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Ohya

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[54] CONTINUOUS STEAM-HEATING METHOD AND APPARATUS FOR CONTINUOUSLY TREATING OR DYEING COTTON AND OTHER FIBERS

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[52] **U.S. Cl.**.....**8/149.1,** 8/149.3, 8/156, 68/5 E, 68/22 R, 68/22 B, 68/43, 100/93 P, 100/238

[51] **Int. Cl.**.....**D06p 5/02,** D06p 7/00

[58] **Field of Search**.....8/149.1, 149.3, 156; 68/5 R, 68/5 C, 5 E; 100/93 P

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[57] **ABSTRACT**

A method of continuously treating or dyeing cotton and other fibers and an apparatus therefor, comprising a mechanism whereby cotton and other fibers are saturated uniformly with a dye liquor or a treating liquor and are fed to a fiber-receiving pipe having a steeply sloped inner surface, a pressing mechanism whereby cotton and other fibers are pressed into the cotton-receiving pipe intermittently in the state of layers, a cylindrical steam-heater provided below the fiber-receiving pipe, a mechanism whereby a sealing force is imparted to the lower end of said steam-heater, and a horizontal steam-heater for the secondary steam-heating.

3 Claims, 6 Drawing Figures

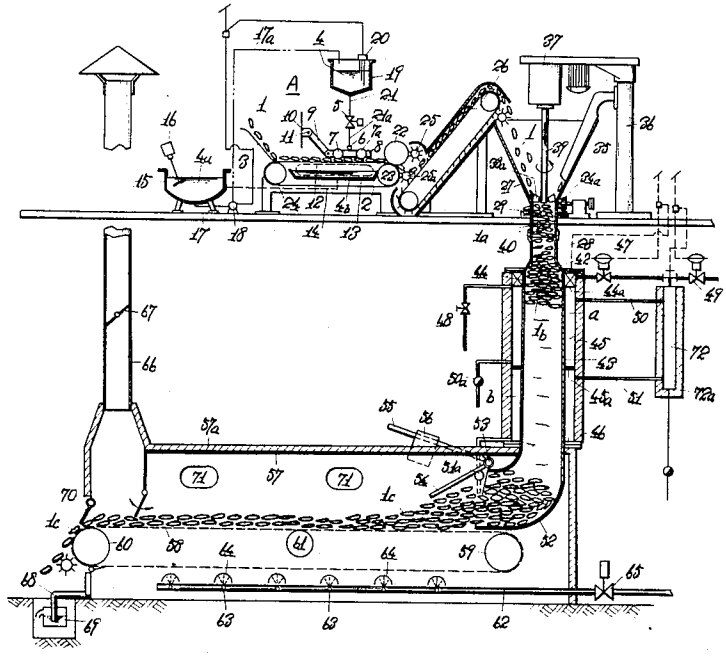

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Fig. 1

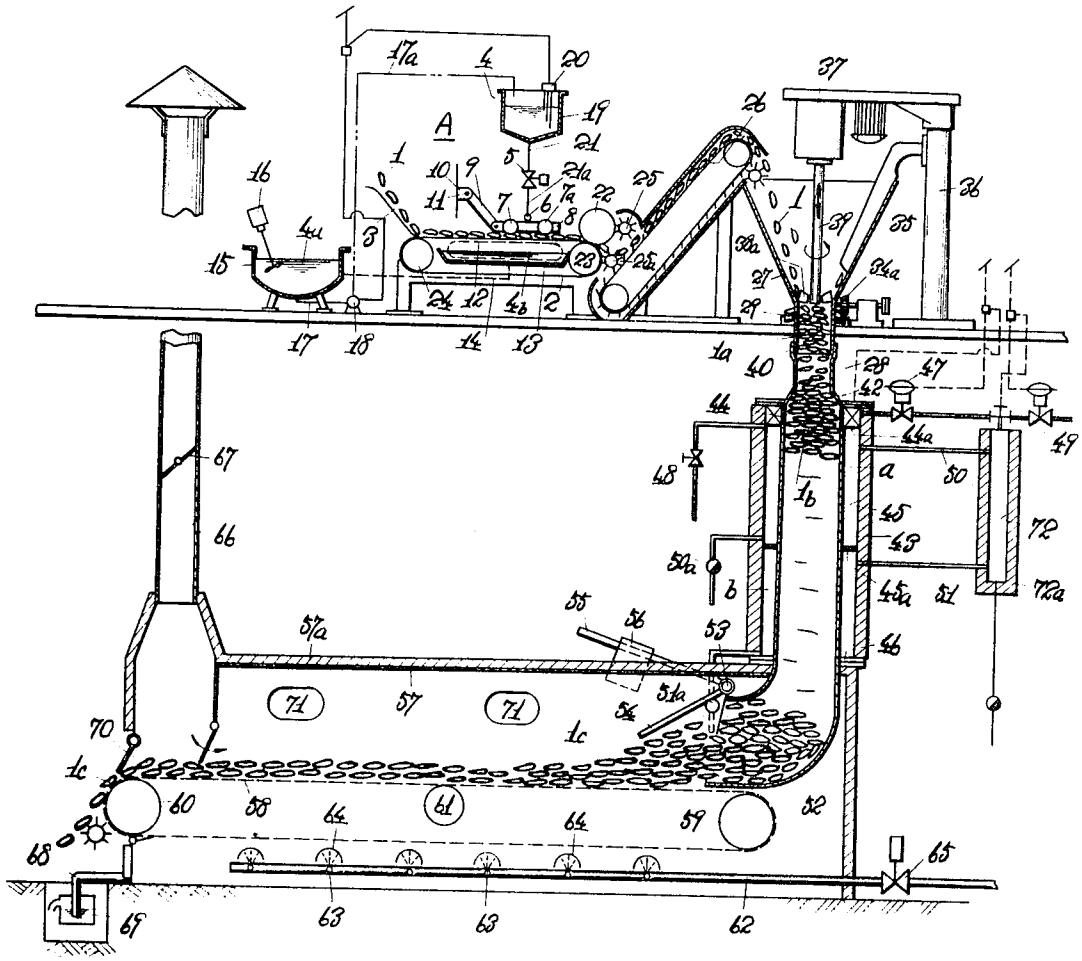

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Fig. 2

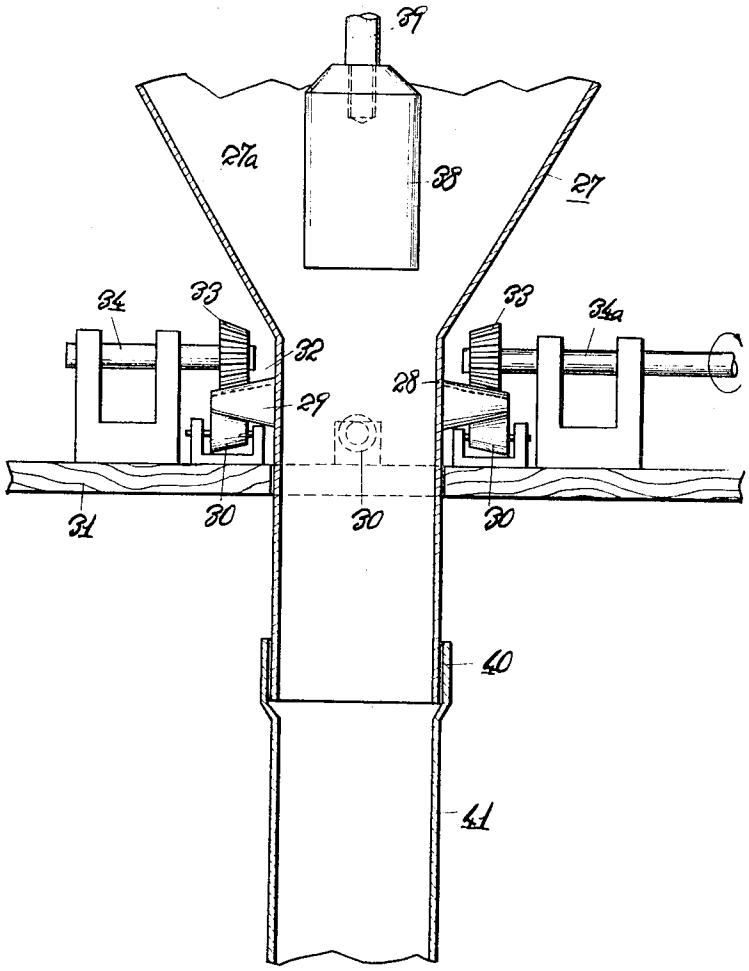

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Fig 3A

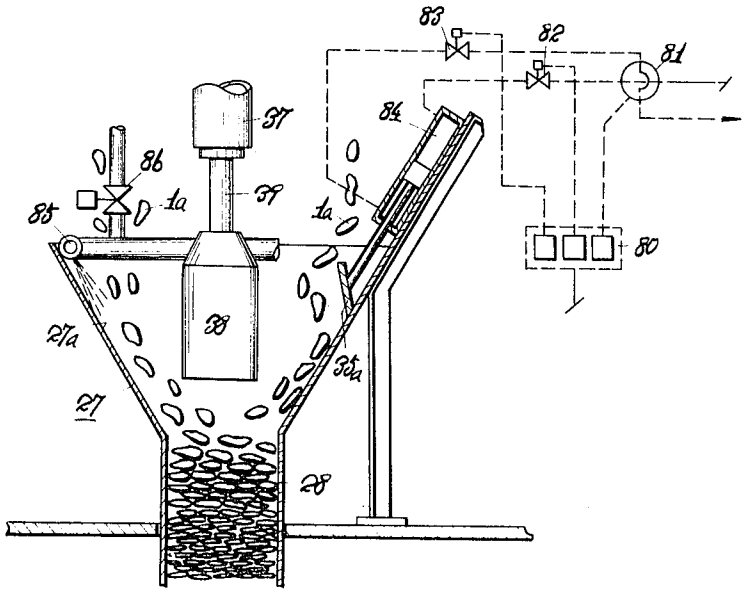

Fig. 3B

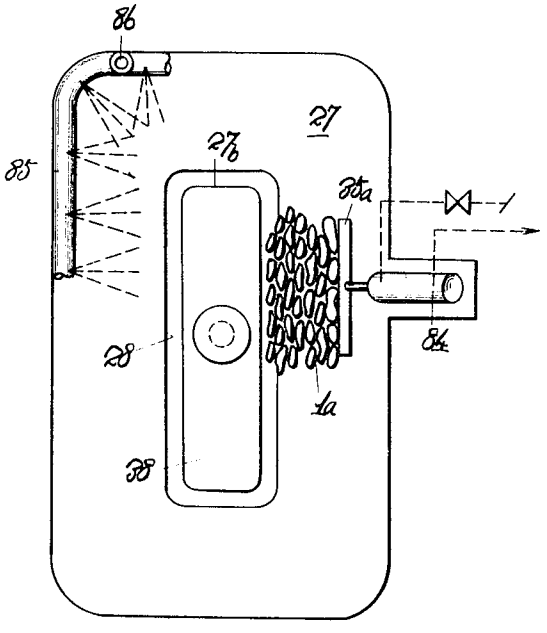

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Fig. 4

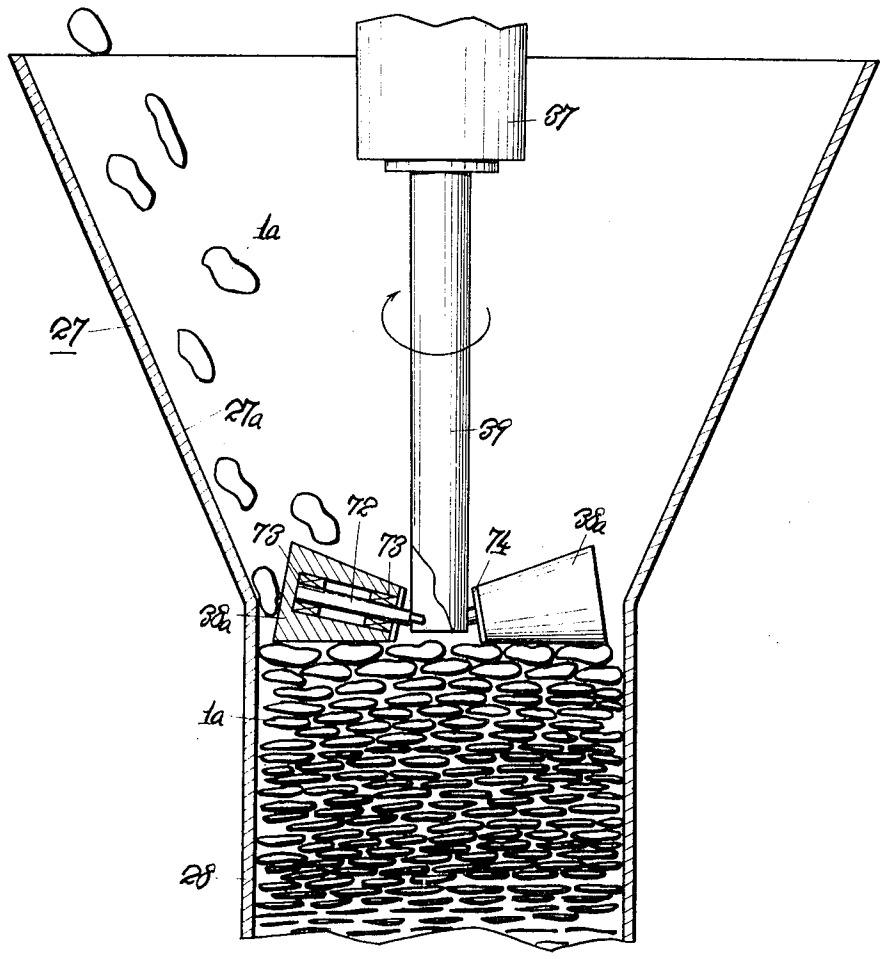

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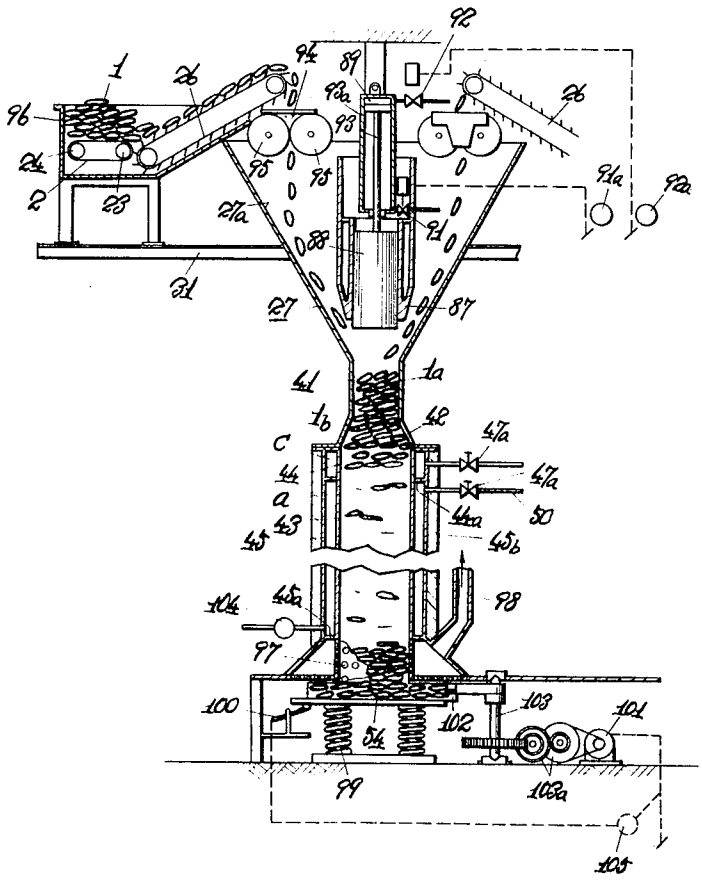
Fig. 5



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CONTINUOUS STEAM-HEATING METHOD AND APPARATUS FOR CONTINUOUSLY TREATING OR DYEING COTTON AND OTHER FIBERS

This invention relates to a method and an apparatus for steam-heating treatment in the case of continuous dyeing or various treatments of cotton and other fibers. An object of the present invention is to make it possible to dye or treat continuously cotton and other fibers, including conjugated fibers and mixed fibers. Another object of the present invention is to provide a method and an apparatus for dyeing cotton and other fibers in multi-colors in one process, in the desired fiber mixing ratio and in the desired color mixing ratio.

