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Remarks:
Amended claims in accordance with Rule 86 (2) EPC.

(54) **Clothes tumble dryer**

(57) Clothes tumble dryer comprising an outer casing (2) provided with a loading door (3), a drying air circuit adapted to cause heated air to be circulated through a perforated rotating drum (4) holding the laundry to be dried, heating means adapted to heat up said drying air, condenser means adapted to remove moisture from the hot moisture-laden drying air exiting the drum; said door (3) forms an air passage (5) establishing fluid communication with said drum (4) for conveying the hot moisture-laden drying air exiting the drum (4) towards and into said condenser means, said door (3) further forming one or more cavities (6) to encapsulate an aerogel layer (7) therein, so as to thermally insulate from the outside said door (3) forming said air passage (5).

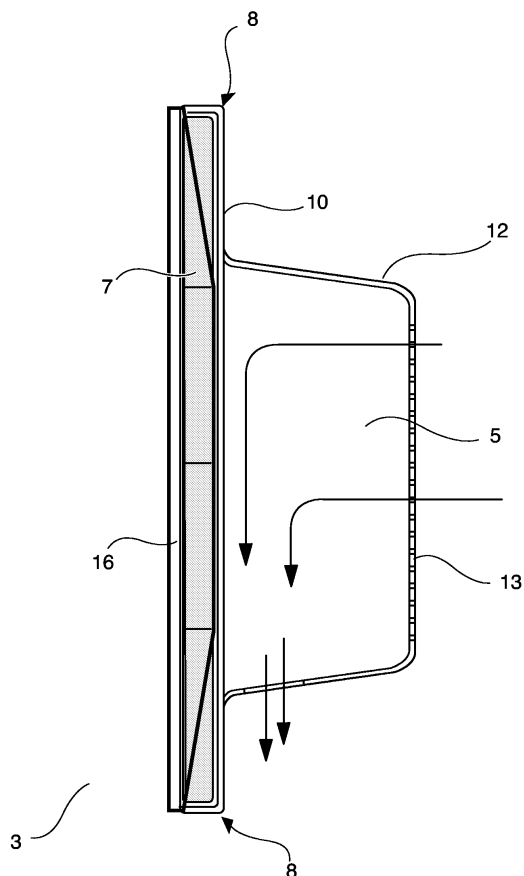


fig.4

Description

[0001] The present invention refers to an improved kind of clothes tumble dryer.

[0002] In the current state of the art as far as the machines and methods for drying clothes are concerned, the most commonly found dryers are generally comprised of an outer casing provided with a loading door, a drying air circuit adapted to cause heated air to be circulated through a perforated rotating drum holding the laundry to be dried, heating means adapted to heat up said drying air, and a condenser adapted to remove moisture from the hot moisture-laden drying air exiting said drum after having flown through the laundry contained therein.

[0003] The dryer further comprises blower means to circulate the drying air through the drum and the drying-air circuit.

[0004] The drying-air circuit is so arranged as to be able to cause the hot moisture-laden air to exit the drum and to deliver the same air into and through the condenser, where the air undergoes a heat-exchange process, in which heat is exchanged with a means lying at a lower temperature, to the purpose of removing from the air the moisture it took away from the clothes in the drum. Thereupon, the air is then heated up again passing through a heating element prior to its being blown again into the drum.

[0005] One of the most intensively pursued design targets in the field of laundry drying machines is to increasingly simplify the construction of the drying-air circuit, in view of being able to reduce the overall dimensions, and related space requirements, of the same circuit and, at the same time, improve the drying performance capabilities of the machine.

[0006] In prior-art laundry dryers, the hot moisture-laden air is taken out of the drum through ducts that add to the bulkiness of the circuit and increase the pressure drop and the flow resistance thereof.

[0007] In addition, it is exactly at those sections, where the drum connects to such ducts, that the hot moisture-laden air gives off a lot of heat due to the considerable convective heat-exchange process that takes place when the air exiting the drum is conveyed into the drying circuit. The resulting heat loss by the drying air has the effect of worsening the thermodynamic efficiency of the machine, since the air cools down before reaching the condenser, thereby reducing the effectiveness of the latter.

[0008] It therefore is a main object of the present invention to provide a clothes tumble dryer, which is effective in doing away with the above-cited drawbacks of prior-art machines.

