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

(72) Inventors:

- **ÖZKÜCÜK, Serhat**
45030 Manisa (TR)
- **YILMAZ, Samet**
45030 Manisa (TR)

(74) Representative: **Ascherl, Andreas et al**
KEHL, ASCHERL, LIEBHOFF & ETTMAYR
Patentanwälte - Partnerschaft
Emil-Riedel-Strasse 18
80538 München (DE)

(54) **LIGHT BASED ICE DETECTION UNIT, REFRIGERATOR WITH ICE DETECTION UNIT AND METHOD FOR DEFROSTING OF A REFRIGERATOR**

(57) The before mentioned invention refers to an ice detection unit (1), at least comprising
a light source (6) for emitting visible light (60),
an optical means (62) for dividing said visible light (60) in multiple light beams (7.1-7.7),
multiple detection means (8.1-8.7) for detecting light of said light beams (7.1-7.7) and for outputting of signals representing detected light,

wherein refraction property changes of said optical means (62) are causing light path changes of the light paths of said multiple light beams (7.1-7.7), wherein refraction property changes are caused in dependency of the amount of ice on a surface of said optical means (62), wherein said signal output at least differs between a situation without ice on said surface of said optical means (62) and a situation with ice on said surface of said optical means (62).

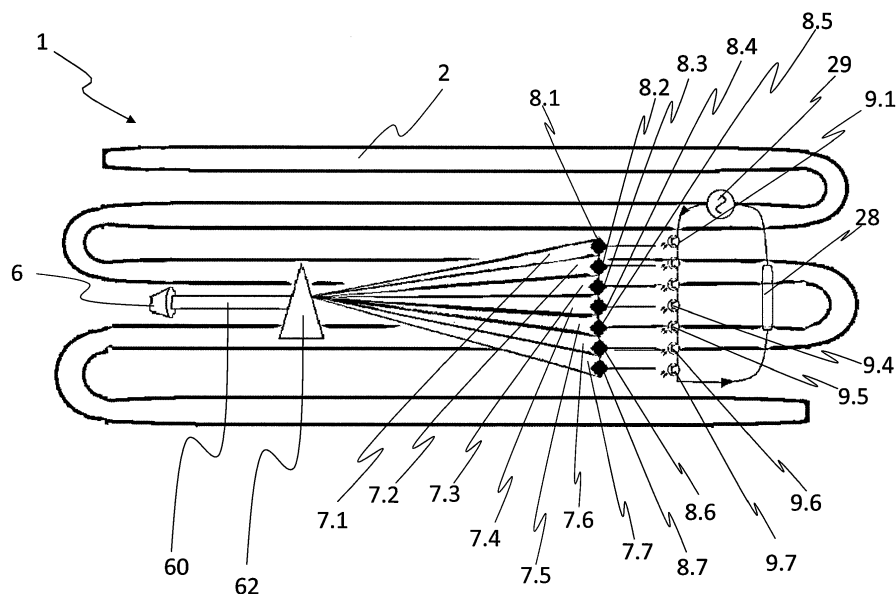


Fig. 1

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Description

[0001] The present invention refers to an ice detection unit according to claim 1, a refrigerator according to claim 8 and a method for operating a refrigerator according to claim 10.

Background of the Invention

[0002] In all no-frost refrigerators, there is a heater on the heat-exchanger for prevent icing. After starting of refrigerator, heat-exchanger starts cooling and icing. This is unwelcome situation by user and inefficient situation by cooling performance of refrigerator. So, there is located a heater on the heat-exchanger in all no-frost refrigerators to prevent icing. After a long certain time (8-12 hours) starting of the refrigerator, the heater works a small certain time (5-10 minutes) for the reason to melt the ice. This operation is called as defrost.

