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(54) **Energy saving household clothes drying machine**

(57) A household clothes drying machine comprises a drum (1), a delivery conduit (2) that conveys the drying air into said drum (1), and an outlet conduit (4) that removes the drying air from the interior of said drum (1). On the rear region of the drum (1) where a side of an elevator (30) is joined there is a proper opening (31), so that a portion of the drying air can flow from the outer region of the drum (1), and thorough said opening (31), from a lateral side of the elevator (30) into it. With respect of said opening (31), on the other side the

elevator (30) is open into the inner volume of the drum, so the air crossing said elevator flows into the drum, where it mixes with the drying air therein blown in a conventional way.

The air deviated into the lifter is taken from an outer cylindrical element (20) formed on one side by the rear circular base (21) of the drum, on the opposite side by an annular region of the inner surface of the back wall (22) of the drying machine, and laterally by a cylindrical strip (23) joining said circular base (21) with said inner surface of the back wall (22).

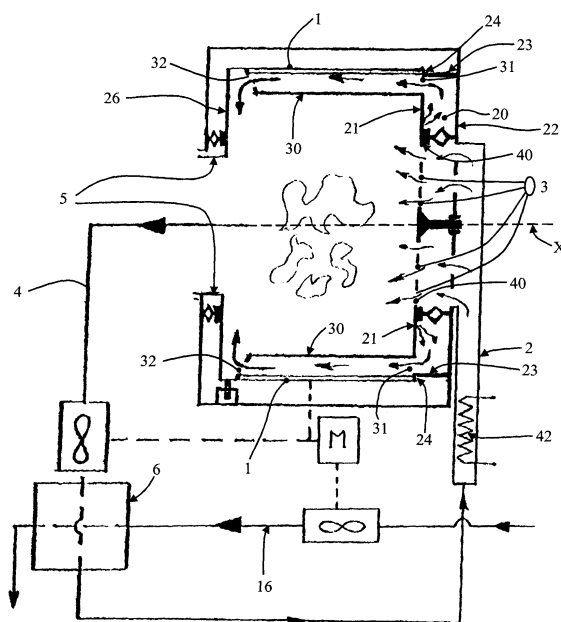


Fig. 3

Description

[0001] This invention refers to a kind of clothes drying machine, preferably of the type for use in households, which is provided with improved means for circulating the drying air to ensure high energy efficiency.

[0002] The machines, which the present invention refers to, are generally known in the art. They have on the other hand been described, along with a detailed discussion of a technical nature on the advantages and the drawbacks of a number of different variations in the design and general embodiment thereof, in the European Patent Application no. EP 04106204.3 filed by this same Applicant with the title "Low noise Household Clothes Drying Machine", to which reference should therefore be made for greater convenience and brevity in this description.

[0003] It should however be right away appreciated that, while the above-cited European Patent Application refers to condenser-type clothes drying machines, which are well known in their peculiarities to all those skilled in the art, so that they do not need any further explanation here, the present invention applies in the broadest sense to the generality of clothes drying machines of the tumbler-type, i.e. provided with a rotating drum and flown through by a flow of appropriately heated-up drying air, which is blown into and through the rotating drum via an appropriate opening to eventually leave said drum through a second air-removal opening. In this sense, the present invention therefore applies also to the so-called exhaust-type clothes drying machines, in which the air is taken from the outside ambient, duly heated up, blown into the rotating drum, removed from the same rotating drum and, eventually, exhausted again into the outside ambient, as opposed to what occurs in condenser-type clothes drying machines, in which the air is on the contrary caused to circulate in a closed-loop circuit that includes a suitable condenser arrangement, so as this is illustrated symbolically in Figure 1.

[0004] Both condenser-type and exhaust-type clothes drying machines share - further to the rotating drum - a common operating feature, i.e. the circumstance that in both cases there are provided an air delivery or inflow conduit and an outflow conduit, along with related openings arranged in the walls of the drum, through and in which the drying air is caused to circulate with the aid of means largely known as such in the art.

[0005] In connection with both types of clothes drying machines, an usually neglected drawback should be duly pointed out here. Reference is made here to the fact that the coupling between the drying air delivery conduit and the related inflow opening in the drum, as well as the coupling between the drying air exhaust conduit and the related outflow opening in the drum are provided with appropriate annular gaskets, e.g. of felt or some other low-friction and highly deformable material, as indicated at G 1 and G2, respectively, in Figures 1 and 2.

[0006] These gaskets, however, give generally rise to

air leakages, which may reach values of up to approximately 20 percent of the total air flow rate.

