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(54) PLANT FOR MAKING ADJUSTABLE THICKNESS FLAKE ICE MADE WITH WATER OR OTHER LIQUID ELEMENTS

(57) System for producing flake ice whose principle is based on using two sides of the same evaporator (1) by employing two ice-breaking knives (3) that contemporaneously translate from one to the other side of the evaporator (1) such to allow the slab of ice formed on the two flat surfaces (2) to be detached by the combined action of spraying water (10) or another liquid or semi-thick element on its outer part and of circulating a refrigerant fluid or low temperature intermediate fluid inside the evaporator (1) which has a shape perfectly flat and free at the two sides inside which the channels (301) for the circulation of gas have been obtained.

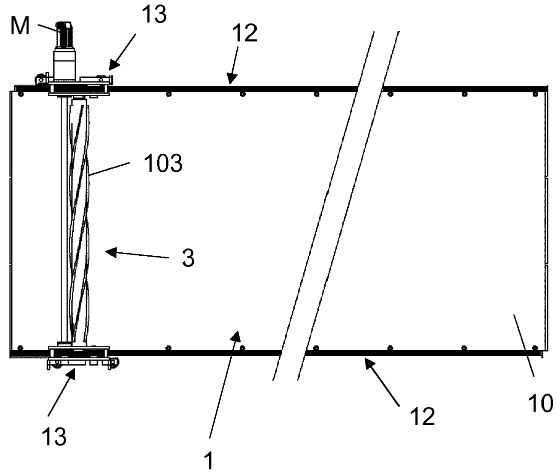

Fig. 1

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Description

[0001] The present invention relates to a flake ice making plant whose principle is based on spraying water or another semi-thick liquid element onto the surfaces of the two shell sides opposite to each other of the same heat exchanger (evaporator) inside such exchanger there are provided channels for generating a circulation of refrigerant fluid or low temperature intermediate fluid, for forming a slab of ice on said shell surfaces and along such shell surfaces two ice-breaking knives contemporaneously translate, one for each of said surfaces thus causing the slab of ice formed on said two surfaces to be detached and possibly causing said slab of ice to be broken to pieces.

[0002] Particularly the invention relates to a plant for making flake ice, possibly also with an adjustable thickness, made with water or other liquid elements according to the preamble of claim 1.

[0003] Information about known flake ice making plants are available in literature and on the market but most of them are characterized by using scraping knives or rotatable movable parts that contact the ice surface causing it to break which are used only on one shell side since, as they are circular apparatuses, namely with cylindrical exchangers, such action involves the use of evaporators with a considerable thickness and solid material (carbon steel, stainless steel) that have a reduced heat transfer capacity, mainly in view of the thickness necessary to withstand the stress (8...10 mm). These plants, since are circular with stationary evaporator, can use only one side of their surface. The temperature of the coolant gas, inside them, is always kept at values around -26/-30° in order to compensate for the reduced heat transfer capacity. There is a patent of 1965 (GB 1097932) that describes a circular evaporator with two knives but due to the complexity in carrying it out and to some obvious structural inconsistencies its manufacturing has not been carried out.

[0004] Current systems need water containing a moderate amount of salt (80 gr./1000L) to reduce its hardness and consequently the stress of the reduction unit moving the ice-breaking knife. The "flaking" cylinders (cylindrical evaporators) have diameters of 100/160 cm and they require a mechanism for rotating the knife with a lever arm of 50/80 cm with a consequent increase in the torque 6/8 times higher than the one described in the invention.

[0005] A second family of flake ice making plants is characterized by the use of vertical flat evaporators that use both the two surfaces and that are very similar, in the operation, to the one of the invention but without ice-breaking knives, however they are characterized by being made of stainless steel or carbon steel and by the need of reversing the cooling cycle for heating the ice such that the part in contact with the evaporator melts and allows the slab to fall down due to gravity then it being broken by another apparatus.

[0006] This technology does not allow subcooled ice (-6°) to be produced since it is brought back to 0° (melting ice) moreover it has a reduced C.O.P. due to the necessary time for carrying out the defrost cycle. No system available on the market uses the evaporator made of aluminium directly in contact with water due to corrosion and mechanical strength reasons, even if this element permits a heat transfer 12 times higher than stainless steel and 4 times higher than carbon steel if referred to the same thickness (10 mm).

[0007] The document US2010/0064717 describes a plant of said type and according to the preamble to claim 1 having an extruded, cylindrical heat exchanger.

[0008] The document describes several constructional arrangements of the heat exchanger which are all directed to obtain a final cylindrical shape both as a single piece and as composed of arcuate elements connected with each other such to form together a cylindrical shaped exchanger. One embodiment provides to use extrusions made of aluminium and particular planar extrusions, that is rectangular panels subjected to further processing steps for deforming the rectangular flat panels into circular sections or in a cylindrical element. Since the flat extruded piece is provided with internal webs delimiting the passage channels for the refrigerant fluid, such arcuate processing besides requiring greater costs and processing time is also critical since it involves high mechanical stresses on the webs that therefore can be unsuitably deformed, can change in their thickness and also have cracks that compromise the sealing between adjacent channels.

[0009] A further drawback of known devices, including the device according to US2010/0064717 is the fact that in order to drive and operate the ice-breaking knives, at least the inner knife, or both the knives are supported so as to protrude by a rotating arm coaxial with the cylinder shaft, therefore the construction is expensive and heavy and the movement of the arm with the knives requires a considerable driving power.

[0010] The invention aims at providing a plant for making adjustable thickness flake ice made with water or other liquid elements that by means of simple and inexpensive arrangements allows the above drawbacks of the current known plants to be overcome while increasing the productivity and reducing energy-related and structural costs.

