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Bergholtz

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[54] METHOD FOR TREATING TEXTILE MATERIAL WITH A CIRCULATING LIQUID

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[51] **Int. Cl.**.....**B05c 8/02**

[58] **Field of Search**.....68/189; 8/154, 155.2, 158, 8/155, 155.1

[56] **References Cited**

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[57] **ABSTRACT**

The steps of placing material to be treated in a container, forming the material as separate bodies by placing the material in separate chambers and providing a relatively small clearance between the bodies and the chambers; forming the chambers as part of a heat-exchanger and providing a circulating treatment fluid (heating or cooling) in controlled quantities and maintaining the temperature within the chambers at a desired level; circulating the fluid in a closed circulation system and recirculating the treatment fluid repeatedly through the bodies of material and/or reversing the direction of flow of treatment fluid through the chamber.

5 Claims, 6 Drawing Figures

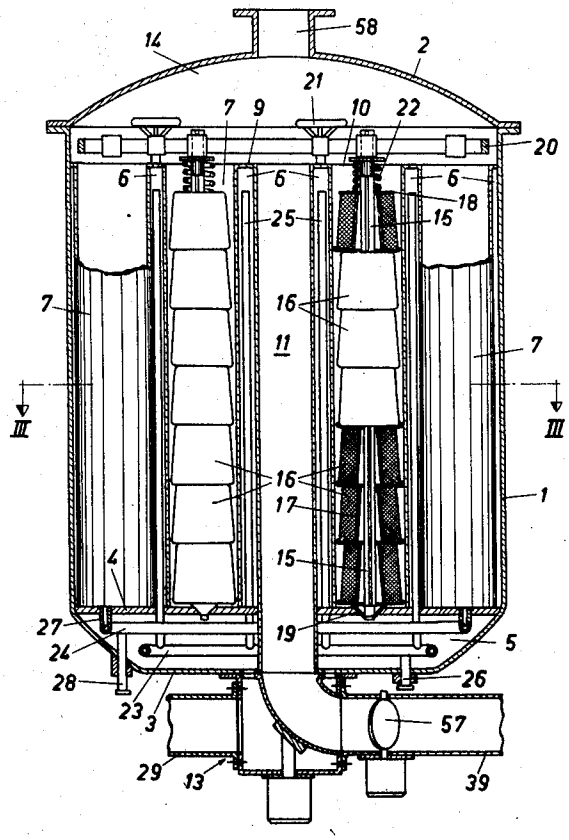

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FIG. 1

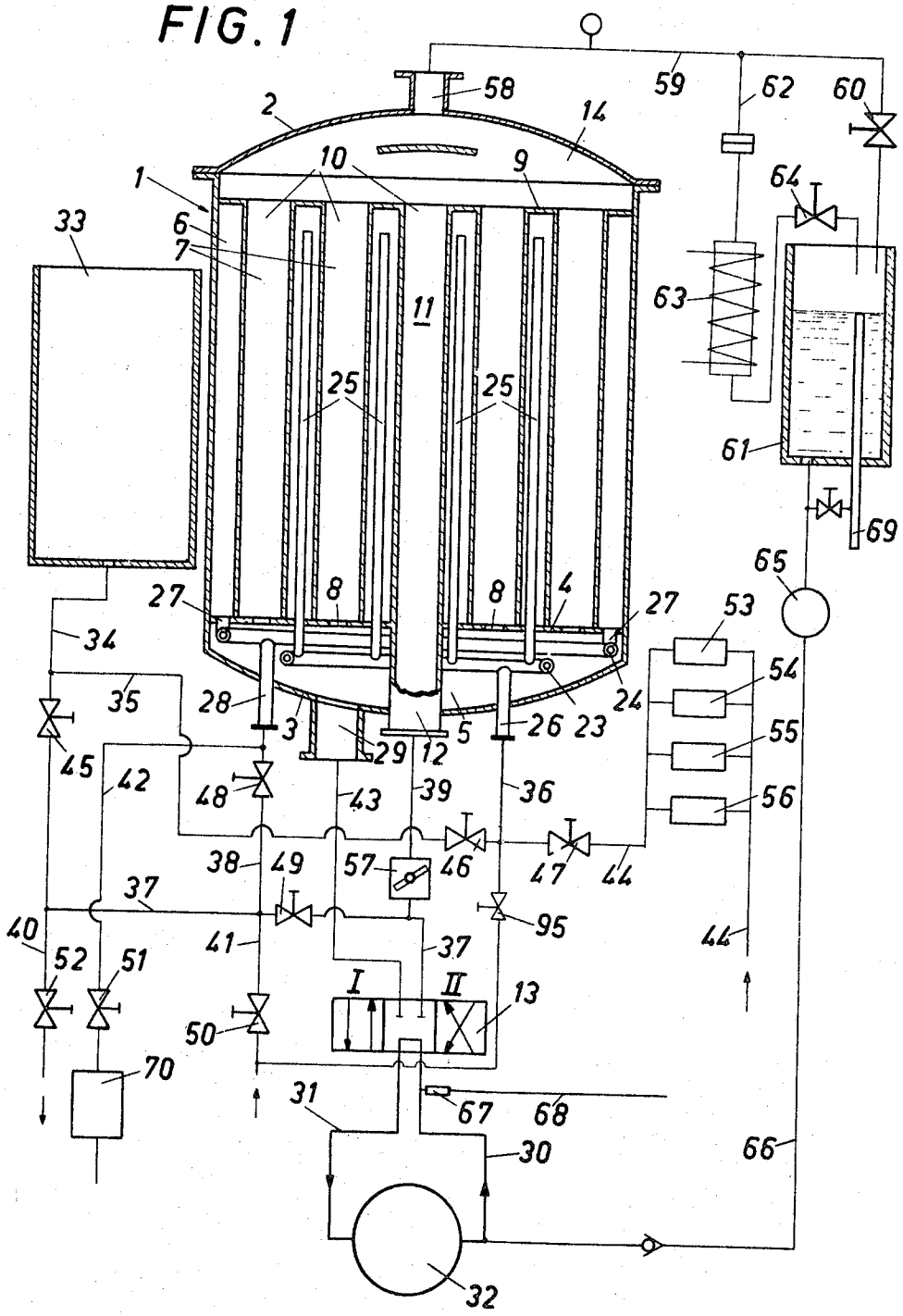

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FIG. 2

