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(54) **Washing machine**

(57) A washing machine (4) comprises a liquid recirculation system the with an ejector (20) having an inlet opening (1) in flow communication with a supply duct (21), a suction opening (2) in flow communication with a first recirculation duct connected to the bottom (13) of the washing tub (6), and an outlet opening (3) in flow

communication with at least one second or third recirculation duct, wherein the second recirculation duct includes a cleaning agent compartment (11) and the third recirculation duct (27) bypasses the cleaning agent compartment (11).

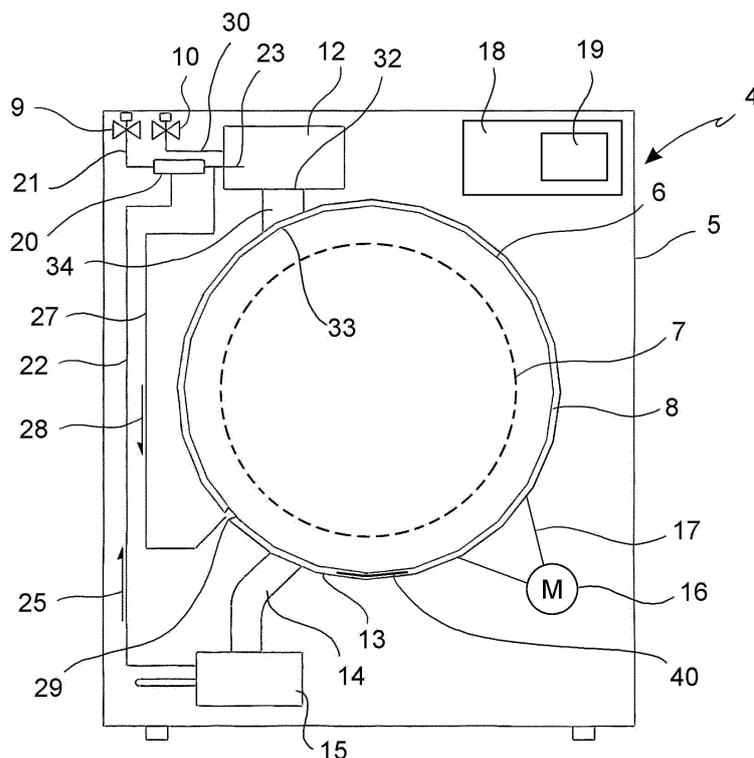


FIG. 1

Description

[0001] The present invention relates to a device and method for washing laundry, particularly a household washing machine.

[0002] The household washing machines comprise a support structure and a housing, inside which a washing tub is housed, which is provided with a front opening that can be closed by a porthole door frontally hinged to the housing. A basket to receive the laundry to be subjected to the washing operation is housed inside the washing tub, in a rotatable manner about a horizontal or inclined axis. The basket also defines a front opening arranged at the washing tub opening, in order to be able to carry out the laundry loading and unloading.

[0003] The washing tub is suitable to hold the washing liquid during the laundry washing steps.

[0004] In order to allow the loading of the tub with grid water and cleaning substances and additives, a system for loading the washing water is provided for, which is connectable to the water supply system. A drain duct is provided for on the washing tub bottom, with an associated drain pump that provides for the removal of the washing liquid from the tub and that controls, together with the loading system, the liquid level inside the tub. In order to heat the washing liquid contained in the tub, an electric resistor is provided for, which is arranged inside the tub in the interspace between the tub wall and the laundry basket.

[0005] The washing and washer-dryer machines of the prior art, and the washing and drying methods implemented thereby, while being satisfactory from several aspects, are bulky and have a high consumption of water, electric power, and cleaning agent.

[0006] In order to decrease the consumption of water and cleaning agent, it is known to provide the washing machines with recirculation systems that remove the washing liquid from the tub and put it back into the laundry basket, so that a reduced liquid volume is repeatedly poured onto the laundry to be washed. Such recirculation systems typically use an electric recirculation pump that, however, consumes electric power, in addition to increase the manufacturing cost and the overall dimensions of the washing machine.

[0007] Furthermore, pumps are known, which are referred to as ejectors, which use the Venturi effect of a converging-diverging nozzle to convert the pressure energy of a driving fluid into velocity energy, which, in turn, creates a low pressure that draws and drags a driven fluid. The driving fluid and the dragged driven fluid may be liquids or gases. Fig. 8 schematically illustrates a typical ejector with an inlet nozzle 1 for the driving fluid, a suction opening 2 for the driven fluid, and a convergent-divergent outlet nozzle 3 for the flow of the mixed driving and drive fluids.

[0008] Therefore, the main object of the present invention is to provide a washing machine, as well as a washing method, which use an ejector (jet pump) for the recircu-

lation of the washing liquid, and which are configured so as to reduce the consumptions of water, cleaning agent, and electric power.

[0009] A further object of the invention is to provide a washing machine with an improved water and cleaning agent supply system.

[0010] These and other objects are achieved by a washing machine comprising:

- 10 - a laundry basket supported within a washing tub suitable to hold a washing liquid,
- a first supply duct for supplying grid water into the washing tub,
- a drain duct to drain the washing liquid from the washing tub,
- 15 - a cleaning agent container having at least one cleaning agent compartment suitable to hold a cleaning agent,
- an ejector (jet pump) having an inlet opening in flow communication with the first supply duct, a suction opening, and an outlet opening,
- 20 - a first recirculation duct connecting in flow communication a bottom of the washing tub with the suction opening of the ejector,
- 25 - a second recirculation duct connecting the outlet opening of the ejector in flow communication with the laundry basket (8).

[0011] According to an aspect of the invention, at least one further supply duct is provided that is connectable to the water supply system by the first supply valve or by a further supply valve and in flow communication with the cleaning agent compartment, bypassing the ejector.

[0012] According to a further aspect of the invention, the second recirculation duct connects the outlet opening of the ejector in flow communication with the cleaning agent compartment which in turn is in flow communication with an upper region of the laundry basket.

[0013] According to a further aspect of the invention, a third recirculation duct (27) connects in flow communication the outlet opening (3) of the ejector (20) to the laundry basket (8), bypassing the cleaning agent compartment (11).

[0014] By virtue of the recirculation system with an ejector and by virtue of the use of the ejector together with two parallel reintroduction ducts, a direct one and the other one through the cleaning agent compartment, there is the possibility of:

- 50 A) exploiting the grid water pressure for the pumping action, obviating the cost for an electric recirculation pump, and saving electric power during washing,
- B) repeatedly reusing water and cleaning agent and obtaining a complete emptying of the cleaning agent compartment, thus saving water and cleaning agent.

