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(54) **DEVICE FOR MAKING ARTIFICIAL SNOW**

VORRICHTUNG ZUR HERSTELLUNG VON KÜNSTLICHEM SCHNEE

DISPOSITIF POUR FABRIQUER DE LA NEIGE ARTIFICIELLE

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Description

[0001] The present invention relates to a device for making artificial snow.

[0002] A device for making artificial snow according to the preamble of claim 1 is known from FR1372024.

[0003] Devices are already known for manufacturing artificial snow by using water and compressed air, whereby water is atomised in compressed gas and the atomised water is frozen by the cooling effect of the air expansion.

[0004] A compressor is used to supply the compressed gas in the known devices.

[0005] It is known that the compressed gas, which generally consists of air, can have a very high temperature at the outlet of this compressor and can also be moist.

[0006] The known devices thus also contain one or more after-coolers to cool the compressed air, such that the moisture in the compressed air condenses as a result of cooling and can be separated as a condensate using a water separator or similar.

[0007] These after-coolers are generally constructed in the form of air-air regenerative heat exchangers, in which the incoming hot compressed air is cooled by compressed air that has already been cooled.

[0008] The known devices are incorporated in a building of substantial dimensions in which the compressor is housed, and whereby the inlet of the compressor is connected to the outside air to draw in the air to be compressed, while the outlet of the compressor installation is connected to a snow gun to supply the compressed air.

[0009] The pipes provided for the realisation of the abovementioned connections are sizeable in order to emit the heat from the compressed air to the space in the abovementioned building, and to utilise this heat to warm up the cold air drawn in.

[0010] A disadvantage is that this installation is quite large and rather immobile.

[0011] Another disadvantage is that the temperature of the compressed gas at the inlet of the snow cannon is difficult to control.

[0012] A disadvantage attached to this is that the quality of the snow produced depends on the weather conditions, such that the device has rather limited reliability.

[0013] Improved devices are also known, in which there is an additional heat exchanger after the after-cooler for the purpose of controlling the temperature of the outgoing compressed gas.

[0014] A disadvantage is that such a device only enables rudimentary control of the temperature, such that it is not possible to produce high-quality snow under all conditions.

[0015] A further disadvantage is that the heat exchanger cannot prevent moisture condensing in the after-cooler and freezing there.

[0016] A further additional disadvantage is that the known devices use a lot of energy.

[0017] The purpose of the present invention is to pro-

vide a solution to one or more of the abovementioned and/or other disadvantages, by providing a device for making artificial snow by means of a snow cannon in which water is atomised by means of compressed air, whereby this device is provided with a compressor for supplying compressed air, which compressor is positioned in a compressor area with an inlet for supplying air from the environment and an outlet to deliver the compressed air to the snow cannon via a pipe, whereby, according to the specific characteristic of the invention, the abovementioned device comprises a heat exchanger with a primary part and a secondary part, whereby the compressed air from the compressor is guided through the primary part, and whereby the abovementioned secondary part makes part of the evaporator of a closed cooling circuit in which a coolant is circulated by means of a compressor element that is driven by a drive, and whereby the abovementioned device includes a controller for controlling the abovementioned cooling circuit in order to obtain the desired temperature or pressure dew point at the outlet of the primary part of the heat exchanger.

[0018] An advantage is that the temperature of the compressed air at the outlet of the primary part of the heat exchanger can be well controlled, such that the snow produced is always of a very good quality and the quality of the snow is not subject to the weather conditions.

[0019] The invention enables the cooling circuit to be controlled accurately so that the desired temperature and/or desired pressure dew point of the compressed air is realised.

[0020] Another advantage is that the device is relatively compact with respect to the known devices.

[0021] An advantage attached to this is that the device is cheaper, not only with regard to the installation cost but also with regard to energy consumption.

[0022] In the most practical embodiment the device can be incorporated into a container, and thus be produced as a mobile device.

[0023] An advantage of this is that the container can be easily transported, such that the device can deliver compressed air for the production of snow at different locations, and consequently a relatively large piping system is not needed to connect different snow cannons to one centrally located device for supplying compressed air.

[0024] In a practical embodiment of the invention, the cooling circuit contains a second heat exchanger that forms the condenser of the cooling circuit, and which is located downstream from the compressor element and upstream from the expansion means provided in the cooling circuit.

[0025] In the most practical embodiment the coolant that flows through this second heat exchanger is cooled by a fan. Preferably the abovementioned fan is arranged such that it blows air over the second heat exchanger to the compressor area.

