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Masero et al.

[11] **3,895,447**

[45] **July 22, 1975**

[54] **APPARATUS FOR TREATING CELLULOSIC-CONTAINING ARTICLES TO RENDER THEM CREASE RESISTANT**

[75] Inventors: **Kenneth J. Masero,** Los Altos; **David L. Wise,** Salinas, both of Calif.

[73] Assignee: **Vaportech Corporation,** Inglewood, Calif.

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[21] Appl. No.: **358,993**

[52] **U.S. Cl.** **34/48;** 34/36; 34/109; 34/131; 34/212; 34/216

[51] **Int. Cl.** **F26b 19/00**

[58] **Field of Search** ..... 68/5 C, 5 D, 20; 34/36, 34/37, 109, 130–133, 139, 140, 151, 210, 212, 215–217, 46, 48

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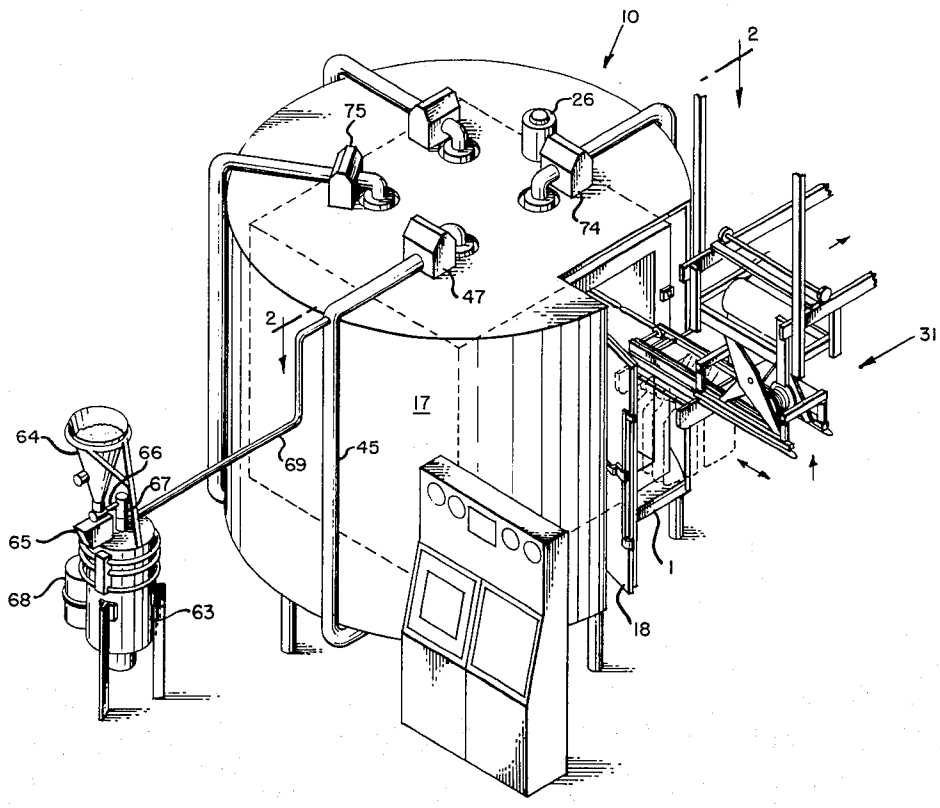
Primary Examiner—Carroll B. Dority, Jr.
Assistant Examiner—Larry I. Schwartz
Attorney, Agent, or Firm—Seed, Berry, Vernon & Baynham

[57] **ABSTRACT**

An apparatus for treating articles containing cellulosic fibers in all or a part of their composition with reactive chemicals to render the article crease resistant is disclosed. The apparatus includes a carousel unit having four treating chambers mounted for rotation at spaced time intervals through four treatment positions. Each of the treating chambers has inlet and outlet ports therein for circulation of heated gas therethrough and retractable valve means connecting the inlet and outlet ports of each chamber to the gas circulation means. Articles to be treated are placed in the first treatment chamber and preheated by circulation of heated air therethrough. The heating chamber then rotates to a second position wherein a gaseous mixture of treating chemicals is circulated through the treating chamber. The chamber then rotates to a third and fourth position wherein the articles are further treated.