[0015] Further advantageous aspects of the invention will be apparent from the following description of some

embodiments thereof by way of non-limiting example, with reference to the appended Figures, in which:

- Fig. 1 is a schematic view of a washing machine with a recirculation system according to a first embodiment of the invention;
- Fig. 2 shows an enlarged detail of the recirculation system in Fig. 1;
- Fig. 3 is a schematic view of a washing machine with a recirculation system according to a second embodiment of the invention;
- Fig. 4 shows an enlarged detail of the recirculation system in Fig. 3;
- Fig. 5 is a schematic view of a washing machine with a recirculation system according to a third embodiment of the invention;
- Fig. 6 shows an enlarged detail of the recirculation system in Fig. 5;
- Fig. 7 is a schematic view of a detail of the recirculation system of a washing machine according to a further embodiment;
- Fig. 8 is a theoretical illustration of an ejector,
- Fig. 9 is a schematic view of a washing machine with a recirculation system according to a fourth embodiment of the invention;
- Fig. 10 shows an enlarged detail of the recirculation system in Fig. 9;
- Fig. 11 is a schematic view of a washing machine with a recirculation system according to a third embodiment of the invention;
- Fig. 12 shows an enlarged detail of the recirculation system in Fig. 11;
- Fig. 13 is a schematic view of a washing machine with a recirculation system according to a third embodiment of the invention;
- Fig. 14 shows an enlarged detail of the recirculation system in Fig. 13.

[0016] With reference to the figures, a washing machine 4 or washer-dryer machine, intended as a particular embodiment of the washing machine, comprises a support and housing structure 5, inside which a washing tub 6 is housed, which is provided with a front opening that is closable by a porthole door 7 frontally hinged to the housing. A basket 8 to receive the laundry to be subjected to the washing operation is housed inside the washing tub 6, in a rotatable manner about a horizontal or inclined axis. The basket 8 also defines a front opening arranged at the washing tub 6 opening, in order to be able to carry out the laundry loading and unloading.

[0017] The washing tub 6 is suitable to hold the washing liquid during the laundry washing steps.

[0018] In order to allow the loading of the tub with grid water and cleaning substances and additives, a system for loading the washing water is provided for, which is connectable to the water supply system. Such washing water loading system may comprise a plurality of water flow paths, extending, for example, from two supply elec-

trovalves 9, 10, through respective cleaning agent compartments 11 of a cleaning agent container 12, up into the washing tub 6.

[0019] A drain duct 14 connects to the bottom 13 of the washing tub 6, with associated drain pump 15 which provides for the removal of the washing liquid from the tub 6 and which controls, together with the supply electrovalves 9, 10 the liquid level within the tub 6.

[0020] In order to heat of the washing liquid contained in the tub 6, an electric coil resistor 40 may be provided for, which is arranged inside the tub 6, particularly on the tub bottom 13, in the interspace between the wall of the tub 6 and the laundry basket 8.

[0021] For the stirring and mixing of the laundry with the washing liquid, the laundry basket 8 may be actuated in rotation by an electric motor 16 and a transmission 17.

[0022] The operation of the washing machine is controlled by an electronic, electric, or electro-mechanical control unit 18, operatively connected to a user control interface 19 which is located at an outer wall of the support structure 5 and which allows selecting the washing cycles and the characteristics thereof. In response to the selections carried out by the user by means of the user interface 19, the control unit 18 drives the various components of the washing machine 4.

[0023] The washing machine 4 further comprises a recirculation system of the washing liquid with an ejector (jet pump) 20 having an inlet opening 1, a suction opening 2, and an outlet opening 3.

[0024] The inlet opening 1 is in flow communication with a first supply duct 21 extending from the first supply electrovalve 9 which, in turn, is connectable to the water supply system.

[0025] A first recirculation duct 22 connects in flow communication the bottom 13 of the washing tub 6 with the suction opening 2 of the ejector 20. A second recirculation duct 23 connects in flow communication the outlet opening 3 of the ejector 20 to the laundry basket 8 and includes the cleaning agent compartment 11 (Figs. 1, 3, 5, 9, 11).

[0026] Alternatively, the second recirculation duct 23 connects the outlet opening 3 of the ejector 20 in flow communication with the laundry basket 8, bypassing the cleaning agent compartment 11 (Figs. 13, 14).

[0027] A third recirculation duct 27 connects in flow communication the outlet opening 3 of the ejector 20 to the laundry basket 8, bypassing the cleaning agent compartment 11 of the cleaning agent drawer 12.

[0028] In this manner, a first grid water flow 24 in the first supply duct 21 forms the driving fluid for the ejector 20, and a recirculation flow 25 in the first recirculation duct 22 is the driven fluid that is suctioned by the ejector 20.

[0029] The second recirculation duct 23 carries a first partial flow 26 of the mixture of grid water and recirculated liquid. Said first partial flow 26 passes through the cleaning agent compartment 11 (so as to mix with a cleaning agent or cleaning additive contained in the cleaning agent

compartment upon the passage of the first partial flow 26) before arriving to the laundry basket 8.

[0030] The third recirculation duct 27 carries a second partial flow 28 of the mixture of grid water and recirculated liquid. Said second partial flow 28 is isolated from the cleaning agent in the cleaning agent drawer 12 and goes directly back to the laundry basket 8 (Fig. 1).

[0031] The recirculation system operates in the following manner: when the first supply valve 9 is opened, the pressurized grid water enters the ejector 20 which, by applying a vacuum, begins to suction water and the cleaning agent (recirculation flow 25) from the tub bottom 13. Part of the mix of water and cleaning agent arrives partially (through the second recirculation duct 23) inside the cleaning agent compartment 11 and partially sprinkles the laundry in the laundry basket 8 through the third recirculation duct 27 which extends externally to the cleaning agent drawer 12 and which is directly connected to a front joint 29 at the loading opening of the laundry basket 8.

[0032] In this manner a deposition of the cleaning agent onto the tub bottom is obviated, and a forced mixing is implemented in the first crucial washing steps, thereby immediately activating the chemical action of the cleaning agent.

[0033] Furthermore, by virtue of the recirculation system with ejector and, alternatively, by virtue of the use of the ejector together with two parallel reintroduction ducts, a direct one and the other one through the cleaning agent compartment, there is the possibility of:

- A) exploiting the grid water pressure for the pumping action, obviating the cost for an electric recirculation pump, and saving electric power during washing,
- B) repeatedly reusing water and cleaning agent and obtaining a complete evacuation of the cleaning agent compartment, thus saving water and cleaning agent.

[0034] The ejector may have a double outlet opening 3 or an outlet opening 3 with a Y-shaped bifurcation, or the second recirculation duct 23 is connected to the outlet opening 3 of the ejector 20 and the third recirculation duct 27 is branches off from the second recirculation duct 23 in a point upstream of the cleaning agent compartment 11. The second recirculation duct 27 may form a spraying nozzle 36 or a plurality of dispensing openings, which spray or dispense the first partial flow 26 into the cleaning agent compartment 11.

[0035] In accordance with an embodiment, the washing machine 4 comprises at least one further supply duct 30, 30' connectable to the water supply system by the first supply valve 9 or by a further supply valve 10, and in flow communication with the cleaning agent compartment 11, bypassing the ejector 20.

[0036] For example, the further supply duct can include a second supply duct 30 which connects the second supply electrovalve 10 in flow communication with the clean-

ing agent compartment 11 of the cleaning agent drawer 12, so that, by opening the second supply valve 10, the second supply duct 30 brings a second grid water flow 31 into the cleaning agent compartment 11 so that it is mixed with a cleaning agent or cleaning additive contained in the cleaning agent compartment 11 upon the passage of the second grid water flow 31. Analogously to the first partial flow 26, the second grid water flow 31 also passes from the cleaning agent drawer 12 into the laundry basket, for example, by means of a single loading duct 34 that connects an outlet opening 32 of the cleaning agent drawer 12 with a tub loading opening 33 formed in an upper region of the washing tub 6.

