GARMENT FINISHING TUNNEL


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ABSTRACT

A garment finishing apparatus and method wherein suspended garments are conveyed through a thermally insulated chamber and subjected to a moisture treatment to remove wrinkles. The moisturizing treatment cycle is synchronized with the operation of the conveyor and the opening and closing of the chamber doors. A moisturizing atmosphere is created in the chamber by a novel steam-water mixing nozzle which injects moisture into the chamber at a high water-to-steam ratio while the chamber is maintained at a negative pressure. The chamber includes a drip-free inner ceiling and means to re-evaporate the moisture condensate, and exhaust and recirculating fans which operate during timed moisturizing, conditioning, and drying cycles.

13 Claims, 10 Drawing Figures
GARMENT FINISHING TUNNEL

The present invention relates to garment finishing and more particularly apparatus and methods for removing wrinkles from garments by subjecting them to a high humidity atmosphere.

It has long been known that wrinkles can be removed from garments by subjecting the garments to a high humidity atmosphere, particularly at some elevated temperature. Typically, devices of the prior art have done this by subjecting the garments to steam, and for this purpose some devices have been proposed for treating garments with steam in closed or semi-closed chambers.

The devices of the prior art have been characterized by their ability to process garments at a certain rate and with a certain degree of quality. The devices have been further characterized by their steam or energy consumption, usually defined in terms of boiler horsepower required, and the amounts of heat and moisture which they return to the environment or plant in which they are used.

It is a principle objective of the present invention to provide a garment finishing device of the moisturizing chamber type which has a greater garment finishing capacity than do devices of the prior art, but which consumes less steam or energy, and returns less heat and unused moisture to the environment, than do devices of the prior art heretofore proposed.

Moisturizing garment finishing chambers of the prior art have normally operated by subjecting the inside of the garment finishing chamber to steam. The steam adds both heat and moisture to the garment, which heat and moisture aid in removing wrinkles. It has been found that elevating the temperature within the chamber to materially above 160°F does little to improve the quality or reduce the time required in dewrinkling the garments. It has further been found, however, that the relative moisture content of the chamber interior, when increased above that which is normally produced by the use of steam alone, greatly accelerates the dewrinkling process and more completely removes wrinkles.

It is a particular objective of the present invention to provide a garment finishing device in which the garments are subjected to a high moisture atmosphere at a relatively low but still elevated temperature, and to do so with minimum boiler horsepower requirements.

Accordingly, the present invention provides a garment finishing tunnel in which moisture is injected through a nozzle of novel structure which impinges water and steam sprays at right angles to provide the chamber with a moist, warm, fog-like atmosphere having high water-to-steam ratio. In a preferred form the moisturizing mist is injected into the chamber via the nozzle while the chamber is maintained at a negative pressure, thereby enhancing the envelopment of the garments with the injected moisture.

Devices of the prior art, in normal operation, generate moisture which condenses inside the chamber. This condensate wets the inside of the chamber, and as a result water drips upon the garments which are being finished. This formation of condensate has also required that affirmative steps be taken, i.e., external plumbing connections, to insure its removal from the chamber, otherwise it collects and eventually floods. These characteristics of the prior art devices provide definite disadvantages, not only in the need to remove the condensed moisture from the chamber, and in the possible damaging of the garments which come into direct contact with this condensed moisture, but result in the generation of excess heat and the consumption of excess energy. These further disadvantages result from the fact that, normally, this moisture is communicated to the chamber in the form of steam only, and therefore excess moisture represents excessive steam and thus excessive energy, i.e., boiler horsepower, required to produce the steam. This excess energy, in addition to being costly, is wasted in the form of heat when this moisture condenses upon the walls of the chamber. The wasted heat and condensing moisture result in water and heat being transferred to the environment.

It is another objective of the present invention to eliminate the water condensate which is returned to the environment and to prevent damage of the garments by dripping of condensate formed upon the walls of the chamber.

Accordingly, the present invention provides an insulated chamber which includes a false ceiling and floor which are adapted to collect any condensate which forms and to direct it, without its dripping upon the garments, to a reservoir where it is in turn re-evaporated into the atmosphere of the chamber and reused to moisten the garments. The re-evaporation is accomplished by a dual purpose steam pipe which, in addition to passing through the reservoir to re-evaporate the condensate, also serves as the inlet pipe to a steam heat exchanger through which air is circulated to dry the garments.