[0011] According to a first aspect the invention solves the above problem by a plant for making flake ice made with water or other liquid elements according to the preamble of claim 1 that provides in combination the characteristics of the characterizing part of said claim 1.

[0012] In this case, the evaporator is composed of a flat panel provided with two heat transfer surfaces parallel to each other and composed of external sides of walls placed on the opposite faces of said panel while a plurality of channels for circulating the refrigerant fluid or the low temperature intermediate fluid are interposed between said walls, there being provided two of said ice-breaking knives, each ice-breaking knife being intended to operate on a corresponding heat transfer surface.

[0013] According to a further advantageous characteristic, the heat transfer surfaces have at least two opposite peripheral edges that are parallel to each other and to the advancing direction of the ice-breaking knife or knives along the corresponding surface of the heat exchanger, while said knife or said pair of knives is mounted at its ends on a sliding element or on a carriage or on a slide respectively, which slide along sliding guides carried by said heat exchanger at said peripheral edges parallel to each other.

[0014] Advantageously the sliding elements or the carriages or the slides are made in the form of a bridge overlapping the corresponding peripheral edge of the exchanger and with a central area cooperating with the corresponding sliding guide the sliding guides being provided at the head sides of the exchanger along said peripheral edges, parallel to each other and oriented in the advancing direction of the ice-breaking knives, while they have extensions supporting the ends of the rotation shafts of the ice-breaking knives on the two opposite sides of the heat exchanger.

[0015] By such arrangement the supports of the knives are very compact and light and easily enable the fact that at least one sliding element, or a carriage or a slide are motorized.

[0016] One embodiment provides that at least one sliding element or at least one carriage or at least one slide bears at least one motor driving the translation in the advancing direction of the ice-breaking knives, which motor drives at least one pinion cooperating with a rack fastened to the heat exchanger along the corresponding peripheral edge of the exchanger and/or along the corresponding sliding guide.

[0017] It is possible to provide several variants.

[0018] In a variant said at least one motor drives only the translation of the ice-breaking knives.

[0019] The knives can be composed of stationary elements, such as scraping blades or spatulas or the like.

[0020] The knives can be also of the rotating type.

[0021] In this case in combination with the translation it is possible to provide both the passive rotation and the active rotation.

[0022] In the event of passive rotation of the knives, the translation movement of the knives along the surface of the heat exchanger, in combination with the engagement of the blades in the ice layer, causes the knives mounted so as to rotate idle about an axis to be entrained by rotation.

[0023] In the event of an active rotation it is possible to provide also a separate motor for rotatably driving individually each knife or in an engaged manner all the knives.

[0024] In this last case of the active rotation it is also possible a variant where a single motor by suitable transmissions provides both to move the knives along the heat exchanger, and to rotate the knives.

[0025] Still according to a non limitative embodiment, when there are provided rotating ice-breaking knives, they are composed of a cylindrical core from which ice-breaking blades protrude that end by their operating edge along a cylindrical envelope surface coaxial with the cylindrical core and said knives are mounted so as to rotate about the shaft of said cylindrical core, said shaft being oriented transverse to the advancing direction of said knives along the surfaces of the opposite sides of the heat exchanger.

[0026] In one embodiment the blades are of the helical type.

[0027] It is also possible to provide possibly a higher number of helical blades each knife rotating similarly to a multi-start screw thread.

[0028] The pitch of the helical arrangement can be selected according to the requirements of breaking the slab of ice.

[0029] A particularly advantageous embodiment provides the heat exchanger to be composed of a rectangular shaped flat panel.

[0030] By the arrangement described above it is possible to make the heat exchanger in the form of an extruded panel having a predetermined thickness and two flat surfaces parallel to each other on opposite sides there being provided a plurality of passage channels for the fluid comprising one or more flat elements wherein channels for circulating the refrigerant fluid or the low temperature intermediate fluid are obtained which are made in the thickness of said panel.

[0031] Advantageously the extruded panel is a section bar made of aluminium.

[0032] Still according to a further advantageous characteristic, the heat transfer surfaces are covered each one by a sheet, preferably made of steel.

[0033] The inventor has made and tested a prototype of the ice maker by using three extrusions made of aluminium of cm 400 x 35h and 1,6 of thickness, composed of 12 channels for the circulation of gas at a temperature of -15°C covered on both the sides by a sheet of SAE 304 stainless steel with a thickness of 10/10 mm for protecting the underlying extrusion made of aluminium.

[0034] The reduced thickness of the sheet of stainless steel does not exhibit important mitigations as regards heat transfer with the extrusion and the making of ice on its surface is fast almost as the aluminium.

[0035] The covering sheets are sprayed by a thin water spray producing slabs of ice with thicknesses adjustable from 1 mm to 3 mm with the thickness difference not affecting the detaching capacity but resulting only in the different output per hour.

[0036] The detaching step is produced by the knives hitting on the meniscus of ice formed on the two shell sides. The ice, transformed into flakes of small sections falls within the transport tray such to be introduced in the storage bin. The production cycle is carried out:

- Spraying the heat transfer surfaces of the exchanger/evaporator on both the sides for 15";

- Stopping the pump to cause the formed ice to freeze up to the temperature of -8°C;
- Starting the ice-breaking knife that completes its travel (for a panel long 4 mt. in 10") by going at the other shell side (Fig.1).
- Starting the production cycle for returning back to the opposite side.

[0037] Therefore the knives go to and fro from one end to the other one of the panel composing the heat exchanger where the ice layers are formed.

[0038] The position of the panel forming the heat exchanger advantageously is the vertical or substantially vertical one. However this position has not to be considered limiting any other orientation in the space of the heat exchanger.

[0039] The evaporation temperature remains set between - 15° and -18° for the whole production cycle.

