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(54) **Method for finishing fabrics or knitwear in ammonia and relative device**

(57) Method and device for the continuous finishing of fabrics (11) or knitwear in ammonia, comprising at least a step of impregnating the fabric (11) in liquid ammonia and at least a subsequent step of heating/drying the fabric (11), wherein, before said impregnation with liquid ammonia, the fabric is subjected to at least a treatment of complete deaeration/de-gassing performed in an environment (12) substantially closed and kept in conditions of great depression with respect to atmospheric pressure.

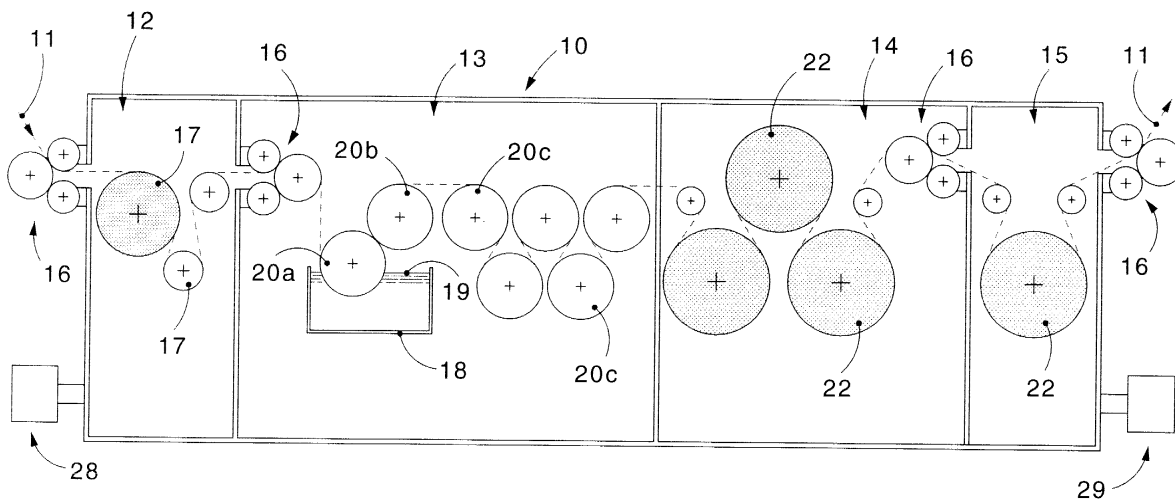


fig. 1

Description

FIELD OF THE INVENTION

[0001] The invention concerns a method for the continuous finishing of fabrics or knitwear in ammonia, and the device suitable to achieve the method.

[0002] The invention is applied in the field of textiles to perform continuous finishing treatments on fabrics or knitwear of cellulose fibres, for example cotton, viscose, linen or wool, so as to improve the distinctive characteristics of the product and provide a more valuable, comfortable, stable and resistant fabric for the making-up operations.

BACKGROUND OF THE INVENTION

[0003] In the textile field, the fabric before it is made up is subjected to various finishing treatments, the function of which, with dyeing, is to confer on the fabric the desired distinctive characteristics which improve the quality and usability by the final user.

[0004] These characteristics, which are often contrasting, can comprise the pleasantness of the touch of the fabric, high resistance to ageing and wear, high mechanical resistance and resistance to abrasion, good compatibility with the skin, greater resistance to creasing.

[0005] Among those finishing treatments intended to obtain the characteristics set forth above, specifically for fabrics based on cellulose fibres, a process using liquid ammonia baths has been studied and applied for a long time.

[0006] In this process, a fabric is impregnated with ammonia for a time varying from 1 to 25 seconds and at a temperature of around -34°C, that is, the temperature of liquefaction of ammonia at atmospheric pressure; during the reaction step the fabric is normally subjected to longitudinal or transverse tension.

[0007] The quality of the fabrics is improved because ammonia exerts a swelling effect on the cellulose fibres with a crystalline orientation of the cellulose, without damaging the structure of the fibre as happens with other treatments, for example with caustic soda or similar.

[0008] This treatment gives the textile material various advantages, including a greater affinity with the dyes, a better stability in washing, a better anti-crease effect, a softer touch, and the "new" effect is maintained for a long time even after repeated washes.