[0007] Even in exhaust-type clothes drying machines, anyway, the problem of drying air leaking through the gaskets between the conduits and the drum is a rather serious and generally acknowledged one. As a matter of fact, if the exhaust air, instead of being totally conveyed and exhausted into the outside ambient, comes to be partly released inside the machine, this would imply serious as far as the safety, the efficacy and the functional state of the machine itself are concerned, owing to the high moisture content in the exhaust air flowing out of a drying drum.

[0008] As far as condenser-type clothes drying machines are concerned, in which the drying air is recovered and continuously circulated in a closed-loop circuit, basically to the purpose of recovering the thermal energy contained therein, the above-cited problem has a different purport. These machines are in fact so designed as to desirably allow the totality of the moisture contained in the drying air to be removed therefrom, so as to ensure a quick and perfect drying of the clothes. However, for this aim to be reached, it is of the utmost importance that the flow of the drying air is entirely conveyed into and through the condenser. Now, this most obviously implies that there are no losses and/or leakages of drying air at the gaskets provided as sealing means between the drying air circulation conduits and the drum.

[0009] In condenser-type clothes drying machines, therefore, a loss of a significant portion of the drying air at or through these gaskets generates a corresponding loss of energy efficiency, which is heavily detrimental as far as the quality and the performance levels of currently produced clothes drying machines are concerned, and a low level of moisture released into the surrounding ambient.

[0010] In the cited European Patent Application this drawback is effectively reduced by containment means adapted to enclose the drum, together with the respective motor and the driving belt, within a common space that is substantially closed outwardly.

[0011] However said containment means, even if effective both from the point of view of noise reduction and energy saving, turns to be quite expensive due to the appreciable amount of material required and in the general production costs.

[0012] It would therefore be desirable, and it is actually a main purpose of the present invention, to provide a clothes drying machine of either the condenser type or the exhaust type, which is particularly effective in the energy consumption, without being too much expensive in the production costs.

[0013] It would be further desirable, and it is another purpose of the present invention, to provide a clothes drying machine, in particular of the condenser type, in which the above-described losses and leaks of moisture-laden air from the drying air circulation circuit are avoided in almost a radical, total manner.

[0014] According to the present invention, these aims, along with further ones that will be apparent from the following description, are reached in a clothes drying machine incorporating the features as recited in the appended claims.

[0015] Anyway, features and advantages of the present invention will be more readily understood from the description that is given below by mere way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 3 is a median vertical-section view through the axis of the drum of a first embodiment of a clothes drying machine according to the present invention, as illustrated in a symbolical manner;
- Figure 4 is a schematic and transparent perspective view of the drum of the previous figure, showing specifically an elevator according to the invention,
- Figure 5 is a rear view of the drum shown in Figure 4,
- Figure 6 is a perspective detailed view of the elevator of fig. 5,
- Figure 7 is a front view, taken from the drum axis "X", of the elevator of fig. 6.-
- Figure 8 is a median vertical- section view through the drum axis of a different embodiment of a machine according to the invention.

[0016] In a clothes drying machine according to a prior-art embodiment there is provided a drum 1 adapted to hold the clothes to be dried, to which there is associated a delivery conduit 2 letting the drying air into the drum through an appropriate inflow opening 3, an air outlet or exhaust conduit 4 removing the drying air from the interior of the drum through a corresponding outflow opening 5, wherein said conduits 2 and 4 are joined to each other via a condenser 6, which is adapted to cause the moisture contained in the drying air flowing therethrough to condense, said condenser being furthermore flown through by a flow of "cold" air, i.e. air taken in from the outside ambient and sent to said condenser 6 via a corresponding cooling conduit 16.

[0017] It should of course be appreciated that, as already pointed out hereinbefore, the condenser 6, along with said cooling conduit associated therewith, is cited here to mere illustrative and exemplifying purposes in connection with an embodiment and a particularly advantageous application of the present invention, since these parts might equally be omitted, i.e. not necessarily be provided, in the case that the clothes drying machine is of the exhaust type.

[0018] According to the present invention, and with reference to fig. 3, the preferred embodiment of the drying machine is provided with the following features:

- 1) Behind said drum a substantially cylindrical element 20 is defined, which is coaxial with the drum axis, and whose front wall 21 is a portion of the rear wall of the drum, which takes the same numerical

identification 21, being the same physical means; the opposite vertical wall, which from here on will be called "base", may be the back wall is a portion of the back wall 22 of the machine cabinet, and the lateral cylindrical strip 23 is implemented so as to close in an almost hermetic way such cylindrical element 20.

