METHOD AND APPARATUS FOR WATERPROOFING TEXTILES

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ABSTRACT OF THE DISCLOSURE

A method and an apparatus for treating fibrous articles to render the same water repellent. The method comprises the steps of moving articles in a drum in one direction, then in the reverse direction for predetermined time intervals, spraying a liquid treating medium, which contains an organic material having a hydrophobic terminal portion containing fluorine, on the article and changing the direction of the spray when the direction of drum rotation changes. The amount of treating medium should be controlled to wet the articles. The liquid carrier phase of the medium is removed by evaporation.

The apparatus comprises a drum rotatable about and having its axis generally horizontally positioned, drive means for rotating the drum in one direction and then in the reverse direction at predetermined rates, fluid dispensing means adapted to spray a liquid into the drum at a predetermined rate, and means for changing the direction of the spray when the direction of rotation of the drum is changed to maintain the spray directed at the articles in the drum.

This application is a continuation in part of application of prior copending U.S. application, Ser. No. 442,882, filed Mar. 26, 1965, now abandoned.

This invention relates to a method and an apparatus for treating fabrics to make the same water repellent and/or oil repellent and in one aspect is particularly related to a method and apparatus for the treatment of garments after the same have been freshly dry-cleaned. At present, most dry cleaning establishments are provided with means for applying a water repellent to freshly dry-cleaned garments. One present method involves placing the garments in a drum, usually the dry cleaning machine drum, and pumping water repellent solutions into the drum, rotating the garments in the drum to wet the same and then pumping the solutions back into a storage tank. The garments are then spun in the drum to partially dry the same to remove any excess solution. The excess solution removed by spinning is also pumped back into the storage tank. The garments are then removed and placed in a reclaiming apparatus where the garments are dried by evaporating the solvent remaining in the garment. The evaporated solvent is condensed and recovered. During this process, the solutions that are pumped back into the storage tank after the garments are tumbled in the solution in the drum are contaminated by the soaps or dry cleaning detergents and by dyestuffs and dirt from the garments. This contamination of the solution makes its use in subsequent treatments less efficient because of the presence of the detergents. Also, the dyestuffs contained in the solution may cause staining on subsequent loads of garments as the solutions are pumped back to the drum to process another load.

After several loads are processed in this manner and the solution from the storage tank is depleted below the level required to process another load it is necessary to boil off the remaining solvent for use in the preparation of a new batch of repellent solution and it is necessary to throw out the residue which contains the water repellent chemicals, detergents, dye-stuffs and dirt. This is a waste of the treating chemicals.

Another method which is less elaborate than the process described above includes the dipping of articles or garments to be treated in a vat of treating solution, removing the same and allowing the excess solution to drain off, then placing the garments in a centrifugal extractor and then in a solvent reclaiming apparatus to recover the remaining solvent held by the garments. This method, as in the first described method, causes a contamination of the treating solution, rendering it less effective for subsequent treating and causing a loss of chemicals after the solution is too dirty for further use.

The water repellency attained by the methods of using the medium is not the same as by boiling. The water repellency attained by the methods using the commonly known hydrocarbon waxes as the repellent chemical is usually quite low due to the rewetting effect of the dry cleaning detergents left on the garments before this repellent treatment is applied. Additionally, the garments so treated are generally rendered quiet stiff and harsh feeling at high concentrations of the repellents necessary to obtain repellency by these chemicals and by these processes.

Since the discovery of certain fluorocarbons and their particular use in the treating of fabrics to make the same water, oil and stain repellent, considerable attention has been given to the problem of properly treating fabrics with these fluorocarbons and applying the fluorocarbons to the garments such that a fluorocarbon treatment will be economical enough for the general public. At present, the cost of fluorocarbons is such that the processing of garments by any method above described would make the cost nearly prohibitive. Since the fluorocarbons provide a treatment for garments which does not change the feel of the garments significantly from that of untreated garments of the same fibers, this treatment is highly desirable. For this reason this type of treatment is suitable for many garments upon which the conventional repellents could not be used or upon which it was undesirable because of the change in the feel of the material. Additionally, fluorocarbons provide a much more desirable treatment since these chemicals are less susceptible to rewetting caused by the residual dry cleaning detergents held in the garments.

The present invention affords a process and apparatus by which fluorocarbons may be economically used on garments to render the same water, oil and stain repellent.

The present invention has the advantage of providing a process by which successive loads of garments can be treated without a decrease in the efficiency of the treatment from one load to the next and there is no danger of transfer of dyestuffs from one load of garments to a subsequent load of garments.

The present invention has the advantage of providing a process by which there is little, if any, waste of the chemicals as no chemicals have to be thrown out due to contamination.

