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(71) Applicant (for all designated States except US): **ILLINOIS TOOL WORKS INC.** [US/US]; 3600 West Lake Avenue, Glenview, Illinois 60026 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **TRUESDALE, Brian, J.** [US/US]; 2441 Stonybrook Street, Wauconda, Illinois 60084 (US). **KNOWLES, Terrence, J.** [US/US]; 509 Kazimour Drive, Barrington, Illinois 60010 (US).

(74) Agent: **HAUPTMAN, Benjamin, J.; LOWE HAUPTMAN HAM & BERNER, LLP**, 1700 Diagonal Road, Suite 300, Alexandria, Virginia 22314 (US).

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(54) Title: ACOUSTIC MULTI-FUNCTION ICE DETECTION SYSTEM

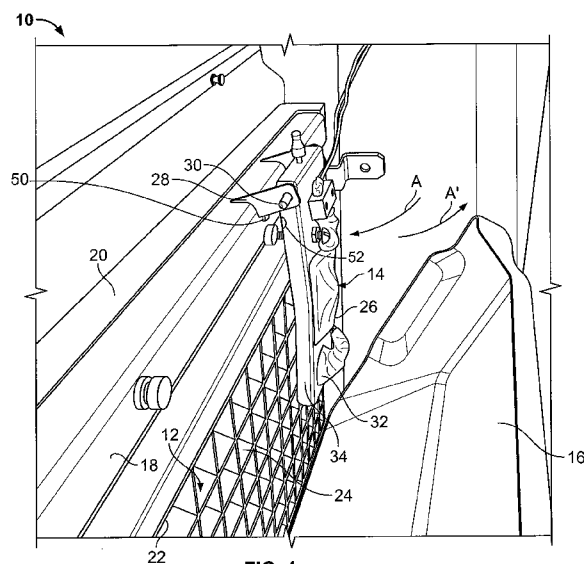


FIG. 1

(57) Abstract: A system for detecting ice of a particular thickness includes an ice-forming housing, and an ice detection assembly pivotally secured to the ice-forming housing. The ice detection assembly includes a deflection arm, and one of a sensing device or a sensed device located on or within the deflection arm. The sensing device is configured to detect movement of the sensed device away from a calibrated position.

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ACOUSTIC MULTI-FUNCTION ICE DETECTION SYSTEM

RELATED APPLICATIONS

[0001] This application relates to and claims priority benefits from U.S. Provisional Patent Application No. 61/182,891 entitled “Multi-Function Ice Detection System and Method,” filed June 1, 2009, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] Embodiments of the present invention generally relate to a system and method for detecting the presence of ice, and more particularly to a system and method of detecting the presence and thickness of ice through the use of trapped acoustic waves.

BACKGROUND OF THE INVENTION

[0003] Typical systems for detecting the presence of ice use capacitive sensing systems that determine impedance from a sensor electrode to ground. A conventional ice forming machine includes an ice grid. As water flows over the grid, the water freezes. With continued freezing, the layer of ice continues to grow outward. When the ice layer grows far enough, the water cascading over the ice layer contacts the capacitive electrode or sensor. If the water makes continuous contact with the electrode for an extended period of time, the ice forming machine transitions to a harvest mode and heats the grid so that the layers of ice break off.

[0004] Many commercial ice-making system machines use sensors to detect a state of an ice-making process. Such sensing systems and methods are shown and described in United States Patent No. 7,026,943, entitled “Acoustic Wave Ice and Water Detector,” and United States Patent Application Publication No. 2008/0202142, entitled “System and Method for Detecting Ice,” both of which are hereby incorporated by reference in their entireties.

[0005] During an ice-making cycle, an electronic control is triggered to harvest the ice made by an ice-making machine when ice is detected by an ice sensor. When the ice is harvested, the ice slides horizontally off of the downwardly-angled ice making grid, through the force of gravity. As ice slides off the grid, the ice forces the ice sensor, which is typically mounted on a pivot at the top of the grid, to swing upward, thereby allowing the ice to fall into a collection bin below. The harvested ice also pushes a similarly pivoted ice curtain upward to allow the ice to fall into the bin.

[0006] The curtain typically has a magnet integrated therein to trigger a reed switch or similar magnetic detection device to indicate that the ice has fallen away from the grid, and that the next ice-making cycle may begin. If the door sensor does not trigger as expected, however, this may indicate that the ice may not have formed properly to allow the sheet to fall. If ice does not form, the door does not move into an open position, and therefore does not trigger the door sensor. After a certain period of time (as set forth in a control algorithm), the ice-making machine times out and either attempts a new cycle, or after several failed cycles, deactivates the ice-making machine. Such an ice cycle failure is typically driven by a lack of water, blockages, or an ice sensor that is set too close to the ice grid.

[0007] Additionally, the ice-collection bin below the curtain may be filled to the point where it does not allow ice to fall past the curtain. In this case, the curtain may move up but will not return to its normal position, thereby indicating that the machine is full and the ice-making process should cease. Accordingly, the control unit waits for the door to open and subsequently close before a new ice-making cycle is initiated. If the door does not return to the closed position, the control unit assumes the bin is not full.

SUMMARY OF THE INVENTION

[0008] Embodiments of the present invention provide a sensor that detects the upward rotation of the ice sensor, thereby eliminating the need for the ice curtain and/or the curtain magnetic switch/sensor assembly.

[0009] Certain embodiments of the present invention provide a system for detecting ice of a particular thickness. The system includes an ice-forming housing and an ice detection assembly.

[0010] The ice forming housing includes a sensing device or a sensed device.

[0011] The ice detection assembly is pivotally secured to the ice-forming housing, and includes a deflection arm, a transducer, and the other of the sensing device or the sensed device. The transducer may be located on or within the deflection arm, and is configured to generate a trapped acoustic wave within a medium. Ice of a particular thickness is detected when ice that forms from the ice-forming housing contacts the medium and dampens the trapped acoustic wave within the medium. The sensing device is configured to detect movement of the sensed device away from a normal position, which is calibrated as such.

[0012] The ice-forming housing may include a bracket that pivotally secures the deflection arm to the ice-forming housing. One of the sensing device or the sensed device downwardly extends from the bracket and the other of the sensing device or the sensed device is embedded in, or mounted on, an upper portion of the deflection arm that pivotally connects to the bracket.

[0013] The sensing device may include a magnetic sensor, and the sensed device may include a magnet. The magnetic sensor may include a reed switch. Optionally, the magnetic sensor may include a solid-state Hall effect device.

