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(71) Applicant: **Nespolo, Guido**
31040 Mansuè (Treviso) (IT)

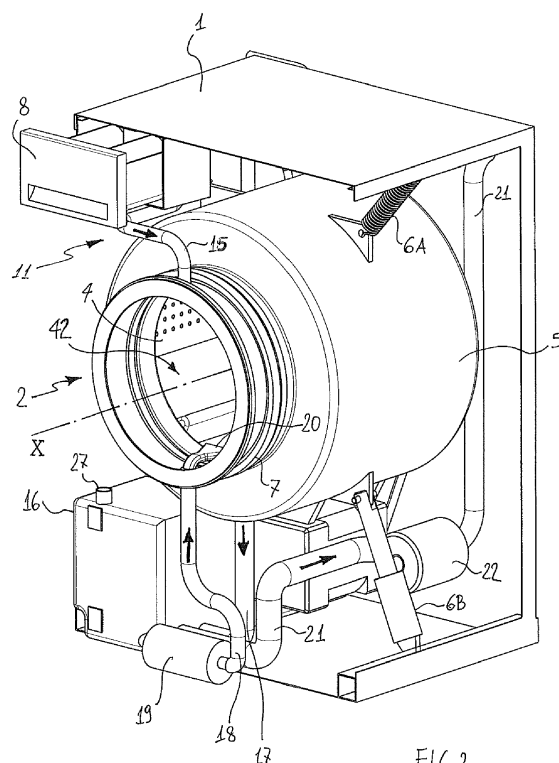
(72) Inventor: **Nespolo, Guido**
31040 Mansuè (Treviso) (IT)

(74) Representative: **Giugni, Diego et al**
Propria S.r.l.
Via della Colonna, 35
IT-33170 Pordenone (IT)

(54) **Washing machine and related washing method**

(57) The present invention refers to a washing machine and the related washing method.

A washing machine according to the invention comprises a tub (5), a drum (4) rotatably mounted inside said tub (5) to rotate around an axis (X), said drum (4) defining a space (42) to contain the laundry to be treated, hydraulic means (11, 16, 19, 18, 20) to supply a treatment fluid inside the space (42). The washing machine according to the invention is characterized in that the drum (4) includes a shell (30) that extends around said axis (X) and is provided with one or more perforated portions (31) that hydraulically connect the space (42) with the tub (5), and one or more imperforated portions (33), said one or more perforated portions (31) being arranged in correspondence of valving elements (34) operable to adjust the passage of the treatment fluid through said perforated portions (31) and in that it includes a hydraulic line (17, 16, 19, 18, 20) that connects the tub (5) to the drum (4) even when said valving elements (38) prevent a passage of fluid through the perforated portions (31).



Description

[0001] The present invention refers to a washing machine and the related washing method.

[0002] Generally, a washing machine of known type includes a washing unit suspended inside a holding body by suspension means. The washing unit consists of a tub for containing a washing fluid and a drum, rotatably mounted inside the tub, in which is placed the laundry to be treated. A laundry loading opening closable by a door is formed on the body that houses the washing machine and is connected to the tub by a watertight bellows element. Pumping means supply and drain water and/or a washing fluid into and out of the tub, while suitable electric heating elements housed in the interspace between the drum and the tub heat the water and/or a washing fluid.

[0003] To carry out a washing cycle in a washing machine of the known type described above, it is generally necessary to charge a sufficient quantity of water to saturate the laundry and maintain a predetermined level inside the drum so that the heating elements are permanently immersed in the fluid to be heated. Normally, for a load of laundry of 6 kilograms, it is necessary to load the washing machine tub with a quantity of water of 15 to 20 litres, depending on the type of fabrics to be washed. One part of this water, generally 4 to 5 litres, is in fact contained within the drum but is held inside the interspace between the drum and the tub and submerges the heating elements. This quantity of water is not strictly necessary to carry out the washing process, but it is present due to the geometrical configuration of the washing unit. Evidently, heating a quantity of water that is not necessary for the washing process is a needless waste of energy and water which it would be desirable to avoid.

[0004] In the state of the art are also known laundry treatment machines in which the water supplied in the washing chamber is in a quantity substantially sufficient to saturate the laundry uniformly and completely without further accumulations in the interspace formed between the drum and the tub. One example of a machine of this type is disclosed in US Patent 4,489,455. In this type of machine, considering the fact that the quantity of water in the tank is not sufficient to submerge the heating elements, it is necessary to replace said heating elements with other heating means that are capable of heating the water absorbed in the laundry to be washed. For this purpose, US Patent 4,489,455 proposes to use a jet of hot air circulating between the drum loaded with laundry soaked with water and an air heater in fluid communication with the drum through an aeraulic system.

[0005] One solution of the type described above is rather complicated from the construction point of view because it requires an accessory air circuit, including a fan, to be contained within the body that houses the machine, which consequently must be enlarged by increasing the dimensions of the machine. Moreover, the presence of such a circuit complicates considerably the assembling of the machine and increases undesirably the

production costs. Further complications connected with such a method of heating the washing liquid are due to the washing process, which is rather noisy and relatively long. Moreover, the maintenance of the temperature of the washing liquid during all the phases of the washing process is particularly difficult.