The novel process of the present invention includes moving fibrous articles which are to be treated first in one circumferential direction within a rotating treating drum, and applying a liquid treating medium to the articles while they are moving by introducing and distributing the liquid medium into the drum and onto the articles at a controlled and preferably uniform rate. This introduction of the liquid medium may be accomplished by such methods as discharge of the liquid medium from nozzles, orifices,
a weir or other similar and suitable flow control and dispensing means. The position or direction of the discharge from the liquid dispensing means is changed upon each change in the direction of rotation of the treating drum to maintain the discharge toward the moving articles in a downward direction and against the direction of movement of the drum. The amount of liquid medium discharged into the treating drum and the time period the articles are moved is controlled to effect complete uniform wetting of the articles in a short period of time and such that there is substantially no excess or accumulation of liquid within the drum at any time during the process (other than that liquid covering the articles per se). When the articles are uniformly wet, preferably saturated, by the liquid treating medium including fluorochemicals, they are dried only by evaporation. This means that all the fluorochemicals contained in the liquid medium, in a predetermined quantity, remains on the treated articles and therefore affords an efficient use of chemicals. The evaporated carrier liquid may be reclaimed by condensing the vapors from the drying operation.

The liquid treating medium may be a solution or a dispersion, wherein the carrier phase can be an organic liquid or an aqueous liquid and the dispersed or solute phase includes an organic material having an oleophobic and/or hydrophobic terminal portion containing fluorine. The dispersed or solute phase may also include conventional auxiliary treating aids such as: surfactants, detergents, metal salts of organic acids, metal ion complexes, complexing agents, textile modifying resins, and textile sizing agents.

This process has the advantage of affording substantially no liquid phase accumulated within the treating drum as the articles are wetted, which liquid must be pumped to or from the treating drum and which can become contaminated as above described.

The present invention further provides a novel apparatus for use in the treating of the fibrous articles such that the same will be uniformly treated by the water and/or oil repellent chemicals with no loss of chemicals and in a minimum amount of time.

The above and further advantages of the present invention will become apparent after a reading of the following detailed description which refers to the accompanying drawing wherein:

FIGURE 1 is a vertical sectional view of one embodiment of an apparatus constructed in accordance with the present invention;

FIGURE 2 is a partial front elevation view of the apparatus of FIGURE 1 with certain parts broken away to show interior members;

FIGURE 3 is a fragmentary enlarged sectional view of the apparatus of FIGURE 1 taken generally along the line 3--3 of FIGURE 2;

FIGURE 4 is a diagrammatic view of the fluid system for the apparatus of FIGURE 1;

FIGURE 5 is a schematic diagram of a control circuit for the apparatus of FIGURE 1;

FIGURE 6 is a fragmentary vertical sectional view corresponding generally to FIGURE 1 but showing a showing a second embodiment of the dispensing means;

FIGURE 7 is a fragmentary view taken along the line 7--7 of FIGURE 6 showing the inner face of the door;

FIGURE 8 is a sectional view taken along line 8--8 of FIGURE 7; and

FIGURE 9 is a fragmentary diagrammatic view of a modification of the fluid system of FIGURE 4.

In connection with the following description of the apparatus and its operation, the treating medium used will be a solution in which the solvent is organic.

The apparatus illustrated in FIGURES 1 through 3 comprises a casing or housing 6 which includes side panels 7, a rear supporting panel 8 and a front panel 9.
of air pressure through the air line 70. This air line 70 leads to a solenoid valve 100 to be described later. This damper permits ambient air around the housing 6 to enter the plenum chamber 38 during a deodorizing cycle of the apparatus.

An opening 71 is formed in the shell 36 adjacent the front panel 9 of the housing 6 in an area between the transverse panels 46 and 47 as illustrated in FIGURES 1 and 2. The opening 71 allows the air passing out the outlet opening 52 of the plenum chamber to move downwardly between the front panel 9 and a support ring 73 (most clearly illustrated in FIGURE 2) mounted within shell 36 and which extends around the forward end of the cylindrical body 104 and is concentric with the ring 20 of the open end of the drum 18.

The air passing through the opening 71 and between the upper portion of the ring 73 and the front panel 9 is drawn downwardly toward the door 13. The door 13 has a perforate or foraminous plate 56 mounted thereon in transversely spaced parallel relationship with a window 14 by means of spacers 77 extending between the door 13 and the plate 76. The plate 76 is positioned to fit in the front open end of the drum 18 when the door is closed and latched as shown in FIGURES 1 and 3. The foraminous plate 76 allows for the distribution of the air before it enters into the drum 18 and as it passes through the drum and through the openings in the end wall 21 of said drum. The air passing through the end wall 21 of the drum is drawn downwardly between said end wall and the rear panel 8 of the housing 6. The shell 36 is provided with an opening 79 in the lower rear periphery thereof through which the air leaves the shell 36.

