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**I-33170 Pordenone (IT)**(54) **Energy-saving clothes drier.**

(57) Clothes drying machine comprising a rotating drum (2) that is crossed by a flow of air taken in by at least a blower (5) and heated before being blown into said drum by at least a heating element (7) to return to said blower (5) through said drum and at least a condenser means (3), said air flowing through an adjustable air-flow diverter arrangement (15), whereas a second flow of air that flows over said condenser is in turn taken in and then blown outside through a second flow path of said air-flow diverter arrangement (15).

Said air-flow diverter arrangement can be adjusted so as the flow of dehumidified air returning from the drum (2) is diverted outside and, at the same time, the air flowing in from the condenser means through the blower (14) is diverted toward said drying air intake blower (5) and from here to the heating element (7), with the cooling air intake blower (14) switched off.

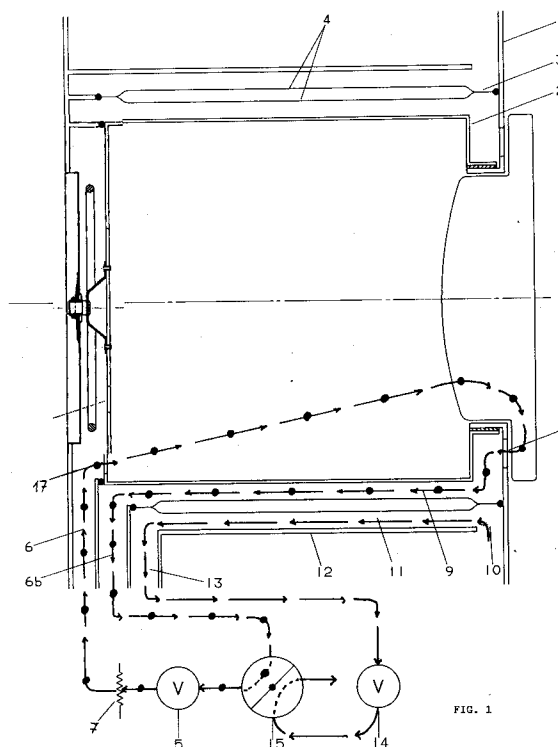


FIG. 1

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This invention relates to a condenser-type clothes drying machine, in which the "cool" condensation medium is room-temperature air itself.

Such a clothes drying machine is provided with a rotating drum holding the clothes to be dried, ie. the drying load.

It is widely known from the prior art that, in order to complete in a satisfactory way the drying of a washload filled into the rotating drum of traditional-type clothes drying machines, a continuous flow of mechanically forced air is circulated through the same drum, said air being preliminarily heated up by an appropriate air heating element, preferably of the electric resistance type, which is installed in a location upstream of the air inlet into the drum, and blown into the drum by an appropriate blower.

Said air is usually taken in from the outside ambient through appropriate conduits and, after having being circulated inside the drum, where it absorbs moisture from the clothes, it is blown outside the same drum through further appropriately provided conduits that convey said hot, moist air to impinge against and flow along a cool wall located inside the same appliance. Upon contacting said cool wall, the moisture contained in the hot air is caused to condense on the same wall, from which it is then collected and removed with the use of various means and methods which are known in the art.

After having being in this way dehumidified, the air, which is at the same time also cooled down by the same cool wall, is conveyed back into the conduits leading to the actual drying process for recirculation, by the action of the blower, through the heating element and the rotating drum holding the clothes to be dried. In this way, it is common knowledge that condenser-type clothes driers generally use the same air to complete a drying cycle, by recirculating it in a closed-loop pattern.

In almost all cases, at least as far as clothes driers for household use are concerned, performances are fully adequate, also in consideration of the fact that clothes driers of the afore mentioned type do not exhaust moist air into the ambient, ie. avoid doing something that would quite obviously turn out to be a considerable drawback, especially in winter time when doors and windows in residential units are kept usually closed.

