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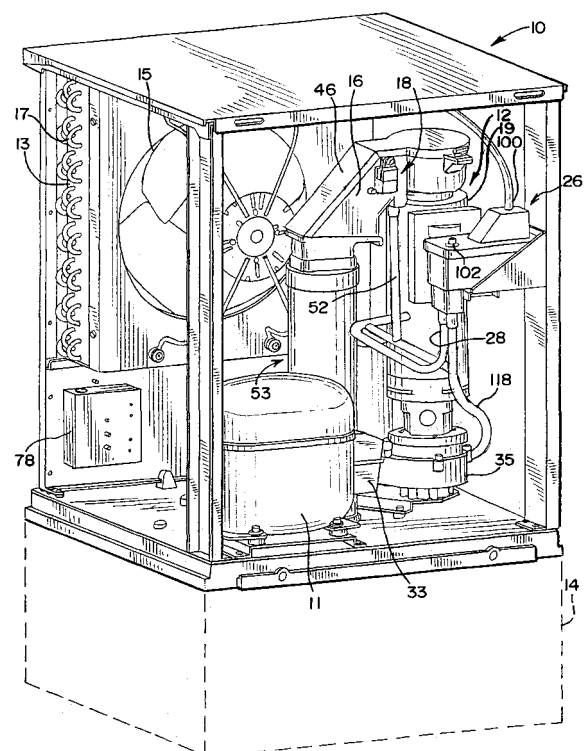
Remarks:

Claims No. 21-31 are deemed to be abandoned due to non-payment of the claims fees (Rule 31 (2) EPC).

(54) **Ice making machine and method of controlling an ice making machine**

(57) An ice forming apparatus (12) capable of forming ice pieces is provided, including, a transfer zone between the ice forming apparatus (12) and a storage area, and a ice sensing apparatus (12) configured to both detect migration of the ice pieces through the transfer zone and to detect build-up of the ice pieces in the transfer zone. The ice forming apparatus (12) is preferably an auger-type, such as a flaker-type or a nugget-type device.

FIG.1



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Description**CROSS-REFERENCE TO RELATED PATENT APPLICATIONS**

5 **[0001]** This patent application claims the benefit under 35 U.S.C. § 119(e) of U.S. provisional patent application Serial No. 60/689,387, filed June 10, 2005, which is hereby incorporated by reference.

BACKGROUND

10 1. Field of the Invention

15 **[0002]** The present invention relates generally to an ice making machine and a method of controlling an ice making machine. More particularly, the invention relates to an ice making machine having an ice sensing apparatus for the detection of ice pieces and a method of controlling the ice making machine based on the detection. Although the present invention is related to all types of ice making machines, it is particularly suitable for use in an auger-type ice making machine, such as a flake or a nugget making machine.

2. Related Technology

20 **[0003]** In a conventional auger-type flake ice making machine, an ice forming apparatus includes an ice making chamber that is cooled to a relatively low temperature by a cooling fluid, such as refrigerant. Water is delivered to the ice making chamber and contacts the wall of the ice making chamber to form ice. Furthermore, an auger is positioned within the ice making chamber and has an auger flight with a diameter slightly less than that of the ice making chamber wall. Therefore, as the auger rotates, the auger flight removes portions of the ice from the chamber wall and transports
25 the ice in the upward direction towards an opening in the top of the ice making chamber. The ice is expelled from the opening and migrates towards an ice storage bin, where it is stored until removed for consumption. More particularly, the storage bin is typically located below the top of the ice making chamber so that the ice pieces naturally fall through or slide along a transfer zone, such as an ice chute.

30 **[0004]** Ice making machines currently include a control system to ensure that all of the various ice-making components are properly functioning. More particularly, the control system measures system conditions to prevent possible damage to the system components, such as the auger, the auger motor, and the ice making chamber.

35 **[0005]** One such control system, disclosed in U.S. Patent No. 6,463,746, measures the current in the auger motor during ice-making to prevent potential damage to the ice producing machine. For example, if the current flow through the motor exceeds a predetermined threshold, the system compressor is turned off. However, this system may not be able to detect other types of system failures, such as a failure to reach or maintain an effective ice-making temperature in the chamber.

40 **[0006]** A similar control system to the one described above is an auger rotation sensor disclosed in U.S. Patent No. 6,609,387. A sensor is coupled with the inner surface of the ice making cylinder and a magnet is coupled to the auger rotating within the cylinder. The sensor and the magnet cooperate to detect abnormal rotation of the auger. However, as with the above-described design, this control system fails to detect failures other than those relating to the rotation of the auger.

45 **[0007]** Another control system, disclosed in U.S. Patent No. 6,601,399, measures the rate of water consumption by measuring the water level in the reservoir over a period of time. If the water is not consumed at a minimum threshold rate, a controller adjusts the capacity of the freezing circuit. However, as with the other known designs, this system only detects a particular type of system failure and is not able to detect if ice is actually being produced.

50 **[0008]** In addition to failing to detect if ice is being produced, the above control systems fail to detect the ice level within the storage bin. Therefore, additional sensors are required to detect when a desired amount of ice is in the storage bin, while preventing an undesirable overflow condition in the storage bin or in a transfer zone connecting the ice forming apparatus to the storage bin.

55 **[0009]** One type of ice level detector, which is disclosed in U.S. Patent No. 5,172,595, is an ultrasonic sensor that is positioned at a top portion of the storage bin. In this design, once the ice sensor detects ice pieces at a relatively high threshold level in the storage bin, a controller deactivates the compressor and prevents the formation of ice until some of the ice is removed from the storage bin and the ice drops below the threshold level. However, the optical sensor is unable to detect normal ice migration from the ice maker and therefore cannot be utilized to determine whether the ice maker is functioning properly.

60 **[0010]** Another type of ice level detector, which is disclosed in U.S. Patent No. 5,142,878, includes a movable detection plate 32b mounted at the top of a vertical delivery chute 31 that leads to a storage bin 41. When the storage bin 41 becomes filled and the ice pieces accumulate within the delivery chute 31, the ice pieces cause displacement of the

detection plate 32b, thereby opening a proximity switch and stopping the ice making process. However, the detection plate is only displaced when the ice pieces accumulate in the delivery chute; not when ice pieces migrate through the delivery chute 31 during normal ice making. Therefore, the detection plate is unable to detect normal ice migration from the ice maker and therefore cannot be utilized to determine whether the ice maker is functioning properly.

[0011] Yet another type of ice level detector, which is disclosed in U.S. Patent No. 5,390,504, includes a switch assembly 20 mounted at the top of a horizontal discharge passage and a movable detection plate 15c mounted at the top of a vertical delivery chute 14. Both the switch assembly 20 and the detection plate 15c are configured to be displaced by accumulated ice within the horizontal discharge passage and the vertical delivery chute 14, respectively. However, due to their location at the top of the horizontal discharge passage and the vertical delivery chute 14, the switch assembly 20 and the detection plate 15c are unable to detect normal ice migration from the ice maker and therefore cannot be utilized to determine whether the ice maker is functioning properly.

[0012] It is therefore desirable to provide an improved, low cost, simple ice making machine, and an improved method of controlling the machine, so as to reduce the risk of damage to the auger, the auger motor, and the ice making chamber, and to achieve and maintain a desired ice level in the storage bin.

SUMMARY

[0013] In overcoming the limitations and drawbacks of the prior art, the present invention provides an ice making machine including an ice forming apparatus capable of forming ice pieces, a transfer zone between the ice forming apparatus and a storage area, and an ice sensing apparatus configured to detect at least some of the ice pieces during the migration of the ice pieces through the transfer zone.

[0014] In one aspect of the invention, the ice sensing apparatus further detects a build-up of the ice pieces in the transfer zone. Furthermore, the ice sensing apparatus in this design may include a movable portion having a first position corresponding to the migration of the ice pieces and a second position corresponding to the build-up of the ice pieces in the transfer zone. The ice sensing apparatus in this design may also include a first sensor to detect the first position of the movable portion and a second sensor to detect the second position of the movable portion.

[0015] In another aspect, a method of controlling an ice making machine is provided, including the steps of: a) forming ice pieces with an ice forming apparatus, b) permitting migration of the ice pieces from the ice forming apparatus through a transfer zone to a storage area; c) detecting at least some of the ice pieces migrating through the transfer zone; and d) deactivating the ice forming apparatus if no migrating ice pieces are detected within a predetermined time period.

[0016] The above aspects of the present invention therefore permit monitoring of the ice-making operation to provide a simple, low cost design for detecting the migration of ice pieces through the transfer zone; thereby reducing part complexity and cost of the ice making machine.

[0017] In yet another aspect of the present invention, the ice forming apparatus includes an outlet section that cooperates with the transfer zone to at least partially define a clean zone. The ice sensing apparatus includes a first portion located within the clean zone and a second portion positioned outside of the clean zone. This aspect of the present invention reduces the amount of moisture that is exposed to the second portion, thereby improving the performance and the effective life of the sensor components.

[0018] Further objects, features and advantages of this invention will become readily apparent to persons skilled in the art after a review of the following description, with reference to the drawings and claims that are appended to and form a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1 is an isometric view of an ice making machine embodying the principles of the present invention and including an ice forming apparatus and an ice chute extending to the inlet of an ice storage area;

[0020] Figure 2 is an enlarged, isometric view of the ice making machine and the ice chute shown in Figure 1, having various components removed therefrom for clarity purposes;

[0021] Figure 3 is a cross-sectional view of the ice chute taken along line 3-3 in Figure 2, showing an ice sensing apparatus coupled with the ice chute;

[0022] Figure 4a is an enlarged view of the ice chute in Figure 3, where the ice sensing apparatus is in a first position, indicative of migration of ice pieces down the ice chute;

[0023] Figure 4b is an enlarged view similar to that shown in Figure 4a, where the ice sensing apparatus is in a second position, indicative of a build-up of the ice pieces in the ice chute;

[0024] Figure 5a is a flowchart showing a method for operating an ice making machine during a normal operation mode;

[0025] Figure 5b is a flowchart showing a method for restarting an ice making machine after a safety shutdown has occurred;

[0026] Figure 6 is a top view of a water reservoir shown in Figure 1;

[0027] Figure 7 is a side view of the water reservoir shown in Figure 6;

[0028] Figure 8 is a front view of the water reservoir shown in Figure 6;

[0029] Figure 9 is an enlarged cross-sectional view taken along line 9-9 in Figure 3, showing a portion of the ice sensing device; and

[0030] Figure 10 is an exploded view of the auger and the casing of the ice forming apparatus shown in Figure 1.

DETAILED DESCRIPTION

[0031] The present invention will now be further described. In the following passages, different aspects of the invention are defined in more detail. Each aspect so defined may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

[0032] Referring now to an embodiment of the present invention, Figure 1 shows an ice making machine 10 generally including an ice forming apparatus 12 capable of forming ice pieces, a storage area for storing the ice pieces (represented by an inlet tube 53 and an ice bin 14, which is shown in phantom lines), a transfer zone, such as an ice chute 16, for delivering the ice pieces to the storage area, and an ice sensing apparatus 18 configured both to detect the migration of the ice pieces along the ice chute 16 and to detect the build-up of the ice pieces in the ice chute 16.

