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(54) **DEVICE AND METHOD FOR RECOOLING COOLANTS OR RECOOLING MEDIA, OR FOR OBTAINING COLD FROM AN AIR CURRENT**

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(57) **ABSTRACT**

The invention relates to an apparatus and to a method for the recooling of coolants or of recoolant media or for extracting cold from an airstream. The apparatus comprises at least one air-humidifier (**10**) to add moisture to the airstream. Positioned downstream of the air-humidifier (**10**) is a heat exchanger (**12**), which is in interaction with a coolant circuit. The apparatus comprises a blower means (**14**), which propels the airstream through the air-humidifier (**10**) and the heat exchanger (**12**). In the heat exchanger (**12**) the airstream is warmed and its moisture evaporated.

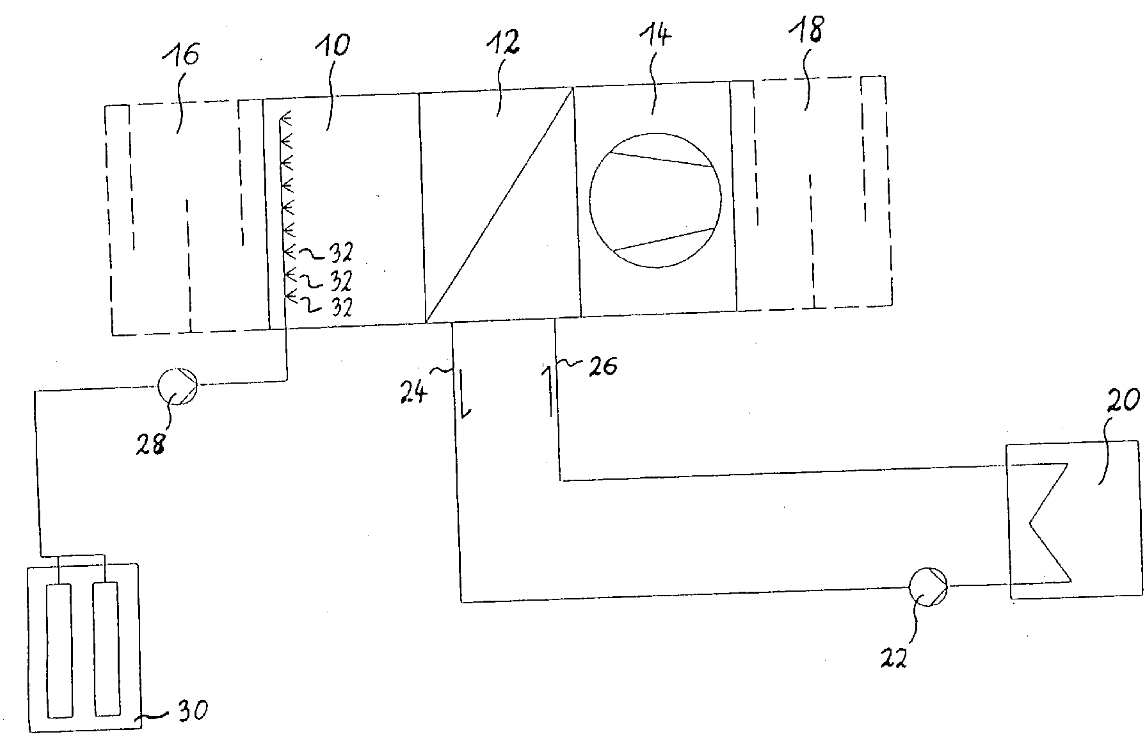

Fig. 1

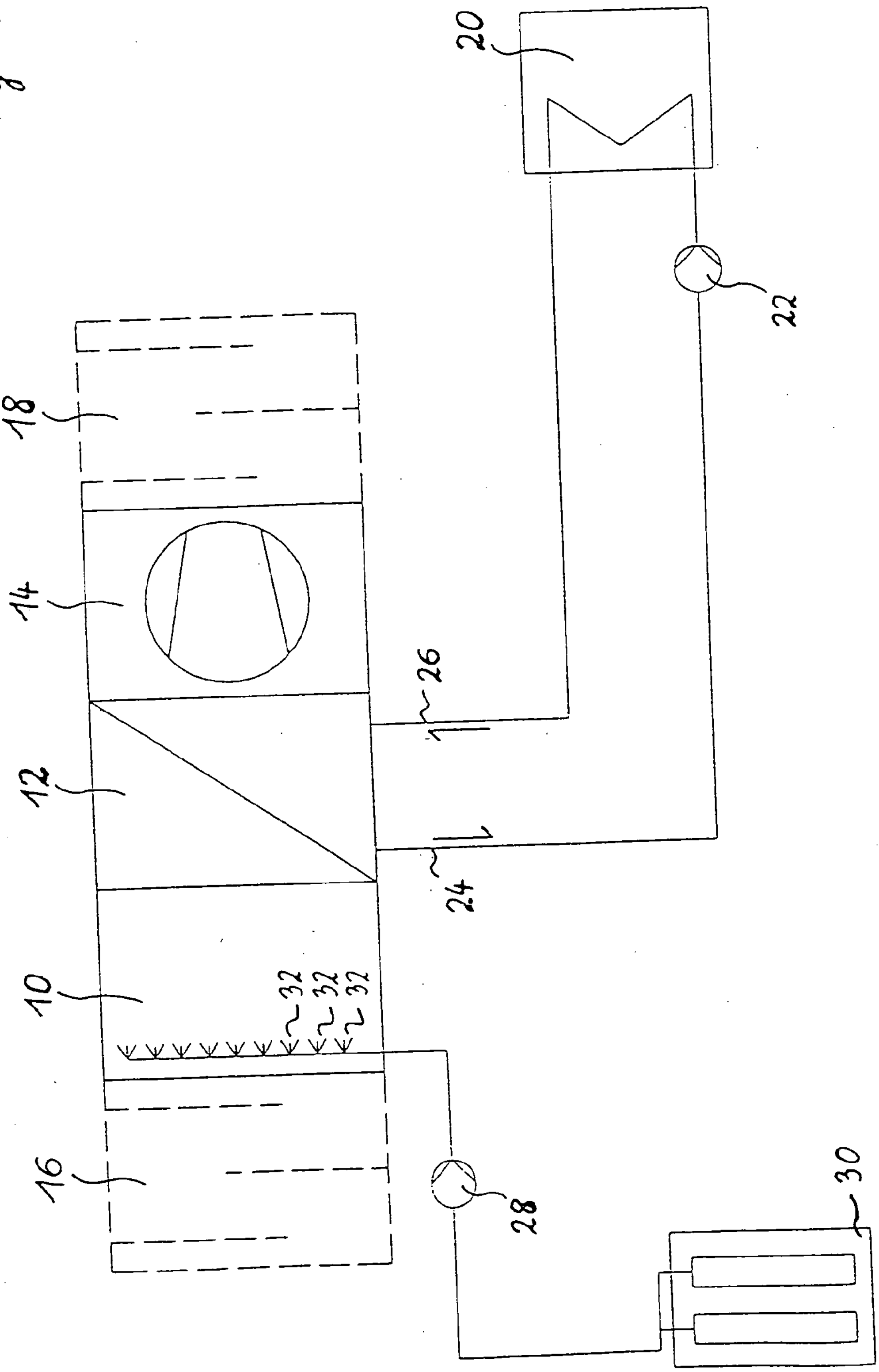

Fig. 2

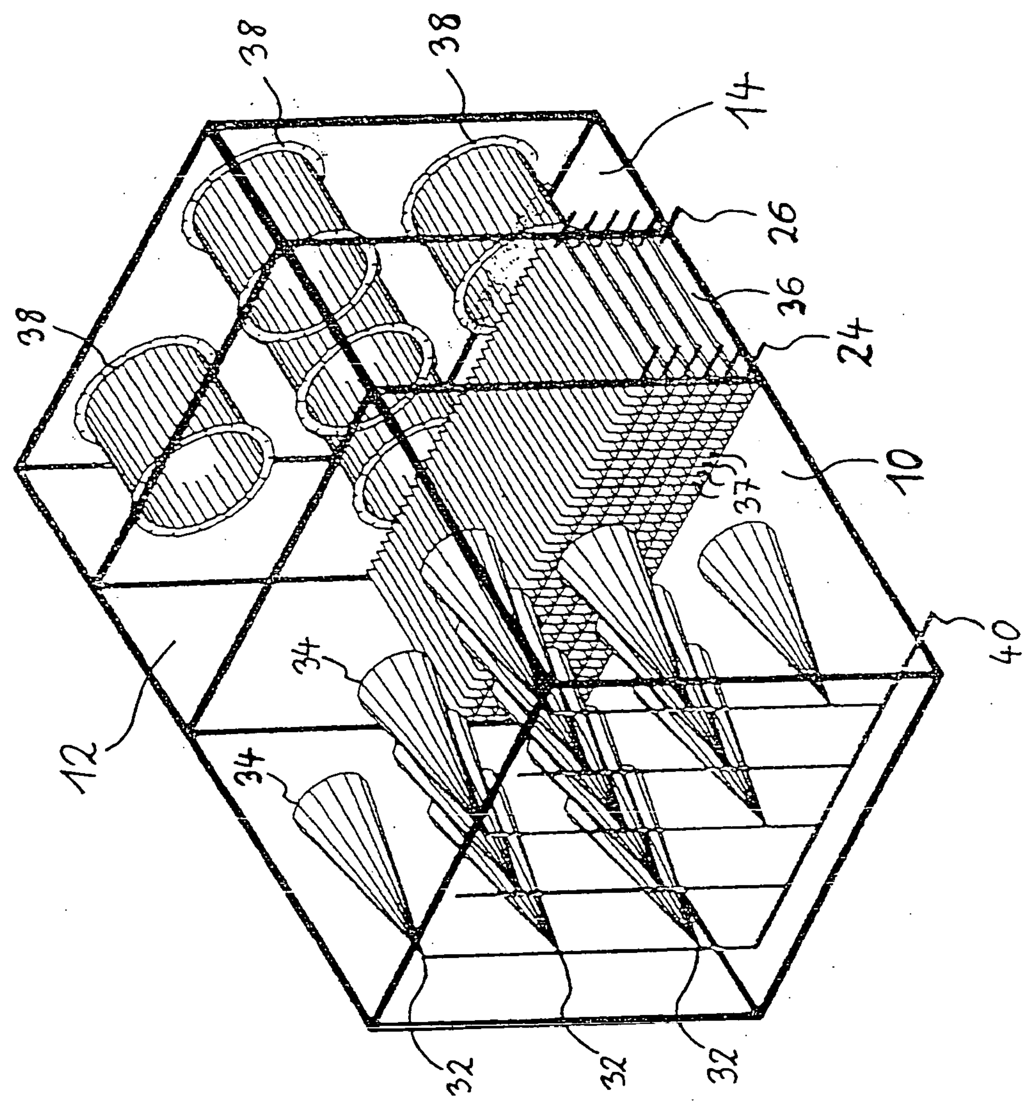

Fig. 3

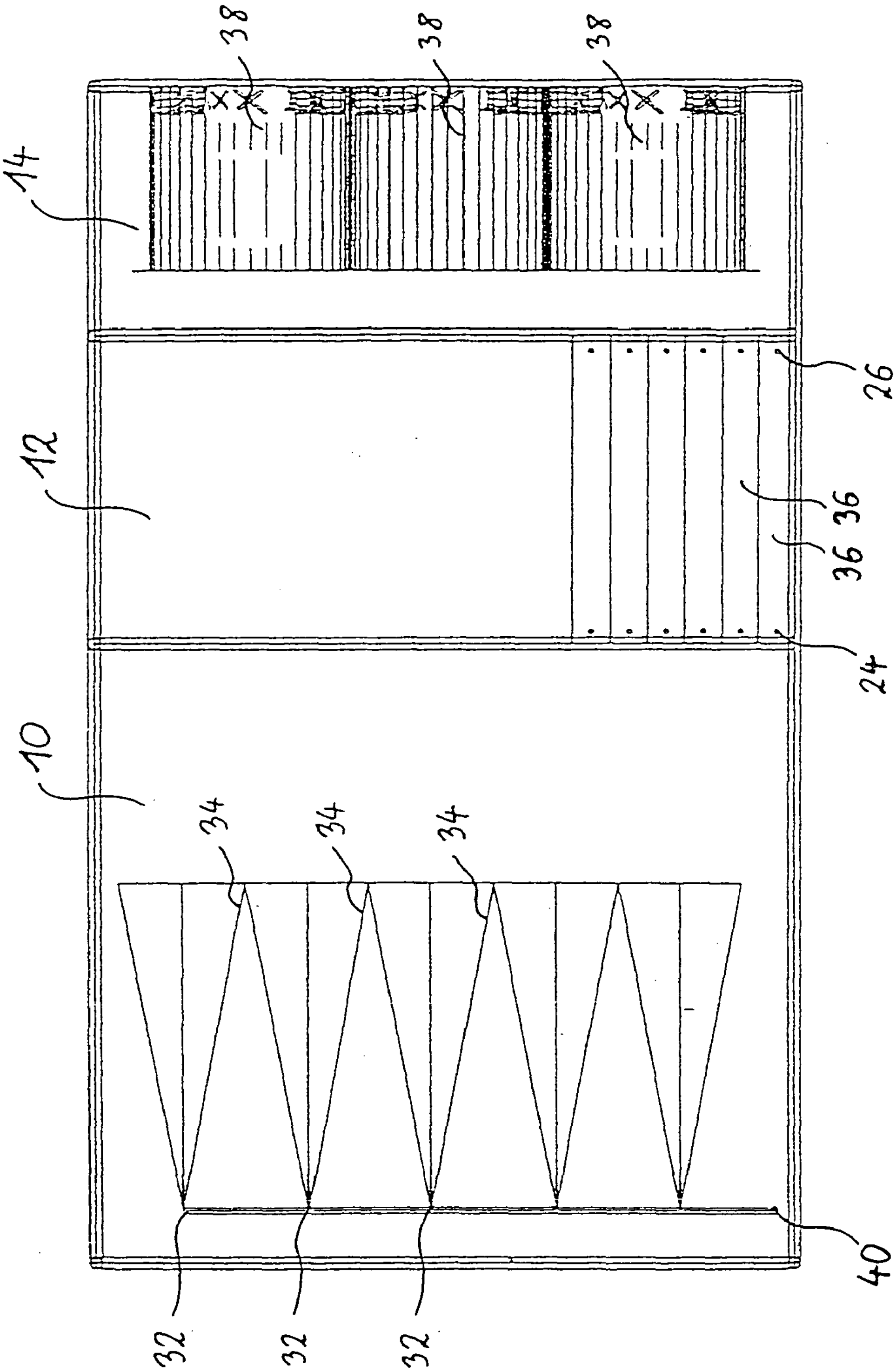

Fig. 4

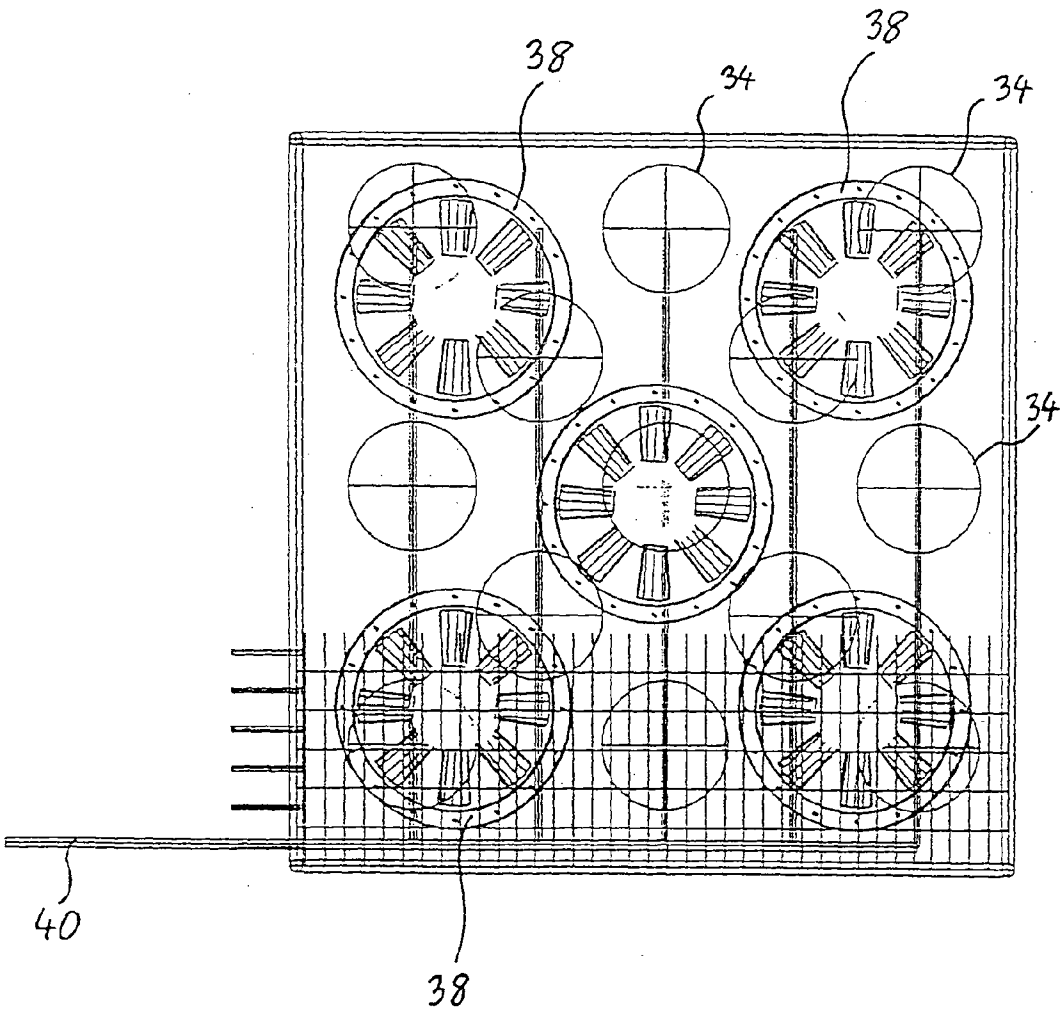

