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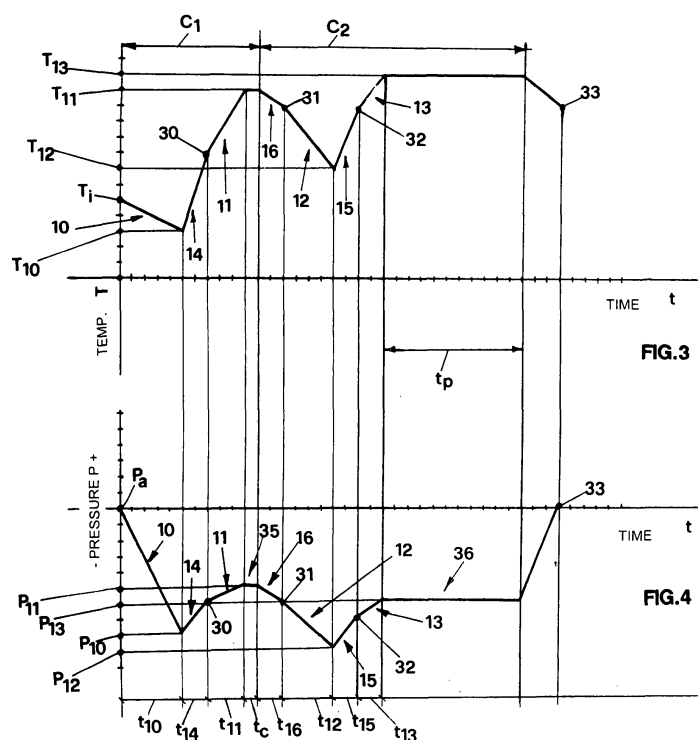
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(54) Method and equipment for conditioning and heat-setting textile articles

(57) A method of conditioning and heat-setting textile products in an autoclave (21) is disclosed comprising: two or more thermal cycles (C1, C2), at least one of which comprising a transfer phase (16) of water present in the autoclave (21) to inside a recovery tank (22), a suction phase (10, 12) to put the autoclave (21) under vacuum, a water return phase (14, 15) from the recovery tank (22) to the autoclave (21), a heating phase (11, 13) of water contained in the autoclave (21) to gen-

erate saturated steam, a stay phase (35, 36) in the autoclave (21) for a predetermined time (t_c , t_p) of the reached conditions of temperature (t_{11} , t_{13}) and pressure (p_{11} , p_{13}), restoring in the autoclave (21) the ambient pressure (P_a) at the end of the last stay phases (36). Each phase of transfer (16) and return (14, 15) of said water occurs spontaneously by suction produced by the difference of pressure existing between autoclave (21) and recovery tank (22).



Description

[0001] The present invention relates to a method of treatment for conditioning and heat-setting textile articles, more particularly yarns made of natural fibres such as wool or cotton or mixed natural and synthetic fibres.

[0002] The invention relates also to an equipment carrying out such a conditioning and heat-setting method.

[0003] It is well-known that yarns wound on cones and bobbins, before being used in weaving looms or in circular knitting machines, must undergo a treatment to absorb a predetermined amount of humidity.

[0004] Indeed, it is the presence of a correct humidity percentage inside the yarn that allows to stabilize its twist and avoid breakage when working on looms or knitting machines.

[0005] Moreover, a correct dimensional yarn stabilization allows to increase the working-speed of the machinery as well.

[0006] More particularly, in the synthetic mixed yarns the high temperature at which the treatment is carried out, heat-sets also the synthetic fibre.

[0007] The yarn treatment allows also to condition the article by causing it to absorb the maximum water amount admitted by law, which is variable as a function of the kind of fibres, because the yarns are being sold at a price fixed with reference to a stated humidity content.

[0008] Indeed, it is clear that if the yarn is sold with a humidity amount higher than the admitted one, the customer pays the product at a higher price relative to the agreed one.

[0009] Conversely, if the yarn is sold with a humidity content lower than the admitted one, the manufacturer is damaged because it supplies to the customer a yarn weight higher than the quantity paid for.

[0010] The yarn treatment may be carried out in proper rooms where it remains for a rather long time that generally goes from 16 to 24 hours in a room kept at constant humidity.

[0011] Such a method of treatment became obsolete in view of the required long time and is replaced by autoclave treatments with saturated steam having the advantage to be quicker and to allow the treatment repetitiveness.

[0012] According to one of the known techniques, the yarn wound on cones or bobbins, is introduced into an autoclave by placing the cones or bobbins on support fixtures.

[0013] The treatment cycle provides for an air-suction phase from the autoclave, followed by a heating phase in which inside the autoclave under vacuum, a water amount on its bottom is evaporated.

[0014] More particularly, with reference to Figures 1 and 2 showing the development of temperature and pressure inside the autoclave respectively, a treatment cycle of the prior art provides for:

- a suction phase, indicated by lines 1, during which, at the same time of lowering pressure inside the autoclave from the ambient value P_a to the value P_1 , there is also a temperature decrease from the starting value T_i to the final value T_1 , in view of the endothermal nature of the evaporation process of water inside the autoclave;
- a heating phase, shown by lines 2, during which there is a temperature rise up to the value T_2 and also a pressure rise up to the value P_2 in view of the water evaporation inside the autoclave;
- a stay time at temperature T_2 and pressure P_2 , indicated by lines 3, during which the yarn absorbs humidity reaching the desired humidity condition;
- a restoration of the ambient pressure in the autoclave, indicated by lines 4, allowing to return the autoclave and the material to the temperature and pressure conditions T_2 and P_a respectively;
- a discharge of the treated material at point 5.

[0015] The treatment time T is variable according to the users requirements and comprises:

- a time interval t_1 during which the suction phase causing vacuum inside the autoclave occurs (lines 1);
- a time interval t_2 required to heat the autoclave and produce the saturated steam (lines 2);
- a time interval t_3 allowing the yarn to absorb the humidity existing in the autoclave (lines 3);
- a time interval t_4 in which the starting pressure conditions are restored in the autoclave (lines 4).

[0016] Thermal cycles of the described kind which are generally common to all the known treatments carried out in an autoclave, have the advantage to be much quicker in comparison with the previously described treatments.

