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(54) A machine for drying laundry for domestic use

(57) Laundry drying machine (1) comprising ventilation means, including a fan (7), for generating a forced flow (F) of air, and heating means, including a heat pump (10), for heating the air of the forced flow (F); said machine (1) has a control system including a control unit (6), provided for controlling execution of a plurality of operating programs of the machine (1), and a user interface (5), which has selection means (S) for selecting a desired operating program, the machine (1) further comprises change-over means (20), which can be controlled by the control unit (6) for assuming a first operating condition and a second operating condition in order to obtain from the heat pump (10) heating and cooling, respectively, of the air of the forced flow (F), the control unit (6) is provided for controlling the change-over means (20) so as to assume the second operating condition following upon selection of at least a first one of the operating programs that can be selected via the selection means (S).

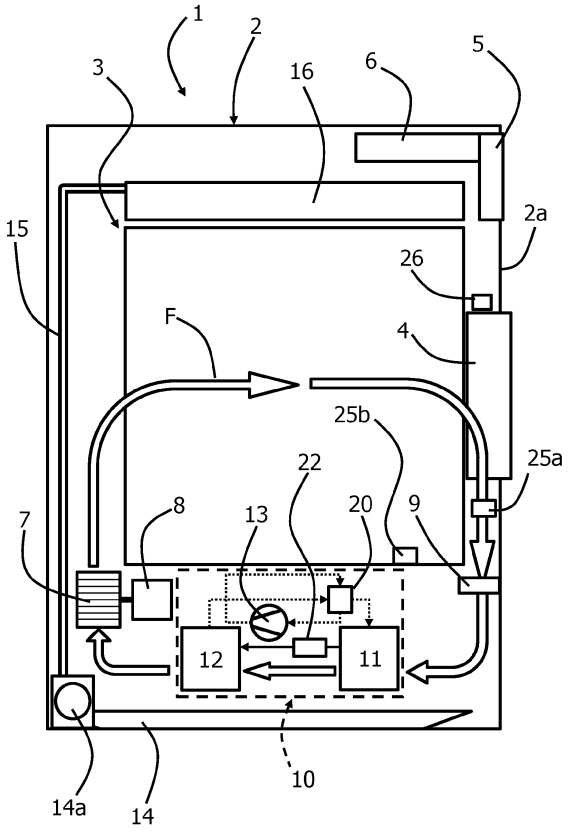

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to a laundry-drier machine.

State of the art

[0002] Laundry-drier machines are typically provided with a cabinet, rotatably housed within which is a drum, designed to contain the laundry to be dried. In some solutions, the drum has a perforated cylindrical wall and is rotatably mounted within a tank: this is typically the case of the so-called washer-drier machines, i.e., machines that enable washing and subsequent drying of a load of laundry. Drier machines in a strict sense, instead, are not normally provided with a tank. In some solutions, the drum is constituted by a non-perforated cylindrical wall, associated to which are a front flange and a rear flange, provided with openings for passage of a flow of drying air. In other solutions, the drum basically consists of just the cylindrical wall, the open ends of which are rotatably constrained to respective front and rear containment elements, with interposition of suitable sliding seal means.

[0003] The machine has a ventilation system, for generating and conveying a forced flow of air, and heating means, for heating the air of the forced flow. The ventilation system typically comprises a ducting, associated to which are a fan and the means for heating the air.

[0004] In the majority of known solutions, the heating means comprise at least one electrical resistance, but in recent times - mainly for reasons of energy efficiency - there has been a widespread use of heat pumps.

[0005] Heat-pump machines envisage two substantially closed circuits: the first circuit is the circuit for the forced air, which is passed over the garments, whilst the second circuit is the circuit for the coolant, which passes into a compressor set between an evaporator and a condenser. In said applications, the temperature of the coolant increases following upon the compression undergone by means of the compressor. The coolant is then made to pass into a condenser, where it transfers heat to the flow of forced air, which is thus heated. From the condenser, the coolant passes first into an expansion valve, which expands and cools the fluid, and then into the evaporator, to return again to the compressor. The condenser performs the same function of heating of the flow of air as the one performed by the electrical resistance in the other known solutions.

[0006] Irrespective of the type of heating means, the fan forces the air into the drum, via a delivery branch of the ventilation circuit after the air itself has been heated via heating means. The hot air traverses the inside of the drum and collects the moisture yielded by the laundry items contained therein, said items being thus progressively dried. The moist air exits from the drum through its front wall, which is provided with a central opening, used - in the case of front-loading machines - also for loading and unloading the laundry.

[0007] In traditional "condensation" machines, the front opening of the drum is in fluid communication with the intake branch of the ventilation system, upstream of the fan, along which there is a condenser device designed to extract the moisture from the air taken in from the drum, said dehumidified air being then re-heated and re-introduced into the drum via the delivery branch of the system. In heat-pump machines, the corresponding evaporator is directly exploited to bring about condensation of the moisture of the air of the forced flow. The water resulting from condensation is collected in a suitable container, from which, via a pump, it is brought into a container accessible by the user, for corresponding manual emptying.

[0008] Traditional electrical-resistance machines usually envisage also an open ventilation circuit, via which fresh air is taken from outside the cabinet of the machine, by means of a front fan. A duct inside the base of the machine deviates the flow of this air towards the condenser device. The air thus cools the condenser device and at the same time exits therefrom slightly heated. This slightly heated air - which can possibly be exploited to reduce the temperature of the motor of the machine - then exits from the cabinet from the bottom part of the motor compartment.

[0009] The operating programs that can be executed on the machine according to the known art are used for drying the items of laundry and, possibly, for reducing bad smells or creasing of the laundry. These programs generally have a relatively long duration, of roughly between 30 and 210 minutes. The temperature of the air is in general comprised between 55°C and 65°C.

