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(54) Air conditioning apparatus and method having a refrigerating fluid which is not harmful to at least the ozone layer

(57) The air conditioning apparatus, with a refrigerating fluid which is not harmful to at least the ozone layer, includes at least a first safety zone (5) wherein at least part of said electrical and/or electronic members of the apparatus are arranged; the safety zone has selected dimensions for preventing the formation of either minimum or maximum concentration of said coolant within said flammable limits; and at least a first chamber (6) comprising said electrical and/or electronic members adapted to operate the apparatus; the chamber is crossed by an air flow initially produced by the ventilator (4) for removing any minimum or maximum concentration of the coolant falling within said flammable limits, from the chamber.

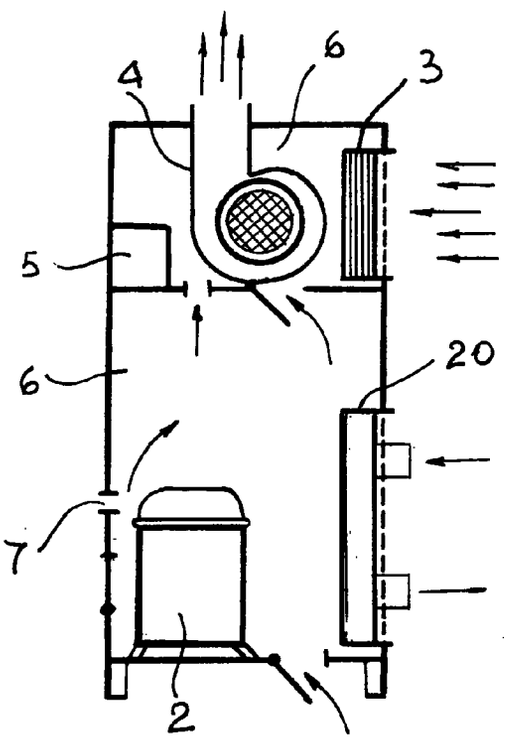

Fig. 1

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Description

The present invention relates to an air conditioning apparatus and method having a refrigerating fluid which is not harmful to at least the ozone layer.

It is known that the stratospheric ozone layer, which protects the earth surface from the ultraviolet radiation generated by the sun, has been degraded mainly by compounds based on chlorofluoromethanes.

For the above reason, and also because these compounds are contributing to the greenhouse effect, they were banned from aerosol cans and from other applications.

For the above reasons, the old environmentally dangerous refrigerating fluids have been substituted by synthetic products, HFC halocarbons, which are in the same family of the substituted fluids but have no chlorine atoms, and of course no bromide atoms, in their molecule and are therefore completely safe with respect to the ozone layer.

However, even if the hydrogen atoms in the HFC molecule limit the mean atmospheric life of HFCs, compared to the completely halogenated hydrocarbons, they still a cause of anthropogenic greenhouse effect, which is the other important environmental emergency of our time.

Since in a short while new regulations and laws will restrict the use of such fluids, at least where technically feasible, as for example in the production of cold or in thermodynamic heating, there has been a tendency to abandon the use of synthetic fluids in favour of natural fluids which have always been present in nature and therefore ensure the absence of aggressiveness towards the environment.

Among the natural substances that can be used as refrigerating fluids there is air, CO_2, nitrogen, noble gases (helium and argon), hydrocarbons and ammonia.

Namely, in the most common applications in the field of cold generating, ammonia, CO_2 and some of the hydrocarbons are of special interest.

In the case of ammonia, however, sealed compressors must be used which have to be compatible with this substance by extensively using aluminum and providing the stator coils with a sleeve.

It is also difficult to determine the lubricants that are soluble in this substance and is also difficult to use limited charge systems for the refrigerating fluid with the use of plate type evaporators and condensers.

Therefore, the use of ammonia increases the production costs enormously, especially in the field of air conditioning, considering the sophisticated and expensive safety systems provided in such apparatus.

In the same manner, the use of CO_2 has several disadvantages.

For example, among others, the low critical temperature of CO_2 (31°C) increases the lamination losses and forces the use of hypercritical cycles in the current applications.

Furthermore, the compression efficiency of an air conditioning apparatus operating with carbon dioxide is so much lower, when compared to a traditional apparatus, that is unacceptable.

