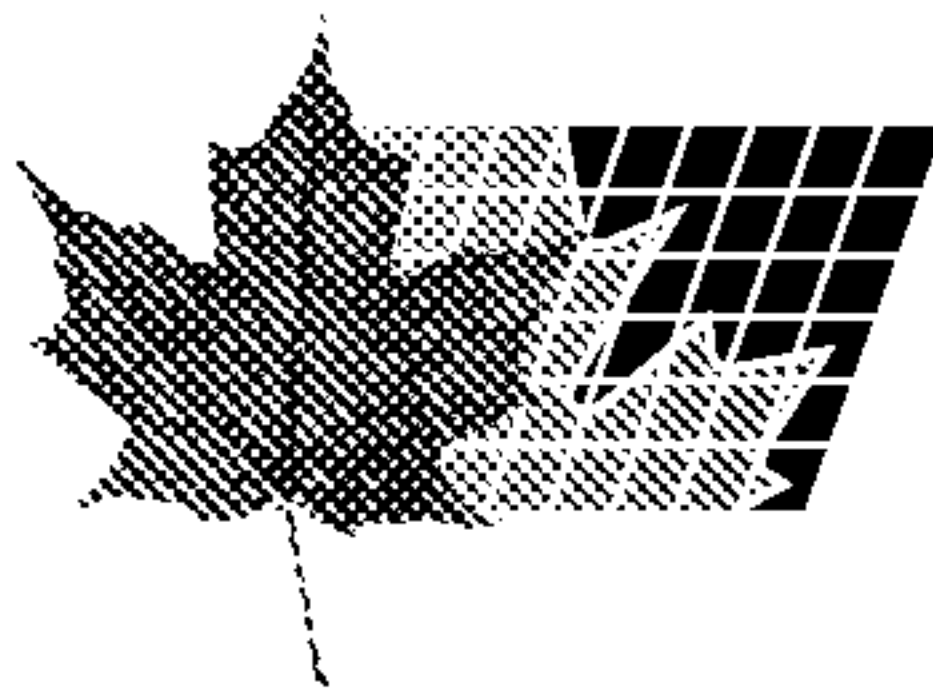




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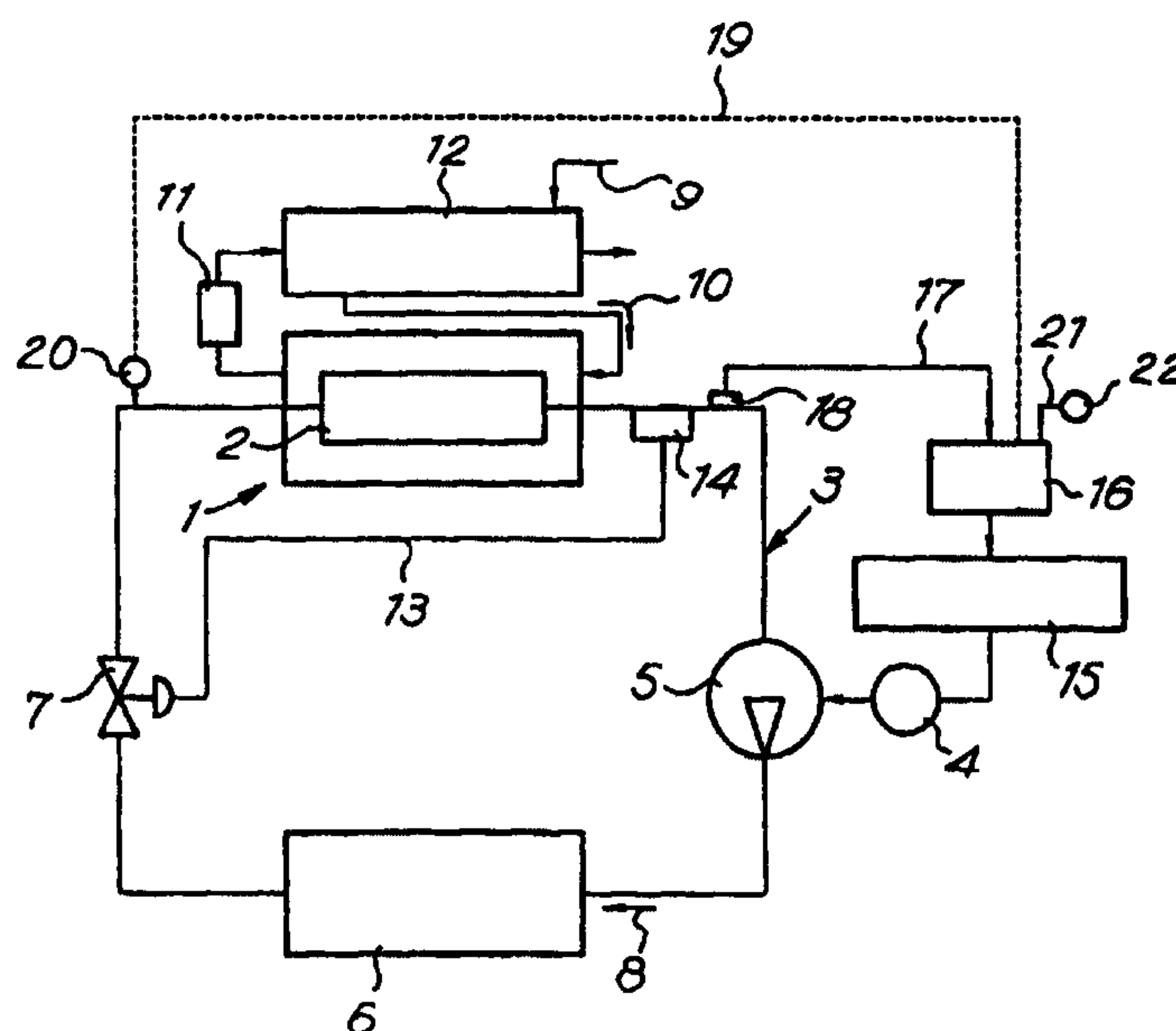
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(54) **PROCEDE ET DISPOSITIF DE SECHAGE PAR LE FROID**

