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(54) **Washing machine with recirculation pump**

(57) A washing machine including a tub (2), a drum (3) rotatably supported inside the tub (2), a recirculation circuit including a recirculation pipe (8) and a recirculation pump (18), the recirculation circuit being connected to

the tub (2) and adapted to convey inside the tub (2) re-circulation water taken from the tub (2), wherein the recirculation circuit comprises a steam generator (13) for generating steam, which is conveyed into the tub (2) through the recirculation circuit.

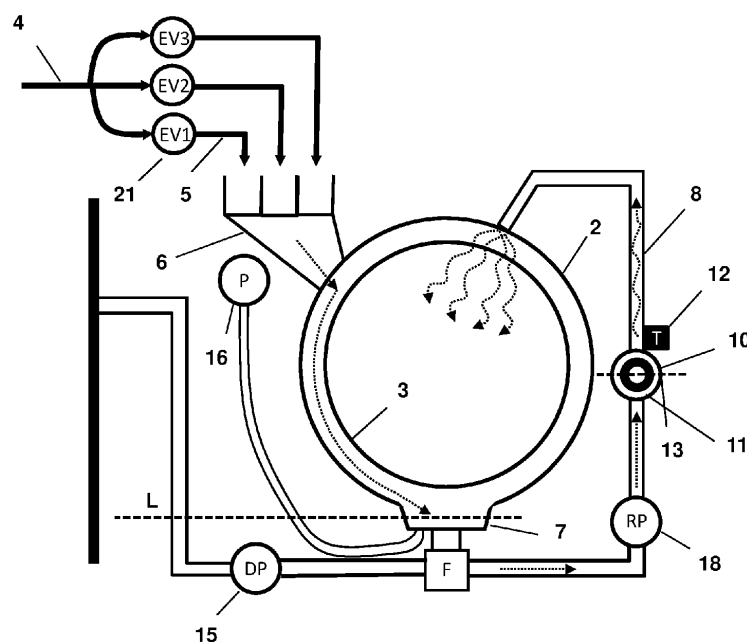


Fig. 3

Description

Field of technology

[0001] The present invention relates to a water bearing appliance intended for washing and/or drying clothes, having an article treating chamber, where the clothes to be washed/dried are introduced, including a steam cycle. In particular said household appliance may be a washing machine, or a washer-dryer, that is a laundry washing machine with additional drying function.

Background

[0002] Generally, a water bearing appliance (e.g. a washing or a washing/drying machine) includes an article treating chamber rotatably supported within a cabinet and made to rotate by means of a driving device, typically including an electric motor connected to the article treating chamber e.g. via a belt.

[0003] In detail, with reference to Figure 1 showing a functional schematic view of a state of the art washing machine, such machine includes a rotating drum 3, for carrying out a washing, rotatably supported within a tub 2 situated within a cabinet or outer body (not shown in the Figure). Water necessary to carry out the washing is derived from a main via a common supply pipe 4 and introduced into the tub 2 via washing water supply pipe 5, by opening of a first solenoid valve 21. Water is loaded by the washing water supply pipe 5 into one compartment of the detergent drawer 6. The water then flows from the drawer into the tub reaching the sump 7, where it is heated by a heater 17. Laundry is introduced into the drum through, for example, an aperture in the front wall of the body.

[0004] Some machines are also equipped with a recirculation circuit, including a recirculation pump 18 (RP) and a recirculation pipe 8. During washing, water is taken from the sump and put again into the tub and the drum thus improving washing performance and decreasing water consumption. A pressure sensor 16 (P), either analogic or digital, takes care to maintain the water level L. When the cycle has finished and the water has to be drained out, a drain pump 15 (DP) pushes the water out via a discharge pipe 9.

[0005] The most recent washing machines provide also a steam cycle, during which steam is generated and ejected into the tub, thus reaching the laundry inside the drum. This system has also the advantage of carrying out a sterilization of the laundry.

[0006] Many different solutions are known as far as the steam generation system is concerned. According to the basic idea, a heater is integrated to the tub and is used to heat up the water until steam is generated.

[0007] From patent application WO-A-2006/129912 a washing machine is known adapted to generate and apply steam in order to enhance washing performance while enabling sterilization of laundry. The washing ma-

chine includes a heater installed in the tub and a controller. The controller operates the heater to heat the water contained in the tub to generate steam, rather than just warming the water. The washing machine further comprises a water level sensor to detect a water level in the tub, and the controller operates the heater according to a detection result of the water level sensor. The washing machine has an additional advantageous effect in that, due to the steam, the laundry is also sterilized. Other modifications were made in the attempt to save energy and simplify the washing machine configuration.

[0008] Patent application WO-A-2006/129913 discloses a method of controlling washing operation of a washing machine, which method comprises the steps of supplying water into a tub, soaking the laundry with water, and supplying steam by heating the water using a heater installed in the tub to generate the steam.

[0009] Patent application JP-A-04158896 discloses a fully automatic washing machine, in which a steam generating cycle is performed before a washing cycle to obtain good washing and sterilizing effect. A small quantity of supply water is introduced and heated in the tub before the washing cycle, in a manner not to wet the laundry and to produce steam that sterilizes the laundry and loosens the fibers thereof.

