



(11)

EP 2 826 909 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.01.2015 Bulletin 2015/04

(51) Int Cl.:
D06F 39/00 ^(2006.01)
D06F 58/28 ^(2006.01)
D06F 58/26 ^(2006.01)
D06F 58/20 ^(2006.01)

(21) Application number: **13177180.0**

(22) Date of filing: **19.07.2013**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME

(72) Inventors:
• **Ros, Paolo**
33080 Porcia (PN) (IT)
• **Solerio, Daniele**
33080 Porcia (PN) (IT)

(71) Applicant: **Electrolux Appliances Aktiebolag**
105 45 Stockholm (SE)

(74) Representative: **Nardoni, Andrea et al**
Electrolux Italia S.p.A.
Corso Lino Zanussi, 30
33080 Porcia (PN) (IT)

(54) **Method for operating a steam generation unit in a laundry dryer and method of operating a laundry dryer**

(57) The invention relates to a method for operating a steam generation unit (90) in a laundry dryer (2), the laundry dryer comprising a laundry storing compartment (17) for receiving laundry (19) to be treated; a steam generation unit (90) for generating steam for laundry steam treatment, wherein the steam generation unit (90) is an inline steam generator comprising a heater (282); means for controlling the flow rate of water provided to the steam generation unit (90), wherein the supply rate for supplying water to the steam generation unit is controlled by controlling the activation of a water supply pump supplying water from a water reservoir (140), or by controlling the

opening/closing of a valve (280) that is connected to a water reservoir (140) or connected to a water mains line. The method comprises: starting the control of the heater (282) for heating the steam generation unit (90), and thereafter starting the control of the water supply pump or of the valve (280); wherein after starting the control of the water supply pump or valve (280), the water supply pump or the valve is controlled according to a predetermined time sequence, in particular independent of the current operation status of the heater (282) or the current temperature of the steam generation unit (90).

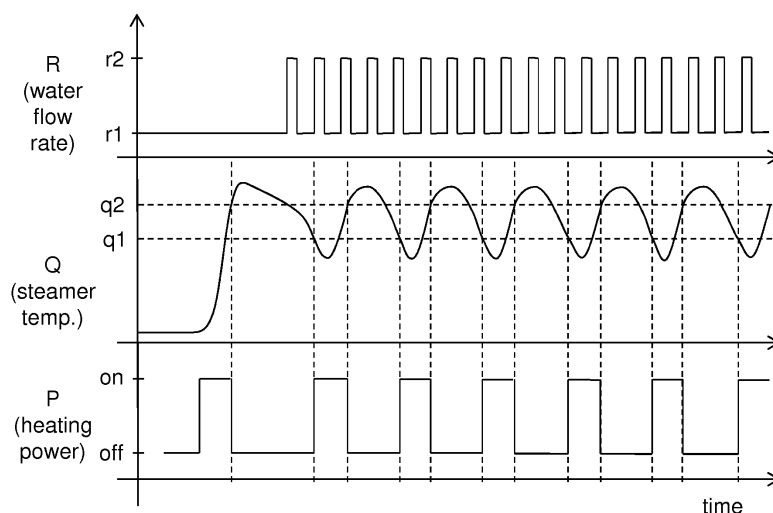


Fig. 49

Description

[0001] The invention relates to a method for operating a steam generation unit in a laundry dryer.

[0002] EP 1 887 127 A1 discloses laundry treating machines having means for applying a steam treatment to laundry.

The steam is directed inside a rotatable drum containing the laundry to be treated. Such steam treatment is used for removing odours from laundry or for relaxing and removing wrinkles from clothes.

[0003] WO 2004/059070 A1 teaches a laundry dryer with a laundry storing compartment defined by a cylindrical rotatable drum, a loading opening at the front end of the drum and a drum back wall at the rear end. This laundry dryer contains a processing unit having an evaporator for generating steam in order to remove odours from the laundry disposed in the drum. The steam is injected into the laundry storing compartment by an outlet of the process air channel fluidly connected to the laundry storing compartment at its rear end. The processing unit and its evaporator are arranged outside the laundry storing compartment adjacent to the mentioned outlet of the process air channel.

[0004] EP 1 889 966 B1 discloses a water supply control for a steam generator of a fabric treatment appliance using a temperature sensor. The fabric treatment appliance comprises a steam generator with a steam generation chamber configured to hold water, a temperature sensor configured to sense a temperature representative of the steam generation chamber at a predetermined water level in the chamber, and a controller coupled to the sensor. The controller is configured to control the flow of water based on the sensed temperature in order to control the level of water in the steam generation chamber.

[0005] It is an object of the invention to provide a method for operating a steam generation unit in a laundry dryer by which the steam generation for steam treatment of the laundry is further improved.

[0006] The invention is defined in claim 1. Particular embodiments of the invention are set out in the dependent claims.

[0007] According to claim 1 a method for operating a steam generation unit is related to a laundry dryer comprising a laundry storing compartment for storing the laundry to be treated and a steam generation unit for generating steam for laundry treatment. Preferably, the steam generation unit is an inline steam generator comprising a heater. The laundry dryer further comprises means for controlling the flow rate of water provided to the steam generation unit. The supply rate of water to the steam generation unit is controlled by said means by controlling the activation of a water supply pump and/or by controlling the opening and/or closing of a valve. Said water supply pump and/or said valve can be connected to a water reservoir and/or to a water mains line. The method for operating the steam generation unit comprises starting the control of the heater for heating the steam generation unit followed by starting the control of the water supply pump and/or of the valve. After starting the control of the water supply pump and/or of the valve, the water supply pump and/or the valve is controlled according to a predetermined time sequence.

[0008] The predetermined time sequence is and can not be changed by the means for controlling the flow rate. Thus the predetermined time sequence is fixed and invariant during the operation of the steam generation unit. In particular the predetermined time sequence is not dependent on any parameter (like temperature) during the control. By applying the predetermined time sequence the pump activation and/or valve closing/opening is controlled with the fixed sequence over time. The time sequence once applied or selected is not changed or adapted. Controlling of the water supply pump and/or the valve according to the predetermined time sequence represents a feed-forward control and is not a feed-back control reactive to any current operation parameter of the steam generation unit.

[0009] Preferably the control of the water supply to the steam generating unit, in particular the below mentioned predefined sequence(s) of water supply to the steam generating unit is adapted such that forming of condensed water and ejecting condensed water droplets into the laundry treatment chamber is minimized. For example at the time of storing fixed parameter settings in a storing device of the apparatus (by the manufacturer of the apparatus) the parameter setting which is used for generating the predetermined time sequence is set in accordance with fixed and known hardware parameters of the steam generating unit (and preferably the steam supply arrangement (steam conduit and/or nozzle unit)). For example at the time of manufacturer programming of or data storing to the memory device (ROM or PROM) one or more of following are known and thus fixed hardware parameters for the steam generating unit and connected elements: heating power, maximum flow rate, heat masses of the conduit and/or nozzle, heat mass of steam generating unit.

[0010] In an embodiment a storing device is associated to the means for controlling the flow rate, wherein one or more fixed predetermined time sequences are stored in the storing device. This or one of these fixed predetermined time sequences are used by the means for controlling during the control of the water supply. Once the predetermined time sequence is retrieved from the storing device there is no change or modification and the time sequence is executed without change and without change of the predetermined time sequence to another one. Even the one or more predetermined time sequences stored in the storing device is(are) preferably not modified.

[0011] Preferably the means for controlling the flow rate of water supplied to the steam generation unit is a control unit for controlling the overall operation of the apparatus and/or the storing device is the program memory of the apparatus.

[0012] In particular the predetermined time sequence is independent of the operation status of the heater and/or the current temperature of the steam generation unit. When starting the control of the water supply pump and/or of the valve,

the control of the water supply pump and/or the valve is independent of any operation status of the heater and/or any operating temperature of the steam generation unit.

[0013] In a preferred embodiment, the inline steam generating unit, which may be a flow-through or flow-type steam generator, has a low water storing capacity, stores a limited amount of water temporarily, and/or transforms water to steam essentially at the rate of water supply. Thus water input to the inline steam generating unit is essentially vaporized as steam when leaving the output. As an important advantage compared to other steam generators (in particular as compared to the boiler-type steam generators), the inline steam generator has a very short reaction time due to its lower volume of stored water. As a result, its steam generation rate can be adjusted very accurately and quickly by controlling its water input rate and/or heating power input. In a preferred embodiment, the inline steam generating unit is designed such that it reaches its operation temperature (e.g. to the predetermined upper temperature threshold) within less than 20, 15, preferably 10, 8 or 5 seconds. Preferably, the steam generating unit is arranged at a bottom or lower section of the apparatus. More preferably, the steam generating unit is arranged at or at the top of a battery top cover or basement shell.

[0014] Preferably the predetermined time sequence is determined according to the laundry treatment program. The time sequence may be determined according to an operation status and in particular according to the temperature of the steam generation unit measured before or at the beginning of the time sequence. More preferably the water supply pump and/or the valve is/are controlled by a sequence of two or more time sequences, each of which is predetermined according to the laundry treatment program and/or an operation status such as a temperature of the steam generation unit, wherein the operation status is measured before or at the beginning of the respective time sequence.

[0015] In an embodiment, the method further comprises heating the steam generation unit to a predetermined upper temperature threshold after starting the control of the heater. Preferably, the control of the water supply pump and/or the valve is started after the predetermined temperature threshold has been reached or exceeded.

[0016] In another embodiment, the control of the water supply pump and/or the valve is started when a predetermined time has elapsed after starting the control of the heater. Preferably, the time to be elapsed between starting the control of the heater and starting the control of the water supply pump and/or the valve is determined according to an operation status such as a temperature of the steam generation unit before or at the time of starting the control of the heater.

[0017] Preferably, the control of the heater comprises energizing the heater when a measured temperature of the steam generation unit drops or is below a first predetermined temperature limit. Alternatively or preferably additionally the heater control further comprises de-energizing the heater when a measured temperature of the steam generation unit rises or is above a second predetermined temperature limit. Preferably the second predetermined temperature limit is above the first predetermined temperature limit. The first predetermined temperature limit and/or the second temperature limit may be above the upper temperature threshold as explained above that may be used for triggering the control of the water supply pump and/or the valve.

[0018] In an embodiment, the method for operating the steam generation unit further comprises introducing water into the steam generation unit and repeatedly increasing and decreasing the flow rate of water provided to the steam generation unit. Preferably said repeated increasing and decreasing of said flow rate is achieved by controlling the activation and/or de-activation of the water supply pump and/or by controlling the opening and/or closing of the valve according to a predetermined time sequence. This predetermined time sequence may be the or may part of the predetermined time sequence determining the overall control of the water supply pump and/or the valve as described above. In another embodiment it may be an additional predetermined time sequence applied for modulation of the overall control of the water supply pump and/or the valve. In an embodiment, said repeated increasing and decreasing may be implemented as a periodic modulation of the water flow rate during a limited period of time.

[0019] Preferably, said repeatedly increasing and decreasing of the flow rate of water provided to the steam generation unit may be controlled so that the water flow rate follows a sequence of predetermined target flow rates. It shall be understood that the real flow rate of water provided to the steam generation unit at any time may deviate from the related target flow rate e.g. due to inaccuracies of actuators (pumps, valves, etc.), sensors (temperature, flow, water level, etc.), and means of processing (amplifiers, calculations, signal lines, etc.).

[0020] In embodiments, the predetermined time sequence and/or sequence of target flow rates may be changed during a laundry treatment program of the laundry dryer. Preferably, the predetermined time sequence and/or sequence of target flow rates may be chosen based on purpose and/or state of the laundry treatment program.

[0021] In an embodiment, the flow rate of water provided to the steam generation unit may be decreased and increased gradually resulting in a continuous sequence of flow rates. In another embodiment, the flow rate of water may be changed stepwise resulting in an essentially discontinuous sequence of flow rates.

[0022] Of course, it is possible to combine various embodiments of the method (such as e.g.: with continuous vs. essentially discontinuous sequences of flow rates) in a laundry dryer so that different laundry treatment programs may use different embodiments or the appropriate embodiment may be chosen based on purpose and/or state of the laundry treatment program and/or based on the state of the steam generation unit. For example, a laundry treatment program may comprise both a continuous and an essentially discontinuous sequence of flow rates. Furthermore, for example, in

a laundry treatment program the water supply pump and/or the valve may be controlled according to a first predetermined time sequence that is independent of the current operation status of the heater.

[0023] In an embodiment, the laundry dryer further comprises a nozzle unit, a steam conduit, and optionally a drain outlet. The nozzle unit comprises one or a plurality of nozzle outlets for injecting steam generated in the steam generation unit into the laundry storing compartment. The steam conduit is arranged for providing steam from the steam generation unit to the nozzle unit. The optional drain outlet is arranged for draining water from within the nozzle unit to the outside.

[0024] In an embodiment, the method further provides for a warm-up phase of the steam generation unit and/or a steam conduit and/or a nozzle unit. Preferably, during the warm-up phase the heating power or the average heating power of the steam generation unit is higher than during normal operation. Preferably, during the warm-up phase the water supply rate or the average water supply rate for supplying water to the steam generation unit for steam generation is lower than during normal operation. More preferably, during the warm-up phase the heating power (or the average heating power) of the steam generation unit is higher than during normal operation and the water supply rate (or the average water supply rate) for supplying water to the steam generation unit for steam generation is lower than during normal operation. Preferably, at the end or during the warm-up phase, the heating power (or the average heating power) is decreased towards the heating power applied during normal operation and/or the water supply rate (or the average water supply rate) for supplying water to the steam generation unit is increased towards the water supply rate applied during normal operation.

[0025] The described warm-up phase is arranged for achieving a soft-start of the steam generation unit which is beneficial as it can drastically reduce the condensation of water droplets in the steam generation unit and/or steam conduit and/or nozzle unit while one or several of them have not yet reached their final operating temperature and thus are still relatively "cold". As a consequence, the warm up phase helps to reduce the amount of water droplets reaching the laundry inside the laundry storing compartment, while allowing to use the system's full steam generation capacity after the warm-up phase. Preferably, the control of the water supply and/or the control of the heater during the warm-up phase are arranged to minimize the amount of water droplets leaving the or the plurality of nozzle outlets. Preferably, the control of the water supply and/or the control of the heater after the warm-up phase are arranged to minimize the amount of water droplets leaving the or the plurality of nozzle outlets. More preferably, the predetermined time sequence for controlling the water supply (i.e. the water supply pump and/or the valve) and/or the repeated increase and decrease of the flow rate of water and/or the control of the heater are arranged to minimize the amount of water droplets leaving the or the plurality of nozzle outlets.

[0026] In an embodiment, the steam generation unit is operated intermittently and the duty rate of operating the steam generation unit is decreasing over time during or at the end of the warm-up phase. In an embodiment, the water supply to the steam generation unit is operated intermittently and the duty cycle of supply is increasing over time during or at the end of the warm-up phase. Preferably, both the steam generation unit and the water supply to the steam generation unit are operated intermittently and the duty rate of the steam generation unit is decreasing and/or the duty rate of the water supply is increasing over time during or at the end of the warm-up phase. It shall be understood that said increasing and/or decreasing may be a gradual or a step-like change over time.

[0027] In an embodiment of the method, the predetermined time sequence comprises a repeated decrease and increase of the liquid supply rate to the steam generation unit and/or comprises repeated stops and starts of the liquid supply to the steam generation unit according to predetermined time intervals T_ON and T_OFF. Preferably, the time interval T_ON is in the range of 3 to 30, 4 to 8, 4 to 6 or 5 to 20 seconds or is preferably around 5 seconds. Preferably additionally or alternatively, the time interval T_OFF is in the range of 6 to 60, 10 to 40, 12 to 20 or 13 to 18 seconds or is preferably around 15 seconds.

[0028] In an embodiment, the laundry dryer further comprises at least one temperature sensor arranged for measuring a temperature of the steam generation unit or a temperature of the steam generated by the steam generation unit. The measured temperature may be used for example for choosing a time sequence for control of the water supply pump and/or the valve, for controlling the heating power of the steam generation unit, for controlling the warm-up phase etc.

[0029] According to another aspect of the invention, a method for operating a laundry dryer relates to a laundry dryer which comprises a rear channel, a back wall of the laundry storing compartment, a rear wall forming at least a portion of a back cover of the dryer, a nozzle unit, a steam conduit, and means for heating the process air. The rear channel is arranged for guiding process air at the backside of the laundry storing compartment, and the compartment back wall comprises a plurality of back wall openings designed for passing process air from the rear channel into the laundry storing compartment. A steam generation unit is arranged for generating steam to be supplied into the laundry storing compartment. The nozzle unit comprises one or a plurality of nozzle outlets for injecting steam generated in the steam generation unit into the laundry storing compartment and optionally a drain outlet for draining water from within the nozzle unit to the outside. The steam conduit is arranged for providing steam from the steam generation unit to the nozzle unit. Preferably, at least a portion of the steam conduit is guided within or in proximity of or in thermal contact with walls delimiting the rear channel.

[0030] The method comprises activating the means for heating the process air before activating the steam generation

unit. This method may be beneficial for example if only a steam laundry treatment is required by a laundry treatment program and therefore the drying process was not activated. In this case, the method provides for an appropriate warm-up of the steam conduit and/or the nozzle unit before guiding steam through the steam conduit and/or the nozzle unit, which can drastically reduce the amount of water droplets reaching the interior of the laundry treatment compartment. It shall be understood that the method introduced here and all of its embodiments can be used independently of or in any combination with the embodiments of the method described above.

[0031] Optionally the method further comprises activating a fan for guiding heated process air into said process air channel and/or the process air fan is (already) activated during the warm-up phase in which the process air is heated. In embodiments (representing normal cases), when steam is to be supplied into the laundry storing compartment which is a rotatable drum, the drum is rotated and the motor rotating the drum is also rotating the fan for driving the process air through the laundry storing compartment. E.g. in this case the process air fan is already activated before the heating of the process air by the means for heating is activated and the fan has not to be additionally activated. Thus in the preferred embodiment the fan is already activated at the time when the means for heating the process air is activated. Preferably the fan for driving the process air is activated at least over the period of heating the process air and/or over the period of steam generation.

[0032] All elements or features of said another method (i.e. particularly the features claimed in claims 10 to 19 and related embodiments) are applicable individually or in any arbitrary combination to the method of claim 1 and all embodiments thereof. For example a preheating by first heating the process air before activating the steam generation unit is also applicable to claim 1 with all the embodiments described in the following and the detailed description. Vice versa all individual elements or features or any arbitrary combination relating to the method of claim 1 are applicable to said another method.

[0033] Preferably, the duration of the activation of the means for heating the process air and/or the heating power used for heating the process air and/or the duration of the activation of the fan and/or the power of the fan are controlled depending on the temperature inside the process air channel. In an embodiment the means for heating the process air is a heat pump system. Preferably, the temperature inside the process air channel is determined by means of a temperature sensor. Alternatively or in addition, if the means for heating the process air is a heat pump system, the temperature inside the process air channel may be determined or calculated indirectly from a refrigerant temperature in the heat pump system, because the refrigerant temperature can be used as a measure for the process air temperature.

[0034] In an embodiment, the delay between activating the means for heating the process air and activating the steam generation unit is a predetermined time. Preferably the predetermined time is chosen according to a temperature inside the process air channel at or before the beginning of the activation of the means for heating the process air. Preferably the temperature inside the process air channel is detected by a temperature sensor. The temperature sensor may detect the process air temperature directly or indirectly. An example of an indirect temperature detection in an apparatus having a heat pump system is the detection by the refrigerant temperature sensor, for example a sensor detecting the refrigerant temperature at the compressor or condenser. In case of using an electrically operated heater preferably the process air temperature is detected using a temperature sensor arranged in the process air path between the electrical heater and the inlet of the laundry storing compartment.

[0035] Preferably the method further comprises deactivating the means for heating the process air or reducing the heating power of the means for process air heating, when the process air reaches a predetermined temperature. For example, the process air heating phase may be shortened or skipped if the process air channel is already heated up.

[0036] In an embodiment, the laundry dryer further comprises a front wall with a front loading opening for loading laundry into the laundry storing compartment and/or a rear frame including said compartment back wall. Preferably, the compartment back wall is opposite to the loading opening.

[0037] Preferably, an or the nozzle outlet(s) of the nozzle unit is/are arranged between said compartment back wall and said rear wall inside said rear channel so that steam ejected from said nozzle outlet passes through at least one back wall opening of the compartment back wall before entering the laundry storing compartment.

[0038] Preferably, the laundry dryer further comprises a heat-pump system having a refrigerant temperature sensor and the method further comprises detecting a temperature signal from the temperature sensor before activating the steam generation unit. If the temperature is below a predetermined temperature threshold, the heat-pump system for heating the process air is activated and, preferably, the steam generation unit for generating steam is activated thereafter as described above. More preferably the refrigerant temperature sensor may be used instead or additionally for determining the temperature of the process air. The temperature sensor for detecting the refrigerant temperature may be arranged at or may be in thermal contact with the outlet region of the compressor, the inlet or outlet region of the condenser or the inlet region of the expansion device. Furthermore, the temperature signal obtained from the refrigerant temperature sensor may be used for choosing, determining, or calculating the predetermined temperature of the process air to be reached.

[0039] In an embodiment, the method further comprises keeping the heating power of the heater of the steam generation unit off (steam generation unit heater deactivated), while the means for process air heating is activated. After heating

the process air and preferably after switching off or deactivating the heater means for heating the process air, the heater of the steam generation unit is switched on or is activated. This is especially useful if the total power that can be provided to certain components of the laundry dryer is limited. In particular it may be beneficial to deactivate the heater or to postpone the activation of the steam generating unit heater during time periods where the means for process air heating is operated at a high power. Preferably, the heating power of the heater of the steam generation unit is controlled depending on the power at which the means for process air heating is operated. Preferably there may be periods of time while operating the means for process air heating during which the heater of the steam generation unit is deactivated and/or there may be other periods of time during which the heater of the steam generation unit is operated at reduced heating power. In case of heating the process air using an electrical heater (e.g. electrical resistance heater), the electrical heater is preferably completely switched off before switching on the steam generating unit heater. In case of heating the process air with a heat pump system (condenser thereof), the compressor may be switched off or preferably may be operated at lower or lowest power consumption mode before activating the steam generating unit heater, if for example a drying process is executed after the steam supply cycle in which the steam is to be supplied from the steam generating unit.

[0040] Preferably, the method further comprises deactivating the means for process air heating after a predetermined period of time or when the steam conduit has reached a temperature within a predetermined temperature range of about 30°C to 40°C.

[0041] As mentioned above, the means for heating the process air may be a heat pump system, in particular the heat exchanger (condenser) transferring heat from the refrigerant to the process air. In another embodiment the means for heating the process air may be an electrical resistor heater. Preferably, a heat pump system and an electrical resistor heater may be combined to form the means for heating the process air. In particular, the electrical resistor heater may be used when the heat pump compressor is not activated. Preferably, the electrical resistor heater may be used to support process air heating when the heat power provided by the heat pump compressor is not sufficient for heating the required amount of process air, possibly depending on the state of a laundry drying program.

