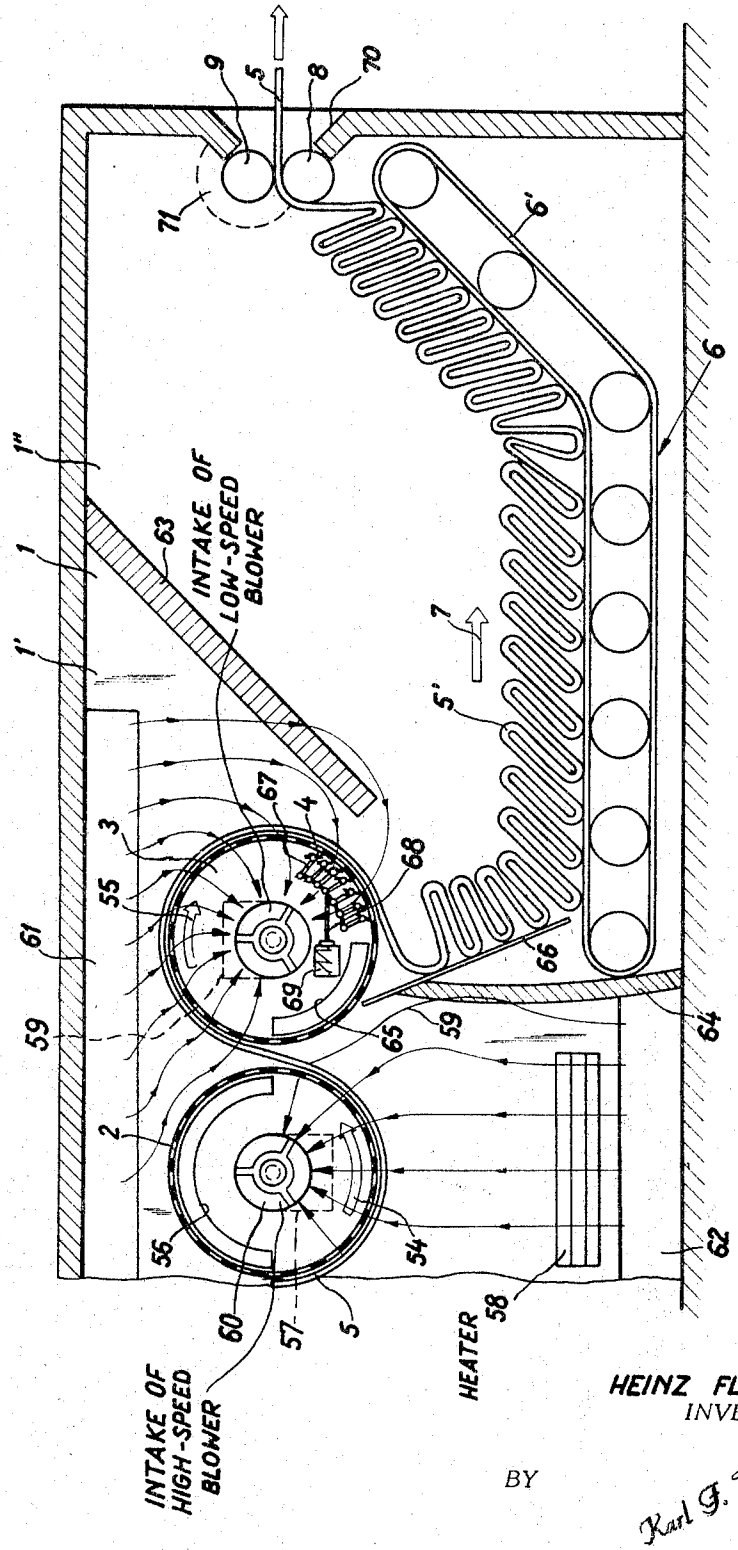
June 6, 1967 H. FLEISSNER 3,323,153

PROCESS FOR THE CONTINUOUS FLUID-TREATMENT OF FABRIC WEBS

Original Filed May 31, 1962 4 Sheets-Sheet 1

FIG. 1



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PROCESS FOR THE CONTINUOUS FLUID-TREATMENT OF FABRIC WEBS

Original Filed May 31, 1962 4 Sheets-Sheet 2

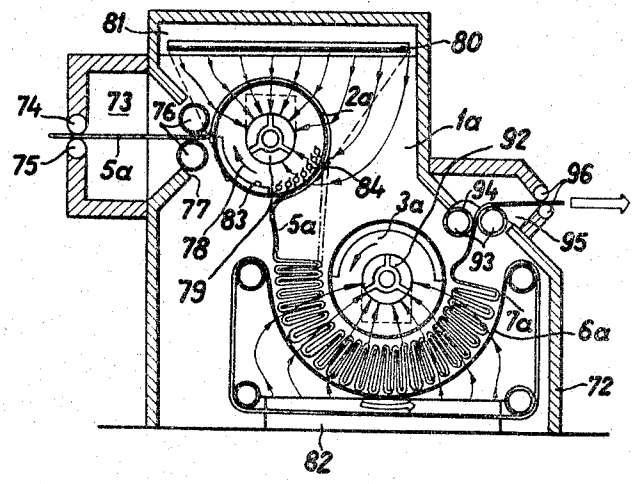


