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(54) **Household clothes drying machine with compact motor**

(57) Condenser-type clothes drying machine comprising: a rotating drum (1), a first duct (2) adapted to circulate, with the help of a first fan (4), a first flow of heated-up air through the drum (1) and an appropriately provided condenser (3), a second duct (5) adapted to circulate, with the help of a second fan (6), a second flow of cooling air through the condenser (3), wherein the first and second fans and the rotating drum are rotatably driven by two coaxially arranged electric motors (7,8); the first electric motor (7) rotatably drives a respective first shaft (9) that is provided with two opposite end portions

carrying two separate motion-transmission means, such as two pulleys (12,13) and respective belts. The second electric motor (8) is arranged between said first electric motor (7) and an end portion of said first shaft (9), and is provided with a respective second shaft (14) in the form of a cylindrical hollow sleeve, inside which said first shaft (9) is housed, and to which there is press-fitted or shrink-fitted a third pulley (15). The two motors (7,8) are housed within a single and same housing (20), and said two electric motors are independently controllable permanent-magnet motors.

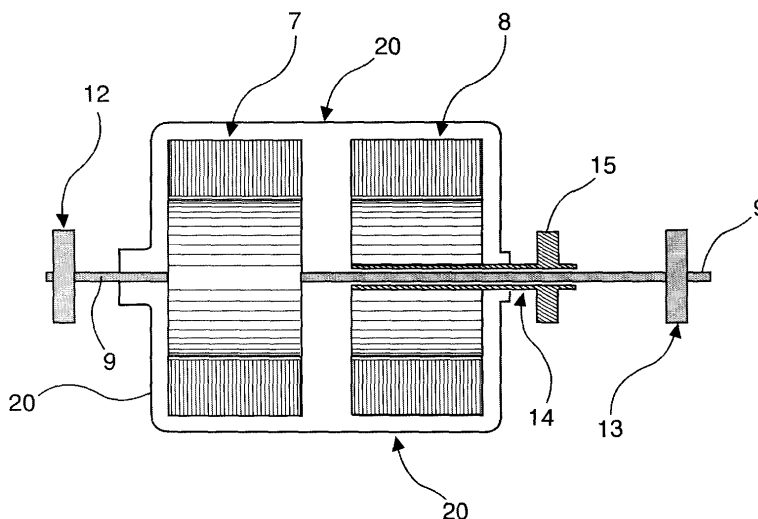


FIG 5

Description

[0001] The present invention refers to an improved kind of clothes drying machine, both of the front-loading and the top-loading type, as well as of the condenser type, provided with a rotating drum and a drive motor to rotatably drive said rotating drum, and further provided with blower means, or fans, for forcedly circulating air in respective drying and condenser cooling ducts, wherein said drying machine is particularly compact in size, and wherein said two fans and said rotating drum are capable to be driven to independently rotate at different speeds that bear no correlation with each other.

[0002] Household condenser-type clothes drying machines are largely known in the art to have to be provided with means needed to rotatably drive both fans used to circulate air in the drying circuit and the condenser-cooling circuit, as well as - of course - to rotatably drive in a selective manner also the rotating drum in which the items to be dried are tumbled.

[0003] In manufacturing this kind of clothes drying appliances, use has normally been made since the beginning of a first electric motor to drive said two fans, and a second electric motor to rotatably drive the drum.

[0004] However, such solution - while functionally effective - proved soon quite expensive and demanding from a construction and manufacturing point of view, owing mainly to the need for two distinct, either asynchronous or induction, i.e. inherently rather expensive electric motors to be provided.

[0005] Furthermore, installing such two motors inside a standard-type household clothes drying machine gives rise to a number of rather tricky mounting problems, since such two motors are rather bulky and, as a result, design engineers have to go to extremes in trying to make the best out of the generally scanty space available inside this kind of appliances.

[0006] A measure that has in the meanwhile been taken in the art in view of solving this particular problem lies in the use of a single electric drive motor for linking to both the driven pulleys of the two distinct fans and the driven pulley of the drum.

[0007] Such solution, which is certainly an optimum one from a purely construction point of view, has however a number of hardly surmountable drawbacks from a functional point of view, i.e.:

a) in the first place, the rotating speeds of the two fans and the rotating drum become rigidly correlated with each other, owing to such components being in fact rigidly connected mechanically to such single driving motor; as a result, since the rotating speed of the drum (approx. 55 rpm) must be kept substantially constant, it practically ensues that even the flow rates of the air in the drying and condenser-cooling circuits become constant, although it would quite on the contrary be appropriate and fully desirable for the flow rates of the air in said circuits to be able to

be varied - even to quite an appreciable extent - in accordance with and during the various steps through which a drying cycle is progressing;

b) in addition, when the direction of rotation of the drum is cyclically reversed, the same drum is caused to stop for a short time and this quite obviously also causes the air in the two circuits to be stopped from flowing; owing to safety reasons - which anyone skilled in the art is well aware of - even the heating elements used to heat up the drying air require to be de-energized during these reversal periods, and such need does of course not fail to introduce a number of construction and manufacturing complications, along with a corresponding reduction in the overall reliability of the appliance due to the need for power at line voltage to be frequently and repeatedly switched off and on during a drying cycle.

