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DESCRIPTION

FIELD OF THE INVENTION

[0001] The present invention relates to a refrigeration apparatus. In particular, but not exclusively, the invention relates to a refrigeration apparatus for use in storing and transporting vaccines, perishable food items, packaged beverages or the like, and for the cooling or temperature control of equipment such as batteries, in the absence of a reliable supply of electricity. Aspects of the invention relate to an apparatus and to a method.

BACKGROUND

[0002] A large proportion of the world's population does not have access to a consistent and reliable supply of mains electricity. The storage of vaccines, food items and beverages at appropriate temperatures is difficult in such areas where this absence of a constant and/or reliable supply of electrical power restricts the widespread use of conventional refrigeration equipment. Further, shipping these items while cooled and with minimal access to electricity poses additional complications.

[0003] In WO 2013/110957 there is described an apparatus for cooling objects such as food items, beverages or vaccines comprising at least two reservoirs, a cooling device for cooling fluid contained in one of the reservoirs and a thermal transfer region between respective upper regions of the reservoirs. The thermal transfer region permits thermal transfer between the fluid contained in the reservoirs such that cooling of the fluid in one reservoir causes cooling of the fluid in the other reservoir.

[0004] In WO 2003/101861 there is described a packing container for biological products, in particular blood, that permits the transport and storage thereof for a given period at a storage temperature which is essentially constant and below ambient temperature. The container comprises an external shell of a form suitable for transport, enclosing a box containing the biological product. An insulating material fills at least a part of the included space between the box and the external walls of the shell. The box is contained in a hollow chamber which is essentially spherical containing a pre-solidified material the melting point of which is substantially the same as the storage temperature desired for the biological products.

[0005] The applicants have identified improved apparatus to facilitate packaging, transportation and efficiency in some applications. It is against this background that the present invention has been conceived. Other aims and advantages of the invention will become apparent from the following description, claims and drawings.

SUMMARY

[0006] According to a first aspect of the present invention there is provided a functionally orientation agnostic, mobile refrigeration apparatus having the features of claim 1.

[0007] Embodiments include a mobile refrigeration apparatus comprising a thermally conductive spherical shell contained within an insulated container and substantially full of water. Suspended in the center of the thermally conductive spherical shell is a cooling element that generates ice from the water contained within the thermally conductive shell. A thermally insulating cup is housed within the thermally conductive spherical shell and contains the cooling element. The thermally insulating cup is configured to always orient upright despite the orientation of the insulated container and is enabled for the water contained within the thermally conductive shell to pass in and out of the thermally insulating cup.

[0008] Certain embodiments provide for orienting the thermally insulating cup by-using a gimbal. Other embodiments make use of a thermally insulating cup rotatably mounted about a bar which rotatably mounts to the insulated container. Still other embodiments provide for use of a modified thermally insulating cup.

[0009] According to a second aspect of the present invention there is provided a method of operating an orientation agnostic refrigerator, the method comprising the steps of claim 12.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1A is a cut away illustration of a mobile refrigeration unit;

FIG. 1B is a flowchart of operation of a functionally orientation agnostic refrigerator;

FIG. 2 is a cut away illustration of a mobile refrigeration unit using a powered rotation bar;

FIG. 3 is a cut away illustration of a mobile refrigeration unit using a gimbal;

FIG. 4A is a cut away illustration of a mobile refrigeration unit using a free floating icy core;

FIG. 4B is a close up of a floating icy core; and

FIG. 5 is a cut away illustration of a mobile refrigeration unit with a buoyant hemisphere,

FIG. 6 is a cut away illustration of a shippable refrigerated vending machine;

FIG. 7 is a flow chart illustrating a method of refrigerator shipping;

FIG. 8 is a flow chart illustrating a method for venting a refrigerator shipping container;

FIG. 9 is a cut away diagram of a plurality of sensors associated with refrigerated shipping containers;

FIG. 10 is a flowchart for redirection of refrigerated shipping container based upon sensor warning; and

FIG. 11 is a flowchart of distribution prevention based on sensor failure.

DETAILED DESCRIPTION

[0011] A refrigeration unit designed for prolonged cooling with intermittent power supplies and adaptability to rotation is described. A spherical design is utilized comprising internal compartments that shift according to orientation of the sphere and enable internal cycling of water at substantially 4 degrees Celsius about an icy core. The refrigerator may be used for the cold storage and transportation of vaccines without freezing the contents of said vaccines.

[0012] For purposes of this disclosure, the term "cup" refers to an object which contains fluids and is not entirely sealed.

[0013] With reference to FIG. 2 of US 2014-0360214, a weir means of temperature regulation was taught. US 2014-0360214 taught the use of two fluid reservoirs separated by a thermally insulated dividing wall. One of these reservoirs contained a refrigeration unit which generated an icy core. The reservoirs were joined by an open slot which created a mixing region where water which was substantially 4 degrees Celsius cycled between the two regions. The apparatus disclosed in US 2014-0360214 is useful; however, when turned on a side, the mixing region ceases to function properly. Due this orientation issue, shipping the apparatus in a functional state is problematic.

[0014] FIG. 1A is a cut away illustration of a mobile refrigeration apparatus 2. The apparatus 2 comprises an insulated container 4 and a spherical cooling globe 6. The insulated container 4 comprises suitable thermal insulation for shipping temperature sensitive items, a payload space 8 to store items, and an access door 10. The volume inside the insulated container 4 is dedicated to spherical cooling globe 6, physical support of the spherical cooling globe (not shown), payload space 8, and the support of payload items (not shown). In certain embodiments, refrigeration apparatus is affixed to the insulated container, but stored outside of the internal volume of the insulated container.

[0015] The spherical cooling globe 6 comprises a thermally conductive shell ("shell") 12 substantially full of water. The extent to which the spherical cooling globe 6 is full of water is dependent on the amount of ice contained within the shell 12. Inside the shell 12, there is a suspended insulating cup ("cup") 14. The cup 14 separates two reservoirs of water inside the shell 12: the water inside the cup, and the water outside of the cup. Where the two reservoirs

meet, there are mixing regions 16. Inside the cup, is a cooling element 18. The cooling element 18, when powered cools the water within the shell and in the immediate vicinity of the cooling element 18, an icy core forms.

[0016] The water inside the cooling globe 6 does not necessarily need to be pure. The important characteristic is having a fluid material having a critical temperature at which the density of the fluid is the greatest, such that when the fluid is above or below that temperature, the fluid is less dense. In the case of pure water, this temperature is four degrees Celsius. Colder or warmer water is less dense than water at 4 degrees Celsius.

[0017] In operation, water that is four degrees Celsius will come to rest outside of the cup 14. When that water warms, the warmer water will rise up in the shell 12, and enter the mixing zones 16. Water in the cup will be cooler due to the presence of the cooling element 18. The warmer water rising from the four degree reservoir will cool in the mixing zone and sink once reaching four degrees again into the cup 14. Once in the cup 14, the water will cool further from four degrees, and rise again back into the mixing zone 16. This effect causes the water outside of the cup 14 and in contact with the shell 12 to substantially maintain a temperature of 4 degrees Celsius. When the spherical cooling globe 6 is rotated or rolled to another orientation, the cup 14 inside the shell 12 re-orientes so the mixing zones 16 are maintained.

[0018] The cooling element 18 takes various forms. In a thermoelectric cooling arrangement, the cooling element 18 comprises a cooling plate, and a heating plate resides outside of the insulated container 4. In some arrangements the cooling element 18 provides cooling with a refrigerant pumped therethrough by means of a pump and refrigeration apparatus external to the insulated container 4. In some arrangements, the cooling element 18 is operated by refrigerant that has been cooled by expansion of compressed refrigerant in the manner of a conventional vapor-compression refrigeration cycle additionally external to the container.

[0019] FIG. 1B is a flowchart of operation of a functionally orientation agnostic refrigerator. In step 102, the mobile refrigeration apparatus 2 is oriented in a first position. In step 104, the water inside the shell 12 equalizes at approximately four degrees Celsius. Based on the construction of the cooling globe 6, water warming from four degrees rises to meet colder water which is falling as the cooler water warms to four degrees. Rising water in the mixing zone cools down and sinks towards the cooling element 18. Water by the cooling element 18 cools and returns to the mixing zone.

[0020] In step 106, the mobile refrigeration apparatus 2 is reoriented. In step 108, the insulator cup 14 re-orientes with the mobile refrigeration apparatus 2. The reorienting occurs based on design implementations which make use of weights, buoyant materials, or balance mechanisms to automatically re-orient. In step 110, the cooling globe 6 continues to equalize temperature at four degrees,

[0021] FIG. 2 is a cut away illustration of an example of a mobile refrigeration unit using a powered rotation bar 20. Examples include spherical cooling globe 6 rotatably mounted on a

powered rotation bar ("bar") 20. The bar 20 is further rotatably mounted to a powered rail ("rail") 22 outside of the spherical cooling apparatus and inside the container.

[0022] The bar 20 provides power and/or refrigerant delivery and removal to and from the cooling element 18. Where the bar 20 contacts the rail, additional tubing or heat exchanging apparatus is concealed. Certain arrangements are configured where the cooling element 18 functions only in a single, predetermined orientation or the bar 20 within the rail 22. Other, more expensive, arrangements include functional cooling at all orientations. Certain examples of bar 20 and rail 22 interface are designed such that the bar is affixed as a spoke in a wheel, and the wheel rotates within the rail 22 to provide an improved seal for concealing heat exchanging apparatus. The bar 20 and rail 22 are thermally insulated.

[0023] The cooling element 18 is mounted centrally on the bar 20 and optionally includes an ice growth sensor (not shown) mounted perpendicularly to the bar 20. The ice growth sensor instructs the cooling element 18 to cease function when ice freezes over the ice growth sensor. The ice growth sensor improves power efficiency of the spherical cooling globe 6 and additionally prevents ice from contacting the cup 14.