[0017] However, these cycles have also some drawbacks, of which the main one consists in the general impossibility to condition the yarn homogeneously, obtaining the same humidity conditions both outside and inside and in the middle of the cone or bobbin.

[0018] Indeed, at the end of the treatment the distribution of humidity in the yarn is steadily decreasing from the outer surface to the interior of the cone or bobbin, in view of the difficulty met by the steam to reach and condense on the yarn replacing air in the inner zones near the tube or cone on which the yarn is wound.

[0019] Modified thermal cycles are also known, in which the described cycle is followed by another similar cycle, generally indicated with 6 in Figures 1 and 2, allowing to obtain on the yarn a more homogeneous distribution of humidity between inside and outside the cone or bobbin.

[0020] Such modified thermal cycles improve the uniform distribution of humidity, without obtaining, however, a perfectly homogeneous distribution.

[0021] As a matter of fact even with a double treatment cycle it is not possible to substitute the humidity arising from condensation of saturated steam for the air present in the innermost and coldest zones of the bobbin or cone.

[0022] A method of treatment for conditioning and heat-setting textile products as well as an equipment adapted to carry out such a method are also known from the International application having the publication number WO98/21390 and the corresponding US patent number 6,094,840.

[0023] The cited method is an improvement relative to the previously described methods because it provides for removing hot water from the autoclave after each treatment cycle and collecting it in a recovery tank to be again used in the subsequent cycle so as to recover the heat contained therein.

[0024] Such a method, however, has some acknowledged inconvenience, the main one being that after each vaporization cycle air coming from outside is introduced into the autoclave and enters again inside the material to be treated.

[0025] It is clear that the air fraction entered inside the material "dilutes" the steam introduced inside the same material and at each subsequent cycle the same conditions arise again so as to make inefficient the increase of the number of consecutive treatment cycles.

[0026] Moreover, pumps are used to transfer hot water from the autoclave to the recovery tank and vice versa.

[0027] The present invention aims at overcoming the above drawbacks.

[0028] More particularly, the object of the invention is to provide a method and an equipment for conditioning and heat-setting textile products that in comparison with equivalent treatment methods of the prior art, obtains a more homogeneous distribution of humidity between inside and outside of the product.

[0029] More particularly, in case of yarns wound on cones or bobbins, the object is to obtain a more homogeneous distribution of humidity between inside and outside the cone or bobbin.

[0030] Another object of the method and equipment of the invention is to obtain a lower air concentration and a better humidity distribution in the product under treatment in comparison with methods and equipments of the prior art carrying out the same number of cycles.

[0031] A last, but not least object is to obtain also a reduction of the treatment times with the method and equipment of the invention.

[0032] The foregoing objects are attained by a method of treatment for conditioning and heat-setting textile articles in an autoclave, more particularly of yarns wound in bobbins or cones, that according to the main claim comprises the following steps:

- introducing the yarn to be treated into said autoclave;

- closing said autoclave;
- carrying out two or more thermal cycles, at least one of which comprises sequentially:

- 5 - a phase of transferring water present in said autoclave, to a recovery tank;
- a suction phase adapted to put said autoclave under vacuum;
- 10 - a phase of returning the water present in said recovery tank to said autoclave;
- a phase of heating the water contained in said autoclave to generate saturated steam;
- 15 - a stay phase in said autoclave for a time length determined by the temperature and pressure conditions reached at the end of each of said heating phases;

- restoring in said autoclave the ambient pressure at the end of the last of said stay phases;
- 20 - opening said autoclave;
- taking the treated product out from said autoclave,

and is characterized in that each of said transfer phases of said water from said autoclave to said recovery tank and return of said water from said recovery tank to said autoclave, occurs spontaneously by the suction produced by the pressure difference existing between said autoclave and said recovery tank.

[0033] During said transfer and return phases, the interior of the autoclave does not communicate with the outside air and an atmosphere of saturated steam at a pressure lower than the atmospheric pressure is existing in the autoclave.

[0034] Advantageously the method and the equipment of the invention allow to supply inside the cone or the bobbin, a greater quantity of saturated steam and consequently of humidity so as to replace almost totally the air present in the yarn.

[0035] In a further advantageous way a more homogeneous distribution of humidity is obtained as well.

[0036] Still advantageously, the treatment time of the method of the invention is also lower than the treatment time of the prior art methods thus allowing to carry out quicker cycles with lower costs.

[0037] The foregoing objects and advantages will be better understood by the following description of a preferred embodiment of the method of the invention and of the equipment to carry out the method, which is given as an illustrative, but non-limiting example with reference to the accompanying sheets of drawings in which:

- Figures 1 and 2 show a cycle of thermal treatment of the prior art;
- 55 - Figures 3 and 4 show the treatment cycle of the present invention;
- Figures 5 to 7 show the equipment carrying out the treatment method of the invention in different operative phases.

The treatment method of the invention is described with reference to the temperature-pressure diagrams shown in Figures 3 and 4 respectively and is carried out in an equipment generally indicated with 20 which is shown in Figures 5 and 6 and comprises:

- an autoclave 21;
- a water recovery tank 22;
- a vacuum pump 23.

[0038] The method and the equipment of the invention will be described hereinbelow when used for treating yarns; however, the same method and equipment may be used also to carry out the treatment of other textile products.

[0039] As to the treatment method, it provides that the cones or bobbins of yarn to be treated are introduced into the autoclave 21 being arranged on suitable support fixtures allowing free circulation of steam amid cones or bobbins.

[0040] Preferably, but not necessarily, the thermal cycles are two and are indicated with C1 and C2 in Figures 3 and 4 where one can see that each cycle comprises a suction phase 10, 12 adapted to put the autoclave 21 under vacuum, followed by a heating phase 11, 13 of water contained in the autoclave to generate saturated steam.

[0041] At the end of each heating phase there is a stay phase 35, 36 for a time t_c , t_p maintaining the attained conditions of temperature, humidity and pressure.

[0042] More particularly, at the end of the stay phase 36 of the second cycle C2, before taking out the yarn treated in the autoclave 21, the ambient pressure P_a is restored.

