US 20040187518A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2004/0187518 A1

(43) Pub. Date: Sep. 30, 2004

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(54) DEVICE AND METHOD FOR STORING AND REGENERATING A TWO-PHASE COOLANT FLUID

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(21) Appl. No.: **10/481,959**

(22) PCT Filed: **Jul. 1, 2002**

(86) PCT No.: **PCT/FR02/02282**

(30) **Foreign Application Priority Data**

Jul. 3, 2001 (FR) 01.08821

Publication Classification

(51) **Int. Cl.**[7] **F25D 17/02**

(52) **U.S. Cl.** **62/434**; 62/435

(57) **ABSTRACT**

The invention concerns a device for storing a two-phase coolant fluid **(4)** designed to circulate in a heat transfer circuit **(10)**, comprising: a compartment **(2)** for storing and regenerating the two-phase coolant fluid; at least an indirect heat exchange means **(6)** between a refrigerant and the coolant fluid **(4)**; a circulating means **(8)** to circulate the coolant fluid **(4)** in the heat transfer circuit **(10)**; a two-phase recycling and cooling circuit for the coolant fluid **(4)**. Said device comprises: another compartment for ice slurry conditioning **(20)**, connected to the heat transfer circuit **(10)**; means for introducing part of the coolant fluid **(4)**, enriched in solid phase, into said other compartment; a drawpoint **(24)** on the storage and regeneration compartment **(2)**, and means for injecting **(26, 28)** the coolant fluid in liquid phase, into said other compartment; and a mixing member, co-operating with said other compartment.