[0024] The spherical cooling globe 6 has an additional weight 24 mounted at the base of the shell so when the container 4 is rotated on the axis of the rail 22, the spherical cooling globe 6 rotates to maintain orientation of the cup 14 and cooling element 18. Items in the payload space 8 are contained in wall mounted satchels or cages to prevent creating friction with or physically blocking the bar 20 and spherical cooling globe 6.

[0025] Inside the spherical cooling globe 6, the cup 14 is rotatably mounted on the bar 20. At the top rim, the cup 14 is made of buoyant material 26. When the container 4 is rotated about an axis perpendicular to the rail 22, the cup 14 rotates about the bar 20 and the buoyant upper rim 26 remains upright.

[0026] Additionally affixed to the inside of the cup 14 is mesh netting 28. The mesh netting 28 acts as a collector for broken or split chunks of the icy core. If the container 4 is dropped, and the icy core cracks or splits and chunks of ice fall off, the netting keeps the chunks of ice inside the cup 14 rather than allow the chunks of ice to float out of the cup 14 thereby causing harm to the cooling mechanism of the cooling globe 6.

[0027] The shell 12 has a hatch 30 enabling the shell 12 to fill with water.

[0028] FIG. 3 is a cut away illustration of an example of a mobile refrigeration unit using a gimbal. Examples include spherical cooling globe 6 mounted inside an insulated container 4 via starts 32. Inside the spherical cooling apparatus, a three-axis gimbal 34 ensures the cup 14 remains upright despite the orientation of the insulated container 4.

[0029] Gimbal arrangements do not require that items contained in the payload 8 space refrain from contact with the shell 12. Rotation is conducted inside the shell 12. Gimbal axes 34A-C

are aerodynamic so as to prevent drag with water within the shell 12. Gimbal axes 34A-C, mounting arms 36, and struts are thermally insulated and provide a space to conceal power cabling and/or heat exchanging apparatus.

[0030] When the insulated container 4 is reoriented, the first two gimbal; axes 34A-B rotate to compensate, and the third gimbal axis 34C which the cup 14 is affixed to remains stationary and upright.

[0031] The cooling element 18 is affixed inside the cup 14 at the center of the spherical cooling globe 6. The cooling element 18 optionally includes an ice growth sensor mounted radially from the center of sphere of ice.

[0032] Gimbal 34 arrangements include other compatible components of bar 20 arrangements.

[0033] FIG. 4A is a cut away illustration of a mobile refrigeration unit 2 using a free floating icy core 19 and FIG. 4B is a close up of a free floating icy core 19. Examples include a cup 14A and an icy core 19 which are free floating inside the water contained within the shell 12.

[0034] The free floating cup 14A is shaped in a largely spherical manner with a buoyant spout 38 mounted on top. The spout 38 on the free floating cup 14A is made of buoyant material. Regardless of the orientation of the shell 12, the spout 38 of the free floating cup 14A will orient upwards and abut against the inner side of the shell 12. The spout 38 includes mixing vents 40. The mixing vents 40 provide for an interface between the water reservoir inside the free floating cup 14A and the water reservoir outside of the free floating cup 14A despite that the spout 38 abuts against the inner surface of the shell 12.

[0035] The free floating icy core 19 comprises a buoyant disc and a heavy cooling element. The buoyant disc 42 is made from a material less dense than ice. The buoyant disc 42 will remain upright and abut the netting 28 affixed inside the cup 14A. The buoyant disc 42 is insulating and provides for a spacer between the cooling element 18 and the netting 28 so that ice does not form entangled with or above the netting 28.

[0036] Additionally an ice growth sensor 44 is mounted at the edge of the buoyant disc 42 to prevent the function of the cooling element 18 once ice 46 has formed out to the edge of the buoyant disc 42. A refrigeration pipe 48 extends upward from the buoyant disc 42 to conceal heat exchanging apparatus. The refrigeration pipe 48 is additionally threaded through the netting 28 and is directed out of the free floating cup 14A through the spout 38.

[0037] The shell 12 in free floating arrangements additionally comprises a refrigeration connector 50. In certain examples, the refrigeration connector 50 is affixed to the hatch 30 on the shell 12, though in other examples the refrigeration pipe 50 is affixed in another location on the surface of the shell 12. The refrigeration pipe 48 is preferably flexible so as to not impede the rotation of the shell 12 inside the insulated container 4.

[0038] When a user intends for the cooling element 18 to operate and generate ice 46, the insulated container 4 and shell 12 are oriented upright and the refrigeration pipe 48 and the refrigeration connector 50 match up. When the refrigeration pipe 48 and connector 50 match up, heat exchanging apparatus is functional.

[0039] Still other examples, not forming part of this invention, do not include the use of a cooling element 18. Such examples are pre-prepared with pre-made blocks of ice 46, filled with cool water, and sealed. Optionally, examples of the cooling globe 6 which do not use a cooling element 18 are designed smaller and used in large quantities to more effectively use volume inside the insulated container. The effect is similar to that of filling the payload space with ice cubes (or spheres), but the outer surface of each sphere remains at four degrees Celsius rather than zero or below.

[0040] FIG. 5 is a cut away illustration of a mobile refrigeration unit with a buoyant hemisphere 52. Examples not forming part of this invention, include a shell 12 containing an insulating and buoyant hemisphere 52. The shell 12 is supported in the insulated container 4 by struts 32. Inside the shell 12 is an insulating hemisphere 52. The rest of the volume of the shell 12 is substantially full of water. The insulating hemisphere 52 contains buoyant material 54 on the outer region of the hemisphere 52. The buoyant material 54 is less dense than ice.

[0041] Accordingly, the insulating hemisphere 52 will always float to settle at the upper hemisphere of the shell 12 regardless of the orientation of the insulated container 4 or the shell 12. The water in the shell 12 remains in contact with the lower hemisphere of the shell and absorbs heat from the payload space while the upper hemisphere of the shell 12 is comparatively thermally inert.

[0042] On the underside of the insulating hemisphere 52 is a cavity with a cooling element 18. The cooling element 18, when active, generates ice 46 from the water contained within the shell 12. In use, water by the ice 46 will be close to zero degrees, while denser water closer to four degrees will sink to the bottom of the lower hemisphere of the shell 12. As the water warms from four degrees, the water rises and comes into contact with cooler water by the ice 46, cools down again, and returns to the bottom of the lower hemisphere of the shell 12.

[0043] The cooling element 18 is affixed to a refrigeration pipe 48 which is embedded through the center of the insulating hemisphere 52. The refrigeration pipe contains heat exchanging apparatus. During cooling operation, the insulated container 4 is placed in the appropriate orientation for the refrigeration pipe 48 to match up with a refrigeration connection 50 concealed internally within a strut. The refrigeration connection enables heat exchanging apparatus outside the volume of the insulated container to use the cooling element 18 inside the shell 12.

[0044] In another smaller and simpler example illustrated in FIG. 5, a plurality of small, thermally conducting shells 12 including buoyant insulating hemispheres 52 comprise a

significant portion of the volume of the insulated container 4, The buoyant insulating hemispheres 52 include a cavity on the underside of the hemisphere for insertion of a block of ice 46. The remainder of the volume of the shell is substantially filled with water.

[0045] In comparison to FIG. 5, the smaller and simpler example is the same, without the cooling element 18, the refrigeration pipe 48, the refrigeration connection 50, and the struts 32. The cooling scheme occurs in precisely the same manner. The effect is similar to that of filling the payload space with ice cubes (or spheres), but the outer surface of each sphere remains at four degrees Celsius rather than zero or below.

[0046] FIG. 6 is a cut away illustration of a shippable refrigerated vending machine 56. The shippable refrigerated vending machine 56 is designed to reduce human involvement in the distribution of refrigerated goods, especially vaccines. The refrigerated vending machine 56 is designed with a spherical cooling globe 6. The cooling globe 6 maintains a temperature of substantially four degrees Celsius for prolonged periods of time, measured in days, without power and regardless of the orientation of the cooling globe 6.

[0047] The cooling globe 6 may be constructed similarly to above disclosed cooling globe 6 arrangements. In some examples, the refrigerated vending machine 56 uses a plurality of small cooling globes 6 which maintain the temperature of four degrees Celsius for a prolonged period of time without power and regardless of orientation.

[0048] The cooling globe(s) 6 is housed within a vending machine containment 8A. The vending machine containment 8A comprises an insulated container 4. Support struts 32 maintain positioning of the cooling globe 6 and conceal heat exchanging apparatus 58 between the cooling globe 6 and refrigeration apparatus 60. When set up for operation, the refrigeration apparatus 60 is plugged in and provides power as necessary to a cooling element (not shown) housed within the cooling globe 18.

[0049] Before use, one or more payload belts 62 or cartridges are wrapped around the cooling globe 6. The payload belts 62 are inserted through a hatch 10 on the insulated container 4. The hatch 10 is sealed before use and/or shipping.

[0050] Upon arriving at a destination, the refrigerated vending machine is set up and customers make selections which are delivered to a vending compartment by a payload feeder. Selection of payload is determined by suitable known vending selection apparatus.

[0051] In some arrangements, the selection of payload 64 such as medication and vaccines is determined through a biometric scanner 66. The biometric scanner 66 is governed by a logic circuit 68 and a memory 70 for storing records and instructions. The biometric scanner 66 either determines the identity of a customer through biometric identification such as a fingerprint, retinal, or other suitable biometric identification or performs a need based scan. Need based scans comprise blood tests or other suitable quickly performed biometric tests. As an illustrative example, a refrigerated vending machine having a payload 64 of insulin performs

a blood sugar test on customers.