[0014] Alternatively, one or both of the sensing device and/or the sensed device may include an accelerometer that is configured to detect an angle of the deflection arm from a gravitational plumb.

[0015] Alternatively, one or both of the sensing device and/or the sensed device may include an electromechanical switch.

[0016] The sensing medium may include a substrate having an acoustic wave cavity. Optionally, the sensing medium may include a sensor strip.

[0017] The ice-forming housing may include an ice grid having a plurality of ice forming compartments. The ice grid may be configured to be heated to form ice cubes when the ice contacts the medium. The ice cubes may be collected in an ice collection bin.

[0018] The system may also include a control unit operatively connected to the ice detection assembly. The control unit may directly mount to the ice detection assembly.

[0019] Certain embodiments of the present invention provide a system for detecting ice of a particular thickness. The system includes an ice-forming housing, and an ice detection assembly pivotally secured to the ice-forming housing. The ice detection assembly may include a deflection arm, and one of a sensing device or a sensed device located on or within the deflection arm. The sensing device is configured to detect movement of the sensed device away from a calibrated position.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0020] Figure 1 illustrates an isometric view of an ice forming system according to an embodiment of the present invention.

[0021] Figure 2 illustrates a simplified lateral view of an ice forming system according to an embodiment of the present invention.

[0022] Figure 3 illustrates an isometric view of an ice detection assembly according to an embodiment of the present invention.

[0023] Figure 4 illustrates a rear view of an ice detection assembly according to an embodiment of the present invention.

[0024] Figure 5 illustrates a lateral view of an ice detection assembly according to an embodiment of the present invention.

[0025] Figure 6 illustrates a front view of an ice detection assembly according to an embodiment of the present invention.

[0026] Figure 7 illustrates a simplified lateral view of an ice forming system according to an embodiment of the present invention.

[0027] Before the embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting. The use of "including" and "comprising" and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items and equivalents thereof.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Figure 1 illustrates an isometric view of an ice forming system 10 according to an embodiment of the present invention. The ice forming system 10 includes an ice grid 12, an ice detection assembly 14 and an ice collection bin 16. The ice grid 12 and the ice detection assembly 14 are connected to a source of power (not shown). Additionally, the ice detection assembly 14 and the ice grid 12 may also be in electrical communication with a control system, such as a processing unit (not shown in Figure 1). The control system may be mounted directly on the ice detection assembly 14, or may be remotely located therefrom.

[0029] The ice grid 12 includes a main housing 18 having a top surface 20 integrally connected to side walls (not shown in Figure 1), which are, in turn, integrally connected to a base (not shown in Figure 1). An ice forming chamber 22 is defined between the top surface 20, the side walls and the base. A plurality of forming compartments 24 are positioned within the ice forming chamber 22. The plurality of forming compartments 24 are configured to form ice cubes.

[0030] The ice detection assembly 14 includes a deflection arm 26 pivotally connected to the top surface 20 of the ice grid 12 through a bracket 28. The deflection

arm 26 is configured to pivot in the directions of arrows A and A' about an axis defined by rods 30 that secure the deflection arm 26 to the bracket 28. A sensor housing having a transducer 32 operatively connected to an acoustic wave cavity 34 is secured to the deflection arm 26. The transducer 32 and acoustic wave cavity 34 may be distally located from the deflection arm 26, as shown in Figure 1. The transducer 32 is on one side of the acoustic wave cavity 34, the other side of which is exposed to water and ice proximate the ice grid 12. The transducer 32 is electrically connected to the source of power.

[0031] In operation, water cascades over the ice forming chamber 22 and into the individual compartments 24. As the ice grid 12 cools, the water collected within the ice compartments 24 freezes and grows outwardly towards the ice detection assembly 14. As discussed below, the ice detection assembly 14 senses when the ice bonds to the acoustic wave cavity 34, at which point the cooling process stops and an ice harvest mode begins. In particular, the ice grid 12 may be heated to break the ice off from the compartments 24. As the ice breaks off, the ice may hit the deflection arm 26 as it falls toward the collection bin 16. As the ice hits the deflection arm 26, the deflection arm 26 is pushed back in the direction of arrow A' so that the ice falls into the collection bin 16.

[0032] Figure 2 illustrates a simplified lateral view of the ice forming system 10 according to an embodiment of the present invention. As noted above, the ice detection assembly 14 includes the transducer 32 operatively connected to a rear of the acoustic wave cavity 34. The ice detection assembly 14 utilizes one or more acoustic waves trapped in the acoustic wave cavity 34 to detect the presence of ice on the outer surface 36 of the acoustic wave cavity 34. To detect the presence of ice, a trapped acoustic wave, such as a trapped shear acoustic wave, is generated within the acoustic wave cavity 34 by the transducer 32, as described in United States Patent No. 7,026,943, entitled "Acoustic Wave Ice and Water Detector," which is incorporated by reference in its entirety.

[0033] As shown in Figure 2, the acoustic wave cavity 34 is defined by a raised area 38 of a substrate 40. The acoustic wave cavity 34 is formed on the substrate 40 by

an area of increased mass such that the mass per unit surface area of the acoustic wave cavity 34 is greater than the mass per unit surface area of the substrate 40 immediately adjacent the acoustic wave cavity 34. The acoustic wave cavity 34 may also be defined by an area of increased mass that is not raised above the substrate 40. Such cavities may be formed, for example, by depositing a thin layer of material on the surface of the substrate 40 in an area defining the acoustic wave cavity 34. Such cavities may also be formed with material of greater mass than the substrate 40 throughout the cavity or in a portion thereof.

[0034] The raised area 38 defining the acoustic wave cavity 34 may be square, rectangular or other shapes. The raised area 38 may have a circular circumference or peripheral edge. The raised area 38 may have a flat surface or may have a curved, dome-like surface, as shown in Figure 2.

[0035] The height and geometry of the acoustic wave cavity 34 that will support a trapped or resonant acoustic wave is the same as the height and geometry requirements of an acoustic wave cavity supporting a trapped shear wave as described in United States Patent No. 7,106,310, entitled "Acoustic Wave Touch Actuated Switch," which is incorporated by reference in its entirety.