[0040] The invention solves and improves the following drawbacks present in currently known ice making plants:

- Compared with a traditional vertical drum plant, twice the ice-forming surface is used, since the two sides of the evaporator are used.
- In the same occupied space it is possible to produce 300% more of ice with an energy consumption lower by 30-40% and therefore with a coefficient of performance (C.O.P.) passing from 1,5 to 2,1.
- The heat transfer of the ice-forming surface improves from W.m.k° 17 to 290 for the use of the extrusion of aluminium.

[0041] Further objects and advantages of the present invention will be more clear from the following detailed description of some embodiments of the invention, made with reference to the annexed figures, wherein a plant according to the invention is schematically shown.

Figure 1 is a side elevation view of the exchanger with the rotating ice-breaking knives according to the present invention.

Figure 2 is a cross-section of the exchanger with the ice-breaking knives.

Figures 3 and 4 are enlarged views of the upper carriage and of the lower one respectively supporting the corresponding ends of the ice-breaking knives.

[0042] With reference to the annexed drawing, 1 denotes the board or panel forming the heat exchanger for making the ice.

[0043] In one embodiment the exchanger is composed of an evaporator of a thermodynamic circuit intended to carry out a fluid compression and evaporation cycle according to one of the different known refrigeration cycles.

[0044] In the preferred shown embodiment the heat exchanger is composed of a rectangular flat panel. The two opposite faces of the rectangular panel are parallel to each other and are composed of two flat walls both in thermal contact with circulation channels provided in the intermediate gap between said two walls.

[0045] Advantageously, according to one embodiment, this heat exchanger can be made as an extruded section bar, with the two faces composed of flat walls 101 connected with each other by means of intermediate ribs 201 which are parallel and spaced apart from each other such to form a plurality of parallel channels 301 extending in a direction parallel to two peripheral edges opposite and parallel to each other of the panel.

[0046] Suitably shaped terminals for connecting the ends of the channels with each other at the head sides of the panel oriented transverse to the axes of the channels 301, connect pairs of channels with each other such to form a coil circulation or the like that distributes the coolant fluid on the surface of the walls composing the two faces of the panel.

[0047] Advantageously the panel is made of aluminium.

[0048] A sheet 2 or covering membrane preferably made of stainless steel is coupled to the outer surfaces of the panel faces.

[0049] Advantageously these two membranes or sheets are bordered by a seal glued on the perimeter such to prevent moisture from entering between the two different surfaces, that is between the rear side of the sheets and the surface of the respective coupling wall of the exchanger.

[0050] Spray nozzles 10 (not shown in detail) spray water jets on the outer surface of the sheets which keep wet the ice producing surfaces.

[0051] Thus a slab of ice adherent to the outer surfaces of the sheets 2 on the two opposite faces of the exchanger is generated. Such slabs of ice are detached by means of a pair of ice breaking knives 3.

[0052] It is possible to provide any type of ice breaking knife both static, such as for example a scraping knife and a rotating one.

[0053] In the shown embodiment there is provided a rotating ice breaking knife 3 for each face of the heat exchanger. The knives have a cylindrical core mounted on a rotation shaft and a series of helical blades 103 radially protrude therefrom ending with their active operating edge at a cylindrical envelope surface coaxial to the cylindrical core and to the rotation shaft.

[0054] The ice breaking knives both of the static type not shown and of the type shown in the example are mounted so as to translate parallel to a pair of opposite peripheral edges parallel with each other of the flat panel composing the heat exchanger. The translation means provide a unit for the end stop and for reversing the translation direction at the head ends of the panel composing the heat exchanger, such that the knives move forward and backward between the two ends of the panel with reference to the translation direction of the knives.

[0055] In the shown example the knives are translated in a direction perpendicular to their rotation shaft.

[0056] The translation and the possible rotation of the knives can be carried out independently for each knife.

[0057] However in the preferred embodiment by the shape of the exchanger it is possible for the two knives 3 to be translated together and operated together so as to rotate by a single motor M by means of transmissions for the motion of the motor to the translation devices and to the knives, for advancing and rotating them respectively.

[0058] With reference to the devices translating and rotating the knives 3, the particular configuration of the heat exchanger according to the invention, that is in the form of a flat panel inside which coolant fluid circulation channels are obtained and providing at least two peripheral edges parallel to each other on the opposite sides of the panel and two surfaces producing the slabs of ice parallel to each other and placed on the opposite faces of the panel, allows these devices to be made in a very simple, strong manner, such to guarantee an optimal accuracy in positioning the knives with respect to the slab of ice. Moreover the characteristics of the shape of the heat exchanger allow the translation and rotational operating devices to be made with a very light construction and therefore such to require a relatively low driving power.

[0059] Particularly with reference to the present example, along the two longer edges of the panel composing the heat exchanger and that, considering the shown position of the panel, in this example coincide with the upper and lower horizontal edges, there is provided a sliding guide 12 respectively. Astride of said guide two slides 13 are placed, an upper slide and a lower slide respectively connected with each other at extensions beyond the two faces of the exchanger. The two slides 13 can be connected to each other by the shafts around which the ice breaking knives 3 rotate or in another manner.

[0060] The forward movement of the knives in the direction parallel to the longitudinal, horizontal edges and therefore to the two guides 12 occurs by means of a motor M carried by the upper carriage and that by means of a transmission drives two pinions 14, placed at the two ends respectively of a spindle mounted so as to rotate in the two slides 13. The pinions 14 are provided at one of two longitudinal horizontal edges respectively of the heat exchanger and in particular substantially at one side of the sliding guides 12, there being provided in a position coinciding with each pinion 14, a rack 15 extending for all the length of said guides 12.