[0008] It would therefore be desirable, and it is actually a main object of the present invention, to provide a condenser-type clothes drying machine, which is adapted to operate in a selectively controllable manner as far as both the rotating speed and the direction of rotation of the drum and the rotating speed, and therefore also the related air flow rates, of the two fans of the drying and condenser-cooling circuits are concerned, wherein such clothes drying machine shall be at the same time capable of being provided by doing away with the drawbacks generally encountered in the prior art, where use is made of two bulky motors taking up two respective, distinct large spaces within the appliance.

[0009] According to the present invention, these aims are reached in a particular kind of clothes drying machine, which may be of both the front-loading and the top-loading type, as well as of the inclined-axis type, and which is provided with two motors for distinctly driving the rotating drum and the two fans provided in the respective drying and condenser-cooling circuits, as described below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a symbolical view of the drum and the functionally most important circuits of a drying machine according to the prior art;
- Figure 2 is a schematical view of the drum and the two distinct drying and condenser-cooling air circuits, as well as the drum rotation driving arrangement, in a clothes drying machine according to the present invention;
- Figure 3 is a median sectional view through the axis of the motors of the two electric motors and the related mechanical connections in a clothes drying machine according to the present invention;
- Figure 4 is a median sectional view of the assembly of the two electric motors shown in Figure 3,

in an improved embodiment of the present invention;

- Figure 5 is a median sectional view of the assembly of the two electric motors shown in Figure 4, in a further improved embodiment of the present invention;
- Figure 6 is a schematical view of the drum and the two distinct drying and condenser-cooling air circuits, with distinct driving means for the rotating drum and the two fans, according to an improved embodiment of the present invention;
- Figure 7 is a median sectional view through the axis of the motors of the three electric motors and the related mechanical connections in the machine that is represented schematically in Figure 6.

[0010] With reference to Figures 1 and 2, a clothes drying machine according to the present invention comprises a rotating drum 1, a first drying-air duct 2 circulating a flow of hot air through said drum and collecting the hot moisture-laden air exiting the drum to convey it through a condenser 3, from which said flow of air is sent again - upon being heated up anew by the heating elements 14 - into the drum 1; it further comprises a first fan 4 provided to forcedly circulate a flow of air in and through said first duct 2, a second duct 5 that takes air in from the outside and conveys it - by the action of an appropriately provided second fan 6 - into and through said condenser 3, from which this flow of cooling air is eventually exhausted outside.

[0011] With reference to Figures 2 and 3, to rotatably drive said two fans and said rotating drum there are provided two electric motors, which are arranged and connected as described below.

[0012] Basically, said two motors 7, 8 are arranged coaxially, and a first motor 7 is adapted to rotatably drive the respective first shaft 9, which extends through said first motor 7, and whose two end portions 10, 11 are arranged on the opposite sides of said motor.

[0013] To said two shaft end portions there are applied two respective pulleys 12, 13, round which there are passing respective driving belts (not shown).

[0014] Of course, depending on or according to also the actual physical configuration of the various parts and members of the machine, as well as the location or arrangement thereof, it will at this point be also possible and/or advantageous for the two fans 4 and 6 not to be connected to respective belts passing round and driving said pulleys 12 and 13, but rather shrink-fitted or press-fitted on to said first shaft 9; this. However, is a solution that represents a technical equivalent and falls outside the actual scope of the present invention, so that said pulleys 12 and 13 will be further referred to as general means for transmitting the rotational motion to the two fans 4 and 6 throughout the following description.

[0015] The second electric motor 8 is arranged be-

tween said first motor 7 and an end portion 11 of said first shaft 9, wherein said second motor 8 is provided with a respective second shaft 14 made in the form of a hollow cylinder and so sized as to be able to contain said first shaft therewithin.

[0016] These two shafts are not engaging each other, nor they are in contact with each other, so that each shaft is able to freely rotate independently of each other.

[0017] A third pulley 15 is applied on to the second shaft 14.

[0018] With reference to Figure 4, in view of keeping outer dimensions as compact as possible, said third pulley 15 is located on the section of said second shaft lying on the side that is opposite to the one where the first motor is located - of course, with respect to said second motor.