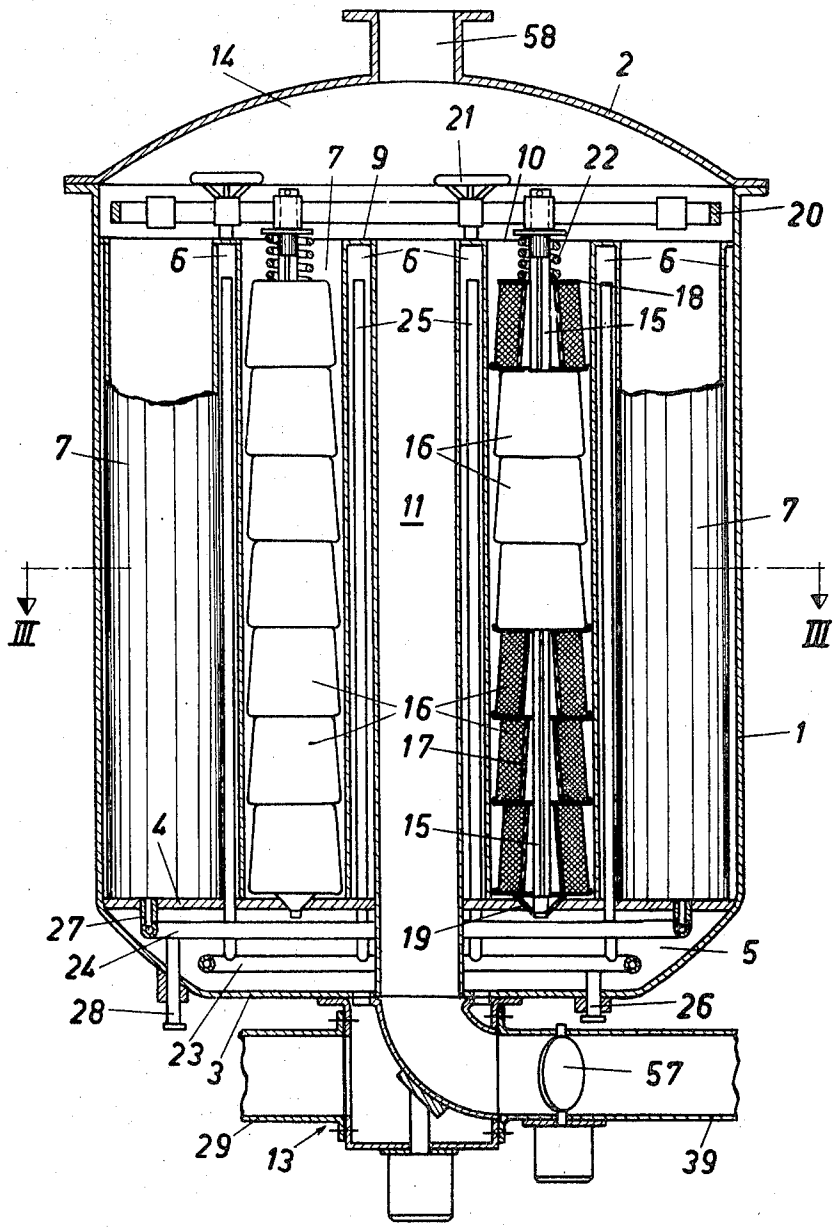

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FIG. 3

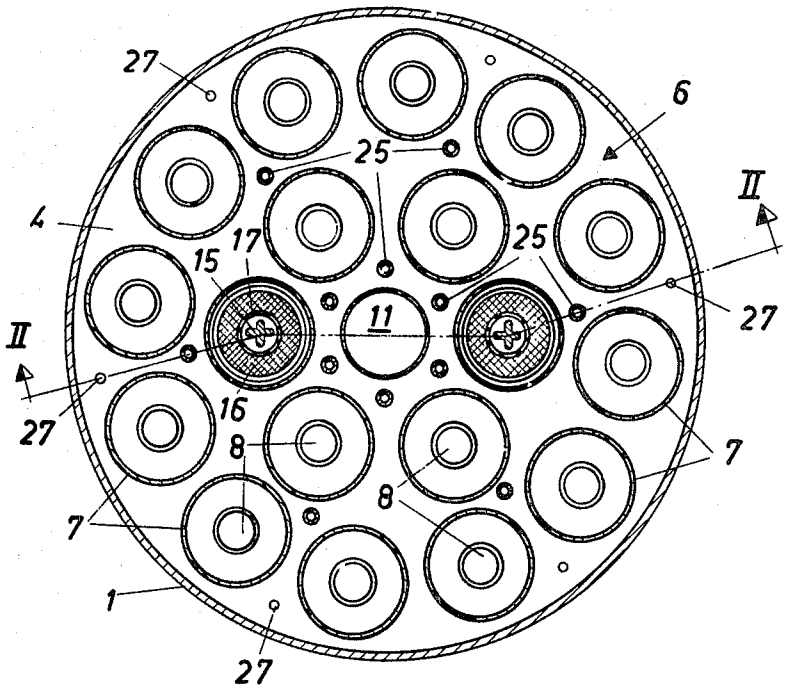

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FIG. 4

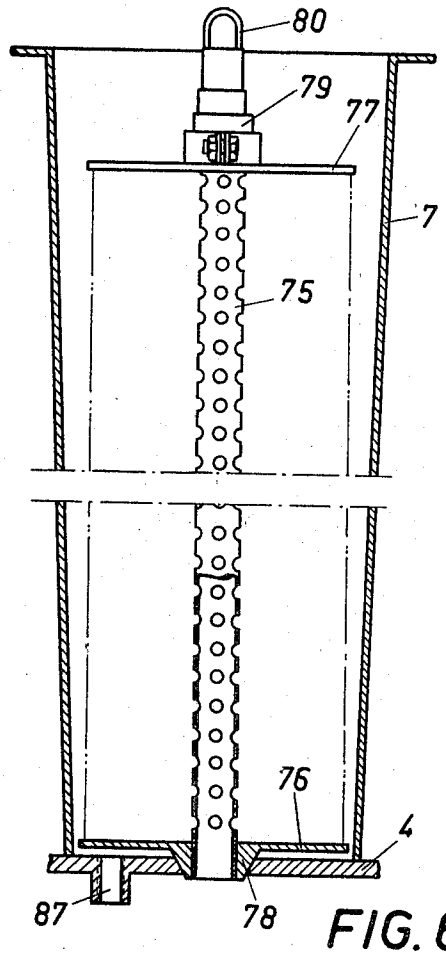


FIG. 5

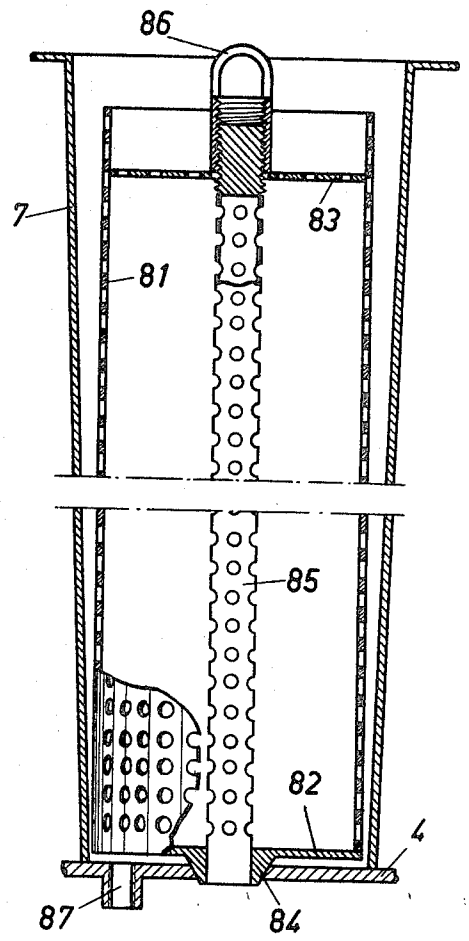
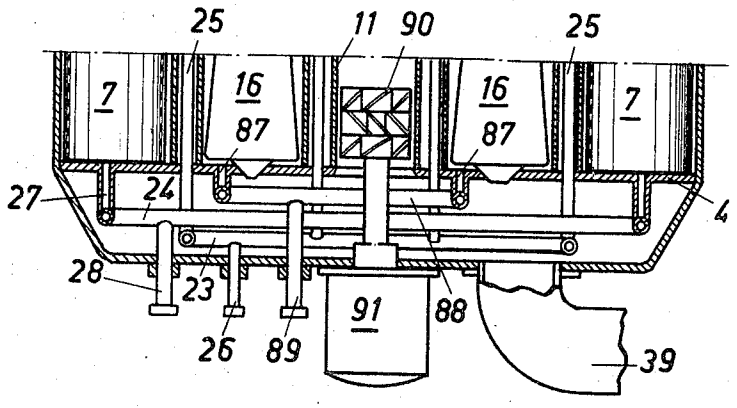


FIG. 6



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METHOD FOR TREATING TEXTILE MATERIAL WITH A CIRCULATING LIQUID

BACKGROUND OF THE INVENTION

The present invention refers to a method for washing, rinsing, bleaching, dyeing or performing other treatment with a liquid of textile material in loose or worked shape, preferably in a vertical container in which the material is enclosed in such a manner that the treating liquid will flow through the material.

With hitherto known apparatuses for dyeing yarn, the latter is wound on perforated steel bobbins. The bodies obtained in that manner are placed in a container between upper and lower liquid distributors on a carrying member in such a manner that the treating liquid will flow from the bobbins outwards through the material, or vice versa. When the treating liquid has passed through the material it is heated in a heat exchanger located in the lower portion of the apparatus before it is once