[0010] It should be recalled that an operating program is aimed at execution of a cycle of treatment of laundry items and is made up of a predetermined automatic sequence of operating steps, which, executed by a control logic, cause passage from a start-of-cycle state to an end-of-cycle state. To each operating step there corresponds, on the part of the control logic, activation of predetermined electrical loads and monitoring of physical quantities, such as for example the time and/or the humidity and/or the temperature, representing the current state of execution of the program and designed to determine the actions of control during execution of the cycle. Start of a program generally occurs following upon a command imparted by a user, for example by means of a start button. Starting from the start-of-cycle state the aforesaid predetermined automatic sequence of operating steps is carried out.

[0011] The end of the program is determined by reaching of a certain predetermined condition associated to the program itself, detected by the control system of the machine. Said predetermined condition is typically represented by reaching of a predetermined program time, or of a temperature of the drying air or of a certain rate of humidity of the air or moisture of the load of laundry.

Passage of the predetermined program time can be measured by the control unit of the machine, typically provided with an internal clock of its own, whilst the temperature and/or humidity can be detected via suitable sensor means belonging to the control system. Once said predetermined condition is reached, the treatment cycle is completed, and consequently the program goes into the end-of-cycle state and terminates.

[0012] Laundry-drier machines are also usually provided with a sensor for opening/closing the door of the machine. In the case where, after starting a drying program, the user opens the door of the machine - for example, for adding garments to be dried - the program is interrupted or paused. When the door is reclosed, the program restarts from the current state at the moment when it was paused, typically by pressing the start button. It should be noted that the drying process entails rotation of the drum of the machine at a relatively low speed (roughly comprised between 45 and 55 r.p.m.), and this causes during running of the program the drum not to have to be blocked in the closed condition, unlike what occurs in the course of a washing program, where the speed of rotation of the drum can reach high values, even higher than 1000 r.p.m.

Summary of the invention

[0013] The object of the present invention is basically to provide, in a simple and inexpensive way, a laundry-drier machine having functions additional to the traditional ones, for the benefit of the user.

[0014] Said purpose is achieved, according to the present invention, by a laundry-drier machine and by a method of control of operation of a laundry-drier machine having the characteristics specified in the annexed claims. The claims form an integral part of the technical teaching provided in relation to the invention.

Brief description of the drawings

[0015] Further purposes, characteristics and advantages of the invention will emerge clearly from the ensuing detailed description, with reference to the annexed drawings, which are provided purely by way of explanatory and non-limiting example and in which:

- Figure 1 is a partial and schematic cross section of a laundry-drier machine according to the invention;
- Figure 2 is a schematic representation of a control panel of the machine of Figure 1;
- Figure 3 is a simplified diagram of a system for conditioning the air of the machine of Figure 1, which uses a reversible heat pump;
- Figures 4 and 5 are simplified diagrams representing operation of the reversible heat pump of the system of Figure 3, in two different operating modes.

Description of preferred embodiments of the invention

[0016] Reference to "an embodiment" or "one embodiment" in the context of the present description is intended to indicate that a particular configuration, structure, or characteristic described in relation to the embodiment is comprised in at least one embodiment. Hence, phrases such as "in an embodiment" or "in one embodiment" and the like, that may be present in various points of the present description, do not necessarily all refer to one and the same embodiment. Moreover, the particular configurations, structures, or characteristics can be combined in any adequate way in one or more embodiments. The references used in what follows are merely provided for convenience and do not define the sphere of protection or the scope of the embodiments.

[0017] It is pointed out that in the sequel of the present description, the word *"end",* when referred to an operating program or cycle of the machine, indicates a condition in which all the operating steps envisaged by the program for the purposes of achieving the specific objective of the program itself have been executed, this corresponding to a predetermined condition being reached by a monitored quantity, such as time elapsed and/or moisture content of the garments or humidity of the air and/or temperature of the air.

[0018] It is moreover pointed out that in the sequel of the present description only the elements useful for an understanding of the invention will be described in particular detail, taking for granted that the machine forming the subject of the invention comprises all the other elements in themselves known for normal operation of a laundry-drier machine.

[0019] With particular reference to Figure 1, designated as a whole by 1 is a laundry-drier machine according to the present invention. In the case illustrated, the machine 1 is a drier machine, namely, a machine designed to perform only drying functions, of the condensation type.

[0020] The machine 1 has a load-bearing structure or cabinet 2, rotatably mounted within which is a drum 3, designed for containing the laundry. The drum 3 has a generally cylindrical shape and is mounted for rotating about a substantially horizontal axis of rotation. Provided within the cabinet 2 are means, of a type in itself known, for rotatably supporting the drum 3, which can, for example, be of a rolling type, such as wheels or rollers, or of a sliding type, such as runners.

[0021] The cabinet 2 has a front face, comprising a front wall 2a, having an opening - not indicated - on which a door 4 is mounted for enabling access to the inside of the drum 3. In the front face of the cabinet 2, in particular in its upper region, a control panel or user interface of the machine is provided, designated as a whole by 5. The panel 5 forms part of a control system of the machine, which includes a control unit 6, preferably of an electronic microcontroller type, prearranged for controlling execution of a plurality of operating programs of the machine.

[0022] A possible simplified embodiment of the control panel 5 is represented in Figure 2. The panel 5 comprises at least one ON/OFF button, designated by ON, means for selection and start of one from a plurality of operating programs and, preferably, display means. In the example, the aforesaid selection and starting means comprise a rotary selector S with a number of positions and a program-start button R, but other means can obviously be used for the purpose, such as a series of pushbuttons or a selector with linear slider with a number of positions. In the example, the display means comprise a display D, which in possible variant embodiments can be replaced by warning lights. In the embodiment exemplified, moreover, also provided on the panel 5 are signaling means, for example, represented by a buzzer, designated by B. It should be noted that a warning means of an acoustic type can be installed in another position, also inside the cabinet 2, and hence not necessarily on the control panel 5.

[0023] The machine 1 comprises ventilation means, designed for generating a forced flow of air, and heating means, designed for heating the air of the forced flow.

