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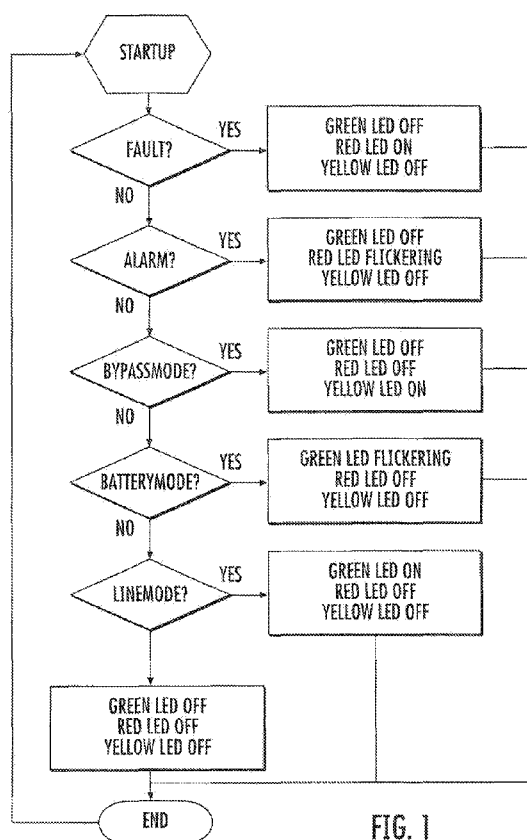


FIG. 1

(57) Abstract: An uninterruptible power supply (UPS) includes a chassis and door mounted on the chassis and having a cavity defined therein. A light emitting device is positioned in the cavity and configured to project light from the cavity onto a surface of the door to indirectly illuminate at least a portion of the surface. The light emitting device may be used to indicate a status of the UPS.



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A METHOD AND APPARATUS FOR INDICATING THE STATES OF A UPS USING INDIRECT LIGHT SOURCE

FIELD OF THE INVENTION

[0001] The present invention relates to uninterruptible power supplies (UPSs) and, more particularly, to UPSs with status indication capabilities.

BACKGROUND OF THE INVENTION

[0002] An uninterruptible power supply (UPS) typically is an AC supply with constant voltage and frequency, which includes energy storage device. It typically includes a rectifier and inverter as its main components. Using a storage device, for example, a battery, the UPS may provide uninterruptible power loads such as industrial control systems, computer and communication network systems components such as computers, servers, storage devices, network devices and the like. UPSs may also be used to provide power to industrial equipment requiring continuous operation, even when the main power source fails.

[0003] When the power source is present, the UPS may regulate the voltage provided to a load. When the main power source is lost (e.g., due to power failure), the UPS may immediately provide AC power to the load from the storage device so as to maintain the normal operation of the load, thus protecting against software and hardware malfunction or damage.

[0004] A typical UPS has three operating modes: an on-line mode, an on-battery mode and a bypass mode. When the main power source is normal, the UPS may operate in the on-line mode. When a fault or alarm occurs, a controller of the UPS may identify the type of the fault or alarm according to the sampled data so as to determine whether to switch to one of the other two modes. For example, if the main power source is cut off, the UPS may be switched to the on-battery mode. When the voltage of the battery reduces to a lower level, the UPS may be switched to the bypass mode.

[0005] As the various operating states may influence the loads significantly, it is desirable to indicate the current mode of the UPS to an operator in real time so as to enable the operator to take control actions to handle abnormal situations. Some conventional UPSs may use a buzzer to indicate the states of the UPS. For example, in the on-line mode, the buzzer does not sound. In the battery mode, the buzzer may sound at intervals, with the duration of the intervals changing according to the capacity of the battery, e.g., the lower the capacity is, the shorter the intervals. In the bypass mode, the buzzer may sound at intervals

having a certain duration. When a fault or alarm has occurred in the UPS, the buzzer may continuously sound. While such techniques may be effective, when the UPS is positioned in an enclosed cabinet or space it may be difficult for the operator to hear the buzzer, thus making it difficult to determine whether an abnormal state has occurred.

[0006] Other conventional techniques inform an operator about the state of the UPS by software. This may require the operator to periodically check the status, which may be inconvenient.

SUMMARY

[0007] Some embodiments provide an uninterruptible power supply (UPS) including a chassis having a panel at a face thereof, the panel having a cavity defined therein. A light emitting device is positioned in the cavity and configured to project light from the cavity onto a surface of the panel to indirectly illuminate at least a portion of the surface. The light emitting device may be used to indicate a status of the UPS. The panel may comprise a door of the UPS.