more forced through the material. The treating liquid is circulated with rather high speed. According to a simple rule of the thumb the velocity should correspond to an exchange of 1–1.5 times the liquid content of the container every minute, or approximately 15–20 liters of liquid for every kilo of material per minute. In such an apparatus the yarn bodies are mounted on top of each other to a height of about 1.5 meters. This brings about a corresponding difference in height between the upper and the lower liquid distribution conduit and consequently a corresponding pillar of liquid, which must be taken into account together with the resistance brought about by turbulence in the central liquid conduit between said distribution conduits. During the passage of the liquid through the material the speed, furthermore, will be reduced.

The disadvantage with dyeing apparatuses of the above-mentioned type is the liquid ratio, i.e., weight of material compared to volume of liquid, which in a conventional apparatus may be 1:10–1:15. The large volume of liquid requires a high supply of heat. A further disadvantage is the differences in temperature which will occur during the heating of the liquid. If the liquid within the container is exchanged every minute and the temperature is raised 1° C./minute there is a temperature lag in the container of 1° C. Ordinarily this lag is in fact somewhat higher, as the heat exchanger is located in the lower part of the container, whereby a concentration of heat in the lower region of the heat exchanger is brought about. The dyes used nowadays have an action speed which is highly dependent of the temperature. An increase of 2° C. may therefore double this speed. It is therefore essential that as an even a temperature as possible be maintained. The detrimental influence of the temperature difference may be reduced if the exchange of liquid is increased (if the liquid is exchanged twice per minute and the temperature is increased 1° C. per minute the temperature lag is 0.5° C.). An increased velocity of the liquid will, however, increase the resistance in the textile material, which brings about a risk of clogging and a decreasing flow, inter alia depending on the difference in height between the upper and the lower body of yarn. A further disadvantage of these known apparatuses is the comparatively long time required for the procedure, which inter alia depends on the temperature sinking by approximately 15°–20° C. when the treating liquid is transferred from the preparation receptacle to the cold apparatus, this loss being compensated by reheating in the apparatus.

