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(54) Process and machine for washing fabric in roped form

(57) The process comprises the following stages: making the rope of fabric pass through a nozzle (9) located within a hermetically sealable washing vessel (1), and then joining the start and the end of the fabric to form it into a closed loop; supplying to the nozzle (9) for a predetermined period a flow of a fluid capable of causing the loop of fabric to rotate and a flow of a liquid solvent capable of wetting the fabric and of dissolving the dirt thereon; at the end of the washing period, interrupting the flow of solvent, extracting from the vessel (1) the liquid solvent contained in it and the solvent vapours from the circulating air; and then interrupting the supply of the said driving fluid to the nozzle (9) and extracting the washed fabric from the vessel.

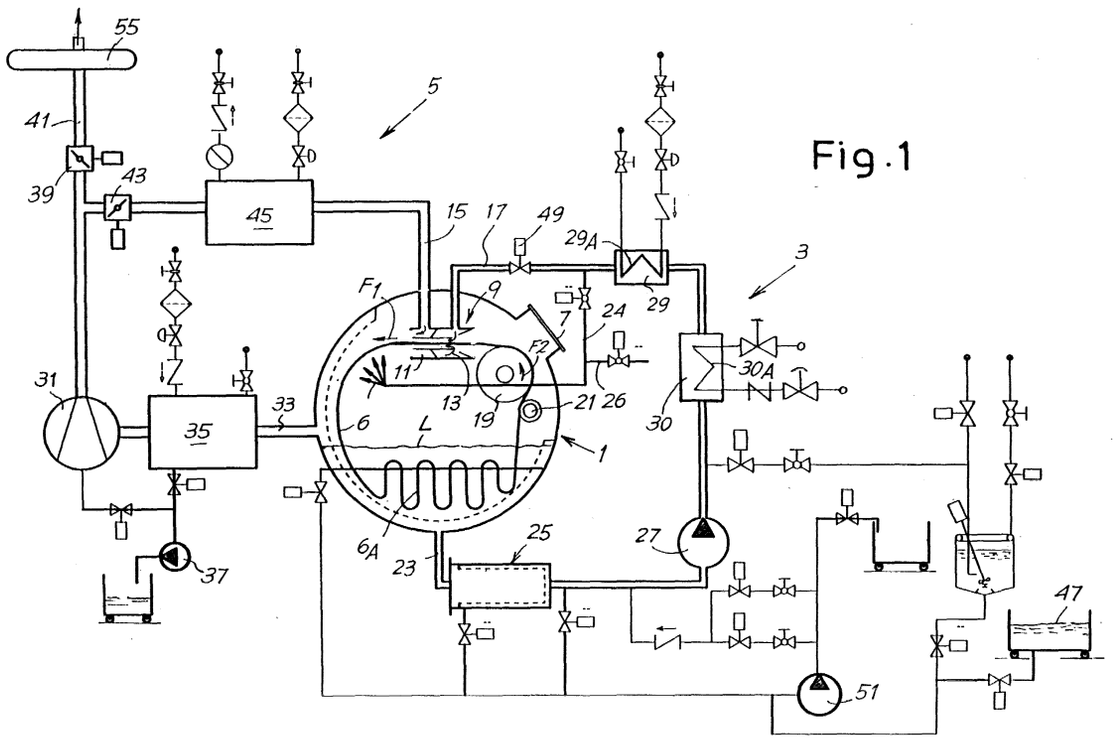

Fig.1

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Description

[0001] The present invention relates to a discontinuous process for washing pieces of fabric joined in a rope - and possibly folded and sewn longitudinally into a "bag" - to form a continuous loop. In the known processes for washing a rope of fabrics, washing is carried out in water with detergents, by means of washing machines of the rotary drum type. However, these machines generally have a limited capacity, and therefore only one piece can be washed at a time. Moreover, these machines have relatively long washing times, since the movement of the piece in the water is dependent on gravity and therefore the rotation speed of the drum is limited. Furthermore, the pieces tend to become entangled, making the unloading of the machine time-consuming and difficult, and there is a considerable volume of liquid effluent which has to be purified and disposed of according to regulations.