[0003] Document US4843830A discloses a differential ice sensing system and method for a cold drink beverage dispenser or the like. The beverage dispenser has an ice bath cooling tank containing a supply of water. A refrigerated cooling surface is provided within the tank so as to freeze a portion of the water into a body of ice. The beverage dispenser has a beverage flow path which is cooled by the liquid in the ice bath. The differential ice sensing system comprises a first conductivity (or impedance) probe which is disposed in the water of the ice bath at a position where it will sense the conductivity of the ice when the body of ice formed on the refrigerated surface attains a predetermined size. A second conductivity probe is disposed within the liquid so that it is maintained in conductivity sensing relationship with the liquid. Each of the probes is responsive to an electric current supplied thereto to measure the electrical conductivity in its vicinity. A system is provided for detecting conductivity differences between the first and second probes indicative of the presence of ice at the first probe and for generating a signal indicating presence of ice at the first probe. This signal may be utilized to block the flow of refrigerant to the refrigerated surface when the body of ice formed has reached a pre-determined size and to initiate the flow of refrigerant when the body of ice is less than a desired size.

[0004] Document WO0009960A2 discloses an apparatus and method that regulates the size of an ice bank and that prevents short cycling of the compressor therefor and operation thereof at undesired voltages. A microprocessor based control circuit includes a circuit for sensing line voltage combined with an ice bank sensing circuit. The ice bank sensing circuit is of the conductivity sensing type wherein the electrical conductivity between two probes is sensed. The microprocessor continually monitors the probes to determine if refrigeration is needed or not, and continually senses the line voltage to determine if that voltage is within the design limits of the refrigeration compressor. The voltage sensing circuit can also sense

if power has been interrupted where the voltage drops to zero.

[0005] Document US3782130A discloses a refrigerator, said refrigerator is arranged to cool part of an area for which an indication of the imminence of ice-formation is required. A first temperature sensitive circuit and a first conductivity probe are situated in that part of the area while a second temperature sensitive circuit and a second conductivity probe are situated outside it. A first differential amplifier compares the conductivities of the conductivity probes and a second differential amplifier compares the outputs of the temperature sensitive circuits. The outputs of one of the differential amplifiers controls the refrigerator while the output of the other differential amplifier provides the said indication.

[0006] Document DE2641600A1 discloses the initiator of a deicing system is used in an evaporator, especially in a heat pump. The initiator has electrode scanning the evaporator surface. The conductivity increased by ice formation switches the deicing device on by a discriminator circuit. The deicing device is started only if the evaporator is actually covered with ice. The deicer is not connected when the environment is cold but dry, nor when the electrode gap is subjected to droplets. The electrode is arranged in front of the end edge of the air baffle plates connected to the evaporator pipe. The effective length of the electrode is short in relation to the end edge. The discriminator circuit switches the deicer on only if the higher conductivity is still present after a delay time. The electrode consists of a head held on a rod fixed on an insulating support on the baffle plate.

[0007] Disadvantages of prior art system are unnecessary power consumption, expensive and complex sensors and/or non-sensitive systems.

[0008] Thus, the main problem is that the presence and amount of ice on the heat-exchanger is not detected simultaneously without sensors. Defrost operation is done automatically with help of periodic programming. Existence of ice and need of heating to melt the ice is unknown. So, this periodic defrost operation causes inefficient situation by energy consume and cooling performance of No-frost refrigerators.

Object of the Invention

[0009] Therefore, it is the object of the present invention to provide an advanced ice detection unit, a refrigerator with such an advanced ice detection unit and a method for operating such a refrigerator.

Description of the Invention

[0010] The before mentioned object is solved by an ice detection unit according to claim 1. The term ice preferably comprises besides ice also snow, but it is possible to limit the term ice also to ice only. The ice detection unit preferably comprises at least a light source for emitting visible light, an optical means for dividing said visible light

in multiple light beams, multiple detection means for detecting light of said light beams and for outputting of signals representing detected light, wherein refraction property changes of said optical means are causing light path changes of the light paths of said multiple light beams, wherein refraction property changes are caused in dependency of the amount of ice on a surface of said optical means, wherein said signal output differs between a situation without ice on said surface of said optical means and a situation with ice on said surface of said optical means.