[0033] The ice making machine 10 includes components of a refrigeration system that promotes heat exchange between a circulating fluid, such as a refrigerant, and the ambient air. As is well known in the art, gaseous refrigerant is drawn into a compressor 11, which causes an increase in both the pressure and temperature of the refrigerant. Exiting the compressor 11 in a gaseous phase, the refrigerant is then condensed into a liquid phase by a condenser 13. More specifically, a condenser fan 15 forces ambient air across heat exchange tubes 17 within condenser 13, thereby cooling the refrigerant flowing through the heat exchange tubes 17. Next, the refrigerant flows through an expansion valve (not shown), which causes the refrigerant to expand into a low-pressure, low-temperature mixture of gas and liquid. The mixture of gas and liquid then flows into an evaporator section (not shown) of the ice forming apparatus 12 and cools an ice making chamber 20 (as shown in Figure 10) to a freezing temperature that is preferably close to or below 5 degrees Fahrenheit (-15 degrees Celsius).

[0034] As shown in Figures 2 and 10, a heat exchange tube 22 carrying the refrigerant is utilized for cooling the ice making chamber 20. More specifically, the heat exchange tube 22 extends into the ice forming apparatus 12 near a lower portion of the ice making chamber 20, coils around a housing defining the ice making chamber 20, and exits the ice forming apparatus 12 near an upper portion of the ice making chamber 20. The coiled portion of the heat exchange tube 22 is surrounded by a casing 24 for insulative and protective purposes. The casing 24 is preferably made of metal, such as a tin-based solder.

[0035] Referring back to Figure 1, ice making water is delivered from a water reservoir 26 to a lower portion of the ice making chamber 20 via a supply tube 28. The ice making water is preferably delivered to the ice making chamber 20 via natural flow forces. The ice making water typically fills the ice making chamber 20 to the same level as the water reservoir 26.

[0036] Furthermore, as shown in Figure 10, an auger 30 is positioned within ice making chamber 20 and includes a generally spiral-shaped auger flight 32. The auger flight 32 has a diameter that is slightly less than the diameter of the ice making chamber 20 so that the auger flight 32 removes most of the ice build-up from the ice making chamber 20 wall. For example, the auger flight diameter is preferably between 0.001 and 0.01 inches smaller than the ice making chamber diameter so that all but a thin layer of ice is removed from the ice making chamber wall when the auger 30 rotates. An auger motor 33 rotates the auger 30, via an auger drive gear system 35 (Figure 1), in a direction so that the flight generates a lifting motion. As mentioned above, the ice making chamber 20 is generally filled with water along the length of the auger 30 so that the water adjacent to the ice making chamber wall is frozen into ice crystals. Therefore, as the ice crystals are being formed, the rotating auger flight 32 scrapes the layer of ice from the inner surface and transports the newly-formed ice in the upward direction.

[0037] Next, as shown in Figure 10, the ice is separated into pieces by an ice cutting head 37 having a plurality of generally vertical blades 39. The leading edge of each of the blades 39 preferably has a tapered portion 41 to act as a wedge and split the ice into ice pieces 38 (Figures 4a and 4b). The ice cutting head 37 shown in the figures is coupled to the auger 30 via a pair of bearings 43 so that the ice cutting head 37 does not rotate along with the auger 30. Based on the size and shape of the cutting head, the ice forming apparatus 12 can be used to form ice pieces 38 into a desired shape and size.

[0038] Referring back to Figure 2, the ice pieces 38 are then forced upwards past the ice cutting head 37 and through an opening 34 defined by the ice making chamber 20 and the ice cutting head 37, where a rotating ice wiper 36 sweeps the ice pieces 38 away from the opening 34. The ice wiper 36, which includes a pair of projections 40 coupled to a body portion 42, is connected to the auger 30 such that the respective components 30, 36 rotate in unison with each other. The body portion 42 has an arcuate, tapered underside surface that gradually urges the ice pieces 38 in a radial direction

out of the opening 34. The ice that is extruded through the ice cutting head 37 breaks into one of the ice pieces upon contact with the underside of the body portion 42, thereby forming one of the ice pieces 38. Therefore, the distance between the tapered underside of the body portion 42 and the opening 34 controls the length of the ice pieces 38. Furthermore, as the auger 30 and the ice wiper 36 rotate, the projections 40 sweep the ice pieces 38 further away from the opening 34.

[0039] Additionally, a nugget forming device (not shown) may be positioned at the top portion of the auger 30 to compact the ice by forcing the ice through generally small extrusion orifices. The compacted ice is then cut or broken into relatively small nuggets by an ice cutting component within the nugget forming device. In addition to altering the shape and the size of the ice pieces 38, the above described post-formation treatments squeeze out water clinging to the ice, thereby causing the ice pieces 38 to have a higher cooling capacity per pound of ice and increasing the cooling potential of the ice pieces 38.

[0040] After being expelled from the ice making chamber 20, the ice pieces 38 move through a transfer zone and into the ice storage area. The transfer zone is defined by a path between the ice making chamber 20 and the ice storage area. For example, the transfer zone in the figures includes, but is not limited to, the area adjacent to the ice making chamber opening 34, a strainer 50 (which will be discussed in more detail below), and the ice chute 16.

[0041] The transfer zone is part of what is known as the food zone; the area that often contains ice during normal operation of the machine. For example, in the figures, the food zone includes, but is not limited to, the following: the ice making chamber 20, the area adjacent to the ice making chamber opening 34, the ice chute 16, and the storage bin inlet tube 53 and the ice bin 14. Because the ice pieces 38 are typically used for consumption by people, National Sanitation Foundation guidelines require that surfaces that potentially contact food are made of food grade materials. For example, a housing 45 defining the ice chute 16 and the storage bin 14 is preferably formed by food grade plastic and the auger 30 and the inner surface of the ice making chamber 20 are formed by food grade metal.

[0042] For purposes of the present invention, a portion of the food zone is defined as a "clean zone". The clean zone 44 includes the outlet section of the ice forming apparatus and the transfer zone. Furthermore, a protective lid 46 (Figure 1) covers the ice chute 16 and the area above the ice making chamber opening 34 to prevent dust, dirt, and other contaminants from entering the clean zone 44 (the protective lid 46 has been removed in Figures 2, 4a, and 4b for illustrative purposes only). The protective lid 46 is also preferably constructed of food grade plastic. Additionally, the protective lid 46 is preferably connected to the housing 45 by a plurality of flanges 48 (Figure 2) to prevent contaminants from entering the clean zone 44 and to prevent heat exchange between the ice pieces 38 and the ambient air.

[0043] As shown in Figure 2, the strainer 50 is located between the opening 34 and the ice chute 16 to prevent water, from melting ice, from flowing down the ice chute 16. The strainer 50 preferably permits drainage of water into a water recirculation tube 52. More specifically, water flows through the strainer 50, along the water recirculation tube 52, and back into the supply tube 28 to be supplied to the ice making chamber 20. Alternatively, the water may be discarded or recirculated to a different component in the ice making machine 10. The strainer 50 has a slight, upward slope to further prevent water from flowing down the ice chute 16.

[0044] After being formed in the ice making chamber 20, the ice pieces 38 are forced away by the ice wiper 36, across the strainer 50, and towards the ice chute 16 by the rotating projections 40. For example, the ice pieces 38 are initially directly contacted by the ice wiper 36 and are forced onto the strainer 50. Next, due to the upward slope of the strainer 50, the ice pieces 38 do not typically migrate into the ice chute 16 by natural gravity forces alone. However, subsequently-formed ice pieces 38 that are expelled from the ice making chamber 20 force the ice pieces 38 across the strainer 50 and into the top of the ice chute 16. The ice chute 16 is generally downwardly-sloping so that the ice pieces 38 are able to naturally migrate down the ice chute 16 and are detected by the ice sensing apparatus 18. After the ice sensing apparatus 18, the ice pieces 38 migrate down a storage bin inlet tube 53.

[0045] The ice sensing apparatus 18 shown in the figures includes a contact mechanism, the movement of which is caused by engagement with the ice pieces 38. For example, the contact mechanism includes a contact plate 54 positioned along the path of migration of the ice pieces 38 such that the ice pieces 38 contact the contact plate 54 during migration towards the ice storage area. The contact plate 54 is pivotally supported via a rod 56 that extends along an axis 58 and that is rotatably supported by a pair of saddles 60, sometimes known as bearings, on opposing sides of the housing 45. More specifically, the saddles 60 are relatively smooth, low friction surfaces conforming to the shape and the size of the rod 56 such that a low friction seal 62 is formed by the respective components 56, 60, to permit low-friction rotation of the rod 56 and the contact plate 54. The low friction seal 62 may also prevent some moisture from migrating along the rod 56.

[0046] As best shown in Figure 3, the rod 56 includes an enlarged-diameter collar portion 64 to prevent axial travel of the rod 56 and to reduce the moisture migrating along the rod 56 by forming an overlapped engagement with the housing 45. The rod 56 preferably snaps into engagement with the saddles 60 to prevent disengagement therefrom. However, alternatively, the protective lid includes a securing mechanism such as a tab with a semi-circular recess to prevent vertical displacement of the rod 56.

[0047] The contact plate 54 is located within the clean zone 44, and is therefore preferably made of a food grade

material, such as food grade plastic. Additionally, the contact plate 54 preferably includes one or more slots 55 to permit water or small ice fragments to flow past the contact plate 54 without causing the displacement thereof. When the ice sensing apparatus 18 is not being moved by the ice pieces 38, the contact plate 54 hangs generally vertically in a neutral position 57, as will be discussed in more detail below.

[0048] At least one of the end portions of the rod 56 preferably extends through the housing 45 and out of the clean zone 44. For example, a first end portion 66 extends through a first side of the housing 45 and a second end portion 68 extends through the opposing side of the housing 45. A signal member, such as an interrupting vane 70, is coupled to the first end portion 66 of the rod 56 such that the contact plate 56, the rod 56, and the interrupting vane 70 rotate in unison with each other. The interrupting vane 70 in the figures is a generally thin, metal plate intersected by the rod 56. The interrupting vane 70 is positioned adjacent to a sensor device 72 that detects the position of the interrupting vane 70, thereby determining the position of the contact plate 54.

[0049] As shown in Figure 9, the sensor device preferably includes two Hall-effect sensors, including two magnets 74a, 74b facing a first side of the interrupting vane 70 and two sensor elements 76a, 76b facing a second side of the interrupting vane 70. In the figures, the magnets 74 are positioned on the inboard side of the interrupting vane 70 and the sensor elements 76 are positioned on the outboard side, but a reverse configuration may be used. In one design, the Hall-effect sensors have a supply voltage between 4.5 and 5.5 VDC filtered, at least a 10 K Ω pull-down resistor connected from the output to the ground, and a nominal 10 nF noise capacitor connected from output to ground. When the interrupting vane 70 is positioned between a magnet 74 and its sensor element 76, an electromagnetic field is disrupted and the sensor element 76 sends a signal to a controller 78 (Figure 1). Whether the interrupting vane 70 disrupts the electromagnetic field between one, both or neither sets of the magnets and sensors 74, 76 indicates the position of the interrupting vane 70 and the contact plate 54.

