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(54) **Heat pump laundry dryer**

(57) The invention refers to a heat pump laundry dryer. A heat pump laundry dryer according to the invention comprises a casing (1) accommodating therein a heat pump system having a refrigerant fluid evaporating unit and a refrigerant fluid condensing unit for carrying out a drying treatment on laundry, said dryer further comprising a basement (8) having a condensate draining path (21) for conveying moisture condensed from a drying air flow towards a reservoir (24), wherein said condensing unit lays over a basement surface (14) which is provided with a condensate guide (26) for driving water condensed onto the condensing unit to the condensate draining path (21).

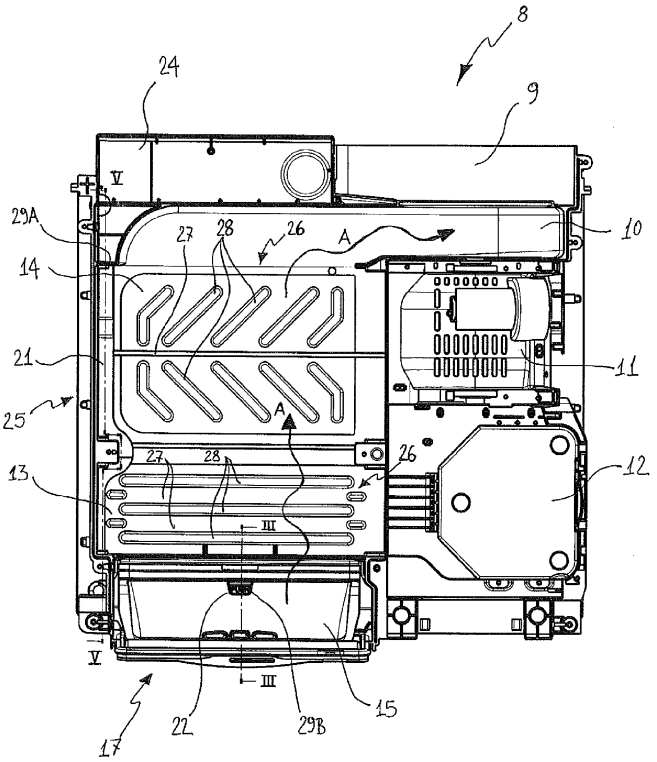

FIG. 2

EP 2 458 074 A1

Description

[0001] Laundry dryers generally comprise a casing that houses a laundry container, like a rotating drum, where laundry to be treated is received, and an air circuit for carrying out drying operation by circulating hot air through the laundry container. In a heat pump laundry dryer, drying air coming out from the laundry container is first dehumidified through a first heat exchanging portion (a refrigerant fluid evaporating unit) of a heat pump circuit, and then heated through a second heat exchanging portion (a refrigerant fluid condensing unit) of the same heat pump circuit thereby achieving a considerable energy saving compared to condenser type laundry dryer. In the latter type of laundry dryer, condensing means in the form of an air-air heat exchanger are provided in the drying air circuit for removing moisture from laundry drying air while heat is generated by an electric resistance placed within the drying air circuit.

[0002] Prior art laundry dryers of heat pump type generally provide draining arrangements in correspondence of a refrigerant evaporating unit where moisture is effectively condensed from a drying air flow, but such dryers have no provision for collecting condensate in other regions of the drying air circuit where temperature may be favorable to moisture condensation. In a laundry dryer of heat pump type, one of the above said regions has been found to be the heat exchanger (a refrigerant fluid condensing unit) provided for heating the drying air flow. This is due to the fact that the position of the condensing unit is quite near to that of the cold surfaces of the evaporating unit and therefore moisture can be further condensed on a region of the condensing unit adjacent to the evaporating unit. Presence of condensate on a condensing unit of a heat pump circuit is particularly undesired because the condensing unit yield drops dramatically.

[0003] In a heat pump type dryer, a further potential moisture condensing surface may be the region in front of the evaporating unit, i.e. a region upstream such unit considering the flow direction of laundry drying air, because the drying air enters that region with the highest amount of humidity with respect to the whole drying air circuit. Since that region may feel the evaporator low temperature, a moisture condensation becomes highly probable. In addition, in said region facing the evaporator unit, drying air flow changes its direction from a substantially vertical plane to a substantially horizontal plane. This causes air to contact drying air conduit walls thereby increasing possibility for a moisture condensation on such walls. A moisture condensation in that region may disadvantageously cause undesired and uncontrolled water shedding.

[0004] In addition, since moisture condensed on parts of the drying air circuit not provided for this aim may contain impurities, such as fluff, scale or the like, when condensate is drained and collected in a reservoir it may damage a pump device provided in the reservoir for pumping collected condensate to a main container placed on an upper portion of the laundry dryer cabinet.

[0005] The aim of the present invention is therefore to solve the noted drawbacks and thus providing a heat pump laundry dryer having an improved condensed water draining circuit.

[0006] An object of the present invention is to provide a heat pump laundry dryer having an improved performance in draining moisture condensed from a drying air flow.

[0007] A further object of the invention is to provide a heat pump laundry dryer having an improved reliability compared to prior art dryers.

[0008] Another object of the invention is to provide a laundry dryer avoiding the risk that moisture, which incidentally condenses on regions of a drying air circuit where temperature is favourable to such condensation can decrease performance of operational components.

[0009] Yet another object of the present invention is to provide a heat pump laundry dryer wherein maintenance intervention operated by specialized technicians are simplified compare to known dryers.

[0010] Advantages, objects, and features of the invention will be set forth in part in the description and drawings which follow and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention.

[0011] The objects and advantages of the invention may be reached and attained by a laundry dryer comprising a casing accommodating therein a heat pump system having a refrigerant fluid evaporating unit and a refrigerant fluid condensing unit for carrying out a drying treatment on laundry, said dryer further comprising a basement having a condensate draining path for conveying moisture condensed from a drying air flow towards a reservoir wherein said condensing unit lays over a basement surface which is provided with a condensate guide for driving water condensed onto the condensing unit to the condensate draining path.

[0012] Preferably, the basement surface comprises a first portion supporting the condensing unit and a second portion, out of said first portion and wherein the condensate draining path is formed.

[0013] Preferably, wherein said first portion is placed on a level that is higher than levels on which condensate path extends, with respect to a common reference surface.

[0014] Preferably, the first portion is placed on a level that is higher than levels on which condensate path extends, with respect to a common reference surface.

[0015] Preferably, the first and second portions form an angle therebetween and said second portion being sloping towards a first cabinet rear wall which is opposite to a second cabinet front wall on which a laundry loading opening is formed.

[0016] Preferably, the condensate guide comprises one or more walls integrally formed with basement and sloping towards the condensate draining path.

[0017] Preferably, the condensate guide comprises a plurality of conveyors configured and arranged for directing condensate towards said one or more sloping walls.

[0018] Preferably, the condensate draining path is integrally formed with basement.