[0011] This solution is beneficial since the property of splitting white light into colors. According to this unit respectively system a white color light source, a glass prism and color sensitive photo detectors are utilized. The white color light source is located on further means, in particular a heat exchanger of a refrigerator, that is located at the same time towards the glass prism. The color sensitive photo detectors array is located on another side of the glass prism. Each detector means, in particular color sensitive photo detector, excites its own transistor gate and transistors are preferably connected in series with each other. Respectively each detector means, in particular color sensitive photo detector, is coupled for signal exchange with a transistor, wherein said transistors are connected with each other in series.

[0012] The light source and the optical means or the light source and the detection means or the detection means and the optical means or all of these are preferably electrically isolated from each other. This is beneficial since the detection of light is very exact and therefore the detection of ice and/or snow is very exact.

[0013] Further preferred embodiments of the present invention are subject-matter of the dependent claims and/or of the following parts of the specification.

[0014] According to a preferred embodiment of the present invention multiple detection means are outputting said signals representing detected light in dependency of at least one predefined parameter. Said predefined parameter is preferably at least the color of detected light and/or the light intensity. This solution is beneficial since the color of detected light and/or the light intensity can be detected and evaluated in a beneficial manner.

[0015] The light source emits according to a preferred embodiment of the present invention white light and said optical means preferably comprises or consist of a prism, in particular comprising or consisting of glass. Said prism preferably divides said white light into light beams having different colors. This embodiment is beneficial since preferably one light source is sufficient, since white light comprises multiple light beams of different colors, said multiple light beams can be divided from each other by usage of an optical means. It is also conceivable that a range of light colors is emitted by said light source, wherein the overall color of such a light beam differs from white.

[0016] Each detector means comprises according to a further preferred embodiment of the present invention a color sensitive photo detector, wherein said color sensi-

tive photo detectors are arranged as array. Said photo detectors of said array preferably have a predefined distance to each other, wherein the distance between a first detector and a second detector can differ with respect to a distance between a second detector and a third detector.

[0017] Each color sensitive photo detector has according to a further preferred embodiment of the present invention its own transistor gate and wherein said transistors are connected with each other in series. This embodiment is beneficial, since this system respectively unit also can be implemented without microcontroller IC (directly hardware system).

[0018] According to a further embodiment each color sensitive photo detector is connected with a micro controller for analyzing signals outputted by said color sensitive photo detectors, wherein said micro controller controls a heating means in dependency of said analyzed signals. This embodiment is beneficial since the amount of ice on a heat-exchanger can be detected with the help of color sensitive photo detector/S. A microcontroller IC can be integrated into such a unit respectively system and defrost operation, in particular operation of a heating means, can be done according to a predefined number of sensed color and/or in dependency of an evaluation of signals emitted by at least one or multiple detection means.

[0019] Each color sensitive photo detector detects according to a further preferred embodiment of the present invention one of at least three, in particular at least or exactly or up to four, at least or exactly or up to five, at least or exactly or up to six or at least or exactly or up to seven, different colors. The optic means preferably divides white light in at least or exactly two colors, wherein said individual color light beams are traveling a predefined path in case no ice or snow is present. Said path differs in case ice or snow is present. Thus, since a microcontroller knows which color and/or light intensity must be detected by each detection means to have a "no-ice" situation, all further detected values or not detected values are indicating a specific ice situation respectively the presence of ice.

[0020] The fluid, in particular water, freezes below 5°, in particular below 1° or below 0°, and ambient pressure of 10.1 N/cm².

[0021] The above mentioned object is also solved by a refrigerator, in particular no frost refrigerator. Said refrigerator preferably comprises a least a cooling means for cooling down the atmosphere inside the refrigerator, a heater means for melting of accumulated ice or snow inside the refrigerator, an ice detection unit according to any of the before mentioned claims for detecting ice or snow inside the refrigerator and for actuating the heater means in dependency of detected ice or snow. This embodiment is beneficial since ice or snow can be detected and reduced respectively removed whenever detected and thus not just in dependency of a predefined time slot.