[0050] Figures 2, 3, and 9 show the interrupting vane 70 and the contact plate 54 in the neutral position 57 so that the interrupting vane 70 interrupts the electromagnetic field with two sets of magnets and sensors 74a, 74b, 76a, 76b (causing the first and second sensor elements 76a, 76b to be "closed"). The interrupting vane 70 and the contact plate 54 are in the neutral position 57 when the forces acting thereon are negligible or non-existent. More specifically, the interrupting vane 70 and the contact plate 54 are typically in the neutral position 57 when no ice pieces 38 are migrating along the ice chute 16.

[0051] Figure 4a shows migration 79 of the ice pieces 38 along the ice chute 16 during normal ice making operation. More specifically, a relatively low number of ice pieces 38 are discharged from the ice making chamber 20 and permitted to migrate towards the inlet tube 53 and ice storage bin 14, thereby actuating the contact plate 54 forward into a first position 80. When the contact plate 54 and the interrupting vane 70 are in the first position 80, the interrupting vane 70 is positioned between only the first magnet 74a and the first sensor element 76a of the sensor device 72, thereby opening the first sensor element 76a and indicating to the controller 78 the position of the contact plate 54. In this position, the interrupting vane 70 defines a first angle 82 with the vertical direction. In other words, when the contact plate 54 is contacted by the migration 79 of the ice pieces 38, the interrupting vane 70 pivots forward from the neutral position 57 by an amount equal to the first angle 82. After the ice pieces 38 migrate past the ice sensing apparatus 18, the contact plate 54 swings back to the neutral position 57 due to gravitational forces, as will be discussed further below. Additionally, a magnetic force from the magnets 74a, 74b also cooperates with the above-discussed gravitational forces to urge the interrupting vane 70 towards the neutral position.

[0052] Figure 4b shows a build-up 83 of the ice pieces 38 along the ice chute 16 when the ice storage area is full. More specifically, a relatively high number of ice pieces 38 are prevented from entering the ice storage area and become stacked upon each other underneath the contact plate 54, thereby actuating the contact plate 54 further forward into a second position 84. When the contact plate 54 and the interrupting vane 70 are in the second position 84, the interrupting vane 70 is positioned between neither of the magnets 74 and the sensor elements 76 of the sensor device 72, thereby maintaining the open state of the first sensor element 76a, opening the second sensor element 76b, and indicating to the controller 78 the position of the contact plate 54. In this position, the interrupting vane 70 defines a second angle 86 with the vertical direction that is greater than the first angle 82.

[0053] After the build-up 83 of the ice pieces 38 has been removed, the contact plate 54 swings back to the neutral position 57 due to the gravitational and magnetic forces. However, the build-up 83 is typically not removed until some or all of the ice pieces melt or until some of the ice pieces 38 have been removed from the ice storage area, such as during ice dispensing. The latter of the two events is more preferable and more likely to occur due to the relatively cold temperature within the housing 45.

[0054] The second end portion 68 of the rod 56 includes a counterweight 88 for balancing the weight of the interrupting vane 70. More specifically, the sensor element 70 and the counterweight 88 have generally equal weights to prevent the end portions 66, 68 of the rod 56 from being urged out of the saddles 60. Additionally, the counterweight 88 may be designed to rotationally counter the weight of the interrupting vane 70 to urge the contact plate 54 into the neutral position 57 (Figure 2). For example, the cantilevered nature of the counterweight 88 creates a rotational torque on the rod 56, the contact plate 54, and the interrupting vane 70 to urge the contact plate 54 into the neutral position 57. More specifically,

as shown in Figure 4a, when the contact plate is in the first position 80, the counterweight is in a first position 92 and urges the contact plate 54 into the neutral position 57. Similarly, as shown in Figure 4b, when the contact plate 54 is in the second position 84, the counterweight is in a second position 94 and also urges the contact plate 54 into the neutral position 57.

[0055] Although unnecessary, a trough 96 is preferably formed in the housing 45. This matches the trough in the sensor device 72 on the opposing side of the housing 45 through which the interrupting vane swings, to simplify tooling of the manufacturing machines. In this manner the same part can be molded for both sides, although magnets and sensors are added only to the sensor element 72.

[0056] The ice sensing apparatus 18 may alternatively be an electronic apparatus, such as an optical sensor, an infrared sensor, or any other suitable device. As another alternative design, an alternative sensor element may be coupled with the above-described, mechanically actuated ice sensing apparatus 18, such as an optical sensor element to determine the position of a mechanically actuated plate. In yet another alternative design, the ice sensing apparatus 18 includes a single pair of sensor components, such as a single magnet 74 and a single sensor element 76 that detect the position of the interrupting vane 70. In this design, the ice sensing apparatus 18 may not be able to determine the extent of rotation of the interrupting vane 70, but it may determine the duration that the interrupting vane 70 is held in the rotated state. The duration of the plate displacement is particularly useful because the plate displacement caused by the migration 79 of the ice pieces 38 typically occurs for a shorter duration than the plate displacement caused by the build-up 83 of the ice pieces 38. Therefore, the controller 78 can typically determine which condition (normal ice migration 79 or ice build up 83) is occurring based on the duration of the plate displacement.

[0057] The water reservoir 26 includes a first mechanism for controlling the water level in the water reservoir 26 and a second mechanism for deactivating the ice forming apparatus 12 if the water level is below a predetermined threshold. For example, as shown in Figures 6-8, the water reservoir 26 includes a float valve 100 configured to control a volume flow of water into the water reservoir 26 and a water level sensor 102 configured to detect a water level within the water reservoir 26.

[0058] The float valve 100 is a mechanically-actuated float valve having a floating element 104, a valve 106, and an attachment arm 108 extending therebetween. When the floating element 104 is positioned at or above a predetermined height within the water reservoir 26, the arm 108 causes the valve 106 to be in a closed position (as shown by the floating element 104 drawn in the phantom line in Figure 7). If the floating element moves below the predetermined height, the arm 108 causes the valve 106 to move into an open position, thereby permitting water to flow into the water reservoir 26.

[0059] The water level sensor 102 is electrically connected to the controller 78 to deactivate the ice forming apparatus 12 if the water level in the water reservoir 26 drops below a predetermined level. The water level sensor 102 includes a floating element 110 having a magnet coupled thereto and a guide arm 112 connecting the floating element to a reed switch 114. The reed switch 114 detects the position of the magnet on the floating element 110 to determine a threshold water level within the reservoir 26. The water level sensor 102 is configured to open an electrical circuit, indicating to the controller 78 that the water level has dropped below a predetermined level (as shown by the floating element 110 drawn in the solid line in Figure 7). However, if the water level is above the predetermined level (as shown by the floating element 110 drawn in the phantom line in Figure 7), then the water level sensor will close the electrical circuit. When the electrical circuit is open, the controller 78 preferably waits 20 seconds before shutting down, as is discussed in more detail below.

[0060] If the water level in the water reservoir 26 is undesirably low, or if the water reservoir 26 is empty, the ice making chamber 26 may not receive a sufficient amount of water to make ice. Additionally, the lack of water in the ice making chamber 20 may cause the chamber temperature to drop to an undesirable level; thereby causing damage to the ice forming apparatus 12. For example, if no water is present in the ice making chamber 20, the temperature therein will become too cold and the walls of the ice making chamber 20 may be permanently deformed; thereby preventing an effective scraping contact between the auger 30 and the walls of the ice making chamber 20 and potentially damaging the auger 30.

[0061] The water reservoir 26 also includes an overflow tube 116 that diverts water if the reservoir 26 is overflowing. More particularly, the overflow tube 116 includes a stand-up portion 116a that extends into the water reservoir 26 by a predetermined distance. The predetermined distance is preferably greater than the normal operational water level in the water reservoir 26, such that when the float valve 100 is functioning properly the water level is below the top of the stand-up portion 116a of the overflow tube 116.

[0062] Furthermore, the water reservoir 26 includes a drainage tube 118 for drain water from the water reservoir 26 when desired. For example, when performing maintenance on and cleaning of the ice making machine 10, it may be desirable to drain the water from the system. During normal operation of the ice making machine 10, a water dump solenoid valve (not shown) closes the drainage tube 118 to maintain the desired water level within the water reservoir 26.

[0063] Referring to Figure 5a, a method 120 of controlling an ice making machine will now be discussed. During an initial start-up operation 122, the ice making machine 10 is activated and a start-up operation timer located in the controller 78 resets and restarts in step 124. Next, in step 126, the controller 78 inputs signals from the first sensor element 76a

to determine whether the interrupting vane 70 has been displaced forward into the first position 57. In other words, the controller 78 is determining whether ice pieces 38 are being produced by the ice forming apparatus 12. If no ice is formed for a start-up time period of eight minutes, during step 127, then the ice making machine 10 is deactivated and switched into a safety shutdown mode in step 128, as will be discussed in further detail below. During the start-up time period, if

an error has occurred with the formation of ice, the ice forming apparatus 12 typically does not undergo serious damage to the auger 30 or the auger motor during the first eight minutes of operating under this failure condition. More specifically, upon start-up, the temperature in the ice forming apparatus 12 is typically warm enough such that water in the ice making chamber 20 will likely not freeze into a solid block during the first eight minutes after start-up. Therefore, the eight minute time period is typically a safe start-up time period. However, in other configurations the start-up time period may be varied.

[0064] However, if no water is present in the ice making chamber 20 during start-up, the eight minute start-up time period may be long enough to freeze the walls of the ice making chamber 20; thereby causing deformation of the walls. Therefore, if the water reservoir has an undesirably low level, the controller 78 will preferably shut-down the ice making machine 10. For example, as mentioned above, once the controller 78 is signaled that the water level is below a predetermined level, the controller 78 will wait 20 seconds before switching into safety shutdown mode. However, if the water level rises to or above the predetermined level during the 20 seconds, the controller 78 will resume normal operation.

[0065] Once the first sensor element 76a indicates the production of ice, the ice making machine 10 enters a normal mode of operation in step 129 and resets and restarts the normal operation timer in step 130. During the normal mode of operation 129, the controller 78 continues to input signals from the first sensor element 76a to determine whether the interrupting vane 70 has been displaced forward into the first position 57 in step 132. If no ice is formed for a predetermined time period, then the ice making machine 10 is deactivated and switched into a safety shutdown mode in step 128, as will be discussed in further detail below. The term "predetermined time period" refers to a time period that is determined anytime before the predetermined time period begins. For example, the predetermined time period may be a fixed time period that is programmed into the controller. As another example, the predetermined time period may be a variable time period that is calculated by the controller.

[0066] The predetermined time period in the embodiment shown in Figure 5a is a variable activity window time period that is calculated by the controller based on recent ice activity. If no ice is detected during the variable activity time period, during step 131, then the ice making machine 10 is deactivated and switched into a safety shutdown mode in step 128. For example, the variable activity window time period is period of time ranging from a minimum of 90 seconds up to a maximum of 135 seconds that varies based on recent ice making activity. More specifically, if the previous X number of ice pieces have been detected at relatively long time intervals, such as 80 seconds between the respective displacements of the contact plate 54, then the activity window will likewise be relatively high (where the variable "x" is a set number programmed into the controller). However, if the previous X number of ice pieces have been detected at relatively short time intervals, such as 20 seconds between the respective displacements of the contact plate 54, then the activity window will likewise be equal to 90 seconds.