[0010] In patent application US-2008/0314092 a laundry appliance is disclosed wherein a nozzle is provided for introducing water and a device is provided for generating steam. The device includes a tank, a heating element, an inlet opening and a common outlet for the water and steam, provided with a nozzle disposed in the edge region of the container opening. Apart from the outlet and the nozzle, the water injection circuit and the steam generating system have separated paths.

[0011] In patent application WO 2006/104310 a washing machine is described which has a steam generator for producing and supplying steam to the tub. A drum is rotated when the steam is supplied, so that the steam can be brought into contact with the laundry quickly and uniformly. The washing machine can further include a recirculation pump for drawing water from the tub and return it to the tub again in a recirculation cycle. The steam generation device and the recirculation pump are mounted into separated circuits, independent from each other and having in common an outlet with a nozzle.

[0012] Some washing machines, known as washer-dryer machines, beside the washing cycle also include a drying cycle, in which a drying process is carried out on the laundry using steam and/or an air circulation system, possibly including a condenser device to remove the water. The drying air circulates in an air recirculation pipe connected to the tub.

[0013] Also environmental and energy consumption issues are becoming more and more important. A key parameter to save energy and water is to reduce the amount of water actually used to wash the laundry. Heating of the wetted load accounts for the major part of the energy consumption of a washing machine. Thus, by reducing

the amount of water used during the main wash, less energy is required to heat up the contents of the drum.

[0014] A method and system allowing to limit the temperature losses in order to improve the energy consumption would be highly appreciated.

Objects of the disclosure

[0015] It is an object of the present disclosure to overcome at least some of the problems associated with the prior art.

[0016] A further object of the present invention is to provide a water bearing drying appliance (e.g. a washing machine, a tumble dryer or a washer-dryer, i.e. a laundry washing machine with additional drying function) which allows easy assembly and energy saving.

[0017] Another object of the present invention is to propose a washing or washing-drying machine in which steam temperature losses are reduced, with a substantial energy saving, and in which the steam flow inside the drum is optimized.

[0018] Another object of the invention is to propose a washing or washing-drying machine with a more compact configuration, including a steam generating system which can be easily applied, with minimal changes, to standard washing machines and washing-dryer machines with concentrated wash and steam function.

Summary

[0019] The present disclosure provides a water bearing appliance as set out in the accompanying claims.

[0020] Accordingly, the present disclosure provides a washing machine including: a tub; a drum, rotatably supported inside the tub; a recirculation circuit including a recirculation pipe and a recirculation pump, the recirculation circuit being connected to the tub and adapted to convey inside the tub recirculation water taken from the tub, characterized in that the recirculation circuit comprises a steam generator for generating steam, which is conveyed into the tub through the recirculation circuit. The recirculation circuit is adapted to move the water taken from a first opening in the tub and to convey the water back in the tub through a second opening. Preferably, the second opening is at a higher height in the tub compared to the first opening. Advantageously, the steam generator includes a chamber and a heater situated within the chamber.

[0021] According to a first embodiment of the present invention, the steam generator is placed along the recirculation pipe, downstream of the recirculation pump, with the chamber connected to the recirculation pipe.

[0022] According to a variation of the first embodiment of the present invention, the steam generator is situated along the recirculation pipe, upstream of the recirculation pump, between the recirculation pump and a sump of the tub, with the chamber connected to the recirculation pipe.

[0023] According to a second embodiment of the

present invention, the steam generator includes a heater integrated within the recirculation pump.

[0024] Advantageously, the recirculation pump is positioned at the level of the sump of the tub, so that water can partially cover the heater within the recirculation pump.

[0025] Optionally, the heater features a thermostat aimed at interrupting the power supply when the temperature reaches a certain level due to the water level being too low to partially cover the heater.

[0026] While water within the tub is kept at a level not to wet the laundry, during formation of steam, the steam is driven by natural convection along the recirculation pipe and into the tub.

[0027] Optionally, the machine according to the invention further comprises a temperature sensor used for fine regulation of the steam temperature, this temperature sensor being also possibly used as an indirect measurement of the water level within the lower part of the tub.

[0028] Optionally, water is loaded directly into the tub via a separate independent path including an additional pipe, branched from a main pipe and connected to the tub at a position so as to by-pass a detergent drawer.

[0029] Optionally water is loaded directly into the tub via a separate independent path including an additional pipe, branched from a main pipe and connected to a sump of the tub, thus by-passing a detergent drawer.

[0030] Optionally, water is supplied to or sprayed towards the heater of the steam generator via the additional pipe.

[0031] The present invention offers a number of benefits. One of the advantages of the invention derives from the integration of steam generator (including a heater) in the recirculation circuit connected to the tub. A particular advantage derives from the integration of the heater with the recirculation pump itself, thus requiring minimal changes to the machine design and manufacturing.

[0032] Another advantage is the reduction in the loss of steam temperature, due to the use of the recirculation pump and the recirculation pipe to convey the steam generated by the heater. This optimizes the steam flow inside the drum.

[0033] A further advantage is the reduced quantity of water to be heated to produce steam; in a preferred embodiment of the present invention water level is maintained within predetermined threshold so that the heater is only partially covered. Steam is produced quickly and with low energy consumption.