[0022] According to a further preferred embodiment

said cooling means is a heat-exchanger and said optical means is arranged on or besides said heat-exchanger, wherein on or besides preferably means in a distance smaller than 10cm or smaller than 5cm or smaller than 1 cm or directly contacting.

[0023] The above mentioned object is also solved by a method for operating a refrigerator. Said method preferably comprises at least the steps: Cooling down a food storage section by means of a cooling means, detecting ice or snow inside the food storage section by means of operating an ice detection unit according to any of claims 1 to 10, Operating an ice reduction respectively removing means, in particular a heating means, in case the presence of ice or snow is detected. This embodiment is beneficial since ice or snow can be detected and reduced respectively removed whenever detected and thus not just in dependency of a predefined time slot. This method can be used in all cooler devices in particular in cooler devices having a heat-exchanger part. The inventive method and unit, respectively system, can be used for all ice detection application.

[0024] Said light source emits according to a further preferred embodiment of the present invention white light and said optical means comprises or consist of a prism, wherein said prism divides said white light into light beams having different colors. Said light beams, which preferably have different colors and/or intensities, are directed to specific detection means, wherein each detection means outputs a signal in case a predefined color and/or intensity is detected.

[0025] Further benefits, goals and features of the present invention will be described by the following specification of the attached figures, in which exemplarily components of the invention are illustrated. Components of the systems and methods according to the inventions, which match at least essentially with respect to their function can be marked with the same reference sign, wherein such components do not have to be marked or described multiple times with respect to said figures.

[0026] In the following the invention is just exemplarily described with respect to the attached figures.

Brief Description of the Drawing

[0027]

Fig. 1 shows a schematic illustration of the ice detection unit according to the present invention and

Fig. 2 shows a schematic illustration of a refrigerator having an ice detection unit according to fig. 1.

[0028] Fig. 1 shows an ice detection unit 1 coupled with a heat exchanger means 2. The ice detection unit 1 can be arranged beside or on top of a surface of said heat exchange unit 2.

[0029] The ice detection unit 1 comprises at least a light source 6, an optical element 62 and detection means

8.1-8.7 for detection of light. Each detection means 8.1-8.7 is preferably configured for detecting a specific range of light waves, in particular a specific light wave, and/or an intensity of light energy. Each detector means 8.1-8.7 preferably detects a different range of light waves respectively a different light wave. Said ranges of light waves preferably do not overlap. Thus, each detector means 8.1-8.7 is preferably configured as light intensity detector and/or as color sensitive photo detector. It is also conceivable that each detector means 8.1-8.7 has the same technical properties but different detection respectively light analyzing parameters. Additionally or alternatively it is conceivable that each detector is structurally identical and emits signals that vary in dependency of the captured light.

[0030] All detector means are preferably arranged as array.

[0031] Said detector means 8.1-8.7 are preferably coupled with transistor means 9.1-9.7, in particular via an individual transistor gate of said preferably individual transistor 9.1-9.7.

[0032] Transistor means 9.1-9.7 are preferably connected in series.

[0033] Said series connection of transistors is preferably connected with a defrost heater 28 that operates a heater source with defrost heater current 30 in case one or multiple or the majority or a group of predefined transistors indicate that the corresponding detection means do not detect light or light of a predefined color respectively of a predefined range or waves respectively of a predefined wave and/or of a predefined light intensity.

[0034] Reference numbers 7.1-7.7 preferably indicate different ranges of light waves or different light colors, in particular red (7.1), orange (7.2), yellow (7.3), green (7.4), blue (7.5), purple (7.6) and light purple (7.7).