[0043] The first thermal cycle C1 comprises in detail the following phases in this order:

- a suction phase 10 adapted to put the autoclave 21 under vacuum without water inside it;
- an introduction phase 14 of water inside the autoclave 21;
- a heating phase 11 of water inside the autoclave 21 to generate the saturated steam;
- a stay phase 35 maintaining the attained conditions of temperature and pressure;

and the second thermal cycle C2 comprises the following phases in this order:

- a transfer phase 16 of water present inside the autoclave 21 to a recover tank 22;
- a suction phase 12 adapted to put the autoclave 21 under vacuum;
- a return phase 15 to the autoclave 21 of water present in the recovery tank 22;
- a heating phase 13 of water inside the autoclave 21 to generate the saturated steam;
- a stay phase 36 maintaining the attained conditions

of temperature and pressure.

[0044] According to the invention each transfer phase 16 of water from the autoclave 21 to the recovery tank 22 and each return phase 14, 15 of said water from said recovery tank 22 to said autoclave 21, occurs spontaneously by suction produced by the pressure difference existing between said autoclave 21 and said recovery tank 22.

[0045] Still according to the invention, during said phases of transfer 16 and return 14, 15, the interior of the autoclave 21 does not communicate with the outside air and inside the autoclave there is an atmosphere of saturated steam at a lower pressure than the atmospheric one.

[0046] Again with reference to the temperature-pressure diagrams of Figures 3 and 4, one can see that the second cycle C2 starts after a pre-set time t_c from the stay phase 35 of the first cycle C1, during which the values of temperature T_{11} and pressure P_{11} reached at the end of the heating phase 11, remain constant.

[0047] Looking at the temperature pressure diagram of Figures 3 and 4 one can see that the temperature T_{10} reached inside the autoclave 21 at the end of the suction phase 10 of the first cycle C1, is lower than both the starting temperature T_i and the temperature T_{12} reached at the end of the suction phase 12 of the second cycle C2.

[0048] As to the pressure P_{10} reached inside the autoclave 21 at the end of the suction phase of the first cycle C1, it is higher than the pressure P_{12} reached at the end of the suction phase 12 of the second cycle C2, and both are lower than the ambient pressure P_a .

[0049] As far as the heating phases are now concerned, the temperature T_{11} reached inside the autoclave 21 at the end of the heating phase 11 of the first cycle C1, is lower than the temperature T_{13} reached at the end of the heating phase 13 of the second cycle C2.

[0050] Finally, pressure P_{11} reached inside the autoclave 21 at the end of the heating phase of the first cycle C1, is higher than the pressure P_{13} reached at the end of the heating phase 13 of the second cycle C2, and both are anyway lower than the ambient pressure P_a .

[0051] Obviously, the values of temperature and vacuum that are obtained inside the autoclave 21 depend on the kind of yarn to be treated and the final features to be obtained.

[0052] Again as a function of the kind of yarn to be treated and of the final features to be obtained, the times t_{10} , t_{14} , t_{16} , t_{12} , t_{15} , t_{13} , t_c , t_p of the previously described corresponding treatment phases are selected.

[0053] Thus one can see that the length of time t_{10} of the suction phase 10 of the first cycle C1 is greater than the length of time t_{12} of the suction phase 12 of the second cycle C2.

[0054] Moreover, one can see that also the length of time t_{11} of the heating phase 11 of the first cycle C1 is greater than the length of time t_{13} of the heating phase

13 of the second cycle C2.

[0055] The method of the invention described by the temperature-pressure cycles shown in Figures 3 and 4 is carried out by the already mentioned equipment generally indicated with 20 and shown in Figures 5 to 7, comprising:

- an autoclave 21;
- a water-recovery tank 22;
- a vacuum pump 23, preferably, but not necessarily of the liquid loop kind.

[0056] The autoclave 21, the tank 22 and the pump 23 are connected to each other through pipes provided with on/off valves.

[0057] More particularly, the autoclave 21 is connected to the water recovery tank 22 through a water transfer pipe 24 which is intercepted by valve 24a and a water return pipe 28 intercepted by valve 28a.

[0058] More particularly, one can see that the transfer pipe 24 and the return pipe 28 are both connected to the autoclave 21 at a hydraulic seal 21a arranged on the bottom whose function is to allow transfer of water from the tank 22 to the autoclave 21 without admission of air inside the autoclave.

[0059] As to the hydraulic seal 21a, it is of a kind known per se and generally consists of a pipe in which there is water acting as a diaphragm against entrance of air during the flow of water from the tank 22 to the autoclave 21.

[0060] To this purpose one can see also that the return pipe 28, in order to avoid even more entrance of air into the autoclave 21 during transfer of water from the tank 22, is connected at the bottom of the tank 22, while the transfer pipe 24 used to transfer water from autoclave to the tank 22, is connected at the tank top.

[0061] Both the autoclave 21 and the tank 22 are connected to the vacuum pump 23 through a first suction pipe 25 intercepted by a corresponding valve 25a and a second suction pipe 26 intercepted by a corresponding valve 26a, respectively. Finally, an auxiliary suction pipe 27 provided with a corresponding valve 27a, connects the first suction pipe 25 to the tank 22.

[0062] Inside the autoclave 21 there are also thermal exchange means, not shown in the drawings, intended to heat water to produce the saturated steam.

[0063] Operatively to carry out the treatment, the yarn to be treated is introduced into the autoclave 21 inside which there is no water.

[0064] Any possibly present water is transferred through the transfer pipe 24 to the tank 22 where there is already water A shown in Figure 5.

[0065] The yarn inside the autoclave 21 is therefore at the starting temperature T_i indicated in Figure 3 and at the atmospheric pressure P_a indicated in Figure 4, corresponding to the starting point of the suction phase 10 of the first thermal cycle C1.

[0066] Upon closure of the valves 24a, 28a, 26a and

27a, inside the autoclave 21, vacuum is generated through the vacuum pump 23 sucking air through the first suction pipe 25 upon opening the on/off valve 25a.

[0067] During the suction phase inside the autoclave 21 the temperature and pressure conditions indicated by points T10 and P10 respectively are reached, where the temperature T10 is lower than the starting temperature T_i .

[0068] Indeed, the steam expansion occurs with adiabatic cooling caused by the phase transition.