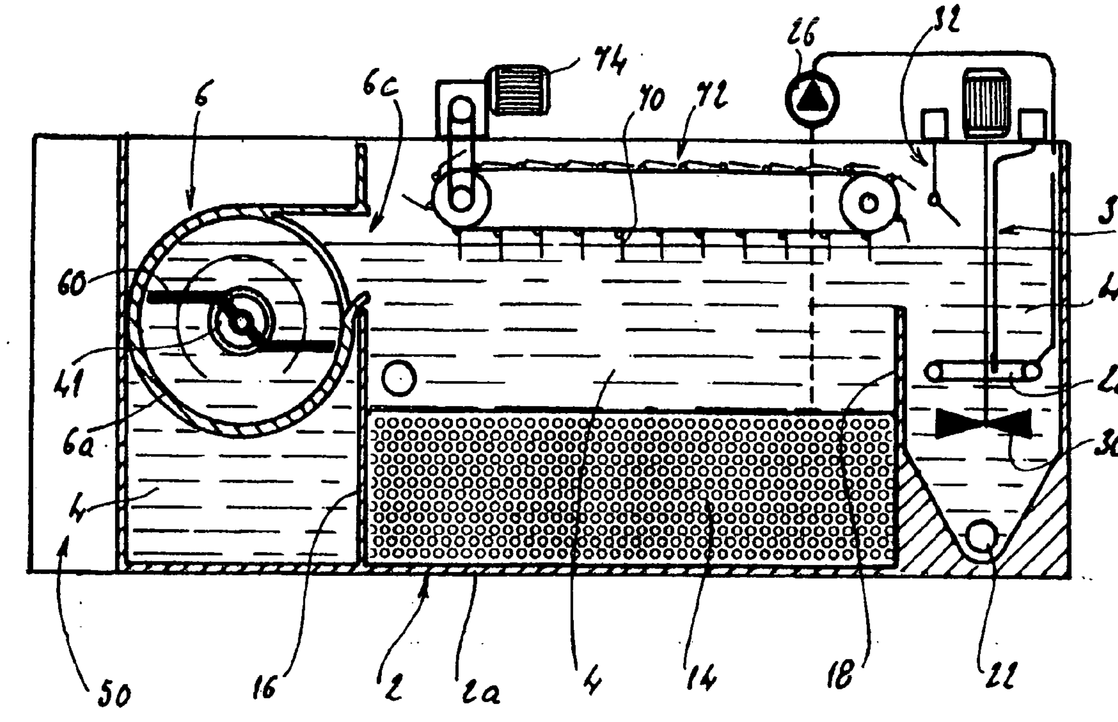


FIG 1

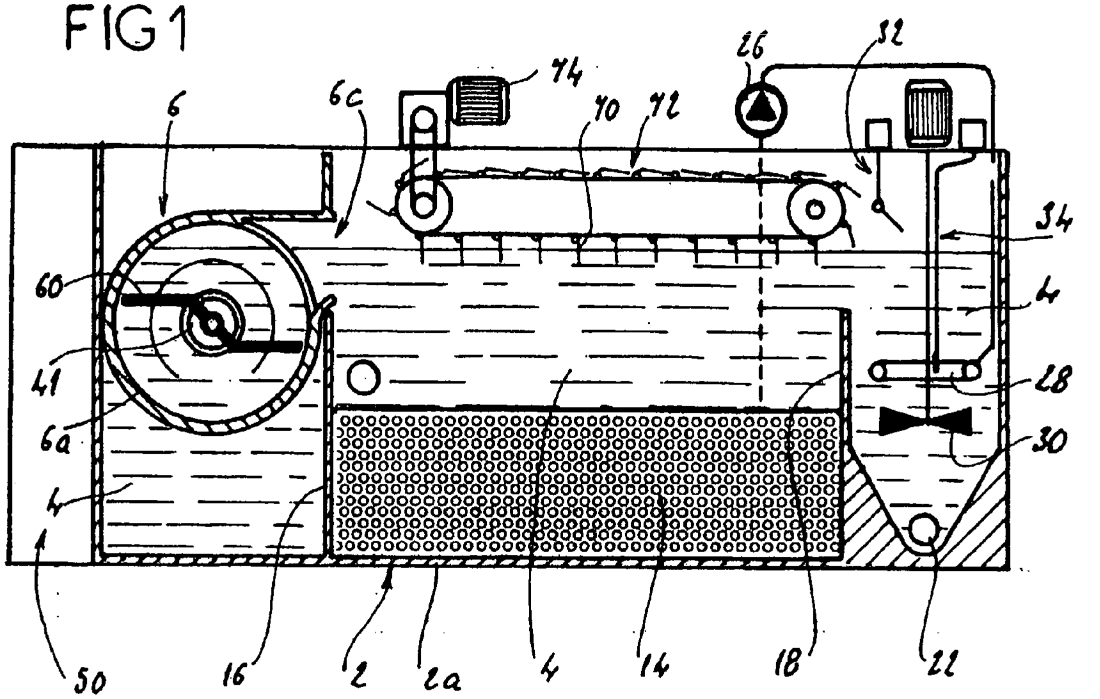

6
6c
74
70
72
26
32
34
60
41
6a
4
28
30
50
16
2
2a
14
18
22

FIG 2

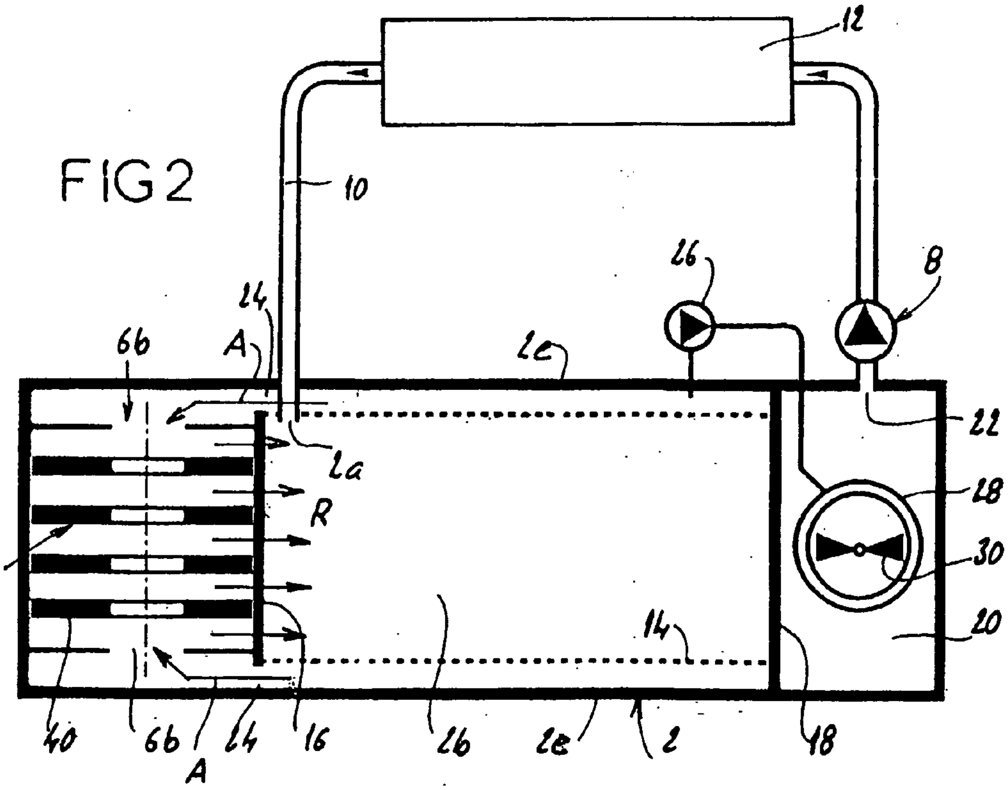

12
10
26
8
24
6b
A
2c
22
2a
R
28
30
6
14
20
40
16
2b
18
2

FIG 3

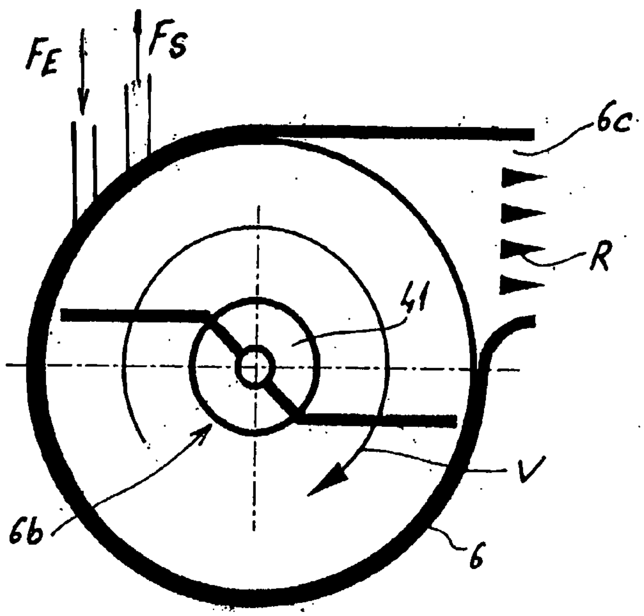


FIG 4

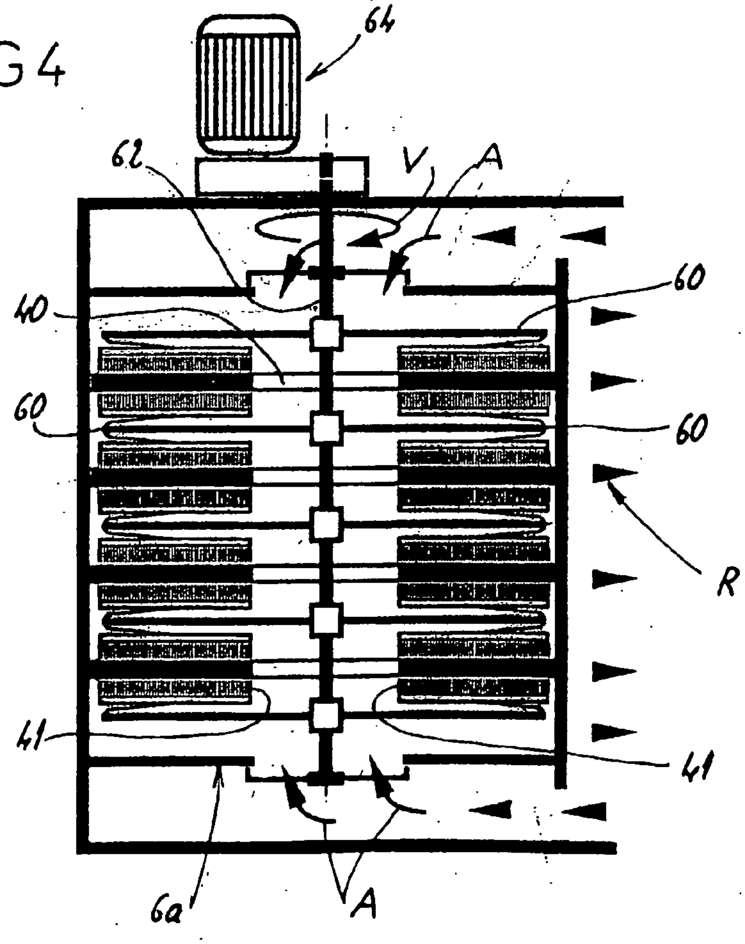


FIG 5

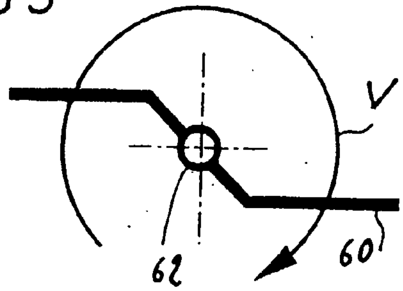


FIG 6

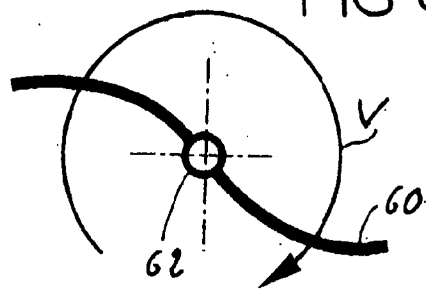


FIG 7

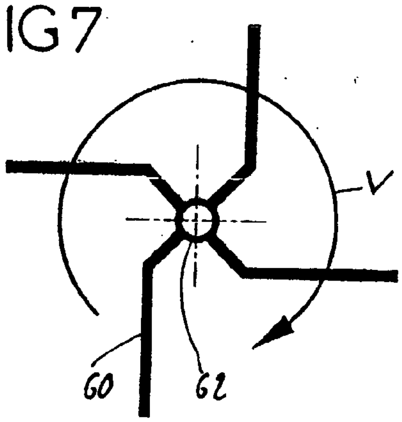


FIG 8

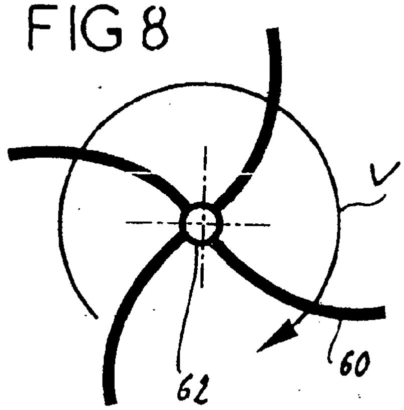


FIG 9

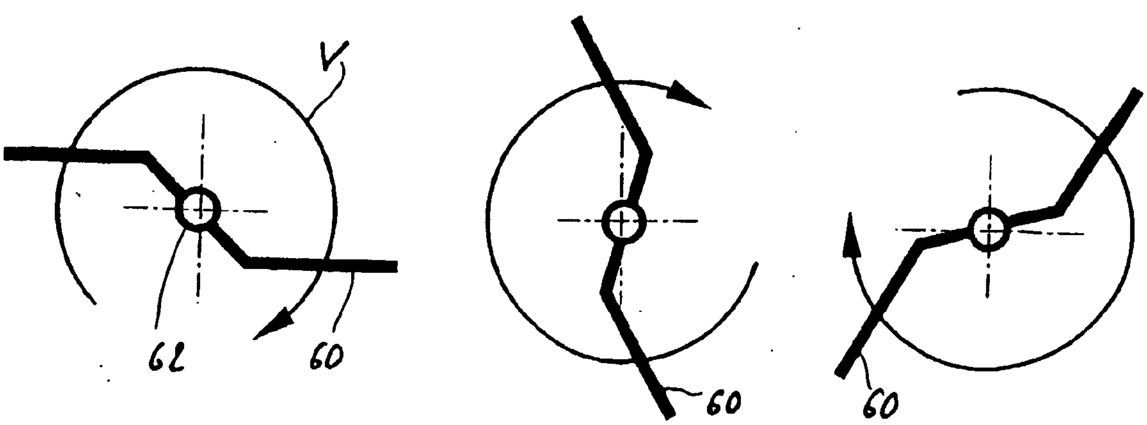


FIG 10

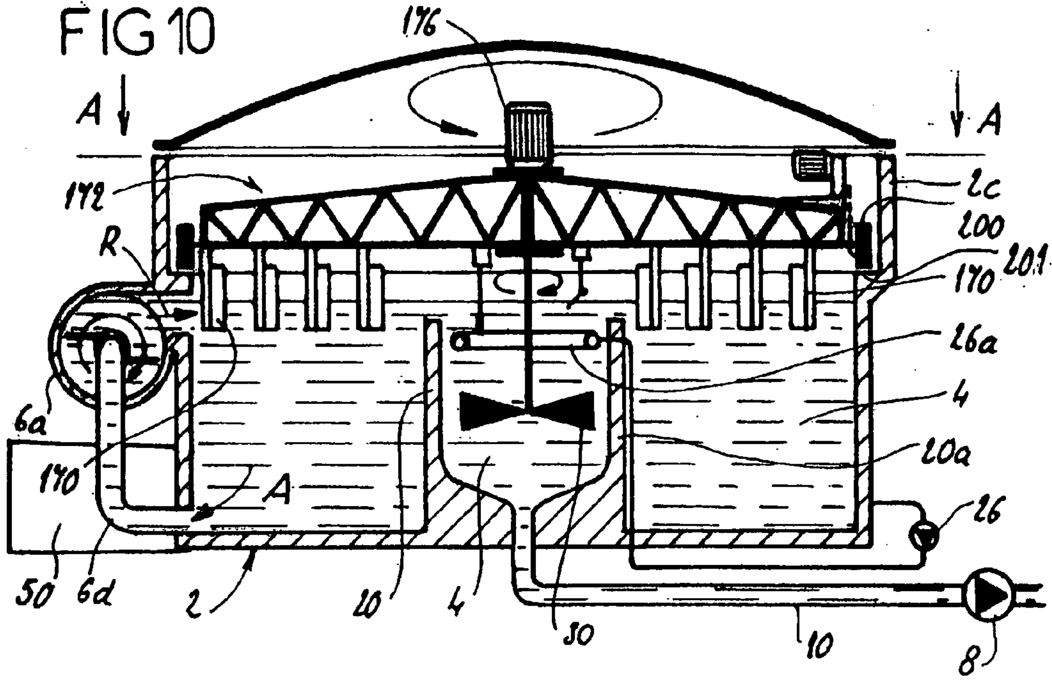

176
A
A
172
2c
200
201
R
170
26a
4
6a
170
20a
A
26
50
6d
2
20
4
30
10
8

FIG 11

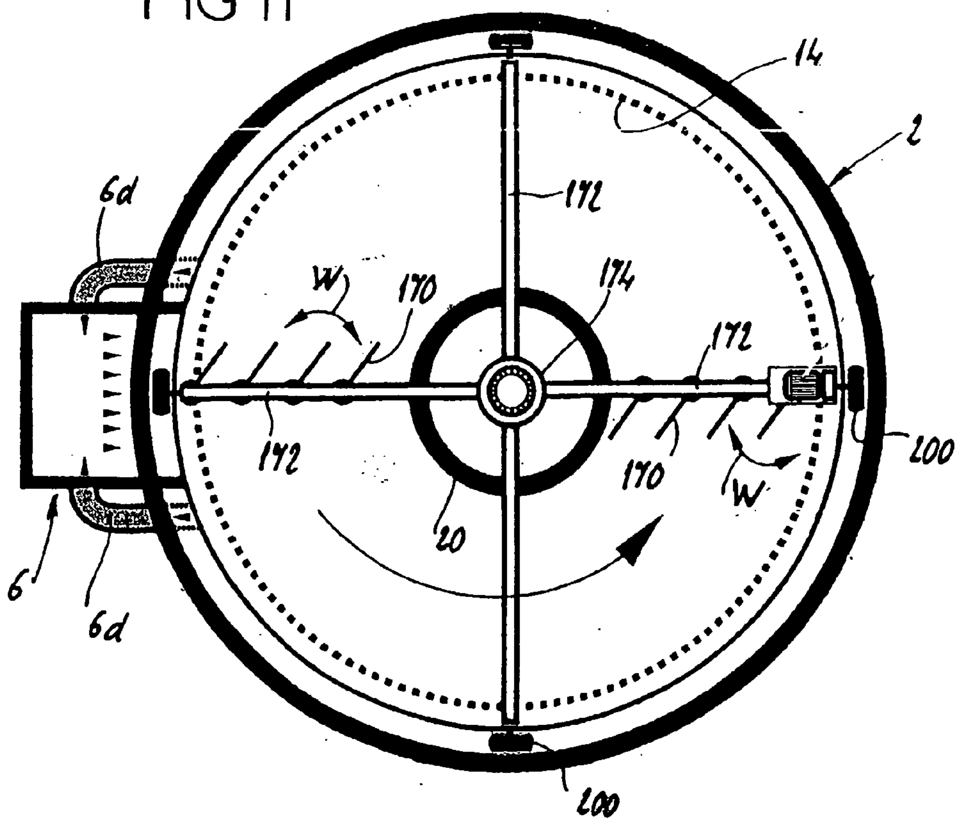

14
2
6d
172
W
170
174
172
172
200
170
W
20
6
6d
200

FIG 12

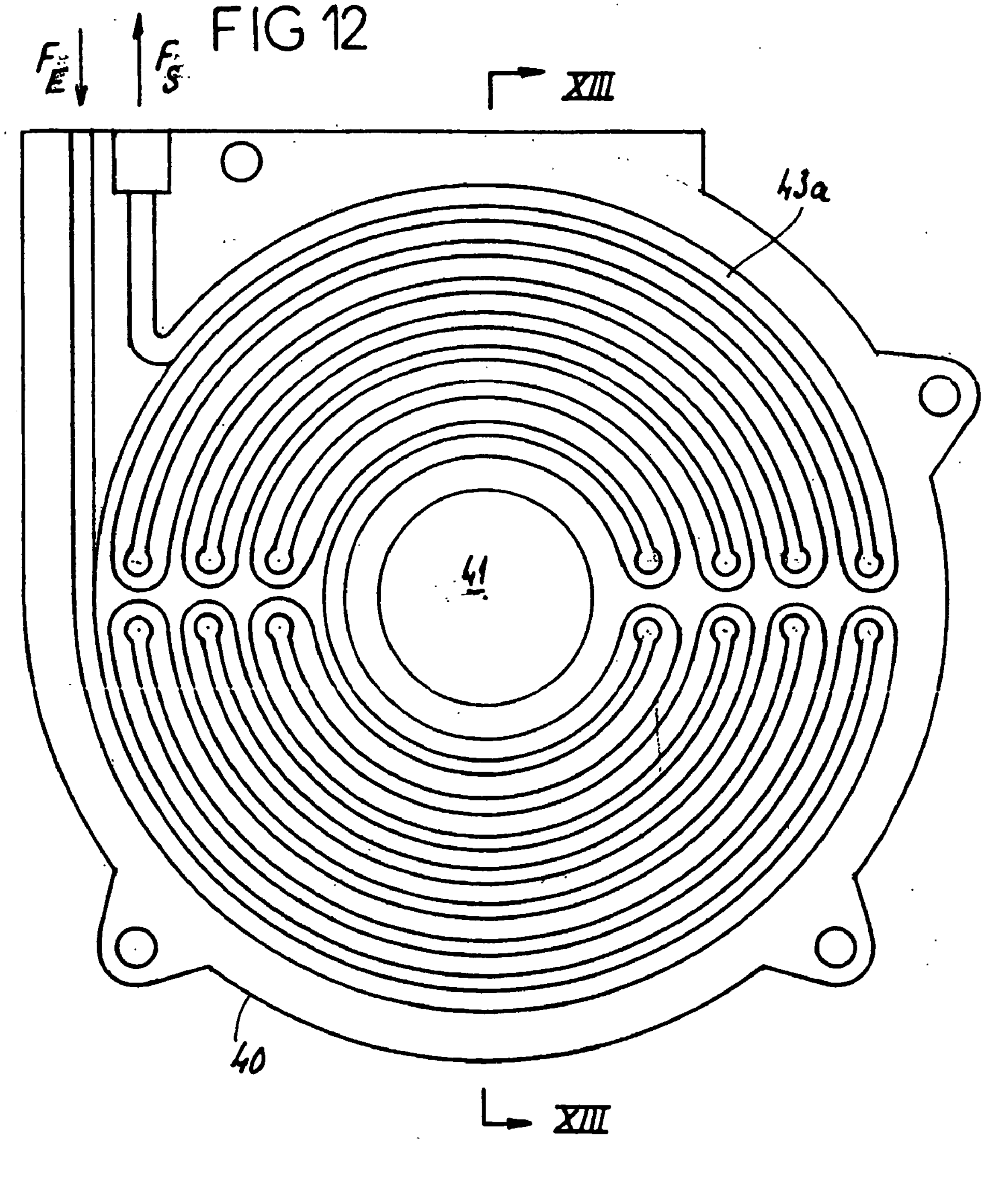
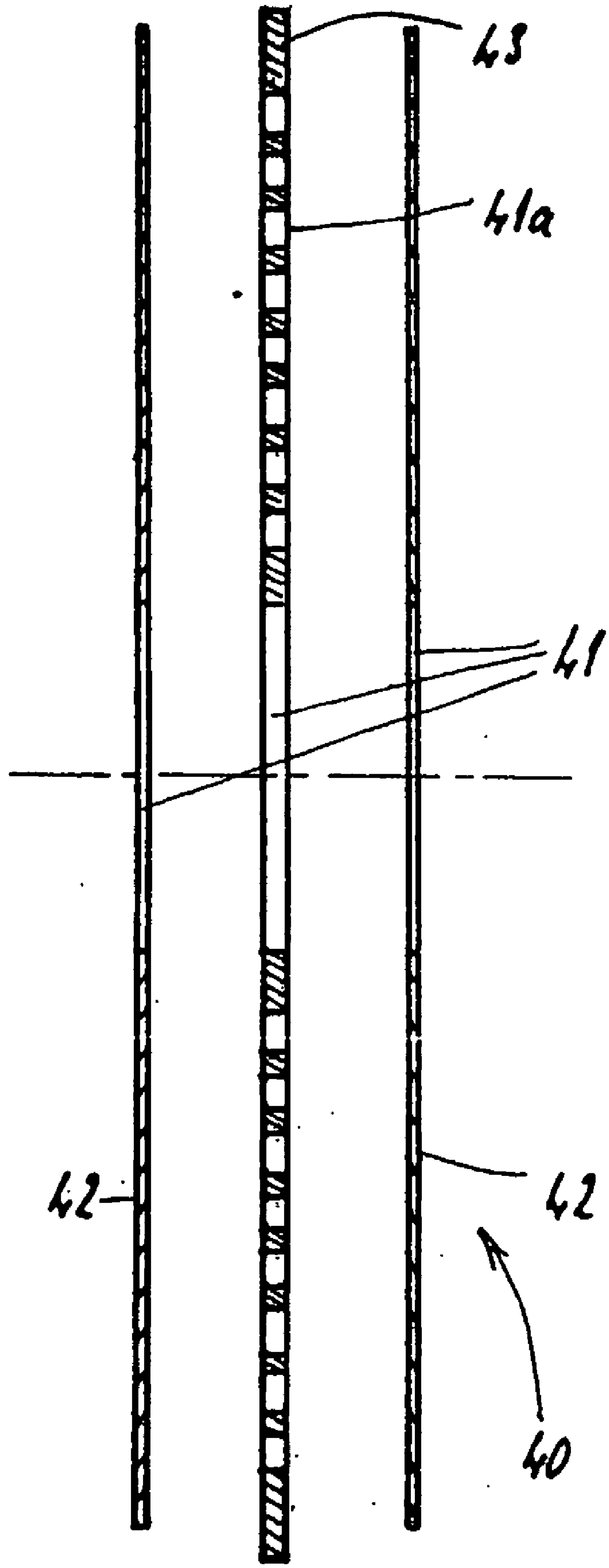


FIG 13



DEVICE AND METHOD FOR STORING AND REGENERATING A TWO-PHASE COOLANT FLUID

[0001] The present invention relates to the storage and regeneration of a cooling fluid.

[0002] The term "ice slurry" is to be understood as meaning a cooling fluid comprising two phases of the same body in melting/crystallization equilibrium, for example water to which an antifreeze agent such as salt, alcohol, monoethylene glycol or monopropylene glycol has been added. This body in melting equilibrium may also be a eutectic. The solid phase in divided form, for example ice microcrystals, is distributed uniformly