[0024] In the example of embodiment illustrated, the ventilation means include a substantially closed path for the air (not indicated), defined in a known way within the cabinet 2, and possibly comprising a hollow part of the door 4. The aforesaid path substantially extends between an opening of the front wall of the drum 3 and at least one opening of the rear wall of the drum 3. In Figure 1, the white arrows designated by F indicate the forced flow along the aforesaid path and through the drum 3. The ventilation means further comprise a fan 7 that is operative along the aforesaid path and that is preferably - but not necessarily - driven by the same motor 8 that is to bring about rotation of the drum 3. Along the path for the air a filter 9, of a conception in itself known, is preferably provided, which can be inspected by the user of the machine 1.

[0025] In the embodiment exemplified, the means for heating the air include a heat pump 10, which operates along the path for the air and comprises a first heat exchanger 11, a second heat exchanger 12, and a compressor 13, which is operatively set between the two heat exchangers 11 and 12. The heat pump 10 can possibly include a respective filter for the air. The heat exchangers can be of any type known in the sector, for example ones comprising a coil for a working fluid of the heat pump, in particular a coolant, where the compressor and the heat exchangers are connected in a closed circuit for said fluid. The path of the air is such that the flow F will be forced to traverse, or in any case lap, the heat exchangers 11 and 12, for providing a heat exchange with the coolant of the heat pump 10.

[0026] Once again with reference to the non-limiting example of Figure 1, designated by 14 is a tray for collecting the water produced by condensation of the moisture present in the air of the forced flow F at output from the drum 3. In the example, associated to the tray 14 is a pump 14a, which, via a duct 15, takes the condensation water from the tray 14 to a removable container 16, positioned in the top part of the machine 1. To the container 16 there can be associated an overflow duct, not represented, in communication with the tray 14 itself.

[0027] According to a characteristic of the invention, the machine 1 comprises change-over means, designated as a whole by 20 in Figures 1 and 3, which can be controlled by the control unit 6 for assuming a first operating condition and a second operating condition, in which the heat pump 10 causes heating and cooling, respectively, of the air of the forced flow F. The control unit 6 is provided for controlling the change-over means 20 in order to assume the aforesaid second operating condition following upon selection of at least one of the operating programs, which can be selected via the selection means S.

[0028] In the preferred embodiment of the invention, the heat pump 10 is a reversible heat pump, configured in such a way that:

- when the air of the flow F is to be heated, for example in the course of a typical drying program, the change-over means 20 are in the respective first operating condition, with the heat exchanger 11 that operates as evaporator and the second heat exchanger 12 operates as condenser, whilst
- when the air of the flow F is to be cooled, for example in the course of a program for refreshing the laundry, described hereinafter, the change-over means 20 are in the respective second operating condition, with the heat exchanger 12 that now operates as evaporator and the heat exchanger 11 that operates as condenser.

[0029] In a preferred embodiment of the invention, such as the one illustrated and as will emerge more clearly hereinafter, the ventilation means of the machine are provided for obtaining a unidirectional forced flow in such a way that, in both of the operating conditions of the change-over means 20, the forced flow F of air to be heated or cooled, after leaving the drum 3, passes first through the heat exchanger 11, irrespective of whether the latter at the moment operates as condenser or as evaporator, and subsequently through the heat exchanger 12.

[0030] In one embodiment, and as may be seen in particular in Figures 4 and 5, the change-over means 20 include valve means of the heat pump 10, which preferably comprise a four-way switchable valve 21.

[0031] In its first switching condition (visible in Figure 4), the valve 21 is operative for directing the frigorific fluid of the heat pump 10 from the heat exchanger 11 to the compressor 13, and from the compressor 13 to the heat exchanger 12.

[0032] In this condition, as already explained above, the heat exchanger 11 operates as evaporator, and is cold, whilst the heat exchanger 12 operates as condens-

er, and is hot. The flow of air F leaving the drum 3 reaches the heat exchanger 11, where condensation of the corresponding moisture is produced, and then reaches the heat exchanger 12, for being heated. The condensation water is collected in the tray 14.

[0033] In its second switching condition (visible in Figure 5), the valve 21 is instead operative for directing the frigorific fluid of the heat pump 10 from the heat exchanger 12 to the compressor 13, and from the compressor 13 to the heat exchanger 11.

[0034] In this condition, there is in practice a reversal of the frigorific cycle, as compared to the previous case, with the heat exchanger 11 that operates as condenser, and is hot, whilst the heat exchanger 12 operates as evaporator, and is cold. The flow of air F leaving the drum 3 reaches the heat exchanger 11, where it heats up, and then reaches the heat exchanger 12, for being cooled. In this condition, the air leaving the drum 3 is in any case already relatively cooled air substantially without humidity (as will emerge hereinafter, the program with cold flow F is used for the treatment of dry garments).

[0035] Obviously, the heat pump 10 envisages a line of return of the frigorific fluid between the two exchangers 11 and 12, along which a reduction of pressure of the frigorific fluid must take place. In the example of embodiment, and as illustrated in Figures 3-5, said line comprises a capillary duct, represented schematically by the block 22, within which the reduction of pressure occurs by lamination of the flow. When the valve 21 is in the respective first switching condition, the capillary duct 22 enables flow of the frigorific fluid from the heat exchanger 12 to the heat exchanger 11, as may be seen in Figure 4. Instead, when the valve 21 is in the respective second switching condition, the capillary duct 22 enables flow of the frigorific fluid from the heat exchanger 11 to the heat exchanger 12.

[0036] As mentioned previously, operation of the heat pump 10 to bring about cooling of the air of the forced flow F is exploited for the purposes of execution of a program for refreshing dry laundry, which can be selected via the means S and can be started via the pushbutton R of the user interface. In the course of said refreshing program, the valve 21 is in the condition of Figure 5, and the control system of the machine controls the heat pump 10 for sending and maintaining the air of the forced flow F at a substantially predetermined temperature, preferably between 5°C and 12°C, for example approximately 10°C. In this way, it is possible to cool items of laundry contained in the drum 3 that are already dry.

[0037] The program in question can thus be used to refresh dry garments, for example in order to render them pleasant to wear, for example in the summer, once they have been taken out of the drum 3. The same program, or a similar refreshing program, can be provided for abating the concentration of acari in certain garments or smells of a load of laundry.

