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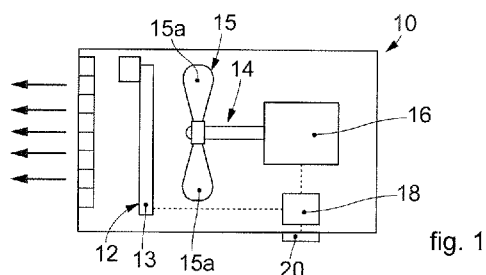


fig. 1

(57) Abstract: A method is described to regulate a conditioning apparatus (10), comprising a heating/cooling device (12) and a ventilation device (14) suitable to generate a flow of air toward the heating/cooling device (12) in order to direct it toward a room to be conditioned, wherein the method comprises the step of switching on the conditioning apparatus (10) in a switch-on instant (t_0), the step of activating the heating/cooling device (12) and the ventilation device (14), the step of determining a commutation instant (t^*), and the step of driving the ventilation device (14) so that, until the previously determined commutation instant (t^*), the ventilation device (14) is stationary or rotates at a maximum speed equal to a certain speed ($V_{\text{THRESHOLD}}$) of the ventilation device.



“METHOD TO REGULATE A CONDITIONING APPARATUS”

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FIELD OF THE INVENTION

The present invention concerns a method to regulate a conditioning apparatus,
5 and in particular a method to regulate the start-up step of the conditioning
apparatus which allows to supply an optimal sensation of comfort for a user.

BACKGROUND OF THE INVENTION

Conditioning apparatuses are known, to regulate the temperature of the inside
rooms of a building, or the inside of a vehicle.

10 Conditioning apparatuses for a room can be portable, for example, so that they
can be moved to a desired position, attached to the walls of the room to be
conditioned, or integrated inside them.

In particular, conditioning apparatuses are known which comprise a heating or
cooling device and a fan that blows air toward the heating or cooling device, to
15 heat or cool the room respectively.

In the start-up step, conditioning apparatuses of the known type typically have
the disadvantage that the fan starts to operate at its nominal power from the
moment it is switched on, directing the air toward the heating/cooling device,
which, however, is not yet at the desired temperature. As a consequence, the flow
20 of air generated by the fan and introduced into the room is not adequately
conditioned until the heating/cooling device reaches the expected operating
temperature.

This can cause an unpleasant sensation for the user, who is initially hit by a
flow of air having a certain speed and a temperature substantially equal to the
25 room temperature, which is therefore not comfortable for the user. The higher the
delivery of air emitted by the conditioning apparatus, the more unpleasant the
sensation is.

In recent years, manufacturers have increasingly sought to optimize the
performance of air conditioning apparatuses, with the aim of generating a high
30 degree of well-being or comfort for a user.

For example, conditioning apparatuses are known which provide to open the
passage of air toward the room to be conditioned only after a certain time, when
the air has already at least partly heated/cooled.

These apparatuses have the disadvantage that they are not very efficient in the initial step in which, although fully functioning, they consume energy to generate a flow of air which, however, is not used for the purpose of conditioning the room. Moreover, these apparatuses have the disadvantage that they are complex
5 since they require an alternative path for the flow of air generated during the initial step so that it does not reach the room to be conditioned or at least is not directly directed toward the user.

An example of an apparatus in which the flow of air emitted is correlated with the temperature of a refrigerant liquid is described, for example in US-B-
10 5.533.352.

In general, however, apparatuses known in the state of the art do not allow to optimize the sensation of well-being, or comfort, for a user, as they do not allow an adequate monitoring of the actual temperature variation perceived by a user.

One purpose of the present invention is therefore to provide a method to
15 regulate a conditioning apparatus that is better than regulation methods of known apparatuses.

Another purpose of the present invention is to provide a method to regulate a conditioning apparatus which allows to modulate the initial transitory step of the apparatus, until the device has reached a functioning that allows to guarantee the
20 ideal conditions of comfort desired by the user, and to prevent alterations occurring of the initial thermal conditions perceived by the user.

The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

25 SUMMARY OF THE INVENTION

The present invention is set forth and characterized in the independent claim, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

In accordance with the above purposes, a method is provided to regulate a
30 conditioning apparatus, in which the conditioning apparatus comprises at least thermal conditioning means and a ventilation device suitable to generate a flow of air toward the thermal conditioning means in order to direct it toward the room to be conditioned.

In some embodiments, the thermal conditioning means can comprise a heating device, or a cooling device, or both, possibly also integrated into a single device.

The conditioning apparatus according to the present invention, can be, by way of example, a fan, or a conditioner, for example of a domestic type, or a conditioning system integrated in a motor vehicle, in the cabin of a bridge crane
5 or in another similar or comparable space to be conditioned.