The present invention further provides means for exhausting the atmosphere from the chamber and further means for recirculating the atmosphere within the chamber in a manner which efficiently provides warm air for drying the finished garments.

More particularly, the preferred embodiment of the present invention includes a chamber having sets of doors at opposite ends thereof and a circular conveyor upon which suspended garments are transported into the chamber through one set of doors and out of the chamber through the opposite set of doors. The controls of the devices of the present invention operate to automatically transport the garments into the chamber and to time the opening and the closing of the doors, and further to control in a sequential timed fashion the garment treating cycle which includes a moisturizing phase in which moisture is injected into the chamber, a conditioning phase in which the garments are permitted to stand within the moist chamber atmosphere, and a drying phase in which dry air is circulated through the suspended garments from below to partially inflate the garments and remove the moisture from them. During the moisturizing phase, the moisture is injected into the chamber while negative pressure is applied to the interior of the chamber through operation of an exhaust fan. During the drying phase, warm air is recirculated throughout the chamber by withdrawing the air from the top of the chamber and returning the withdrawn air to the bottom of the chamber through a heat exchanger, while portions of the withdrawn air are exhausted to atmosphere by the exhaust fan.

The present invention provides the advantages of finishing the garments better and faster than the devices of the prior art have done, and does so with the consumption of approximately one-fourth of the power required by comparable devices of the prior art. By so do-
ing, not only is less boiler capacity required to operate the device, but the plant in which the device is being used is subjected to far less heating and thus less operator discomfort than has been incident with devices of the prior art. Also, no connection of the chamber to an external drain is required to dispose of condensate.

These and other objectives and advantages of the present invention will be more readily apparent from the following detailed description of the drawings, illustrating one preferred form of a moisturizing tunnel according to principles of the present invention, wherein:

FIG. 1 is a partial cutaway perspective view of one preferred form of a garment finishing tunnel according to principles of the present invention;

FIG. 2 is a cross sectional view partially in elevation taken generally along lines 2—2 of FIG. 1;

FIG. 3 is a horizontal cross sectional view taken generally along lines 3—3 of FIG. 1 and showing the doors in closed position;

FIG. 4 is a fragmentary cross sectional view similar to portions of FIG. 3 but showing the doors in opened position;

FIG. 5 is a view, partially broken away, of a portion of the conveyor of the device of FIG. 1;

FIG. 6 is a top view, partially broken away, of a portion of the conveyor of the device of FIG. 1 illustrating particularly a portion of the conveyor drive;

FIG. 7 is an axial cross sectional view illustrating the nozzle structure employed in the embodiment of this invention;

FIG. 8 is a diagram of the water and steam system of the device of FIG. 1;

FIG. 9 is a diagrammatic view illustrating the controls of the system of FIG. 1; and

FIG. 10 is a timing diagram illustrating a sequence of operation provided by the control system of FIG. 9.

Referring to FIG. 1, a garment moisturizing tunnel 10 according to the present invention is illustrated. The tunnel 10 includes a cabinet 11 which defines a finishing chamber 12 internal thereof. The cabinet 11 is provided with two sets of doors which define openings which communicate the chamber 12 with the external atmosphere. The sets of doors include a set of entry (or exit) doors at 13 (see FIGS. 3 and 4) and a set of exit (or entry) doors 14. Both sets of doors are pivotally connected to the cabinet 11.