Fig. 5

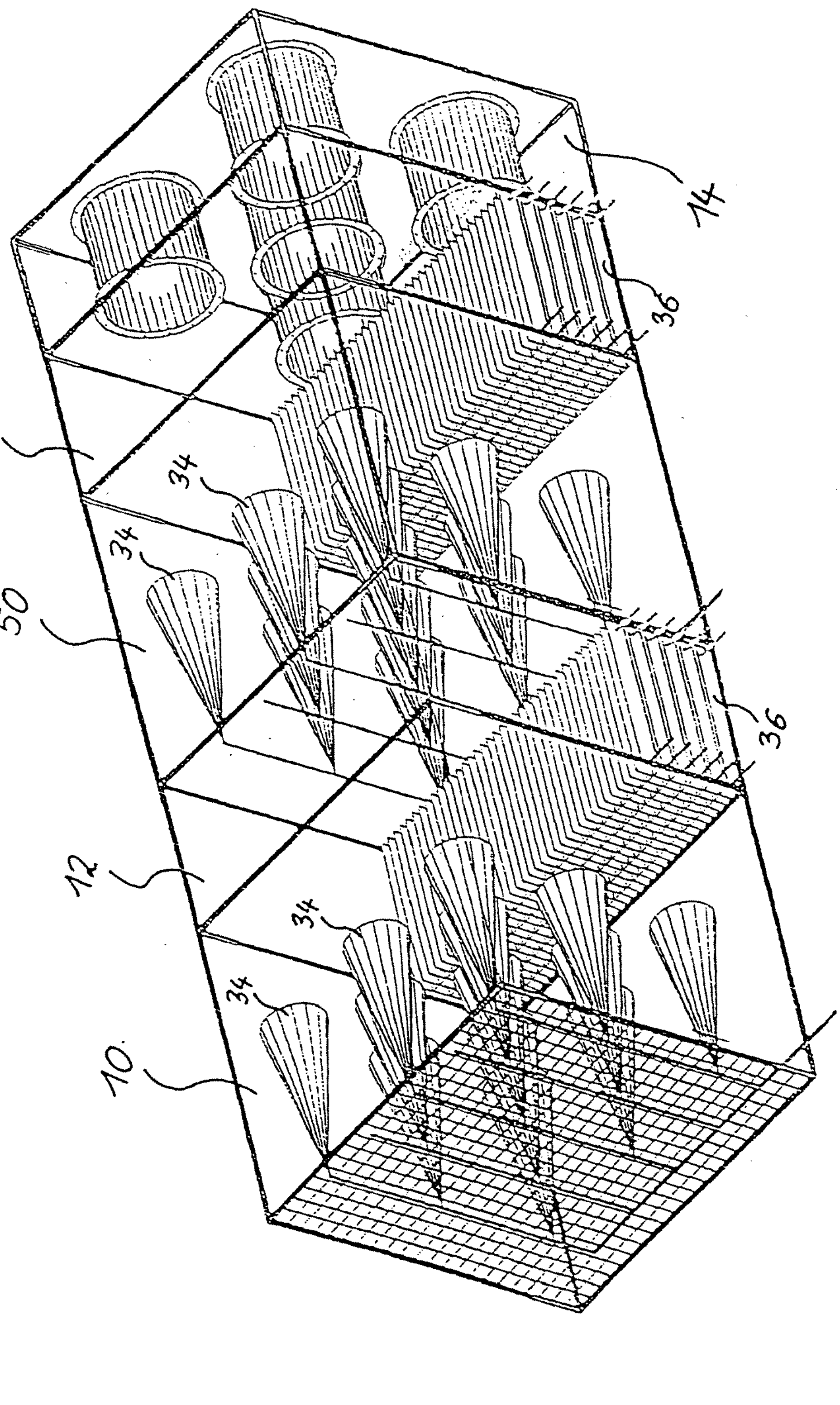

Fig. 6

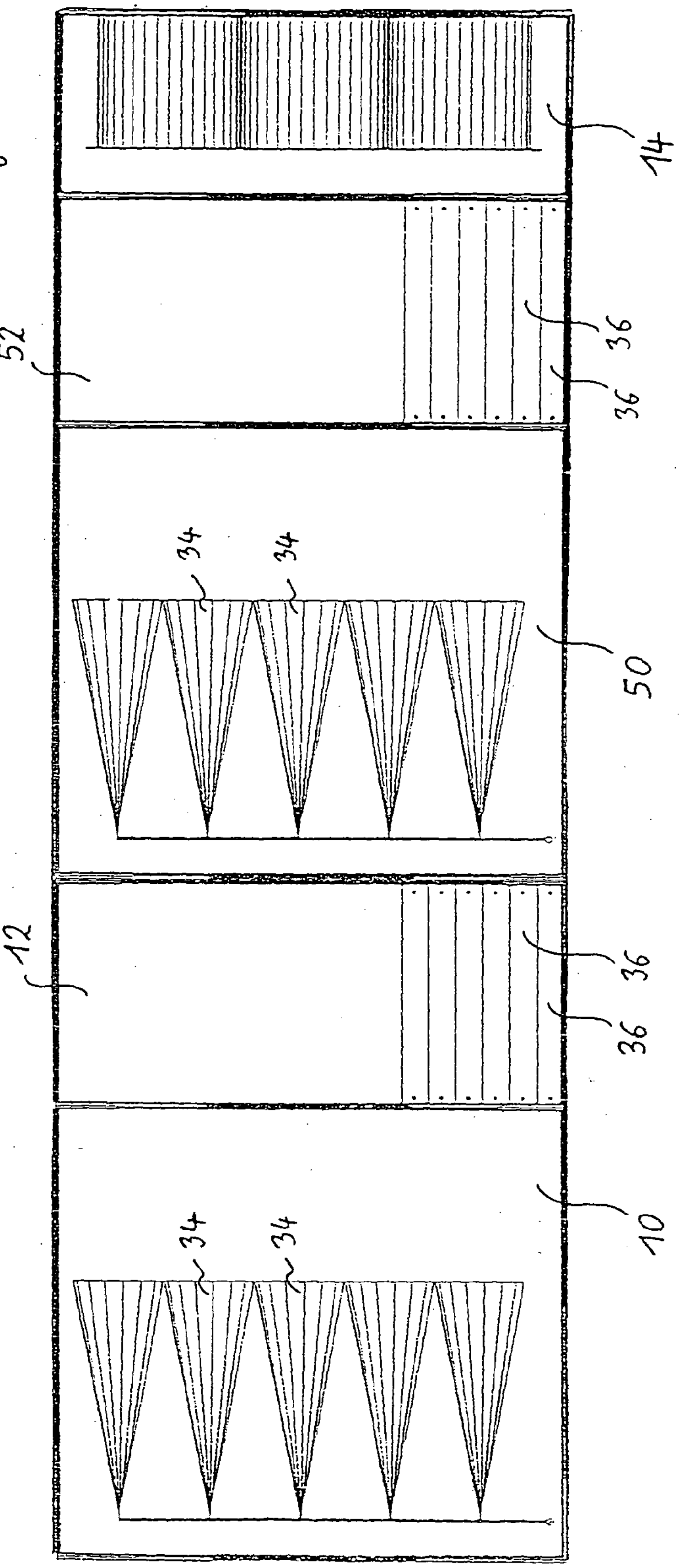

Fig. 7

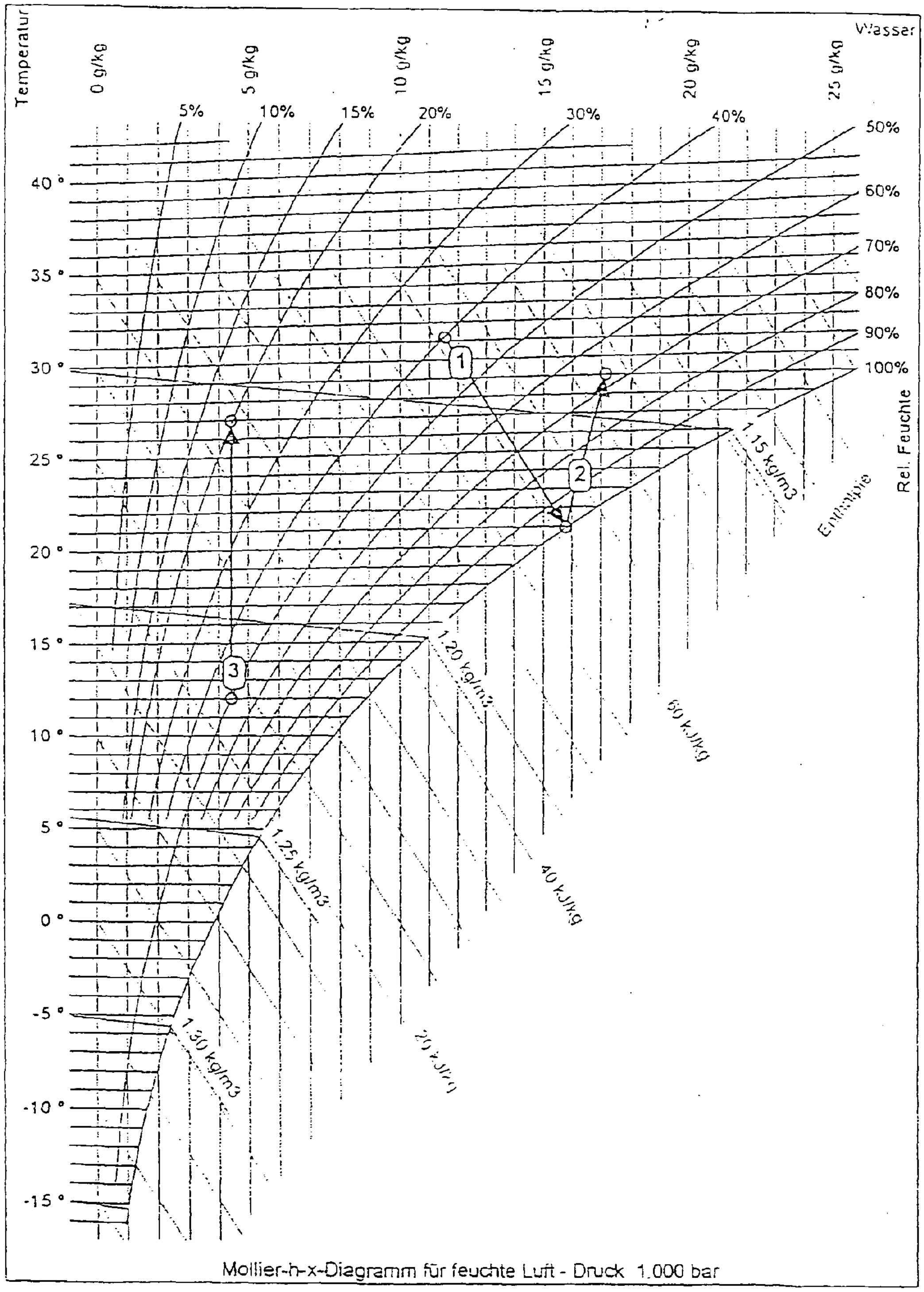
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Fig. 8

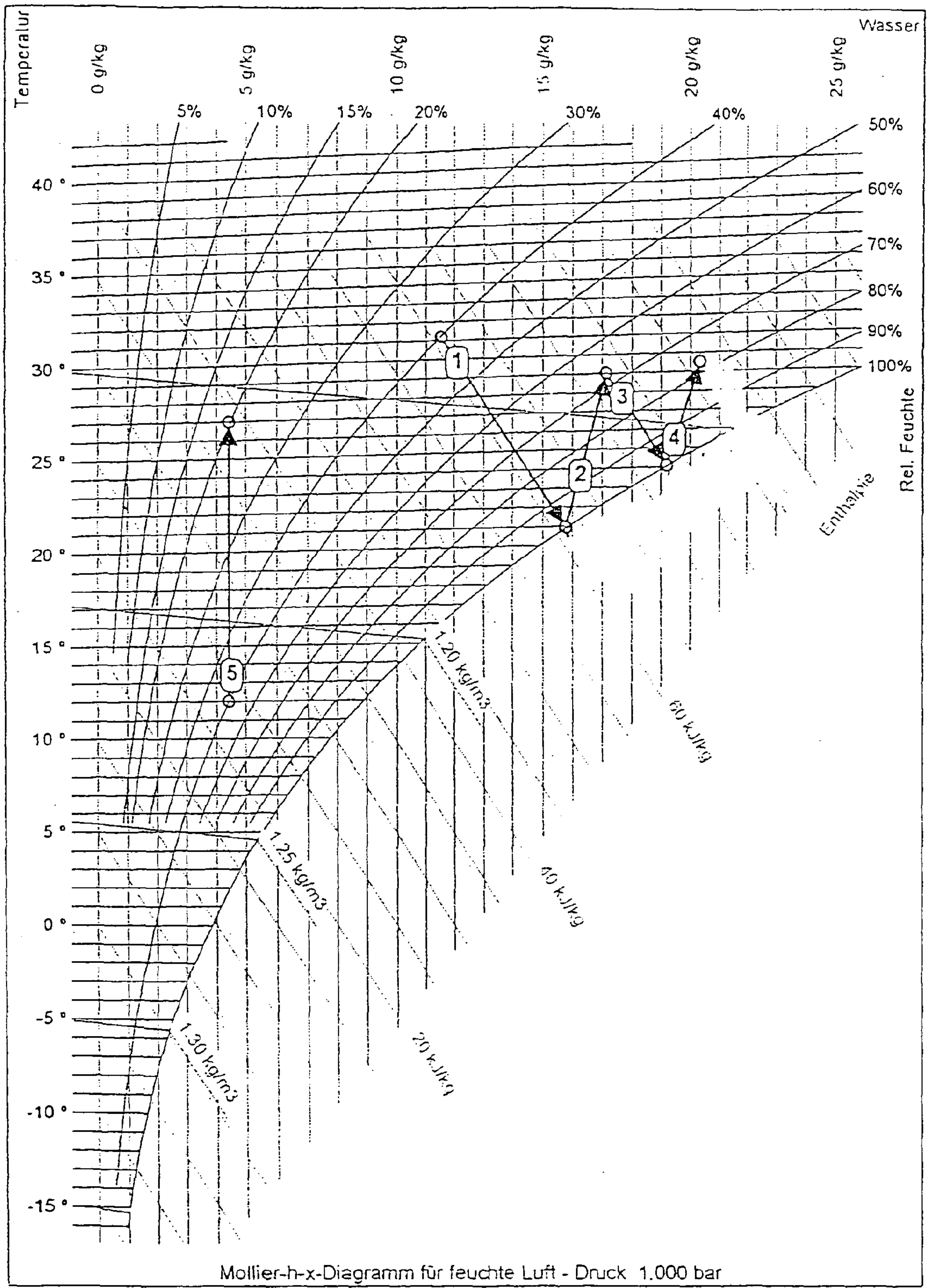
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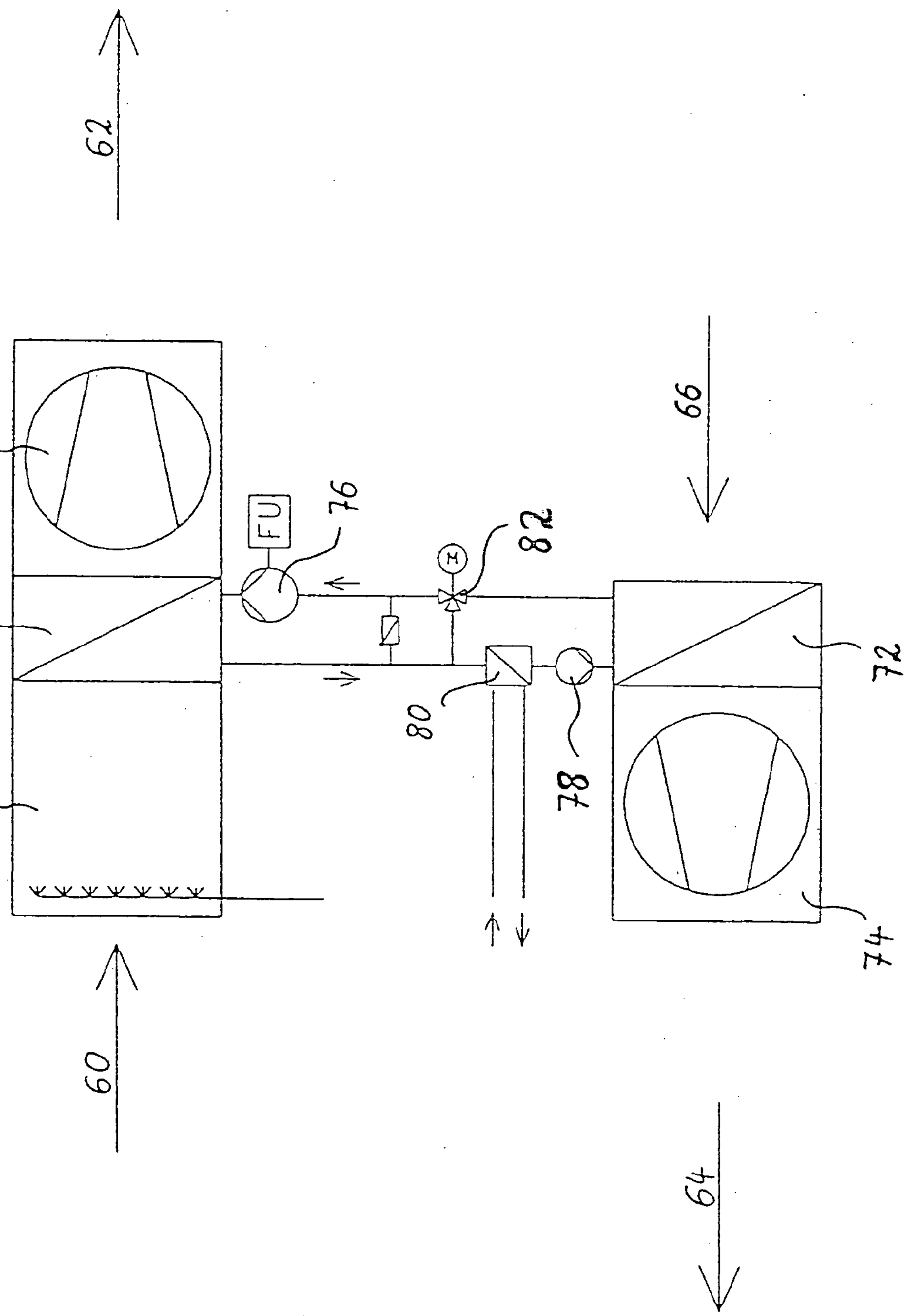
Fig. 9