[0002] There are also known washing systems which use solvents, such as perchloroethylene, in rotary drum machines. For the most part, these systems have the same disadvantages as those cited above. There are also washing systems which use solvents on fabrics stretched widthways; however, these systems require very costly and bulky machinery.

[0003] The process for washing a rope of fabrics according to the invention, which is intended to essentially overcome the disadvantages of the known processes, comprises the following stages:

- before the loop of fabric is closed, the fabric is inserted into a drive nozzle located inside a washing vessel which is sealed from the external environment and is provided with an access hatch. Upstream from the said nozzle - in the direction of advance of the fabric - there is a return wheel which can receive the fabric from below and guide it towards the nozzle. When the fabric loop is closed, the hatch of the vessel is closed, and a flow of air and/or a flow of a liquid solvent, sufficient to cause the rotation of the fabric loop, is supplied to the drive nozzle, and in all cases a solvent heated or cooled to a predetermined temperature, capable of wetting the fabric and dissolving the dirt on it, is supplied to the fabric;
- these washing conditions are maintained for a predetermined period, the liquid solvent being extracted from the lower part of the vessel, by means of a circulating pump, and then returned to the nozzle after filtering and heating or cooling to the desired washing temperature, and the gas contained in the vessel above the liquid level being recycled by separating from it, by condensation, the solvent and water vapours extracted from the fabric;
- at the end of the washing period, the solvent is extracted from the vessel and its supply to the nozzle is shut off, while the movement of the fabric is continued until it is completely dry and the separation by condensation of the solvent vapours from the circulating air is continued until their presence is considerably reduced within the vessel;
- the supply to the nozzle is interrupted and a negative pressure is created in the interior of the vessel; the access hatch is then opened and the washed fabric is extracted, thus preventing the outflow of any residual vapours to the environment where the operator is located.

[0004] Washing is generally carried out with the solvent heated to a temperature of more than 100°C. However, if a particular feel of the fabric is required, it is possible to supply the washing vessel with solvent cooled to a lower temperature, which may be below 0°C, for example -15°C, to carry out the treatment at this temperature. For this purpose, the solvent circulation path includes a heat exchanger with a coil in which a coolant fluid obtained from a refrigeration system circulates.

[0005] Preferably, the solvent used is perchloroethylene, and jets for spraying solvent and/or other washing substances, such as surfactants or the like, or dyes, for special kinds of washing, can be provided within the washing vessel.

[0006] The process according to the invention permits the use of high-capacity vessels in which several pieces sewn together in a loop can be washed simultaneously, with a relatively low volume of solvent. Since practically the whole of the solvent is recovered, the refluxes to be disposed of are reduced to the quantity of water extracted from the fabric during the wash, this quantity being relatively small since it corresponds to that present in the pieces at the time of their introduction into the vessel. The energy requirement for each piece is also drastically reduced, since the low vaporization heat of perchloroethylene and the rapid movement of the fabrics allow shorter drying times.

[0007] The invention also relates to a machine for washing ropes of fabric by the described procedure according to the invention. This machine comprises:

- a vessel sealed from the external environment, provided with an access hatch;
- inside the vessel: a nozzle through which the rope of fabric can run to permit the supply - tangentially and to the surface of the rope of fabric - of a flow of liquid solvent and/or a flow of forced air to drive the fabric; and a return wheel for the fabric arriving from below, to guide the fabric towards the nozzle;
- means of circulating the liquid solvent, the solvent being filtered and heated or cooled to the desired temperature;
- means of circulating the fabric drive air, with the separation of the solvent and water vapours extracted from the fabric and with the heating of the air to the washing temperature.

[0008] In a preferred embodiment of the invention, the said nozzle has an axial passage for the fabric around which is developed a chamber having an outlet mouth surrounding the said axial passage. A flow of a fluid for driving the fabric is supplied to the said chamber by means of a suitable pipe. The said driving fluid supplied to the chamber of the nozzle can be forced air, a liquid solvent, or a mixture of forced air and a liquid solvent.

[0009] If the nozzle of the vessel is supplied with separate flows of air and solvent, it has, in addition to the said first chamber, a second chamber developed around the said axial passage and communicating with this passage by means of apertures. Thus the said chambers can be used to supply different driving fluids such as air and liquid solvent to the nozzle. In a preferred embodiment, the flow of forced air is supplied to the said first chamber of the nozzle and the flow of liquid solvent is supplied to the said second chamber of the nozzle, and the said first chamber is located downstream from the said second chamber according to the direction of advance of the fabric.