through the liquid phase, to the extent of obtaining a pasty or viscous consistency of the cooling fluid that is, for example, fluid enough that the said fluid can be pumped. The cooling fluids considered according to the invention are therefore obtained, stored, transported and used in mixed and homogenous two-phase form, particularly in a consistency similar to that of a sorbet or ice slurry.

[0003] Cooling fluids comprise a liquid phase and a solid phase in homogeneous mixture. These are themselves generally mixtures of water and alcohol, water and ethylene glycol, water and propylene glycol, water and glycerol, water and ammonia, water and potassium carbonate, water and calcium chloride, water and magnesium chloride, water and potassium acetate, etc; other types of mixture, not containing water, may also be suitable.

[0004] Such cooling fluids perform very well; they absorb heat by the melting of their solid phase, as opposed to conventional liquid cooling fluids which absorb heat only by heating up (appreciable heat).

[0005] To simplify the explanation of the invention, mention will be made hereinafter of a cooling fluid of the ice slurry type, which must be understood to be a fluid as previously defined.

[0006] Cooling fluid in the liquid phase must be understood as meaning, on the other hand, fluid essentially in the liquid phase, that is to say with a low, if not zero, concentration of microcrystals.

[0007] Document U.S. Pat. No. 2,902,839 discloses a device for storing and regenerating a cooling fluid, in two-phase form, but not in the form of ice slurry, intended to circulate solely in liquid form through a heat transfer circuit. The latter comprises one or more heat exchangers for the exchange of heat between the cold and liquid-form cooling fluid and the outside.

[0008] Said device comprises:

[0009] a storage compartment for storing the cooling fluid in the two-phase state, in melting equilibrium;

[0010] at least one indirect heat-exchange means for the exchange of heat between a refrigerant fluid and the cooling fluid, in liquid phase, associated with said compartment and more specifically arranged inside said compartment;

[0011] a circulation means of the pump type, for circulating the cooling fluid, drawn from said compartment in the liquid state in the cold state, in the heat-exchange circuit and for reinjecting it into said compartment;

[0012] a two-phase recycling and cooling circuit for recycling and cooling the cooling fluid, within said compartment, comprising a tapping point at the lower part of said compartment, said recycling circuit incorporating the indirect heat-exchange means and comprising a means for withdrawing/discharging the cooling fluid.

[0013] The indirect heat-exchange means is an exchanger with a scraped surface, generating a mass setting of the cooling fluid over a scraping surface. Separation of the cooling fluid in solid form from the scraping surface requires significant force, thus going against the idea of reducing the operating energy consumption of the device.