The method according to the present invention provides, in particular, to regulate the start-up step of the conditioning apparatus in such a way as to prevent, or at least limit, unpleasant thermal effects for the user in an initial
10 transitory step.

According to some embodiments, the method according to the present invention comprises the step of switching on the conditioning apparatus in a switch-on instant, the step of calculating an “initial equivalent temperature” value which is representative of the thermal conditions of the room at the switch-on
15 instant, the step of activating the thermal conditioning means, and the step of activating the ventilation device.

By “equivalent temperature”, as will be explained hereafter, we mean an equivalent temperature of the air in an isothermal room at 50% relative humidity, in which an individual wearing standard clothing for the activity he/she is performing has the same thermal stress (understood as skin temperature) and the
20 same thermoregulation capacity (understood as skin dampness) as the real room.

In other words, the equivalent temperature is a parameter that combines the conditions of a real room and the psychophysical conditions of an individual by describing a fictitious standard room in which the individual’s response in terms
25 of thermal comfort is known.

The method according to the invention also provides to determine a commutation instant of the ventilation device, subsequent to the switch-on instant, such that an “equivalent temperature” as defined above, calculated in said commutation instant, is substantially equal or in any case as near as possible to
30 the initial equivalent temperature calculated at the switch-on instant.

The equivalent temperature, as we will see better hereafter, is characterized and influenced by pairs of air speed and temperature values; the variation of said equivalent temperature, for example determined by regulating the fan speed and

possibly also of the heating/cooling element, can be controlled by acting on the regulation parameters of the conditioning apparatus.

According to some embodiments, the method provides to determine a commutation instant in which the speed of the ventilation device, combined with
5 the temperature values of the heating/cooling device, is such that the “equivalent temperature” value at that instant is substantially equal to the initial equivalent temperature value.

The method according to the invention also provides that, until the commutation instant, the ventilation device is kept stationary, or is driven so as to
10 rotate at a minimum speed, which is lower than the speed of the ventilation device determined for the commutation instant.

In this way, the speed of the fan increases when the heating/cooling element has reached a temperature condition such that the user is hit by a conditioned flow of air having the desired characteristics of comfort.

15 According to some embodiments, the thermal conditioning means comprise a resistive element.

According to some embodiments, the thermal conditioning means comprise a resistance of the PTC type (Positive Temperature Coefficient). In these embodiments, the commutation instant is subsequent to an instant in which the
20 material of which the thermal conditioning means are made reaches its Curie temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other characteristics of the present invention will become apparent from the following description of some embodiments, given as a non-restrictive
25 example with reference to the attached drawings wherein:

- fig. 1 is a schematic view of an example of an apparatus in which the method according to the present invention can be implemented;
- fig. 2 is a graph that schematically shows a comparison of the development of the equivalent temperature perceived by a user in the state of the art and
30 according to the method of the present invention;
- fig. 3a schematically shows two samples of characteristic developments of the power consumption of thermal conditioning means comprised in a conditioning apparatus according to the invention;

- figs. 3b and 3c schematically show a comparison of the development over time of the speed and temperature of a flow of air exiting from the conditioning apparatus to which the method according to the present invention can be applied;
- fig. 4 schematically shows an example of a characteristic development of the resistance as a function of the temperature of thermal conditioning means comprised in a conditioning apparatus according to the invention.

To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one embodiment can conveniently be incorporated into other embodiments without further clarifications.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

Embodiments described here concern a method to regulate a conditioning apparatus 10 shown schematically in fig. 1, and in particular a method that allows to regulate the start-up step of the conditioning apparatus 10 in such a way as to prevent, or at least limit, any negative thermal effects perceived by a user.

According to some embodiments, the conditioning apparatus 10 can be, by way of example, a conditioner, for example of the domestic type, suitable to generate a flow of air toward a room to be conditioned, or a conditioning system integrated in a motor vehicle or a bridge crane, or similar or comparable means, suitable to generate a flow of air toward the cabin.

The conditioning apparatus 10 can be the type suitable both for heating a room, typically when room temperatures are low, and for cooling a room, particularly when room temperatures are high.

The method to regulate a conditioning apparatus 10 according to the invention can initially provide to verify whether the apparatus is operating in heating mode to heat a room, or in cooling mode to cool a room.

In particular embodiments, the verification step provides to control the functioning settings that have been selected by the user.

In other embodiments, the step to verify the mode in which the apparatus is operating can be implemented by means of temperature detection means, for example a temperature sensor of a known type.

We will now describe a method to regulate the conditioning apparatus 10 when it is operating in heating mode to heat a room. It is obvious, however, that

the method according to the invention can also be implemented, suitably adapted, when the conditioning apparatus 10 is operating in cooling mode.