SUMMARY OF THE INVENTION

The aim of the present invention is to propose a method which eliminates, or in any case reduces the above-mentioned disadvantages to a considerable extent. The invention is characterized by the steps in which; material is placed in a number of individual chambers within the container through which chambers the liquid is made to flow between headers located at opposite sides of the chambers and that a heat transferring fluid is introduced into the space between the chambers in order to control the temperature of the treating liquid. Further advantages will be apparent from the specification and the drawings attached hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a section through a dyeing apparatus for effecting the method and a schematic conduit system attached thereto; the material being treated having been removed,

FIG. 2 shows on a larger scale a longitudinal section through the apparatus for effecting the invention showing therein the material to be treated,

FIG. 3 is a section along line III—III in FIG. 2.

FIG. 4 shows a section through a chamber designed to receive woven material,

FIG. 5 shows a section through a chamber designed to receive loose textile fibers, and

FIG. 6 is section through the lower part of a modified embodiment of the apparatus.

The plant contains a dyeing apparatus, generally denoted by 1, and consisting of a container having a lid 2. In the lower portion of the container and at a distance from the end wall 3 thereof a partition wall 4 is arranged, which subdivides the container into a lower header 5 and a main space 6. In the latter a number of individual chambers, each consisting of a vertical tube 7, are arranged, the said tubes being fluidtightly connected to the intermediate wall 4, each by way of an opening 8 in the intermediate wall communicating with the lower header 5. The space 6 is further defined by an outer shell and an upper horizontal wall 9. The latter is provided with openings 10 for the tubes 7 which likewise are fluidtightly connected to this wall. The chambers 7 may be arranged in many suitable ways within the outer shell, in annular rows or in radially arranged rows. The space within the outer shell may furthermore be subdivided into two or more compartments, whereby different temperatures may be kept in various parts of the apparatus. A supply conduit 11 is located centrally in the container 1, the lower end 12 of the conduit passing through the lower header 5 and being connected to a four-way valve 13. The upper end of the supply conduit opens into an upper header 14 in the same manner as the vertical tubes 7. The latter are so dimensioned, that they with a clearance will permit the introduction of bodies of yarn 16 wound upon bobbins (FIG. 2). Each bobbin consists of perforated, conical steel tube 17. At its lower end the rod 15 is provided with a conical member 19 by the aid of which it is possible to connect the internal passage in the stack of bobbins 17 with the header 5 while separating the outside of the bobbins therefrom. The uppermost bobbin 17 of the stack is in its upper end covered by a washer 18 in such a manner that the liquid from the lower header 3 cannot pass out this way, but must flow through the perforation in the bobbins 17 and the bodies of yarn 16. In the upper portion of the container, the rods 15 are centrally located with respect to their pertaining passage by means of an orienting member 20 which by the aid of one or more screw-threaded handles 21 may be brought to force the stacks of yarn bodies 16 against the action of springs 22 towards the partition wall 4.

Two annular distribution manifold pipes 23 and 24 are mounted in the lower distribution header 5. To the first mentioned distribution pipe 23 a number of vertical pipes 25 are attached, which sealingly pass through the partition wall 4 and extend into the space 6 within the container 1 between the vertical chambers 7. The pipes 25 have such length that their open ends will be located just below the upper partition wall 9. The annular distribution pipe 23 is furthermore provided with a connection 26 which extends outside the end wall 3. The second annular distribution manifold pipe 24 likewise is in connection with the space 6 by way of connection pipes 27 which, however, open into space 6 close by the bottom thereof. The second annular distribution manifold pipe 24 is provided with a connection 28, which also extends through the lower end wall 3. This wall is further provided with a con-

nection conduit 29, which might serve as inlet or outlet for the treating liquid, and which is connected to the above-mentioned four-way valve 13. The remaining openings of said valve are connected to the pressure and the suction conduits 30 and 31, respectively, of a pump 32 having a large capacity.

The plant further comprises a receptacle 33 for preparing the dyeing liquid. A conduit 34 extends from the lower portion of the latter and a number of branch conduits 35–41 and connection conduits 42–44, as well as number of valves 45–52 are included in the distribution system. In conduit 44 there is furthermore located a number of steam valves 53–56, which are calibrated in such a manner that for instance an opening of valve 53 will bring about a temperature increase of 1° C. per minute in the container, whereas an opening of valve 54 will result in a temperature increase corresponding to 2° C. per minute, a.s.f. A throttle valve 57 is fitted into conduit 36 close by the lower end 12 of the supply pipe 11.