[0014] EP 0 629 826 discloses a cold transfer device comprising a vertical compartment intended to store and to supply a heat-transfer circuit with a cooling fluid of the ice slurry type. The device comprises an indirect heat-exchange means for the exchange of heat between a refrigerant fluid and the cooling fluid, this device being placed outside the storage chamber. It is pumped in liquid phase from a lower level of the storage compartment to be reinjected at a higher level once it has been enriched with microcrystals of the solid phase.

[0015] An extraction means is also provided for supplying the heat-transfer circuit with cooling fluid of the ice slurry type. This extraction means comprises a cone opening onto a duct in the storage compartment. The opening of the cone is at a higher level and where the cooling fluid is rich in solid phase (ice microcrystals). An agitating means is arranged in the cone, so as to create turbulence in the extracted cooling fluid, regenerating the ice slurry.

[0016] Such a device does not allow precise control over the concentration of microcrystals in the cooling fluid of ice slurry type extracted to feed the heat transfer circuit. Furthermore, the supply to the indirect heat-exchange means is under the hydraulic pressure for the cooling fluid contained in the storage compartment. This may prove to be troublesome during maintenance operations especially, when the storage compartment is very large. A significant storage head of ice slurry may, with certain mixtures, lead to a stratification which may appreciably damage the quality of the ice slurry injected into the installation. Drying-out of the top layer may occur, leading to non-optimum temperature. This disadvantage is all the more pronounced if the ice slurry is not in constant use.

[0017] Also known is a method for storing and regenerating cooling fluid in two-phase form, intended to supply in liquid form one or more heat exchangers belonging to a heat-transfer circuit, consisting in:

[0018] (a) having a cooling fluid comprising a solid phase in melting equilibrium with a liquid phase;

[0019] (b) circulating the cooling fluid in liquid form through a circuit comprising the heat exchanger or exchangers and through a storage and regeneration compartment associated with an indirect heat-exchange means;

[0020] (c) storing the cooling fluid in the compartment to allow the liquid phase and solid phase of said fluid to separate;

[0021] (d) tapping from said compartment the cooling fluid essentially in the liquid phase and circulating it through the indirect heat-exchange means so as to convert it to a solid phase, which is broken down into microcrystals;

[0022] (e) reinjecting the cooling fluid rich in microcrystals leaving the indirect heat-exchange means into said compartment.

[0023] The object of the present invention is to store and to regenerate, constantly, a cooling fluid, of the ice slurry type, so that it is permanently operational, even after long periods of shut down.

[0024] Another object of the present invention is to optimize the consistency of a cooling fluid of the ice slurry type, that is to say to optimize the concentration of microcrystals in the cooling fluid and, in particular, to control this concentration, in order to obtain the maximum storage.

[0025] Another objective of the present invention is to control and to alter, as appropriate, this concentration of microcrystals with a view to improving or adapting the refrigerating properties of the cooling fluid of the ice slurry type, in use.

[0026] An additional object of the present invention is to simplify the installations employing such a cooling fluid, on the one hand, and to facilitate the maintenance operations, on the other.

[0027] According to the invention, the device comprises:

[0028] another compartment for conditioning in the form of ice slurry, connected to the heat-transfer circuit, itself supplied with cooling fluid of the ice slurry type;

[0029] means for introducing some of the cooling fluid enriched in solid phase, outside of the indirect heat-exchange means, into said other compartment, at a higher level;

[0030] a complementary tapping point on the storage and regeneration compartment, in the lower part, and injection means for injecting cooling fluid, in liquid phase, into said other compartment;

[0031] and a mixing member, collaborating with said other compartment, for mixing the liquid and solid phases of the cooling fluid.

[0032] Furthermore, the method according to the invention differs from the method identified hereinabove with reference to the steps named (a) to (e) in that:

[0033] (f) some of the solid-phase-rich cooling fluid is separated and stored in another conditioning compartment in the form of ice slurry;

[0034] (g) some of the solid-phase-lean cooling fluid tapped from the storage and regeneration compartment is injected into said other compartment;

[0035] (h) the solid and liquid phases of the cooling fluid are mixed in said other compartment;

[0036] (i) the cooling fluid obtained in (h) is used to carry out step (a) by tapping cooling fluid conditioned in the from of ice slurry from said other compartment and it is reinjected, downstream of the heat exchanger or exchangers of the heat-transfer circuit into the storage and regeneration compartment, and/or for example at the inlet to the indirect heat-exchange means.

[0037] According to one embodiment of the device according to the invention, the indirect heat-exchange means comprises:

[0038] a crystallization chamber provided, on the one hand, with at least one tapping orifice for solid-phase-lean cooling fluid, communicating with the storage and regeneration compartment in the lower part and, on the other hand, an expulsion opening for expelling solid-phase-rich cooling fluid (**4**);

[0039] at least one hollow disk mounted fixedly in the crystallization chamber in contact with the circulating stream of cooling fluid from the tapping orifice to the expulsion opening, said disk having, passing through it internally, a refrigerant fluid in the course of evaporating or some other cooling fluid at a lower temperature;

[0040] a set of sweeping arms which are mounted on a spindle which is driven in rotation by a geared motor unit, and which arms are arranged with respect to the disk(s) in such a way as to sweep its surface in contact with the cooling fluid and to expel the solid-phase-rich cooling fluid toward the expulsion opening.

[0041] According to an embodiment of the device according to the invention, the indirect heat-exchange means comprises a set of hollow disks which are arranged parallel to one another and spaced apart, and in that at least some of the sweeping arms, mounted fixedly on the spindle of the geared motor unit are angularly offset from one another and, from one disk to the next or from one side of a disk to its adjacent side, to force the cooling fluid to circulate within the crystallization chamber, the sweeping arms together thus constituting the withdrawing/discharging means for recycling the cooling fluid within the storage and regeneration compartment.

[0042] According to one embodiment, the device according to the invention comprises a number of indirect heat-exchange means associated with one and the same storage and regeneration compartment and distributed about said compartment, which runs concentrically around the sole other conditioning compartment.

[0043] The device according to the invention has the advantage of keeping the cooling fluid in motion throughout its circulation through the two compartments, storage and regeneration, and conditioning, respectively, particularly in the indirect heat-exchange means, thus avoiding any setting that carries the risk that the circulation will become blocked by the frozen fluid.

[0044] Another advantage is associated with the large amount of cooling fluid that can be stored in two-phase form in the melting equilibrium, with a view to supplying any cold-transfer circuit.

[0045] Other features and advantages of the invention also from the detailed description hereinafter, with reference to the drawings, are given by way of nonlimiting examples, in which:

[0046] **FIG. 1** depicts a view in section of a storage, regeneration and conditioning device according to the invention;

[0047] **FIG. 2** is a schematic and part view of the device, from above, of **FIG. 1**;

[0048] **FIGS. 3 and 4** are views in section of the indirect heat-exchange means incorporated into the device according to the invention, in section perpendicular to the axis and along the axis of said means, respectively;

[0049] FIGS. **5** to **9** are details of **FIGS. 3 and 4**;

[0050] **FIG. 10** is a view in section of another exemplary embodiment of a device according to the invention;

[0051] **FIG. 11** is a view on AA of **FIG. 10**;

[0052] **FIG. 12** depicts a detail of the indirect heat-exchange means of the device according to the invention;

[0053] **FIG. 13** is an exploded section on XIII-XIII of **FIG. 12**.

[0054] **FIG. 1** is a view in section of a storage, regeneration and conditioning device according to the invention. This device comprises a storage and regeneration compartment **2** containing a cooling fluid **4** in the two-phase state in melting/crystallization equilibrium. The device according to the invention also comprises an indirect heat-exchange means **6** for the exchange of heat between a refrigerant fluid and the cooling fluid **4** essentially in the liquid phase. This indirect heat-exchange means **6** is associated with the storage and regeneration compartment **2**.