The conditioning apparatus 10 comprises at least one conditioning device 12, in particular in this embodiment configured as a heating device 12, and a
5 ventilation device 14 suitable to generate a flow of air through the heating device 12 to direct it to the room to be conditioned.

The conditioning apparatus 10 can also comprise a cooling module of a known type, which will not be described here in detail since it is not important for the purposes of the present invention.

10 According to some embodiments, the heating device 12 can comprise a heating element of the resistive type.

According to other embodiments, the heating device 12 can comprise a thermistor, of a type known in the state of the art.

In particular embodiments, the heating device 12 can comprise a PTC
15 thermistor ("Positive Temperature Coefficient"), known in the state of the art, which comprises a ceramic semiconductor which has a very high positive temperature coefficient.

PTC thermistors have a characteristic behavior in which resistance increases as the temperature of the thermistor itself increases, as can be seen in the graph in
20 fig. 4. In these known thermistors, as the temperature gradually increases and reaches the Curie temperature T_C of the material of which the thermistor is made, the resistance increases considerably and there is a parallel decrease in the current passing through it.

According to other embodiments, the ventilation device 14 comprises a
25 ventilator, or fan, 15 provided with a plurality of blades 15a, and connected to a drive member 16 suitable to make the fan 15 rotate at the desired speed.

According to some embodiments, the conditioning apparatus 10 comprises a control and command unit 18, connected at least to the heating device 12 and to the ventilation device 14 and configured to control the functioning thereof.

30 The control unit 18 can be a computerized unit in which software can be loaded in order to execute one or more specific programs which put into practice the regulation method, when applied to a conditioning apparatus 10.

According to some embodiments, the conditioning apparatus 10 comprises a

user interface 20 by means of which a user can switch the conditioning apparatus 10 on or off, and can possibly set the functioning parameters of the apparatus.

In particular embodiments, the user interface 20 allows the user to set both the desired temperature value, for example expressed in centigrade or Fahrenheit
5 degrees, and also an index indicative of the speed of the flow of air coming out of the apparatus to be obtained, for example equal to “1”, or “2”, or “3”, etc., to which increasing values of speed of the ventilation device 14 correspond.

According to some embodiments, the user interface 20 is operatively connected to the control and command unit 18 and communicates with it to
10 transfer to it the settings selected by the user.

The method according to the invention allows to provide a conditioned flow of air having the characteristics of speed and temperature suitable to provide a sensation of comfort to the user, in particular preventing the user from perceiving
15 sensations of discomfort due to flows of air with temperatures different from those desired.

The method according to the invention provides to measure the user's sensation of comfort using the parameter of the perceived equivalent temperature, called SET (acronym for “*Standard Effective Temperature*”).

The equivalent temperature T_{SET} is defined as the equivalent temperature of
20 the air in an isothermal room with 50% relative humidity, in which an individual wearing standard clothing for the activity he/she is performing has the same thermal stress (understood as the temperature of the skin) and the same thermoregulation capacity (understood as dampness of the skin) as the real room.

In other words, the equivalent temperature T_{SET} is a parameter that combines
25 the conditions of a real room and the psychophysical conditions of an individual, describing a fictitious standard room in which the individual's response in terms of thermal comfort is known.

The equivalent temperature T_{SET} , in its most extensive and complete form, can be calculated according to the following functional relationship:

30
$$T_{SET} = f(T, v, MRT, RH, clo, met)$$

where:

T is the temperature of the air in the room;

v is the speed of the air in the room;

MRT is the mean radiant temperature;

RH is relative humidity;

clo is a coefficient that expresses the thermal insulation of the individual, correlated to the garments he/she is wearing;

5 met is a coefficient that takes into account the individual's level of activity.

Within the field of the present invention, in the formula shown above, one or more of the parameters cited can be assumed as constant values, for example determined on the basis of the settings provided by the user, or on the basis of information supplied at the time of an initial setting of the conditioning apparatus
10 10, or because it is presumed that they will remain so during the time interval considered.

According to some embodiments, the method provides to determine the value of one or more of the parameters shown above, detecting the actual climatic conditions of the room to be conditioned by means of suitable detection devices.

15 For example one or more of the values of temperature, speed, relative humidity, mean radiant temperature, or other, can be detected directly by suitable sensors.

According to variant embodiments, one or more of the above values can be estimated/calculated on the basis of other measurements made; for example, the
20 air speed can be estimated on the basis of the rotation speed of the ventilation device 14.

According to some embodiments, the coefficient clo can be assumed as equal to 1 if the individual is wearing typical winter indoor clothing, and instead equal to 0.5 if the individual is wearing typical summer indoor clothing.

25 According to some embodiments, the coefficient met can be assumed as equal to 1.2, that is, the coefficient associated with a sedentary type activity.