(54) **METHOD AND DEVICE FOR COOL-DRYING**



(57) L'invention concerne un procédé de séchage par le froid d'un gaz contenant de la vapeur d'eau. Ce gaz est guidé à travers la partie secondaire d'un échangeur thermique (1) dont la partie principale forme un évaporateur (2) d'un circuit de refroidissement (3) qui comprend aussi un compresseur (5) commandé par un moteur électrique (4), un condensateur (6), des moyens d'expansion (7) situés entre la sortie du condensateur (6) et l'entrée de l'évaporateur (2). Le circuit de refroidissement (3) dépend aussi de la charge qu'il peut recevoir sans pour autant entraîner la formation de glace dans l'évaporateur (2). Le circuit de refroidissement est caractérisé en ce qu'il fonctionne selon le réglage du régime du moteur (4).

(57) The present invention concerns a method for cool-drying gas containing water vapor, whereby this gas is guided through the secondary part of a heat exchanger (1) whose primary part is the evaporator (2) of a cooling circuit (3) which also contains a compressor (5) which is driven by an electric motor (4), a condenser (6), an expansion means (7) between the outlet of the condenser (6) and the inlet of the evaporator (2), and whereby the above-mentioned cooling circuit (3) is thus controlled as a function of the load that the cooling capacity is adjusted without any ice being formed in the evaporator (2), characterized in that the cooling circuit is controlled by adjusting the rotational speed of the motor (4).

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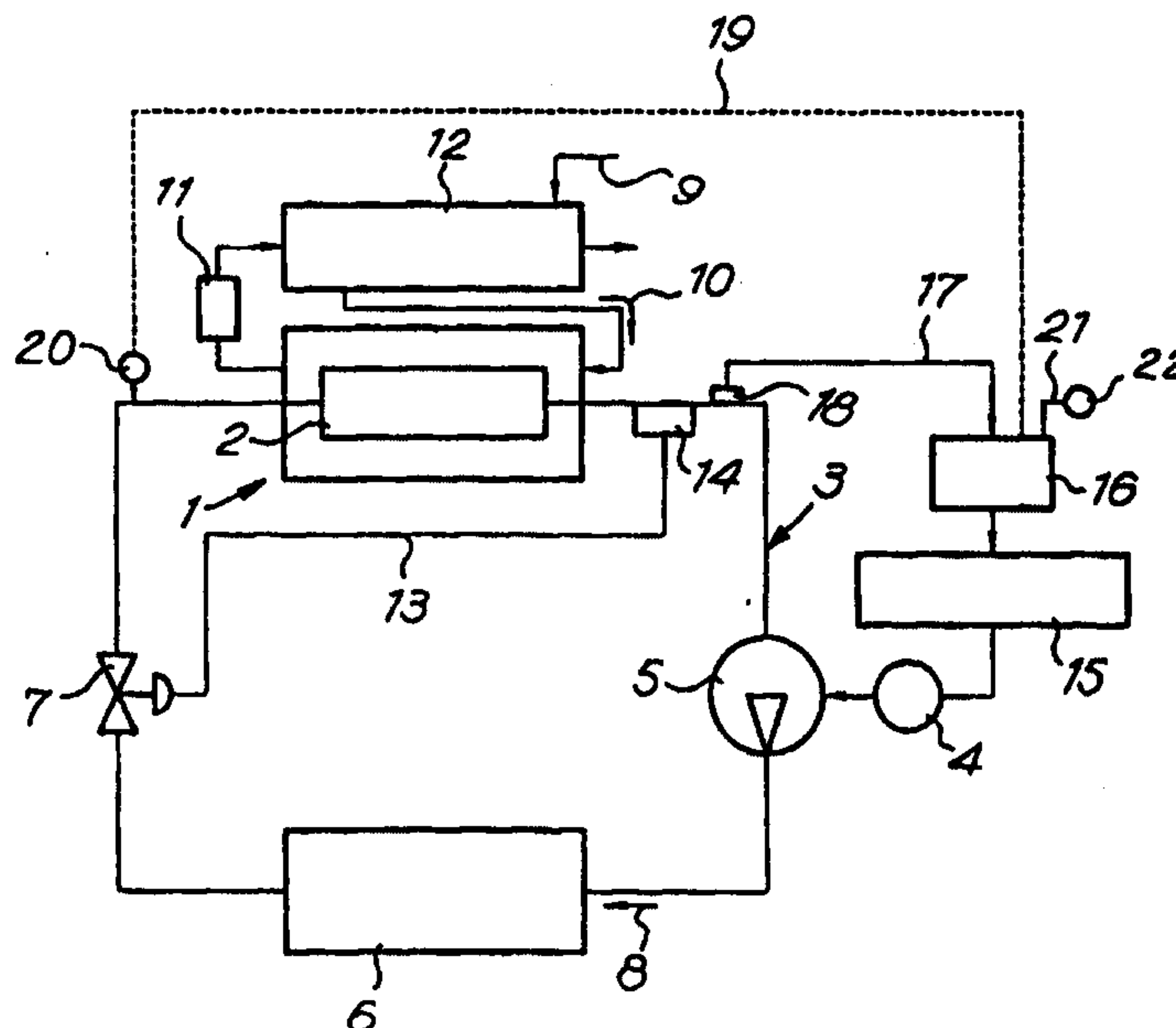
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(57) Abstract

The present invention concerns a method for cool-drying gas containing water vapor, whereby this gas is guided through the secondary part of a heat exchanger (1) whose primary part is the evaporator (2) of a cooling circuit (3) which also contains a compressor (5) which is driven by an electric motor (4), a condenser (6), an expansion means (7) between the outlet of the condenser (6) and the inlet of the evaporator (2), and whereby the above-mentioned cooling circuit (3) is thus controlled as a function of the load that the cooling capacity is adjusted without any ice being formed in the evaporator (2), characterized in that the cooling circuit is controlled by adjusting the rotational speed of the motor (4).