[0061] In the shown embodiment the ice-breaking knives are mounted so as to rotate idle on their shafts and the rotation thereof is determined by the combination of the engagement of the knives in the slab of ice and by the translation of the knives along the exchanger, therefore the multi-start helical blades cause the knives to rotate by entrainment.

[0062] A possible variant may provide on the contrary a transmission not shown in detail that connects the motion of the motor M to the two knives for rotatably driving them about their shaft.

[0063] It has to be noted how the arrangement according to the present invention allows the technical problems of weight and inertia of motion of the known devices to be overcome.

[0064] Regardless of the specific arrangement of the transmission and slides, what is important is that the knives are not supported so as to protrude, but the load of the slides 13 is absorbed by the exchanger itself and in a manner substantially balanced with respect to the central plane oriented in the translation direction of the knives along the exchanger itself.

[0065] This makes it possible to have a very compact, strong and lightweight construction and therefore requiring driving power reduced than the one necessary for moving the knives of the known plants.

[0066] Still according to a further characteristic, the transverse encumbrance of the plant is considerably reduced and therefore it is possible to provide several parallel plants side by side to each other.

[0067] It is also very simple to make plants with exchangers having variable lengths in a modular manner, that is formed by a variable plurality of panels connected in line with each other and having predetermined unit measures.

[0068] Finally it has to be noted that even if the vertical position of the exchanger 1, such as that shown in the figures is the preferred one, also as regards the falling trajectories of the ice flakes 11 produced during the removal of the slab of ice by the ice-breaking knives 3, it is possible to provide also different orientations of the exchanger, that is having different inclinations with respect to the vertical direction.

[0069] Figures 2 to 4 show the ice detaching step that takes place quickly and continuously under the transit of the knives 3. In this step the refrigeration cycle keeps the temperature of the evaporator 1 constant.

[0070] Still according to a further improvement characteristic, one or both the ice-breaking knives 3 can be mounted on the slides 13 in a manner adjustable as regards their distance from the corresponding surface of the heat exchanger where the slab of ice is generated. In order to do this it is possible to provide any known means, such as for example supports of the ends of the rotation shafts of the knives on the respective slide that are movable and lockable in place along translation guides oriented perpendicularly to the heat transfer surfaces of the heat exchanger and integral with the slides 13.

[0071] In figures 1 to 4 the reference numerals refer to the following constructional parts.

1	HEAT EXCHANGER/EVAPORATOR
101	WALLS OF THE HEAT EXCHANGER
201	RIBS
301	CHANNELS FOR CIRCULATION OF COOLANT FLUID
2	COVERING SHEET MADE OF STAINLESS STEEL

3 ICE-BREAKING KNIFE
103 HELICAL BLADES
10 WATER SPRAYING DEVICE
11 ICE FLAKES
M KNIFE TRANSLATING MOTOR
12 SLIDING GUIDE
13 SLIDE
14 TRANSLATION PINIONS
15 RACK

[0072] The invention relates also to a variant of the flake ice making plant that is shown in figure 5.

[0073] Such variant is based on the principle of using an elastic membrane, whether a metallic one or of another deformable and heat conducting material, that is able to perfectly adhere on a variable dimension surface (determined by the desired ice output) and that is able to inflate step denoted by 22 in figure 5 and to return back in the initial position step denoted by 21, such to allow the slab of ice formed on its two surfaces to be detached due to the combination of spraying water or another liquid or semi-thick element on its outer part by means 24, and of the circulation of refrigerant fluid or low temperature intermediate fluid into the evaporator that has a shape perfectly flat and free at the two sides inside which channels for the circulation of the gas have been obtained such as denoted by 28 (in the mentioned case it is an aluminium extrusion).

[0074] Information about other flake ice making plants are available in literature and on the market but they are characterized by using scraping knives or rotatable or movable parts that contact the ice surface causing it to break. Such action leads to the need of making evaporators with a considerable thickness and of a solid material (carbon steel, stainless steel) that have a reduced heat transfer capacity, above all in view of the thickness necessary to withstand the stress (8...10 mm). These plants can use only one side of their surface and the temperature of the gas inside them is always kept at values around -26/-30° with the coefficient of performance of about 1,4. Therefore in order to produce subcooled ice with a final temperature of -6° it is necessary to maintain a temperature difference ranging from 19 to 24°C between the refrigerant gas and the produced ice. It is necessary to use salt diluted in the production water to reduce hardness of the ice which would affect the life of the mechanical members.

[0075] On the contrary in the plant according to figure 5 since the refrigerated structure is made of aluminium with a reduced thickness, the heat transfer is much higher and therefore the refrigerant can evaporate at a higher temperature (-15°C) with a consequent increase in the performances of the refrigerating cycle in the order of 60% (Coefficient of Performance 2,1).

[0076] A second family of flake ice makers is characterized by the use of vertical flat evaporators that use the two surfaces and that are very similar, in the operation, to the one of the invention, however they are characterized by being made of stainless steel or carbon steel and the by the need of reversing the cooling cycle for heating the ice such that the part in contact with the evaporator melts and allows the slab to fall down. This technology does not allow subcooled ice to be produced since it is brought back to 0° moreover it has a reduced Coefficient of performance due to the necessary time for carrying out the defrost cycle.

[0077] No system available on the market uses the evaporator made of aluminium directly in contact with the water due to corrosion and mechanical strength reasons, even if this element permits a heat transfer 12 times higher than stainless steel and 4 times higher than carbon steel.

[0078] A prototype of the plant according to figure 5 has been made, by using two extrusions made of aluminium of cm 200 x 50h and 3 of thickness, composed of 13 channels for the circulation of gas at a temperature of -15°C covered on both the sides by a sheet of Sae 304 stainless steel with a thickness of 4/10 mm on whose perimeter a border made of elastic rubber has been applied by burning such to allow it to be moved without subjecting the steel to a mechanical stress.