[0052] The vending machine 56 goes through several phases. First the vending machine is constructed, the payload 64 is inserted, and the cooling globe 6 is made functional. Then the vending machine 56 is sealed up, and with minimal packaging, shipped to a destination. Depending on the destination and means of shipping, optionally the vending machine 56 is supplied additional power somewhere en-route to refresh the cooling capability of the cooling globe 6. Upon arrival at the destination, the vending machine 56 is oriented upright, and provided whatever power source is available at the destination. Customers then have access to the vending machine 56. When the payload 64 is spent, the vending machine 56 is either refilled, or the cooling globe 6 is drained of water and the vending machine 56 is shipped back to the origin point and refilled.

[0053] In certain examples, an inlet and outlet vent 72 which fills and empties the cooling globe 6 of water is concealed within a strut 32. The inlet and outlet vent 72 enables water to be added and removed without opening the container 4.

[0054] In some examples, a cooling globe 6 is not used. Rather a simpler water-based cooling means described in US 2012-0102994 or US 2014-0360214 are used with a payload cartridge 64 or payload belt 62 and the vending machine 56 is not configured to be shipped as an active cooling unit.

[0055] Certain embodiments of the invention are constructed with easily strip away components. The components are broken down after the delivery of payload items 64 is achieved. The broken down components are more easily packed and return shipped.

[0056] Certain embodiments of the invention use components made from compostable parts. Examples of compostable parts include seeds that are planted during the composting process.

[0057] Certain embodiments of the invention use recyclable components such as thermally conductive plastics and regularly insulating plastics.

[0058] Certain embodiments of the invention use a combination of reusable, recyclable and compostable components. After use, some components are broken down and shipped back to the point of origin, some components are sent to a recycling plant, and some components are left to degrade naturally.

[0059] FIG. 7 is a flow chart illustrating a method of refrigerator shipping. In step 702, a supplier obtains a shipping refrigerator. The shipping refrigerator is preferably water cooled. In some examples, mobile refrigerators as described above are used. In other examples, any other suitable refrigerator capable of being shipped is used.

[0060] Once the refrigerator is chosen, in step 704, a payload is added. In step 706, the payload is sealed in the refrigerator for shipment. In step 708, an itinerary comprising a

destination along with a means or path to arrive at said destination is chosen. Known and common shipping and freight methods are all acceptable. In step 710, the refrigerator is then shipped.

[0061] When an itinerary calls for a particularly long shipping journey, the refrigerator will require additional power to re-cool. In step 712, when the refrigerator requires additional power, a note in the itinerary is added. In step 714, such notation instructs shipping personnel of appropriate action to re-chill the refrigerator. Time to complete the re-chilling of the refrigerator is planned into the itinerary. In step 716, once the refrigerator is re-chilled, the shipping process continues.

[0062] In step 718, the refrigerator arrives at the intended destination. In step 720, once at the destination, the refrigerator payload is distributed to customers or clients. Such customers or clients comprise either consumers for chilled goods, doctors whom provide vaccines to patients, or patients themselves. In step 722, once the refrigerator has completed distribution, unnecessary parts and weight is removed and the refrigerator is return shipped for additional use.

[0063] As an illustrative example, where a refrigerator must be shipped by boat or vessel across the Pacific ocean, there is risk that the temperature inside the refrigerator will rise to an unacceptable level. When the risk is perceived to be too high, additional power is required to generate more ice in the water cooled refrigerator.

[0064] FIG. 8 is a flow chart illustrating a method for venting a refrigerator shipping container. In steps 802-806, similar to the method taught in FIG. 7, first a refrigerator is loaded and sealed for transit, then shipped.

[0065] A given itinerary to ship a refrigerator has multiple legs or segments of shipping. Each leg uses a different mode of transit such as train, plane, and ship. In step 808, when a mode of transit provides a temperature controlled environment, and weight is a greater concern than temperature, in step 810, shipping personnel vent the water from the refrigerator thereby significantly reducing the weight of the refrigerator through the inlet/ outlet vent as pictured in FIG. 6.

[0066] Once the leg where temperature is controlled and weight is a concern is ended, In step 814, the refrigerator is refilled with water and the necessary amount of water is refrozen. If there are remaining legs the determination of step 808, if the refrigerator is too heavy, is made again until the refrigerator arrives at the destination. In step 820, then the payload is distributed.

[0067] As an illustrative example, planes sometimes have refrigerated compartments, but a heavier plane requires a noticeable amount of additional fuel. Water would be vented to accommodate this circumstance.

[0068] FIG. 9 is a cut away diagram of a plurality of sensors associated with refrigerated shipping containers. A refrigerated container's sensors comprise a thermometer both in the payload space of the refrigerator 74A and a thermometer inside the cooling globe 74B. These thermometers 74 record differences in cooling potential and provide data to perform analytics on. As an alternative to a thermometer inside the refrigeration apparatus, a thermometer is placed on the surface of the refrigeration apparatus 74C.

[0069] In addition to the thermometers 74, the refrigerated container 4 additionally includes a humidity sensor 76 and a gyroscope 78. The gyroscope reports the orientation of the container 4. The humidity sensor 76 reports the water content of the air inside the container 4.

[0070] All of these sensors report data to a control chip 80. The control chip 80 in turn reports the sensor information to an outside server by use of a wireless communicator 82. The server (not shown) provides information to shipping personnel. In some examples the control chip 80 reports the data to a surface mounted label 84. The label 84 comprises a digital display or a scannable code. In examples where the control chip 80 does not report data to the label 84, the label 84 is simply a static identification for the container 4.

[0071] The combination of these sensors create warnings when certain thresholds or gradients are met. Thresholds include specific readings, or a change in readings at a specific rate. There are also multiple thresholds to indicate differing levels of severity. Different levels of severity include suggested potential causes associated with the given threshold. A particularly severe threshold warning would suggest that the container was breached, or the refrigeration apparatus had failed.

[0072] FIG. 10 is a flowchart for redirection of a refrigerated shipping container based upon a sensor warning. In step 1002, while during shipping one or more of the sensors of FIG. 9 registers a warning to the server. In step 1004, server operation will determine the severity of the warning as compared to the refrigerated container's itinerary. Such comparison includes factors such as the time remaining on the shipping itinerary, the predicted weather conditions in the remaining legs of the shipping route, the nature of the threshold, the locations of other shipping refrigerators, the destinations of those refrigerators, and the warning status of the other refrigerators in the shipping swarm.

[0073] In step 1006, based upon the determination of severity, remediation measures are taken. If the refrigerator has a minimally severe warning and is near the destination, server operation will not instruct a route change. In step 1008, if there is a severe warning, and the shipping itinerary includes a long journey, server operation will direct that refrigerator to a closer destination, and direct another shipping refrigerator with similar payload, without a warning, to replace the damaged refrigerator's route. In some cases, the new destination for the damaged shipping refrigerator is a disposal facility.

[0074] In step 1010, rerouting is conducted by shipping personnel through use of the surface labels on the shipping refrigerators.

[0075] In step 1012, when the warning is not so severe as to reroute a shipping refrigerator, in some cases the shipping refrigerator is adjusted. In step 1014, personnel are directed to make adjustments including reattaching the refrigerator to a power source and generating more ice, changing the orientation of the refrigerator, moving the refrigerator to a cooler location, or any other reasonable spot adjustments known in the art.

[0076] In step 1016, a shipping refrigerator that is not re-routed is delivered to the original destination.

[0077] FIG. 11 is a flowchart of distribution prevention based on sensor failure. In step 1 102, when onboard sensors generate enough warnings, a final "catastrophic failure" warning is generated and forwarded to the server. When this occurs, in step 1104, the server operation determines the most cost efficient action.

[0078] The payload is either returned, or the payload is sent to the destination but prevented from distribution. The determination depends on how close or far the shipping refrigerator is from the destination. In step 1106, if it is more cost efficient to send the refrigerator back to origin, this is the outcome. In step 1108, if it is cheaper to have a technician resolve the issue at the destination, this is the outcome.

[0079] Where the shipping refrigerator reaches the destination, and catastrophic failure occurs, the distribution mechanism is disabled. The means for removing the payload from the shipping refrigerator is disabled until a technician with special access unlocks the shipping refrigerator. In step 1110, the technician will dispose of the payload as necessary.

[0080] Although the invention is described herein with reference to the preferred embodiment, one skilled in the art will readily appreciate that other applications may be substituted for those set forth herein without departing from the scope of the present invention. Accordingly, the invention should only be limited by the Claims included below.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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- WO2003101861A [0004]
- US20140360214A [0013] [0013] [0013] [0054]
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Krav

1. Funktionelt orienteringsuafhængigt, mobilt køleapparat, der omfatter:

en isoleret beholder (4) med et nyttelastrum (8);

en termisk ledende sfærisk skal (12), der er indeholdt i den isolerede beholder (4) og i

det væsentlige fuld af vand; **kendetegnet ved**

et køleelement (18) til frembringelse af is fra vandet, der er indeholdt i den termisk ledende skal (12), hvor køleelementet (18) er ophængt centralt i den termisk ledende sfæriske skal (12); og

en isolerende skål (14), der er termisk isolerende og optaget i den sfæriske skal (12)

og indeholdende køleelementet (18), den isolerende skål (14) er konfigureret til kontinuerligt at orientere sig opret på trods af orienteringen af den isolerede beholder (4), hvori omorienteringen foregår baseret på designimplementeringer, der gør brug

af vægte, flydende materialer eller balancemekanismer, og som gør det muligt for vandet, der er indeholdt i den sfæriske skal (12), at passere ind og ud gennem den

isolerede skåls (14) top, og hvori den indre temperatur i den isolerede beholder (4) holdes ved i det væsentlige fire grader celsius.