[0010] The vessel is preferably of cylindrical shape with a horizontal axis, with the access hatch located in the upper part in the proximity of the driving nozzle and the return wheel.

[0011] A pipe can be branched from the pipe which supplies the solvent to the nozzle, in order to supply supplementary spray jets, located inside the vessel and capable of wetting the fabric emerging from the nozzle. Another pipe, for injecting other washing or dyeing substances, can also flow into the said supplementary jet supply pipe. Thus the machine has a high flexibility of treatment, enabling the washes to be customized according to the type of fabric to be treated.

[0012] The said solvent circulation means can comprise a pipe for extraction from the lowest point of the vessel, a waste separation filter, a supply pump and at least one heat exchanger capable of heating or cooling the recirculated solvent to the desired temperature before it is sent to the fabric drive nozzle. For example, if the solvent is to be heated it can be made to circulate in a first heat exchanger having a coil in which water vapour at 100°C or above circulates, and if the solvent is to be cooled it can be made to circulate in a second heat exchanger having a coil in which there circulates a coolant liquid, for example at -15°C or at an even lower temperature, obtained from a refrigeration system.

[0013] The said means of circulating the fabric drive air can comprise a pipe for collecting the air from the interior of the vessel above the surface of the solvent contained therein, a cooling unit for condensing the solvent and water vapours and separating them from the air, a fan capable of generating a sufficient pressure and flow of air to drive the fabric, a heat exchanger for heating the air before it is returned to the fabric drive nozzle, and branching valves for interrupting the inflow of air to the nozzle and discharging it to the atmosphere through active carbon filters, or vice versa.

[0014] The invention will be more clearly understood from the description and the attached drawing, which shows a non-restrictive example of the invention. In the drawing,

Fig. 1 shows a diagram of a washing installation in which the process according to the invention can be used;
Fig. 2 shows a side view of this installation; and
Fig. 3 shows the enlarged central area of Fig. 1.

[0015] The installation comprises a washing vessel 1 (Fig. 1), a solvent circulation and filtration system 3 and a forced-air system 5 for moving the fabric 6 during washing. In Fig. 1, the fabric 6 is shown schematically as a solid line.

[0016] The vessel 1 (see also Fig. 3) is a cylindrical container with a horizontal axis X-X, sealed from the external environment and provided with an access hatch 7. Inside the vessel 1 there is a nozzle 9 which has an inner axial cylindrical duct 9A (see also Fig. 3) with a truncated conical inlet portion 9B. The duct 9A is of sufficient diameter to permit the free passage of the rope of fabric, as described more fully below. the nozzle 9 has, externally and coaxially with respect to the duct 9A, a second cylindrical duct 9C which is connected to the duct 9A by means of a diaphragm 9D and the said truncated conical portion 9B, thus forming a front annular chamber 11 and a rear annular chamber 13. The front chamber 11 has, on the left-hand side as shown in Fig. 1, an aperture 11A in the form of a circular ring surrounding the outlet mouth of the duct 9A. A pipe 15 supplies a flow of air to the chamber 11, the flow departing from the said circular ring aperture 11A while passing over the periphery of the fabric 6 and driving it in the direction of the arrow F1. The rear chamber 13 has, within the duct 9A, a mainly annular aperture 13A through which solvent is fed, this solvent being supplied to the chamber 13 by means of a pipe 17. The vessel 1 also contains a return wheel 19 and roller 21 between which the rope of fabric arriving from the bottom of the vessel 1 is made to pass. The vessel also contains a number of jets 22 supplied by pipes 24 and/or 26, the said jets being capable of spraying liquid solutions of substances promoting washing, such as surfactants or the like, and if necessary dyes, on to the rope of fabric leaving the nozzle 9.

[0017] The solvent circulation and filtration system 3 comprises a circulating pump 27 which, by means of a pipe 23, collects the liquid solvent from the lower part of the vessel 1 and sends it, firstly, to a filter 25 capable of retaining the waste products of the wash, and then, in succession, to two heat exchangers 29, 30, in which the solvent, by means of coils 29A, 30A through which a heating fluid and a coolant fluid pass respectively, can be heated or cooled to the desired temperature for the treatment.