[0026] An advantage of this is that the fan distributes

warm air in the compressor area, such that the temperature in the compressor area is above 0° thereby avoiding freezing, and damage due to freezing is thus completely ruled out.

[0027] A further advantage is that no extra large pipes are needed between the outlet of the primary part of the heat exchanger and the inlet of the snow cannon.

[0028] Preferably the temperature of the compressed air at the outlet of the primary part of the heat exchanger is less than 8° Celsius and preferably around 3° Celsius.

[0029] An advantage is that good-quality snowflakes can be produced in this temperature range and the total production time for making the snow is reduced.

[0030] Preferably the compressed air at the outlet of the primary part of the heat exchanger presents a pressure of 8 bar or almost 8 bar.

[0031] Preferably the air is compressed by means of an oil-free compressor such as a water-injected screw compressor.

[0032] An advantage is that the compressed air cannot be contaminated by oil particles, such that this compressed air does not necessarily have to go through one or more filters, which of course has a favourable effect on the cost and size of the device.

[0033] With a water-injected compressor the risk of contaminating the air itself is even completely ruled out.

[0034] With the intention of better showing the characteristics of the invention, a preferred embodiment is described hereinafter by way of an example, without any limiting nature, of a device according to the invention, with reference to the accompanying drawing, which shows a device according to the invention for making artificial snow.

[0035] The device 1 for making artificial snow primarily contains a compressor area 2 with a housing 3, which has an inlet 4 for supplying air from the environment and an outlet 5 for removing the compressed gas such as air.

[0036] In a practical embodiment of the invention, the housing 3 is formed by a container that can be mobile or by a building or similar.

[0037] The dimensions of the housing 3 can, for example, be limited to a floor plan of six metres by six metres, in contrast to existing devices where buildings are used with dimensions that are dozens of metres long and wide.

[0038] There is a grid in a wall of the housing 3 that forms the inlet 4 through which the surrounding air is drawn according to the direction of the arrow L.

[0039] In the housing 3 there is the abovementioned outlet 5 whereby a snow cannon 6 can be supplied with compressed air through a pipe 7.

[0040] The snow cannon 6 also has a supply pipe 8 for water, such that water is atomised by the compressed air in a known way at the outlet of the snow cannon 6, such that snow crystals are formed that disperse from the muzzle of the snow cannon 6.

[0041] For the production of the compressed air, there is a compressor 9 in the compressor area 2 with an inlet for drawing in air and an outlet 11 for removing the com-

pressed air.

[0042] The abovementioned compressor 9 is driven in a known way by means of a drive 10, such as for example, but not necessarily, an electric motor.

[0043] The abovementioned compressor 9 can consist of a single compressor element, as shown in the drawing, but can also be constructed as a multistage compressor, whereby the air is compressed by a number of consecutive compressor elements.

[0044] In a particular embodiment the compressor 9 only contains water-injected compressor elements and intercoolers can also be placed between successive pressure stages. It goes without saying that the invention is not limited to this, as a different type of oil-free compressor, or an oil-injected compressor with appropriate air filtering can be used just as well.

[0045] In a preferred embodiment of the invention, the compressor 9 is set to a maximum service pressure of between 8 bar and 9 bar, and preferably a maximum service pressure of 8.5 bar or almost 8.5 bar.

[0046] According to the invention, there is a heat exchanger 12 in the compressor area 2 for the cooling of the compressed air, with a primary part and a secondary part, whereby the inlet 13 of the primary part is connected to the outlet 11 of the compressor 9.

[0047] Preferably the heat exchanger 12 is designed such that the pressure drop of the compressed air that goes through the primary part is less than 0.2 bar, or even better less than 0.1 bar, and preferably even less than 0.05 bar.

[0048] It is known that by reducing the temperature, the moisture in the compressed air will condense.

[0049] At the outlet 14 of the primary part of the heat exchanger 12 there is preferably a liquid separator 15 that can remove the condensed water.

[0050] According to the invention, the secondary part of the abovementioned heat exchanger 12 forms the evaporator 16 of a closed cooling circuit 17 that is filled with a coolant or cooling fluid.

[0051] As is known, the coolant is circulated by means of a compressor element 18 in the cooling circuit 17, and this compressor element 18 is driven by a drive 19.