[0019] The possibility is given in this way for said two motors to be brought as close as possible to each other, thereby ensuring a first achievement of the present invention.

[0020] A most advantageous improvement of the invention comprises providing the inventive clothes drying machine with suitable control and actuation means (not shown, owing to them being largely known as such in the art), which are adapted to act on said two motors in an independent manner.

[0021] Since the two fans can be rotatably driven in a synchronized manner at mutually correlated speeds, each one of them is connected, preferably via driving belts or similar means of a *per se* known type, to a respective one of said two pulleys 12, 13 fitted on to said first shaft 7; on the contrary, the rotating drum 1 is connected - again via *per se* known means - to said third pulley 15.

[0022] In this way, said two motors may be controlled and rotatably driven in a manner that is fully independent of each other, and - most obviously - this enables not only the rotating speed of said two fans to be varied in a fully independent manner with respect to the rotating speed of the drum, but also the drum to be driven to rotate in the two opposite directions, while keeping the direction of rotation of the fans unaltered. It can therefore be most readily appreciated that the possibility is given in this way for the direction of rotation of the drum to be reversed without the power supply to the heating elements having to be at the same time cut off, since the flow of drying air is in fact able to independently go on uninterruptedly, along with the flow of condenser-cooling air, thereby practically reaching a second aim of the present invention.

[0023] These advantages of the present invention may be still further enhanced to an appreciable extent if said two motors 7 and 8 are permanent-magnet motors, which are largely known to be very compact and to require a considerably smaller mounting space as compared with the motors that are traditionally used in this kind of applications.

[0024] In this way, and with particular reference to Fig-

ure 5, both said motors can be accommodated and supported together within a same and single housing 20 that has typically the same overall size, and therefore takes up the same mounting space, as just a single one of the two traditional asynchronous or induction motors that are used in prior-art clothes drying machines.

[0025] It can therefore be readily noticed and appreciated that the combination of some of the afore-described features of the invention and, in particular, the combination of such features as:

- a single housing 20,
- two permanent-magnet motors accommodated and supported within said single and same housing,
- the coaxial arrangement of said two motors enabling them to be mounted within said single and same housing,
- the provision of the shaft of one of said motors in the form of a hollow sleeve enabling the other shaft to pass through it, thereby enabling said two motors to be mounted in a juxtaposed arrangement and, as a result, taking up the smallest possible space, makes it possible for a clothes drying machine to be ultimately embodied, which is optimized as far as both the size of and the space occupied by the two internal motors and the overall functional flexibility thereof are concerned.

[0026] With reference now to Figures 6 and 7, a further improved embodiment of the present invention comprises taking advantage of the compact size and low space requirements of permanent-magnet motors in view of accommodating in said single and same housing 20 not the fan driving motor 7 and the drum driving motor 8, but rather three distinct motors, i.e. a first motor 7A, a second motor 7B, and a third motor 8 that operates to drive the rotating drum as in the afore-considered embodiment.

[0027] For reasons of greater simplicity and clarity, the same reference numerals as in the previous Figures have been used - wherever this has proved possible - in Figures 6 and 7 to indicate similar parts and details.

[0028] In practice, the motor 7 is split up into two separate motors 7A and 7B, respectively, which are independently linked to respective ones of said two fans 4 and 6 via respective mechanically unconnected shafts 9 and 9A.

[0029] With such solution, owing to said three distinct motors 7A, 7B and 8 being of course capable of being controlled and rotatably driven independently of each other, the ultimate result can be obtained of being able to also control - in a similarly independent manner - the rotating speed of the fans relative to each other, i.e. a possibility that proves particularly valuable in some specific steps during the drying cycle, such as for instance during the initial phase thereof, when the fan of the condenser-cooling air circuit may be driven to operate at a much slower rotating speed, or even kept at a standstill, without any loss in performance, but with an improvement

as far as quietness and energy usage are concerned.

Claims

1. Household condenser-type clothes drying machine, both of the front-loading and the top-loading type, comprising:

- a rotating drum (1),
- a first duct (2) adapted to enable a first flow of heated-up air to be circulated in a closed-loop flowpath through said drum and through an appropriately provided condenser (3),
- a first fan (4) adapted to circulate said first flow of heated-up air along said first duct,
- a second duct (5) adapted to enable a respective second flow of ambient or cooled-down air to be circulated through said condenser (3),
- a second fan (6) adapted to circulate said second flow of air along said second duct,
- said first fan, said second fan and said rotating drum (1) being rotatably driven by appropriate driving means,

characterized in that said driving means comprise:

- two distinct electric motors (7, 8) in a substantially coaxial arrangement (X),
- in which a first electric motor (7) rotatably drives a respective first shaft (9) that is provided with two end portions, one (10) of said end portions lying on a side of said motor and the other one (11) on the opposite side thereof,
- two separate motion-transmission means, preferably comprised of two pulleys (12, 13) and respective belts, engaging respective ones of said two end portions (10, 11) of said first shaft (9),
- in which the second electric motor (8) is arranged between said first electric motor (7) and an end portion (11) of said first shaft (9),
- in which said second electric motor (8) is provided with a respective second shaft (14) in the form of a cylindrical hollow sleeve, inside which said first shaft is housed,
- in which on a side of said second hollow shaft (14) there is provided a related motion-transmission means that may include a related third pulley (15).