These condenser-type clothes driers, however, have a serious drawback in the quite conspicuous way in which they affect the electric bill, ie. in their considerable power requirements.

As a matter of fact, these appliances generally use a considerable amount of energy, which may also exceed the one typically demanded by the simpler exhaust-type machines where the hot air is simply exhausted into the ambient after circulation

through the drum, owing to the fact that they have to heat up a considerable mass of air which still contains some residual moisture that escaped condensation, and which therefore requires a large amount of energy in order to be heated up to the final temperature needed to effectively subtract moisture from the items to be dried.

It is therefore an object of the present invention to eliminate the afore mentioned drawbacks by means of a clothes drying machine provided with an appropriate arrangement and making use of simple construction and manufacturing techniques.

This and further aims are reached according to the invention in a cold-air condenser-type clothes drying machine, comprising a rotating drum adapted to hold the moist clothes to be dried, said drum being crossed by the forced flow of drying air heated up by at least a heating element and blown therethrough by at least a blower, and in which the hot, moist air leaving said drum is conveyed so as to cause it to impinge against and flow along a cool wall, thereby at the same time causing the moisture contained in the same exhaust air to condense on that wall.

According to the present invention, the clothes drying machine in question is characterized in that the condensation element is in this case a fixed, substantially cylindrical envelope surrounding the whole outer wall of the drum at a short distance therefrom; that such a condensation envelope has a plurality of axially extending ribs arranged all along its surface; and that the drier itself can be operated according to two distinct modes, ie. a specially provided mode of operation to be used under cold weather conditions, such as in winter, in which condensation is actually performed along with the closed-loop air recirculation scheme, and a second mode of operation that is particularly appropriate for use under mild weather conditions, such as in summer, in which, after the condensation process, the thus dehumidified air is freely vented outside into the ambient, and therefore usually into the atmosphere, thereby letting the drier operate "almost" as a vented-type appliance, ie. as a drier exhausting its hot, moist air directly outside.

For a deeper understanding, the invention will be further described by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a cross-sectional side view showing schematically a clothes drier operating according to one of the modes according to the present invention, in which the arrows with a dot in the middle (-•->) indicate the closed-loop flow path of the drying air to be condensed;
- Figure 2 is the same cross-sectional side view as in Figure 1, but showing the other

mode of operation of the drier;

- Figure 3 is a view showing schematically, by way of example, a possible arrangement of the air conduits of a drying machine according to the present invention, in which the air flow path lines in the first mode of operation indicated by the arrows, wherein the dotted arrows have the same meaning as explained above;
- Figure 4 is a view showing schematically the same arrangement of the air conduits as in Figure 3, however with the flow path lines followed by the air in the second mode of operation.

With reference to the Figures, it can be seen that the clothes drying machine comprises an outer casing 1 enclosing a rotating drum 2 adapted to contain the moist clothes to be dried and rotatably driven by means of a *per se* known drive motor (not shown). The outer surface of the drum is wrapped all around by a cylindrically shaped, stationary envelope 3, which constitutes the condensation surface and has all along its generating line a plurality of ribs or grooves 4 extending axially, i.e. parallelly to the axis of the cylindrical envelope-condenser 3.

A blower 5 takes in the air and blows it through a conduit 6 to a heating element 7 and from here, continuing along the same conduit 6, into the drum 2 through the inlet opening 17. After having flowed across the drum loaded with damp clothes, and having absorbed part of the moisture from the same clothes, the thus humidified air flows out of the drum through a second opening 8 and is conveyed into the gap 9 formed between the outer surface of the drum and the ribbed or grooved surface of the surrounding envelope 3.

As this hot, damp air flows along said gap 9, the moisture contained in the same air is caused to condense in correspondence of said surface 3, wherein the ribs 4, by increasing the contact area of that surface, are instrumental in promoting the condensation process and enhancing its effectiveness.