Also in the case of carbon dioxide, the air conditioning apparatus would be very expensive and with very low efficiency.

The hydrocarbons used for refrigerators, for example air conditioners, have high physical properties and do not require structural modifications of the principal components of the air conditioners such as, for example, the compressor.

However, the hydrocarbons have disadvantages that considerably restrain their use.

Namely, there are considerable inconveniences regarding safety in using the hydrocarbons due to their flammability and explosivity. If hydrocarbons are used, the apparatus, for example an air conditioner, must be provided with highly sophisticated safety systems which make the conditioner very expensive and without an absolute safety during use or even when idle.

The aim of the present invention is to overcome the above mentioned disadvantages of the prior art.

Within this aim, an important object of the invention is provide an air conditioning apparatus and method having a refrigerating fluid, such as an hydrocarbon for example, which is not harmful to at least the ozone layer, and having an absolutely safe operation.

A further object of the invention to provide an air conditioning apparatus and method with refrigerant fluid that do not require any particular device or system for production and manufacturing, other than those conventionally used.

Still a further object of the invention is to provide an air conditioning apparatus and method, with a refrigerating fluid which is not harmful to at least the ozone layer, having a very high efficiency, even higher than the present efficiency of an air conditioning apparatus using, for example, chlorofluoromethanes.

Still a further object of the invention is to provide an air conditioning apparatus and method, with a refrigerant fluid which is not harmful to at least the ozone layer, having a very low cost and adapted to be widely diffused in the market.

The above aim, as well as these and other objects that will be more apparent hereinafter, are achieved by an air conditioning apparatus, with a refrigerant fluid which is not harmful to at least the ozone layer, comprising a refrigerant fluid compressor, at least a first condenser of said fluid, a choking member of said fluid, an evaporator of said fluid, at least a first ventilator for generating an air flow and electric and/or electronic and mechanical members adapted to operate said ventilator, said refrigerant fluid being a coolant belonging to the class of hydrocarbons and having no negative potential effect against the ozone layer and having no potential greenhouse effect and having flammable limits defined respectively as minimum and maximum concentration of said coolant apt to propagate the flame

through a mixture of said coolant and air, in preset temperature and pressure conditions, characterized in that it has a first safety zone wherein at least part of said electrical and/or electronic members of said apparatus are arranged, said zone having selected dimensions for preventing the formation of either minimum or maximum concentration of said coolant within said flammable limits; and at least a first chamber comprising said electrical and/or electronic members adapted to operate said apparatus, said chamber being crossed by an air flow initially produced by at least said ventilator for removing said minimum or maximum concentration of said coolant, possibly falling within said flammable limits, from said chamber.

The present invention also relates to a method for conditioning air with a refrigerant fluid which is not harmful to at least the ozone layer, said refrigerant fluid being a coolant belonging to the class of hydrocarbons and having no negative potential effect against the ozone layer and having no potential greenhouse effect and has flammable limits defined respectively as minimum and maximum concentration of said coolant apt to propagate the flame through a mixture of said coolant and air in preset temperature and pressure conditions, characterized in that it comprises the steps of: generating at least a first air flow having a selected rate of flow adapted to hit for a preset time all the electric and/or electronic and mechanical members adapted to the operation of an air conditioner for dissolving a possible minimum or maximum concentration of said coolant falling within said flammable limits and adapted to activate a compressor of said air conditioner, at the end of said preset time, and at the same time of its safety and control systems.

Further characteristics and advantages of the invention will be more apparent by the following description of an air conditioning apparatus and a method, according to the invention, illustrated, by way of example in the enclosed drawings in which:

FIG.1 is a schematic side section view of an air conditioner operating with a coolant belonging to the class of hydrocarbons, wherein an air flow is produced to remove a possible minimum or maximum concentration of said coolant falling within the flammable limits;

FIG.2 is still a schematic side view of the air conditioner during operation;

FIG. 3 is a side view of the air conditioner of FIGs. 1 and 2, when not in operation;

FIG. 4 shows the operating step of a two chamber air conditioner for preventing a possible minimum or maximum concentration of said coolant falling within the flammable limits;

FIG. 5 shows the air conditioner of FIG. 4 during the operating step;

FIG. 6 shows the air conditioner of FIGs. 4 and 5 during turning off;

FIG. 7 shows a "Split" type air conditioner using as refrigerant fluid a coolant belonging to the class of hydrocarbons, according to the invention.