[0042] Preferably, the nozzle unit further comprises a drain outlet adapted for draining the water from the nozzle unit to the rear channel and/or a separation chamber for separating steam and water. More preferably, at least a portion of the separation chamber is arranged within the rear channel.

[0043] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

Fig. 1 a schematic view of a laundry dryer,

Fig. 2 a perspective view of the condenser dryer of Fig. 1 - partially disassembled,

Fig. 3 the front view of the dryer of Fig. 2,

Fig. 4 another perspective view of the dryer of Fig. 1 - partially disassembled,

Fig. 5 a front view of the rear frame and parts of a base section of the dryer of Fig. 1,

Fig. 6 an enlarged view of the detail VI in Fig. 5,

Fig. 7 the sectional view of the compartment back wall, nozzle unit and rear wall along line VII-VII in Fig. 6,

Fig. 8 a perspective view of the nozzle unit,

Fig. 9 a rear view of the nozzle unit of Fig. 8,

Fig. 10 the sectional view of the nozzle unit along line X-X in Fig. 9,

Fig. 11 an enlarged view of the detail XI in Fig. 10,

Fig. 12 a rear view of the rear frame with mounted nozzle unit and steam conduit,

Fig. 13 the sectional view of the rear frame along line XIII-XIII in Fig. 12,

Fig. 14 an enlarged view of the detail XIV in Fig. 13,

- Fig. 15 a perspective view of the backside of the rear frame with mounted nozzle unit and steam conduit connected to the nozzle unit and the steam generation unit,
- Fig. 16 a perspective view of the front side of the rear frame according to Fig. 15,
- 5 Fig. 17 a front view of the rear frame of Fig. 12,
- Fig. 18 a perspective view of a front frame, a rear frame and in between a piping with a branching element for branching up a pump unit conduit of a condensation-type laundry dryer,
- 10 Fig. 19 another perspective view of the dryer of Fig. 18,
- Fig. 20 a perspective view of the course of the piping of Fig. 18 between a pump unit, a steamer tank and a drain tank,
- 15 Fig. 21 an enlarged view of the detail XXI in Fig. 18,
- Fig. 22 a side view of the branching element shown in Fig. 21,
- Fig. 23 a sectional side view of the branching element of Fig. 22,
- 20 Fig. 24 the branching element of Fig. 23 in a closed position,
- Fig. 25 the branching element of Fig. 23 in an open position,
- 25 Fig. 26 a perspective view of another model of dryer - in the assembled state,
- Fig. 27 the perspective view of the dryer of Fig. 26 - with disassembled left cover,
- Fig. 28 a perspective view of a dryer's base section carrying a steam generation unit and showing the steamer tank, the drain tank and the piping,
- 30 Fig. 29 a front view to the left front of the dryer parts of Fig. 28,
- Fig. 30 a perspective view according to Fig. 28, without the base section,
- 35 Fig. 31 a front view to the left front of the dryer parts of Fig. 30,
- Fig. 32 a perspective view of the piping between the drain pump, the steamer tank and the drain tank,
- 40 Fig. 33 the piping according to Fig. 32 in a disassembled state,
- Fig. 34 a front view of an enlarged detail of a piping part according to Fig. 33 comprising the branching element,
- Fig. 35 the sectional view of the branching element along line XXXV-XXXV in Fig. 34,
- 45 Fig. 36 a side view of the piping part according to Fig. 33 comprising the branching element,
- Fig. 37 the sectional view of the branching element along line XXXVII-XXXVII in Fig. 36
- 50 Fig. 38 a rear view of the rear frame with mounted nozzle unit according to another embodiment and steam conduit,
- Fig. 39 the sectional view of the rear frame along line A-A in Fig. 38,
- Fig. 40 an enlarged view of the detail B in Fig. 39,
- 55 Fig. 41 a front view of the rear frame of Fig. 38 (compare Fig. 17),
- Fig. 42 a perspective view of the nozzle unit,

Fig. 43 a front view of the nozzle unit of Fig. 42,

Fig. 44 a left view of the nozzle unit of Fig. 42,

5 Fig. 45 a rear view of the nozzle unit of Fig. 42,

Fig. 46 the sectional view of the nozzle unit along line A-A in Fig. 43,

10 Fig. 47 an enlarged view of the detail B in Fig. 46,

Fig. 48 a schematic view of an embodiment of the laundry dryer 2,

Fig. 49 the temporal variation of heating power, steamer temperature, and water flow rate in an embodiment for operating a steam generation unit,

15 Fig. 50 the temporal variation of heating power, steamer temperature, and water flow rate in another embodiment for operating a steam generation unit,

Fig. 51 a flow diagram of an embodiment of a method for operating a steam generation unit,

20 Fig. 52 the temporal variation of heating power and steamer temperature in another embodiment for operating a steam generation unit, and

25 Fig. 53 the temporal variation of heating power, steamer temperature, water flow rate, and temperature of a steam conduit in an embodiment for operating a steam generation unit.

[0044] The following figures are not drawn to scale and are provided for illustrative purposes.

30 **[0045]** Fig. 1 shows a schematically depicted laundry dryer 2. The dryer 2 comprises a heat pump system 4, including a closed refrigerant loop 6 which comprises in the following order of refrigerant flow B: a first heat exchanger 10 acting as evaporator for evaporating the refrigerant and cooling process air, a compressor 14, a second heat exchanger 12 acting as condenser for cooling the refrigerant and heating the process air, and an expansion device 16 from where the refrigerant is returned to the first heat exchanger 10. Together with the refrigerant pipes connecting the components of the heat pump system 4 in series, the heat pump system 4 forms the refrigerant loop 6 through which the refrigerant is circulated by the compressor 14 as indicated by arrow B.

35 **[0046]** The process air flow A within the dryer 2 is guided through a laundry storing compartment 17 of the dryer 2, i.e. through a compartment for receiving articles to be treated, e.g. a drum 18. The articles to be treated are textiles, laundry 19, clothes, shoes or the like. The process air flow is indicated by arrows A in Fig. 1 and is driven by a process air blower 8. The process air channel 20 guides the process air flow A outside the drum 18 and includes different sections, including the section forming the battery channel 20a in which the first and second heat exchangers 10, 12 are arranged. 40 The process air exiting the second heat exchanger 12 flows into a rear channel 20b in which the process air blower 8 is arranged. The air conveyed by blower 8 is guided upward in a rising channel 20c to the backside of the drum 18. The air exiting the drum 18 through the drum outlet (which is the loading opening 53 of the drum 18) is filtered by a fluff filter 22 arranged close to the drum outlet in or at the channel 20. The optional fluff filter 22 is arranged in a front channel 20d forming another section of channel 20 which is arranged behind and adjacent the front cover of the dryer 2. The condensate 45 formed at the first heat exchanger 10 is collected and guided to the condensate collector 30.

[0047] The condensate collector 30 is connected via a drain conduit 46, a drain pump 36 and a drawer pipe 50 to an extractable condensate drawer 40. I.e. the collected condensate can be pumped from the collector 30 to the drawer 40 which is arranged at an upper portion of the dryer 2 from where it can be comfortably withdrawn and emptied by a user.

50 **[0048]** The dryer 2 comprises a control unit 51 for controlling and monitoring the overall operation of the dryer 2. For example and as shown in Fig. 1, the control unit 51 receives a temperature signal from a temperature sensor 41 which is arranged at the outlet of the second heat exchanger 12 (condenser) and which is indicative of the refrigerant temperature at this position. According to Fig. 1, the control unit 51 also controls the drain pump 36. Additionally, the control unit 51 is able to control other parts of the dryer 2.

55 **[0049]** Fig. 2 shows a front perspective view of a partially disassembled condenser dryer that uses a heat pump system 4. In the shown state the loading door of the dryer 2, the right cover, the lower shell of a bottom unit and a bottom panel are removed. The outer appearance of the depicted dryer 2 is defined by a top cover 56, a left cover or wall 58, a front cover 60 having a loading opening 10 and a front top panel 62. The front top panel 62 frames a drawer cover 64 of the condensate drawer 40, wherein here the drawer 40 has a condensate container that is completely pushed in a drawer

compartment located at the upper part of the dryer 2. The right portion of the front top panel 62 forms an input section 66 wherein here the details of the input section 66 are not shown (like indicators, a display, switches and so on).

[0050] The loading opening 54 is surrounded by a loading frame 68 which is formed in the front cover 60. Fig. 26 shows a loading door 55 for closing the loading opening 54 in a closed state. In loading direction behind the bottom section of the loading frame 68 a filter compartment/process air channel 20 is arranged which is adapted to receive the fluff filter 22 and which is formed in a front frame 70. At the back side of the loading opening 54 in the front frame 70 the drum 18 is arranged. In the embodiment shown the drum 18 is a rotating drum cylinder that is extending between the back side of the front frame 70 and the front side of a rear frame 72 (Fig. 4, Fig. 5). The open rear end of cylindrical rotatable drum 18 is closed by a compartment back wall 74 (Fig. 3) which is mounted at the rear frame 72 (Fig. 5). Back wall 74 is preferably provided as a separate element to the rear frame 72, formed for example from a metal plate. The compartment back wall 74 is disposed stationary, whereas the rotatable drum 18 is rotatably coupled to the compartment back wall 74. In the shown embodiment the rotation axis of the drum 18 is horizontal, however, the rotation axis may be inclined with respect to the horizontal axis or may be even vertical with some modifications to the shown embodiment, however without the requirement to modify other groups of the dryer 2.

[0051] Below the condensate drawer 40 and adjacent to the left upper corner of the front cover 60 or left above middle of the loading opening 54, a window panel 76 is inserted into a front cover window opening 78 (Fig. 3, Fig. 4). The window opening 78 and the window panel 76 allow visual inspection into the inside of the dryer outer body to check the liquid level of a liquid reservoir, particularly a steamer (liquid storing) tank 140 (see more detail below).

[0052] As indicated in Fig. 3 showing the dryer of Fig. 2 in front view, the condensate drawer 40 has a draw handle 82 at the drawer cover 64 to be gripped by the user for pushing the condensate drawer 40 in or pulling it out of the condensate drawer compartment 37 that is extending into the interior of the dryer 2 (Fig. 18, Fig. 19). Fig. 3 gives a view onto the compartment back wall 74 which has a plurality of back wall openings 84 through which processing air A enters the laundry storing compartment 17 from the back side or rear side of the drum 18. In the center of the compartment back wall 74 and surrounded by the air back wall openings 84 a cone 86 is arranged which is extending into the laundry storing compartment 17 (preferably with a tapered end) and has in this embodiment laundry detangling function.

[0053] The dryer comprises the following parts described in more detail below: a nozzle unit 88 (Fig. 7 - Fig. 10) and a steam generation unit 90 (in short 'steamer'; see Figs. 15, 16). The nozzle unit 88 has a nozzle outlet 92 for injecting steam generated in the steam generation unit 90 into the laundry storing compartment 17. As can be seen from Fig. 7, the nozzle unit 88 is mounted at a rear wall 94 which is forming at least a portion of a back cover 95 of the dryer 2. The compartment back wall 74 and the rear wall 94 define portion of the rear channel 20b and the rising channel 20c. The compartment back wall 74 comprises a plurality of the back wall openings 84 designed for passing process air from the rear channel 20b, 20c into the laundry storing compartment 17.

[0054] The nozzle unit 88 comprises a base portion 96 mounted at the back side of the rear wall 94. For mounting the base portion it is perforated by mounting holes 96 interacting with mounting screws 98 or the like (Fig. 7, Fig. 8). According to Fig. 7, a steam guiding portion 102 is fluidly connecting the base portion 96 to the nozzle outlet 92. The steam guiding portion 102 is extending from the base portion 96 into the rear channel 20b, 20c such that it spans substantially just the distance between the rear wall 94 and the compartment back wall 74 (i.e. the depth of the rear channel 20b, 20c), whereas the nozzle outlet 92 is in contact with a respective back wall opening 84 at the back side of the compartment back wall 74. The nozzle unit 88 comprises a connection portion 104 which is adapted to connect a steam conduit 106 which fluidly connects the steam generation unit 90 to the nozzle unit 88 (Fig. 10, Fig. 13, Fig. 15).

[0055] The nozzle outlet 92 is arranged at the back side at the compartment back wall 74 in such a manner that steam ejected from the nozzle outlet 92 passes through a respective back wall opening 84 before entering the laundry storing compartment 17 (Fig. 7).

[0056] In the embodiments, several elements of the nozzle unit 88 are formed as a single-piece or monolithic piece or single-molded part. These elements are the base portion 96, a separation chamber 108 contained in the base portion 96 for separating the supplied steam and water, the nozzle outlet 92, the steam guiding portion 102, the connection portion 104 and a substantially plan mounting socket 110 for mounting the nozzle unit 88. The water that is separated in the separation chamber may be formed by condensing the supplied steam - for example in the starting phase of steam supply when the steam conduit and nozzle unit are at low temperature as compared to the steam temperature. Thus, the whole nozzle unit 88 is mountable only by mounting the mounting socket 110 via the mounting holes 98 and some screws 100. The separation chamber 108 defined by the inner geometry of the base portion 96 is closed by a chamber cover 112. Both parts 96 and 112 are joined together by a welding joint 114 (e.g. ultrasonic welding) such that these parts are integrally fixed and connected to each other in an inseparable monolithic manner. Consequently, the separation chamber 108 is water and steam proof.

[0057] The mounting socket 110 is part of the base section and mounted at the back side of the rear wall 94. In this regard, the rear wall 94 is perforated by a nozzle port 116 thus allowing the steam guiding portion 102 to extend from the base portion 96 through this nozzle port 116 into the rear channel 20b, 20c. To avoid any escape of process air out of the rear channel 20b, 20c in the region of the nozzle port 116, there is provided a flat sealing element 101 clamped

between the back side of the rear wall 94 and the mounting socket 110 (Fig. 7, Fig. 10).

[0058] As can be seen from Fig. 15 and Fig. 16, the steam generation unit 90 is arranged in a base section 118 of the dryer 2. The steam conduit 106 is passing through a conduit port 120 contained in a bottom section of the rear frame 72 which is forming a portion of the back cover of the dryer 2 in this embodiment. The extension of the steam conduit 106 is such that a portion 122 of the steam conduit 106 extends at the back side of the rear frame 72 and the rear wall 94 from the conduit port 120 to the connection section 104 of the nozzle unit 88 (Fig. 15). The nozzle unit 88 and the steam conduit 106 are designed such that steam is supplied from the steam generation unit 90 to the nozzle unit 88 and condensed liquid (water) is drained from the nozzle unit 88 to the steam generation unit 90. For this purpose, the separation chamber 108 has a steam inlet 124 in fluid connection towards the steam generation unit 90 and a chamber outlet 126 in fluid connection towards the nozzle outlet 92 (Fig. 10, Fig. 14). The chamber outlet 126 is in fluid communication with the steam guiding portion 102 for guiding the steam from the separation chamber 108 to the nozzle outlet 92. The connection portion 104 comprises a conduit stub 128 for mounting the steam conduit 106, particularly its steam conduit portion 122, thereto (Fig. 9).

[0059] The steam inlet 124 is arranged at a lower section of the separation chamber 108, whereas the chamber outlet 126 is arranged at an upper section of the separation chamber 108. Simultaneously, the steam conduit portion 122 is descending from the connection portion 104 and the steam inlet 124 towards the steam generation unit 90 thus forming a draining conduit for draining water from the separation chamber 108 towards the steam generation unit 90. Thus, separation of steam and condensed water is realized in a natural physical manner without any complex design. In this regard, the flow axis direction of the steam inlet 124 (or the allocated/associated connection portion 104) and the flow axis direction of the steam guiding portion 102 are perpendicular to each other. In other embodiments, these flow axes are inclined to each other in an angle different from 90°.

[0060] The nozzle unit 88 comprises a single nozzle outlet 92 which is associated to one predefined back wall opening 84 (Fig. 7, Fig. 14). In further embodiments, the nozzle unit 88 comprises a plurality of nozzle outlets 92 and each one of these nozzle outlets 92 is assigned to a predefined one of a plurality of back wall openings 84. The nozzle outlet 92 is designed to direct a steam flow exiting this nozzle outlet 92 directly through its associated back wall opening 84 into the laundry storing compartment 17. In this regard, the nozzle outlet 92 abuts with its front surface portion 132 against an opening rim 130 of the respective associated back wall opening 84 such as to form a sealing between the nozzle outlet 92 and the compartment back wall 74. The nozzle outlet 92 is arranged such that its inner cross section area is centrally aligned to the cross section area of the associated wall opening 84.

[0061] According to Fig. 17, a first horizontal plane 134 running through the center of the laundry storing compartment 17 is defined and a second horizontal plane 136 running through the highest point of the laundry storing compartment 17 is defined. The distance between these two planes 134, 136 defines a vertical range 138. Along this range 138, the one nozzle outlet 92 or a plurality of nozzle outlets 92 is assigned to respective back wall openings 84. In other embodiments here not shown the assigned back wall opening(s) 84 is/are arranged in the upper third or in the upper fourth or in the upper fifth of the range 138.

[0062] The condensation-type laundry dryer 2 according to Fig. 18 comprises in principle the elements and parts shown in Fig. 1. In particular, a drain tank (i.e. condensate drawer 40), a steam generation unit 90, a steamer tank 140 for storing liquid to be supplied to the steam generation unit 90 for generating the steam, and a pump unit (i.e. drain pump 36) for pumping the liquid collected in the condensation collection unit (i.e. condensate collector 30) to the drain tank 40 and the steamer tank 140 are provided. Additionally, a branching element 142 is provided. This element 142 is made for branching a pump unit conduit 144 into a steamer tank unit 146 and into a drain tank unit 148 (Fig. 20). The pump unit conduit 144 is connecting the branching element 142 to the pump unit 36. The steamer tank conduit 146 is connecting the branching element 142 to the steamer tank 140. The drain tank conduit is connecting the branching element 142 to the drain tank 40. The conduits 144, 146, 148 form a piping 150 for conveying the condensate to different destinations in the dryer.

[0063] The branching element 142 comprises a backflow-preventing member 152 preventing a backflow of liquid from the steamer tank 140 towards the pump unit 36. The backflow-preventing member 152 shown in Fig. 23 is a one-way valve arranged in the branching element 142. Furthermore, the backflow-preventing member 152 is arranged in the branch 154 of the branching element 142 where the liquid flows towards the steamer tank conduit 146. The member 152 comprises a valve seat 156 at a valve passage 158 and a valve member 160 which is adapted to cooperate with the valve seat 156. The movable valve member 160 is constituted by a ball or sphere and is urged against the valve seat 156 when the pump unit 36 is not activated and subsequently liquid tends to flow back from the line 146 towards the steamer tank 140 towards the branching element 142 and towards the pump unit 36. If this is the case, the valve member 160 and the valve seat 156 cooperate to close the valve passage 158, i.e. the valve member 160 is in a close position (Fig. 24). Then the liquid in the branch between the backflow-preventing member 152 and the upper hydraulic point of the steamer tank conduit 146.

[0064] If the valve member 160 is actuated by liquid pressure exerted by liquid pressurized by the pump unit 36 the valve passage 158 will be opened, i.e. the valve member 160 is in an open position (Fig. 23, Fig. 25). Within the valve

passage 158 and opposite to the valve seat 156 there is arranged a stopping element 162 for restricting the opening path of the valve member 160 when the liquid is flowing into the forward direction 164 of the one-way backflow-preventing member 152. In other words, the stopping element 162 is designed to provide a clearance passage 166 for the liquid flow which bypasses the valve member 160 in its open position (Fig. 25). Thus, the backflow-preventing member 152 provides additionally a liquid flow restriction.

[0065] The liquid flow restriction function of the branching element 142 is adapted to reduce the liquid flow into the steamer tank conduit 146 in comparison to the liquid flow into the drain tank conduit 148. Due to the valve member 160 in its open position according to Fig. 25 the flow resistance between the branching element 142 and the steamer tank 140 is higher than the flow resistance of the drain tank conduit 148 between the branching element 142 and the drain tank 40. The valve member 160 and the stopping element 162 a liquid flow restricting element of the branching element 142 by providing a reduced liquid flow cross section towards the steamer tank conduit 146 in comparison to the liquid flow cross section towards the drain tank conduit 148. The liquid flow cross section towards the steamer tank conduit 146 is defined particularly by the clearance passage 166 and an orifice 168 arranged in the axial end region of the branch 154 and having a diameter or cross section area that is less than the inner diameter 170 or cross section area of the branch 154 providing the fluid connection to the drain tank conduit 148.

[0066] In Fig. 20, the branching element 142 is arranged in a region of the base section 118 of the dryer 2 (see also Fig. 18). In further embodiments the branching element 142 is arranged at an upper region 172 of the cabinet of the dryer 2 (Fig. 28 - Fig. 31). In this regard, the branching element 142 is preferably arranged in a height level within the dryer which is at least 3/4 or 4/5 or 5/6 of the total height of the dryer 2. As seen from Fig. 22 - Fig. 25, the branching element 142 is made as a T-junction.

[0067] According to Fig. 20 or Fig. 28, the highest point 174 of the steamer tank conduit 146 has a height level which is lower than the highest point 176 of the drain tank conduit 148. In particular, the height level of the steamer tank conduit 146 is at least 3/4 or 4/5 or 5/6 of the height level of the drain tank conduit 148. In other embodiments, the highest point 174 of the steamer tank conduit 146 has the same height or is even higher than the highest point 176 of the drain tank unit 148.

[0068] Regarding Fig. 28 - Fig. 31, it can be seen that the conduit 146 arranged between the branching element 142 and the steamer tank 140 is designed such that its connection length between the branching element 142 and the steamer tank 140 is minimized with respect to the connection line provided by the conduit 144, 148 between the pump unit 36 and the drain tank 40. Hereby a second piping 184 for supplying the condensate to the steamer tank 140 and removable tank 40 is provided.

[0069] In Fig. 28 and Fig. 29 it can be seen that the steam generation unit 88 is arranged in the region of the base section 118 of the dryer 2. The steam generation unit 88 is supplied with liquid to generate steam in order to convey this steam to the nozzle unit 90, as described above. The liquid is supplied to the steam generation unit from the steamer tank 140 via a connection conduit 178 (Fig. 28 - Fig. 31).

[0070] Fig. 34 - Fig. 37 show a branching element 142 in a second piping 184 having a design different to the design of the piping 150 according to Fig. 20 - Fig. 25. The branching element 142 according to Fig. 34 - Fig. 37 does not have a backflow-preventing function but only a liquid flow reducing function such that a flow resistance between the branching element 142 and the steamer tank 140 is higher than a flow resistance of the drain tank conduit 148 between the branching element 142 and the drain tank 40. This liquid flow reduction towards the steamer tank 140 occurs by a conduit passage 180 in the branch 154 having locally a smaller diameter 182 than the inner diameter 170 in the branching element 142 towards the drain tank conduit 148 and towards the drain pump 36.