[0069] At the end of the suction phase 10 and upon closure of the valve 25a, the valve 28a intercepting the water-return pipe 28 is opened, so that as shown in Figure 6, a portion Aa of water A contained in the tank 22, passes spontaneously to the autoclave 21 where it is sucked by the vacuum existing inside it.

[0070] Therefore, one can see that water transfer from tank 22 to the autoclave 21 occurs spontaneously by suction and therefore without using pumps.

[0071] Moreover, during the return phase of water from tank 22 to autoclave 21, the tank 22 is put in communication with the outside while inside the autoclave 21 the atmosphere of saturated steam generated by vacuum is maintained.

[0072] Indeed, the presence of the hydraulic seal 21a and the fact that withdrawal of water from tank 22 occurs at the lowest part of it, prevent entrance of air into the autoclave.

[0073] In this way the material being treated does not lose the humidity previously acquired, as it happens on the contrary in the equipment described in the patent cited in the introductory part of the description.

[0074] The water introduction phase 14 lasts for the time t_{14} and occurs with increase of pressure and temperature inside the autoclave 21 in view of the evaporation of a portion of water Aa.

[0075] Water inflow inside the autoclave ends at the points indicated with 30 in the diagrams of Figures 3 and 4 and corresponds with the condition of the equipment 20 shown in Figure 6.

[0076] Then it begins the heating phase 11 of the autoclave 21 carried out through the already mentioned heating means that could be for instance thermal exchange coils or other known systems.

[0077] Heating lasts for the time t_{11} until the temperature and pressure conditions shown by points T11 and P11 in the diagrams of Figures 3 and 4 respectively are reached.

[0078] During the heating phase there is also a further increase of pressure inside the autoclave because of the presence of saturated steam filling the autoclave chamber.

[0079] The temperature and pressure conditions T11 and P11 are kept for a time t_c to allow the saturated steam to penetrate into the yarn and condense in the innermost zones of the cone or bobbin, replacing the air inside them.

[0080] Since the first cycle C1 alone is not sufficient

to extract completely all the air present in the yarn, a second similar cycle C2 is carried out thereafter.

[0081] More particularly, another transfer phase to the recovery tank 22 of water present in the autoclave 21 is carried out, shown in the diagrams of Figures 3 and 4 where it is indicated by line 16. Such a transfer is carried out through the transfer pipe 24, upon opening of valve 24a, putting the tank 22 under vacuum through the second suction pipe 26 and upon opening the on/off valve 26a as shown in Figure 7.

[0082] In this way inside the tank 22 a pressure is created lower than the pressure existing inside the autoclave 21, thus taking water still present in the autoclave inside the tank 22.

[0083] Therefore, one can see that also the transfer phase of water from autoclave 21 to tank 22 occurs without using pumps as it happens in the prior art systems.

[0084] Therefore, the same conditions of Figure 5 occur in the yarn with all the water A contained in the tank 22.

[0085] With reference to the diagrams, during such a phase there is a pressure decrease inside the autoclave and also a temperature decrease.

[0086] The end of the phase of removing water from autoclave 21, indicated by point 31 in the diagrams, is also the start of the suction phase 12 inside the autoclave 21 through the first suction pipe 25 upon closure of valve 24a and opening of valve 25a.

[0087] At the end of the suction phase 12, inside the autoclave 21 there are the temperature and pressure conditions T12 and P12 respectively, with increase of vacuum in the autoclave relative to the vacuum reached at the end of the suction phase 10 of the first thermal cycle C1.

[0088] Then water is introduced again into the autoclave 21 during the phase indicated by 15, occurring as already described in a quite similar way to the corresponding phase 14 of the first thermal cycle C1, that is by vacuum and through the return pipe 28, upon opening of the on/off valve 28a and closure of valve 25a.

[0089] Therefore, in the equipment the situation shown in Figure 6 occurs, where water transfer is terminated after a time t15 when reaching the point 32.

[0090] A further heating of water present in the autoclave occurring in a time t13 according to the phase indicated by line 13 in the diagrams, allows to reach the temperature and pressure conditions T13 and P13 respectively.

[0091] Thereafter one can see a long stay phase of the temperature and pressure condition maintained for a time tp.

[0092] During such time tp, the saturated steam penetrates further into the cone or bobbin and condensing at the inner colder zones, carries out a true "flushing" operation during which the condense water replaces the air molecules still present in the yarn.

[0093] Practically one obtains the almost full replacement of still present air and therefore a humidification of

the cone or bobbin inner zone with percentages of humidity equal to the values of the outer zone.

[0094] By combining the two thermal cycles C1 and C2, a more homogeneous distribution of humidity between inside and outside of cone or bobbin is obtained.

[0095] At the end of time tp inside the autoclave 21 the atmospheric pressure is restored and when reaching the temperature and pressure conditions indicated in the diagrams by the final point 33, the treated yarn is taken out.

[0096] On the base of the foregoing one can therefore understand that the method of the invention and the equipment to carry out the method are attaining all the intended objects.

[0097] More particularly, the spontaneous transfer by vacuum of water from autoclave 21 to tank 22 and vice versa, allows to save use of pumps.

[0098] Moreover, the presence of the hydraulic seal 21 a in the autoclave 21 and the connection of the return pipe 28 at the bottom of tank 22, allow to transfer water avoiding the contemporaneous entrance of air into the autoclave, therefore without losing humidity by the materials under treatment and shortening the cycle time.

[0099] It is clear that the values of temperature reached in the various treatment phases and the length of time of said phases will vary as a function of the kind of yarn and the heat-setting degree that one wants to obtain on it.

[0100] Moreover, modifications could be made to the equipment for instance the vacuum pump may be of any type and more autoclaves and/or water recovery tanks may be provided.

[0101] Said variations of method and equipment, when falling within the scope of the appended claims, are to be considered all covered by the present patent.