[0036] Embodiments of the present invention use the transducer 32 to generate a trapped resonant acoustic wave within the acoustic wave cavity 34, as described in United States Patent No. 7,026,943. The transducer 32 is electrically connected to a processing unit 41. When no ice contacts the raised area 38 of the acoustic wave cavity 34, a known amplitude, impedance or decay rate of a trapped acoustic wave cavity is sensed by the processing unit 41 (or detection circuit 42). Thus, the processing unit (or detection circuit 42) determines that no ice is contacting the acoustic wave cavity 34. When ice contacts the acoustic wave cavity 34, however, the sensed amplitude, impedance or decay rate changes. That is, when the ice 44 contacts the acoustic wave cavity 34, the acoustic energy trapped in the acoustic wave cavity 34 is dampened. As such, the processing unit 41 or detection circuit 42 is able to determine that ice is bonding to the acoustic wave cavity 34.

[0037] As shown in Figure 2, the processing unit 41 and the detection circuit 42 are shown as being remote from the ice detection assembly 14. However, the processing unit 41 and the detection circuit 42 may be mounted on the ice detection assembly 14, such as on a rear wall.

[0038] When the processing unit 41 or detection circuit 42 determines that ice is contacting the acoustic wave cavity 34, the processing unit 41 may transition the ice grid 12 into a heating mode, in which the compartments 24 may be heated in order to break off the formed ice 44 protruding therefrom. As the ice breaks off from the compartments 24, the ice falls into the collection bin 16. As noted above, ice that hits the ice detection assembly 14 forces it to swing backward in the direction of A'. As such, ice above the ice detection assembly 14 is allowed to fall into the collection bin 16.

[0039] The ice detection assembly 14 may also include a heating element 43, such as a coil heater, operatively connected to a rear surface of the substrate 40. The heating element 43 may be used to slightly heat the acoustic wave cavity 34 so that water condensation does not freeze on the acoustic wave cavity 34. Condensation that freezes to ice could produce an ice detection reading (i.e. the processing unit 41 or detection circuit 42 may detect the presence of ice through a change in amplitude, impedance or decay rate of a trapped acoustic wave) before the growing ice 44 from the compartments 24 contacts the acoustic wave cavity 34.

[0040] The ice detection assembly 14 may be spaced from the ice grid 12 at a desired distance, depending on the size of ice to be formed. As such, the system 10 is able to determine a desired thickness of ice. That is, when the ice contacts the acoustic wave cavity 34, the processing unit 41 or detector circuit 42 determines that ice of a particular thickness (as determined by the spacing of the detection assembly 14 from the ice grid 12) has formed. If larger chunks of ice are desired, the ice detection assembly 14 may be moved away from the ice grid 12. If smaller chunks of ice are desired, the ice detection assembly 14 may be moved closer to the ice grid 12. The bracket 28 may be adjustable through directions denoted by arrows B and B'. For example, the bracket

28 may include a telescoping neck 46 that allows it to move through the directions B and B'.

[0041] As shown in Figure 2, the transducer 32 may be in close proximity to the ice 44 and flowing water over the ice grid 12. Thus, the transducer 32 and associated electronics may be sealed to prevent adverse effects that may arise from water contacting electronic components. A sealing compound may be applied over the transducer 32 and associated electronics to prevent water ingress. Moreover, the transducer 32 and the acoustic wave substrate 40 may be integrally formed and connected to one another, thereby providing an improved seal therebetween.

[0042] Referring to Figures 1 and 2, a sensing device, such as a magnetic sensor 50, may extend downwardly from the bracket 28. A sensed object, such as a magnet 52, may be located on or within the deflection arm 26 proximate the magnetic sensor 50. As shown in Figures 1 and 2, the magnet 52 and the magnetic sensor 50 are separated by a gap. Optionally, the magnetic sensor 50 may be located on or within the deflection arm 26, while the magnet 52 may extend from the bracket 28.

[0043] The processing unit 41 and/or the detection circuit 42 monitors readings from the magnetic sensor 50. In the normal position, as shown in Figure 2, for example, the magnetic sensor 50 detects the magnetic field of the magnet 52. The detected value sensed and relayed to the processing unit 41 and detection circuit 42 is calibrated as the normal position. When the deflection arm 26 swings in the directions of arcs A or A', however, the detected magnetic field changes. The detected changed value is relayed to the processing unit 41 and/or the detection circuit 42. Accordingly, the processing unit 41 determines that a change from the calibrated value exists, and therefore the ice detection assembly 14 is not in the normal position.

[0044] In one embodiment, the magnetic sensor 50 may be a reed switch that triggers when the ice sensor rotates into proximity with the magnet 52.

[0045] Alternatively, the sensing device may be an electronic solid-state accelerometer/inclinometer that is mounted on a printed circuit board of the assembly

14. The accelerometer/inclinometer detects the angle of the deflection arm 26 from a gravitational plumb. Accelerometers and inclinometers are discrete solid-state devices that are capable of detecting the relative tilt of a device by gravity. These devices may be calibrated to recognize the normal down and up positions of the assembly 14.

[0046] In another embodiment, the magnetic sensor 50 may be a solid-state Hall effect device, which is configured to detect the presence of the magnet 52.

[0047] Optionally, the sensing device may include an electromechanical switch mounted to the assembly 14 that is triggered by rotation of the deflection arm 26, thereby pushing an actuator on the switch. The electromechanical switch replaces a mechanical stop with a simple plunger that actuates when the deflection arm 26 rotates.

[0048] The sensing device 50 and the sensed device 52 provide a system and method that reduces costs and simplifies the ice forming system 10. That is, the sensing device 50 and sensed device 52 cooperate to detect the upward rotation in the direction of arc A' of the deflection arm 26. Accordingly, the system 10 does not need an ice curtain or a curtain magnetic switch/sensor assembly. A microcontroller, such as may be found in the processing unit 41 and/or circuit 42, controls operation of the system 10, instead of an additional control system.

[0049] The processing unit 41 and/or circuit 42 are configured to detect the formation of ice at a desired thickness, detect motion of the deflection arm 26 away from the normal position, and perform timing and control functions for the system 10.

[0050] Figures 3 and 4 illustrate isometric and rear views, respectively, of an ice detection assembly 51 according to an embodiment of the present invention. The ice detection assembly 51 includes a planar support plate 53 having upturned lateral walls 54. The plate 53 may be formed of plastic. Pivoting rods 56 are located at proximal ends of the lateral walls 54 and allow the ice detection assembly 51 to be pivotally attached to a bracket of an ice grid.