Ultimately, the water from said condensation process is conveyed by the same ribs or grooves toward a condensate well (not shown), in which it is collected throughout the drying process and from which it is periodically emptied in any appropriate way.

Finally, the thus dehumidified drying air is conveyed again into an appropriate conduit 6b that leads it, through a two-way arrangement 15 acting as a flow diverter adapted to divert two flows of air, as it will be explained further on, again to the blower 5 that will readmit it into the just described cycle.

The cooling down of the condensation envelope 3, as requested so as to maintain a certain difference between its temperature and the temperature of the hot, damp air flowing out of the drum, and therefore to enable the moisture contained in the same air to effectively condense, is brought about by taking in fresh air from the outside of the machine and conveying it through an appropriate conduit 10 into a second gap 11 formed by the outer surface of said envelope 3 and a second envelope 12 that surrounds said condensation envelope 3 by substantially wrapping it all over its surface.

Said cooling air flows then through a separate conduit 13 to reach a second suction blower 14 that forces it through and exhausts it then outside through the afore mentioned two-way arrangement 15 acting as a flow diverter.

In a first mode of operation, to be switched on when the machine is operated in a closed room and, therefore, particularly suitable for use in winter time or under prevailing conditions of cold weather, the clothes drier operates in the above described way. The advantages of this mode of operation lie in the fact that the appliance actually operates as a real condenser-type drier, i.e. ensuring full condensation so that no moisture is vented outside the machine, thus avoiding what would undoubtedly turn out to be a nuisance in winter, when living spaces and rooms in the house usually have their doors and windows shut, thereby causing moisture to stagnate with the well-known damaging effects on both people and properties.

In this mode of operation of the clothes drier, the power consumption of the appliance runs at an average level. However, it shall be duly considered that the cooling air, which is taken in at an ambient temperature through the conduit 10, is vented again into the room at a significantly higher temperature, since it is warmed up by the wall of the condensation envelope 3 that takes up a good deal of the heat contained in the hot, damp air leaving the drum. As a consequence, in all cases in which rooms where a clothes drier of the described kind is installed are heated artificially, the heat brought in this way directly into the same room by the drier should actually to be deducted from the energy utilization figure of the drier itself.

The second mode of operation of the clothes drier according to the present invention is illustrated schematically in Figure 2.

It can be noticed that, in this particular case, the air conveyed through the conduit 13, after having contributed to the cooling down of the condensation envelope 3, and having been caused to flow further so as to reach beyond the blower 14, which in this case is however not switched on, flows into the two-way arrangement 15 which is set

in such a way that the air, instead of being vented outside as in the previously described case, is conveyed toward the blower 5 and, therefore, is admitted into the whole afore described heating-up, humidification, cooling-down and condensation cycle.

Upon completion of the condensation phase, the exhaust air being let into the conduit 6b flows back to the flow diverting arrangement 15. However, owing to its different setting as mentioned above, the latter does no longer convey the air toward the blower 5 to start a new drying cycle, but just vents it outside.

The advantages of this second mode of operation, from an energy consumption point of view, are quite apparent. As a matter of fact, the ambient temperature of the air taken in from outside through the conduit 10 is typically at moderately high values in summer. The air itself is then additionally heated up by the outer surface of the envelope 3 during the condensation phase. It therefore is already at a rather high temperature when it is caused to pass through the heating element 7, so that it will be brought up to the required drying temperature more quickly with a beneficial energy saving effect.

A further feature connected with this particular mode of operation lies in the fact that the drying air, after the condensation process, which however leaves it with a part of its moisture contents, is vented outside. It will in any case be immediately appreciated that, if this mode of operation is switched on when the room in which the clothes drier is installed has its windows open, that is in summer or under prevailing conditions of mild weather, such a venting is far from being a nuisance, since moisture is spontaneously and quickly eliminated through the open windows.