[0067] If ice is formed during the normal operation time period, then the controller inputs signals from the second sensor element 76b to determine whether the interrupting vane 70 has been displaced into the second position 84 in step 134. In other words, the controller inputs signals to determine whether a build-up of ice pieces 38 has occurred. If the build-up has occurred, then the ice making machine 10 is deactivated and switched into a full bin mode in step 129, as will be discussed in further detail below. If no build-up has occurred, then the normal operation timer will be reset and restarted. Therefore, during the normal operation of the ice making machine 10, the ice forming apparatus 12 will be active until no migrating ice piece 38 is able to displace the contact plate 54 for a time period equal to the activity window or until the build-up 83 of ice pieces 38 occurs.

[0068] Although the flowchart in Figure 5a shows step 134 occurring only after step 132 occurs, in an alternative embodiment the controller immediately switches the system into the safety shutdown step 129 as soon as the electro-magnetic field associated with the second sensor element 76b is open, regardless of the timing of the disruption with respect to the ice making operation.

[0069] Referring to Figure 5b, the safety shutdown mode 128 will now be discussed. Generally, upon a system failure, the controller 78 will deactivate the ice making machine 10. The controller 78 will then repeatedly attempt to restart the ice making machine 10 until the expiration of a primary time period. The primary time period permits the controller 78 to attempt a limited number of restarts so that the system is able to overcome naturally solvable problems, such as a low evaporator start-up temperature, but is not permitted to perpetually attempt to overcome problems that require maintenance or other intervention, such as a failed or an undesirably low water supply.

[0070] After a system failure, the ice making machine waits for a secondary time period before attempting to restart the ice making machine 10. This secondary time period will provide the ice making machine 10 with any time necessary to overcome the above-mentioned naturally solvable problems.

[0071] As shown in Figure 5b, in step 136 the controller 78 determines whether a restart indicator signal is equal to yes. If the restart indicator signal is equal to yes, then the ice making machine 10 has been restarted recently and the primary timer should continue to run rather than being reset and restarted in step 137. In other words, if the restart

indicator is equal to yes, then the primary timer should continue to run without being reset. However, if the restart indicator is equal to no, then the ice making machine 10 has not experienced a failure recently and the primary timer should be reset and restarted.

[0072] Next, in step 138, a secondary timer resets and restarts regardless of whether the ice making machine 10 has been restarted recently. As mentioned above, the secondary timer calculates an appropriate waiting period before attempting to restart. More specifically, during step 140, a secondary time period is randomly determined. For example, a predetermined base waiting period (such as eight minutes) is added to a random time period (such as any integer between 0 and 52 minutes) to determine the secondary time period. Once the secondary time period is calculated, during step 142, the controller will continuously determine whether the secondary time period has expired.

[0073] The random secondary time period may be advantageous to improve the efficiency of the ice making machine 10 by having less "down time" due to system errors. Many system failures may be self-correcting with the deactivation of the ice making machine 10. For example, if the ice in the ice making chamber 20 becomes too thick and prevents rotation of the auger 30, the ice will melt during a certain period of deactivation. However, it is often impossible for the controller to predict the required duration of this period of deactivation; thereby leading to the possible scenarios where the deactivation period is too short and the ice will fail to sufficiently melt and where the deactivation period is too long and the ice making machine 10 is unnecessarily sitting idle. Therefore, the random secondary time period results in a series of varied deactivation periods over a series of shutdowns, possibly resulting in an ideal deactivation period.

[0074] Once the secondary time period has expired, during step 144, the controller determines whether the primary timer has been running for a threshold amount of time, such as 300 minutes. As mentioned above, if the primary timer has been running for the threshold amount of time, the ice making machine 10 will shutdown completely in step 146 and cease automatic restarting attempts until the system is manually restarted by a technician. However, if the primary timer has not been running for the threshold amount of time, then the system will set the restart indicator equal to yes in step 148 and restart the system in step 150, thereby returning to step 122 in Figure 5a. When the primary timer has expired and the ice making machine 10 enters shutdown mode 146, the restart indicator is automatically set equal to "NO" in step 145 so that the ice making machine 10 will not register a recent restart event after the system is manually restarted.

[0075] The ice making machine 10 is further capable of operating in various control modes. Generally, in a preferred design, the modes are as follows: startup mode, normal ice mode, clean mode, safety shutdown mode, bin full mode, and off mode.

[0076] Generally speaking, the startup mode is the mode when power is applied or reapplied, commonly referred to as P.O.R. If a bypass switch is not depressed during this state, then a five minute delay is enforced prior to moving to the next state. The purpose of the five minute delay is to protect the auger drive gear system 35 and the compressor 11. For example, if the water in the ice making chamber 20 happened to have been frozen to a point that the auger drive gear system 35 would be damaged, this time period will allow the ice to melt. Also, if the ice making machine 10 was running when power was interrupted, the evaporator and the refrigerant stored therewithin may still be cold upon reapplication of power. If the relatively cold refrigerant is allowed to enter the compressor 11, the compressor 11 may be damaged. Therefore, the five minute time delay allows the evaporator to warm up naturally and allows the liquid refrigerant to change into a gas state before entering the compressor 11.

[0077] During startup mode of the ice making machine, startup mode occurs if a toggle switch is in the "Ice" (on) position and the sensor elements 76a, 76b are both closed. The toggle switch is a manually operated switch that allows the end user to switch the ice making machine 10 between different modes (ice making mode, off mode, and clean mode). The control verifies the water-sensing switch is closed, after which the gear motor starts immediately. After a five second delay the compressor and fan motor start.

[0078] If the unit is in a restart situation, where the unit stopped due to an open second sensor element 76b, a five-minute time period must be timed out prior to starting. After the five-minute time period, if the control verifies that the following conditions are present then the gear motor starts immediately: the first sensor element 76a is closed, the off time is less than 30 minutes, and the water-sensing switch is closed. After a five second delay the compressor and fan motor start. The water dump solenoid is energized for 30 seconds and then de-energized, thereby opening and closing the drainage tube 118 to flush the water reservoir 26 and provide fresh ice making water. After the water sensing switch recloses, the compressor and fan motor start.

[0079] For both a nugget ice machine and a flaked ice machine, during a power interruption restart (if the unit stops due to a power interruption), upon restoration of power the unit will have a five-minute time delay before the startup sequence is initiated. During the time delay, a signal, such as a bank of LEDs, will flash. The time delay will be bypassed if the bypass switch is pressed. The control board may have seven LED's, which function as follows:

LED #1: NUGGET - Color RED, will indicate the control is configured for nugget ice machines when illuminated.

LED #2: FLAKER - Color RED, will indicate the control is configured for flaked ice machines when illuminated.

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LED #3: HES#1 - Color GREEN, will work in conjunction with Hall Effect Switch #1.

LED #4: HES#2 - Color GREEN, will work in conjunction with Hall Effect Switch #2.

5 **LED #5:** CLEAN - Color YELLOW, will indicate the unit is in a clean sequence when illuminated.

LED #6: MAINT - Color RED, will indicate that maintenance is required. This LED is only used when the control is configured for a nugget ice application.

10 **LED #7:** WATER OK - Color GREEN, will work in conjunction with the water-sensing switch, when the switch is closed, (adequate water to operate), the light on, when the switch is open the light is off.

15 **[0080]** During normal operation mode, as described above, the ice discharged from the evaporator will intermittently contact the ice contact plate 54 as it falls into the bin. The control will see intermittent opening and re-closing of the first sensor element 76a: this is used to determine that the unit is functioning normally. During the first eight minutes of operation, the control must see at least one opening and re-closing of the first sensor element 76a. After the first eight minutes of operation the control must see at least one opening and re-closing of the first sensor element 76a during the activity window. If the control fails to see this opening and re-closing of the first sensor element 76a, the unit goes into a safety shutdown mode as described below. If at any time during normal operation the water sensor switch stays open for 20 continuous seconds, the unit goes to a safety shutdown mode as described below, and a "WATER OK" LED will flash.

20 **[0081]** At any point in the operation, if the second sensor element 76b is open, the unit goes into the full bin mode. In the shutdown mode, the compressor / fan motor and the gear motor are de-energized immediately. Once the unit stops, it must remain off for five minutes before it is allowed to restart as described above. During the shutdown period, the LED associated with HES#2 will flash indicating a full bin condition if the second sensor element 76b is active.

25 **[0082]** In order to determine when the system is to be cleaned, a timer monitors and tracks the time (in hours) between clean or flushing activities. On power up, this timer is set to zero. After each hour of operation, the timer is incremented. The exception is that during the "random timeout" as described in the SAFETY SHUTDOWN MODE, the timer IS NOT incremented. The cleaning sequence listed below can be initiated if the Ice (on)-Off-Clean toggle switch is placed in the "Clean" position. A clean sequence can also be initiated automatically. When the Clean Timer reaches 50 hours, the unit will stop making ice and go through a clean sequence as described below, and goes back to ice making. The Clean Timer is reset to zero. If a clean cycle is manually initiated by the toggle switch, the Clean Timer is also reset to zero.

30 **[0083]** During the clean mode, the yellow LED, CLEAN, on the control board is illuminated. The water sensor switch will open and close during a clean sequence; this is normal and should be ignored by the control. The time periods and component operation during a clean cycle are provided by Table 1.

Table 1

Time (Minutes)	Evaporator Gear Motor	Water Dump Solenoid	Refrigeration Compressor	Comments
0.00 - 0.75	Off	On	Off	Dump
0.76 - 10.00	On*	Off	Off	Wash (add cleaner)
10.01 - 10.75	On	On	Off	Dump
10.76 - 12.75	On	Off	Off	Rinse
12.76 - 13.50	On	Off	Off	Dump
13.51 - 15.50	On	Off	Off	Rinse
15.51 - 16.25	On	On	Off	Dump
16.26 - 18.25	On	Off	Off	Rinse
18.26 - 19.00	On	On	Off	Dump
19.01 - 21.00	On	Off	Off	Rinse
*Gear motor will not turn on until the water level switch is closed.				

55 **[0084]** If the toggle switch is switched from "Clean" to "Off" or "Ice" (on) prior to the completion of the initial 0.75-minute dump cycle, the "Clean" sequence will abort. After the initial 0.75-minute dump cycle, if the toggle switch is turned to

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the "Off" position, the unit stops, and when the switch is turned to another position, the unit will resume and completes the clean sequence. If the unit is turned back to the "Clean" position, the unit stops after the sequence is complete. After the initial 0.75-minute dump cycle, if the toggle switch is turned to the "On" position, the unit completes the cleaning sequence and goes to a startup sequence and starts making ice. If the toggle switch is turned to "Off" within the first 15

[0085] The unit ice making machine 10 goes into a safety shutdown mode if any of the following occur:

A. The water sensor switch is open for 20 continuous seconds or more while the unit is in the normal operating sequence mode:

1. If the control senses open water-sensing switch for more than 20 seconds during a normal freezes cycle, the unit goes into a safety shutdown mode.
2. In the shutdown mode, the compressor / fan motor and the gear motor are de-energized immediately.
3. It must remain off for five minutes no matter the position of water sensing switch.
4. During the five-minute shutdown period, the LED for WATER OK flashes.
5. After the 5-minute shutdown period and the water-sensing switch is closed, the control initiates startup sequence as outlined in the sequence of operation.

Or

B. The Hall-Effect Switch (HES)#1 fails to open and re-close at least once during the first eight minutes of operation after start-up or re-start.