The door operating mechanism can be best understood by reference jointly to FIGS. 1, 3, 4 and 3. FIG. 3 shows the entry doors 13 and the exit doors 14 in their closed position, while FIG. 4 shows the doors in their opened position. The doors 13 are rigidly secured to plates 71 and 72 which are in turn pivotally mounted to the cabinet 11 by the hinge pins 73 and 74 respectively. Similarly, the doors 14 are mounted to the plates 75 and 76 which are pivotally mounted by the hinge pins 77 and 78 to the cabinet 11. The doors are constrained so as to open and close together by the linkage members 81, 82 and 83, which are pivotally connected at their opposite ends to different sets of the plates 71, 72, 75 and 76. The automatic opening and closing of the doors is provided through a door drive assembly 88 which includes a motor 89 having a cam 90 rigidly mounted to its output shaft 91, the cam 90 serving as a bellcrank. The cam 90 is pivotally linked by a pin 94 to a rocker arm 96 which has its opposite end pivotally linked to the plate 76. As the motor 89 is energized, in a given direction, the doors will be moved alternately to the opened and closed positions through the levers 96, 83, 82 and 81. The doors are provided with appropriately positioned limit switches (not shown) that are actuated by cam 90 which operate to signal the controls of the machine to stop the motor 89 when the doors are either in their opened or closed position.

Referring again to FIG. 1, the finishing tunnel is provided with a conveyor assembly 20 which forms a closed path through the chamber 12 via the doors 13 and 14 to convey garments from a handling area 21 adjacent the finishing tunnel and through the chamber 12. The conveyor assembly 20 includes an overhead tubular trackway 23 which is suspended from the top of the cabinet 11 by means of rigid supports 24, 25 and 26, which are attached to the top of the cabinet 11 and have free ends projecting beyond the cabinet 11 to which are attached vertical tie rods 28, 29, 30 and 31. The lower ends of the tie rods 28-31 are rigidly attached to the trackway 23 and support the trackway 23, in a substantially horizontal plane. An endless linktype conveyor 35 is suspended from the trackway 23. The conveyor is adapted to receive the hook portions of hangers which carry the garments to be finished.

Referring to FIGS. 5 and 6, the details of the conveyor 20 are best illustrated. The trackway 23 is a generally hollow and cylindrical tube and carries a wheeled carrier 41 having a pair of rollers 42 and 43 which ride on the lower internal surface of the trackway 23. The wheels 42 and 43 are connected by a carrier body portion 44 which pivotally supports the wheels 42 and 43 at the axes 45 and 46. The conveyor 35 is made up of a plurality of links 36 illustrated as links 36-1 and 36-2 in FIG. 5. These links are identical and are pivotally connected to one another about a vertical hinge pin 51. The vertical hinge pin 51 has a hooked top which terminates in a horizontally oriented end portion 52 which is in turn pivotally connected to the carrier body member 44 of the carrier 41. The hinge pin 51 extends through the wall of the trackway 23 by way of the horizontal slot 54 in the side thereof. The pin 51 is provided with a retaining nut 56 at its lower end which retains the link sections 36 onto the pin 51.

The conveyor 35 is moved about the trackway 23 by a drive mechanism 60 located generally as shown in FIG. 1. The drive mechanism 60 includes a motor 61 having an output drive chain 62 which drives a conveyor drive wheel 63 via a sprocket 64. The wheel 63 has, in the periphery thereof, four equally spaced radially extending fork members 65, each of which is adapted to engage the pin members 51 of the conveyor 35. The drive wheel 63 is positioned at the corner of the conveyor assembly 20 adjacent the entry doors 13 of the cabinet 11. The drive assembly 60 operates to advance the conveyor along the trackway 23 when the motor 61 is energized.

The conveyor assembly 23 is provided with two sets of cams and corresponding limit switches (neither shown) which provide means for indicating the position of the conveyor so that the conveyor can be halted when a given load of garments is positioned properly within the chamber 12. The first of the sets of cams is positioned at two equally spaced points along the closed path of the conveyor 35. In the path of these cams is positioned a limit switch which is tripped when the conveyor is at two points, 180° apart with respect to each other on the conveyor's path of rotation through the chamber 12. The cams are positioned to
actuate the limit switch when a load of garments is positioned either at the operator area 21 or within the chamber 12 so that, when the conveyor is actuated, it will transport a load from the operator area 21 and into the chamber 12 while returning that portion of the conveyor which was previously within the chamber 12 and may be carrying a finished load of garments back to the operator area 21. The second set of cans may be positioned at four equally spaced points about the conveyor 35 and operates to trip the same limit switch to stop the conveyor at any one of four positions, including the positions at which it stops under the control of the first set of cans, the other two positions being intermediately spaced positions. The operation of these cans and the means for selecting which of the sets is operable will be explained in more detail in connection with the control diagram of FIG. 9.