[0055] A circulation means **8** of the pump type depicted for example in **FIG. 2** is provided to circulate the cooling fluid **4** tapped from the storage and regeneration compartment **2** in a heat-transfer circuit **10** comprising one or more heat exchangers **12**. The heat-transfer circuit **10** opens downstream of the heat-exchange means **12** into the storage and regeneration compartment **12**.

[0056] By way of an alternative not depicted in the figures, it is also possible to reinject the cooling fluid **4** downstream of the heat-exchange means **12** directly into the indirect heat-exchange means **6** if the return of the cooling fluid **4** is at a temperature higher than the crystallization temperature.

[0057] The heat transfer circuit **10** thus opens for example into the storage and regeneration compartment **2**, via an opening **2***a*.

[0058] The volume into which the heat-transfer circuit **10** opens is preferably partially separated or demarcated from the remainder of the storage and regeneration compartment **2** and may in its lower part comprise gratings **14** able to contain the cooling fluid **4** in solid phase in said storage and regeneration compartment **2**. The gratings **14**, thus constituting a filter, may be omitted when the storage and regeneration compartment **2** is large enough to obtain good separation of the cooling fluid **4** in the liquid phase towards the bottom.

[0059] The storage and regeneration compartment **2** delimits a central separation region **2***b* including the lower part arranged, on the one hand, between the gratings **14** and, on the other hand, between two boundary walls **16** and **18**. The first boundary wall **16** provides partial delineation between the storage and regeneration region **2***b* and the region comprising the indirect heat-exchange means **6**. The second boundary wall **18** provides partial delineation between the storage and regeneration region **2***b* and another conditioning compartment **20** in the form of an ice slurry, of said cooling fluid **4**. This second compartment **20** is connected to the heat-transfer circuit **10** via an opening **22** associated with the circulation means **8**. The other conditioning compartment **20** is also supplied with cooling fluid **4** of the ice slurry type.

[0060] The device according to the invention also comprises a two-phase recycling and cooling circuit for recycling and cooling the cooling fluid **4** within the storage and regeneration compartment **2**. This two-phase recycling and cooling circuit comprises at least one tapping point **24** at the lower part of said storage and regeneration compartment **2**. The gratings **14** are spaced away from the corresponding side walls **2***e* to constitute flow corridors opening onto the tapping point or points **24**, supplying the indirect heat-exchange means **6**. The recycling and cooling circuit also incorporates the indirect heat-exchange means **6** and further comprises a means for withdrawing and discharging the cooling fluid **4**. The cooling fluid **4** is thus drawn into the indirect heat-exchange means **6**, as depicted for example in **FIG. 4** by the arrows "A".

[0061] The other conditioning compartment **20** and the indirect exchange means **6** are, for example, arranged one on each side of the central storage and regeneration region **2***b*, mainly constituting the storage and regeneration compartment **2** for the cooling fluid **4**.

[0062] The other conditioning compartment **20** is supplied at an upper level with at least some of the solid-phase-rich cooling fluid **4** outside of the indirect heat-exchange means itself, and this is done using introduction means **72**.

[0063] A complementary tapping point on the storage and regeneration compartment **2**, this being at the lower part, associated with means **26** for injecting cooling fluid **4** in liquid phase into said other conditioning compartment **20** is also provided.

[0064] The cooling fluid **4** in liquid phase is thus conveyed to the other conditioning compartment **20** for example with the aid of a distribution tube **28** arranged more or less in its central part.

[0065] A mixing member **30** is also provided to collaborate with the other conditioning compartment **20** so as to mix the liquid and solid phases of the cooling fluid **4** which are contained in said other compartment **20**. The device according to the invention also comprises a level detector **32** for determining the fill level of the other conditioning compartment **20** with the cooling fluid **4** in the form of ice slurry.

[0066] According to one exemplary embodiment, the device also comprises a measuring member **34** for determining the solid phase concentration of the cooling fluid **4** in the form of ice slurry in the other conditioning compartment **20**. The measuring member **34** is for example produced with a temperature sensor, or an electrical conductivity or capacitive sensor or with means for measuring opacity, which is associated with appropriate analysis means, of the electronic or microprocessor type.

[0067] The circulation means **8** allows the cooling fluid **4** to be reinjected downstream of the heat exchanger or exchangers **12** of the heat-transfer circuit **10**, for example into the storage and regeneration compartment **2**, via an orifice **2**a formed therein at a lower level.

[0068] According to an alternative form of embodiment of the device according to the invention, the circulation means **8** and the heat-transfer circuit **10** are also or solely connected to the indirect heat-exchange means **6** so that the cooling fluid **4** can be reinjected directly thereinto downstream of the heat exchanger or exchangers **12**.

[0069] The indirect heat-exchange means **6** is depicted schematically more specifically in **FIGS. 2, 3** and **4**.

[0070] The indirect heat-exchange means **6** comprises a crystallization chamber **6**a provided, on the one hand with at least one tapping orifice **6**b for tapping of solid-phase-lean cooling fluid **4**, communicating via the tapping orifices **24** with the storage and regeneration compartment **2** of the lower part and, on the other hand, with an expulsion opening **6**c for expelling solid-phase-rich cooling fluid **4**.

[0071] The indirect heat-exchange means **6** also comprises at least one hollow disk **40** mounted fixedly in the chamber **6**a, in contact with the stream of cooling fluid **4** circulating from the tapping orifice **6**b to the expulsion opening **6**c. The hollow disk **40** has passing across it internally a refrigerant fluid in the course of evaporating, for example NH_3. The hollow disk or disks **40** are supplied with this refrigerant fluid via a refrigeration unit **50** arranged for example beside the heat-exchange means **6**. By way of an alternative according to the invention, the refrigerant fluid may be replaced by another cooling fluid, different from the one circulating in the heat-transfer circuit **10**, but colder.

[0072] The indirect heat-exchange means **6** also comprises a set of sweeping arms **60** mounted on a spindle **62**, which is driven in rotation by a geared motor unit **64**. The sweeping arms **60** are arranged with respect to the hollow disk(s) **40** in such a way as to sweep their surface in contact with the cooling fluid **4** and to expel the enriched cooling fluid **4** in the process of being supercooled toward the expulsion opening **6**c of the chamber **6**a. Crystallization of the cooling fluid **4** thus occurs directly in the discharged and expelled stream. The expulsion of the cooling fluid **4** and more precisely the discharge of this cooling fluid **4** is depicted schematically by the arrows "R" as shown in **FIGS. 4 and 3**. The return of the cooling fluid **4** or of the ice slurry is downstream of the heat exchangers **12**. The or each hollow disk **40** has a central passage **41** through which the spindle **62** passes. The cooling fluid **4** is thus drawn through the tapping openings **6**b to then circulate from the passage or passages **41** to the periphery of each hollow disk **40**, by a centrifugal effect.

[0073] One exemplary embodiment of a hollow disk **40** is depicted in **FIGS. 12 and 13**. The hollow disk **40** comprises, for example, two lateral plates **42** and an intermediate plate **43**, each one provided with a central passage **41**.

[0074] The intermediate plate **43**, cut into serpentines **43**a, is sandwiched and trapped closely and with sealing between the lateral plates **42**. The serpentines **43**a thus produce the circulation path for a refrigerant fluid, the circulation of which is depicted schematically for example by the arrows Fe and Fs in **FIGS. 3 and 12**. The arrows FE and FS correspond respectively to the inlet and outlet directions of the refrigerant fluid circulating in the hollow disk **40**.

[0075] The indirect heat-exchange means **6** comprises, for example, a set of hollow disks **40** which are arranged parallel to one another and spaced apart. At least some of the sweeping arms **60** mounted fixedly on the spindle **62** of the geared motor unit **64** are offset angularly from one another, from one disk to the next, or from one side of a disk to its adjacent side, to force the cooling fluid **4** to circulate within the crystallization chamber **6**a. The set of sweeping arms **60** as a whole thus constitutes intake and discharge means for recycling the cooling fluid **4** within the storage and regeneration compartment **2**. The rotation of the sweeping arms **60** is depicted schematically by the arrow "V" in **FIGS. 3 and 4**.