2. Apparat ifølge krav 1, yderligere omfattende:

en roterende drivstang (20), hvorpå køleelementet (18), den isolerende skål (14) og sfæriske skal (12) er monteret, og hvor den sfæriske skal (12) og køleelementet (18)

er monteret på den roterende drivstang (20) i en fast orientering, og den isolerende skål (14) er monteret på den roterende drivstang (20) i en frit drejende konfiguration;

og

en cirkulær drivskinne (22), der er fastgjort indvendigt i den isolerede beholder (4), og

hvorpå den roterende drivstang (20) er monteret;

hvori den roterende drivstang (20) roterer frit inden i den cirkulære drivskinne (22) således, at til trods for orienteringen af den isolerede beholder (4), så er den

roterende drivstang (20) i en vandret orientering, og den cirkulære drivskinne (22) trækker kraft fra en ekstern kilde, og leverer kraft til den roterende drivstang (20), som

dernæst leverer kraft til køleelementet (18).

3. Apparat ifølge krav 1, yderligere omfattende:

understøtninger, der monterer den sfæriske skal (12) i det væsentlige centralt i den isolerede beholder (4) og indbefatter indlejrede elektrisk ledningsføring fra ydersiden af den isolerede beholder (4) til den sfæriske skal (12); og
et kardanled (34), der er monteret inden i den sfæriske skal (12) og er konfigureret til at opretholde en opret retning af den isolerende skål (14) og inkluderer den indlejrede elektriske ledningsføring, der leverer kraft fra understøtningerne til køleelementet (18).

4. Apparat ifølge krav 1, yderligere omfattende:

en flydende top (38), der er fastgjort den isolerende skåls (14) top, hvilket sikrer den oprette orientering af den isolerende skål (14);
et rør (48) fastgjort til køleelementet (18) og er orienteret til at passere gennem den flydende top (38), røret (48) indbefatter elektriske ledningsføring til at levere kraft til køleelementet (18); og
en luge (30) på den sfæriske skals (12) overfalde;
hvori orientering af lugen (30) ligesom den sfæriske skals (12) top yderligere orienterer røret (48) med lugen (30) og giver brugerne adgang til den elektriske ledningsføring.

5. Apparat ifølge et hvilket som helst af kravene 1 til 4, yderligere omfattende:

net (28), der er spændt hen over den isolerende skål (14) og over køleelementet (18), og er konfigureret til at fange og samle is, der brækker af køleelementet (18).

6. Apparat ifølge et hvilket som helst af kravene 1 til 5, hvori køleelementet (18) yderligere omfatter en isvækst-føler, der er konfigureret til at begrænse væksten af is omkring køleelementet (18), således at køleelementet (18) slukker, når is når en forudbestemt vækststørrelse.

7. Apparat ifølge et hvilket som helst af kravene 1 til 6, yderligere omfattende:

automat-betjeningsstyreenheder, der er monteret på ydersiden af den isolerede beholder (4) og gør det muligt for brugere at vælge nyttelastemner (64); og

en automatdispenser, der er monteret inden i den isolerede beholder (4) og er konfigureret til at skubbe en valgt nyttelastemne (64) ud af den isolerede beholder (4).

5 8. Apparat ifølge krav 7, hvori automat-betjeningsstyreenhederne omfatter en biometrisk scanner (66).

9. Apparat ifølge et hvilket som helst af kravene 1 til 8, hvori nyttelastrummet (8) i det væsentlige er fuld af vacciner og medicin.

10

10. Apparat ifølge et hvilket som helst af kravene 1 til 9, yderligere omfattende:

en styreenhed (80);

et antal termometre (74), der er anbragte på et antal placeringer både indvendigt og udvendigt i forhold til den isolerede beholder (4) og i kommunikation med styreenheden (80);

15

en fugtighedsføler (76), der er monteret indvendigt i den isolerede beholder (4) og i kommunikation med styreenheden (80);

en gyroskopføler (78), der er monteret på den isolerede beholder (4) og i kommunikation med styreenheden (80);

20

en geo-positioneringsindretning, der er monteret på den isolerede beholder (4) og i kommunikation med styreenheden (80);

et accelerometer, der er monteret på den isolerede beholder (4) og i kommunikation med styreenheden (80); og

25

en netværks-kommunikationsindretning (82), der er monteret på den isolerede beholder (4) og i kommunikation med styreenheden (80) og tilvejebringer data til et eksternt netværk fra andre komponenter, der er i kommunikation med styreenheden (80).

30

11. Apparat ifølge krav 10, yderligere omfattende: en forsendelsesnetværksserver, der er i kommunikation med det eksterne netværk og overvåger den isolerede beholders (4) forsendelsesfremskridten og overfører opdaterede forsendelsesinstruktioner for den isolerede beholder (4) over det eksterne netværk.

12. Fremgangsmåde til betjening af et orienteringsuafhængigt køleskab, fremgangsmåden omfatter:

5 generering af en isblok omkring et køleelement (18), der er indeholdt i en selvorienterende isolerende skål (14) inde i en termisk ledende sfærisk skal (12), der i det væsentlige er fyldt med vand, og derved bringer temperaturen på vandet, der er tættest på den sfæriske skal (12), til fire grader celsius;

10 gør det muligt for vand, der er koldere end fire grader celsius, og som er tæt på isblokken, at stige op og ud af den isolerende skål (14), og for vand, der er varmere end fire grader celsius til at falde ned i den isolerende skål (14) og køle, mens det er tæt på isblokken;

hvor den sfæriske skal (12) er indeholdt inden i en isoleret beholder (4), hvor den isolerede beholder (4) omorienteres, således at en anden flade af den isolerede beholder (4) er opret; og

15 omorientering af den isolerende skål (14) således, at skålens (14) top orienterer sig mod den side af den isolerede beholder (4), der for tiden står opret.

13. Fremgangsmåde ifølge krav 12, yderligere omfattende:

at overvåge størrelse af isblokke med en isvækstføler; og

20 som svar på at isblokken falder under en forudbestemt størrelsesgrænse generere yderligere is med køleelementet (18);

14. Fremgangsmåde ifølge et hvilket som helst af kravene 12 til 13, yderligere omfattende:

at overvåge størrelse af isblokke med en isvækstføler;

25 at overvåge den isolerede beholders placering ved hjælp af en placeringsbevidst indretning indenbords den isolerede beholder (4);

ved hjælp af en processor at beregne hastigheden for issmeltning sammenlignet med afstanden fra den nærmeste strømkilde for at bestemme en forventet tid for temperatursvigt i forhold til tiden fra den nærmeste strømkilde; og

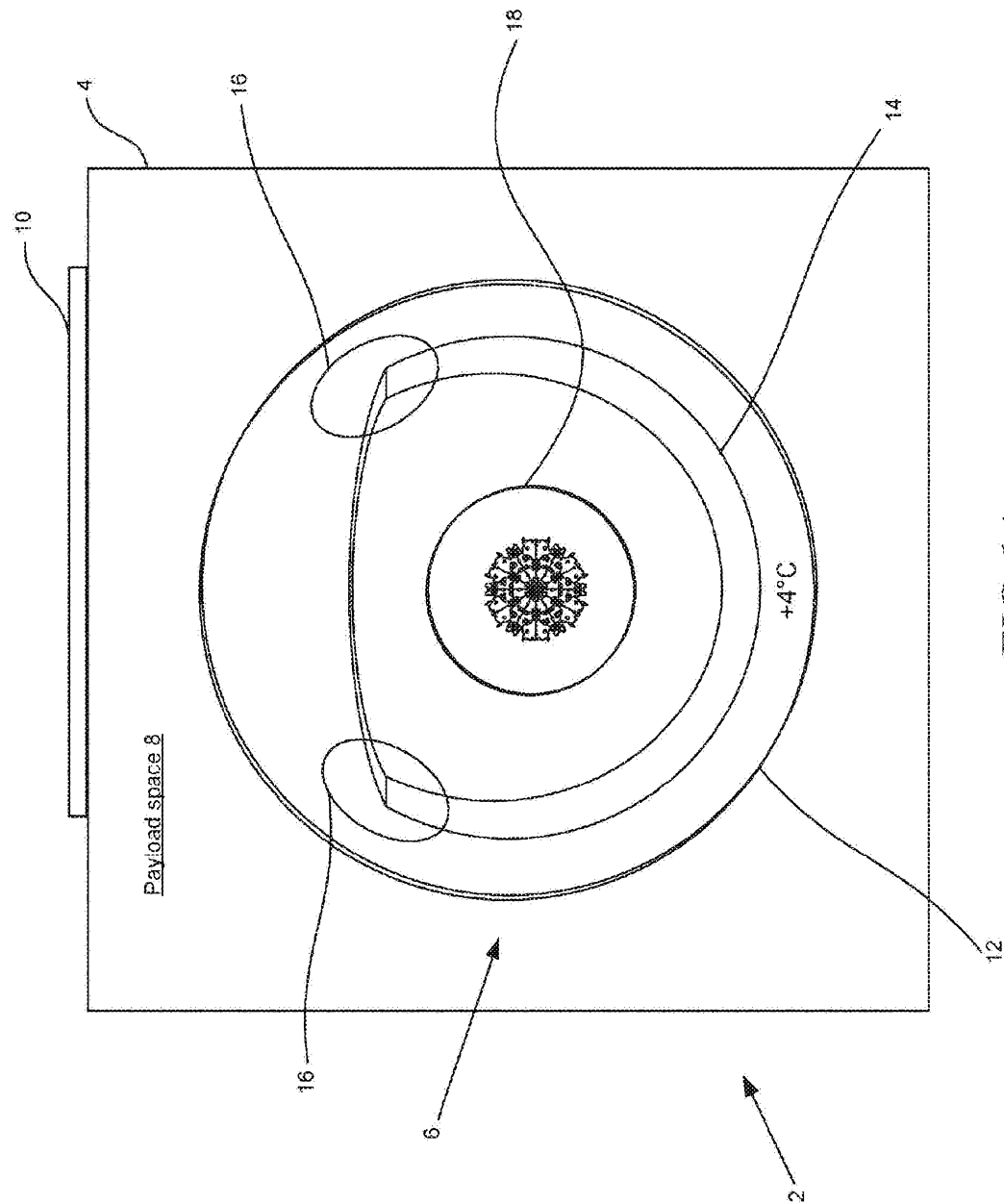
30 med en forsendelsesnetværksserver at udstede modificerede forsendelsesinstruktioner for den isolerede beholder (4) for at omdirigere den isolerede beholder (4) til en første kendt strømkilde baseret på det forventede tidspunkt for temperatursvigt.