9 Claims, 9 Drawing Figures



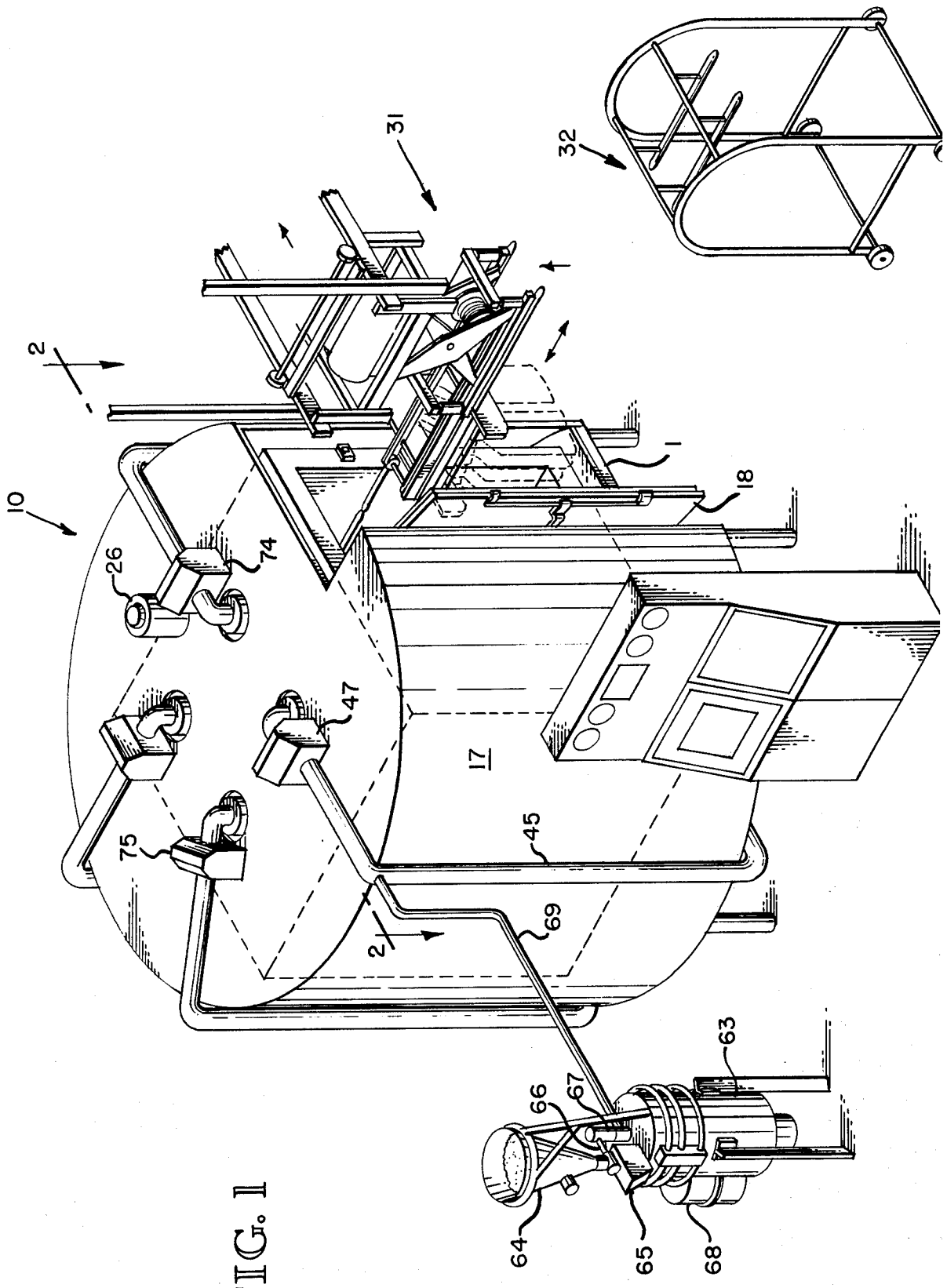


FIG. 1

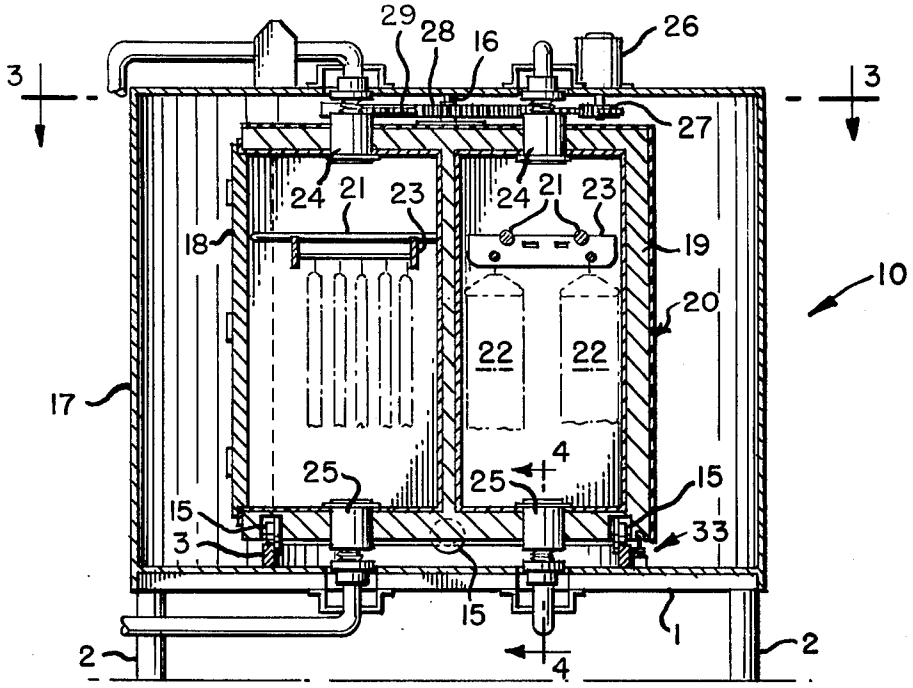

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FIG. 2

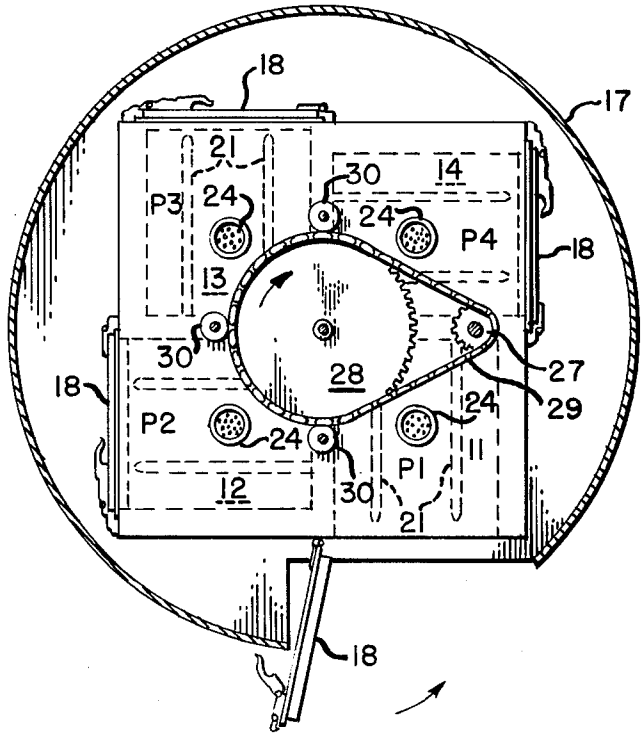
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FIG. 3

