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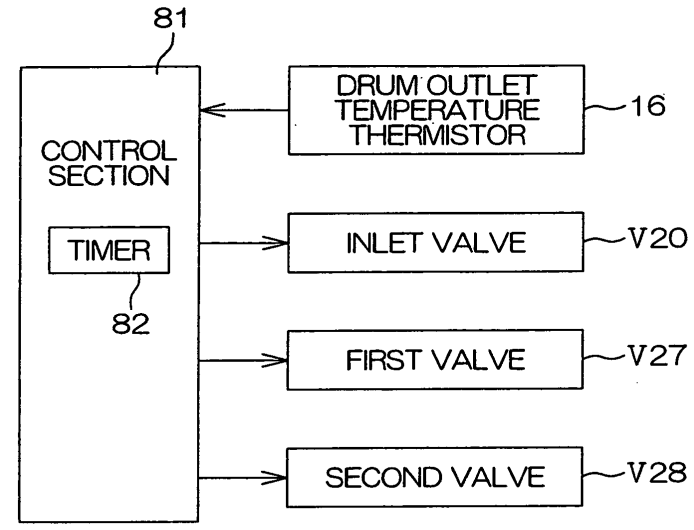
(54) Laundry apparatus

(57) A laundry apparatus according to the present invention is capable of stably regulating a laundry drying temperature without reduction in the service life of a valve which regulates the amount of steam to be supplied to heating unit . In the laundry apparatus, a first steam supply passage (24a) having a relatively great passage diameter and a second steam supply passage (24b) having a relatively small passage diameter are provided independently of each other. Thus, a relatively great amount of steam is supplied from the first steam supply passage (24a) to a drying heater (13) with a first valve (V27) being opened, and a relatively small amount of steam is supplied to the drying heater (13) with a second valve (V28) being opened. By selectively using the first valve (V27) and the second valve (V28), the opening/closing frequencies of these valves are reduced. This makes it possible to stably regulate the laundry drying temperature while preventing reduction in the service lives of these valves.

FIG. 3



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a laundry apparatus having a laundry drying function.

Description of Related Art

[0002] There are conventionally known laundry apparatuses which are capable of drying laundry contained in a rotatable drum thereof (see, for example, Japanese Unexamined Patent Publication No. HEI8(1996)-168595). Such laundry apparatuses have been introduced in coin-operated laundry shops, cleaning facilities, general households and the like.

[0003] A dry cleaner disclosed in the patent publication described above includes an outer tub and a drum rotatably supported in the outer tub and configured to contain laundry. A circulation duct is connected to the outer tub, and a heater serving as heating unit employing steam as a heat source is provided in the circulation duct. While the laundry contained in the drum is agitated by rotation of the drum, air heated by the heater in the circulation duct is applied to the laundry to dry the laundry.

[0004] In the dry cleaner disclosed in the aforementioned patent publication, a single valve is provided in a steam supply passage which connects a steam source to the heater. With the valve being opened, the steam is supplied from the steam source to the heater. By closing the valve, the supply of the steam to the heater is stopped. Where the temperature of the air heated by the heater is to be changed, a steam supply amount is controlled by opening and closing the valve. If the air heating temperature is changed, a laundry drying temperature (more specifically, the temperature of the air heat-exchanged with the laundry, which is an index indicating the drying state of the laundry) is also changed.

[0005] Where the laundry drying temperature is to be finely controlled, the valve should be frequently opened and closed. This may reduce the service life of the valve. Further, where the amount of the steam to be supplied with the valve being opened is set at a higher level for increasing the laundry drying temperature in a short time, the steam is abruptly supplied to the heater at a higher pressure when the valve is suddenly opened. The impact of the abrupt supply of the steam may damage the heater. If the amount of the supplied steam is increased, the laundry drying temperature is steeply increased. Therefore, where the fine control of the laundry drying temperature is desired, the valve opening/closing frequency is further increased.

SUMMARY OF THE INVENTION

[0006] In view of the foregoing, it is a main object of the present invention to provide a laundry apparatus which is capable of stably regulating a laundry drying temperature without reduction in the service life of a valve which regulates the amount of steam to be supplied to heating unit.

[0007] It is another object of the present invention to provide a laundry apparatus which ensures an extended service life of heating unit.

[0008] A laundry apparatus according to the present invention comprises: a laundry containing tub having an inlet and configured to contain laundry; an air flow passage connected to the inlet of the laundry containing tub to allow air to flow into the laundry containing tub from the inlet; heating unit which heats the air in the air flow passage by steam; a first steam supply passage having a greater passage diameter for supplying the steam to the heating unit; a second steam supply passage provided separately from the first steam supply passage and having a smaller passage diameter for supplying the steam to the heating unit; a first supply valve provided in the first steam supply passage to be opened and closed for permitting and preventing the supply of the steam to the heating unit; and a second supply valve provided in the second steam supply passage to be opened and closed for permitting and preventing the supply of the steam to the heating unit.

[0009] The laundry containing tub may have an outlet, and the air flow passage may include a circulation duct connected to the outlet of the laundry containing tub and configured to allow the air flowing into the laundry containing tub through the inlet to flow out through the outlet to circulate the air in the laundry containing tub.

[0010] The laundry apparatus may further comprise controller which opens and closes the first supply valve and the second supply valve individually or simultaneously. The controller may be configured to first open the second supply valve and then the first supply valve when the heating of the air is started.

[0011] The laundry apparatus preferably further comprises a temperature sensor for detecting an air temperature at the outlet. The controller is preferably configured to close the first supply valve when the temperature detected by the temperature sensor exceeds a target temperature, close the second supply valve when the temperature detected by the temperature sensor is further increased to an upper limit temperature which is higher by a predetermined degree than the target temperature, and open only the second supply valve when the temperature detected by the temperature sensor is reduced to a lower limit temperature which is lower by a predetermined degree than the target temperature.

[0012] According to the present invention, the air is heated in the air flow passage with the steam by the heating unit, and the heated air flows into the laundry containing tub through the inlet to dry the laundry in the laundry containing tub. The first steam supply passage having a relatively great passage diameter and the second steam supply passage having a relative small passage

diameter are provided independently of each other for supplying the steam to the heating unit. The first supply valve is provided in the first steam supply passage, and a relatively great amount of steam is supplied to the heating unit from the first steam supply passage with the first supply valve being opened. On the other hand, the second supply valve is provided in the second steam supply passage, and a relatively small amount of steam is supplied to the heating unit with the second supply valve being opened.

[0013] Therefore, the laundry drying temperature can be increased to the target temperature in a short time by mainly opening the first supply valve. After the laundry drying temperature reaches the target temperature, a drastic fluctuation in laundry drying temperature can be suppressed by mainly opening and closing the second supply valve.

[0014] In the present invention, the first supply valve and the second supply valve are selectively used for regulating the laundry drying temperature. Thus, the first supply valve and the second supply valve are less frequently opened and closed as compare with a case where a single supply valve is employed for regulating the laundry drying temperature. This makes it possible to stably regulate the laundry drying temperature, while preventing the reduction in the service lives of the first supply valve and the second supply valve.

[0015] Since the laundry drying temperature is regulated by controlling the valve opening/closing frequencies of the first supply valve and the second supply valve, cost reduction and structural simplification can be achieved without the need for employing an expensive and complicated supply valve capable of controlling the opening degree of the valve.

[0016] The air in the laundry containing tub is circulated through the circulation duct of the air flow passage. Therefore, the air heated by the heating unit and supplied to the laundry containing tub exchanges heat with the laundry in the laundry containing tub to cause moisture contained in the laundry to evaporate, and then is reused for the drying of the laundry rather than being discharged together with the evaporated moisture to the outside. Therefore, the laundry apparatus is environmentally friendly.

