United States Patent [19]

Shmuel

[11] **3,837,801**

[45] **Sept. 24, 1974**

[54] **METHOD AND APPARATUS FOR PROCESSING FABRICS IN ROPE-LIKE FORM**

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[73] Assignee: **Woodside Construction Corp.,** Johnsville, N.Y.

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[21] Appl. No.: **236,662**

[52] **U.S. Cl.** **8/151.1,** 8/152, 68/62, 68/176, 68/177

[51] **Int. Cl.** **B05c 3/134**

[58] **Field of Search** ..... 8/151.1, 152; 68/176, 177, 68/205 R, 62, 175

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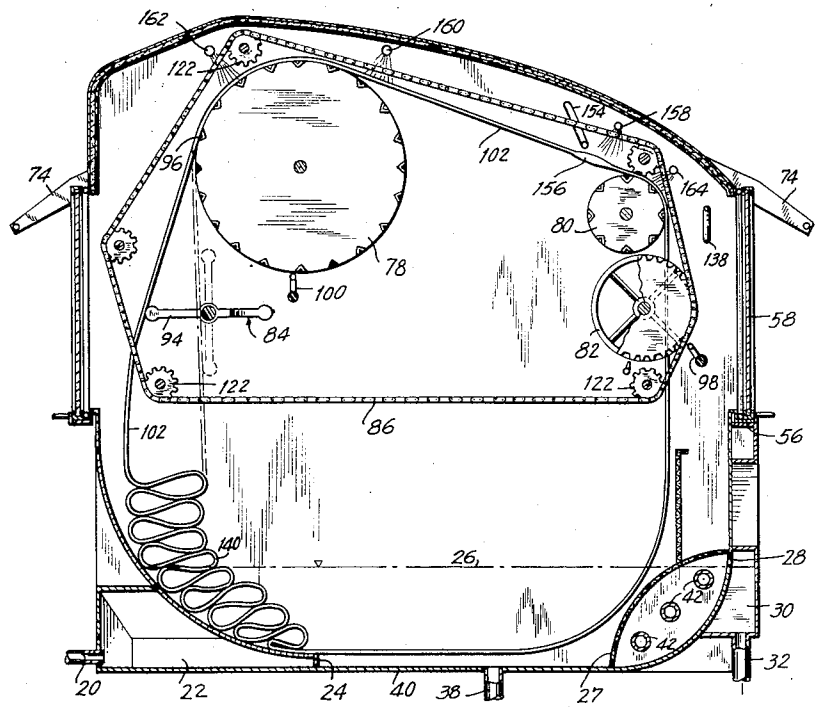
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Primary Examiner—Harvey C. Hornsby
Assistant Examiner—Philip R. Coe
Attorney, Agent, or Firm—Kirschstein, Kirschstein, Ottinger & Frank

[57] **ABSTRACT**

An apparatus and method for processing a fabric in a vat, which vat is at least partially filled with a processing liquid. The fabric is in rope-like form and has a leading and a trailing end. Means is provided for forming vertically pleated adjacent piles of the fabric at the back of the vat wherein the fabric at the top of each pile is in the same vertical plane as the fabric at the bottom of the same pile. Means is provided for winding the fabric into helical convolutions, each of which contains one such pile, wherein the fabric unwinds at the trailing end and rewinds at the leading end as successive convolutions advance in a direction toward the trailing end of the fabric and for intermittently moving the convolutions in a direction perpendicular to the vertically pleated piles of fabric. The vat has a doubly insulated frame to reduce radiation loss therefrom so that the temperature in the vat above the surface of the processing liquid is approximately equal to the temperature in the vat below the surface of the processing liquid whereby chilling of the fabric is avoided after the fabric has been pulled through and lifted above the surface of the processing liquid.

12 Claims, 14 Drawing Figures



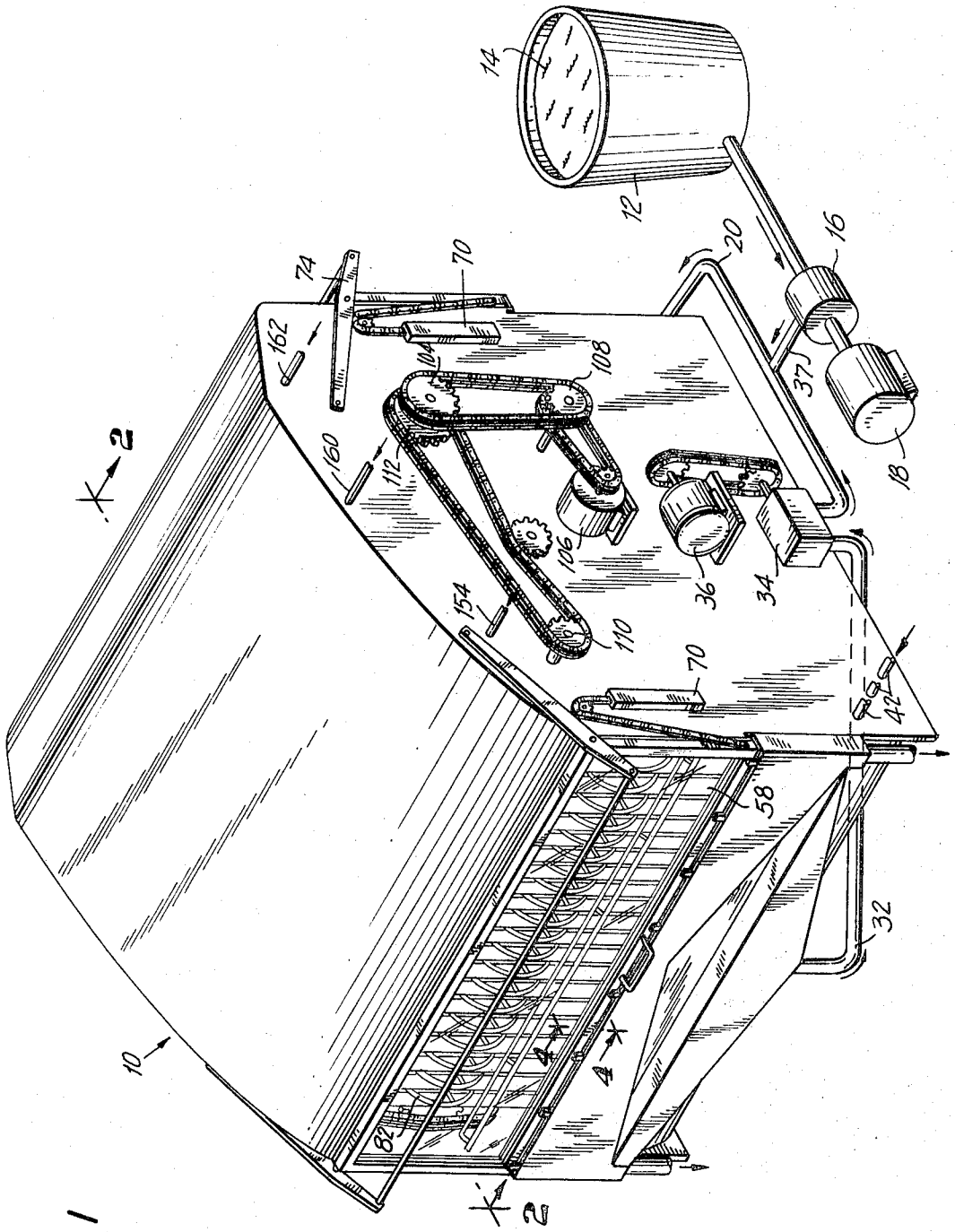

14
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16
20
74
70
162
104
108
37
18
160
112
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34
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110
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42
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82
2
2
4
4