FIG. 4

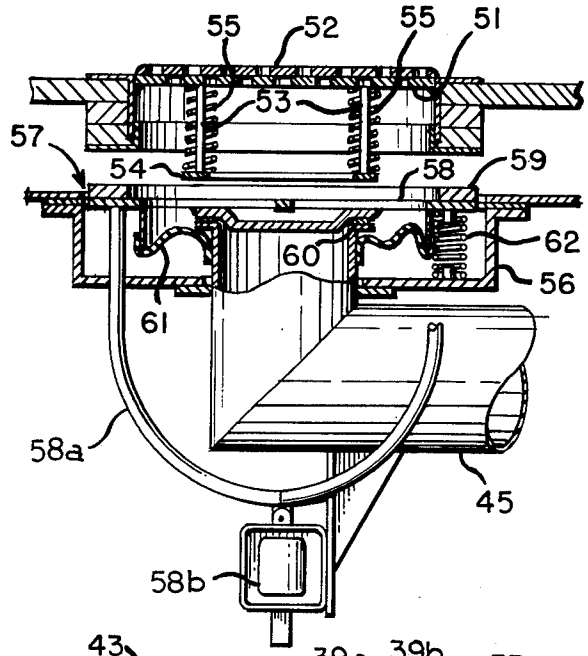
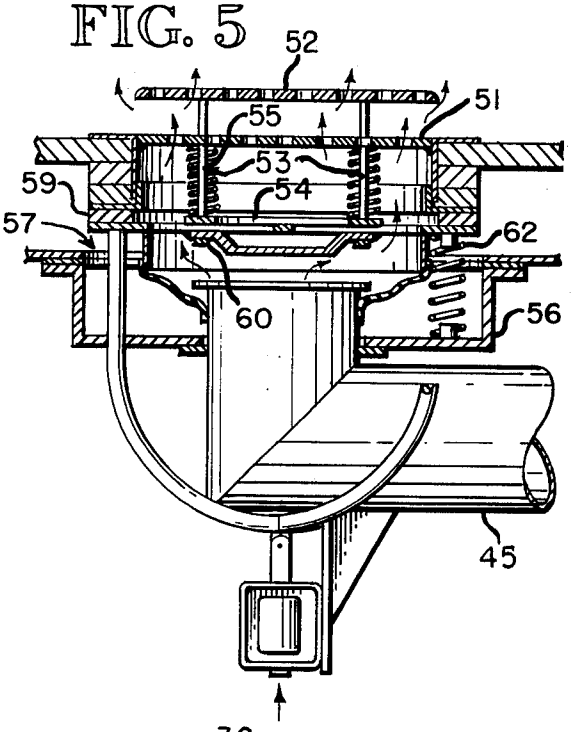