According to the present invention, cotton or other fibers are first saturated uniformly by one or a plurality of dye liquors or by a treating liquor supplying device, are dropped into a cotton-receiving pipe of inverted-cone shape, inverted-pyramid shape or other shapes and are sent intermittently in pressed layers into a steam-heater of vertical cylindrical shape (for direct and indirect steam-heating) by means of a filling piston which has perpendicular reciprocating motion, whereby the dye liquor or the treating liquor is adsorbed on the surface of the fiber and then diffuses into and fixes within the fiber structure. Fibers thus-treated are further sent into a horizontal chain conveyor belt-type steam-heater for the secondary steam heating, by way of a J type outlet portion having a switch device to maintain a proper pressure and heating by a weight, spring, compressed air, etc.

In a horizontal conveyor belt-type steamer conventionally used for dyeing cotton and other fibers, the contact between the saturated high temperature steam for steam-heating and the relative low temperature of the material to be dyed causes water to precipitate on the surface of the material. Also, the high temperature steam causes a lowering of the viscosity of the dyeing auxiliaries which in turn causes the dye liquor to settle, with the result of unlevel dyeing and irregular treating.

The present invention has its greatest merit in that it eliminates the aforementioned trouble by effecting adsorption of dyes, auxiliaries, etc. and diffusion of these materials within the fiber at the first stage of treatment by using a vertical type steam-heater.

The nature and advantages of the present invention will be understood more clearly from the following description made with reference to the accompanying drawings in which:

FIG. 1 is a front elevation, in longitudinal section, of an apparatus embodying the present invention.

FIG. 2 is a detail drawing of a material fiber feeding part.

FIG. 3A shows details of the operating condition of the cylindrical fiber-receiving pipe of inverted cone-shape and parts related thereto shown in FIG. 1 and FIG. 2.

FIG. 3B is a plan view of FIG. 3A.

FIG. 4 and FIG. 5 show respectively a different embodiment from those shown in FIGS. 1, 2, 3A and 3B, each illustrating the operating condition of the fiber-receiving pipe and parts related thereto.