Fig. 2 shows the development over time of the equivalent temperature T_{SET} in the initial switch-on step of an apparatus 10 starting from a switch-on instant t_0 according to the state of the art (indicated by a line of dashes) and according to
30 the present invention (indicated by a continuous line).

As can be seen, when a user switches on a conditioning apparatus of a known type, the development of the equivalent temperature T_{SET} (indicated by a line of dashes) tends to decrease rapidly to a minimum level T_{LOW} .

The greater the difference between the initial equivalent temperature T_{SET_0} , perceived by a user in correspondence with a switch-on instant t_0 of the apparatus 10, and the minimum level T_{LOW} , the greater is the sensation of thermal discomfort perceived by the user.

5 On the contrary, the method according to the invention allows to maintain the equivalent temperature T_{SET} perceived at a level such as to prevent, or at least limit, a significant alteration of the thermal condition perceived by a user.

Thanks to the method according to the present invention, in fact, the equivalent temperature T_{SET} tends to remain substantially constant and equal to
 10 the initial value T_{SET_0} up to a commutation instant t^* , so that switching on the conditioning apparatus 10 does not alter the thermal condition perceived by the user. In other words, the method according to the invention allows to neutralize, or at least to significantly limit, the disturbing effects of the environmental conditions (in particular the speed and temperature of the air in the room to be
 15 conditioned) because the conditioning apparatus 10 has been switched on, at least in an initial transitory step, so that the user maintains his sensation of comfort unchanged.

The method to regulate a conditioning apparatus 10 according to the invention provides to determine the commutation instant t^* to which there corresponds a
 20 fan rotation speed at most equal to $V_{THRESHOLD}$ of the ventilation device 14, such that in the room to be conditioned there are specific values of air temperature and speed T^* , v^* such as to guarantee an equivalent temperature value T_{SET} substantially equal, or in any case as near as possible, to the initial equivalent temperature value T_{SET_0} perceived by the user, calculated in correspondence to
 25 the switch-on instant t_0 . In other words, to determine the commutation instant t^* at least the following equation must be satisfied:

$$T_{SET} = f(T^*, v^*, MRT, RH, clo, met) \cong T_{SET_0}$$

As we said, some parameters in the above formula can be considered constant.

According to some embodiments, the step of calculating an initial equivalent
 30 temperature value perceived by a user T_{SET_0} comprises:

- detecting a temperature of the air in the room T_0 and a speed of the air in the room v_0 at said switch-on instant t_0 ;
- calculating the initial equivalent temperature T_{SET_0} as a function of the

temperature T_0 and the speed v_0 detected.

According to some embodiments, to determine the commutation instant t^* , the method comprises the following steps:

- memorizing information relating to the development over time of the variable quantities that affect the equivalent temperature T_{SET} on which the conditioning apparatus 10 can act;
- identifying at least one pair of values of air temperature and speed T^* , v^* , different from the temperature and speed values T_0 , v_0 detected at the switch-on instant t_0 , which allow to obtain an equivalent temperature value T_{SET} equal to the initial equivalent temperature value T_{SET_0} calculated at the instant t_0 ;
- since the parameters T^* , v^* are known, obtaining the commutation instant t^* starting from the information memorized on the development over time of the temperature T and the air speed v .

According to some embodiments, the method provides to obtain, from the speed value v^* identified, a rotation speed value $V_{THRESHOLD}$ of the ventilation device 14 such as to generate a speed of the air in the room equal to v^* .

According to some embodiments, the step of memorizing information on the development over time of the variable quantities can provide to introduce a plurality of speed values of the fan 15 into the apparatus 10 which define the development of the speed with respect to time, and/or a plurality of room temperature values T detected when the conditioning apparatus 10 is switched on, so as to make the information regarding the development over time of the room temperature and the air speed in the room available when the apparatus is switched on.

According to some embodiments, it can be provided that the information relating to the development over time of the temperature and the speed are introduced into the conditioning apparatus 10 and memorized in the control and command unit 18 during the production step and/or the initial setting step of the conditioning apparatus 10.

According to variant embodiments, it can be provided that the information relating to the development over time of the temperature and speed are monitored and memorized continuously during the functioning of the conditioning apparatus 10, allowing a more precise modulation of the start-up step as a function of the

characteristics of the conditioning apparatus 10.

Based on this information, therefore, and knowing a pair of temperature and speed values, it is possible to determine at what point in time they correspond, and consequently it is possible to obtain the commutation instant t^* .

5 In embodiments where the heating device 12 comprises a PTC thermistor, the method according to the present invention provides that the commutation instant t^* is subsequent to the instant in which the thermistor has reached its characteristic Curie temperature T_C .

10 In these embodiments, the commutation instant t^* could be near to an instant in which the power absorbed by the heating device 12 stabilizes and is near to or equal to the nominal power value P_{NOM} of the heating device (fig. 3a).