2. Household clothes drying machine according to the preamble of claim 1, **characterized in that** said driving means comprise:

- three distinct electric motors (7A, 7B, 8) in a substantially coaxial arrangement (X),
- in which a first electric motor (7A) rotatably

- drives a respective first shaft (9) that is provided with motion-transmission means (13) connected to a first fan,
- in which the third electric motor (8) is provided with a respective third shaft (14) in the form of a cylindrical hollow sleeve, said first shaft (9) being accommodated therewithin,
 - in which the second electric motor (7B) is provided with a respective second shaft (9A), which is positioned on the opposite side of said first shaft (9) and is in turn provided with respective motion-transmission means (12) at an end portion thereof, said second electric motor being in turn positioned on the opposite side of said first electric motor (7A) relative to said third motor (8),
 - in which on to a side of said third hollow shaft (14) there is shrink-fitted or press-fitted a third pulley (15).
3. Clothes drying machine according to claim 1, **characterized in that** said third pulley (15) is press-fitted on to the side of said second hollow shaft on the opposite side of said first motor relative to said second motor.
 4. Clothes drying machine according to claim 1 or 2, **characterized in that** each one of said two motion-transmission means (12, 13) of said first shaft is connected to a respective one of said first and second fans (4, 6), and **in that** said third pulley (15) is connected to means transmitting rotary motion to said rotating drum (1).
 5. Clothes drying machine according to claim 1, 3 or 4, **characterized in that** there is provided a single housing (20) accommodating both said electric motors (7, 8), said first shaft (9) and said second shaft (14) in the form of a hollow sleeve protruding outwards therefrom.
 6. Clothes drying machine according to claim 2, 3 or 4, **characterized in that** there is provided a single housing (20) accommodating all of said three electric motors (7A, 7B, 8), said first shaft (9), said second shaft (9A) and said third shaft (14) in the form of a hollow sleeve protruding outwards therefrom.
 7. Clothes drying machine according to any of the preceding claims, **characterized in that** said electric motors are permanent-magnet motors.
 8. Clothes drying machine according to any of the preceding claims, **characterized in that** it is provided with control means that are adapted to operatively control said electric motors in a manner that is fully independent of each other.