[0018] The forced-air system 5 for moving the fabric during washing comprises a fan 31 - generally of the

centrifugal type - which, by means of an intake pipe 33, collects from the interior of the vessel 1 the air carrying vapours of solvent and water extracted from the fabric being washed, and returns it to the nozzle 9 by means of the delivery pipe 15. A condensation unit 35, containing a coil in which circulates a coolant fluid, for example water at low temperature, is connected in the pipe 33 to separate the said solvent and water vapours from the air by condensing them and discharging them periodically by means of an extraction pump 37. In the pipe 15 there are a branch valve 39 leading to a discharge pipe 41, a shut-off valve 43 and a heat exchanger 45 capable of heating the air forced by the fan 31, by means of a coil in which steam circulates, before it reaches the nozzle 9.

[0019] With this arrangement, the fabric 6 to be washed is inserted through the hatch 7 into the chamber 1 and is made to pass in the form of a rope through the nozzle 9, and is then made to pass between the return roller 21 and wheel 19. The fabric 6 is then closed to form a ring by joining the leading and trailing flaps by temporary stitching. When the hatch 7 has been closed and sealed, the fan 31 and the motor of the wheel 19 are then started so that the rope of fabric circulates within the vessel in the direction of the arrow F1. The fabric forms a series of loops 6A on the bottom of the vessel. At the same time, the circulating pump 27 is started, to collect the solvent from a reservoir 47 by means of suitable pipes provided with shut-off valves and to send it - through the pipe 17 and the nozzle 9, and through the pipe 24 and the sprayers 22 - to wet the fabric 6. Consequently, a level L of liquid solvent, in which the said loops 6A of fabric are partially immersed, is established in the vessel 1. Efficient washing is therefore achieved with short treatment times and a minimum of waste to be disposed of.

[0020] On completion of the wash, the supply of solvent to the chamber 1 is interrupted by closing a shut-off valve 49 in the pipe 17. An extraction pump 51 extracts all of the liquid solvent from the bottom of the vessel 1 through the filter 25, sending it to a decantation reservoir 53 from which it is recovered and recycled. The movement of the rope of fabric 6 is maintained until the fabric is completely dry and the solvent and water vapours are virtually completely eliminated by being condensed in the unit 35, and the liquid thus collected is discharged. The outflow of the fan is then switched from the nozzle 9, by suitable operation of the valves 39 and 43, to the discharge pipe 41 which sends it to the atmosphere after it has passed through active carbon filters 55 for the separation of any residues of solvent. At this point, the hatch 7 can be opened and the washed fabric 6 can be extracted, sufficient negative pressure being maintained in the vessel 1 by the fan 31 to prevent the outflow of residual solvent vapours towards the personnel engaged in the unloading of the fabric.

[0021] It is to be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, and that this invention can be varied in its forms and arrangements without departure from the scope of the guiding principle of the invention. The presence of any reference numbers in the attached claims has the purpose of facilitating the reading of the claims with reference to the description, and does not limit the scope of the protection represented by the claims.

Claims

1. Discontinuous process for washing fabrics in a rope formed from one or more pieces - if necessary folded and sewn longitudinally to form a "bag" - sewn together to form a continuous loop, **characterized in that** it comprises the following stages:

   - before the loop of fabric (6) is closed, the fabric is inserted into a drive nozzle (9) located inside a washing vessel (1) which is sealed from the external environment and is provided with an access hatch (7), a return wheel (19) which can receive the fabric (6) from below and guide it towards the nozzle (9) being located upstream from the said nozzle (9);
   - when the fabric loop (6) is closed, the hatch (7) of the vessel is closed, and a flow of air and/or a flow of a liquid solvent, sufficient to cause the rotation of the fabric loop, is supplied to the drive nozzle (9), and in all cases a solvent heated or cooled to a predetermined temperature, capable of wetting the fabric and dissolving the dirt on it, is supplied to the fabric;
   - these washing conditions are maintained for a predetermined period, the liquid solvent being extracted from the lower part of the vessel (1), by means of a circulating pump (27), and then returned to the nozzle (9) after filtering and heating or cooling to the desired washing temperature, and the gas contained in the vessel above the liquid level (L) being recycled by separating from it, by condensation, the solvent and water vapours extracted from the fabric;
   - at the end of the washing period, the solvent is extracted from the vessel (1) and its supply to the nozzle (9) is shut off, while the movement of the fabric is continued until it is completely dry and the separation by condensation of the solvent vapours from the circulating air is continued until their presence is considerably reduced within the vessel;
   - the supply to the nozzle (9) is interrupted and a negative pressure is created within the vessel (1); the access hatch (7) is then opened and the washed fabric is extracted, thus preventing the outflow of any residual vapours to the environment where the operator is located.