[0009] Within this general object, it is a purpose of the present invention to reduce the bulkiness of the drying air circuit provided inside the clothes tumble dryer.

[0010] It is another purpose of the present invention to simplify the conveyance of the air exiting the drum towards the drying circuit, so as to improve air circulation

inside the dryer altogether.

[0011] Still another purpose of the present invention is to reduce the heat loss, i.e. the amount of heat dissipated by the drying air exiting the drum, when it is conveyed into the drying circuit.

[0012] According to the present invention, these aims, along with further ones that will become apparent from the following disclosure, are reached in an arrangement incorporating the features as defined and recited in the claims 1 to 9 appended hereto.

[0013] Features and advantages of the present invention will anyway be more readily understood from the description that is given below by way of nonlimiting example with reference to the accompanying drawings, in which:

- Figure 1 is a perspective view of a clothes tumble dryer according to the present invention, showing in particular the air passage;
- Figure 2 is a perspective cross-sectional view of the air passage of the clothes dryer illustrated in Figure 1;
- Figure 3 is a perspective view of the door frame of the clothes dryer according to the present invention;
- Figure 4 is a side elevational, cross-sectional view of the door of the clothes dryer according to the present invention, showing an aerogel layer sealingly enclosed in the frame thereof.

[0014] With reference to the above-cited Figures, the clothes tumble dryer according to the present invention - as generally indicated at 1 in said Figures - comprises an outer casing 2 provided with a loading door 3, a drying air circuit adapted to cause a flow of heated air to be circulated through a perforated rotating drum 4 holding the laundry to be dried, heating means adapted to heat up said drying air, condenser means adapted to remove moisture from the hot moisture-laden air exiting the drum after having flown through the laundry contained in the drum.

[0015] The door 3 forms an air passage 5 that, when the door 3 is closed, fluidly communicates with said drum 4 so as to convey the hot and moisture-laden drying air exiting the drum 4 towards the condenser means; it further forms one or more cavities 6 to encapsulate, i.e. enclose an aerogel layer 7 therein, so as to thermally insulate from the outside the door 3 forming said air passage 5.

[0016] In a preferred embodiment of the present invention, the dryer comprises a closed-loop drying-air circuit, through which the hot and moisture-laden drying air is conveyed, when leaving the perforated rotating drum, and the dehydrated drying air from the condenser is then delivered back into the drum, upon having duly heated up again, so as to remove additional moisture from the clothes being tumbled in the drum.

[0017] In such preferred embodiment, the dryer further comprises an open-loop cooling-air circuit adapted to cause a stream of cooling air taken in from outside to circulate through and over the condenser to cool it down before being eventually exhausted into the outside atmosphere again.

[0018] The tumble dryer comprises blower means adapted to cause the drying air to circulate inside the drum and through the closed-loop drying-air circuit, as well as to cause the cooling air to circulate through the open-loop cooling-air circuit.

[0019] The door 3 comprises a door frame 8 that, along side edges thereof, is provided with recesses 9 integrally forming corresponding rotating pins adapted to engage corresponding guides provided in the outer casing of the dryer. These pins are adapted to rotate inside said guides so as to enable the door 3 to rotate relative to the outer casing 2 and, therefore, access to be gained into the drum 4 to load and unload clothes in and from the same drum.

[0020] The door frame 8 has an inner side 10 that faces the drum 4 when the door 3 is closed, and an outer side 11 facing the outside of the machine.

[0021] The inner side 10 of the door frame 8 forms the air passage 5 adapted to convey the hot moisture-laden drying air exiting the drum 4 towards the condenser.

[0022] The air passage 5 is formed by the inner side 10 of the door frame 8 by means of a collecting or baffle member 12 projecting from the inner side 10 of the door frame 8 towards the drum 4 to receive and collect the air exiting the same drum. To this purpose, the collecting member 12 is provided with an inflow portion 13 provided and arranged in such manner as to come to lie in a position close to an aperture of the drum 4 or to be received into said aperture when the door 3 is closed. In particular, the inflow portion 13 comprises a surface provided with a plurality of perforations, through which the drying air is able to flow from the drum 4 into said air passage 5. A removable filter (not shown) is arranged inside the baffle member 12 for retaining fluff being carried by the drying air flowing therethrough. The filter is adapted to be cleaned after each drying cycle by the user.