A bottom panel 81 extends transversely between the front panel 9 and the rear panel 8. This bottom panel 81 joins side panels 82 (one of which is shown) to enclose the cylindrical body 104. The shell 36 is provided with the rear panel 8. Another inverted U-shaped member forms an air passage 83 between the front panel 9 and the rear panel 8 in aligned relation with the cover 17 mounted on the front panel 9. This air passage 83 has an inlet positioned adjacent the front panel 9. Mounted at the inlet to the air passage 83 and extending into said passage is a suitable lint collecting device such as the bag 84 illustrated in FIGURE 1. At the rear of the air passage 83 and formed in the rear panel 8 is an outlet opening. Joined to the rear panel 8 and enclosing the outlet opening is pipe 87 connected to the intake of a centrifugal blower 91. The blower 91 is suitably driven by a motor (not shown) and serves to move air into the plenum chamber 35 down along the front panel 9, through the drum 18 and through the lint bag 84 in the air passageway 83. The exhaust side of the blower 91 is connected to a pipe T 93 which has one leg thereof connected to a vent pipe 94 leading to an exhaust stack or an outside vent (not shown). The pipe 94 allows the air drawn through the drum to be directed outside of the area in which the apparatus is located. The T 93 is provided with a flap valve 96 which fits within the T to selectively close off the passage of air through the vent pipe 94 or through the other arm of the T 93. The valve 96 is pivoted on a shaft 97 which is rotated through 90° by a radial arm 98 which is in turn connected to a suitable motor 99 which may be selectively either a solenoid, an air or a hydraulic cylinder. As illustrated, an air cylinder is used, the plunger of which is moved by air admitted through a line leading from a source of air pressure. The other arm of the solenoid operated valve 100, which valve also controls the flow of the air line through 70 to the cylinder 69.

The other arm of the T 93 is connected to a pipe 101 which leads to a condensing unit 102 used for reclaiming heavy organic solvents. The condensing unit 102 includes a vertically positioned cylindrical body 104 formed at its lower end with a funnel-shaped end wall. A cooling coil 106 extends within the cylindrical body 104 and has a suit-
which spacer extends a fastening bolt 134. A second spacer 133 and bolt 134 also supports the plate 131 adjacent to the one directly below the rollers 128 and 129, positioned as shown in FIGURE 2, thus suitably position and support the ring 126 for rotation relative to the housing 16 and to the axis of the drum 18.

One set of rollers 128 and 129 is positioned substantially below the axis of the ring 126 and the other two sets are positioned symmetrically above the diameter of the drum and are spaced circumferentially of each other 120° about the ring 73. A pair of stops 136 and 137 are formed on the support ring 126 and are positioned circumferentially to each side of the spray tube 121. These stops 136 and 137 are adapted to locate the tube 121 in desired positions with respect to the interior of the drum 18 upon movement of the support ring.

The support ring 126 is rotated about its axis at predetermined desired intervals by means of a cable 141 which is positioned around the axially extending flange of the support ring 126. The ends of the cable are secured to a rotating hub 142 and the cable 141 makes several turns around the hub 142 in opposite directions with respect to each end of the cable such that upon rotation of the hub 142 the cable will be wrapped upon and simultaneously unwound therefrom to effect a rotation of the support ring 126. The hub 142 is secured to a rotatable shaft 143 which is journalled in suitable brackets 144 and 146 and mounted on the support ring 73. The shaft 143 extends through the transverse panel 46 and a suitable bushing 147 and it is connected to the gearing of a reversible drive motor 149. The motor 149 when energized thus rotates the hub 142 in either a clockwise or counterclockwise direction to move the support ring 126 from the position of the tube 121 shown in solid lines in FIGURE 2 to the position shown in dotted lines which positions are circumferentially space 90° with respect to each other. As the tube 121 is moved from the solid line position thereof to the dotted line position, the direction of the spray from the nozzles 122 is changed and in each position the discharge from the tips will be directed at the articles moving in a tumbling manner within the drum. When the tube 121 is positioned in the solid line position, as seen in FIGURE 2, the drum 18 is rotating in a counterclockwise direction and as the articles fall from the upper portion of the drum the spray will strike said articles. When the tube 121 is positioned in its dotted line position the drum 18 will be rotating in a clockwise direction and as the articles fall from the periphery of the drum the spray will effectively reach the falling articles.

Suitable guide pulleys 151 and 152 are supported on the ring 73 below the hub 142 to maintain the cable 141 in the support ring 126 as the cable 141 is fed off or wound upon the hub 142.

Referring now to FIGURE 4 the fluid flow of the treating solution will be described. The fluorochemical and the solvent in the desired proportions are mixed in a solution reservoir 156. The reservoir 156 holds a predetermined amount of solvent and a measured amount of fluorochemical by weight for said predetermined amount of solvent. The fluorochemical is inserted into the reservoir 156 through an access opening 157. The reservoir 156 is vented by a tube 158. The solvent is pumped into the reservoir 156 through a line 159 by a pump 161. The pump 161 can draw the solvent from a storage reservoir (not shown) or from the recovered solvent storage tank 184. The solution is drawn from the storage reservoir through the line 162, a valve 163 and a line 164 leading from the storage reservoir. The solution is pumped from the solution reservoir 156 through a line 166 by a pump 167. The discharge from the pump 167 pumps the solution through a filter 168 into a line 169. The line 169 is provided with a pressure gauge 171, a solenoid pressure valve 173 and a check valve 172. From the check valve 172 the solution is directed through a line 124 to the spray tube 121. A bypass line 176 is connected to reservoir 156 and the line 169 intermediate the filter 168 and pressure gauge 171. A pressure responsive bypass valve 177 is placed in the line 176.