Or

C. The HES#1 fails to open and re-close at least once during any *activity window*, after the initial eight minute startup period, when the unit is in a normal operating mode:

1. The unit goes into a safety shutdown mode.
2. In the shutdown mode, the compressor / fan motor and the gear motor are de-energized immediately.
3. The control times out for a period of $\{8 + \text{random}[0, 52]\}$ minutes then tries the restart sequence. In other words, the time out period is equal to 8 minutes plus a random number between 0 and 52 minutes.
4. During the timeout period the LED for HES#1 flashes if it is active; else, it will not illuminate.
5. During the restart sequence, the dump valve is energized for 30 seconds, the evaporator gear motor is energized, and the control waits for the water-sensing switch to be closed before energizing the compressor and fan motor contactor.
6. If safety condition is still detected, the control generates another random timeout period then tries the restart sequence again.
7. These random restarts will occur until one of the following:

- a. a total of 300 minutes from the first safety shutdown has elapsed and no successful restart has been achieved. At that time the unit will turn off and will require manual intervention to restart.
- b. Within the 300 minutes a successful restart (10 minutes of normal ice-making) is registered. With this event, the elapsed clock is reset to zero.

8. When the unit turns off due to 7a, the LED for HES#1 flashes until the toggle switch is toggled to "Off" and back to "Ice" (on).

9. If the control is reset in this manner, the board will flash the problem related LED's if the switch is turned to the "Off" position at anytime during the first 48 hours after the reset occurred, after which time the reset is erased from the memory.

[0086] During bin full mode, when the ice chute is full and the bin can not accept any more ice, the second sensor element 76b opens and the unit shuts down immediately. After a 5 minute time delay, the unit checks for "full bin" status prior to progressing to the "Restart" mode.

[0087] During the off mode, the unit is idle. This mode is entered when the ice-off-clean selector switch is in the "Off" position.

[0088] In another embodiment of the present invention, the ice storage area is a device for dispensing ice, such as a medical dispenser, which is able to be used in sanitary applications, such as medical applications in hospitals or the like. More specifically, the medical dispenser is positioned below the ice making machine 10 and is generally sealed from the atmosphere to prevent contamination of the ice located within. The medical dispenser includes an inlet connected to the storage bin inlet tube 53 to receive ice pieces 38 from the ice making machine 10. The ice pieces are then stored

within a body portion of the medical dispenser, which is preferably a one-piece component made of food grade plastic.

[0089] Additionally, the medical dispenser includes an outlet formed in the body and a dispensing device coupled with the outlet to automatically dispense ice when indicated by a user. For example, the dispensing device may include a sensor for detecting the presence of a user's drinking cup (or any other container utilized by the user) or an actuating arm that is to be actuated by the user's drinking cup. The sensor or the actuating arm will then send a signal (mechanical or electrical) to an agitator located within the body of the medical dispenser. The agitator then rotates and forces ice pieces out of the dispensing device and into the user's drinking cup. The dispensing device may also include a pivoting door that prevents ice from exiting the body of the medical dispenser until indicated by a user. Any other suitable ice storage and/or ice dispensing device may be used with the present invention. The dispensing device may also include a blue LED light to indicate that the ice making machine 10 is on and to illuminate the front of the medical dispenser unit for a user.

[0090] Referring back to Figure 10, the auger 30 and the casing 24 of the ice forming apparatus 12 will now be discussed in more detail. A water seal 160, a C-clip 162, a bearing bush 164 and the upper bearing 43 are received by an upper shaft portion 172 of the auger 30 and are positioned above the ice cutting head 37 to form a watertight seal between the auger upper shaft portion 172 and the ice cutting head 37 while permitting relative movement between the respective components 30, 37. Similarly, the lower bearing 43, a bearing bush 166, a C-clip 168, and a shaft seal 170 are received by an upper shaft portion 172 of the auger 30 and are positioned below the ice cutting head 37 to form a second seal and permit relative movement between the respective components 30, 37. Additionally, a run-on ring 174 and an O-ring 176 are received by a lower shaft portion 178 of the auger 30 to form a watertight seal between the auger 30 and the casing 24 and to prevent water from leaking into the auger motor 33. The auger lower shaft portion 178 also includes a key slot 182 that receives a feather key 180 to be coupled with the auger motor 33. For example, the lower shaft portion 178 is received within a rotatable sleeve (not shown) of the auger motor 33 and the feather key 180 is received within a slot in the sleeve to rotate the auger 30 when the auger motor 33 is activated.

[0091] The above components are received within the casing 24 and are further secured therewith by a water seal 184, a C-clip 186, a roller bearing 188, a shim ring 190, and a second C-clip 192. More specifically, the water seal 184 cooperates with the run-on ring 174 to form the lower seal between the auger 30 and the casing 24. Additionally, the roller bearing 188 permits relative movement between the auger 30 and the casing 24 during rotation of the motor sleeve. Additionally, a plurality of screws 194 are received within openings 195 in the casing and secured to the ice cutting head 37 via threaded openings 196 to prevent rotation of the ice cutting head 37 with respect to the casing 24.

[0092] The ice making chamber 20 is preferably manufactured by Ziegler, which is located in Isernhagen, Germany, and is commercially available as model numbers ZNE125, ZNE200, ZNE300, ZNE400, ZNE500, ZNE1000, ZNE200FE, ZNE300FE, ZNE400FE, ZNE500FE, and ZNE1000FE, where the number in each model number indicates the capacity of the ice making chamber 20 in kilograms per hour and the designation "FE" indicates that flaked ice is made (no designation means that nugget ice is made). The auger drive gear system 35 is preferably a gear system that prevents the auger motor 33 from undesirably operating in the reverse direction due to loads present on the auger 30 during system startup. The water level sensor 102 is preferably a Gems type LS-3 water level sensor manufactured by Gems Sensors, which is located in Plainville, Connecticut.

[0093] The above described embodiment provides a low cost, simple design and method for detecting the migration of the ice pieces through the transfer zone and for detecting the build-up of the ice pieces in the transfer zone. Furthermore, the above described embodiment provides an improved ice sensing apparatus by substantially separating a portion of the apparatus from the clean zone and the naturally-occurring moisture located therein.

[0094] While the invention has been described in connection with an auger-type ice machine, it can also be used with other types of machines, such as cube-type machines, nugget-type machines, or medical dispenser machines.

[0095] It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, that are intended to define the spirit and scope of this invention.

Claims

1. An ice making machine, comprising:

- a) an ice forming apparatus capable of forming ice pieces;
- b) a transfer zone connecting the ice forming apparatus with a storage area so as to permit migration of ice pieces from the ice forming apparatus to the storage area; and
- c) an ice sensing apparatus configured to detect at least some of the ice pieces during the migration of the ice pieces through the transfer zone.

2. The ice making machine of claim 1 wherein the transfer zone is located with respect to the storage area so that a build-up of ice pieces occurs in the transfer zone when the storage area is full.
3. The ice making machine of claim 2 wherein the ice sensing apparatus is configured to detect at least some of the ice pieces during the build-up of the ice pieces in the transfer zone.
4. The ice making machine of claim 3 wherein the ice sensing apparatus includes a movable portion having a first position corresponding to the migration of the ice pieces and a second position corresponding to the build-up of the ice pieces in the transfer zone.
5. The ice making machine of claim 4 wherein the ice sensing apparatus includes a first sensor to detect the first position of the movable portion and a second sensor to detect the second position of the movable portion.
6. The ice making machine of claim 4 wherein the movable portion comprises a contact plate positioned along a path of the migration of the ice pieces in the transfer zone.
7. The ice making machine of claim 6 wherein the ice sensing apparatus further includes a rod coupled with the contact plate and a signal member coupled with the rod, and wherein the contact plate and the signal member are configured to pivot in unison between a neutral position, said first position, and said second position.
8. The ice making machine of any one of claims 3 to 7 further comprising a controller in electrical connection with the ice sensing apparatus and the ice forming apparatus, wherein the controller is configured to deactivate the ice forming apparatus if the ice sensing apparatus fails to detect the migration of the ice pieces through the transfer zone during a predetermined time period.
9. The ice making machine of claim 8 wherein the predetermined time period is equal to a first duration during an initial start-up operation of the ice making machine and is equal to a second duration shorter than the first duration after the initial start-up operation of the ice making machine.
10. The ice making machine of claim 9 wherein the controller is configured to deactivate the ice forming apparatus if the build-up of the ice pieces in the transfer zone is detected.
11. The ice making machine of claim 10 wherein the controller is configured to immediately deactivate the ice forming apparatus if the build-up of the ice pieces in the transfer zone is detected.
12. A combination of the ice making machine of any one of claims 1 to 11 and an ice storage bin, the ice storage bin providing at least a portion of said storage area.
13. An ice making machine, comprising:
 - a) an ice forming apparatus having an outlet section and being configured to form ice pieces and;
 - b) a transfer zone connecting the outlet section of the ice forming apparatus with a storage area so as to permit migration of ice pieces from the ice forming apparatus to the storage area; the outlet section of the ice forming apparatus and the transfer zone together comprising a clean zone; and
 - c) an ice sensing apparatus configured to detect the presence of ice pieces within the transfer zone, wherein the ice sensing apparatus includes a first portion located within the clean zone and a second portion positioned outside the clean zone.
14. The ice making machine of claim 13 wherein the first portion of the ice sensing apparatus comprises a contact plate positioned along a path of the migration of the ice pieces through the transfer zone.
15. The ice making machine of claim 14 wherein the second portion of the ice sensing apparatus includes a signal member coupled with the contact plate such that the contact plate and the signal member are configured to pivot in unison between a first position and a second position.
16. The ice making machine of claim 15 wherein the ice sensing apparatus includes a sensor for sensing whether the signal member is in the first position.