[0017] According to the present invention, the controller first opens the second supply valve and then the first supply valve when starting the heating of the air. Therefore, a relatively small amount of steam is first supplied to the heating unit, and then a relatively great amount of steam is supplied to the heating unit. Thus, the pressure of the steam in the heating unit is increased stepwise. If the opening of the first supply valve preceded the opening of the second supply valve, a steam pressure in the heating unit would be steeply increased, so that the impact of the steep pressure increase would result in damage to the heating unit. In the present invention, however, the steam pressure in the heating unit is increased stepwise when the heating of the air is started. Therefore, the impact to be exerted on the heating unit by the steam pressure is alleviated, so that the service life of the heating unit is extended.

[0018] According to the present invention, the temperature sensor detects the laundry drying temperature defined by the air temperature at the outlet, i.e., the temperature of the air heat-exchanged with the laundry in the laundry containing tub. Thus, a laundry drying state can be accurately detected.

[0019] Further, the controller closes the first supply valve when the temperature detected by the temperature sensor exceeds the target temperature, closes the second supply valve when the temperature detected by the temperature sensor is further increased to the upper limit temperature which is higher by a predetermined degree than the target temperature, and opens only the second supply valve when the temperature detected by the temperature sensor is reduced to the lower limit temperature which is lower by a predetermined degree than the target temperature.

That is, if the laundry drying temperature is changed from the target temperature, the opening/closing operation of the second supply valve is not performed immediately after the change in laundry drying temperature but after a lapse of a predetermined period for regulating the laundry drying temperature. This prevents the second supply valve from chattering.

Since only the second supply valve having a relatively low steam supply capacity is opened and closed for regulating the drying temperature, a drastic fluctuation in drying temperature is suppressed as compared with a case in which the first supply valve having a relatively high steam supply capacity is opened and closed. Therefore, the drying temperature can be stably regulated.

[0020] With reference to the attached drawings, embodiments of the present invention will hereinafter be described more specifically.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a front perspective view of major portions of a dry cleaner 1 as a laundry apparatus according to one embodiment of the present invention.

Fig. 2 is a pipeline diagram of the dry cleaner 1.

Fig. 3 is a block diagram showing an arrangement for a control operation for the supply of steam to a drying heater 13 in the dry cleaner 1.

Fig. 4 is a flow chart for explaining the control operation for the steam supply to the drying heater 13 in a drying process.

Fig. 5 is a diagram illustrating changes in drum outlet temperature observed with time in the drying process with and without the inventive arrangement.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

External Construction of Dry Cleaner

[0022] Fig. 1 is a front perspective view of major portions of a dry cleaner 1 as a laundry apparatus according to one embodiment of the present invention. Reference will be made to directional arrows shown in Fig. 1 for directional notation.

[0023] Referring to Fig. 1, the dry cleaner 1 is, for example, for business use, and includes a generally rectangular box-shaped main body 2, and a tank/filter kit 3 (see Fig. 2).

[0024] The main body 2 includes a rack-like frame 2a. An outer tub 4 and a drum 5 accommodated in the outer tub 4 are provided within the frame 2a. The outer tub 4 and the drum 5 function as a laundry containing tub. The frame 2a is fixed to a floor. An operation panel 2b is attached to a front face portion of the frame 2a above the outer tub 4, specifically, at around a level of user's eyes. A user operates operation buttons (not shown) of the operation panel 2b to cause the dry cleaner 1 to perform desired operations, and the operation status of the dry cleaner 1 is displayed on a display panel (not shown) of the operation panel 2b.

[0025] The outer tub 4 is of a generally rectangular box shape, and has a generally cylindrical space defined therein. The outer tub 4 has an outer tub opening 4a formed in a front wall thereof as communicating with the inside thereof and having a round shape as seen from the front side. An annular metal rim 4b is fitted along the periphery of the outer tub opening 4a. An annular packing 4c is attached to an inner peripheral front edge of the rim 4b. The rim 4b has a hinge 4d provided at a left edge portion thereof, and an engagement projection 4e provided at a right edge portion thereof. A door (not shown) is attached to the hinge 4d so as to be pivotal about a pivot shaft of the hinge 4d to open and close the outer tub opening 4a. The door (not shown) has an engagement projection (not shown) provided at a portion thereof opposite from the hinge side. When the door (not shown) closes the outer tub opening 4a, the engagement projection (not shown) of the door is engaged with the engagement projection 4e of the rim 4b, whereby the door (not shown) is locked with the outer tub opening 4a closed.

[0026] Four corners of a bottom face of the outer tub 4 are connected to the frame 2a via dampers 2c. Therefore, even if the outer tub 4 vibrates during the operation of the dry cleaner 1, the vibrations of the outer tub 4 are damped by the dampers 2c and hence prevented from being propagated around the dry cleaner 1 through the frame 2a.

[0027] The drum 5 has a generally cylindrical hollow shape, and is disposed with its center shaft extending generally horizontally, specifically, extending anteroposteriorly. The drum 5 is rotatable about the center shaft thereof. The drum 5 has a drum opening 5a formed in a front wall thereof at a position corresponding to the outer tub opening 4a as communicating with the inside of the drum 5. The drum opening 5a is anteroposteriorly opposed to the outer tub opening 4a. Therefore, laundry can be loaded into the drum 5 through the outer tub opening 4a and the drum opening 5a with the door (not shown) being opened. A plurality of baffles 5b are provided on an inner peripheral surface of the drum 5 as projecting toward the center shaft.

Internal Construction of Dry Cleaner

[0028] Fig. 2 is a pipeline diagram of the dry cleaner 1. With reference to Fig. 2, the internal construction of the dry cleaner 1 will hereinafter be described in detail.

[0029] The outer tub 4 has an air inlet 6 (inlet) through which air is introduced into the drum 5, and an air outlet 7 (outlet) through which the air is expelled from the drum 5. A circulation duct 8 (air flow passage) is connected to the air outlet 7 and the air inlet 6. That is, the circulation duct 8 is a closed circuit which connects the air outlet 7 and the air inlet 6 to each other.

[0030] The dry cleaner 1 is an apparatus designed to perform a dry cleaning process with the use of a special solvent such as a petroleum-based solvent or a silicone-based solvent (the silicone-based solvent is used in this embodiment). The dry cleaning process is advantageous in that laundry is less liable to shrink and oil stains are more easily removed as compared with a water cleaning process in which the laundry is washed with water. On the other hand, it is not desirable to release the solvent used for the dry cleaning to the external environment. Therefore, the dry cleaner according to this embodiment is of a type which is adapted to recover all the used solvent.

[0031] More specifically, a predetermined amount of solvent supplied from a tank 31 to be described later is contained in the outer tub 4, and the laundry is washed with the solvent in a washing process. After the washing process, the solvent is recovered from the outer tub 4 into the tank 31. Further, the drum 5 is rotated at a higher speed to remove residual solvent from the laundry. The removed solvent is also recovered into the tank 31. Thereafter, a drying process is performed to dry the laundry by circulating the air between the circulation duct 8 and the drum 5 while rotating the drum 5 at a lower speed. The vapor of the solvent resulting from vaporization of the solvent from the laundry in the drying process is also recovered by condensation thereof. During the rotation of the drum 5, the laundry is agitated by the baffles 5b. Thus, the laundry is efficiently washed and dried.