With reference to the above figures, the air conditioner apparatus according to the invention, generally designated by the reference numeral 1, in a per se known manner comprises a compressor 2, for the refrigerant fluid, at least a condenser 20 of said fluid, a choking member of said fluid (not illustrated in the drawings), an evaporator 3 of said fluid, at least a first ventilator 4, for generating an air flow, and electrical and/or electronic and mechanical means (temperature and current protector of the compressor, manostat, conventional safety systems, thermostats and flow controllers), not illustrated in the drawings, adapted to correctly operate the air conditioner.

Advantageously, the refrigerant fluid circulating in the air conditioner is a coolant belonging to the class of hydrocarbons, and may be a mixture of hydrocarbons or, for example, propane, in order to have no potential negative effect on the ozone layer or no potential greenhouse effect.

The coolant operating in the air conditioner according to the invention has its flammable limits defined respectively as minimum and maximum concentration of coolant apt to propagate the flame through a mixture of coolant and air in preset temperature and pressure conditions.

In other words, it has been found that once the minimum and maximum concentration, above and below which the hydrocarbon is flammable, have been established, it is possible to maintain a situation of absolutely safe operation inside the air conditioner.

All the risks associated with the use of hydrocarbons as refrigerant fluid are therefore eliminated and the hydrocarbons can be exploited for their advantages as mentioned above.

In particular, the apparatus or conditioner 1 has at least one first safety zone 5 wherein at least a part of the electric and/or electronic members are arranged for operating the conditioner.

For example, inside the first zone 5 there may be accommodated a timer, a thermostat, one or more on/off switches for turning on and off the conditioner or the other elements.

The first safety zone is in fact provided with such dimensions as to prevent the formation of a minimum or maximum concentration of coolant (propane) which may fall outside those maximum or minimum concentrations wherein the coolant becomes flammable.

In this manner, it is impossible that inside the safety zone 5 the coolant explodes or becomes flammable even in the presence of sparks or electric discharges.

As shown in the drawings, the first safety zone 5 is arranged inside the air conditioner but it is not excluded that the safety zone may be provided outside the conditioner or even, depending on the minimum and maximum limit that it is desired to overcome such that the coolant does not become flammable, the safety zone can be defined by the room where the conditioner is located.

The air conditioner also has a first chamber 6 where all the electrical and mechanical members are arranged (ventilators, evaporators, condensers, compressors, etc.) for the correct operation of the apparatus.

Advantageously, an air flow is generated in the first chamber 6. The air flow may initially be produced by the first ventilator 4, or by another ventilator, adapted to remove any minimum or maximum concentration of coolant, falling within the flammable limits, from the first chamber before starting the compressor and therefore before starting the operation of the air conditioner.

In this manner, in case of leak of coolant, the formation of pockets of coolant inside the air conditioner is always prevented. The coolant, and therefore the gas thereof, may in fact ignite or explode when the air conditioner is started because of possible sparks or electrical discharges.

In other words, before the air conditioner is started, the inside of the conditioner is "washed" in order to remove any possible concentrations of gas that may have formed.

After the "washing" operation, the air conditioner is ready to operate using an hydrocarbon such as propane without any danger.

Clearly, during the operation of the air conditioner inside the first chamber 6 the air flow will always be sufficient to prevent the formation of gas pockets.

Conveniently, the air conditioner is provided with disposal means for disposing of any concentration of coolant which falls within the flammable limits even when the conditioner is idle.

In fact, even when the air conditioner is idle, coolant leaks may form gas pockets inside the conditioner which may ignite or explode not just at the activation of the conditioner but also for accidental causes such as sparks or electrical discharges or flames close to the air conditioner.

For example, the disposal means may be defined by a plurality of apertures 7 provided on the casing of the air conditioner in order to ensure a constant air exchange inside the conditioner preventing the formation of gas pockets even when the conditioner is idle.

Beside the apertures 7, which have an insufficient capacity when the conditioner is operating, further apertures 8 may be provided which are automatically activated to move to a closure position during the operation of the conditioner and to an open position both during the "washing" step, performed before the starting the conditioner, and when the conditioner is idle.

In a preferred embodiment, further to first chamber 6, the air conditioner, which uses a refrigerant fluid belonging to the class of hydrocarbons, comprises a second chamber 10, which, according to the need, accommodates the mechanical and electrical members operating the conditioner.