[0009] The industrial application of the ammonia treatment has been studied in depth for many years, but has always come up against practical problems and problems of application which, although they have not prevented this treatment from being widely used, have entailed a limitation to its use in industry.

[0010] To be more exact, the plants used at present generally have high investment and management costs which allow the plants to be installed only for very high

volumes of work. Moreover, these plants have the problem that they pollute the air and are also unsafe for the workers, because it is difficult totally to prevent ammonia leakage at outlet from the treatment.

[0011] Conventional installations have another problem connected with recovering and regenerating the ammonia used; this problem is linked both to factors of environmental pollution and also to economic factors caused by the cost of this substance.

[0012] Various systems have been proposed in the state of the art to solve the problem of recovering and regenerating the ammonia.

[0013] A first system, described for example in the patents BE-A-1.009.874 and US-A-4.189.847 provides to immerse the fabric emerging from the ammonia treatment into a solution of tepid water, with a subsequent distillation of the ammonia solution and condensation of the ammonia. This system has problems caused by the high consumption of electric and heat energy, and by the complexity and difficulty of managing the plant.

[0014] Another recovery system, described in the patents US-A-3.664.158, US-A-3.980.429, US-A-3.915.632, and US-A-4.074.969, provides that the ammonia is removed through evaporation, by bringing the fabric emerging from the treatment into contact with one or more heated rollers.

[0015] The device described in these patents comprises, in general, an ammonia treatment chamber kept substantially at atmospheric pressure and a small entrance chamber, before said treatment chamber, defined by a system with two sliding seals, the purpose of which is to insulate the inside of the machine from the outside environment. To compensate for the losses of the two sliding seals, the small chamber before the treatment chamber is kept at a slight depression by a ventilator, which conveys the gases of air and ammonia to a regeneration plant. The fabric enters the treatment chamber taking with it a large quantity of air inside the interstices of the fibres. The air consists of nitrogen, water, oxygen, carbon dioxide, which are pollutants for ammonia.

[0016] These patents provide to suck in the evaporating ammonia from inside the machine and to send the polluted ammonia to a recovery system the function of which is to separate and recover an important part of the ammonia.

[0017] The systems described in these patents are not only complex and costly, but also have the serious disadvantage that the ammonia treatment takes place on a fabric which has a large quantity of air in the interstices of the fibres; this makes the treatment itself problematic and inefficient, and makes the recovery of the ammonia difficult and costly.

[0018] The present Applicant has devised and tested a solution which solves these problems and allows to obtain other advantages as set forth hereafter, based on the experiences of the state of the art and the problems of industrial applicability as shown.

SUMMARY OF THE INVENTION

[0019] The invention is set forth and characterized in the respective main claims, while the dependent claims describe other characteristics of the main embodiment.

[0020] The purpose of the invention is to achieve a method and device for the continuous finishing treatment in ammonia of fabrics with cellulose based fibres, wherein the conditions of recovery and regeneration of the ammonia are improved, preventing problems of environmental contamination and reducing the costs deriving from the leakage of said substance.

[0021] Another purpose of the invention is to achieve a device which has lower installation and management costs than those of existing plants.

[0022] To be more exact, the aim of the invention is to eliminate a specific section dedicated to recovering the ammonia by separating the air and the water vapors from the ammonia vapors; said recovery section in fact entails high installation and management costs.

[0023] According to the invention, before it is impregnated with ammonia, the fabric to be treated is subjected to a treatment of complete de-aeration (de-gassing) and/or drying inside a closed chamber where a great depression is created with respect to atmospheric pressure, for example with a residual pressure of around 1÷200 millibar.

[0024] In a preferential embodiment, the residual pressure is around 1÷10 millibar.

[0025] The main purpose of the de-aeration is to eliminate every trace of air from the fabric, so that the fabric is presented for impregnation or immersion substantially without any air in the interstices between the fibres and in a condition of substantially zero residual humidity.

[0026] On the one hand the absence of air encourages a closer contact of the fibres of the fabric with the liquid ammonia, which is therefore free to penetrate in depth and in a capillary manner, thus enhancing the results and effects of the treatment.

[0027] On the other hand, the absence of air prevents, at outlet from the treatment, any air from mixing with the ammonia and thus making the removal and recovery more difficult and less efficacious.