[0038] The operating programs, which can be selected via the selection means S, comprise treatment programs that terminate when at least one condition arises, which can be detected by the control system of the machine. As per the known art, the condition or conditions that determine the end of one of said programs may comprise program time and/or temperature of the air of the forced flow and/or rate of humidity of the air of the forced flow or of moisture of the items of laundry. Expiry of the program time can be conveniently measured by the control unit 6, the microcontroller of which is equipped with an internal clock of its own, whilst the temperature of the air and the moisture of the garments can be detected by the unit 6 via purposely provided sensor means of a type in itself known, represented by the blocks 25a and 25b of Figure 1, which form part of the control system. In the example, the moisture of the items of laundry is measured by means of a sensor 25b, for example a conductivity sensor, which operates directly inside the drum so as to come into contact with the garments themselves.

[0039] In one embodiment, the operating programs of the machine comprise at least one program, the end of which is determined by a condition of the door 4. Consequently, for said purpose, the control unit 6 is programmed to bring about the end of said further program following upon the detection of the condition of the door 4 made via sensor means, designated in Figure 1 with 26. The sensor means 26 can, for example comprise, a microswitch, which can switch between a state of closing and a state of opening, which are obtained when the door is closed or open, respectively.

[0040] The operating program, the end of which depends upon the condition of the door 4, can, for example, be the refreshing program referred to above. In this perspective, then, the user can set the dry garment or garments to be refreshed in the drum 3, close the door 4 and, after turning the machine 1 on and selecting the program via the selector S, start the program itself by pressing the pushbutton R. The control unit 6 thus governs the motor 8 in order to bring about rotation of the drum 3 and start of the fan 7, as well as of the heat pump 10, with switching of the valve 21 into the position of Figure 5. The load of the drum 3 is then progressively cooled, until a predetermined temperature is reached, for example approximately 10°C, which can be detected via the sensor means 25a. When said predetermined temperature is reached, the unit 6 controls the heat pump 10 so as to cause, once again with the aid of the sensor 25a, a substantial maintenance of the predetermined temperature. In a preferred embodiment, the predetermined temperature is then maintained up to end of the program.

[0041] Preferably, after the aforesaid temperature has been reached the control system (possibly with pre-set delay time) supplies a warning to the user, for example an indication of an acoustic or visual type. For this purpose, as has been seen previously, the machine 1 can be provided with suitable signaling means, represented in the example of Figure 2 by a buzzer B. Alternatively, or in addition, a signalling of a visual type is possible, exploiting the display D or other suitable warning means,

for example, of a luminous type. The user, thus informed that the program temperature has reached, and consequently that the load has been refreshed, can open the door 4 of the machine when desired, thus determining the end of the program itself, and take out the load. The warning may, for example, be of a continuous or intermittent type.

[0042] In one embodiment, verification of the state of the door 4 that causes the end of the program is activated by the control unit 6 only after the predetermined temperature has been reached. In this way, after start of the program and before the aforesaid temperature is reached, the user has the possibility of suspending the program temporarily by opening the door 4 (for example, for adding one or more garments to be refreshed). Upon reclosing of the door 4, and following upon a restart command by the user, for example by pressing the button R, the program resumes execution, proceeding from the current state at the moment of opening of the door. In this embodiment, then, only opening of the door 4 after a predetermined temperature has been reached causes ending of the program.

[0043] In general terms, the program proceeds, after start of warning for the user, if the door 4 is not opened, with the control unit 6 that governs the heat pump 10 so as to maintain the predetermined temperature of the flow F. In a possible embodiment, the control logic can be configured for terminating the program when a predetermined maximum period of time elapses (for example, measured to starting from start of the program, or from reaching of the predetermined temperature, or from start of the warning for the user). Until expiry of the aforesaid period, in any case, the heat pump 10 and the fan 7 remain operative for maintaining the predetermined temperature of the flow F.

[0044] The operating program the end of which depends upon the condition of the door 4 may also be a program different from the aforesaid refreshing program, such as for example a program for warming dry laundry, which can also be selected via the means S and can be started by pressing the pushbutton R of the user interface 5. In the course of said warming program, the valve 21 is in the condition of Figure 4, and the control system of the machine governs the heat pump 10 in order to bring and maintain the air of the forced flow F to a temperature substantially of between 34°C and 38°C, for example approximately 36°C. The this way, it is possible to warm the items of laundry that are already dry introduced into the drum 3 or render them tepid. The program in question can hence be used, for example, for bringing certain garments up to body temperature, in order to render them pleasant to wear, such as, for example, in the case of a bathrobe to wear after a bath or a shower. The same program, or a similar warming program, can be envisaged for warming particular garments are worn during fitness session for slimming purposes because they increase perspiration (for example, neoprene garments that, if heated before being worn, accentuate their function).

[0045] Execution of such a warming program is basically performed in a way similar to what has been described above with reference to the refreshing program, obviously taking into account that the air of the flow F is in this case heated. Hence, in the course of the program, the control unit 6 governs the heat pump 10, with switching of the valve 21 into the position of Figure 4, so as to warm the load of the drum 3 progressively, in a substantially monotonic/linear way, until a predetermined temperature is reached, for example approximately 36°C, which can be detected via the sensor means 25a. When said predetermined temperature is reached, the unit 6 controls the heat pump 10 and the fan 7 so as to cause a substantial maintenance of the temperature thus reached. Also in this case, preferably, the control system issues the warning that the predetermined temperature has been reached, for example via the buzzer B. The user, thus warned that the load has been warmed, can open the door 4, so bringing about end of the program, and take out the load. Also in relation to the warming program, the control logic can be configured in such a way that the end of the program occurs upon opening of the door 4 after the predetermined temperature is reached or else, if the door is not opened, upon expiry of a predetermined maximum period of time, measured starting from start of the program, or from reaching of the predetermined temperature, or from start of the warning for the user.

[0046] It should be emphasized that, in the course of the refreshing program or of the warming program referred to above, the control system of the machine monitors, via the sensor means 25a, just the temperature of the air of the forced flow F, without monitoring humidity: what is important, in fact, for the purposes of warming or refreshing of the garments to be warn, is the fact that the pre-defined temperature is reached, which must preferably be maintained util the user brings about end of cycle by opening the door 4.