In this case, for example, first safety zone 5 is arranged inside first chamber 6 but may be arranged also inside second chamber 10. A second safety zone may be arranged in chamber 10 and may accommodate further electrical members. As said first safety zone, second safety zone is sized in order to prevent the formation of minimum or maximum concentration of coolant which may fall within its flammable limits.

Conveniently, a second ventilator 15 is arranged in second safety zone 10 and is adapted to provide a second air flow in the safety zone having a different direction with respect to the direction of the air flow generated by first ventilator 4.

In this case, first ventilator 4 may be constituted by the ventilator of the evaporator 3, while second ventilator 15 may be constituted by the ventilator of first condenser 20.

Conveniently, a second condenser may be provided for example in second chamber 10, in case the propane air conditioner is operated by refrigerating the first and second condensers both by water or air or by water and air.

The same concepts described above may be applied to a "Split" type conditioner, i.e. a conditioner having a body arranged externally to the room and a body arranged inside the room, as shown in FIG. 7 by way of example.

In this case, the first and second chambers are spaced apart and each chamber has its own casing separate from the casing of the other chamber.

The two chambers are connected together only by a conduit 25 wherein the refrigerant fluid flows.

Each chamber is then provided with an evaporator and with a safety zone. Each chamber is therefore "washed", as explained above, by means of an air flow generated for removing possible gas pockets.

The present invention also relates to a method for air conditioning with a refrigerant fluid which is not harmful to at least the ozone layer.

To this purpose, a refrigerant fluid is used which is defined by a coolant belonging to the class of hydrocarbons, in particular a mixture of hydrocarbons or a hydrocarbon such as propane.

The method consists in generating at least a first air flow having a selected rate of flow adapted to hit for a preset time all the electric and/or electronic and mechanical members adapted to the operation of an air conditioner.

In this manner, a possible minimum or maximum concentration of said coolant falling within said flamma-

ble limits can be absorbed ensuring a totally safe operation of the conditioner.

The compressor is activated only at the end of the preset time wherein the air flow is generated, and at the same time of the safety and control systems of the conditioner.

Clearly, besides generating a first air flow and before activating the compressor, at least a second air flow can be generated if desired, with a different direction with respect to the first one, in order to dissolve any minimum or maximum concentrations of the coolant falling within the flammable limits.

The operation of the apparatus according to the invention is apparent from what has been described and illustrated above.

In particular, by moving the switch to the on position the ventilator of the evaporator and/or condenser is activated. The ventilator generates an air flow adapted to remove any gas pockets that may have formed inside the conditioner body (FIGs. 1, 2, 3).

By subsequently activating a second switch or a thermostat, a second ventilator of the condenser and/or evaporator is activated as well as a timer for expelling any gas pocket formed inside the machine (FIGs. 4, 5, 6).

After a preset time, the timer activates the compressor with the control and safety systems and the air conditioner can operate in absolute safety even if a pure hydrocarbon, for example propane, is used as refrigerant fluid.

By turning the thermostat or an adapted switch in the off position, the ventilator of the condenser and/or evaporator is stopped together with the compressor and the control and safety systems.

The main switch is then turned to the off position in order to stop also the first ventilator of the evaporator and possibly to open the delivery apertures for rendering the air conditioner absolutely safe regardless whether it remains idle for long or short periods of time.

It has been seen in practice that the apparatus and the method according to the invention are particularly advantageous in allowing to use a pure hydrocarbon, such as propane, as refrigerant fluid in an air conditioner and at the same time ensuring maximum safety of the air conditioner in any working condition at any temperature and pressure.

Such an air conditioner has an equal or superior efficiency with respect to the conventional air conditioners and has a lower cost still having no potential negative effect on the ozone layer and no potential greenhouse effect.

The apparatus and method according to the invention may have numerous modifications and variations, all within the inventive concept; furthermore, all the details may be substituted with technically equivalent elements.