[0019] Preferably, the condensate draining path comprises at least one condensate retaining region thereby forming a liquid trap for preventing drying air dispersing along path from entering reservoir.

[0020] Preferably, at least one condensate retaining region (29B) comprises a filter (22).

[0021] Preferably, at least one condensate retaining region comprises a siphon-shaped surface.

[0022] Preferably a condensate retaining region is placed in proximity of the basement surface between the reservoir and a basement surface portion which is out of a portion supporting the condensing unit.

[0023] Preferably, the reservoir is arranged in proximity of a first cabinet rear wall which is opposite to a second cabinet front wall on which a laundry loading opening is formed.

[0024] Preferably, the evaporating unit lays over a further basement surface which is provided with a further condensate guide for driving water condensed onto the evaporating unit to the condensate draining path.

[0025] Preferably, the condensate draining path extends on an edge region of the basement from a region where drying air exiting a laundry container changes its flow direction from a substantially vertical plane to a substantially horizontal plane before entering a drying air moisture removing unit, towards said reservoir.

[0026] Preferably, the reservoir is in fluid communication with a main container placed on a top region of the cabinet, a pumping device being provided for transferring condensate from reservoir to the main container.

[0027] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate possible embodiments of the invention and together with the description serve to explain the principles of the invention. Like reference numbers represents like features throughout the accompanying drawings, wherein:

[0028] Figure 1 shows a perspective view of a laundry dryer according to the invention;

[0029] Figure 2 shows a plane view of a first embodiment of a basement for a laundry dryer according to the invention;

[0030] Figure 3 shows a cross sectional view taken along line III-III in Figure 2;

[0031] Figure 4 shows a perspective view of a front part of basement shown in Figure 2 with a disassembled fluff filter;

[0032] Figure 5 shows a side cross sectional view taken along line V-V in Figure 2;

[0033] Figure 6 shows a perspective cross sectional view taken along line V-V in Figure 2;

[0034] Figure 7 shows an enlarged view of a part of Figure 2 with evidenced areas for supporting a refrigerant fluid evaporating unit and a refrigerant fluid condensing unit;

[0035] Figure 8 shows a rear perspective view of a portion of laundry dryer illustrated in Figure 1;

[0036] With reference to Figure 1, a laundry dryer according to the invention comprises a casing 1 formed by a first couple of upright side walls 2A, 2B arranged on a front and rear side of the treating machine and by a second couple of upright side wall 2C, 2D arranged on lateral sides of such machine. An upper wall portion 3 and a bottom wall portion 4 close the ends of the box-like structure formed by the upright side walls 2A, 2B, 2C, 2D, joined together.

[0037] A laundry container comprising a drum (not shown) rotatably mounted within the casing 1. Further operational devices, such as heat exchanging devices, fluid conduits, fluid pumping devices and so on, for carrying out a drying treatment on laundry are provided within the casing 1. A front door 5, pivotally coupled to the front upright side wall 2A, is provided for closing a laundry loading opening allowing access to the drum interior region to place laundry to be treated therein.

[0038] An extractable moisture tank in the form of a drawer 6 is slidably arranged on the top of the casing 1, for being periodically emptied by a user in case the laundry dryer cannot be connected to a waste water net through a pipe. A user control interface 7 is arranged on the top of the casing 1 near the drawer 6 for input of laundry drying programs and displaying machine working conditions.

[0039] On a bottom inner portion of the casing 1 a basement 8 is provided as supporting structure for operational devices of drying machine. In Figure 2 it is disclosed a first embodiment of a basement 8 suitable for being mounted on a heat pump type laundry drying machine. Basement 8 comprises a fan seat portion 9 for partly receiving a fan (not shown) that receives drying air, i.e. air circulating within a drying air circuit that fluidly connects a laundry container with air dehumidifying and air heating devices, from a conduit 10 collecting drying air after it is passed through said dehumidifying and heating devices. An electric motor seat 11 is arranged between the fan seat 9 and a refrigerant fluid compressor seat 12 such that an electric motor (not shown) may be accommodated on seat 11 and operatively connected to a fan and a refrigerant fluid compressor for powering them through a single shaft line.

[0040] A refrigerant fluid compressor (not shown) is received on its seat 12 and forms part of a heat pump system which is further provided with a refrigerant fluid evaporating unit and a refrigerant fluid condensing unit for respectively dehumidifying and heating drying air passing therethrough. Such evaporating unit and condensing unit may be accommodated on supporting surfaces 13, 14 formed onto basement 8. The refrigerant fluid condensing unit supporting surface 14 faces conduit 10 such that drying air heated by said condensing unit

may be cyclically directed towards a fan inlet and then supplied to a laundry container.

[0041] A surface 15 is provided in a basement region 17 upstream of said refrigerant fluid evaporating unit supporting surface 13 considering the drying air flow direction schematically indicated by arrows A in Figure 2. Surface 15 is placed at the bottom of a chamber 16 (Figure 3) and it is slightly sloping towards the refrigerant fluid evaporating unit. Chamber 16 receives drying air coming out from a laundry container lying over the basement 8 and then directs such air towards the refrigerant fluid evaporating unit for removing moisture therefrom by a condensing operation. Inside chamber 16 drying air changes its flow direction from a substantially vertical plane to a substantially horizontal plane before reaching the refrigerant fluid evaporating unit. Furthermore, within chamber 16, the basement region 17 is, preferably, provided with a fluff filter 18 extending in a transverse direction relative to the drying air flow schematically indicated by arrow A in Figure 3. Periodical cleaning of fluff filter 18 may be performed manually by removing filter 18 after having accessed chamber 16 through an opening 32 (Figure 4) covered by a hinged door 20.

[0042] Since surface 15 faces the evaporating unit of the heat pump system, i.e. a heat exchanger capable of condensing moisture contained in drying air, and considering that chamber 16 receives drying air after it has just left the laundry container, i.e. air highly enriched in moisture, surface 15 is arranged to drain moisture that condenses before entering the evaporating unit. A portion of a condensate draining path 21, 29B, 30B is therefore provided on surface 15 of basement region 17, i.e. in a front portion thereof. As mentioned above surface 15 is slightly sloping towards the refrigerant fluid evaporating unit, therefore condensate may flow towards path 21 sliding on surface 15 under gravity force effect. Walls 35 protrude from surface 13 to form a condensate collecting portion 36 that, when filled with condensate, generates a liquid trap preventing drying air entering chamber 16 to by-pass filter 18 escaping underneath the latter. In this way drying air rich in fluff is not passed towards the evaporating unit without being filtered through filter 18. Since drying air within chamber 16 has not yet passed through fluff filter 18, moisture condensed in that basement region 17 may have a relatively large amount of fluff impurities dispersed therein, for this reason a filter 22 is preferably provided onto the surface 15. In this way, condensate is filtered by filter 22 before entering the draining path 21. In order to allow periodical cleaning of filter 22, the later is, preferably, associated to a removable support 23 mountable on surface 15 by arranging it on a region 29B formed on such surface 15 as shown in Figure 4 and as it will be further described below.