[0052] Furthermore, in the closed cooling circuit 17 between the outlet of the compressor element 18 and the secondary part of the heat exchanger 12, there is successively a condenser 20 and expansion means, for example in the form of an expansion valve 21.

[0053] In a practical embodiment the abovementioned condenser 20 is formed by a second heat exchanger and this second heat exchanger is cooled by means of a fan 22 that blows air over the condenser 20 and this air is further blown into the compressor area 2.

[0054] In the most practical embodiment of the invention the speed of the abovementioned fan 22 can be adjusted in order to control the temperature of the coolant at the outlet of the condenser 20. To this end the abovementioned fan can, for example, be driven by means of a speed-controlled motor that is connected to a control

unit to which measuring means are also connected to measure the abovementioned temperature at the outlet of the condenser, for example in the form of a temperature sensor in the pipe section between the expansion valve 21 and the condenser 20.

[0055] In a practical embodiment of the invention, the expansion valve 21 can be constructed as a thermostatic or electronic valve and this valve 21 is connected to a temperature sensor 23 that is positioned at the outlet 14 of the primary circuit.

[0056] According to the invention, the device is equipped with a controller 24 to control the flow of the coolant, and the abovementioned controller 24 ensures the realisation of the desired temperature or pressure dew point at the outlet 14 of the primary part of the heat exchanger 12.

[0057] The controller 24 can thus control the speed of the drive 19, whereby a drive is used in the form of a frequency-controlled motor, for example.

[0058] The controller 24 can also be used to control the motor of the fan 22 and/or to control the expansion valve 21, and if applicable to also drive the drive 10 of the compressor 9.

[0059] It is clear that to control the temperature or pressure dew point, the control of the drive 10 of the compressor 9 is one of the possibilities, but other arrangements are also possible.

[0060] Between the outlet 11 of the compressor 9 and the inlet 13 of the primary part of the heat exchanger 12, there is preferably an after-cooler 25 and a second water separator 26.

[0061] The method for making artificial snow by means of a device 1 according to the invention is very simple and as follows.

[0062] A gas such as air is drawn into the compressor area 2 and compressed by the compressor 9. The hot compressed air is first driven through the after-cooler 25 and the second water separator 26, after which this already partially cooled gas is guided through the primary part of the heat exchanger 12, such that the compressed air at the outlet 14 of the primary part has an even lower temperature.

[0063] The condensate that is formed in the after-cooler 25 and the heat exchanger 12 is separated in the respective liquid separators 26 and 15, and the cold less moist air is then taken to the snow canon 6 via a pipe 7. In the snow cannon 6 the water will be atomised by the cooled compressed air so that snow crystals are formed.

[0064] The cooling of the compressed air in the primary part of the heat exchanger 12 is realised by driving a coolant through the secondary part of the heat exchanger 12. Preferably this coolant flows in the opposite direction to the air that flows through the primary part of this heat exchanger.

[0065] By passing through the secondary part, the abovementioned coolant is heated and then cooled by the condenser 20, which in this case is placed immediately downstream from the compressor element 18 in the

cooling circuit 17.

[0066] The temperature of the coolant will then fall by flowing through the last-mentioned condenser 20, as the fan 22 blows air over this condenser 20.

5 [0067] The air that is blown over the condenser 20 by the fan 22 is heated.

[0068] Because this warm air spreads through the entire compressor area 2, the temperature in the compressor area 2 will always stay above freezing point.

10 [0069] The coolant that leaves the condenser 20 is then guided through the expansion valve 21, and then again to the inlet of the secondary part of the heat exchanger 12.

15 [0070] For the heat exchanger 12 and the cooling circuit 17 connected to it with the controller 24, a conventional cool dryer can be used if necessary, however the air-air recuperative heat exchanger that is normally used in such a cool dryer is left out.

[0071] An advantage is that the device can be easily built from a compressor that is connected to a suitable cool dryer which is available on the market.

[0072] The present invention is by no means limited to the embodiment described as an example and shown in the drawing.