FIG. 1

FIG. 2

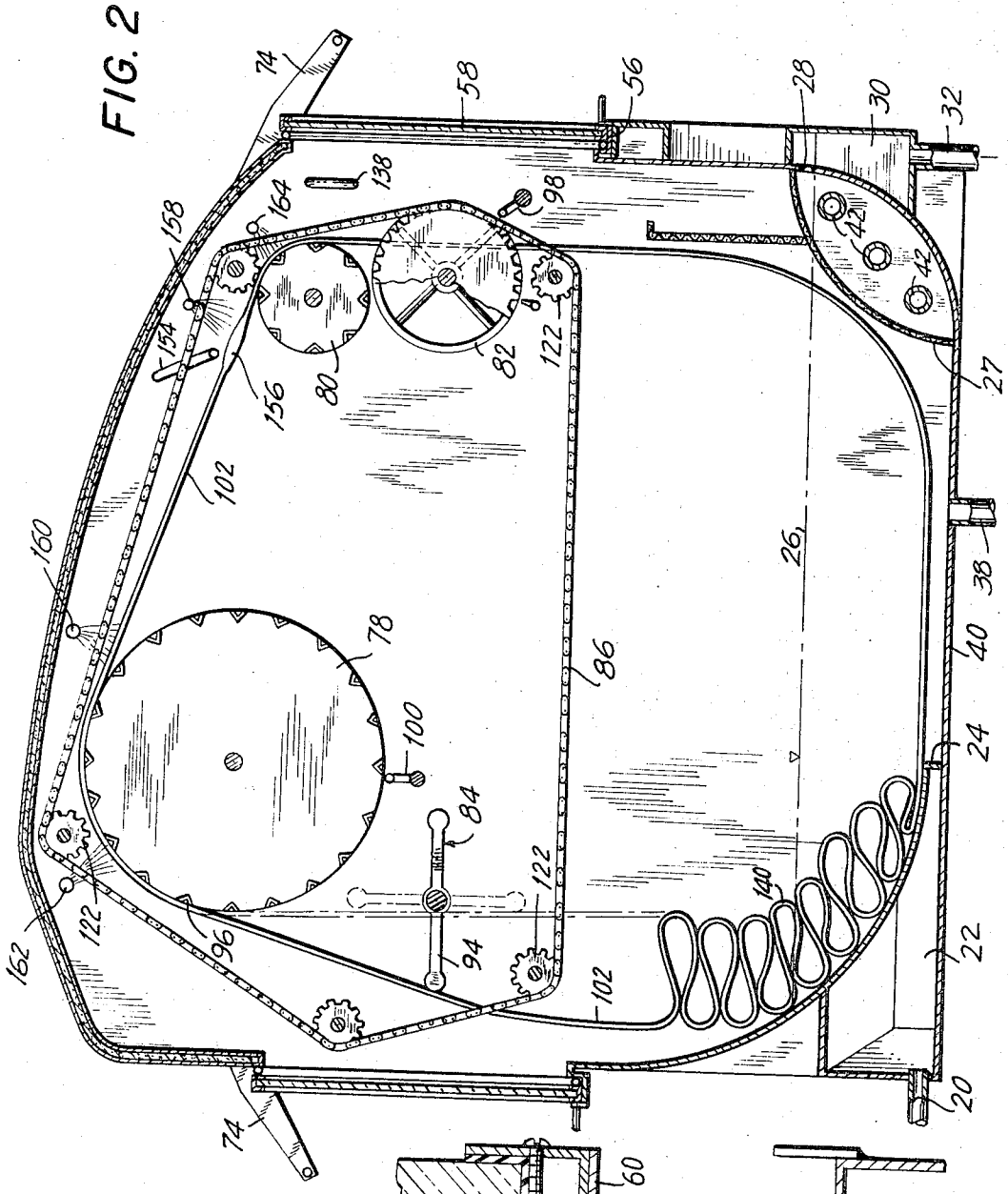

74
58
56
28
30
32
138
98
164
158
42
154
156
80
82
122
27
102
160
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78
86
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100
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24
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140
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96
94
22
102
74
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FIG. 3

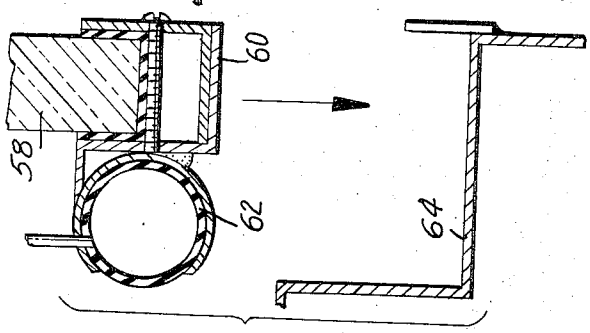

60
58
62
64

FIG. 5

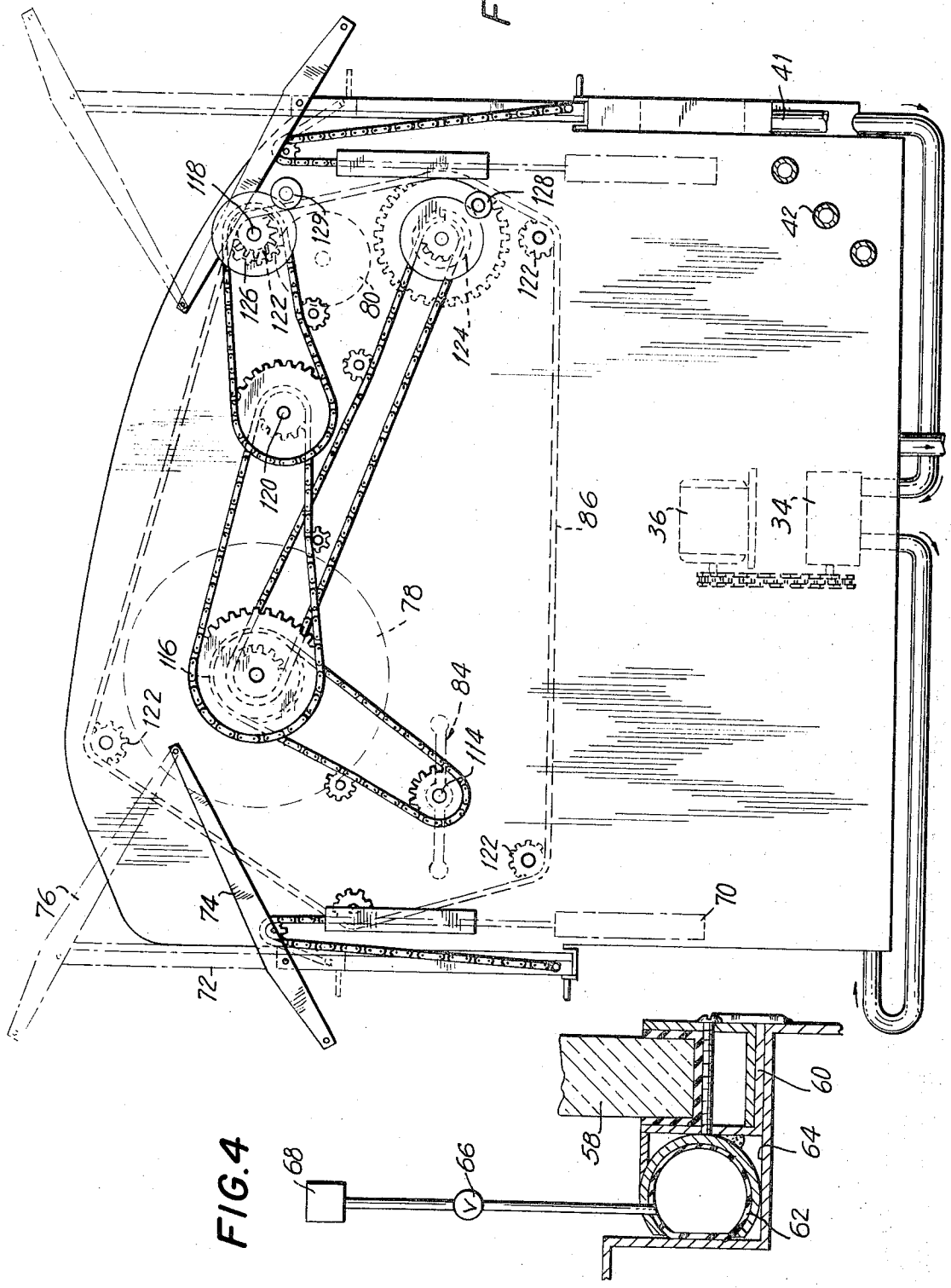

41
42
118
129
128
126
122
80
124
120
86
36
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FIG. 4