[0037] It is important to note that the second supply valve 10 may be actuated independently from the first supply valve 9, and the second grid water flow 31 does not actuate the ejector 20, whereby the water recirculation and supplying functions can be carried out in a selective and independent manner.

[0038] Alternatively, or in addition, the at least one further supply duct 30, 30' can include a third supply duct 30' branched off from the first supply duct 21 upstream of the ejector 20 and in flow communication with the cleaning agent compartment 11 (Figs. 12, 14).

[0039] In an embodiment (Figs. 3 and 4), the ejector 20 is arranged within the cleaning agent container 12. Preferably the ejector is located in an upper zone of the cleaning agent container 12 to exploit the force of gravity for the purpose of conveying the flows.

[0040] In a preferred embodiment, the ejector 20 is formed in an upper wall 35 or upper lid of the cleaning agent container 12. For example, the ejector 20 may be injection molded together with at least one portion of the upper wall or lid 35.

[0041] This reduces the manufacturing costs and the internal overall dimensions of the washing machine.

[0042] In accordance with a further embodiment (Figs. 5, 6, 7) the third recirculation duct 27 has an approximately upright length, with an air gap 39 formed between an upper tube end 37 and a lower tube end 38 aligned with and facing the upper tube end 37, so as to prevent a backflow of contaminated water to the grid in the case where a vacuum were applied. Advantageously, the upper tube end 37 is tapered downwardly in a converging manner and forms a converging nozzle that accelerates the second partial flow 28 so as to create a liquid sheet with a jet having a reduced width in outlet. The liquid exiting the converging nozzle, passing through the air gap 39, reaches the lower tube end 38, also tapered in a converging manner downwardly (funnel-shaped) and located under the converging nozzle 37. The air gap height, i.e., the vertical distance between the tube ends 37, 38, may range from 2mm to 5mm.

[0043] An inlet opening of the first recirculation duct 22 may be connected, for example, to the tub bottom 13 or to the drain duct 14 upstream of the drain pump 15.

[0044] The description hereto provided relates to a front loading washing machine. However, the concepts

of the invention can be similarly applied also to top loading washing machines (Figs. 9 - 12). In such machines, the laundry basket 8 has a loading opening 41, for example, a casement loading opening, formed in a side wall of the basket 8 and that can be overlapped by an upper opening 42 of the washing tub 6 and the support structure 5, which may be closed and opened by a hinged lid 43. In the top loading washing machines, the cleaning agent container 12 may be preferably formed or connected directly to the hinged lid 43 and it is arranged in flow connection with the several ducts at least when the lid 43 is closed (machine operative state) .

[0045] It shall be apparent that, to the washing machine according to the present invention, those skilled in the art, in order to meet contingent, specific needs, will be able to make further modifications and variations, all of which anyhow fall within the protection scope of the invention, as defined by the following claims.

Claims

1. A washing machine (4), comprising:
 - a laundry basket (8) supported within a washing tub (6) suitable to hold a washing liquid,
 - a first supply duct (21) connectable to the mains water grid by a first supply valve (9),
 - a drain duct (14) to drain the washing liquid from the washing tub (6),
 - a cleaning agent container (12) in communication with an upper region of the washing tub (6) and having at least one cleaning agent compartment (11) suitable to hold a cleaning agent,
 - a ejector (20) having an inlet opening (1) in flow communication with the first supply duct (21), a suction opening (2) and an outlet opening (3),
 - a first recirculation duct (22) that connects in flow communication a bottom (13) of the washing tub (6) with the suction opening (1) of the ejector (20),
 - a second recirculation duct (23) that connects the outlet opening (3) of the ejector (20) in flow communication with the laundry basket (8).
2. The washing machine (1) according to claim 1, comprising at least one further supply duct (30, 30') connectable to the mains water grid by means of the first supply valve (9) or by means of a further supply valve (10), and in flow communication with the cleaning agent compartment (11), bypassing the ejector (20).
3. The washing machine (1) according to claim 1 or 2, wherein the second recirculation duct (23) connects the outlet opening (3) of the ejector (20) in flow communication with the cleaning agent compartment (11).
4. The washing machine (1) according to claim 3, comprising a third recirculation duct (27) that connects in flow communication the outlet opening (3) of the ejector (20) to the laundry basket (8), bypassing the cleaning agent compartment (11).
5. The washing machine (1) according to claim 4, wherein the second recirculation duct (23) is connected to the outlet opening (3) of the ejector (20) and the third recirculation duct (27) is branched off from the second recirculation duct (23) in a point upstream of the cleaning agent compartment (11).
6. The washing machine (1) according to any of the claims 2 to 5, wherein the at least one further supply duct (30, 30') comprises a second supply duct (30) connectable to the mains water grid by means of a second supply valve (10) and in flow communication with the cleaning agent compartment (11), wherein the second supply valve (10) can be actuated independently from the first supply valve (9).
7. The washing machine (1) according to claim 2, wherein the at least one further supply duct (30, 30') comprises a third supply duct (30') branched off from the first supply duct (21) upstream of the ejector (20) and in flow communication with the cleaning agent compartment (11).
8. The washing machine (1) according to any of the preceding claims, wherein the ejector (20) is arranged within the cleaning agent drawer (12).
9. The washing machine (1) according to any of the preceding claims, wherein the ejector (20) is formed in an upper wall (35) of the cleaning agent container (12).
10. The washing machine (1) according to claim 9, wherein the upper wall (35) forming the ejector (20) is configured as a lid manufactured separately and subsequently connected to a lower shell of the cleaning agent container (12).
11. The washing machine (1) according to claim 9, wherein the ejector (20) is injection molded together with a portion of the upper wall (35).
12. The washing machine (1) according to claim 4, wherein the third recirculation duct (27) has an upright length with an air gap (39) formed between an upper tube end (37) and a lower tube end (38), wherein the upper tube end (37) forms a nozzle converging downwardly and the lower tube end (38) forms a funnel converging downwardly and located under the converging nozzle.
13. The washing machine (1) according to any of the

preceding claims, wherein the first recirculation duct (22) is connected to the drain duct (14) upstream of the drain pump (15).

- 14. The washing machine (1) according to claim 3 or any of the claims dependent from claim 3, wherein the second recirculation duct (27) forms a sprayer nozzle (36) or a plurality of openings dispensing the first partial flow (26) into the cleaning agent compartment (11).