The air circulating and exhaust system is illustrated in FIGS. 1, 2 and 3. An air return chamber 101 is provided which communicates with the top portion of the chamber 12 where air is withdrawn from the chamber 12, and also communicates with a second chamber 102. An exhaust fan 105 removes air from the chamber 102 and exhausts it through the vertical exhaust stack 106. A recirculating fan 107 withdraws air from the chamber 102 and transports it to a chamber 108 where it is formed upwardly into the chamber 12 through a heat exchanger 110 where the air is heated during recirculation.

Referring to FIG. 3, the exhaust stack 106 is located within the chamber 101. The exhaust and recirculating fans 105 and 107 have drive motors 111 and 112 respectively.

A heat exchanger 110 extends substantially the length of the chamber 12 at the bottom thereof and has mounted at its center the moistening nozzle 120, which is also illustrated in FIG. 2.

Referring to FIG. 2, the air circulating path is shown in which air is circulated from the chamber 12 and upwardly through an opening 123 provided in a false roof composed of members 124 and 125. The recirculating air flows upwardly through the opening 123 and downwardly through the duct 101 and into the chamber 102. From the chamber 102, the air is forced by the recirculating fan 107 into the chamber 108 beneath a subfloor 130. The air from the chamber 108 travels upwardly through the heat exchanger 110 where it is heated and re-enters the chamber 12. The exhaust fan 105 exhausts air from the chamber 102 through the stack 106 to remove the moist air and to depressurize the chamber 12.

To reduce condensation on the walls of the chamber and to prevent any condensation which forms from dripping upon the garments, several features are incorporated into the device. First, the outer walls 140 and the outer ceiling 140b of the device are provided with insulation 141 to prevent the outward flow of heat into the environment and to maintain the inner surface of the walls at a high temperature to thereby reduce condensation. The upper portion of the chamber 12 which is provided with the false roof 124 and 125 is adapted to direct the condensate which forms toward the side walls and thus down to the bottom of the chamber. For example, condensate which forms on the lower surface of the roof 124 and 125 will flow to the side walls of the chamber 12 and down the side walls to the false or subfloor member 130. Also, because the warm air is free to circulate on both sides of the upper roof members 124 and 125, these members are maintained at a higher temperature, and thus condensate is less likely to form there. However, condensate may form on the lower surface of the upper roof member 142, but this condensate, if it drips from the roof 142, will be directed by the upper surfaces of the false roof 124 and 125 toward the sides or false or subfloor where it is permitted to drain to the false floor 130. At the false floor 130, the returning condensate will collect at the corner 144 and 145 adjacent the heat exchanger 110 where it will be re-evaporated by the hot steam pipes 148 which surround the heat exchanger 110.

The water and steam system of the moistening tunnel is illustrated in FIG. 8. FIG. 8 shows the heat exchanger 110 which is continually heated by hot steam from a boiler 150 via the steam pipes 148. The steam pipes 148 are those pipes illustrated in FIG. 2, which re-evaporate the condensate which forms on the false floor 130. The pipe 148 encircles the heat exchanger 110 and carries steam to input port 149 of the heat exchanger 110. The output port 151 of the heat exchanger 110 is connected to the input port 152 of a tank 153. The tank 153 accumulates water which has condensed in the pipe 154, while the unaccumulated water returns through the pipe 155 to the boiler steam return. The condensate flows through a pipe 157 to the hot water input 159 of the moistening nozzle 120. In this manner, the collected hot water is used to moisturize the steam.

The nozzle 120 is also provided with a steam input 161 which is connected to the boiler steam output port through the steam line 162. The lines 157 and 162 are each connected through a respective solenoid controlled valve 171, 172. The operation of the valves 171 and 172 will be better understood in connection with the diagram of FIG. 9 and timing diagram of FIG. 10, while the nozzle 120 is illustrated in more detail in FIG. 7.