An embodiment of the present invention will therefore be explained below with reference to the attached drawings:

In FIG. 1, numeral 1 is a small mass of cotton or other fiber to be supplied for saturation with a dye liquor or treating liquor. This fiber is supplied onto chain belt conveyor plates 2 preferably made of stainless steel, reinforced synthetic resin or other proper material, by way of a sliding board 3 on which the fiber slides down. The chain belt conveyor 2 is stretched between driving rollers 23 and 24. A dye liquor or a treating liquor 4 stored in a service tank 19 is jetted onto fibers on the chain belt conveyor plate 2, passing through a pipe 21, a flow regulating valve 5, another pipe 21*a* and a supply liquor flowing out of pipe 6 having many small perforations. A pair of parallel press rollers 7 and 7*a* of comparatively heavy weight are arranged, before and after the pipe 6, on the chain belt conveyor plate 2, at right angles to the direction of the travel of the conveyor plate. These parallel press rollers have their respective both ends mounted on the bearing of a bearing fixing plate 8. These press rollers rotate in concert with the rotation of the chain belt conveyor. The fixing plate 8 is connected to one end of a connecting rod 9, the other end of which is connected by a pin 11 to a fixed bearing 10 so as to check the progressive movement of a pressing part comprising rollers 7 and 7*a*. Liquor is supplied to the fibers due to the weight of the press rollers 7 and 7*a* in the following manner:

Small masses of fiber are first compressed flat by the roller 7. A dye liquor or a treating liquor from the supply liquor flowing out pipe 6 is saturated into the uniformly compressed fibers due to the pressure of the roller 7*a*. The chain belt conveyor is supported from below so that it can withstand the weight of the pressing part comprising rollers 7 and 7*a*. It is also supported by a square supporting plate 12 having many perforations of a small bore, through which surplus supply liquor is drained. Lubricity originating from the viscosity of the liquor contributes to smoothing the sliding between the chain belt plate 2 and the supporting plate 12. Liquor dropped through the many perforations of a small bore of the supporting plate 12 is received in a receptable 13 as indicated by 4*b* and then taken into a liquor storing tank 15 by way of a pipe 14. Then, it is stirred by an agitator 16, together with the liquor 4*a* already stored, for uniformity. The stored liquor 4*a*, guided by a pipe 17, passes through a pipe 17*a* by means of a supply liquor pump 18 and is again supplied to the service tank 19 provided above, as the treating liquor 4. Regulation of the head of the service tank 19 is effected by means of a floatless relay 20 or by other proper means. Thus, the head pressure of the stock liquor 4 is kept constant and the flow rate of the liquor to be supplied to the flowing out pipe 6 from the flow regulating valve 5 is stabilized. A squeezing roller 22 covered with natural or synthetic rubber or the like, is provided above a driving roller 23 of the chain belt conveyor 2, with the conveyor belt plate therebetween. Cotton or other fibers saturated with the liquor, along with the chain belt conveyor plate, are carried forward between the roller 22 and the roller 23, and are squeezed to ensure uniform saturation of liquor into the fibers. As there is a fear that fibers adhere to and wind around the rollers 22 and 23 due to the stickiness of the saturated liquor, these rollers are equipped with fluff removing wheels 25 and 25*a* respectively, which turn reversely to remove fibers sticking to the rollers. Thus, groups of cotton or other fiber mass sent out of a (or a plurality of) saturation liquor supplying device are dropped into a cylindrical fiber-receiving pipe 27 of inverted cone-shape with a smooth inner wall of steep slope, by way of a (or a plurality of) needle lattice conveyor 26. The cylindrical fiber-receiving pipe of inverted cone-shape 27 forms a cylindrical feeding pipe of a large bore 28 at its lower end. The pipe 28 is provided with a support ring 29 (refer to FIG. 2) having an inside diameter corresponding to the outside diameter of the pipe 28. The underside of the support ring 29 is sloped in relation to the outer periphery and is supported with at least three supporting rollers 30, 30, 30 — fitted to a working floor 31 under the fiber-receiving pipe 27 of inverted cone-shape. A rack gear 32 is provided at the upper surface of the support ring 29, with which are engaged pinion bevel gears 33, whereby the whole of the fiber-receiving pipe 27 of inverted cone-shape is fixed in relation to perpendicular and horizontal directions. One of the shafts 34 of these pinion bevel gears is a motive shaft 34*a*. By the driving rotation of the shaft 34*a*, the inverted cone-shaped cylinder is caused to perform a horizontal rotary motion. The inner surface of the fiber-receiving pipe 27 of inverted cone-shape acts as a fiber-receiving surface 27*a*, along which a scraping-down mechanism is provided. In the embodiment shown by FIG. 1, a spatula 35 is a scraping-down mechanism and its one end is fixed to a supporting pole 36. This spatula 35 scrapes down fibers, sticking to the fiber-receiving surface 27*a* due to viscosity of liquor, into the bottom of the cylinder and thus effective feeding of fibers into the pipe 28 is carried out. The supporting pole 36 supports the scraping-down spatula 35 and also a reciprocating mechanism 37 employing air pressure, water pressure or motor driving. The reciprocating mechanism supports a vertical shaft 39 and gives it vertical