[0035] The ice detection unit according to the present invention preferably operates in at least two

[0036] A first state is a no ice detection operation state: A surface of optical means 62 respectively glass prism is clear and it splits a mixture of light waves, in particular white light 60, into individual waves length respectively into groups of wave length, in particular into the colors of the white light. Since the presence of ice on said surface of said optical means 62 indicates ice on heat exchanger and since no ice on said surface of said optical means 62 indicates no ice on said heat exchanger, then an undisturbed light beam path represents no ice on the heat-exchanger. When a plurality of colors, in particular all seven colors, occur, color sensitive photo detectors 8.1-8.7 can sense the color spectrum and that means, system does not include any ice (on the glass prism surface). So, defrost operation is unnecessary at this condition.

[0037] A second state is an ice detection operation: Glass prism 62 surface is fumbled and frost (or is snowed) when there is ice on the heat-exchanger 2 (invers to "no ice detection operation"). At this time the glass prism 62 cannot split into the colors of the white light fully or par-

tially. Thus, not all seven color or predefined intensities can occur, color sensitive photo detectors cannot sense the color spectrum and that means, system include snow or ice (on the glass prism surface). So, defrost operation is needed at this condition.

[0038] Fig. 2 shows that ice detection unit 1 arranged on or beside or in close vicinity of a heat exchange means 2. Both, heat-exchange means 2 and ice detection unit 1 are preferably part of a refrigerator 25.

[0039] Heating means 24 can be operated for predefined time slots or as long as no change of state is recognized.

[0040] Thus, the present invention refers to an ice detection unit 1. This ice detection unit preferably comprises at least a light source 6 for emitting visible light 60, an optical means 62 for dividing said visible light 60 in multiple light beams 7.1-7.7, multiple detection means 8.1-8.7 for detecting light of said light beams 7.1-7.7 and for outputting of signals representing detected light, wherein refraction property changes of said optical means 62 are causing light path changes of the light paths of said multiple light beams 7.1-7.7, wherein refraction property changes are caused in dependency of the amount of ice on a surface of said optical means 62, wherein said signal output at least differs between a situation without ice on said surface of said optical means 62 and a situation with ice on said surface of said optical means 62. This unit or device or system can be used both with microcontroller, in particular control unit 24, or directly as hardware system with no microcontroller. This system is also preferably perfectly isolated. There is preferably no electrical conductivity between excitation side, in particular light source 6, and sensor side, in particular detector means 8.1-8.7.

[0041] This solution is beneficial since the property of splitting white light into colors is used. According to the invention a white color light source is provided and the white light is split into the colors by help of glass prism. According to icing of glass prism surface, color array changes. Defrost operation activated according to sensed color.

[0042] As shown in Fig. 2 said refrigerator 25 preferably comprises a control unit 24, in particular a micro controller for actuating respectively operating of at least heating means 28, in particular in dependency of signals emitted by color sensitive photo detection means 8.1-8.7. In such a case transistor means 9.1-9.7 are not mandatory, since said detection means 8.1-8.7 preferably communicate directly with control unit 24 and control unit 24 preferably communicates directly with heating means 24.

[0043] In summary, the invention describes an ice detection unit 1, which at least comprises a light source 6 for emitting visible light 60, an optical means 62 for dividing said visible light 60 in multiple light beams 7.1-7.7, multiple detection means 8.1-8.7 for detecting light of said light beams 7.1-7.7 and for outputting of signals representing detected light properties, wherein refraction property changes of said optical means 62 are causing

light path changes of the light paths of said multiple light beams 7.1-7.7, wherein refraction property changes are caused in dependency of the amount of ice on a surface of said optical means 62, wherein said signal output at least differs between a situation without ice on said surface of said optical means 62 and a situation with ice on said surface of said optical means 62.