[0071] In the above the reason for reducing the flow rate of condensate pumped by the pump unit 36 toward the steamer tank 140 as compared to the higher flow rate pumped towards the condensate drawer 40 (drain tank) is the expectation that only a lower portion of the condensate is needed for steam treatment of the laundry. Thus most part of the condensate formed in a laundry drying cycle will normally not be required for steam treatment. The steamer tank 140 is provided with an overflow conduit 190 shown in Fig. 30 by which excess water that can not be stored by the steamer tank 140 is flowing back to the condensate collector 30. From there it is pumped upward to tanks 40 and 140 again. By reducing the ratio of the flow rate to steamer tank 140 an excessive activation of the pump 36 can be avoided.

[0072] In both embodiments of above piping 150 or 184, a backflow prevention member (compare 152) and/or a flow restriction element (compare 166 or 170) can be provided at the branching element 142. Alternatively the backflow prevention member can be provided at any position between the branching element and the inlet to the steamer tank 140 of the steamer tank conduit 146.

[0073] In the following, a modified nozzle unit 300 is described in detail. As compared to the nozzle unit 88, nozzle unit 300 has a few modifications and is a preferred embodiment of the present invention. Apart from these modifications, the nozzle unit 300 is preferably embodied as above nozzle unit 88, as can be seen from Figs. 38 to 47. For example mounting and piping structure as well as positioning of the nozzle outlet are as for nozzle unit 88. It shall be understood that all the advantages and details of nozzle unit 88 also apply to the modified nozzle unit 300 and will therefore not be repeated here except when specific differences or advantages are to be highlighted.

[0074] As can be seen from Figs. 38 and 39, the nozzle unit 300 is mounted at a rear wall 94 which is forming at least a portion of a back cover 95 of the dryer 2. As in the above embodiment, the compartment back wall 74 and the rear wall 94 define portion of the rear channel 20b and the rising channel 20c (cf. Figs. 7, 39, and 40). The compartment back wall 74 comprises a plurality of the back wall openings 84 designed for passing process air from the rear channel 20b, 20c into the laundry storing compartment 17. The nozzle unit 300 preferably comprises a base portion 301 mounted at the back side of the rear wall 94, see Fig. 40. It is particularly beneficial to arrange the nozzle outlet 92 at the back side of the compartment back wall 74 in such a manner that steam ejected from the nozzle outlet 92 passes through a respective back wall opening 84 before entering the laundry storing compartment 17 (see also Figs. 41 and 7/17).

[0075] The nozzle unit 300 comprises at least one drain outlet 308 for draining water from within the nozzle unit to the outside, as can be seen in Figs. 40, 42, 43, 44, 46, and 47. In particular, it is beneficial for the nozzle unit and the drain outlet(s) to be arranged such that the water is drained from the nozzle unit to the rear channel 20b, 20c. A preferred embodiment of this arrangement is shown in Figs. 39 and 40. Draining condensed water out of the nozzle unit provides the advantage that less water remains within the steam path and so less water needs to flow back to the steam generation unit and probability of condensate droplets being ejected through the nozzle outlet onto laundry in the drum is lowered. Draining the condensed water to the rear channel further provides the advantage that the water can evaporate into the process air that may be guided through the rear channel, in which case it may also reach the laundry as evaporated steam together with the process air flowing into the laundry storing compartment 17 through the back wall openings 84.

[0076] Fig. 40 shows that in preferred embodiments of the nozzle unit 300, the steam guiding unit 102 of nozzle unit 88 may be partially or completely replaced by a separation chamber 302. In such embodiments the steam guiding portion 102 - if present - extends from the separation chamber 302 towards the rear side of the compartment back wall 74. The separation chamber 302 serves for separating condensed water from the flow of steam so as to avoid water droplets reaching the laundry 19 inside the laundry storing compartment 17 (compare separation chamber 108 described above). Condensed water may be formed by (partial) condensation of the supplied steam - for example in the starting phase of the steam supply when the steam conduit and nozzle unit are at low temperature as compared to the steam temperature.

[0077] Fig. 40 is a sectional view of the nozzle unit 300 mounted to the rear wall 94 of the laundry dryer and depicts a preferred embodiment of the separation chamber 302. As can be seen, the separation chamber 302 preferably has at least one steam inlet 124 in fluid connection with the steam generation unit 90, e.g., by means of a steam conduit 106, and furthermore has one or more steam outlets 126 (see also Figs. 46 and 47) in fluid connection with one or more nozzle outlets 92. In the embodiment shown, the drain outlet 308 is arranged at the separation chamber such that condensed water is drained out of the separation chamber.

[0078] As can be seen in Fig 40, it is particularly beneficial to design the separation chamber 302 to have a portion 304 arranged within the rear channel 20b, 20c and/or another portion 306 arranged at the back side of the rear wall 94. This embodiment has several advantages. First, it allows to optimize the space requirements for a given size (here: depth) of the separation chamber. Second, having a portion 306 of the separation chamber 302 at the back side of the rear wall 94 provides a simple way for arranging a lateral conduit stub 128, which in turn reduces the amount of space needed for the connection of the steam conduit 106 to the nozzle unit 300. Third, having a portion 306 of the separation chamber 302 at the back side of the rear wall with a lateral conduit stub 128 allows to arrange for a significant deflection of the steam path direction inside the separation chamber, which is beneficial for an efficient separation of condensed water from the steam. Furthermore, having a portion 304 of the separation chamber 302 within the rear channel 20b, 20c provides a simple way for draining water from the separation chamber into the rear channel, since no guiding, no conduit, no sealing or similar means is needed between the drain outlet(s) 308 and the rear channel.

[0079] According to Figs. 40, 42, 43, 44, 46, and 47, it is preferable to arrange the drain outlet(s) at or close to the lowest portion of the nozzle unit 300 or the separation chamber 302, particularly because condensed water will accumulate at the lower parts of the steam path due to its higher density as compared to the steam. Condensed water will therefore accumulate at the drain outlet and will be pushed towards the outside of the nozzle unit 300 by the pressure of the steam. In preferred embodiments, the separation chamber is designed or formed so that condensed liquid is guided towards the drain outlet.

[0080] As depicted by Figs. 39 and 40 the compartment back wall 74 and the rear wall 94 are arranged to form at least part of the rear channel 20b, 20c. In this way it is simple to arrange the drain outlet 308 of the nozzle unit 300 inside the rear channel as described above.

[0081] Further details of preferred embodiments of the nozzle unit according to the present invention are depicted in Figs. 42 to 47. Thereof Figs. 42, 43, 44 and 45 show the nozzle unit 300 at different viewing sides, namely a perspective front/left-side view, a front view, a left-side view and a rear view, respectively.

[0082] In the following, a method for operating a steam generation unit in a laundry dryer 2 (compare Fig. 1) will be explained in more detail (exemplified for steam generation unit 90). Fig. 48 provides a schematic view of some components of the laundry dryer 2 relevant for understanding the operation of the steam generation unit. As already described in detail above, the exemplary laundry dryer comprises a laundry storing compartment 17 for storing laundry to be treated and means (here a heat pump system 4) for heating a flow of process air A which is introduced into the laundry storing

compartment 17 by means of a fan 8 and a process air channel 20b, 20c. The laundry dryer 2 further comprises a steamer tank 140 serving as a liquid or water reservoir and containing liquid or water that can be guided to a steam generation unit 90 through connection conduit 178. The steam generation unit comprises a heater 282. A valve 280 is arranged for controlling the flow rate of liquid flowing into the steam generation unit. In addition to or instead of the valve 280, preferably there is a water supply pump for supplying liquid to the steam generation unit. The pump and/or valve are preferably operated under the control of the control unit 51. The control unit 51 retrieves the parameters for executing the program from a program memory 52. The control unit 51 can store current program status data, user settings and other data (e.g. error codes for maintenance) in the memory 52.

[0083] The steam generation unit (in short also called "steamer") is arranged for converting the supplied liquid into a flow of steam that is directed through a steam conduit (see 106) and into a nozzle unit 88 or 300. Preferably, the steam generation unit is an inline steam generation unit. The nozzle unit serves for injecting the steam into the laundry storing compartment and may have its nozzle outlet within the compartment or preferably arranged behind a back wall 74 of the compartment (compare units 88 or 300). Fig. 48 also shows several heat/temperature sensors 292, 294, 296, 298 arranged in thermal contact at and/or assigned to the heat pump system 4, the process air channel 20b, 20c, and the steam generation unit 90. Furthermore, in the depicted embodiment there is a thermal connection 284 between the process air channel 20b and the steam conduit 106.

[0084] Here and in the following, the expressions "liquid" and "water" shall be used interchangeably, meaning that the liquid stored in steamer tank or guided to the steam generation unit may be pure water or may be a liquid or a mixture of liquids (possibly including water) appropriate for steam generation in the steam generation unit and applicable for laundry treatment in a laundry dryer.

[0085] Although the arrangement shown in Fig. 48 is useful for explaining various embodiments for operating a steam generation unit 90, it is to be understood as an example only. Other embodiments may not comprise all of the shown components and/or may have additional components and/or may have arranged the components differently. For example, an embodiment may have no or fewer heat sensors or may have heat sensors applied to other components than proposed in the figure. Furthermore, it shall be understood that the various embodiments of the method described below can be combined with the various embodiments of the laundry dryer 2 and its components described above as may be appropriate for obtaining the required benefits.

[0086] In an embodiment for operating a steam generation unit 90 in a laundry dryer 2, the flow rate of liquid provided from the reservoir 140 to the steam generation 90 unit is controlled by means of a water supply pump and/or by a valve 280. By controlling the activation of the pump and/or the opening/closing of the valve 280 (preferably using control unit 51), it is possible to dose the amount of liquid introduced into the steam generation unit in a given time interval, i.e. to control the flow rate of liquid supplied to the steamer 90. Preferably, the heating power supplied to the steam generation unit for generating steam can be controlled by controlling the heater 282 (preferably using control unit 51), e.g., by switching or adjusting the power supply of the heater 282.

[0087] Preferably, the method comprises starting the control of the heater 282 for heating the steam generation unit 90 and thereafter starting the control of the water supply to the steam generation unit 90 by starting the control of the water supply pump and/or the valve 280. In particular it is beneficial to switch on the heater 282 first and start supplying liquid to the steam generation unit only after the steam generation unit 90 has reached a predefined temperature threshold required for proper operation. Preferably thereafter, the control of the water supply pump and/or the valve 280 is independent of the operation status of the heater 282 or the current temperature of the steam generation unit 90. Preferably in addition, the overall control of the laundry dryer 2 (preferably using control unit 51) is adapted such that the control of the steam generation unit 90 with its heater 282 terminates when the control of the water supply terminates or vice versa. In this way it may be ensured for example, that the heater 280 stops heating the steam generation unit 90, when no more water is supplied to the steam generation unit 90, and/or that no more water is supplied to the steam generation unit 90, when the heater 280 stops heating the steam generation unit 90.

[0088] In an embodiment of the method, the water supply, i.e., the water supply pump and/or the valve 280 is controlled by a predetermined time sequence which is independent of the current operation status of the heater 282 and/or the current temperature of the steam generation unit 90. The memory shown in Fig. 48 stores the settings for at least one predetermined time sequence. Preferably two or more settings for predetermined time sequences are stored which are different of each other. The settings for a predetermined time sequence is fixed and invariantly stored in the memory or memory section, the memory may be a ROM type memory (e.g. EPROM) which is set from the factory site.

[0089] Fig. 49 is a diagram showing the variations over time of the heating power P provided to the heater 280, of the liquid flow rate R provided to the steamer 90, and of the temperature Q of the steamer. Here and in the following 'operating the heater' or means supplying heating power P to the heater. First the control of the heater 282 is activated and the heating power is switched on until the steam generation unit 90 has reached a threshold q_2 of its temperature Q . A certain period of time after the activation of the heater control, the control of the water supply is activated. In the example shown, the control of the water supply is adapted such that the rate R of water flowing to the steam generation unit 90 oscillates between a lower value r_1 and a higher value r_2 . Preferably, the lower value r_1 may correspond to no water

flowing to the steamer. However, in other embodiments it may be preferred to have water flowing to the steamer at a non-zero rate r_1 (standby-operation during heating-up the steamer) before starting the control of the water supply (i.e. when the temperature threshold q_2 is reached and flow rates may be raised up to r_2 due to flow control fully active).

[0090] Preferably, said predetermined time sequence for controlling the water supply is a sequence of the target flow rates of water provided to the steam generation unit 90 and the water supply pump and/or the valve 280 are controlled so that the effective water flow rate follows the predetermined sequence of target flow rates. It shall be understood that the effective or controlled flow rate of water provided to the steam generation unit at any time may deviate from the related target flow rate for various reasons, e.g. due to inaccuracies of actuators (pumps, valves, etc.), sensors (temperature, flow, water level, etc.), and/or means of processing (amplifiers, calculations, signal lines, etc.) - but this is not the intended operation. The predetermined time sequence or, if there are two or more predetermined time sequences, each one of the time sequences, is fixed in that as soon as one or the time sequence has been selected, the time behavior of the pump (activation/inactivation) and/or valve (open/closed) is fixed and will not be adapted in dependency of any other current operational parameter of the steam generation unit 90. Under terms of control application of the predetermined time sequence to the pump and/or valve is a feed-forward control and not a feedback control.

[0091] In an embodiment, the control of the water supply may be started immediately or a predetermined period of time after activating the control of the heater 282. In another embodiment, after activating the control of the heater 282, the steam generation unit 90 may first be heated until its temperature Q reaches a predetermined upper temperature threshold. The control of the water supply may be started immediately or a predetermined period of time after the predetermined upper temperature threshold has been reached or is exceeded.

[0092] In the example depicted in Fig. 49, the control of the water supply pump and/or the valve 280 is arranged so that after its activation the flow R of liquid to the steamer oscillates between two rates r_1 and r_2 according to a predetermined time sequence. Preferably $r_1 = 0$. As can be seen, this oscillation is independent of the operation status of the heater 282 (after reaching the predetermined upper temperature threshold) and of the temperature Q of the steam generation unit 90. On the other hand, the control of the heater 282 in this example is arranged so that the heater is switched off, when the temperature Q of the steam generation unit 90 is at or rises above a second threshold q_2 , and that the heater is switched on, when the temperature Q of the steam generation unit 90 is at or drops below a first threshold q_1 . For measuring the temperature Q , a temperature sensor 296 may be provided at the steam generation unit 90. Of course, other temperature sensors, e.g., attached to or integrated in the steam conduit may be used for this purpose instead or in addition.

[0093] Noticeably, depending on the physical design of the steam generation unit, the temperature T of the steam generation unit 90 may continue to increase when the heater has been switched off and/or the temperature Q of the steam generation unit 90 may continue to decrease after the heater has been switched on. One of the thresholds q_1 or q_2 may be identical to the mentioned predetermined upper temperature threshold used for triggering the activation of the control of water supply. In another embodiment, said predetermined upper temperature limit may be chosen separately and, in particular, the second threshold q_2 at which the heater is deactivated may be above said predetermined upper temperature limit.

[0094] In particular, it can be beneficial to choose a predetermined time sequence (temporal profile) for controlling the water supply pump and/or the valve 280 in such a way that no or essentially no water is supplied to the steamer 90 while the heater 282 is on and/or that all or most of the water is supplied to the steamer 90 during time periods, where the heater 282 is off. This is not an effect of the control of the water supply and the heating power as such, but the consequence of selecting the predetermined temporal profile and the heating power strength and the heating control parameters in dependency of the steam generator as device to be controlled in such a way that the non-overlap of periods of heating and water supply result. Generally it is to be noted that in the embodiment of operating using the predetermined time sequence for water supply, the water supply over time is fixed according to the predefined sequence which specifically means that it is independent of the temperature and the temperature control (except for example that the time sequence starts only when the predetermined heater temperature threshold is achieved), while the temperature control is also reactive to the temporal temperature changes caused by the water supply.

[0095] An example of control by a predetermined time sequence of water supply is shown in the diagram of Fig. 50. Again, the control of the heater is switched on first and the heater 282 heats the steam generation unit 90. Thereafter, the control of the water supply is activated and then follows a predetermined time sequence. As can be seen, in this embodiment the selected time sequence results in water being supplied to the steamer only during time periods when the heater 282 is off, i.e. when the heating power P is zero or close to zero.

[0096] Fig. 51 is a flow diagram showing the major steps of an embodiment of the method for operating a steam generation unit 90 in a laundry dryer 2. As already explained above, the control of the heater 282 is activated first. When the temperature Q of the steam generation unit 90 is at or rises above a temperature threshold q_2 , the heater is switched off and the control of the water supply, i.e., of the water supply pump and/or the valve 280 is activated. The control of the water supply thereafter is independent of the operation status of the heater 282 and of the temperature of the steam generation unit 90. When the steamer temperature Q is at or drops below a temperature threshold q_1 , the heater 282

is switched on until the temperature threshold q_2 is reached again. This process is repeated, e.g., until no more steam generation is required by the laundry treatment program or, e.g., until steam generation is to be interrupted. In that case the control of the water supply and the control of the heater are de-activated.

[0097] As depicted in Fig. 52, it may be particularly beneficial in particular, if during controlling of the heater, the heater 282 is switched off when the temperature T of the steam generation unit 90 rises above a temperature limit q_2 and the heater 282 is switched on when the temperature T of the steam generation unit 90 drops below a temperature limit q_1 , wherein the temperature limit q_1 is above the temperature limit q_2 . Due to the fact that the temperature of the steam generation unit 90 tends to continue to rise after switching off the heater and tends to continue to drop after switching on the heater (see above), this can lead to a more constant temperature profile of the steam generation unit 90.

[0098] In an embodiment of the method, the predetermined time sequence comprises a repeated decrease and increase of the liquid supply rate to the steam generation unit and/or comprises repeated stops and starts of the liquid supply to the steam generation unit according to predetermined time intervals T_{ON} and T_{OFF} (see Fig. 50). Preferably, the time interval T_{ON} is in the range of 3 to 30 seconds. Preferably, the time interval T_{OFF} is in the range of 6 to 60 seconds. More preferably the time interval T_{ON} is in the range of 3 to 30 seconds and the time interval T_{OFF} is in the range of 6 to 60 seconds. In a further embodiment, the repeated decrease and increase of the liquid supply rate may be an additional modulation applied to predetermined average liquid supply rates. The parameters of the modulation such as, e.g., duty cycle, frequency, and/or amplitude may be chosen depending on, e.g., the current state of the laundry treatment program and/or the purpose of the laundry treatment program and/or the state (e.g. measured temperature Q) of the steam generation unit, etc.

[0099] In embodiments of the method, the water supply pump and/or valve 280 may be controlled according to a sequence of predetermined time sequences, wherein each predetermined time sequence is chosen as appropriate for the current state of the laundry dryer 2, the state and/or purpose of the laundry drying program, and/or the state of one or more components of the laundry dryer. In particular, the method may provide for a warm-up phase for warming up the steam generation unit 90, a steam conduit 106, and/or a nozzle unit 88 or 300. The predetermined time sequence applied during the warm-up phase may be arranged so that the heating power or the average heating power of the heater 282 is higher than during normal operation of the steam generation unit, e.g. after the warm-up phase. Alternatively or in addition, the predetermined time sequence applied during the warm-up phase may be arranged so that the rate of water supplied to the steamer 90 is lower than during normal operation of the steam generation unit, e.g. after the warm-up phase.

[0100] Fig. 53 is a diagram showing the variations over time of the heating power P applied to the heater 280, of the liquid flow rate R supplied to the steamer 90, of the temperature Q of the steamer, and of the temperature Q' of a steam conduit as it may arise in an embodiment of the method comprising a warm-up phase T_{warm} . In this example, both a reduced water flow rate r_2 and an increased heating power p_2 are applied during the warm-up phase as compared to the water flow rate r_3 and the heating power p_1 applied after the warm-up phase. The warm-up phase according to Fig. 53 ends when the temperature Q' of the steam conduit reaches a temperature threshold q'_1 . A temperature sensor 298 (see Fig. 48) may be attached to or integrated in the steam conduit 106 for measuring the temperature of the steam conduit and/or the temperature of the steam generated by the steam generation unit 90. The temperature threshold q'_1 may be a predetermined value or it may be determined from a state of the laundry dryer and its components, such as, e.g., the purpose and/or state of the laundry treatment program, the temperature of the steam generation unit, the ambient air temperature, etc.

[0101] A preferable method for operating a laundry dryer 2 as described above and as depicted e.g. in Fig. 48 comprises activating a means for heating the process air A before activating the steam generation unit 90. Preferably said means for heating the process air A may be a heat pump system 4, in particular the heat exchanger 12 of the heat pump system 4. Alternatively or in addition, an electrical resistor heater may be provided for heating the process air. Preferably, at least a portion of the steam conduit 106 is guided close to, is guided in, or is in thermal contact with the process air channel 20b, 20c so that there is a thermal connection 284 between the process air channel and the steam conduit. Optionally, the method comprises activating the fan 8 for blowing heated process air through the process air channel 20b, 20c.

[0102] This method is beneficial for reducing the amount of water droplets reaching the laundry in the laundry storing compartment, as the heated process air heats the process air channel which in turn supports heating of the steam conduit due to the thermal connection 284. As a consequence there will be less condensation of steam in the steam conduit. Heating the process air channel according to this method is particularly useful when the laundry dryer is used with a program comprising steam treatment of the laundry only, so that the drying process was not activated and thus the process air channel has not been heated before. Preferably, the duration and/or power of the heating of process air and/or the delay before activating the steam generation unit are adapted according to the current temperature in the process air channel. For this purpose, at least one temperature sensor 294 may be attached to or integrated in the process air channel and/or the temperature sensor of the heat pump system 4 is used for detecting indirectly the process air temperature. If for example the refrigerant temperature sensor of the compressor or at the outlet of the compressor

is used, the refrigerant temperature is detected which is a measure for the refrigerant temperature in heat exchanger 12. Heat exchanger 12 transfers the refrigerant heat to the process air and thus the refrigerant temperature is a measure for the process air temperature.

[0103] Thus in an embodiment, the laundry dryer comprises a heat pump system 4 that has a refrigerant temperature sensor 292 and the method comprises detecting the temperature signal from the refrigerant temperature sensor 292 before activating the steam generation unit 90. If the temperature corresponding to the detected signal is below a predetermined threshold, then the heat pump system 4 is activated in order to heat the process air A. Preferably, in such an embodiment, the temperature of the process air A is determined or at least estimated indirectly from the temperature of the refrigerant of the heat pump system 4.

[0104] Preferably, the method further comprises deactivating the means for heating the process air or reducing its heating power before activating the steam generation unit 90. In this way, the total power required by the laundry dryer 2 during steam generation can be reduced, which is especially beneficial if it is desired to not exceed a certain maximum power limit. For the same benefit, the method may additionally or instead comprise reducing the heating power of or deactivating the heater of the steam generation unit while the means for process air heating is active.