reciprocating motion, whereby a piston **38** at one end of the vertical shaft **39** is moved up and down and material to be steam-heated **1***a* is pushed down into the feeding pipe **28**. An extreme end of the feeding pipe **28** is inserted in a cylindrical introduction pipe **31** of almost the same diameter as the pipe **28**, with a fitting-in part **40** (refer to FIG. 4). For the reciprocating device for the above-mentioned piston **38**, various reciprocating mechanisms in general use can be utilized, but the following mechanism may also be used:

As indicated by FIG. **4**, one or a plurality of tapered rolls (in some cases, it can be of slopeless type) of free rotation **38***a* is arranged radially about a vertical shaft **39**. A rotary shaft **72** of the tapered roll is secured to the vertical shaft **39**, which is rotated by a reciprocating mechanism which has both rotary motion and reciprocating motion. Rotary bearings **73**, **73** for the tapered rolls should preferably be of the nonlubrication type and are blocked with a blocking board **74**. Under this arrangement, it is possible that by rotating the shaft **39**, fibers saturated with liquor are pressed into the feed pipe **28** as fiber layers **1***a*. In this instance, there is no need of rotating the fiber-receiving pipe **27**. In the case of feeding fibers saturated with liquor for continuous dyeing or treatment in bulk, it is possible to employ a fiber-receiving pipe of the fixed inverted-elliptical cone shape or the fixed inverted-pyramidal shape (as shown by **27***b* of FIG. 3), instead of the rotatable inverted cone-shaped cylinder. In this instance, in order to prevent fibers saturated with a viscous liquor from sticking to and depositing on the surface of the fiber-receiving pipe and to drop fibers smoothly into the cylinder **28**, an air-jetting pipe **85** which has perforations facing downward and which is adjustable in air-jetting quantity by a valve **86**, is provided around the circumference of the cylinder **27** so that small masses of fiber may be forced to slide down. As indicated by FIG. 3A, a scraping-down board **35***a* is provided at the upper part of the sloped inner surface **27***a* of the fiber-receiving pipe **27**. This scraping-down board **35***a* performs a scraping-down operation from the upper part toward the bottom part of the fiber-receiving pipe **27** by means of the cooperative operation of a pair of time-limit regulators **80** for letting in or sending out air, a changeover valve **81** and a reciprocating motion device **84** (comprising a plurality of air cylinders, a piston rod mechanism, valves **82** and **83**, etc.). In this case, as there is no need of rotating the fiber-receiving pipe **27** and the feeding pipe **28**, the aforementioned fitting-in part **40** is also unnecessary. Therefore, it is preferable to integrate the feeding pipe **28** and the introduction pipe **41** and to make their horizontal section in any desired shape, such as a circular shape, an elliptical shape, an angular shape, etc. The introduction pipe **41** is long enough to have an ample filling capacity and is connected with the head of a steam-heater **42** presenting the appearance of an inverted funnel (refer to FIG. **5**). The part between the head of the steam-heater **42** and an inner pipe **43** of the steam-heater has many perforations or forms a steam jetting-out part **44** partitioned with a partition board **44***a*. This part is intended for preventing the material to be steam-heated **1***b* and live steam from jetting out reversely. The aforementioned steam-heater comprises a double pipe, i.e., an inner pipe **43** and an outer pipe **45** provided concentrically.

Following the steam jetting-out part **44**, several steam-heating chambers are provided, each being partitioned perfectly from the other with partition boards, i.e., the first indirect heating chamber *a* is partitioned with partition boards **44***a* and **45***a* and the second indirect steam-heating chamber *b* is partitioned with partition boards **45***a* and **46**. Low pressure steam to be supplied to the direct steam jetting-out part **44** having many perforations is supplied from a minute pressure-regulating valve **47**. Residual drains at the start of operation are discharged by an exhaust valve **48**. The first indirect steam-heating chamber *a* and the second indirect steam-heating chamber *b* are supplied with steam through an inlet **50** and an inlet **51** respectively, by way of a pressure regulating valve **49** so that those chambers are always kept at a proper pressure. Drain produced at this time is discarded from steam traps **50***a* and **51***a*. Thermal energy of steam supplied to the direct steam heating chamber is absorbed by the material to be steam-heated and by liquor saturated therewith and accordingly diffusion action is effected from the circumference toward the central part. In the indirect steaming and heating part, the chemical and physical treatment of the fibers or dyeing effect progress within the fibrous structure from the boundary surface of the fiber towards the central part. The first stage steam-heating effect on the material to be treated progresses gradually as the fiber descends inside the inner pipe **43**, making the uniform processing effect possible.