[0006] A further disadvantage of the washing machine disclosed in US 4,489,455 lies in the fact that heating by means of hot air is rather inefficient, and in fact involves a waste of energy that, although it is lower than in the case of heating water that is not necessary for the washing process, still remains considerably high.

[0007] One objective of the present invention is therefore to provide a washing machine and the relative washing method that overcome the drawbacks and disadvantages of the prior art washing machines and washing methods.

[0008] In the scope of the above objective, one purpose of the present invention is to provide a washing machine that reduces the energy and water consumption required to carry out a laundry washing cycle.

[0009] Another purpose of the invention is to provide a washing machine that avoids the loss of heat toward structural elements of the machine in contact with the laundry during the washing process.

[0010] Still another purpose of the present invention is to provide a washing machine that makes it possible to achieve an effective utilization of the washing agent.

[0011] Still another purpose of the present invention is to provide a washing machine that is simple to build and has a contained cost of production.

[0012] One not least important purpose of the present invention is to provide an efficient washing method that improves the cleanliness of the laundry treated with said method.

[0013] A further purpose of the invention is provide a washing method that requires a smaller quantity of energy and water compared to known prior art washing methods.

[0014] The above objective and purposes are achieved by a washing machine and the relative washing method having the characteristics set out in the enclosed claims. Characteristics and advantages of the invention will be evident from the description which follows, by way of non-limiting example, with reference to the enclosed drawings, wherein:

- Figure 1 shows a perspective view of a washing machine according to the present invention;
- Figure 2 shows a perspective view of the right side of the washing machine of Figure 1 in which the part of the machine housing has been removed;
- Figure 3 is a perspective view of the left side of the washing machine of Figure 1, partially in cross section, in which part of the machine housing has been removed;
- Figure 4 is a perspective view of the rotating drum of the machine of Figure 1.

[0015] With reference to the enclosed figures, a washing machine according to the invention includes a housing cabinet 1 consisting of a box-shaped body on whose front part is provided a laundry loading opening 2 that may be closed by a door 3 hinged on the housing cabinet 1. Through the loading opening 2 it is possible to load the laundry inside the space 42 of a drum 4 rotating around an axis X and installed inside a tub 5 that is suspended inside the holding cabinet 1 by means of suspension elements 6A, 6B comprising springs and friction shock absorbers. The loading opening 2 is connected to the tub 5 by means of a flexible bellows assembly 7 capable of elastically deforming by effect of the vibrations applied to the tub 5 by the rotation of the unevenly distributed load contained inside the drum 4. A dispensing drawer 8 for the washing agent, and for other laundry treatment substances, is slidably connected to the machine housing cabinet 1 and accessible from the front part of said cabinet 1. On said front part of the cabinet 1 is provided a user interface 9 carrying control elements 10 such as push buttons, knobs, etc., to enter the laundry treatment parameters defined by the user, such as for example the temperature of the washing fluid, the rpm speed of the centrifuge, and so on.

[0016] A hydraulic circuit 11 draws the water from a source, such as the water supply network, through a solenoid valve 12 installed in a suction duct 13 and feeds it through a duct 14 into a space of the dispensing drawer 8 to dissolve any washing agent or other laundry treatment substance contained in said drawer 8. The water that passes through the dispensing drawer 8 is conveyed into the space 42 of the drum through a supply duct 15 that passes through the bellows assembly and is preferably installed in an upper portion of the latter. Between the solenoid valve 12 and the dispensing drawer 8 extends a further duct 25 that conveys the water drawn from the water supply to another space of the dispensing drawer 8 which does not receive the water conveyed through the duct 14.

[0017] The tub 5 is hydraulically connected to a tank 16 that collects the laundry treatment fluid through a drain pipe 17. The tank 16 is preferably arranged in the lower portion of the machine or it is formed in the body of the tub 5 as a fluid collecting space. In the latter case, the pipe 17 is not necessary. The drum 4 is hydraulically connected to the tank 16 through a supply duct 18 provided with a pump 19 for transferring the fluid from the tank 16 to the space 42 of the drum 4. For this purpose, the supply duct 18 is installed in a suitable opening formed on the bellows element 7 and includes a nozzle 20 for feeding the liquid drawn from the tank 16 into the drum 4.

[0018] A drain pipe 21 is provided to draw the fluid contained in the tank 16 and expel it outside the machine through a pump 22.

[0019] The tank 16 is further connected to the suction duct 13 that draws in the water from the supply network through a pipe 23 that branches off from the solenoid

valve 12 and reaches the tank 16 by by-passing the dispensing drawer 8. As will be seen later, the pipe 23 is used to fill the tank 16 at least partially without involving the dispensing drawer 8, for example during one of the drum loading operations 4 to start the laundry treatment and/or during one of the rinsing operations for the laundry contained in the drum 4.