[0105] Preferably, the means for heating the process air is deactivated or its heating power is reduced after a predetermined period of time. More preferably, the means for heating the process air is deactivated or its heating power is reduced when the temperature of the process air A and/or the process air channel 20b, 20c and/or the steam conduit 106 reaches a predetermined temperature threshold or is within a predetermined temperature range. More preferably, the means for heating the process air is deactivated or its heating power is reduced when the temperature of the steam conduit is within a predetermined temperature range of about 30°C to 40°C. Preferably, at least one temperature sensor 294, 298 is attached to or integrated in the process air channel and/or the steam conduit 106.

[0106] In the above, of course, the overall control of the laundry dryer or at least one laundry treatment program of the laundry dryer is designed so that the control of the water supply pump and/or the valve is terminated when the control of the steam generation unit is terminated, or vice versa.

Reference Numeral List:

2	laundry dryer	55	loading door
4	heat pump system	56	top cover
6	refrigerant loop	58	left cover
8	blower	60	front cover
10	first heat exchanger	62	front top panel
12	second heat exchanger	64	drawer cover
14	compressor	66	input section
16	expansion device	68	loading frame
17	laundry storing compartment	70	front frame
18	drum	72	rear frame
19	laundry	74	compartment back wall
20	process air channel	76	window panel
20a	battery channel	78	front cover window opening
20b	rear channel	82	drawer handle
20c	rising channel	84	back wall opening
20d	front channel	86	detangling cone
22	fluff element	88	nozzle unit
30	condensate collector	90	steam generation unit
36	drain pump	92	nozzle outlet
37	condensate drawer compartment	94	rear wall
		95	back cover
40	condensate drawer	96	base portion
41	temperature sensor	98	mounting hole
46	drain conduit	100	mounting screw
50	drawer pipe	101	sealing element
51	control unit	102	steam guiding portion
52	program memory	104	connection portion
54	loading opening	106	steam conduit

(continued)

	108	separation chamber	174	highest point
	110	mounting socket	176	highest point
5	112	chamber cover	178	connection conduit
	114	welding joint	180	conduit passage
	116	nozzle port	182	smaller diameter
	118	base section	184	pipng
10	120	conduit port	190	overflow conduit
	122	steam conduit portion	280	valve
	124	steam inlet	282	heater
	126	chamber outlet	284	thermal connection
	128	conduit stub	292, 294, 296, 298	temperature sensors
15	130	opening rim	300	nozzle unit
	132	front surface portion	301	base portion
	134	first horizontal plane	302	separation chamber
	136	second horizontal plane	304, 306	separation chamber portions
	138	range	308	drain outlet
20	140	steamer tank	A	process air flow
	142	branching element	B	refrigerant flow
	144	pump unit conduit	P	heating power of the steam generation unit
	146	steamer tank conduit		
25	148	drain tank conduit	p1, p2	heating power levels
	150	pipng	Q	steamer temperature
	152	backflow-preventing member	q1, q2	steamer temperature thresholds
	154	branch		
	156	valve seat	Q'	temperature of steam conduit
30	158	valve passage	q'1	steam conduit temperature threshold
	160	valve member		
	162	stopping element	R	water flow rate
	164	forward direction	r1, r2, r3	water flow rates
35	166	clearance passage	T_ON	heater-on time interval
	168	orifice	T_OFF	heater-off time interval
	170	inner diameter	T_warm	warm-up phase
	172	upper region		

Claims

1. Method for operating a steam generation unit (90) in a laundry dryer (2), the laundry dryer comprising a laundry storing compartment (17) for receiving laundry (19) to be treated,
a steam generation unit (90) for generating steam for laundry steam treatment,
wherein the steam generation unit (90) is an inline steam generator comprising a heater (282),
means for controlling the flow rate (R) of water provided to the steam generation unit (90), wherein the supply rate for supplying water to the steam generation unit is controlled
by controlling the activation of a water supply pump supplying water from a water reservoir (140), or
by controlling the opening/closing of a valve (280) that is connected to a water reservoir (140) or connected to a water mains line,
wherein the method comprises:

starting the control of the heater (282) for heating the steam generation unit (90), and thereafter
starting the control of the water supply pump or of the valve (280),
wherein after starting the control of the water supply pump or valve (280), the water supply pump or the valve is controlled according to a predetermined time sequence.

2. Method according to claim 1, wherein the control of the water supply pump or the valve (280) is independent of the current operation status of the heater (282) or the current temperature (Q) of the steam generation unit (90).

3. Method according to claim 1 or 2, wherein the method further comprises:

after starting the control of the heater (282), heating the steam generation unit (90) to a predetermined upper temperature threshold, and
after the predetermined upper temperature threshold has been reached or is exceeded, starting the control of the water supply pump or of the valve (280), or
starting the control of the water supply pump or of the valve (280), when a predetermined time has elapsed after starting the control of the heater (282).

4. Method according to any of the previous claims, wherein the control of the heater (282) comprises:

energizing the heater (282), when a measured temperature (Q) of the steam generation unit drops or is below a first predetermined temperature limit (q1), and
de-energizing the heater when a measured temperature (Q) of the steam generation unit rises or is above a second predetermined temperature limit (q2).

5. Method according to any of the previous claims, wherein the method further comprises:

introducing water into the steam generation unit (90), and
repeatedly increasing and decreasing the flow rate (R) of water provided to the steam generation unit (40) by controlling the activation of the water supply pump or by controlling the opening/closing of the valve (280) according to a or the predetermined time sequence.

6. Method according to any of the previous claims, wherein the predetermined time sequence is selected such that the water supply pump is activated or the valve is opened and water is supplied to the steam generation unit (90) only in time periods in which the heater (282) is deactivated.

7. Method according to any of the previous claims, wherein the predetermined time sequence of control of the water supply pump or the valve (280) comprises repeated decrease and increase of the liquid supply rate to the steam generation unit (90), or comprises repeated stops and starts of the liquid supply to the steam generation unit (90) according to predetermined time intervals T_ON and T_OFF.

8. Method according to any of the previous claims, wherein the laundry dryer (2) further comprises a nozzle unit (88, 300) comprising:

one or a plurality of nozzle outlets (92) for injecting steam generated in the steam generation unit (90) into the laundry storing compartment (17), and
a steam conduit (106) for providing steam from the steam generation unit (90) to the nozzle unit (88, 300), and optionally a drain outlet (308) for draining water from within the nozzle unit (88, 300) to the outside.

9. Method according to any of the previous claims, wherein the laundry dryer (2) further comprises at least one temperature sensor (296, 298) arranged for measuring a temperature (Q) of the steam generation unit (90) or a temperature of the steam generated by the steam generation unit (90).

10. Method of operating a laundry dryer (2), wherein the laundry dryer (2) comprises:

a laundry storing compartment (17) for storing laundry (19) to be treated,
a rear channel (20b, 20c) for guiding process air (A) at the backside of the laundry storing compartment (17),
a back wall (74) of the laundry storing compartment, wherein the compartment back wall (74) comprises a plurality of back wall openings (84) designed for passing process air (A) from a rear channel (20b, 20c) into the laundry storing compartment (17),
a rear wall (94) forming at least a portion of a back cover (95) of the dryer (2),
a steam generation unit (90) for generating steam to be supplied into the laundry storing compartment (17),

a nozzle unit (88, 300) comprising:

one or a plurality of nozzle outlets (92) for injecting steam generated in the steam generation unit (90) into the laundry storing compartment (17), and

a steam conduit (106) for providing steam from the steam generation unit (90) to the nozzle unit (88, 300), and optionally a drain outlet (308) for draining water from within the nozzle unit (88, 300) to the outside, and means (12) for heating the process air (A) for drying the laundry in the laundry storing compartment, wherein at least a portion of the steam conduit (106) is guided within or in proximity of or in thermal contact with walls delimiting the rear channel (20b, 20c), and wherein the method for operating the laundry dryer (2) comprises:

activating the means for heating the process air (A) before activating the steam generation unit (90), and optionally activating a fan (8) for guiding heated process air (A) into said rear channel (20b, 20c).

11. Method according to claim 10, wherein the method further comprises:

deactivating the means for heating the process air (A) before activating the steam generation unit (90), or reducing the heating power of the means for process air heating before activating the steam generation unit (90), when the process air reaches a predetermined temperature.

12. Method according to claim 10 or 11, wherein the laundry dryer (2) further comprises one of, more of or all of the following:

a front wall (60) with a front loading opening (54) for loading laundry (19) into the laundry storing compartment (17), wherein the compartment back wall (74) is opposite to the loading opening (54), and a rear frame (72) including said compartment back wall (74), wherein the laundry storing compartment (17) is formed or is essentially formed by a cylindrical, rotatable drum (18) which is open at the both axial ends and wherein the compartment back wall (17) is stationary and closes the backside of the drum and a loading door (55) and a portion of a front frame (68) are closing the front side of the drum.

13. Method according to claim 10, 11, or 12, wherein a nozzle outlet (92) of the nozzle unit (88, 300) is arranged between said compartment back wall (74) and said rear wall (94) inside said rear channel (20b, 20c) so that steam ejected from the nozzle outlet (92) passes through at least one back wall opening (84) of the compartment back wall (74) before entering the laundry storing compartment (17).

14. Method according to any of the previous claims, wherein the laundry dryer (2) further comprises a heat-pump system (4) having a refrigerant temperature sensor (292), and wherein the method comprises, before activating the steam generation unit, detecting a temperature signal from the temperature sensor (292), if the temperature is below a predetermined temperature threshold, activating the heat-pump system (4) for heating the process air, and activating the steam generation unit (90) for generating steam.

15. Method according to any of the previous claims, wherein the laundry dryer (2) further comprises a heat-pump system (4) having a refrigerant temperature sensor (292), and wherein the predetermined temperature of the process air (A) is determined by means of the refrigerant sensor (292).

16. Method according to any of the previous claims, wherein the method further comprises at least one of the following:

reducing the heating power (P) of or deactivating the heater (282) of the steam generation unit (90) while the or a means for process air heating is active.

17. Method according to any of the previous claims, wherein the method further comprises deactivating the or a means for heating the process air after a predetermined period of time or when the steam conduit (106) has reached a temperature (Q') within a predetermined temperature range of about 30°C to 40°C.

18. Method according to any of the previous claims, wherein the or a means for heating the process air (A) is a heat

pump condenser or an electrical resistor heater,

19. Method according to any of the previous claims, wherein the or a nozzle unit (88, 300) further comprises
a drain outlet (308) adapted for draining the water from the nozzle unit (300) to the rear channel (20b, 20c), or
a separation chamber (302) for separating steam and water, wherein at least a portion of the separation chamber
(302) is arranged within the rear channel (20b, 20c).

5

10

15

20

25

30

35

40

45

50

55

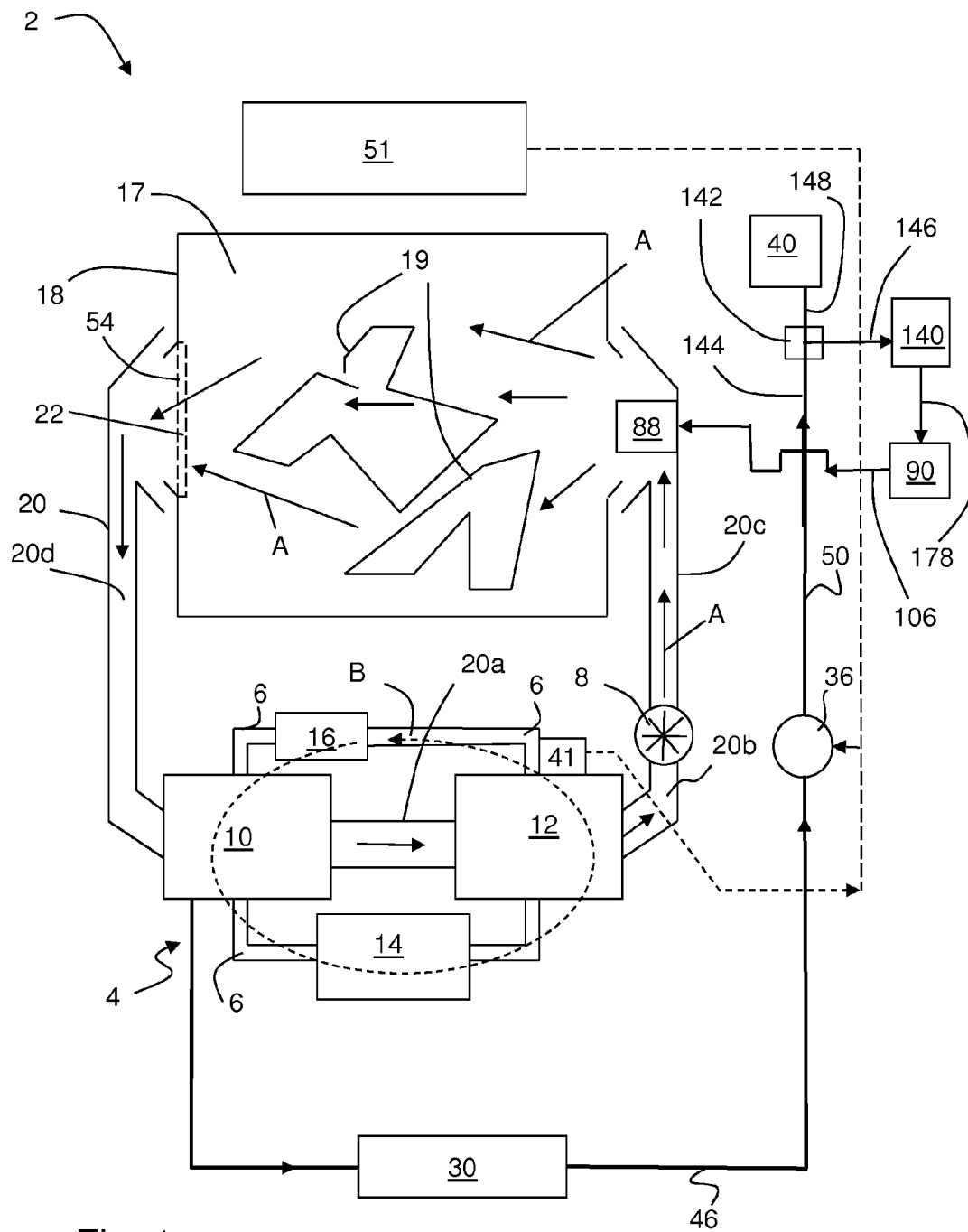
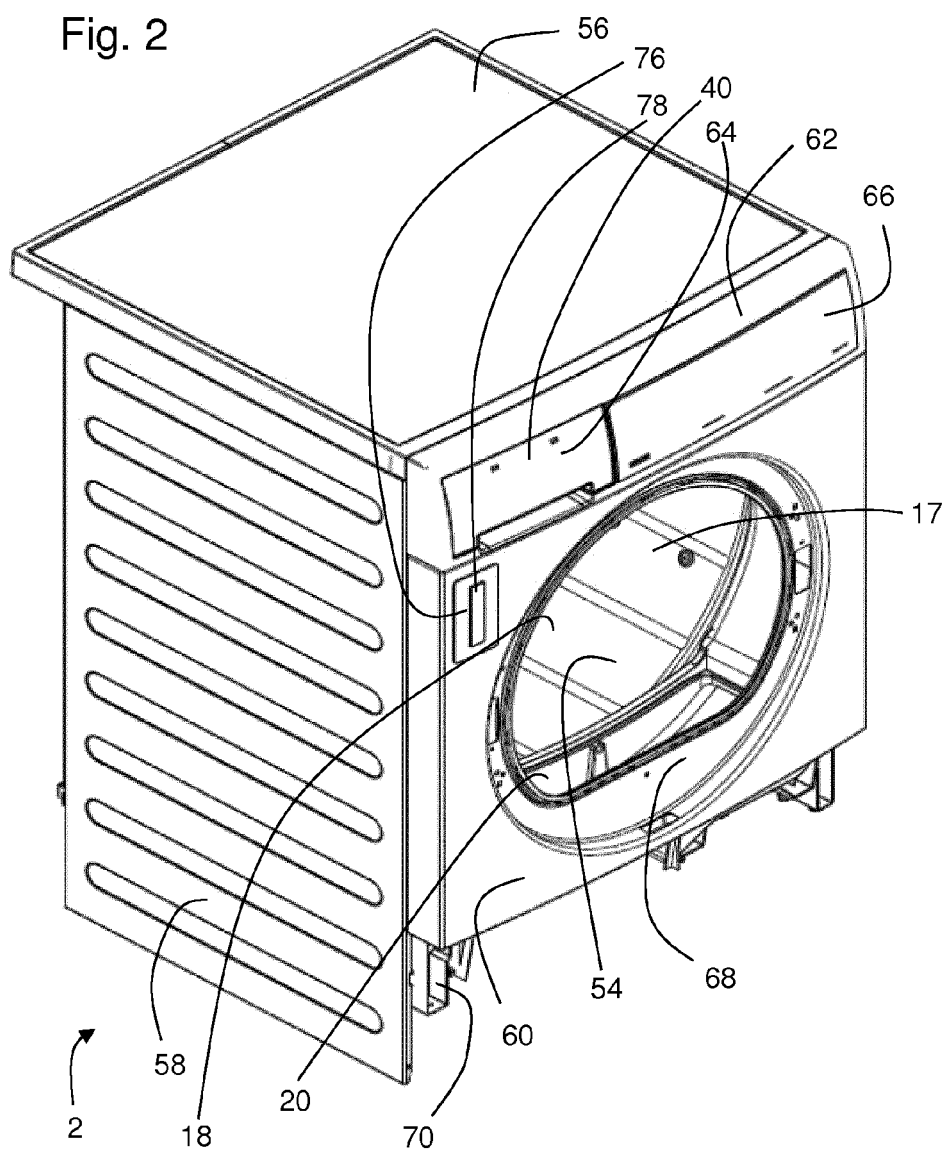