Connected to the lower end of the partition board of the second indirect steam-heating chamber is an outlet part **52** of a J type cylindrical tube and at the upper part of an extreme end of this J type cylindrical tube is provided a press-cover **54** movably fitted to an axis **53**. A lever **55** is fixed to one end or both ends of this axis. A weight **56** is movably mounted on this lever so that fibers which have passed the first steam-heating stage may be forced into a steam heater **57** from the outlet part **52** of the J type tube against the external force upon the press-cover **54**. Instead of a load of the weight mentioned above, a pneumatic piston lever device or other conventional pressing methods may be employed for the same purpose. The outlet of the J type cylindrical tube mentioned above is inserted in the steam-heater **57** for the secondary steam-heating stage and small masses of fiber forced out of the outlet are arranged in order on a conveyor **58** in the steam-heater **57** (for example, a conveyor belt plate mounted on the endless chain, a belt conveyor, a lattice feeder, etc.). The conveyor plate mounted on the endless chain is stretched between a pair of chain driving wheels **59** and **60**, with a supporting chain wheel **61** (if necessary) therebetween so that the chain conveyor can withstand the total weight of the belt conveyor plate and fiber masses **1***b* being steam-heated. A steam jetting-out pipe **62** having many small perforations **63** is provided under the conveyor **58**. A cover **64** is provided for each group of small perforations so as to mitigate the jetting out force of steam which jets out through the perforations. The steam-heater **57** is covered at its outer surface with a heat-insulating board **57***a* so that the inside temperature may be kept at around 100° C. under the saturated condition. High pressure steam is supplied from a steam valve **65** for steam heating purposes. Connected to the inner top end of the steam-heater **57** is a duct **66**, through which residual steam and various gasses generated in the steam-heater are exhausted. A damper **67** is provided in the duct so as to regulate the amount of exhaust. Drain, extraction liquid, etc., which sometimes may be produced and stick to the inner wall side of the steam-heater are discharged out of water-tight storing tank **69** by way of a drain flowing-out pipe **68** provided at the bottom of the steam-heater. Fibers **1***c* which have been steam-heated are sent to one end of the steam-heater by the driving of the conveyor chain and are discharged outwardly, passing on a driving wheel **60** and pushing up a sealing board **70**. The required number of inspection windows are peep windows **71**, **71** — are made at the side of the secondary steam-heater **57** to inspect the condition of fibers inside the steam therethrough. A steam header **72** supplies the source of indirect steam at the first steam-heating stage and is covered at its outer surface with a heat-insulating board **72***a*. The whole outer surface of the first indirect steam-heater body is also covered with a heat-insulating layer.

FIG. **5** shows a different embodiment of the present invention. In the drawing, the number **1** represents loose fibers in small masses piled up in tank **96**. These fibers **1** are taken out of the bottom of the tank onto conveyors **2** and **26** by degrees, dropped on pad rolls **95**, are padded with a dye liquor **94** and then dropped onto the inner surface **27***a* of the fiber-receiving pipe **27** (the same as in the case of the foregoing embodiment). The tank **96**, conveyors **2** and **26** are provided, in plurality, about the peripheral edge of the fiber-receiving pipe **27**. At each set of these arrangements, fibers of one and the same type or different types are padded with dye liquor of one and the same shade or different shades, in the desired fiber mixing

ratio and in the desired color mixing ratio. When material to be dyed **1***a* is stored in the fiber-receiving pipe **27** in a certain quantity, a filling piston **88** which has vertical reciprocating motion lowers and forces the material to be dyed into an adjacent vertical cylindrical steam-heater **41**. This operation is carried out intermittently and fiber layers **1***b* are formed inside the indirect steam-heating part *a*.

The filling piston **88** has reciprocating motion, guided by a guiding member **87**. The reciprocating motion of the filling piston is controlled by a connecting rod **93** which is worked by a device comprising a piston **89** to be operated by air pressure, oil pressure or hydraulic pressure and a cylinder **93***a*. The compression stroke, the bottom dead point stop, the lifting stroke and the top dead point stop are controlled by means of electromagnetic valves **91** and **92** connected to the cylinder **93***a* and time-regulating parts **91***a* and **92***a*. The indirect steam heating part *a* comprises an inner pipe **43** and an outer pipe **45**, i.e., a concentric double pipe covered with a heat-insulating layer **45***b* at the outermost surface. The direct steam-heating part *c* and the indirect steam-heating part *a* are separated with a partition board **44***a*. The inner pipe portion of the direct steam-heating part *c* forms a perforated board **44** having many small perforations, through which adequate quantities of steam are directly jetted out by operating properly a steam valve **47***a* of a steam pipe **50**. Drain is separated and discarded by a steam trap **104**. In this instance, in order to heat uniformly the whole area of the steam-heating part *a*, it is better to divide the steam-heating part *a* into several sections and to provide each section with a steam valve and a steam trap.