[0047] It should moreover be recalled that the typical operating programs envisaged for drying laundry, here including the drying programs that can be executed by the machine 1, envisage one or more steps in which the air is heated and forced through the drum 3 in order to dry the laundry, and at least one final step, substantially a cooling step, in the course of which the means for heating the air are inactive and the ventilation means are, instead, active. This final cooling step of a drying cycle is carried out mainly because, below a threshold of absolute humidity, it becomes more advantageous to work by reducing the temperature, in order to have a higher relative humidity and favour condensation. In practice, in a typical drying cycle, the temperature of the air is brought up to a value of stability or else to a predetermined value, which is then maintained via thermostatting for a certain time, considering that when the garments are almost dry the temperature starts to rise. The program, before terminating, carries out the aforesaid final cooling step.

[0048] According to a preferential characteristic, instead, in the course of the program for warming dry laundry described above, the aforesaid final cooling step is absent: this precisely owing to the fact that the ultimate purpose is to take out the garments warmed to a substantially predetermined temperature.

[0049] From the description provided, the characteristics of the present invention emerge clearly, as likewise its advantages.

[0050] The fact that, according to the invention, the frigorific cycle of the heat pump can be reversed enables enhancement of the functions of the machine, to the evident benefit of the users, who can take advantage of new useful programs, such as the refreshing program described previously.

[0051] The use of a heat pump of a reversible type is particularly advantageous in view of the fact that it enables implementation in a simple and economic way of both the aforesaid refreshing program and the traditional drying programs (as well as, in an advantageous embodiment, the aforesaid warming program).

[0052] The fact that, in one advantageous embodiment, the end of one or more programs can be determined by mere opening of the door of the machine, enables reaching and maintenance of predetermined treatment conditions up to any desired instant, not pre-determined by the machine, but determined by an action of the user. In other words, a substantial advantage is that the desired final condition for the garments (heating or cooling to a certain temperature) is maintained until the user intervenes directly on the machine by opening its door: instead, in the case where the program were to terminate at a predetermined time, or when a certain temperature is reached, the effectiveness of the treatment would be markedly reduced if the user were to take out the garments from the machine after some delay). A correlated advantage is the optimization of the duration of the program, and consequently of its energy consumption, which is adapted to the effective needs of the user: this is obtained with the minimum of interactions required from the user, limiting said interactions to opening of the door (which is an action in any case necessary to take out the load of laundry).

[0053] It is clear that numerous variations may be made by the person skilled in the sector to the laundry-drier machine described by way example, without thereby departing from the scope of the invention as defined in the annexed claims.

[0054] In the examples of embodiment described previously, the treatment temperature for the refreshing program (and for the possible warming program) is a temperature pre-defined by the program. In possible variant embodiments, it is possible to equip the user interface of the machine with a purposely provided selector, of a type in itself known, for enabling the user to set a desired temperature within the range of possible temperatures.

[0055] The invention may, of course, be applied also to machines for washing and drying laundry, by introducing arrangements that are evident for the person skilled in the art, taking into account that in this case the laundry drum turns inside a tank.

Claims

1. A machine for drying laundry, having a cabinet (2) within which a rotatable laundry drum (3) is housed, the drum (3) being accessible by a user through a door (4) of the machine (1), the machine comprising:

   - ventilation means (7), adapted for generating a forced flow of air (F), the ventilation means including one fan,
   - heating means, adapted for heating air of the forced flow (F), the heating means including one heat pump (10) having one first heat exchanger (11), one second heat exchanger (12) and one compressor (13) operatively arranged between the first and the second heat exchanger (11, 12),
   - a control system (5, 6, 25a, 25b, 26) including a control unit (6), prearranged for controlling execution of a plurality of operating programs of the machine; and a user interface (5), having selection means (S) for selecting a desired operating program among the said plurality of operating programs,

   the machine (1) being **characterized by** further comprising change-over means (20), controllable by the control unit (6) to take on one first operating condition and one second operating condition, for obtaining from the heat pump (10) heating or cooling of air of the forced flow (F), respectively, and in that the control unit (6) is prearranged for controlling the change-over means (20) to take on the second operating condition as a result of the selection of at least one first program of said plurality of operating programs, the at least one first program being selectable through the selection means (S).

2. The machine according to claim 1, wherein the heat pump is a reversible heat pump (10) and

   - in the first operating condition of the change-over means (20), the first heat exchanger (11) operates as an evaporator and the second heat exchanger (12) operates as a condenser, and
   - in the second operating condition of the change-over means (20), the first heat exchanger (11) operates as a condenser and the second heat exchanger (12) operates as an evaporator.

3. The machine according to claim 2, wherein the ventilation means (7) are prearranged for generating a unidirectional forced flow, in such a way that, in both the operating conditions of the change-over means

(20) the forced flow (F) of air to be heated or cooled, respectively, after exiting the drum (3) passes first through the first heat exchanger (11) and then through the second heat exchanger (12) of the heat pump (10).

4. The machine according to claim 2 or 3, wherein the change-over means (20) include valve means (21) of the heat pump (10), switchable by the control unit (6) between one first and one second switching condition, and wherein:

- in the first switching condition the valve means (21) are operative for addressing a work fluid, or refrigerant, of the heat pump (10) from the first heat exchanger (11) to the compressor (13) and from the compressor (13) to the second heat exchanger (12), and
- in the second switching condition the valve means (21) are operative for addressing the work fluid of the heat pump (10) from the second heat exchanger (12) to the compressor (13) and from the compressor (13) to the first heat exchanger (11).

5. The machine according to claim 4, wherein the valve means comprise a four-way valve (21).

6. The machine according to claim 4 or 5, wherein the heat pump (10) also comprises a return line (22) of the flow of the work fluid of the heat pump (10), arranged for allowing:

- a flow of the work fluid from the second heat exchanger (12) to the first heat exchanger (11), when the valve means (21) are in the respective first switching condition, and
- a flow of the work fluid from the first heat exchanger (11) to the second heat exchanger (12), when the valve means (21) are in the respective second switching condition.