It has been additionally found out that a further improvement of the energy utilization efficiency, ie. a further reduction in energy consumption, can be achieved through a functional modification added to the just described second mode of operation of the clothes drier according to the present invention.

As a matter of fact, if said second mode of operation, to be typically used in summer or under mild weather conditions, is modified by switching on also the blower 14, while at the same time de-energizing the heating element 7, and taking care of arranging the motors driving both blowers 14 and 5 so as to have them flushed by the respective flow of air generated by the same blowers, it ensues that the temperature of the air, while no longer raised by the heating element 7, does not even fall, as opposed to what may actually be assumed, and is kept on average at a value of approx. 40°C, as it has been possible to find out and demonstrate experimentally, owing to the heat

wasted by the above mentioned driving motors of the two blowers, said waste heat being in fact fully taken up by the circulating air.

Therefore, a further mode of operation is practically implemented in this way, wherein only the blowers 5 and 14 are switched on, while the heating element is de-energized.

This further mode of operation enables rather long, but extremely economical drying processes to be carried out, which would undoubtedly be considered as being of considerable advantage by the users in all those cases where the time needed by the appliance to complete drying is not so important as it on the contrary is the final energy bill, ie. where a marked reduction in energy consumption is a top priority.

For the sake of brevity, no description is given here of either the methods and devices that can be used to control said three modes of operation of the clothes drying machine as described above or the actual embodiment of said two-way air flow diverter means 15, since all of them can easily be implemented in any of a number of possible variations by anyone skilled in the art on the basis of the teachings disclosed herein.

It will be further appreciated that the present invention may be embodied in anyone of a number of different ways or may be subject to any modification as considered to be appropriate, without departing from the scope of the present invention, as limited only by the scope of the appended claims.

## Claims

1. Clothes drying machine comprising a rotatable drum (2) adapted to hold the damp clothes to be dried and crossed by a flow of air, which is taken in by at least a blower (5) and heated up by at least a heating element (7) before being blown into said drum, said air being further caused to condense by at least a condenser means (3) after having taken up moisture from the clothes to be dried and before being ultimately conveyed back to said blower (5), **characterized in that** before reaching said blower (5) said air flows through an adjustable air flow diverter arrangement (15), **and in that** a second flow of cooling air flushes said condenser means, said second flow of air being taken in downstream of said condenser by a second blower (14) and being then vented outside through a second flow path of said air flow diverter arrangement (15).
2. Clothes drying machine according to claim 1, **characterized in that** said air flow diverter arrangement (15) is capable of being adjusted

so that the dehumidified air flowing in from the drum (2) is diverted by said flow diverter arrangement (15) to be vented outside, while at the same time the cooling air flowing in from the condenser means (3) through the blower (14) is diverted by said air flow diverter arrangement (15) toward the blower (5) taking in the drying air, and from here toward the heating element (7), to be eventually blown into said drum, the cooling air suction blower (14) being de-energized.

3. Clothes drying machine according to claim 2, **characterized in that** the cooling air suction blower (14) is switched on and the heating element (7) is at the same time de-energized.
4. Clothes drying machine according to any of the preceding claims, **characterized in that** said condenser means (3) is formed by a fixed, substantially cylindrical envelope, which has the same height as, but a slightly larger diameter than said drying drum (2), and is fitted in a regular way around said drum so as to enclose its outer surface almost completely.
5. Clothes drying machine according to claim 4, **characterized in that** a plurality of axially extending ribs or grooves (4) are provided on said cylindrical condenser means (3).