[0028] According to a variant, to improve the conditions of de-aeration and drying of the textile material, inside the depression chamber there is at least a heated roller, the function of which is to make the residual humidity contained inside the textile material evaporate, before it is impregnated with ammonia.

[0029] At outlet from the ammonia treatment, after the fabric has possibly been squeezed to eliminate the excess liquid, the fabric is subjected to a drying process which causes the ammonia incorporated in the fabric to vaporize.

[0030] Given the substantial absence of air and water in the fabric, the ammonia vaporizes practically in a pure state, and therefore no complex processes or the relative plants are necessary, to separate the ammonia from

the air in the vapor stage or from the water in the liquid solution stage.

[0031] The vaporized ammonia can therefore be directly returned to the liquid state by means of appropriate cooling and condensation, or by compression.

[0032] The recovered liquid ammonia, in a preferential embodiment, is returned to the impregnation zone, together with a possible percentage of fresh ammonia needed to reintegrate the quantity lost through chemical reaction during the processing.

[0033] In a preferential embodiment, downstream of the drying zone and before outlet from the treatment, the fabric is subjected to a further step of drying in a closed environment wherein a great depression is created with respect to atmospheric pressure, so as to eliminate every residue of ammonia between the fibres of the fabric. According to a variant, the closed environment cooperates with heating means able to accentuate the drying action on the fabric before it is discharged from the treatment device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] These and other characteristics of the invention will become clear from the description of the preferential embodiments, given with reference to the attached drawings wherein:

Fig. 1 is a schematic side view of a device for finishing fabrics in ammonia according to a preferential embodiment of the invention;

Fig. 2 is a schematic view of a first embodiment to recover and recirculate the ammonia;

Fig. 3 is a variant of Fig. 2.

DETAILED DESCRIPTION OF THE PREFERENTIAL EMBODIMENTS

[0035] In the attached Figures, the number 10 denotes generally a device for treating a fabric 11 in liquid ammonia, said fabric 11 arriving from previous preparation, finishing and possibly dyeing steps.

[0036] The device 10 comprises in sequence a drying/de-aeration chamber 12, an ammonia treatment chamber 13, a main drying chamber 14 and a final de-aeration/drying chamber 15.

[0037] At least the chambers 13 and 14, in other embodiments, can be incorporated into a single chamber if they are working in equal pressure conditions, for example atmospheric pressure.

[0038] At inlet to and outlet from each of said chambers 12, 13-14 and 15, there are sealing means 16 of the roller type, able to prevent air from outside entering inside the chambers, and also to prevent a chamber being contaminated by another chamber.

[0039] The impregnation chamber 13 and the main drying chamber 14 work, in this case, at equal pressure and are not separated by sealing means.

[0040] For ease of illustration, the sealing means 16 shown are all of the same type; however, it is clear that any type of sealing means 16 suitable for the purpose can be used.

[0041] The function of the first drying/de-aeration chamber 12 is to completely de-aerate the fabric 11 at inlet to eliminate every trace or residue of air mixed between the fibres and in the interstices of the fabric 11.

[0042] To obtain this purpose, the chamber 12 is equipped with pump means 28 able to create inside an environment of great depression with respect to atmospheric pressure, for example with a residual pressure in the range of 1÷200 millibar, advantageously between 1÷10 millibar.

[0043] The fabric 11 entering the device 10 is therefore made to pass through said first chamber 12 on conveyor rollers 17, wherein, thanks to the great depression, it is subjected to extremely intense de-aeration and drying which eliminates all the air between the fibres.

[0044] At least the first conveyor roller 17 is advantageously heated and its function is to make the residual humidity present in the fabric 11 evaporate, before it is impregnated with ammonia.

[0045] After de-aeration, the degassed fabric 11 is sent, through relative sealing means 16, to the ammonia treatment chamber 13, in which it is immersed in a tank 18 containing a quantity of liquid ammonia 19.

[0046] In the case shown here, the fabric 11 is immersed in the tank 18 by wrapping the fabric 11 on a roller 20a partly immersed in the tank 18.

[0047] According to the invention, the chamber 13 is kept at atmospheric pressure and at a temperature suitable to keep the ammonia 19 in its liquid state at that pressure, that is, around -34°C.