Material to be dyed **1***b* continually filled in the steam heating part is steam-heated for a proper duration of time at a proper temperature as it passes through the latter, and dyes in dye liquor adsorb on the surface of fiber, are diffused into the fiber and are fixed. Thus, the dyeing process is completed.

The inner pipe **43** has many small perforations **97** at the part lower than the last partition board **45***a*, like the direct steam-heating part *c*. The residual water content is discarded in the form of a vapor through a pipe **98**. The dyed fiber material is then pushed out of the outlet of the steam-heating part *a* in the form of disc-like lumps of several layers. The outlet of said steam-heating part is blocked with a press-cover **54** by means of a spring **99**. The material dyed is pushed out against the elasticity of the spring **99** of the press-cover **54**. When the cover **54** lowers by a certain distance or to the level of a limit switch **100**, a check metal (not shown in the drawing) is locked and at the same time, a relay **105** is actuated and a motor **101** begins to run, whereby a fiber-discharging device **102**, fitted to a rotary shaft **103**, works in a horizontal direction, through the medium of a reduction gear **103***a*, and the dyed material on the press-cover is discharged to the succeeding process. At the same time, as the discharge is finished, the aforementioned check metal is unlocked and by means of the elasticity of the spring **99**, the cover **54** is forced to restore its original position and contacts tightly with the dyed material exposed at the underside of the outlet of the steam-heating part *a*. The fiber discharging device **102** which has discharged the dyed material by the foregoing process returns to its original position after its first revolution and opens the point of contact (not shown in the drawing), closes the relay **105**, and stops the motor **101**. As a substitute for the aforementioned limit-switch **100**, it is possible to start or stop the motor **101** by using a photoelectric tube. In the operation of this embodiment, there is caused a blank condition of putting in the material fiber or material to be dyed at the start or at the finish of the operation, with the result of unsatisfactory delivery of pressurized material. Therefore, waste cotton or round cushion-like pads should be filled in the steam-heater before the start of operation and when the filling of the loose fiber is finished, filling of waste cotton or round cushion-like pads should be started and continued until all of the material to be dyed is discharged out of the outlet of steam-heater. In this embodiment, by providing one or a plurality of loose fiber supplying devices, fibers of one and the same type or different types can be supplied to each supplying device for padding with a dye liquor of one and the same color or different colors. Moreover, by regulating the amount of supply at each supplying device, material can be finished continuously in the desired fiber mixing ratio and in the desired color mixing ratio. Furthermore, as the material to be dyed is steam-heated in the steam-heater under the compressed condition, conjugated fiber which will shrink by heating is not allowed to shrink in the steam-heater and retains its original shape.

What I claim is:

1. A continuous steam-heating method for continuously treating or dyeing cotton and other fibers using a single or plurality of dye liquors or treating liquor supply means which comprises saturating the fibers with the dye liquor or treating liquor; dropping the saturated fibers into a fiber-receiving pipe of inverted cone-shape having a steeply sloped smooth inner surface; compressing the fibers into the state of layers and delivering the thus-compressed fibers into a steam-heating chamber whereby the fibers are indirectly and directly steam-heated by way of a vertical cylinder to effect adsorption of the dye liquor or treating liquor onto the surface of the fibers, whereupon the said dye or treating liquor is diffused into the inner portions of the fibers and fixed therein; said steam heating chamber being bent at the lower egress where a sealing force is provided so as to increase the steam-heating effect.

2. The method as claimed in claim 1, wherein a steam-heater is bent into a J type at its lower egress where a switch device is provided so as to maintain a suitably pressurized steam-heating at the inside by a sealing force for efficient dyeing or treating of the cotton and other fibers, as the second steam-heating stage fibers are supplied into a horizontal chain conveyor type or a belt type steam-heater which is driven according to the amount of fibers sent out of the J type cylinder for increasing the steam-heating efficiency still further.

3. An apparatus for continuously treating or dyeing cotton and other fibers, comprising a mechanism whereby cotton and other fibers are saturated uniformly with a dye liquor or a treating liquor and are fed to a fiber-receiving pipe having a steeply sloped inner surface for dropping saturated fibers therealong; a pressing mechanism whereby cotton and other fibers are pressed into the cotton-receiving pipe intermittently in the stage of layers; a cylindrical steam-heater provided below the fiber-receiving pipe; a mechanism whereby sealing force is imparted to the lower end of said steam-heater, and a horizontal steam-heater for secondary steam-heating.

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