17. The ice making machine of claim 16 wherein the sensor is substantially separated from moisture in the clean zone.
18. The ice making machine of any one of claims 1 to 11 and 13 to 17 wherein the ice forming apparatus includes an auger rotating about an axis within a cooling chamber.
19. The ice making machine of claim 13 wherein the ice sensing apparatus is configured to detect at least some of the ice pieces during the migration of the ice pieces through the transfer zone.
20. The ice making machine of claim 19 wherein the transfer zone is located with respect to the storage area so that a build-up of ice pieces occurs in the transfer zone when the storage area is full and wherein the ice sensing apparatus is configured to detect at least some of the ice pieces during the build-up of the ice pieces in the transfer zone.
21. The ice making machine of claim 20 wherein the first portion of the ice sensing apparatus is a contact portion located within the clean zone and the second portion of the ice sensing apparatus is a non-contact portion separated from the clean zone by a generally fluid-tight seal.
22. A method of controlling an ice making machine, comprising:
 - a) forming ice pieces with an ice forming apparatus;
 - b) permitting migration of the ice pieces from the ice forming apparatus through a transfer zone to a storage area;
 - c) detecting at least some of the ice pieces migrating through the transfer zone; and
 - d) deactivating the ice forming apparatus if no migrating ice pieces are detected within a predetermined time period.
23. The method of claim 22 further comprising calculating the predetermined time period based on a frequency at which the ice pieces are formed.
24. The method of any one of claims 22 to 23 wherein the step of forming ice pieces includes rotating an auger about an axis within a cooling chamber.
25. The method of any one of claims 22 to 24 wherein the predetermined time limit is equal to a first time during an initial start-up operation of the ice making machine and is equal to a second time shorter than the first time after the initial start-up operation of the ice making machine.
26. The method of any one of claims 22 to 25 further comprising, after the step of deactivating the ice forming apparatus, reactivating the ice forming apparatus after a delay time period.
27. The method of claim 26 wherein the step of reactivating the ice forming apparatus includes randomly selecting the delay time period from a database of potential delay time periods.
28. A combination of the ice making machine of any one of claims 1 to 11 and 13 to 21 and an ice dispenser configured to dispense at least a portion of the ice pieces formed by the ice forming apparatus.
29. An ice making machine, comprising:
 - a) an auger-type ice forming apparatus capable of forming ice pieces;
 - b) a transfer zone between the ice forming apparatus and a storage area, the transfer zone being configured to cause a build-up of ice pieces in the transfer zone when the storage area is full; and
 - c) an ice sensing apparatus configured to detect the migration of the ice pieces through the transfer zone.
30. An ice making machine, comprising:
 - a) an ice forming apparatus capable of forming ice pieces and having an outlet section;
 - b) a transfer zone between the ice forming apparatus outlet section and a storage area, the transfer zone being configured to cause a build-up of ice pieces in the transfer zone when the storage area is full; the outlet section of the ice forming apparatus and the transfer zone together comprising a clean zone; and
 - c) an ice sensing apparatus configured to detect migration of the ice pieces through the transfer zone and to detect the build-up of the ice pieces in the transfer zone, wherein the ice sensing apparatus includes a contact

portion located within the clean zone and a non-contact portion separated from the clean zone by a generally fluid-tight seal.

31. A method of controlling an ice making machine, comprising:

- a) forming ice pieces with an ice forming apparatus;
- b) promoting migration of the ice pieces from the ice forming apparatus through a transfer zone to a storage area;
- c) detecting the migration of the ice pieces through the transfer zone; and
- d) deactivating the ice forming apparatus if no ice is detected within a desired time period.