DEVICE AND METHOD FOR RECOOLING COOLANTS OR RECOOLING MEDIA, OR FOR OBTAINING COLD FROM AN AIR CURRENT

[0001] The invention relates to an apparatus and a method for the recooling of coolants or of recoolant media, or for extracting cold from an airstream, according to claim **1** and to claim **19**, respectively.

[0002] Installations for recooling or for cold extraction are needed, for example, to cool food products, for freezing processes, for air-conditioning systems in buildings, and in the chemical industry. There are many methodological principles by which cold is transferred from a higher temperature level to a lower one. This requires a supply of energy, because cold in itself is transferred exclusively from the lower to the higher temperature level. A great variety of installations are known, in which either open or closed thermodynamic circulatory processes take place.

[0003] For example, in order to recool an airstream, or to extract cold therefrom, cooling towers are used. For many applications cooling towers in an extremely wide range of sizes are employed. In power stations, for instance, cooling towers are used to cool the discharged water. Cooling towers are installed on air-conditioned buildings in order to recover cold from the discharged air. Such cooling towers operate very reliably, but their energy balance is not particularly favorable. For a building's cooling tower to be functional it must be of a certain minimal size, which often destroys the aesthetics of the building. A cooling tower must always have a relatively large volume. Furthermore, the airstream must always flow in a vertical direction.

[0004] It is an object of the present invention to provide an apparatus and a method for the recooling of a coolant media or to extract cold from an airstream, in which the direction of air flow can be arbitrary and the energy balance is improved in comparison to a cooling tower.

[0005] This object is achieved with respect to the apparatus by the subject matter of claim **1** and with respect to the method by the subject matter of claim **19**.

[0006] The apparatus in accordance with the invention for the recooling of coolants or recoolant media or to extract cold from an airstream exhibits the following characteristics

[0007] at least one air-humidifier to add moisture to the airstream;

[0008] at least one heat exchanger, which is disposed downstream of the air-humidifier and interacts between the airstream and a coolant circuit; and

[0009] a blower means to propel the airstream.

[0010] The moistening of the air, in particular by an extremely fine mist, increases the efficiency of the installation. Because of the evaporative enthalpy of the humidifying liquid particles, in particular the water particles in the airstream, additional thermal energy is needed, which enhances the reclamation of cold. A coolant in a downstream heat exchanger is thus correspondingly more strongly cooled. The ultra-small water particles (aerosols) additionally offer the advantage that they are carried deep into the heat exchanger by the airstream. Because the apparatus comprises a blower means, the airstream can be made to flow in any desired direction, in particular not only vertically but also horizontally. As humidifying liquid water is advantageously employed. However, the invention is not restricted to the use of water as humidifying liquid. Rather, the use of other suitable humidifying liquids is not ruled out.

[0011] Preferably, the apparatus comprises a channel open only at its entrance and exit, and otherwise closed, within which are disposed the air-humidifier, the heat exchanger and the blower means. The channel makes it possible for the humidified air to be blown completely through the heat exchanger. The closed channel thus contributes toward optimizing the energy balance.

[0012] It can further be provided that the blower means is positioned downstream of the heat exchanger. As a result, the blower means has a suction effect, which is advantageous in particular with regard to flow technology. Furthermore, the discharge of air from the blower means then does not have a negative effect on the intended cooling action.

[0013] In particular it is provided that the blower means comprises a plurality of parallel and/or serial ventilators. Because there are multiple ventilators, the possible ways to configure the apparatus and to control the airstream are considerably more numerous. A plurality of small ventilators is more economical than a single, larger ventilator, in particular when a ventilator fails and must be replaced. Furthermore, several ventilators can be turned on separately, which expands the range of possibilities for controlling the airstream.

[0014] In a preferred embodiment of the air-humidifier it is provided that the air-humidifier is a pressurized-water humidifier, comprising a large number of nozzles disposed in the airstream, preferably aiming in the direction of air flow, which eject the water under high pressure, preferably in the range between 0 and 200 bar. By this means the airstream can be humidified with particularly small droplets of water. A fine spray or aerosol is produced, in which the total surface area of the water droplets is especially large. The result is a rapid and intensive evaporation. The evaporative enthalpy of the water droplets can be used to lower the temperature of the coolant still further in the secondary circulation of the heat exchanger. By this targeted humidification, the cold reclamation and hence the efficiency of the entire installation can be increased.

[0015] For optimal utilization of the installation the amount of ejected humidifying liquid can be made continuously adjustable, in particular can be regulated according to the required degree of cooling or to the state of saturation (including supersaturation) of the humidified airstream. The amount of ejected humidifying liquid can be controlled or regulated by way of the pressure of the fluid in the air-humidifier or by means of volume-flow control devices such as valves. Preferably a control of the amount of ejected humidifying liquid is initially brought about, at least when the amounts are small, by altering the fluid pressure. When a particular fluid pressure has been reached, for example 80 bar, it can be useful to regulate the amount of ejected humidifying liquid by adjusting the volume-flow controllers. For pure pressure regulation or the combined regulation just described, the pressure is preferably adjustable between 0 bar and 200 bar. Under typical conditions the pressure of the air-humidification installation is adjusted to about 80 bar.

[0016] It is further provided that the amount of water in the air-humidifier is continuously adjustable or controllable. By means of the adjustment possibilities cited above, the installation can be altered to suit the ambient conditions, on one hand, and on the other the degree of cooling needed while the installation is operating, by a suitable control or regulation.

[0017] Preferably, the air-humidifier introduces an extremely fine mist into the airstream, such that the droplet diameter of the majority of the drops is less than 60 μm, preferably less than 30 μm. With this droplet size an especially rapid evaporation is ensured.

[0018] In one particular embodiment of the apparatus in accordance with the invention it is provided that the air-humidifier is constructed in accordance with German patent DE 41 10 550 C2. With this patented air-humidifier it is possible to cause the entire quantity of injected water to be extremely finely atomized.

[0019] To avoid an annoying noise level, a sound attenuator can be provided ahead of the air-humidifier. Additionally or alternatively, a sound attenuator can be disposed downstream of the blower means. Thus the noise caused by the airstream can be limited directly at the source. The need for sound-insulating devices in the affected buildings is thus considerably reduced.