Brief description of the drawings

[0034] Reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a schematic representation of a prior art washing machine;

Figures 2A-2C show a washing machine in front-side

perspective view with some parts removed, and details of the same machine, respectively;

Figures 3 shows a schematic sectional view of the same washing machine incorporating a first embodiment of the invention;

Figure 4 shows a schematic sectional view of the same washing machine incorporating a first embodiment of the invention in a different arrangement;

Figure 5 shows a schematic sectional view of the same washing machine incorporating a second embodiment of the invention;

Figure 6 shows a schematic sectional view of the washing machine as in Figure 5, including an improvement;

Figure 7 shows a schematic sectional view of the washing machine as in Figure 5, including another improvement.

Detailed description of preferred embodiments

[0035] While the invention has been described in connection with preferred embodiments, it is not intended to limit the scope of the invention to the particular form set forth, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims. As an example the following description refers to washing machine, but those skilled in the art will appreciate that different kind of water bearing machines (e.g. washer-dryer) could implement the solution proposed by the present invention.

[0036] With reference to Figures 2A-2C, a washing machine is shown in front-side perspective view with some parts removed.

[0037] In detail, the machine includes a rotating drum 3, for carrying out a washing, rotatably supported within a tub 2 situated within a cabinet or outer body 1. Water necessary to carry out the washing is derived from a main via a common supply pipe and introduced into the tub 2 via washing water supply pipe 5, by opening of a first solenoid valve. Water is loaded by the washing water supply pipe 5 into one compartment of the detergent drawer 6. The water then flows from the drawer into the tub reaching the sump, where it is heated by a heater. Laundry is introduced into the drum through, for example, an aperture in the front wall of the body 1.

[0038] The machine is also equipped with a recirculation circuit, including a recirculation pump 18 and a recirculation pipe 8.

[0039] Moreover, the machine is provided with a steam generator to carry out a steam cycle, used to heat the laundry inside the drum 3, possibly after the laundry has been wetted with a detergent solution, and/or for refresh-

ing or de-wrinkling the textiles. Such steam generator includes a heater 10 to heat water and generate steam, and all the electric components (not shown in the Figures) to control the operation of the heater 10. The exploded view of Figure 2B shows the recirculation circuit, while Figure 2C shows a particular embodiment of the present invention with the heater 10 integrated in the recirculation pump 18, however, as detailed in the following paragraphs, there are possible alternative embodiments, according to which the heater could be placed out of the pump 18.

[0040] According to a preferred embodiment of the present invention, the steam generator is incorporated into the recirculation circuit (including pipe 8, recirculation pump 18 and heater 10) in order to generate steam, which is then conveyed into the tub 2 by the same recirculation circuit. In other words, the steam thus produced passes through the same recirculation circuit as the water used to create the water jets into the drum.

[0041] This feature has the advantage that a quantity of water smaller than in the prior art washing and/or washer-dryer machines is used to produce the steam, thus obtaining a higher energy efficiency for the production of steam.

[0042] The steam produced passes through the same recirculation circuit as the recirculation water used to make the water jets onto the laundry, and enters into the drum 3. This steam can be used to heat the laundry inside the drum possibly after that it has been wetted with a detergent solution.

[0043] The steam produced can be also used to refreshing, sterilizing or de-wrinkling the laundry.

[0044] Moreover, the steam circuit realized by using the water recirculation circuit has the advantage that the steam is effectively applied to the textiles inside the drum with minimal heat losses in the system and no waste of energy deriving from heating up the washing machine/washer-dryer components, such as the tub 2, the drum 3 and so on.

[0045] Another advantage, due to the foregoing, is a reduction in the loss of steam temperature, as the steam flow inside the drum is optimized.

[0046] Figure 3 shows a schematic sectional view of the same washing machine incorporating a first embodiment of the invention.

[0047] In this first embodiment, the recirculation pump 18 has the function of driving the water into the steam generator 13 (SG). The steam generator 13 is situated along the recirculation pipe 8, downstream of the recirculation pump 18. The steam generator 13 including a heater 10 is situated within a chamber 11, to which the recirculation pipe is connected. In the embodiment described above, the steam generator 13 works as a in-line steam generator, i.e. water is vaporized while flowing through the steam generator itself.

[0048] The recirculation pump 18 is preferably situated at the same height level of the sump 7.

[0049] The heater 10 is not necessarily inside the cir-

cuit, i.e. it is possible an alternative embodiment according to which the heater does not enter into direct contact with water: in such case the heater can be placed in "thermal" contact with water (e.g. divided by a conductive separator) so that part of the energy is transferred from the heater to the water, in order to increase temperature of the water and generate steam.

[0050] When the heater reaches a predetermined operating temperature, the heater is at least partially in thermal contact with the water in the recirculation circuit. As an example the pump could be activated when a predetermined threshold temperature is reached so that the water enters into thermal contact with the heater and the transfer of energy from the heater to the water takes place.

[0051] With reference to Figure 4, according to a variation of this first embodiment, the steam generator 13, including the chamber 11 and the heater 10, is positioned upstream of the recirculation pump 18, in a position between the recirculation pump 18 and the sump 7 of the tub 2.

[0052] According to a preferred embodiment of the present invention, shown in Figure 5, the heater 10 is integrated within the recirculation pump 18. Water passing through the recirculation pump 18 is then heated to generate steam, which is then driven into the tub through the recirculation pipe 8.

[0053] As an alternative, the heater 10 within the recirculation pump 18 is a film heater instead of a soldered heater, thus enhancing the passage of water through the pump. As mentioned for a previous embodiment, the heater 10 is not necessarily inside the circuit, i.e. it is possible an alternative embodiment according to which the heater does not enter into direct contact with water: in such case the heater can be placed in "thermal" contact with water (e.g. divided by a conductive separator) so that part of the energy is transferred from the heater to the water, in order to increase temperature of the water and generate steam.