Claims

1. A method of treatment for conditioning and heat-setting in an autoclave (21) textile products, more particularly yarns wound in bobbins or cones, comprising the following steps:

- introducing the product to be treated into said autoclave (21);
- closing said autoclave (21);
- carrying out two or more thermal cycles (C1, C2), at least one of them comprising sequentially:
 - a transfer phase (16) of water present in said autoclave (21) inside a recovery tank (22);
 - a suction phase (10, 12) adapted to put said autoclave (21) under vacuum;
 - a return phase (14, 15) of water present in said recovery tank (22) inside said auto-

- clave (21);
- a heating phase (11, 13) of water contained in said autoclave (21) to generate saturated steam;
- a stay phase (35, 36) in said autoclave (21) for a predetermined time (tc, tp) of the conditions of temperature (t11, t13) and pressure (p11, p13) reached at the end of each of said heating phases (11, 13);
- restoring in said autoclave (21) the ambient pressure at the end of the last of said stay phases (36);
- opening said autoclave (31);
- taking said treated product out from said autoclave (21),

characterized in that each of said transfer phases (16) of said water from said autoclave (21) into said recovery tank (22) and return (14, 15) of said water from said recovery tank (22) into said autoclave (21), occurs spontaneously by suction produced by the difference of pressure existing between said autoclave (21) and said recovery tank (22).

2. The method according to Claim 1) **characterized in that** during said transfer phases (16) and return phases (14, 15), the interior of said autoclave 21 does not communicate with outside air and an atmosphere of saturated steam at a pressure lower than the atmospheric pressure is present inside said autoclave.
3. The method according to Claim 1) or 2) **characterized by** comprising two thermal cycles (C1, C2), each of them comprising sequentially:
 - a transfer phase (16) of water present in said autoclave (21) inside a recovery tank (22);
 - a suction phase (10, 12) adapted to put said autoclave (21) under vacuum;
 - an introduction phase (14, 15) into said autoclave (21) of said water present in said recovery tank (22);
 - a heating-phase (11, 13) of water contained in said autoclave (21) to generate said saturated steam;
 - a stay phase (35, 36) in said autoclave (21) and for a predetermined time (tc, tp) of the conditions of temperature (t11, t13) and pressure (p11, p13) reached at the end of each of said heating phases (11, 13).
4. The method according to Claim 2) **characterized in that** the temperature (T10) reached inside said autoclave (21) at the end of the suction phase (10) of the first (C1) of said two cycles (C1, C2), is lower than the temperature (T12) reached at the end of the suction phase (12) of the second cycle (C2).

5. The method according to Claim 2) **characterized in that** the pressure (P10) reached inside said autoclave (21) at the end of the suction phase (10) of the first (C1) of said two cycles (C1, C2), is higher than the pressure (P12) reached at the end of the suction phase (12) of the second cycle (C2).
6. The method according to Claim 3) **characterized in that** the temperature (T11) reached inside said autoclave (21) at the end of the heating phase (11) of the first (C1) of said two cycles (C1, C2), is lower than the temperature (T13) reached at the end of the heating phase (13) of the second cycle (C2).
7. The method according to Claim 3) **characterized in that** the pressure (P11) reached inside said autoclave (21) at the end of the heating phase of the first (C1) of said two cycles (C1, C2) is higher than the pressure (P13) reached at the end of the heating phase (13) of the second cycle (C2).
8. The method according to Claim 3) **characterized in that** the length of time (t10) of the suction phase (10) of the first (C1) of said two cycles (C1, C2), is higher than the length of time (t12) of the suction phase (12) of the second cycle (C2).
9. The method according to Claim 3) **characterized in that** the length of time (t11) of the heating phase (11) of the first (C1) of said two cycles (C1, C2), is higher than the length of time (t13) of the heating phase (13) of the second cycle (C2).
10. An equipment (20) adapted to carry out the method of treatment according to Claim 1) **characterized by** comprising:
 - an autoclave (21) to contain the yarn to be treated;
 - a water recovery tank (22) hydraulically connected with said autoclave (21);
 - a vacuum pump (23) pneumatically connected with said autoclave (21) and said water recovery tank (22).
11. The equipment (20) according to Claim 10) **characterized in that** said autoclave (21) is hydraulically connected with said water recovery tank (22) through:
 - a water transfer pipe (24) provided with an on/off valve (24a);
 - and a water return pipe (28) provided with an on/off valve (28a).
12. The equipment (20) according to Claim 11) **characterized in that** said water transfer pipe (24) connects the bottom of said autoclave (21) with the up-

per part of said water recovery tank (22) and said water return pipe (28) connects the bottom of said water recovery tank (22) with the bottom of said autoclave (21).

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13. The equipment (20) according to Claim 12) **characterized in that** said water transfer pipe (24) and said water return pipe (28) are both connected with the bottom of said autoclave (21) at a hydraulic seal (21a) provided inside said autoclave (21). 10
14. The equipment (20) according to Claim 10) **characterized in that** said vacuum pump (23) is connected to the upper part of said autoclave (21) through a first suction pipe (25) provided with an on/off valve (25a) and to the upper part of said water recovery tank (22) through a second suction pipe (26) provided with an on/off valve (26a). 15
15. The equipment (20) according to Claim 14) **characterized in that** said first suction pipe (25) is connected to the upper part of said water recovery tank (22) through an auxiliary suction pipe (27). 20
16. The equipment (20) according to Claim 10) or 14) **characterized in that** said vacuum pump (23) is of the liquid loop kind. 25