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Method and device for cool-drying.

5 The present invention concerns a method for cool-drying
gas containing water vapor, whereby this gas is guided
through the secondary part of a heat exchanger whose
primary part is the evaporator of a cooling circuit which
also contains a compressor which is driven by an electric
10 motor, a condenser, an expansion means between the outlet
of the condenser and the inlet of the evaporator, and
whereby the above-mentioned cooling circuit is thus
controlled as a function of the load that the cooling
capacity is adjusted without any ice being formed in the
15 evaporator.

Such methods are used among others for drying compressed
air.

20 Compressed air which is supplied by a compressor is in
most cases saturated with water vapor or, in other words,
has a relative humidity of 100%. This implies that there
is condensation at the slightest decrease of temperature.
The water of condensation causes corrosion in the pipes
25 and tools, and the equipment will wear out prematurely.

That is why the compressed air is dried, which may be
done in the above-mentioned manner, by means of cool-
drying. Also other air than compressed air or other
30 gases may be dried in this manner.

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Cool-drying is based on the principle that, by lowering the temperature, moisture from the air or the gas condenses, after which the water of condensation is separated in the liquid separator and after which the air
5 or the gas is heated again, as a result of which this air or this gas is no longer saturated. The heat is discharged by the cooling circuit in the evaporator.

The same applies to other gases than air, and each time
10 air is referred to hereafter, the same also applies to other gases than air.

In practice, there is an ISO-standard which determines the possible dew point and the corresponding lowest air
15 temperature for reference values.

In order to prevent the lowest air temperature from dropping below 0°C and thus the evaporator from freezing up, a necessary condition is that the temperature of the
20 evaporator is higher than 0°C.

According to known methods, to this end, the temperature is measured on the inlet of the evaporator, or, since there is a definite connection between the temperature of
25 the evaporator and the pressure of the evaporator for a specific cooling liquid in the cooling circuit, the pressure is measured before or after the evaporator.

The cooling circuit is then controlled such that the
30 temperature of the evaporator or the pressure of the evaporator has the required value, and for example the

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pressure of the evaporator coincides with a temperature which is situated a few degrees below the required lowest air temperature or LAT, but not below 0°C.

5 According to these known methods for cool-drying, the motor of the compressor of the cooling circuit which is driven at a constant frequency is switched on and off as a function of the temperature of the evaporator. If this pressure of the evaporator decreases too much, said motor
10 is stopped. If the pressure of the evaporator subsequently increases too much as the expansion valve is still open, the motor is started again.

Such a regulation makes it possible for the compressor to
15 be switched off when the load drops beneath the cooling capacity, as a result of which the energy consumption will decrease. The surplus of cooling capacity is stored in a thermal mass. However, this regulation is very disadvantageous as the compressor is continuously
20 switched on and off in case of a small load, while also the pressure of the evaporator and the dew points fluctuate strongly. Moreover, the cool-dryer must be built relatively large.

25 Another known method consists in measuring the lowest air temperature (LAT) on the outlet of the secondary part of the heat exchanger and to switch off the motor of the compressor of the cooling circuit when the temperature threatens to drop below 0°C. This method, whereby the
30 motor is thus also switched on and off, offers the same disadvantages as the preceding one.

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Another possibility for regulating the pressure of the evaporator would consist in selecting an evaporator which is large enough and in carrying back hot gases on the outlet of the compressor to the inlet of the compressor by means of a bypass.

This regulation method is disadvantageous in that, since the compressor motor is continuously working, also when there is no load or when the load is low, the energy consumption is equal to the energy consumption at a nominal load, as the high and low pressure in the cooling circuit are continuously kept at a constant level.

The object of the invention is a method for cool-drying which does not have the above-mentioned and other disadvantages and which makes it possible to save energy in a simple manner, without any pressure variations in the cooling circuit and without much wear of the compressor and its motor.

In accordance with the invention, this object is accomplished in that the cooling circuit is controlled by adjusting the rotational speed of the motor.

25

Instead of switching the motor on or off, its speed is adjusted. By increasing the rotational speed of the motor, more mass flow of cooling liquid can be pumped round, and thus can be obtained a higher cooling output.

30

- 5 -

The temperature of the evaporator can be measured and the above-mentioned cooling circuit can be controlled as a function of the measured temperature of the evaporator.

- 5 According to another embodiment, the pressure of the evaporator can be measured and the above-mentioned cooling circuit can be controlled as a function of the measured pressure of the evaporator.
- 10 According to yet another embodiment, the lowest gas temperature (LAT) can be measured and the above-mentioned cooling circuit is controlled as a function of this lowest gas temperature (LAT).
- 15 According to yet another embodiment, the dew point temperature of the gas can be measured and the above-mentioned cooling circuit is controlled as a function of this dew point.
- 20 Preferably, the rotational speed of the motor is adjusted by modifying the frequency of the supply current.