[0020] Inside the tank 16 is provided a heating element 26 in the form of an electric heating element. If preferred, the heating element 26 may be in the form of a microwave emitter, a heat exchanger or other heating device of known type. The tank 16 is further provided with a level indicator 27 that measures the level of the fluid inside the tank 16 and that, through a signal line (not shown in the figures), communicates the data to a control unit that manages the operation of the machine. According to a preferred embodiment, the level indicator 27 consists of a sensor of reed type installed on a floating element sliding inside a guide 29 and of two or more magnetic elements 28 arranged outside the tank to activate said sensors at predetermined levels.

[0021] In Figure 4 is shown a drum 4 of a washing machine according to the invention. The drum 4 includes a substantially cylindrical shell 30 provided with one or more perforated portions 31 wherein through holes 32 are formed, and one or more imperforated portions 33, preferably arranged in a position adjacent to said one or more perforated portions 31. The latter are arranged in correspondence of valving elements 34 operable to adjust the passage of a fluid from the space inside the drum 4 to the outside of the same, or, in other words the passage of the fluid that leaves the drum 4 and flows into the tank 5. Each of the valving elements 34 is preferably formed by flaps 40 hinged to the shell 33 so as to oscillate between a first position in which the flaps 40 adhere to the shell 33 so that they hermetically close the holes 32 and a second position in which the flaps are detached from the shell and allow the opening of the holes 32 and the consequent passage of the fluid through the holes 32. Preferably, the portion of the flaps 40 that closes the holes 32 includes an element made of rubber or other suitable material for hermetically and temporarily seal the holes. Travel limiting means 41 are arranged in correspondence of each flap 40 to limit its rotation, that is, the lifting of the radially outermost surface of the shell 33, thus defining the maximum travel of each flap 40 and guaranteeing at the same time that it will not interfere with the internal surface of the tub 5 during the rotation of the drum 4. Suitable elastic means (not shown in the figures) are provided on each flap 40 to oppose its lifting from the outer surface of the shell 33. In this manner, the flaps 40 can be moved from their first closing position to their second opening position, impelling a rotation to the drum 4 sufficient to generate a centrifugal force that overcomes the opposing action of the elastic means.

[0022] The shell 33 is closed at one end by an end wall 35 on which is installed a pulley 36 to drive the drum 4 into rotation, and at the other end it is partially closed by

an annular wall 37 that forms a laundry loading opening 38. In the internal surface of the shell 33, inside the space 42 containing the laundry, a plurality of stirring elements 39 protrude toward the axis of rotation X of the drum to produce an effect of agitation of the laundry when the drum 4 rotates around the axis X.

[0023] The construction of the drum 4 makes it possible to maintain the contents hermetically sealed from the outside until the flaps 40 are opened. In this manner, the fluid required for the washing operations can be charged directly inside the drum 4 by means of the ducts 18 and 15 without also needlessly filling the cavity between the radially outermost surface of the drum 4 and the radially innermost surface of the tub 5, as normally happens in washing machines of conventional type. In this manner, no water is charged, nor heated, in excess of the real washing requirements, resulting in an advantage in terms of energy economy.

[0024] Herein will be described an example of a washing method according to the present invention. The washing machine is loaded with a load of laundry to be treated by placing the laundry inside the space 42 in the drum 4 through the loading opening 2, and the dispensing drawer 8 is at least partly filled with a washing agent and/or with additional laundry treatment substances. The washing machine is started through one of the control elements 10 on the user interface 9, and a washing program is inputted in the machine through another one of said control elements 10. By the opening of the solenoid valve 12, a first quantity of water is sent, through the duct 14, into a space in the dispensing drawer 8 to dissolve the washing agent or other laundry treatment substance contained in said drawer 8. The water that flows through the dispensing drawer 8, enriched by the washing agent to form a treatment fluid, is then conveyed into the drum 4 through the infeed duct 15 that passes through the bellows assembly 7 and starts to soak into the laundry contained in the drum 4. Said first quantity of water is preferably in such an amount as to allow the collection and transportation of all the washing agent from the dispensing drawer 8 to the drum 4 but not sufficient to completely saturate the laundry. In this manner, the laundry inside the drum 4 can be put through a first soaking with a fluid with a high concentration of washing agent for an immediate deterging action on the laundry. In order to achieve an optimal penetration of the concentrated fluid into the laundry, the rotation of the drum 4 can be impelled at such a speed as to move the flaps 40 toward their opening position. In this manner, the concentrated fluid is moved by centrifugal force and passes through the fabrics. The fluid leaving the drum 4 is collected by the tub 5 and sent to the tank 16 through the drain pipe 17. From the tank 16, the concentrated fluid can be redirected into the drum through the pump 19, the duct 18 and the nozzle 20.

[0025] If desired, a further quantity of water can be fed into the drum 4 through the ducts 14, 15 and the dispensing drawer 8 until the quantity of water necessary to carry out a washing operation is reached. The inflow of water

into the drum 4 can take place while the drum 4 rotates at such a speed as to maintain the flaps 40 closed, or the drum 4 can be made to rotate in an interval of time included between a first water inflow and the next one in order to uniformly soak the laundry.