FIG. 7

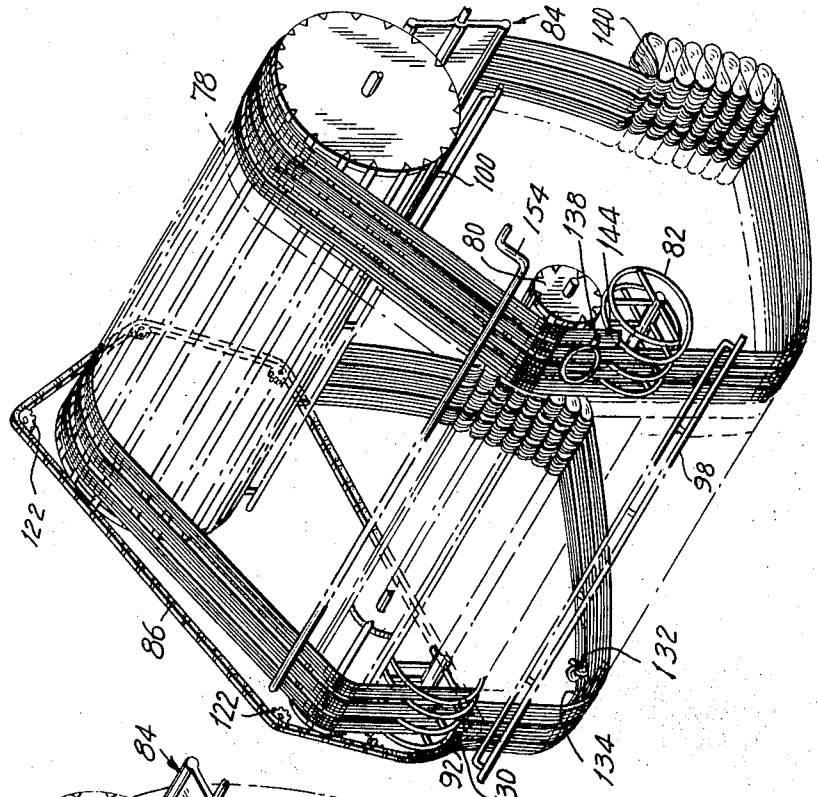

78
84
140
100
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138
144
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98
122
86
132
134
92
130

FIG. 6

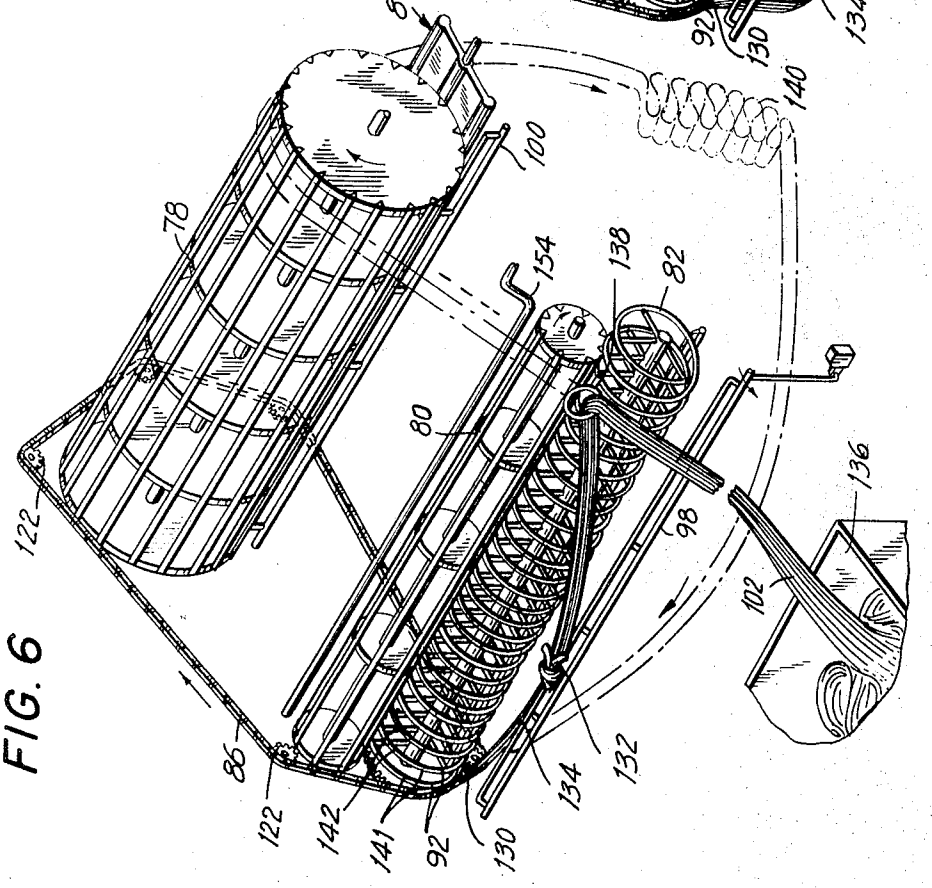

84
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141
92
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FIG. 8