[0032] In the drying process, a blower 10 is rotated by a blower motor 9, whereby the air in the drum 5 is circulated from the air outlet 7 into the air inlet 6 through the circulation duct 8. Drying coolers 11 and 12 are provided in the circulation duct 8, and a drying heater 13 (heating unit) is provided adjacent the air inlet 6. The air flowing out of the drum 5 into the circulation duct 8 through the

air outlet 7 contains the vaporized solvent (solvent gas). The air containing the solvent gas is cooled by the drying coolers 11 and 12, so that the solvent gas in the air is liquefied. That is, the solvent-containing air flowing through the circulation duct 8 is cooled by the drying coolers 11 and 12, whereby the solvent is condensed and recovered from the air. Thereafter, the air is heated by the drying heater 13, and the heated air is supplied as drying air into the drum 5 through the air inlet 6. In the drum 5, the heated air is heat-exchanged with the laundry, whereby the solvent contained in the laundry is vaporized. The vaporized solvent flows together with the air into the circulation duct 8 through the air outlet 7. This cycle in which the air in the drum 5 is circulated between the drum 5 and the circulation duct 8 is repeated, thereby drying the laundry in the drum 5. The dry cleaner 1 is configured such that the drying air from the air inlet 6 is supplied to the laundry in the drum 5 through the outer tub opening 4a and the drum opening 5a. The drum opening 5a is an opening having the greatest size in the drum 5, so that the drying air can be efficiently supplied to the laundry through the drum opening 5a. Further, the air in the drum 5 is circulated through the circulation duct 8. Therefore, the air heated by the drying heater 13 and supplied into the drum 5 is heat-exchanged with the laundry in the drum 5 to vaporize moisture (solvent) from the laundry, and then reused for the drying of the laundry rather than being expelled together with the vaporized moisture to the outside. Accordingly, the dry cleaner 1 is environmentally friendly.

[0033] Meanwhile, the solvent is flammable. Therefore, there is the danger of ignition or explosion of the vaporized solvent unless the temperature of the heated air is reliably controlled in the drying process.

[0034] For detecting the temperature of the heated air supplied into the drum 5 from the air inlet 6, a drum inlet temperature thermistor 14 and an inlet over-temperature preventing thermistor 15 are provided downstream of the drying heater 13 (on a downstream side with respect to an air flow direction - this definition holds true for the following description) in the circulation duct 8. Though not shown, the inlet over-temperature preventing thermistor 15 is connected to a transistor circuit, and configured such that the circuit is cut off through the transistor, for example, when a temperature of 95°C is detected. Therefore, the inlet over-temperature preventing thermistor 15 is advantageous in that it ensures more accurate detection of an operation temperature and a quicker response to the temperature than a thermostat.

[0035] For detecting the temperature of the air expelled from the air outlet 7, a drum outlet temperature thermistor 16 (temperature sensor) and an abnormal outlet temperature judging thermistor 17 which monitors the drum outlet temperature thermistor 16 to check whether or not the drum outlet temperature thermistor 16 malfunctions are provided in the circulation duct 8. For detecting the temperature of the air cooled by a downstream one of the two drying coolers 11 and 12, a cooler temperature thermistor 18 and a cooler over-temperature preventing thermistor 19 which constitutes a part of a safety circuit are provided in the circulation duct 8.

[0036] Further, an aspiration port 20 and a gate valve V14 are provided between the drying cooler 12 and the drying heater 13 in the circulation duct 8 for regulating the internal pressure of the circulation duct 8 when the circulation duct internal pressure is excessively increased. Normally, the aspiration port 20 is opened, and the gate valve V14 is opened to permit the air to flow through the circulation duct 8. Further, the circulation duct 8 has an explosion protection port 26 which, if the solvent gas-containing air flowing through the circulation duct 8 happens to be ignited to cause explosion, releases the blast of the explosion. The explosion protection port 26 is biased in a closing direction by a spring not shown.

[0037] The drying coolers 11 and 12 are connected to a freezing machine 23 through coolant passages 22a, 22b and 22c. The freezing machine 23 is disposed outside the main body 2. When a drying cooler electromagnetic valve 2Y inserted in the coolant passage 22a is opened, a coolant (e.g. , cold water) flows from the freezing machine 23 into the drying cooler 12 and the drying cooler 11 through the coolant passages 22a and 22b, whereby the drying cooler 12 and the drying cooler 11 perform a cooling operation. The drying coolers 11 and 12 are herein connected in series with each other to the freezing machine 23, but may be connected in parallel with each other to the freezing machine 23. More specifically, the coolant passages 22a and 22c may be provided for each of the drying coolers 11 and 12 to supply the coolant individually to the drying coolers 11 and 12 from the freezing machine 23. Of course, freezing machines 23 may be respectively provided for the drying coolers 11 and 12.

[0038] The drying heater 13 is a so-called radiator which radiates heat of steam passing therethrough from fins thereof to heat the ambient atmosphere, and is connected to steam passages 24 and 25. More specifically, the steam passage 24 connects an external steam source to the drying heater 13. An inlet valve V20 is inserted in the steam passage 24. The steam passage 24 is branched into a first steam supply passage 24a having a relatively great passage diameter and a second steam supply passage 24b having a relatively small passage diameter between the drying heater 13 and the inlet valve V20. A first valve V27 (first supply valve) is inserted in the first steam supply passage 24a, and a second valve V28 (second supply valve) is inserted in the second steam supply passage 24b. On the other hand, the steam passage 25 is a passage through which the steam supplied from the steam passage 24 to the drying heater 13 is expelled to the outside.

[0039] With the inlet valve V20 and the first valve V27 and/or the second valve V28 being opened, steam (e.g. , steam at 110 to 120°C) is supplied to the drying heater 13, whereby the drying heater 13 heats the air in the circulation duct 8 by the steam. Since the first steam sup-

ply passage 24a and the second steam supply passage 24b are different in steam supply capacity, the steam may be supplied to the drying heater 13 from one or both of the first steam supply passage 24a and the second steam supply passage 24b as required. The supply of the steam to the drying heater 13 will be described in detail later.

[0040] In the drying process, the rotation of the blower motor 9, and the opening and closing of the inlet valve V20 and the first valve V27 and/or the second valve V28 are typically controlled based on temperatures detected by the drum inlet temperature thermistor 14, the drum outlet temperature thermistor 16 and the cooler temperature thermistor 18.

[0041] The tank/filter kit 3 includes the tank 31 which stores the solvent, and a first filter 32 and a second filter 33 which are connected in series for filtering the solvent pumped up from the tank 31. A pump-up pipe 34 is connected to a bottom of the tank 31 at one end thereof. A valve V1 is inserted in the pump-up pipe 34. The other end of the pump-up pipe 34 is connected to a junction 35. A solvent pump 36 is connected to the junction 35 on its suction side and to an inlet of a three-way valve V6 on its ejection side. One outlet of the three-way valve V6 is connected to one end of a flow pipe 37, and the other end of the flow pipe 37 is connected to the tank 31 via a valve V19. The flow pipe 37 is branched at its intermediate portion (between the three-way valve V6 and the valve V19) to be connected to the serial connection of the first filter 32 and the second filter 33. A flow pipe 38 is connected to an outlet of the second filter 33, and a distal end of the flow pipe 38 is connected to an inlet of a solvent heat exchanger 39 provided in the main body 2.

[0042] A bypass pipe 40 is connected to the other outlet of the three-way valve V6 at one end thereof, and the other end of the bypass pipe 40 joins the flow pipe 38 connected to the inlet of the solvent heat exchanger 39.

[0043] Therefore, the solvent is applied to the solvent heat exchanger 39 through the first filter 32 and the second filter 33, or applied to the solvent heat exchanger 39 through the bypass pipe 40 with the filters 32 and 33 bypassed by switching between the outlets of the three-way valve V6.