[0051] The support plate 53 securely supports a sensor strip 58, which may be formed of metal. One end of the sensor strip 58 is secured to the plate 53 proximate a

top portion of the plate 52. The secured end of the sensor strip 58 is connected to a transducer 60. That is, the transducer 60 is operatively connected to an end of the sensor strip 58 to produce a trapped acoustic wave within the sensor strip 58. The sensor strip 58 includes an extension beam 62 that extends from the transducer 60 over a length of the plate 53. That is, the extension beam 62 is part of the sensor strip 58, itself. The extension beam 62 of the sensor strip 58 may be secured in place by one or more securing clips 64 that extend from the plate 53. For example, the securing clips 64 may snapably secure to edges of the extension beam 62 of the sensor strip 58. An ice contacting hook 66 extends from the extension beam 62 past the lower edge of the plate 53. While the extension beam 62 is generally coplanar with the planar portion 67 of the plate 53, the hook 66 extends inwardly past the plane 67 of the plate 53. The sensor strip 58 may be, for example, a 5" long, 0.4" wide and 35 mm thick strip of stainless steel operating in shear mode at 1.2 MHz.

[0052] Figure 5 illustrates a lateral view of the ice detection assembly 51. As shown in Figure 5, the hook 66 curves inwardly in the direction of arrow C from the extension beam 62. A flattened ice contacting portion 68 of the hook 66 is connected to an inwardly curved portion 70 extending from the extension beam 62. An upturned tip 72 is, in turn, integrally connected to the flattened ice contacting portion 68. The plane x of the flattened ice contacting portion 68 is inwardly-offset in the direction of arrow C from the plane y of the extension beam 62. As shown in Figure 5, the flattened ice contacting portion 68 extends past the plate 52 in the direction of arrow C.

[0053] Figure 6 illustrates a front view of the ice detection assembly 51 according to an embodiment of the present invention. The plate 53 provides a shield that protects the transducer 60 (shown, e.g., in Figure 5) from direct contact with ice and water.

[0054] Figure 7 illustrates a simplified lateral view of an ice forming system 80 according to an embodiment of the present invention. The ice forming system 80 includes the ice detection assembly 51 pivotally connected to an ice grid 82 through a bracket 84, and operates similar to the ice forming system 10 shown and described in

Figures 1 and 2. In particular, water 86 flows over the ice grid 82 to form ice 88 that grows and eventually contacts the ice contacting portion 68 of the hook 66. The transducer 60 is connected to a processing unit, which detects changes in amplitude, impedance, wave decay rate or the like. That is, the processing unit (or detecting circuit) detects when ice contacts the ice contacting portion 68 and transitions the system 80 to an ice harvesting mode, as discussed above with respect to Figures 1 and 2. The processing unit may be located on or within the assembly 51, as noted above.

[0055] Referring to Figures 3-7, it has been found that the sensor strip 58, which may alternatively be a tube or rod, is an efficient medium for propagating certain types of acoustic waves. The transducer 60 generates an acoustic wave within the sensor strip 58 that travels all the way to the hook 66, reflecting back and forth, and which is confined by the sides and ends of the sensor strip 58. That is, the generated acoustic wave is trapped within the sensor strip 58. It has been discovered that confined or trapped shear waves within the sensor strip 58 (and by extension, torsional waves in rods and tubes) may be significantly absorbed by ice bonded to the ice contacting portion 68, as opposed to the length of the sensor strip 58. Water flowing on the sides of the sensor strip 58 does not materially absorb wave energy. As such, the system 80 is able to discriminate between the presence of water and ice. Moreover, the sensor strip 58 is insensitive to mineral deposits (scale), in stark contrast to conventional sensing devices.

[0056] The sensor strip 58 is long enough to displace the transducer 60 and associated electronics out of the path of the water 86. As such, the water 86 is not able to infiltrate the transducer 60 or the associated electronics, thereby alleviating a need to provide additional sealing. The sensor strip 58 is easier to manufacture than conventional ice sensing devices. In general, it has been found that the sensor strip 58 may be bent, twisted and folded in various shapes without affecting performance. In general, the curvature radii of the sensor strip 58 are large in relation acoustic wavelengths of generated waves within the sensor strip 58.

[0057] Further, as noted above, the sensing device 50 downwardly extends from the bracket 84, and the sensed device 52 may be embedded within an upper end of the support plate 53 proximate the sensing device 50. Optionally, the sensing device 50 may be on or within the plate, while the sensed device 52 extends from the bracket 84.

[0058] The sensing device 50 may be a magnetic sensor configured to detect changes in a magnetic field, while the sensed device 52 may be a magnet.

[0059] As discussed above, the system 80 is calibrated such that detection of the plate 53 in a normal position causes the system 80 to produce ice. However, when the plate 53 swings up, the sensing device 50 detects a change, such as a change in magnetic field, which is relayed to the processing unit, which then ceases ice production until the sensing device 50 detects the calibrated normal position (that is, when the plate 53 returns to its normal position).

[0060] Embodiments of the present invention may not use propagating waves. Instead, embodiments of the present invention utilize trapped wave motion, as described in United States Patent No. 7,106,310 and United States Patent No. 7,026,943. Detecting ice through trapped wave motion provides a detection system that is more sensitive to the presence of ice and greatly simplifies signal processing. Plastic acoustic wave sensing systems may be advantageous over metal acoustic wave sensing systems because their thermal conductivity is less than typical metals, which allows for better thermal insulation from the ice generating surfaces.

[0061] Embodiments of the present invention provide a simplified and efficient system and method for detection of motion in an ice-making machine, as described above. Certain embodiments may detect motion, and therefore ice formation, without the use of an electronic control system. Certain embodiments provide an ice sensing system and method that replaces timed cycles, thereby improving energy efficiency.

[0062] Additionally, certain embodiments of the present invention provide the sensing devices discussed above that detect when ice falls. For example, the sensing device, such as a magnetic sensor, detects that the sensed device, such as a magnet,

swings away from the ice grid, such as through a detected change in magnetic field strength, such that the detected movement indicates that ice is falling. A control unit, such as the processing unit 41, which may be mounted directly on the assembly 14, or remote therefrom, may be used to command the machine to deactivate. Such a configuration eliminates the need for an ice bin resistive sensor, such as found in prior systems.

[0063] While various spatial and directional terms, such as upper, bottom, lower, mid, lateral, horizontal, vertical, and the like may be used to describe embodiments of the present invention, it is understood that such terms are merely used with respect to the orientations shown in the drawings. The orientations may be inverted, rotated, or otherwise changed, such that an upper portion is a lower portion, and vice versa, horizontal becomes vertical, and the like.