[0048] According to a variant, the chamber 13 is kept in a condition of depression, or slight pressure, to lower the liquefaction temperature of the ammonia.

[0049] A roller 20b associated with the roller 20a performs a squeezing function; it can be brought into contact with the roller 20a with an adjustable pressure to subject the fabric 11 to a more or less intense squeezing.

[0050] The fabric 11 is then accompanied under tension towards the outlet of the chamber 13 by a plurality of conveyor rollers 20c, arranged on offset planes so that it has the time to react to a controlled tension, for a time normally between 5 and 25 seconds, advantageously between 5 and 15 seconds.

[0051] The fabric 11 is then made to exit from the chamber 13 and sent to the main drying chamber 14.

[0052] In the specific case, the fabric 11 is dried by making it pass continuously in contact with three heated rollers 22; it is clear, however, that the number and arrangement of the rollers 22 can be different from the one shown here.

[0053] The chamber 14 can work at atmospheric pressure, in depression or also in pressure.

[0054] The heating performed by the rollers 22 causes the ammonia, present in a liquid state between the

fibres of the fabric 11, to evaporate.

[0055] Thanks to the de-aeration of the fabric 11 performed in the chamber 12 at inlet to the device 10, and to the fact that no air has been introduced into the treatment zones, the ammonia vaporizes in the chamber 14 in a nearly pure state, since all contact and mixing of the ammonia with air or other gases has been prevented.

[0056] The ammonia vapors which develop inside the chamber 14 are collected by means of a fume intake tube 21 (Fig. 2) associated with a ventilator/suction device 23, and sent to a condenser 24 able to cool the vapors and fumes and to condense any possible traces of ammonia solution.

[0057] The condenser 24 is associated with a storage tank 25 where the NH_4OH , which can form from the reaction of the residual water taken in by the fabric 11 with the ammonia vapors, is collected.

[0058] The storage tank 25 can be associated with heating means (not shown) able to encourage a subsequent evaporation of the ammonia.

[0059] The partly cooled ammonia is conveyed from the condenser 24 to a cooling device 26, for example of the chiller type.

[0060] The function of the device 26 is to lower the temperature of the ammonia to around -34°C, that is, the temperature of liquefaction at atmospheric pressure, and allow to refill the impregnation tank 18 with liquid ammonia by means of an introduction tube 27. Between the cooling device 26 and the tank 18 there can be an accumulation tank for the liquid ammonia.

[0061] At outlet from the chamber 14, the fabric 11 is sent, through sealing means 16, to a final drying chamber 15, the function of which is to eliminate from the fabric 11 the residual traces of ammonia in the interstices of the fibres and partly bound, though weakly, to the fibres themselves.

[0062] The chamber 15 is associated with a vacuum pump 29 suitable to create inside a great depression with respect to atmospheric pressure (with a residual pressure in the range of 1÷200 millibar, advantageously 1÷10 millibar) in order to completely de-aerate the fabric 11, removing every residue of ammonia, normally present in this step to a percentage of 2÷3%.

[0063] To improve the efficacy of the final de-aeration, the fabric 11 is made to pass in the chamber 15, in this case, above a heated roller 22 which causes an even more energetic evaporation of the residual ammonia fumes. The heated roller 22 may be omitted.

[0064] According to a variant which is not shown here, inside the final drying chamber 15, and upstream of the heated roller 22, there is a vaporizer bar, or a mixture of steam and nebulized water.

[0065] The small percentage of humidity produced, in the conditions of great depression in the chamber 15, penetrates in depth into the fibres of the fabric 11, and evaporates when in contact with the heated roller 22, taking with it the residual traces of ammonia left inside the fabric 11.

[0066] At outlet from the final drying chamber 15 there can be a vaporizer device or a hot water immersion bath.

[0067] The ammonia fumes produced in the chamber 15 are sucked in through the vacuum pump 29 and conveyed to the tube 21.

[0068] The fumes mix in with the fumes sucked in by the drying chamber 14 by means of the ventilator/suction device 23 and conveyed to the condenser 24 to re-integrate the ammonia as explained above. The condenser 24 is associated with a heat-regulation system to cool the fumes of NH_3 and possibly to condense traces of water and NH_4OH .