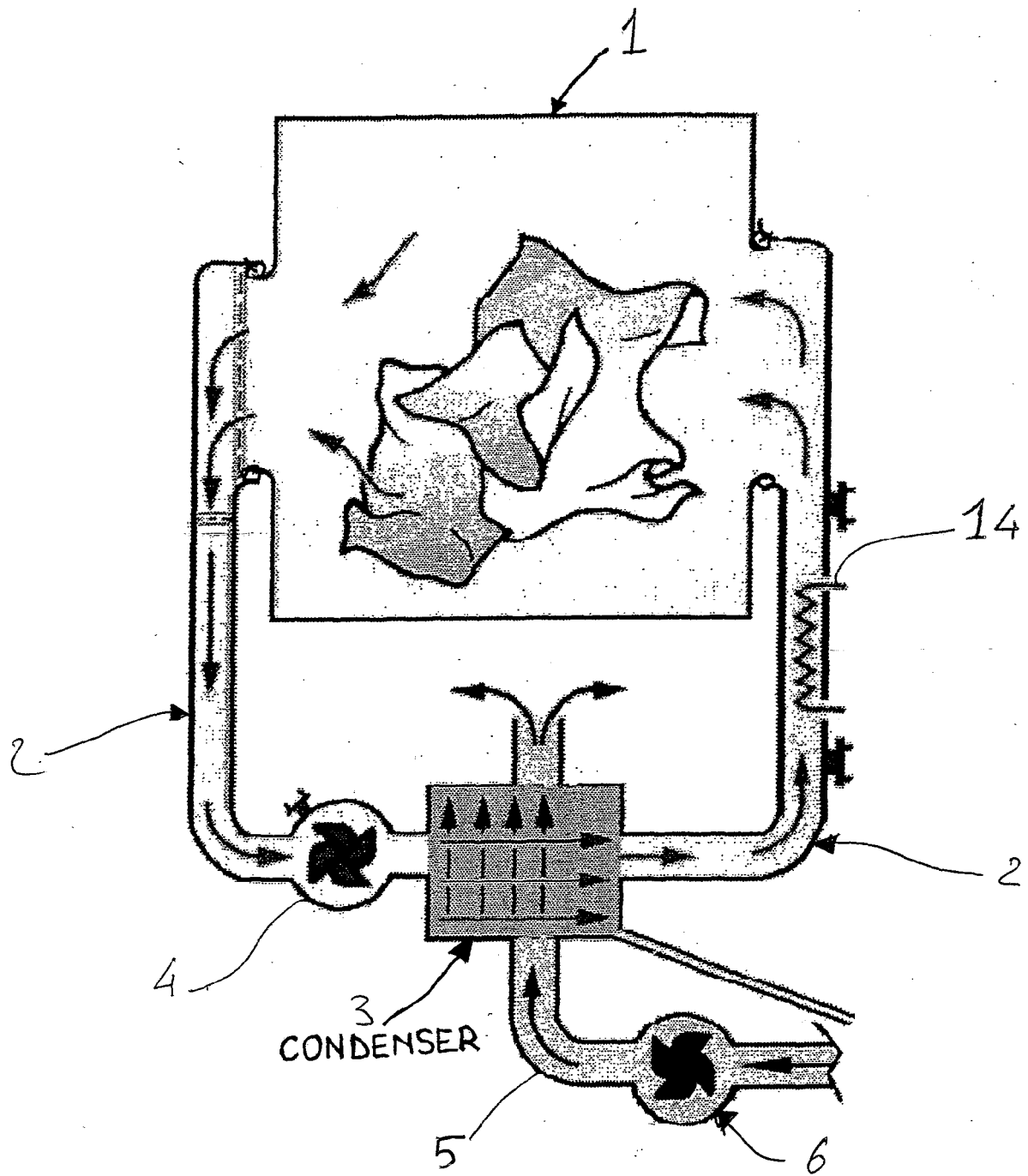


FIG. 1

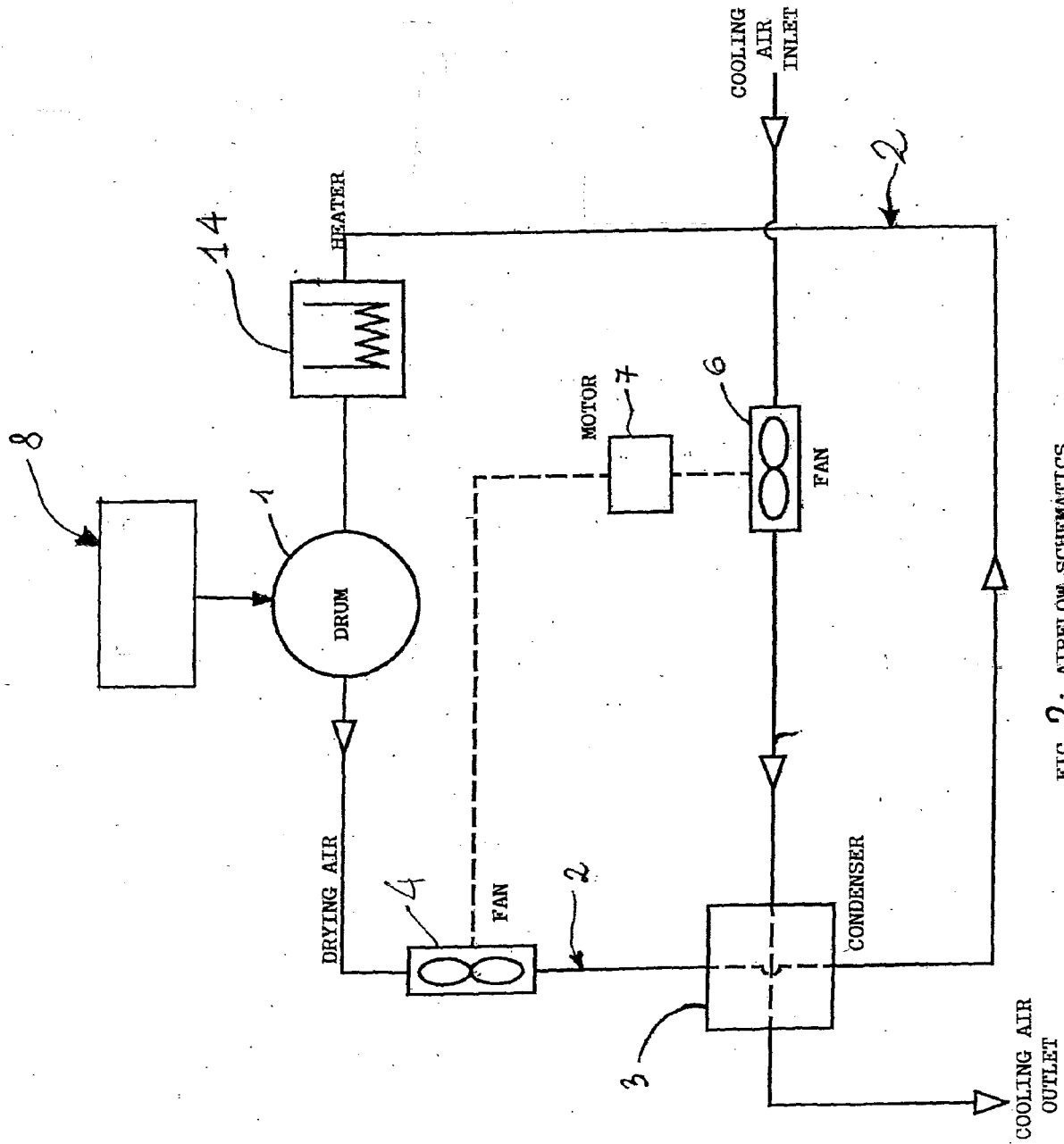