Referring to FIG. 7, the nozzle 120 is shown provided with a heavy brass casing 181 having its steam input 161 connecting with a stepped inner bore 182 defining a central cavity. Steam entering port 161 will heat the casing 181 so that the water entering port 159 which also connects with the inner bore 182 will be heated to a high temperature just below its boiling point. The inner bore 182 includes a small diameter lower section 183 which communicates with the steam port 161 and a larger diameter upper portion 184 which communicates directly with the water port 159. The walls of portions 182 and 183 are connected by an annular step 188. An inner sleeve portion 185 having an inner diameter approximately equal to that of the lower portion 182 and an outer diameter just slightly less than the inner diameter of the portion 184 is loosely fitted into the upper portion 184 of the chamber 182. An annular groove 187 is provided in the outer surface of the sleeve 185 in approximate alignment with the water input port 159. Water entering the port 159 is communicated around the sleeve 185 and then forced upwardly between the sleeve 185 and the outer wall 186 of the large portion 184 of the chamber 182. This water is then forced upwardly and emitted from the nozzle through a plurality of notches 191 closely spaced along the outer periphery of the upper rim 192 of the sleeve 185. In this manner, a circular pattern of water is emitted axially from the upper portion of the nozzle 120.
The sleeve 185 has a central cap 189 having an upper surface 190 extending slightly above the upper surface of the rim 192 to provide a small gap between the disc 195 and flange 192. Alternatively, spacer washers 190a may be used for this purpose. A plate 195 is secured tightly to the top 190 of the sleeve 185, and casing 181 is also tightly seated against the step 188 by a bolt 196 which projects through a bore of the annular sleeve 185 and thus secures the three components, namely the casing 181, the sleeve 185 and the plate 195, in a fixed relationship to form the nozzle 120. Steam entering the chamber 182 through the port 161 passes through the chamber 197 within the sleeve 185 and out through a plurality of annularly located apertures 198 which constitute the steam nozzle portion at the upper portion 189 of the sleeve 185. Steam passing through the nozzle apertures 198 is directed against the lower surface of the diverter plate 195 which diverts the steam radially and causes it to be emitted from the nozzle in a radial fan pattern through the opening provided between the disc 195 and the flange 192 of the sleeve 185. This fan of steam intercepts the entire circular water spray pattern which is being emitted from the holes 191 at right angles to finely disperse the water into the radial steam pattern to carry it in a fog-like mist along with the steam into the chamber 12. In this manner, a highly moist fog-like atmosphere is created within the chamber 12 by a moistening steam which is composed of water and steam in a ratio in which the water contributed by the hot water entering port 159 is greater than that water provided by the steam entering the port 161. Typically, this ratio is in the neighborhood of three to one.

The controls of the preferred embodiment of the apparatus are best illustrated in FIG. 9. Since the circuitry which performs the control operations is conventional, it is illustrated in partial block diagram form. The controls include their connections with the several operational elements discussed above. These elements are the door motor 89, the doors 13 and 14, the conveyor assembly 20, the conveyor motor 61, the exhaust fan 105, the recirculating fan 107, the moistening nozzle 120, and the water and steam solenoid operated valves 171 and 172, respectively. The controls also include a foot switch 210 which is indirectly connected in circuit with the door motor 89 so that a momentary depression of the foot switch 201 will start the door motor operating. Once started, the door motor 89 will continue to operate to open the doors 13 and 14 until such time as a door open limit switch 202 signals that the door is in an opened position. The signal from the door open limit switch is also connected in circuit with the conveyor motor 61 in a manner which will start the conveyor motor 61 to drive the conveyor 20 until such time as the appropriate position cam has been tripped. Cams which are pre-selected and set, as represented symbolically by selector switch 204 in the diagram, are provided to select either the 90° position or the 180° position, at the operator's option. The selectedcams operate to trip the cam limit switches which are connected in series with a conveyor motor stop circuit 205 which operates to stop the conveyor motor 61 when the garments are in proper position. The signal communicated by circuit 205 also re-energizes the door motor 89 to start the door motor operating to close the doors 13 and 14. When the doors are closed, a door close limit switch 206 communicates a signal which also operates, as does the signal from limit switch 202, to stop the door motor 89. This is represented by the OR-gate 210 having inputs connected to the limit switches 202 and 206 and an output connected to the door motor 89.