[0026] Optionally, if, through the ducts 14, 15 and the dispensing drawer 8, not all the treatment fluid necessary to carry out a laundry washing operation is applied, a second quantity of water is added into the tank 16 through the solenoid valve 12 and the pipe 23, by-passing the dispensing drawer 8. By means of the pump 19, the quantity of water sent to the tank 16 is transferred to the drum 4 through the supply duct 18 and spread on the laundry through the nozzle 20. This second quantity of water combines with the first quantity that was supplied through the dispensing drawer 8 and has a high concentration of washing agent. This concentration is thus diluted, and the two quantities of fluid form a mass of treatment fluid sufficient to saturate the laundry. In this mode, the drum 4 can also be rotated at a slower speed than necessary to cause the opening of the flaps 40, so that all the fluid fed into the drum 4 remains inside the drum without flowing into the tub 5. The drum 4 can be rotated during the inflow of water through the nozzle 20 or during the time interval between one inflow cycle and the next one, in the case in which the water inflow is interrupted one or more times. Naturally, the supply of water into the drum 4 through the fluid supply line that includes the pipe 23, the tank 16, the pump 19, the duct 18 and the nozzle 20, can be carried out at the same time as the water supplied through the hydraulic circuit 11 comprising the ducts 14, 15 and the dispensing drawer 8, or the two water inflows can be carried out alternately.

[0027] Both in the case in which the necessary laundry treatment water is all supplied through the dispensing drawer 8 and in the case in which the water is supplied partly through the dispensing drawer 8 and partly through the tank 16 and the nozzle 20, the water inflow is interrupted, by closing the solenoid valve 12 the moment in which the water level inside the drum 4 overflows into the interspace between the drum 4 and the tub 5, passing through the gap between the edge of the drum 4 that defines the laundry loading opening 38 and the edge of the tub on which the bellows assembly 7 is fastened. The overflowed fluid is collected in the tub 5 and sent to the tank 16 through the drain pipe 17. When the fluid overflowed from the drum 4 and collected in the tank 16 reaches a level that activates the level indicator 27, the indicator sends a signal to a control unit that manages the operation of the machine to indicate that the fluid in the drum 4 is in a quantity necessary to carry out the washing operations.

[0028] At this point, the drum 4 is rotated at a speed necessary to open the flaps 40 to discharge as much fluid as possible through the duct 17 and to heat it inside of the tank 16 by means of the heating element 26 to the desired temperature or to a temperature slightly higher than the required wash temperature, considering that the

laundry inside the drum 4 remains soaked with fluid at a temperature lower than the temperature to which the fluid is heated inside the tank 16.

[0029] The heated fluid is redirected inside the drum 4 through the supply duct 18 and the nozzle 20, and the laundry is washed by periodically rotating the drum 4 at a speed such as to maintain the flaps 40 in their closed position. When the temperature of the fluid in the drum 4 drops below the required wash temperature, the rotation speed of the drum 4 is increased to open the flaps 40 and discharge the treatment fluid into the tank 16 through the tub 5 and the drain pipe 17 to carry out a new heating cycle by the heating elements 26. The treatment fluid that overflows from the drum 4 into the tub 5 by effect of the rotation of the drum is collected inside the tank 16 and sent back into the drum 4 by operating the pump 19 upon a signal from the level indicator 27 present in the tank 16.

[0030] At the end of the laundry washing time, all the treatment fluid is discharged again into the tank 16 as explained above and the fluid collected in the tank 16 is discharged by the pump 22 through the drain pipe 21.

[0031] To rinse the laundry, the water fed into the drum 4 can be made to flow through the dispensing drawer 8 by means of the ducts 25 and 15 and/or by filling the tank 16 by means of the pipe 23 and by transferring the contents of the tank 16 into the drum 4 through the duct 18 and the nozzle 20. Each laundry rinsing phase ends with a spinning step, that is, with the transfer of the water from the drum 4 to the tank 16 and the subsequent discharge of the rinsing water from the machine through the duct 21.

[0032] It has been found that the invention achieved the preset objective and purposes, as a washing machine is provided having a better energy efficiency in comparison with prior art washing machines, since the quantity of water and the electric power required to wash a laundry load of about 6 kg with optimal results is about 25-30% less than with conventional washing machines. This saving is advantageously achieved by a washing method that requires heating only the water that is actually necessary for the laundry washing operations. Moreover, the satisfactory laundry cleaning results achievable with a washing method according to the present invention are advantageously achieved with an optimal use and an efficient distribution of the mixture of water and washing agent making up the washing fluid.

[0033] It was also found that the construction of a washing machine according to the invention does not entail particular assembling problems, as the machine does not in fact have a complicated structure.

[0034] Naturally, the invention can also be applied in a top loading washing machine, and the materials as well as the shapes and dimensions of the individual components of the invention can be the most suitable for the specific requirements.