[0008] In some embodiments, the cavity may include an elongate vertical cavity proximate an edge of the panel. In some embodiments, The elongate vertical cavity may include respective first and second elongate vertical cavities proximate respective first and second edges of the panel. In further embodiments, the light emitting device may include a strip of light emitting devices positioned in the elongate vertical cavity. The strip of light emitting devices may include light emitting devices of different colors.

[0009] In some embodiments, the cavity is configured to conceal the light emitting device and the cavity and the light emitting device may be configured to provide an indirect display on the surface of the panel.

[0010] The UPS may further include a control circuit configured to control the light emitting device to indicate a state of the UPS using the light emitting device. The control circuit may be configured to control a color and/or a flickering of the light emitting device to indicate states of the UPS.

[0011] The light emitting device may include at least one light emitting diode (LED).

[0012] In some embodiments, the door may include a rectangular plate and an extruded member affixed to an edge of the plate and extending over the surface of the plate to define the cavity. The light emitting device may be mounted on the extruded member. The plate may have an elongate channel defined therein adjacent the edge of the plate and the extruded member may extend over the channel to define the cavity. A wall of the channel

may extend beyond the overlying extruded member and the light emitting device may be configured to illuminate the wall of the channel to provide a display viewable from a front side of the panel.

[0013] Some embodiments provide a door assembly for use with an electronics chassis. The door assembly includes a rectangular panel having a cavity defined therein and a light emitting device positioned in the cavity and configured to project light from the cavity onto a surface of the panel to indirectly illuminate at least a portion of the surface. The cavity may include an elongate vertical cavity proximate an edge of the panel. The light emitting device may include a strip of LEDs mounted in the elongate vertical cavity. The elongate cavity may include respective first and second elongate cavities proximate respective first and second edges of the panel and the light emitting device may include at least one light emitting device in at each of the first and second cavities. The cavity may be configured to conceal the light emitting device while supporting direction of light therefrom onto the surface of the panel via an opening of the cavity.

[0014] Still further embodiments provide methods of operating a UPS including indirectly illuminating a surface of a door of the UPS with a light emitting device positioned within a cavity of the door to indicate a state of the UPS. The cavity may be configured to block direct viewing of the light emitting device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Embodiments of the invention are described hereinafter with reference to the accompanying drawings, wherein:

[0016] Fig. 1 is a flowchart illustrating operations for indicating status of a UPS according to some embodiments;

[0017] Fig. 2 is a schematic front view of a door mounted on a UPS chassis according to some embodiments; and

[0018] Fig. 3 is a sectional view of the door of Fig. 2 taken along the A-A line in the Fig.2.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] Some embodiments provide methods for indicating the states of UPS using a light emitting diode (LED) device, wherein the LED device comprises three LEDs with red, yellow and green color respectively. Figure 1 illustrates exemplary operations for indicating the states of a UPS using an LED device. Referring to the Fig.1:

1) after startup, determining whether any fault has occurred, wherein if a fault has occurred, the red LED is on while the other LEDs are off and the method goes to step 7), and if no fault has occurred, the method goes to step 2);

2) determining whether any alarm has been raised, wherein if an alarm has been raised, the red LED is flickering while the other LEDs are off and the method goes to step 7), and if no alarm has been raised, the method goes to step 3);

3) determining whether the UPS is in a bypass mode, if the UPS is in the bypass mode, the yellow LED is on while the other LEDs are off and the method goes to step 7), and if the UPS is not in the bypass mode, the method goes to step 4);

4) determining whether the UPS is in a battery mode, if the UPS is in the battery mode, the green LED is flickering while the other LEDs are off and the method goes to step 7), and if the UPS is not in the battery mode, the method goes to step 5);

5) determining whether the UPS is in an on-line mode, if the UPS is in the on-line mode, the green LED is on and the other LEDs are off and the method goes to step 7), and if the UPS is not in the on-line mode, the method goes to step 6);

6) making all the LEDs to be off and the method goes to step 7); and

7) ending and returning to the step 1).

[0020] In the step 2), the flickering frequency of the red LED may be additionally utilized to indicate the level of the alarm, higher the level is, higher the flickering frequency is.

[0021] In the step 4), the flickering frequency of the green LED may be additionally utilized to indicate the capacity of the battery, the lower the capacity is, the higher the flickering frequency is.