The materials employed, as well as the dimensions, may be any according to the specific needs and the state of the art.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Air conditioning apparatus, with a refrigerating fluid which is not harmful to at least the ozone layer, comprising a refrigerant fluid compressor (2), at least a first condenser (20) of said fluid, a choking member of said fluid, an evaporator (3) of said fluid, at least a first ventilator (4) for generating an air flow and electric and/or electronic and mechanical members adapted to operate said ventilator, said refrigerant fluid being a coolant belonging to the class of hydrocarbons and having no negative potential effect against the ozone layer and having no potential greenhouse effect and having flammable limits defined respectively as minimum and maximum concentration of said coolant apt to propagate the flame through a mixture of said coolant and air in preset temperature and pressure conditions, characterized in that it has at least a first safety zone (5) wherein at least part of said electrical and/or electronic members of said apparatus are arranged, said zone having selected dimensions for preventing the formation of either minimum or maximum concentration of said coolant within said flammable limits; and at least a first chamber (6) comprising said electrical and/or electronic members adapted to operate said apparatus, said chamber being crossed by an air flow initially produced by at least said ventilator for removing said minimum or maximum concentration of said coolant, possibly falling within said flammable limits, from said chamber.

2. Air conditioning apparatus, with a refrigerating fluid which is not harmful to at least the ozone layer, comprising a casing supporting a refrigerant fluid compressor (2), at least a first condenser (20) of said fluid, a choking member of said fluid, an evaporator (3) of said fluid, at least a first ventilator (4) for generating an air flow and electric and/or electronic and mechanical members adapted to operate said ventilator, said refrigerant fluid being a coolant belonging to the class of hydrocarbons and having no negative potential effect against the ozone layer and having no potential greenhouse effect and having flammable limits defined respectively as minimum and maximum concentration of said coolant apt to propagate the flame through a mixture of said coolant and air in preset temperature and pressure conditions, characterized in that it has at least a first safety zone (5) wherein at least part of said electri-

cal and/or electronic members of said apparatus are arranged, said zone having selected dimensions for preventing the formation of either minimum or maximum concentration of said coolant within said flammable limits; and at least a first chamber (6) and a second chamber (10) comprising said electrical and/or electronic members adapted to operate said apparatus, said first and second chambers being crossed by at least a first and second air flows initially generated respectively by first and second ventilators (4; 15) for removing said minimum or maximum concentration of said coolant, possibly falling within said flammable limits, from said chambers.

3. Apparatus, according to claim 1 or 2, characterized in that it comprises disposal means (7, 8) of said concentration of coolant falling within said flammable limits, when said apparatus is idle.

4. Apparatus, according to one or more of the preceding claims, characterized in that it comprises at least a second safety zone (5) accommodating at least said electrical members and having preset dimensions, as said first safety zone, adapted to prevent the formation of any minimum or maximum concentration of said coolant falling within said flammable limits.

5. Apparatus, according to one or more of the preceding claims, characterized in that said first and second zones are respectively arranged in said first and second chambers.

6. Apparatus, according to one or more of the preceding claims, characterized in that said first chamber has a separate casing spaced apart from a casing of said second chamber.

7. Apparatus, according to one or more of the preceding claims, characterized in that it comprises at least a second condenser, said first and second condensers being cooled by water and/or air.

8. Apparatus, according to one or more of the preceding claims, characterized in that said coolant is an hydrocarbon or a mixture of hydrocarbons.

9. Method for conditioning air with a refrigerant fluid which is not harmful to at least the ozone layer, said refrigerant fluid being a coolant belonging to the class of hydrocarbons and having no negative potential effect against the ozone layer and having no potential greenhouse effect and having flammable limits defined respectively as minimum and maximum concentration of said coolant apt to propagate the flame through a mixture of said coolant and air in preset temperature and pressure conditions, characterized in that it comprises the steps of: generating at least a first air flow having a selected rate of flow adapted to hit for a preset time all the electric and/or electronic and mechanical members adapted to the operation of an air conditioner for dissolving a possible minimum or maximum concentration of said coolant falling within said flammable limits and adapted to activate a compressor of said air conditioner, at the end of said preset time, and at the same time of its safety and control systems.

10. Method, according to claim 9, characterized in that, after generating said at least first air flow and before activating said compressor, at least a second air flow is generated having a different direction with respect of said first air flow, said second air flow being adapted to dissolve any minimum or maximum concentration of said coolant falling within said flammable limits.

11. Method, according to one or more of the preceding claims, characterized in that, when said air conditioner is disactivated, disposal means of said minimum or maximum concentration of said coolant falling within said flammable limits are activated.