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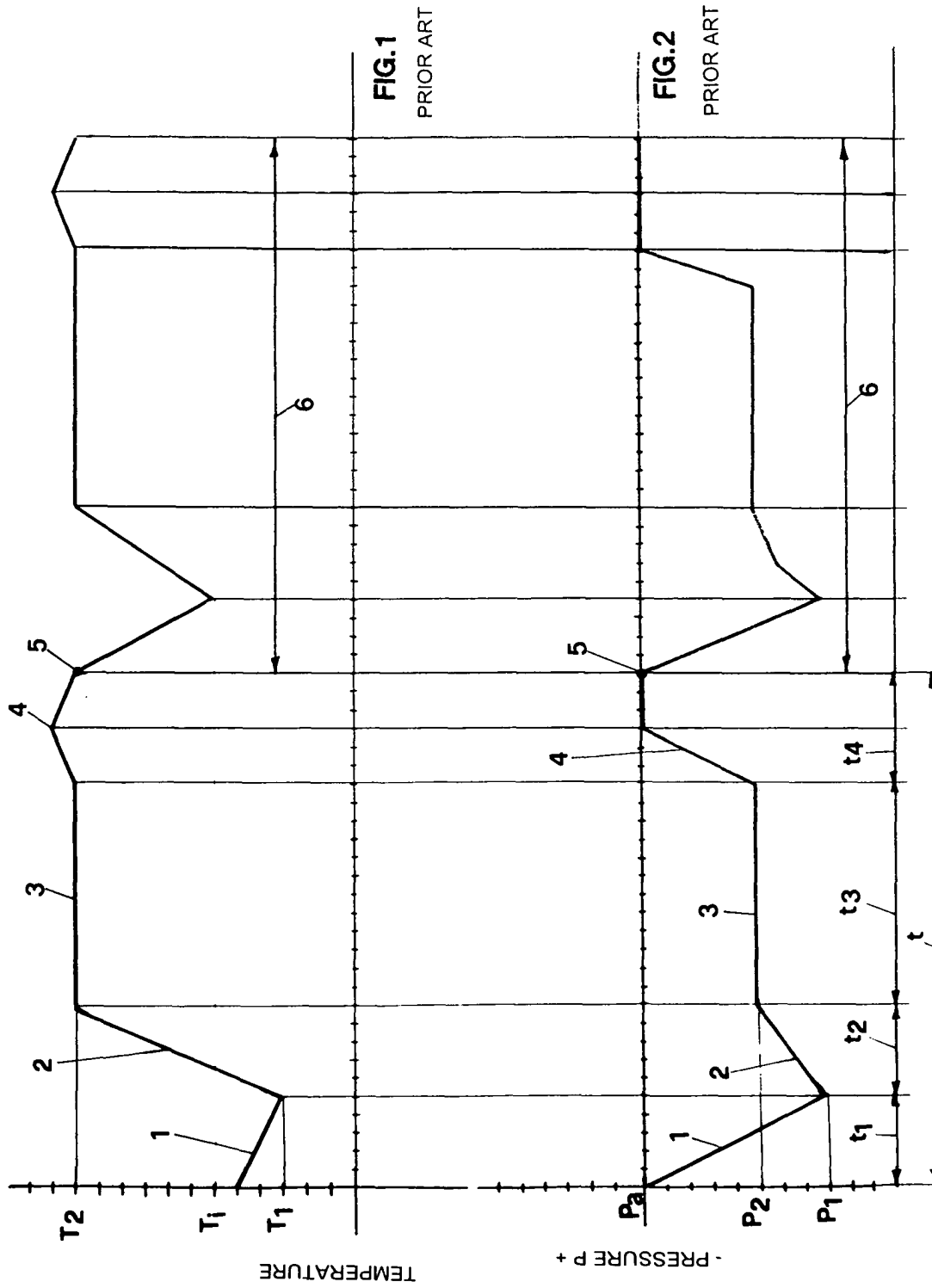
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