An air line 179 is provided to direct air through the nozzles 122 and the tube 121 to clear the same of chemical solution at the end of the spray cycle. The line 179 is connected to the line 124 but the check valve 172. Line 179 is connected to a source of compressed air through a solenoid operated valve 181 and a check valve 182.

The condensate from the vapor drawn through the condensing unit 102 drains through the drain tube 112 into the separator 113. This condensate includes both the solvent and some water. The heavier solvent settles and the water forms on the top of the solvent in the top of the separator unit 113. Thus any water vapor condensed is separated from the solvent and is drained off through the tube 114. The solvent drains out through the tube 117 into the recovered solvent tank 184 after the amount of solvent in the separator reaches a predetermined height.

This tank 184 is provided with a vent 186 to allow air to escape as the solvent drains into said tank. The recovered solvent from the tank 184 may be pumped from said tank by the pump 161 through a line 187 by opening the manual valve 185, connecting the line 162 leading to the pump 161. Thus, when the solution in the reservoir 156 becomes depleted to the extent that a load of articles may not be properly treated without replenishing the solution in the reservoir 156, the recovered solvent from the tank 184 will be pumped into the reservoir 156 and if this solution is not sufficient to provide the quantity in the reservoir 156 desired then the valve 163 is opened and the pump completes the filling of the reservoir 156 by solvent from the storage tank by drawing the same through the line 164.

The control system illustrated diagrammatically in FIGURE 5 will be described with the following description of the operation of the apparatus through a process cycle. In treating a load of articles, the operator weighs the articles to be treated and places the same in the drum 18. The control system for the apparatus includes three manually set timers 192, 193 and 194 and a cycle timer 196. The timer 196 is controlled by a synchronous motor to provide a predetermined repetitive timed cycle. The timers 192, 193 and 194 of the control unit are set to the desired positions which positions are determined by the weight of the articles in the drum and the length of the period for the application of the solution. The timer 193 controls the drying period for drying the articles and reclaiming the solvent and the timer 194 controls the machine cooling and deodorizing period. As an example, for a load of articles weighing 30 pounds (15 kilogram) with an application of 1.2 pounds (kilograms) of solution per pound (kilogram) of articles and a nozzle discharge rate of 1.2 pounds (0.55 kilogram) of solution per minute the application timer 192 may be set for 30 (33 minutes), the reclaiming timer 193 may be set for 25 minutes and the deodorizing timer 194 may be set for 5 minutes. A temperature control 202 is set to provide the desired temperature during the reclaiming cycle and for example may be set at about 130° F. (55° C.). After each of the timers have been set, and only after all of the timers 192, 193 and 194 are set, the cycle is ready to begin. In starting the cycle the operator moves the switch 191 to the "on" position. This energizes the application timer 192 and the cycle timer 196. This simultaneously energizes the drum motor 27 and the solenoid on the solution valve 173 and the solution pump 167.

The drum begins rotation in a first direction, e.g., counterclockwise to afford repeated movement of the articles in the drum and past the solution sprayed from the nozzles 122 in the tube 121 which is in an initial position to the left of the drum axis. After an interval of one minute the timer 196 de-energizes the motor 27 causing a rearrangement or turning of the articles and energizes the motor.
149 which affords movement of the spray tube 121 from its initial position to a position on the right of the drum axis to afford a change in the direction of the spray. This movement takes approximately four seconds and when the tube 121 reaches its second position, a limit switch 197 and the timer 196 energizes the drum drive motor 27. The drum will now rotate in its reverse direction, i.e., clockwise, to repeatedly move the spray tube from the first to the second position under the control of timer 196. At the end of one minute, the drum will stop again, the position of the spray tube 121 will be changed to its initial position and the drum begins rotation in its initial counterclockwise direction. This change in the direction of drum rotation at one-minute intervals, and the traversing movement of the tube 121 continues throughout the entire process cycle although the spraying continues only until the expiration of the time set on the application timer 192.

After the expiration of the time set on the application timer 192, the pump 167 is stopped and the spray solenoid valve 173 is closed. The timer 192 then energizes a time delay relay 198 which energizes the solenoid on the valve 181 allowing air to enter and clean the tube 121 and the nozzles 122. At this time the motor on the blower 91 is energized and the retracting timer 193 takes over to time the retracting cycle. At the expiration of the time set for the time delay relay 198 the air solenoid valve 181 will be closed.

When the retracting timer 193 is energized, the temperature control 202 is energized and the solenoid for the steam valve 58 is energized to open said valve, and a solenoid valve 199, which controls the flow of coolant to the condensing unit 102 is opened. During this period of time the timer 196 continues the rotation of the drum in opposite directions at one-minute intervals. The blower 91 circulates the vapor within the apparatus through the plenum chamber 38, down through the foraminous plate 76 and into the drum 18. This heated air or vapor then evaporates the solvent from the articles and the vapor is drawn through the end wall 21 of the drum 18, through the passage 83, and the lint bag 84 to the blower 91. The blower 91 draws this vapor up through the pipe 101 to the condensing unit 102. In the condenser 102 the vapors are condensed and the condensate drains through tube 112 into the separator 113. In the separator 113 the solvent is separated from the water which may also have been present in the vapors. When the time interval for the retracting timer 193 is over in the drum valve solenoid 58 is closed, a time delay relay 201 is energized, and the timer 194 is energized.