Fig. 1

Fig. 2



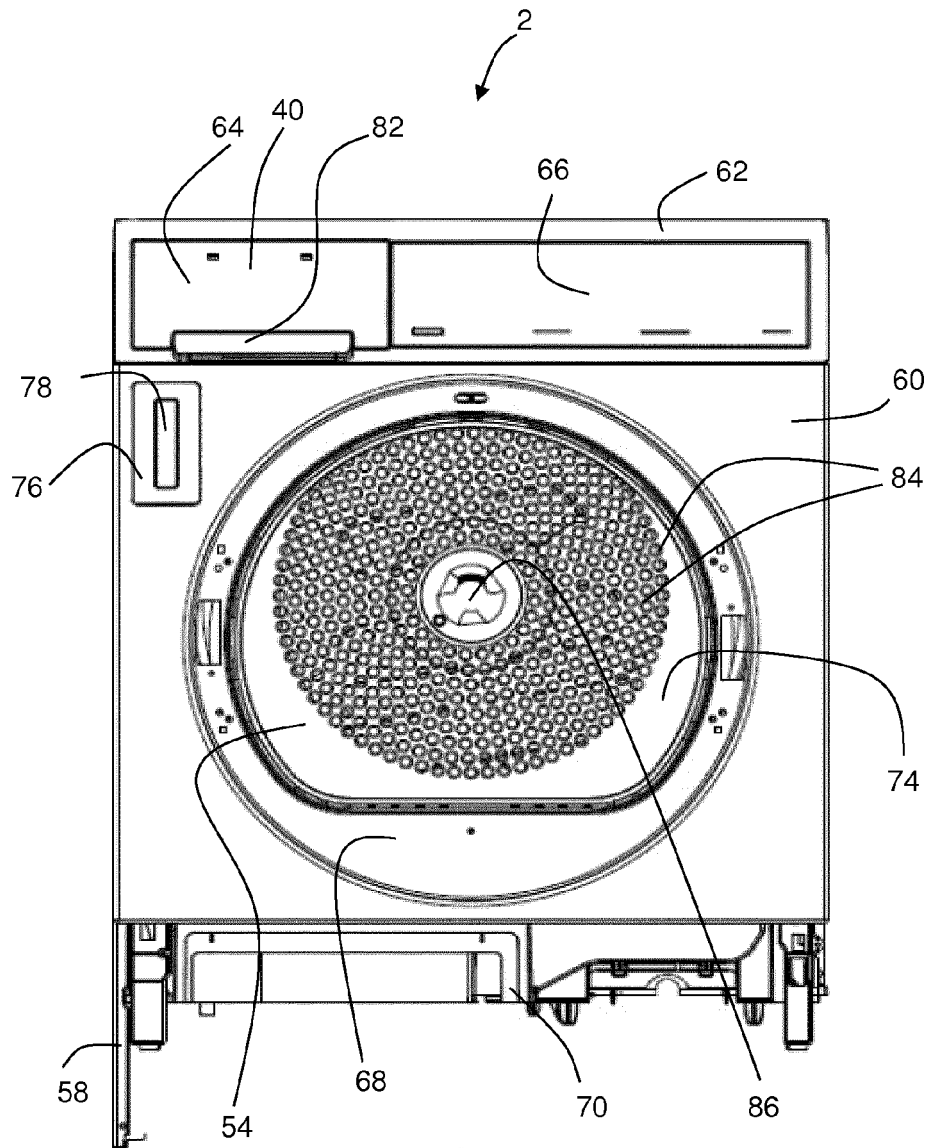


Fig. 3

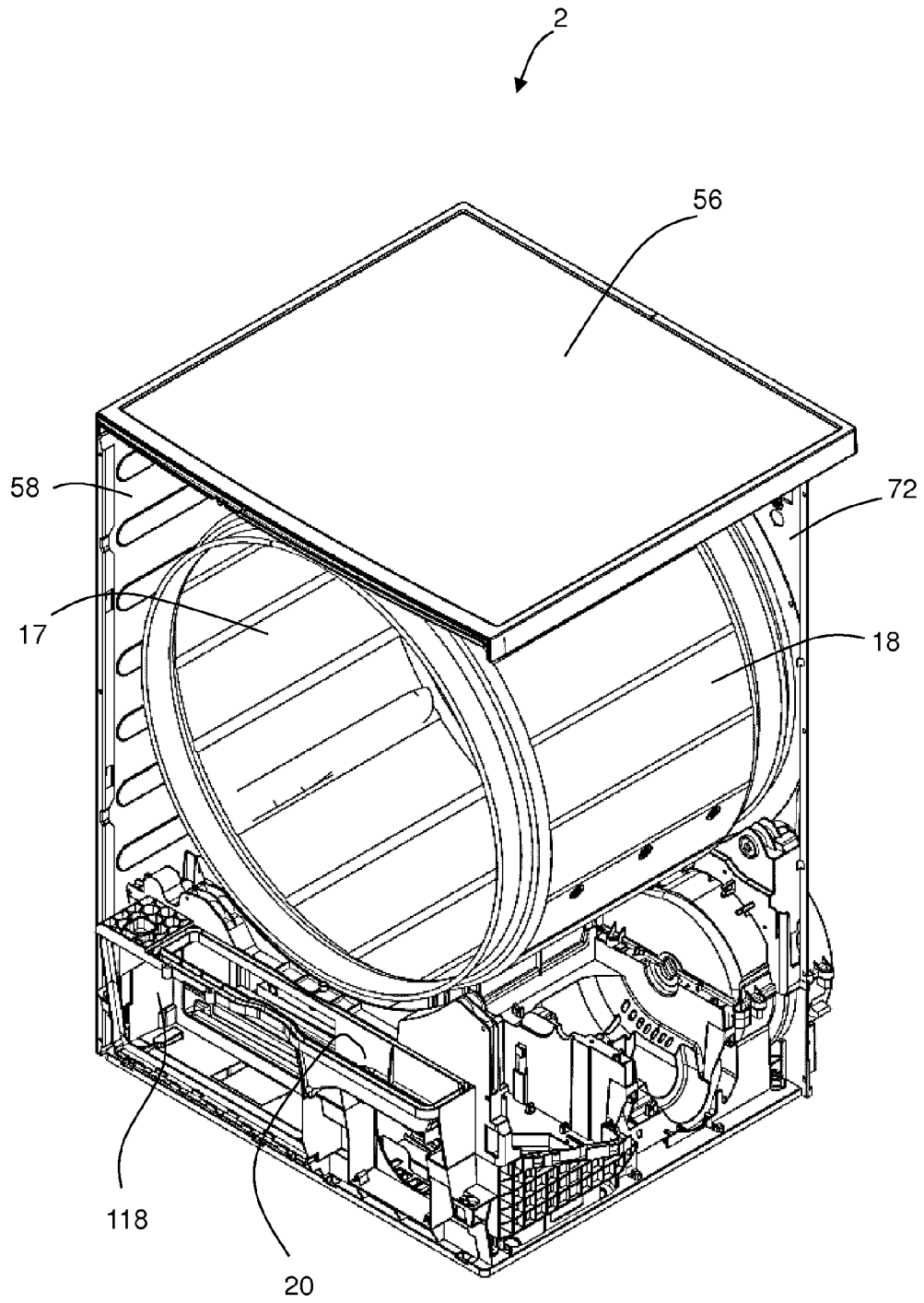


Fig. 4

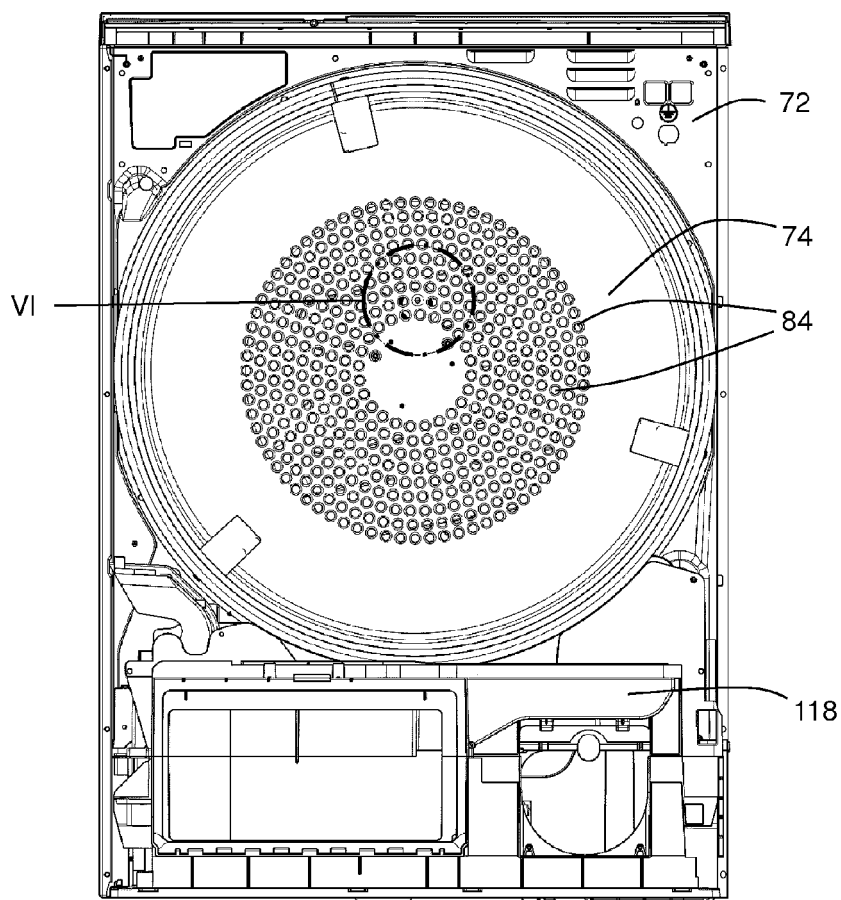


Fig. 5

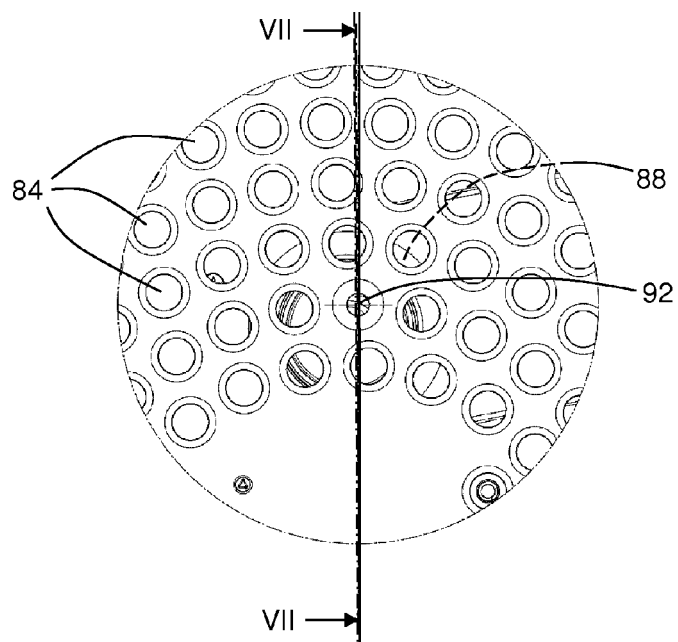


Fig. 6

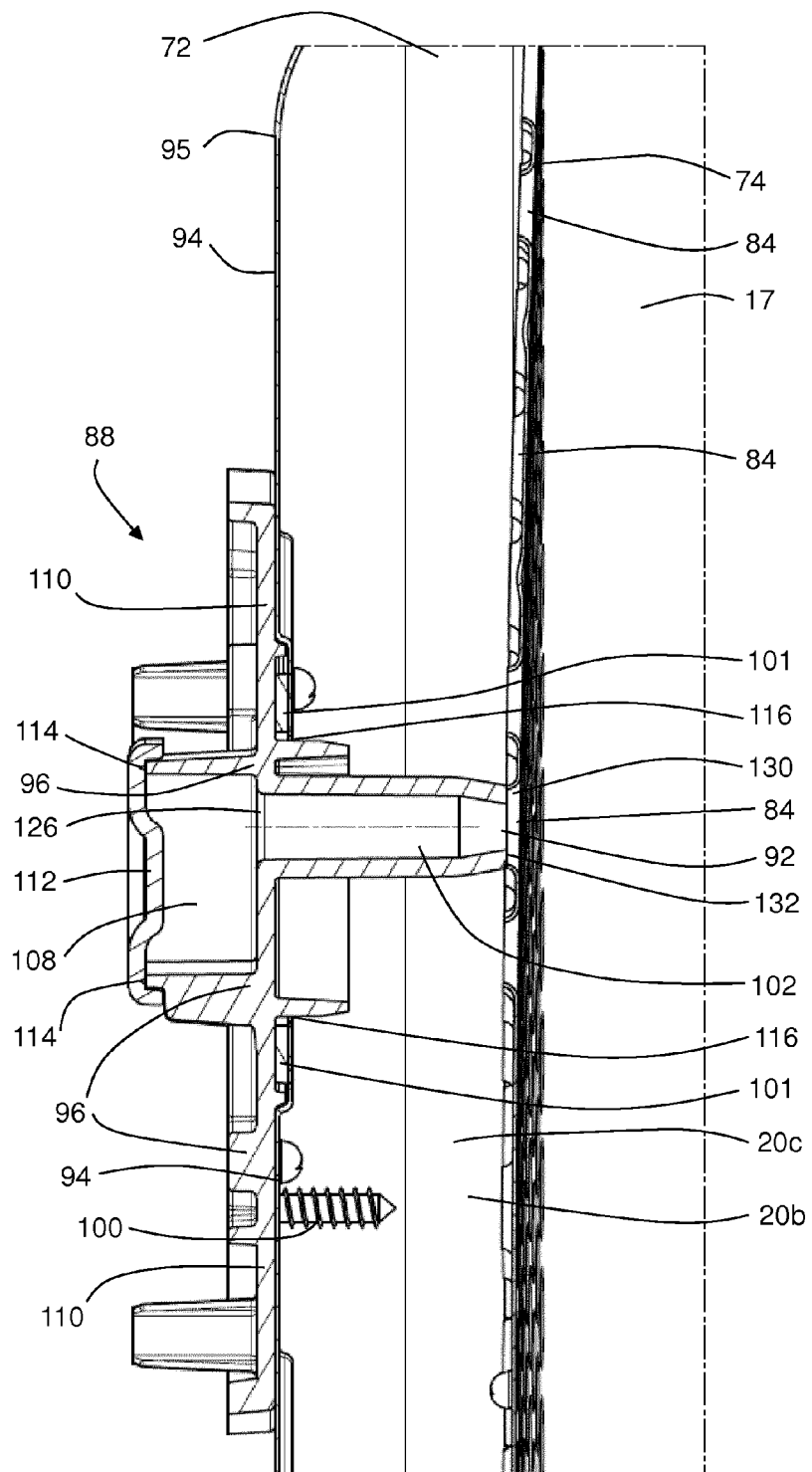


Fig. 7

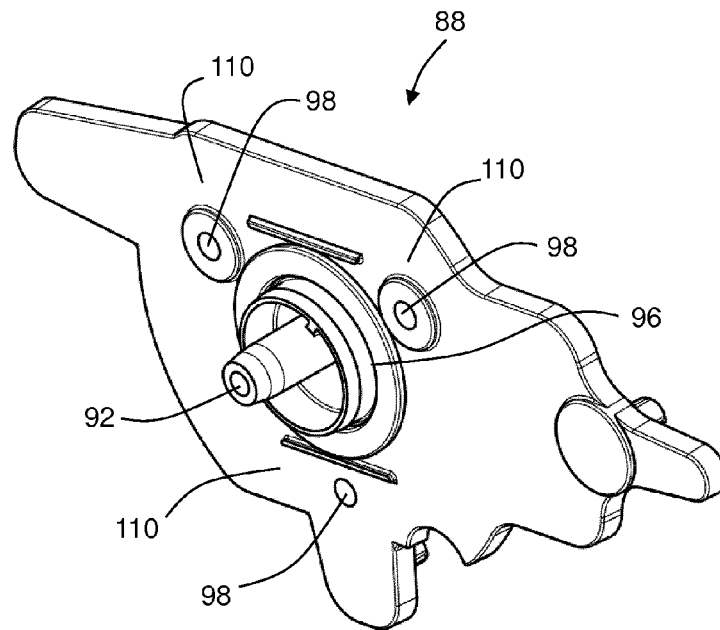


Fig. 8

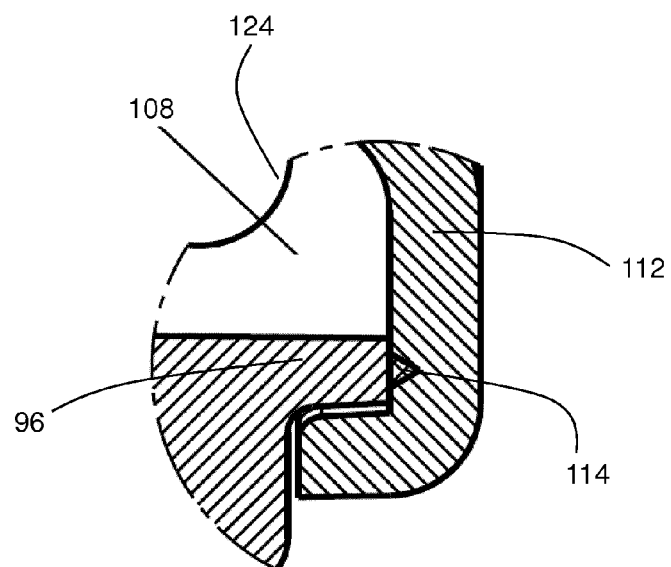


Fig. 11

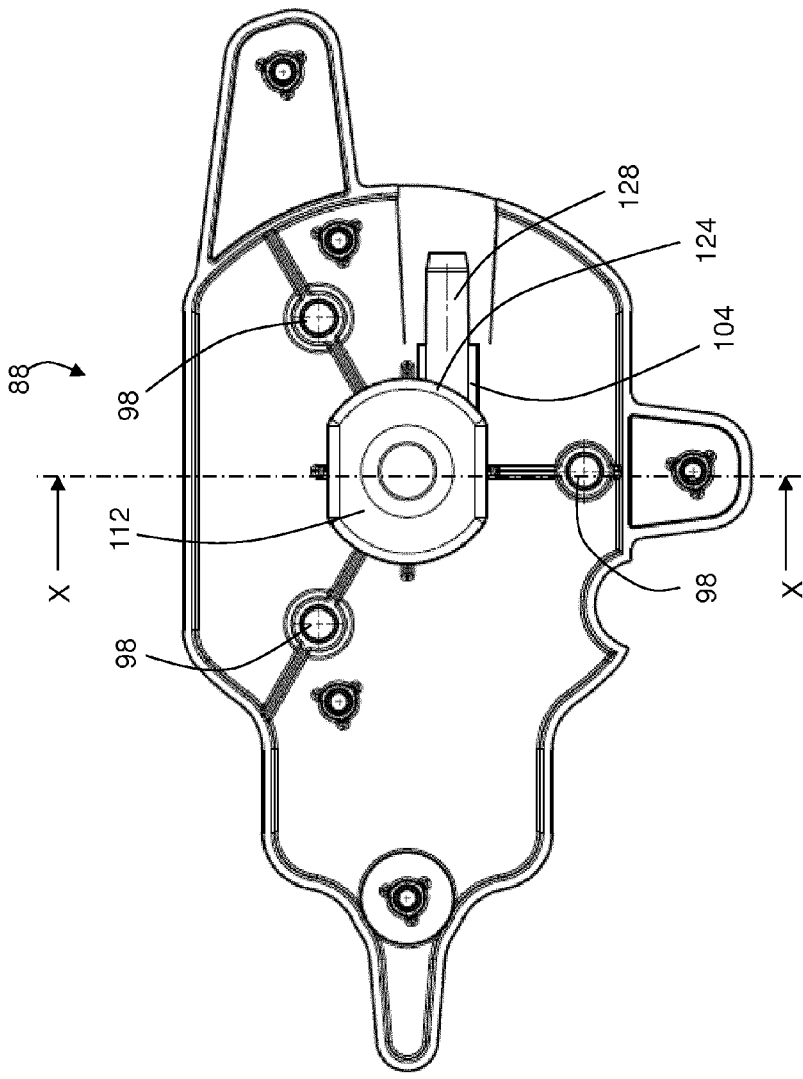


Fig. 9

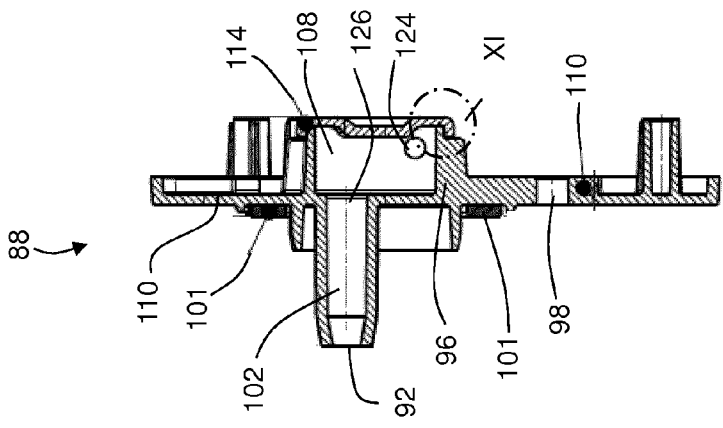


Fig. 10

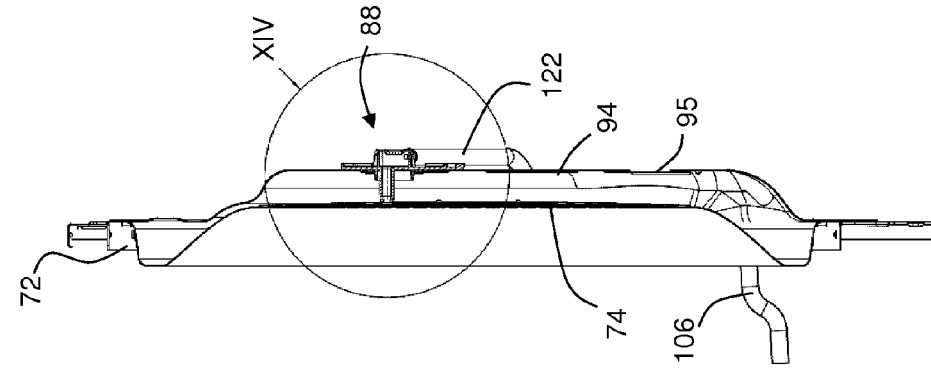


Fig. 13

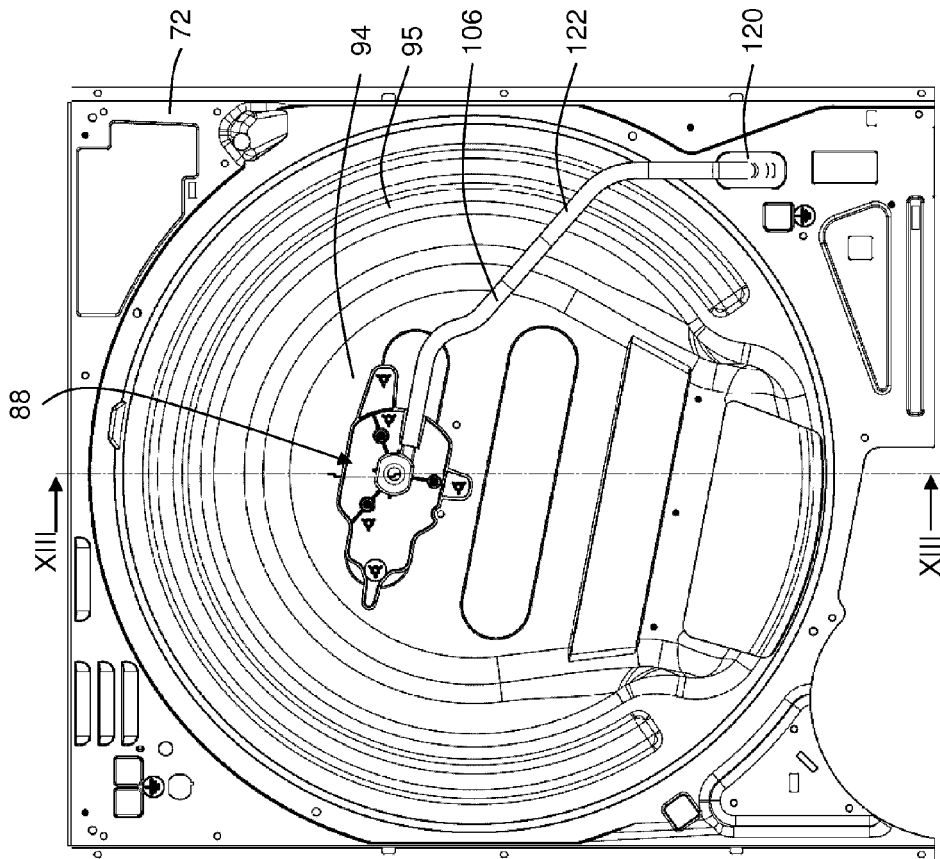


Fig. 12

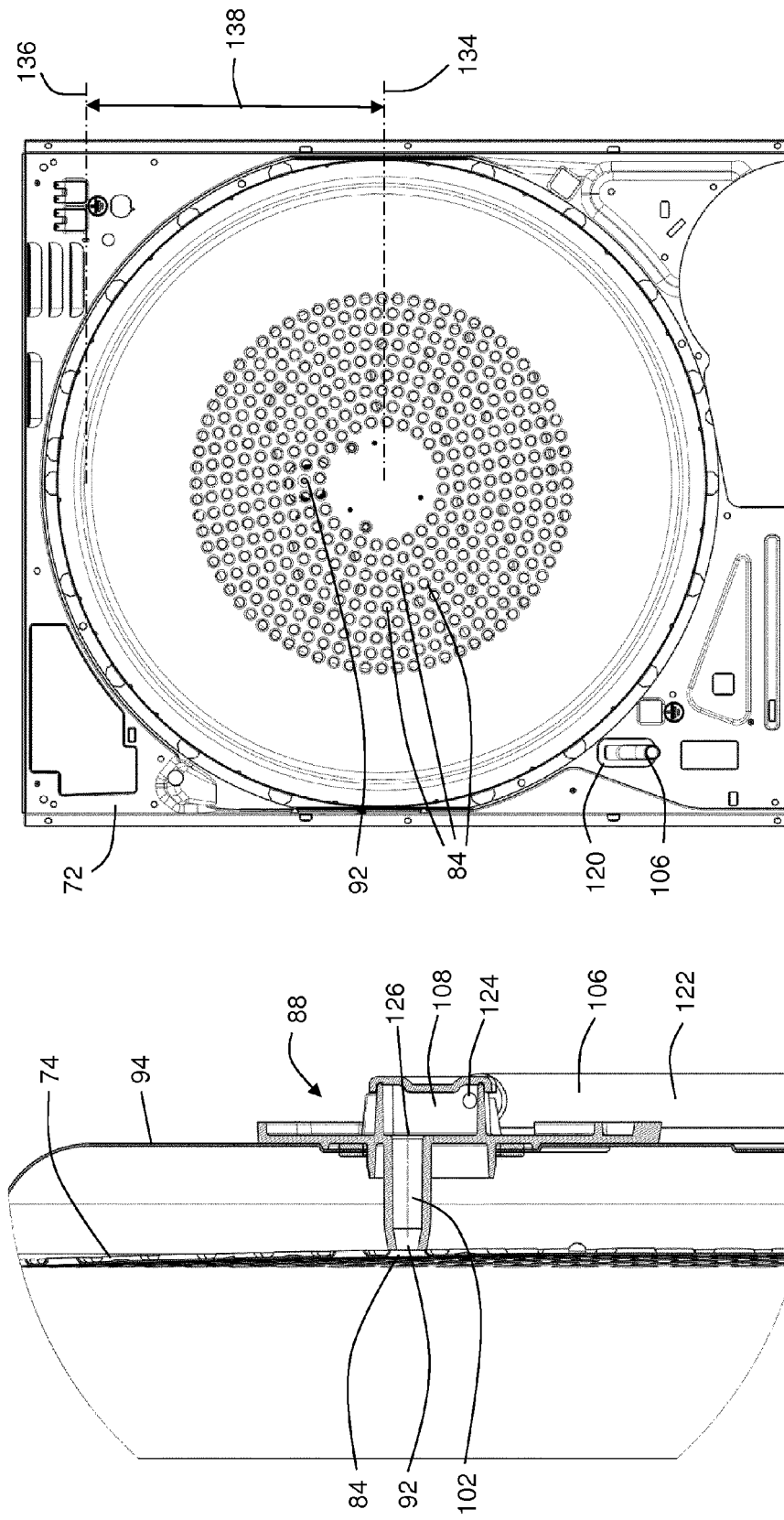


Fig. 17

Fig. 14

Fig. 15

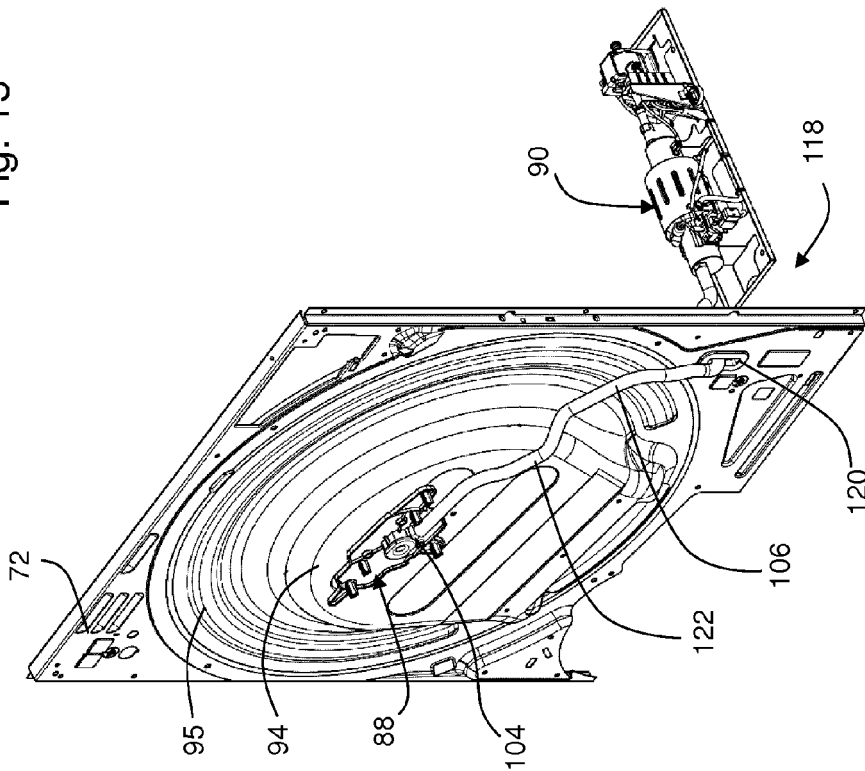
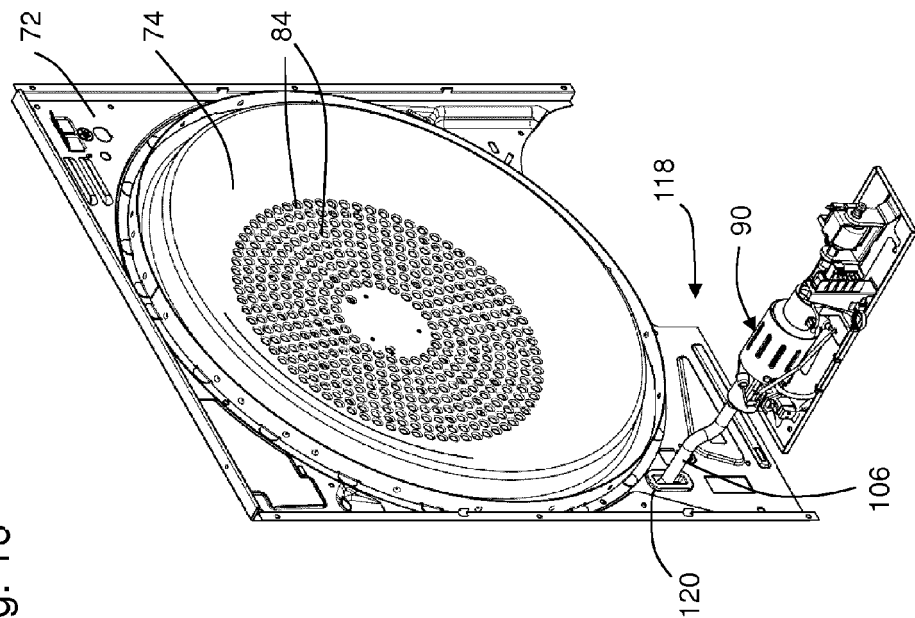