[0020] It is further provided that the coolant circuit comprises a coolant. The coolant here can be present in the form of a refrigerating agent or a liquid recoolant medium. Liquids have a relatively high specific heat capacity, so that the heat transport in the coolant circuit can be optimized. Furthermore, a liquid circuit is relatively simple to construct and thus economical to produce.

[0021] To further optimize the coolant circulation it can be provided that substances are added to the recoolant medium, the melting point of which is within the range of operating temperatures of the liquid recoolant medium. In this way the melting enthalpy of these substances can be used to optimize further the heat transport in the coolant circuit and hence the entire process of cold reclamation.

[0022] For regulating the installation it is further provided that the rotational speed of the ventilators can be continuously adjusted. As a result, the entire apparatus can be regulated both by setting the r.p.m. of the ventilators and also by setting the pressure in the air-humidifier. Depending on the particular embodiment, what is measured is either the temperature in the return path of the recoolant medium or the pressure of the refrigerating agent after the condenser. In case this measured value is below a predetermined set point, the first response is to increase the rotational speed of the ventilators continuously until either the predetermined set point or a maximal speed of the ventilators is reached. In the latter case, if the set point has not yet been reached, the amount of fluid in the air-humidifying installation is increased by raising the fluid pressure or by continuous or discontinuous opening of pressurized-flow devices, in particular valves. When the set point is reached, first the speed of the ventilators can be reduced, so as to keep the acoustic stress for the surroundings as low as possible.

[0023] The method of cold reclamation from an airstream in accordance with the invention comprises the steps of:

[0024] providing an airstream derived from air discharged from an air-conditioned building or from ambient air;

[0025] humidifying the airstream by spraying into it an extremely fine mist of water;

[0026] warming the airstream while simultaneously reducing the relative humidity, the energy for this process being taken from a coolant circuit;

[0027] discharging the airstream into the surroundings.

[0028] By humidifying the airstream with very small water droplets, the efficiency for cold reclamation can be considerably increased. As the airstream is warmed, the water droplets evaporate, so that in particular because of the evaporative enthalpy of the water droplets, additional thermal energy is required. This thermal energy is withdrawn from the coolant in the coolant circulation, so that the coolant is additionally cooled. The method in accordance with the invention thus represents an improved method of reclaiming cold from an airstream.

[0029] The airstream can be made up, for example, of the air discharged from an air-conditioned building. It is likewise possible to use the ambient air. By humidifying the airstream, its temperature is first reduced. Thereafter the airstream is rewarmed in the heat exchanger, in which process the remaining water droplets evaporate. On the basis of evaporative enthalpy, additional thermal energy is withdrawn from the coolant, so that the yield of the cold-reclamation process and the efficiency of the entire installation is improved.

[0030] Additional features, advantages and special embodiments of the invention are the subject matter of the subordinate claims.

[0031] Preferred embodiments of the invention are explained in the following, with reference to the attached drawings, wherein

[0032] **FIG. 1** is a block diagram of a first embodiment of apparatus in accordance with the invention but with additional peripheral components;

[0033] **FIG. 2** is a perspective view of the first embodiment of the apparatus in accordance with the invention;

[0034] **FIG. 3** is a side view of the apparatus shown in **FIG. 2**;

[0035] **FIG. 4** is a front view of the apparatus shown in **FIGS. 2 and 3**;

[0036] **FIG. 5** is a perspective view of a second embodiment of apparatus in accordance with the invention;

[0037] **FIG. 6** is a side view of the apparatus shown in **FIG. 5**;

[0038] **FIG. 7** is a Mollier-h,x diagram for humid air with the thermodynamic state changes in accordance with the first embodiment;

[0039] **FIG. 8** is a Mollier-h,x diagram for humid air with the thermodynamic state changes in accordance with the second embodiment;

[0040] **FIG. 9** shows an exemplary application of apparatus in accordance with the invention in the air-conditioning of buildings.

[0041] The block diagram of **FIG. 1** represents a first embodiment of an apparatus for the recooling of coolant or of recoolant media or for cold extraction from an airstream. The main components of the apparatus are a pressurized-water humidifier **10**, a heat exchanger **12** and a blower means **14**. The heat exchanger **12** is positioned downstream of the pressurized-water humidifier **10**. The blower means **14** in turn is positioned downstream of the heat exchanger **12**. The airstream moves from the pressurized-water humidifier **10** through the heat exchanger **12** to the blower means **14**. The flow of air is generated by a suction effect of the blower means **14**. Disposed ahead of the pressurized-water humidifier **10** is a sound attenuator **16**, while a second sound attenuator **18** is disposed after the blower means **14**.

[0042] The pressurized-water humidifier **10** comprises a plurality of nozzles **32**, which are disposed within the airstream. Upstream of the nozzles **32** is a high-pressure pump **28**, and upstream of the latter, in turn, a water-treatment installation **30** is disposed.

[0043] The heat exchanger **12** is coupled to a coolant circuit. In addition to the heat exchanger **12** the coolant circuit comprises a return conduit **24**, a coolant pump **22**, a refrigeration machine **20** and a forward conduit **26**.

[0044] The water-treatment installation **30** is preferably constructed as a reverse-osmosis installation. This offers the advantage that the supplied water is largely free from lime and salts, so that maintenance of the installation as a whole can be done at longer intervals. By means of the high-pressure pump **28**, the water is sent from the water-treatment installation **30** to the air-humidifier **10**. Because the water is under pressure and the nozzles **32** have a relatively small diameter, the water is added to the airstream in the form of very small droplets. That is, a spray of mist is produced in the airstream. The total surface area of this mist is very large in relation to its volume. The consequence is that when the airstream enters the heat exchanger **12**, the water droplets evaporate very rapidly and almost completely. The heat exchanger **12** brings about a thermal interaction between the airstream and the coolant circuit, which contains a suitable liquid as coolant. On account of evaporative enthalpy, evaporation of the water droplets in the heat exchanger **12** requires additional thermal energy, and this energy is withdrawn from the coolant while the latter is in the heat exchanger **12**. The temperature difference between the coolant in the forward conduit **26** and that in the return conduit **24** is thus considerably higher than it would be if the airstream had not been humidified. In the return conduit **24** the coolant is sent through the coolant pump **22** of the refrigeration machine **20**. The refrigeration machine **20** is in principle a heat exchanger that provides interaction between the coolant circuit and a cooling installation, for example an air-conditioning installation. In the refrigeration machine **20** the temperature of the coolant is returned to a higher level. By way of the forward conduit **26** the coolant is sent back to the heat exchanger **12**.

[0045] The air-humidifier **10**, the heat exchanger **12** and the blower means **14** are situated in a closed channel, so that the blower means **14** generates suction. This is particularly advantageous from the viewpoint of flow technology. The channel can function both vertically and horizontally. The apparatus can thus be adapted to the architectonic situation. The sound attenuators **16** and **18** are advantageous but not absolutely necessary. Because the water droplets evaporate practically completely in the heat exchanger **12**, the apparatus produces almost no waste water. All that is discharged into the surroundings is air. The air supply sent into the first sound attenuator **16** or the pressurized-water humidifier **10** can be obtained from the air discharged from an air-conditioned building or from the ambient air. The velocity of the airstream is between 0.5 m/s and 5 m/s. The water pressure produced by the high-pressure pump **28** can be regulated and is between 0 and 200 bar. The assembly consisting of the pressurized-water humidifier **10**, the heat exchanger **12** and the blower means **14** has an overall length of about 1 m.

[0046] **FIG. 2** shows in perspective an assembly consisting of the pressurized-water humidifier **10**, the heat exchanger **12** and the blower means **14**. The pressurized-water humidifier **10** comprises a plurality of nozzles **32**, all of which lie in one plane, which is perpendicular to the direction of flow of the airstream. By way of a conduit **40** pressurized water is sent to the nozzles **32**. From the nozzles **32** the water droplets are sprayed in the direction of flow of the airstream. The nozzles **32** are constructed such that the spray of water droplets emitted by each of them has the shape of a cone **34**. In this way the airstream is moistened uniformly over a complete cross section. Downstream of the pressurized-water humidifier **10** is the heat exchanger **12**. The heat exchanger **12** comprises a plurality of modules **36**, each of which is connected to a forward conduit **26** and a return conduit **24**. Each module **36** comprises a plurality of elongated lamellae **37**. The plane of the lamellae **37** is parallel to the direction of air flow. Because of the geometric arrangement of the modules **36** and the lamellae **37**, the resistance to flow of the airstream within the heat exchanger **12** is relatively slight. The large number of lamellae **37** and their large surface area allow a comparatively high degree of heat exchange to be achieved. As a result of the modular construction of the heat exchanger **12**, the number of modules **36** can be varied. Hence the heat exchanger **12** can be prepared for various kinds of heat transfer. The heat exchanger **12** shown in **FIG. 2** contains a plurality of modules **36** that fill up its entire cross section. However, only six modules **36** are shown in **FIG. 2**, so that the internal structure can be seen more clearly.

