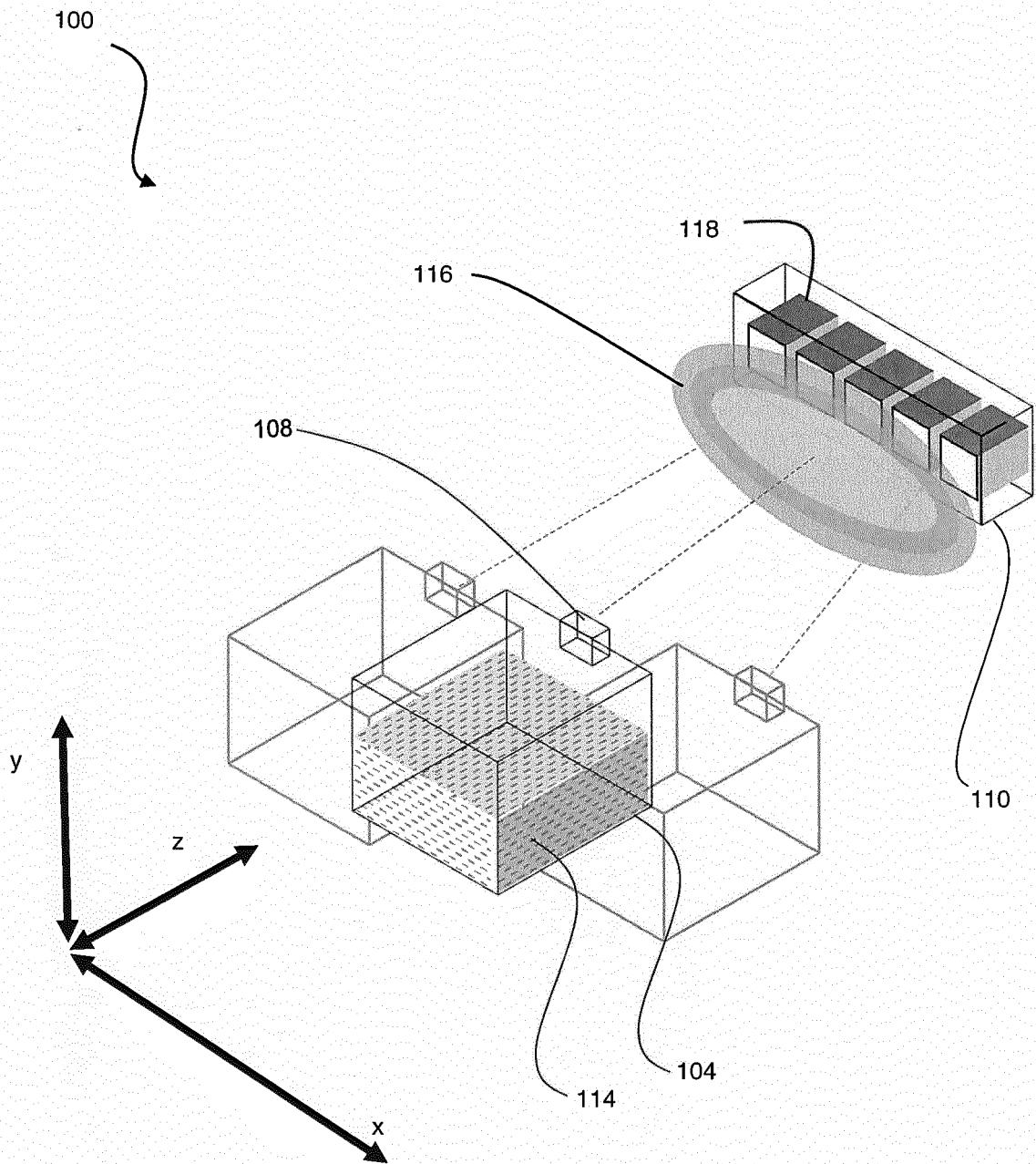


Figure 2A

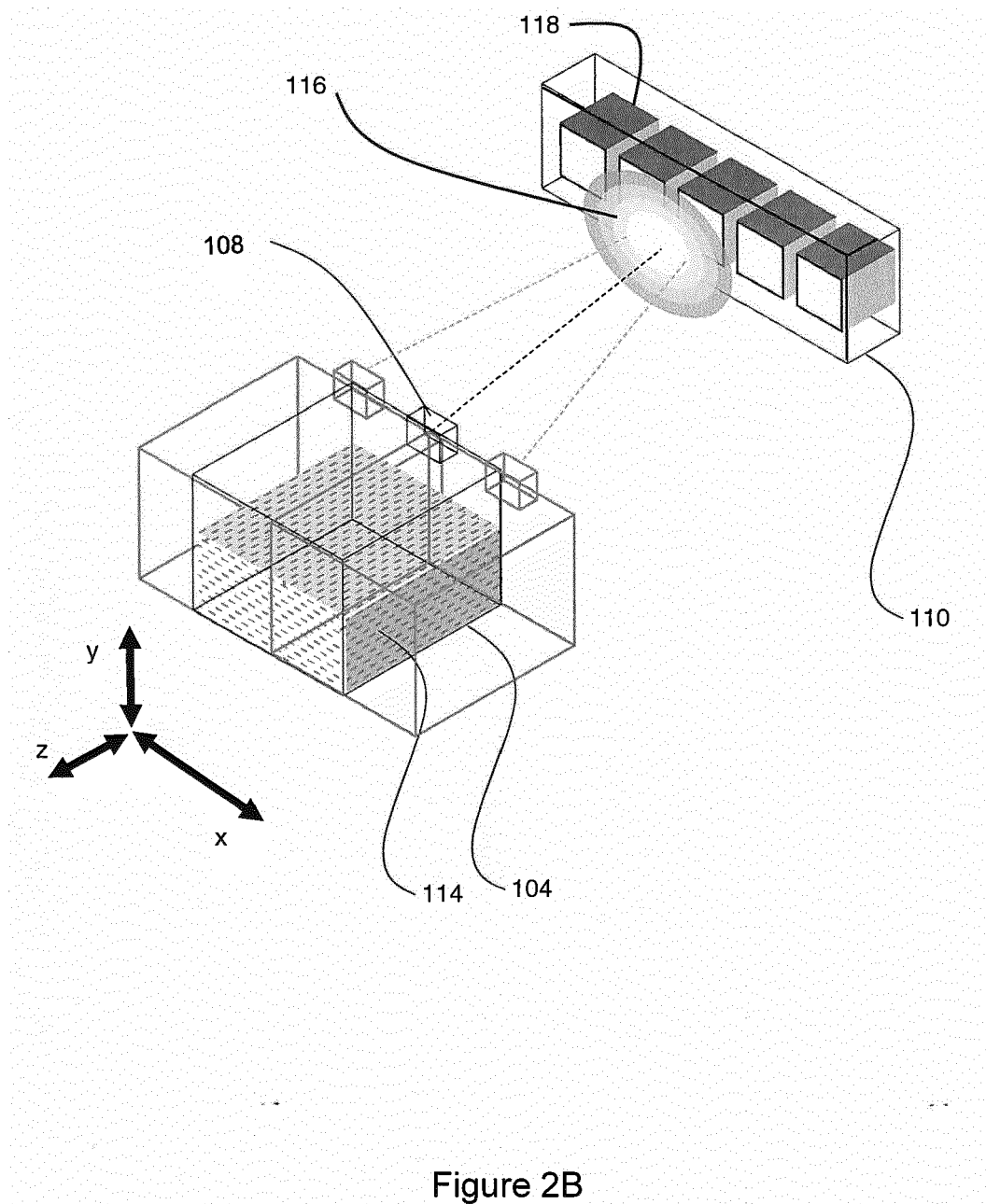


Figure 2B

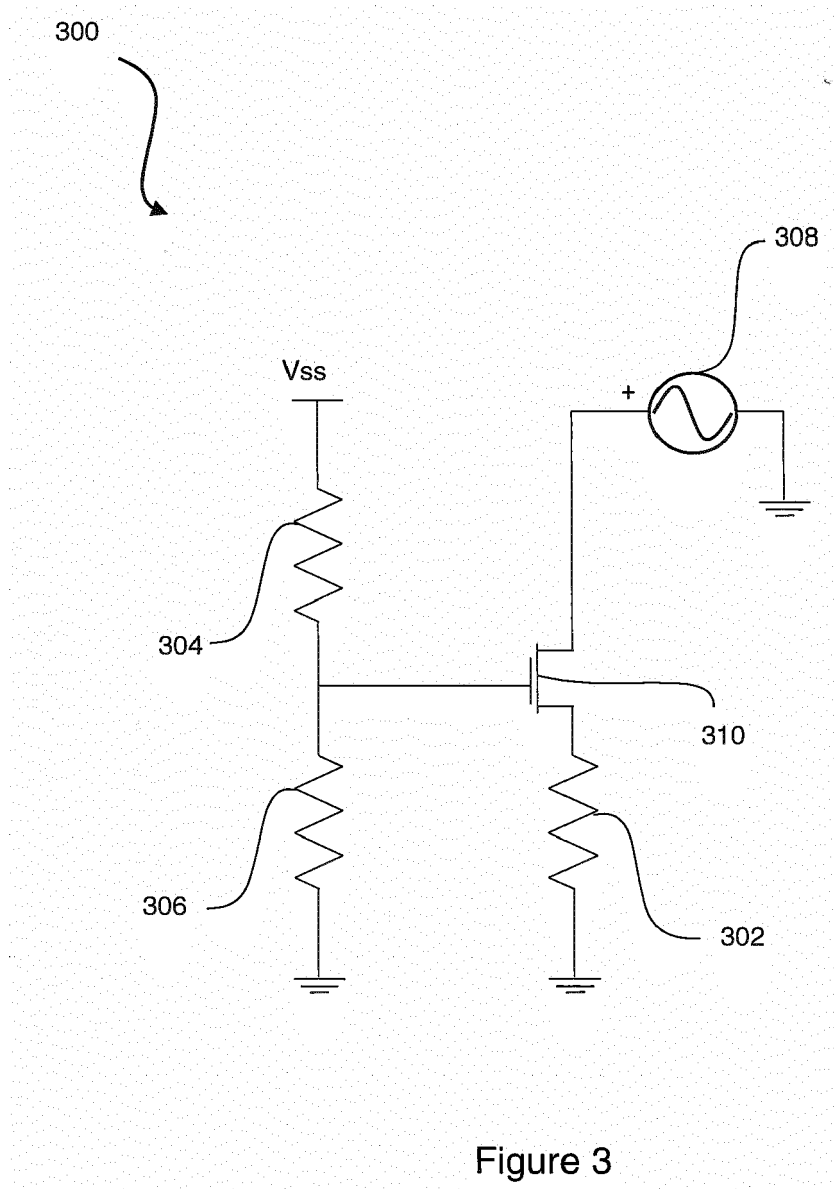


Figure 3



EUROPEAN SEARCH REPORT

Application Number
EP 17 18 3083

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP S58 20141 U (N.N.) 7 February 1983 (1983-02-07) * the whole document *	1-12	INV. F25D21/02
A	DE 295 21 065 U1 (BUSE UDO [DE]) 24 October 1996 (1996-10-24) * the whole document *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 January 2018	Examiner Bidet, Sébastien
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 18 3083

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-01-2018

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP S5820141	U	07-02-1983	NONE
DE 29521065	U1	24-10-1996	NONE

15

20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82