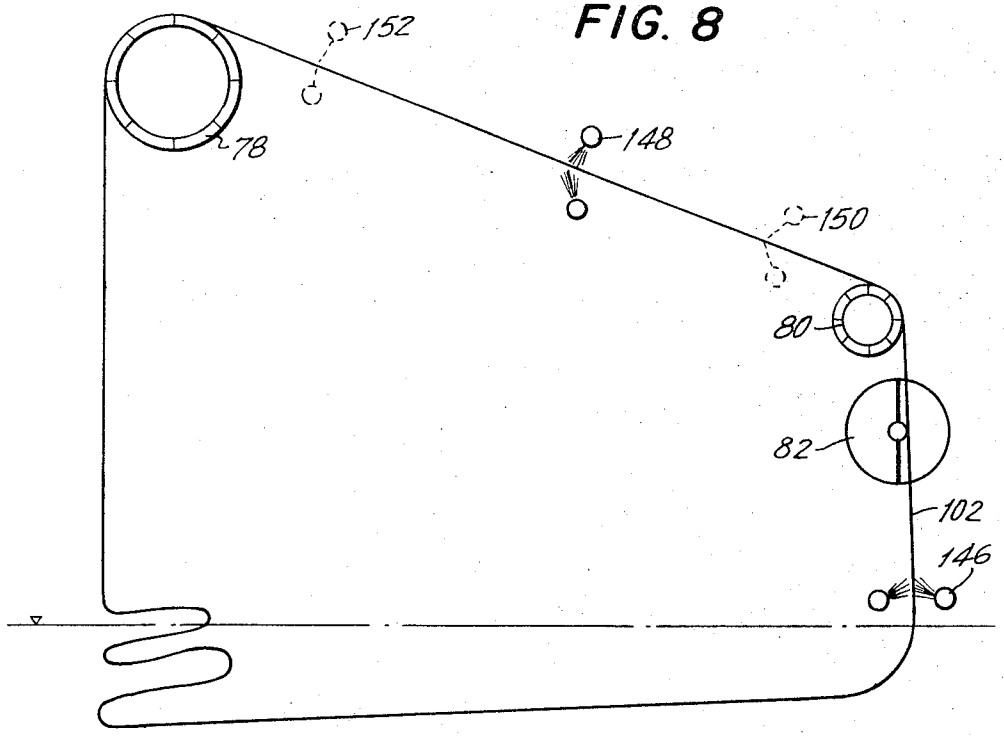


FIG. 14

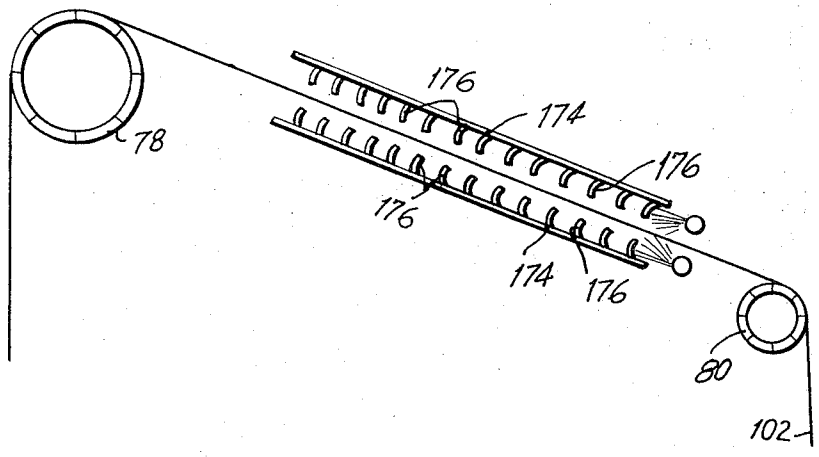


FIG. 9

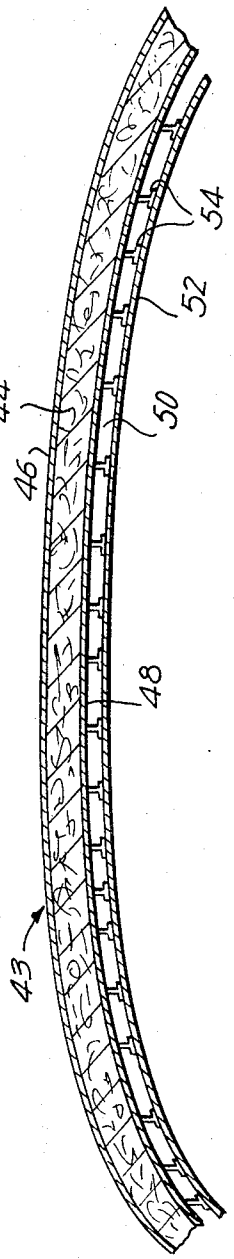


FIG. 10

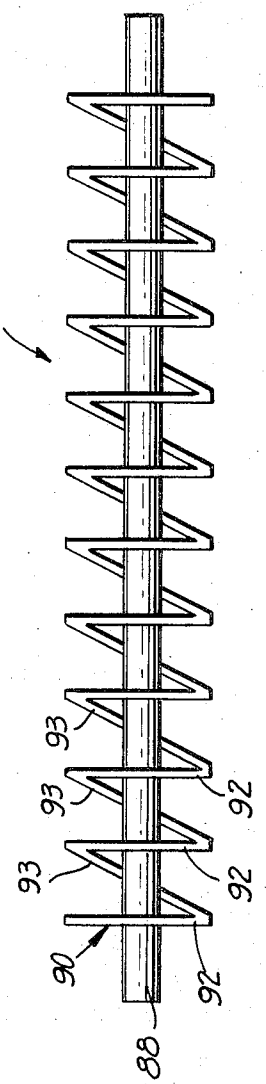


FIG. 12

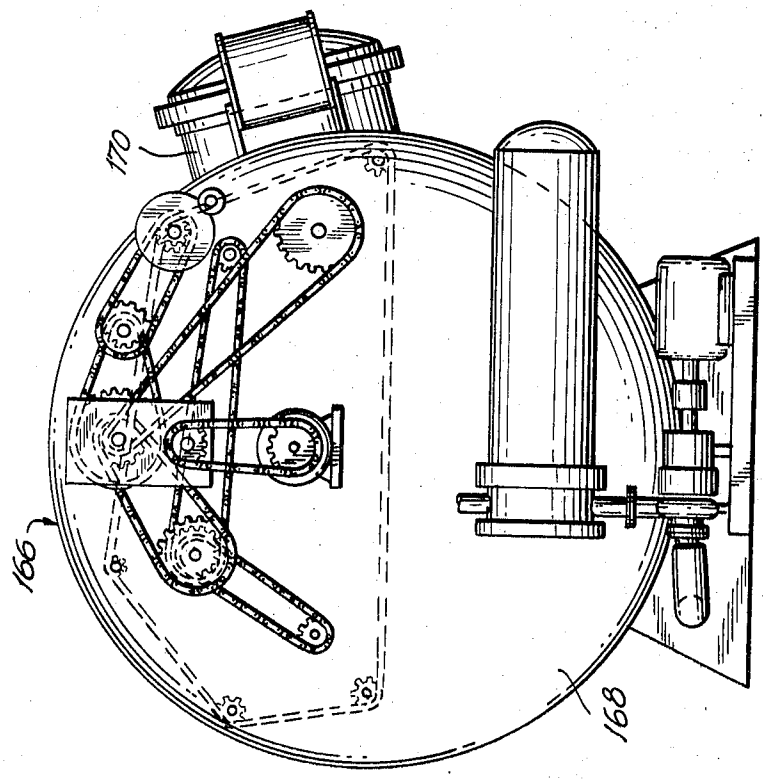
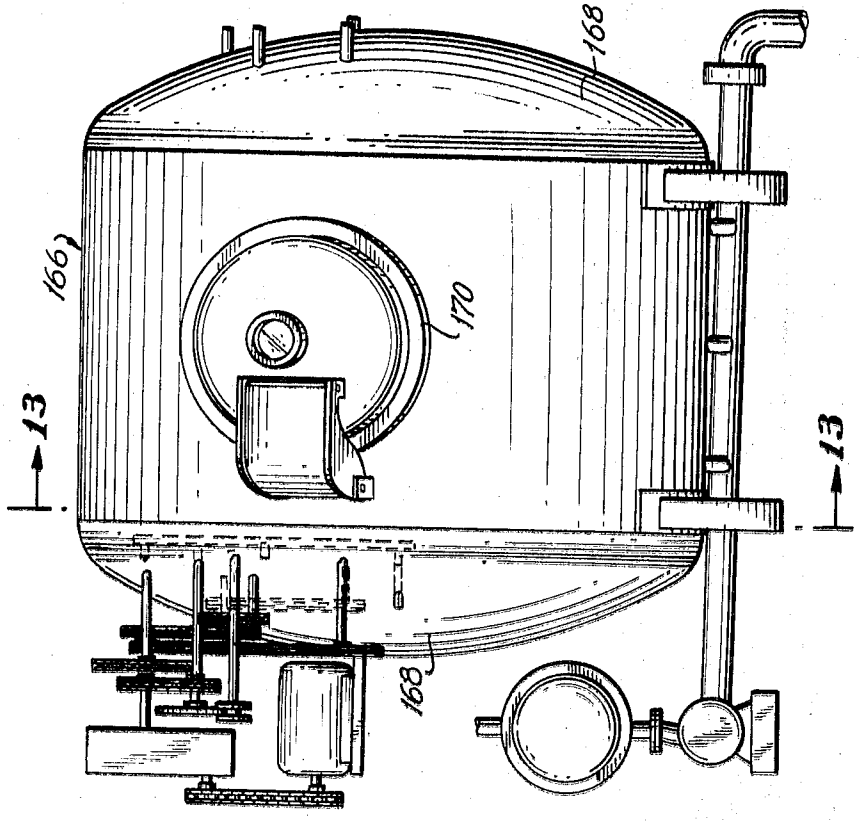