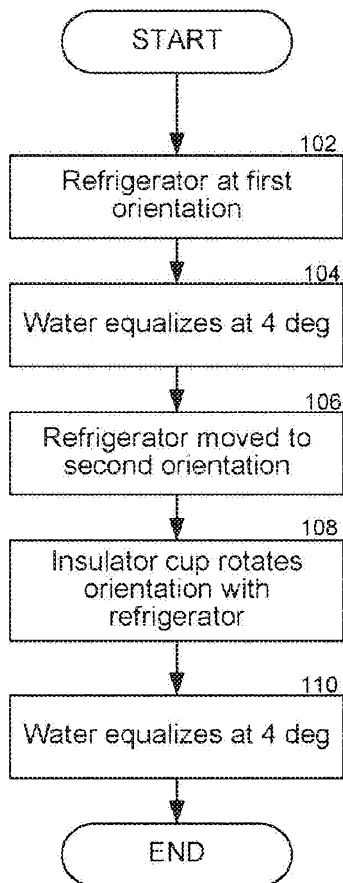
15. Fremgangsmåde ifølge et hvilket som helst af kravene til 12 til 14, yderligere omfattende:
- modtagelse af en salgsanmodning fra betjeningsstyreenheder på den isolerede beholders (4) yderside; og
- 5 at skubbe genstande (64) ud af nyttelastrummet (8) i den isolerede beholder (4) i henhold til salgsanmodningen.