FIG.1

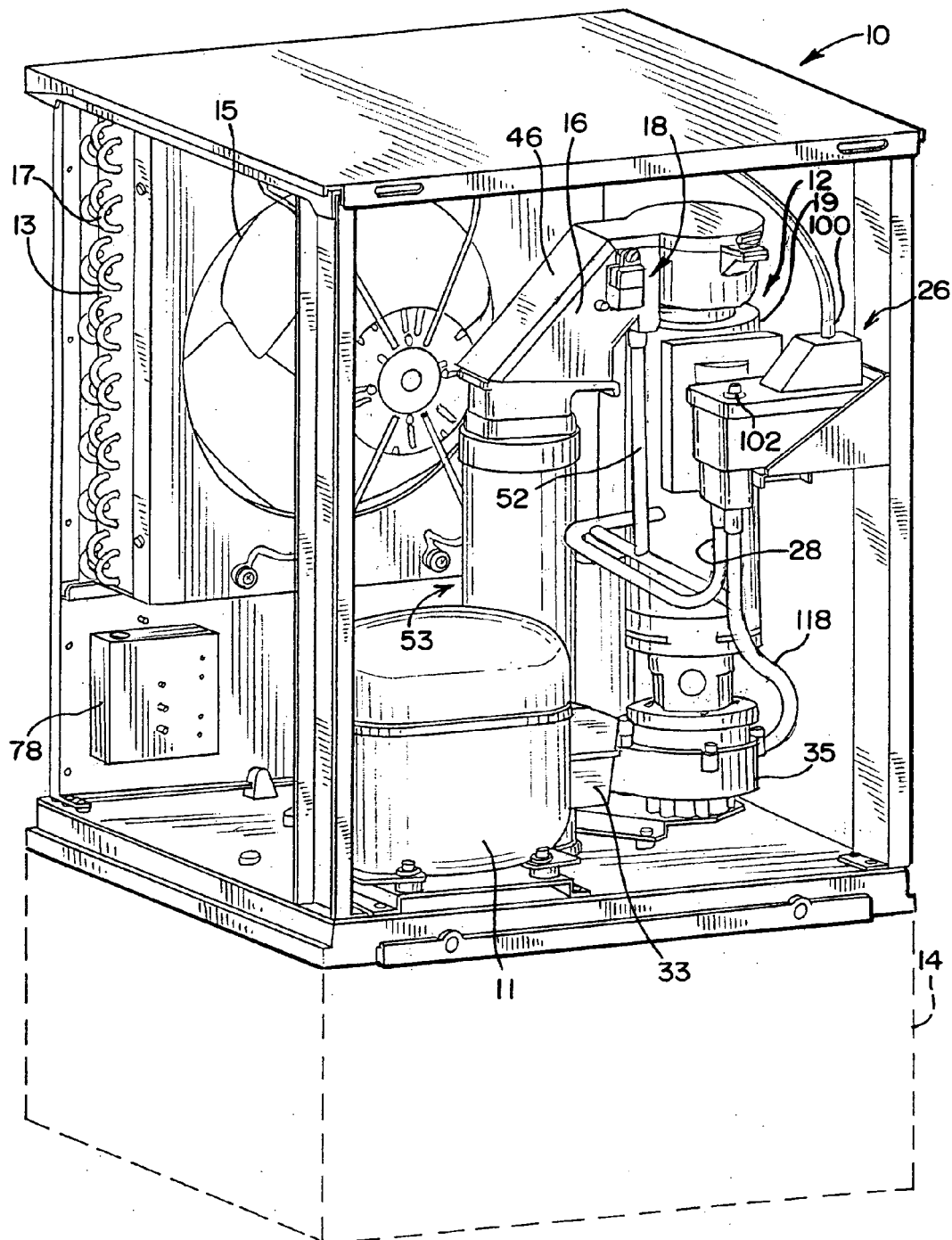


FIG. 2

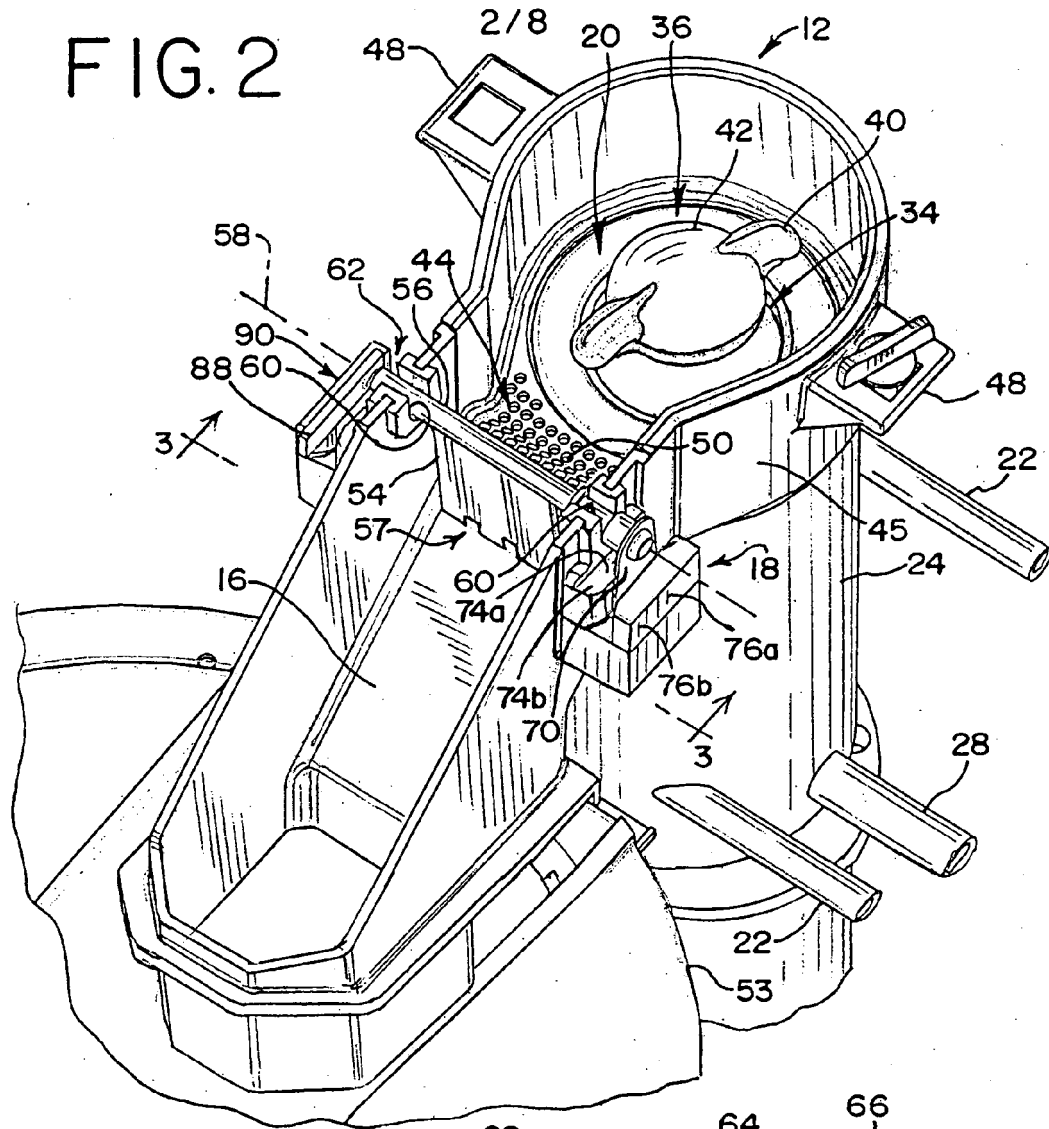


FIG. 3

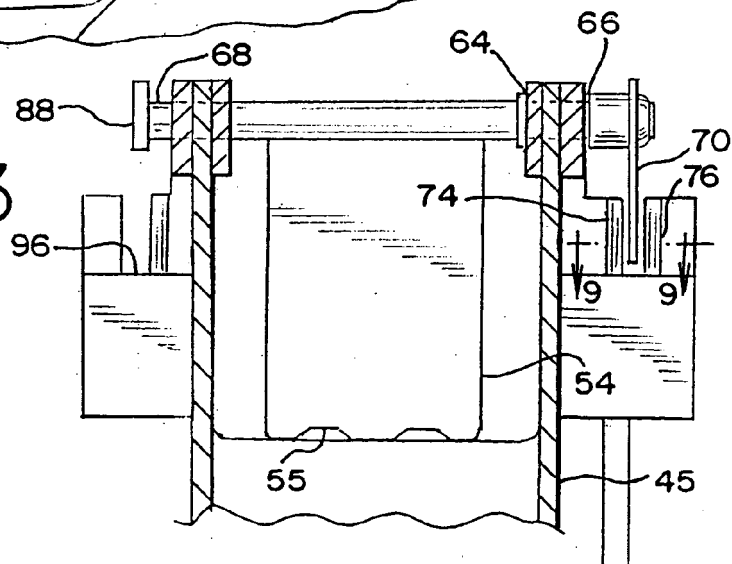


FIG.4a

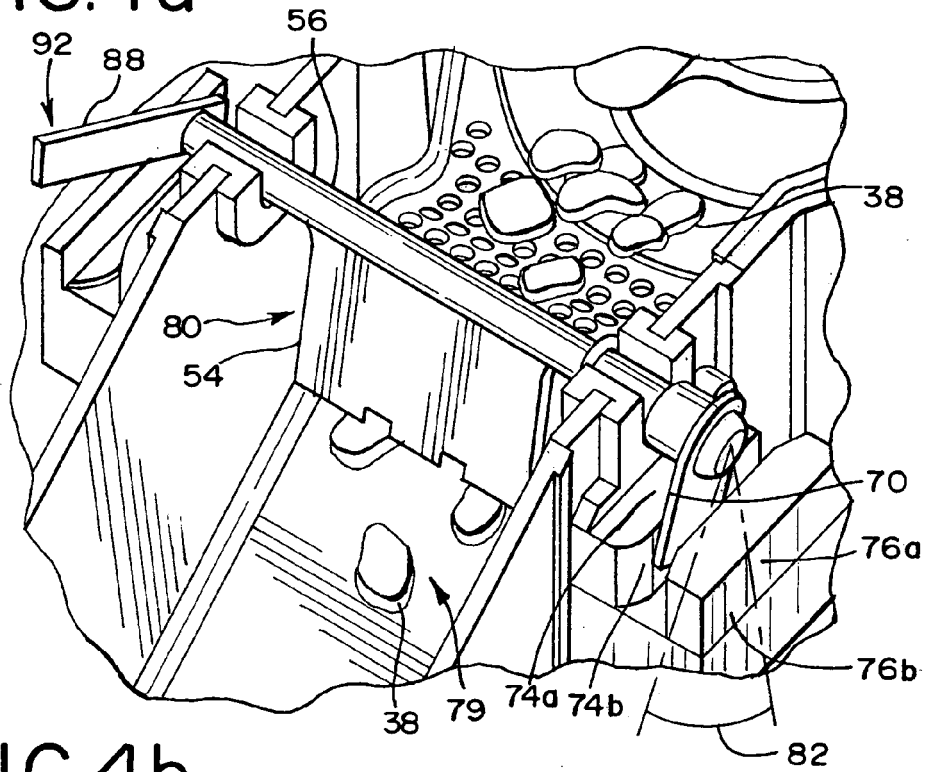


FIG.4b

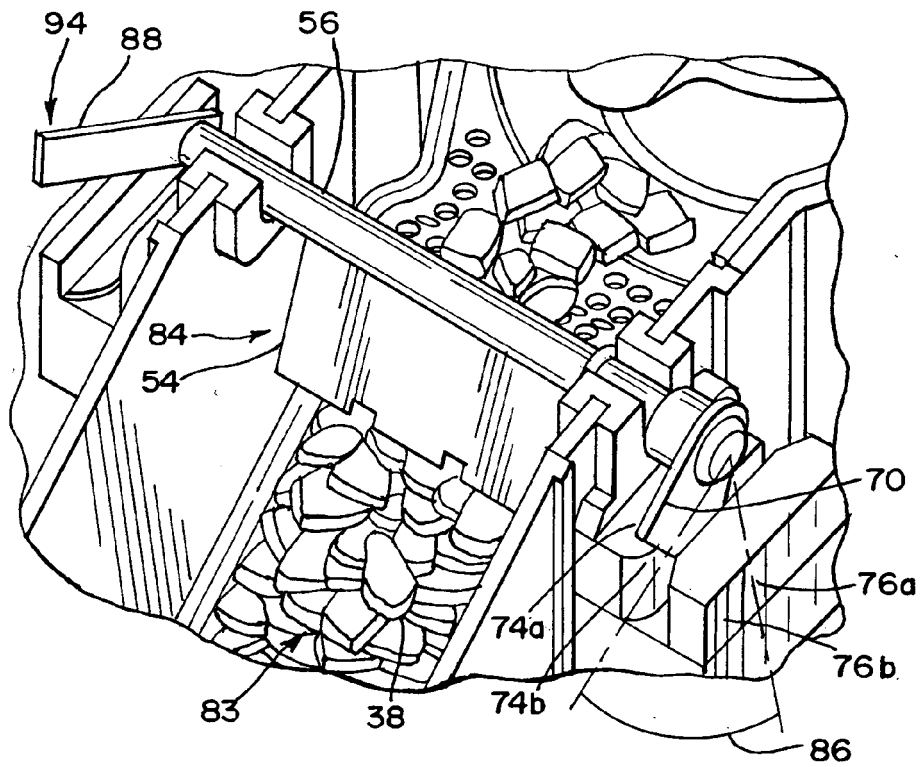


FIG. 5a

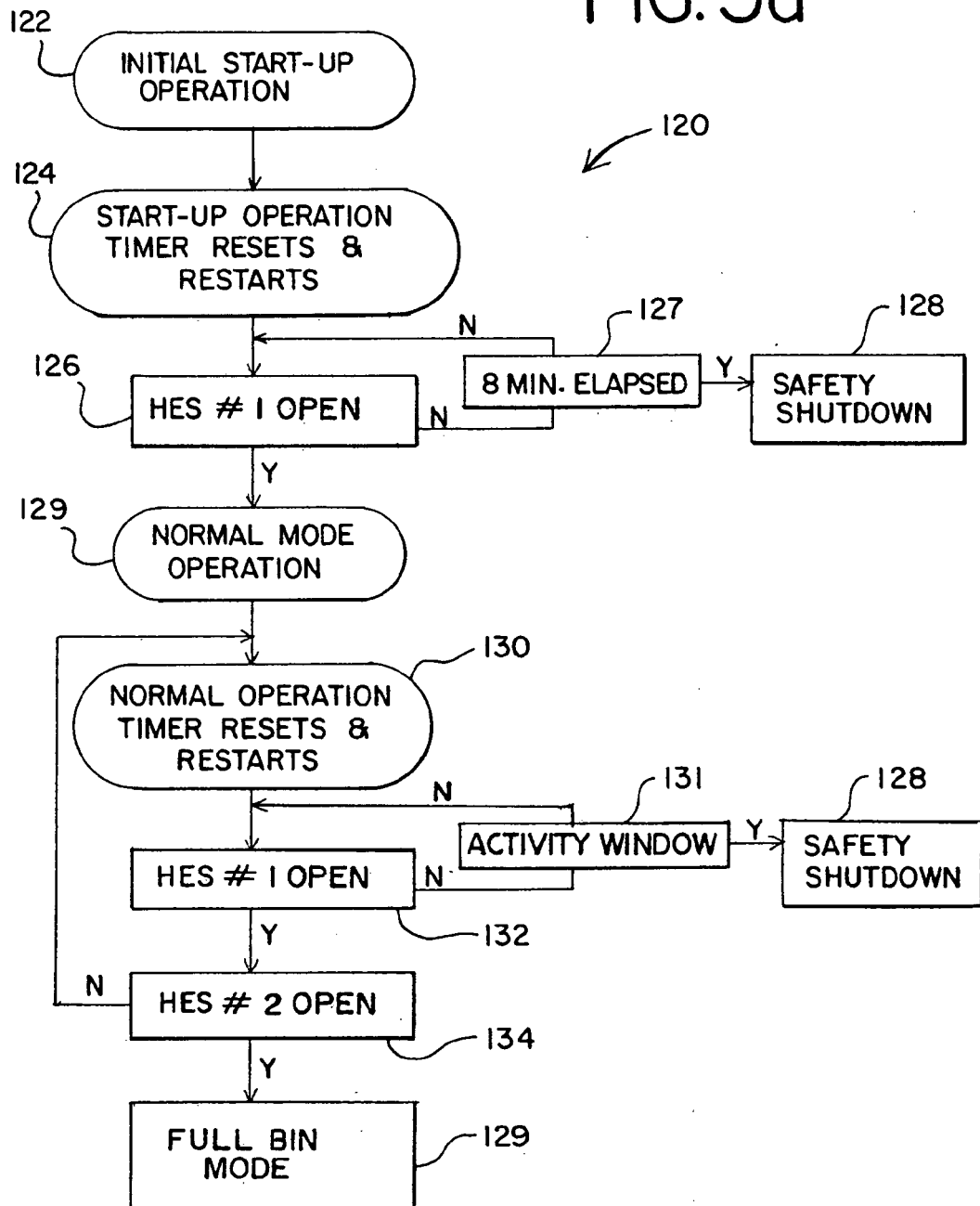


FIG. 5b

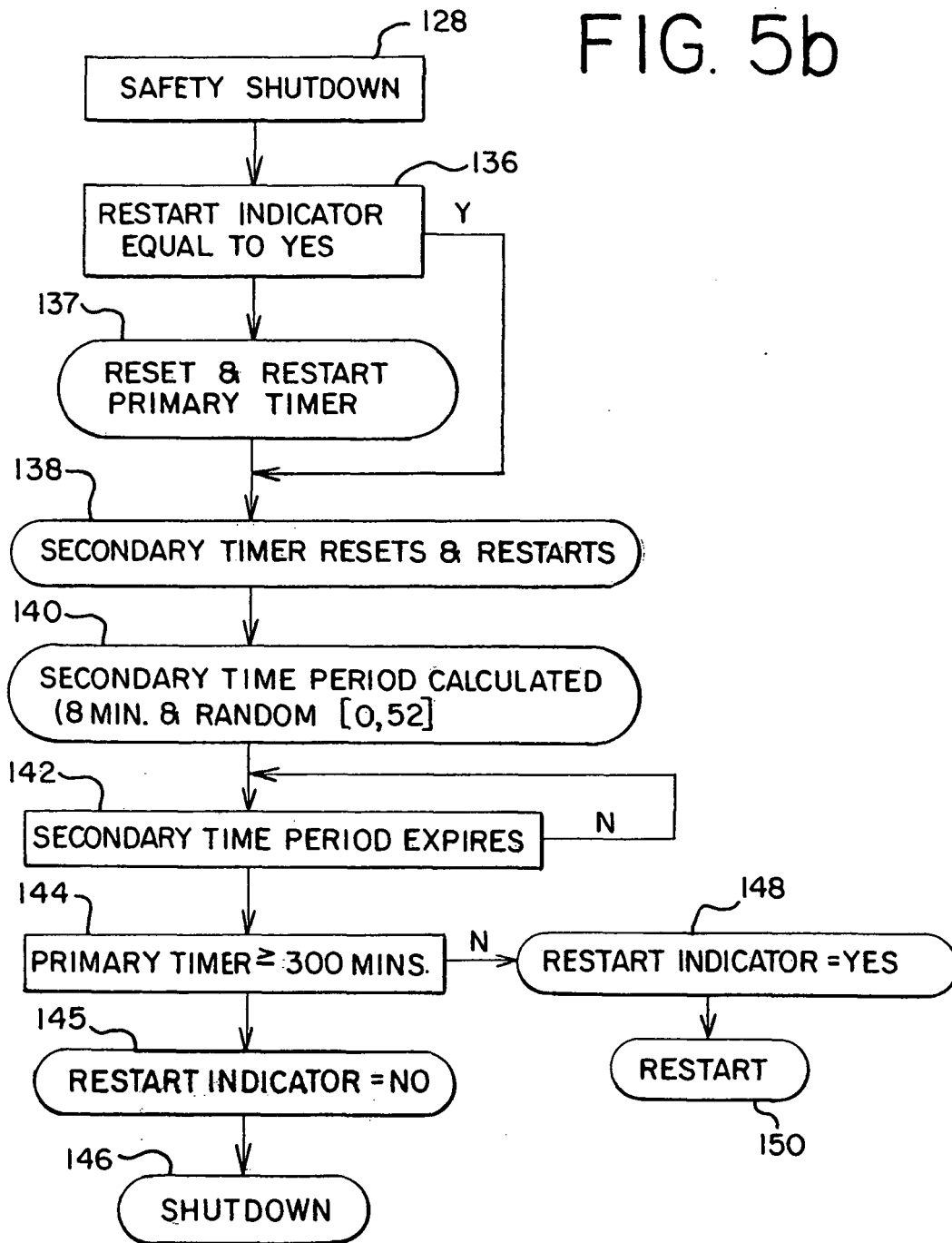