According to a special embodiment of the invention, the ambient temperature is measured and the rotational speed
25 of the motor is adjusted as a function of the measured ambient temperature.

At high ambient temperatures, whereby the air or the gas is also relatively warm and may contain more moisture
30 than when it is cold, it is not necessary to cool it to 3°C in the heat exchanger in order to obtain dry air.

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Thus, the energy consumption of the above-mentioned cool-dryers is too high, and they require relatively large and expensive components in order to supply the cooling output. By taking into account said ambient temperature, 5 the required cooling output may be kept lower, such that the cool-dryer can be made less large.

Preferably, the rotational speed of the motor of the compressor is adjusted such that the lowest air or gas 10 temperature on the outlet of the evaporator is 20°C lower than the measured ambient temperature, without dropping below 3°C, however.

It is assumed that, when the outgoing air or the outgoing 15 gas has a relative humidity of 50%, the danger of corrosion in pipes and equipment is excluded, and the above-mentioned control device guarantees that said relative humidity will not be higher than 50%.

20 The invention also concerns a device for cool-drying or a cool-dryer which is particularly suitable for applying the above-mentioned method.

The invention in particular concerns a device for cool- 25 drying, containing a heat exchanger whose primary part is the evaporator of a cooling circuit which also contains a compressor which is driven by an electric motor, a condenser, an expansion means between the outlet of the condenser and the inlet of the evaporator, a control 30 device to control the above-mentioned motor and measuring means coupled thereto, whereas the secondary part of the

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heat exchanger is part of a pipe for the gas and a liquid separator is erected on the outlet of said heat exchanger, in said pipe, whereby the device contains means to adjust the rotational speed of the motor while
5 the control device controls these means as a function of the value measured by the measuring means.

The measuring means may be provided on the cooling circuit and they may be means to measure the temperature
10 of the evaporator or the pressure of the evaporator.

However, the measuring means may also be provided on the pipe for the gas, in the secondary part of the heat exchanger or downstream to it, and they may be means to
15 measure the lowest gas temperature (LAT) or means to measure the dew point.

Preferably, the means for regulating the rotational speed of the motor consist of a frequency converter.
20

According to a special embodiment of the invention, the cool-dryer contains means for measuring the ambient temperature which are also coupled to the control device, and this control device is such that it adjusts the speed
25 of the motor both as a function of the value measured by the measuring means and as a function of the temperature measured by the means for measuring the ambient temperature.

30 In order to better explain the characteristics of the invention, the following preferred embodiments of a cool-

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dryer according to the invention are described as an example only without being limitative in any way, with reference to the accompanying drawings, in which:

- 5 figure 1 represents a block diagram of a device for cool-drying according to the invention;
figure 2 represents a block diagram analogous to that of figure 1, but in relation to another embodiment of the invention.

10

The device for cool-drying which is schematically represented in figure 1 mainly contains a heat exchanger 1 whose primary part forms the evaporator 2 of a cooling circuit 3 in which are also successively erected an
15 electric motor 4 driven by a compressor 5, a condenser 6 and an expansion valve 7.

This cooling circuit is filled with cooling fluid, for example freon 404a, whose direction of flow is
20 represented by the arrow 8.

The secondary part 1A of the heat exchanger 1 is part of the pipe 9 for humid air to be dried, whose direction of flow is represented by the arrow 10.

25

After the heat exchanger 1, i.e. on its outlet, a liquid separator 11 is erected in the pipe 9.

Before it reaches the heat exchanger 1, this pipe 9 may
30 possibly extend through a pre-cooler or recuperation heat exchanger 12 with one part and subsequently, after the

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liquid separator 11, extend again through the recuperation heat exchanger 12, counterflow to the above-mentioned part.

5 The heat exchanger 1 is a liquid/air heat exchanger and, from a constructional point of view, may form a whole with the possible recuperation heat exchanger 12 which is an air/air heat exchanger.

10 The expansion valve 7 is a thermostatic valve whose thermostatic element is coupled to a bulb 14 provided on the outlet of the evaporator 2 on the cooling circuit 3 by means of a copper guide 13 and which is filled with the same cooling liquid.

15

According to a variant which is not represented in the figure, this expansion valve is an electronic valve, however, which is coupled to a temperature gauge erected on the far end of the evaporator 2 or after it.

20

In small cool-dryers, the expansion valve 7 may be replaced by a capillary tube.

The compressor 5 is a volumetric compressor which
25 supplies an almost invariable volume flow at an invariable rotational speed, for example a spiral compressor, whereas the motor 4 is an electric motor whose rotational speed can be adjusted by changing the frequency.

30

- 10 -

Also, this motor 4 is coupled to a frequency converter 15 which is controlled by a control device consisting of a built-in PID controller 16.

- 5 The frequency converter 15 may for example adjust the frequency between 0 and 400 Hz and forms means to adjust the rotational speed of the motor 4.

According to a first embodiment, the PID controller 16 is
10 connected to measuring means 18 via a pipe 17 to measure the pressure of the evaporator, for example a pressure transmitter with a pressure range from -1 tot 12 bar which transforms the pressure in an electric signal, in particular a current, which is erected on the inlet or
15 the outlet of the evaporator 2, as is represented in the figure by means of a dashed line.

According to a second embodiment, the PID controller 16 is connected to the measuring means 20 via a pipe 19 to
20 measure the temperature of the evaporator, for example a thermocouple in the cooling circuit 3, on the inlet of the evaporator 2 and thus between this evaporator 2 and the expansion valve 7.

25 Indeed, for a given cooling fluid, there is a definite connection between the temperature of the evaporator and the pressure of the evaporator. The higher the temperature, the higher the pressure. Strictly speaking, this connection is not linear, but in the field of
30 operation, i.e. between 0°C and 25°C, the deviation from a linear is to be practically neglected.