Fig. 16



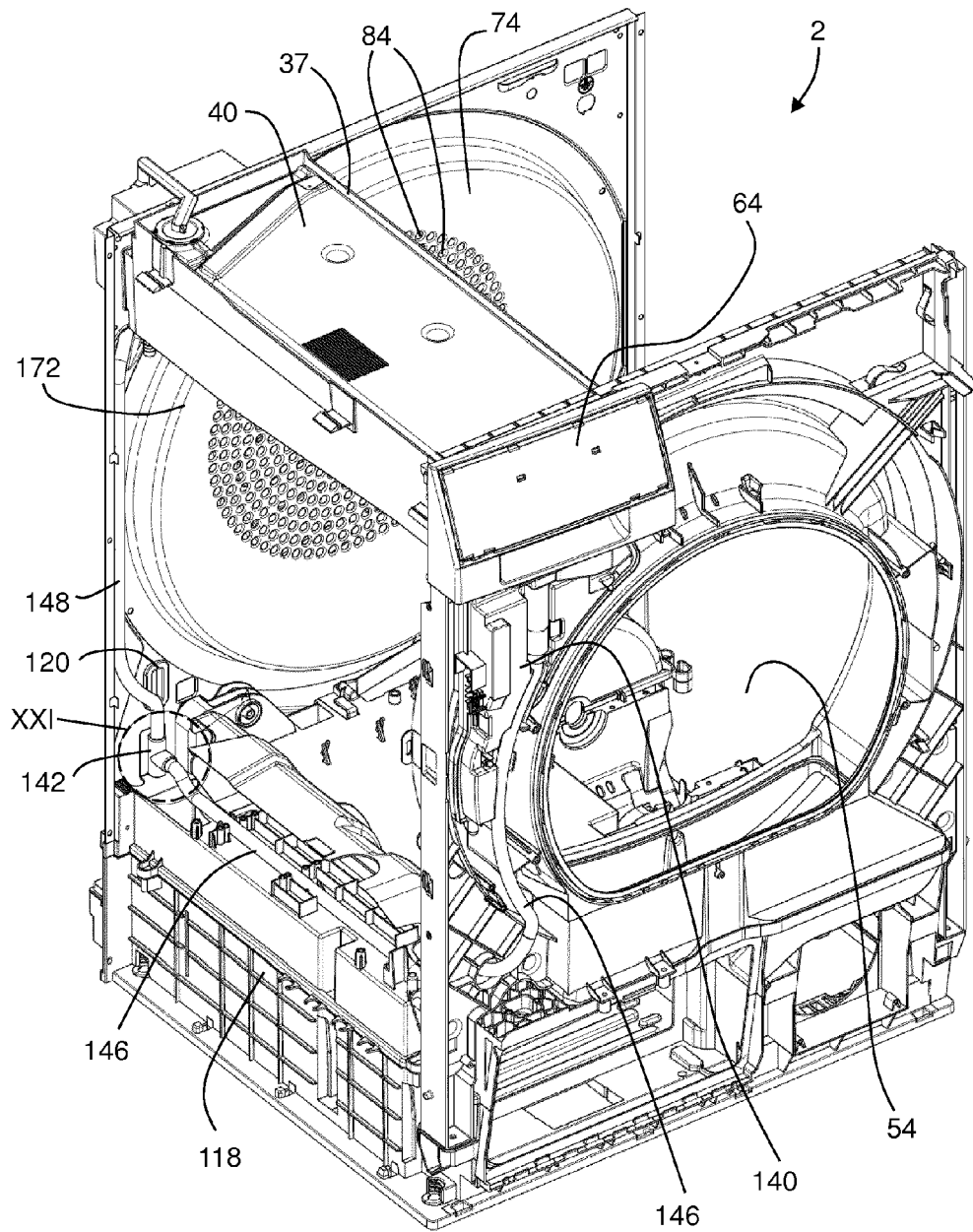


Fig. 18

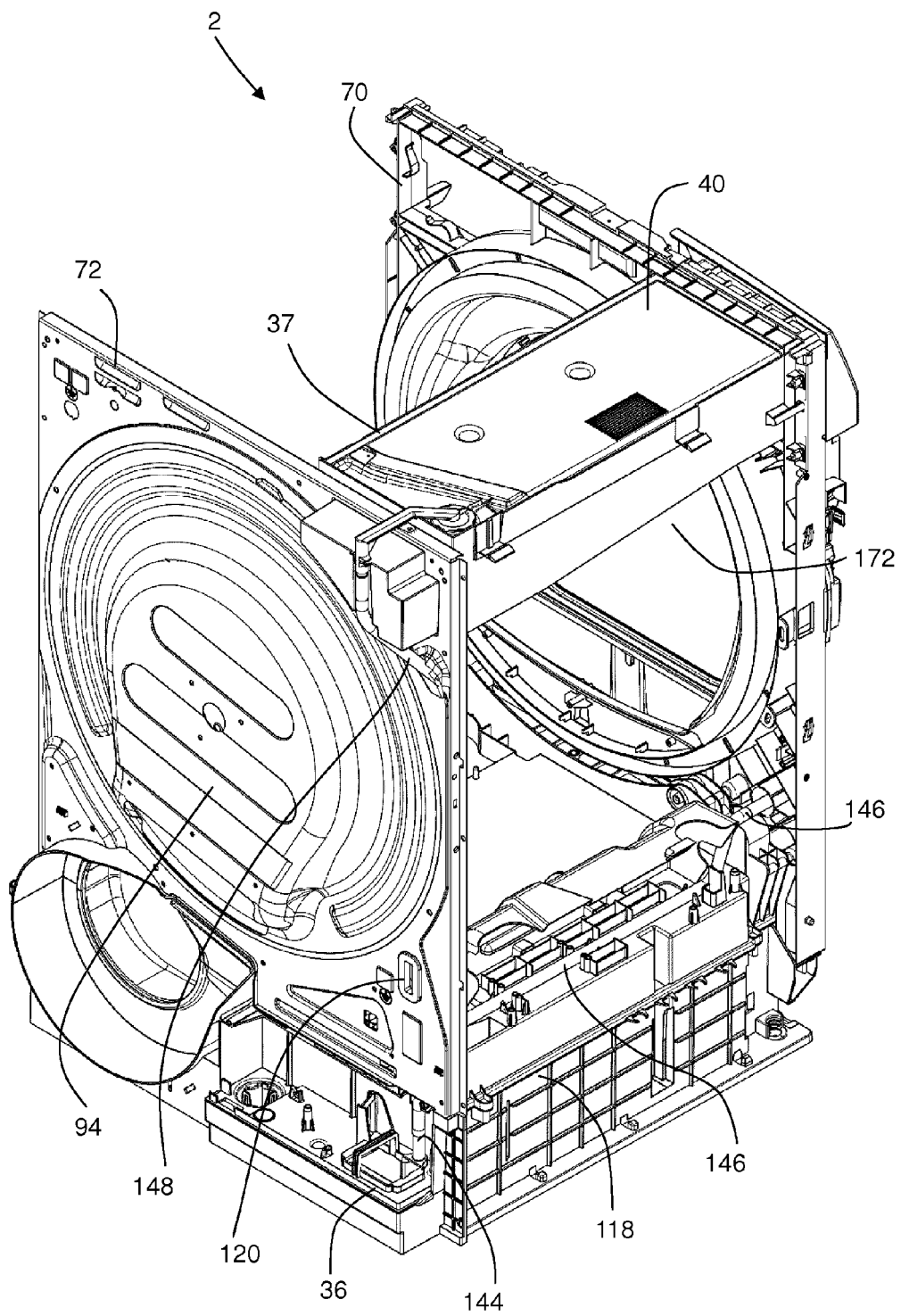


Fig. 19

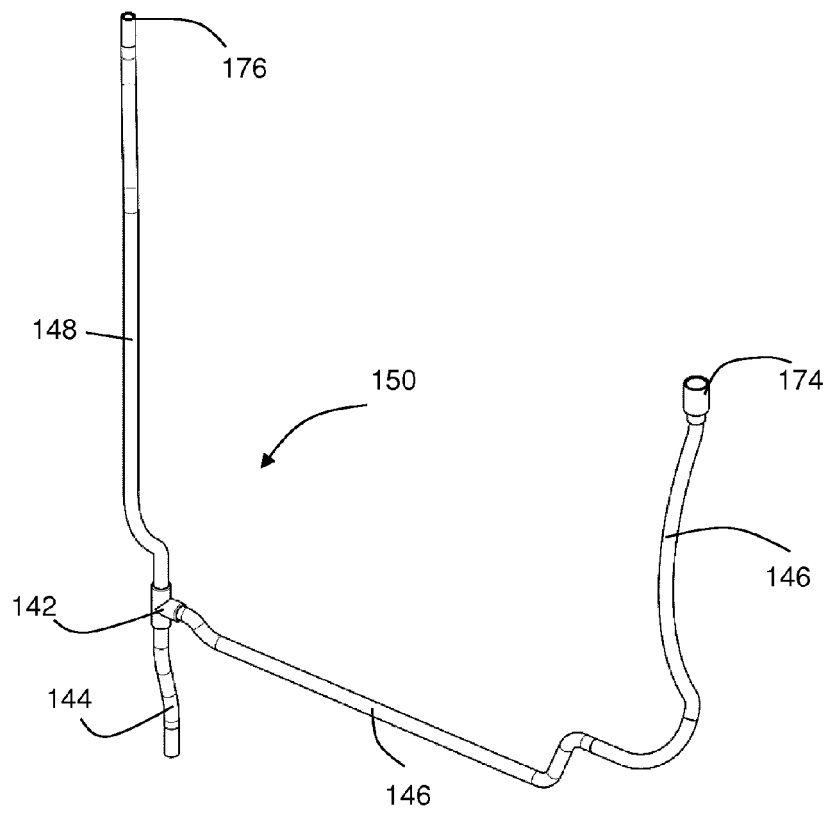


Fig. 20

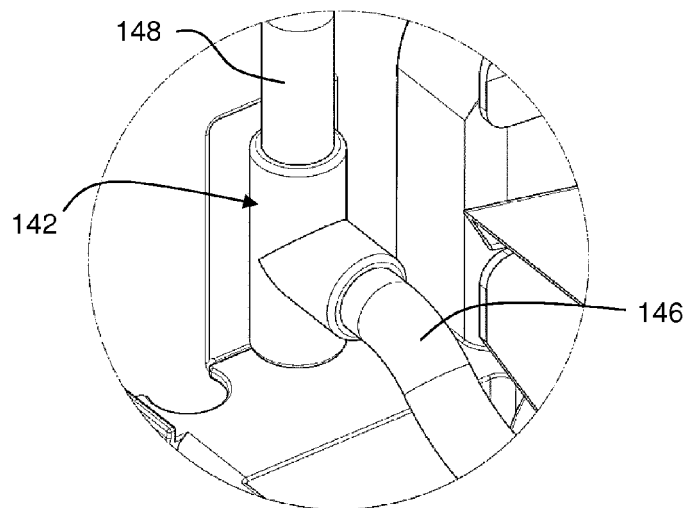


Fig. 21

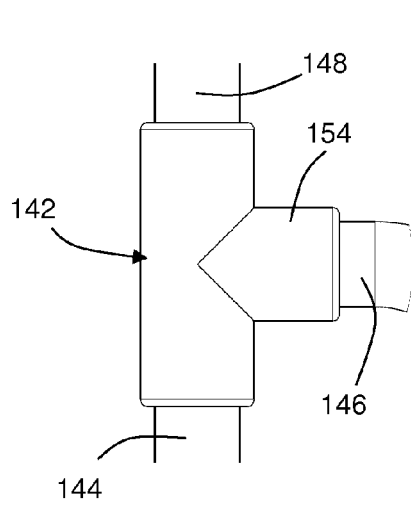


Fig. 22

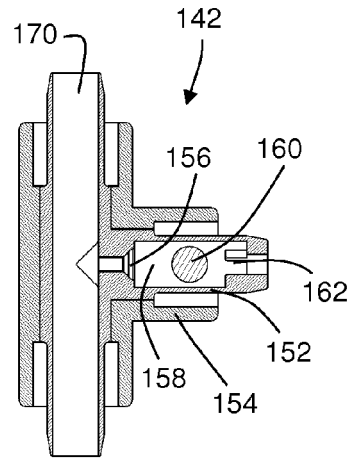


Fig. 23

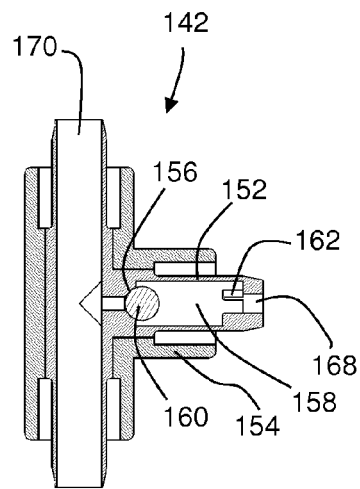


Fig. 24

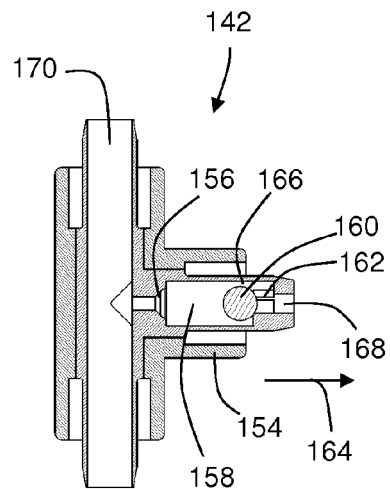


Fig. 25

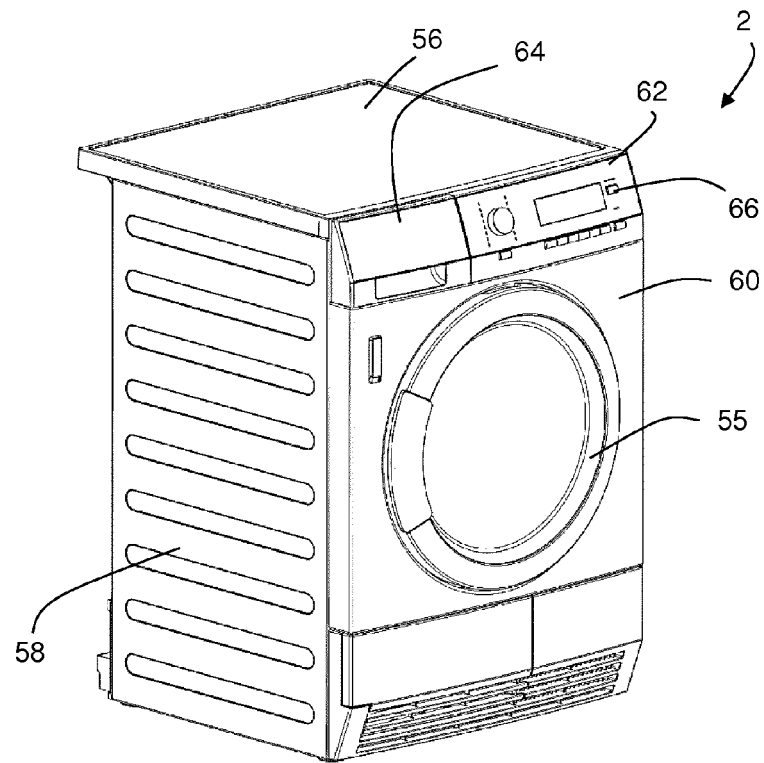


Fig. 26

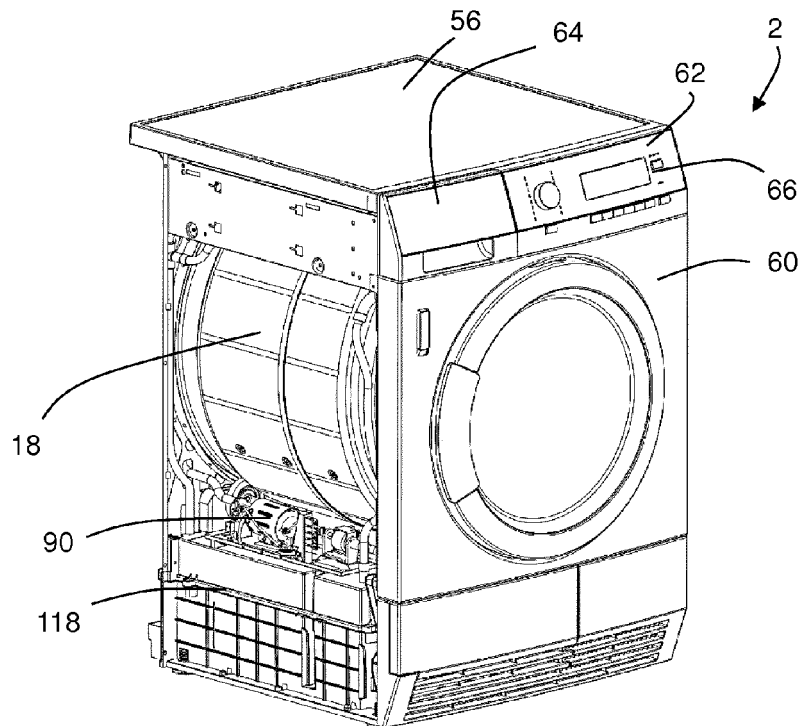


Fig. 27

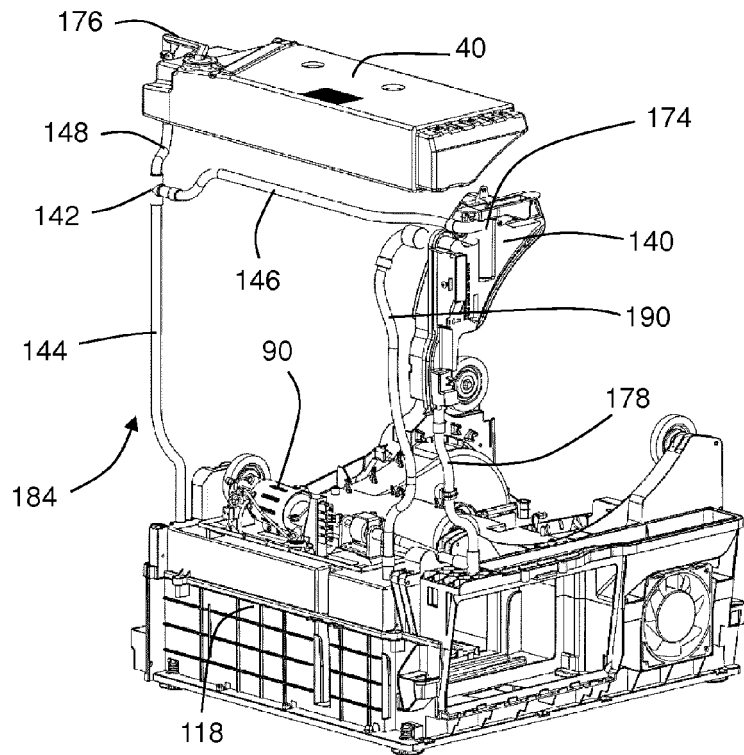


Fig. 28

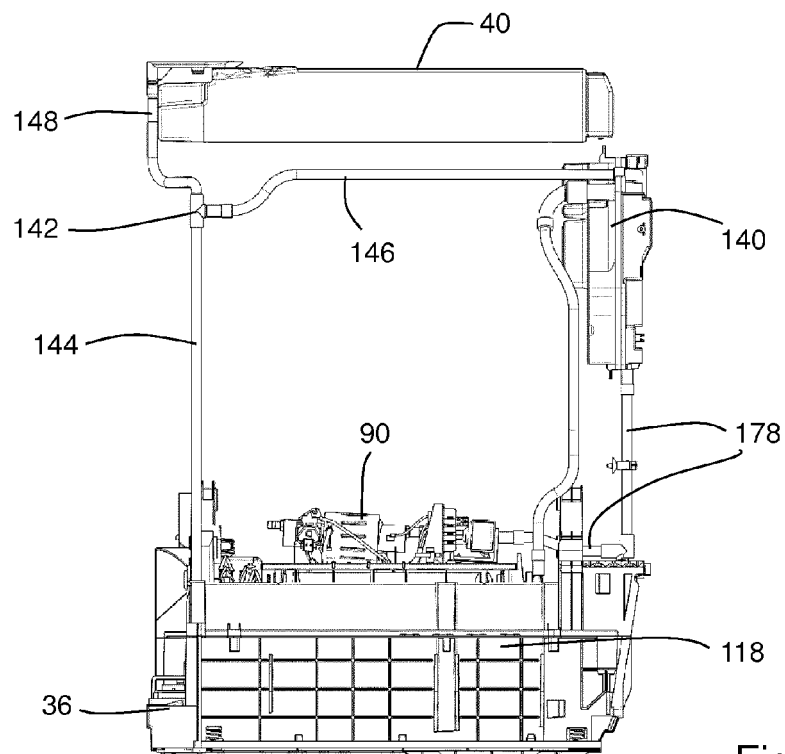


Fig. 29

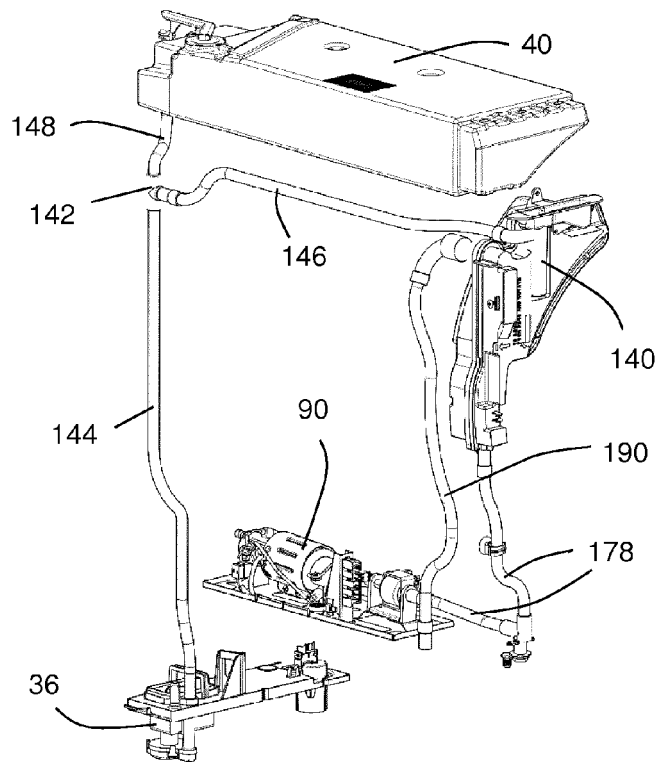


Fig. 30

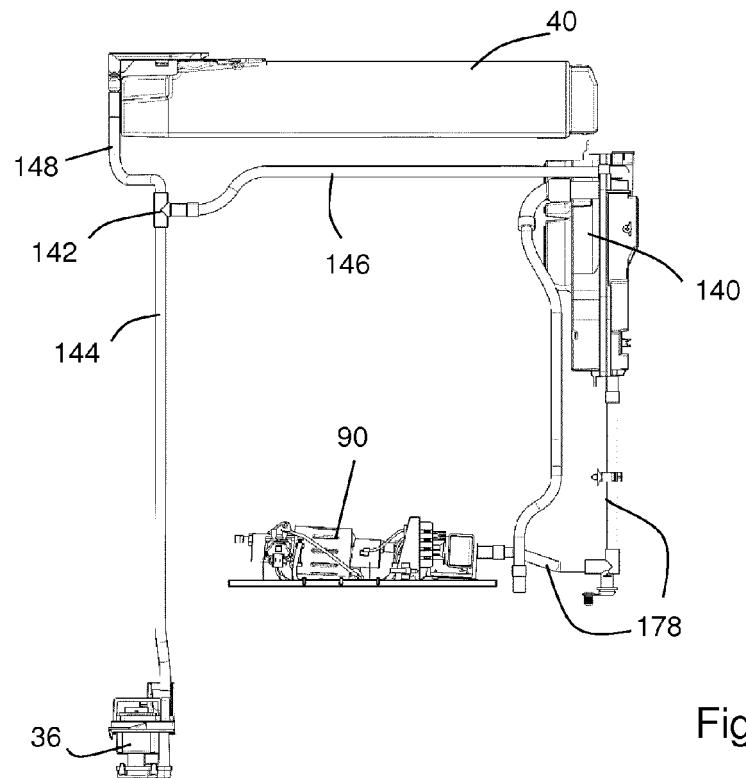


Fig. 31

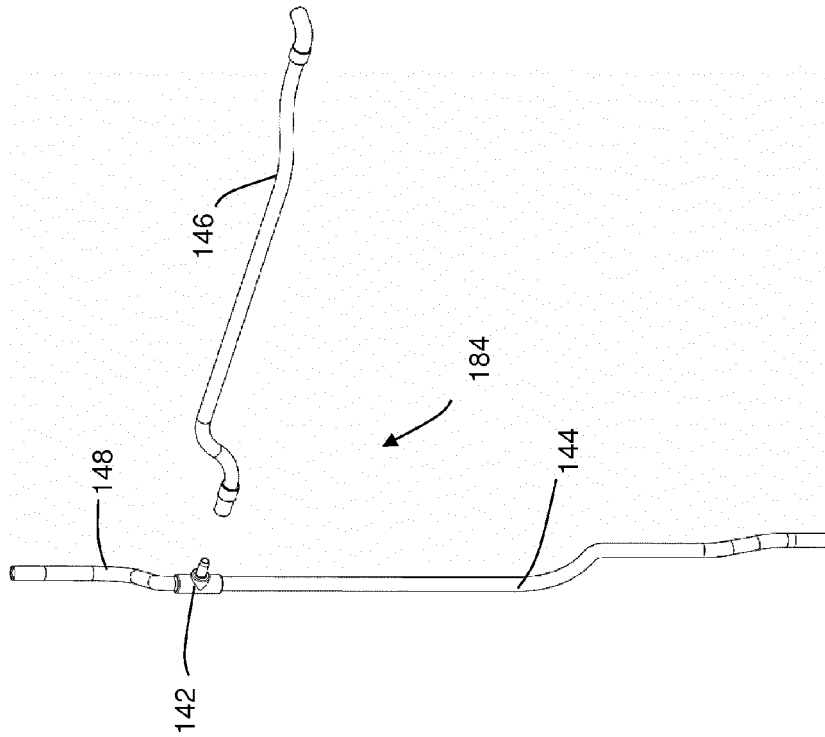


Fig. 33

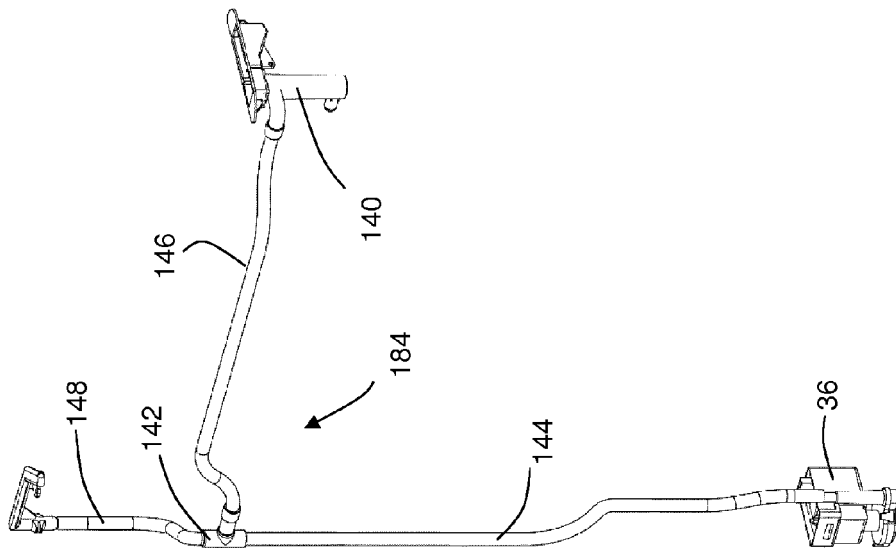


Fig. 32

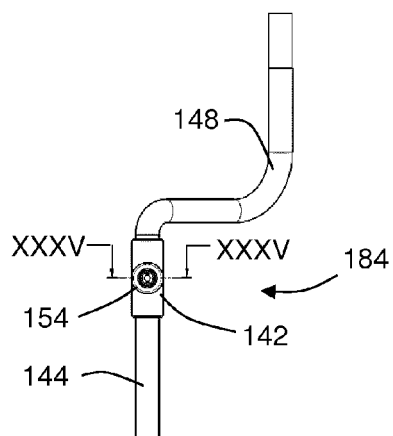


Fig. 34

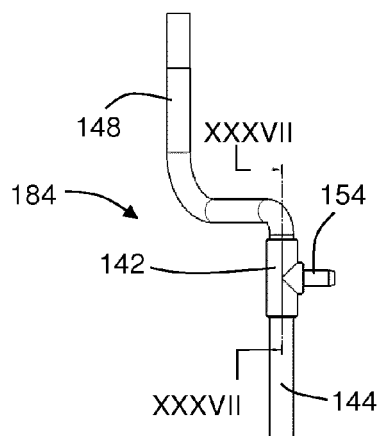


Fig. 36

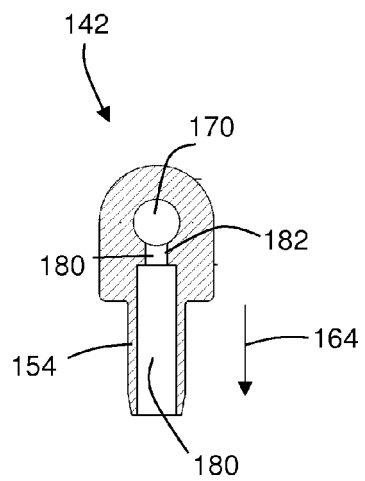


Fig. 35

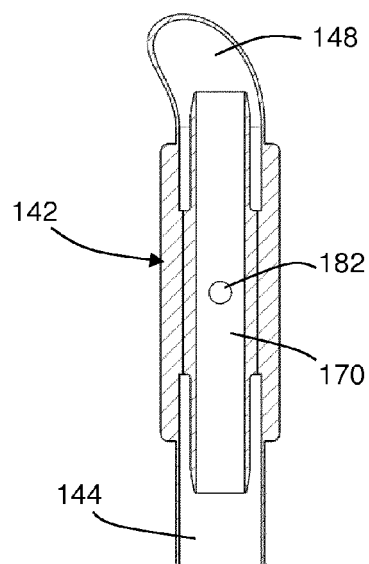


Fig. 37

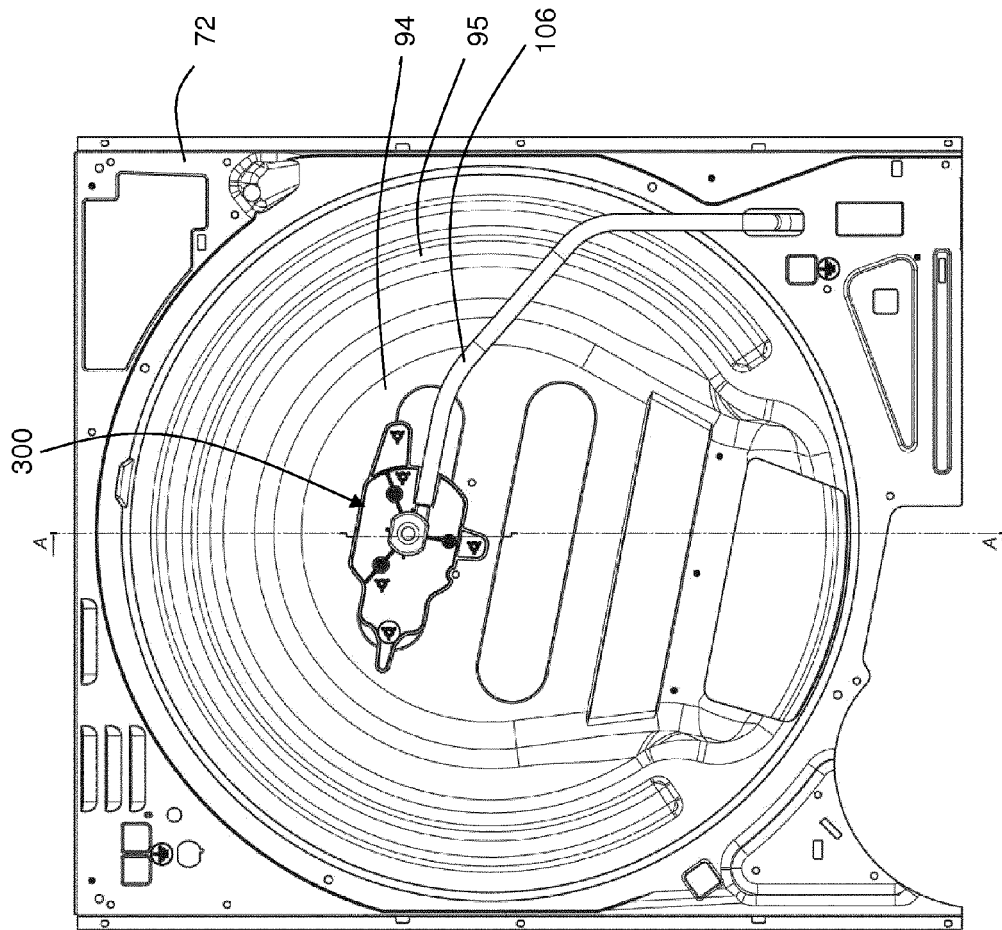


Fig. 38

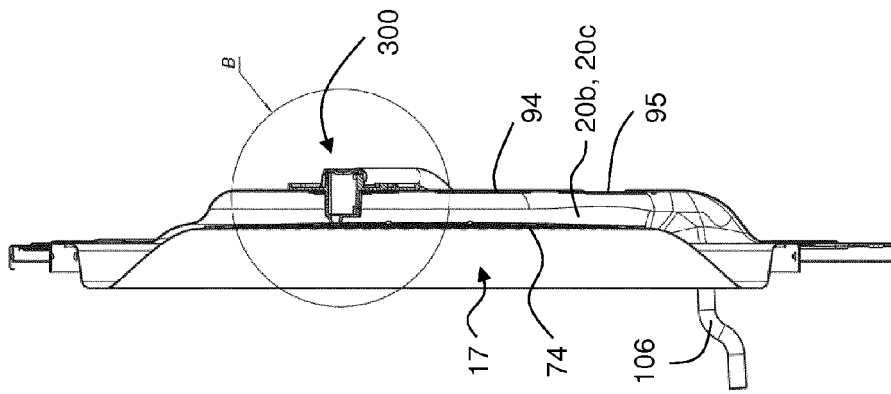


Fig. 39

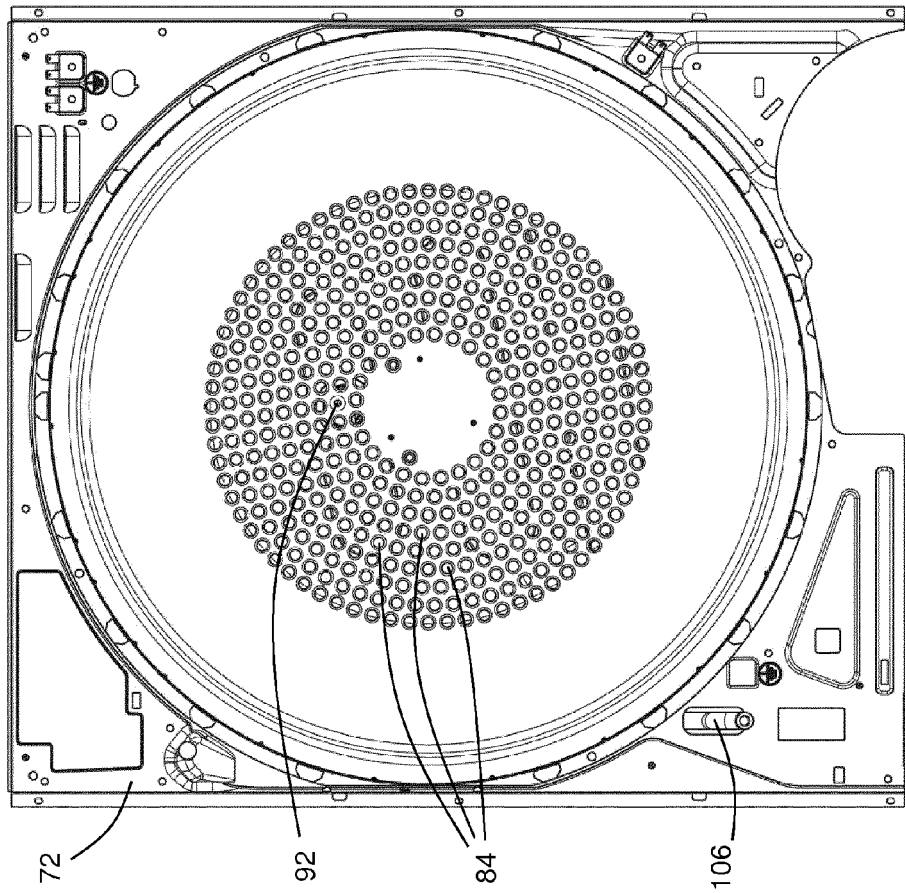


Fig. 41

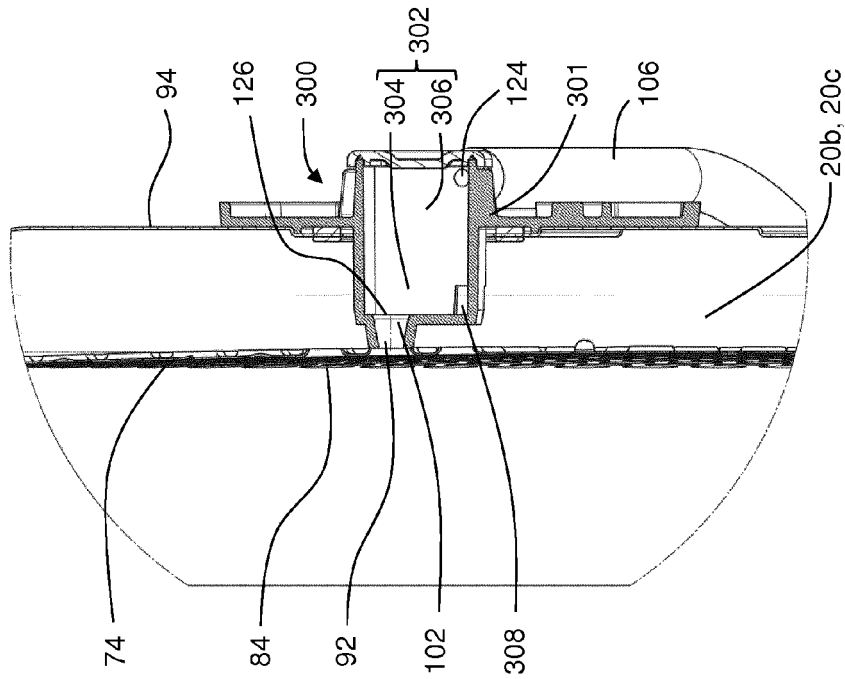


Fig. 40

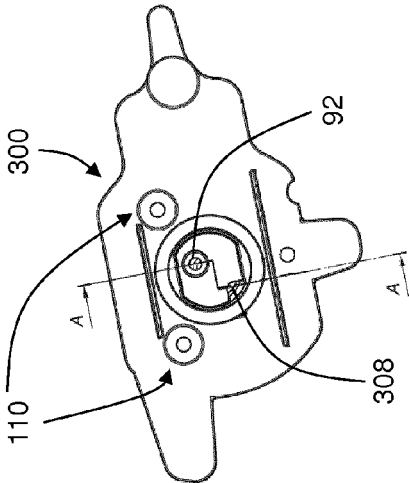


Fig. 43

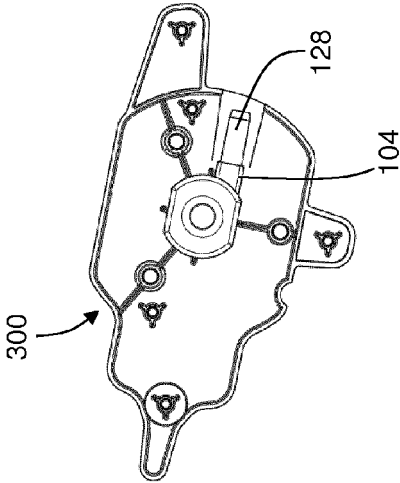


Fig. 45

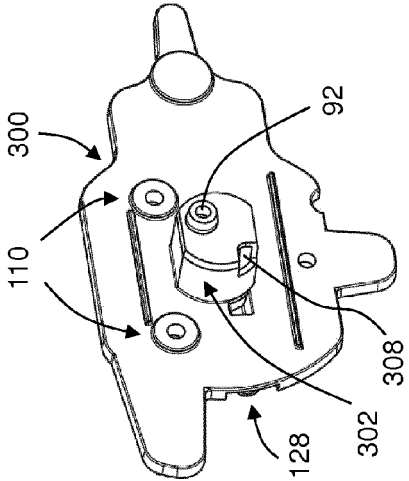


Fig. 42

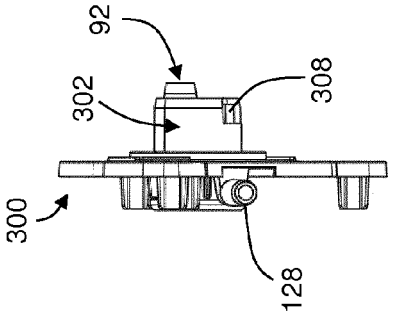


Fig. 44

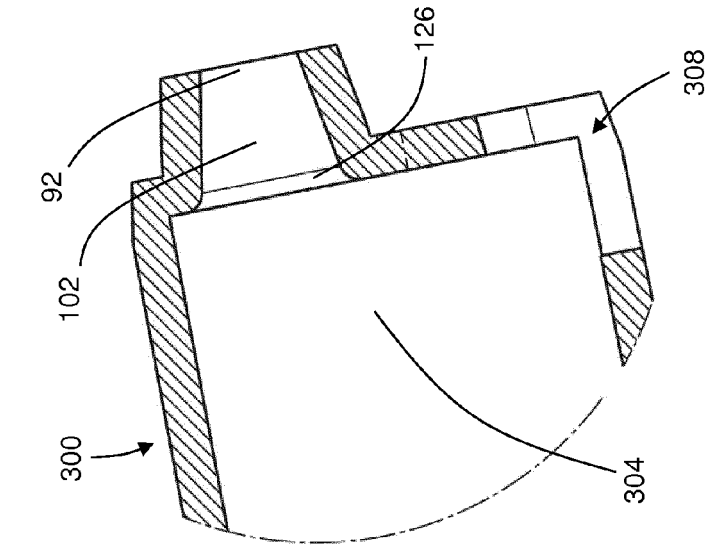


Fig. 46

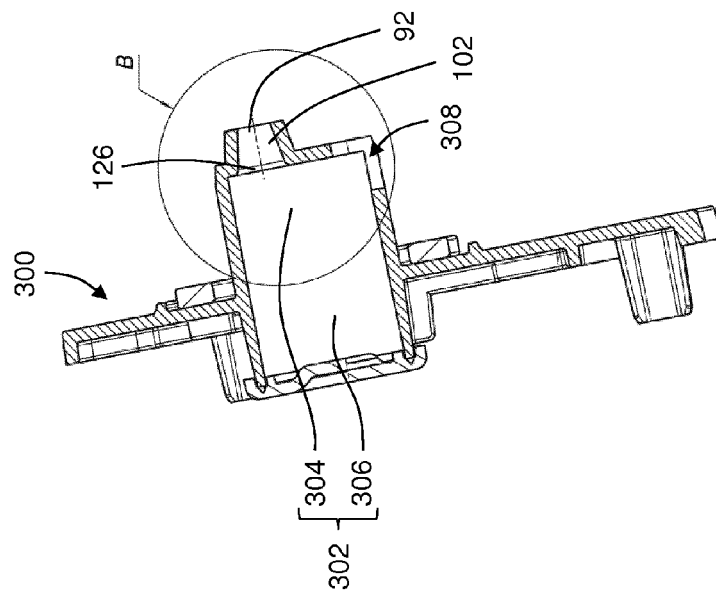


Fig. 47

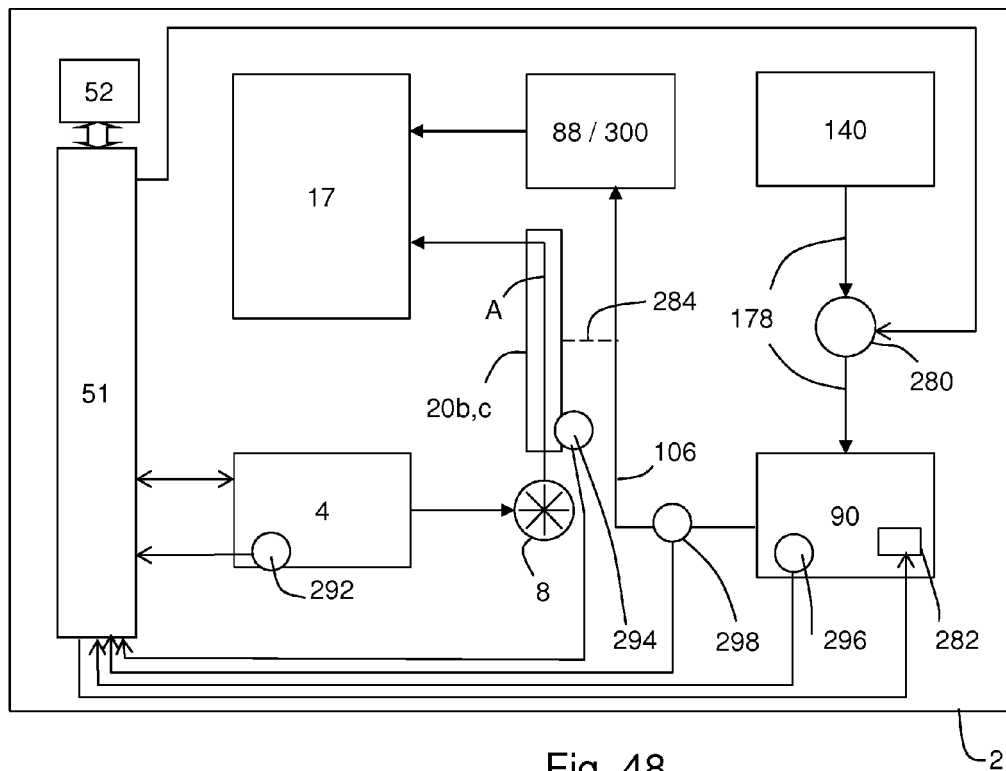


Fig. 48

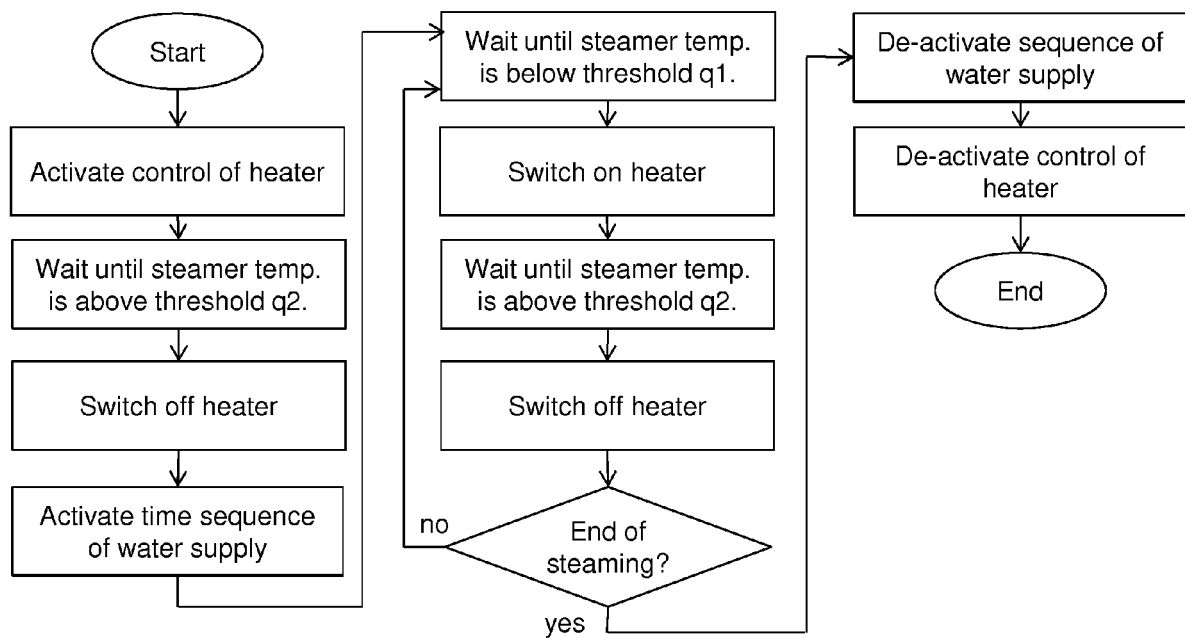


Fig. 51

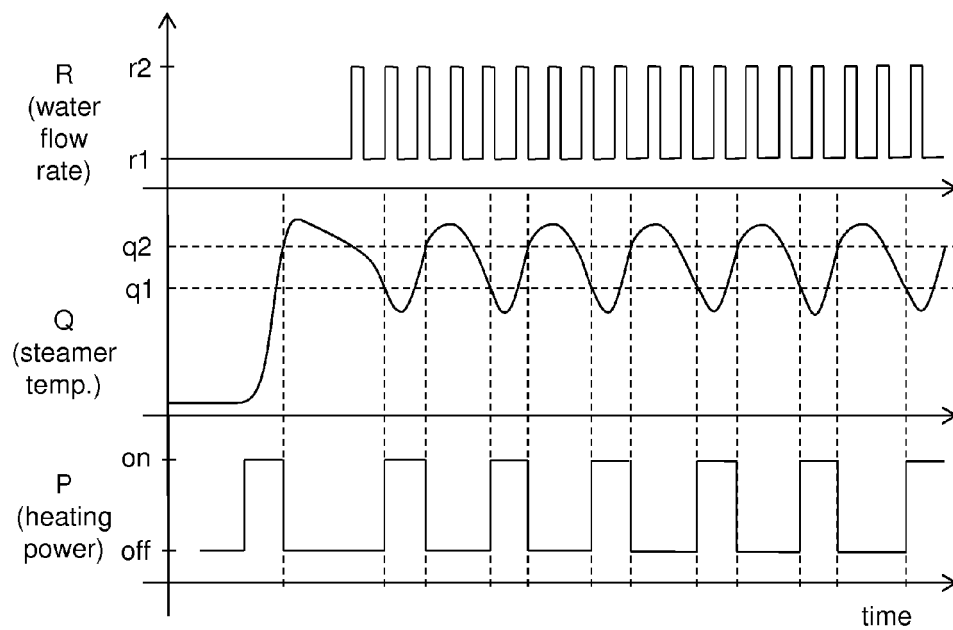


Fig. 49

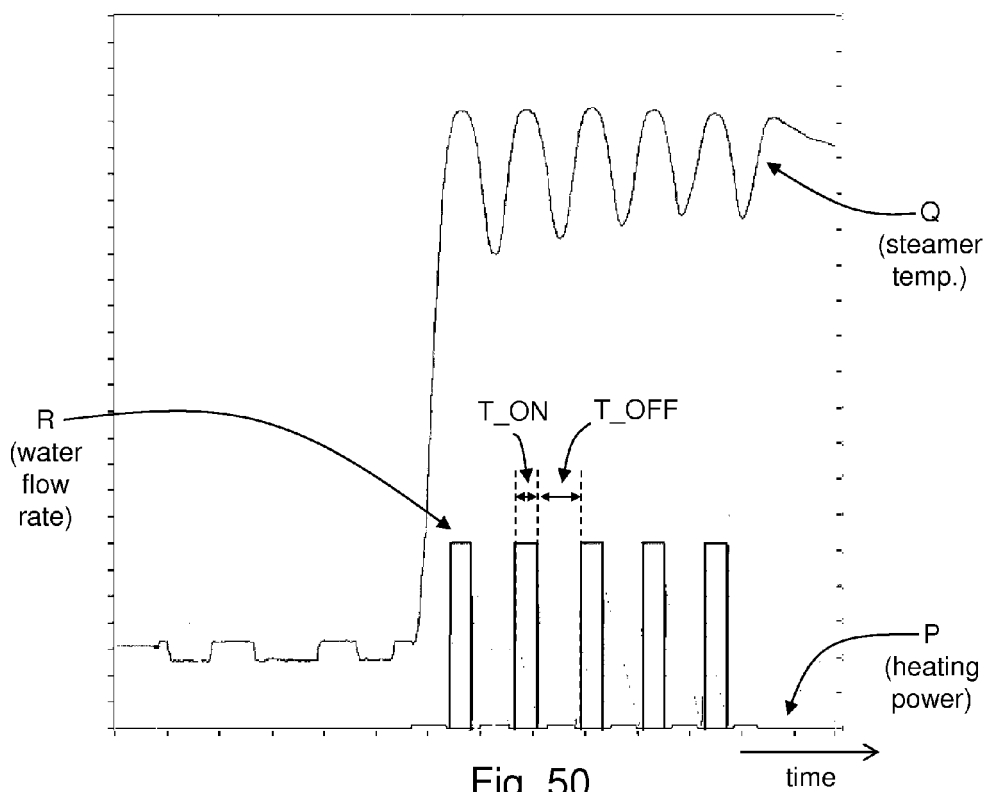


Fig. 50

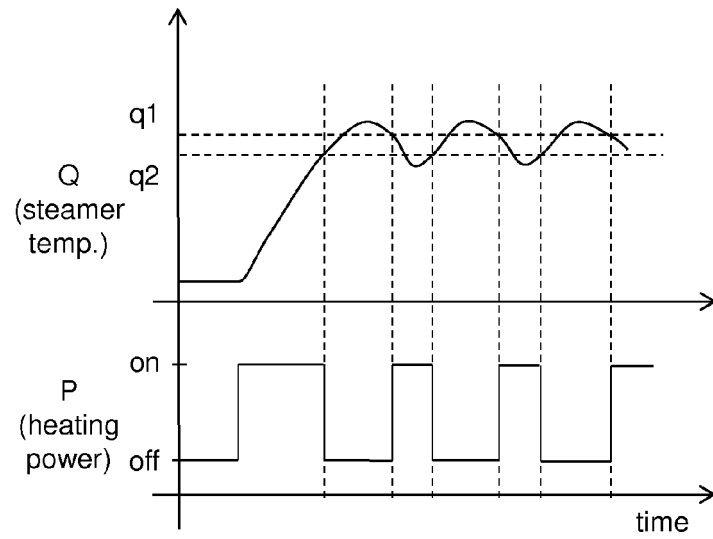


Fig. 52

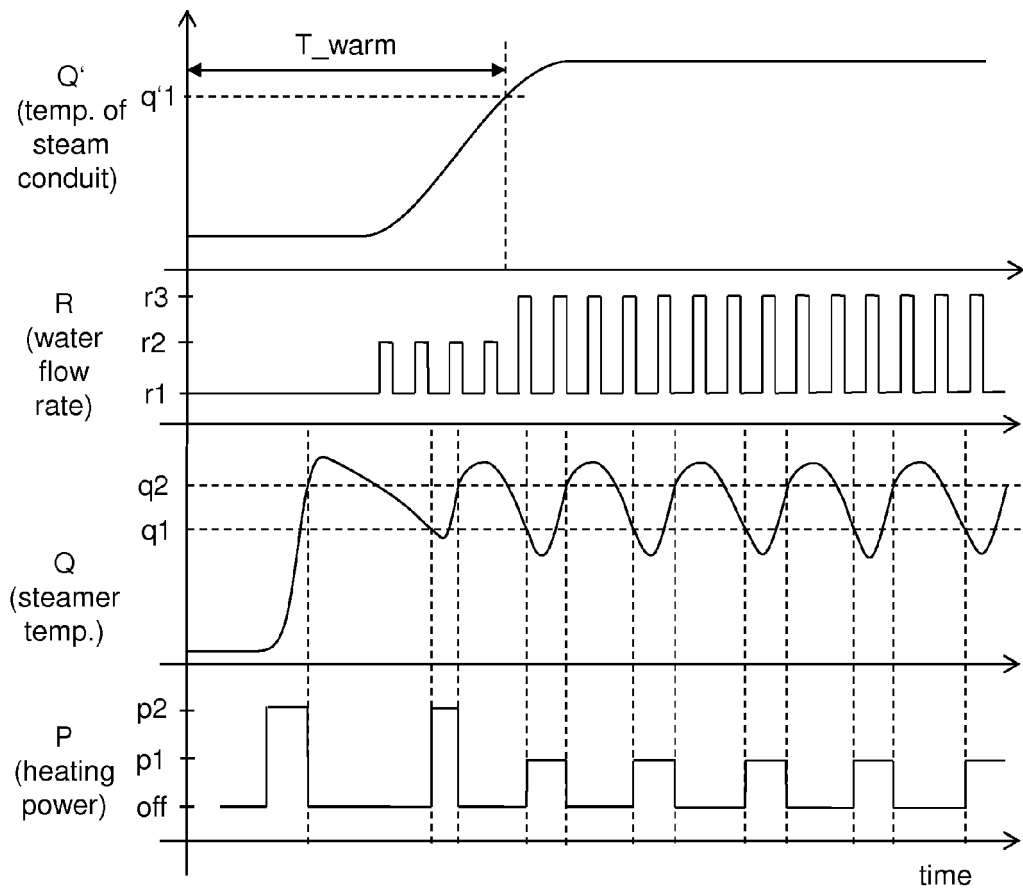


Fig. 53



EUROPEAN SEARCH REPORT

Application Number
EP 13 17 7180

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	EP 2 006 432 A2 (MIELE & CIE [DE]) 24 December 2008 (2008-12-24) * the whole document *	1-9	INV. D06F39/00 D06F58/26 D06F58/28 D06F58/20