FIG. 2

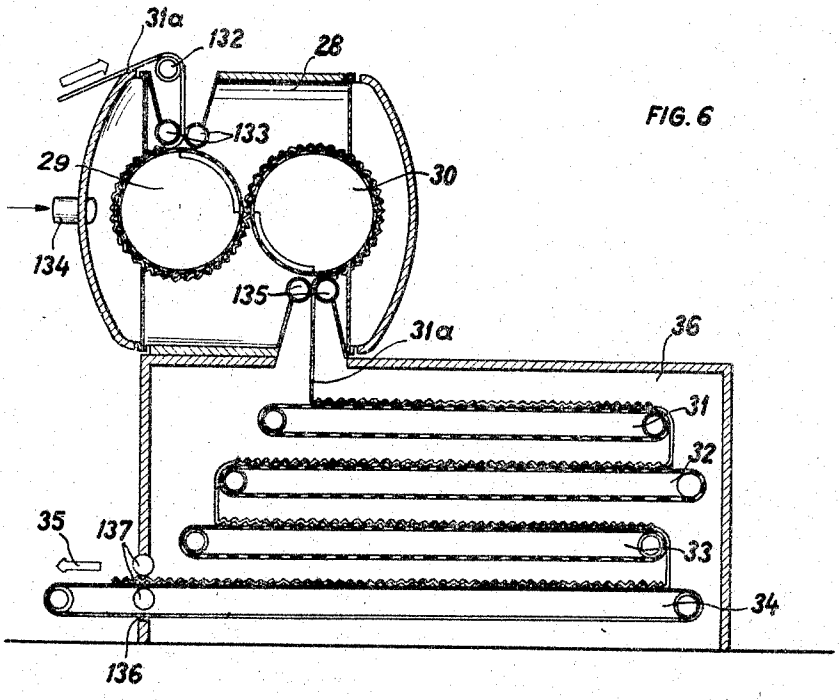


FIG. 6

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PROCESS FOR THE CONTINUOUS FLUID-TREATMENT OF FABRIC WEBS

Original Filed May 31, 1962 4 Sheets-Sheet 3

FIG.3

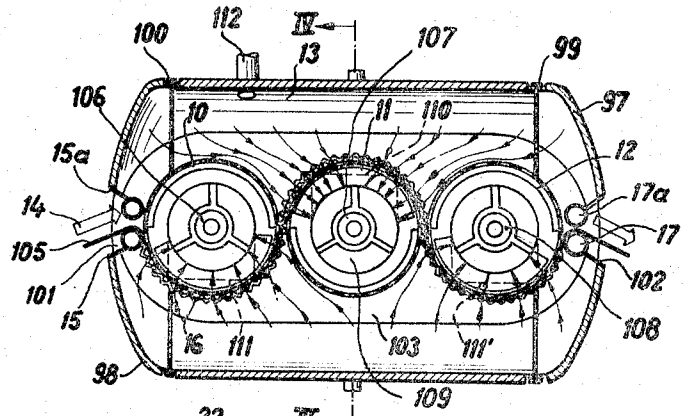


FIG.5

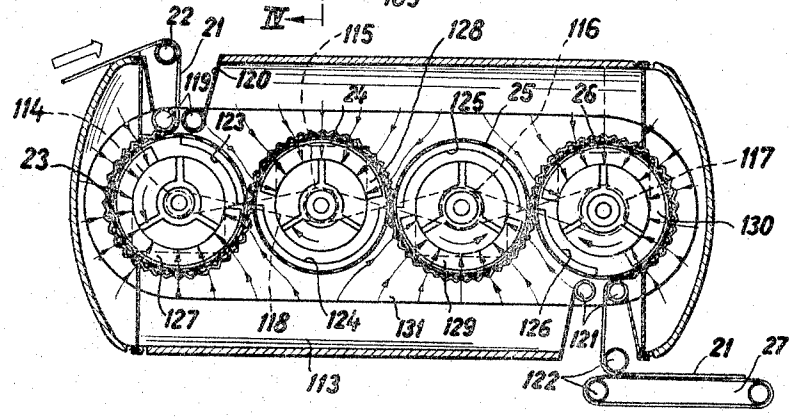
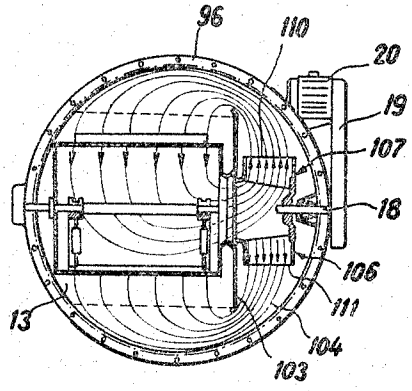