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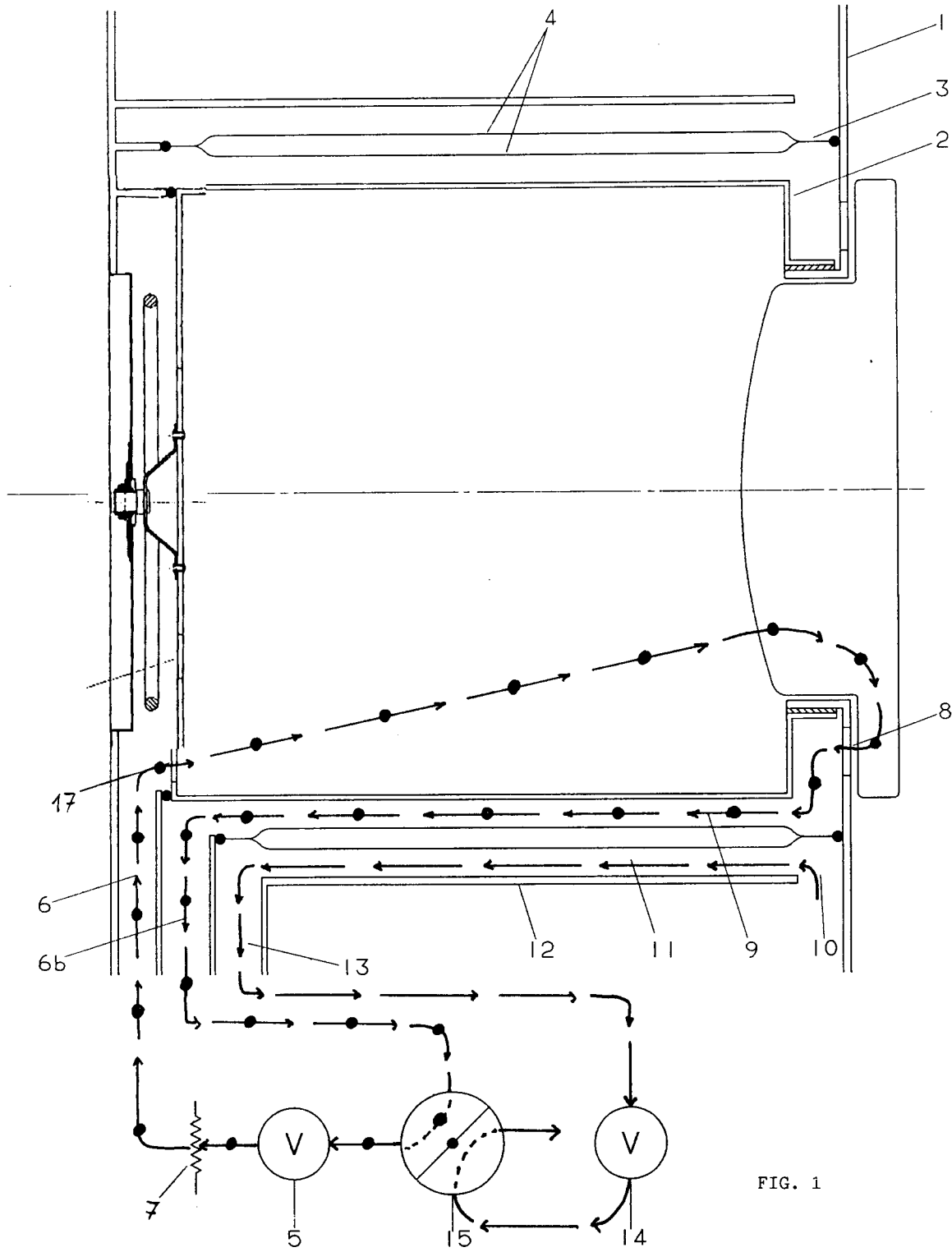