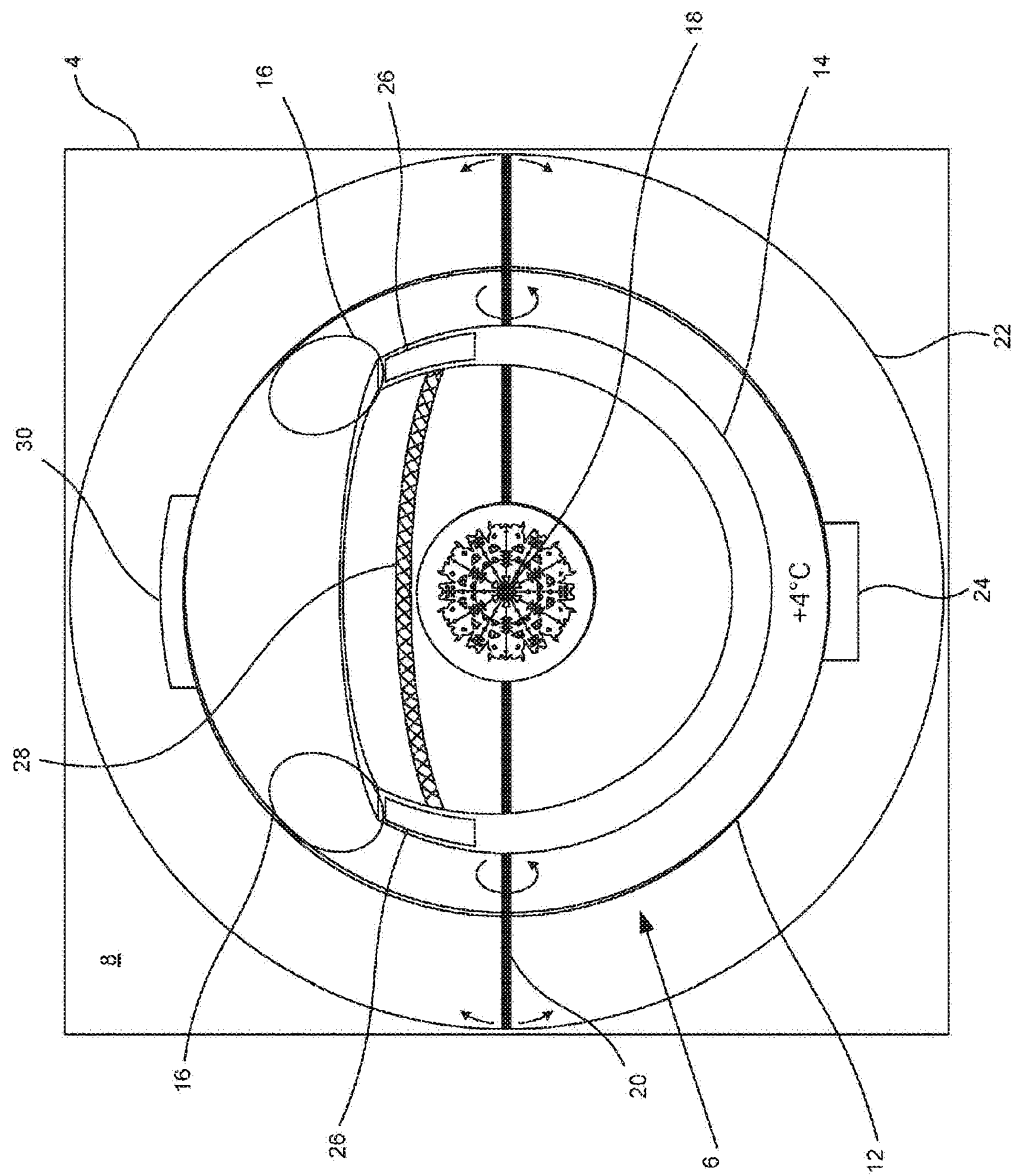
10

15

DRAWINGS



**FIG. 1B**



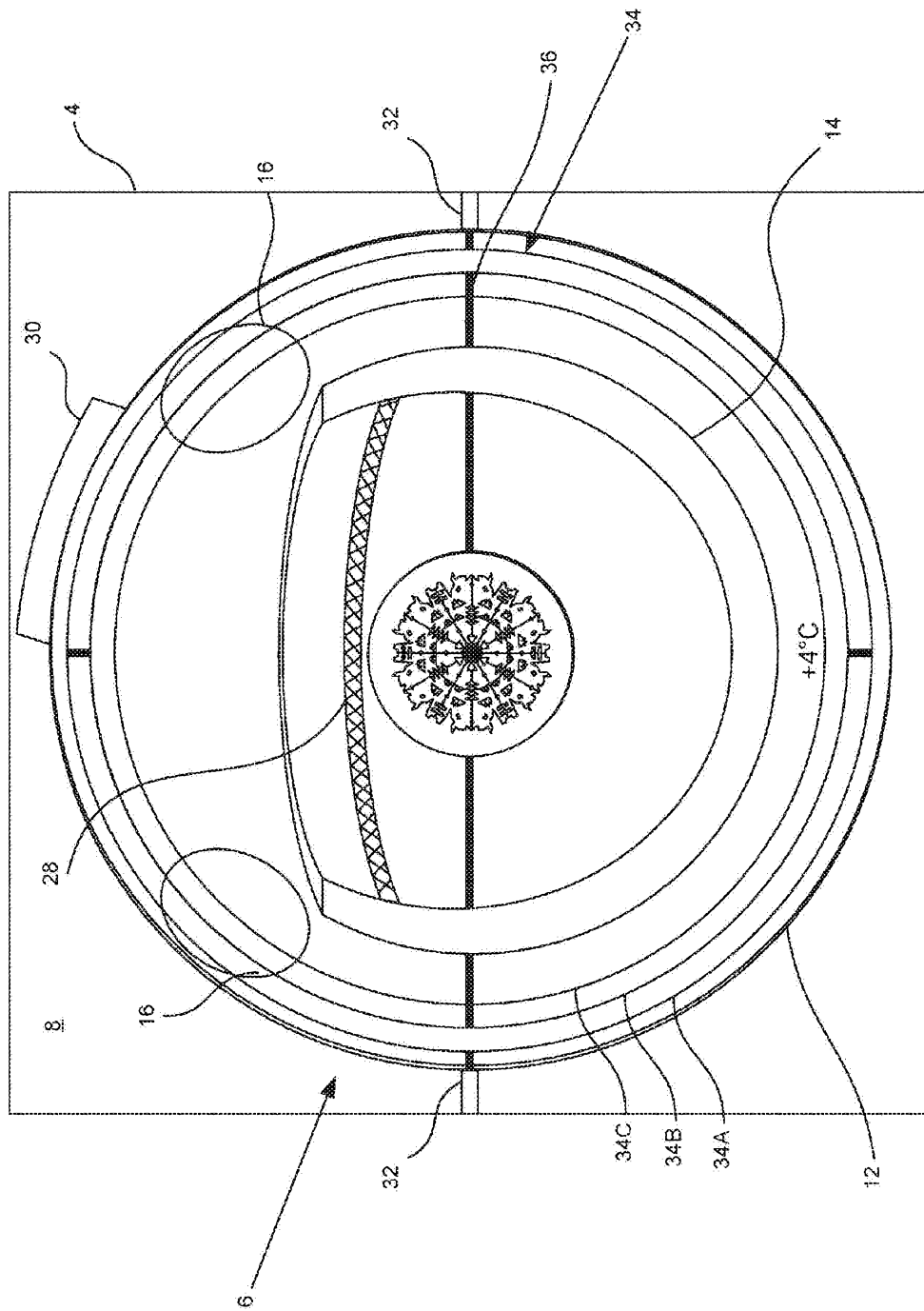
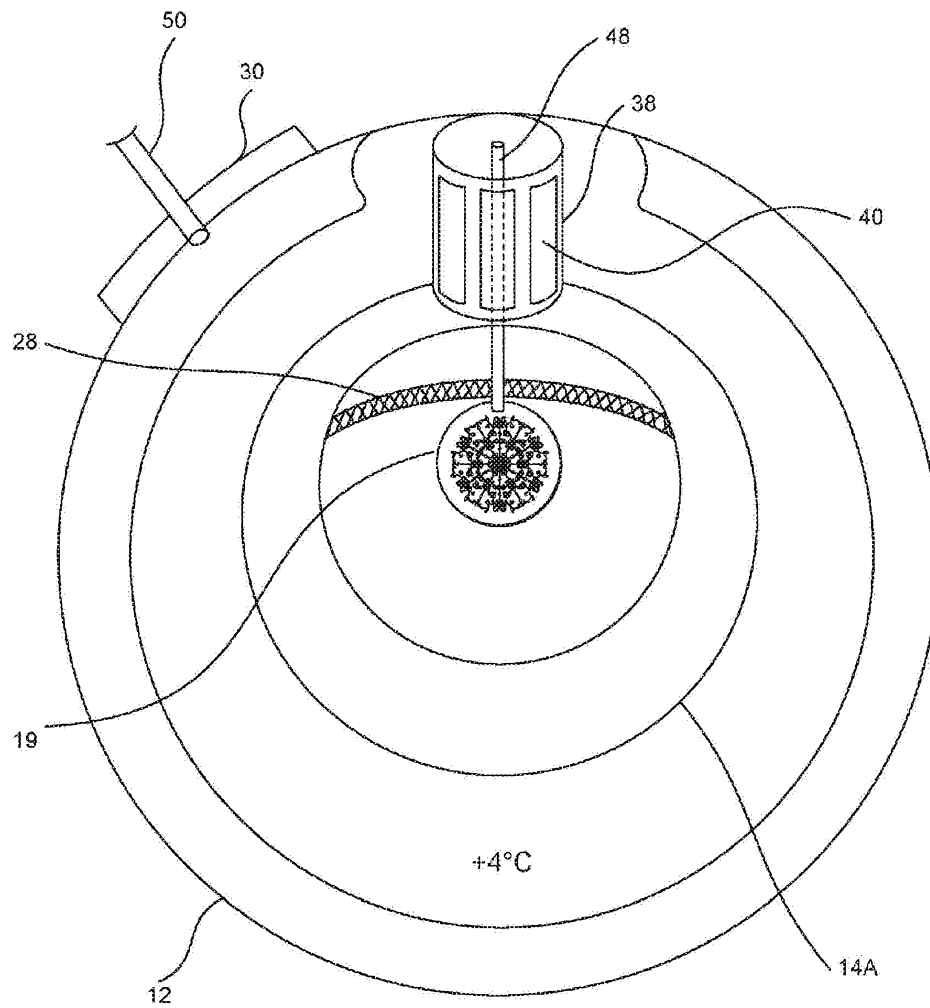
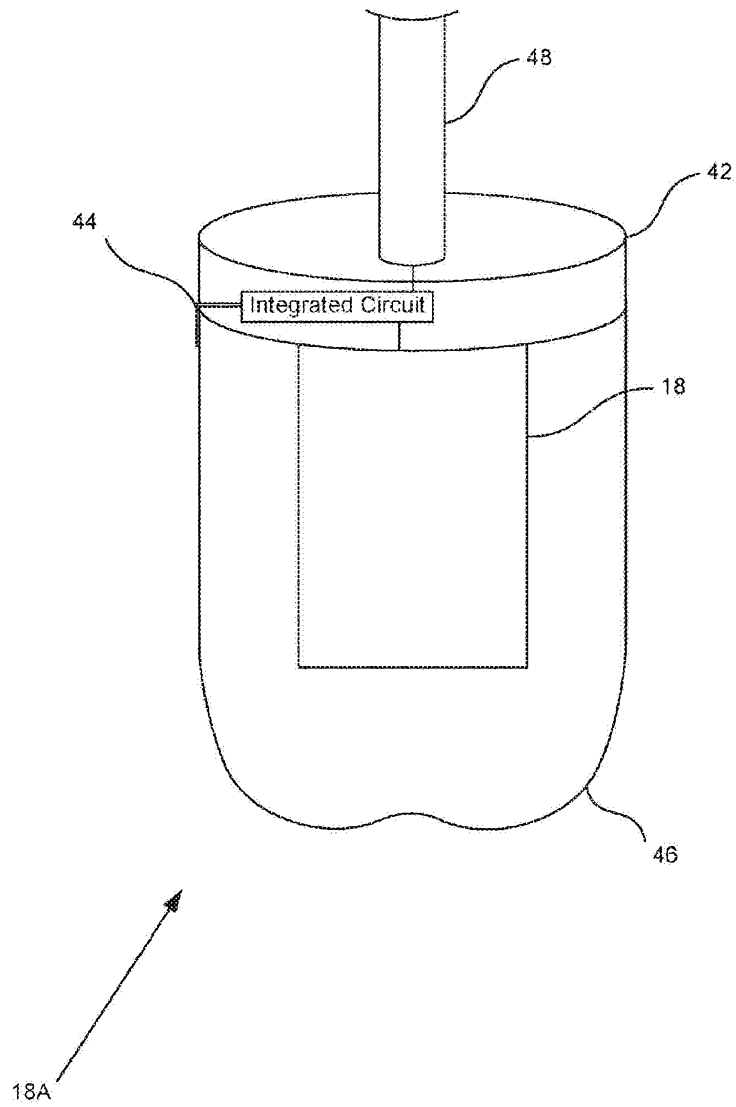