FIG.4



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PROCESS FOR THE CONTINUOUS FLUID-TREATMENT OF FABRIC WEBS

Original Filed May 31, 1962 4 Sheets-Sheet 4

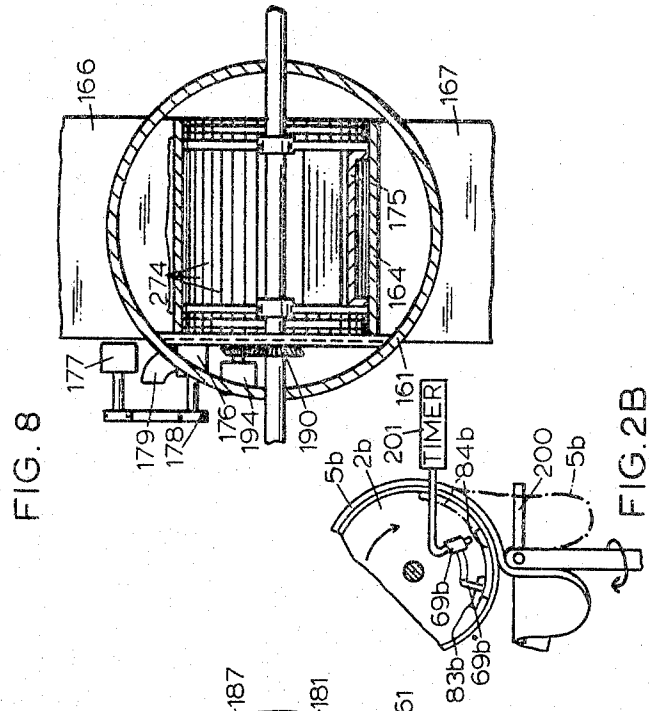


FIG. 8

FIG. 2B

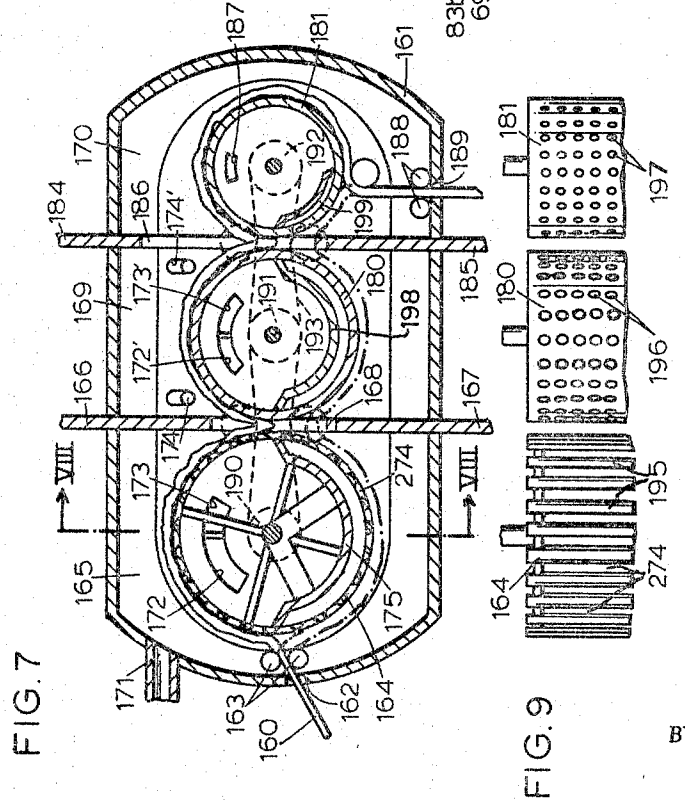


FIG. 7

FIG. 9

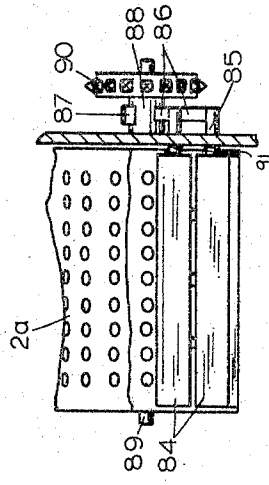


FIG. 2A

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United States Patent Office 3,323,153
Patented June 6, 1967

3,323,153

PROCESS FOR THE CONTINUOUS FLUID-TREATMENT OF FABRIC WEBS

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Original application May 31, 1962, Ser. No. 198,972, now Patent No. 3,242,702, dated Mar. 29, 1966. Divided and this application Feb. 11, 1966, Ser. No. 538,887
Claims priority, application Germany, May 31, 1961, F 34,067
6 Claims. (Cl. 8—149.3)

ABSTRACT OF THE DISCLOSURE

Process for the continuous fluid-treatment of fabric webs (e.g. the treatment of fabrics with steam or the like for fixing dies etc.) whereby the fabric web is passed along at least two perforated surfaces in a substantially closed chamber and fluid is drawn through the webs in a first zone along one of said surfaces at a relatively high rate per unit quantity of the material treated and drawn through the web in a subsiding zone at a second surface at a relatively low rate per unit quantity, at least a portion of the fluid drawn through the web at said first zone being heated and recirculated for a subsequent passage through the web.