In the facts it is not possible to fully close such cylindrical element 20 between the drum rear wall and said cylindrical strip 23, as the drum rear wall rotates with the drum itself, while said cylindrical strip is firmly joined with the back wall of the machine; therefore it is needed to let, between said cylindrical strip and the drum rear wall, a small ring shaped gap 24, which allows the relative motion and without slithering between said elements.

2) The elevators 30, usually arranged inside the drum according to the prior art, are not closed on their sides, but they are open laterally, so that each of said elevators shows a pair of opposite openings on their back and on their front respectively 31, 32.

3) At last, the drum rear wall 21 is provided with a plurality of through-apertures 25 (figures 4, 5) arranged in such positions so as to exactly correspond to the positions of the respective elevators, so that the rear openings 31 of the elevators are mating said apertures 25; in conclusion it will be soon clear that the inner volume of said elevators is directly connected with the inner volume of said substantially cylindrical element 20.

Moreover it will be easily observed that said cylindrical element 20, to be able of collecting the drying airflow, escaping from the ring-shaped gap between the drum rear wall 21 and said inflow opening 3, and to lead said drying airflow straight into said elevators, has to show a diameter about of the same size of the drum diameter.

As far as the central bodies of said elevators are concerned, they do not stretch till the drum front wall 26, but they terminate before it, so that the front openings 32 get directly onto the drum inner volume.

The invention operation will be now clear: in the facts the drying hot air-flow, which gets off the ring-shaped gap 24 between the drum rear wall 21 and the conduit 2 of the drying air coming from the heating resistor 42, is directly collected by the almost hermetic chamber constituted by said cylindrical element 20, and from here it immediately spreads into said elevators across said drum through-apertures 25 and the openings 31 of the corresponding elevators.

[0019] The effect of such running of the hot air-flow inside and through said elevators is that these elevators are immediately and strongly heated, as the air running in them has been just heated; then they can immediately transfer the received heat towards the drying load which is brought into contact with them inside the drum, accord-

ing to the known operation.

[0020] As the heat is transferred more directly and more effectively by conduction than by convection, as well known, and as said elevators show towards the inner drum a not negligible surface area, it comes that a remarkably amount of heat is directly brought on and into contact to the drying load, through the elevators hot surface.

[0021] The final effect is therefore a better aptitude of transferring heat from the hot air to the drying load, with a general improvement of the drying performances.

As far as the air circulation inside the elevators is concerned, it is obviously allowed by said front openings 32, through which the drying air flow, previously blown into the respective elevators, escapes and directly penetrates into said drum.

To sum up there is no loss of drying hot air, but by means of the instant invention the heat only therein contained is transferred to the drying load, so achieving a better efficiency.

Of course the invention may assume other and different embodiments which however can identically exploit the present teaching; for example, with reference to fig. 8, said base of said cylindrical element 20 may even be not a proper portion of the rear wall 22 of the machine cabinet, but it may consist as well of a specific wall 22A, distinct and separate from said rear wall 22.

Claims

1. Front-loading clothes drying machine comprising a drum (1) holding the clothes to be dried, an inflow opening (3) that opens into said drum, a delivery conduit (2) that conveys the drying air into said drum through said inflow opening, an outflow opening (5) adapted to allow the drying air to flow from the interior of said drum out to the exterior thereof, an outlet or exhaust conduit (4) that removes the drying air from the interior of said drum through said outflow opening, a motor (7) adapted to rotateably drive said drum in a selective manner,
characterized in that it comprises a substantially cylindrical element (20) positioned behind said drum, formed by a portion of the rear wall (21) of the drum, by a base placed behind said portion of the rear wall of the drum, and by a lateral cylindrical strip (23), said portion of the rear wall (21) being provided with a plurality of through apertures (25) so arranged as to correspond to the positions of said elevators (30), wherein said elevators are opened on their respective opposite sides (31,32) .

2. Clothes drying machine according to claim 1, **characterized in that** the front portion of said elevators terminates before of reaching the drum front wall (26), so that said elevator front openings (32) directly

come out into the inner drum.

3. Clothes drying machine according to claim 1 or 2, **characterized in that** the diameter of said lateral cylindrical strip (23) is basically the same size of the drum diameter.
4. Machine according to claim 3, **characterized in that** said base of said substantially cylindrical element (20) is carried out by a portion of the back wall (22) of the machine.
5. Machine according to claim 3, **characterized in that** said base of said substantially cylindrical element (20) is carried out with a specific wall (22A) separate from said machine back wall (22).