FIG. 5



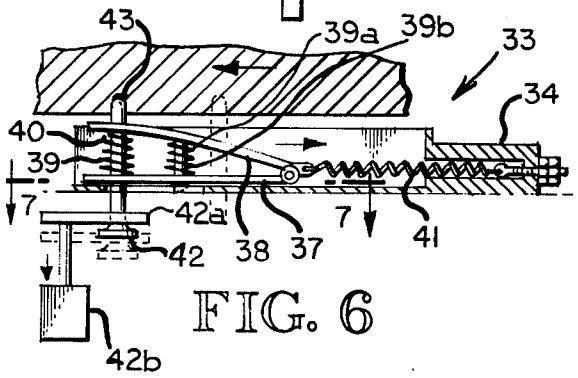


FIG. 6

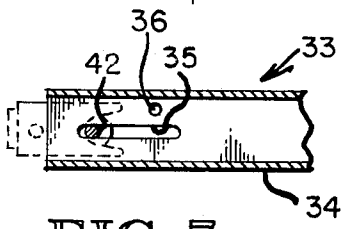


FIG. 7

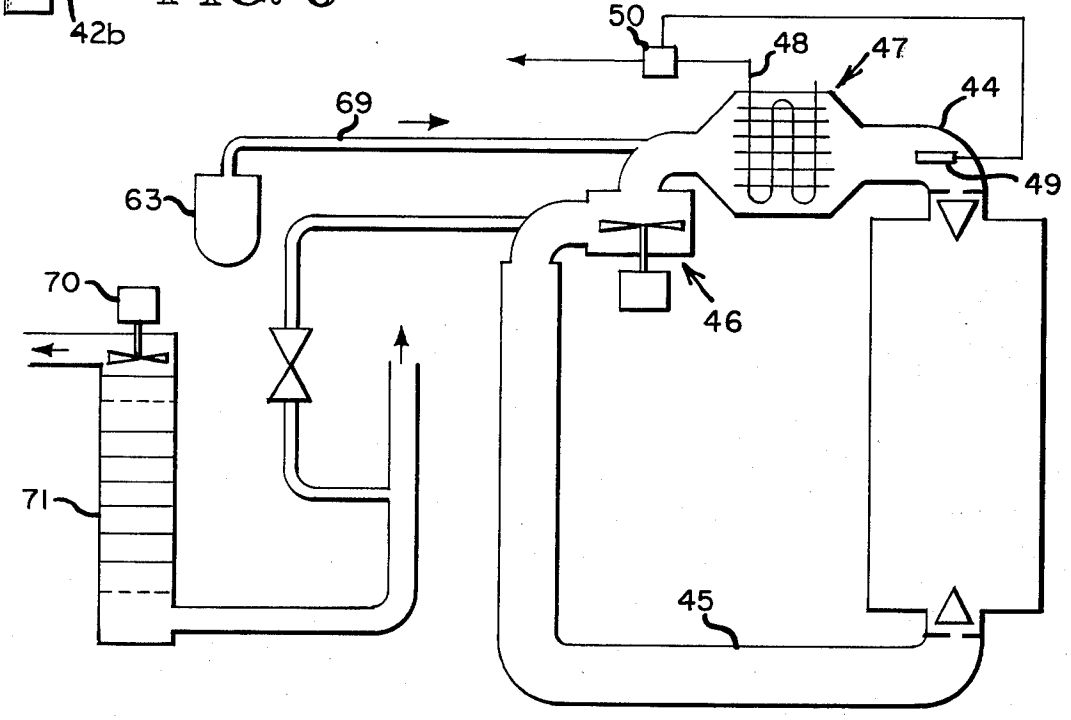
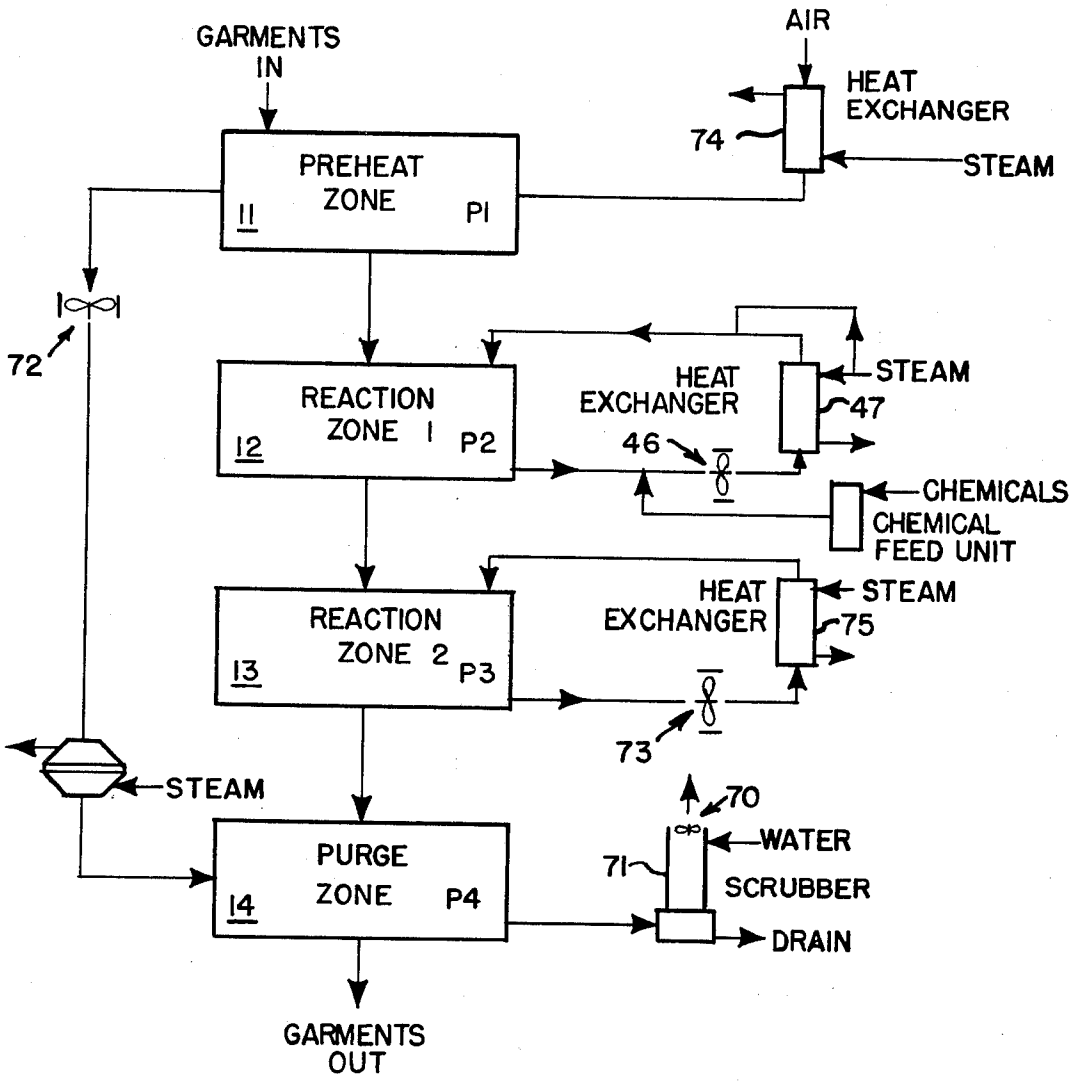


FIG. 8


GARMENTS IN
AIR
HEAT EXCHANGER
74
STEAM
PREHEAT ZONE
11
PI
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REACTION ZONE 1
12
P2
HEAT EXCHANGER
46
STEAM
47
CHEMICALS
CHEMICAL FEED UNIT
REACTION ZONE 2
13
P3
HEAT EXCHANGER
STEAM
75
73
STEAM
70
WATER
71
SCRUBBER
PURGE ZONE
14
P4
DRAIN
GARMENTS OUT

FIG. 9

APPARATUS FOR TREATING CELLULOSIC-CONTAINING ARTICLES TO RENDER THEM CREASE RESISTANT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus for treating cellulosic articles to render them crease resistant.