7. The machine according to claim 6, wherein the return line (22) comprises at least one capillary duct adapted to cause lamination of the work fluid of the heat pump (10).

8. The machine according to claim 1, wherein the plurality of operating programs comprises at least one of:

- a program for heating dry laundry, during which the change-over means (20) are in the respective first condition, the control system (5, 6, 25a, 25b, 26) being in particular configured for bringing the air of the forced flow (F) to, and then maintaining it at, a temperature substantially comprised between 34 and 38 °C during the program for heating dry laundry,
- a program for cooling dry laundry, during which the change-over means (20) are in the respective second condition, the control system (5, 6, 25a, 25b, 26) being in particular configured for bringing the air of the forced flow (F) to, and then maintaining it at, a temperature substantially comprised between 5 and 12 °C during the program for cooling dry laundry.

9. The machine according to claim 8, wherein

- the plurality of operating programs comprises operating programs which end upon achievement of a condition detectable by the control system (5, 6, 25a, 25b, 26);
- the control system (5, 6, 25a, 25b, 26) is prearranged for causing ending of at least one said operating program as a result of the detection of a condition of the door (4) of the machine (1), carried out through sensor means (26),

wherein the said at least one operating program comprises at least one of the program for heating dry laundry and the program for cooling dry laundry.

10. The machine according to claim 9, wherein the control system (5, 6, 25a, 25b, 26) is prearranged for

- counting time, and
- upon expiry of a predetermined time period, causing ending of the said at least one operating program,

the control system (5, 6, 25a, 25b, 26) being in particular prearranged for maintaining air of the forced flow (F) at a substantially predetermined temperature until expiry of the above said predetermined time period.

11. The machine according to claim 8, wherein

- the plurality of operating programs comprises laundry treatment programs during which the change-over means (20) are in the respective first condition, for causing heating of air of the forced flow (F), with the ventilation means (7) being active for forcing air heated by the heat pump (10) through the drum (3), said treatment programs including a final step during which the heat pump (10) is inactive and the ventilation means (7) are active, and
- during the program for heating dry laundry the said final step is absent.

12. The machine according to one of the preceding claims, wherein the control system (5, 6, 25a, 25b, 26) comprises signaling means (B, D), for signaling achievement of a determined temperature of air of

the forced flow (F), the signaling means (B, D) comprising in particular at least one of acoustic signaling means (B) and visual signaling means (D).

13. A method for controlling operation of a machine for drying laundry, wherein during at least one first operating program of the machine (1) air of a forced flow (F) is heated by means of a heat pump (10) which includes one first heat exchanger (11), one second heat exchanger (12) and one compressor (13) operatively arranged between the first and the second heat exchanger (11, 12), and wherein during at least one second operating program the heat pump (10) is used for obtaining cooling of air of a forced flow (F).

14. The method according to claim 13, wherein

- during the at least one first operating program the first heat exchanger (11) operates as an evaporator and the second heat exchanger (12) operates as a condenser,
- during the at least one second operating program the first heat exchanger (11) operates as a condenser and the second heat exchanger (12) operates as an evaporator,
- the forced flow (F) is a unidirectional flow, i.e. during the at least one first operating program and during the at least one second operating program the forced flow (F) of air to be heated or cooled, respectively, after exiting the drum (3) passes first through the first heat exchanger (11) and then through the second heat exchanger (12) of the heat pump (10).

15. The method according to claim 13 or 14, wherein

- the at least one first operating program comprises a program for heating dry laundry, particularly during which air of the forced flow (F) is brought to, and then maintained at, a temperature substantially comprised between 34 and 38 °C, and/or
- the at least one second operating program comprises a program for cooling dry laundry, particularly during which air of the forced flow (F) is brought to, and then maintained at, a temperature substantially comprised between 5 and 12°C.