FIG. 2: AIRFLOW SCHEMATICS

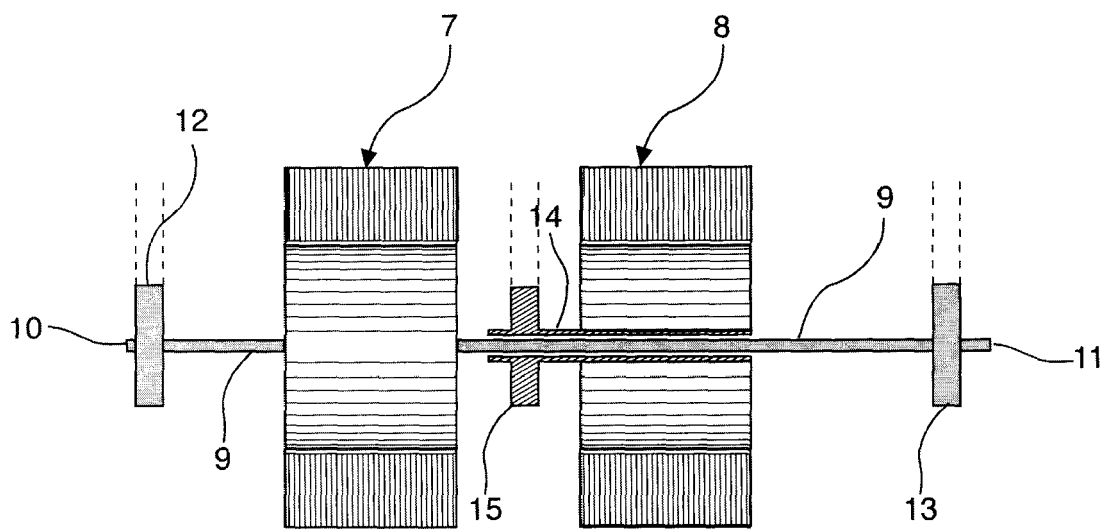


FIG 3