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In both embodiments, the PID controller 16 is connected to means 22 via a pipe 21 to measure the ambient temperature and which transform this temperature into an electric signal, in particular a current.

The working of the cool-dryer is as follows:

The air to be dried is carried through the pipe 9 and thus through the heat exchanger 1, counterflow to the cooling fluid in the evaporator 2 of the cooling circuit 3.

In this heat exchanger 1, the damp air is cooled, as a result of which condensation is formed which is separated in the liquid separator 11.

The cold air, which contains less moisture after this liquid separator 11 but yet has a relative humidity of 100%, is heated in the recuperation heat exchanger 12, as a result of which the relative humidity decreases to about 50%, while the fresh air to be dried is already partly cooled in this heat exchanger 12 before being supplied to the heat exchanger 1.

25

The air on the outlet of the recuperation heat exchanger 12 is thus drier than on the inlet of the heat exchanger 1.

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In order to prevent the evaporator 2 from freezing, the air in the heat exchanger 1 is not cooled below 3°C, which is the LAT for low ambient temperatures.

- 5 With higher ambient temperatures, the LAT may be higher and may be cooled to an LAT which is 20°C lower than the ambient temperature, and in any case not below 3°C.

Is the LAT too high, this means that there is not enough
10 cooling and thus not enough condensation of moisture to sufficiently dry the air.

Said LAT is situated 2 to 3°C above the actual temperature of the evaporator which is measured by the
15 measuring means 20.

The above-mentioned LAT conditions are met by adjusting the rotational speed of the motor 4 as a function of the temperature of the evaporator measured by the measuring
20 means 20 by means of the PID controller 16 and the frequency converter 15 controlled by it in the one embodiment, or the pressure of the evaporator measured by the measuring means 18 in the other embodiment.

- 25 The cooling output is equal to the mass flow of cooling liquid circulating in the cooling circuit 3, multiplied by the enthalpy difference of the air before and after the heat exchanger 1. By increasing the rotational speed of the motor 4, the compressor 5 can pump round more mass
30 flow, and thus can be supplied a larger output with the same enthalpy difference. The mass flow is the volume

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flow of the compressor 5, multiplied by the density of the cooling liquid in the suction condition, which itself depends on the temperature of the evaporator and the overheating.

5

The PID controller 16 adjusts the measured temperature or pressure by adjusting the rotational speed, so that this temperature is a few degrees lower than the above-mentioned LAT, but yet higher than 0°C, the pressure of the evaporator is reached respectively, which coincides with a temperature which is a few degrees lower than the LAT and which is for example equal to 1°C, whereby for freon R404a, the pressure of the evaporator is effectively about 5.2 bar.

15

In this manner, the cooling output is adjusted to the load.

As the means 22 also measure the ambient temperature, the PID controller 16 coupled to it can take this temperature into account.

By means of the PID controller 16 and the frequency converter 15 controlled by it, the rotational speed of the motor 4 is then adjusted such that, as long as the ambient temperature is low, in particular below 23°C, the above-mentioned condition is met and thus the LAT on the outlet of the secondary part 1A of the heat exchanger 1 is about 3°C, but at a higher ambient temperature, this LAT is 20°C lower than the ambient temperature measured by the means 21.

30

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The pressure of the evaporator has a set point which is a few degrees lower than the required LAT. The temperature which is obtained by subtracting some 22°C from the ambient temperature, can be calibrated as the set point of the PID controller 16.

A minimum and a maximum set point may possibly be set in the PID controller 16, whereby the minimum is 1°C. When calibrating the PID controller 16, this set point can be adjusted for example via a control panel or via an analogous inlet.

The frequency is adjusted between for example 30 and 75 Hz.

The maximum load of the cool-drying device is relatively small, since, at higher ambient temperatures, the LAT can be higher than 3°C, as a result of which the cooling output decreases and the components may thus be less expensive and cooling fluid is saved on.

In the condenser 6, the cooling fluid which has been heated in the compressor 5 as a result of the compression, is cooled until it has a liquid state, whereby use can be made of a fan or of cooling water to discharge the heat to the environment.

When the pressure in the condenser 6 is too high, the motor 4 is automatically switched off.

- 15 -

After the condenser 6, the liquid cooling fluid may possibly be collected in a receptacle and/or it may be further cooled by an extra heat exchanger.

- 5 Thanks to the expansion valve 7, the liquid cooling fluid is expanded to a constant evaporator pressure, which of course results in a temperature decrease.

10 The expansion valve 7 only controls the overheating in the evaporator 2 and makes sure that the evaporator 2 is always optimally used, but it cannot be used to the control the pressure or temperature of the evaporator.

15 By applying a thermostatic expansion valve 7, there will always be overheating after the evaporator 2, so that there is no danger of cooling liquid entering the compressor 5, so that there is no need for a liquid separator in the cooling circuit 3 and so that the amount of cooling fluid is restricted.

20

This overheating is measured by distracting the temperature measured by the bulb 14 from the temperature of the evaporator, either before the evaporator 2 (internal equalization) or after the evaporator (external
25 equalization). This difference is compared to a set value by the expansion valve 7 and, in case of a deviation, the expansion valve 7 will correct it by opening or by closing.

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The degree of overheating has an influence on the LAT, but we may assume that this overheating is kept at a practically constant level by the expansion valve.