[0023] The above-mentioned collecting member 12 defines an abutment frame 14 that extends around the inflow portion 13 and is peripherally provided with a sealing member 15. When the door 3 is closed, said abutment frame 14 is adapted to rest against an undercut provided on the outer casing 2 and correspondingly shaped so as to be able to receive the abutment frame 14 and enable the perforations of the inflow portion 13 of the collecting member 12 to come to lie inside the peripheral rim of the aperture of the drum 4. In addition, the sealing member 15 is adapted to provide an air-tight coupling of the peripheral edge of the frame 14 with the receiving undercut in the outer casing, when the door 3 is closed, so as to force the drying air exiting the drum 4 to solely flow through the perforations of the inflow portion 13 of the collecting member 12 and, as a result, to flow into the air

passage 5 of the door 3.

When the dryer is operating, the drying air exits the drum 4, flows through the perforations in the inflow portion 13 of the collecting member 12 entering the air passage 5, and is deflected by the inner side 10 of the door frame 8 so as to be directed towards an outflow aperture provided in the air passage 5 of the door 3, through which said air passage 5 fluidly communicates with the condenser.

[0024] The inner side 10 of the door frame 8 therefore defines an airflow deflecting surface, over which the drying air flowing in from the drum 4 is adapted to stream to be deflected and conveyed towards the outflow aperture of the air passage 5, from which the air reaches then the condenser.

[0025] The outer side 11 of the door frame 8 forms a pluralities of cavities or compartments 6, which are separated from each other by partitions and are adapted to be filled with aerogel granules 7.

[0026] Aerogels have a very low density and an extremely low heat conductivity. The term "gel" refers to a coherent, rigid, continuous three-dimensional network of colloidal particles. Gels are produced by the aggregation of colloidal particles (typically under acidic conditions when neutralizing salts are absent) to form a three-dimensional gel microstructure. When a gel is then dried (through the removal of liquid from the pores) with the use of means in which the coherent gel microstructure is preserved, as this for instance occurs in supercritical drying, a low-density "aerogel" is formed. One suitable process for the production of aerogels is described in US 3,122,520. The aerogel granules may have any suitable diameter, preferably of approx. 5 to 10 mm.

[0027] Any suitable aerogel granules can be used in the present invention and, in particular, the aerogels used are those based on metal oxides that are suitable for the sol-gel technique (C.J. Brinker and G.W. Scherer, Sol-Gel Science 1990, Chapters 2 and 3), such as for instance Si or Al compounds, or those based on organic substances suitable for the sol-gel technique, such as melamine-formaldehyde condensates (US Pat. No. 5,086,085) or resorcinol-formaldehyde condensates (US Pat. No. 4,873,218). Mixtures of the above-mentioned materials may be used, as well. Preferably used are anyway aerogels containing Si compounds, such as in particular SiO₂ aerogels.

[0028] An outer panel 16 is adapted to be applied on to the door frame 8 so as to encapsulate, i.e. enclose the aerogel inside the same door 3.

[0029] The aerogel granules form a layer that thermally insulates the inner side of the door frame forming the air passage provided for the drying air exiting the drum to flow therethrough, thereby preventing the heat of the same air from dissipating outside the machine. The external surface of the door acts, in fact, as a heat sink.

The heat loss from the drying air due to convective heat exchange with the inner side of the door frame is drastically reduced, thereby improving the thermal efficiency of the drying cycle as a whole.

[0030] According to the present invention, the dryer is therefore provided with a door that integrally forms a portion of the drying air circuit, thereby enabling the bulkiness of the same circuit and the space occupied by it inside the machine to be reduced and further enabling the pressure drop and the turbulence of the air flow to be reduced owing to the design of the air passage.

[0031] Furthermore, the door of the dryer forms a conveyance means that establishes an effective fluid communication between the drum and the condenser, thereby reducing flow resistance and pressure losses and maximizing the passage of the drying air from the drum into the circuit.