[0047] Downstream of the heat exchanger **12**, the blower means **14** is disposed. The blower means **14** comprises five ventilators **38** arranged in parallel. Because the pressurized-water humidifier **10**, the heat exchanger **12** and the blower means **14** are arranged in series in a closed channel, the five ventilators **38** operate as suction ventilators. This sucking action is especially favorable from a thermodynamic viewpoint. The ventilators **38** can be driven separately, so that the air flow can be adjusted to different velocities. For example, in the center of the channel the airstream velocity can be made different from that in the peripheral regions of the channel. There is thus a means of correcting the velocity distribution within the channel in such a way as to make the air flow as nearly laminar as possible. Because the blower means **14** comprises several ventilators **38**, maintenance work can be done on individual ventilators **38** with no need to turn off the installation as a whole. Hence if one ventilator **38** becomes defective or nonfunctional, only that particular ventilator **38** must be repaired or replaced, whereas the remaining components of the blower means **14** can remain in the installation.

[0048] **FIG. 3** is a side elevation of the apparatus shown in **FIG. 2**. The pressurized-water humidifier **10** comprises a number of nozzles **32**, disposed in a matrix, that is usually higher than can be seen in the purely schematic **FIG. 3**. By way of the feed pipe **40** the pressurized water is supplied. The spray cones **34** preferably have an angle between 30° and 90°. To increase the effectiveness, means can be provided in the air channel to make the air turbulent. The heat exchanger **12** comprises a plurality of modules **36**. In **FIG. 3** only six modules are shown, but in actuality the heat exchanger **12** contains modules **36** distributed over its entire cross section. Each module has its own forward conduit **26** and a return conduit **24**. In the blower means **14** five ventilators **38** are arranged in parallel.

[0049] **FIG. 3** makes clear the arrangement of the ventilators **38**. With this arrangement the formation of turbulence in the air channel can be largely prevented, which has a favorable effect on the energy balance of the installation as a whole.

[0050] **FIG. 4** is a front elevation of the apparatus shown in **FIGS. 2 and 3**. This view makes clear that the distribution of the nozzles **32** and the geometrical configuration of the spray cones **34** are such that the entire cross section of the air channel is encompassed. Furthermore, in the blower means **14** the ventilators **38** are distributed so that the suction effect is obtained over the entire cross section of the air channel.

[0051] **FIG. 5** shows a second embodiment of apparatus in accordance with the invention. The second embodiment differs from the first embodiment in that in addition to the pressurized-water humidifier **10** and the heat exchanger **12** it comprises another pressurized-water humidifier **50** and another heat exchanger **52**. The pressurized-water humidifier **10**, the heat exchanger **12**, the additional pressurized-water humidifier **50**, the additional heat exchanger **52** and the blower means **14** are arranged in series, in this order. With the second embodiment the yield of the cold-reclamation process is even higher than with the first embodiment. In the drawing for reasons of clarity only six modules **36** are shown in each of the heat exchangers **12** and **52**, whereas in fact the two heat exchangers **12** and **52** are filled with modules **36** over their entire cross section. Because the blower means **14** is situated at the end of the air channel, a suction effect is produced throughout the air channel.

[0052] **FIG. 6** is a side elevation of the apparatus shown in **FIG. 5**. The thermodynamic changes of state that occur during its operation are as follows. In the pressurized-water humidifier **10** the humidity of the air that is sucked in is raised to approximately 100%. At the same time the temperature of the airstream is reduced, because the energy needed for evaporation is drawn from the airstream. Subsequently, in the heat exchanger **12**, the temperature of the airstream is raised again, dependent on the temperature of the coolant. The heating is brought about by the fact that the temperature of the coolant in the coolant circuit is always higher than the temperature of the moisture-saturated air. Furthermore, the evaporative enthalpy of the water droplets in the spray of mist is utilized. The processes that take place in the pressurized-water humidifier **10** and in the heat exchanger **12** are then repeated in the pressurized-water humidifier **50** and in the heat exchanger **52**. The coolant in the coolant circuit, having itself been cooled in this way, is preferably used in turn to cool a supply of air to an air-conditioning installation or for recooling a coolant in another refrigeration machine.

[0053] **FIG. 7** shows a Mollier-h,x diagram for humid air with the thermodynamic changes of state found for apparatus in accordance with the first embodiment. In the Mollier-h,x diagram the relevant thermodynamic state variables, such as temperature, relative humidity and enthalpy, are represented graphically.

[0054] Arrow **1** shows the thermodynamic change of state of the airstream while it is being humidified in the pressurized-water humidifier **10**. Initially, the airstream has a temperature of 31° C. and a relative humidity of 40%. Alternatively, this air can be taken from the surroundings. This depends in particular on the general climatic conditions, the current weather situation and the demand for reclaimed cold. The humidification process is carried out with water, the temperature of which corresponds approximately to that of tap water. The humidification lowers the temperature of the airstream to 21.5° C., and simultaneously raises the relative humidity of the airstream to 100% and makes it supersaturated. The airstream can take up a particular amount of water until it reaches the state of saturation.

[0055] Having subsequently entered the heat exchanger **12**, the air is heated and can then again take up water. Because more water was sprayed into the airstream than it could initially absorb, the excess water evaporates in the heat exchanger **12**, obtaining the energy needed for this process by withdrawing it from the coolant within the heat exchanger **12**. The amount of energy withdrawn corresponds to the energy of evaporation of the water droplets. The amount of water that evaporates in the heat exchanger **12** depends on the temperature of the coolant when it enters the heat exchanger **12**.

[0056] Arrow **2** shows the thermodynamic change of state of the airstream in the heat exchanger **12**. Owing to exchange of heat with the heat exchanger **12** and simultaneous evaporation of the water droplets, the relative humidity of the airstream is reduced to about 67%. In this evaporation process the specific enthalpy of the air is raised by about 12 kJ/kg. This required evaporative enthalpy is obtained by withdrawal in the form of thermal energy from the coolant circuit in the heat exchanger **12**. The temperature of the coolant is thereby reduced. The coolant can subsequently be used for cooling the air introduced into the air-conditioned building or for recooling another coolant or for other cooling purposes. In addition, the temperature of the airstream in the heat exchanger **12** is raised to 29° C. By way of the blower means **14** the airstream is sent into the surroundings.

[0057] In the steps of the method indicated by arrows **1** and **2** an amount of energy is used that is provided by the evaporation of the water. This energy is also called latent energy. In the heat exchanger **12**, however, the tangible energy of the air is also used, i.e. the energy component that depends on the temperature. After the adiabatic cooling the air has a temperature of 21.5° C.; then it flows through the heat exchanger **12** and becomes several ° C. warmer. The energy involved in this heating amounts to 0.336 Wh per ° C. and per m^3 of air flowing past.

[0058] **FIG. 8** shows a Mollier-h,x diagram for humid air with the thermodynamic changes of state found for the second embodiment. Because the second embodiment involves two stages, both the humidification process with cooling and also the heating with evaporation in the airstream are repeated. In the second embodiment, too, the initial temperature of the airstream is 31° C. The initial humidity is likewise 40%. The thermodynamic changes of state according to arrows **1** and **2** are identical to those according to the arrows **1** and **2** in **FIG. 7**. Whereas in the first embodiment the airstream is released into the surroundings after the first evaporation process, here another humidification occurs in the pressurized-air humidifier **50**. The corresponding thermodynamic change of state is indicated by arrow **3**. The temperature of the airstream is lowered from 29° C. to 24° C. The relative humidity is raised in the second pressurized-air humidifier **50** from about 67% to nearly 100%. In this stage, again, the airstream is in a state in which it cannot take up any more moisture. In the heat exchanger **52** a substantial part of the moisture evaporates, so that at the output of the heat exchanger **52** the relative humidity of the airstream is about 78%. The temperature of the airstream is raised from 24° C. to about 30° C. in the heat exchanger **52**. This of course requires that the temperature of the coolant in the forward conduit of the heat exchanger **52** must be higher than the final temperature of the airstream in the heat exchanger **52**. The coolant in the coolant circuit is correspondingly cooled in the heat exchanger **52** and can be used in another heat exchanger to cool the air supplied to an air-conditioned building.