List of reference numbers

[0044]

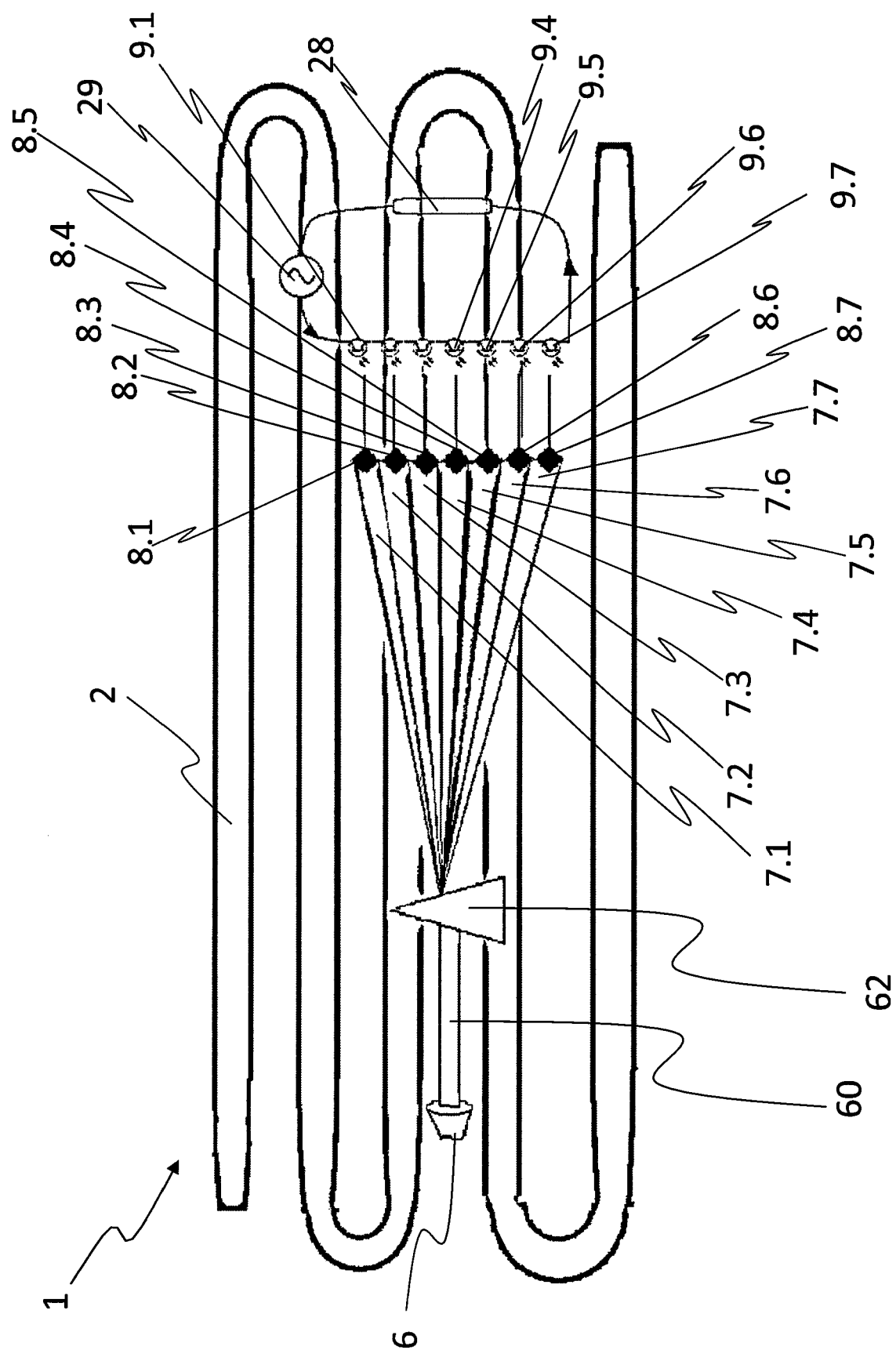
1	ice detection unit
2	heat exchanger means
6	light source
7.1	first light beam with first color
7.2	second light beam with second color
7.3	third light beam with third color
7.4	fourth light beam with fourth color
7.5	fives light beam with fives color
7.6	sixth light beam with sixth color
7.7	seventh light beam with seventh color
8.6	sixth detection means of color sensitive photo detector array
8.7	seventh detection means of color sensitive photo detector array
9.6	sixth transistor
9.7	seventh transistor
24	control unit
25	refrigerator
28	heating means
29	heater source
30	defrost heater current
60	light beam of white light
62	prism