The lid 2 of the container 1 is provided with an outlet opening 58, from which a conduit 59 provided with a valve 60 leads to an open receptacle 61. A branch pipe 62 is connected to a conduit 59 and passes through a cooler 63, which by way of a valve 64 is connected to receptacle 61. The latter is connected to the suction side of a pump 65, the outlet of which by way of conduit 66 is connected to the pressure conduit 30 from pump 32. The receptacle 61 is further provided with an overflow pipe 69. Reference 70 denotes a condense water separator. An injector 67 connected to a compressed air conduit 68 is also attached to this pressure conduit 30 from the pump. The air is finely divided in the stream of flowing liquid whereby the latter will contain a large number of very tiny air bubbles. These will aid the dyeing process. Part of the air bubbles will be caught in the material and will restrict the passageways for the liquid therethrough. This will increase the velocity, which has an advantageous influence upon the dyeing process and ensures a more even distribution of the dyestuff over the material.

The plant operates in the following manner, it being presupposed that one dyeing operation is just finished and that the space 6 surrounding the chambers is filled with hot water from this operation. The chambers 7 of the container 1 are charged with yarn bodies 16 mounted on rods 15 and the container 1 is closed. A treating liquid has been prepared in the receptacle 33 and heated to the desired temperature. The liquid is now transferred from receptacle 33 to the apparatus by the valves 45 and 49 being opened, while the remaining valves are closed. The liquid will thus pass through conduits 34 and 37 to the four-way valve 13, which is put into position II, whereby the lower header 5 is connected to the pressure side of the pump. The liquid will thus pass through openings 8 in the partition wall 4 and flow into the perforated bobbins 17 and through the bodies of yarn 16 which are stacked on each other. Hereby all air will be displaced from the container. If the volume of liquid in the receptacle 33 is not sufficient to fill the container 1 valve 45 is closed and valve 48 is opened in such a manner that the hot water in the space 6, i.e., the exchanger, can flow to the suction side of the pump 32 by way of conduits 38 and 37. Simultaneously with the opening of valve 48, valve 46 is also opened, whereby space 6 will be connected with the atmosphere by way of the empty receptacle 33. If still further water is required this is added by opening the cold water supply valve 50, all other valves with the exception of valve 49 being closed. During the filling procedure valve 60 has been open so the container has been completely evacuated. When the container is filled with fluid this will flow out through a conduit 59 to the receptacle 61. This is provided with an electronic device, which closes valves 48, 49, 50 and 60 and opens valve 52 in such a manner that the preparation receptacle 33 may be washed and emptied. Any possible content in the heat exchanger space 6 is also drained through valve 48 being opened for a short while, whereupon valve 51 is opened. The heating of the liquid in container 1 is obtained by steam being admitted to space 6 by way of valves 53–56 and valve 47, and through pipes 44, 36, 26 and the annular distribution pipe 23, from which it is distributed to the vertical pipes 25. Steam will thus flow out into the space 6 and will condense on the cooler outside surfaces of the chambers 7. The condense water will be drained away through the pipes 27, the annular distribution pipe 24, the connection 28 and conduit 42 to the condense water separator 70.

During the dyeing process a certain steam pressure is maintained in the container, such a pressure being regulated by means of a needle valve 64. The four-way valve 13 is shifted from position 1 to position 2 with intervals of a few minutes, which means that the circulation direction through the chambers is reversed in such a manner that the liquid on one occasion flows from the inside and outwards through the bodies of yarn, and the next time flows from the outside of the bodies into the bobbins. As the volume of the liquid in each tube is comparatively small and the tubes along their entire length are enclosed by the heating fluid it is possible to maintain a very exact temperature in the dyeing liquid.

When the dyeing procedure is finished valves 47 and 51 are closed and valves 50 and 48 are opened whereby cold water will be admitted to the heat exchanger 6 to cool the dyeing liquid enclosed in chambers 7. When the cold water has reached the level of the upper end of the vertical pipe 25 close by the upper wall 9 the water flows out through said pipes and is by way of conduit 26 transferred to the preparation receptacle 33 by way of conduits 26, 36, 35 and 34. Beside valves 50 and 48 valve 46 is also open, whereas all other valves are closed. As the hot water, i.e., the water which has been heated by the contact with walls of chambers 7, has less gravity than the cooler water supplied, the hot water will rise on top of the cool water in such a manner that only the hottest water will be withdrawn through pipes 25. Hereby an efficient cooling is obtained and heated water is produced which may be utilized for instance for rinsing purposes.