2. Prior Art Relating to the Disclosure

Various means of obtaining permanent or durable press articles have been developed using both wet phase and vapor phase techniques. Vapor phase techniques require distinctly different apparatus than that developed for wet phase techniques. One vapor phase apparatus is illustrated by U.S. Pat. No. **3,513,669.** Equipment developed to date for vapor phase treatment has not been generally suitable, particularly for carrying out the vapor phase process disclosed herein and in application Ser. No. **119,905** filed Mar. **1, 1971** now abandoned, entitled "Process for Cross-Linking Cellulosic Fiber Containing Materials and the Products Thereof," assigned to the assignee of this application. The equipment disclosed herein is particularly adapted to carrying out the vapor phase processes for treatment of cellulosic materials, including the vapor phase process disclosed in the co-pending application.

SUMMARY OF THE INVENTION

The objects of this invention are to provide apparatus for the vapor phase treatment of articles to render them crease resistant which (1) is useful in conjunction with vapor phase processes for treatment of cellulosic materials such as disclosed in application Ser. No. **119,905,** (2) can process articles at high production rates on a batch-continuous basis with a minimum of chemical usage in a relatively short time cycle, (3) utilizes treating chambers mounted on a carousel arrangement for movement of the treating chambers through the varying treatment zones and (4) utilizes a unique valve system for connecting and disconnecting the gas circulation means to each of the treatment chambers at desired times.

These and other objects are accomplished by an apparatus comprising a rotatable carousel unit made up of a series of vapor-confining treatment chambers mounted for rotation between a first and succeeding treatment positions for treatment of articles contained therein. Each of the treatment chambers includes access permitting articles to be treated to pass into and out of the treatment chamber, support means in each chamber to support articles positioned therein in a spaced-apart relation, and inlet and outlet ports therein permitting introduction, circulation and exhaust of an externally supplied gas stream to the various treatment zones. Power means are provided to rotate the carousel unit and each treatment chamber at periodic intervals through the various treatment zones. Gas circulation means are provided at each of the treatment positions for circulating a temperature controlled gas stream through the treatment chambers when desired. Valve means are associated with each of the gas circulating means and inlet and outlet ports of the treating chambers, each valve retracting to a non-interfering position from the inlet and outlet ports before rotation of the carousel unit to the next treatment position. Once in the succeeding treatment position the valves advance into sealing contact with the inlet and outlet ports of the treatment chambers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an overall perspective view of the apparatus for treating articles illustrating the carousel unit, a portion of the loading unit for loading the articles into a treatment chamber of the unit, a loading rack for storage of the articles to be treated, the control console and the chemical feeding unit feeding vaporous chemical mixture into a treating chamber;

FIG. **2** is a vertical cross-sectional view along section line **2—2** of FIG. **1** illustrating the arrangement of the treatment chambers and valves controlling circulation of gas through the respective treating chambers;

FIG. **3** is a horizontal cross-sectional view of the carousel unit of FIG. **1** illustrating the arrangement of the treatment chambers and the driving arrangement thereof;

FIGS. **4** and **5** are vertical cross-sectional views along section line **4—4** of FIG. **2** of one of the valves connecting the gas circulating means to the ports of each of the treating chambers, FIG. **4** illustrating the valve in retracted position and

FIG. **5** illustrating the valve in operating position for admitting gas into the treating chamber;

FIG. **6** is a partial vertical cross-sectional view of the index mechanism of the carousel treatment chamber unit;

FIG. **7** is a top view along section line **7—7** of FIG. **6** of the index mechanism;

FIG. **8** is a schematic flow diagram of the gas circulating means at one treatment position wherein vaporous chemical mixture is fed into the circulating gas stream; and

FIG. **9** is a schematic flow diagram of the overall process.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The treating apparatus illustrated in FIG. **1** includes a lower support frame **1** supported from a support surface on legs **2.** A circular track **3** (see FIG. **2**) is mounted on the support frame. A carousel unit **10** consisting of four vapor-confining treating chambers **11,** 12, 13 and **14** is mounted for rotation on the circular track **3.** The carousel unit is supported on the track by three or more wheels **15** mounted on the underside of the carousel unit. A shaft **16** centered in the carousel unit extends through the outer housing or shell **17** of the treating apparatus to aid in stabilizing the carousel unit for rotation.

Each of the treating chambers includes a top wall, bottom wall, side walls and rear wall. The front wall of each chamber is an insulated door **18** hinged to allow access for putting in and taking out articles to be treated. The door is similar to a refrigerator door in that it seals the chamber against discharge of chemical vapors contained therein. Each of the treating chamber walls is fabricated from an inert, noncorrosive material such as stainless steel. The walls of each chamber are surrounded with a layer of insulation **19.** The outer supporting walls **20** of each of the treating chambers may be of any suitable material, such as plywood, metal, plastic, etc. Parallel support rods **21** for articles to be treated are secured to the rear wall of each of the treating chambers and project toward the door of each

chamber. The articles to be treated 22 are supported in the chambers in spaced relation on a rack 23 which slides over and is supported by the projecting rods 21. Each treating chamber has inlet and exhaust ports 24 and 25 located in the respective top and bottom walls for introduction and exhaust of gas into each of the chambers. Details of the ports and valve means associated with each of them will be described with reference to FIGS. 4 and 5.

The carousel unit 10 and its associated treating chambers are rotated between the treatment positions by a drive motor 26 mounted on the top of the housing 17. The shaft of the motor extends through an opening in the housing and has a sprocket 27 secured thereto. Shaft 16 of the carousel unit has a larger sprocket 28 secured thereto in line with the sprocket 27 secured to the shaft of the motor 26. A chain or belt 29 connects the two sprockets. Idler wheels 30 mounted on shafts secured to the top wall of the housing press against the chain and sprocket 28 to prevent the chain from disengaging.