The time delay relay 201 maintains the solenoid valve 199 on the coolant open so that vapor will continue to be condensed as it is circulated through the machine but this vapor is no longer heated in the plenum chamber 38 due to the closing of the steam valve 58. As the blower 91 continues to circulate the air within the apparatus for several minutes the entire apparatus is cooled down. The time delay relay 201 de-energizes the solenoid on the valve 199 after the expiration of the several minutes and the circulation of the coolant through the coil 106 is stopped. The time delay relay 201 energizes the solenoid of the valve 100 on the compressed air line. The solenoid valve 100 opens the air line to operate the cylinder 69 which operates the damper 66 and operates the motor 99 which closes the door 30 of the valve 96 in the T 93. When the damper 66 is opened room air is allowed to enter the plenum chamber 38 and to be drawn through the drum 18 by the blower 91. The air leaving the blower 91 is then directed through the pipe 94 to the stack or to the atmosphere. The room air moving through the drum removes the odor of the solution from the articles and this period lasts about four minutes. At the end of the time set on the deodorizing timer 194 the solenoid valve 100 is closed, the motor on the blower 91 is de-energized and the cycle timer 196 is de-energized to stop the drum rotation cycles. Also, the cycle timer 196 operates a suitable buzzer alerting the operator that the process is complete. The articles are now properly treated, dried and deodorized.

Referring now to the modification illustrated in FIGURES 6 through 8, wherein the parts corresponding to the like parts in FIGURES 1 through 3 have the same reference numeral, it will be noted that two sets of oppositely directed spray nozzles have been added to the tube 121 and nozzles 122 as the liquid dispensing means. The nozzles are recessed in relation to the inner surface of the foraminous plate 76 which is formed with a rectangular opening 206 extending across the plate above the center line thereof as best shown in FIGURE 7. Each set of nozzles, in the illustrated apparatus, includes a lower nozzle 207 and an upper nozzle 208 supported by vertical plates 209 mounted on the plate 76. Plates 209 extend from the plate 76 toward the door 13 and are disposed at about 45° to the plane of plate 76. An upper plate 211 and a lower plate 212 extend between the plates 209 with the lower plate 212 being at a slight incline to drain toward the drum 18.

The nozzles of each set are preferably designed to deliver solution in a planar diverging pattern across the drum and toward the opposed drum wall 19. With no garments in the drum the pattern from the sprays would impinge on the wall along a generally axially extending line on the drum wall on one side of a vertical plane parallel to and through the axis of the drum and below a horizontal plane through the drum axis. The sprays from the upper set would impinge similarly on the opposite side of a vertical plane through and parallel to the drum axis and below the horizontal plane. The two sets do not operate simultaneously but the discharge from one set would be a “mirror-image” of the discharge of the other. The upper nozzle 208 of each set is designed to deliver about twice as much solution as the lower nozzle 207 and the spray therefrom is directed to impinge on the rear about the two-thirds of the drum wall. The lower nozzle 207 is directed toward the front portion of the drum wall. The nozzles 207 and 208 of each set are connected by means of flexible tubing 213 to two fixtures 214 which are mounted in the door 13. Each fixture 214 is then connected by suitable flexible tubing 215 through separate solenoid valves 216 and 217 (as diagrammatically illustrated in FIGURE 9) to the treating solution supply line 124 (FIGURE 4) in place of the tube 121. The solenoid valves 216 and 217 are connected in the electrical circuit to the timer 196 to be operated to change the direction of spray upon each change in the direction of drum rotation, during an application cycle. As viewed in FIGURE 7 the left-hand set of nozzles 207 and 208 would deliver solution when the drum is rotating in a counterclockwise direction as viewed from the rear of the drum. The circuitry for the apparatus of this modification is substantially the same as illustrated in FIGURE 5 except the two above mentioned solenoid valves 216 and 217 and the motor 27 are each connected to the timer 196, and the limit switch 197 and motor 149 are excluded.