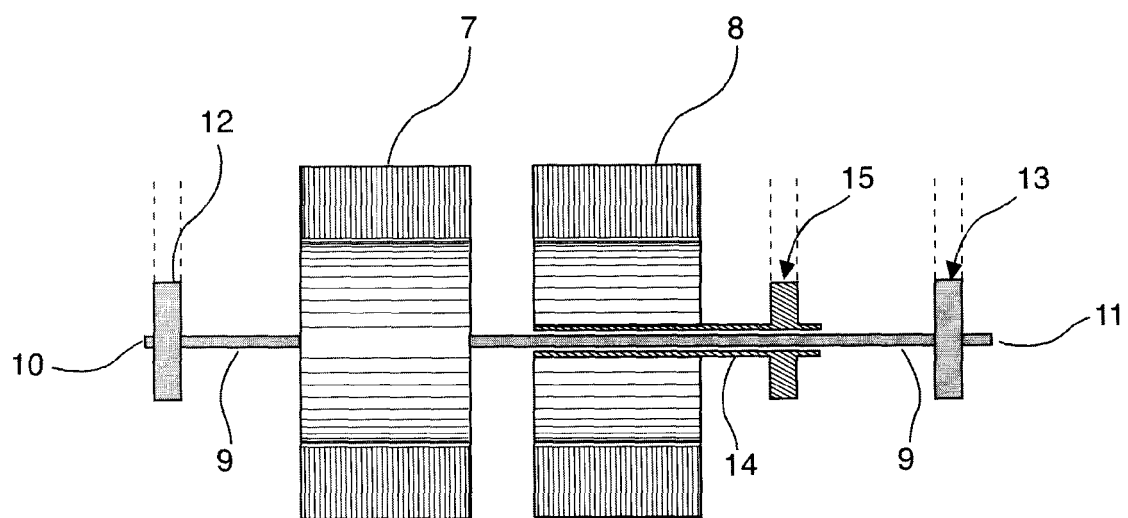
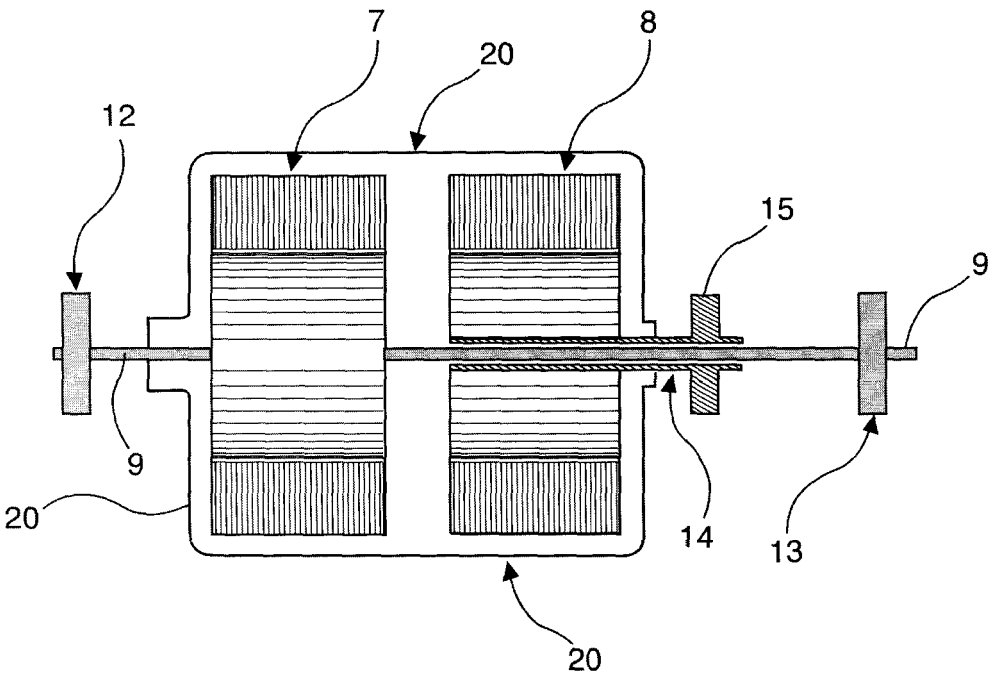