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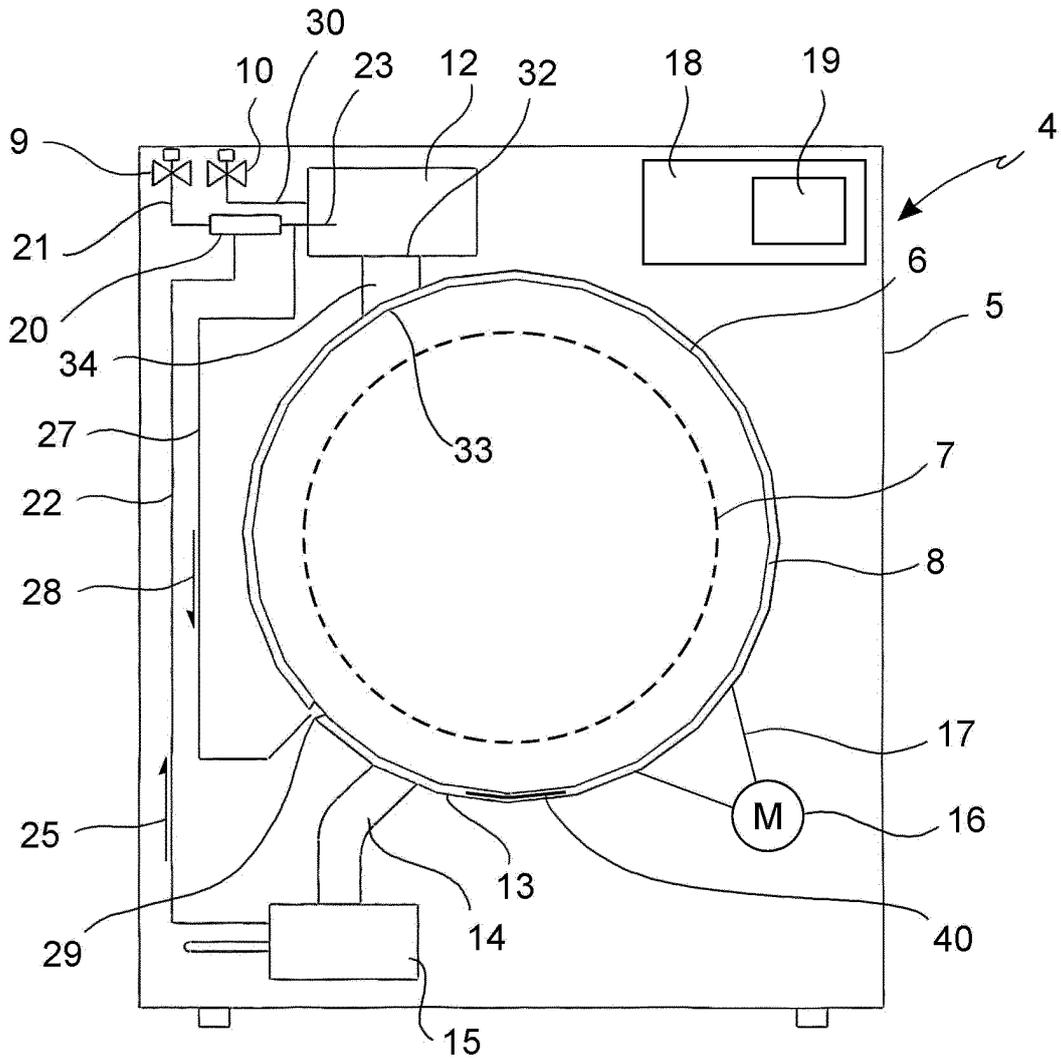