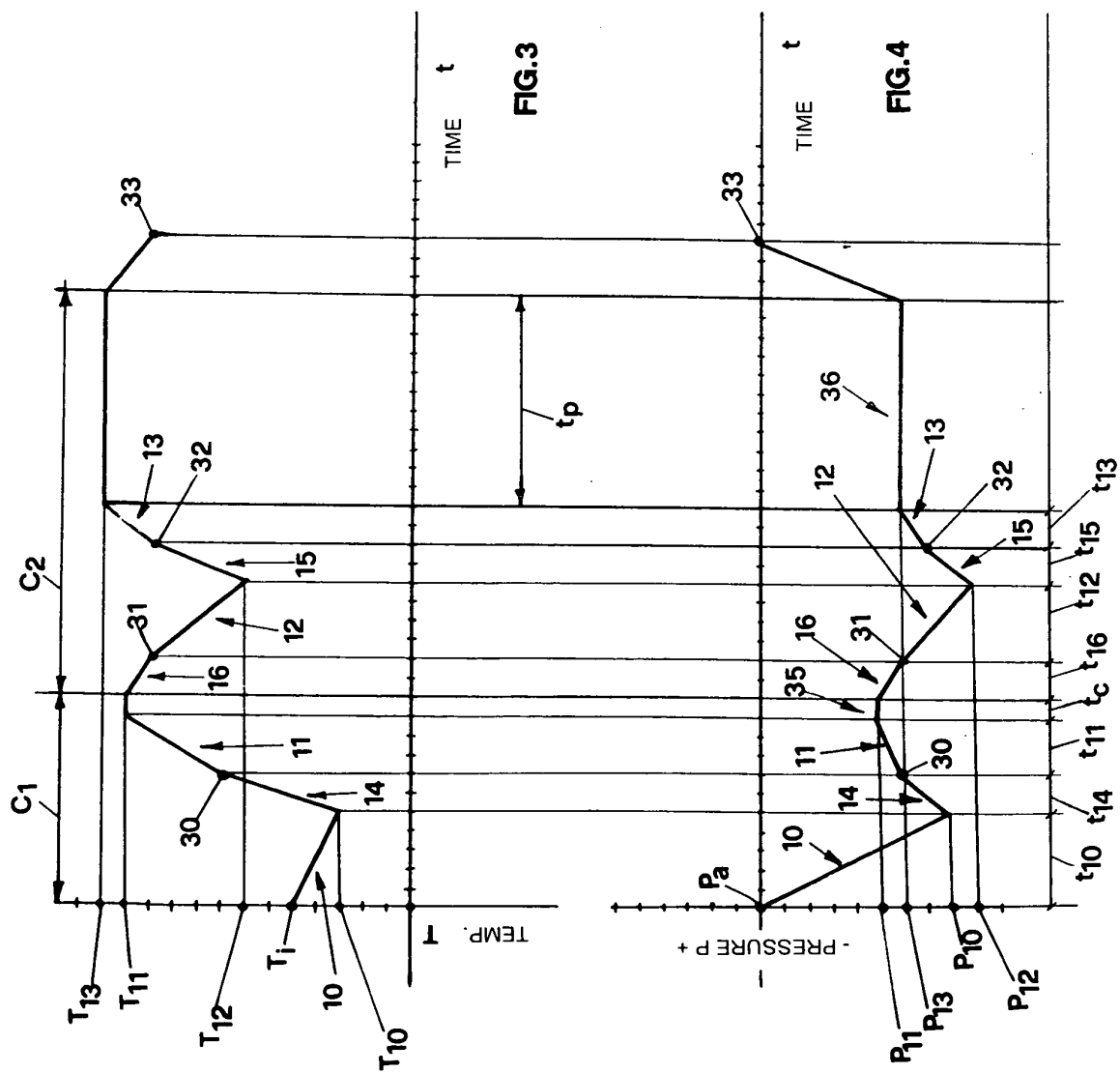
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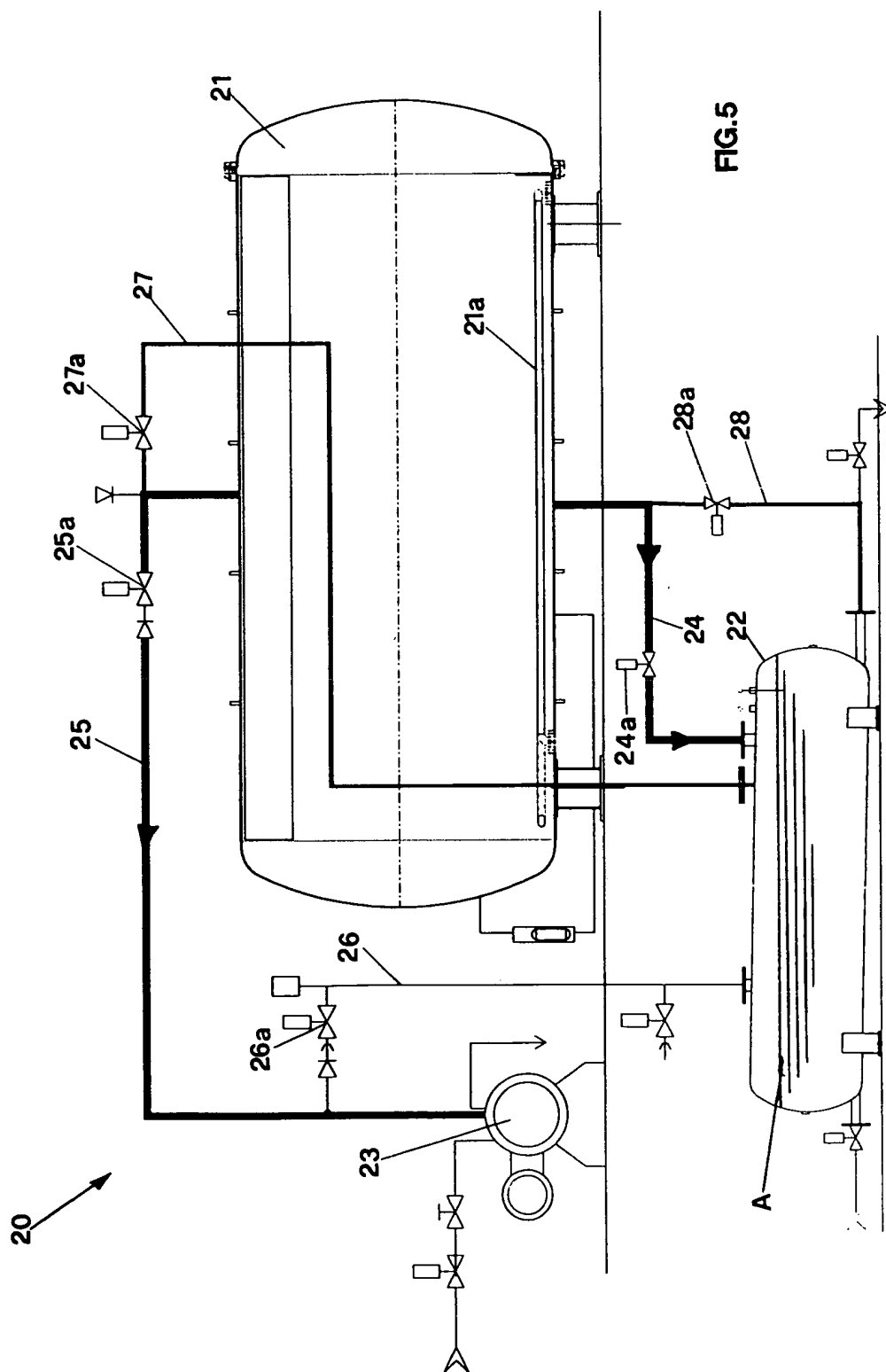
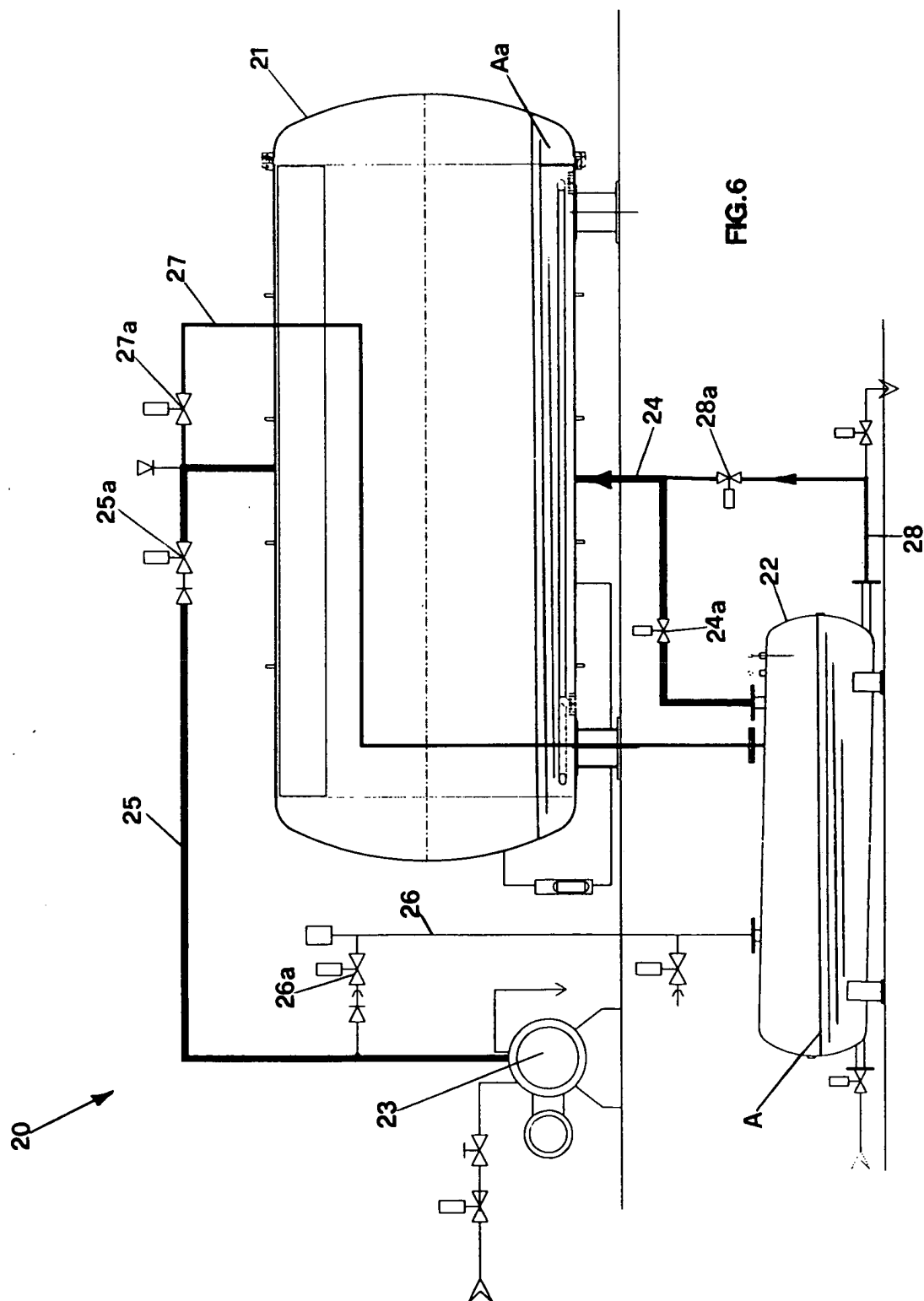