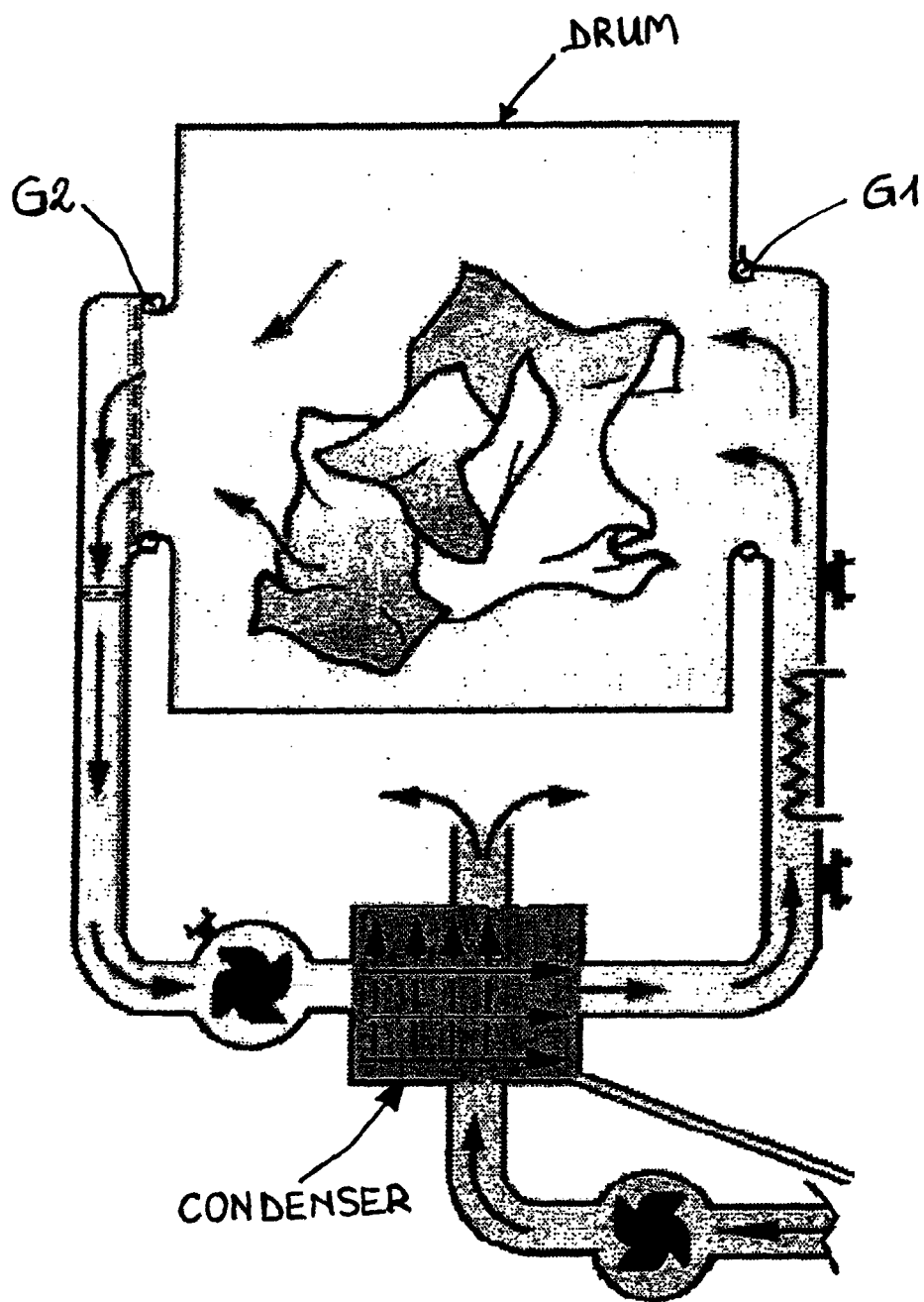


Fig. 1

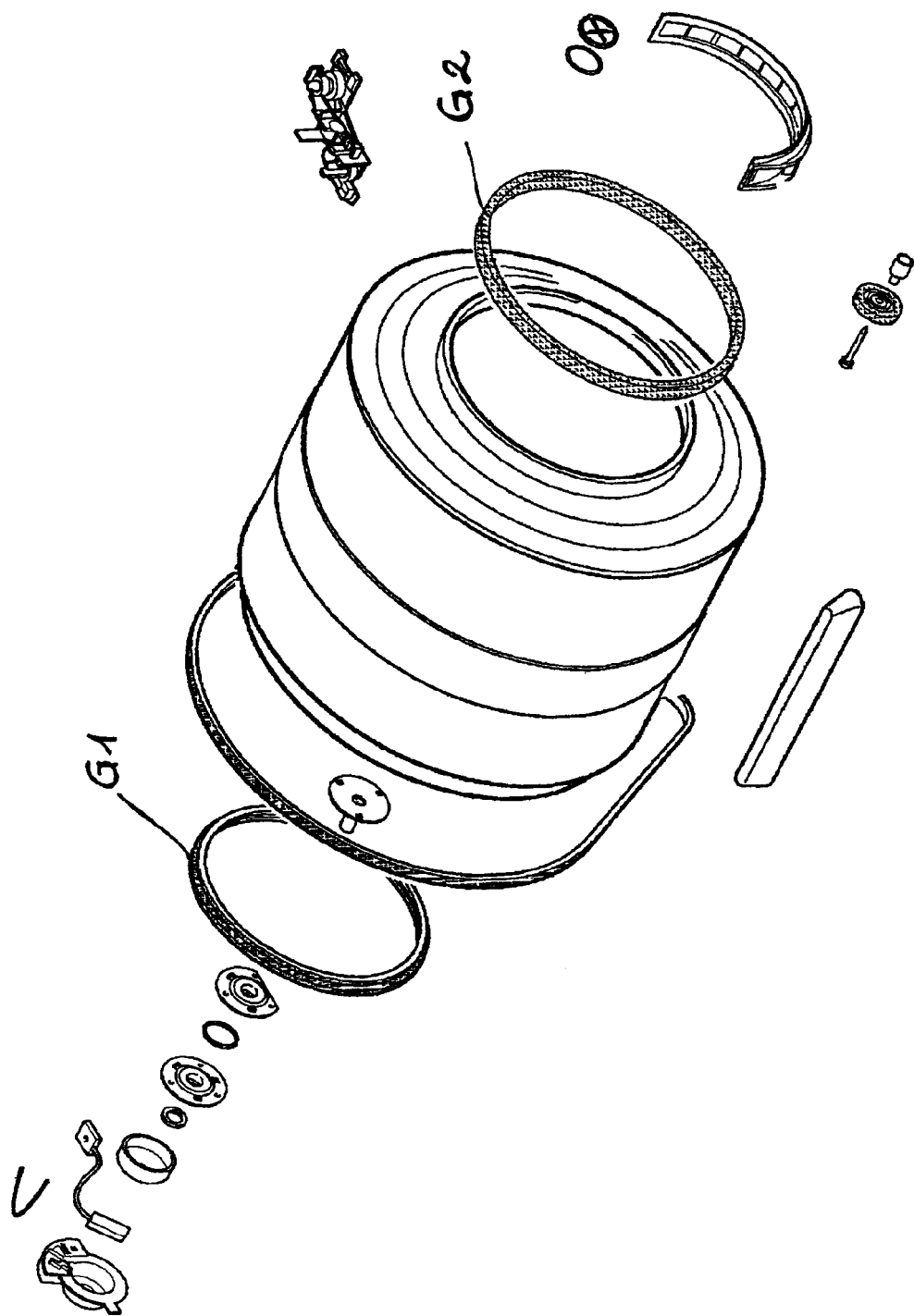


Fig. 2

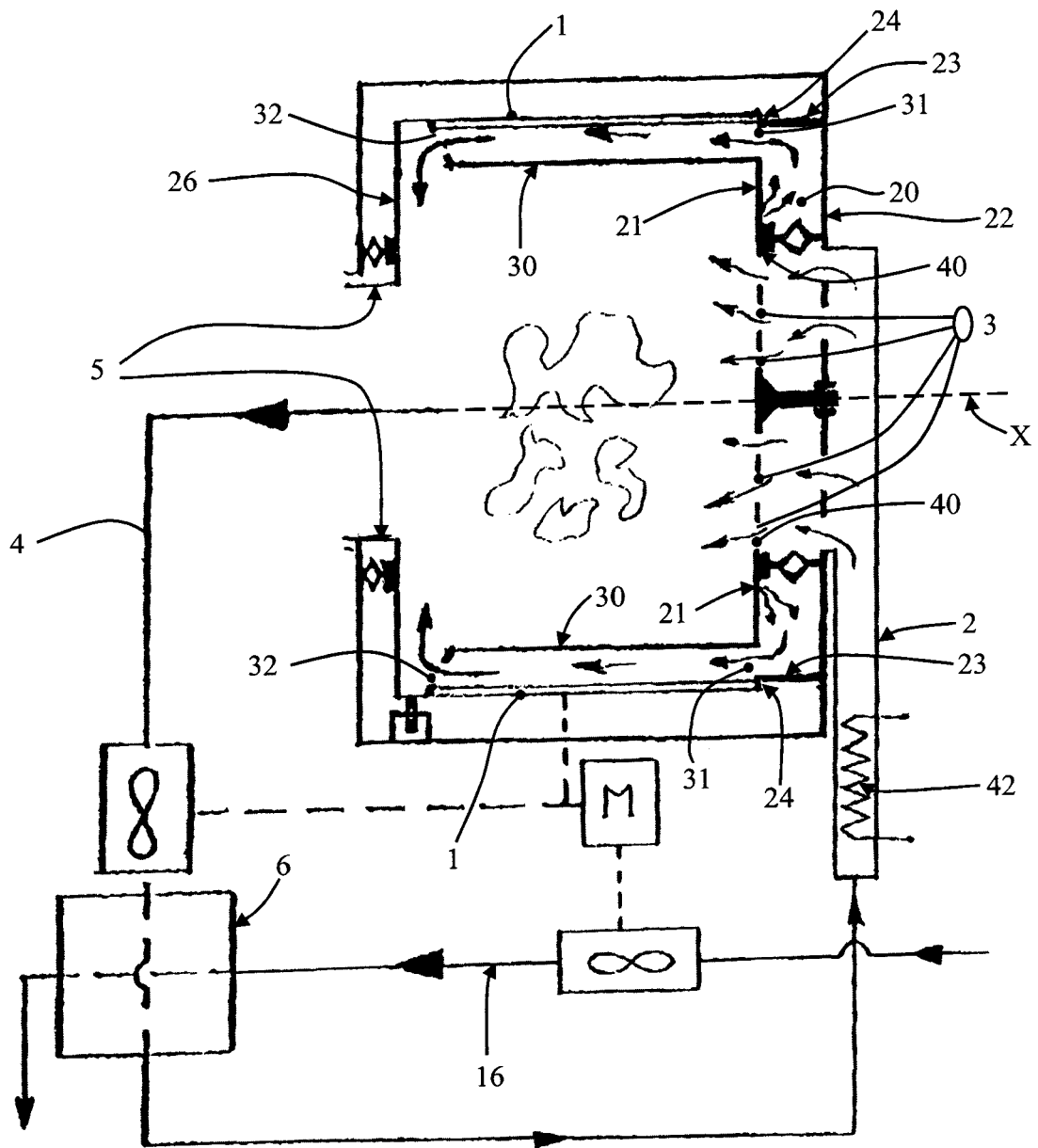


Fig. 3

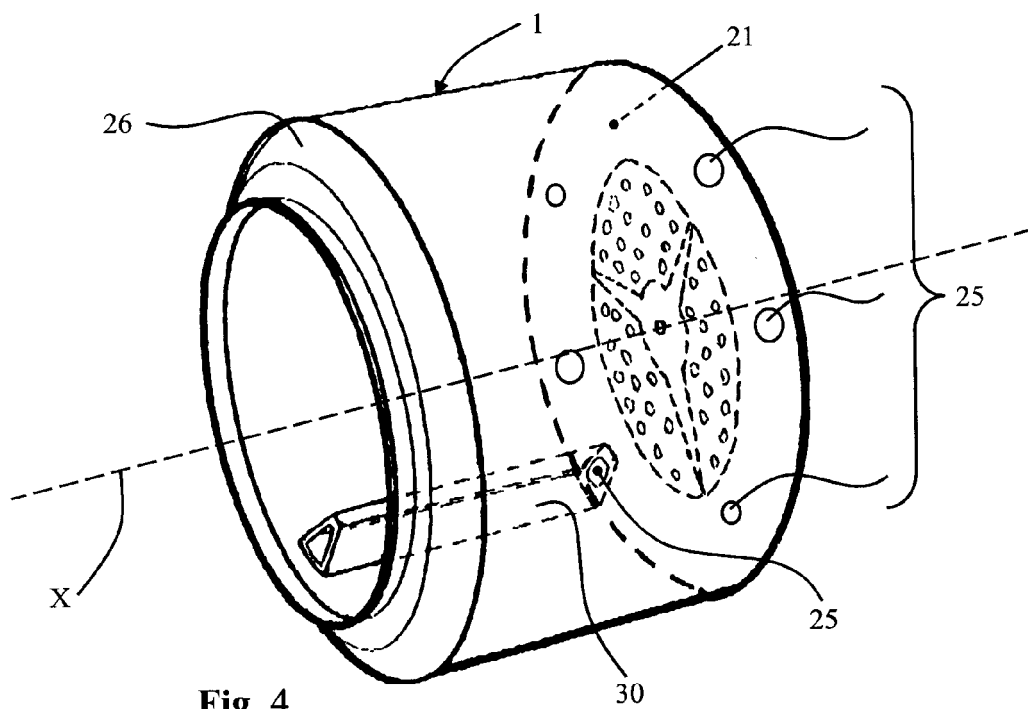