2. Washing process according to Claim 1, **characterized in that** the solvent used is perchloroethylene.

3. Process according to Claim 1 or 2, **characterized in that** jets (22) for spraying solvent and/or other washing substances, such as surfactants or the like, or dyes, are located within the washing vessel (1).

4. Machine for washing ropes of fabric according to a process as described in any one of Claims 1 to 3, **characterized in that** it comprises:

- a vessel (1) sealed from the external environment, provided with an access hatch (7);
- inside the vessel (1), a nozzle (9) through which the rope of fabric (6) can run to permit the supply - tangentially and to the surface of the rope of fabric - of a flow of liquid solvent and/or a flow of forced air to drive the fabric; a return wheel (19) for the fabric arriving from below, to guide the fabric towards the nozzle (9); and a means (17, 13) of supplying a solvent for washing the fabric;
- means (25, 27, 29, 30) of circulating the liquid solvent, with filtration and provision for heating or cooling the liquid solvent to a desired temperature;
- means (35, 31, 45) of circulating the fabric drive air, with the separation of the solvent and water vapours extracted from the fabric and with the heating of the air to the washing temperature.

5. Machine according to Claim 4, **characterized in that** the said nozzle (9) has an axial passage (9A) for the fabric, around which is developed a chamber having an outlet mouth (11A) surrounding the said axial passage (9A), a flow of a fluid for driving the fabric being supplied to the said chamber by means of a pipe (15).

6. Machine according to Claim 5, **characterized in that** the said fluid supplied to the said chamber (11) consists of forced air.

7. Machine according to Claim 5, **characterized in that** the said fluid supplied to the said chamber (11) consists of a liquid solvent.

8. Machine according to Claim 5, **characterized in that** the said fluid supplied to the said chamber (11) consists of a mixture of forced air and a liquid solvent.

9. Machine according to Claim 5, **characterized in that** the said nozzle (9) has, in addition to the said first chamber (11), a second chamber (13) developed around the said axial passage (9A) and communicating with it by means of apertures (13A), a second flow of fluid being sent to the said second chamber by means of a pipe (17).

10. Washing machine according to Claim 9, **characterized in that** a flow of forced air is supplied to the said first chamber (11) of the nozzle (9), and **in that** a flow of a liquid solvent is supplied to the said second chamber (13) of the nozzle, the said first chamber (11) being located downstream from the said second chamber (13) according to the direction of advance of the fabric.

11. Washing machine according to any one of Claims 4 to 10, **characterized in that** the said vessel (1) is of cylindrical shape with a horizontal axis (X-X), with the access hatch (7) located in the upper part in the proximity of the drive nozzle (9) and the return wheel (19).

12. Machine according to any one of Claims 4 to 11, **characterized in that** a supply pipe (24) for supplementary spray jets (22), located within the vessel and capable of wetting the fabric as it leaves the nozzle, is branched from the pipe (17) supplying the solvent to the nozzle (9).

13. Machine according to Claim 12, **characterized in that** another pipe (26), to enable other washing or dyeing substances to be injected, flows into the said supply pipe (24) of the supplementary jets (22).

14. Machine according to any one of Claims 4 to 13, **characterized in that** the said solvent circulating means comprise a pipe (23) for extraction from the lowest point of the vessel (1), a waste separation filter (25), a circulating pump (27), and a heat exchanger (29) for heating the recycled solvent to the desired temperature before it is sent to the fabric drive nozzle.