This is a division of application Ser. No. 198,972, filed May 31, 1962, now U.S. Patent No. 3,242,702.

My present invention relates to a method of continuous treatment of fabric webs with fluids and, more particularly, the continuous treatment of textiles with steam.

In the steaming of continuous webs of fibrous material such as textiles, autoclaves have been provided wherein a charge of the textlie fabric is introduced into the vessel, which is sealed against the ambient atmosphere and filled with steam. Occasionally, the autoclave is evacuated prior to the introduction of the steam. This arrangement is intermittent in nature and requires a relatively large amount of time for the charging and discharging of the autoclave.

In copending application Ser. No. 142,561, which I filed Oct. 3, 1961 jointly with Wolfgang Friedel. I have disclosed apparatus for the continuous treatment of fibrous webs, i.e. the drying of such webs, wherein the webs are conveyed by perforated carriers. The devices disclosed in these applications are not, however, suitable in themselves for the treatment of webs or bands of material with steam or wet high-temperature atmospheres, since large heat and pressure losses would inevitably result. Moreover, it is important to note in connection with the steam treatment of textile fabrics, and especially the steam fixing of dyed materials, that condensation of liquid upon the material must be avoided. Thus, when working with saturated steam, it is vital that a dyed material be heated as quickly as possible to avoid the condensation of moisture thereon and a consequent dilution or redistribution of the dyestuff thereon.

It is an object of the present invention, therefore, to provide a process for treating webs of fibrous material with heated fluids as well as an apparatus for carrying out this process.

This object is realized, according to the invention, by a process wherein the fibrous material, in the form of a band or web, is treated with steam circulated through the material at a relatively high rate so that relatively small amounts of heat per unit volume or weight of the steam is given up to the fibrous material. Upon each pass through the material the steam is reheated so that the difference between the loss of heat by the steam and its increase in heat is relatively small. Consequently, the temperature drop in the steam while it is in contact with the material is minimal, thereby guaranteeing that no substantial precipitation of moisture upon the web will take place. In a process of this type, it is possible to employ a fluid consisting almost 100% of steam since a superheating of the steam prior of its contact with the web is not necessary. When the material to be treated is brought to the saturation temperature, condensation thereon can no longer occur so that it is possible to reduce the volume of steam passed through the web to a minimum.

By an increase in the temperature of the steam treatment above 100° C., the duration of the treatment time can be substantially reduced. It has been found, for example, that each 10° C. rise in the steam temperature approximately halves the required treatment time. Thus, if a treatment time of 30 minutes is required at a temperature of 100° C., only 15 minutes is necessary at 110° C. and about 7.5 minutes at 120° C. To prevent superheating of steam at the latter temperature I maintain the steam at a pressure of about two atmospheres since the saturation temperature at a pressure of two atmospheres is about 119.62° C. The temperature has, of course, a maximum since each textile material to be treated is to some degree temperature sensitive. Wool, for example, is particularly sensitive to temperatures in excess of 120° C.

The process of the present invention can be carried out in an apparatus for continuously treating webs of fibrous material (e.g. porous textiles or the like) with a fluid at elevated temperatures; the system comprises a pressure chamber containing conveyor means for transporting the web while the fluid is passed therethrough. As disclosed in said copending application, the conveyor means may include preforated drums or conveyor belts through which the fluid is drawn. The pressure chamber is formed with relatively thick walls and is generally of cylindrical configuration so as to be able to withstand the high steam pressures employed. Other round configurations, e.g. spherical, may also be employed. The perforated drums may be rotatable within the chamber about generally parallel axes arranged therein between the inlet and the outlet of the chamber. Thus, the axes may lie along a common plane so that the drums are oriented in a substantially straight row whereby the web of material can alternately under- and overshoot the drums along a generally sinusoidal transport path.

Since, as previously mentioned, it is desirable to circulate, at least initially, the treating fluid through the web at a relatively high rate per unit quantity of material treated, I prefer to provide means for passing a large quantity of treating fluid through each unit quantity of the web. Such means may include means for driving the successive drums in such a way that a drum proximal to the inlet is displaced with a peripheral speed in excess of that of a drum distal from the inlet. Thus, if the rate at which the treating fluid is drawn through the drums is substantially equal, the material conveyed by the first or proximal drum will have less intense contact with the treating fluid than the material passing through a subsequent zone along the treatment path. The variation in peripheral speeds may be accomplished by rotating the drums with different angular velocities or by providing them with different diameters. Moreover, it is possible to insure a higher rate of fluid flow per unit quantity of material processed in the first zone if the first drum is provided with openings whose total cross-section along the drum periphery hugged by the web is in excess of that of a succeeding drum.