[0064] Variations and modifications of the foregoing are within the scope of the present invention. It is understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text and/or drawings. All of these different combinations constitute various alternative aspects of the present invention. The embodiments described herein explain the best modes known for practicing the invention and will enable others skilled in the art to utilize the invention. The claims are to be construed to include alternative embodiments to the extent permitted by the prior art.

[0065] Various features of the invention are set forth in the following claims.

CLAIMS

1. A system for detecting ice of a particular thickness, comprising:
 - an ice-forming housing, said ice-forming housing comprising one of a sensing device or a sensed device; and
 - an ice detection assembly pivotally secured to said ice-forming housing, said ice detection assembly comprising:
 - a deflection arm;
 - a transducer located on or within said deflection arm, said transducer configured to generate a trapped acoustic wave within a medium, wherein ice of a particular thickness is detected when ice that forms from said ice-forming housing contacts said medium and dampens the trapped acoustic wave within said medium; and
 - the other of said sensing device or said sensed device located on or within said deflection arm, wherein said sensing device is configured to detect movement of said sensed device away from a calibrated position.
2. The system of claim 1, wherein said ice-forming housing comprises a bracket that pivotally secures said deflection arm to said ice-forming housing, and wherein one of said sensing device or said sensed device downwardly extends from said bracket and the other of said sensing device or said sensed device is embedded in, or mounted on, an upper portion of said deflection arm that pivotally connects to said bracket.
3. The system of claim 1, wherein said sensing device comprises a magnetic sensor, and said sensed device comprises a magnet.
4. The system of claim 3, wherein said magnetic sensor comprises a reed switch.

5. The system of claim 3, wherein said magnetic sensor comprises a solid-state Hall effect device.

6. The system of claim 1, wherein one or both of said sensing device and/or said sensed device comprises an accelerometer, wherein said accelerometer is configured to detect an angle of said deflection arm from a gravitational plumb.

7. The system of claim 1, wherein one or both of said sensing device and/or said sensed device comprises an electromechanical switch.

8. The system of claim 1, wherein said sensing medium comprises a substrate having an acoustic wave cavity.

9. The system of claim 1, wherein said sensing medium comprises a sensor strip.

10. The system of claim 1, wherein said ice-forming housing comprises an ice grid having a plurality of ice forming compartments.

11. The system of claim 10, further comprising an ice collection bin, wherein said ice grid is configured to be heated to form ice cubes when the ice contacts said medium, the ice cubes being collected in said ice collection bin.

12. The system of claim 1, further comprising a control unit operatively connected to said ice detection assembly.

13. A system for detecting ice of a particular thickness, comprising:
an ice-forming housing; and
an ice detection assembly pivotally secured to said ice-forming housing, said ice detection assembly comprising:

a deflection arm;

one of a sensing device or a sensed device located on or within said deflection arm, wherein said sensing device is configured to detect movement of said sensed device away from a calibrated position.

14. The system of claim 13, wherein said ice-forming housing comprises a bracket that pivotally secures said deflection arm to said ice-forming housing, and wherein one of said sensing device or said sensed device downwardly extends from said bracket and the other of said sensing device or said sensed device is embedded in, or mounted on, an upper portion of said deflection arm that pivotally connects to said bracket.

15. The system of claim 13, wherein said ice detection assembly further comprises a transducer located on or within said deflection arm, said transducer configured to generate a trapped acoustic wave within a medium, wherein ice of a particular thickness is detected when ice that forms from said ice-forming housing contacts said medium and dampens the trapped acoustic wave within said medium.

16. The system of claim 13, wherein said sensing device comprises a magnetic sensor, and said sensed device comprises a magnet.

17. The system of claim 16, wherein said magnetic sensor comprises a reed switch.

18. The system of claim 16, wherein said magnetic sensor comprises a solid-state Hall effect device.

19. The system of claim 13, wherein one or both of said sensing device and/or said sensed device comprises an accelerometer, wherein said accelerometer is configured to detect an angle of said deflection arm from a gravitational plumb.

20. The system of claim 13, wherein one or both of said sensing device and/or said sensed device comprises an electromechanical switch.

21. A system for detecting ice of a particular thickness, comprising:
an ice-forming housing, said ice-forming housing comprising:
an ice grid having a plurality of ice forming compartments;
a bracket; and
one of a sensing device or a sensed device downwardly extending from said bracket;
an ice detection assembly pivotally secured to said ice-forming housing, said ice detection assembly comprising:
a deflection arm, wherein said bracket pivotally secures said deflection arm to said ice-forming housing;
a transducer located on or within said deflection arm, said transducer configured to generate a trapped acoustic wave within a medium, wherein ice of a particular thickness is detected when ice that forms from said ice-forming housing contacts said medium and dampens the trapped acoustic wave within said medium; and
the other of said sensing device or said sensed device embedded in, or mounted on, an upper portion of said deflection arm that pivotally connects to said bracket, wherein said sensing device is configured to detect movement of said sensed device away from a calibrated position;

an ice collection bin, wherein said ice grid is configured to be heated to form ice cubes when the ice contacts said medium, the ice cubes being collected in said ice collection bin; and

a control unit operatively connected to said ice detection assembly.

22. The system of claim 21, wherein said sensing device comprises a magnetic sensor, and said sensed device comprises a magnet.