Additionally, this modification illustrates means for varying the rotational speed of the drum 18. As illustrated in FIGURE 6, a motor support bracket 218 is pivotally mounted to the rear wall 8 of the apparatus on a shaft 219. The reversible motor 27 has a variable pitch, spring-loaded belt pulley 221 attached to the drive shaft thereof. A drive belt 31 affords a driving connection between the pulley 221 and the driven pulley 230 on the gear box 24 which drives the shaft 23 and the drum 18. A bracket 222 is fixed to the gear box 24 and extends upwardly therefrom to a position below the pivoted bracket 218. An adjustable stop member 223 is mounted on the bracket 222 to provide an adjustable minimum spacing between the bracket 218 and the bracket 222. An air motor or cylinder 224 is supported on the bracket 218 and has a piston rod 226 extending through the bracket 218 into
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abutting relation with the bracket 222. Actuation of the air motor 224 by applying air pressure against the piston raises the bracket 218 and motor 27 to pull the belt 31 toward the center of the pulley 221 to decrease the rotational speed of the drum 18. Rotation of the drum may be varied between 25 and 70 r.p.m. Actuation of the air motor 224 is controlled by a 3-way solenoid actuated valve (not shown) which may be operated from the timer 192 or the timers 193 and 194 depending on whether a higher speed is desired during the period for application of the solution to the garments or during the drying period. Compressed air for the motor 224 is available from the same source of compressed air which is connected to the solenoid valve 181.

In a preferred embodiment of the apparatus of the drum is 36 inches (92 centimeters) in inside diameter and about 27 inches (69 centimeters) long, and it has 4 circumferentially spaced ribs 33 which have a radial dimension of 4 inches (10 centimeters). A drum this size can handle loads of garments of between 10 and 30 pounds (5 and 15 kilograms). A drum rotation of approximately 26 r.p.m. gives the garments a good tumbling action, i.e., the articles are prone to fall from the surface of the drum before they reach drum top dead center. A preferred rotational speed during drying is between 35 to 40 r.p.m. Means may be provided to gradually increase the rotational speed of the drum during the application period to maintain a good tumbling action on the garments as the same get heavier. When the apparatus as illustrated in FIGURES 1 through 3 is used the drum is rotated at a speed to tumble the garments to avoid tangling of the garments with the tube 121. The garments may be tumbled or moved with the drum surface in a device of the type illustrated in FIGURES 6, 7 and 8. When they are moved with the drum surface, the drum is rotated at speeds between 50 and 70 r.p.m. during application of the solution from the spray nozzles. During tumbling and when reversing the direction of rotation of the drum, a turning or rearrangement of the garments is afforded such that different surfaces of the garments are exposed to the spray from the liquid dispensing means to uniformly wet the garments in a minimum amount of time without having free liquid in the drum. When the garments are carried with the drum and the direction is reversed periodically, different surfaces are exposed to the spray and the higher speed increases the wetting effect on the garments to uniformly wet the garments in a minimum amount of time without free liquid in the drum.

The nozzles may be selected to have predetermined delivery rates and the delivery rates of the nozzles are dependent upon the types of garments treated and the specific gravity of the solvent used with the fluorochromatics. When using solvents having a high specific gravity, and/or when the garments to be treated are capable of retaining and holding a large amount of solution, the amount of solution to be applied may be relatively high. For example, when using a solvent having a relatively high specific gravity and when treating garments formed of several layers (quilted garments) the amount of solution applied may be 2.0 pounds (kilograms) of solution per pound (kilogram) of garments. At other times when using solvents having a lower specific gravity and when treating garments made of certain fibers (silk) and tightly woven, the amount of solution required may be only 0.4 times the weight of the garments to give a satisfactory treatment. In all cases however it is not desirable to apply solution in a quantity exceeding that which can be held by the garments. The object is to uniformly wet the garments but to have substantially no free liquid within the drum at any time during the process. Complete wetting of the garments or articles is obtained by the spray contacting of the articles and by wicking in the articles.

Suitable materials for rendering fibrous articles oil, water and stain repellent are organic materials having an oleophobic and/or hydrophobic terminal portion containing fluorine. The preferred oil and water repellent materials may be represented by the following typical formula:

\[(R_5)_m(Q_p)\]

in which \(R_5\) is a fluorine-containing terminal organic radical of about 3 to about 20 carbon atoms, preferably about 4 to about 12, with the number of substituted fluorine atoms being equal to at least the number of carbon atoms and containing no substituents other than hydrogen or halogen. More preferably \(R_5\) corresponds to the radical \(Y(CF_2)_x\) in which \(Y\) is hydrogen, chlorine or fluorine and \(Z\) is a gaseous halogen (chlorine or fluorine), preferably both \(Y\) and \(Z\) are fluorine, and \(x\) is an integer of between about 2 to about 12, preferably at least 4 and preferably not greater than about 12. \(Q\) is an organic moiety substantially free of fluorine atoms, \(Q\) accounting for the solubility of the chemical in organic solvents and the attachment of the fluorochrome to the treated substrate as well as the organic radical for linking a plurality of \(R_5\) groups, and \(m\) and \(p\) are integers equal to or greater than 1.

\(R_5\) is the oleophobic and/or hydrophobic terminal portion of the molecule and may be acyclic or alicyclic and in the most preferred embodiment is perfluorinated. Typical examples of \(Q\) are radicals such as: hydrocarbon; poly acrylate or methacrylate; poly sulfonamido or carbamamido acrylate or methacrylate; polyvinyl ether; polyurethane; and alkylpyridinium salt.

The following are examples of suitable liquid treating media containing oil and water repellent materials suitable for treating fibrous articles or garments in accordance with this invention.