12. Method, according to one or more of the preceding claims, characterized in that said coolant is a pure hydrocarbon.

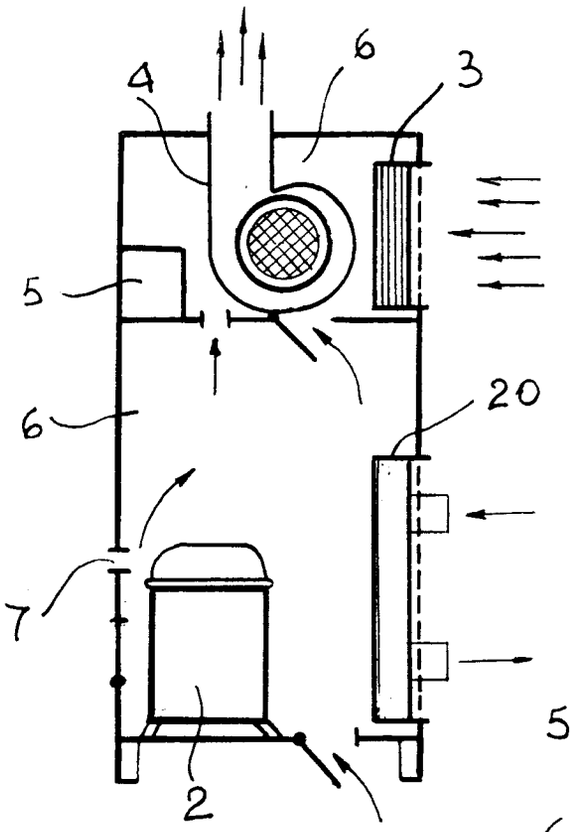