[0076] Advantageously, the expulsion opening **6**c is shaped, positioned and orientated in such a way as to expel the solid-phase-rich cooling fluid **4** to the other conditioning compartment **20**, thus constituting means of introduction thereinto. The sweeping arms **60** may adopt different shapes depicted by way of example in FIGS. **5** to **9**. The sweeping arms **60** may thus be curved as depicted in **FIGS. 6 and 8**, or elbowed as depicted in **FIGS. 5 and 7**. The number of sweeping arms **60** for sweeping the surface of a hollow disk may also vary. Specifically, it is possible, as depicted in **FIGS. 5 and 6**, to sweep the surface of a hollow disk **40** using two sweeping arms **60** or, for example, using four sweeping arms **60**, as is depicted in **FIGS. 7 and 8**. This list is not in any way limiting. It is also possible to add more sweeping arms **60**, to sweep the same surface. The term "sweeping" is to be understood in the broadest sense, that is to say also as encompassing arms **60** encouraging disruption of the supercooled boundary layer near the hollow disk **40**. A supercooled boundary layer is to be understood as meaning the film which cools upon contact with the hollow disk **40**. The term "sweeping" does not necessarily means to say that there is mechanical contact between the arms and the surface of the hollow disk **40**, for example via brushes **41**. The term "supercooling" is to be understood as meaning cooling to a temperature lower than the usual freezing temperature.

[0077] **FIG. 9** shows an exemplary embodiment in which the adjacent sweeping arms **60** are angularly offset from one another.

[0078] According to the embodiment (cf. **FIG. 1**), the expulsion opening **6**c is positioned and orientated in such a way as to expel the solid-phase-rich cooling fluid **4** into the storage and regeneration compartment **2**, and more specifically into the central region **2**b at an upper level. The introduction means **72** then extend at an upper level into said storage and regeneration compartment **2**. They comprise moving blades **70** designed to push the cooling fluid **4** toward and into the conditioning compartment **20**. The moving blades **70** are advantageously mounted on a chain or a belt driven by a geared motor unit **74**.

[0079] According to another exemplary embodiment of the device according to the invention, depicted in **FIGS. 10 and 11**, the moving blades **170** are mounted on horizontal arms **172**, themselves fixed on a vertical spindle **174** driven by a geared motor unit **176**. The moving blades **170** are, for example, orientable with respect to their horizontal mounting arms **172**, as depicted schematically in **FIG. 11** by the arrows "W".

[**0080**] In this exemplary embodiment, the device according to the invention comprises a plurality of indirect heat-exchange means **6** (just one of which is depicted in **FIG. 11**), which are associated with one and the same storage and regeneration compartment **2**. The indirect heat-exchange means **6** are distributed about the storage and regeneration compartment, which itself runs concentrically around the sole other conditioning compartment **20**.

[**0081**] The wall **20***a* delimiting the other conditioning compartment **20** has a preferred height that does not substantially alter the solid-phase cooling fluid **4** supply from the blades **170**. A mixing member **30** immersed in the other conditioning compartment **20** is, for example, mounted on the spindle **174** and rotates therewith. For installations with high refrigerating capacity, that is to say devices of significant size, it is possible to provide, at the end of each horizontal arm **172**, a support wheel **200** running along a rim **201** formed in the upper part on the wall **2***c* demarcating the storage and generation compartment **2**.

[**0082**] The operation of the device depicted in **FIGS. 10 and 11** is, for the remainder, identical to that of the device depicted in **FIG. 1**. The refrigeration source **50** may be placed beside, underneath, or completely independently of the indirect exchange means **6**. The admission of cooling fluid **4** in liquid phase into the indirect heat-exchange means **6** or, more specifically, into the chamber **6***a* is via ducts **6***d* opening into the storage and regeneration compartment **2**.

[**0083**] The device according to the invention makes it possible to employ a method for storing and regenerating a cooling fluid in two-phase form and intended to supply one or more heat exchangers **12**. This method makes it possible to illustrate the operation of such a device according to the invention. We therefore have a cooling fluid **4** comprising a solid phase in melting/crystallization equilibrium with a liquid phase, and said cooling fluid **4** is circulated through the circuit comprising the heat exchangers **12** and into a storage and regeneration compartment **2** associated with an indirect heat-exchange means **6**. The cooling fluid **4** is constantly stored in the storage and regeneration compartment, thus allowing the liquid phase and the solid phase of said fluid to separate. Tapping the cooling fluid **4** from said storage and regeneration compartment **2**, essentially in the liquid phase, and circulating it through the indirect heat-exchange means **6** allow said fluid to be converted to a solid phase, which is broken down into microcrystals. The latter, rich in microcrystals, is then reinjected into the storage and regeneration compartment **2**.

[**0084**] In accordance with the invention, some of the cooling fluid **4** rich in microcrystals or solid phase is separated off and stored in the other conditioning compartment **20** in the form of ice slurry. Some of the cooling fluid **4** in liquid phase, or lean in solid phase, taken from the storage and regeneration compartment **2** is then injected into said other conditioning compartment **20** so as to mix the solid and liquid phases of the cooling fluid **4** in said other conditioning compartment **20**. The ice slurry mixed in the other conditioning compartment **20** is thus ready to be drawn or pumped into the heat-transfer circuit **10**. The cooling fluid **4** or ice slurry is returned downstream of the heat exchangers **12** either directly into the crystallization chamber **6***a* or into the storage and regeneration compartment **2** at a lower level.

[**0085**] According to the invention, the method also consists in altering the amount of solid-phase-lean cooling fluid **4** injected into the other conditioning compartment **20**. The method according to the invention also consists in determining, in the conditioning compartment **20**, the solid-phase concentration and in altering this concentration as necessary by acting on the amount of solid-phase-lean cooling fluid **4** injected into the other conditioning compartment **20**.

[**0086**] According to the method according to the invention, it is also possible to determine the fill level of the other conditioning compartment **20** with cooling fluid of the ice slurry type, and to use the result of this determination to act on the angle of incidence of the blades **170** or the speed at which the blades **70**, **170** move. It is also possible to accelerate, slow down or if necessary interrupt the various operations of said method and, in particular, operations (f), (g) and (h). It is thus possible to influence the orientation of the blades **170** in order to alter the amount of solid phase cooling fluid **4** reinjected into the other conditioning compartment **20**.

[**0087**] The amount of cooling fluid **4** in the liquid phase reinjected into the other conditioning compartment **20** is governed by the measurement member **34** determining the microcrystals concentration.

[**0088**] According to this method, and by virtue of the device employing this method, it is thus possible to produce refrigeration sources able to supply large entities or large units, or even whole districts, for air conditioning purposes.

[**0089**] The movement of the microcrystal-enriched cooling fluid **4** encouraged as appropriate by the introduction means of the blades **70**, **170** type, generates a movement in the reverse direction of the liquid-phase cooling fluid **4** in the bottom of the storage and regeneration compartment **2**. This movement is advantageously toward the crystallization chamber **6***a*. The movement of the liquid-phase cooling fluid **4** toward the crystallization chamber **6***a* is thus encouraged at the same time as the movement of the microcrystal-rich cooling fluid toward the other conditioning compartment **20**. The blades **70** and **170** constantly keep the crystal-rich or solid-phase upper part in the pasty state, and prevent the crystals from setting en masse. This device is necessary in large-capacity units, for example those used discontinuously.