(A) 0.6 weight percent solution of a segmented terpolymer of N-ethyl perfluorooctanesulfonamidomethyl methacrylate, isoprene and triacryaryl in 1,1,1,3-tetrachloroethane.

(B) 0.7 weight percent solution of a terpolymer of N-methyl perfluorooctanesulfonamidocarboxylate, N-methyl perfluorooctanesulfonamidomethyl methacrylate and glycidyl methacrylate in 1,1,1-trichloroethane.

(C) 0.3 weight percent solution of an aluminum complex of aluminum isopropoxide, ethyl acetate and stearic acid and 0.4 weight percent of the fluorochrome of B above in 1,1,1-trichloroethane.

(D) 0.6 weight percent solution of an adduct of an aromatic polycyanate and N-methyl perfluorooctanesulfonamidocarboxylate in 1,1,1-trichloroethane.

(E) 0.6 weight percent solution of a copolymer of N-methyl perfluorooctanesulfonamidomethyl methacrylate, octadeyl methacrylate, and glycidyl methacrylate in tetra chloroethylene.

(G) 0.3 weight percent solution of the aluminum complex of C above and 0.4 weight percent of the fluorochrome of F above in tetrachloroethylene.

(H) 0.6 weight percent solution of the aluminum complex of C above and 0.4 weight percent of the fluorochrome of F above in "Stoddard solvent," i.e., a straight run petroleum distillate, flash point not lower than 100°F. (38° C.), 50% boiling below 350°F. (177° C.) and a dry point not higher than 410°F. (210° C).

(I) 0.8 weight percent aqueous latex of poly(N-methyl perfluorooctanesulfonamidocarboxylate).
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The apparatus disclosed thus affords means for automatically performing the process of spraying a liquid treating medium containing an organic material having a hydrophobic terminal portion or a hydrophobic and an oleophobic terminal portion containing fluorine in a predetermined direction while repeatedly moving fibrous articles through the spray and turning the articles to expose, over a period of time, different surfaces of the articles to the spray until the articles are substantially saturated by the treating medium, at which time the articles are then moved within a stream of warm air until the articles are dried only by the evaporation of the liquid carrier phase of the treating medium and not by first wringing or extruding the treating medium to partially dry the articles.

Having thus disclosed and described the novel method and novel apparatus of the present invention, which apparatus affords means for carrying out the method, it is to be understood that certain changes and modifications may be obvious to one having ordinary skill in the art without departing from the scope of the present invention.

What is claimed is:

1. The method of treating fibrous articles to render the same water repellent comprising the steps of: moving said articles within a drum first in one direction and then in the reverse direction for predetermined time intervals, spraying a liquid treating medium containing a fluorocarbon material having a hydrophobic terminal portion containing fluorine on said articles as the same are moving in the drum, changing the direction of said spray as the direction of movement of said articles is changed, controlling the amount of medium sprayed such that sufficient medium will be sprayed onto said articles to uniformly wet the same with said medium and such that at no time is there any substantial amount of free liquid within the drum, and removing the liquid carrier phase of the treating medium from the articles by evaporation.

2. The method of treating fibrous articles to make the same water repellent comprising the steps of placing the articles within a drum, rotating said drum in one direction to move the articles within the drum, spraying the articles with a liquid treating medium containing an organic material having a hydrophobic terminal portion containing fluorine, changing the direction of drum rotation at predetermined intervals and changing the direction of the spray upon each change in the direction of drum rotation to maintain the spray directed at said articles, controlling the amount of medium sprayed on said articles during a predetermined interval of time, such amount of medium sprayed being sufficient to uniformly wet the articles and have substantially no free liquid present within the drum, and drying the articles by evaporation of the liquid carrier phase of the treating medium from the articles.

3. The method of claim 1 in which the hydrophobic terminal portion of said organic material contains a perfluoroalkyl group of at least four carbon atoms.

4. The method of claim 1 in which said liquid treating medium is an aqueous dispersion of said organic material having a hydrophobic terminal portion.

5. The method of claim 1 in which the terminal portion of said organic material is both hydrophobic and oleophobic and is dissolved in a solvent to form said liquid treating medium.

6. The method of treating fibrous articles such as articles of clothing to render the same water and oil repellent comprising the steps of moving the articles in a random mass within a drum by rotating said drum in one direction, spraying the articles with an organic solvent containing an organic solvent and a fluorocarbon having a perfluoroalkyl group of at least four carbon atoms, changing the direction of drum rotation after a predetermined timed interval, changing the direction of the spray as the direction of drum rotation is changed so the spray will strike said articles, changing the direction of drum rotation and of the spray after the expiration of a subsequent timed interval until the passage of a set time interval.
dependent on the amount of articles contained in the drum, controlling the rate of spray sprayed upon said articles such that solution weighing between about 0.4 and 2.0 times the weight of said articles is sprayed on said articles during said set time, and removing and recovering said organic solvent from said articles by vaporizing said solvent and subsequent condensing the vapor.