15. Machine according to Claim 14, **characterized in that** the said solvent circulating means comprise a further heat exchanger (30) provided with a coil (30A) in which a coolant fluid from a refrigeration installation circulates, to cool the solvent to a predetermined temperature.

16. Machine according to any one of Claims 4 to 14, **characterized in that** the said means of circulating the fabric drive air comprise a pipe (33) for collecting the air from the interior of the vessel (1) above the surface (L) of the solvent contained therein, a cooling unit (35) for the condensation and separation of the solvent and water vapours from the air, a fan (31) capable of generating a sufficient pressure and flow of air to drive the fabric, a heat exchanger (45) for heating the air before it is returned to the fabric

drive nozzle (9), and branching valves (39, 43) for interrupting the inflow of air to the nozzle (9) and for discharging it to the atmosphere through active carbon filters (55), or vice versa.

Fig.1

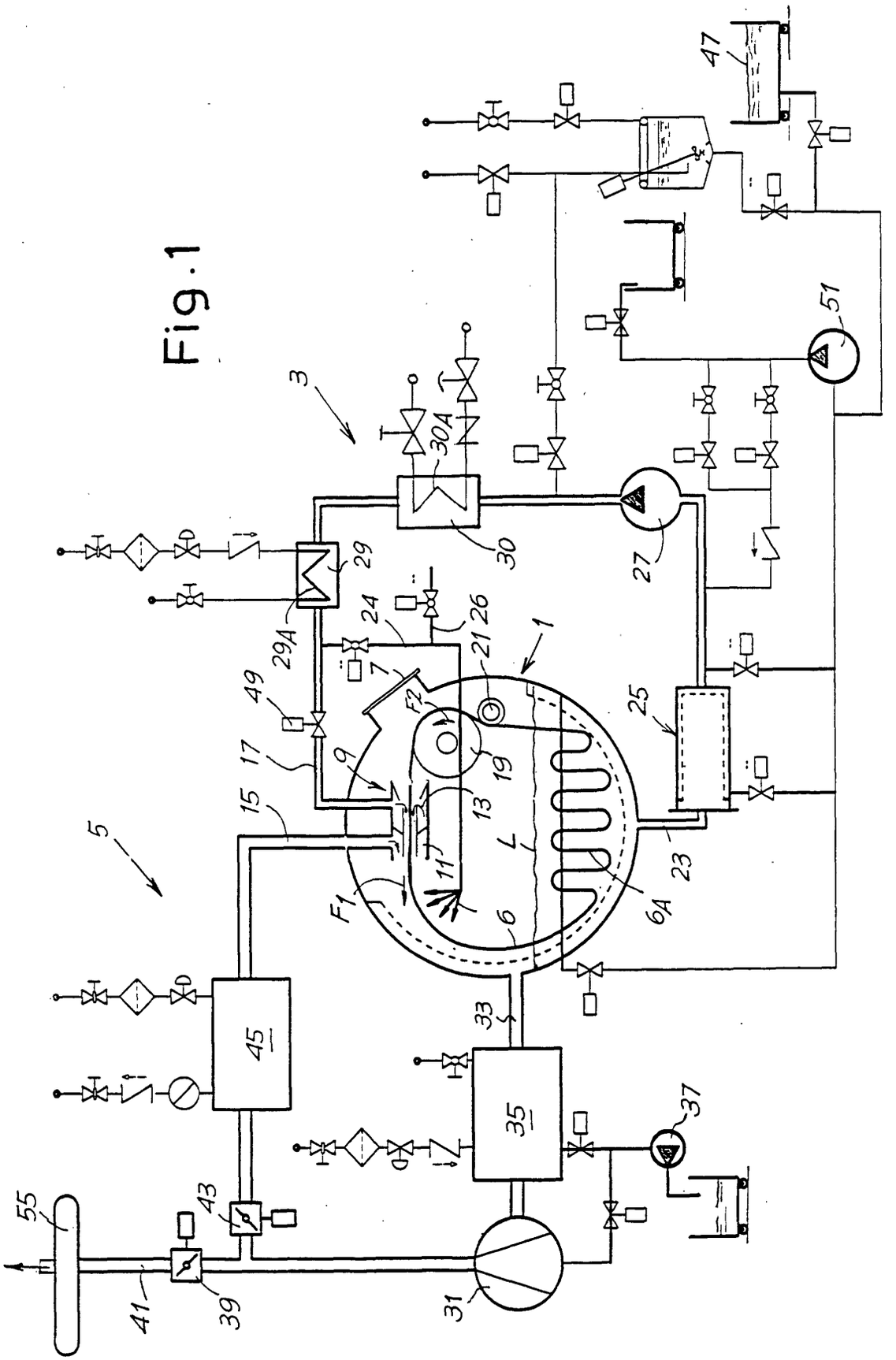
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Fig.2