FIG. 11



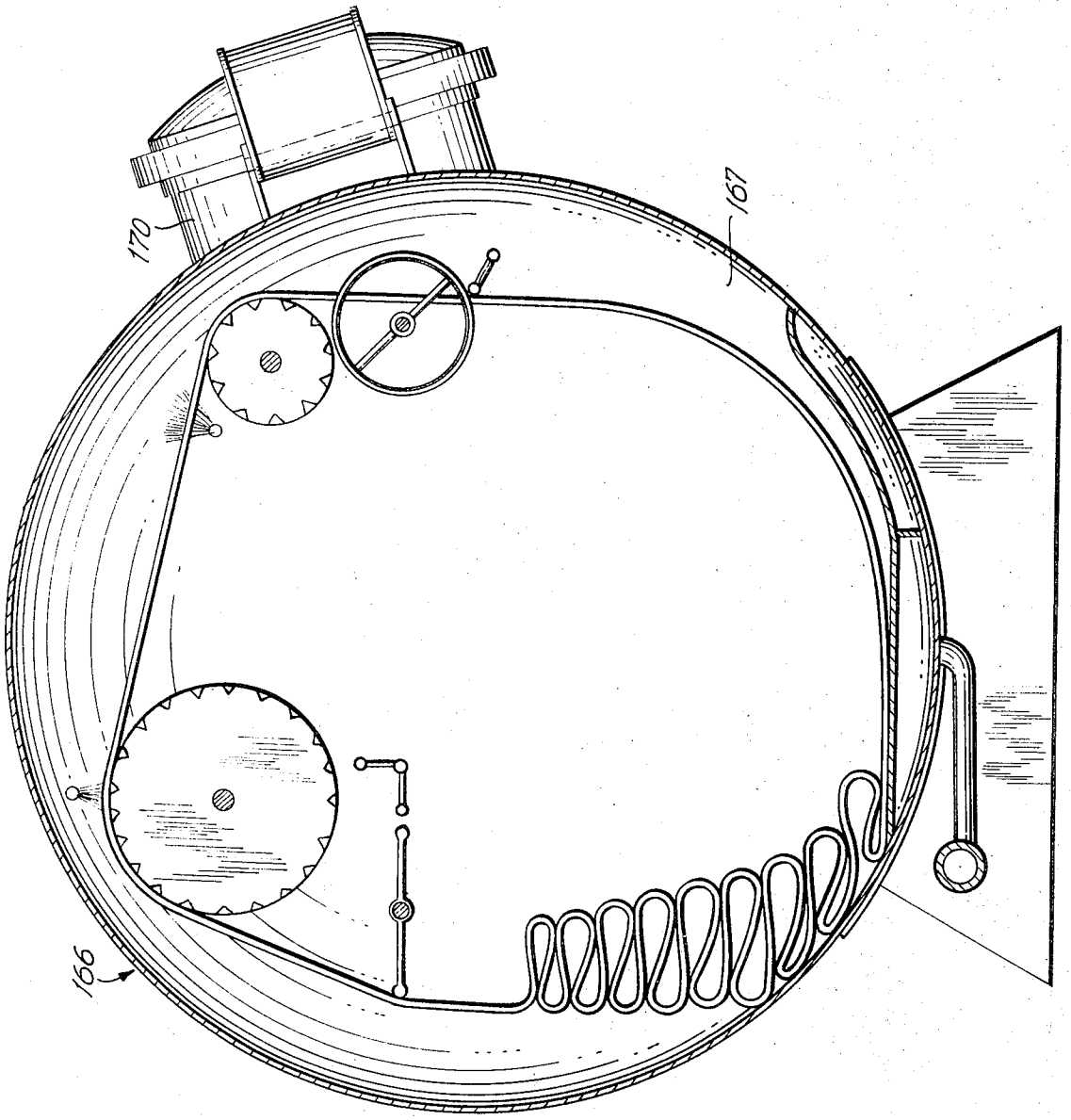


FIG. 13

METHOD AND APPARATUS FOR PROCESSING FABRICS IN ROPE-LIKE FORM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus and method for treating fabrics and more particularly for dyeing fabrics which are in rope-like form.

2. Description of the Prior Art

Previous fabric dyeing machines, such as the apparatus described in U.S. Pat. No. 3,308,639, show rope-like fabric fed from a helical guide to an elliptical winch roller in such a manner that the fabric forms continuous helical convolutions. After each convolution of the fabric leaves the winch roller, it forms a pleat which falls to the back of the dye vat. The pleating is caused by the elliptical shape of the winch roller. However, since the continuous movement of the helical guide causes the fabric on each convolution to leave the winch roller at a point which varies along the length of the roller, the pleats form a leaning pile (stack). Adjacent piles overlap, like shingles. Fabric is continuously pulled from the bottoms of the piles to retraverse the winch roller. The overlapping, in combination with the bottom pulling, buoyancy of the fabric, and movement of the processing liquid causes the piles to tumble and become disoriented, thereby tangling, knotting and twisting the fabric. As a result, time is lost reordering the fabric and the fabric is unevenly dyed. Furthermore, the elliptical shape of the winch roller pulls the fabric unevenly, i.e. at a varying speed, from the helical guide so as to create uneven stresses in the rope-like material, and an unevenness of dying. Still further, the uneven loads caused by the elliptically shaped winch roller unevenly load the drive motors thereby requiring the use of larger and more expensive drive motors to prevent frequent breakdowns.

Still further, prior art dyeing apparatus, especially open vat type apparatus, as described in the above referred to patent, result in unwanted temperature gradients existing within the vats and also above and below the liquid levels. These temperature gradients cause chilling of the fabric and produce uneven dyeing.

A further problem resulting in the uneven dyeing of material can be caused by uneven concentrations and flow of the dye material within the liquid bath, which uneven concentrations especially results when dye material is poured into an open vat.

Another source of uneven dyeing results from having creases formed in the material as it is pulled along the surface of the drive or winch rollers. Still further, the penetration of dye into the fabric, and the time it takes to complete the dyeing cycle, can be favorably improved by operating the apparatus at a higher temperature than is practicable when using open vat type apparatus such as described in the above referred to prior art patent.

If a dye cycle begins using a dye color which is lighter than the dye color used to previously treat other fabric, the fabric may tend to have dark stains formed therein after contacting the drive rollers, if the driver rollers are not adequately cleaned beforehand.

SUMMARY OF THE INVENTION

1. Purposes of the Invention

It is an object of this invention to provide an improved apparatus and method for processing fabric in rope-like form.

It is a further ojbect of this invention to prevent tangling of pleated piles of fabric as the fabric is pulled through a processing liquid.

It is anoher object of this invention to reduce stressing of the fabric as it is pulled over drive rollers.

It is a further object of this invention to reduce creasing of the fabric as it is pulled over the drive rollers.

It is an additional object of this invention to prevent chilling of the fabric as it passes through and above the surface of the processing liquid.

Still another object of this invention is to reduce the radiation loss from the processing vat.

Still a further object of this invention is to make the constitution of the processing liquid more uniform throughout the dye vat.

Still another additional object of this invention is to reduce the tension in the fabric as it is pulled over the rear drive roller so that the fabric enters the processing liquid in a relaxed state.

Other ojbects of the invention will in part be obvious and in part will be pointed out hereinafter.

2. Brief Description of the Invention

According to a broad aspect of the invention there is provided an apparatus and method for processing a fabric in a vat, said vat being partially filled with a processing liquid, said fabric being in rope like form and having a leading and a trailing end, said apparatus comprising means for forming vertically pleated piles of said fabric at the back of said vat, said fabric at the top of each pile being in the same vertical plane as said fabric at the bottom of each said pile, and means for winding said fabric into helical convolutions and for intermittently moving said fabric in a direction perpendicular to the vertically pleated piles of fabric, whereby said fabric unwinds at the trailing end and rewinds at the leading end as successive convolutions advance in a direction towards the trailing end of said fabric.

A feature of the invention provides that said pleat forming means is comprised of a horizontally extending front drive roller, said rollers and bar being mutually parallel, means for driving said front and rear drive rollers so as to pull said fabric through said vertical guide means, over said front drive roller, then over said rear drive roller and past said pleating bar towards the back of said vat, and means for rotating said pleating bar so that said bar moves towards and beyond a horizontal position past the back edge of said rear drive roller, so as to push said material towards the back of said vat, and then said bar moves in front of the back edge of said rear drive roller so as to permit said fabric to swing under its own weight toward the front of said vat whereby the pleats are formed in a vertical pile.

Another feature of the invention provides that said winding and moving means further includes a closed loop carrier, the leading end of said rope-like fabric being attached to said carrier, a mutilated spiral including parallel straight reaches perpendicular to the length of the spiral, which reaches constitute said vertical guide means and are located at the front of the spiral when the spiral is stationary, said spiral further including inclined reaches connecting the ends of said perpendicular reaches, said inclined reaches being at the rear of the spiral when the spiral is stationary, means for intermittently rotating said carrier 360° to wind the

leading end of said fabric past the rollers and bar, and means for substantially concurrently intermittently rotating said spiral 360° to advance the convolutions lengthwise of the rollers and bar, and then idle the spiral in a stationary position with the perpendicular reaches at the front of the spiral to serve as vertical guides for the fabric.

According to another aspect of the invention there is provided a vat for processing a fabric in a vat, said vat being partially filled with a processing liquid and having fabric processing means included therein, said vat forming an enclosed pressurized chamber, end sides of said vat being rounded so as to increase the volume of said chamber and to allow for use of a thinner gauge material for the end sides of said vat.

According to still another aspect of the invention, there is provided an apparatus and method for processing a fabric in a vat, said vat being at least partially filled with a processing liquid, said fabric being in rope-like form and having a leading and a trailing end, said apparatus comprising a horizontally extending substantially circular front drive roller, a horizontally extending substantially circular rear drive roller, and means for driving said front and rear drive rollers at the same tangential velocity so as to eliminate imposition of changing strain on said fabric as said fabric is driven by said front and rear drive rollers.

According to an alternate aspect of the invention, the tangential velocity of the front drive roller is made greater than that of the rear drive roller so as to overfeed the fabric as it approaches the rear drive roller. Power jets are placed between the front and rear drive rollers and adjacent the front drive roller so as to propel the fabric towards the rear drive roller. A shoot or guide channel concentrates the stream of liquid onto the fabric in a turbulant manner so as to cause strands of the fabric to telescope inward before the fabric reaches the rear drive roller, thereby allowing the fabric to enter the processing liquid in a relaxed manner, so that the relaxed fabric is more effectively treated.

According to a further aspect of the invention there is provided an apparatus and method for processing a tubular fabric in a vat, said vat being partially filled with a processing liquid, said fabric being in rope-like form and having a leading and a trailing end, said apparatus comprising means for pulling said fabric through a 360° loop, the loop extending above and below the surface of said processing liquid, said pulling means including front and rear drive rollers, means for blowing air into said tubular fabric so as to inflate the same and thereby reduce the creasing of said fabric as said fabric is pulled by said front and rear drive rollers. Another aspect of the invention comprises the provision of means for streaming said processing liquid onto said fabric before and after air is blown into said fabric.