Claims

1. Washing machine comprising a tub (5), a drum (4) rotatably mounted inside said tub (5) to rotate around an axis (X), said drum (4) defining a space (42) to contain laundry to be treated, hydraulic means (11, 16, 19, 18, 20) to supply a treatment fluid inside the space (42), **characterized in that** the drum (4) includes a shell (30) that extends around said axis (X) and is provided with one or more perforated portions (31) that hydraulically connect the space (42) with the tub (5), and one or more imperforated portions (33), said one or more perforated portions (31) being arranged in correspondence of valving elements (34) operable to adjust the passage of the treatment fluid through said perforated portions (31) and **in that** it includes a hydraulic line (17, 16, 19, 18, 20) that connects the tub (5) to the drum (4) even when said valving elements (38) prevent a passage of fluid through the perforated portions (31).
2. Washing machine according to claim 1, wherein each of said one or more perforated portions (31) is arranged adjacent to said one or more imperforated portions (33), and said valving elements (34) are arranged in the radially outermost surface of said shell (30).
3. Washing machine according to claim 1 or 2, wherein said valving elements (34) include flaps (40) movable by effect of the centrifugal force generated by the rotation of the drum (4) between a first position in which said valving elements (34) close said perforated portions (31) and a second position in which said valving elements (34) open said perforated portions (31).
4. Washing machine according to claim 3, wherein said second position is defined by travel limiting means (41) connected to the shell (30) in proximity of each of said flaps (40).
5. Washing machine according to any of the previous claims, wherein said valving elements (34) are movable against the action of counteracting elastic means.
6. Washing machine according to any of the previous claims, wherein said hydraulic line (17, 16, 19, 18, 20) includes heating means (26) arranged inside a tank (16).
7. Washing machine according to claim 6, wherein said tank (16) is hydraulically connected to the tub (5) through a drain pipe (17) and is also hydraulically connected to the drum (4) through a treatment fluid supplying duct (18).

8. Washing machine according to claim 7, wherein said supplying duct (18) bypasses the tub (5). 5
9. Washing machine according to claim 7 or 8, wherein the supplying duct (18) includes a nozzle (20) arranged in a bellows (7) connecting the tub (5) with a charging opening (2) formed in a body (1) that houses the machine. 10
10. Washing machine according to any of the previous claims from 6 to 9, wherein said tank (16) is provided with a level indicator (27). 15
11. Method for washing laundry in a washing machine according to one or more of the previous claims, **characterized in that** it comprises the following steps: 20
- a) supplying a treatment fluid inside a drum (4) containing laundry to be treated while keeping valving elements (34) provided on the drum (4) in closed position; 25
 - b) suspending step a) when a quantity of treatment fluid that overflowed from the drum (4) is collected in a tank (16); 30
 - c) draining the treatment fluid from the drum (4) by opening the valving elements (34) and imparting to the drum (4) a rotation around an axis of rotation X; 35
 - d) collecting the fluid drained in step c) into the tank (16), heating it and supplying it back into the drum (4) through a hydraulic line (17, 16, 19, 18, 20), while keeping the valving elements (34) in a closed position; 40
 - e) while keeping the valving elements (34) closed, alternating periods of rotation of the drum (4) with periods of immobility of the drum (4), collecting into the tank (16) and supplying back into the drum (4) the treatment fluid that overflows from the drum (4). 45
12. Method according to claim 11, wherein step a) is carried out by supplying a quantity of water through a hydraulic circuit (11) comprising a dispensing drawer (8). 50
13. Method according to claim 12, wherein a further quantity of water is supplied into the drum (4) through a fluid supplying line (23, 16, 18, 20) that bypasses said dispensing drawer (8). 55
14. Method according to any one of claims from 11 to 13, wherein in step c) the opening of the valving elements (34) is brought about by the centrifugal force generated by the rotation of the drum (4) around the axis of rotation X.
15. Method according to any one of claims from 11 to 14, wherein step d) is brought about when the temperature of the treatment fluid contained in the drum (4) is lower than a predefined washing temperature.