23. The system of claim 22, wherein said magnetic sensor comprises a reed switch.

24. The system of claim 22, wherein said magnetic sensor comprises a solid-state Hall effect device.

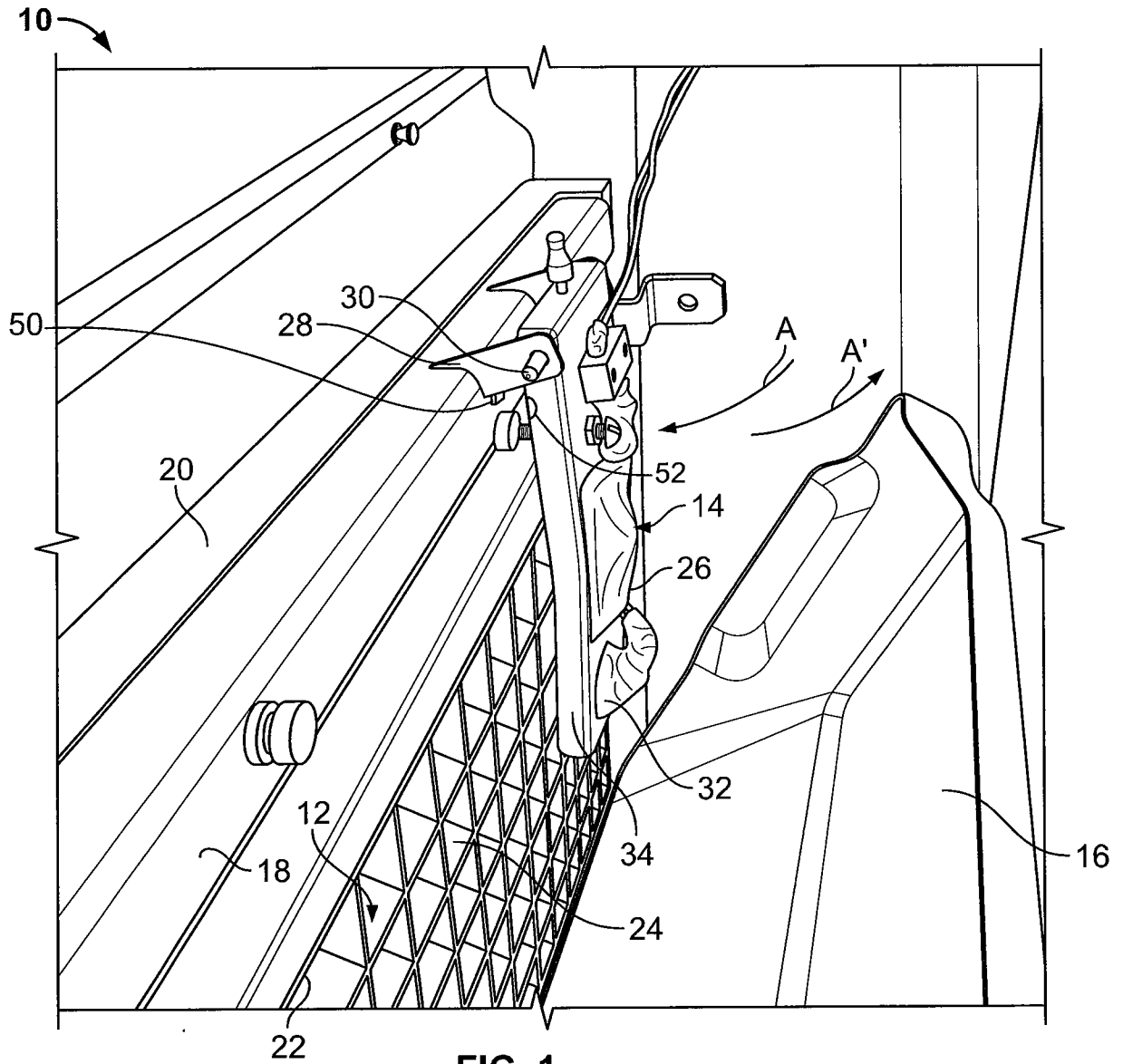
25. The system of claim 21, wherein one or both of said sensing device and/or said sensed device comprises an accelerometer, wherein said accelerometer is configured to detect an angle of said deflection arm from a gravitational plumb.

26. The system of claim 21, wherein one or both of said sensing device and/or said sensed device comprises an electromechanical switch.

27. The system of claim 21, wherein said sensing medium comprises a substrate having an acoustic wave cavity.

28. The system of claim 21, wherein said sensing medium comprises a sensor strip.

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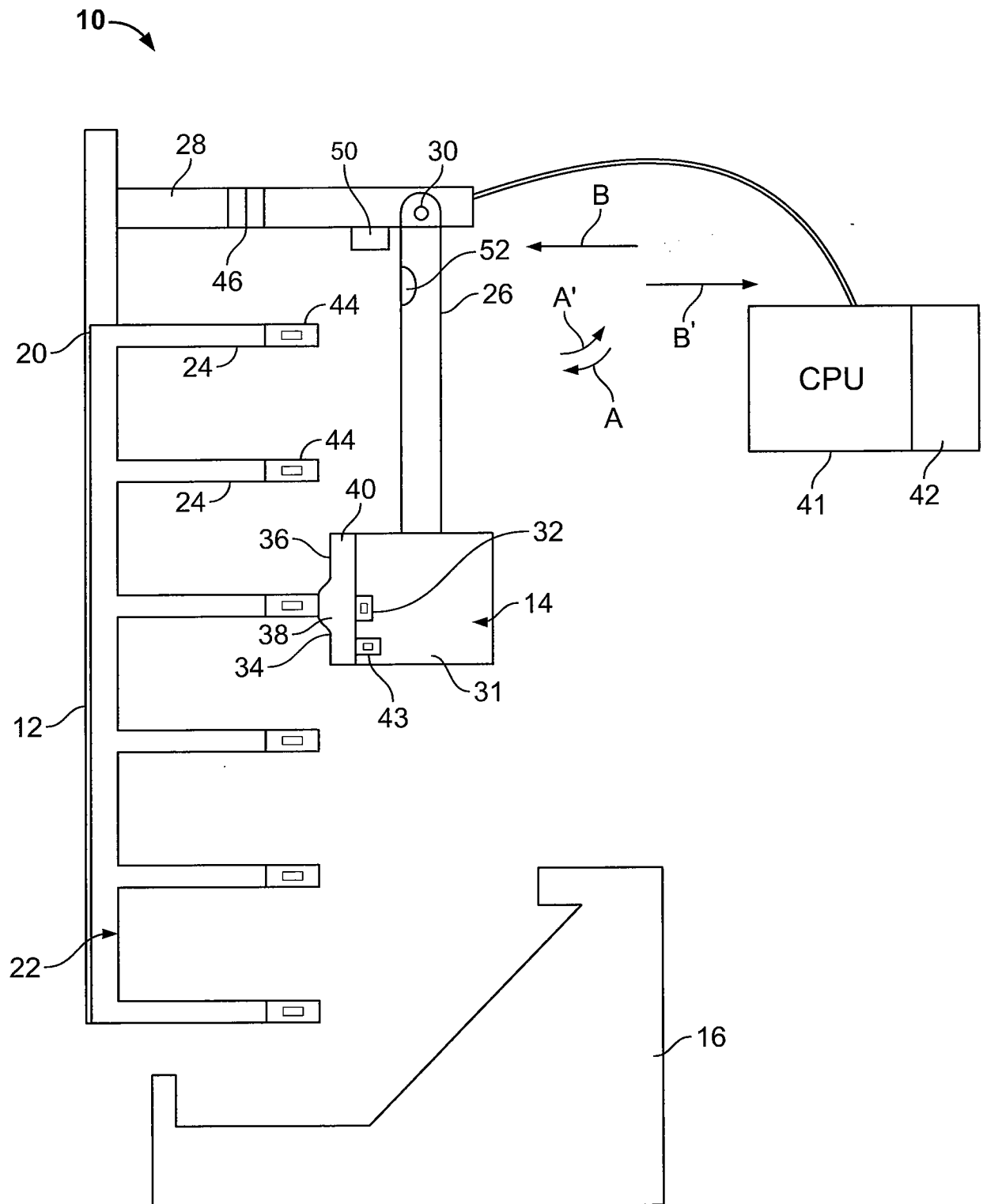