According to a still further aspect of the invention, there is provided an apparatus and method for processing fabric in a vat, said vat being partially filled with a processing liquid, said fabric being in rope-like form and having a leading and a trailing end, said apparatus comprising means for pulling said fabric in a 360° loop, the loop being formed above and below the surface of said processing liquid, said pulling means including parallel horizontally extending front and rear drive rollers in contact with said fabric, and means for streaming said processing liquid onto said fabric in the direction having a substantial component parallel to the direction of movement of said fabric before said fabric passes over said front and rear drive rollers so as to reduce the strain imposed on said fabric as said fabric is driven by said front and rear drive rollers and to increase the penetration of said processing liquid into said fabric so as to improve the overall processing of said fabric.

According to an additional aspect of the invention there is provided a vat for processing fabric, said vat being partially filled with a processing liquid, said fabric being in rope-like form, said vat including means for processing said fabric therein, said vat having doubly insulated frame portions to reduce radiation loss from said vat so that the temperature in said vat above the surface of said processing liquid is approximately equal to the temperature in said vat below the surface of said processing liquid thereby avoiding chilling of said fabric after the fabric has been pulled through said processing liquid and is above the surface of said processing liquid.

According to a further aspect of the invention there is provided a vat and method for processing fabric, said vat being partially filled with a processing liquid, said fabric being in rope-like form, said vat including means for processing said fabric, means for introducing said processing liquid from a tank into the bottom of said vat, and means for circulating said processing liquid between the rear and the front of said vat so as to provide for uniform constitutions of said processing liquid and more even processing of said fabric.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, in which are shown various possible embodiments of my invention:

FIG. **1** is a perspective view of a vat for processing a rope of fabric in accordance with the present invention;

FIG. **2** is a sectional view of FIG. **1** taken substantially along the line **2—2**, said view showing the drive rollers, mutilated spiral, carrier chain, pleater bar and one convolution of the fabric vertically piled at the rear of the vat;

FIG. **3** is an enlarged cross-section of a door seal shown in FIG. **2** before the door is closed;

FIG. **4** is a view similar to FIG. **2** after the door is closed;

FIG. **5** is an end view of the processing vat, showing the means for driving the drive rollers, the carrier chain, the mutilated spiral and the pleater bar, and also the means for circulating the processing liquid;

FIG. **6** is an internal perspective view of the processing apparatus showing the fabric as loading is started;

FIG. **7** is an internal perspective view of the fully loaded processing apparatus;

FIG. **8** is a schematic view of one convolution of the fabric loaded onto the apparatus and showing the location of means for streaming processing liquid onto the fabric in a fashion such as to assist movement of the fabric in the apparatus;

FIG. **9** is an enlarged fragmentary sectional view of the insulating frame of the vat;

FIG. **10** is a front view of the mutilated spiral;

FIG. **11** is a front view of a processing vat providing a high pressure chamber;

FIG. **12** is an end view of the vat shown in FIG. **11**;

FIG. 13 is a cross-section of the vat shown in FIG. 11 the same being taken substantially along the line 13—13 and showing the same handling apparatus as is shown in FIG. 1; and

FIG. 14 is an enlarged partial schematic view of the apparatus shown in FIG. 8 showing the stream of liquid placed between the front and rear drive rollers and adjacent the front drive roller, and guide shoots for concentrating the liquid onto the fabric.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A processing vat **10** embodying the present invention is illustrated in FIG. **1.** A supply tank **12** is shown filled with a processing liquid **14,** which liquid can be a dye, bleach or cleaning agent. Processing liquid **14** is drawn out of the bottom of tank **12** by a pump **16,** which pump in turn is driven by a motor **18.** Liquid **14** then passes through a pipe **20** and into a rear manifold **22** (shown in FIG. **2**) that extends from end to end of vat **10.** Processing liquid **14** flows through holes **24** in the front of rear manifold **22** so that the bottom of vat **10** fills up to a liquid level or surface **26.** The processing liquid is passed through a wire mesh screen or baffle **27,** through an overflow opening **28** into a front mainfold **30,** out of vat **10** through a pipe **32** and a pump **34,** which forces the liquid back through pipe **20** into rear manifold **22.** As showin FIG. **1,** pump **34** is driven by a motor **36.** In this manner, processing liquid **14** in vat **10** is continuously circulated between the respective rear and front manifolds **22** and **30,** while fresh processing liquid from tank **12** can be added thereto through a pipe **37** which leads into pipe **20.** Thus, a uniform concentration of processing liquid is maintained within the bottom of vat **10** so as to provide for a more even processing and treating of fabric therein.

Processing liquid **14** can be drained from vat **10** via a pipe **38** leading from a bottom wall **40** as shown in FIG. **1.** Of course, pipe **38** has a valve (not shown) connected therein so as to prevent processing liquid **14** from continuously draining from the bottom of the vat. As shown in FIG. **5,** an overflow pipe **41** is connected to an upper front manifold so as to insure that the surface of processing liquid **14** never exceeds a specified level. Radient steam coils **42** (shown in FIG. **2**) are placed below surface **26** of processing liquid **14,** and between wire mesh screen **27** and front manifold **30** so as to heat processing liquid **14** to a suitable temperature.

In order to avoid chilling of the fabric after it leaves surface **26** of liquid **14,** which chilling would deleteriously affect even processing of the fabric, it is necessary to try to maintain the temperature within the vat and above surface **26** of processing liquid **14** at approximately the same temperature as the processing liquid. In order to do this, it is necessary to keep the heat loss from vat **10** to a minimum. The heat loss can be reduced by insuring that the top, sides and doors of vat **10** are doubly insulated. FIG. **9** shows an enlarged sectional view of the top **43** of vat **10** (the same structure is employed for the ends and back of the vat and for the rear door), wherein a glass wool layer **44** is placed beneath an outer plate **46** and is held by strips **48.** An air space **50** of, for example, approximately one-half inch depth, is formed between a lining **52** and the glass wool layer. Strips **48** are held away from lining **52** via a plurality of spacers **54.**

Heat loss from within vat **10** can also be reduced by providing an improved seal assembly **56,** shown n FIG. **2** for a front door **58.** As shown in an enlarged view in FIG. **3,** the door seal assembly **56** consists of a frame **60** which holds glass door **58** and a flexible tubular sealing member **62,** e.g. a rubber hose, which member runs along the side and bottom edges of door **58.** When the door seal assembly **56** is disengaged, as shown in FIG. **3,** from a U-shaped track **64** in which the bottom and sides of frame **60** are slidably receivable, tubular member **62** is not inflated. However, as shown in FIG. **4,** when door seal assembly **56** engages track **64** when door **58** is slid to closed position, tubular member **62** is internally pressurized by opening a valve **66** so that a pressurized gas from a source **68** can be supplied thereto, whereby to force the door against the vat. In this manner, a more effective door seal is provided so as to reduce the heat loss from within vat **10.** Of course, when door **58** is again opened, tubular member **62** can be depressurized. The pressurizing and depressurizing of tubular member **62** can be accomplished either manually or automatically.

Door **58** is shown closed in FIG. **1** and a counterweight **70,** which is attached thereto, is shown in a raised position. Door **58** can be slid to a higher vertical position **72,** shown in dotted lines in FIG. **5,** as counterweight **70** is lowered as shown in dotted lines, while a pivoting arm **74** which is attached to the top of door **58,** swings to a higher position **76,** also shown in dotted lines.

As shown in FIG. **2,** there is provided a horizontally extending rear or primary drive roller **78,** a horizontally extending front or secondary drive roller **80,** a horizontally extending mutilated spiral **82,** a horizontallly extending pleater bar **84** and a closed loop carrier **86.** Carrier **86** is in a verticle plane adjacent one end of and perpendicular to the axis of rotation of rear drive roller **78,** front drive roller **80,** and pleater bar **84,** wherein the drive rollers and bar are mutually parallel thereto. Rear drive roller **78** and front drive roller **80** have a cylindrical shape and are repsectively formed by a parallel series of transverse rods attached to circular discs.