The door close limit switch also, upon signaling the sealing of the chamber, provides an electrical signal on the line 212 which connects with the first of a series of sequentially connected timers 220. The first of these timers 221 controls the duration of a moisturizing interval, the second, 222, controls the duration of a conditioning interval, and the third, 223, controls the duration of a drying interval. Each of the timers has a respective output 224, 225 and 226 which operates the machine functions which occur during their respectively controlled intervals. Each also has a respective end of interval output 227, 228 and 229, which signals the end of the interval and provides a means to trigger the next one of the sequential timers. Each of the timers is provided with a means for setting the duration of the interval from, for example, zero to 90 seconds. These means are illustrated by the dials 231, 232 and 233, respectively. Each of the timers is also provided with a timer bypass push button switch 235, 236 and 237, respectively, which is used to manually control the duration of the respective interval when a manual/automatic mode selector switch 240 is in the manual position. When the mode switch 240 is in the automatic position, however, the operation of the processing cycle is under the control of the timers 220.

The output 224 of the timer 221, which represents the duration of the moistening cycle, is electrically connected to the steam solenoid valve 172. This output is also connected to the input of an AND-gate 241 which has its output connected to the water solenoid valve 171. Another input of the AND-gate 241 is connected to a wet-dry steam control switch 242, operated by a dial 243, which controls the injection of water to the nozzle 120 and provides a means to select either wet or dry steam. The output 224 is also connected to an AND-gate 245 which has its output connected through an OR-gate 246 to the recirculating fan 107. When an air switch 247 is actuated by the dial 249, the moist atmosphere is recirculated during the moistening portion of the cycle. The output 224 is also connected through an OR-gate 249 to the exhaust fan 105 to operate the exhaust fan to depressurize the chamber 12 during the moisturizing cycle.

During the conditioning portion of the finishing cycle, the garments are allowed to stand in the moisturized atmosphere of the conditioning chamber. No operations occur during this time.

During the drying portion of the finishing cycle, the output 226 of the timer 223 is electrically connected through the OR-gate 249 to operate the exhaust fan 105, and also through the OR-gate 246 to operate the recirculating fan 107.

The general sequence of operations can now be understood by reference jointly to FIGS. 9 and 10. First, the operator will set the controls on the control panel to select (1) either the manual or automatic mode of operation, (2) whether wet or dry steam is to be used, (3) whether air is to be recirculated during the moistening portion of the conditioning of the finishing cycle, and (4) whether the conveyor is to stop at two positions 180° apart or four positions 90° apart along its trackway. If the automatic mode is selected, the operator will dial the timers for the respective portions of the fin-
ishing cycle on the dials 231, 232, and 233 which control the durations of the outputs on lines 224 through 226, respectively, of the timers 221 through 223, respectively. Next, the operator will remove any finished garments that are adjacent his operating station on the conveyor if these have not been previously removed, and then he will load the garments to be finished upon the conveyor at his operation station. Next, he will press the foot switch 201 to actuate the automatic cycle of the machine. The actuation of the foot switch is shown by curve a in the timing diagram of FIG. 10. The foot switch actuation a causes the door motor 89 to begin to drive the door motor to its open position. When the door has attained its open position, the door open limit switch 202 is actuated. This causes the door motor to stop as illustrated by curve b of FIG. 10. The actuation of the door open limit switch is illustrated by curve d of FIG. 10. The actuation of the limit switch 202 also initiates the operation of the conveyor drive motor 61 which drives the conveyor until the garments to be finished are either adjacent the 90° position immediately outside the chamber doors 13, or are in position in the inside of the chamber 12, as will be determined by the setting of the selector switch 204. When the garments are to be stopped at the 90° position, the previously loaded set of garments which will have been at that position prior to the initiation of the cycle by depression of the foot switch 201 will have been moved during the present cycle to the inside of the chamber 12. The operation of the conveyor motor is illustrated by curve f of the diagram of FIG. 10 and the actuation of the limit switches is indicated by curve g of FIG. 10. The operation of the limit switch serves to stop the conveyor motor 61 and also to initiate the door motor 89 to move the doors to their closed position as illustrated by curve e of FIG. 10. When the doors have achieved their closed position, the door close limit switch 206 is actuated as shown in curve e of the diagram of FIG. 10. This signal, curve e initiates the finishing cycle along line 212 by initiating the timer 221 as illustrated in curve h of FIG. 10. During this interval, the nozzle solenoids and the exhaust fan are also operating as is illustrated by curves k and l of FIG. 10. A new interval in the moisturizing portion of the interval, the timer 222 is initiated as illustrated by curve i of FIG. 10 to mark the duration of the conditioning interval in which the clothes are allowed to stand in the atmosphere within the chamber. At the end of the conditioning interval, curve i, the timer 223 is initiated to mark the duration of the drying interval as illustrated by curve j of FIG. 10. During this interval, the exhaust fan and the recirculating fan are both operating as illustrated by curves m and n, respectively, of FIG. 10. While the timing diagram is illustrated in connection with the controls of FIG. 9 set in the positions illustrated therein, it will be apparent from studying these two figures that the functions may be modified, particularly the water control solenoid 171, the exhaust fan 105, and the recirculating fan 107, in accordance with settings at the dials 243 and 248. At the end of the drying interval, curve j, the automatic operation of the device will stop as illustrated at point 250 in FIG. 9.