Claims

1. Ice detection unit (1), at least comprising a light source (6) for emitting visible light (60), an optical means (62) for dividing said visible light (60) in multiple light beams (7.1-7.7), multiple detection means (8.1-8.7) for detecting light of said light beams (7.1-7.7) and for outputting of signals representing detected light properties, wherein refraction property changes of said optical means (62) are causing light path changes of the light paths of said multiple light beams (7.1-7.7), wherein refraction property changes are caused in dependency of the amount of ice on a surface of said optical means (62), wherein said signal output at least differs between a situation without ice on said surface of said optical means (62) and a situation with ice on said surface of said optical means (62).

2. Ice detection unit (1) according to claim 1,
characterized in that
said multiple detection means (8.1-8.7) are outputting said signals representing detected light in dependency of at least one predefined parameter, wherein said predefined parameter is at least the color of detected light and/or the light intensity of light. 5
3. Ice detection unit (1) according to claim 1 or 2,
characterized in that
the light source (6) emits white light (60) and said optical means (62) comprises or consist of a prism (62), wherein said prism (62) divides said white light (60) into light beams (71-7.7) having different colors. 10 15
4. Ice detection unit (1) according to any of the preceding claims,
characterized in that
each detector means (8.1-8.7) comprises a color sensitive photo detector, wherein said color sensitive photo detectors are arranged as array. 20
5. Ice detection unit (1) according to claim 4,
characterized in that
each color sensitive photo detector is coupled for signal exchange with a transistors (9.1-9.7), wherein said transistors are connected with each other in series. 25 30
6. Ice detection unit (1) according to claim 4,
characterized in that
each color sensitive photo detector is connected with a micro controller for analyzing signals outputted by said color sensitive photo detectors, wherein said micro controller (24) controls a heating means (28) in dependency of said analyzed signals. 35
7. Ice detection unit (1) according to any of claims 4 to 6,
characterized in that
each color sensitive photo detector (8.1-8.7) detects one of at least three, in particular at least or exactly or up to four, at least or exactly or up to five, at least or exactly or up to six or at least or exactly or up to seven, different colors. 40 45
8. Refrigerator (25), in particular no frost refrigerator, at least comprising
a cooling means (26) for cooling down the atmosphere inside the refrigerator (25),
a heater means (28) for melting of accumulated ice or snow inside said refrigerator (25),
an ice detection unit (19) according to any of the before mentioned claims for detecting ice (4) or snow inside the refrigerator (25) and for actuating the heater means (28) in dependency of detected ice (4) or snow. 50 55
9. Refrigerator (25) according to claim 8,
characterized in that
said cooling means is a heat-exchanger (2) and said optical means (62) is arranged on or besides said heat-exchanger (2).
10. Method for operating a refrigerator (25), at least comprising the steps:

Cooling down a food storage section by means of a cooling means (26),
Detecting ice (4) or snow inside the food storage section by means of operating an ice detection unit (1) according to any of claims 1 to 7,
Operating a heating means (28) in case the presence of ice (4) or snow is detected.
11. Method according to claim 10,
characterized in that
said light source (6) emits white light and said optical means (62) comprises or consist of a prism (62), wherein said prism (62) divides said white light into light beams (7.1-7.7) having different colors, wherein said light beams (7.1-7.7), which have different colors, are directed to specific detection means (8.1-8.7), wherein each detection means (8.1-8.7) outputs a signal in case a predefined color is detected.