[0043] As illustrated in Figure 2, condensate draining path 21, that is preferably made integral with basement 8, extends from a front to a rear side of basement 8 along an edge region 25 thereof, and preferably in a direction which is substantially parallel to a drying air flow direction schematically indicated by arrows "A" in Figure 2. In particular, condensate draining path 21 is configured and arranged not only to collect condensate dropped from the refrigerant fluid evaporating unit and that formed within chamber 16 as described above, but also condensate that may incidentally drop from the refrigerant fluid condensing unit. In order to remove said condensate and conveying it towards a reservoir 24 provided on basement 8, and preferably integrally molded thereon, condensate draining path 21 is in fluid communication with the evaporating unit supporting surface 13 and with the condensing unit supporting surface 14 thereby avoiding undesired condensate accumulation on operational devices of laundry machine. Preferably, as shown in Figures 2, 6 and 7, condensate draining path 21 runs onto a basement surface portion 25 that supports neither the refrigerant evaporating unit nor the refrigerant condensing unit whose resting areas 40, 41 have been indicated in Figure 7 with a couple of rectangular hatches over supporting surfaces 13, 14, respectively. Over the condensate draining path 21 it may extend only pipes bent portions for circulating a refrigerant inside said evaporating and condensing units, however, such pipes bent portions lays on higher planes relative to path 21 surface and therefore they do not touch the latter that remains free from obstructions and let the condensate to be drained towards reservoir 24. In other words, condensing draining path 21 preferably surrounds supporting surfaces 13, 14 without passing through them.

[0044] In practice, condensate draining path 21 extends along a basement surface portion 25, which is free from evaporating and condensing units that therefore do not rest on that portion of the basement 8.

[0045] Each of said supporting surfaces 13 and 14 comprises at least one condensate guide 26 that extends transversally relative to condensate draining path 21 and has one or more walls 27, preferably sloping walls, integrally formed with basement 8 that extend transversally with respect to the extending direction of condensate draining path 21 and slope towards the latter such that condensate, under gravity force, flows to path 21. Further conveyors 28 configured and arranged for directing condensate towards sloping walls 27 are provided onto supporting surfaces 13 and 14, and such conveyors 28 may serve as resting surfaces for refrigerant fluid condensing and evaporating units.

[0046] Figure 5 shows a side cross sectional view of basement 8 taken along line V-V in Figure 2. As it can be seen, condensate draining path 21 slopes from the front part of basement (right side in Figure 5) to the rear part thereof (left side in Figure 5). In addition, supporting surfaces 13 and 14 are placed on a level "H" that is higher than levels "h" of condensate path 21 relative to the resting surface of basement 8 on a floor and form an angle with the path 21 extension surface. In other words, with a resting surface of basement 8 on a floor as reference, the basement surface portion 25 shown in Figures 2, 6 and 7 extends on a lower level compared to supporting

surfaces 13, 14. In this way, under gravity force, condensate can first flow from supporting surfaces 13, 14 into path 21 and then towards a reservoir 24.

[0047] As shown in Figure 8, reservoir 24 is advantageously placed in the rear part of basement 8 in proximity of, but without being covered by, cabinet rear wall 2B, i.e. the wall opposite to cabinet wall 2A provided with a laundry loading opening closed by a hinged door 5. Furthermore, reservoir 24 is protected by a cover 42 associated to the cabinet rear wall 2B through a screw or the like. In this way, reservoir 24 may be easily accessible from the outside rear part of machine casing 1 by removing cover 42 and without the need to disassemble the whole rear side upright cabinet wall 2B. Further advantageously, reservoir 24 may be integrally molded with basement 8.

[0048] Condensate received within reservoir 24 is pumped up by a pumping device 43 to an extractable moisture tank in the form of a drawer 6 (Figure 1) placed on a front upper portion of the cabinet 1 for periodical emptying operation. By accessing reservoir 24 it is possible to reach pumping device 43 and a level sensor 44 that measures level of condensate within reservoir 24 to switch pumping device on only when condensate reaches a predetermined level within reservoir 24, maintenance operations can therefore be simplified.

[0049] As disclosed in the attached Figures, condensate air path 21 extends at least partly within drying air circuit while reservoir 24 is placed outside such circuit, i.e. it is separated from drying circuit. Therefore, in order to prevent drying air drained together with condensate along path 21 from reaching and entering reservoir 24, one or more condensate retaining regions 29A, 29B are provided in the condensate draining path 21 and/or on reservoir 24. The aim of said retaining regions 29A, 29B is to create a liquid barrier or trap to air that may accidentally be drained, i.e. dispersed through path 21. This can be achieved, for example, by a siphon-shaped surface 30A that may have an outlet opening 36A placed either upstream of a passage 31 leading condensate from path 21 to reservoir 24 as depicted in Figure 6, or forming itself the opening 31, i.e. coinciding with opening 31 such that said siphon-shaped surface 30A has an outlet section within reservoir 24. In an alternative embodiment the outlet opening 36A can be provided downstream of opening 31.

[0050] Since a high probability to drain drying air though condensate draining path 21 exists in the basement region 17 upstream of said refrigerant fluid evaporating unit supporting surface 13, it is preferred that a further condensate retaining region 29B (Figures 2-4 and 6) is provided onto surface 15 placed at the bottom of chamber 16. Such region 29B, advantageously in the form of a siphon-shaped surface 30B, may provide a seat for the condensate filter and, preferably, may removably receive the support 23 of filter 22.

[0051] Either of condensate retaining regions 29A, 29B may be integrally formed onto basement 8 as part of the condensate draining path 21.

[0052] A further way to provide a liquid trap to drying air may be that of keeping opening 31 under a water head. This may be achieved by increasing the minimum water level inside the reservoir 24 on which pumping device 43 is activated for pumping condensate up to the extractable moisture tank in the form of a drawer 6. A water level increase can be obtained, in principle, by moving pumping device 43 and the condensate level sensor 44 higher relative to the resting surface of basement 8 on a floor. The applicant has found that the positioning height of pumping device 43 and level sensor 44 must taking into consideration geometrical height dimensions of basement 8, and in particular level "H" of supporting surfaces 13, 14 and height "h" (Figure 5) of condensate draining path 21 that constitutes limits for said positioning, beyond which a water reflux from reservoir 24 towards and over surfaces 13, 14 would be produced, thereby causing an undesirable dramatic drop of condensing and/or evaporating units yield. The effective location of pumping device 43 and level sensor 44 is actually a compromise between the above geometrical limits and the need of forming a sufficient water head into reservoir 24 so as to generate a liquid trap for air dispersing along condensate draining path 21.

[0053] As it can be inferred from the description above, a laundry dryer according to the invention has an efficient and reliable condensed moisture draining circuit. In addition, the present invention allows to collect moisture that may incidentally condense onto regions of the drying air circuit where temperature is favorable and to efficiently drain it towards a reservoir. In this way condensate formed on undesired regions of a drying air circuit does not represent a source of possible performance reduction for operational components of a laundry dryer.