For example, the nominal power value P_{NOM} can be equal to about 1,400 Watts. In general, the nominal power value P_{NOM} can be smaller, or greater, depending on the type and size of the conditioning apparatus 10. During use,
15 when a user switches on the conditioning apparatus 10, in correspondence with a switch-on instant t_0 , the method according to the present invention provides that the control and command unit 18 activates the heating device 12 and/or the ventilation device 14.

According to some embodiments of the method according to the invention, it
20 is provided to activate the heating device 12 at the switch-on instant t_0 , and only afterward is it provided to activate the ventilation device 14.

According to these embodiments, the commutation instant t^* can coincide with the instant of activation of the ventilation device 14, which therefore, before this instant, is inactive with zero rotation speed.

25 According to other embodiments, the method according to the invention provides to activate the heating device 12 and the ventilation device 14 substantially at the same time as the switch-on instant t_0 .

According to some embodiments, after the step of activating the heating device 12 and the ventilation device 14, the method comprises the step of driving
30 the ventilation device 14 so that it rotates at a speed lower than said speed $V_{THRESHOLD}$, up to the commutation instant t^* , determined by the method steps described above.

In other embodiments, the method according to the invention provides to keep

the rotation speed of the ventilation device 14 equal to a substantially constant value lower than the threshold speed $V_{\text{THRESHOLD}}$, up to the commutation instant t^* .

5 In other embodiments, the method according to the invention provides to keep the speed of the ventilation device 14 constant and equal to the threshold speed $V_{\text{THRESHOLD}}$, up to the commutation instant t^* .

10 In other embodiments, the method according to the invention provides to vary the rotation speed of the ventilation device 14 so that it increases over time, while still remaining below the threshold speed $V_{\text{THRESHOLD}}$. In particular embodiments, the method according to the invention provides to selectively drive the ventilation device 14 so that its speed increases with different growth ramps, as a function of the temperature gradient existing in the room to be conditioned.

15 In some embodiments of the method according to the invention, in which the apparatus is functioning in heating mode, the speed $V_{\text{THRESHOLD}}$ can be such as to generate an air speed in the room lower than 0.5 m/s.

In some embodiments, the speed $V_{\text{THRESHOLD}}$ can be such as to generate, for example, an air speed in the room of less than 0.4 m/s, or less than 0.2 m/s, or possibly equal to about 0.1 m/s.

20 According to some embodiments, the speed $V_{\text{THRESHOLD}}$ can be equal to the minimum value at which the ventilation device 14 can be made to rotate, that is, the value below which the latter would stop.

25 According to some embodiments, the method according to the invention comprises the step of increasing the rotation speed of the ventilation device 14 after the commutation instant t^* , as can be seen in fig. 3b. In this step, the rotation speed of the ventilation device 14, which up to the commutation instant t^* is equal to or lower than the speed $V_{\text{THRESHOLD}}$, reaches a value V_{USER} . The value V_{USER} is a value that is a function of the settings introduced by the user in the user interface 20.

30 In embodiments where the heating device 12 comprises a PTC thermistor, the method according to the invention provides to make the ventilation device 14 rotate at a speed lower than $V_{\text{THRESHOLD}}$, or even zero speed, until the power absorbed by the heating device 12 has stabilized and is already near to the nominal value P_{NOM} provided in its normal operating state.

Thanks to this, the regulation method according to the invention allows to keep the ventilation device 14 stationary, or to make it rotate at a speed lower than or equal to $V_{\text{THRESHOLD}}$ until the heating device 12 has heated up sufficiently. In this way the flow rate of the air exiting in the initial step is zero, or negligible,
5 and therefore the user perceives only slightly, or does not perceive at all, an unpleasant sensation caused by an insufficiently heated jet of air.

Thanks to the method according to the present invention, it is therefore possible to render minimal, or even zero, a difference ΔT_{SET} between the equivalent temperature value perceived by the user initially T_{SET_0} and the
10 equivalent temperature value perceived by the user at the commutation instant t^* , a difference value that is indicative of the alteration of the thermal condition perceived by the user in the transitory step that immediately follows the switching-on of the apparatus 10.

With reference to fig. 3a, two examples of possible developments 100, 101 of
15 the power absorbed by the heating device 12 (in particular, as we said, a PTC thermistor) as a function of time, can be seen.

With reference to fig. 3b, it should be noted that the development of speed in known apparatuses, indicated by a line of dashes, is significantly different from the development of the rotation speed of the ventilation device 14 which was
20 described previously in relation to the method according to the invention. As can be seen, in known apparatuses, the rotation speed reaches a value very near to the speed V_{USER} well before the commutation instant t^* , which means that the rotation speed of the ventilation device 14, and therefore the speed of the flow of air emitted, is at normal operating speed shortly after switching on, when the
25 heating device 12 is still cold.