X	EP 1 659 205 A2 (SAMSUNG ELECTRONICS CO LTD [KR]) 24 May 2006 (2006-05-24) * the whole document *	1-9	
X	DE 10 2008 003247 A1 (LG ELECTRONICS INC [KR]) 17 July 2008 (2008-07-17) * the whole document *	1-12, 18, 19	
A		13-17	
X,D	EP 1 889 966 A2 (WHIRLPOOL CO [US]) 20 February 2008 (2008-02-20) * the whole document *	1-9	
A,D	EP 1 887 127 A1 (ELECTROLUX HOME PROD CORP [BE]) 13 February 2008 (2008-02-13) * the whole document *	1-9	
A,D	WO 2004/059070 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]; MOSCHUETZ HARALD [DE]; ZIEMANN AND) 15 July 2004 (2004-07-15) * the whole document *	1-9	TECHNICAL FIELDS SEARCHED (IPC) D06F
A	EP 1 932 965 A1 (LG ELECTRONICS INC [KR]) 18 June 2008 (2008-06-18) * the whole document *	1-9	
A	EP 1 873 297 A2 (LG ELECTRONICS INC [KR]) 2 January 2008 (2008-01-02) * the whole document *	1-9	
X	EP 2 390 404 A1 (ELECTROLUX HOME PROD CORP [BE]) 30 November 2011 (2011-11-30)	10, 11, 14, 15, 18, 19	
A	* the whole document *	12, 13, 16, 17	
----- -/-			
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 May 2014	Examiner Spitzer, Bettina
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	

EPO FORM 1503 03.82 (F04C01)



EUROPEAN SEARCH REPORT

 Application Number
 EP 13 17 7180

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 A	DE 10 2008 028177 A1 (LG ELECTRONICS INC [KR]) 24 December 2008 (2008-12-24) * the whole document *	10-12, 18,19 13-17	
X A	US 2009/282696 A1 (KIM MIN-JI [KR] ET AL) 19 November 2009 (2009-11-19) * the whole document *	10,11 12-19	
X A	WO 2011/074850 A2 (LG ELECTRONICS INC [KR]; PARK HYE YONG [KR]; KIM YANG HWAN [KR]) 23 June 2011 (2011-06-23) * the whole document *	10 11-19	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 May 2014	Examiner Spitzer, Bettina
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			



Application Number

EP 13 17 7180

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 13 17 7180

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-9

method of operating a steam generation unit in a laundry dryer

2. claims: 10-19

method of operating a laundry dryer

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

EP 13 17 7180