- 5 If necessary, this influence of the overheating can be taken into account by for example a sort of master/slave control circuit. The slave control circuit is the above-described control with the PID controller 16, whereas the master control circuit could adjust the set point of the
- 10 pressure or temperature of the evaporator as a function of the actual LAT, and thus could for example lower the set point if the LAT remains too high as the overheating after the evaporator 2 is too high.
- 15 Although the pressure or temperature of the evaporator is adjusted by modifying the rotational speed, it may be possible to entirely switch off the motor 4 in case the load is zero, for example by placing a thermostatic sensor in the heat exchanger 1 which, should the
- 20 temperature in the evaporator 2 drop to zero degrees, switches off the motor 4 and starts it again as soon as the temperature has risen to 3°C.

The embodiment of the invention represented in figure 2

25 mainly differs from the above-described embodiments in that the measuring means 18 for measuring the pressure of the evaporator and/or the measuring means 20 for measuring the temperature of the evaporator provided on the cooling circuit 3 have been replaced by measuring

30 means 23 for measuring the lowest air temperature (LAT).

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These measuring means 23 have been provided on the pipe 9, either in the secondary part 1A of the heat exchanger 1, for example on the surface of the evaporator 2, or as represented in figure 2, downstream the heat exchanger 1, for example between this heat exchanger 1 and the liquid separator 11.

The PID controller 16 is then connected to these measuring means 23 and to the means 22 for measuring the ambient temperature by means of a pipe 21.

In this embodiment, the PID controller 16 controls the frequency converter 15 and thus the rotational speed of the motor 4 as a function of the measured lowest air temperature LAT.

Measuring the LAT offers a major advantage in that the temperature of the cooling fluid may be lower than 0°C without the evaporator thereby freezing up, i.e. before ice is formed on the air side of the evaporator, since this phenomenon is determined by the LAT.

Since with low evaporator temperatures, for example -5°C, on the side of the cooling fluid, and major temperature differences, for example of 8°C (between +3°C and -5°C), there may be evaporation without any danger of freezing, the heat exchanger 1 can be made very compact.

If the measured lowest air temperature LAT rises or drops, the PID controller 16 will order the speed of the motor 4 to increase, decrease respectively, such that, as

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long as the ambient temperature measured by the temperature gauge 22 is low, in particular lower than 23°C, this measured LAT temperature will not drop below some 3°C, so as to make sure that the evaporator 2 will
5 not freeze up.

Thanks to this control, the cooling is thus adjusted according to the load, whereby the evaporator temperatures on the side of the cooling fluid may drop
10 below zero without the evaporator 2 freezing up on the air side, however. As a result, not only the energy consumption of the motor 4 is restricted to a minimum, but the heat exchanger 1 can be made relatively compact, which also implies savings on the cost of the device.

15

In this embodiment also, the overheating in the evaporator 2 is controlled by the expansion valve 7, as a result of which the cooling fluid expands.

20 Although the lowest air temperature is adjusted by modifying the rotational speed of the motor 4, it may be possible in this embodiment as well to entirely switch off the motor 4 in case of a zero load.

25 According to a variant of the preceding embodiment which is not represented in the figures, the measuring means 23 for measuring the lowest air temperature are replaced by measuring means for measuring the dew point of said air. Such measuring means or dew point gauges are available on
30 the market and hence are not further described here.

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Instead of the LAT, the dew point of the air is thus measured on the same place. The working is analogous to the above-described working, whereby the speed of the motor 4 is thus adjusted such that the cooling in the heat exchanger 1 is optimal, but the evaporator 2 is prevented from freezing up.

The invention is by no means limited to the above-described embodiments represented in the accompanying drawing; on the contrary, such a method and device for cool-drying can be made in all sorts of variants while still remaining within the scope of the invention.

In particular, instead of a PID controller 16, the control device may contain another controller, for example a PI or P controller. Although the ambient temperature is preferably also taken into account, among others to restrict the output of the device, it is possible, according to a simpler embodiment, to adjust the rotational speed of the motor 4 merely as a function of the evaporator temperature, the evaporator pressure, the lowest gas temperature or the dew point of the gas.

Instead of damp air, other gases than air containing water vapor can be dried in the same manner and with the same device. The LAT is then the lowest gas temperature.

AMENDED CLAIMS

[received by the International Bureau on 07 October 1999 (07.10.99);
original claims 1, 4-22 replaced by new claims 1-19
remaining claims unchanged (5 pages)]

1. Method for cool-drying gas containing water vapor,
5 whereby this gas is guided through the secondary part
(1A) of a heat exchanger (1) whose primary part is the
evaporator (2) of a cooling circuit (3) which also
contains a compressor (5) which is driven by an electric
motor (4), a condenser (6), an expansion means (7)
10 between the outlet of the condenser (6) and the inlet of
the evaporator (2), and whereby the above-mentioned
cooling circuit (3) is thus controlled as a function of
the load that the cooling capacity is adjusted without
any ice being formed in the evaporator (2), characterized
15 in that the cooling circuit (3) is controlled by
adjusting the rotational speed of the motor (4) as a
function of a measured temperature of the gas or the
evaporator.
- 20 2. Method according to claim 1, characterized in that the
temperature of the evaporator (2) is measured and in that
the above-mentioned cooling circuit (3) is controlled as
a function of the measured evaporator temperature.
- 25 3. Method according to claim 2, characterized in that the
rotational speed of the motor (4) is adjusted such that
the evaporator temperature is situated 2 to 3°C below the
lowest gas temperature (LAT).
- 30 4. Method according to claim 1, characterized in that the
lowest gas temperature (LAT) is measured and in that the

above-mentioned cooling circuit (3) is controlled as a function of this lowest gas temperature (LAT).

5 5. Method according to claim 4, characterized in that the lowest gas temperature (LAT) is measured on the outlet of the secondary part (1A) of the heat exchanger (1).