FIG. 2

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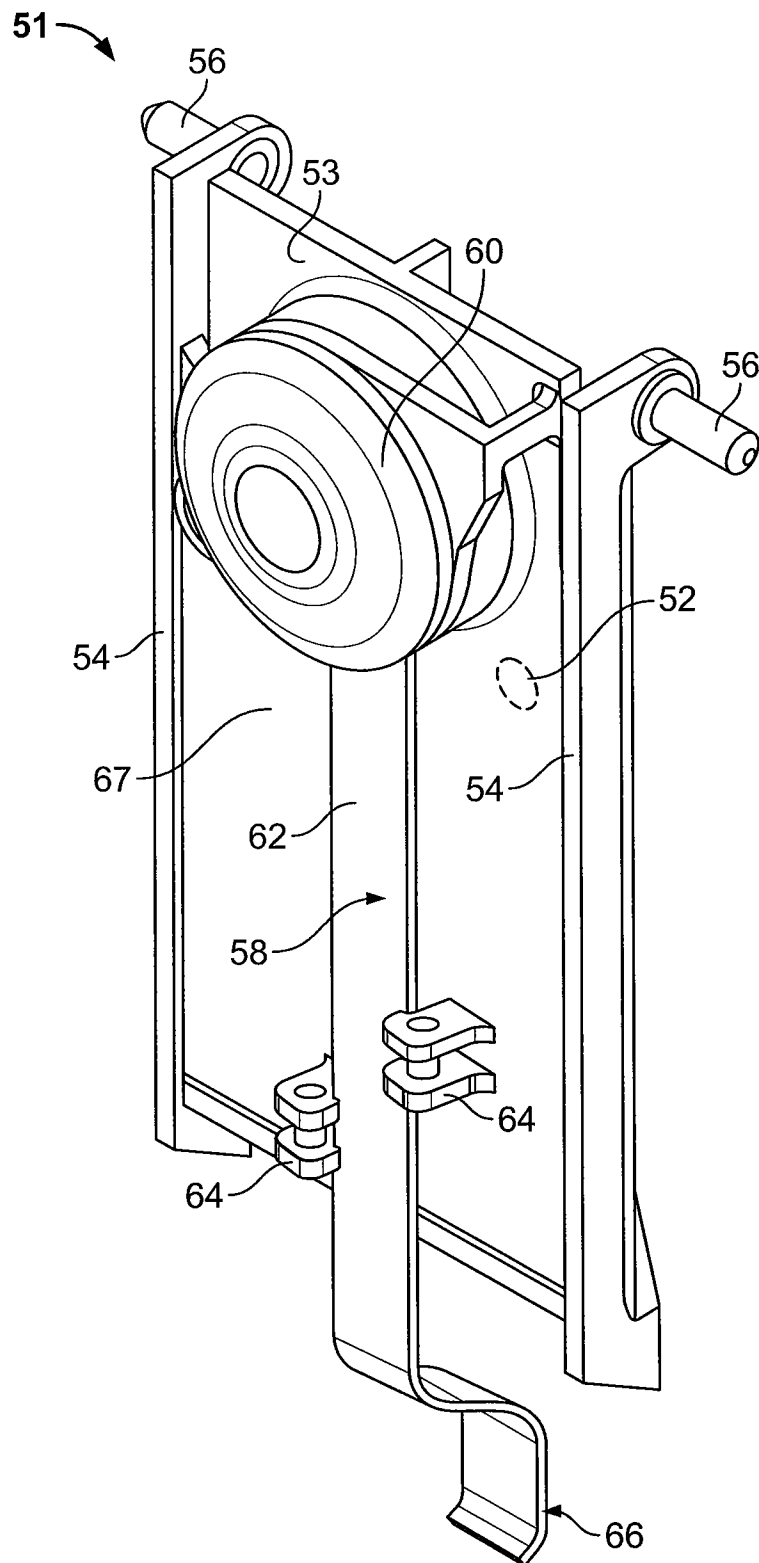