[0069] If any small quantities of water are introduced into the chamber 15, both NH_3 fumes and a solution of NH_4OH will be formed; the solution of NH_4OH will be condensed inside the condenser 24 and collected in the tank 25.

[0070] According to a variant shown in Fig. 3, downstream of the condenser 24 there is a compressor 31, working at high pressure, for example around 8÷15 bar.

[0071] The compressor 31 causes the ammonia vapors arriving from the condenser 24 to liquefy, by means of compression; it thus substantially performs the same function as the cooling device in Fig. 2. The liquid ammonia is then stored in a tank 32.

[0072] Since the compression is exothermic, the tank 32 is associated with cooling means able to cool the ammonia which, at these pressures, is in a liquid state.

[0073] From the tank 32 the ammonia is re-introduced into the tank 18 through a reduction valve 33.

[0074] From the above description it is clear that, thanks to the inlet chamber 12 which has the function of completely deaerating the fabric 11 before it is impregnated with ammonia, the outlet chamber 15 which has the function of eliminating every residue before outlet, the device shown ensures an extremely efficient treatment and a very efficient re-integration of the ammonia used.

[0075] The main function of the chambers 12 and 15 is to separate the outer, polluting environment from the zones where the fabric is impregnated with ammonia, preventing all contamination with air and water; on the one hand this facilitates the elimination and recovery of the ammonia from the fabric, and on the other hand it greatly reduces the risk of environmental contamination.

[0076] Although some preferential forms of embodiment of the invention have been described, it is clear that modifications and variants can be made thereto, without departing from the spirit and scope of the invention as defined by the attached claims.

Claims

1. Method for the continuous finishing of fabrics (11) or knitwear in ammonia, comprising at least a step of impregnating the fabric (11) in liquid ammonia and at least a subsequent step of heating/drying the

fabric (11), the method being characterized in that, before said impregnation with liquid ammonia, it provides a step wherein the fabric (11) is subjected to at least a treatment of complete de-aeration/de-gassing performed in an environment (12) substantially closed and kept in conditions of great depression with respect to atmospheric pressure.

2. Method as in Claim 1, characterized in that it provides a step of drying the fabric (11) in association with said de-aeration/de-gassing step.

3. Method as in Claim 2, characterized in that said drying step is performed by taking said fabric (11) into contact with at least a heated drawing element (17).

4. Method as in Claim 1 or 2, characterized in that it provides that the residual pressure maintained in said environment (12) in great depression is in the range of 1÷200 millibar.

5. Method as in any claim hereinbefore, characterized in that it provides that the residual pressure maintained in said environment (12) in great depression is in the range of 1÷10 millibar.

6. Method as in Claim 1, characterized in that it provides to subject the fabric (11) emerging from the heating/drying step to a final de-gassing and possible drying step performed in an environment (15) substantially closed and kept in conditions of great depression with respect to atmospheric pressure.

7. Method as in Claim 6, characterized in that it provides that the residual pressure maintained in said environment (15) in great depression is in the range of 1÷200 millibar, advantageously 1÷10 millibar.

8. Method as in Claim 6 or 7, characterized in that it provides to subject the fabric (11) to a heating treatment inside said environment (15), performed by at least a heated roller (22), to accentuate the drying action.

9. Method as in any claim from 6 to 8 inclusive, characterized in that it provides to subject the fabric (11) to a vaporization/humidification treatment inside said environment (15) to eliminate traces of residual ammonia between the interstices and fibres.

10. Method as in Claim 1, characterized in that it provides to convey fumes and vapors obtained from the heating/drying step to at least a cooling/condensation step to return the ammonia to liquid form.

11. Method as in Claim 1, characterized in that it provides to convey fumes and vapors obtained from the heating/drying step to at least a compression

step with pressures in the range of 8÷15 bar to liquefy said fumes and vapors and return the ammonia to liquid form.