[0079] The reduced thickness of the sheet of stainless steel does not exhibit important mitigations as regards heat transfer with the extrusion and the production of ice on its surface takes place with a heat transfer coefficient almost equal to that of aluminium.

[0080] The sheet has been sprayed by an atomized water spray producing slabs with thicknesses adjustable from 1 mm to 7 mm with the thickness difference not affecting the capacity of being detached.

[0081] The detachment step occurs by the inflation with dry air between the membrane and the extrusion, step denoted by 22, by introducing a maximum pressure of 0,2 bar, the detachment occurs readily on the whole surface that has been previously exposed to the water spray.

[0082] The duration of the cycle directly depends on the volume of the air suction pump, anyway it does not exceed 20". The evaporation temperature remains set between -12° and -16° for the whole production cycle.

[0083] Compared with a traditional vertical drum plant, the surface on which the ice is produced by the new system, can be from two to six times greater with the occupied space being the same, to the advantage of output that can be twice than in the vertical cylinder, in relation to the overall volume of the machine.

[0084] Further objects and advantages of the present invention will be more clear from the following detailed description of some embodiments of the invention, made with reference to the single figure in the annexed drawing, where a plant according to the invention is schematically shown.

[0085] With reference to figure 5 it shows the board (evaporator) coupled to the two stainless steel membranes bordered by a seal glued on the perimeter. The effect of water that keeps the ice producing surfaces 26 wet is visible. The membrane remains perfectly glued on the evaporator due to the suction produced by the vacuum pump.

[0086] 22 shows the ice detaching step that readily occurs under the action of the compressed air that takes the inner space between the two membranes 223 and the evaporator.

[0087] In this step the refrigerating cycle keeps the temperature of the evaporator as constant, therefore there is no need for a defrost cycle.

[0088] 21 shows the membrane suction step that takes place by opening the valve 221 and 210 that puts the inner space between the evaporator and the membrane in communication with a storage tank 216. This is constantly kept in vacuum condition (this allows vacuum pumps with small dimensions to be used that can work while ice is forming).

[0089] Valves 23 and 25, alternatively, provide to introduce the pressure necessary for inflating the membrane for the ice detaching step.

[0090] 216 denotes a vacuum tank, 217 denotes a pressurized tank, 219 denotes a vacuum pump, 220 show dehydrator filters for taking external air. A solenoid valve 221 opens when the amount of air in the circuit is insufficient (it acts only for compensating for small air leakages from the circuit).

[0091] Number 212 denotes a check valve (one-way valve) and 215 a pressure adjusting valve, while 214 and 29 denote solenoid valves supplying water to the membrane.

[0092] The number 24 denotes the nozzles spraying water on the membranes, when the membrane is in step 21.

Claims

1. Flake ice making plant, comprising a heat exchanger provided with at least one heat transfer surface, a circuit feeding a refrigerant fluid or a low-temperature intermediate fluid to the evaporator, a device for spraying water or another liquid or semi-thick element on the heat transfer surface and at least one rotating or scraping ice-breaking knife for crushing the ice layer formed on the heat transfer surface,
characterized in that
the heat exchanger, possibly in the form of an evaporator, is composed of a flat panel provided with two heat transfer surfaces composed of the outer sides of walls placed on the opposite faces of said panel, while a plurality of channels for circulating the refrigerant fluid or the low temperature intermediate fluid are interposed between said walls, there being provided two of said ice-breaking knives, each ice-breaking knife being intended to operate on a corresponding heat transfer surface.

2. Plant according to claim 1, wherein the heat transfer surfaces have at least two opposite peripheral edges that are parallel to each other and to the advancing direction of the ice-breaking knife or knives along the corresponding surface of the heat exchanger, while said knife or said pair of knives is mounted at its ends on a sliding element or on a carriage or on a slide respectively, which slide along sliding guides carried by said heat exchanger at said peripheral edges parallel to each other.

3. Plant according to claim 2, **characterized in that** the sliding elements are made in the form of a bridge with a central area cooperating with the corresponding sliding guide the sliding guides being provided at the head sides of the exchanger along said peripheral edges, parallel, oriented in the advancing direction of the ice-breaking knives, while they have extensions supporting the ends of the rotation shafts of the ice-breaking knives on the two opposite sides of the heat exchanger.

4. Plant according to one of the preceding claims, wherein at least one sliding element, or a carriage or a slide are motorized.

5. Plant according to one or more of the preceding claims, wherein at least one sliding element or at least one carriage or at least one slide bears at least one motor driving the translation in the advancing direction of the ice-breaking knives, which motor drives at least one pinion cooperating with a rack fastened to the heat exchanger along the corresponding peripheral edge of the exchanger and/or along the corresponding sliding guide.

6. Plant according to one or more of the preceding claims, wherein the ice-breaking knives are mounted so as to rotate idle and they rotate by a combined action of engagement of the blades in the corresponding slab of ice and of translation of the knives along the heat exchanger or they are rotatably driven by a motor, preferably said at least one motor.

7. Plant according to one or more of the preceding claims, wherein the ice-breaking knives are composed of a cylindrical core from which ice-breaking blades protrude that end by their operating edge along a cylindrical envelope surface coaxial with the cylindrical core and said knives are mounted so as to rotate about the shaft of said cylindrical core, said shaft being oriented transverse to the advancing direction of said knives along the surfaces of the opposite sides of the heat exchanger.

8. Plant according to one or more of the preceding claims, wherein the flat panel forming the heat exchanger has a rectangular shape.