FIG. 3

**FIG. 4A**

**FIG. 4B**

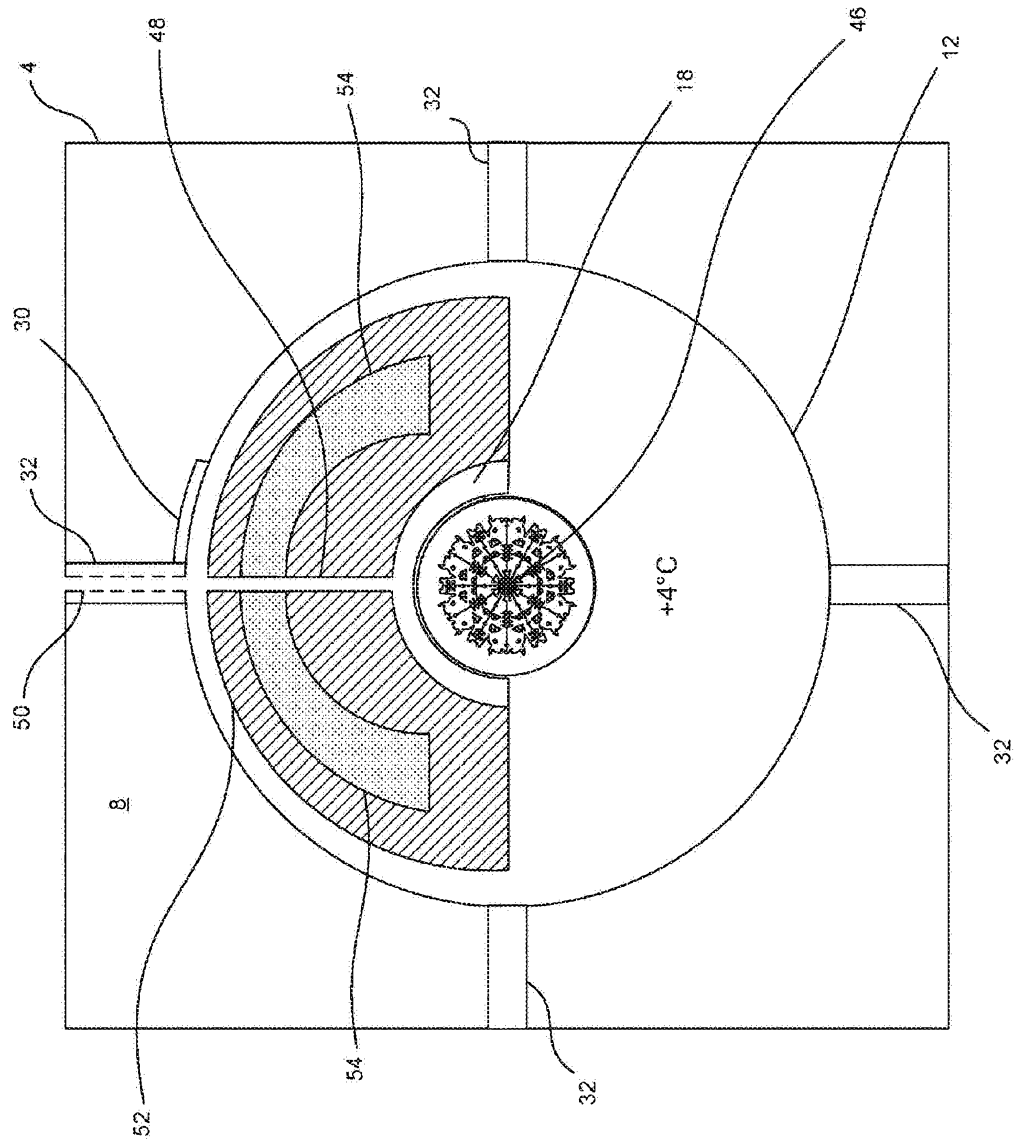
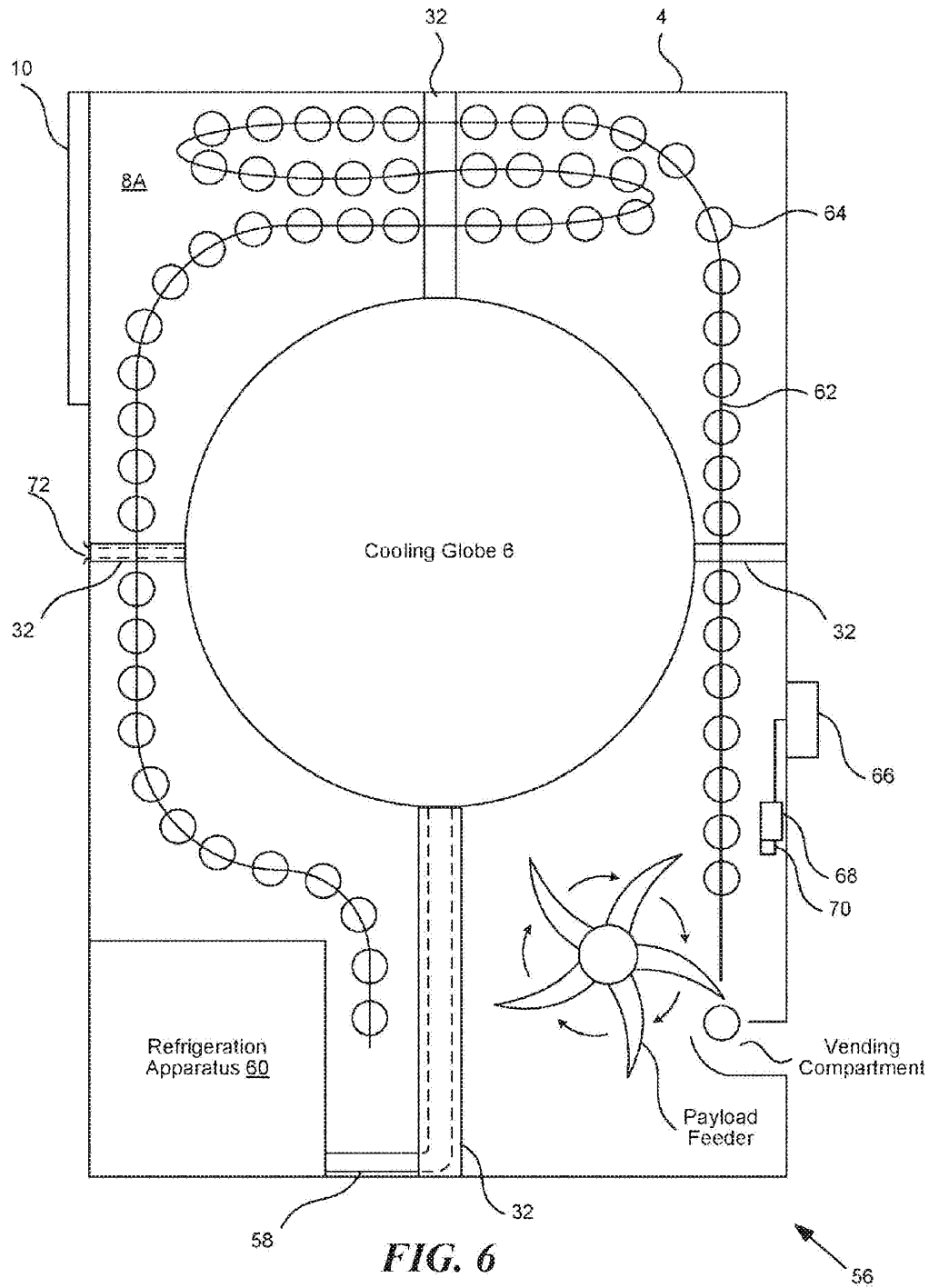
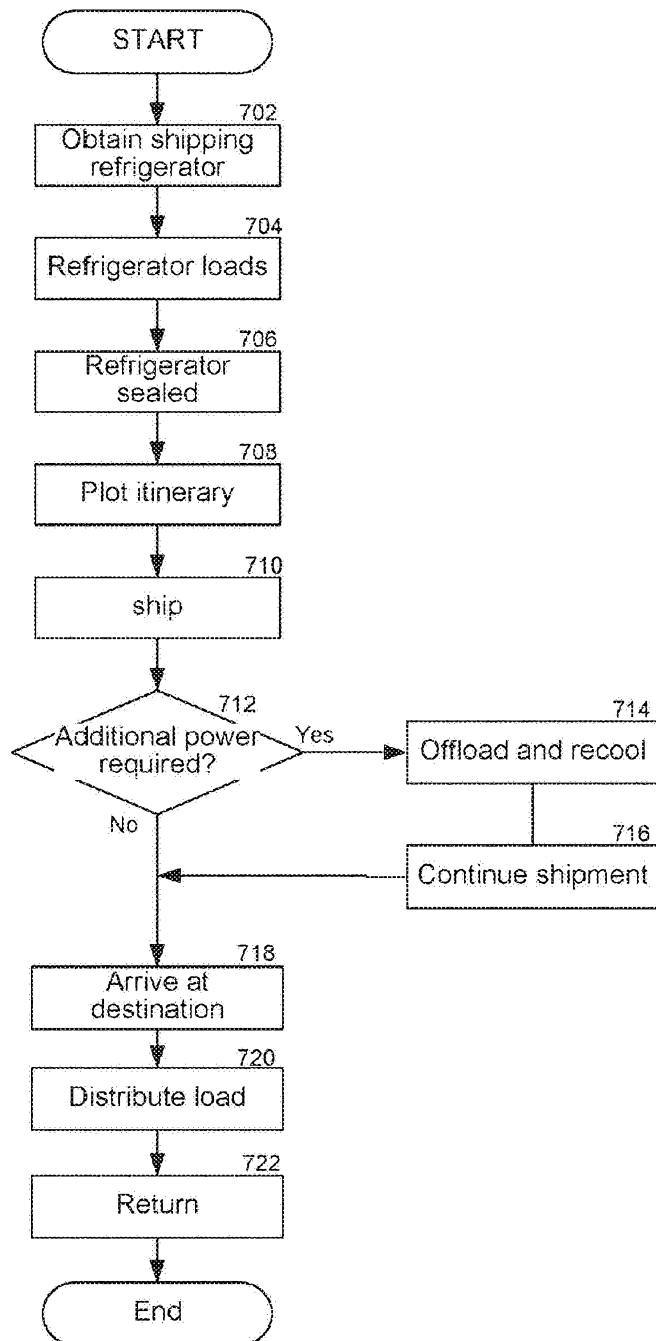
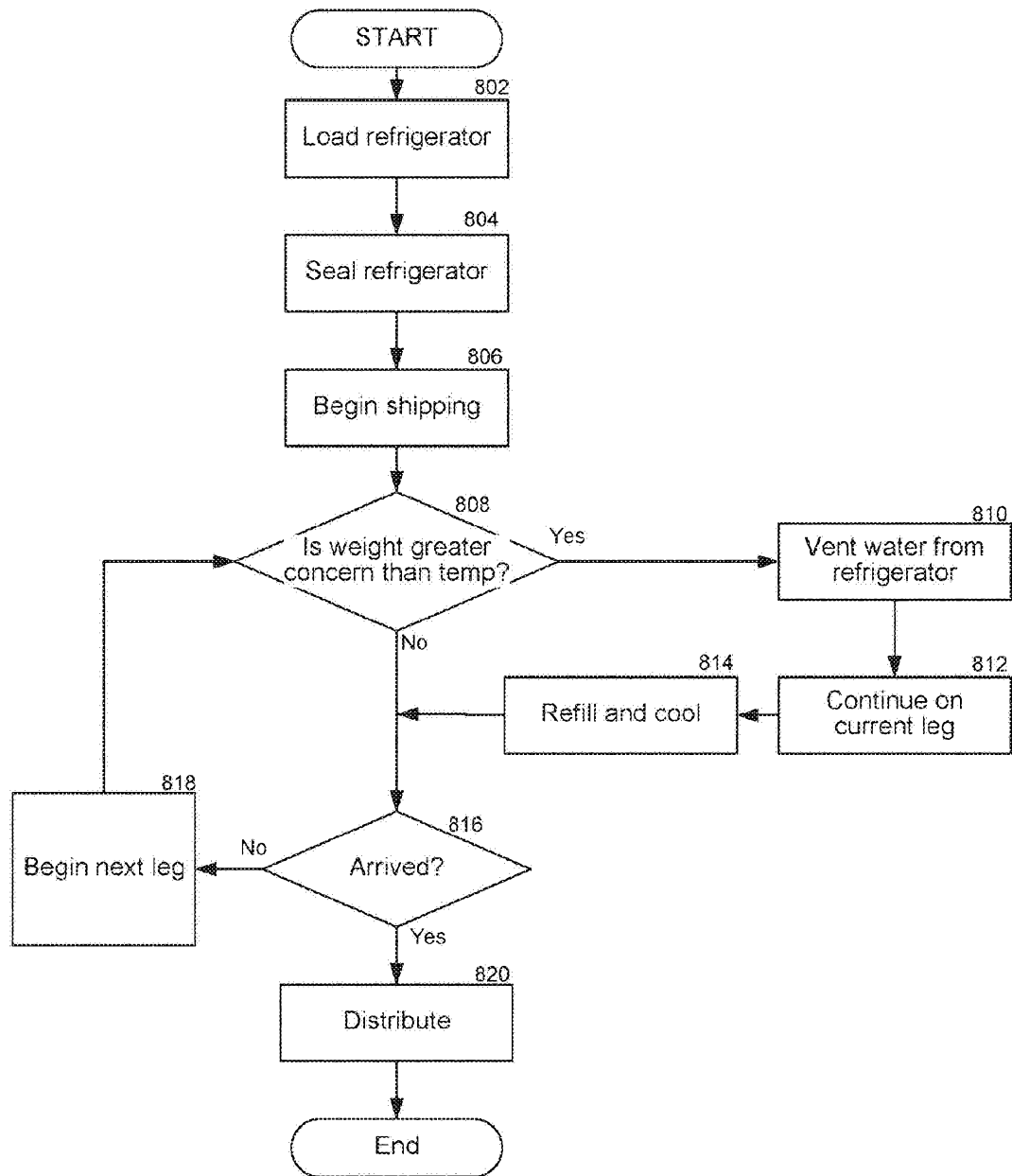
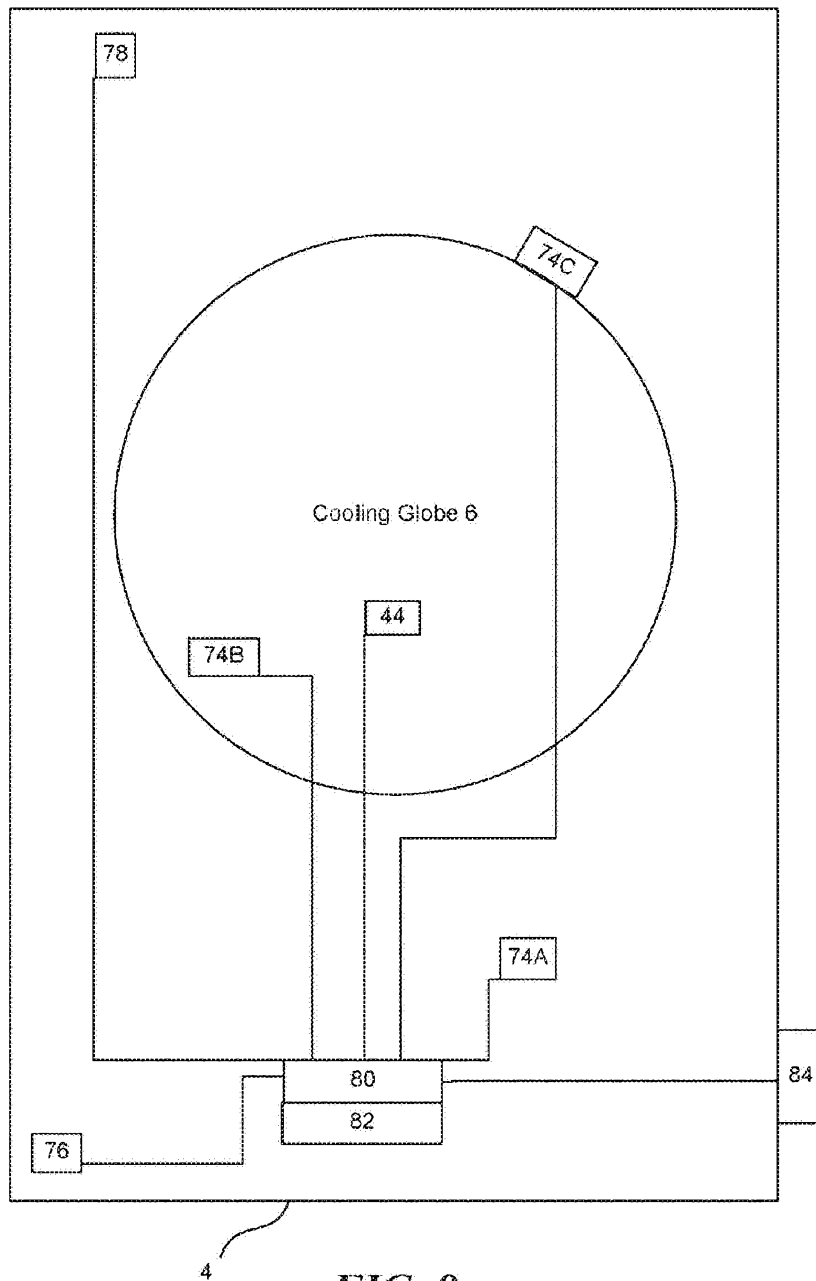