12. Device for finishing fabrics or knitwear in ammonia, comprising at least a chamber (13) wherein the fabric (11) is treated with liquid ammonia and a drying chamber (14) arranged downstream of said treatment chamber (13), the device being characterized in that upstream of said chamber (13) it comprises at least a chamber (12) for the complete de-aeration/de-gassing of the fabric (11), inside which the fabric (11) is made to pass before being sent to the ammonia treatment, said chamber (12) being associated with means (28) able to create inside an environment of great depression with respect to atmospheric pressure. 5
13. Device as in Claim 12, characterized in that said means (28) are able to create a residual pressure inside said chamber (12) in the range of 1÷200 millibar, advantageously 1÷10 millibar. 10
14. Device as in Claim 12, characterized in that it comprises means to dry the fabric (11) arranged inside said de-aeration/de-gassing chamber (12). 15
15. Device as in Claim 14, characterized in that said drying means comprise at least a heated roller (17) around which the fabric (11) is wound. 20
16. Device as in any claim from 12 to 15 inclusive, characterized in that it comprises a final de-aeration/drying chamber (15) inside which the fabric (11) is made to pass after it has passed through said drying chamber (14), said chamber (15) being associated with means (29) able to create therein an environment with a great depression. 25
17. Device as in Claim 16, characterized in that said means (29) are able to create a residual pressure inside said chamber (15) in the range of 1÷200 millibar, advantageously 1÷10 millibar. 30
18. Device as in Claim 16, characterized in that it comprises at least a heated roller (22) arranged inside said chamber (15) and able to dry the fabric (11) passing through. 35
19. Device as in Claim 15, characterized in that it comprises means for the vaporization/humidification of said fabric (11) arranged inside said chamber (15). 40
20. Device as in any claim from 12 to 19 inclusive, characterized in that it comprises sealing means (16) arranged between the outside of the device (10) and said de-aeration chamber (12), and between said chamber (12) and said treatment chamber (13). 45
21. Device as in any claim from 12 to 20 inclusive, characterized in that it comprises sealing means (16) arranged between the drying chamber (14) and said final drying chamber (15), and between said final drying chamber (15) and the outside of the device (10). 50
22. Device as in Claim 16, characterized in that it comprises at least a cooling device (26) arranged downstream of said final drying chamber (15), said cooling device (26) being able to liquefy the ammonia vapors sucked in at least from inside said drying chamber (14) and to allow said ammonia to be re-used in the treatment chamber (13). 55
23. Device as in Claim 16, characterized in that it comprises compression means (31) with high working pressure, around 8-15 bar, arranged downstream of said final drying chamber (15), said compression means (31) being able to liquefy the ammonia vapors sucked in at least from inside said drying chamber (14) and to allow said ammonia to be re-used in the treatment chamber (13).