[0054] Those skilled in the art will appreciate the advantages of the integration of the heater 10 into the recirculation pump 18. This optimizes both assembling and the steam flow into the tub and the drum.

[0055] A further advantage is the reduced water consumption and the reduced amount of free wash liquid during the main wash. Due to the reduced quantity of water, a consistent energy saving is possible, because less energy is required to heat up the content of the drum.

[0056] The arrangement of the heater 10 into the recirculation pump 18 can be clearly seen in Figures 2B, 2C as mentioned above, where the position of the heater 10 with respect of the recirculation pump body is shown.

[0057] The water should preferably be maintained at the proper level, to ensure safety of the whole system. Therefore, during the steam cycle water is loaded into the tub by opening the solenoid valve 21, the same as during the washing cycle, but in the steam cycle the pressure sensor 16 preferably keeps the water at a lower

level, i.e. below the drum limit, so as to avoid wetting the laundry.

[0058] The pressure sensor keeps the water at a proper level, just enough to partially cover the heater 10 when this latter is integrated into the recirculation pump 18 or when the heater 10 is provided upstream of the recirculation pump 18. This way the steam is produced without activation of the pump, and then driven, by natural convection into the tub, via the recirculation pipe 8, to be ejected onto the laundry.

[0059] As the water level lowers due to steam generation, a solenoid valve, for instance solenoid valve 21, is operated again to open and refill the circuit up to the proper level. As mentioned above, the heater when at predetermined operating temperature, is at least partially in thermal contact with the water in the recirculation circuit.

[0060] For safety reason, the pump features a thermostat, which cuts off the power supply when the temperature goes above a certain level, which may happen when the water level is too low and the pump heater 10 is not, at least partially, covered.

[0061] A temperature sensor 12 may be optionally provided, at the chamber 11 or close to the recirculation pump 18 with the heater, respectively, for the fine regulation of the steam generation.

[0062] This temperature sensor may also be used as an indirect measurement of the water level.

[0063] In fact, during normal operating conditions, if the water level is too low, the temperature increases, whereas, if it is too high the temperature decreases.

[0064] The circuit with such configurations can rely on one or more of three different ways to monitor and maintain the water level:

- using a pressure sensor (possibly dedicated to the circuit pressure),
- using a temperature sensor,
- using a heater thermostat.

[0065] Optionally, a further improvement can be incorporated in the invention, about the water loading system. If the water to be transformed into steam is loaded, as in the traditional way, through the detergent drawer, it may happen that detergent residuals get in contact with the heater, thus generating bad smell and possibly causing malfunction of the system.

[0066] To avoid this, a separate independent path can be used for the water, which is loaded by means of an additional pipe 20, branched from the main pipe 4, and an additional solenoid valve 24. This configuration is shown in Figure 6.

[0067] When solenoid valve 24 is opened, water flows through the additional pipe 20 and enters the tub 2 just beneath the detergent drawer 6. Then, it flows to the sump 7 following the conventional path. In this way, the detergent drawer 6 is bypassed.

[0068] Another improvement is shown in Figure 7. In

this case, water is led directly to the sump 7 by the additional pipe 19, thus by-passing the full conventional path normally followed by the water-detergent solution falling from the detergent drawer 6.

[0069] Even if in the present description no mention has been made to the heater which heats the water in the tub (see heater 17 in Figure 1 describing a prior art machine), those skilled in the art will appreciate that it cannot be excluded that such heater is provided in addition to the heater 10 in the recirculation system.

[0070] It will be understood that, while in the foregoing reference was mainly made to a household appliance embodied in the form of a laundry washing machine, the present invention is suitable for a washer-dryer, and in general for any apparatus intended for washing-drying clothes.

[0071] As an example, as mentioned above with reference to the heater, while in the above discussed embodiments, components like the recirculation pump or the heater have been described as integrated within the circuit (i.e. in direct contact with the water flowing inside), alternative embodiments would be possible with such components operating from outside the circuit.

[0072] It will be appreciated that alterations and modifications may be made to the above without departing from the scope of the disclosure. Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the solution described above many modifications and alterations. Particularly, although the present disclosure has been described with a certain degree of particularity with reference to preferred embodiment(s) thereof, it should be understood that various omissions, substitutions and changes in the form and details as well as other embodiments are possible; moreover, it is expressly intended that specific elements described in connection with any disclosed embodiment of the disclosure may be incorporated in any other embodiment as a general matter of design choice.

[0073] For example, similar considerations apply if the components have different structure or include equivalent units. Also, it should be easily understood by those skilled in the art that the present invention may be extended to a large variety of household appliances not only to a washing machine that has been used in the above description as mere example of how the present invention may be embodied.

Claims

1. A washing machine including:

- a tub (2);
- a drum (3), rotatably supported inside the tub (2);
- a recirculation circuit including a recirculation pipe (8) and a recirculation pump (18), the recirculation circuit being connected to the tub (2)

and adapted to convey inside the tub (2) recirculation water taken from the tub (2) **characterized in that**

the recirculation circuit comprises a steam generator (13) for generating steam, which is conveyed into the tub (2) through the recirculation circuit.