A further way of obtaining a rapid cooling of the liquid within the containers is to drain the space within the heat exchanger through conduit 28, 38, 40 and to open valve 95 in the cold water supply conduit. The cold water will then flow through conduits 36, 26 and distribution pipe 23 and be ejected through pipes 25 against the lower wall of the upper header. From this wall it falls as a shower onto the walls of the chambers 7 and is drained away by circuit 27, 28, 48, 37, 40 and 52. When the dyeing liquid in the container 1 has been cooled to the desired temperature it is possible by means of steam very rapidly to force the remaining cooling water out of the container by closing valves 50 and 46 and opening valves 47 and 45.

During the next step of the procedure the bodies of yarn are washed with cold water by the valves 50, 49 and 60 being opened whereas the remaining valves as well as the throttle 57 are closed. With the four-way valve 13 in position II the dyeing liquid will flow out through the outlet pipe 29 and to the receptacle 61 from which it flows out through the overflow pipe 69. When the rinsing is finished valve 50 is closed and valve 52 is opened, whereupon four-way valve 13 is brought to position 1. The suction side of the pump 32 will then be connected to the lower header 5 at the container and the pressure side of the pump is connected to outlet conduit 40.

If the temperature of the rinsing water is too low it may be heated by means of steam in the same manner as is done with the dyeing liquid.

FIG. 4 shows a modified embodiment of a chamber 7 suited to receive woven material wound on a central body. The walls of the chamber 7 taper somewhat outwards from the bottom towards the top in such a manner that the clearance between the mainly cylindrical roll of cloth and the internal wall of the chamber will increase in the direction away from the bottom. The taper is chosen in such a manner that the velocity of the liquid flowing through the clearance will remain mainly constant, irrespective of the fact that a certain volume is added to or removed from the main stream, respectively, as the distance from the bottom of the chamber increases. The same type of tapering chambers may of course also be used in the apparatus of FIG. 1 one treating yarn bobbins.

The cloth is wound on a perforated tube **75** provided with two end plates **76** and **77**. The end plate **76** turned downwards is provided with a truncated conical projection **78** adapted to fit into the corresponding opening of the lower partition wall **4**. The upper end plate **77** is adjustable in the longitudinal direction of the central tube and is provided with a sleeve **79** designed to close any openings in the perforated tube which will be located outside the upper end plate **77**, when the latter is adjusted downwards in order to accommodate cloth having lesser breadth than the height of the chamber **7**. The central tube **75** is closed upwards in such a manner that the circulation of the liquid will be from the lower header through the tube outwards through the cloth or from the chamber through the cloth into the central tube. The latter is furthermore at its upper end provided with an eye **80** to facilitate lifting the complete unit into and out of the chamber.

The expression perforated tube must not be understood as necessarily implying a cylindrical member. Any type of hollow supporting element provided with suitably distributed openings may be used. The element may for instance be formed as a helically wound thin rod or wire.

FIG. **5** shows a corresponding embodiment suited for the treatment of unworked material, i.e., loose textile fibers which is stuffed into a perforated cylinder **81** adapted to be fitted into the chamber **7**. The latter is also in this embodiment provided with tapering walls in such a manner that the clearance between the wall of the cylinder and the internal wall of the chamber will increase in the direction away from the bottom to maintain an even flow velocity within the clearance. Both ends of the cylinder are closed by end walls **82** and **83**, respectively. The latter wall is designed as a removable lid, and the bottom end wall **82** is provided with an extension **84** suited to fit into the opening in the lower partition wall **4**. A perforated tube **85** extends through the cylinder and is at its upper part provided with an eye **86** to facilitate handling. The circulation of the fluid is the same as in the embodiment according to FIG. **4**.

FIG. **6** shows the lower part of a modified embodiment of an apparatus shown in FIG. **2**. The lower end wall **4** is provided with the same annular distribution pipes **23** and **24** and the connections therefrom to the space **6** in the exchanger, i.e., pipes **27** to the bottom thereof, and pipes **25** to the top thereof.

When synthetic solvents are used in connection with a dyeing process it may be necessary thoroughly to extract the solvent from the material before the latter is removed from the chambers. The liquid is drained in the ordinary manner, and in order to facilitate extraction of the solvents wetting the material each chamber **7** is provided with an outlet passage **87**, which is in communication with an annular collector **88**, from which fluid may be conducted away by a pipe **89**.

When using such synthetic solvents hot air is blown into the lower header, which air in the same manner as the liquid will pass through the internal passage, the steel bobbins **17** or the central tubes **75** or **85**, respectively, outwards through the material and then away through the upper header. This hot air will evaporate the solvent remaining in the material and blow it out in the chambers where it will condense on the internal walls thereof.