Claims

1. Device for making artificial snow by means of a snow cannon (6) in which water is atomised by means of compressed air, whereby this device is provided with a compressor (9) for supplying compressed air, which compressor (9) is positioned in a compressor area (2) with an inlet (4) for supplying air from the environment and an outlet (5) to deliver the compressed air to the snow cannon (6) via a pipe (7), wherein the above-mentioned device (1) comprises a heat exchanger (12) with a primary part and a secondary part, whereby the compressed air from the compressor (9) is guided through the primary part, and whereby the abovementioned secondary part makes part of the evaporator (16) in a closed cooling circuit (17) in which a coolant is circulated by means of a compressor element (18) that is driven by a drive (19), **characterised in that** the abovementioned device includes a controller (24) for controlling the abovementioned cooling circuit, in order to obtain a desired temperature or pressure dew point at the outlet (14) of the primary part of the heat exchanger (12).
2. Device according to any one of the preceding claims, **characterised in that** at the outlet (14) of the primary part of the heat exchanger (12) is provided a liquid separator (15) for removing the condensed water.
3. Device according to any one of the preceding claims, **characterised in that** the cooling circuit (17) com-

prises a heat exchanger (20) downstream from the compressor element (18), which heat exchanger (20) forms the condenser of the cooling circuit (17) and **in that** this heat exchanger (20) is cooled by means of a fan (22) blowing air over the heat exchanger (20) in the compressor area (2).

4. Device according to any one of the preceding claims, **characterised in that** the compressor (9) compresses air that is drawn in from the compressor area (2). 5
5. Device according to any one of the preceding claims, **characterised in that** the controller (24) is such that the temperature at the outlet (14) of the primary part is between 3° and 8° Celsius, preferably between 3° and 5° Celsius. 10
6. Device according to any one of the preceding claims, **characterised in that** the controller (24) is such that the temperature of the outlet (14) of the primary part is 3° Celsius or around 3° Celsius. 15
7. Device according to any one of the preceding claims, **characterised in that** the controller (24) is such that a pressure dew point in the order of magnitude of 3° Celsius is realised. 20
8. Device according to any one of the preceding claims, **characterised in that** the compressor (9) is set to a maximum working pressure of 8.5 bar. 25
9. Device according to any one of the preceding claims, **characterised in that** the heat exchanger (12) is designed such that the pressure drop of the compressed air over the primary part is less than 0.2 bar, or even better less than 0.1 bar, and preferably less than 0.05 bar. 30
10. Device according to any one of the preceding claims, **characterised in that** the device (1) is mobile and housed in a container. 35
11. Device according to any one of the preceding claims, **characterised in that** the device (1) comprises a conventional cool dryer without recuperative heat exchanger. 40
12. Device according to any one of the preceding claims, **characterised in that** an after-cooler (25) is provided between an outlet (11) of the abovementioned compressor (9) and an inlet (13) of the abovementioned primary part of the heat exchanger (12). 45
13. Device according to claim 12, **characterised in that** just downstream from the after-cooler (25) is provided a second liquid separator (26). 50

Patentansprüche

1. Vorrichtung zur Herstellung von Kunstschnee mittels einer Schneekanone (6), worin Wasser mittels verdichteter Luft vernebelt wird, wobei diese Vorrichtung mit einem Verdichter (9) für die Zufuhr verdichteter Luft versehen ist, welcher Verdichter (9) in einem Verdichterraum (2) mit einem Einlass (4) zur Zufuhr von Luft aus der Umgebung und einem Auslass (5) zur Abfuhr der verdichteten Luft durch eine Leitung (7) zu der Schneekanone (6) aufgestellt ist, wobei die vorgenannte Vorrichtung (1) einen Wärmetauscher (12) mit einem Primärteil und einem Sekundärteil umfasst, wobei die verdichtete Luft von dem Verdichter (9) durch den Primärteil geleitet wird und wobei der vorgenannte Sekundärteil Teil des Verdampfers (16) in einem geschlossenen Kühlkreislauf (17) ist, worin ein Kühlmittel mittels eines Verdichterelements (18), das durch einen Antrieb (19) angetrieben wird, zirkuliert wird, **dadurch gekennzeichnet, dass** die vorgenannte Vorrichtung eine Steuerung (24) zur Steuerung des vorgenannten Kühlkreislaufs umfasst, um an dem Auslass (14) des Primärteils des Wärmetauschers (12) eine gewünschte Temperatur oder einen gewünschten Drucktaupunkt zu erhalten.
2. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** an dem Auslass (14) des Primärteils des Wärmetauschers (12) ein Flüssigkeitsabscheider (15) zum Abführen des Kondenswassers vorgesehen ist.
3. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** der Kühlkreislauf (17) stromabwärts von dem Verdichterelement (18) einen Wärmetauscher (20) umfasst, welcher Wärmetauscher (20) den Kondensator des Kühlkreislaufs (17) bildet, und dass dieser Wärmetauscher (20) mittels eines Ventilators (22) gekühlt wird, der Luft über den Wärmetauscher (20) in den Verdichterraum (2) bläst.
4. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** der Verdichter (9) Luft verdichtet, die aus dem Verdichterraum (2) angesaugt wird.
5. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** die Steuerung (24) derart ist, dass die Temperatur am Auslass (14) des Primärteils zwischen 3° und 8° Celsius, bevorzugt zwischen 3° und 5° Celsius beträgt.
6. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** die Steuerung (24) derart ist, dass die Temperatur des Auslasses (14) des Primärteils 3° Celsius oder ungefähr 3° Cel-