[0054] Advantageously, fluff incidentally flushed away by condensing moisture from surfaces onto which it may be accumulated is prevented from reaching a reservoir where condensate is collected thereby avoiding damages to a pump provided for pumping condensate from said reservoir to a main water container.

[0055] The present invention can be applied to all machine suitable to carry out a drying treatment on laundry, i.e. it can be applied on a heat pump type laundry dryer, a condenser type laundry dryer or a washing-drying machine, that is a machine adapted to both washing and drying laundry.

Claims

1. A laundry dryer comprising a casing (1) accommodating therein a heat pump system having a refrigerant fluid evaporating unit and a refrigerant fluid condensing unit for carrying out a drying treatment on laundry, said dryer further comprising a basement (8) having a condensate draining path (21) for conveying moisture condensed from a drying air flow

towards a reservoir (24) **characterized in that** said condensing unit lays over a basement surface (14) which is provided with a condensate guide (26) for driving water condensed onto the condensing unit to the condensate draining path (21).

2. A laundry dryer according to claim 1 wherein said basement surface (14) comprises a first portion (41) supporting the condensing unit and a second portion (25), out of said first portion (41) and wherein the condensate draining path (21) is formed.

3. A laundry dryer according to claim 1 or 2 wherein said first portion (14) is placed on a level (H) that is higher than levels (h) on which condensate path (21) extends, with respect to a common reference surface.

4. A laundry dryer according to any preceding claim wherein said first and second portions (14, 25) form an angle therebetween and said second portion (25) being sloping towards a first cabinet rear wall (2B) which is opposite to a second cabinet front wall (2A) on which a laundry loading opening is formed.

5. A laundry dryer according to any preceding claim wherein the condensate guide (26) comprises one or more walls (27) integrally formed with basement (8) and sloping towards the condensate draining path (21).

6. A laundry dryer according to claim 5 wherein the condensate guide (26) comprises a plurality of conveyors (28) configured and arranged for directing condensate towards said one or more sloping walls (27).

7. A laundry dryer according to any preceding claim wherein the condensate draining path (21) is integrally formed with basement (8).

8. A laundry dryer according to any preceding claim wherein said condensate draining path (21) comprises at least one condensate retaining region (29A, 29B) thereby forming a liquid trap for preventing drying air dispersing along path (21) from entering reservoir (24).

9. A laundry dryer according to claim 8 wherein said at least one condensate retaining region (29B) comprises a filter (22).

10. A laundry dryer according to claim 8 or 9 wherein said at least one condensate retaining region (29A, 29B) comprises a siphon-shaped surface (30A, 30B).

11. A laundry dryer according to any claim 8 to 10 wherein a condensate retaining region (29A) is placed in proximity of the basement surface (14) between the reservoir (24) and a basement (8) surface portion (25) which is out of a portion (41) supporting the condensing unit.

12. A laundry dryer according to any preceding claim wherein the reservoir (24) is arranged in proximity of a first cabinet rear wall (2B) which is opposite to a second cabinet front wall (2A) on which a laundry loading opening is formed.

13. A laundry dryer according to any preceding claim wherein said evaporating unit lays over a further basement surface (13) which is provided with a further condensate guide (26) for driving water condensed onto the evaporating unit to the condensate draining path (21).

14. A laundry dryer according any preceding claim wherein the condensate draining path (21) extends on an edge region (25) of the basement (8) from a region (17) where drying air exiting a laundry container changes its flow direction from a substantially vertical plane to a substantially horizontal plane before entering a drying air moisture removing unit, towards said reservoir (24).

15. A laundry dryer according to any preceding claim wherein the reservoir (24) is in fluid communication with a main container (6) placed on a top region of the cabinet (1), a pumping device being provided for transferring condensate from reservoir (24) to the main container (6).