[0022] Through above-described operations, an operator could visually determine the state of the UPS. The operator could identify an abnormal situation and handle it in time even if the UPS is located in the enclosed cabinet or space.

[0023] Further embodiments provide a UPS and a front door of a UPS which may be used to implement the operations described above. Referring to Figs. 2 and 3, A UPS includes a chassis 10 having a panel, in this case, a front door 20, at a face of the chassis 10. The door 20 includes a plate 1 bent to form grooves or channels 2 at its right and left edges. Each channel 2 has a first wall 21 and a second wall 22. Extruded aluminum members 4 are attached to the edges of the plate 1 and include portions that extend over the channels 2. The extruded aluminum members 4 engage the edges of the plate 1 and form gaps 3 between the extruded aluminum members 4 and the plate 1 at the inner channel wall 22. The extruded

aluminum members 4 and the plate 1 together define semi-enclosed spaces or cavities 6 which are in communication with the exterior through the gaps 3. LED light bars 5 including three LEDs with red, yellow and green color are positioned in the cavities 6 and mounted on the extruded aluminum members 4. The light bars 5 are driven by a control circuit 30, which may include components in the door 20 and/or in the chassis 10. Light emitted from the LED light bars 5 is reflected through the gaps 3 and onto the channel walls 22, thus providing indirect lighting indicators while concealing the light bars 5 within the cavities 6. These indicators may be used to implement the UPS status indicating operations described above with reference to Fig. 1. Some embodiments of the invention as described above may provide a relatively wide viewing angle and relatively large display area, which may make it easier for an operator to discern the state of the UPS.

[0024] According to further embodiments, LED colors may not be limited to red, yellow and green. For example, other color combinations, such as red, green and white, may also be used. The various correspondences between colors and states may vary from that described above, e.g., green, yellow and red may be used to represent different states than as described above. However, it will be appreciated that red is commonly used to indicate fault, alarm or other emergency states, and green is commonly used to indicate a normal state.

[0025] According to further embodiments, the LED device may further include LEDs with additional colors, for example, the LED device may include red, yellow, blue and green LEDs for indicating states of the UPS. For instance, a continuous red LED may be used to indicate a fault, a flickering red LED may be used to indicate an alarm, a continuous yellow LED may be used to indicate when the UPS is in the bypass mode, a continuous blue LED may be used to indicate when the UPS is in the battery mode, and a continuous green LED may be used to indicate when the UPS is in the on-line mode.

[0026] In some embodiments, the determining steps of the above-described operations may be performed as follows: determining whether any fault has occurred; determining whether any alarm has been raised; and determining whether the current mode is the bypass mode, the battery mode or the on-line mode. However, embodiments of the inventive subject matter are not limited to such an order. In some embodiments, the order may be changed. For example, the determining steps may be performed as follows: determining whether any alarm has been raised; determining whether the current mode is the bypass mode; determining whether any fault has occurred; and determining whether the current mode is the on-line mode. According to further embodiments, the states of the UPS are not limited to the above, that is, the states are not limited to fault, alarm, bypass mode,

battery mode and on-line mode. Additional states of the UPS may be provided, which can be indicated through the other different states of the LED device.

[0027] An LED indicator according to some embodiments may be controlled by a microcontroller unit (MCU)), digital signal processor (DSP), or other electronic control device(s). The MCU or other control device(s) may receive a signal representing the state of the UPS and control the LEDs in the LED device to be on, off or flickering according to the received signal through the method mentioned above. Some embodiments provide methods for indicating the states of the UPS in which various states of the UPS are indicated with different state of a LED device, wherein the LED device comprise multiple LEDs with different colors, the multiple LEDs are controlled to present different state of the LED device, and the states of the LED device include the color of the emitted light, flickering or not, and the flickering frequency.

[0028] Finally, it should be noted that the above embodiments are only used to illustrate embodiments of the inventive subject matter with no limitations. Although the inventive subject matter is described in detail with reference to the embodiments, the ordinary skilled person in the art should understand that modifications or equivalent alternatives of the inventive subject matter is defined by the claims appended without departing from the spirit and scope of the inventive subject matter.