Spiral **82,** as shown in front view in FIG. **10,** is comprised of a bar **88** attached to a wire section **90.** Wire section **90,** which forms a series of convolutions, is comprised of vertical guide means having vertically adjacent parallel straight reaches **92** perpendicular to the length of the spiral which are always located at the front of the spiral when the spiral is stationary so as to provide for an improved guide for the fabric which passes therethrough while the apparatus is being loaded or operated. The ends of adjacent reaches **92** are connected by inclined reaches **93,** which inclined reaches are always at the rear of the spiral when the spiral is stationary. Such vertical guide means also assist in the formation of vertically pleated piles to be explained later.

Pleater bar **84** rotates upon its axis and when it is in the horizontal position, one portion **94** extends past a rear edge **96** of rear drive roller **78** and when pleater bar **84** is in the vertical position, it is aligned below rear drive roller **78** and does not extend beyond rear edge **96** of rear drive roller **78.**

Also shown in FIG. **2** are a front safety limit bar **98** and a rear safety limit bar **100.** Safety limit bars **98** and **100** serve to activate a power cut-off switch so as to

turn the apparatus off in the event that fabric **102** somehow becomes tangled and falls against either of the safety limit bars.

Rear drive roller **78** is driven by a rear drive shaft **104,** (shown in FIG. **1**) which shaft is in turn driven by a motor **106** via a gear linkage arrangement **108.** Front drive roller **80** is driven by a front drive shaft **110,** which in turn is coupled to rear drive shaft **104** by a suitable gear linkage arrangement **112,** which linkage arrangement provides that the surface speed or tangential velocity of rear drive roller **78** is the same as that of front drive roller **80** so that fabric **102,** which is pulled over both front and rear drive rollers, is not unnecessarily stressed as would be the case if the surface speed of the drive rollers were different. Furthermore, since drive rollers **78** and **80** are cylindrically shaped, rather than elliptically shaped as in the prior art, they provide a more even loading for motor **106.** As shown in FIG. **5,** pleater bar **84** is driven by a pleater shaft **114,** which shaft in turn is driven by rear drive shaft **104** via a gear linkage arrangement **116.** Carrier **86** is driven by a carrier drive shaft **118** which in turn is also driven by rear drive shaft **104** via a gear linkage arrangement **120.** Carrier **86** rotates in a closed path determined by sprockets **122.**

While front and rear drive rollers continuously move at a constant speed during loading and operation of the apparatus, carrier **86** and spiral **82** move only intermittently so that in the course of time necessary for one convolution of fabric **102** to complete one full revolution (cycle) through the apparatus, carrier **86** and spiral **82** both make one complete revolution within a fraction of that time and remain stationary through the remainder of the same fabric cycle. Such intermittent operation of spiral **82** and carrier **86** is provided by respective clutches **124** and **126,** which serves to disengage respective spiral and carrier drive shafts. Standard manual or automatic means can be used to properly engage and disengage clutches **124** and **126.** The spiral and carrier drive shafts are respectively coupled to braking mechanisms **128** and **129** so as to prevent any prolonged movement in the respective spiral and carrier after their drive shafts have been disengaged.

The loading of the apparatus is illustrated in FIG. **6** wherein carrier **86** has a hook **130** attached thereto at a point slightly below spiral **82.** A leading end **132** of fabric **102** is attached to hook **130** via a leader material **134.** Fabric **102,** which in this example has a tubular form of the type that is generally woven by cylindrical winding machines, is led from a storage bin **136** through a loadng poteye **138** over the front portion of front drive roller **80** to leader material **134.** Loading poteye **138** is a stationary member which is supported by the frame of vat **10.** Carrier **86** makes one quick and complete revolution pulling fabric **102** out of storage bin **136** and into engagement with respective front and rear drive rollers **80** and **78.** Alternatively, when so desired, carrier **86** can make a little less than one complete revolution and then inch up until the revolution is complete. Front and rear drive rollers **80** and **78** move fabric **102** towards the back of vat **10,** while pleater bar **84,** (shown in FIG. **2**) which is revolving at an angular velocity in excess of the angular velocity of the revolving fabric, pushes fabric **102** further towards the back of vat **10** as it (pleater bar) moves towards the horizontal position and lets the fabric move under its own weight towards the front of the vat as it (pleater bar) moves towards the vertical position so as to form a vertically pleated pile **140** in the rear of vat **10.** Carrier **86** then makes a quick revolution and stops so as to feed fabric from the bottom of vertically pleated pile **140** through a first vertical guide means provided by adjacent pairs of vertical reaches **92** at that end of the spiral which is adjacent carrier chain **86,** over front drive roller **80,** rear drive roller **78** and towards the back of vat **10,** while forming a vertically pleated pile at the back of the vat. Carrier **86,** substantially concurrently with the movement of spiral **82,** makes another quick revolution and stops so as to advance the first formed convolution of fabric to the adjacent vertical guide means **142** of spiral **82,** whereafter two convolutions with two vertically pleated piles are formed. The process is continued until successive convolutions of fabric are formed and the machine is completely loaded as shown in FIG. **7,** whereupon a trailing end **144** of fabric **102** hangs freely.

When the loaded apparatus is in operation, carrier **86** makes one complete revolution, and trailing end **144** of fabric **102** unwinds. Leading end **132** of fabric **102** rewinds through first vertical guide means **139** as fabric **102** is pulled through processing liquid **14,** and vertically pleated piles **140** are formed towards the back of vat **10.** Substantially concurrently with the movement of carrier **86,** spiral **82** revolves to advance the material in the axial direction perpendicular to the vertical plane of the vertically formed pleated piles towards trailing end **144** of fabric **102,** so that, in effect, fabric **102** is being rewound as it is being unwound on the apparatus so as to remain stationary thereon during the processing fabric **102.** It should be noted that the pleated piles are so vertically formed because the pleating operation is mainly carried out while spiral **82** is stationary, and fabric **102** is thus being pulled through the vertical guide means of spiral **82** so as to avoid any movement of the fabric in the direction perpendicular to the vertical plain of the vertically formed pleated piles.

In order to avoid any unnecessary stressing of the fabric as it first contacts drive rollers **80** and **78** during the loading operation, poteye **138** is provided with holes **146** along the inner circumferential portion thereof, while processing liquid is pumped from the bottom of vat **10** through these holes so as to sufficiently wet fabric **102** before fabric **102** initially contacts drive rollers **80** and **78.**

Furthermore, as shown in FIG. **8,** circular spray bars **146** and **148** can be located respectively before front drive roller **80** and rear drive roller **78** so as to again supply a stream of processing liquid **14** from the bottom of vat **10,** which liquid has a substantial component that hits fabric **102** parallel to the direction of movement of the fabric. The fibers of fabric **102** are thus spread apart, thereby resulting in an increase in the penetration of the processing liquid within the fabric and an improvement in the overall processing of fabric **102.** Alternatively, circular spray bars **150** and **152** could also be added for the same reason described above or any combination of circular spray bars **146, 148** and **150** and **152** could be used.

Still further, in order to avoid creasing of fabric **102** as it passes over front and rear drive rollers **80** and **78,** respectively, air is blown into the fabric from an air injection bar **154,** (shown in FIGS. **1, 2, 6** and **7**) so as to form a blown-up portion **156** in fabric **102,** which

tends to remove some of the creases which have been formed within the fabric. Injection bar **154** has suitable holes therein for allowing the air to escape into the fabric. The air, or as a matter of fact, any suitable gas, can be pumped from outside of vat **10** but should pass through processing liquid **14** so that the temperature of the pumped air is approximately the same as the temperature within vat **10,** thereby avoiding chilling of fabric **102** during this operation.

In order to improve the effect of the air blowing operation, a stream of processing liquid **14** can be applied to fabric **102** from a circular spray bar **158** located between air injection bar **154** and front drive roller **80,** and additionally processing liquid **14** can be applied to fabric **102** from circulator spray bar **160** located between air injection bar **154** and rear drive roller **78.** An additional circulating spray bar **162** is so located as to apply a stream of processing liquid **14** onto fabric **102** when fabric **102** is in contact with rear drive roller **78** so as to improve the adherence of fabric **102** to rear drive roller **78,** thus resulting in a lessoning of the straining of fabric **102** during the processing cycle. Circular spray bar **162** and an additional circular spray bar **164** can be provided so that a stream of liquid from the bottom of vat **10** is applied over the respective rear and front drive rollers in order to clean the rollers before another processing operation on another fabric begins.

It should also be noted that instead of loading the apparatus in such a manner that fabric **102** forms successive convolutions, fabric **102** can be so loaded as to have only one convolution by eliminating spiral **82** and replacing it with a single vertical guide means previously described.