It should be noted that the curve showing the increase in the rotation speed of the ventilation device 14 in fig. 3b is shown purely by way of example. Depending on the type of motor 16 and the way in which it controls the ventilation device 14, many other curves or ramps can naturally be provided,
30 more or less inclined, representative of the increase in speed of the ventilation device 14 from the switch-on/commutation instant until the speed value V_{USER} is reached.

With reference to fig. 3c, it can be seen how, while in the state of the art the

development of the air temperature (indicated with a line of dashes) increases substantially linearly starting from the switch-on instant t_0 , in the method according to the invention the development of the temperature of the air is substantially similar to that of the rotation speed of the ventilation device 14.

5 In particular, in the method according to the invention the air temperature remains very low until near to the commutation instant t^* . Subsequently, the temperature increases with a first gradient of growth up to an instant near to an instant in which the stabilization of the power absorbed by the heating device 12 takes place.

10 Furthermore, after this instant of stabilization of the power absorbed, the temperature increases further until it reaches a temperature set by the user by means of the user interface 20. For example, after the stabilization instant, the temperature can grow with a second gradient of growth, which is lower than the first gradient of growth.

15 It is clear that modifications and/or additions of steps can be made to the method to regulate a conditioning apparatus as described heretofore, without departing from the field and scope of the present invention.

20 It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of regulation method, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

CLAIMS

1. Method to regulate a conditioning apparatus (10), comprising a step of switching on said conditioning apparatus (10) in a switch-on instant (t_0), a step of activating thermal conditioning means (12) and a ventilation device (14) comprised in said conditioning apparatus (10), said ventilation device (14) being suitable to generate a flow of air toward said thermal conditioning means (12) in order to direct it toward a room to be conditioned, said method being **characterized in that** it comprises a step of calculating an initial equivalent temperature value perceived by a user (T_{SET_0}) representative of the room's thermal conditions in correspondence with said switch-on instant (t_0) and a step of determining a commutation instant (t^*), subsequent to said switch-on instant (t_0), in which said ventilation device (14) is made to rotate at a speed that is less than , or equal to, a reference value of rotation speed ($V_{THRESHOLD}$), in order to render minimum, or indeed zero, a difference (ΔT_{SET}) between said initial equivalent temperature value perceived by the user (T_{SET_0}) and the equivalent temperature value perceived by the user in correspondence with said commutation instant (t^*), said difference (ΔT_{SET}) being indicative of the alteration of the thermal condition perceived by the user in the transitory step that follows the switching on of said conditioning apparatus (10).
2. Method as in claim 1, **characterized in that** it provides that until said commutation instant (t^*) said ventilation device (14) is stationary, or rotates at a speed lower than or equal to said rotation speed ($V_{THRESHOLD}$).
3. Method as in claim 1 or 2, **characterized in that** the step of calculating an initial equivalent temperature value perceived by a user (T_{SET_0}) comprises:
- detecting a temperature of the air in the room (T_0) and an air speed in the room (v_0) in correspondence with said switch-on instant (t_0);
 - calculating said initial equivalent temperature perceived by a user (T_{SET_0}) as a function of said temperature and speed detected (T_0 , v_0) in correspondence with said switch-on instant (t_0).
4. Method as in any claim hereinbefore, **characterized in that** the step of determining said commutation instant (t^*) comprises the steps of:
- memorizing information relating to the development over time of the values of temperature (T) and speed (v) of the flow of air, as a function of which the

equivalent temperature value (T_{SET}) is variable;

- determining at least a pair of values of air temperature and speed (T^* , v^*) among said values memorized, different from said temperature and speed detected (T_0 , v_0), which allow to obtain an equivalent temperature value (T_{SET}) substantially equal to said initial equivalent temperature perceived by a user (T_{SET_0});

- obtaining from said determinate speed (v^*) the value of rotation speed of said ventilation device (14);

- obtaining said commutation instant (t^*) in correspondence with which said pair of values (T^* , v^*) is obtained, determined as a function of said rotation speed value obtained and of said memorized information.

5. Method as in any claim hereinbefore, **characterized in that** said equivalent temperature perceived by a user (T_{SET}) is calculated according to the following functional relation:

$$T_{SET} = f(T; v; MRT; RH; clo; met)$$

where:

T is temperature of the air in the room;

v is the speed of the air in the room;

MRT is the mean radiant temperature;

RH is the relative humidity;

clo is a coefficient that expresses the heat insulation of the individual;

met is a coefficient that takes into account the level of activity of the individual.

6. Method as in any claim hereinbefore, **characterized in that** said commutation instant (t^*) follows an instant in which the material of which said conditioning means (12) are made reaches its own characteristic Curie temperature (T_C).