WHAT IS CLAIMED IS

1. An uninterruptible power supply (UPS) comprising:
a chassis comprising a panel at a face thereof, the panel having a cavity defined therein; and
a light emitting device positioned in the cavity and configured to project light from the cavity onto a surface of the panel to indirectly illuminate at least a portion of the surface.
2. The UPS of claim 1, wherein the panel comprises a door.
3. The UPS of claim 1, wherein the cavity comprises an elongate vertical cavity proximate an edge of the panel.
4. The UPS of claim 3, wherein the elongate vertical cavity comprises respective first and second elongate vertical cavities proximate respective first and second edges of the panel.
5. The UPS of claim 3, wherein the light emitting device comprises a strip of light emitting devices positioned in the elongate vertical cavity.
6. The UPS of claim 5, wherein the strip of light emitting devices comprises light emitting devices of different colors.
7. The UPS of claim 1, wherein the cavity is configured to conceal the light emitting device.
8. The UPS of claim 1, wherein the cavity and the light emitting device are configured to provide an indirect display on the surface of the panel.
9. The UPS of claim 1, further comprising a control circuit configured to control the light emitting device to indicate a state of the UPS using the light emitting device.

10. The UPS of claim 9, wherein the control circuit is configured to control a color and/or a flickering of the light emitting device to indicate states of the UPS.

11. The UPS of claim 1, wherein the light emitting device comprises at least one light emitting diode (LED).

12. The UPS of claim 1, wherein the panel comprises a rectangular plate and an extruded member affixed to an edge of the plate and extending over the surface of the plate to define the cavity.

13. The UPS of claim 12, wherein the light emitting device is mounted on the extruded member.

14. The UPS of claim 12, wherein the plate has an elongate channel defined therein adjacent the edge of the plate and wherein the extruded member extends over the channel to define the cavity.

15. The UPS of claim 14, wherein a wall of the channel extends beyond the overlying extruded member and wherein the light emitting device is configured to illuminate the wall of the channel to provide a display viewable from a front side of the panel.

16. A door assembly for use with an electronics chassis, the door assembly comprising:

a rectangular panel having a cavity defined therein; and
a light emitting device positioned in the cavity and configured to project light from the cavity onto a surface of the panel to indirectly illuminate at least a portion of the surface.

17. The door assembly of claim 16, wherein the cavity comprises an elongate vertical cavity proximate an edge of the panel.

18. The door assembly of claim 17, wherein the light emitting device comprises a strip of LEDs mounted in the elongate vertical cavity.

19. The door assembly of claim 17, wherein the elongate cavity comprises respective first and second elongate cavities proximate respective first and second edges of the panel and wherein the light emitting device comprises at least one light emitting device in at each of the first and second cavities.

20. The door assembly of claim 16, wherein the cavity is configured to conceal the light emitting device while supporting direction of light therefrom onto the surface of the panel via an opening of the cavity.

21. A method of operating a UPS, the method comprising:
indirectly illuminating a surface of a door of the UPS with a light emitting device positioned within a cavity of the door to indicate a state of the UPS.