Fig. 1

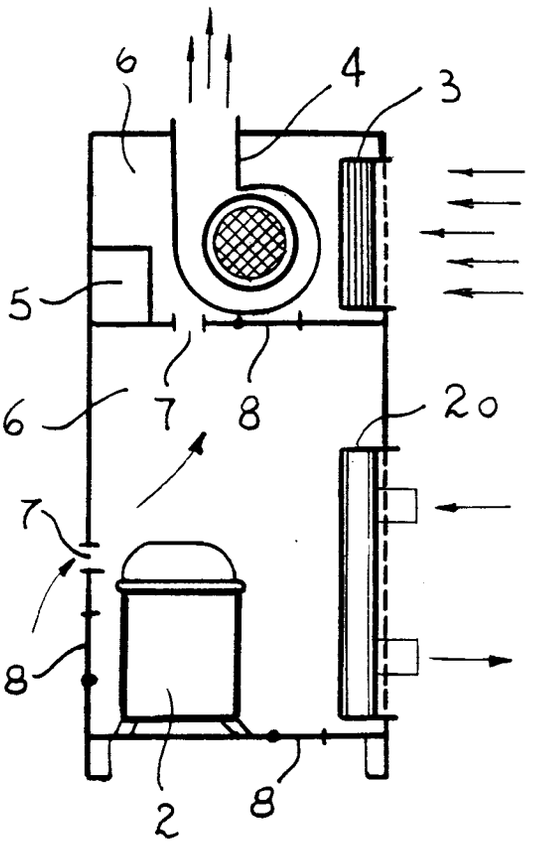

Fig. 2

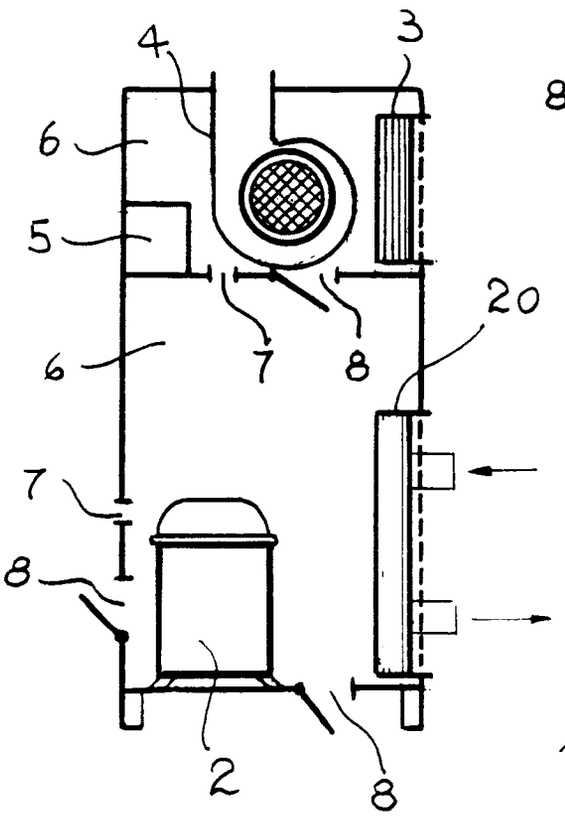

Fig. 3

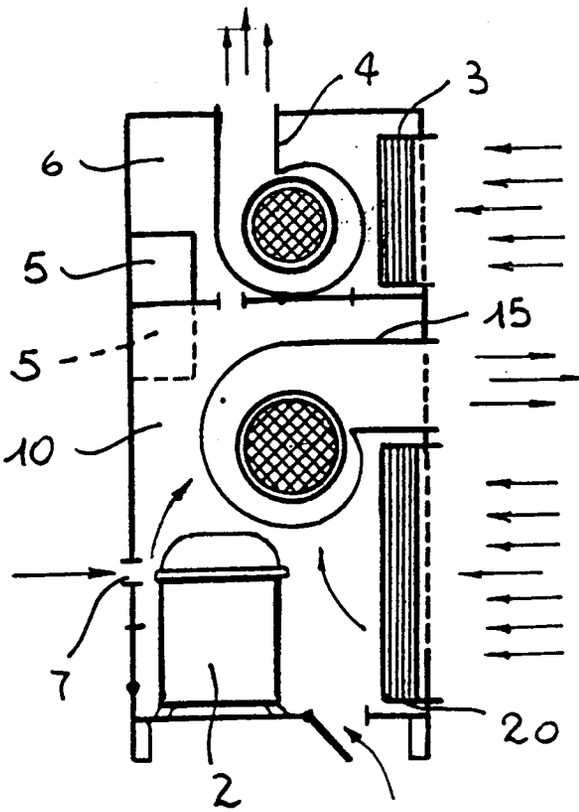