10 6. Method according to claim 1, characterized in that the dew point of the gas is measured and in that the above-mentioned cooling circuit (3) is controlled as a function of this dew point.

15 7. Method according to any of the preceding claims, characterized in that the cooling circuit is controlled such that the temperature of the evaporator on the side of the cooling fluid drops below zero without this evaporator freezing up on the air side.

20 8. Method according to any of the preceding claims, characterized in that the rotational speed of the motor (4) is adjusted by modifying the frequency of the supply current.

25 9. Method according to any of the preceding claims, characterized in that the ambient temperature is measured and the rotational speed of the motor (4) is adjusted, taking into account the measured ambient temperature.

30 10. Method according to claim 9, characterized in that the rotational speed of the motor (4) of the compressor (5) is adjusted such that the lowest gas temperature

(LAT) on the outlet of the evaporator (2) is 20°C below the measured ambient temperature, without dropping below 3°C however.

5 11. Method according to any of the preceding claims, characterized in that the cooling medium is expanded by an expansion valve (7) before the evaporator (2) and in that the overheating is measured after the evaporator (2) and compared to a set value whereby, in case of
10 deviation, the expansion valve (7) will correct this by opening or by closing.

12. Method according to any of the preceding claims, characterized in that, after the heat exchanger (1) and
15 the liquid separator (11), the gas to be dried is heated in a recuperation heat exchanger (12) by the gas to be dried which is supplied to the first heat exchanger (1).

13. Device for cool-drying, containing a heat exchanger
20 (1) whose primary part is the evaporator (2) of a cooling circuit (3) which also contains a compressor (5) which is driven by an electric motor (4), a condenser (6), an expansion means (7) between the outlet of the condenser (6) and the inlet of the evaporator (2), a control device
25 (16) to control the above-mentioned motor (4) and measuring means (18, 20 or 23) coupled thereto, whereas the secondary part (1A) of the heat exchanger (1) is part of a pipe (9) for the gas, and a liquid separator (11) is erected on the outlet of said heat exchanger (11), in
30 said pipe (9), characterized in that the device contains means (15) to adjust the rotational speed of the motor

(4) while the control device (16) controls these means (15) as a function of a temperature of the gas or the evaporator measured by the measuring means (18 or 20).

5 14. Device according to claim 13, characterized in that the temperature measuring means (20) are provided on the cooling circuit (3) and are means to measure the temperature of the evaporator.

10 15. Device according to claim 13, characterized in that the temperature measuring means (23) are provided on the pipe (9) for the gas in or downstream to the secondary part (1A) of the heat exchanger (1), and are means to measure the lowest gas temperature (LAT).

15 16. Device according to claim 13, characterized in that the measuring means are provided on the pipe (9) for the gas in or downstream to the secondary part (1A) of the heat exchanger (1), and are means to measure the dew
20 point.

17. Device according to any of claims 13 to 16, characterized in that the means for adjusting the rotational speed of the motor consist of a frequency
25 converter (15).

18. Device according to any of claims 13 to 17, characterized in that it contains means (22) for measuring the ambient temperature which are also coupled
30 to the control device (16) and in that this control device (16) is such that it adjusts the rotational speed