Claims

1. Clothes tumble dryer comprising an outer casing (2) provided with a loading door (3), a drying air circuit adapted to cause heated air to be circulated through a perforated rotating drum (4) holding the laundry to be dried, heating means adapted to heat up said drying air, condenser means adapted to remove moisture from the hot moisture-laden drying air exiting the drum, **characterized in that**, said door (3) forms an air passage (5) establishing fluid communication with said drum (4) for conveying the hot moisture-laden drying air exiting the drum (4) towards and into said condenser means, said door (3) further forming one or more cavities (6) to encapsulate an aerogel layer (7) therein, so as to thermally insulate from the outside said door (3) forming said air passage (5).
2. Clothes dryer according to claim 1, wherein said door (3) comprises a door frame (8) that has an inner side (10), which is arranged so as to face the interior of the drum when said door (3) is closed, and an outer side (11) facing the outside of the machine, said inner side (10) of the door frame (8) forming the air passage (5) adapted to convey the hot moisture-laden drying air exiting the drum (4) towards and into the condenser means.
3. Clothes dryer according to claim 2, wherein said air passage (5) is formed by the inner side (10) of the door frame (8) and an air collecting member (12) provided so as to protrude from said inner side (10) of the door frame (8) towards the drum (4) to receive and collect the air flowing out of the same drum.
4. Clothes dryer according to claim 3, wherein said air collecting member (12) has an inflow portion (13) provided so as come to lie in proximity of an aperture of the drum (4) when the door (3) is closed.
5. Clothes dryer according to claim 4, wherein said inflow portion (13) comprises a surface provided with

a plurality of perforations through which the drying air is able to flow from the drum (4) towards and into said air passage (5), said inflow portion (13) being adapted to perform as a lint filter for retaining fluff carried by the drying air exiting the drum.

6. Clothes dryer according to claim 5, wherein said air collecting member (12) defines an abutment frame (14) extending around the inflow portion (13) and provided peripherally with seal means (15), said frame (14) being adapted to move, when the door (3) is closed, into abutment against a correspondingly shaped undercut provided on the outer casing (2), said seal means (15) being in turn adapted to establish an air-tight coupling between the peripheral edge of the frame (14) and the undercut of the outer casing (2) when the door (3) is closed, so as to force the drying air exiting the drum (4) to solely pass through the perforations in the inflow portion (13) of the air collecting member (12) and, as a result, to flow into the air passage (5) of the door (3).
7. Clothes dryer according to claim 6, wherein the inner side (10) of the door frame (8) defines an air deflecting surface, on which the stream of drying air flowing in from the drum (6) is able to flow to be diverted and conveyed towards an outflow aperture provided in the air passage (5) and fluidly communicating with the condenser.
8. Clothes dryer according to claim 7, wherein the outer side (11) of the door frame (8) forms a plurality of cavities or compartments (6) that are separated from each other by partitions adapted to contain aerogel granules (7) therein.
9. Clothes dryer according to claim 8, wherein an outer panel (16) is adapted to be applied on to the door frame (8) to encapsulate said aerogel granules (7) in the interior of the same door (3).

Amended claims in accordance with Rule 86(2) EPC.

1. Clothes tumble dryer comprising an outer casing (2) provided with a loading door (3), a drying air circuit adapted to cause heated air to be circulated through a perforated rotating drum (4) holding the laundry to be dried, heating means adapted to heat up said drying air, condenser means adapted to remove moisture from the hot moisture-laden drying air exiting the drum, when closed, said door (3) forms an air passage (5) establishing fluid communication with said drum (4) for conveying the hot moisture-laden drying air exiting the drum (4) towards and into said condenser means, **characterized in that**, said door (3) further forming one or more cavities (6) to encapsulate an aerogel layer (7) therein, so as to

thermally insulate from the outside said door (3) forming said air passage (5).

2. Clothes dryer according to claim 1, wherein said door (3) comprises a door frame (8) that has an inner side (10), which is arranged so as to face the interior of the drum when said door (3) is closed, and an outer side facing the outside of the machine, said inner side (10) of the door frame (8) forming the air passage (5) adapted to convey the hot moisture-laden drying air exiting the drum (4) towards and into the condenser means.