[0044] A steam pipe 41 and a coolant pipe 42 are provided in the solvent heat exchanger 39. The steam pipe 41 and the coolant pipe 42 are each wound, for example, in a coil shape. Steam passages 43 and 44 are connected to the steam pipe 41. The steam passage 43 connects the steam pipe 41 and the steam passage 24, and a valve V21 is inserted in the steam passage 43. On the other hand, the steam passage 44 is a passage through which the steam supplied from the steam passage 43 to the steam pipe 41 is discharged to the outside. With the valve V21 being opened, the steam flows into the steam pipe 41 through the steam passage 43 to be discharged through the steam passage 44. While the solvent passes through the solvent heat exchanger 39, the steam pipe 41 at a high temperature exchanges heat with the solvent to heat the solvent. On the other hand, coolant passages 45a and 45b are connected to the coolant pipe 42, and a solvent cooler electromagnetic valve 3Y is inserted in the coolant passage 45a. With the solvent cooler electromagnetic valve 3Y being opened, the coolant passes through the coolant pipe 42. While the solvent passes through the solvent heat exchanger 39, the coolant pipe 42 exchanges heat with the solvent to cool the solvent. By controlling the opening and closing of the valve V21 and the opening and closing of the solvent cooler electromagnetic valve 3Y, the solvent heat exchanger 39 is switched to heat or cool the solvent, whereby the temperature of the solvent passing through the solvent heat exchanger 39 is regulated at a desired temperature.

[0045] A flow pipe 46 is connected to an outlet of the solvent heat exchanger 39 at one end thereof. The other end of the flow pipe 46 is connected to an inlet of a three-way valve V9. A liquid temperature thermistor 47 for measuring the temperature of the solvent and a liquid over-temperature preventing thermistor 48 for preventing a liquid temperature from being increased to a predetermined temperature or higher are provided in the flow pipe 46.

[0046] A soap concentration sensor 50 is provided downstream of these two thermistors in the flow pipe 46.

[0047] A liquid supply pipe 51 is connected to one outlet of the three-way valve V9 at one end thereof and to the outer tub 4 at the other end thereof, so that the solvent can be supplied into the drum 5. A feedback pipe 52 is connected to the other outlet of the three-way valve V9 at one end thereof and to the tank 31 at the other end thereof.

[0048] A recovery pipe 62 for recovering the solvent condensed by the drying coolers 11 and 12 in the circulation duct 8 has one end connected to a portion of the circulation duct 8 below the drying coolers 11 and 12. The other end of the recovery pipe 62 is connected to a water separator 63. In the water separator 63, water contained in the recovered solvent is separated, and the separated water is drained through a drain pipe 64. Then, the recovered solvent is returned into the tank 31 through a recovery pipe 65.

[0049] The outer tub 4 has a drain port 55 provided at its lowermost portion, and a liquid surface detection chamber 56 is connected to the drain port 55. The liquid surface detection chamber 56 is provided with two liquid surface switches, i.e., a standard liquid surface switch 57 and a drain liquid surface switch 58. The liquid surface detection chamber 56 also serves as a trap which traps a button or the like dislodged from the laundry and falling through the drain port 55 during the washing process.

[0050] A recovery pipe 59 is connected to a lower end of the liquid surface detection chamber 56 at one end thereof. A valve V4 is inserted in the recovery pipe 59. The other end of the recovery pipe 59 is connected to the junction 35.

[0051] A soap pipe 61 is connected to a soap container 60 at one end thereof and to the junction 35 at the other

end thereof. A valve V17 is inserted in the soap pipe 61.

[0052] Next, the flow of the solvent will be described with reference to the pipeline diagram of Fig. 2.

[0053] In the washing process, the solvent stored in the tank 31 is supplied into the drum 5 (the outer tub 4). At this time, the solvent pump 36 is driven with the valve V1 being opened, with the three-way valve V6 being opened to the flow pipe 37 and with the valve V19 being closed. Thus, the solvent in the tank 31 flows into the flow pipe 38 through the first filter 32 and the second filter 33 and, after the temperature of the solvent is regulated by the solvent heat exchanger 39, the solvent flows to the three-way valve V9 through the flow pipe 46. With the three-way valve V9 being opened to the liquid supply pipe 51, the solvent is supplied into the outer tub 4 through the liquid supply pipe 51. During the supply of the solvent, the valve V4 is closed. The amount of the solvent contained in the outer tub 4 is detected by the standard liquid surface switch 57 and, when a predetermined amount of the solvent (suitable for the washing) is contained in the outer tub 4, the valve V9 is switched so as to close the liquid supply pipe 51 and open the feedback pipe 52.

[0054] A soap is preliminarily mixed with the solvent contained in the tank 31 and, when the solvent passes through the flow pipe 46, the concentration of the soap in the solvent is measured by the soap concentration sensor 50. If the soap concentration is lower, the soap is pumped up from the soap container 60 through the soap pipe 61 with the valve V17 being opened, and mixed with the supplied solvent.

[0055] During the supply of the solvent to the outer tub 4, the three-way valve V6 may be switched, as required, to cause the solvent to bypass the filters 32, 33, so that the solvent is applied to the solvent heat exchanger 39 through the bypass pipe 40 and then supplied to the outer tub 4.

[0056] In a solvent draining and removing process, the solvent pump 36 is driven with the valve V4 being opened and with the valve V1 being closed. The solvent is returned into the tank 31 with the three-way valve V6 being opened to the flow pipe 37 and with the valve V19 being opened.

[0057] Alternatively, the solvent flowing through the flow pipe 37 may be caused to flow through the filters 32 and 33, the flow pipe 38, the solvent heat exchanger 39 and the flow pipe 46 with the valve V19 being closed, and then flow through the three-way valve V9 and the feedback pipe 52 back into the tank 31. Thus, the solvent drained from the outer tub 4 after the washing process and the solvent removed from the laundry by the centrifugal force are passed through the filters 32 and 33 for decontamination, and then returned into the tank 31.

Steam Supply to Drying Heater

[0058] Fig. 3 is a block diagram showing an arrangement for a control operation for the supply of the steam to the drying heater 13 in the dry cleaner 1.

[0059] The supply of the steam to the drying heater 13 will hereinafter be described in detail.

[0060] As shown in Fig. 3, the dry cleaner 1 includes a control section 81 (controller) including, for example, a microcomputer and the like. The control section 81 includes a hardware-based or software-based timer 82.

[0061] The drum outlet temperature detected by the drum outlet temperature thermistor 16 is provided to the control section 81. The control section 81 opens and closes the inlet valve V20, the first valve V27 and the second valve V28 individually or simultaneously based on the provided drum outlet temperature. Here, the drum outlet temperature is the temperature of the air heat-exchanged with the laundry in the drum 5, and is detected as an actual laundry drying temperature, whereby a laundry drying state is accurately detected. When power supply to the dry cleaner 1 is on, the control section 81 constantly opens the inlet valve V20. When an abnormal condition such as malfunction of the steam source occurs, the control section 81 immediately closes the inlet valve V20.

[0062] Fig. 4 is a flow chart for explaining the control operation for the steam supply to the drying heater 13 in the drying process.

[0063] When the drying process is started, the control section 81 causes the timer 82 to start time measurement (Step S1). Then, the control section 81 references time measurement data of the timer 82, i.e., an elapsed time T1 from the start of the drying process (Step S2). If the elapsed time T1 exceeds a predetermined period (a driving period predetermined for the drying process) (Yes in Step S2), the control section 81 ends the drying process. On the other hand, if the elapsed time T1 is within the predetermined period (No in Step S2), the control section 81 opens the second valve V28 to supply the steam from the second steam supply passage 24b to the drying heater 13 (Step S3). After a lapse of, for example, two seconds from the opening of the second valve V28 (Yes in Step S4), the control section 81 opens the first valve V27 (Step S5). Thus, the steam is supplied to the drying heater 13 from the first steam supply passage 24a as well as the second steam supply passage 24b. If two seconds have not elapsed from the opening of the second valve V28 (No in Step S4), the control section 81 maintains only the second valve V28 in the opened state. Thus, the second valve V28 is first opened and then the first valve V27 is opened when the heating of the air is started in the drying process. Therefore, a relatively small amount of steam is first supplied to the drying heater 13, and then a relatively great amount of steam is supplied to the drying heater 13. Thus, a steam pressure in the drying heater 13 is increased stepwise. If the opening of the first valve V27 preceded the opening of the second valve V28, the steam pressure in the drying heater 13 would be steeply increased, and an impact of the steep increase in steam pressure would damage the drying heater 13, for example, would make a hole in the drying heater 13. In the dry cleaner 1, however, the steam pressure in the drying heater 13 is increased stepwise, so that the impact ex-

erted on the drying heater 13 by the steam pressure is alleviated. This extends the service life of the drying heater 13.