22. The method claim 21, wherein the cavity is configured to block direct viewing of the light emitting device.

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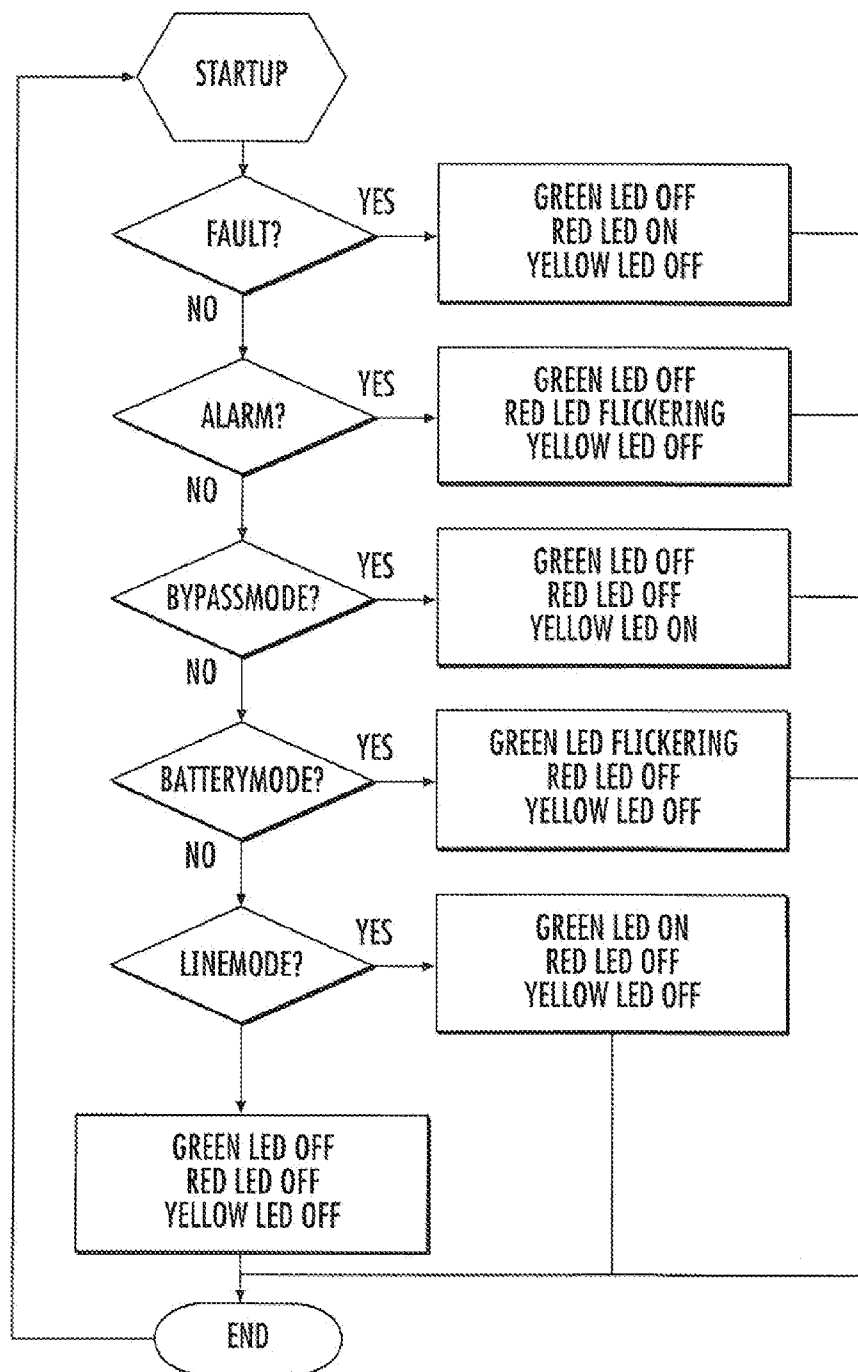