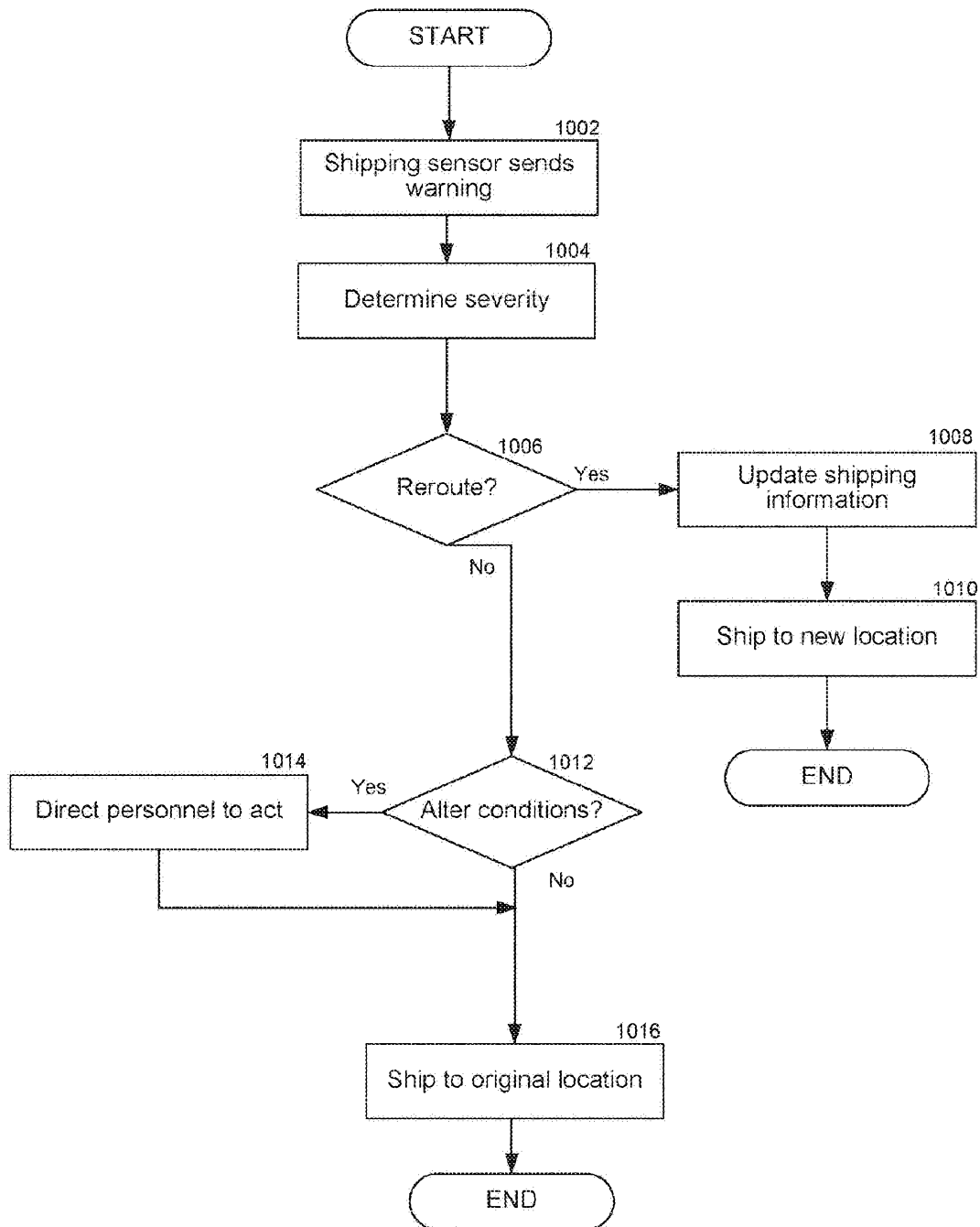
FIG. 5

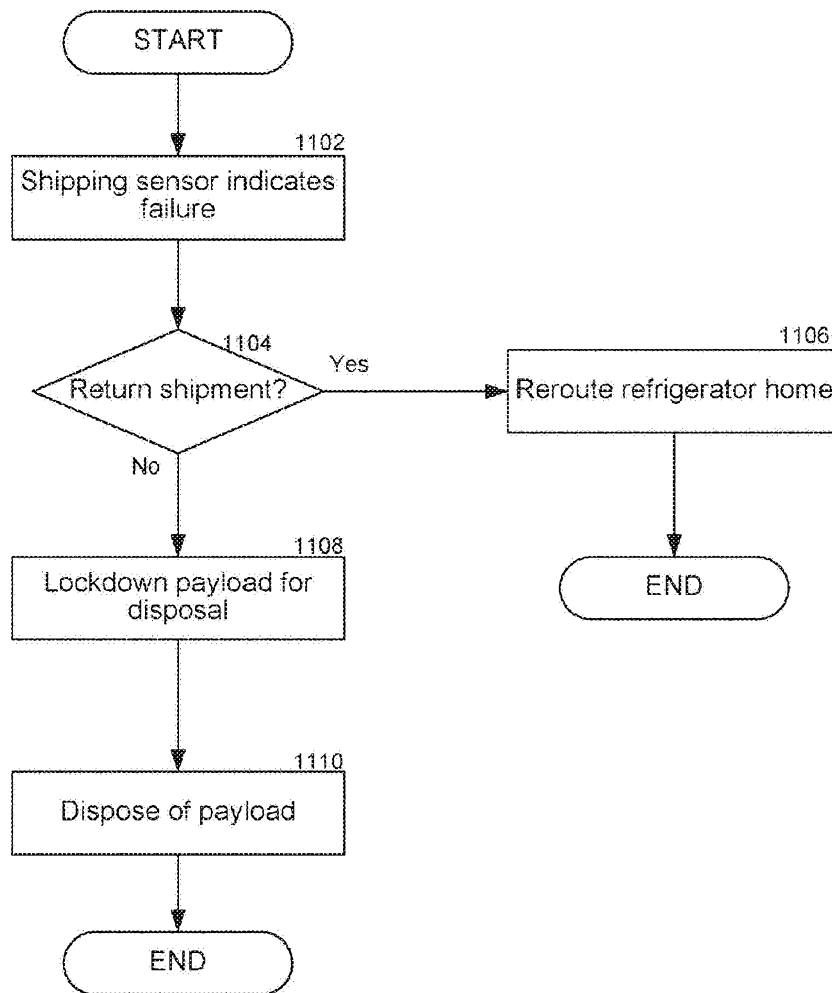


**FIG. 7**

**FIG. 8**

**FIG. 9**

**FIG. 10**

**FIG. 11**