[0064] If the drum outlet temperature (measured temperature) detected by the drum outlet temperature thermistor 16 exceeds a target temperature (Yes in Step S6) with the first valve V27 and the second valve V28 being opened (Step S5), the control section 81 references the elapsed time T1 again (Step S7). Here, the target temperature is a target level of the laundry drying temperature, for example, 70°C. If the drum outlet temperature (measured temperature) does not exceed the target temperature (No in Step S6), the control section 81 returns to Step S2 to reference the elapsed time T1. If the elapsed time T1 is within the predetermined period (No in Step S2), a control sequence from Step S3 to Step S6 is performed. If the elapsed time T1 exceeds the predetermined period (Yes in Step S2), the control section 81 ends the drying process.

[0065] If the elapsed time T1 is within the predetermined period in Step S7 (No in Step S7), the control section 81 closes the first valve V27 (Step S8). Then, the control section 81 judges whether the measured temperature exceeds an upper limit temperature which is higher by e.g. 2°C than the target temperature (Step S9). If the measured temperature exceeds the upper limit temperature (Yes in Step S9), the control section 81 closes the second valve V28 (Step S10). Thus, both the first valve V27 and the second valve V28 are closed, so that the supply of the steam to the drying heater 13 is stopped. If the measured temperature is thereafter reduced to a lower limit temperature which is lower by e.g. 2°C than the target temperature (Yes in Step S11), the control section 81 opens the second valve V28 again (Step S13), and returns to Step S7. On the other hand, if the measured temperature is not reduced to the lower limit temperature after the second valve V28 is closed in Step S10 (No in Step S11) and the elapsed time T1 is within the predetermined period (No in Step S12), the control section 81 maintains the first valve V27 and the second valve V28 in the closed state. On the other hand, if the elapsed time T1 exceeds the predetermined period (Yes in Step S12), the control section 81 ends the drying process.

[0066] If the elapsed time T1 exceeds the predetermined period in Step S7 (Yes in Step S7), the control section 81 ends the drying process.

[0067] If the measured temperature does not exceed the upper limit temperature in Step S9 (No in Step S9), the control section 81 judges whether the measured temperature is below the lower limit temperature (Step S14). If the measured temperature is below the lower limit temperature (Yes in Step S14), the control section 81 opens the first valve V27 again (Step S15). Such a control operation is performed, for example, on the condition that it is supposedly impossible to increase the measured temperature by opening the second valve V28 alone because of an extremely low ambient temperature around the dry cleaner 1. Therefore, the control section 81 opens the first valve V27, so that both the first valve V27 and the second valve 28 are in the opened state. Thereafter, the control section 81 judges whether the measured temperature exceeds the upper limit temperature (Step S16). If the measured temperature exceeds the upper limit temperature (Yes in Step S16), the control section 81 returns to Step S7 to perform a control sequence from Step S7. On the other hand, if the measured temperature does not exceed the upper limit temperature (No in Step S16) and the elapsed time T1 is within the predetermined period (No in Step S17), the control section 81 maintains the first valve V27 and the second valve V28 in the opened state. If the elapsed time T1 exceeds the predetermined period (Yes in Step S17), the control section 81 ends the drying process.

[0068] If the measured temperature is not below the lower limit temperature in Step S14 (No in Step S14), the control section 81 returns to Step S7, and performs the control sequence from Step S7.

[0069] When the measured temperature exceeds the target temperature in Step S6 (Yes in Step S6), the control section 81 closes the first valve V27. When the measured temperature is further increased to the upper limit temperature which is higher by the predetermined degree than the target temperature in Step S9 and the subsequent steps (Yes in Step S9), the control section 81 closes the second valve V28. When the measured temperature is reduced to the lower limit temperature which is lower by the predetermined degree than the target temperature (Yes in Step S11), the control section 81 opens only the second valve V28. That is, where the measured temperature is changed from the target temperature, the drum outlet temperature is controlled by opening and closing the second valve V28 not immediately but after a lapse of a predetermined period. This prevents the second valve V28 from chattering. The control of the drum outlet temperature is achieved by opening and closing only the second valve V28 which has a relatively low steam supply capacity. Therefore, a sudden change in drum outlet temperature is suppressed as compared with the case in which the control of the drum outlet temperature is achieved by opening and closing the first valve V27 having a relatively high steam supply capacity, so that the drum outlet temperature can be stably controlled.

[0070] Fig. 5 is a diagram illustrating changes in drum outlet temperature observed with time in the drying process with and without the inventive arrangement.

[0071] In the dry cleaner 1, as described above, the first steam supply passage 24a having a relatively great passage diameter and the second steam supply passage 24b having a relatively small passage diameter are independently provided for supplying the steam to the drying heater 13 (see Fig. 2). A relatively great amount of steam is supplied from the first steam supply passage 24a to the drying heater 13 by opening the first valve V27 provided in the first steam supply passage 24a. On the other hand, a relatively small amount of steam is supplied to the drying heater 13 by opening the second valve V27

provided in the second steam supply passage 24b.

[0072] Therefore, the drum outlet temperature (the laundry drying temperature or the measured temperature) can be increased to the target temperature in a relatively short time, as indicated by a solid line in Fig. 5, by mainly opening the first valve V27. After the laundry drying temperature reaches the target temperature, a drastic fluctuation in laundry drying temperature can be suppressed by mainly opening and closing the second valve V28. That is, the first valve V27 and the second valve V28 are selectively used for regulating the laundry drying temperature. Therefore, the opening/closing frequencies of the first valve V27 and the second valve V28 are reduced as compared with a case in which a single supply valve is used for regulating the laundry drying temperature (see a broken line in Fig. 5).

[0073] Where the single supply valve (hereinafter referred to as "comparative valve") is used for regulating the laundry drying temperature, the amount of the steam to be supplied is typically set at a value between the amount of steam to be supplied with the first valve V27 being opened and the amount of steam to be supplied with the second valve V28 being opened. In this case, greater time is required for increasing the laundry drying temperature to the target temperature as compared with the case in which the first valve V27 is used. If the comparative valve is opened for regulating the laundry drying temperature at around the target temperature, the laundry drying temperature is quickly increased to the upper limit temperature as indicated by a broken line in an enlarged view in Fig. 5. Therefore, the comparative valve should be closed immediately after having been opened. This increases the opening/closing frequency of the comparative valve, thereby reducing the service life of the comparative valve. Where the second valve V28 is mainly used for regulating the laundry drying temperature at around the target temperature, however, greater time is required for increasing the laundry drying temperature to the upper limit temperature because of a lower steam supply capacity of the second valve V28 as compared with the case in which the comparative valve is used. Therefore, the opening/closing frequency of the second valve V28 is correspondingly reduced. Since the second valve V28 is mainly used for regulating the laundry drying temperature at around the target temperature, the opening/closing frequency of the first valve V27 is also reduced. In the dry cleaner 1, the opening/closing frequencies of the first valve V27 and the second valve V28 are thus reduced, making it possible to stably regulate the laundry drying temperature while preventing the reduction in the service lives of these valves.

[0074] It should be understood that the present invention be not limited to the embodiment described above, but various modifications may be made within the purview of the appended claims.