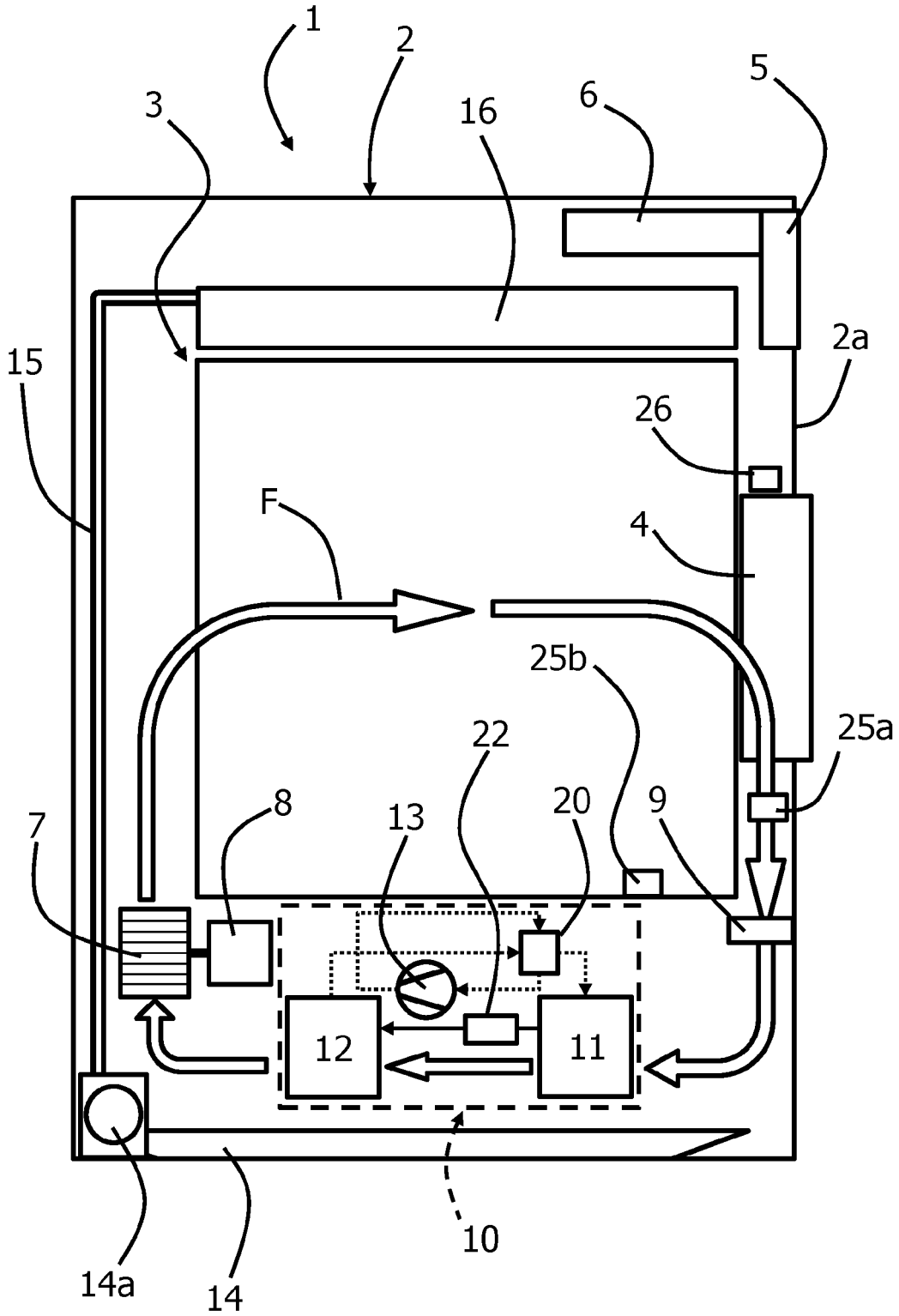


Fig. 1

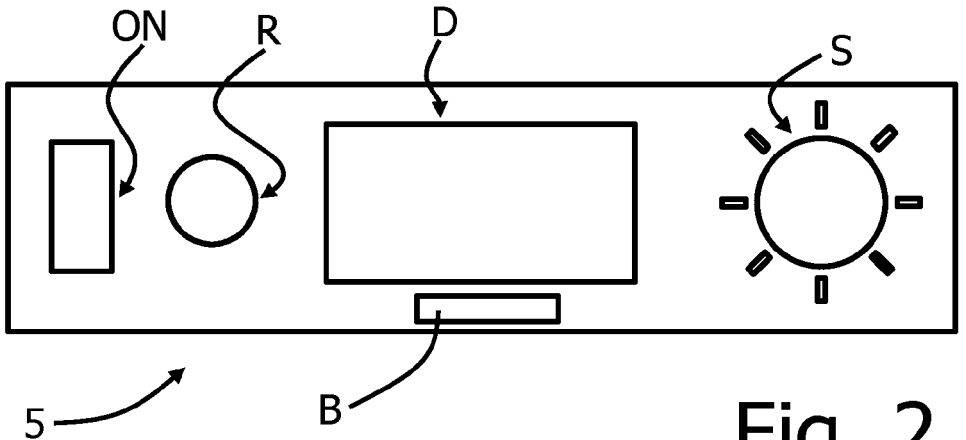


Fig. 2

Fig. 3

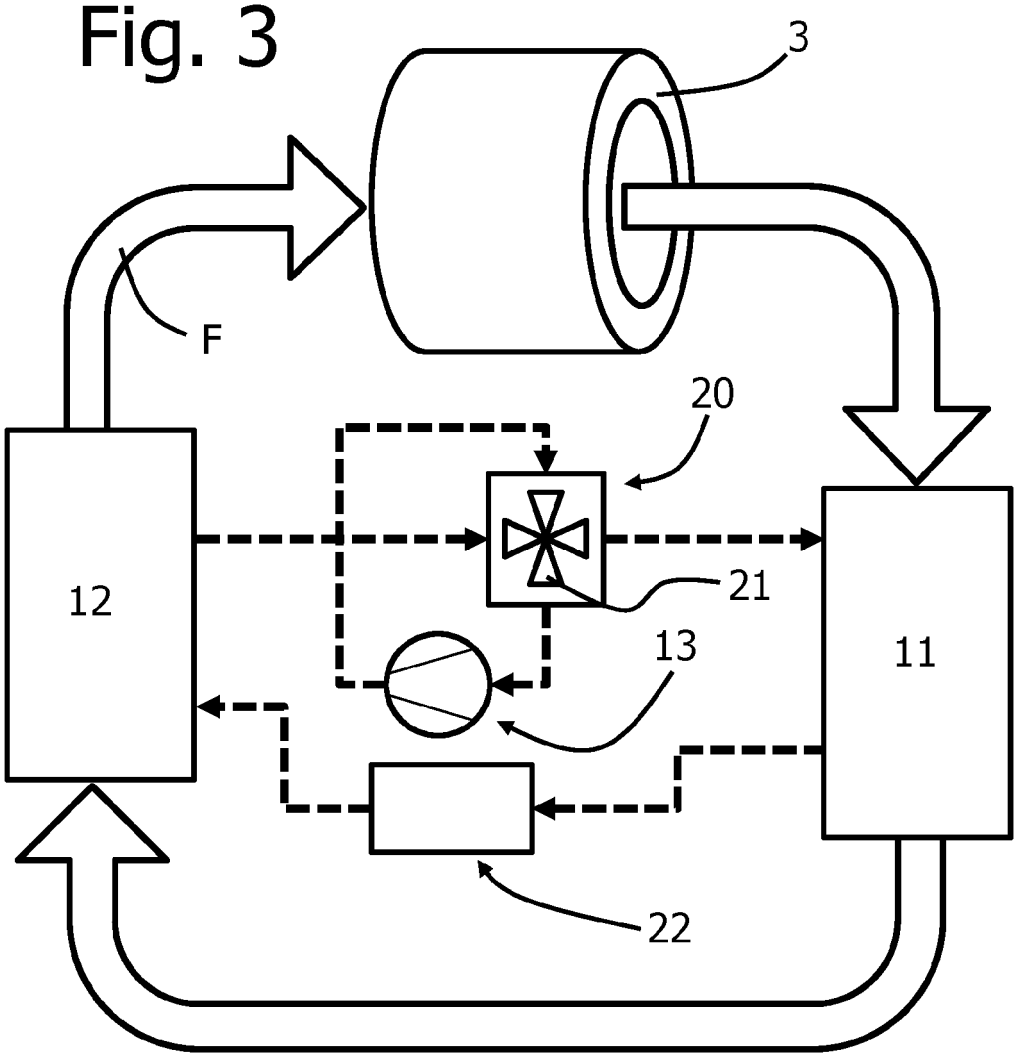


Fig. 4

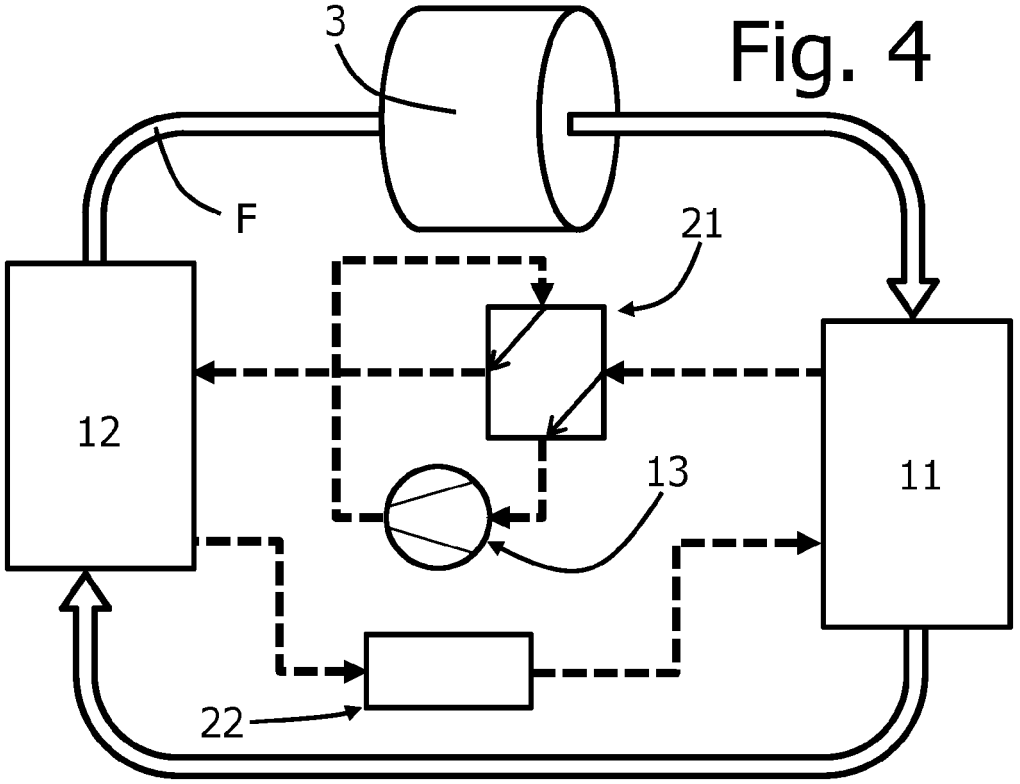