Fig.4

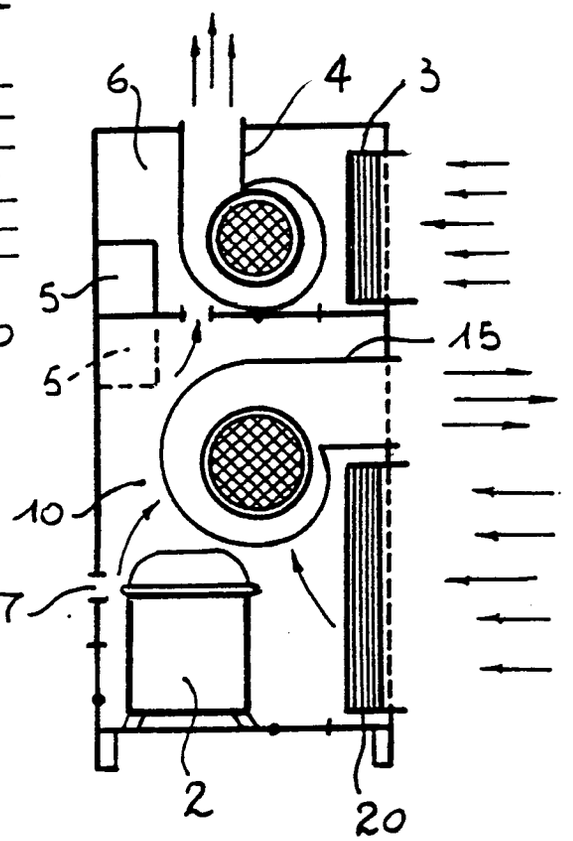

Fig.5

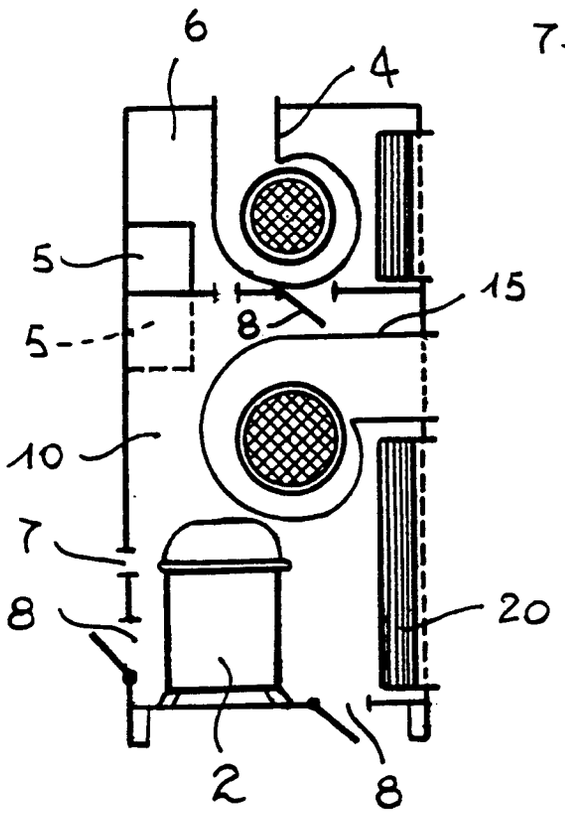

Fig.6

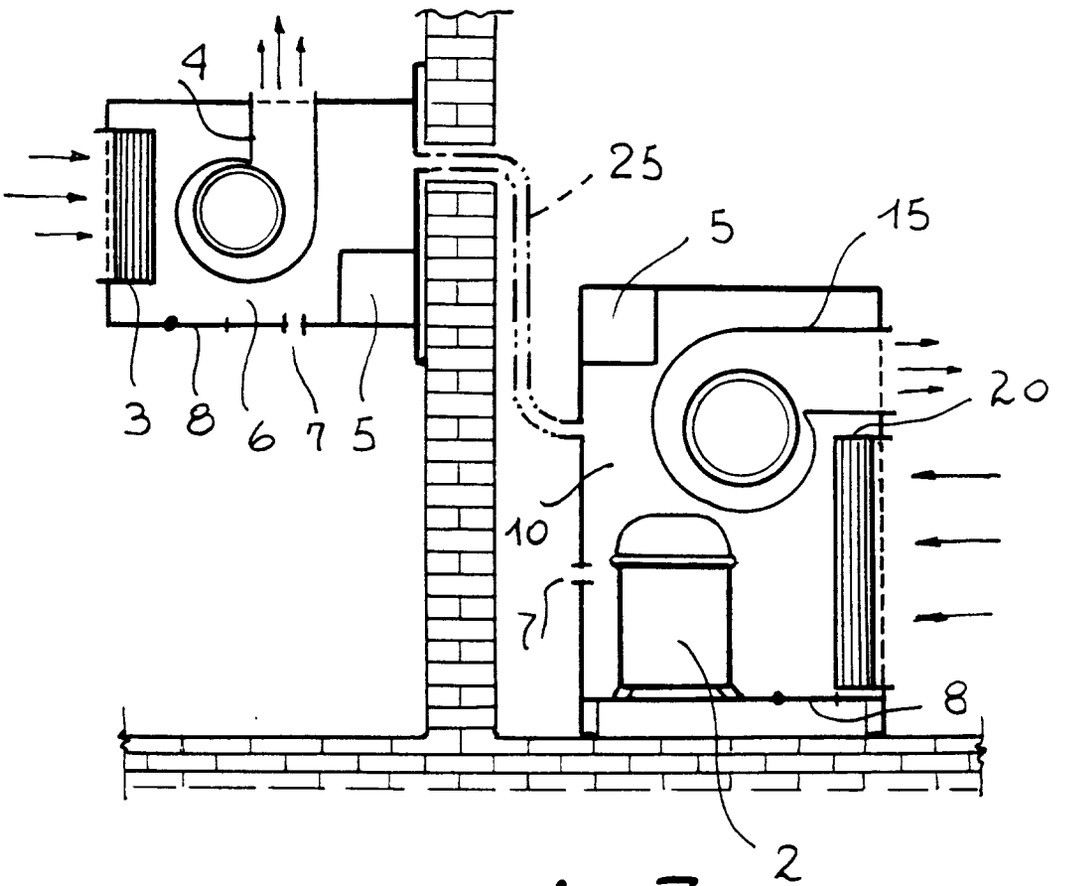

Fig. 7