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-05-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2006432 A2	24-12-2008	AT 530693 T	15-11-2011
		DE 102007028618 A1	02-01-2009
		EP 2006432 A2	24-12-2008
		ES 2371788 T3	10-01-2012
		PL 2006432 T3	29-02-2012
		US 2008313920 A1	25-12-2008

EP 1659205 A2	24-05-2006	CN 1776073 A	24-05-2006
		EP 1659205 A2	24-05-2006
		JP 2006141985 A	08-06-2006
		KR 20060055222 A	23-05-2006
		US 2006101586 A1	18-05-2006

DE 102008003247 A1	17-07-2008	AU 2008200122 A1	31-07-2008
		CN 101220554 A	16-07-2008
		DE 102008003247 A1	17-07-2008

EP 1889966 A2	20-02-2008	CA 2596566 A1	15-02-2008
		EP 1889966 A2	20-02-2008
		US 2008040868 A1	21-02-2008
		US 2010132128 A1	03-06-2010

EP 1887127 A1	13-02-2008	NONE	

WO 2004059070 A1	15-07-2004	DE 10260151 A1	01-07-2004
		EP 1579052 A1	28-09-2005
		US 2007006484 A1	11-01-2007
		WO 2004059070 A1	15-07-2004

EP 1932965 A1	18-06-2008	AU 2007240191 A1	03-07-2008
		CN 101205682 A	25-06-2008
		EP 1932965 A1	18-06-2008
		KR 20080054916 A	19-06-2008
		US 2008141553 A1	19-06-2008

EP 1873297 A2	02-01-2008	CN 101096809 A	02-01-2008
		EP 1873297 A2	02-01-2008
		KR 20080003021 A	07-01-2008
		US 2008006300 A1	10-01-2008

EP 2390404 A1	30-11-2011	CN 102277714 A	14-12-2011
		EP 2390404 A1	30-11-2011
		US 2011289695 A1	01-12-2011

DE 102008028177 A1	24-12-2008	DE 102008028177 A1	24-12-2008
		KR 100866884 B1	04-11-2008

EPO FORM P0459

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

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

EP 13 17 7180

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-05-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2008313922 A1	25-12-2008

US 2009282696 A1	19-11-2009	AU 2009201757 A1	03-12-2009
		DE 102009021040 A1	26-11-2009
		FR 2931171 A1	20-11-2009
		KR 20090119275 A	19-11-2009
		RU 2009118337 A	20-11-2010
		TW 200949183 A	01-12-2009
		US 2009282696 A1	19-11-2009

W0 2011074850 A2	23-06-2011	CN 102656311 A	05-09-2012
		DE 112010004823 T5	20-09-2012
		KR 20110067891 A	22-06-2011
		US 2012324753 A1	27-12-2012
		W0 2011074850 A2	23-06-2011

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1887127 A1 [0002]
- WO 2004059070 A1 [0003]
- EP 1889966 B1 [0004]