9. Plant according to one or more of the preceding

claims, wherein the heat exchanger is an extruded panel having a predetermined thickness and two surfaces flat and parallel to each other on opposite sides there being provided a plurality of passage channels for the refrigerant fluid or the low temperature intermediate fluid which are made in the thickness of said panel.

10. Plant according to one or more of the preceding claims, wherein said flat panel is composed of an extruded section bar made of aluminium.

11. Plant according to one or more of the preceding claims, wherein the heat transfer surfaces are covered each one by a sheet of steel.

12. Plant according to one or more of the preceding claims, wherein the ice-breaking knives are translatable from a starting position to an end position and vice versa along the corresponding heat transfer surface by means of end stop units that control the reverse of the driving motion.

13. Plant according to claim 8, wherein each ice-breaking knife has a size corresponding to the length of a first side of the heat transfer surface, and it is translatable parallel to itself along a second side perpendicular to said first side, the starting and end positions being at the opposite ends of the second side.

14. Plant according to one or more of the preceding claims, wherein each ice-breaking knife is supported adjustable as regards the distance of the blades from the corresponding heat transfer surface.

15. Flake ice making plant, comprising an evaporator provided with a heat transfer surface, a circuit feeding a refrigerant fluid or low temperature intermediate fluid to the evaporator, a device spraying water or another liquid or semi-thick element on the heat transfer surface,

characterized in that

it is based on detaching slabs of ice from a heat exchanger deforming by inflation the walls of said heat exchanger which comprises:

a heat exchanger with one or more flat elements where channels for the circulation of the refrigerant fluid or low temperature intermediate fluid are obtained;

at least one elastic deformable and heat conducting membrane, which elastic membrane has said heat transfer surface it being in thermal contact by adhering to the walls of said heat exchanger, there being provided a circuit feeding compressed air in the intermediate space between the elastic membrane and the evaporator, which compressed air causes the elastic membrane to be deformed by inflation, such to detach from the elastic membrane the ice formed thereon;

the heat exchanger is composed of at least one flat panel, there being provided two said elastic membranes placed on the opposite faces thereof and said elastic membrane is made of steel.