FIG 4



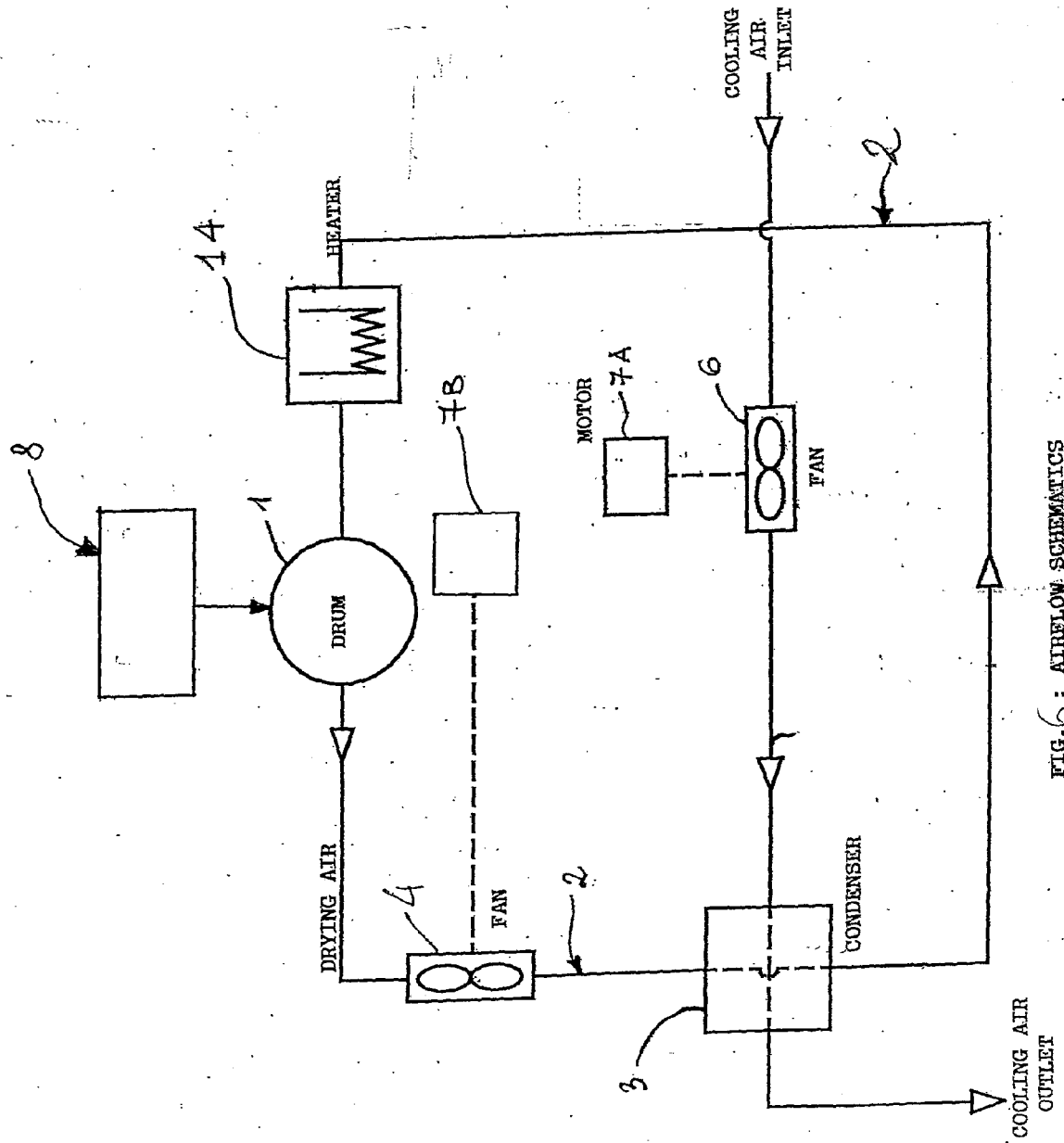
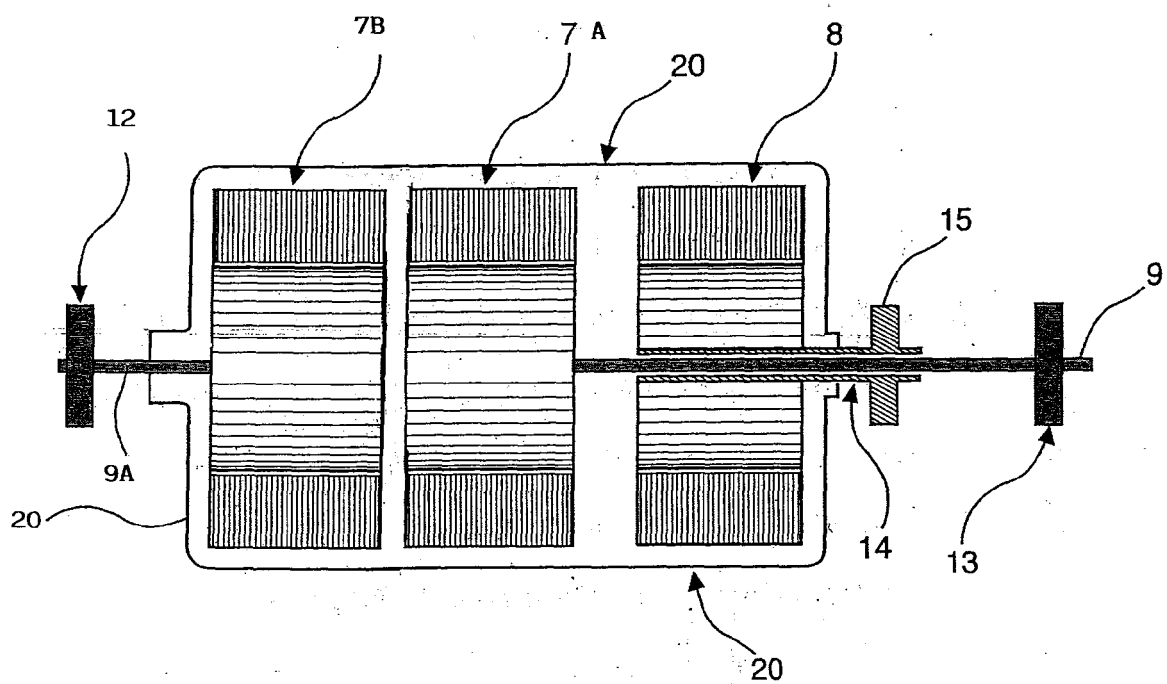


FIG. 6: AIRFLOW SCHEMATICS





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 11 4546

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) D06F
Place of search Munich		Date of completion of the search 19 October 2006	Examiner FALKENTOFT, C
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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