FIG. 1

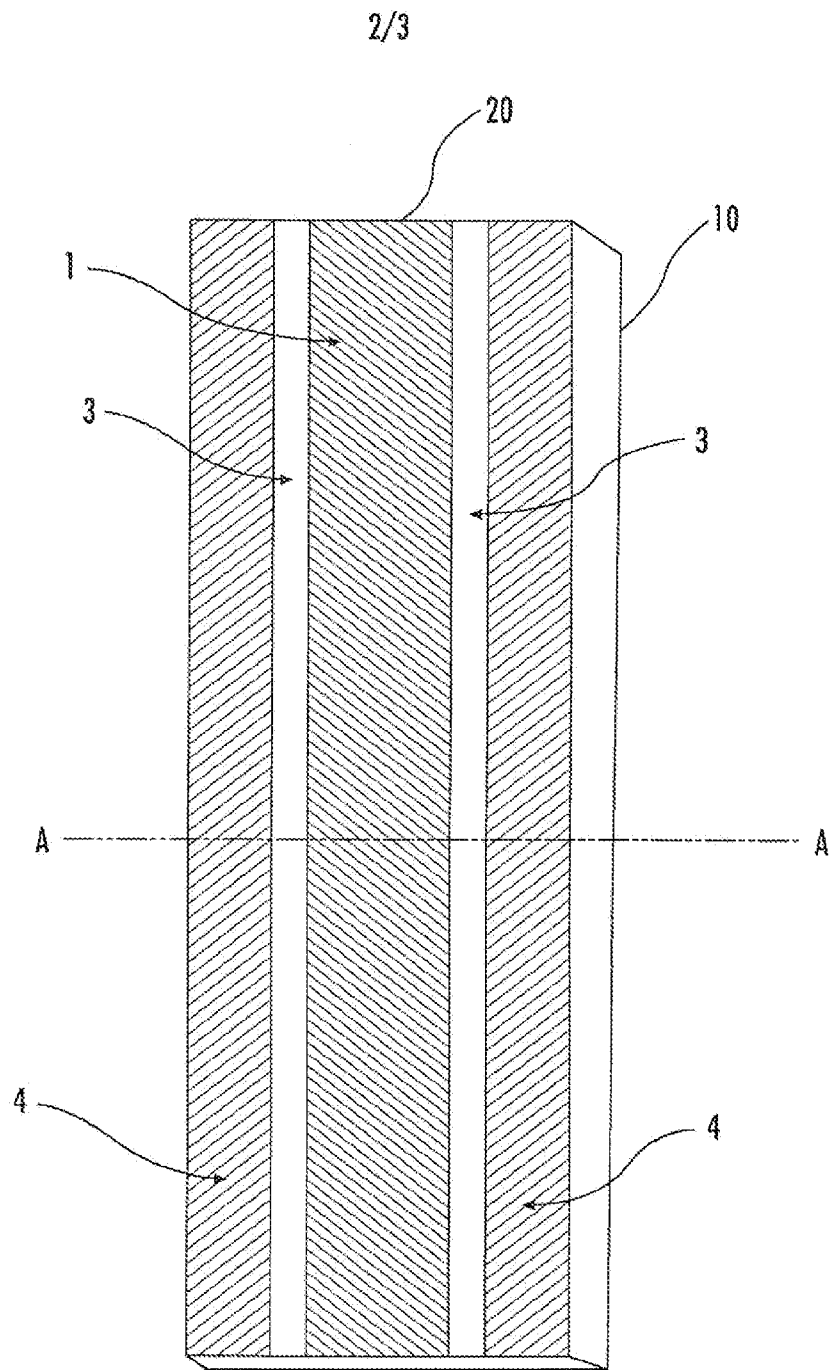


FIG. 2

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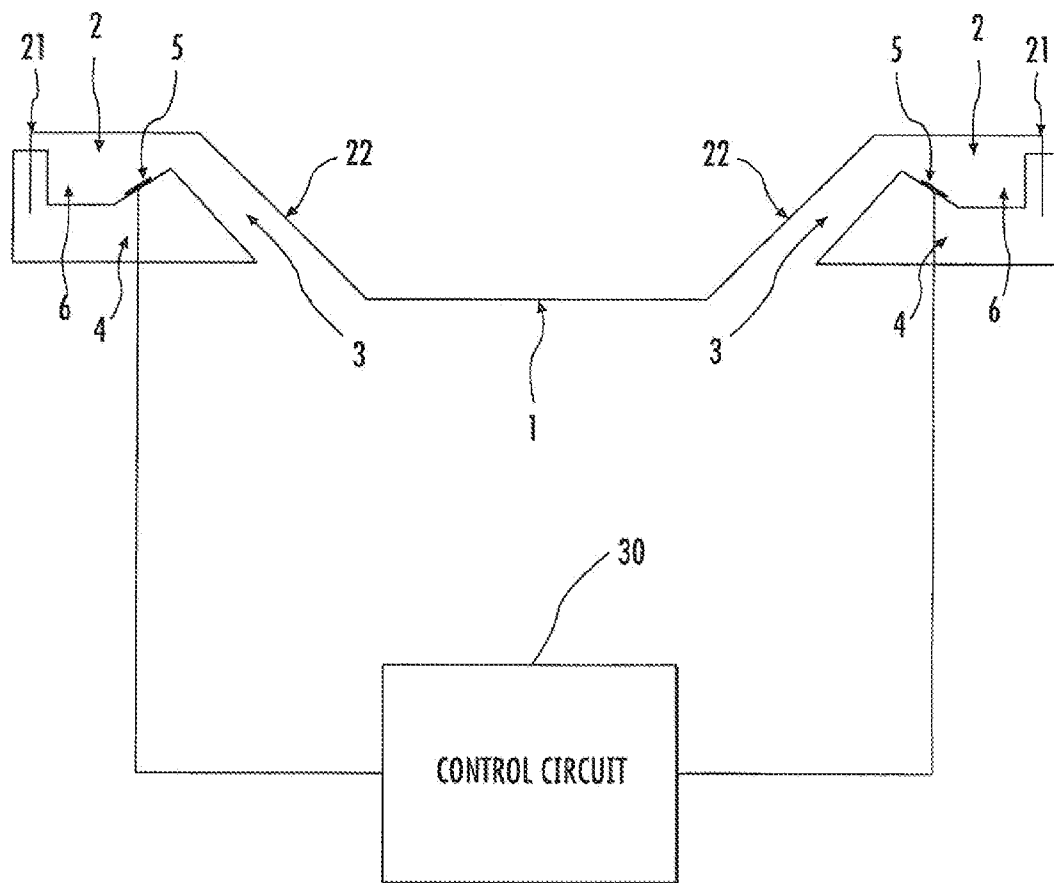


FIG. 3