FIG.6

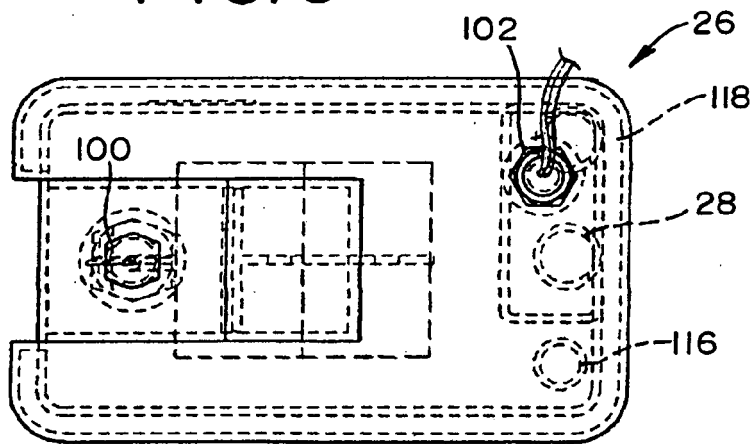


FIG.7

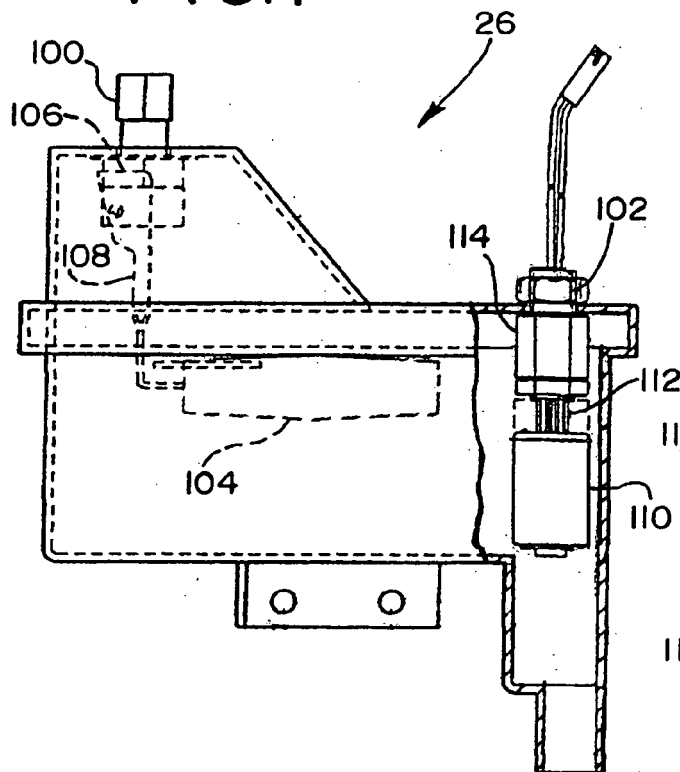


FIG.8

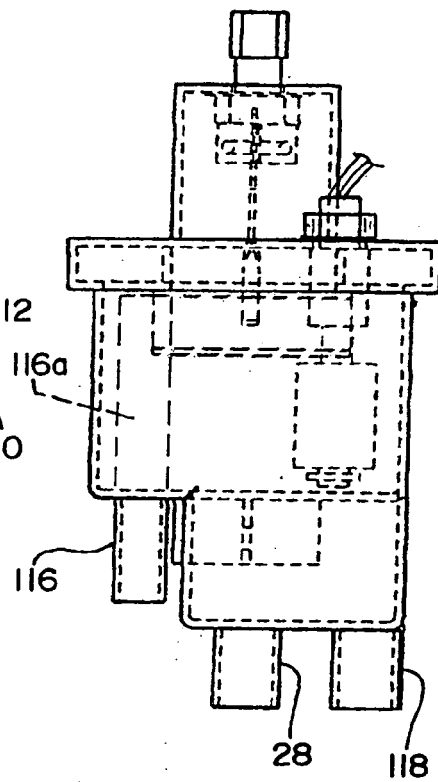


FIG.9

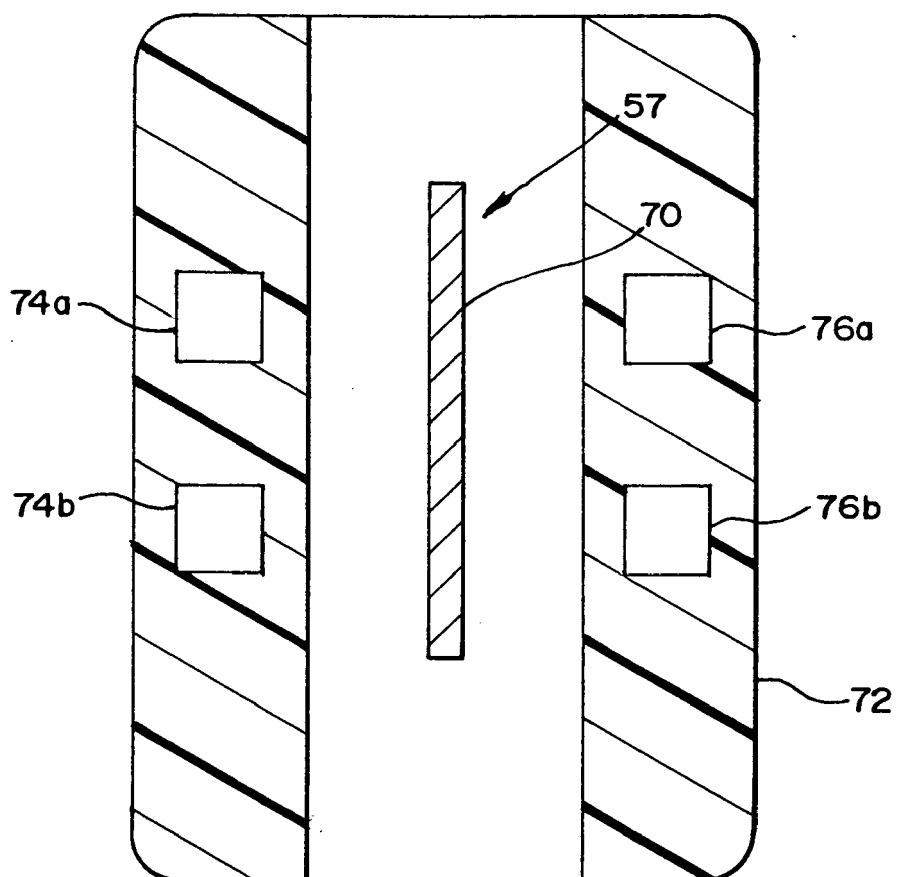
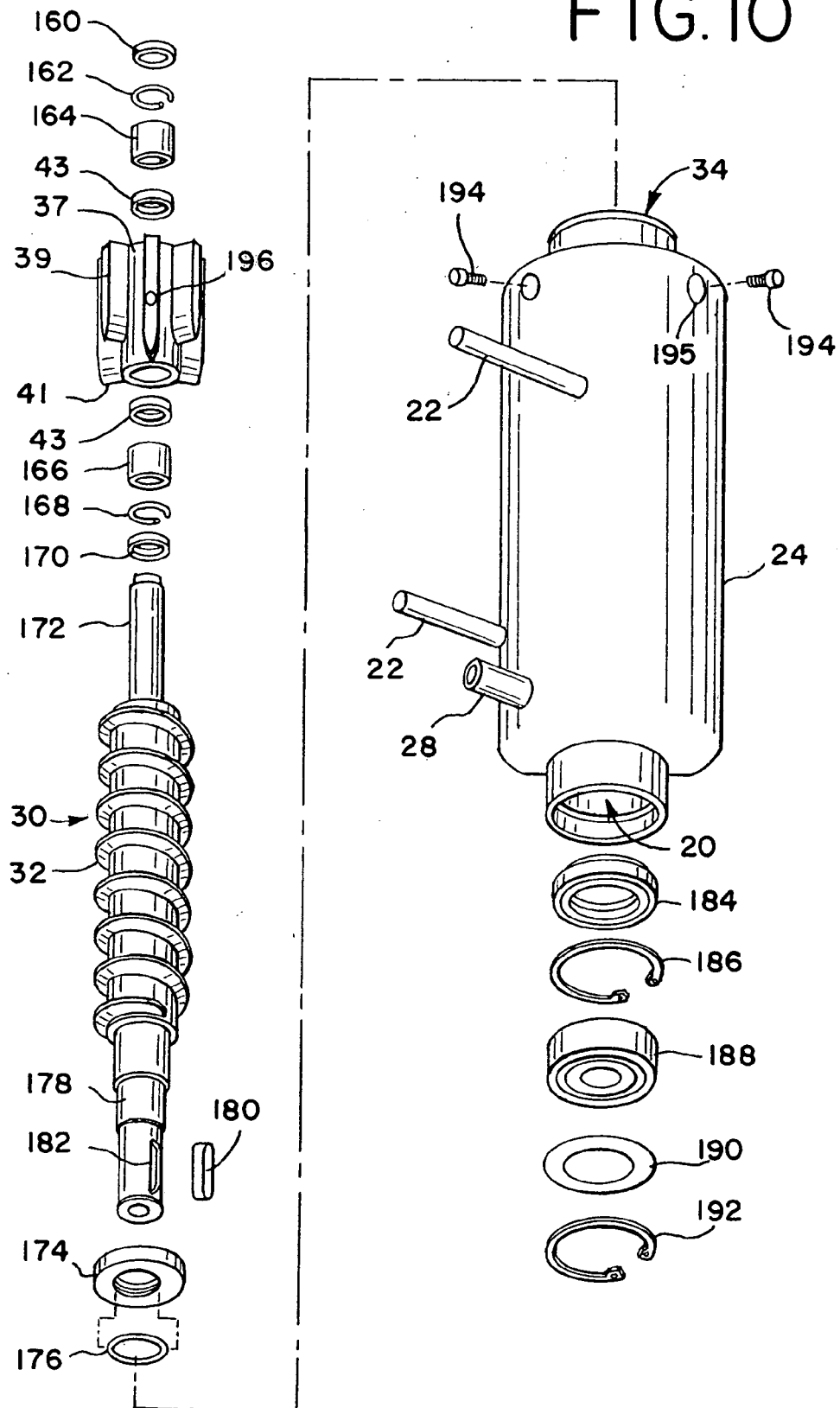


FIG.10



REFERENCES CITED IN THE DESCRIPTION

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