7. The method of treating fibrous articles to render the same water and oil repellent comprising the steps of placing a weighed number of articles within a drum having an imperforate cylindrical wall surface, rotating said drum in one direction to tumble said articles, spraying an organic solution containing a soluble compound having a hydrolephobic and oleophilic terminal portion containing fluorene on said articles from nozzles placed within the periphery of said cylindrical wall portion of said drum, stopping said drum and rotating said drum in the reverse direction, changing the direction of said spray by moving the nozzles with each change in the direction of drum rotation, continuing the rotation of said drum in each direction for a predetermined interval of time, pumping a predetermined amount of solution to said nozzles such that an amount of solution weighing between about 0.4 and 2.0 times the weight of the articles placed within said drum will be sprayed from said nozzles over a preset timed period, discontinuing said spraying and pumping, and drying said articles and recovering substantially all of the sprayed solvent in said solution by evaporation and condensation.

8. In a fabric treating apparatus comprising a casing, a rotatable drum mounted within said casing with its axis generally horizontally positioned, drive means for rotating said casing, means affording access to said drum for the insertion and removal of articles, the improvement comprising liquid dispensing means adapted to spray a liquid treating medium into said drum at a predetermined rate, means for reversing the direction of rotation of said drum at predetermined intervals, and means for changing the direction of the spray from said liquid dispensing means such that when the direction of rotation of said drum is changed the direction of said spray is changed to maintain the spray directed at the articles placed within said drum.

9. A fabric treating apparatus according to claim 8 wherein said liquid dispensing means includes a conduit extending into said drum having a plurality of discharge means positioned thereon, and said means for changing the direction of the spray includes means for moving said conduit to change the direction of the spray from said discharge means.

10. A fabric treating apparatus according to claim 8 wherein said liquid dispensing means includes at least a pair of nozzles supported to discharge into said drum toward opposed surfaces of the drum, and wherein said means for changing the direction of said spray includes means for sequentially operating said nozzles.

11. A fabric treating apparatus comprising in combination a casing, a rotatable drum mounted within said casing and having an imperforate generally cylindrical side wall, a foraminous end wall and a substantially open end; reversible drive means for rotating said drum about its axis in either direction of rotation; said casing being formed with means allowing access to the open end of said drum; liquid dispensing means for spraying solution into said drum at a predetermined rate over a given period of time, means for changing the direction of spray from said dispensing means; control means for said drive means and for said means for changing the direction of spray to change the direction of drum rotation and to change the direction of the spray from said dispensing means to correspond with the change in the direction of drum rotation; a heating chamber; a condensing unit; and means for circulating air through said heating chamber, through said drum and through said condensing unit for evaporating and condensing the solvent in a said solution sprayed upon the fabrics placed in the drum to dry the fabrics and recover the solvent.

12. A fabric treating apparatus comprising in combination a casing; a rotatable drum having an imperforate cylindrical side wall and a perforated end wall positioned within said casing with its axis in a horizontal position; drive means for rotating said drum in opposite directions about its axis; said casing being formed with an access opening allowing the insertion and removal of articles into said drum; a door for said access opening; a liquid dispensing mechanism including a conduit having a plurality of nozzles, pump means for pumping a liquid treating medium from storage means to said conduit and through said nozzles, said pump means and said nozzles being of a size to deliver into said drum a predetermined amount of liquid in a predetermined interval of time; means supporting and positioning said conduit within said drum generally parallel with the axis of rotation of said drum and adjacent the upper peripheral edge portion of said drum and allowing movement of said conduit to change the direction of spray from said nozzles; and control means for said means supporting and positioning said conduit and for said drive means to change the direction of spray and to change the direction of drum rotation in a predetermined cycle, such that in each direction of drum rotation the spray is directed toward articles placed in the drum as the same fall from the upper peripheral toward the lower part of said drum.

13. A fabric treating apparatus comprising in combination a casing; a rotatable drum having an imperforate cylindrical side wall and a perforated end wall positioned within said casing with its axis in a horizontal position; drive means for rotating said drum in opposite directions about its axis; said casing being formed with an access opening allowing the insertion and removal of articles into said drum; a door for said access opening; liquid dispensing nozzles mounted on said door and directed toward different areas within said drum; fabric treating apparatus for pumping a liquid from storage means to said nozzles; said pump means and said nozzles being of a size to deliver into said drum a predetermined amount of liquid in a predetermined interval of time; control means for said drive means to change the direction of drum rotation after predetermined intervals of time and for changing the direction of spray from said nozzles between said different areas upon each change in the direction of drum rotation to maintain the sprays directed toward articles moving within said drum; means for controlling said pumping means; actuating means for heating and moving gases through said drum; and means for changing the speed of said drive means to change the rotational speed of said drum upon actuating said actuating means.

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UNIVERS STATES PATENT OFFICE
CERTIFICATE OF CORRECTION


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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Specification, Column 13, line 12, "trifluoroethane" should be -- trifluorotrichloroethane --.

SIGNED AND SEALED
JUN 2 1970

(SEAL)
Attest:
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