[0075] In the embodiment described above, the laundry drying temperature is increased to the target temperature at the highest rate when the first valve V27 and the second valve V28 are opened, and the laundry drying temperature increasing rate is reduced when the first valve V27 is opened and the second valve V28 is closed. When the first valve V27 is closed and the second valve V28 is opened, the laundry drying temperature increasing rate is the lowest. Therefore, the first valve V27 and the second valve V28 may be selectively opened and closed in different combinations. In this case, the laundry drying temperature can be further optimally controlled without the use of a complicated and expensive supply valve which is capable of controlling the opening degree of the valve.

[0076] The rotation shaft of the drum 5 is not necessarily required to extend horizontally, but may be inclined at a predetermined angle (e.g., not greater than 30 degrees) with respect to a horizontal plane.

[0077] This application corresponds to Japanese Patent Application No. 2006-314580 filed in the Japanese Patent Office on November 21, 2006, the disclosure of which is incorporated herein by reference.

Claims

1. A laundry apparatus comprising:

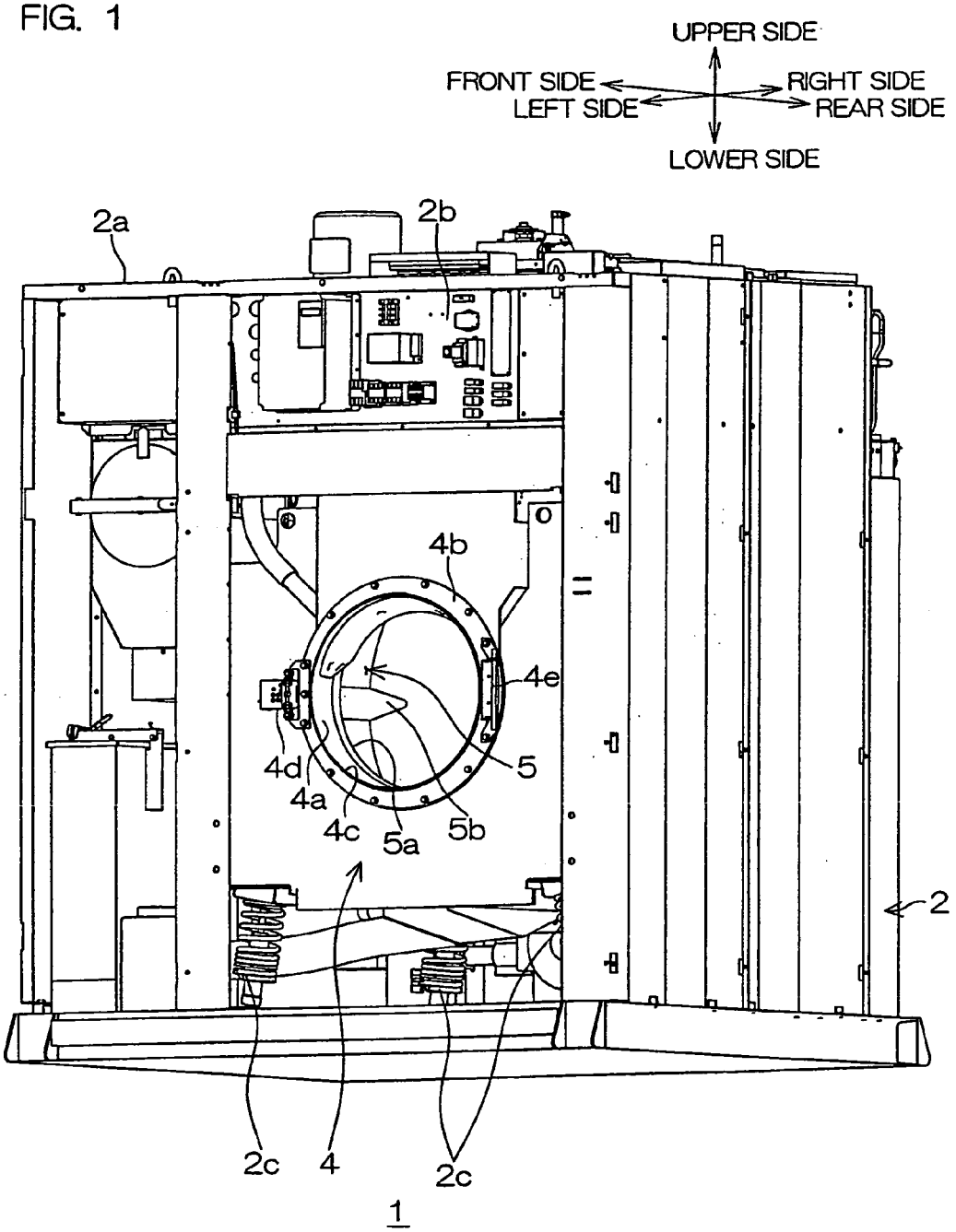
a laundry containing tub (4, 5) having an inlet (6) and configured to contain laundry;
an air flow passage (8) connected to the inlet of the laundry containing tub to allow air to flow into the laundry containing tub from the inlet;
heating unit (13) which heats the air in the air flow passage by steam;
a first steam supply passage (24a) having a greater passage diameter for supplying the steam to the heating unit;
a second steam supply passage (24b) provided separately from the first steam supply passage and having a smaller passage diameter for supplying the steam to the heating unit;
a first supply valve (V27) provided in the first steam supply passage to be opened and closed for permitting and preventing the supply of the steam to the heating unit; and
a second supply valve (V28) provided in the second steam supply passage to be opened and closed for permitting and preventing the supply of the steam to the heating unit.

2. The laundry apparatus according to claim 1, wherein the laundry containing tub has an outlet (7), wherein the air flow passage includes a circulation duct connected to the outlet of the laundry containing tub and configured to allow the air flowing into the laundry containing tub through the inlet to flow out through the outlet to circulate the air in the laundry containing tub.

3. The laundry apparatus according to claim 2, further comprising controller (81) which opens and closes the first supply valve (V27) and the second supply valve (V28) individually or simultaneously,
wherein the controller is configured to first open the second supply valve (V28) and then the first supply valve (V27) when the heating of the air is started.

4. The laundry apparatus according to claim 3, further comprising a temperature sensor (16) for detecting an air temperature at the outlet,
wherein the controller is configured to close the first supply valve (V27) when the temperature detected by the temperature sensor exceeds a target temperature, close the second supply valve (V28) when the temperature detected by the temperature sensor is further increased to an upper limit temperature which is higher by a predetermined degree than the target temperature, and open only the second supply valve (V28) when the temperature detected by the temperature sensor is reduced to a lower limit temperature which is lower by a predetermined degree than the target temperature.