A loader mechanism 31 partially shown in FIG. 1 removes garments or other articles to be treated from a rack 32 and inserts them into the respective treating chambers on a semi-automatic basis. This may also be done manually if desired. The loader does not form a part of this invention.

The carousel unit and four treating chambers associated therewith move between four treatment positions illustrated by the designations P1, P2, P3 and P4 in FIG. 3. In treating position P1 garments or other articles which have been treated are removed from treating chamber 11 by the loader and an untreated batch of articles inserted in the chamber. The door is closed to seal the chamber. On completion of a cycle the carousel unit advances chamber 11 to position P2 and, subsequently to positions P3 and P4.

An index mechanism 33 (FIGS. 6 and 7) is mounted on the lower support frame of the carousel unit to brake and stop the treatment chambers of the carousel unit at the correct treatment position on rotation of the unit from one treatment position to the next. It is necessary that the treating chambers, on rotation from one treatment position to the next, stop at a position for sealing connection to the conduits circulating gas through each of the treatment chambers by the respective valve means to be described. The index mechanism includes a rectangular open-topped, hollow housing 34 having an elongated slot 35 and index pin opening 36 in the bottom wall thereof. Two strips of metal 37 and 38 connected together at one end are mounted in the housing and attached to the rear wall of the housing by a tension adjustable spring 41. A latch pin 39 extends through slot 35 and openings in the forward ends of the metal strips 37 and 38 and is secured to strip 38. A spring 40 is mounted between the metal strips and surrounding the latch pin 39 urges the pin and strip 38 against the lower walls of the treating chambers. The lower end of latch pin 40 has a flattened portion 42 which engages in the open slot of a member 42*a* secured to the arm of a solenoid controlled air cylinder 42*b*. The underside of the treatment chambers of the carousel unit have four holes 43 about the size of the latch pin 42 located at positions relative to the latch pin where the treatment chambers of the carousel unit are to be stopped. An index pin 39*a* is attached at its upper end to metal strip 38 and extends through an opening in strip 39 to mate with the index pin opening 36 in the bottom wall of the housing 34. A spring 39*b* attached to the pin 39*a* and biased against metal strip 38 forces the pin into the pin opening 36. The metal strips 37 and 38, latch pin 39 and index pin 39*a* move between the positions shown in solid and phantom lines in FIG. 6. To allow rotation of the carousel unit, a solenoid controlled air cylinder retracts latch pin 39 to allow the unit to rotate. When the pin is retracted spring 41 retracts the metal strip - latch pin - index pin assembly so that the latch pin occupies the position shown in phantom. The lower portion of the index pin 39*a* is preferably bevelled to allow it to slide out of the opening 36 easily to allow the assembly to move to the rear but to prevent further movement of the assembly in a forward direction. As shown as the unit begins rotating, the solenoid releases the latch pin. It moves against the bottom surface of the treatment chambers of the carousel unit until the next hole 43 is encountered. The drive motor of the carousel unit is turned off just prior to the succeeding index position. When the latch pin is injected into the opening 43 by spring 39, the momentum of the carousel unit carries the latch pin, index pin and strips 37 and 38 forward until index pin 39 a drops into opening 36.

Gas circulating means are provided at each treatment position to circulate gas through the treating chambers. Each of the gas circulating means includes means to heat the gas circulating therethrough. The apparatus described may be adapted for carrying out various vapor phase processes for treating cellulosic-containing articles other than that described in Ser. No. 119,905 now abandoned, though it is particularly adapted to carrying out the vapor phase process described therein. FIG. 8 schematically illustrates the gas circulating system for carrying out the process described in copending application Ser. No. 119,905. Position P2 includes means for feeding a vaporous mixture of reaction treating chemicals into the treatment zone, such as a vaporous mixture of formaldehyde alone or in admixture with an acid. The gas circulating system for position P3 is the same as that illustrated for position P2 except that no chemicals are fed into the gas stream. In position P1, outside air is drawn through a heat exchanger into the treating chamber by an exhaust fan mounted in the duct leading from the exhaust port of the treating chamber. The exhausted air is then circulated through the treatment chamber in position P4 for deodorizing and degassing of the articles contained therein. The gas withdrawn from the chamber in position P4 is fed into a scrubber unit or discharged to the atmosphere, as illustrated by FIG. 9.

Referring to FIG. 8, a treating chamber and its associated inlet and outlet ports 24 and 25 are connected by valve means, schematically shown, to an inlet gas duct 44 and an outlet gas duct 45. A powered blower 46 forcibly circulates gas through the treatment chamber. The blower for positions P2 and P3 is mounted so that its intake is gas withdrawn through the outlet port and outlet gas conduit for reinjection through the inlet port into the treatment chamber. The recirculating gas flows through a heat exchanger 47. The heat exchanger is provided with coils 48 through which super-heated steam flows. A temperature sensor 49 suitably located in or adjacent the treating chamber senses the temperature of the circulating gas in the treating chamber and is connected to a modulating controller 40 which con-

trols the amount of steam flowing through coils **48** to control the temperature of the gas circulating through the treating chamber.