It is also possible to arrange the fluid-displacement means so that, say, a larger quantity of fluid is drawn through the first drum than through a succeeding drum. In each case it is preferable, when several drums are em-

ployed, to effect a stepwise reduction in the rate at which the fluid contacts the material. It will be apparent, accordingly, that successive drums may have successively reduced diameters while being driven with a constant angular velocity; they also may have stepped drives for rotating them with successively reduced angular velocity; or they may be provided with exhaust means for drawing the fluid therethrough having capacities successively smaller in a stepwise relationship. It is not necessary that the material alternately over- and undershoot the drums since advantageous results can also be obtained if the web passes along one side of the drum axis, say, along the upper side of each drum. In the former case alternate drums will rotate in opposite senses whereas in the latter case all the drums rotate in the same sense.

Yet another feature of the invention resides in the provision of means for introducing a first fluid into the preheating or first zone of the transport path in order to raise the temperature of a web to the saturation temperature of a condensable second fluid introduced at a succeeding zone. Hot air may, advantageously, be employed as the first fluid, while steam serves as the second fluid. I have found that it is often desirable to provide partition means between the zones in order to reduce the possibility that fluid in a first zone can enter another zone along the path. In fact, when the pressure chamber is subdivided into an entry portion, which may constitute the preheating zone, an intermediate portion constituting the main steaming zone, and an exit portion, the partition means may include movable members adapted to provide a quick closure of each compartment in order to isolate it from the others.

When employing successive drums operating at progressively reduced peripheral speeds, the web gathers into a pleat-like configuration upon the surface of the slower drum. I have found that, after an initial heating of the web, it is desirable to fold the web into accordion pleats for subsequent treatment by a fluid. Thus, a relatively large quantity of material can be slowly displaced while a treating fluid is drawn therethrough.

The above and other objects, features and advantages of my present invention will become more readily apparent from the following description, reference being made to the accompanying drawing wherein:

FIG. 1 is a somewhat diagrammatic longitudinal cross-sectional view through an apparatus according to the invention;

FIG. 2 is a view similar to FIG. 1 illustrating a modification of the apparatus;

FIG. 2A is an enlarged detail view of the shutters of FIG. 2 showing the actuation mechanism therefor;

FIG. 2B is a fragmental view of another installation similar to that of FIG. 2;

FIG. 3 is an axial cross-sectional view showing still another textile-treating apparatus according to the invention;

FIG. 4 is a view taken generally along the line IV—IV of FIG. 3;

FIGS. 5 and 6 are views similar to FIG. 4 illustrating further modifications;

FIG. 7 is a longitudinal cross-sectional view through still another apparatus according to the invention;

FIG. 8 is a cross-sectional view taken along the line X—X of FIG. 9; and

FIG. 9 is a bottom-plan view of the drums of the apparatus of FIG. 7.

In FIG. 1 of the drawing I show a treatment chamber **1** provided with two perforated drums **2** and **3** of the type generally disclosed in application Ser. No. 142,561, filed Oct. 3, 1961. The drums **2** and **3** each have a perforated periphery and are rotated in opposite senses (arrows **54**, **55**) about their parallel axes by means to be described in greater detail hereinafter. A web **5** of flexible material, e.g. a textile band or other fibrous ribbon, undershoots the first drum **2** while overshooting the second drum **3** along a generally sinusoidal transport path. A stationary

shield **56** blocks the perforations of drum **2** in that region of its rotation wherein its periphery is not covered by the web **5** so that a reduced suction force is needed to draw the treating fluid through the material. The suction force derives from a blower **57** of the type shown in the above-mentioned copending application, which circulates steam through the web **5** past a heater **58** and also supplies part of the steam to the second drum **3** whose blower **59** draws same through the web **5** in this region. The first drum **2** permits the material to be treated with a relatively large volume of steam per unit quantity of material since the blower **57** is a high-speed ventilator drawing the steam through inlet **60** and expelling it via outlets **61** and **62**. That portion of the steam recirculated via outlet **62** through the web **5** in the region of the preheating zone is reheated via heater **58** so that the small amount of heat lost to the web **5** by the steam is restored to it. When the temperature of the web has been raised to the saturation temperature of the steam within chamber **1** (e.g. about 120° C.), the web passes on to drum **3** whereupon steam is drawn through it at a reduced rate. Partitions **63**, **64** are provided between the drum **3** and an endless conveyor **6**, which is representative of conveying means in general and may, in fact, be composed of a plurality of bands, to subdivide chamber **1** into a rapid-heating compartment **1'** and a slow-heating compartment **1''**. Since the duration of the steam treatment will depend upon the fabric treated, the dyestuff employed and other characteristics of the web, chamber **1''** permits the web to remain in contact with the treating fluid for a prolonged period without inordinately increasing the size of the installation. Thus, I provide means for laying the web **5** upon the conveyor band **6**, which moves at a peripheral speed substantially less than that of drum **3** in the direction of arrow **7**, in accordion pleats, loops or folds **5'** which remain in contact with the steam within compartment **1''** for a relatively prolonged period.