sus beträgt.

7. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** die Steuerung (24) derart ist, dass ein Drucktaupunkt in der Größenordnung von 3° Celsius verwirklicht wird. 5
8. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** der Verdichter (9) auf einen maximalen Betriebsdruck von 8,5 bar eingestellt ist. 10
9. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** der Wärmetauscher (12) so gestaltet ist, dass der Druckabfall der verdichteten Luft über den Primärteil weniger als 0,2 bar, oder noch besser weniger als 0,1 bar und bevorzugt weniger als 0,05 bar beträgt. 15
10. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** die Vorrichtung (1) mobil und in einem Behälter untergebracht ist. 20
11. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** die Vorrichtung (1) einen herkömmlichen Kühltrockner ohne rekuperativen Wärmetauscher umfasst. 25
12. Vorrichtung nach einem der vorgenannten Ansprüche, **dadurch gekennzeichnet, dass** ein Nachkühler (25) zwischen einem Auslass (11) des vorgenannten Verdichters (9) und einem Einlass (13) des vorgenannten Primärteils des Wärmetauschers (12) vorgesehen ist. 30
13. Vorrichtung nach Anspruch 12, **dadurch gekennzeichnet, dass** unmittelbar stromabwärts von dem Nachkühler (25) ein zweiter Flüssigkeitsabscheider (26) vorgesehen ist. 35

Revendications

1. Dispositif pour fabriquer de la neige artificielle au moyen d'un canon à neige (6) dans lequel on atomise de l'eau au moyen d'air comprimé, ce dispositif étant équipé d'un compresseur (9) pour l'alimentation d'air comprimé, ledit compresseur (9) étant disposé dans une zone de compresseur (2) comportant une entrée (4) pour alimenter de l'air depuis l'environnement et une sortie (5) pour distribuer l'air comprimé ou canon à neige (6) via un conduit (7), le dispositif susmentionné (1) comprenant un échangeur de chaleur (12) possédant une partie primaire et une partie secondaire, l'air comprimé émanant du compresseur (9) étant guidé à travers la partie primaire, et la partie secondaire susmentionnée faisant partie de l'éva- 45
2. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'on** prévoit, à la sortie (14) de la partie primaire de l'échangeur de chaleur (12), un séparateur de liquide (15) pour éliminer l'eau condensée. 50
3. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le circuit de refroidissement (17) comprend un échangeur de chaleur (20) en aval de l'élément (18) faisant office de compresseur, ledit échangeur de chaleur (20) formant le condenseur du circuit de refroidissement (17), et **en ce que** cet échangeur de chaleur (20) est refroidi au moyen d'un ventilateur (22) qui souffle de l'air sur l'échangeur de chaleur (20) dans la zone (2) du compresseur. 55
4. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le compresseur (9) comprime l'air qui est aspiré depuis la zone (2) du compresseur.
5. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le contrôleur (24) est tel que la température à la sortie (14) de la partie primaire se situe entre 3° et 8 °C, de préférence entre 3° et 5°C.
6. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le contrôleur (24) est tel que la température de la sortie (14) de la partie primaire s'élève à 3 °C ou à environ 3 °C.
7. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le contrôleur 24 est telle que l'on obtient un point de rosée de pression dans l'ordre de grandeur de 3 °C.
8. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le compresseur (9) est réglé à une pression de travail maximal de 8,5 bars.
9. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'échangeur de chaleur (12) est conçu de telle sorte que la chute de pression de l'air comprimé sur la partie primaire est

inférieure à 0,2 bar ou encore mieux inférieure à 0,1 bar et de préférence inférieure à 0,05 bar.

10. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le dispositif (1) est mobile et logé dans un conteneur. 5
11. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le dispositif (1) comprend un sécheur conventionnel à refroidissement par air en l'absence d'un échangeur de chaleur de récupération. 10
12. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'on** prévoit un refroidisseur final (25) entre une sortie (11) du compresseur susmentionné (9) et une entrée (13) de la partie primaire susmentionnée de l'échangeur de chaleur (12). 15
- 20
13. Dispositif selon la revendication 12, **caractérisé en ce qu'on** prévoit, juste en aval par rapport au refroidisseur final (25), un deuxième séparateur de liquide (26). 25

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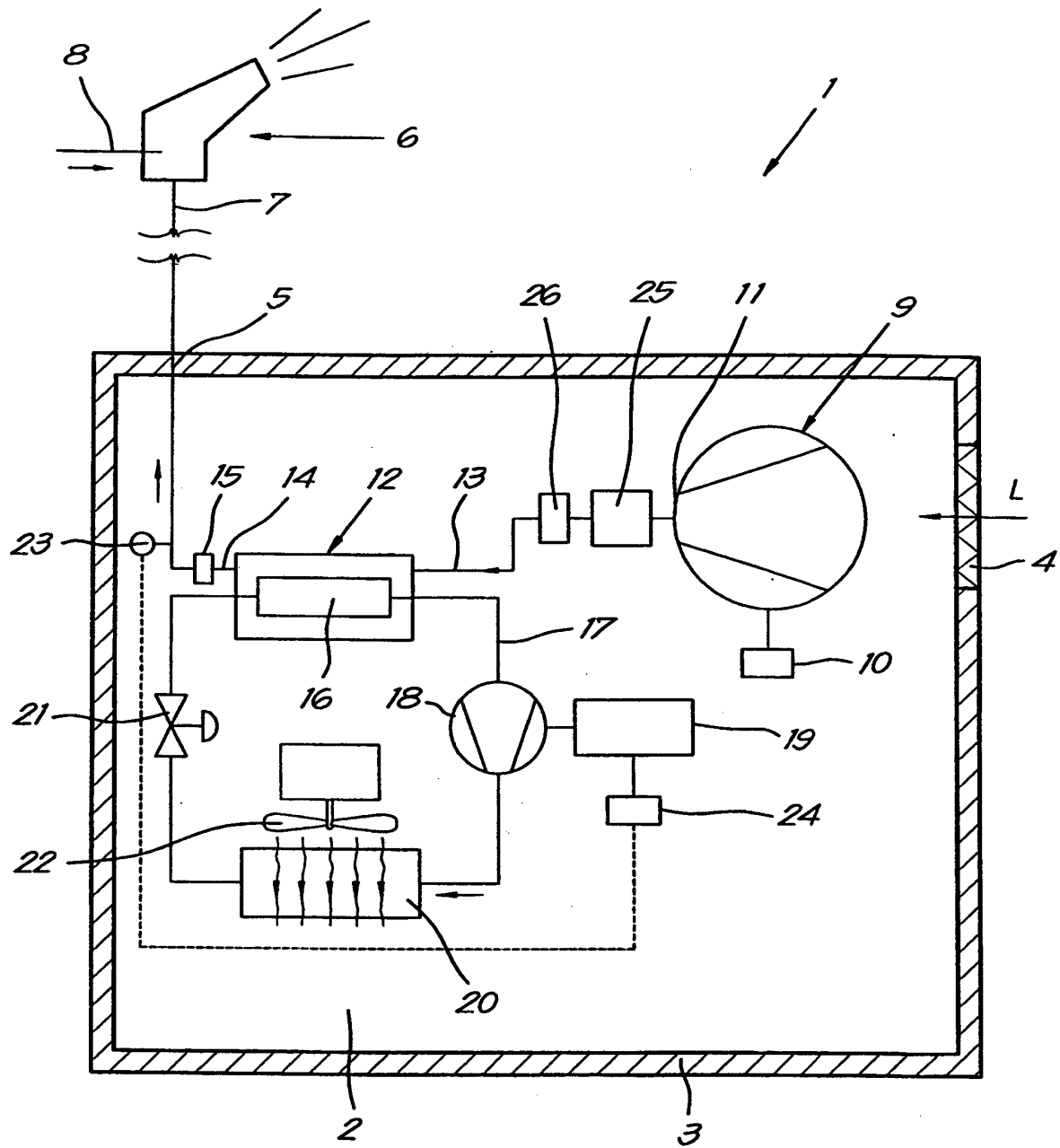


Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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