2. The washing machine of claim 1 wherein the steam generator (13) includes a chamber (11) and a heater (10) situated within said chamber (11).
3. The washing machine of claim 2, wherein said steam generator (13) is situated along the recirculation pipe (8), downstream of the recirculation pump (18), with said chamber (11) connected to said recirculation pipe (8).
4. The washing machine of claim 2, wherein said steam generator (13) is situated along the recirculation pipe (8), upstream of the recirculation pump (18), between the recirculation pump (18) and a sump (7) of the tub (2), with said chamber (11) connected to said recirculation pipe (8).
5. The washing machine of claim 1, wherein the steam generator (13) includes a heater (10) and the recirculation pump (18) comprise said heater (10).
6. The washing machine of claim 5, wherein the recirculation pump (18) is positioned at a level not higher than the sump (7) of the tub (2).
7. The washing machine of any claim 1 to 5, wherein the heater (10) is positioned so that it is at least partially in thermal contact with water of the recirculation circuit.
8. The washing machine of claim 6, wherein the heater (10) features a thermostat aimed at interrupting the power supply when the temperature reaches a certain level due to the water level being too low to cover or partially cover the heater (10).
9. The washing machine of any preceding claim, wherein water within the tub (2) is maintained at a level not to wet the laundry, during formation of steam, and the steam is driven by natural convection along the recirculation pipe (8) and into the tub (2).
10. The washing machine of any preceding claim, further comprising a temperature sensor used for fine regulation of the steam temperature.
11. The washing machine of any preceding claim, wherein water is loaded directly into the tub (2) via a separate independent path including an additional pipe (20), branched from a main pipe (4) and con-

nected to the tub (2) at a position so as to by-pass a detergent drawer (6).

- 12.** The washing machine of any claim 1 to 10, wherein water is loaded directly into the tub (2) via a separate independent path including an additional pipe (19), branched from a main pipe (4) and connected to a sump (7) of the tub (2), thus by-passing a detergent drawer 6.
- 13.** The washing machine of claim 11 or 12, wherein water is supplied to or sprayed towards the heater (10) of the steam generator (13) via the additional pipe (19, 20).

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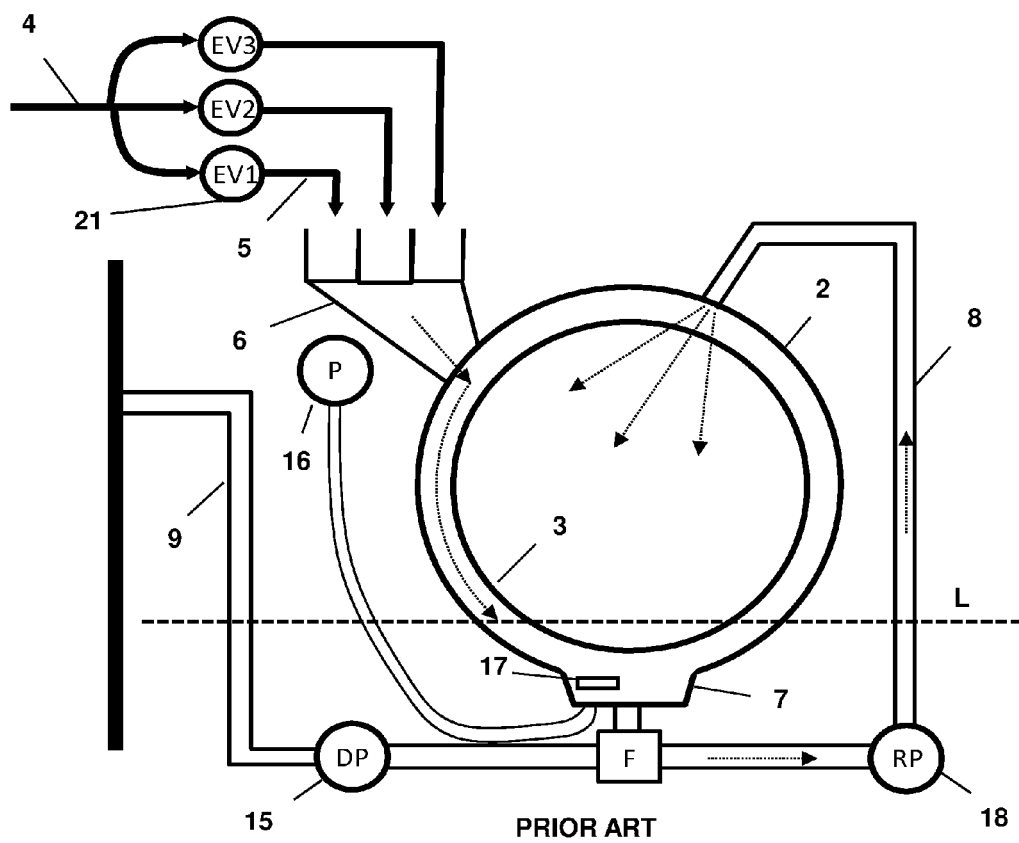
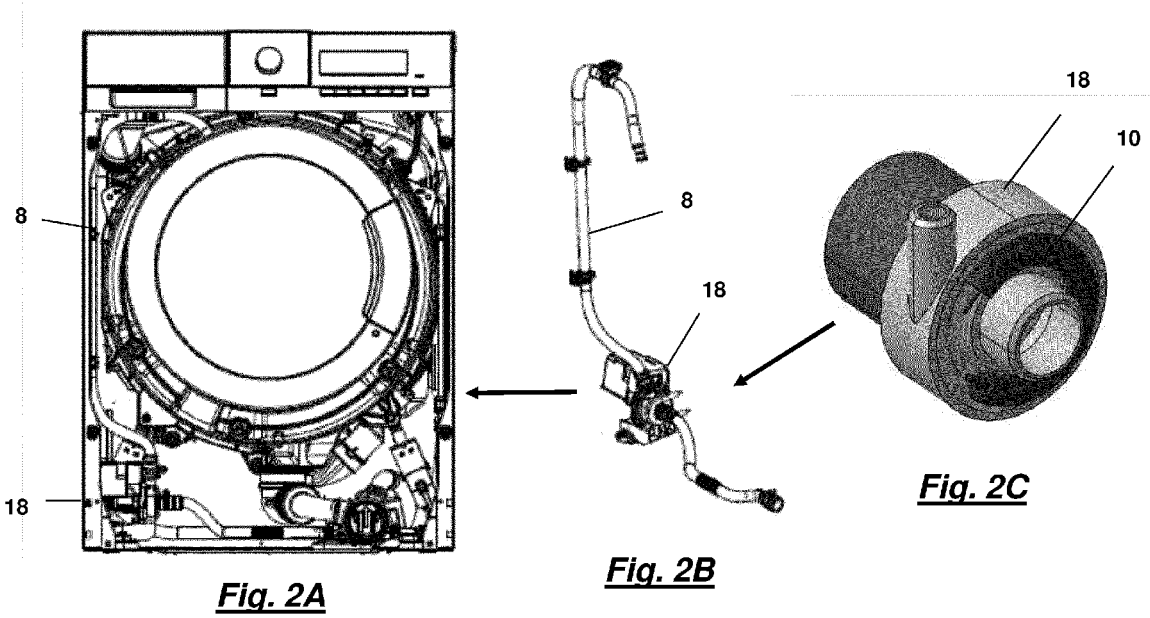