FIG. 1


UPPER SIDE
FRONT SIDE
RIGHT SIDE
LEFT SIDE
REAR SIDE
LOWER SIDE
2a
2b
4b
4e
4d
4a
4c
5a
5b
5
2
2c
4
2c
1

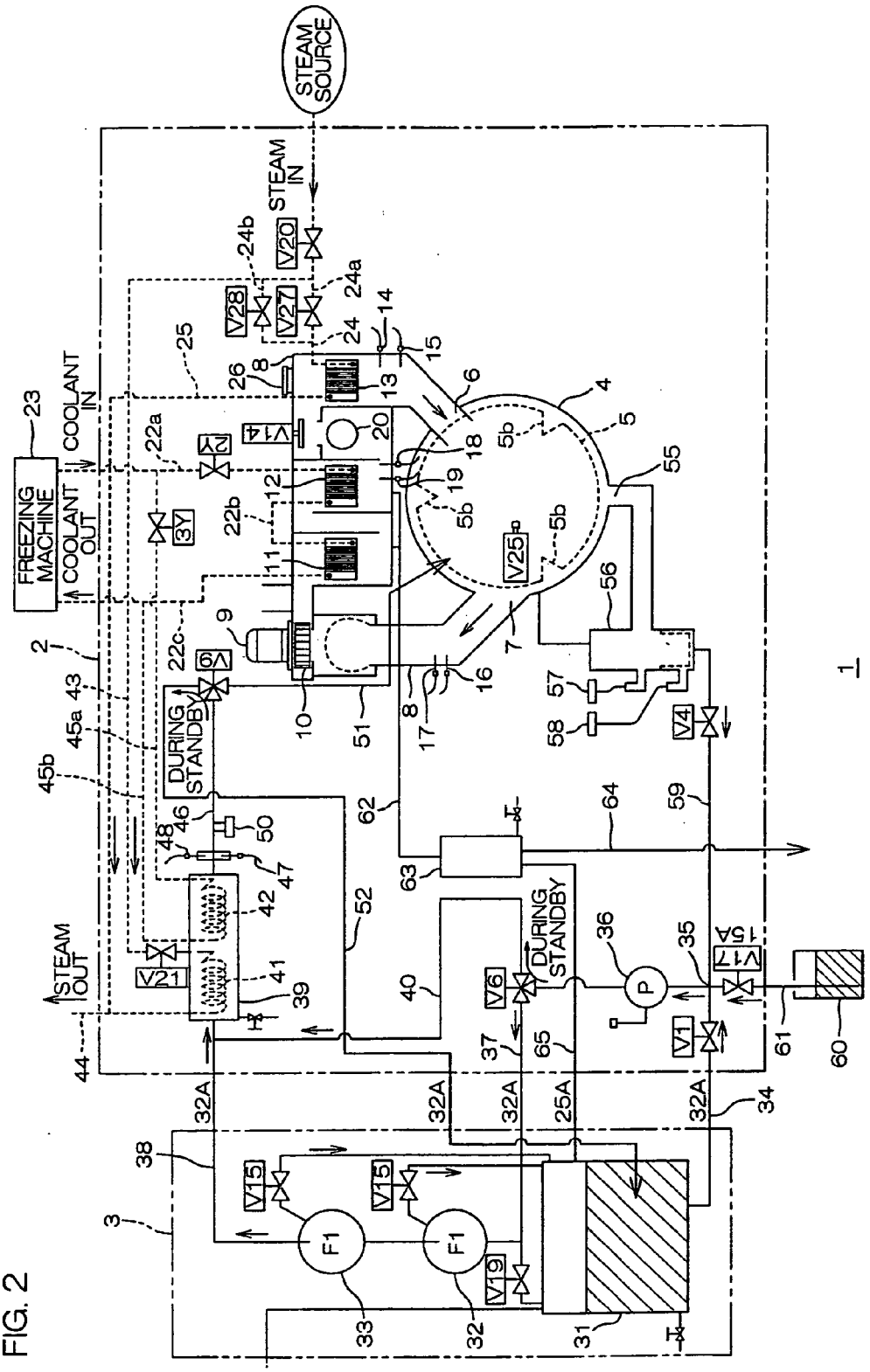

STEAM SOURCE
STEAM IN
V20
24b
24a
V28
V27
24
14
15
25
26
8
13
6
4
5
FREEZING MACHINE
COOLANT IN
COOLANT OUT
23
22a
V14
20
18
5b
55
12
19
22b
3Y
11
V25b
56
9
7
2
22c
6
16
43
10
51
8
17
57
58
V4
45a
45b
DURING STANDBY
62
64
59
46
48
50
47
63
42
52
STEAM OUT
V21
41
39
40
V6
DURING STANDBY
36
35
15A
V1
61
60
44
37
65
32A
25A
34
38
V15
V15
3
F1
F1
V19
33
32
31
1