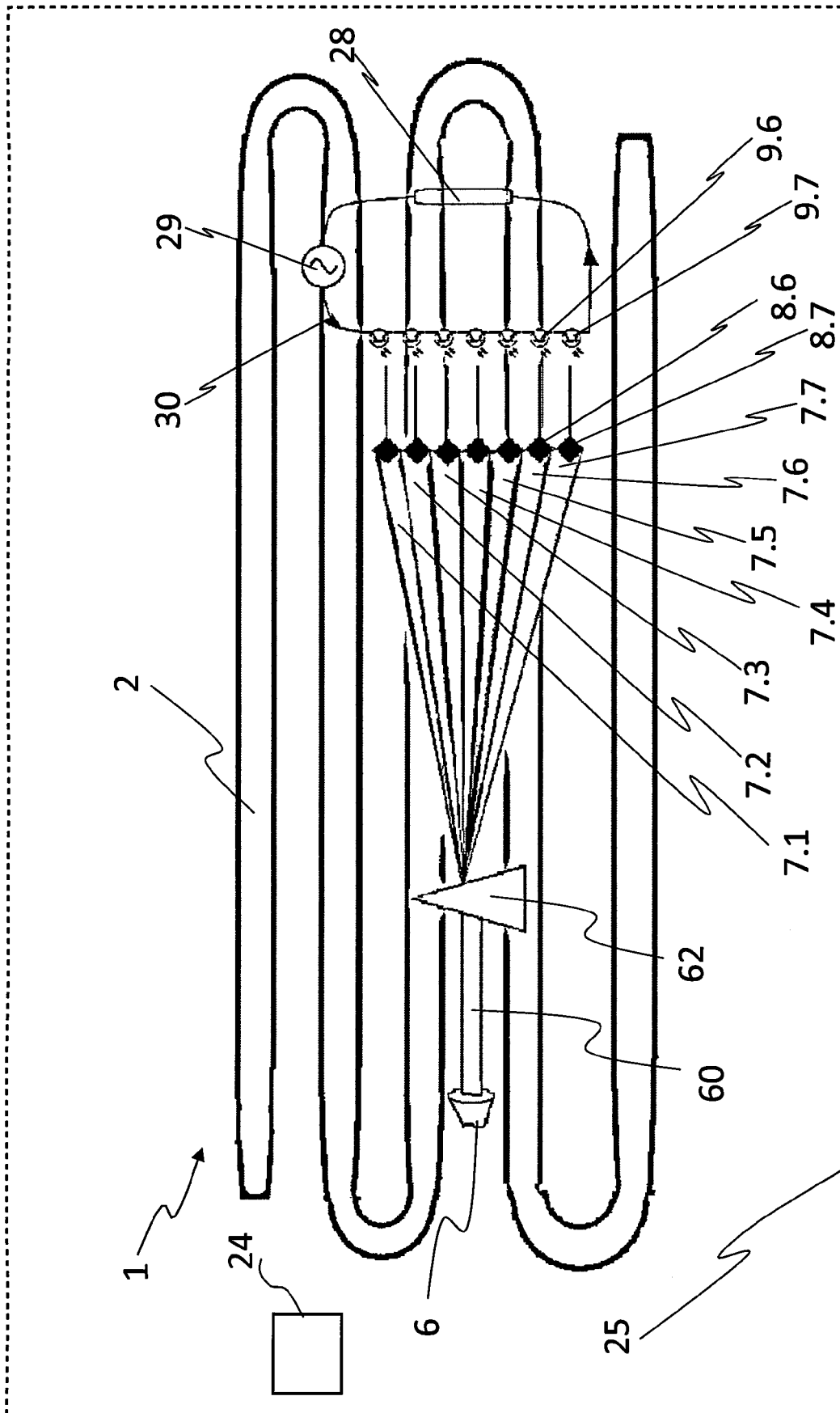


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			F25B F25D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 18 May 2017	Examiner Dezso, Gabor
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ON EUROPEAN PATENT APPLICATION NO.**

EP 16 20 6198

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

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