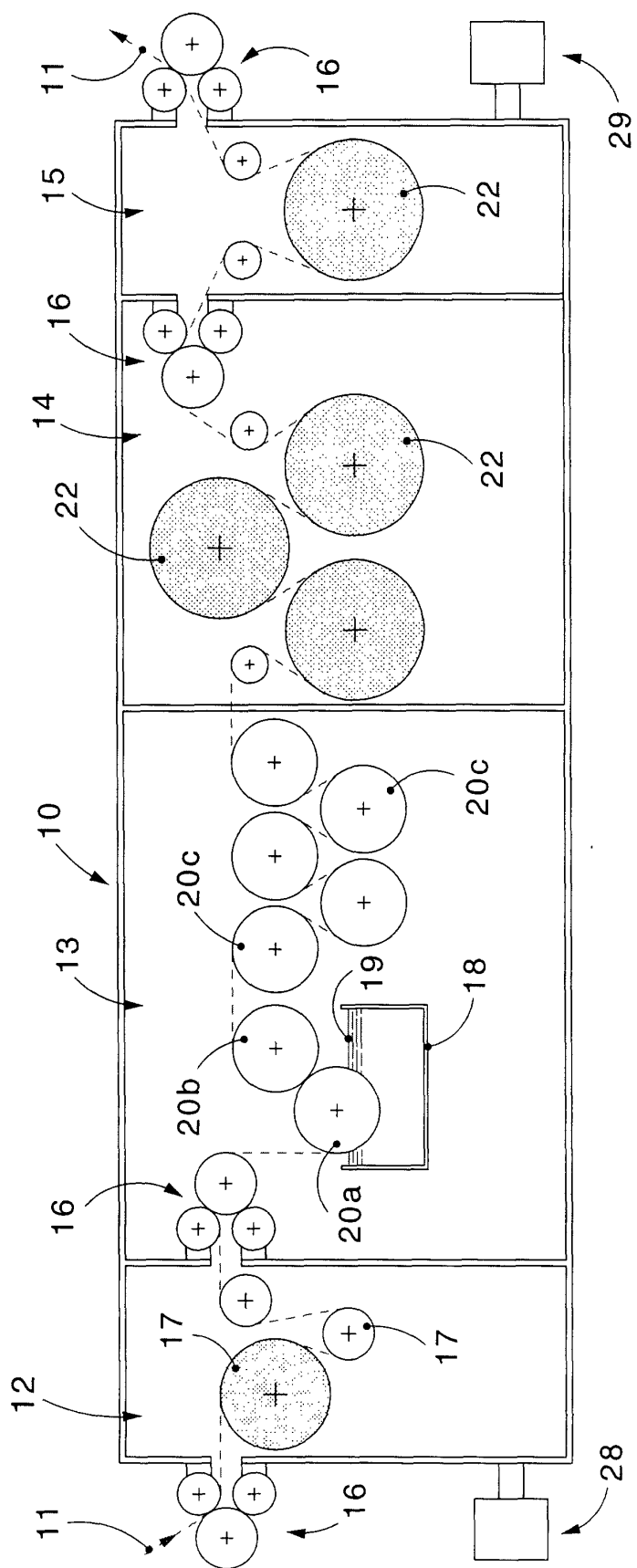


fig. 1

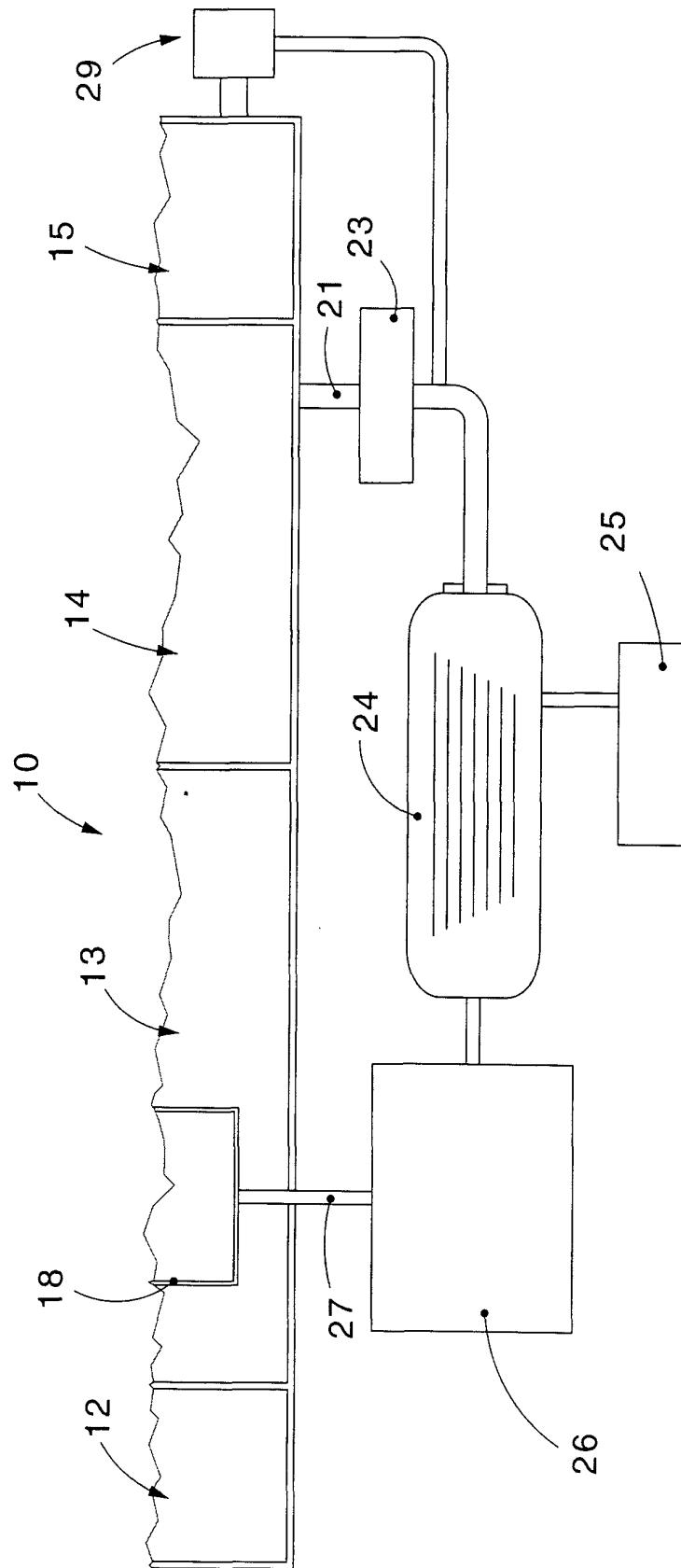