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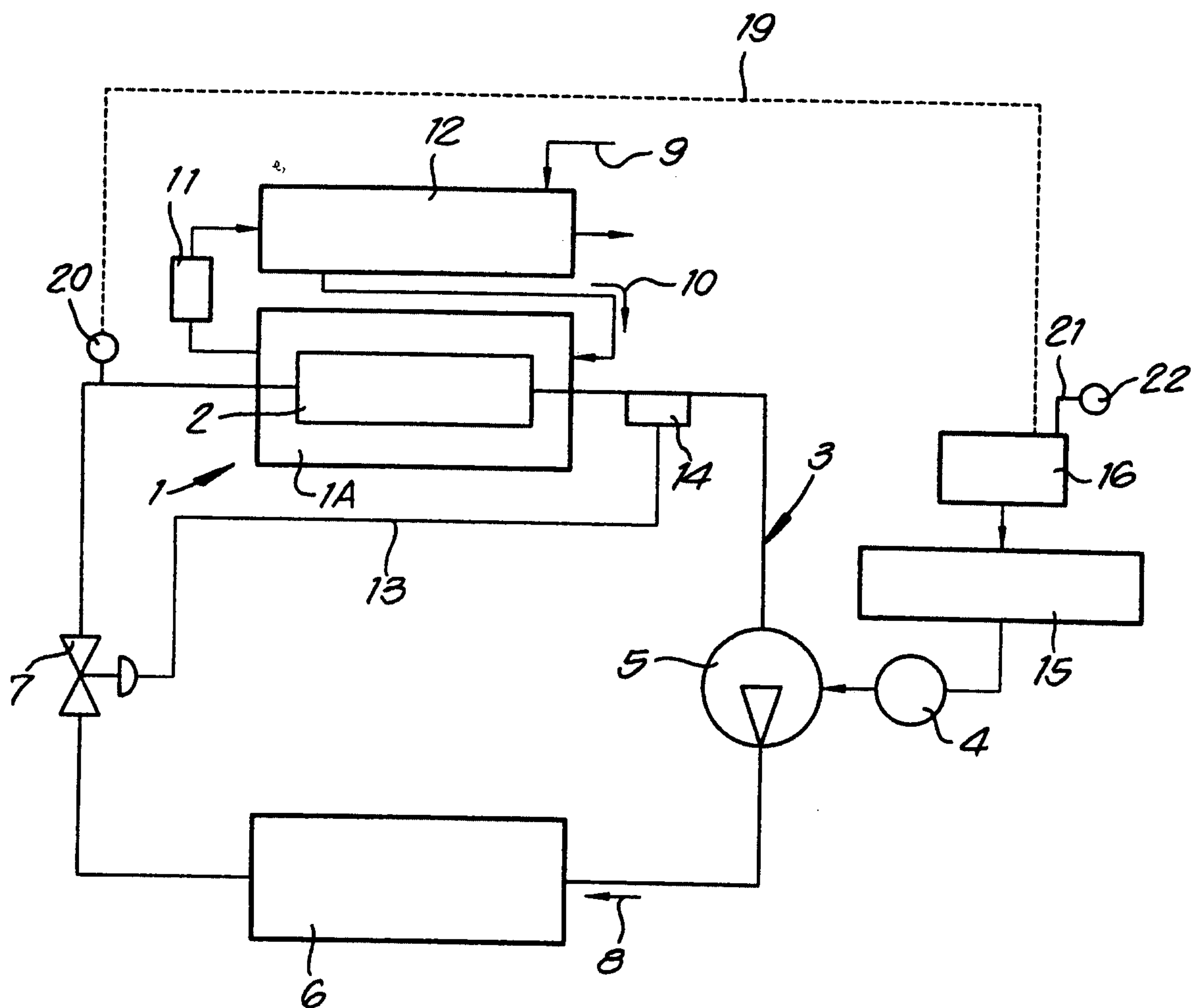
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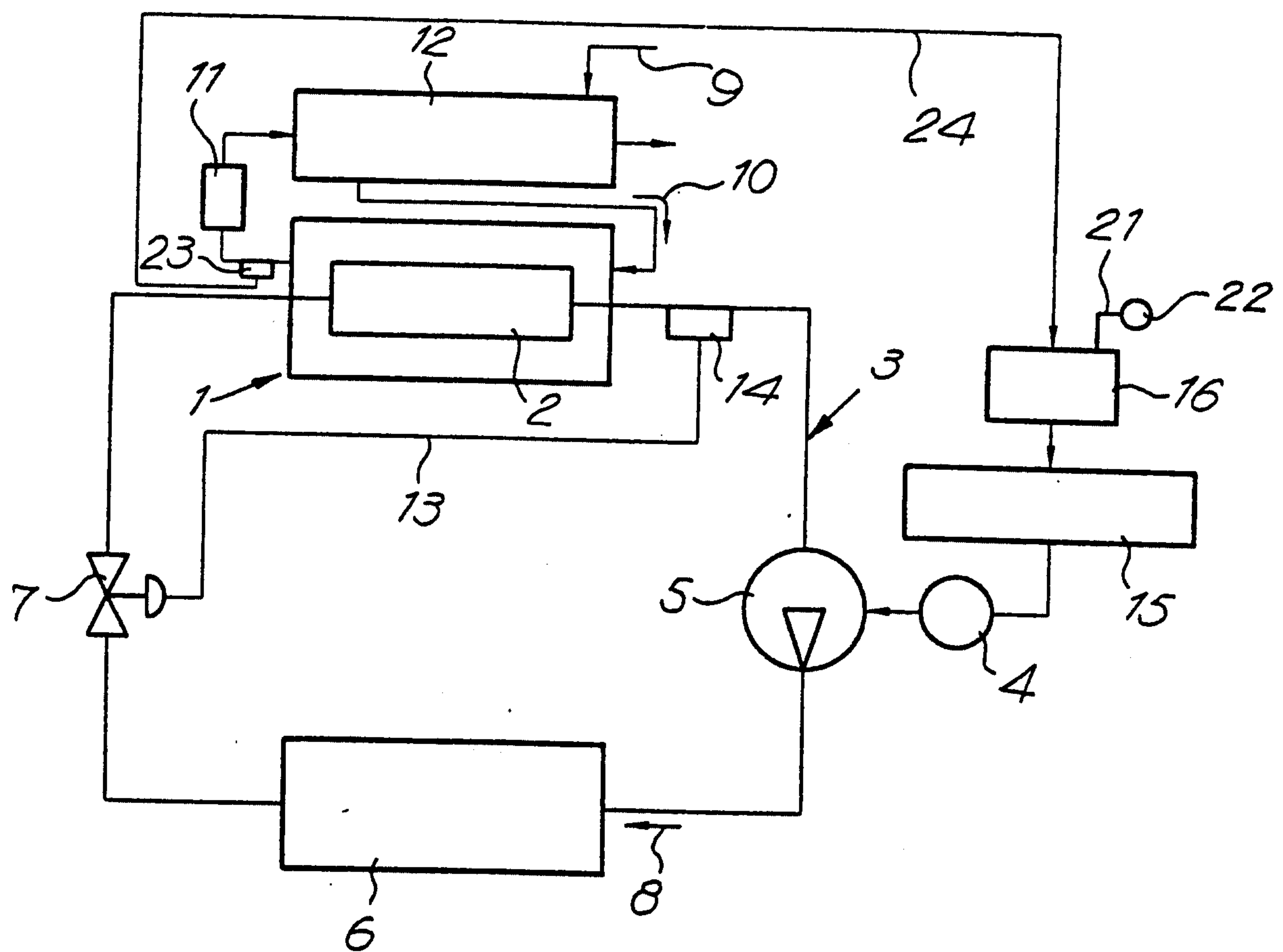
-29-

of the motor (4) both as a function of the value measured by the measuring means (18, 20 or 23) and as a function of the ambient temperature measured by the means (22).

- 5 19. Device according to any of claims 13 to 18, characterized in that the control device is a PID control (16), a PI control or a P control.

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*Fig. 1*

*Fig. 2*