FIG. 2

FIG. 3

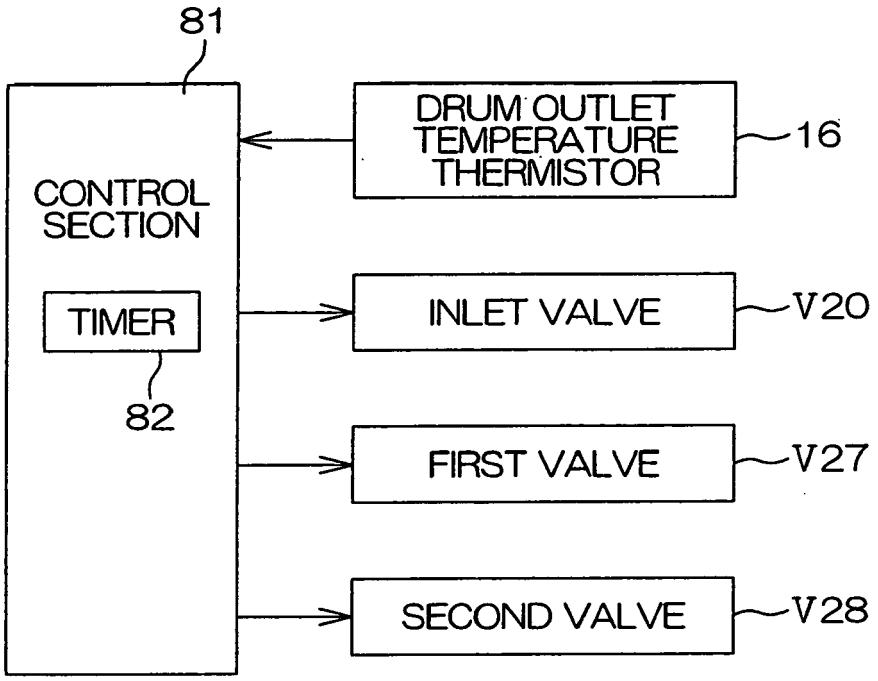

81
CONTROL SECTION
TIMER
82
DRUM OUTLET TEMPERATURE THERMISTOR
16
INLET VALVE
V20
FIRST VALVE
V27
SECOND VALVE
V28

FIG. 4

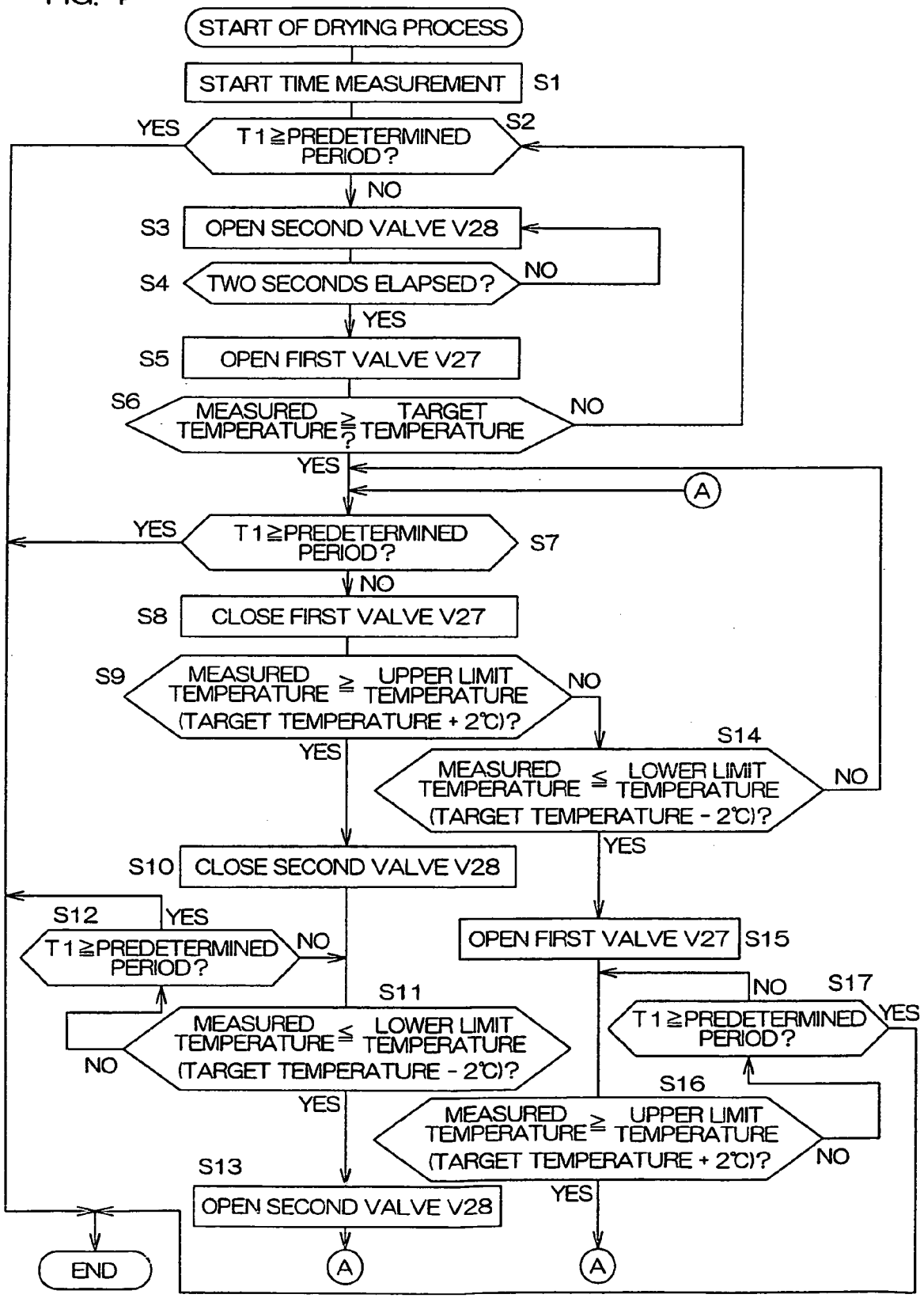
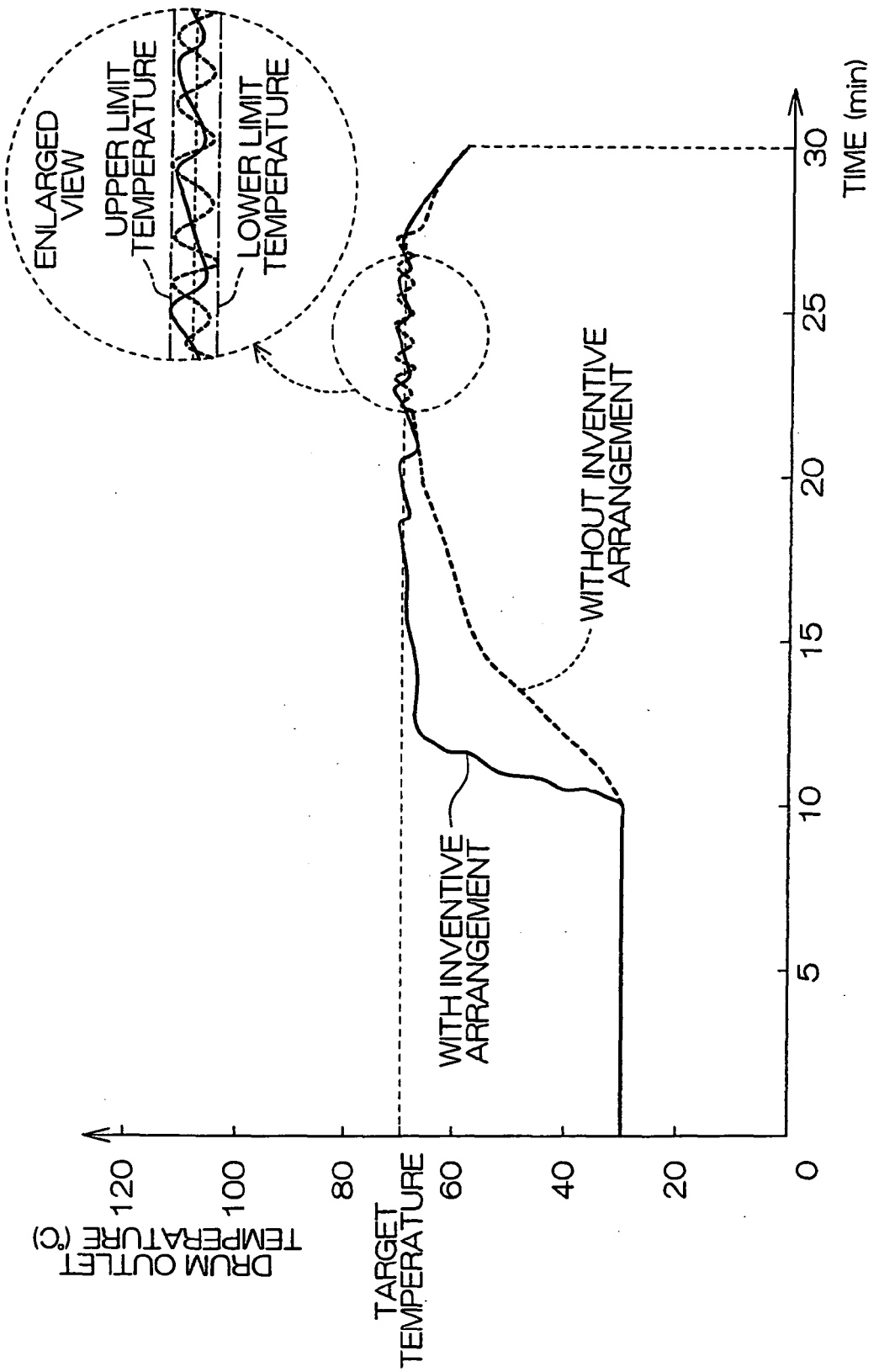

START OF DRYING PROCESS
START TIME MEASUREMENT
S1
T1≧PREDETERMINED PERIOD?
S2
YES
NO
S3
OPEN SECOND VALVE V28
S4
TWO SECONDS ELAPSED?
NO
YES
S5
OPEN FIRST VALVE V27
S6
MEASURED TEMPERATURE ≧ TARGET TEMPERATURE?
NO
YES
A
T1≧PREDETERMINED PERIOD?
S7
YES
NO
S8
CLOSE FIRST VALVE V27
S9
MEASURED TEMPERATURE ≧ UPPER LIMIT TEMPERATURE (TARGET TEMPERATURE + 2℃)?
NO
YES
S14
MEASURED TEMPERATURE ≦ LOWER LIMIT TEMPERATURE (TARGET TEMPERATURE - 2℃)?
NO
YES
S10
CLOSE SECOND VALVE V28
S12
YES
T1≧PREDETERMINED PERIOD?
NO
OPEN FIRST VALVE V27
S15
NO
S17
T1≧PREDETERMINED PERIOD?
YES
S11
MEASURED TEMPERATURE ≦ LOWER LIMIT TEMPERATURE (TARGET TEMPERATURE - 2℃)?
NO
YES
S16
MEASURED TEMPERATURE ≧ UPPER LIMIT TEMPERATURE (TARGET TEMPERATURE + 2℃)?
NO
YES
S13
OPEN SECOND VALVE V28
END
A
A

FIG. 5


DRUM OUTLET TEMPERATURE (°C)
120
100
80
60
40
20
0
TARGET TEMPERATURE
WITH INVENTIVE ARRANGEMENT
WITHOUT INVENTIVE ARRANGEMENT
5
10
15
20
25
30
TIME (min)
ENLARGED VIEW
UPPER LIMIT TEMPERATURE
LOWER LIMIT TEMPERATURE

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEI81996168595 A **[0002]**
- JP 2006314580 A **[0077]**