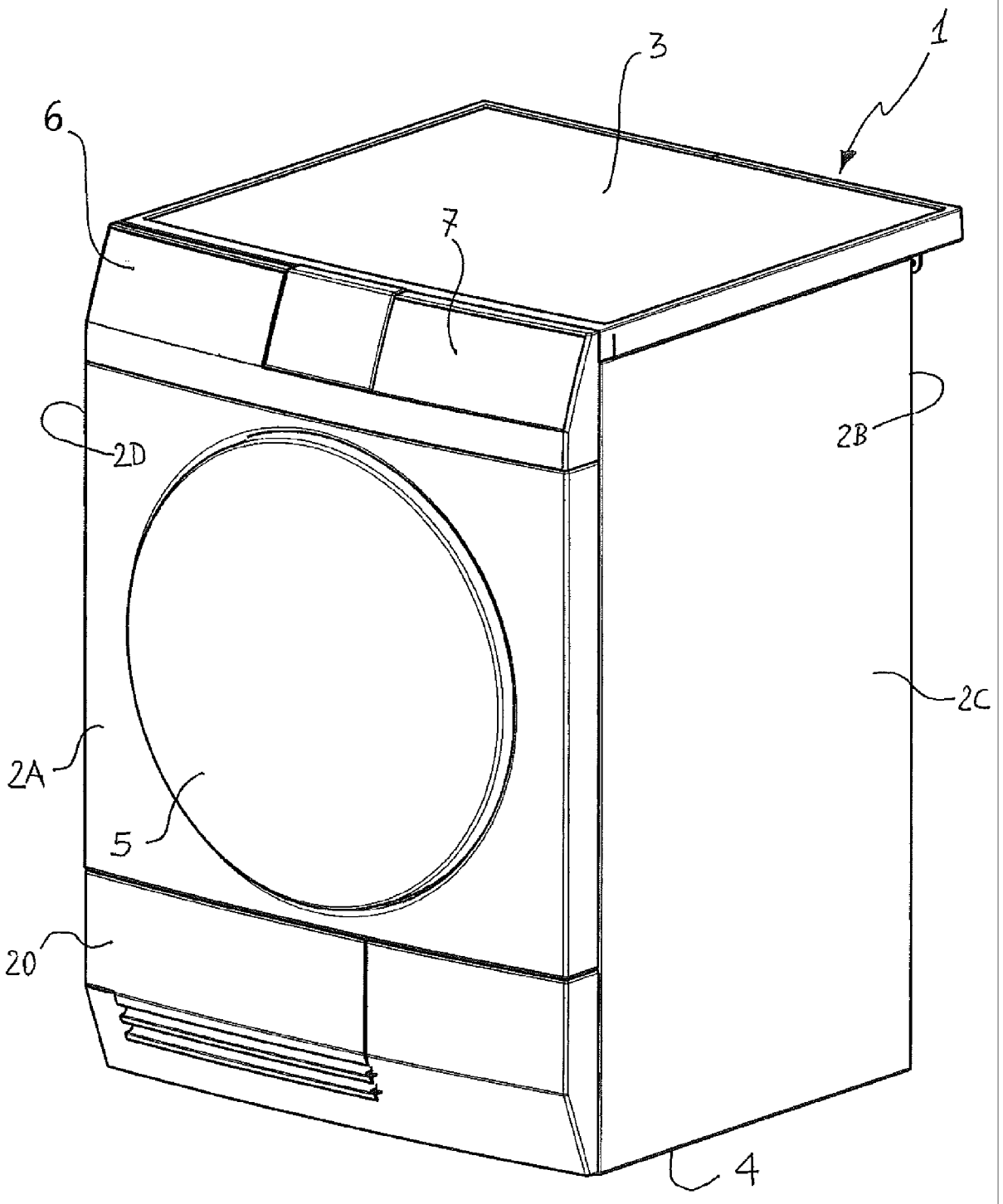

FIG. 1

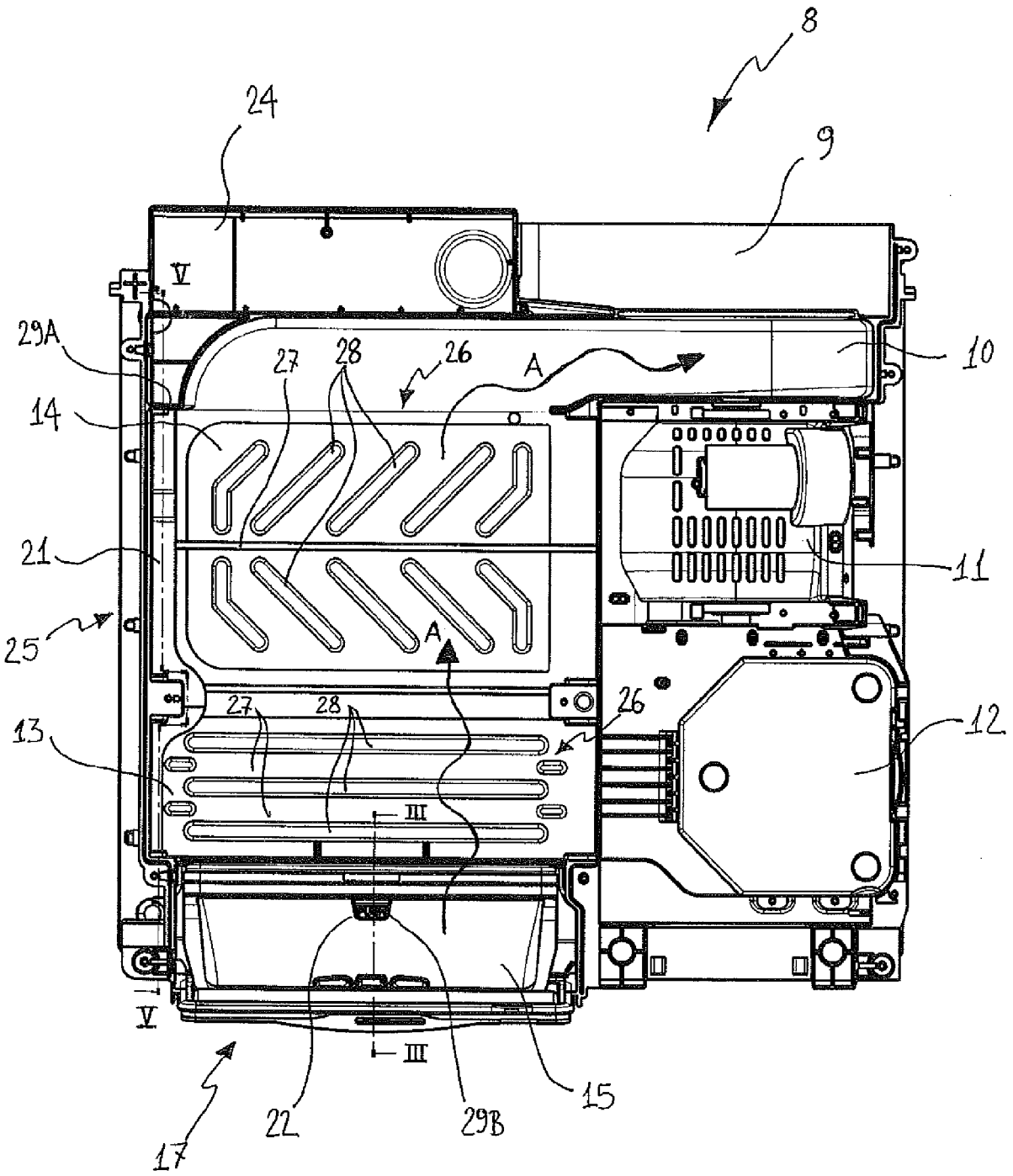
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FIG.2