The folding means comprises a plurality of angularly displaceable dampers **4**, pivotable about axes relatively stationary with respect to the drum and extending parallel to generatrices thereof. In a first operative position the jalousie-like dampers form an extension of the shield **65** of drum **3** to block perforations therein over a substantial arc of its periphery, thereby releasing a substantial length of material and permitting it to fold along guide plate **66** onto conveyor belt **6**. In a second operative position of the dampers **4**, the perforations are unblocked and the fluid sucked into drum **3** draws the web thereagainst so that it is entrained until it again is released as a fold. The dampers **4** are provided with arms **67** pivotally connected to a rod **68** of a periodically operated solenoid **69**. From the upwardly inclined portion **6'** of conveyor belt **6** the folded web **5** is drawn between a pair of rollers **8**, **9**, forming a fluid-retaining gate at the outlet **70** of the chamber. Rollers **8** and **9** are driven by a motor **71** with a peripheral speed in excess of that of band **6** and, if desired, equal to that of drum **3**, so that the web **5** is again straightened as it leaves the apparatus.

In FIGS. 2 and 2A of the drawing I show an arrangement generally similar to that of FIG. 1 but with the treating apparatus arranged in a form of a so-called J-box wherein the J-shaped chamber **1***a* is enclosed by a pressure-retaining housing **72** wherein a perforated transport drum **2***a* is journaled. The web **5***a* is fed into chamber **1***a* via a fluid-pressure-retaining lock **73** whose inlet opening is provided with a pair of rollers **74**, **75** between which the web is fed and which serve to prevent the escape of the fluid within lock **73** and chamber **1***a*.

The web then passes between another pair of rollers **76** at the inlet **77** of chamber **1***a* whence it passes over the drum **2***a*. The latter rotates in the direction of arrow **78** and has a blower (not shown) whose intake **79** draws steam over heating tubes **80** through the web hugging the drum. The outlets **81**, **82** of the blower return the treating fluid to the chamber **1***a*. Drum **2***a* is provided

with a stationary shield portion **83** which blocks the apertures of the ineffective part of the drum. The remaining portion of the shield means is formed by an angularly offset array of dampers **84**, which are of a butterfly type, journaled for rotation about axes extending parallel to generatrices of the drum. The shafts **85** of these dampers are provided with generally radial arms **86** which are successively engaged by cams **87** (one of which can be seen in FIG. 2A) for successive actuation upon rotation of the drum **2***a* to open the dampers **84** and release that portion of the web **5***a* which is entrained along the drum in the region of the dampers.

Cams **87** are carried by the shaft **88** of the drum **2***a* which is journaled on an axle **89** and driven by a sprocket wheel **90**. The cams periodically open the shutters **84**, which are closed by springs **91**, so that the web **5***a* is alternately swung between the dot-dash position thereof and its solid-line position to deposit successive folds of the web upon one another. It should be noted that the expression "web," as used in the present application, is intended to designate sheet material as well as parallel arrays of ribbon or sliver and any other elongated flexible elements which can be drawn against the perforated surface of the conveyor means. The folded web **5***a* passes between a further drum **3***a* and a conveyor belt **6***a*, spaced therefrom, so that the folds are oriented in generally radial direction. The drum **3***a* and conveyor **6***a* are operated with identical angular velocity so that no shear stresses are applied by them to the folds. The movable conveying means **3***a*, **6***a* completely obviate the disadvantages of hitherto known J-box arrangements wherein rigid walls are employed. While the blower of drum **3***a*, whose intake **92** draws the treating fluid through the relatively dense mass of material and the perforated conveyor band **6***a* from outlet **82**, has substantially the same capacity as the blower of drum **2***a* and likewise supplies the outlet **82**, the more compact folds of the web limit the throughput of steam so that a reduced quantity of the latter is employed per unit quantity of material processed in the second stage.

A pair of outlet rollers **93** are arranged at the exit opening **94** and draw the web **5***a* from the magazine formed by drum **3***a* and band **6***a* at a relatively high rate through another lock **95** and its rollers **96**.

In FIG. 2B I show another arrangement wherein a drum **2***b* has its shield **83***b* formed with a slidable shutter extension **84***b*, which is shiftable, as indicated in dot-dash lines, by a solenod **69***b* via its arm **69***b*″ to periodically block and unblock the perforations of portions of the periphery of drum **2***b*. The web **5***b* thus folds in loops onto the bars **200** of a rotary loop dryer. Other well-known dryer types may also be employed. The solenoid (**69***b*) is coupled with a timer **201** which blocks the shutter **84***b* in its dot-dash position for a predetermined period while drum **2***b* rotates so that a loop of any desired length may be formed.