FIG. 1

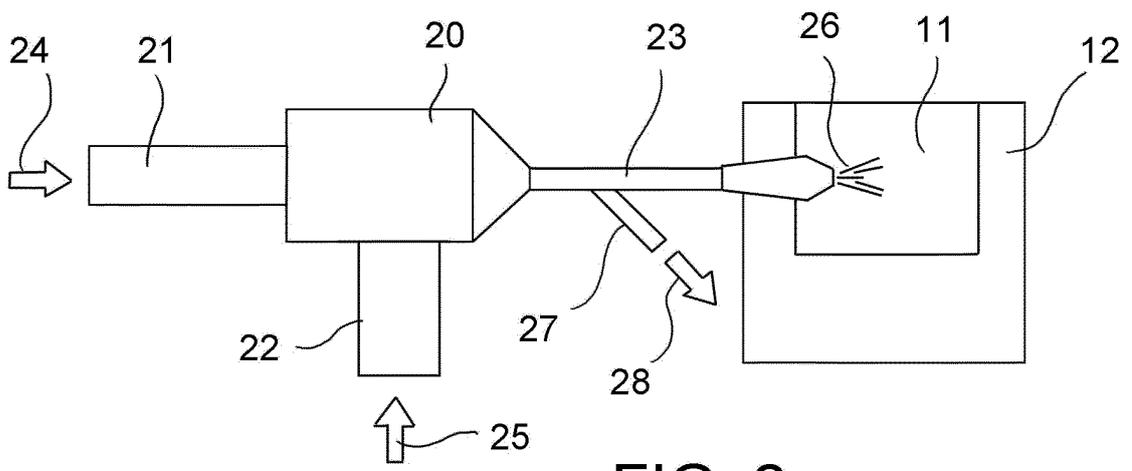


FIG. 2

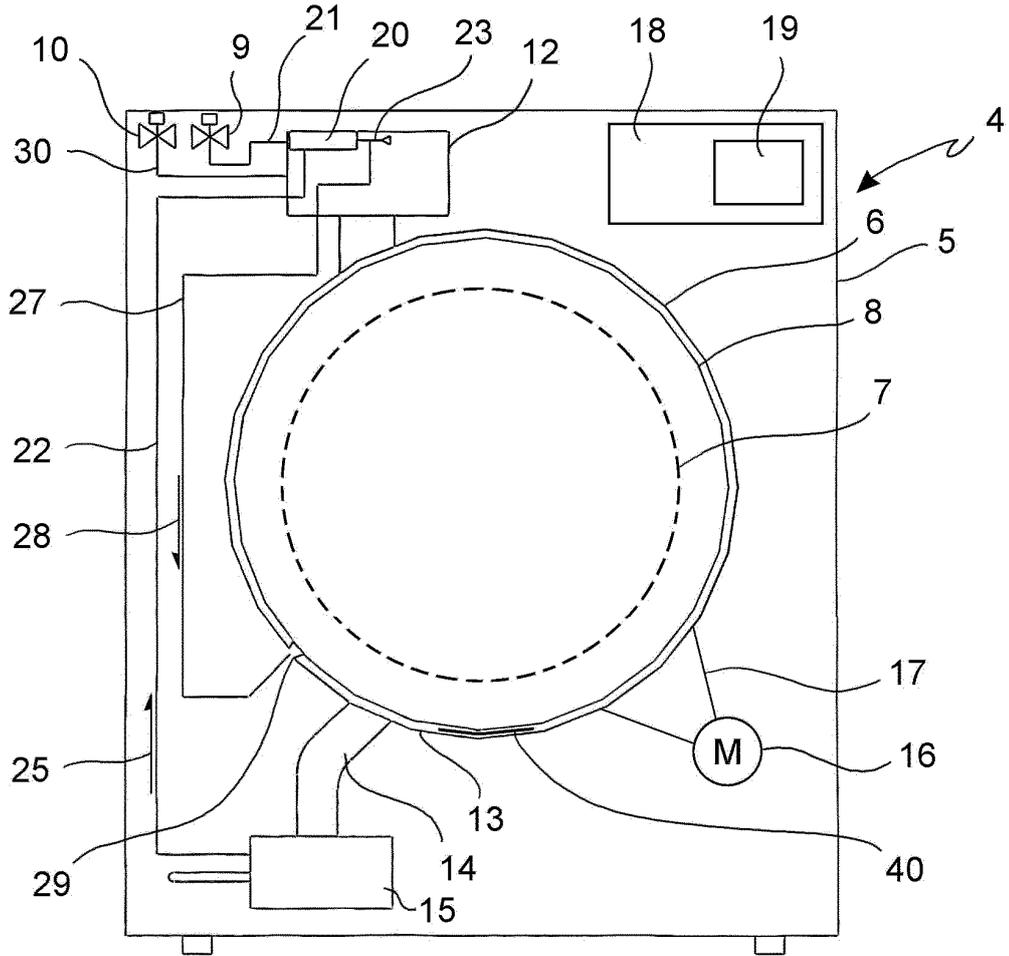


FIG. 3

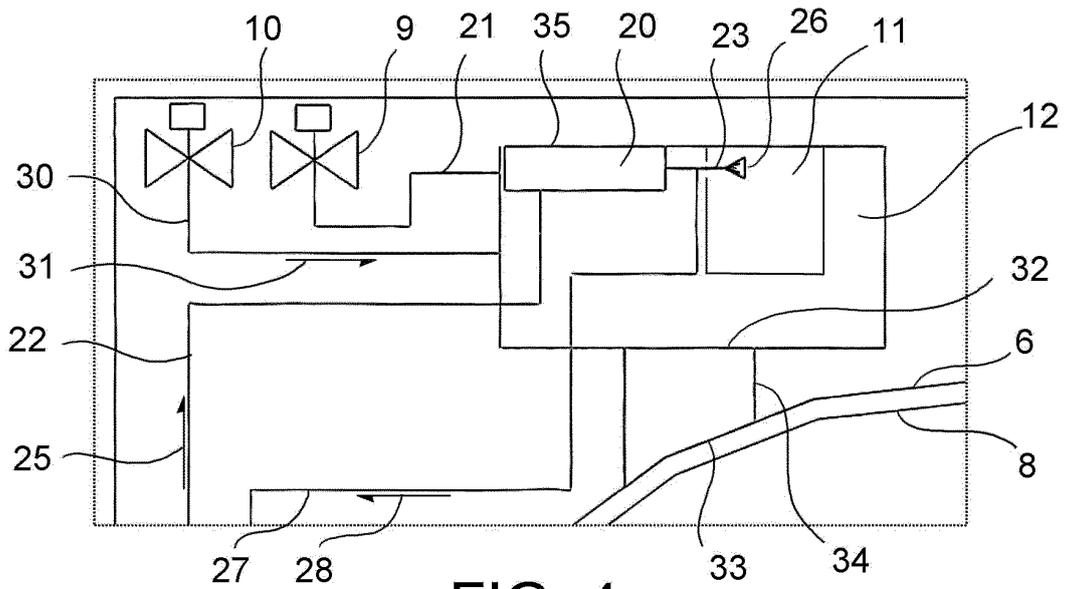


FIG. 4

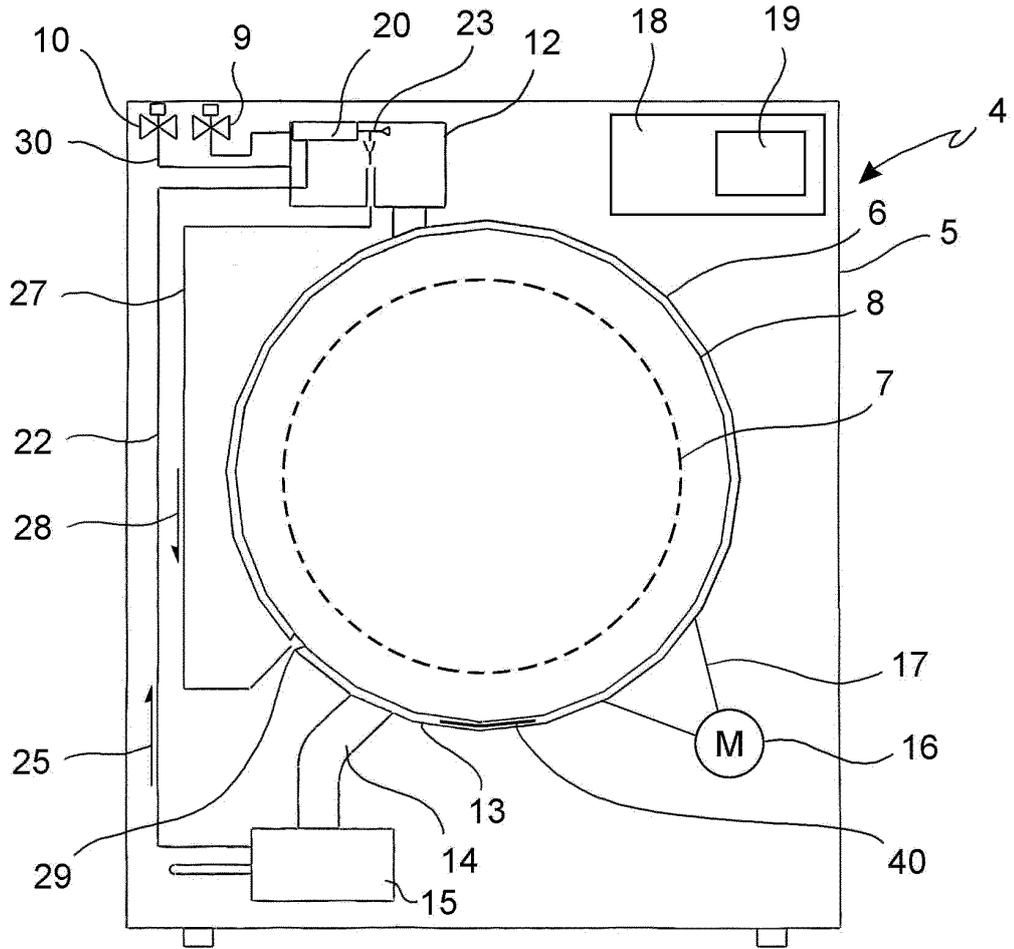


FIG. 5

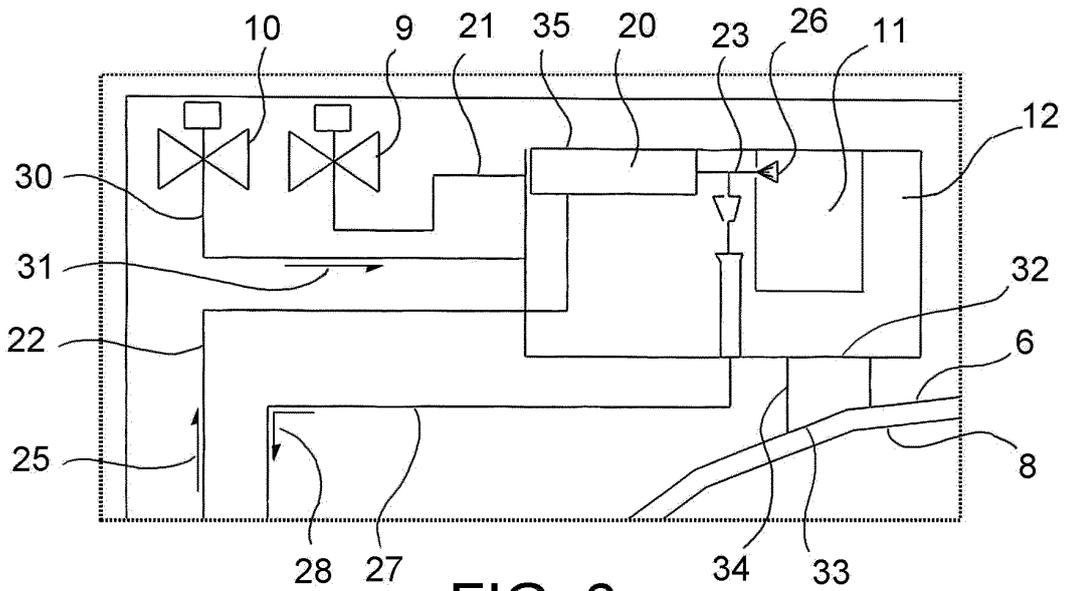


FIG. 6

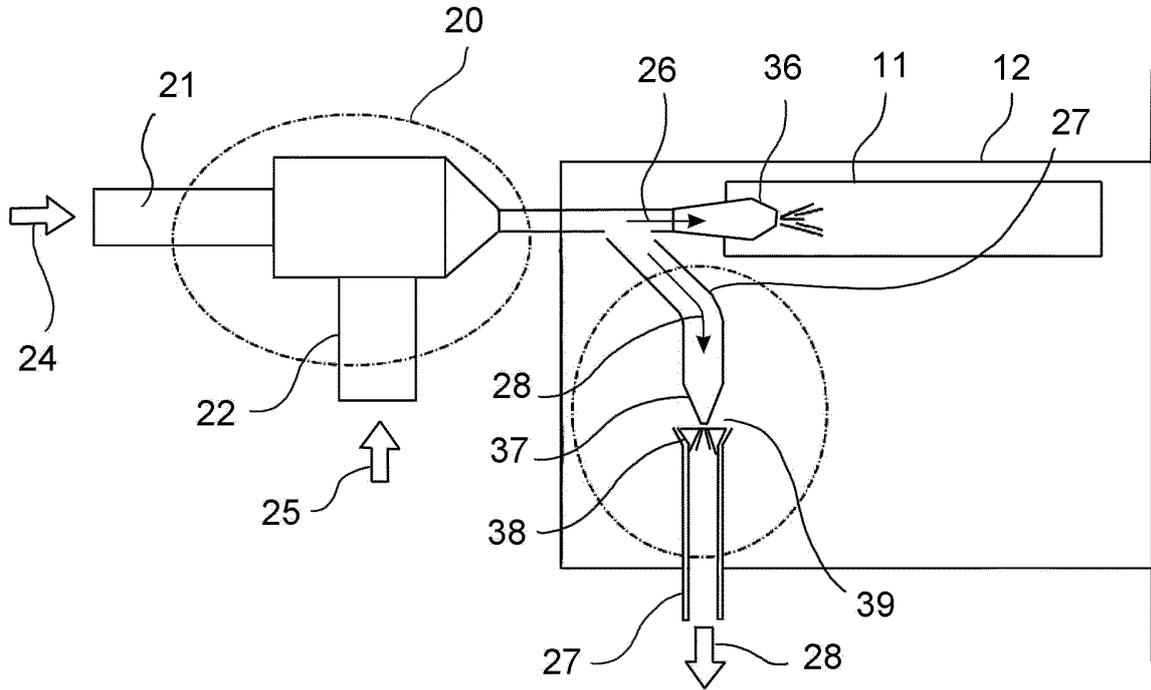


FIG. 7

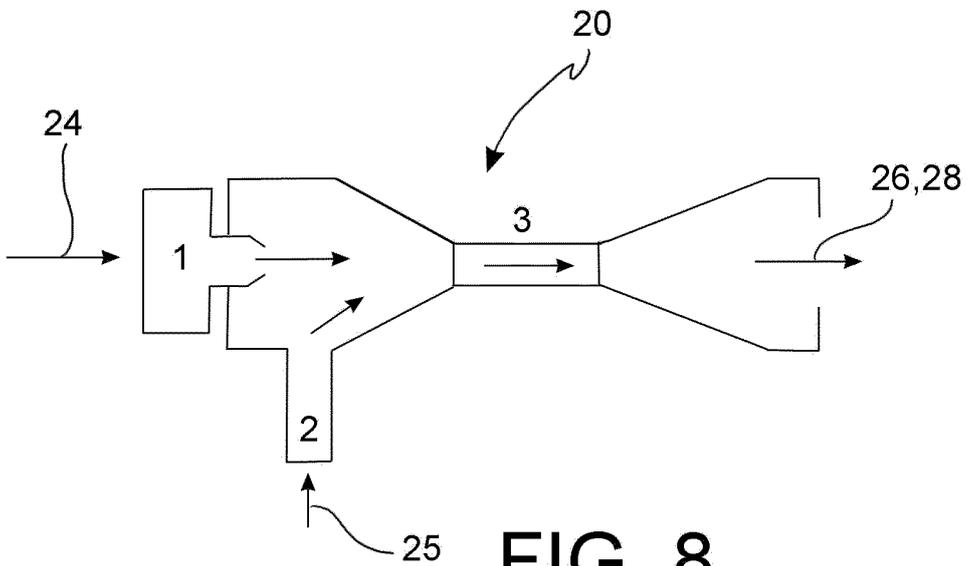


FIG. 8