FIG. 3

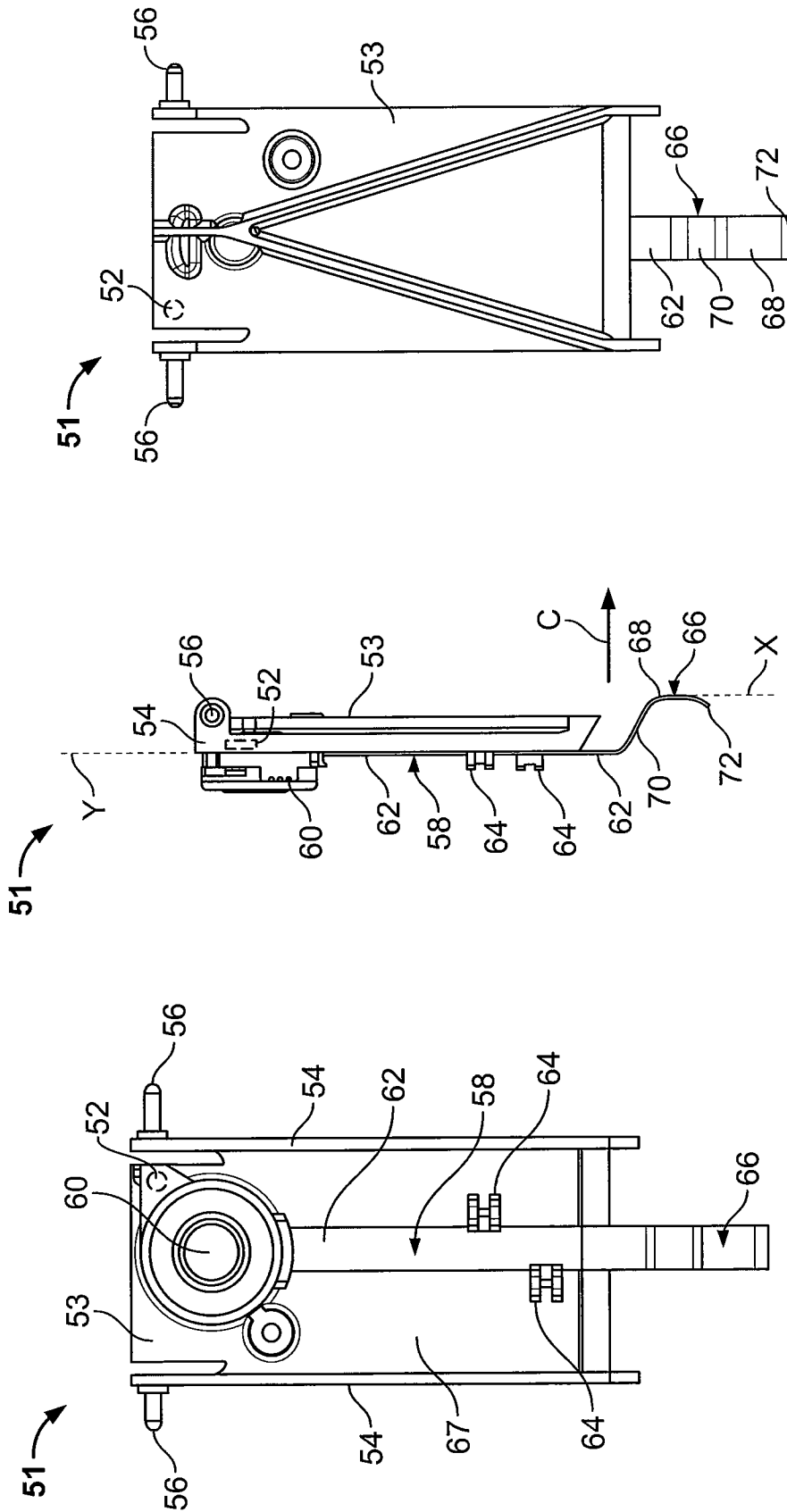


FIG. 4

FIG. 5

FIG. 6

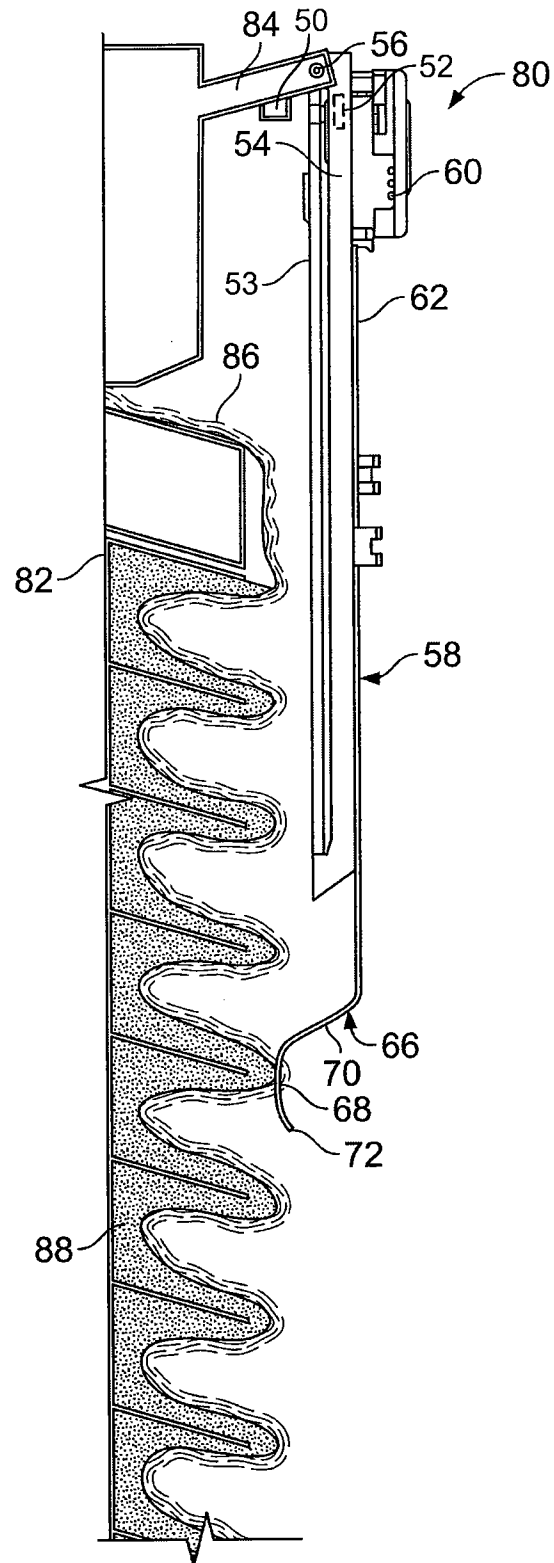


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2010/035515

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01N29/22 G01N29/09 G01N29/11 B64D15/20
ADD.

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)

G01N B64D

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 practical, search terms used)

EPO-Internal, COMPENDEX, INSPEC, 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	EP 1 997 730 A2 (BOEING CO [US]) 3 December 2008 (2008-12-03)	13, 14, 16-20
A	* abstract; figures 1-9 paragraphs [0016] - [0026]	1-12, 15, 21-28
A	US 2008/202142 A1 (KNOWLES TERENCE J [US] ET AL) 28 August 2008 (2008-08-28) cited in the application * abstract; figures 1-7 paragraphs [0005], [0021] - [0041]	1-12, 15, 21-28
A	US 7 026 943 B2 (KNOWLES TERENCE J [US] ET AL) 11 April 2006 (2006-04-11) cited in the application * abstract; figures 1-5 column 2, line 40 - column 9, line 61	1-12, 15, 21-28

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

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

9 August 2010

Date of mailing of the international search report

17/08/2010

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Uttenthaler, Erich

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2010/035515

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			WO	2008103513 A1	28-08-2008
US 7026943	B2	11-04-2006	EP	1644905 A2	12-04-2006
			US	2005016278 A1	27-01-2005
			WO	2005006271 A2	20-01-2005