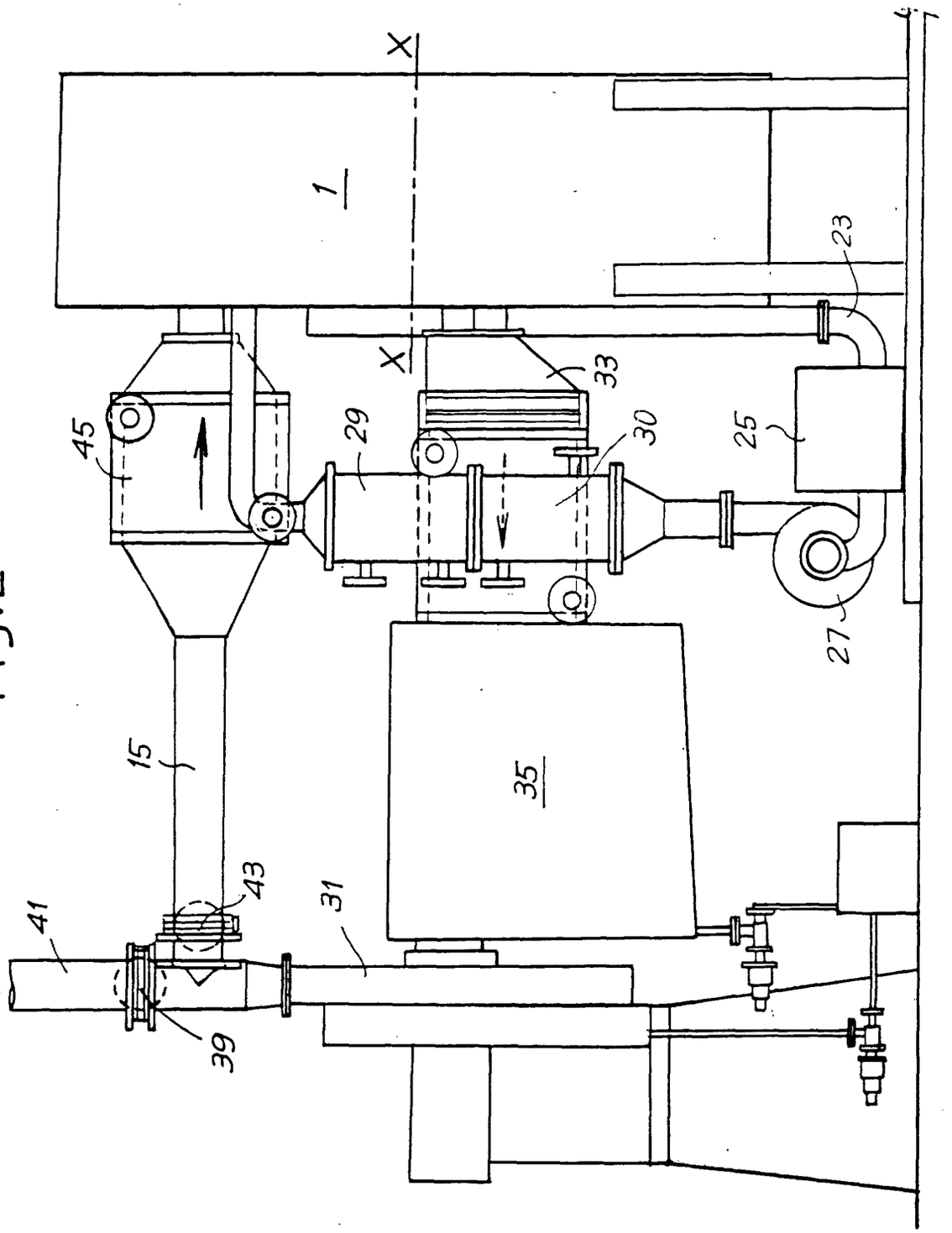
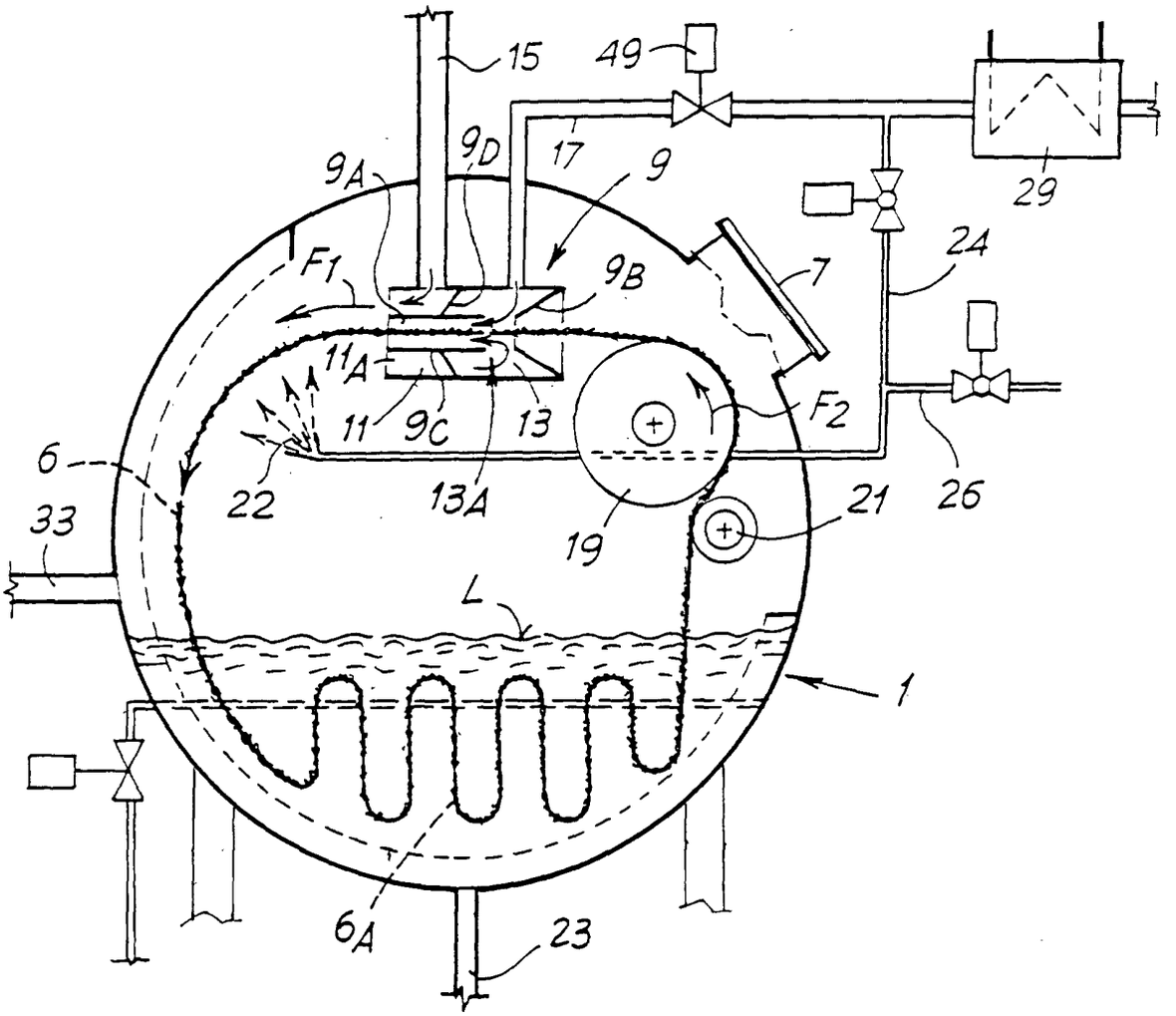


Fig.3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