Fig. 1



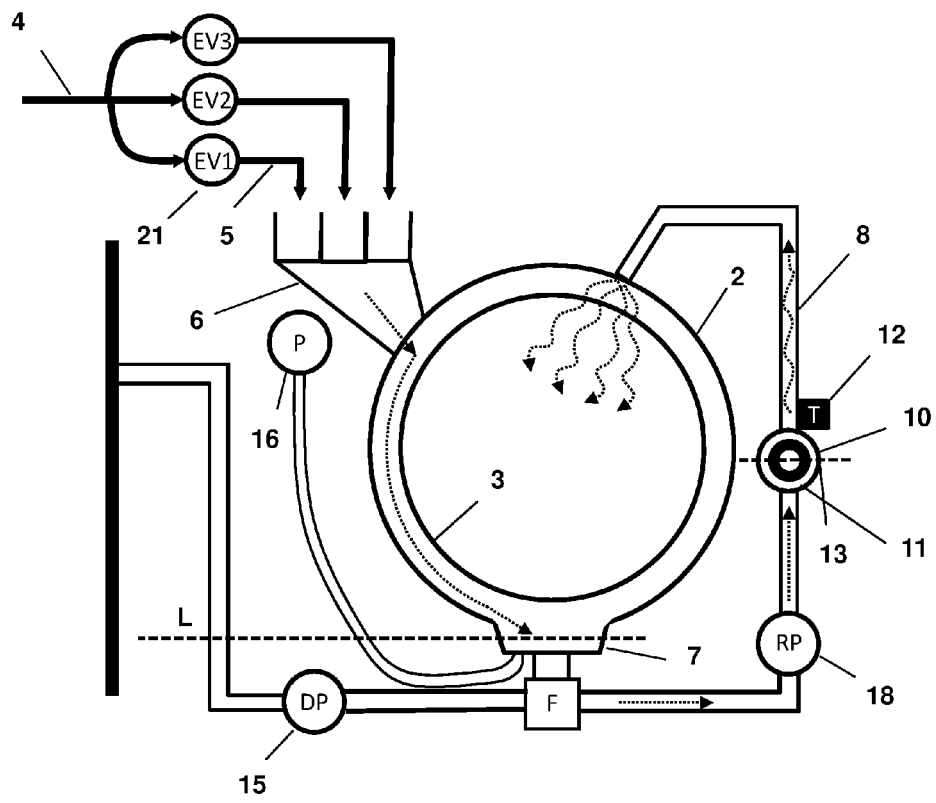


Fig. 3

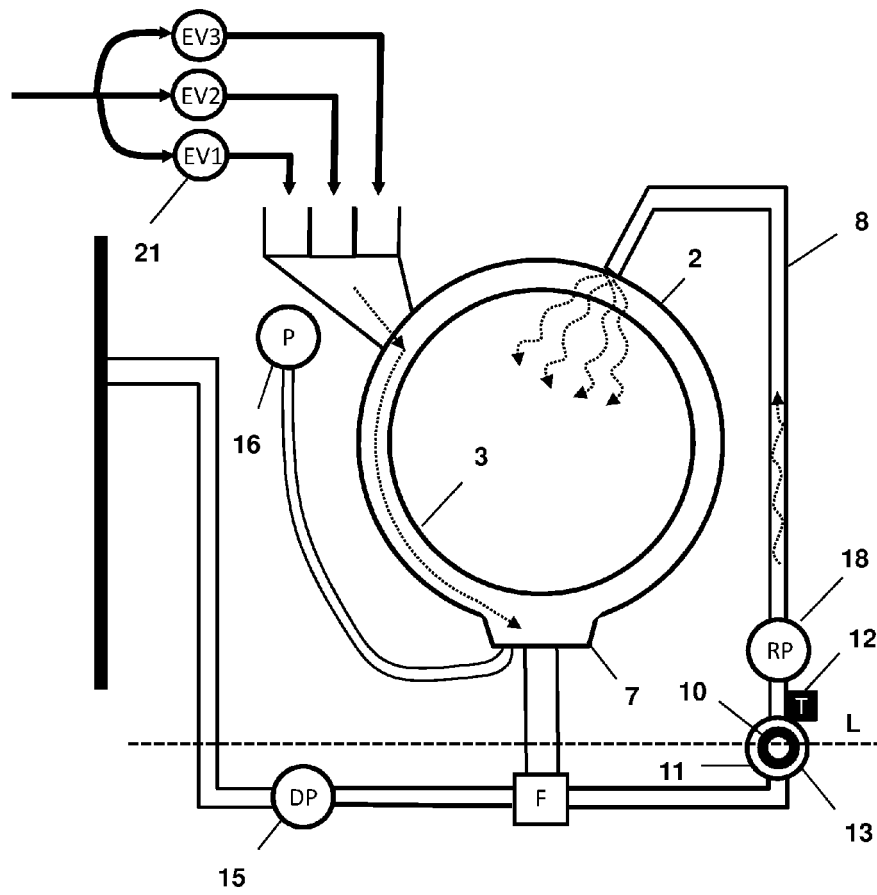


Fig. 4

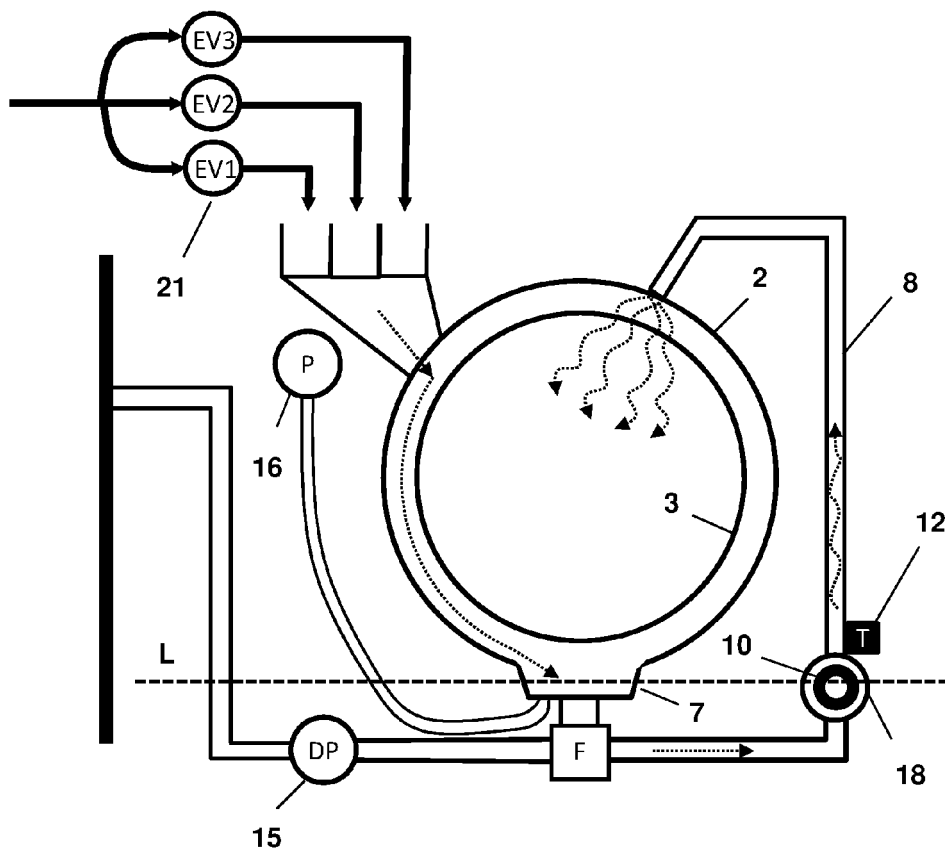


Fig. 5

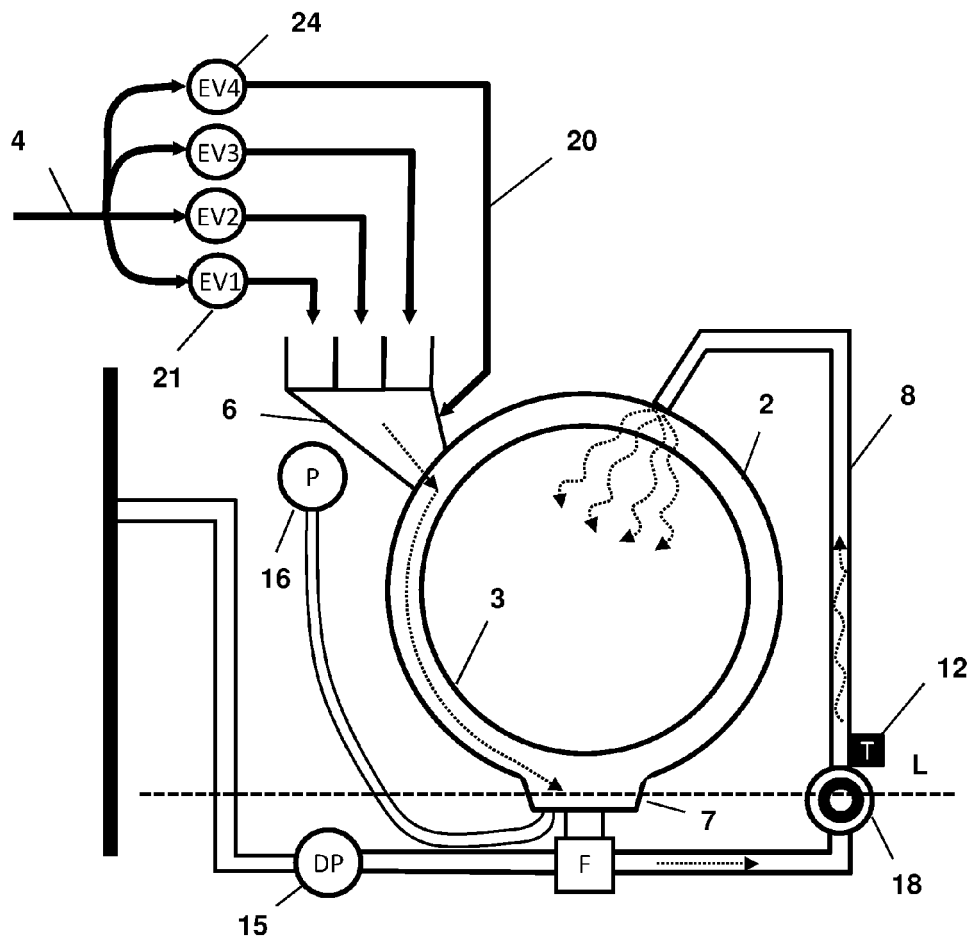


Fig. 6

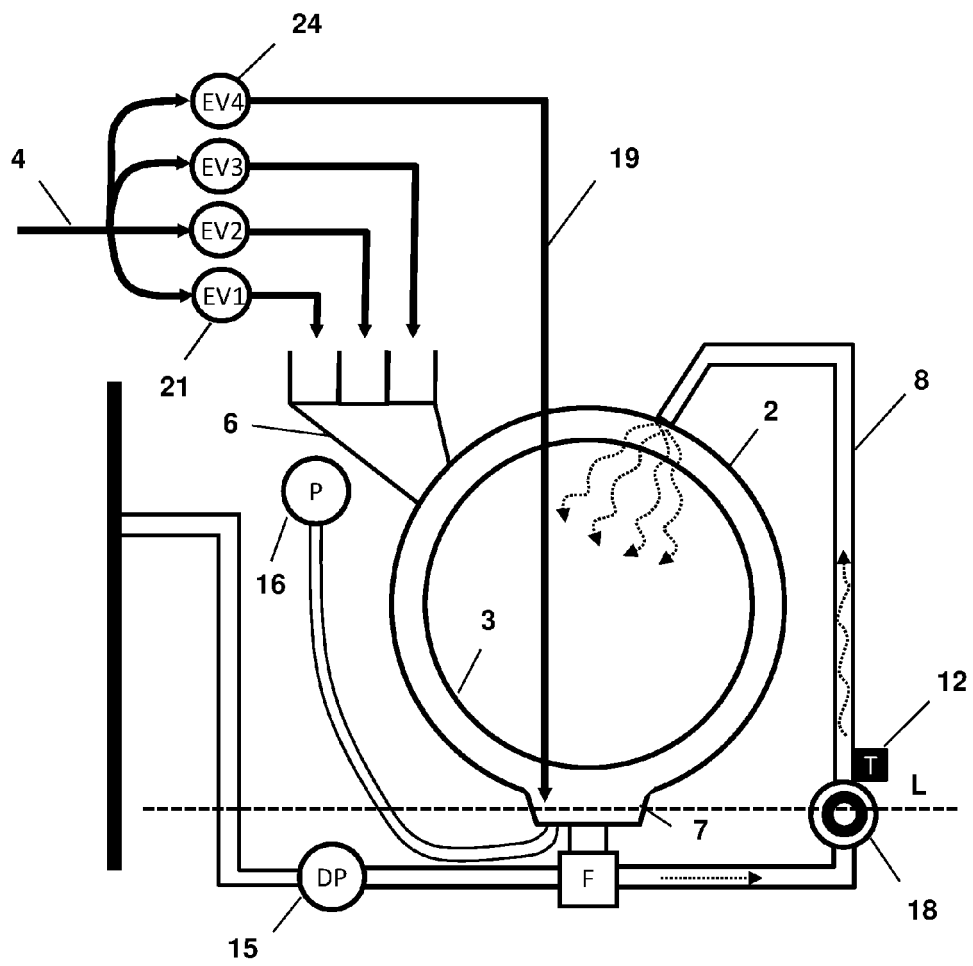


Fig. 7



EUROPEAN SEARCH REPORT

Application Number
EP 11 19 3138

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 April 2012	Examiner Fachin, Fabiano
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			

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EPO FORM 1503 03.82 (P04C01)

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

EP 11 19 3138

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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