3. Clothes dryer according to claim 2, wherein said air passage (5) is formed by the inner side (10) of the door frame (8) and an air collecting member (12) provided so as to protrude from said inner side (10) of the door frame (8) towards the drum (4) to receive and collect the air flowing

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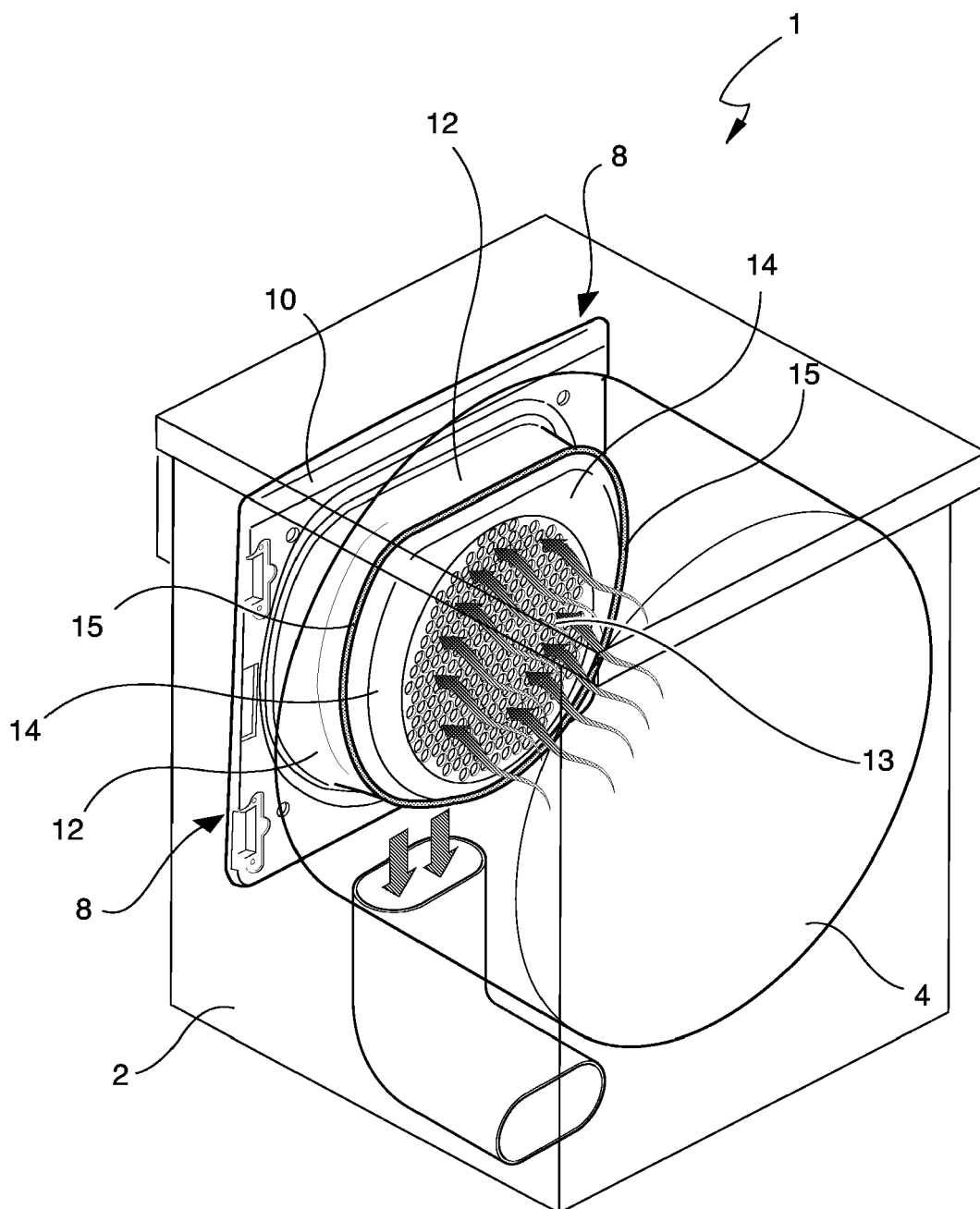