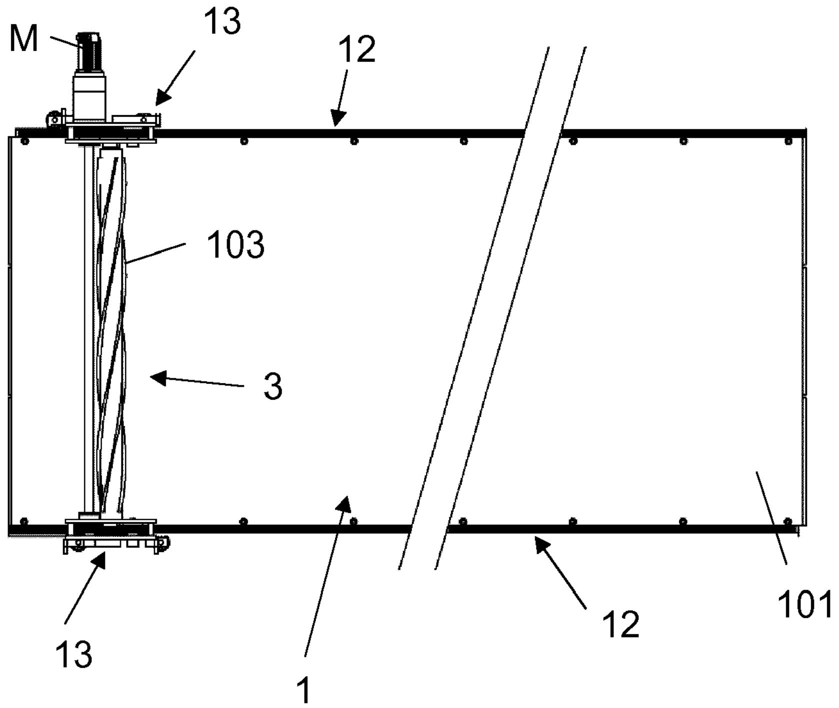

Fig. 1

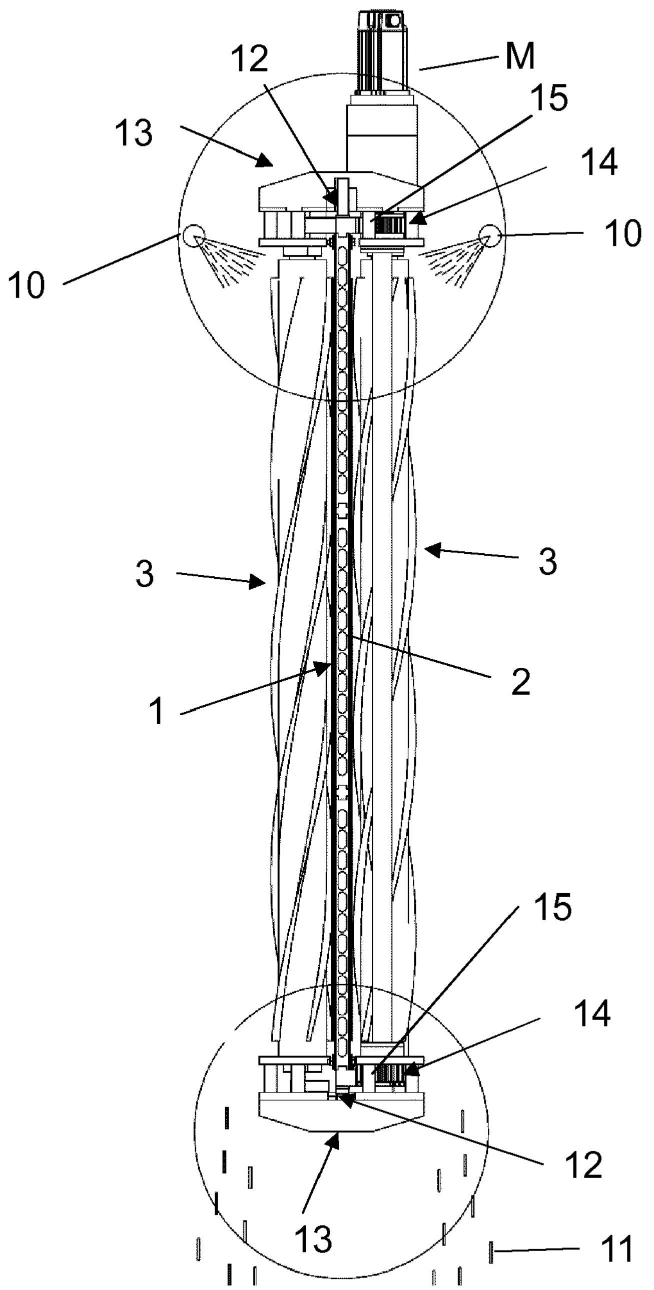

Fig. 2

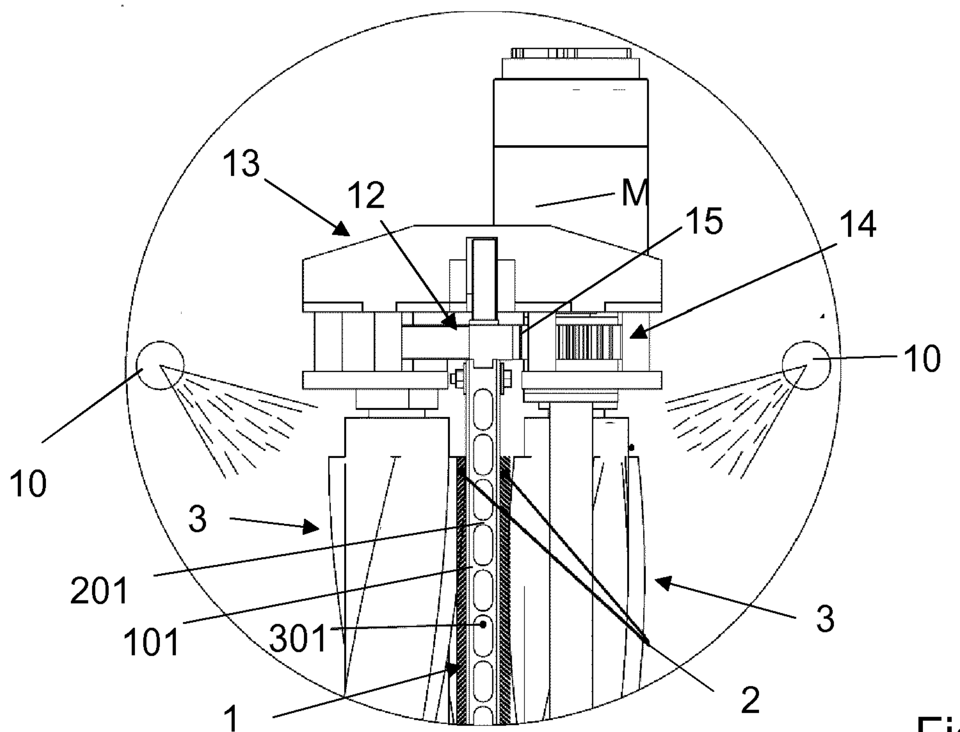

Fig. 3

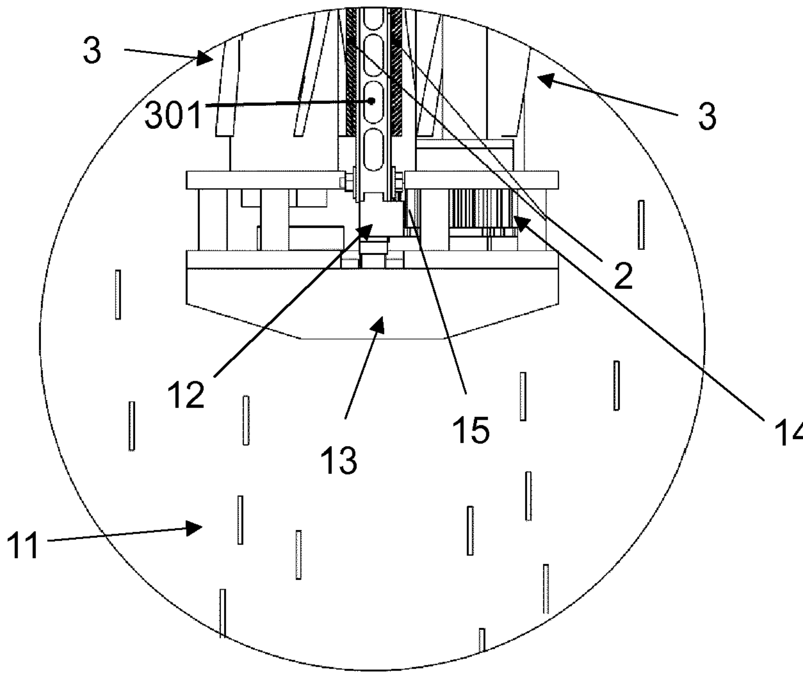

Fig. 4

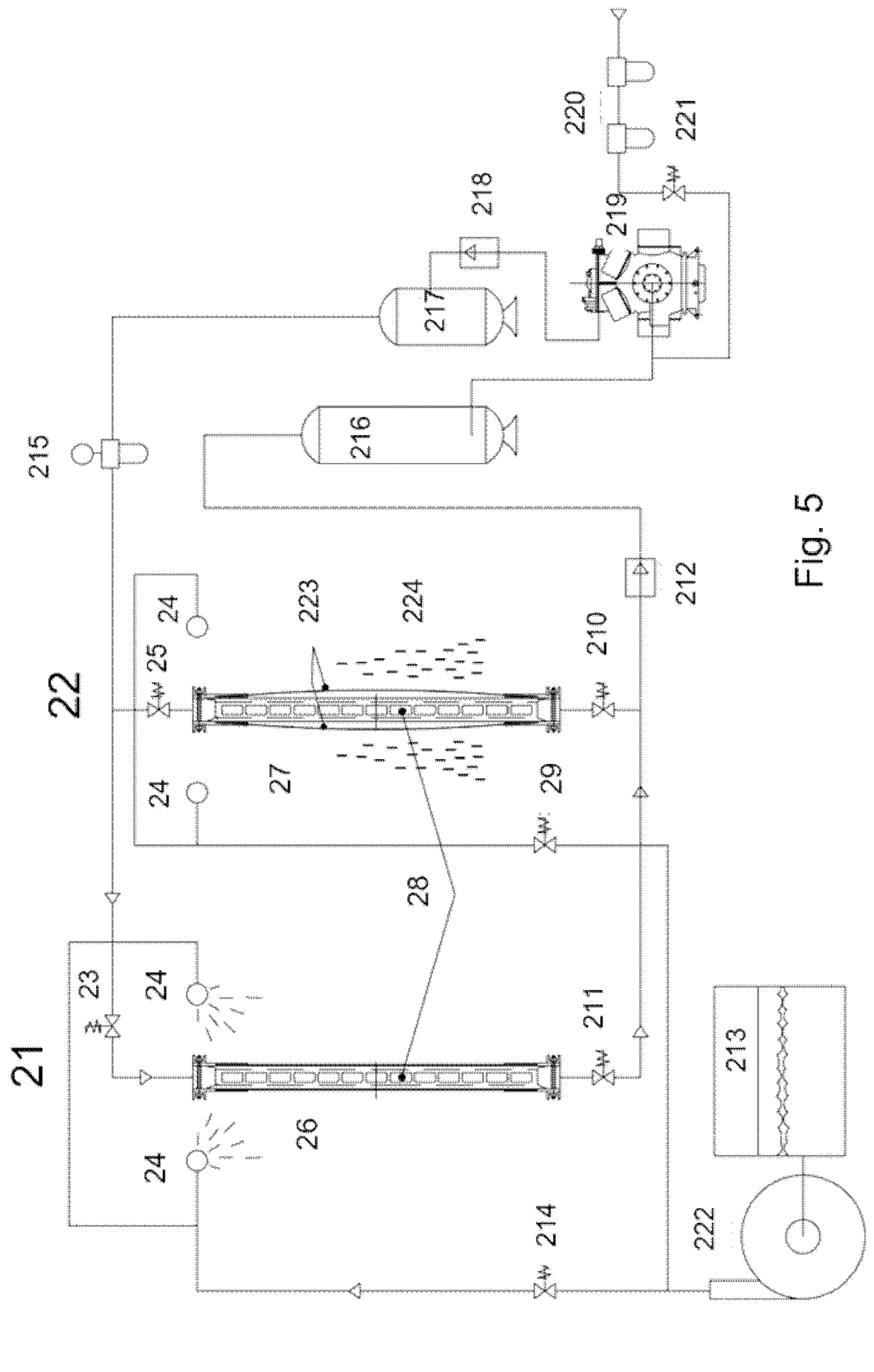
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Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 2674

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/064717 A1 (BURN MARK [US]) 18 March 2010 (2010-03-18) * paragraphs [0013], [0034], [0038], [0089]; figures 1,2,5,6,15 *	1-14	INV. F25C1/14
X	US 5 632 159 A (GALL ANDREW T [US] ET AL) 27 May 1997 (1997-05-27) * column 4, line 53 - column 5, line 40; figures *	1	
X	WO 2004/025197 A1 (FLAGA ICE [DK]; JENSEN BRIAN [DK]) 25 March 2004 (2004-03-25) * abstract; figures *	1	
X	US 5 329 780 A (BROADBENT JOHN A [US]) 19 July 1994 (1994-07-19) * column 3, line 7 - column 6, line 38; figures *	15	