Fig. 4

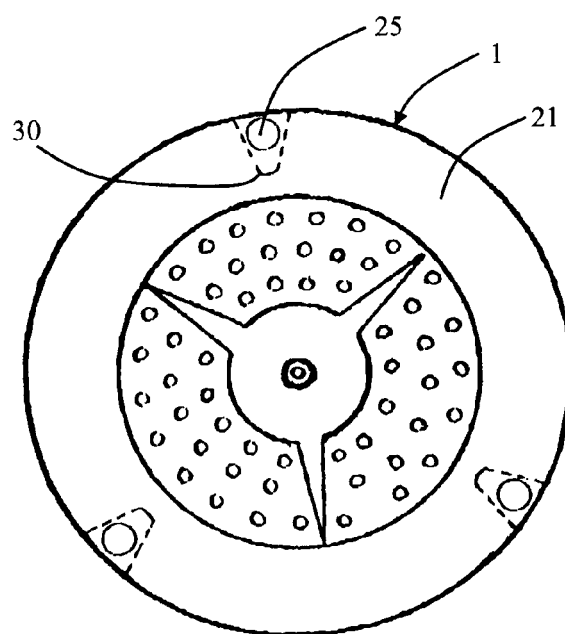


Fig. 5

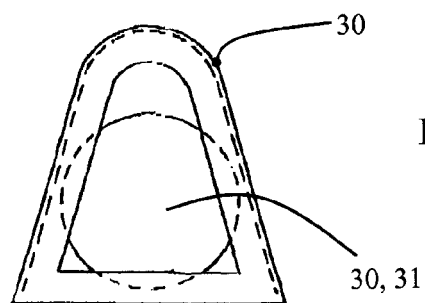


Fig. 6

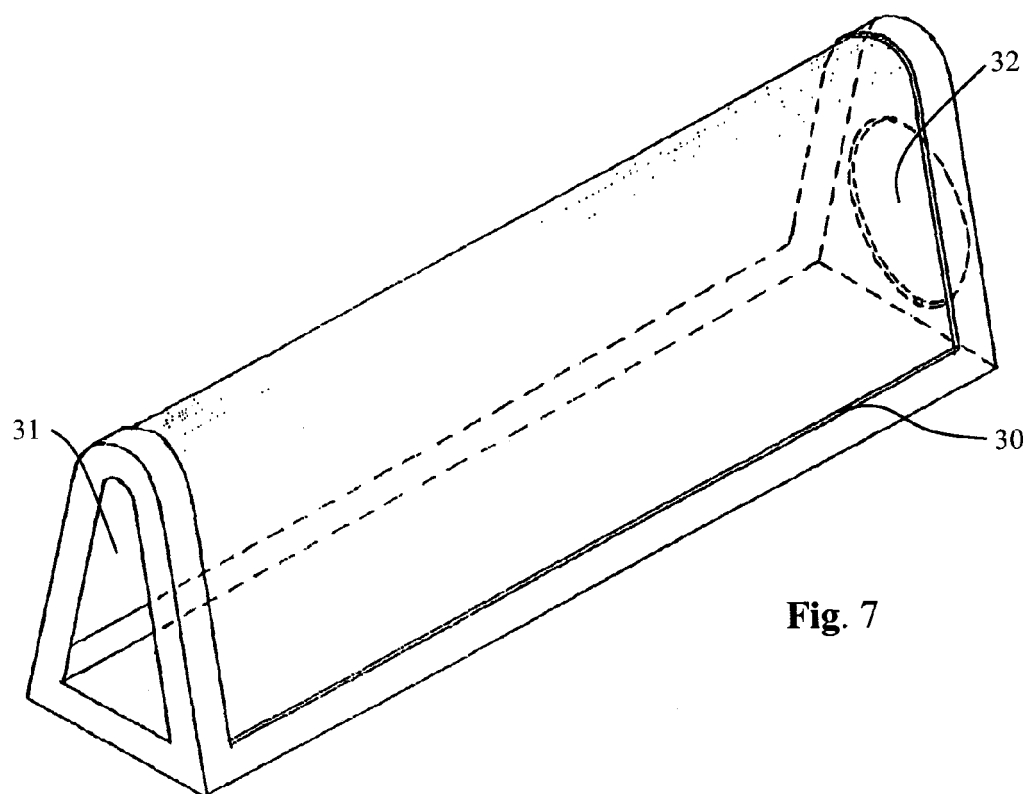


Fig. 7

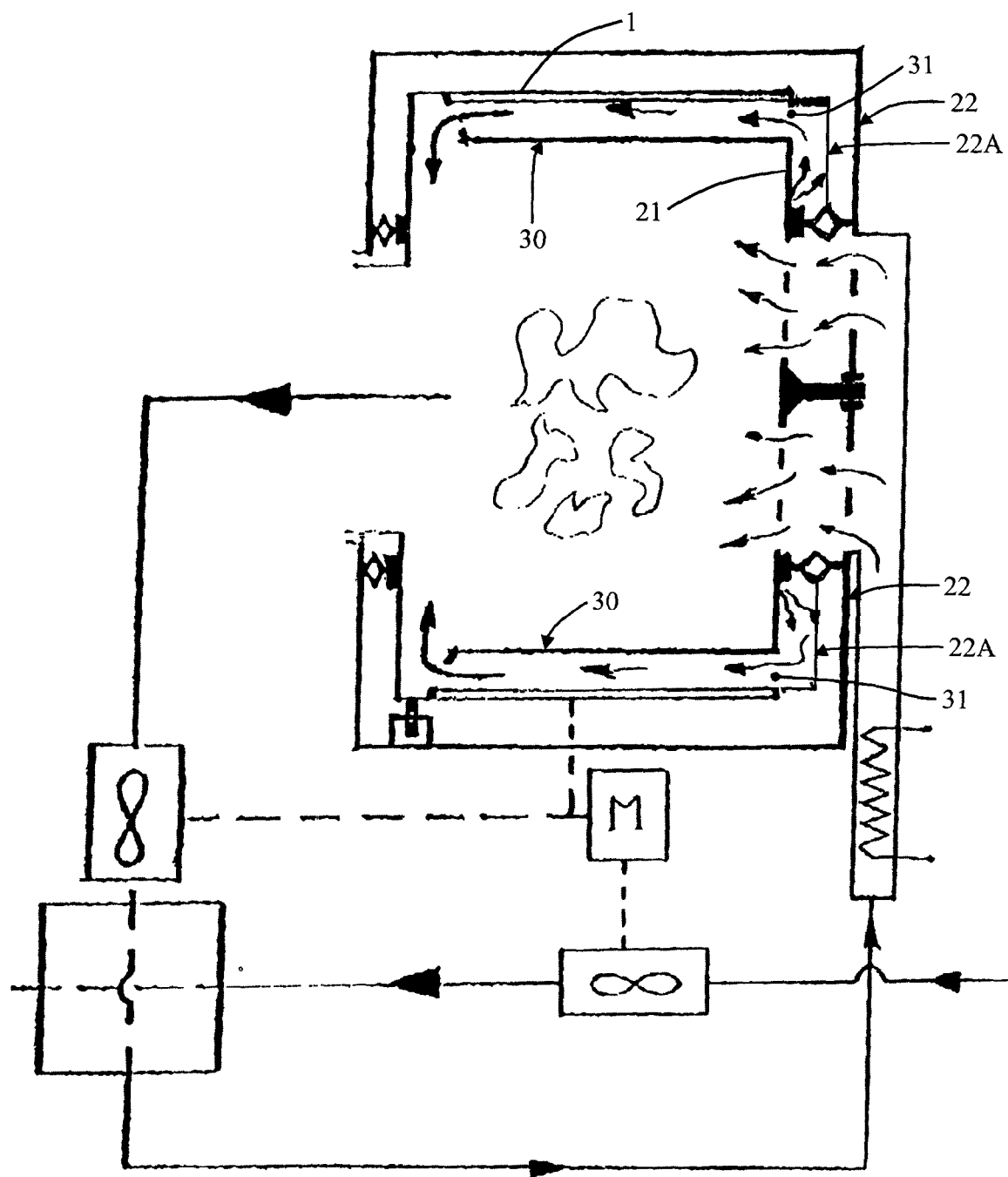


Fig. 8



DOCUMENTS CONSIDERED TO BE RELEVANT			
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 August 2006	Examiner Weinberg, E
CATEGORY OF CITED DOCUMENTS 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	

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 06 11 0696

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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10-08-2006

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REFERENCES CITED IN THE DESCRIPTION

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