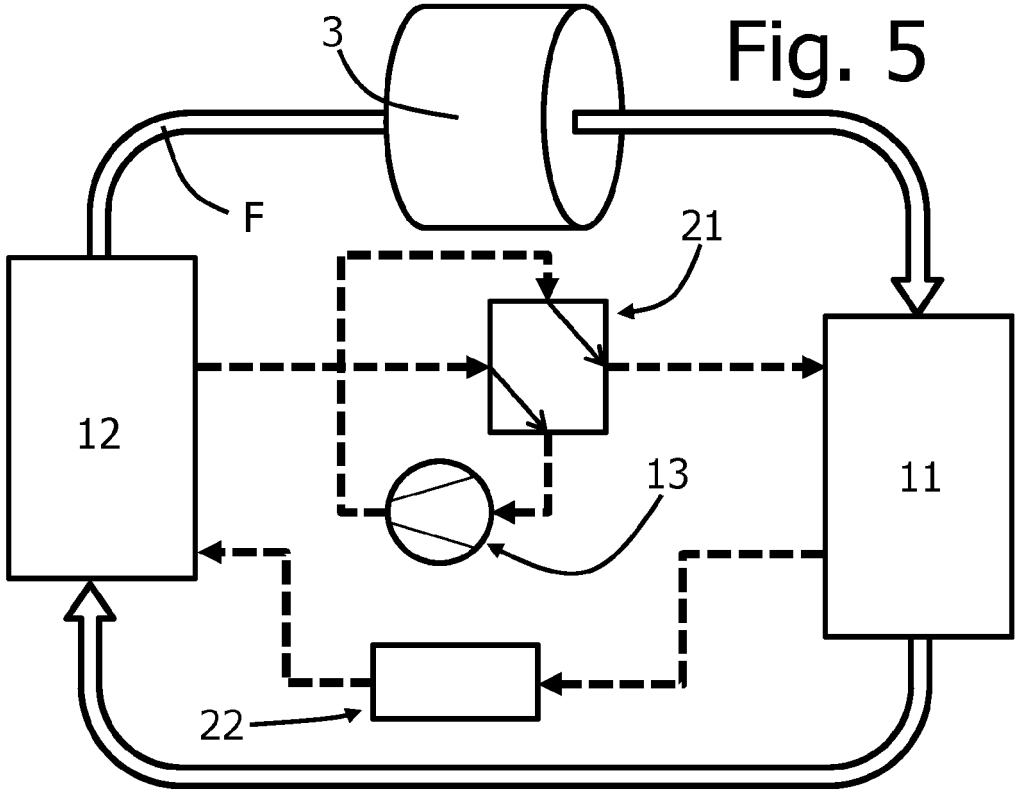


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 11 19 4391

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 April 2012	Clivio, Eugenio

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