1. A device for storing and regenerating a cooling fluid **(4)** in two-phase form, intended to circulate through a heat-transfer circuit **(10)** comprising one or several heat exchangers **(12)**, said device comprising:

a storage and regeneration compartment **(2)** for storing and regenerating the cooling fluid **(4)** in the two-phase state, in melting equilibrium;

at least one indirect heat-exchange means **(6)** for the exchange of heat between a refrigerant fluid or another cooling fluid and the cooling fluid **(4)**, in liquid phase, associated with said compartments **(2)**;

a circulation means (**8**) of the pump type, for circulating the cooling fluid (**4**), drawn from said compartment (**2**), in the heat-exchange circuit (**10**) and for reinjecting it into said compartment;

a two-phase recycling and cooling circuit for recycling and cooling the cooling fluid (**4**), within said compartment, comprising a tapping point (**24**) at the lower part of said compartment, said recycling circuit incorporating the indirect heat-exchange means and comprising a means for withdrawing/discharging the cooling fluid (**4**); characterized in that it comprises:

another compartment for conditioning in the form of ice slurry, connected to the heat-transfer circuit (**10**), itself supplied with cooling fluid (**4**) of the ice slurry type;

means for introducing some of the cooling fluid (**4**) enriched in solid phase, outside of the indirect heat-exchange means, itself into said other compartment, at a higher level;

a complementary tapping point (**24**) on the storage and regeneration compartment (**2**), in the lower part, and injection means (**26, 28**) for injecting cooling fluid (**4**), in liquid phase, into said other compartment;

and a mixing member, collaborating with said other compartment, for mixing the liquid and solid phases of the cooling fluid (**4**).

2. The device as claimed in claim 1, characterized in that it comprises a level detector (**32**) making it possible to determine the fill level of the conditioning compartment (**20**) by the cooling fluid (**4**) in the form of ice slurry.

3. The device as claimed in claim 1 or **2**, characterized in that it comprises a measuring member (**34**) for determining the solid-phase concentration of the cooling fluid (**4**), in the form of ice slurry, in the conditioning compartment (**20**).

4. The device as claimed in claim 1 any one of claims 1 to 3, characterized in that the circulation means (**8**) is designed to reinject, downstream of the heat exchanger or exchangers (**12**) of the heat and transfer circuit (**10**), the cooling fluid (**4**) into the storage and regeneration compartment (**2**), using an orifice (**2*a***) formed in the latter at a lower level.

5. The device as claimed in claim 1 any one of claims 1 to 3, characterized in that the circulation means (**8**) is connected to the indirect heat-exchange means (**6**) so that the cooling fluid (**4**) can be reinjected directly thereinto downstream of the heat exchanger or exchangers (**12**) of the heat transfer circuit (**10**).

6. (Currently Amended) The device as claimed in claim 1 any one of claims 1 to 5, characterized in that the indirect heat-exchange means (**6**) comprises:

a crystallization chamber (**6*a***) provided, on the one hand, with at least one tapping orifice (**6*b***) for solid-phase-lean cooling fluid (**4**), communicating with the storage and regeneration compartment (**2**) in the lower part and, on the other hand, an expulsion opening (**6*c***) for expelling solid-phase-rich cooling fluid (**4**);

at least one hollow disk (**40**) mounted fixedly in the crystallization chamber (**6*a***) in contact with the circulating stream of cooling fluid (**4**) from the tapping orifice (**6*b***) to the expulsion opening (**6*c***), said disc having, passing through it internally, a refrigerant fluid in the course of evaporating or some other cooling fluid at a lower temperature;

a set of seeping arms (**60**) which are mounted on a spindle (**62**) which is driven in rotation by a geared motor unit (**64**), and which arms are arranged with respect to the disk(s) (**40**) in such a way as to sweep its surface in contact with the cooling fluid (**4**) and to expel the solid-phase-rich cooling fluid (**4**) toward the expulsion opening (**6*c***).

7. The device as claimed in claim 6, characterized in that the indirect heat-exchange means (**6**) comprises a set of hollow disks (**40**) which are arranged parallel to one another and spaced apart, and in that at least some of the sweeping arms (**60**), mounting fixedly on the spindle (**62**) of the geared motor unit (**64**) are angularly offset from one another and, from one disc (**40**) to the next or from one side of the disk (**40**) to its adjacent side, to force the cooling fluid (**4**) to circulate within the crystallization chamber (**6*a***), the sweeping arms (**60**) together thus constituting the withdrawing/discharging means for recycling the cooling fluid (**4**) within the storage and regeneration compartment (**2**).

8. The device as claimed in claim 7, characterized in that the expulsion opening (**6*c***) is shaped, positioned and orientated in such a way as to expel the solid-phase-rich cooling fluid (**4**) toward the other conditioning compartment (**20**), thus constituting the means of introduction thereinto.

9. The device as claimed in claim 7, characterized in that the expulsion opening (**6*c***) is positioned and orientated in such a way as to expel the solid-phase-rich cooling fluid (**4**) into the storage and regeneration compartment (**2**) at a higher level, and in that the introduction means extend at a higher level into said storage and regeneration compartment (**2**) and compose moving blades (**70, 170**) designed to push the cooling fluid (**4**) toward and into the other conditioning compartment (**20**).

10. The device as claimed in claim 9, characterized in that the blades (**170**) are mounted on a chain or a belt (**72**) driven by a geared motor unit (**74**).

11. The device as claimed in claim 9, characterized in that the blades (**170**) are mounted on horizontal arms (**172**) themselves fixed to a vertical spindle (**174**) driven by a geared motor unit (**176**).

12. The device as claimed in claim 11, characterized in that the blades (**170**) can be orientated with respect to the horizontal arms (**172**) supporting them.

13. The device as claimed in claim 1 any one of claims 1 to 12, characterized in that it comprises a number of indirect heat-exchange means (**6**) associated with one and the same storage and regeneration compartment (**2**) and distributed about the said compartment, which runs concentrically around the sole other conditioning compartment (**20**).

14. A method for storing and regenerating cooling fluid (**4**) in two-phase form, intended to supply one or more heat exchangers (**12**), consisting in:

(a) having a cooling fluid (**4**) comprising a solid phase in melting equilibrium with a liquid phase;

(b) circulating the cooling fluid (**4**) through a circuit comprising the heat exchanger or exchangers (**12**) and through a storage and regeneration compartment (**2**) associated with an indirect heat-exchange means (**6**);

(c) storing the cooling fluid **(4)** in the compartment **(2)** to allow the liquid phase and solid phase of said fluid to separate;

(d) tapping from said compartment **(2)** the cooling fluid **(4)** essentially in the liquid phase and circulating it through the indirect heat-exchange means **(6)** so as to convert it to a solid phase, which is broken down into microcrystals;

(e) reinjecting the cooling fluid **(4)** rich in microcrystals leaving the indirect heat-exchange means **(6)** into said compartment **(2)**; characterized in that it consists in:

(f) separating and storing some of the solid-phase-rich cooling fluid **(4)** in another conditioning compartment **(20)** in the form of ice slurry;

(g) injecting into said other compartment some of the liquid-phase or solid-phase-lean cooling fluid **(4)** tapped from the storage and regeneration compartment **(2)**;

(h) mixing the solid and liquid phases of the cooling fluid **(4)** in said other compartment **(20)**;

(i) using the cooling fluid **(4)** obtained in (h) to carry out step (a) by tapping cooling fluid **(4)** conditioned in the form of ice slurry from said other compartment **(20)** and reinjecting it, downstream of the heat exchanger or exchangers **(12)** of the heat-transfer circuit **(10)** into the storage and regeneration compartment **(2)**, and or/for example at the inlet to the indirect heat-exchange means.

15. The method as claimed in claim 14, characterized in that it consists in altering the amount of solid phase-lean cooling fluid **(4)** injected into the other conditioning compartment **(20)**.

16. The method as claimed in claim 14, characterized in that it consists in determining, in the other conditioning compartment **(20)**, the solid phase concentration and in altering this concentration as appropriate by altering the amount of solid-phase-lean cooling fluid injected into the other conditioning compartment acting in accordance with claim 15.

17. The method as claimed in claim 14 any one of claims 14 to 16, characterized in that it consists in:

determining the fill level of the conditioning compartment **(20)** with cooling fluid **(4)** of the ice slurry type;

and using the result of this determination to accelerate, direct, slow down or, as appropriate, interrupt the operations in accordance with (f), (g) and (h);

or alter the inclination of the blades **(70, 170)**.

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