From the foregoing detailed description of the structure and operation of one preferred embodiment of the garment finishing tunnel according to the principles of the present invention, the major objectives and advantages of the present invention are readily understandable. Particularly, the greater garment finishing capacity of the device is due in one respect to the exceptionally high moisture content atmosphere which is generated within the chamber 12. This atmosphere is provided in part by the novel mixing nozzle 120 which injects a fog-like mist into the chamber by mixing liquid water and steam. This fog-like mist has approximately five times the moisture concentration than that which would be provided by the use of dry steam alone. Because the steam source contributes only approximately 25 percent of the moisture which is added to the chamber, the amount of boiler horsepower which is required to supply this amount of moisture is much less than that which would be required through the use of steam alone.

The nozzle 120 generates this atmosphere by spraying a cylindrical pattern of water in a path parallel to the axis of the nozzle, and then intercepting this spray pattern with a high pressure radial fan of steam which diverts the flow of the water into the path of the ejected steam at right angles to the path of the sprayed water to finely disperse the water spray into the flow of the steam and thereby generate an exceptionally high moisture fog in the chamber. The water is emitted from the nozzle at a very high temperature very near its boiling point. This water temperature is maintained partially by heating from the steam conducted through the heavy brass housing 181 of the nozzle. The water entering the nozzle housing is supplied from steam condensate at the output of the heat exchanger 110. Thus, this water is initially near its boiling point.

A further aspect which provides great efficiency of design and operation is that the steam which is output from the boiler is used to provide two results prior to being condensed and fed to the nozzle in the form of hot water. These results are, first, that the hot steam is circulated in a path around the heat exchanger through the pipe 148 and used to re-evaporate the condensed moisture which drips from the walls of the chamber and otherwise have to be disposed of by providing an additional drain. In this way, condensate can be eliminated from the chamber by using the energy supplied by a high pressure steam source which is also responsible for injecting the moisture into the chamber as the primary moisturizing source. Thus, the high pressure steam serves sequentially to provide energy to the condensate re-evaporating means and the heat exchanger which is an air warming means, and thereafter to supply the hot liquid water source to the nozzle 120.

The heat exchanger 110 and the nozzle 120 are positioned in an opening in the false floor of the chamber 12. Recirculating air generated by the recirculation fan 107 passes air through the heat exchanger 110 and past the nozzle 120 to envelope the garments in either a moist atmosphere during the moisturizing phase of the cycle, or warm air during the drying phase of the cycle. The recirculating air exits from the chamber through the opening 123 in the sloped false ceiling which serves to reduce condensation and to direct condensation to the reservoir on the false floor, where it is re-evaporated by the steam pipe 148. Also, through the opening 123 in the roof, the effect of the exhaust fan 105, which has one use in removing the moisture atmosphere from the chamber during drying, applies a negative pressure to the inside of the chamber 12 which facilitates the enveloping of the garments within the chamber in moisture and prevents the moisture from
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seeping out of the chamber or condensing near the seams and edges of the doors and other openings to the chamber.