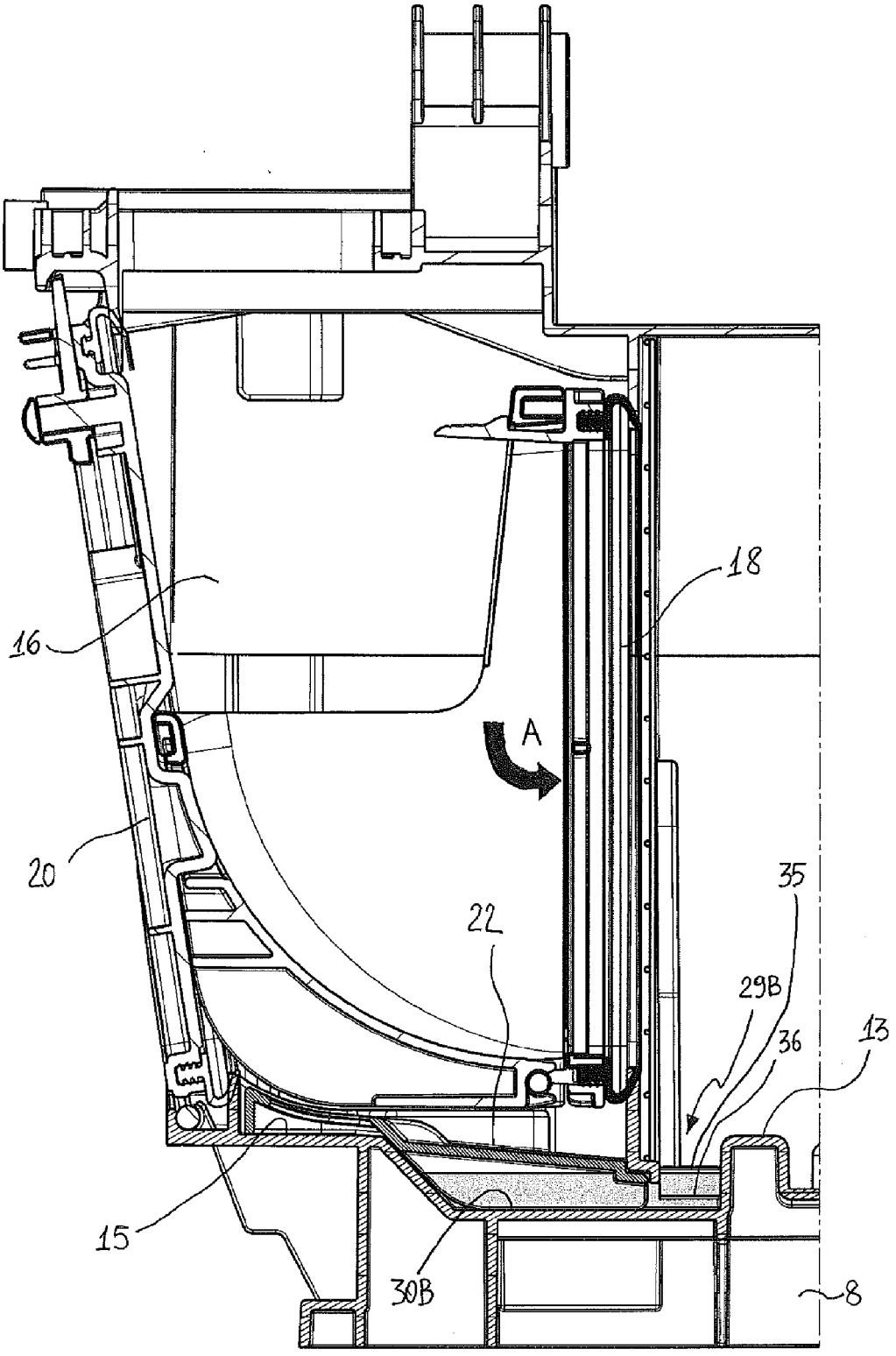

FIG. 3

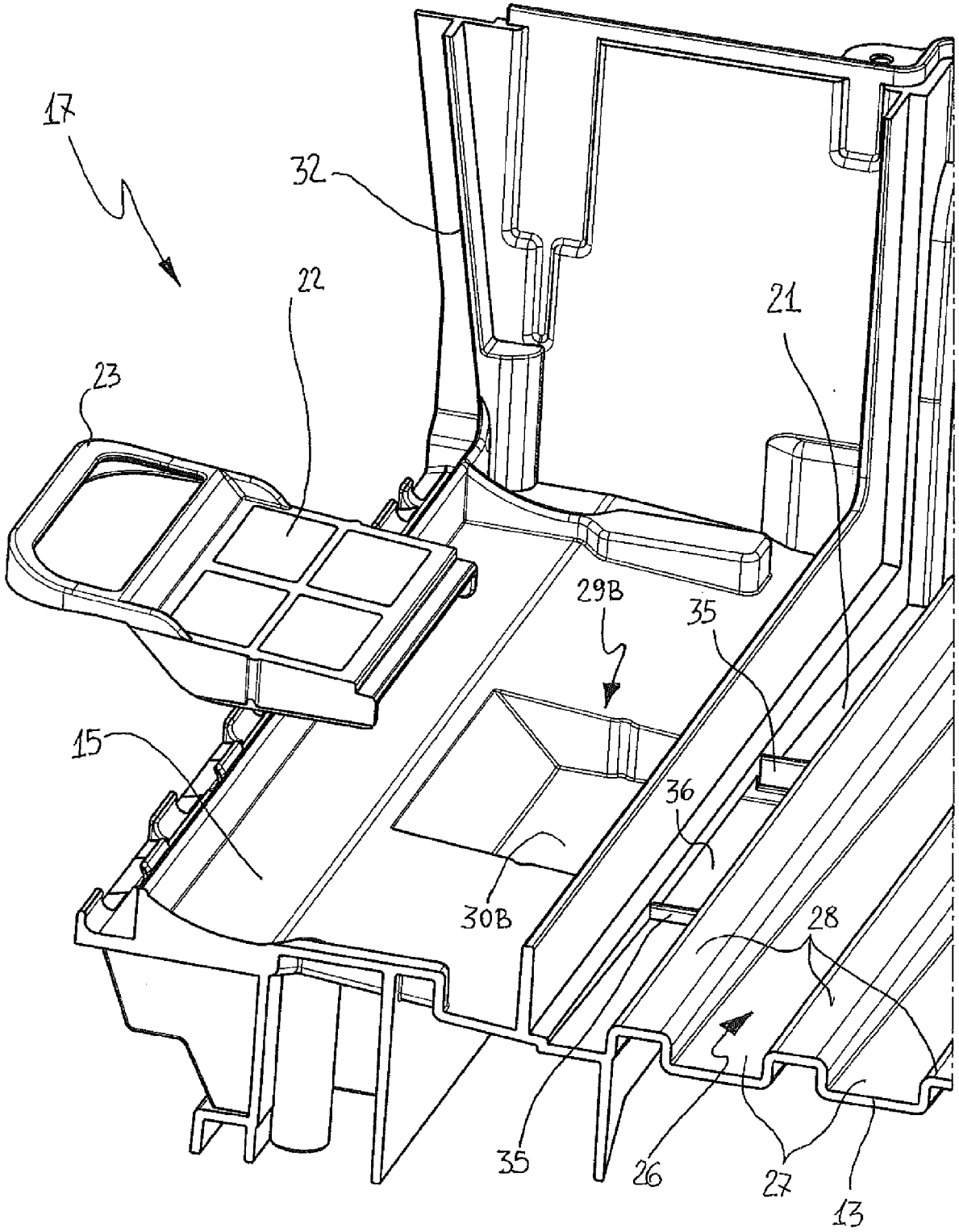

FIG. 4

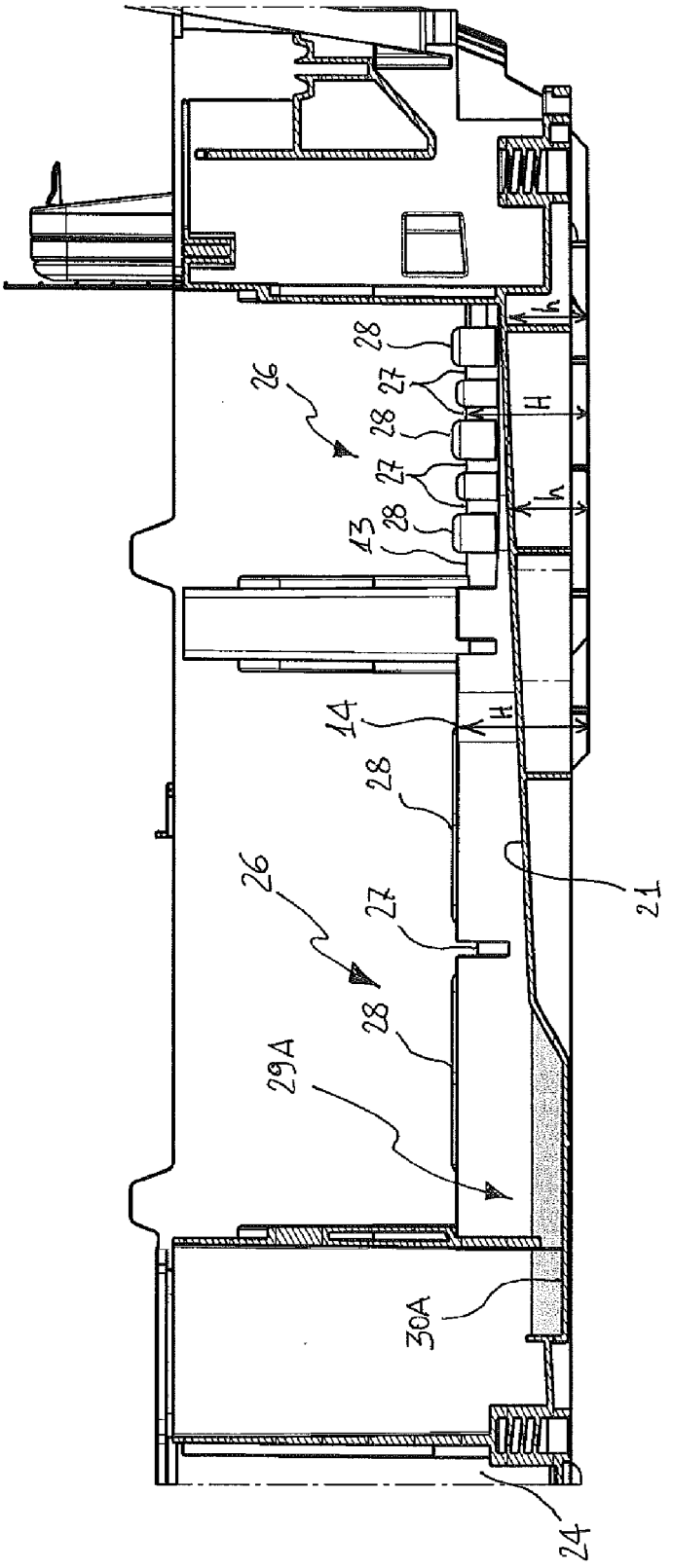

FIG. 5

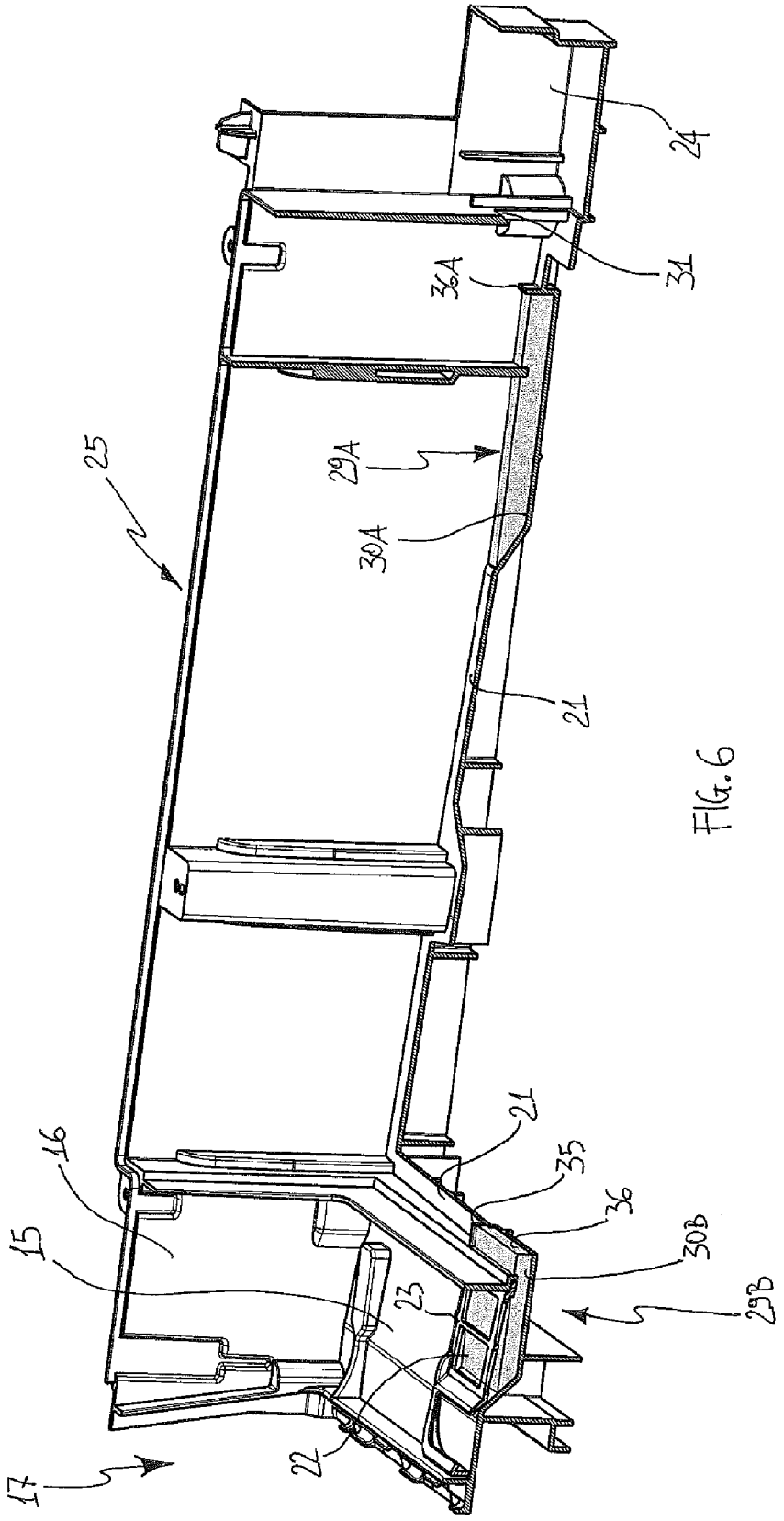

FIG. 6

FIG. 7

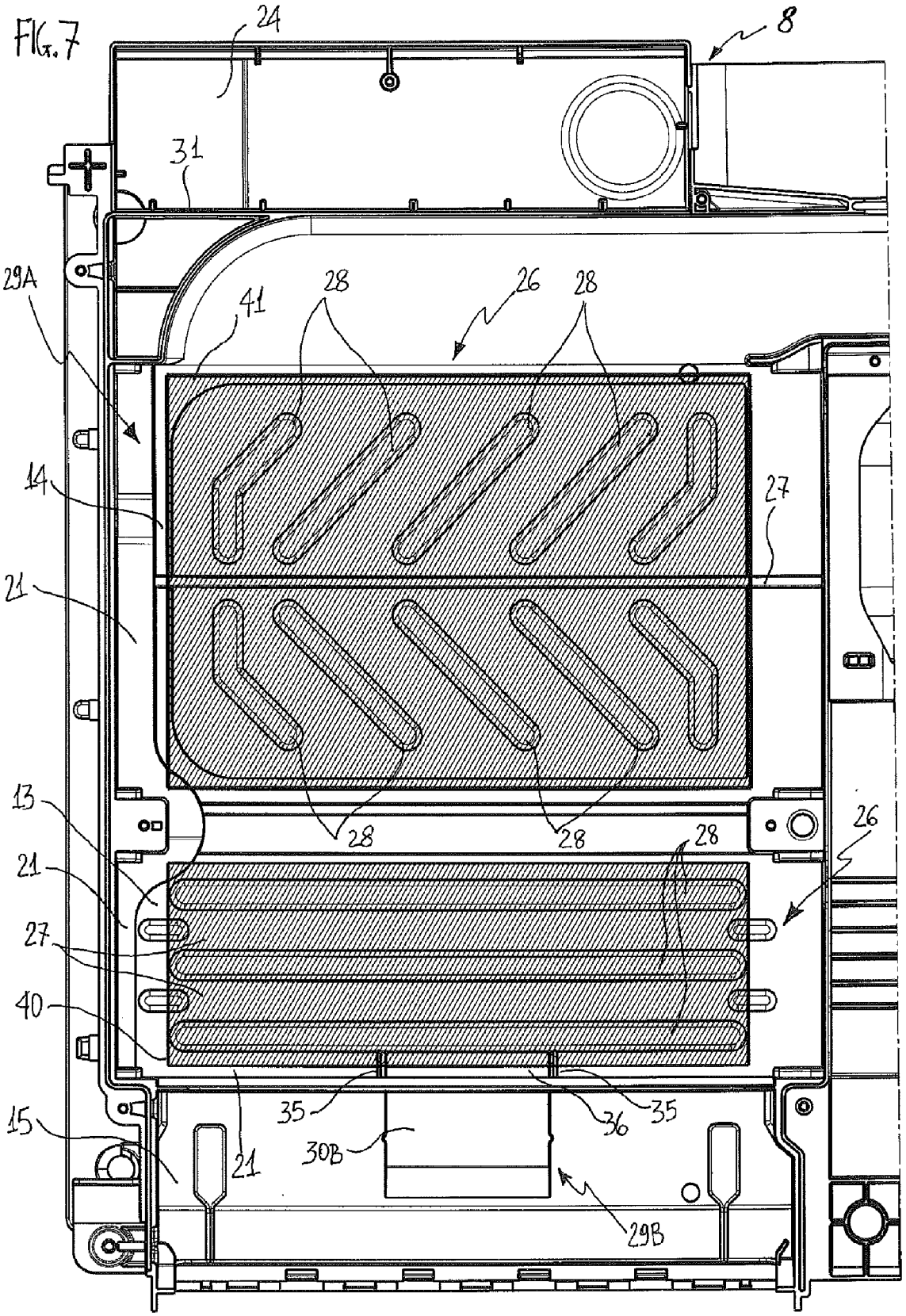
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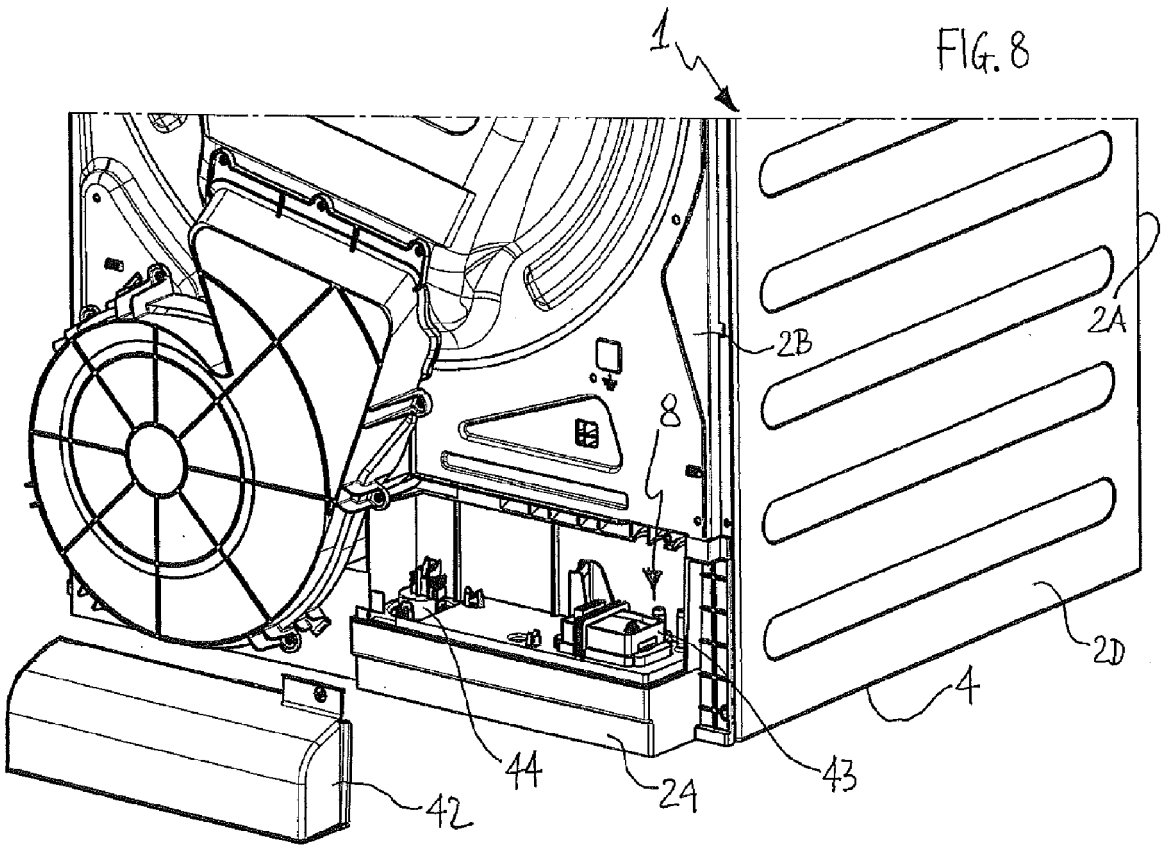
FIG. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 10 19 2931

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 1 550 764 A1 (LG ELECTRONICS INC [KR]) 6 July 2005 (2005-07-06) * paragraph [0037] - paragraph [0052]; figures 2-3 *	1-7, 12-15 8-11	INV. D06F58/24
X	EP 0 211 418 A2 (ZANUSSI ELETTRODOMESTICI [IT]) 25 February 1987 (1987-02-25) * page 4, line 9 - page 5, line 28 *	1	
Y A	DE 203 04 521 U1 (MIELE & CIE [DE]) 22 May 2003 (2003-05-22) * page 2, line 20 - page 3, line 20; figures 3,4 *	8-11 1-7, 12-15	
A	US 2006/272173 A1 (MYUNG HWAN J [KR]) 7 December 2006 (2006-12-07) * paragraph [0040] - paragraph [0048]; figure 3 *	1-15	
A	DE 33 11 077 A1 (LICENTIA GMBH [DE]) 4 October 1984 (1984-10-04) * page 4, line 1 - page 5, line 6 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 June 2011	Hannam, Martin

CATEGORY OF CITED DOCUMENTS

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E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

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