FIG. 1

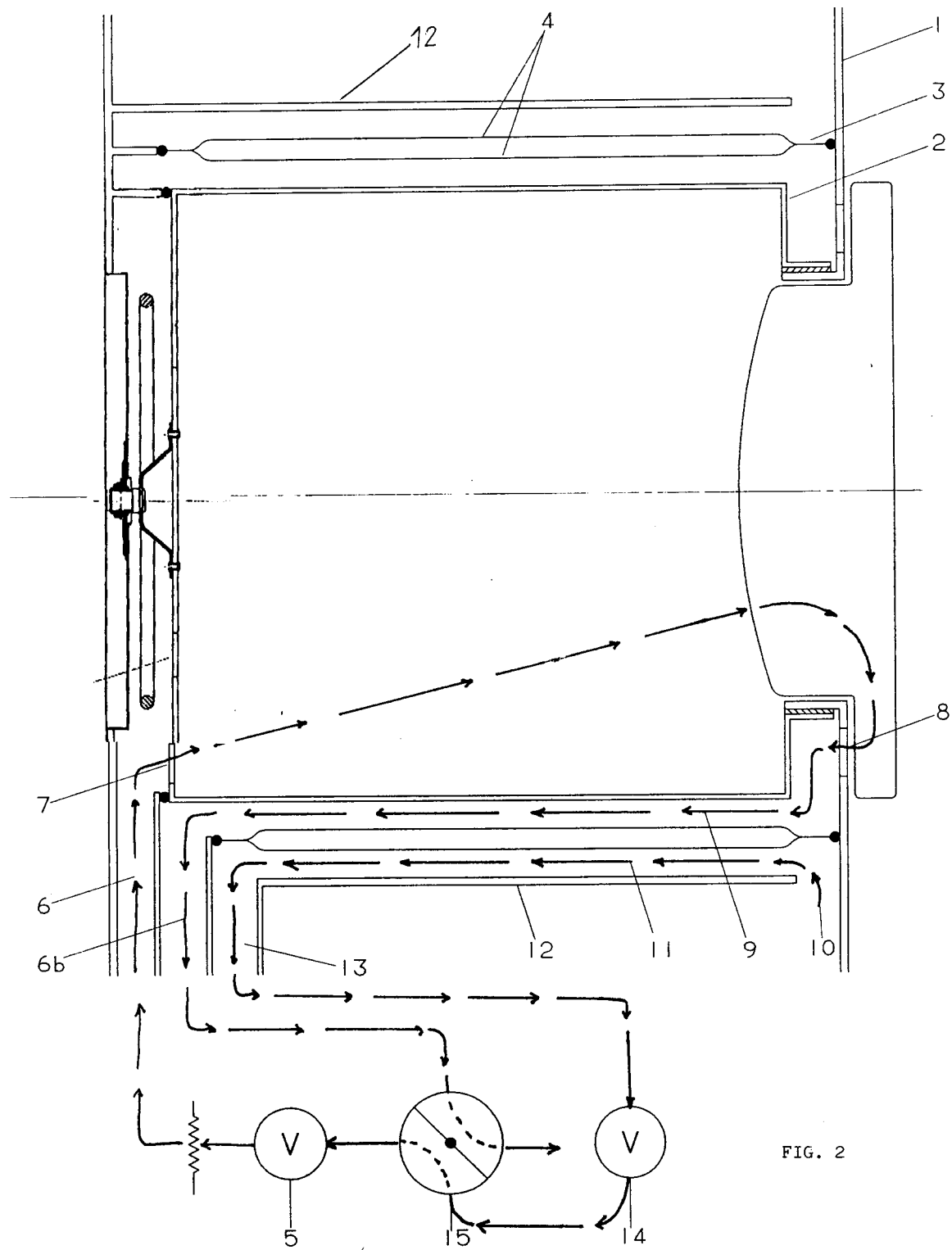


FIG. 2

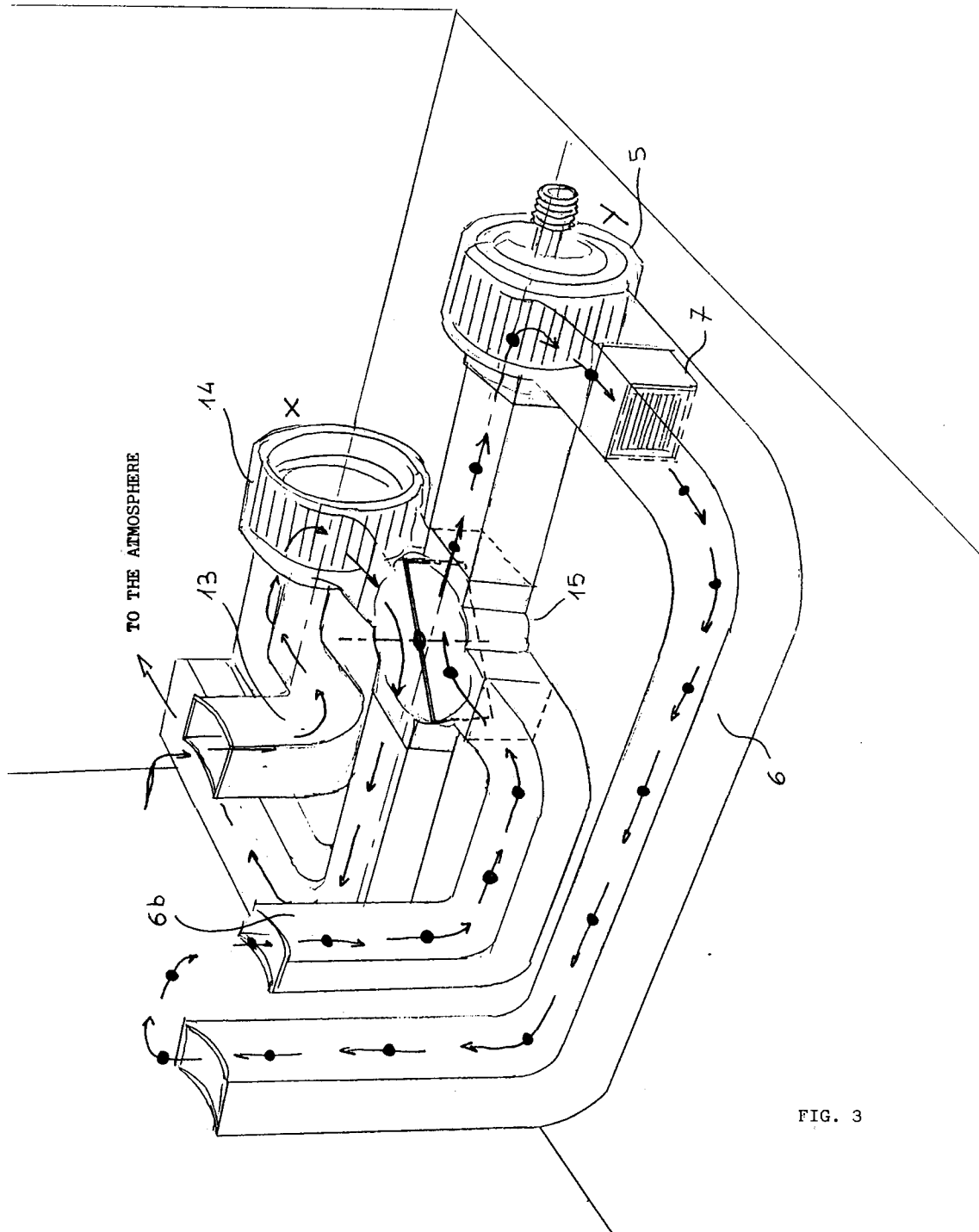


FIG. 3



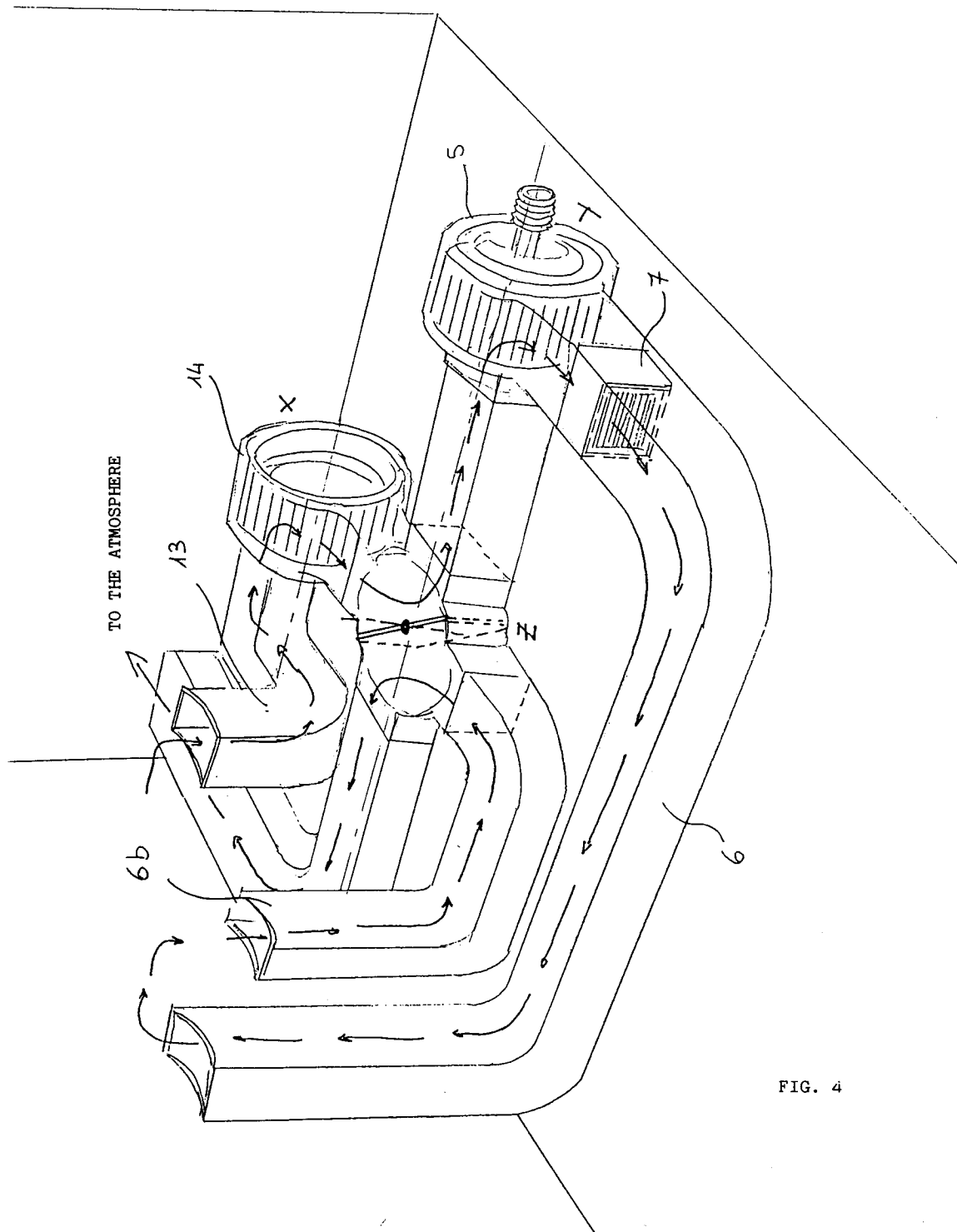


FIG. 4



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# EUROPEAN SEARCH REPORT

Application Number

EP 93 10 8334

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-2 539 153 (THOMSON-BRANDT) * page 4, line 10 - page 5, line 28; figures 2-4 *	1	D06F58/20 D06F58/24
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A	EP-A-0 163 265 (MIELE & CIE. GMBH & CO.) * page 5, line 1 - line 20; figures 3,4 *	1	
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			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D06F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 SEPTEMBER 1993	Examiner COURRIER G.L.A.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document  T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document			