FIG.5



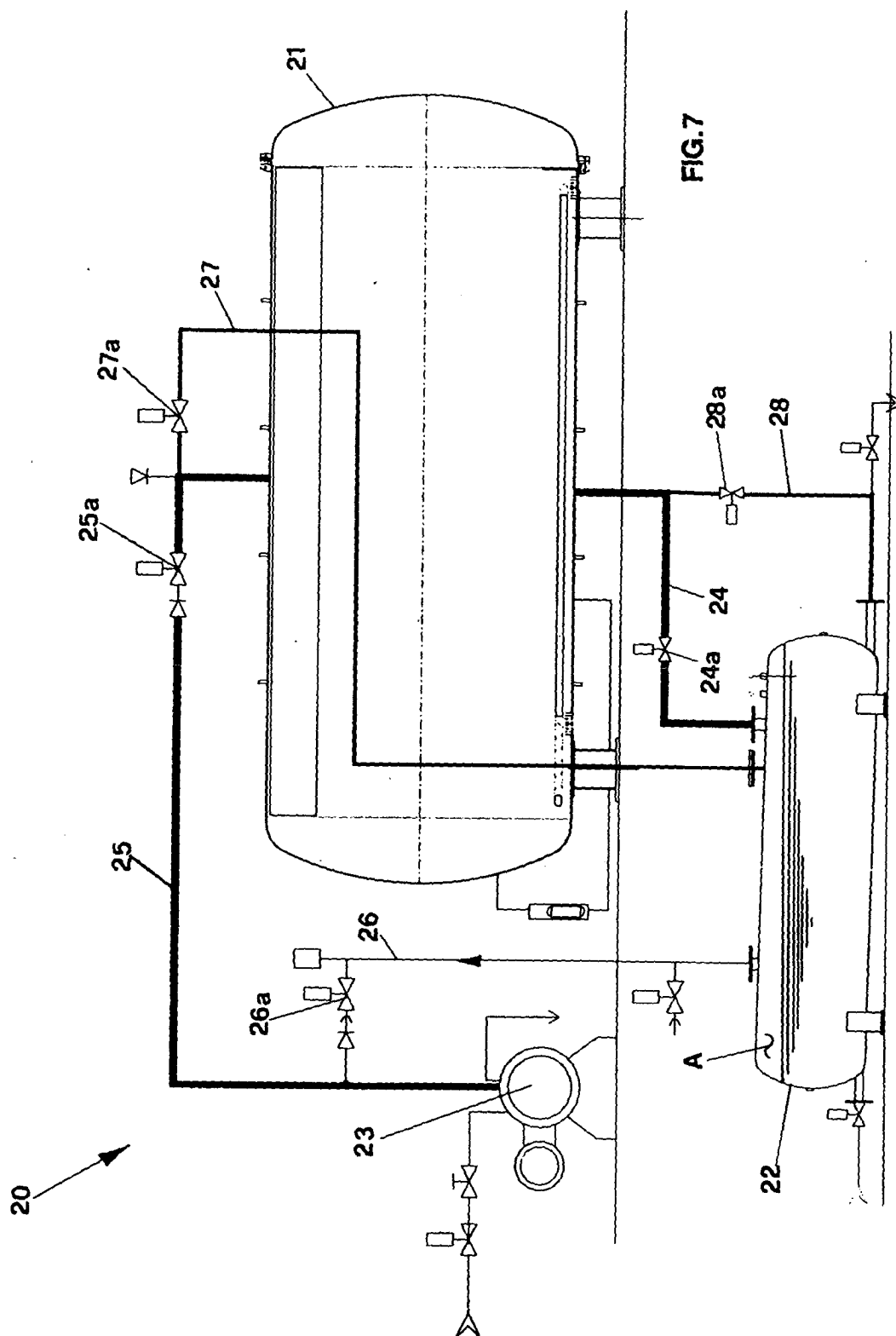


FIG. 7