FIGS. 3 and 4 illustrate a further embodiment of the invention wherein an autoclave **13** whose cylindrical casing **96** is bolted to outwardly convex terminal casing portions **97**, **98** along their flanges **99**, **100**, has an inlet **101** and an outlet **102** at opposite ends of the housing. The material **105** is fed between a pair of rollers **15**, **15***a* at the inlet onto the lower surface of a first perforated drum **10** whence it passes in generally sinusoidal pattern alternately over and under the successive drums **11** and **12**. From drum **12** the web is displaced between another pair of rollers **17**, **17***a* of the outlet opening **102**. The drums **10**, **11** and **12** are jouranled upon a rear plate **103** forming a compartment **104**. The latter houses the blowers **106**, **107**, **108** of these drums, the first two of which are shown in detail in FIG. 4. Blower **107**, for example, draws the steam through its intake **109** after it has passed through the web **105** and distributes it via a discharge opening **110** to the drums **10** and **12** flanking it. Blowers **106**, **108** of these drums expel steam through outlets **111**, **111**′ whence it can feed the central drum **11**. As previously mentioned, the quantity of air drawn through drum **10** is greater than that drawn through drum **11**. Similarly drum **12** draws still less treating fluid, per unit quantity of material, through the web hugging its periphery.

In the embodiment illustrated in FIGS. 3 and 4, the drives for the rotors of the blowers **106**, **107**, **108** (e.g. the motor **20**, belt or gear transmission **19** and rotor shaft **18** shown in FIG. 4) are operated at progressively reduced speeds. The periphery of drum **10** may be provided with perforations having a larger total cross-sectional area than those of drums **11** and **12**, or drum **10** may be rotated with a somewhat higher angular velocity than the other drums. Since rollers **15** and **15***a*, which displace the web **105** in the direction of arrow **14** into the chamber **13**, are driven at a peripheral speed somewhat in excess of that of drum **10**, the material is deposited in a pleated conformation on the drums. This conformation is essentially maintained throughout the transport path of the web inasmuch as the other drums **11** and **12** operate at somewhat slower speeds. It should be noted that the inlet and outlet slots **101**, **102** shown are relatively narrow so that hardly any escape of steam, which may be introduced via a conduit **112**, takes place. Locks such as those shown in FIG. 2 may, of course, also be provided at the inlet and outlet ends of the wind-tunnel shaped chamber **13**.

In FIG. 5 I show another arrangement wherein drums **23**, **24**, **25**, **26** within pressure chamber **113** have driving sprockets **114**, **115**, **116**, **117** of successively larger diameter around which passes a driving chain **118**. The latter, displaced by a conventional motor not shown, rotates the drums alternately in opposite senses and with progressively reduced angular velocity so that a result similar to that previously described is attained. The fabric web **21** is fed in the direction of the arrow over an idler roller **22** between a pair of driven feed rollers **119** at the restricted inlet opening **120** of the installation. Rollers **119** operate with a peripheral speed in excess of that of drum **23** so that the material is gathered into slight folds as it is laid unto the drums. The terminal drum **26** carries web **21** to the outlet rollers **121** whence it passes between another idler roller **122** and the conveyor belt **27** which carries the web away for further processing. It will be immediately apparent that one or more of the drums **23**–**26** can be replaced by conveyor belts or other means having a closed perforated transport surface. As in FIGS. 3 and 4, the unused portions of drums **23**–**26** are covered by shields **123**–**126** while only the intakes **127**–**130** of the associated blowers are shown. The blowers may be positioned behind the plate **131** or at the base of chamber **113**.

The apparatus of FIG. 6 has its treatment chamber subdivided into a preheating or first heating compartment **28**, whose walls are of cylindrical configuration like those of the chamber **13** in FIGS. 3 and 4 so as to withstand the steam pressure (e.g. two atmospheres) therewithin, and a main treatment compartment **36** in which the material **31***a* remains for a prolonged period in contact with the treating fluid at reduced pressure (e.g one atmosphere). The web **31***a* passes over an idler **132** and between two feed rollers **133**, of the character previously described, onto the primary drum **29** which conveys it at a relatively high peripheral speed onto a succeeding drum **30** operating at somewhat lower speed. Thus the steam introduced into the pressure compartment **28** via conduit **134** is drawn through the web into drum **29** at a relatively high rate per unit quantity of material processed while drum **30** draws the steam through the web at a relatively lower rate per unit quantity of material processed.

The steam is circulated and heated by fluid-displacement means of the type previously described and shown in the aforementioned copending application. From compartment **28** the web **31***a* passes between a pair of rollers **135** which deposit it in slight pleats upon the first of a plurality of stacked conveyor belts **31**–**34** which are somewhat

staggered to permit a continuous flow of the material downwardly and out of the lower compartment **36** in the direction of arrow **35**. Again the outlet **136** of this compartment is provided with rollers **137** which prevent the influx of air. It will be understood that other arrangements of the high pressure and low pressure compartments may also be suitable. For instance, the high-pressure and low-pressure compartments may be disposed side by side or one below the other as desired. Moreover, the drums **29** and **30** may be oriented for rotation about axes extending codirectionally with the axis of the cylindrical casing.