By consuming less steam energy in the first instance, and further by the operation of the fans in maintaining the depressurized chamber during the moistening cycle, by provisions for the false roof and false floor to reduce condensation and the heating element 148 to re-evaporate the moisture, and in conjunction with the insulated walls 141, the finishing tunnel transmits far less energy and moisture into the atmosphere of the surrounding room than do any of the devices of the prior art, and, therefore, in addition to being more efficient in this regard, contributes far less to operator discomfort than do devices of the prior art.

What is claimed is:

1. A garment dewrinkling device having a cabinet enclosing a garment treating chamber, and means for conditioning the atmosphere within said chamber comprising:
   a. pressurized steam source;
   b. liquid water source; and
   c. nozzle having
      a. an outer housing defining first and second cavities therein,
      b. a steam input port communicating with said first cavity and connected to said steam source,
      c. a liquid water input port communicating with said second cavity and connected to said water source,
      d. a water discharge opening communicating with said second cavity and oriented to discharge a pattern of water into said chamber, and
      e. a steam discharge opening communicating with said first cavity and oriented to discharge steam into said chamber in a pattern intersecting the pattern of said water across the extent of said water pattern.

2. A device according to claim 1 wherein:
   a. said first chamber defines an axis within said housing;
   b. said second cavity is annular in shape and surrounds said first chamber;
   c. said liquid water discharge opening defines a circular array oriented to discharge said pattern in a path generally parallel to said axis; and
   d. said steam discharge opening defining a circular array internal of the array of said water discharge opening and oriented to discharge steam in a pattern generally radially outward from said axis.

3. A garment dewrinkling device having a cabinet enclosing a garment treating chamber, and means for conditioning the atmosphere within said chamber comprising:
   a. means for injecting a fog-like mist into said chamber;
   b. means injecting means including means for spraying water in liquid form into said chamber in a given pattern and means for injecting steam into said chamber in a different pattern which intersects the pattern of said sprayed water so as to substantially disperse said sprayed water along the path of said steam going into said chamber.

4. A device according to claim 3 further comprising:
   a. means for re-circulating the atmosphere of said chamber.

5. A device according to claim 3 wherein:
   a. a greater amount of water is injected by said water spraying means than by said steam injecting means.

6. A device according to claim 5 wherein:
   a. the ratio of the amount of water sprayed to that injected by steam is approximately 3 to 1.

7. A garment dewrinkling device having a cabinet enclosing a garment treating chamber, and means for conditioning the atmosphere within said chamber comprising:
   a. a source of water in liquid form,
   b. a source of water in steam form,
   c. means for injecting a fog-like mist into said chamber by combining water from both said sources with a greater proportion from said liquid source than from said steam source.

8. A device according to claim 7 wherein:
   a. the ratio of the amount of water from said liquid source to that from said steam source is approximately 3 to 1.

9. A garment dewrinkling device having a cabinet enclosing a garment treating chamber, and means for conditioning the atmosphere within said chamber comprising:
   a. means for collecting condensate forming within said chamber;
   b. means for re-evaporating the collected condensate;
   c. means for recirculating the atmosphere in said chamber by withdrawing it from said chamber and returning it to said chamber; and
   d. means for warming said returning air; and
   e. series connected heating means for said re-evaporating means and said air warming means.

10. A device according to claim 9 further comprising:
    a. a source of high pressure steam connected to the series connected heating means for said re-evaporating means and air warming means.

11. A device according to claim 10 further comprising:
    a. a nozzle connected to said high pressure steam source for injecting steam into said chamber for moisturizing the garments.

12. A method of finishing garments comprising the steps of:
    a. placing the garments in a substantially closed chamber; then
    b. subjecting the garments while in said chamber to moisture in the form of a mixture of liquid water and steam in which the amount of water in liquid form is substantially greater than the amount of water in the form of steam; and then
    c. drying the garments with hot air.

13. A method according to claim 12 further comprising the steps of:
    a. collecting condensate forming inside the chamber; and
    b. re-evaporating the collected condensate into the chamber.