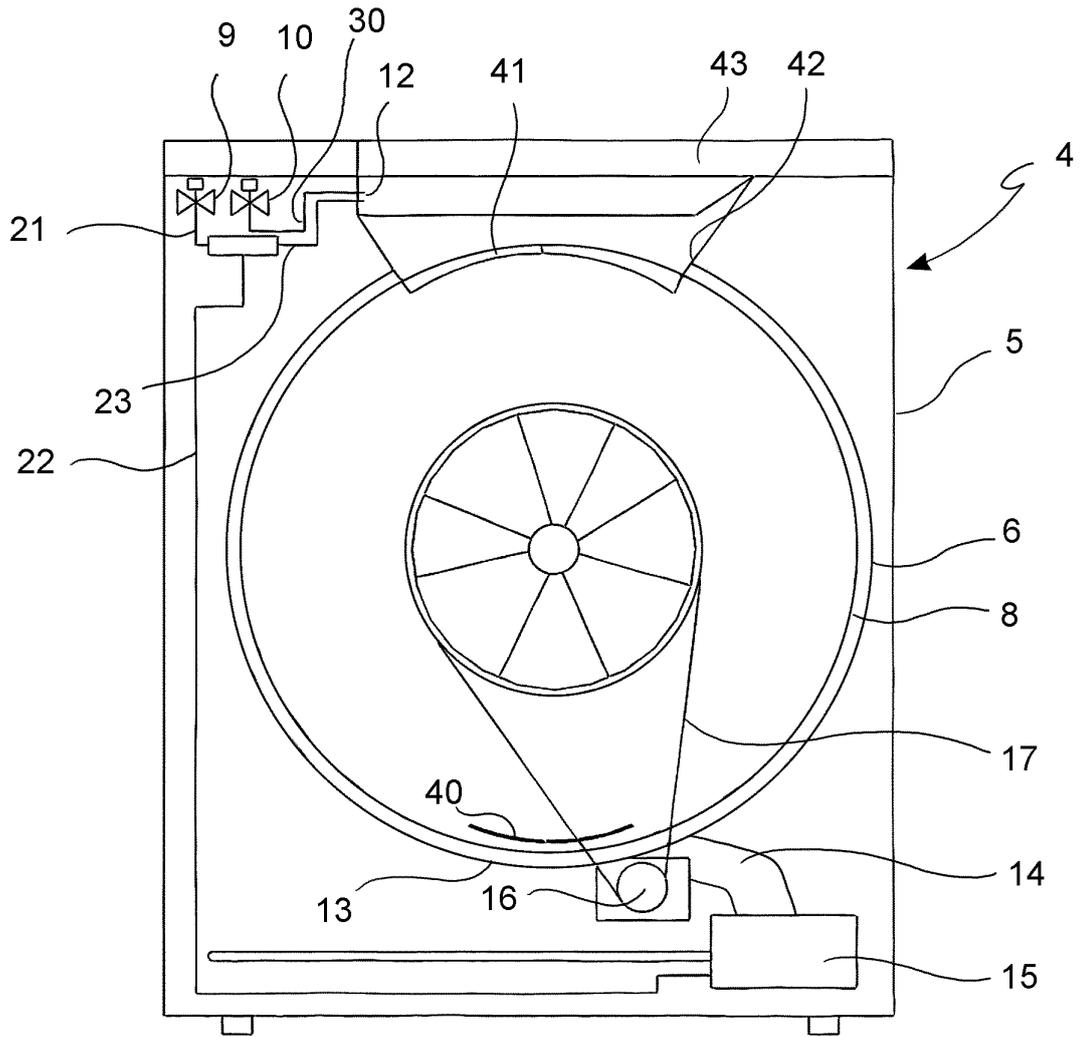


FIG. 9

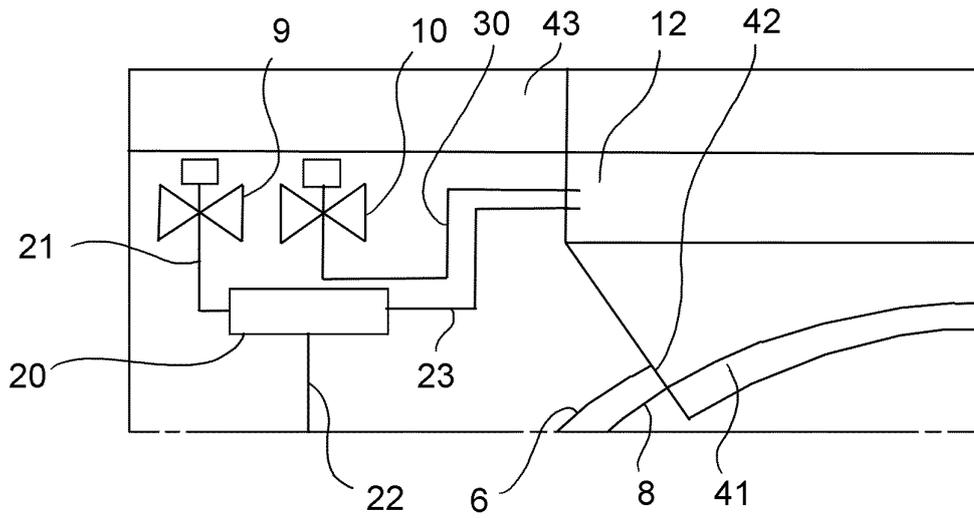


FIG. 10

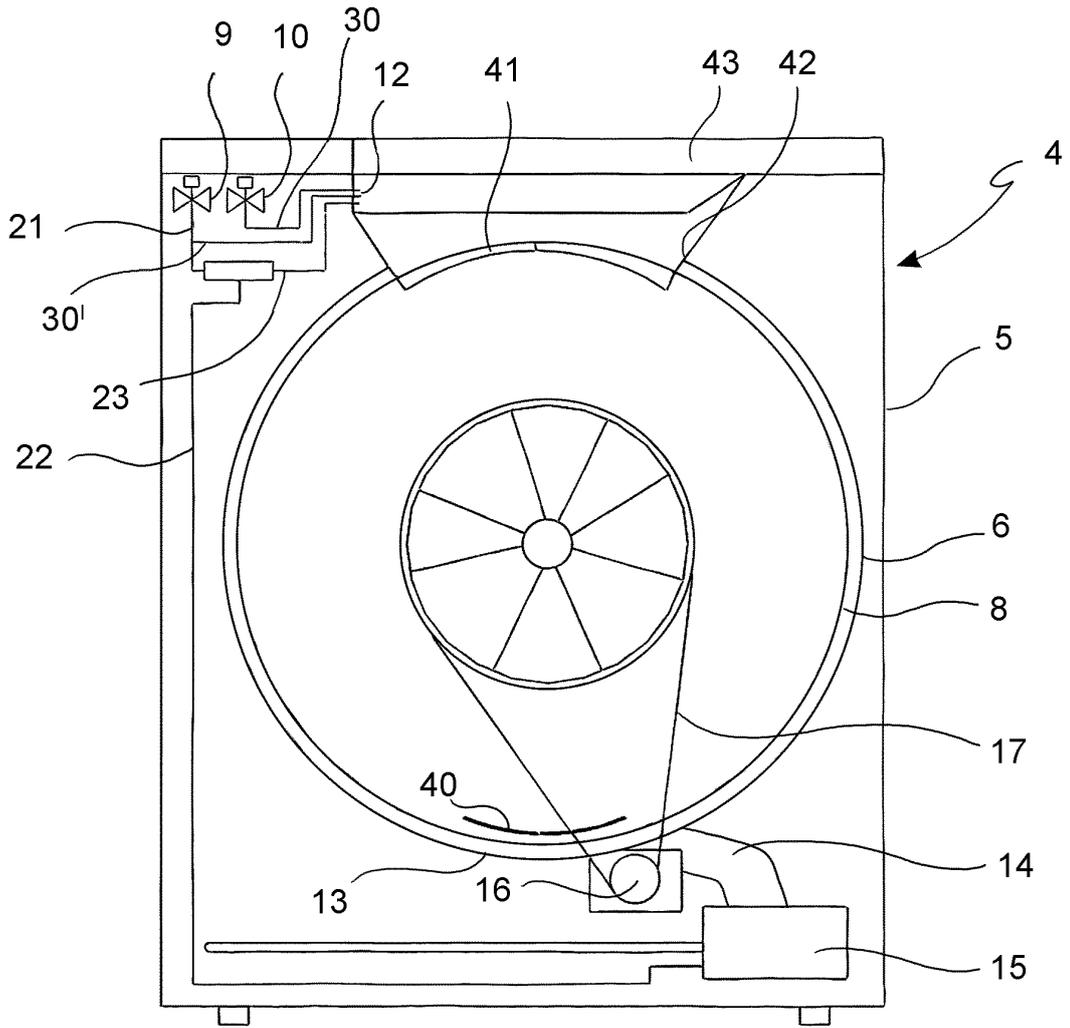


FIG. 11

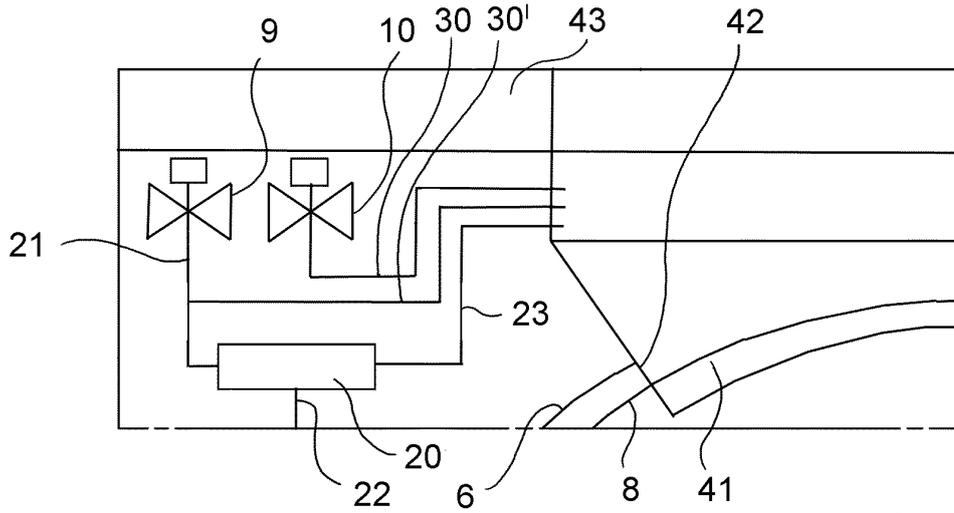


FIG. 12

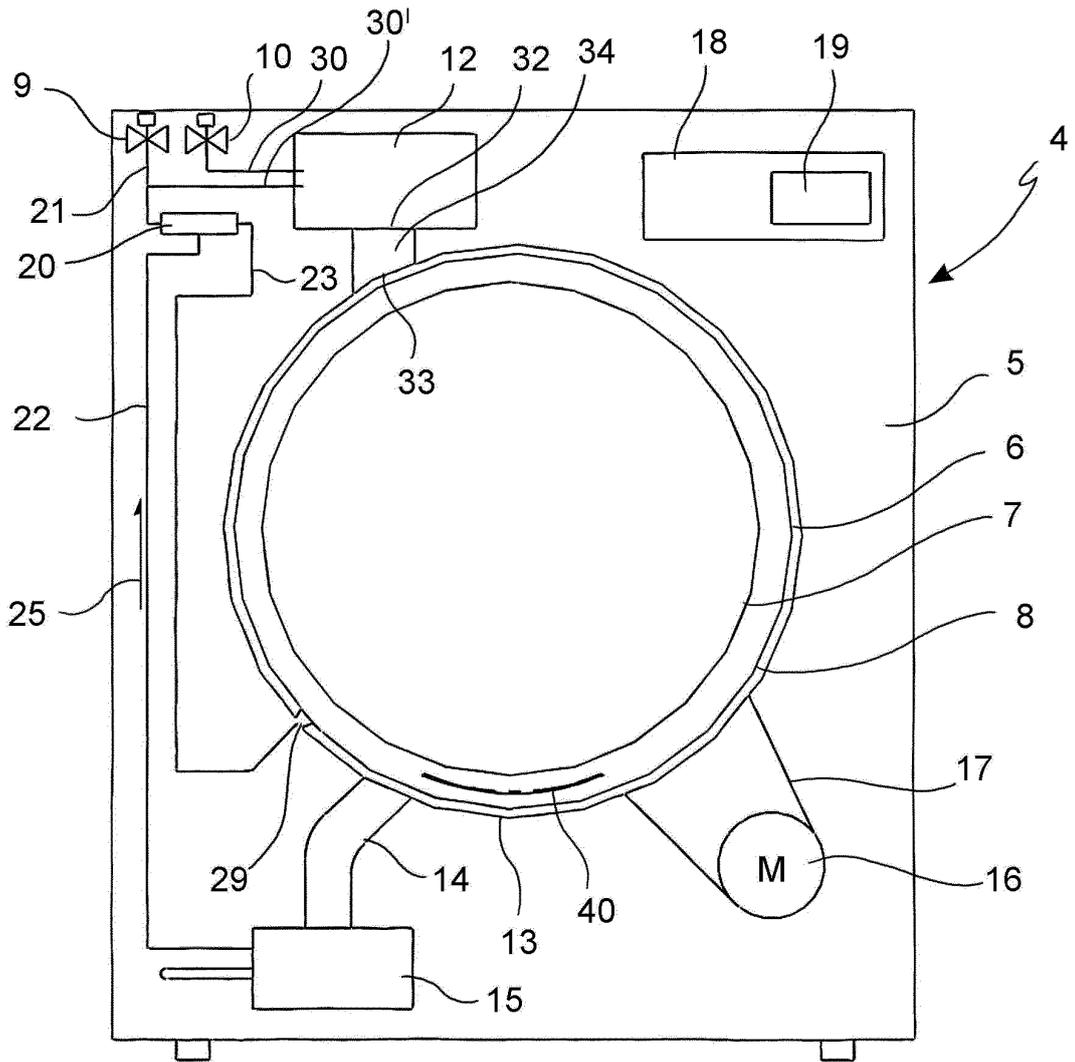


FIG. 13

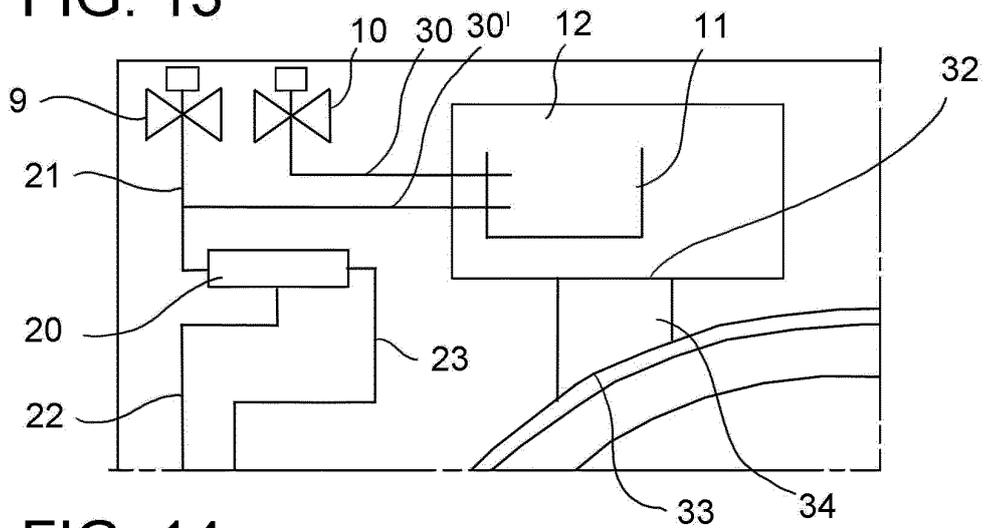


FIG. 14



EUROPEAN SEARCH REPORT

Application Number
EP 14 18 7879

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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	US 2012/060569 A1 (DUNN DAVID SCOTT [US] ET AL) 15 March 2012 (2012-03-15) * paragraph [0020] - paragraph [0028]; figures 2-3 *	1,2	INV. D06F39/08
X	DE 77 35 078 U1 (LICENTIA PATENT VERWALTUNGS-GMBH) 11 May 1978 (1978-05-11) * page 6 - page 7; figure 2 *	1,3,13, 14	
A	US 3 406 710 A (VODA EUGENE M) 22 October 1968 (1968-10-22) * the whole document *	1-14	
			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 16 February 2015	Examiner Diaz y Diaz-Caneja
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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16-02-2015

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82