fig.1

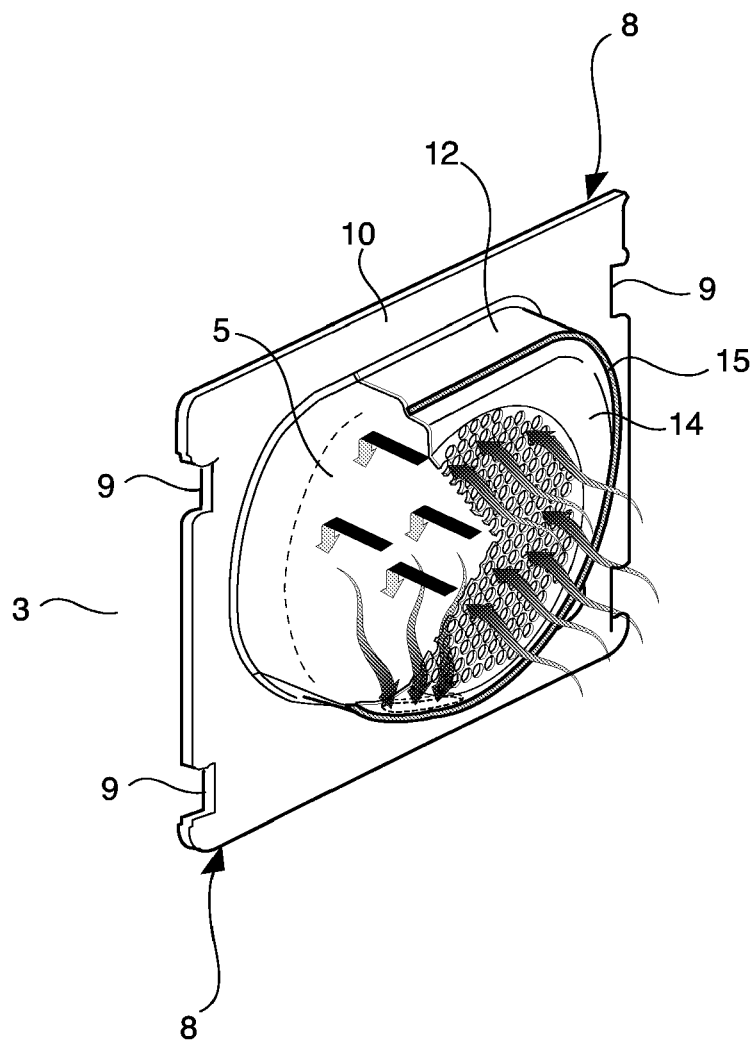


fig.2

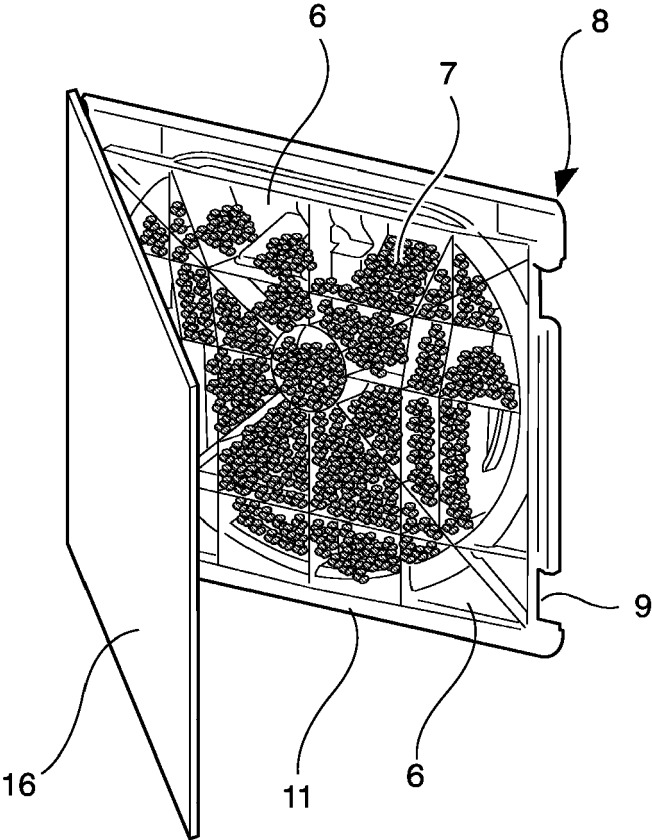


fig.3

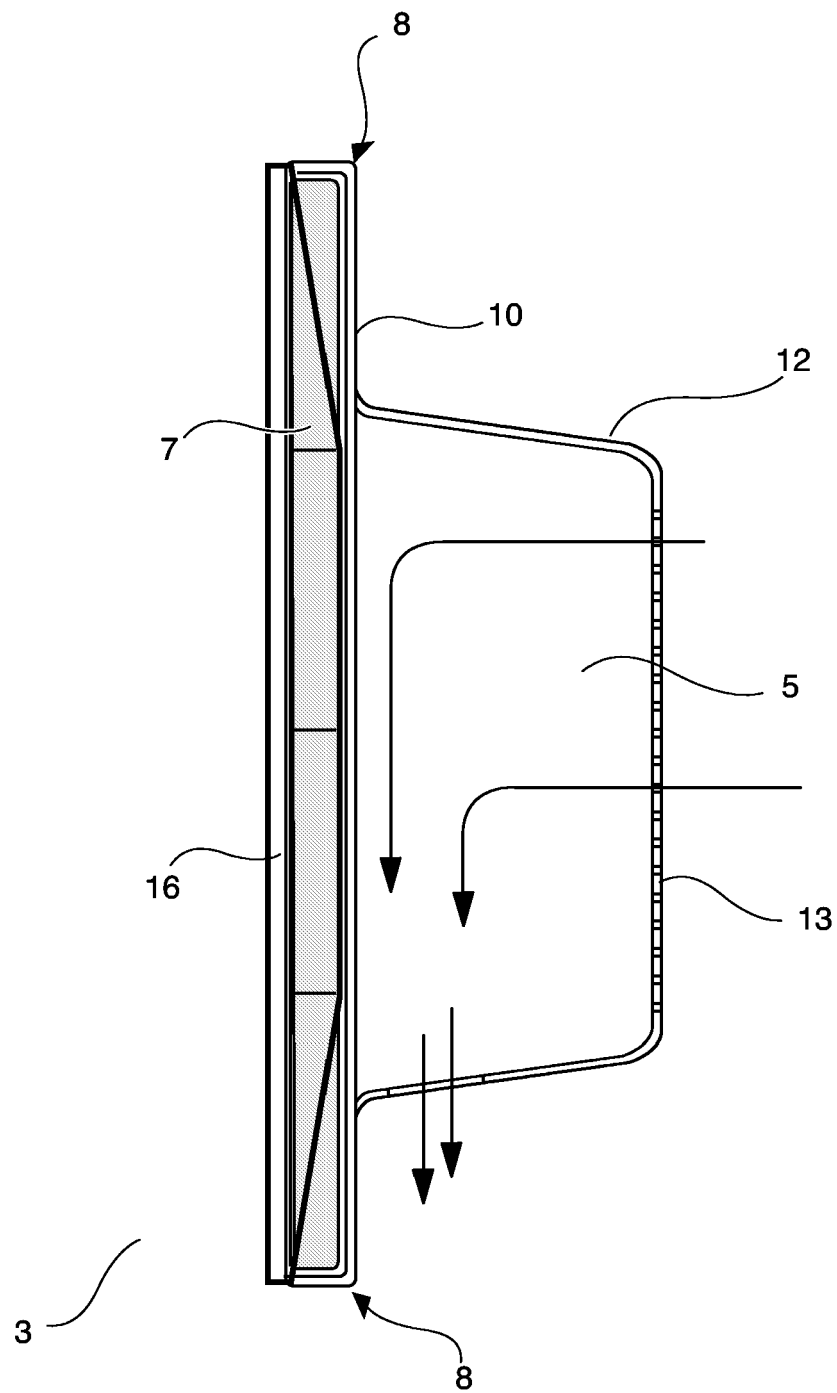


fig.4



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 3 099 542 A (SCOYK HOWARD E. VAN) 30 July 1963 (1963-07-30) * figures *	1-8	INV. D06F58/20 D06F58/02
Y	US 2004/123489 A1 (PANCHERI EUGENE JOSEPH ET AL) 1 July 2004 (2004-07-01) * column 3, paragraph 43; figures *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 June 2006	Examiner DIAZ, M
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EPO FORM 1503 03.82 (P04C01)

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

EP 06 11 1422

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22-06-2006

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REFERENCES CITED IN THE DESCRIPTION

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