X	US 2 683 356 A (GREEN JR CHARLES M) 13 July 1954 (1954-07-13) * column 2, line 32 - column 3, line 36 * * column 5, lines 4-48 * * column 12, lines 26-52; figures *	15	TECHNICAL FIELDS SEARCHED (IPC) F25C F25D F25B
A	JP 2006 084162 A (TOYOTA MOTOR CORP) 30 March 2006 (2006-03-30) * abstract; figure 3 *	1-14	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	18 December 2015	Vigilante, Marco

CATEGORY OF CITED DOCUMENTS

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18-12-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010064717 A1	18-03-2010	US 2010064717 A1	18-03-2010
		US 2012124836 A1	24-05-2012
		WO 2010033146 A1	25-03-2010
US 5632159 A	27-05-1997	AU 2211097 A	22-10-1997
		EP 0890064 A1	13-01-1999
		US 5632159 A	27-05-1997
		US 5918477 A	06-07-1999
		WO 9737175 A1	09-10-1997
WO 2004025197 A1	25-03-2004	AU 2003260285 A1	30-04-2004
		WO 2004025197 A1	25-03-2004
US 5329780 A	19-07-1994	NONE	
US 2683356 A	13-07-1954	NONE	
JP 2006084162 A	30-03-2006	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 1097932 A **[0003]**
- US 20100064717 A **[0007] [0009]**