The reactive chemical vapors injected into the treatment zone in position P2 are kept from entering the atmosphere surrounding the treatment apparatus because of its detrimental effect on working personnel by unique valves connecting each of the treatment chambers at their respective treatment positions to the gas circulating means. The valves do not allow discharge of any significant amount of chemical vapors into the atmosphere. The valves associated with each of the gas inlet and outlet ducts of the gas circulation means and the inlet and outlet ports of each of the treatment chambers are two-part valves—one part of the valve associated with the inlet and outlet ports of the treating chambers and the other part of the valve disposed over the open end of the gas inlet and outlet ducts. FIGS. **4** and **5** illustrate in detail the structure of the valves. FIG. **4** illustrates the position of the valve in retracted position just prior to or during rotation of the carousel unit from one treatment position to the next. In this position, the open end of the gas duct is sealed against discharge of any gas or chemical vapors contained therein into the atmosphere surrounding the treatment apparatus. The treatment chamber is also sealed against discharge of any chemical vapors contained therein. In the operative position illustrated by FIG. **5**, the valve allows free flow of circulating gas contained in the gas duct into and out of the treating chambers. The portion of the valve associated with the inlet and outlet ports of each of the treating chambers has a stationary pertorated plate **51** secured in the port openings therein with respect to the first plate, overlays plate **51** so that, in the position shown in FIG. **4**, the treating chamber is sealed against input or discharge of gas. The second perforated plate **52** has tripod legs **53** attached to the underside thereof extending through the first plate **51**. The tripod legs **53** are interconnected at their lower ends by connecting members **54**. Springs **55** are positioned between plates **51** and members **54** to bias perforated plate **52** into sealing contact with stationary plate **51** in the absence of any pressure exerted on the member **54** and tripod legs **53**.

The portion of each valve associated with the inlet or outlet gas duct at each of the treatment positions comprises a frame member **56** secured to the shell or outer housing **17** of the carousel unit over openings **57** cut therein corresponding to the position of the inlet or exhaust ports of the treating chambers. A perforated diaphragm **58** movable between the positions illustrated in FIGS. **4** and **5** has a sealing ring **60** secured to its lower surface to seal against the terminating edges of the gas duct **45** in the retracted position as shown by FIG. **5**, seals against the lower flanged edge of each port opening of the inlet and exhaust ports associated with each treating chamber. The diaphragm **58** is connected to the duct **45** by flexible bellows members **61** extending between the duct and the diaphragm. A spring **62** extending between the diaphragm **58** and frame member **56** biases the diaphragm into contact with the flange of the exhaust and inlet ports in the absence of opposing force. The valve is moved between the retracted and operating positions shown in FIGS. **4** and **5** by pneumatic, hydraulic or electrical means. FIGS. **4** and **5** illustrate movement of the diaphragm **58** of the valve units by securing the arm of a solenoid **58***b* to a yoke member **58***a* secured to the diaphragm **58**. The solenoid may be secured to the duct as illustrated.

The chemical feeding unit is illustrated in FIG. **1** and comprises a closed vessel **63** which has heating means therein for heating an inert heat transfer liquid contained in the vessel such as paraffin or mineral oil or dibutylphtalate. The chemical reactants normally used in the process are formaldehyde and either formic or acetic acid which are fed into the heated circulating gas stream circulating through gas duct **44** as a vaporous mixture. The formaldehyde is fed into the sealed vessel **81** in solid form as a paraformaldehyde. In such case the paraformaldehyde is held in a hopper **64** and fed in a predetermined ratio to the formic acid into the vessel by a vibratory feeder **65** through line **66** and rotary seal **67** to the line leading into the interior of the vessel. An acid such as acetic or formic acid held in a second sealed vessel **68** is metered into contact with the heat transfer liquid by a liquid pump (not shown) in a predetermined ratio to the formaldehyde. In the vessel **63**, the acid and formaldehyde are vaporized by the heat transfer liquid and flow through duct **69** into the circulating gas stream entering the treatment chamber in position P2.

Chemicals may be injected into the treating chambers in positions P3 and P4, if desired, to accomplish various purposes. For example, chemicals can be injected to aid in deodorizing the articles, waterproof or make the articles fire-retardant.

Superheated steam at **125** psi, more or less, is supplied to each of the coils in the heat exchange units to heat the circulating gas within each of the treating chambers. The temperature of the circulating gas is controlled by modulators controlling the amount of steam circulating through the heat exchange coils of each of the heat exchangers. To begin operation, the heating elements of the chemical feed vessel **63** are activated to heat the heat transfer liquid, generally mineral oil, to a temperature of **120°** to **140°C** for generation of the vaporous mixture of formaldehyde and formic acid. The blower **70** of the scrubber unit **71** is activated and water to the scrubber unit pumped therethrough. Once the inert heat transfer liquid is up to temperature, the rotary valve feeder **67** controlling the metering of paraformaldehyde and the liquid pump feeding formic acid into the heating vessel are activated to feed predetermined amounts of paraformaldehyde and formic acid into the heat transfer liquid.

Valves on the headers of each of the gas circulating means are opened to allow steam into each of the heat exchange units.

The loader mechanism is activated to insert a load of articles to be treated into treating chamber **11**. Once the load is inserted the door is closed and sealed and the blowers **46**, **72** and **73** associated with the treating chambers are activated to circulate gas through each of the treating chambers. In chamber **11** in position P1, gas is drawn through heat exchanger **74** to heat the circulating air to a temperature of **80°C.** to **120°C.** by blower **73**. After a time of **5** to **30** minutes, and preferably **15** minutes, the blowers **46**, **72** and **73** associated with each of the treatment zones are turned off and the valves associated with the inlet and outlet ports of the treatment chambers and gas ducts retracted to allow the carousel unit to rotate to the next treatment position, the valves preventing injection of chemicals into the air surrounding the treatment apparatus. The in-