In FIGS. 7–9 of the drawing, I show a modified arrangement of a linear array of drums for the fluid treatment of a web **160**. The installation comprises a cylindrical housing **161** whose inlet **162** is provided with a pair of rollers **163** which feed the web **160** onto the first drum **164** of a plurality of drums. Hot air is fed into a first compartment **165**, containing the drum **164**, which is delimited by a pair of movable partitions **166**, **167**, slidable in a channel **168** to separate compartment **165** from the steam treatment compartment **169**, **170**. The hot air is introduced via a conduit **171** and is drawn by a pair of high-capacity blowers, whose intakes may be seen at **172**, **173**, through the web carried by the array of angularly spaced slats **274** forming the perforated periphery of drum **164**. A stationary shield **175** blocks the slots of the unused portion of the drum periphery.

As indicated in FIG. 8, each ventilator or blower of drum **164** (one of which is indicated at **176**) is driven by a motor **177** via a transmission **178** to expel the hot air through a vent **179**.

The web **160** passes along the upper side of drum **164** and thence onto the upper sides of drums **180**, **181** in succession. Drums **180** and **181** are located within compartments **169** and **170**, respectively, and serve to treat the web **160** with steam. Drum **180** is provided with two relatively small blowers whose intakes **172**, **173** draw steam, introduced via nozzles **174**, through the web and the perforations in the drum. The nozzles **174** are adjustably mounted in slots **174'** and may be shifted toward or away from the web.

Drum **181** is separated from drum **180** by a pair of movable partitions **184**, **185** vertically slidable in a channel **186**, and is provided with a single blower with an intake port **187** which draws the steam blown into compartment **170** by the blower of drum **180**, through the web. From drum **181**, the web **160** passes between a pair of rollers **188** through the exit opening **189** of the casing **161**. Compartments **165**, **169** and **170** constitute an intake portion, an intermediate portion and an exit portion of the pressure chamber which can be quickly closed off by the sliding partitions **166**, **167** and **184**, **185**.

Drums **164**, **180** and **181** are provided with respective driving sprockets **190**, **191**, **192** which are engaged by a chain **193** driven by motor **194**. Since the drums carry the web **160** along their upper surfaces, they are driven in the same sense as is apparent from FIG. 7. Moreover, the drums **164**, **180** and **181** are of progressively decreasing diameter while their sprockets **190**, **191** and **192** are of the same diameter so that the drum proximal to the inlet operates with a higher peripheral speed than the successively arranged drums. The peripheral speed of the drums is reduced in stepwise fashion between the inlet and the outlet although they are all driven at the same angular velocity.

In FIG. 9 I show the drums **164**, **180** and **181** to be provided with apertures or perforations of successively decreasing cross-sectional area. Thus, each slot **274** between the slats **195** of drum **164** has a greater cross-sectional area than does the longitudinal row of openings **196** in the periphery of drum **180**. The cross-sectional area of the openings of the latter row is, in turn, greater than the corresponding row of openings **197** in drum **181**. Consequently, the throughput of treating fluid drawn into the drums **164**, **180** and **181** is reduced progressively from drum to drum. If desired, shields **175**, **198** and **199** of the drums may be dispensed with and the web **160** returned along the undersides of the drums, as indicated by dot-dash lines, to the inlet opening.

The invention as described and illustrated is believed to admit of many modification within the ability of persons skilled in the art, such modifications being deemed included within the spirit and scope of the appended claims.

I claim:

1. A method of treating a web of flexible textile material with at least one treatment fluid, comprising the steps of:

(a) continuously conveying said web through a substantially closed chamber along at least one perforated surface forming a transport path having a plurality of successive zones;

(b) drawing said fluid through said web and said surface at a first of said zones at a relatively high rate per unit quantity of the material treated; and

(c) subsequently passing said fluid through said web at a succeeding zone at a relatively low rate per unit quantity of said material treated.

2. The method defined in claim **1** wherein said web is at a lower temperature than that of said fluid prior to passage through said first zone, said method further comprising the steps of heating at least a portion of the fluid drawn through said web in said first zone and passing it again through said web.

3. The method defined in claim **1** wherein said fluid is steam and said chamber is maintained at an elevated pressure at least in the region of said first zone.

4. The method defined in claim **1** wherein said web is conveyed through said succeeding zone at a rate of excess of its rate of displacement through said first zone in terms of the quantity of material treated per unit time.

5. The method defined in claim **1**, further comprising the steps of folding said material upon its passage through said succeeding zone.

6. The method defined in claim **1** wherein said web is displaced along a perforated surface in said succeeding zone, and said fluid is drawn through said web and said surface in said succeeding zone.

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