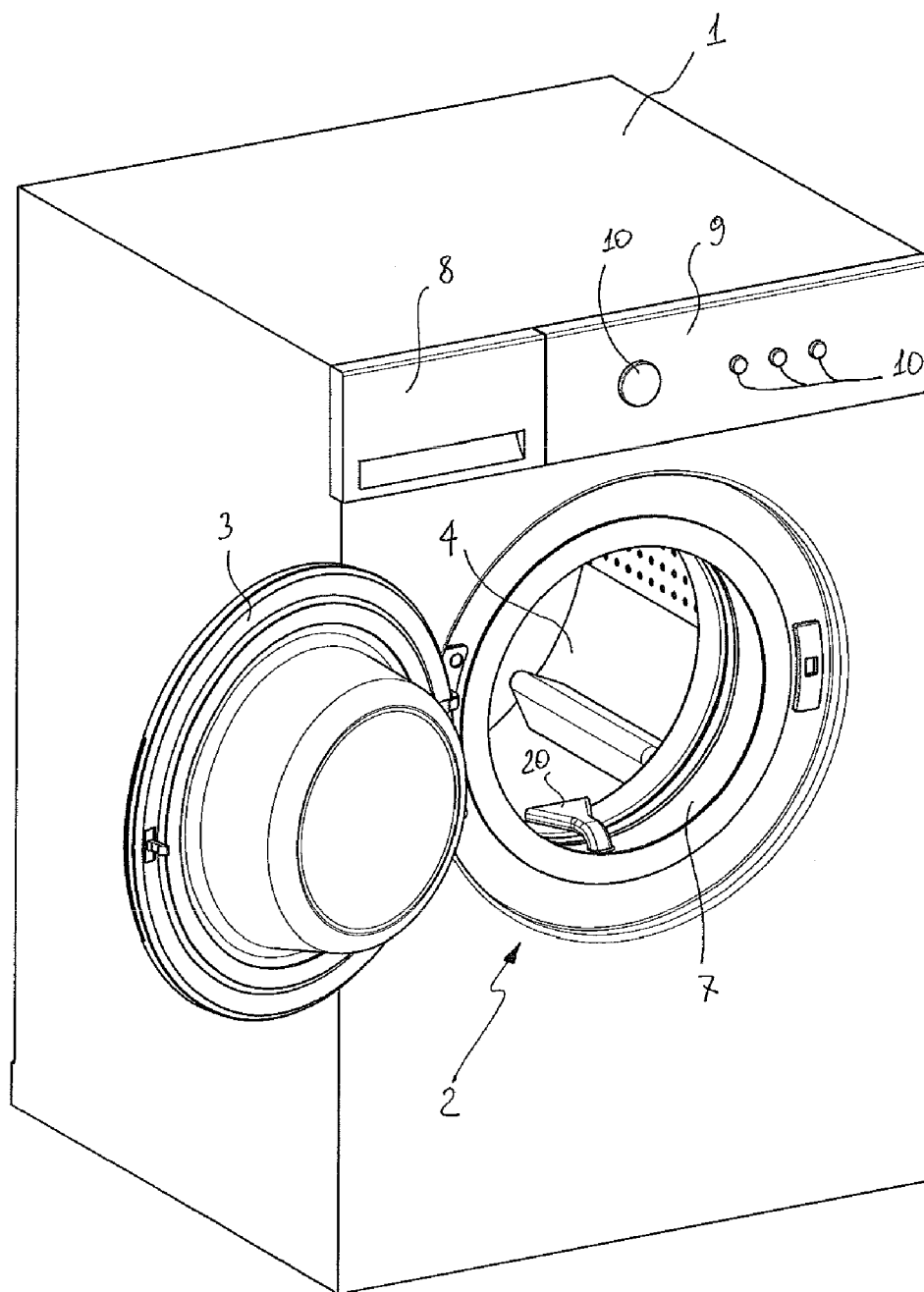
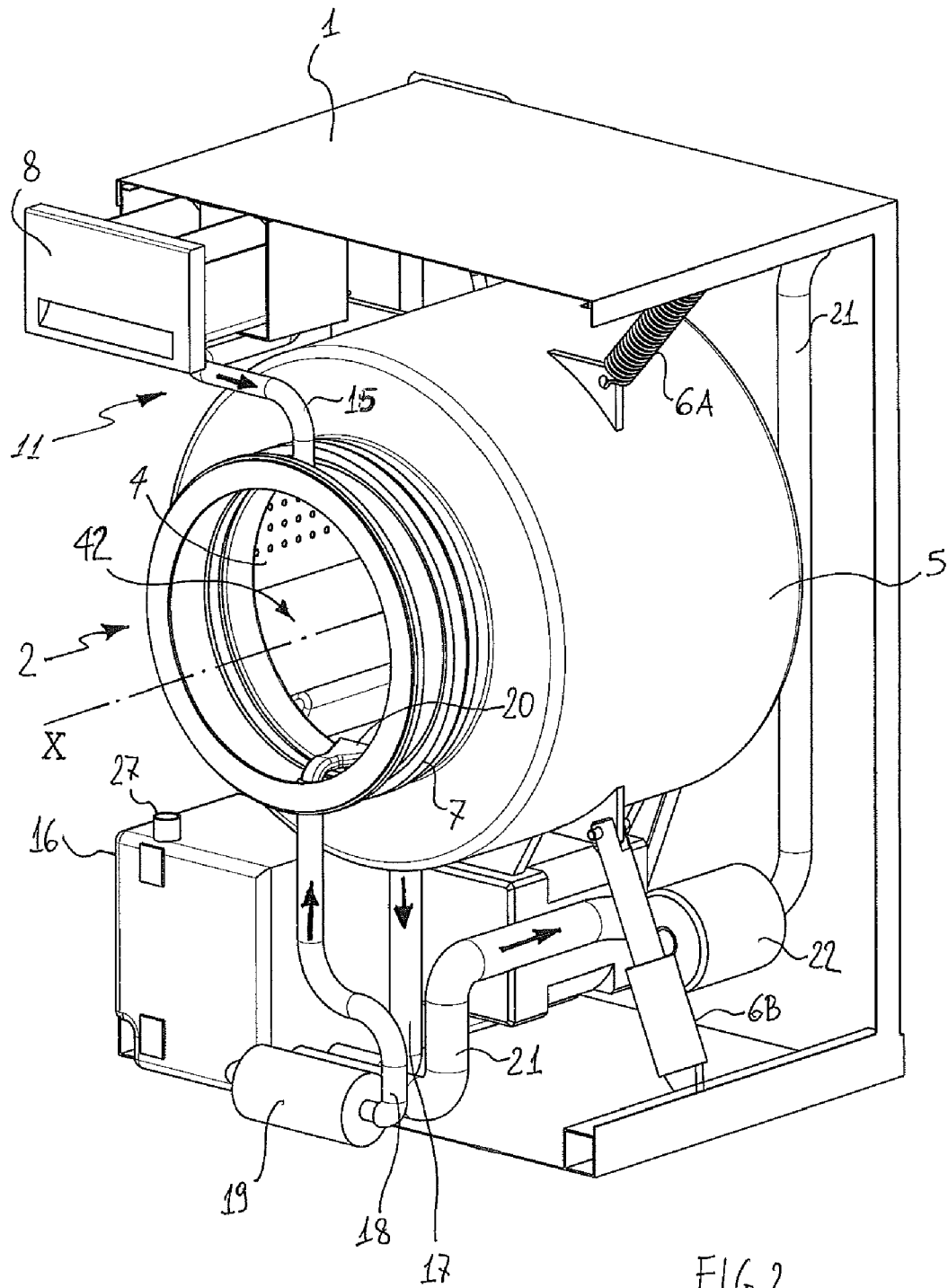
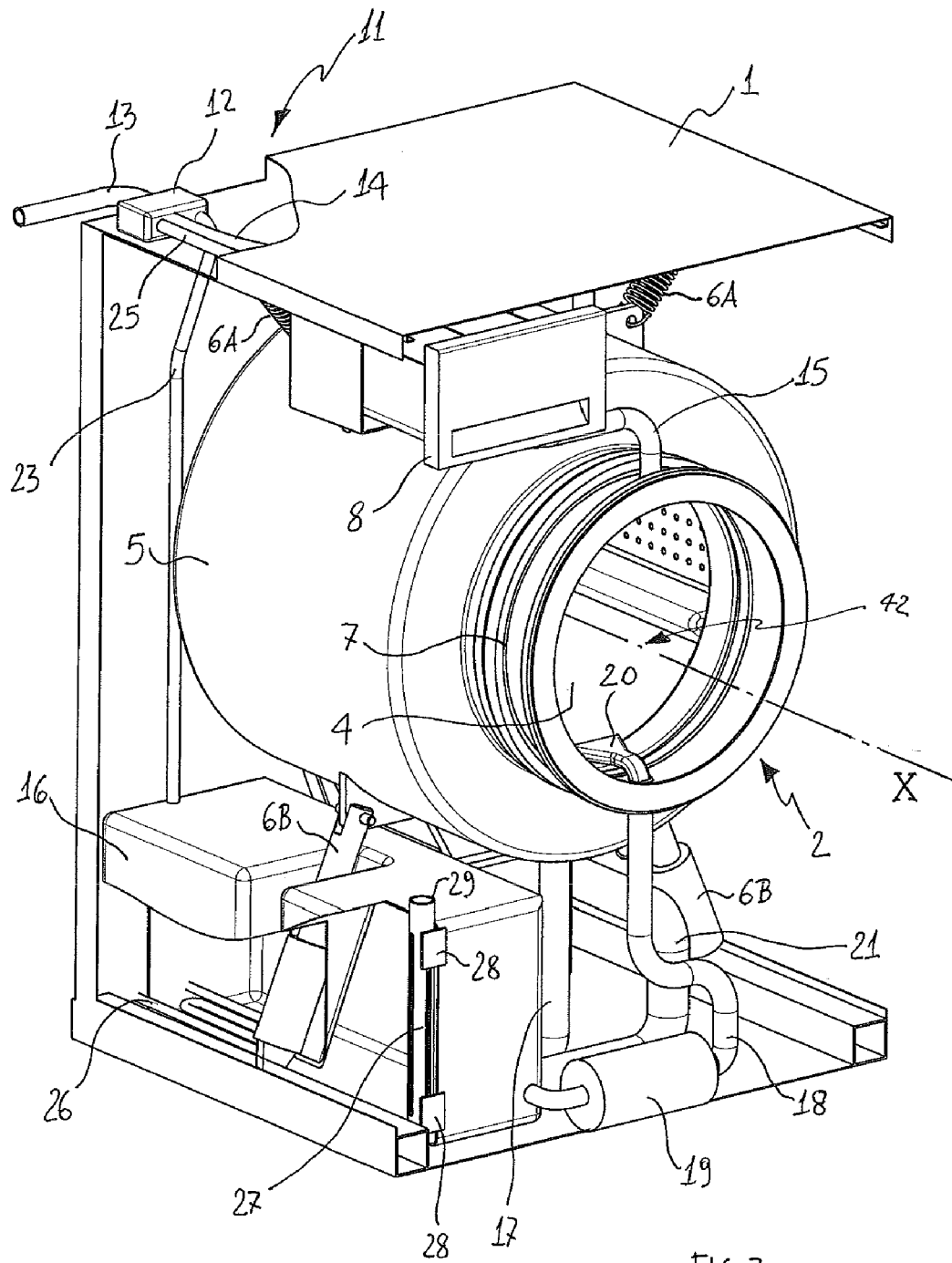
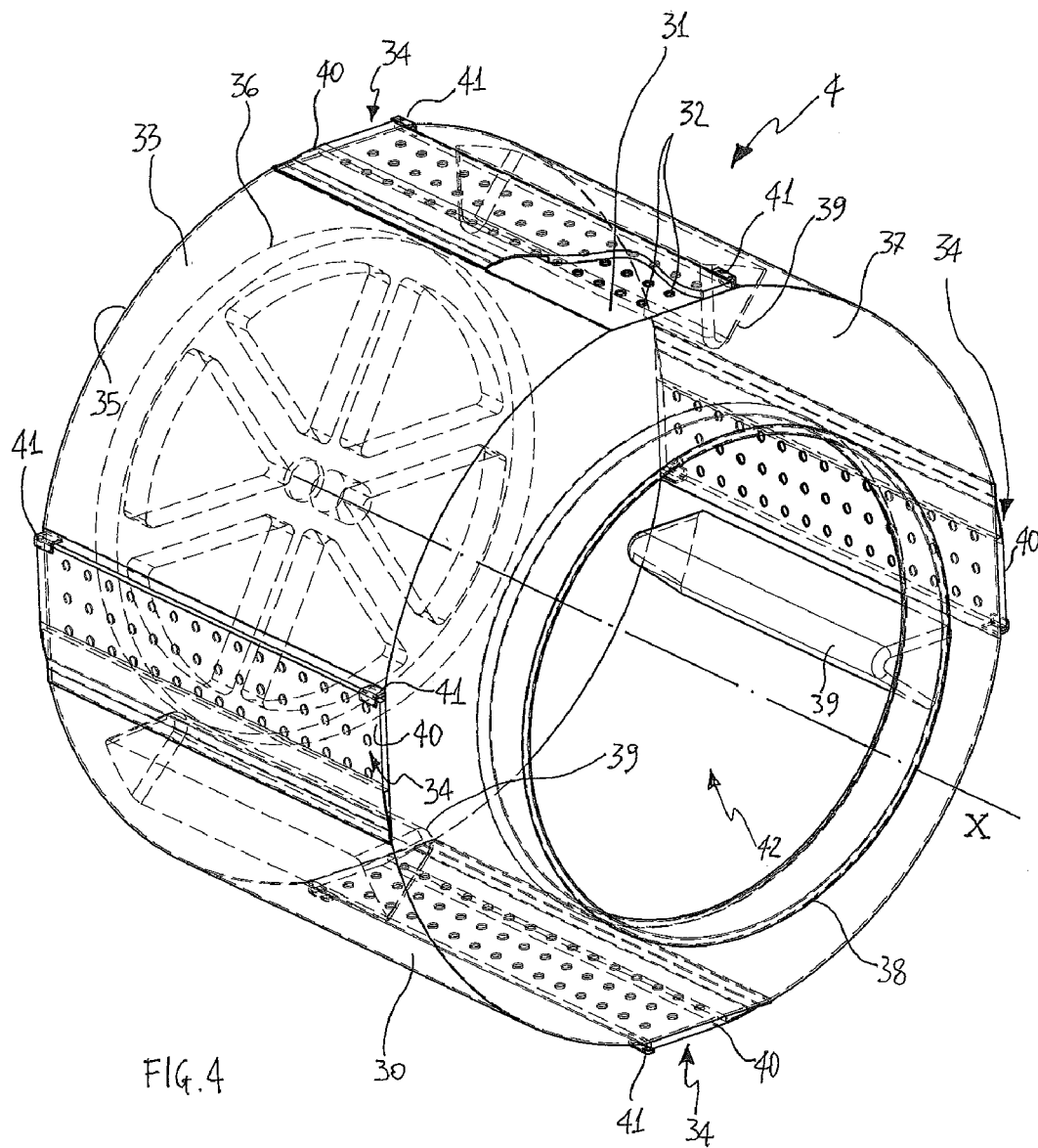


FIG. 1









EUROPEAN SEARCH REPORT

Application Number
EP 11 18 7624

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	US 2009/249840 A1 (JO MIN-GYU [KR] ET AL) 8 October 2009 (2009-10-08) * paragraph [0059] - paragraph [0068]; figures 4,5 * -----	1-15	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			D06F
Place of search		Date of completion of the search	Examiner
Munich		24 April 2012	Hannam, Martin
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 18 7624

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24-04-2012

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REFERENCES CITED IN THE DESCRIPTION

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