dexing latch pin 42 is retracted and the drive motor 26 started. Just out of the index period, the latch pin 42 is released to catch the carousel unit when it reaches the next treatment position. A suitably mounted limit switch tells the drive motor to ceasé operation to allow the unit to coast into the succeeding treatment position. Once in position, the valves advance into operating position and the blowers 46, 72 and 73 associated with each of the chambers are activated. In position P2, a gaseous mixture of formaldehyde and formic acid is injected into the circulating heated gas stream. The articles in the treating chamber in position P2 have been conditioned to be below the polymerization temperature of formaldehyde and formic acid so that the gaseous mixture of formaldehyde and formic acid reacts together and forms a solid polymer which deposits in situ on the articles contained in the treatment chamber. After a second cycle of 5 to 30 minutes, and preferably 15 minutes, the feeder unit controlling feeding of formaldehyde and formic acid is stopped, the blowers stopped and the eight valves retracted away from the inlet and outlet ports of each treatment chamber. The latch pin 42 of the index mechanism is retracted and the carousel unit rotated to position treatment chamber 11 in position P3. In position P3, heated air is circulated through the chamber at a temperature sufficient to depolymerize the solid polymer deposited on the surfaces of the articles contained therein. When this occurs, formaldehyde is generated which cross-links with the cellulosic molecules of the fabric article to render them crease resistant. After a process cycle of 5 to 30 minutes, and preferably 15 minutes, the treatment chamber 11 is rotated to the position P4, where heated gas from the chamber in position P1 is circulated to degas and deodorize the articles contained therein. The heated gas exiting from chamber 11 in position P4, before being discharged into the atmosphere, feeds through the scrubber unit 71 for removal of the chemical vapors contained therein. After a cycle of 5 to 30 minutes, chamber 11 is rotated back into position P1, the door is opened and the bading mechanism activated to unload the treated garments contained therein and load a supply of untreated garments into the chamber for subsequent treatment.

All of the treatment chambers are under a partial vacuum. The chemical feeding vessel is also under a partial vacuum, thus necessitating the rotary seal for feeding of the paraformaldehyde.

The treating unit is capable of efficiently operating at a high production level on a semi-continuous batch basis. The articles treated by the process disclosed in Ser. No. 119,905 utilizing this apparatus have improved crease resistance, durability and color-fastness.

The embodiments of the invention in which a particular property or privilege is claimed are defined as follows:

1. An apparatus for the treatment of articles containing cellulosic fibers in all or a part of their composition with treating chemicals in the vapor phase to render them crease resistant, comprising:

a supporting frame;

a rotatable carousel unit supported for rotation on the frame having a series of vapor-confining treatment chambers mounted thereon for rotation between a first and succeeding treatment positions for treatment of articles contained therein, each treatment chamber including (1) access means permitting the articles to be treated to pass into and out of the treatment chamber, (2) support means within the chamber upon which the articles may be positioned in spaced apart relationship, and (3) inlet and outlet ports therein permitting introduction and exhaust of an externally supplied gaseous stream;

power means operatively connected to the rotatable carousel unit to rotate the unit and each of the treatment chambers at periodic intervals between a first and succeeding treatment positions;

gas circulating means including gas conveying ducts at each treatment position for circulating gas through one or more of the treatment chambers at that position; and

valve means associated with each of the gas circulating means and inlet and outlet ports of each treatment chamber controlling flow of gas into and out of each treatment chamber, each valve means retracting to a non-interfering position from the inlet and outlet ports of the treatment chambers prior to rotation of the carousel unit to the next succeeding treatment position and then advancing in sealing contact with the inlet and outlet ports of each of the treating chambers in the succeeding treatment position.

2. The apparatus of claim 1 wherein there are four treatment chambers and four treatment positions and wherein the gas circulating means of the treatment positions includes temperature control means to control the temperature of gas circulating through the respective treatment chambers.

3. The apparatus of claim 2 wherein the treatment positions include (1) a pre-treatment position, (2) a first reaction position, (3) a second reaction position and (4) a degassing and deodorizing position.

4. The apparatus of claim 3 wherein the gas circulating means of the first reaction position includes vaporizing means to introduce chemicals reactive with the articles into the gas stream passing into the treatment chamber and control means to vary the content of reactive gas vapor contained in the gas stream.

5. The apparatus of claim 2 including index means mounted on the supporting frame engaging the rotatatable carousel unit at each treatment position to stop the carousel unit at the correct position for connection of the gas circulating means through the valve means to the inlet and outlet ports.

6. The apparatus of claim 1 wherein each valve means includes (1) a sealing diaphragm over the duct of each gas circulating means adjacent the inlet and outlet ports of each treating chamber movable between a first position in sealing contact with the inlet and outlet ports of the treating chamber for introducing and discharging gas into and out of the treating chamber and a second retracted position out of contact with the inlet and outlet ports and in sealing contact over the duct to allow rotation of the carousel unit to a succeeding treatment position and prevent escape of gas from the duct into the surrounding atmosphere.

7. The apparatus of claim 6 including means connected to the diaphragm of each of the valve means to move them between said first and second positions.

8. The apparatus of claim 1 wherein the inlet and outlet ports of each treating chamber are covered with layered plates movable relative to one another and having staggered openings therein for passage of gas there-

through when separated and prevention of passage of gas therethrough when together, and means separating one of the plates from the other to allow passage of the gas therethrough when the valve means is advanced into sealing contact with the respective port of the treating chamber.

9. The apparatus of claim **2** wherein the temperature control means includes a heat exchange unit having coils positioned in the duct of the gas circulating means, means supplying heat to the coils, a temperature sensor sensing the temperature of the circulating gas in the treatment chamber and control means modulating the amount of heat supplied to the coils in response to the sensed temperature to control the temperature of the treating chamber.

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