7. Method as in any claim hereinbefore, **characterized in that** said commutation instant (t^*) is near to an instant in which the power absorbed by said thermal conditioning means (12) stabilizes and is near or equal to a nominal power value (P_{NOM}) of said thermal conditioning means (12).

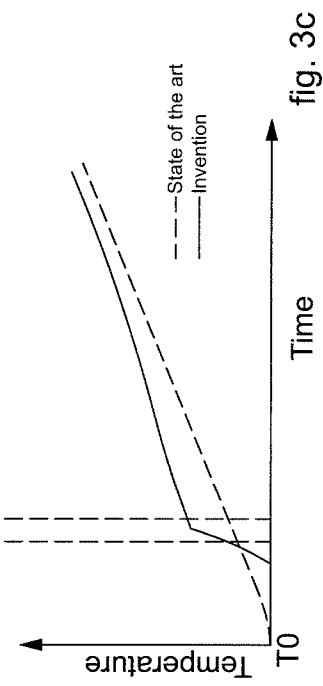
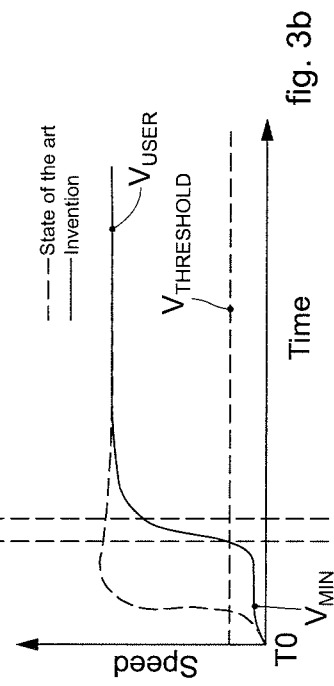
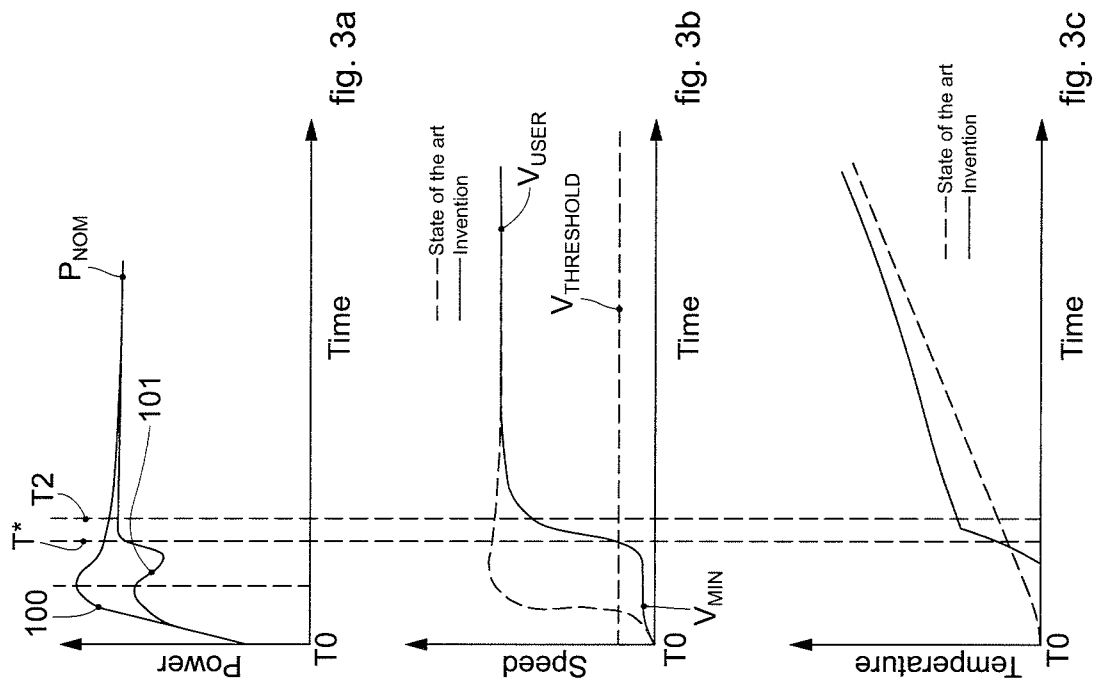
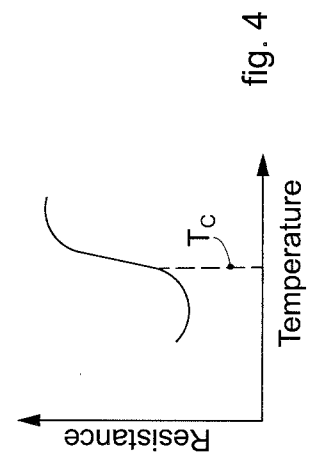
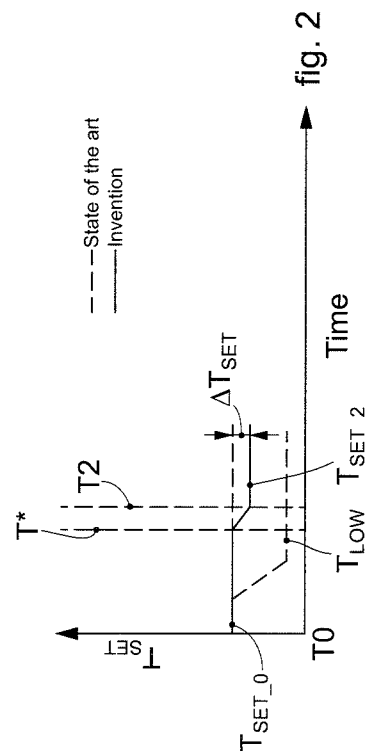
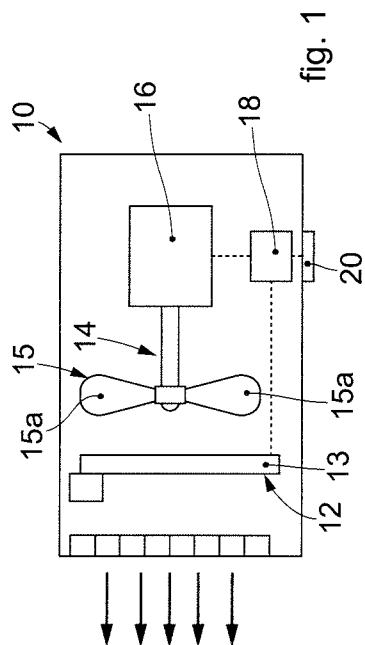
8. Method as in any claim hereinbefore, **characterized in that** said step of driving said ventilation device (14) provides to keep said rotation speed of said ventilation device (14) lower than said threshold value ($V_{THRESHOLD}$) at least until said commutation instant (t^*).