fig. 2

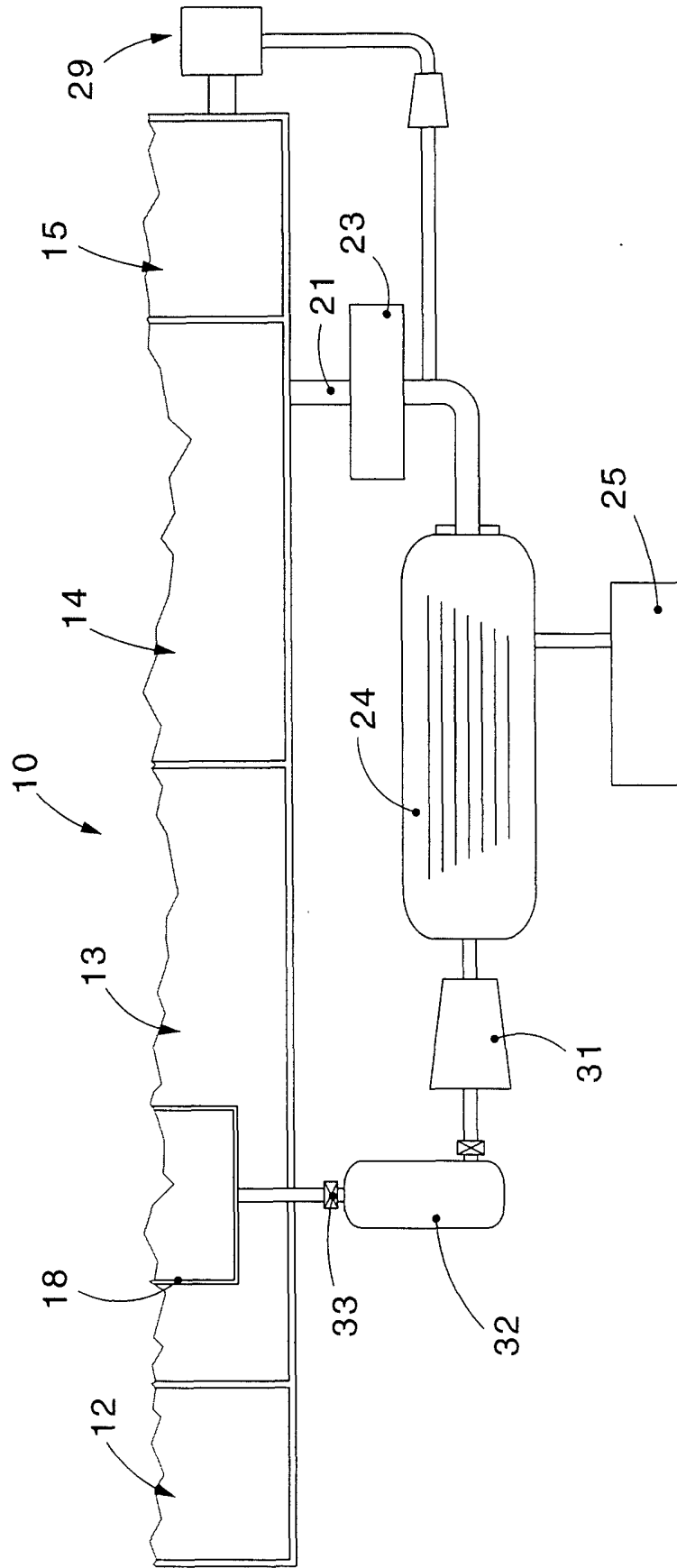


fig. 3