[**0059**] The block diagram of **FIG. 9** represents an air-conditioning unit for buildings and shows as its main component the apparatus in accordance with the invention for cold reclamation. The air-conditioning unit comprises two air channels, namely an exhaust channel and an inlet channel. In the exhaust channel is situated the apparatus according to the first embodiment. The apparatus consists of the pressurized-water humidifier **10**, the heat exchanger **12** and the blower means **14**. In the inlet channel are an incoming-air heat exchanger **72** and an incoming-air blower means **74**. The heat exchanger **12** and the incoming-air heat exchanger **72** are coupled to one another by way of the coolant circuit. The incoming-air heat exchanger **72** mediates an interaction between the inlet channel and coolant circuit. The coolant circuit further comprises two coolant pumps **76** and **78**, a variable heat exchanger **80** for heating or cooling, and a control valve **82**. At the entrance to the exhaust channel room air **60** is sucked in, which typically has a temperature of 26° C. and a relative humidity of about 47%. In the pressurized-water humidifier **10** the air extracted from the room is moistened by means of the nozzles **32**, so that its relative humidity approaches 100%. During this process, the air from the room is cooled to about 20° C. In the heat exchanger **12** a part of the sprayed-in water evaporates and the air temperature rises, so that the relative humidity of the airstream is reduced to about 67%. At the same time, the temperature of the airstream is raised to about 25° C. On the basis of the evaporative enthalpy of the water droplets in the airstream, a relatively large amount of heat is withdrawn from the coolant circuit. In this way the coolant in the coolant circuit becomes distinctly cooler. The heated airstream is passed on to the surroundings as exhaust air **62**. The two coolant pumps **76** and **78** in the coolant circuit are provided to propel the coolant. The variable heat exchanger **80** and the control valve **82** enable the temperature of the coolant in the coolant circuit to be corrected. In this way the coolant temperature in the coolant circuit can be made independent of the exact temperatures of the extracted room air **60**, the exhaust air **62**, the outside air **66** and the air **64** sent into the building. By way of the variable heat exchanger **80** the temperature of the coolant can be either raised or lowered, as required.

[**0060**] The cooled coolant can be used to cool down the airstream in the second air channel. In the second air channel outside air **66** is sucked in from the surroundings. Typical values for the outside air **66** are a temperature of 29° C. and 44% relative humidity. In the heat exchanger **72** for air to be sent into the building, the incoming air is cooled to about 20° C., in which process its relative humidity rises to about 70%. By the additional blower means **74** the cooled outside air is sent into the interior of the air-conditioned building.

[**0061**] The high-pressure pump **28** can be regulated. In particular it is useful to spray more water in, through the pressurized-water humidifier **10**, the higher the temperature of the air **60** extracted from the room. If the temperature of the extracted room air **60** or of the ambient air used in its place is below 20° C., humidification with pressurized water is not absolutely necessary. Therefore it is considered advantageous not to begin spraying water into the airstream until the cooling performance of the unhumidified airstream no longer suffices. Furthermore, the high-pressure pump **28** is advantageously made continuously variable, so that the intensity of the humidification can be adjusted to any desired level. The installation has the advantage that almost no waste water is produced. Similarly, no chemicals are required either in operation or for cleaning purposes, which is advantageous with respect to protecting the environment. Because desalinated water is preferably employed and the water is introduced by spraying, in amounts closely matched to the cooling requirements so that hardly any is wasted, the expenditure of effort for cleaning and maintenance is considerably reduced in comparison with prior-art apparatus.

List of Reference Numerals

[**0062**] **10** Pressurized-water humidifier

[**0063**] **12** Heat exchanger

[**0064**] **14** Blower means

[**0065**] **16** First sound attenuator

[**0066**] **18** Second sound attenuator

[**0067**] **20** Refrigeration machine

[**0068**] **22** Coolant pump

[**0069**] **24** Return conduit

[**0070**] **26** Forward conduit

[**0071**] **28** High-pressure pump

[**0072**] **30** Water-treatment installation

[**0073**] **32** Nozzles

[**0074**] **34** Spray cone

[**0075**] **36** Module

[**0076**] **37** Lamellae

[**0077**] **38** Ventilators

[**0078**] **40** Feed pipe

[0079] **50** Additional pressurized-water humidifier

[0080] **52** Second heat exchanger

[0081] **60** Extracted room air

[0082] **62** Exhaust air

[0083] **64** Air input to room

[0084] **66** Outside air

[0085] **72** Incoming-air heat exchanger

[0086] **74** Input-air blower

[0087] **76, 78** Coolant pumps

[0088] **80** Variable heat exchanger

[0089] **82** Control valve

1. Apparatus for the recooling of coolants or of recoolant media or for extracting cold from an airstream, comprising

at least one air-humidifier **(10)** for the addition of moisture to the airstream;

at least one heat exchanger **(12)**, which is positioned downstream of the air-humidifier **(10)** and interacts between the airstream and a coolant circuit; and

a blower means **(14)** for propelling the airstream.

2. Apparatus as claimed in claim 1, characterized in that the air-humidifier **(10)**, the heat exchanger **(12)** and the blower means **(14)** are disposed in a channel, which defines an entrance and an exit but is otherwise closed.

3. Apparatus as claimed in claim 1 or claim 2, characterized in that the blower means **(14)** is disposed downstream of the heat exchanger **(12)**.

4. Apparatus as claimed in any one of claims 1 to 3, characterized in that the blower means **(14)** comprises a plurality of ventilators **(38)** which are either disposed in parallel or disposed in series.

5. Apparatus as claimed in any one of claims 1 to 4, characterized in that the air-humidifier **(10)** is a pressurized-water humidifier.

6. Apparatus as claimed in claim 5, characterized in that the air-humidifier **(10)** comprises a plurality of nozzles **(32)** disposed in the airstream.

7. Apparatus as claimed in claim 6, characterized in that the orientation of the plurality of nozzles **(32)** is such that an ejection is substantially in the direction of flow of the airstream.

8. Apparatus as claimed in any one of claims 5 to 7, characterized in that the pressure with which humidifying liquid is applied to the air-humidifier **(10)** is continuously adjusted, in particular regulated.

9. Apparatus as claimed in claim 8, characterized in that the pressure with which humidifying liquid is applied to the air-humidifier **(10)** is set, in particular regulated, to values in a range between 0 bar and 200 bar.

10. Apparatus as claimed in any one of claims 1 to 9, characterized in that the amount of water in the air-humidifier **(10)** is continuously adjusted, in particular regulated.

11. Apparatus as claimed in any one of claims 1 to 10, characterized in that the air-humidifier **(10)** produces a fine mist in the airstream.

12. Apparatus as claimed in claim 11, characterized in that the fine mist consists of droplets, such that the majority of droplets has a diameter smaller than 60 μm, preferably smaller than 30 μm.

13. Apparatus as claimed in any one of claims 1 to 12, characterized in that a sound attenuator **(16)** is positioned upstream of the air-humidifier **(10)**.

14. Apparatus as claimed in any one of claims 1 to 13, characterized in that a sound attenuator **(18)** is positioned downstream of the blower means **(14)**.

15. Apparatus as claimed in any one of claims 1 to 14, characterized in that the coolant circuit comprises a liquid coolant.

16. Apparatus as claimed in any one of claims 1 to 15, characterized in that the air-humidifier **(10)** comprises a regulating device to regulate the humidification of the airstream, so that substantially no condensed water remains in the apparatus.

17. Apparatus as claimed in any one of claims 4 to 16, characterized in that the rotational speed of the ventilators **(38)** is continuously adjustable.

18. Apparatus as claimed in claim 17, characterized in that the apparatus can be regulated by adjusting the rotational speed of the ventilators **(38)** and the pressure in the air-humidifier **(10)**.

19. Method for the cooling of a coolant media or for extracting cold from an airstream, comprises the steps of:

providing an airstream derived from air discharged from an air-conditioned building or from ambient air;

humidifying the airstream by spraying into it a fine mist of water;

warming the airstream while increasing the absolute humidity and simultaneously reducing the relative humidity, the energy required for this process being drawn from a coolant circuit; and

discharging the airstream into the surroundings.

20. Method as claimed in claim 19, characterized in that the humidification of the airstream is regulated and directed in such a way that substantially no precipitation is produced.

21. Method as claimed in claim 19 or claim 20, characterized in that the method is carried out with an apparatus as claimed in any one of claims 1 to 18.

22. Method as claimed in any one of claims 19 to 21, characterized in that the steps of humidifying the airstream and warming the airstream are repeated at least once.

23. Method as claimed in any one of claims 19 to 22, characterized in that the humidification of the airstream is performed with pressurized water, with a pressure in a range between 0 bar to 200 bar, and preferably in a range between 20 to 120 bar, and yet more preferably with a pressure of 80 bar.

24. Method as claimed in any one of the claims 19 to 23, characterized in that the amount and the velocity of the airstream are regulated by continuous adjustment of the rotational speeds of ventilators.

25. Method as claimed in claim 23 or claim 24, characterized in that the cooling or cold extraction is regulated both by adjusting the pressure or the output quantity of the pressurized water and by adjusting the rotational speeds of ventilators.

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