9. Method as in claim 6, **characterized in that** said rotation speed ($V_{\text{THRESHOLD}}$) is such as to generate a speed of the air in the room less than 0.5 m/sec.

10. Method as in any claim hereinbefore, **characterized in that**, after said commutation instant (t^*), it comprises the step of increasing the speed of said ventilation device (14) to a speed value (V_{USER}) which is a value that is a function of the settings introduced by a user by means of a user interface (20) comprised in said conditioning apparatus (10).

11. Method as in any claim hereinbefore, **characterized in that** said step of activating said thermal conditioning means (12) and said ventilation device (14) provides to activate said thermal conditioning means (12) and said ventilation device (14) simultaneously.

12. Method as in any claim from 1 to 10, **characterized in that** said step of activating said thermal conditioning means (12) and said ventilation device (14) provides to activate said thermal conditioning means (12) in correspondence with said switch-on instant (t_0) and said ventilation device (14) in correspondence with said commutation instant (t^*) after said switch-on instant (t_0).



INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2018/050143

A. CLASSIFICATION OF SUBJECT MATTER

INV. F25B1/00

ADD. F24D19/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B F24D F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 533 352 A (BAHEL VIJAY O [US] ET AL) 9 July 1996 (1996-07-09) column 2, lines 11-24; figures 2, 4A, 4B, 4C, 8A, 9A, 9B, 10A column 3, line 10 - column 8, line 9 -----	1-12
A	CN 105 222 264 A (WUHU REFRIGERATION EQUIPMENT CO LTD OF MIDEA GROUP) 6 January 2016 (2016-01-06) paragraphs [0017] - [0019], [0053], [0060] - [0099] -----	1-12
A	US 4 873 649 A (GRALD ERIC W [US] ET AL) 10 October 1989 (1989-10-10) column 3, line 4 - column 5, line 68; claim 1 -----	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IT2018/050143

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5533352	A	09-07-1996	CN 1121165 A 24-04-1996
			JP H08105651 A 23-04-1996
			US 5533352 A 09-07-1996

CN 105222264	A	06-01-2016	NONE

US 4873649	A	10-10-1989	AT 108568 T 15-07-1994
			AU 620119 B2 13-02-1992
			CA 1333294 C 29-11-1994
			DE 68916779 D1 18-08-1994
			DE 68916779 T2 22-12-1994
			EP 0380615 A1 08-08-1990
			JP 2884249 B2 19-04-1999
			JP H03501158 A 14-03-1991
			US 4873649 A 10-10-1989
			WO 8912269 A1 14-12-1989