It should be further noted that fabric **102** could be similarly processed within a vat **166** (shown in FIGS. **11, 12** and **13**), which vat has a high pressure sealed chamber **167** (shown in FIG. **13**) and rounded external sides **168** (shown in FIG. **11**). Rounded external sides **168** increase the inner volume of sealed chamber **167** and also allow the use of a thinner gauge material for the frame of vat **166.** As shown in FIG. **12,** vat **166** can have a quick locking pressure door **170.** The pressure within sealed chamber **167** of vat **166** can range typically from 5 to 100 PSIG. As shown in FIG. **13,** the actual fabric processing apparatus is the same as that used in vat **10.**

In an alternate embodiment, which is illustrated in FIG. **14,** the tangential velocity of front drive roller **80** is greater than the tangential velocity of rear drive roller **78** so that the front drive roller tends to over-feed the fabric as it moves towards the rear drive roller. A set of power jets **172** is placed between front and rear drive rollers and adjacent the front drive roller so as to propel the fabric toward the rear drive roller. A set of shoots or guide channels **174** concentrate the stream of processing liquid from the power jets onto the fabric. Turbulator blades **176** extend from shoots **174** in such a manner as to cause the streaming processing liquid to form a turbulance so as to cause the strands of fabric to telescope inward before the fabric reaches the rear drive roller. Due to the telescoping of the fabric caused by the turbulant processing liquid, the fabric does not creep down between the drive rollers, but instead moves over the rear drive roller and enters the vat of processing liquid in a relaxed manner. Th relaxed fabric is thus free from physical deformations, such as creases, since it is not under tension as it moves over the rear drive roller, and is thus more effectively dyed. The fabric is then, of course, pulled over the front drive roller under tension and is stretched back to its non-telescoped form. The above described embodiment can, of course, be applied to apparatus for treating only one convolution of fabric and also to apparatus for treating a plurality of convolutions of fabric.

It thus is seen that there is provided an apparatus for processing fabrics in rope-like form which achieves the several objects of the invention and is well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiments above set forth, it is to be understood that all matter herein described, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

Having now described the invention, there is claimed as new and is desired to be secured by Letters Patent:

1. In an apparatus for processing a fabric in a vat having a front and rear and which vat is partially filled with a processing liquid having an upper surface, the fabric being in rope-like form having a leading and a trailing end, and which apparatus includes means to wind the fabric into helical convolutions of which each includes a pleated section in the liquid, each pleated section having a leading portion and a trailing portion, first means to revolve the leading end of the fabric in a closed path around the axis of a helix formed by the helical convolutions, seconds means at the front of the vat to draw the fabric from the leading portion of each pleated convolution section out of the liquid, third means at the rear of the vat receiving the fabric of each convolution from the second means and depositing the same at the trailing portion of each previous pleated convolution section adjacent the upper surface of the processing liquid, said third means advancing the fabric at a rate per convolution faster than the first means so that the fabric is formed into pleated sections one for each convolution at the rear of the vat in the liquid, and fourth means to advance the convolutions toward the trailing end of the fabric: that improvement comprising

a. means actuating the first means intermittently to revolve the leading end of the fabric once through said closed path more speedily than the second and third means revolve the convolutions once around said axis of the helix, said first means being actuated once for ach single revolution of the helical convolutions around the axis, and

b. means for intermittently actuating the fourth means once more speedily than the second and third means revolve each convolution once around the longitudinal axis of the helix, said fourth means being actuated once for each single revolution of the several convolutions of the helix around said axis,

c. whereby the fabric as deposited at the trailing portion of each pleated convolution section remains substantially constant axially while the fourth means is deactuated so that the deposited fabric of each convolution remains in a common plane perpendicular to the axis of the helix while the fourth means is deactuated.

2. A combination as set forth in claim 1 wherein means is included to pleat the fabric as it is deposited adjacent the surface of the liquid.

3. A combination as set forth in claim 2 wherein the second and third means are horizontally extending substantially circular drive rollers, and wherein the pleating means is a horizontally extending pleating bar below and in back of the rear drive roller, and wherein means is included for rotating the pleating bar so that the bar moves toward and beyond and then back from a horizontal position in back of the back edge of the rear drive roller so as to push the fabric toward the back of the vat and when the bar moves forwardly in front of the back edge of said rear drive roller to permit the fabric to swing under its own weight toward the front of the vat to form the pleated sections.

4. A combination as set forth in claim 3 wherein drive means is provided to rotate the front and rear drive rollers at the same tangential velocity so as to reduce the strain on the fabric as it is advanced by said rollers.

5. A combination as set forth in claim 3 further comprising means for applying a stream of said processing liquid onto said fabric in the direction of movement of said fabric after said fabric passes over said front drive roller and before said fabric passes over said rear drive roller so as to reduce the straining of said fabric as said fabric passes over said front and rear drive rollers and to increase the penetration of the processing liquid into said fabric so as to improve the overall processing of said fabric.

6. A combination as set forth in claim 5 wherein the tangential velocity of the front drive roller is greater than the tangential velocity of the rear drive roller.

7. A combination as set forth in claim 6 further comprising a set of guide plates positioned between said front and rear drive rollers and on opposite sides of said fabric so as to concentrate the stream of processing liquid onto said fabric, said guide plates including turbulator blades extending towards said fabric whereby said stream of processing liquid forms a turbulence and causes strands of said fabric to telescope inward so that said fabric passes over said rear drive roller and into the processing liquid in a relaxed fashion, so as to provide more effective treating of said fabric.

8. In a method for processing a fabric in a vat having a front and rear and which vat is partially filled with a processing liquid having an upper surface, the fabric being in rope-like form and having a leading and a trailing end, and in which method the fabric is wound into helical convolutions of which each includes a pleated section in the liquid, each pleated section having a leading portion and a trailing portion, and further in which method the leading end of the fabric is revolved in a closed path around the axis of the helix formed by the helical convolutions, the fabric from the leading portion of each previous pleated convolution section being drawn out of the processing liquid at the front of the vat and being deposited at the trailing portion of each previous pleated convolution section adjacent the upper surface of the processing liquid, said fabric being drawn out of the processing liquid at the front of the vat and being deposited back to the surface of the processing liquid at a rate per convolution faster than the fabric is wound into helical convolutions so that the fabric is formed into said pleated sections one for each convolution at the rear of the vat in the liquid and still further in which the convolutions are advanced toward the trailing end of the fabric, that improvement comprising:

a. revolving the leading end of the fabric once through said closed path more speedily than the convolutions are rotated around said axis of the helix and then stopping such revolving of the leading end until the several helical convolutions have completed a single revolution around said axis, and

b. advancing the convolutions toward the trailing end intermittently more speedily than the several convolutions are turned a single revolution around the helix and then stopping the advance of said convolutions towardthe trailing end until the convolutions have completed a single revolution around the said axis,

c. so that the fabric as desposited at the leading portion of each pleated convolution section remains substantially constant axially while advancement of the convolutions toward the trailing end stops so that the deposited fabric of each convolution remains in a common plane perpendicular to the axis of the helix while advancement of the convolutions toward the trailing end is stopped.

9. In a method as set forth in claim 8 the further improvement comprising moving the convolutions of the fabric from the front to the rear of the vat by engaging the same with front and rear circular drive rollers and pleating the fabric as it descends from the rear roller to the pleated section of each convolution by passing said fabric over a pleating bar which moves toward and beyond and then back from a horizontal position in back of the rear drive roller so as to push the fabric toward the back of the vat and when the bar moves forwardly in front of the back edge of the rear drive roller to permit the fabric to swing under its own weight toward the front of the vat, such operation being practiced repeatedly to provide pleats.

10. A method according to claim 9 wherein said front and rear drive rollers are rotated at the same tangential velocity so as to reduce the strain on said fabric as said fabric is pulled over said front and rear drive rollers.

11. A method according to claim 9 further comprising the step of applying a stream of said processing liquid onto said fabric in the direction of movement of said fabric after said fabric passes over said front drive roller and before said fabric passes over said rear drive roller so as to reduce the straining of said fabric as said fabric passes over said front and rear drive rollers and to increase the penetration of the processing liquid into said fabric whereby to improve the overall processing of said fabric.

12. A method according to claim 11 further comprising the step of telescoping strands of said fabric inward before the fabric passes over said rear drive roller so that said fabric passes over said rear drive roller and into the processing liquid in a relaxed state, whereby to increase the penetration of processing liquid into said fabric while reducing creasing of said fabric as it passes over said rear drive roller.

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