The external walls of the chambers are cooled by fluid supplied through the pipes **27**. The condensed solvent will collect at the bottom of the chambers and be drained away the conduits **87**, **88** and **89**.

FIG. **6** also includes a further modification. The pump **90** is located within the central conduit **11**, which here is open directly into the lower header. This pump is driven by a reversible motor **91**, which is governed by a suitable mechanism in such a manner that the direction of rotation of the pump will be changed with regular intervals, thus forcing the fluid within the chambers inwards and outwards through the material.

With the above-described design of the plant the following advantages are obtained.

1. The bodies of yarn **16** are narrowly enclosed by the chambers **7** and the space between the latter is utilized as a heat exchanger. The total volume of liquid is therefore considerably less than with conventional dyeing apparatuses, where all bodies are arranged in a common container. The volume of liquid compared to the weight of material will thus be noticeably reduced.

2. The subdivision of the container into a number of smaller chambers **7** brings about an increased velocity of liquid during the operation when utilizing the same size of pump and driving motor as with a conventional dyeing apparatus of corresponding capacity.

3. As the heat exchanger extends all along the long tubes **7** the dyeing liquid will during most of the time it is circulated be in contact with the heat exchanger and only be cooled during the time it passes through the headers and in the design according to FIG. **1** also through the four-way valve **13** and the pump **32**. The volume of liquid in those parts may be one-sixth only of the total volume so the temperature difference during a temperature raise of 1° C. per minute will only amount to one-sixth of a centigrade i.e., only 0.054° C. if the liquid is exchanged once per minute. A head of steam is maintained within space **6**. Steam will condense on the comparatively cooler outer walls of the chamber, whereby fresh steam is admitted into the heat exchanger. In this manner an even temperature is maintained in the treating liquid. When heating the liquid 5° C. per minute the temperature difference between the liquid and the heat exchanger is about 35° C.

4. As the height of the pillar of liquid inside the main body of textile material is mainly the same as that of the column of liquid outside the body within the chamber **7** approximately the same flow-velocity through the lowermost and the topmost part of the body is obtained. A smooth flow through the material is also aided by the fact that the liquid flowing outside the body of material will act as an ejector.

5. As the heat exchanger **6** surrounds the chambers **7** it is possible to take care of the cooling water and utilize it for a following step in the procedure, or during the next dyeing operation.

6. As the volume of treating liquid is small compared to the volume of material and due to the higher flow velocity the time for treating the material may be reduced, when compared to conventional dyeing methods.

7. A more even quality of the products is obtained as a result of the above-mentioned points.

8. When it is desired to dye a small volume of material, which is less than the capacity of container, it is necessary to utilize a number of dummy yarn bodies. Also on that occasion the relation between liquid and material will be acceptable. It is furthermore possible to blank off the openings **8** and **10** to one or more chambers **7**, if the volume of material to be treated should not completely fill all chambers.

What we claim is:

1. A method for treating textile material with a liquid for washing, rinsing, bleaching, dyeing and the like in a container in which the material is disposed in the container in such a manner so that the treating liquid flows through the material characterized by the steps of:

placing the material in a number of individual chambers enclosed by the container wall and extends between distribution and collection headers located at opposite ends of the chambers;

directing the treating liquid flow from one header to the other and passes through the material; and

applying a heat transfer fluid through the space between the chambers and the container wall and controlling the temperature of the treating liquid in the chambers between the headers.

2. A method for treating textile material with a liquid in which the material is formed as a number of bodies, the steps of:

placing one such body in a basically complementary chamber in an apparatus having a plurality of such chambers;

passing a treating liquid continuously through the chambers;

supplying a heat-transfer fluid into the apparatus and outside of the chambers in controlled quantities to maintain the temperature within the chambers at an adjusted level; and

introducing the fluid for heating purposes through one or more pipes in an interspace in the vicinity of an upper wall defining said space, and introducing cooling fluid through one or more pipes closed by the bottom of said interspace.

3. The method according to claim 2, including withdrawing cooling fluid from the interspace through supply pipes for the heating fluid and conveying the heating fluid by way of conduits to a receptacle.

4. The method according to claim 2, including rapidly removing the cooling fluid in the interspace by the introduction of a gaseous fluid such as compressed air or steam by passing it through heating fluid supply pipes and into the interspace.

5. The method according to claim 1 including introducing the fluid for heating purposes through one or more pipes in the interspace in the vicinity of an upper wall defining said space and forming jets striking against said wall and producing a shower spraying the walls of the chambers.

* * * * *