Feb. 25, 1941. E. C. ATWELL 2,233,069

MEANS FOR IMPREGNATING AND COATING ARTICLES

Filed Nov. 20, 1937 7 Sheets-Sheet 1

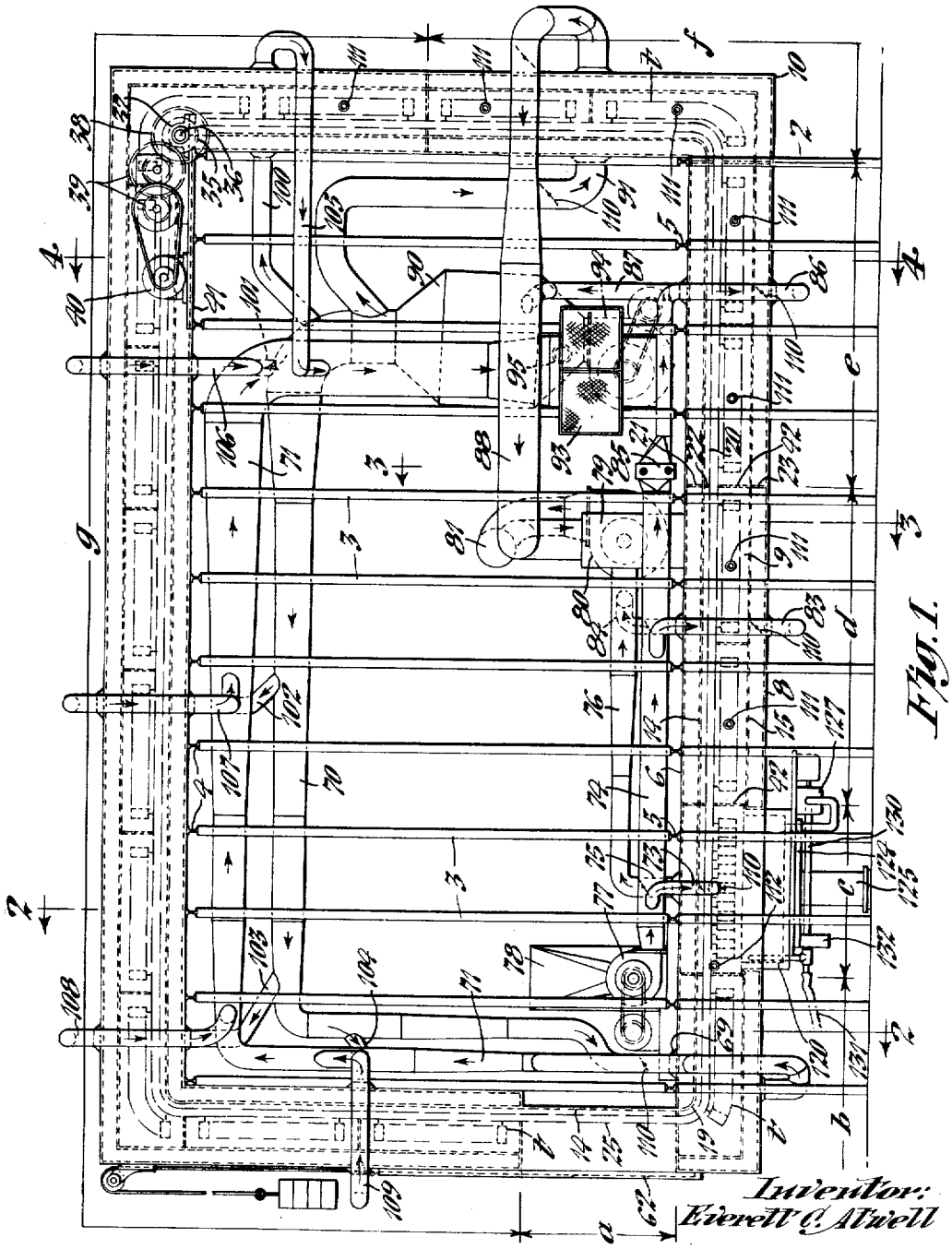


Fig. 1.

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MEANS FOR IMPREGNATING AND COATING ARTICLES

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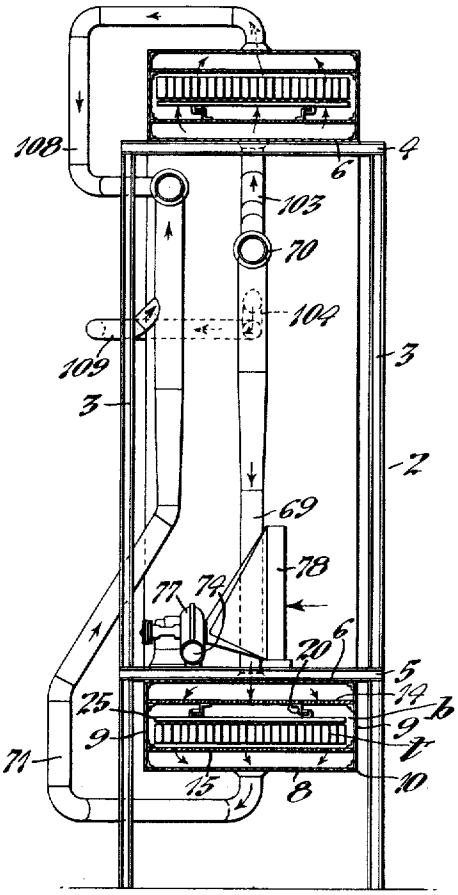


Fig. 2.

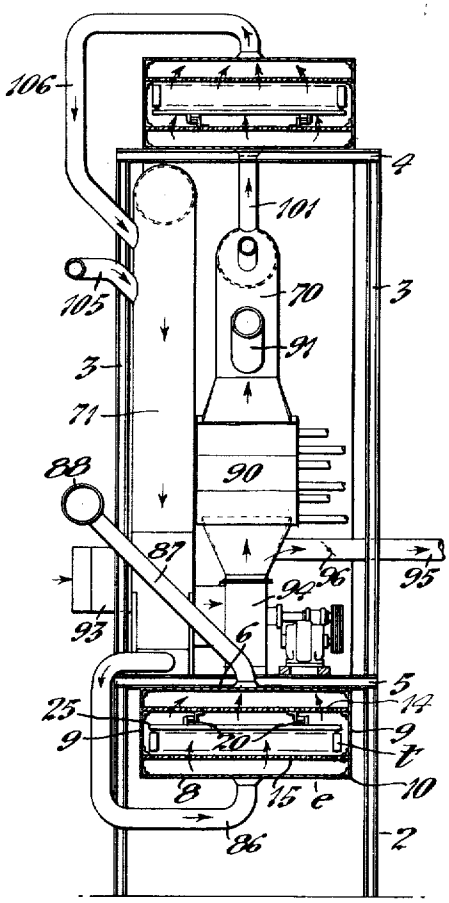


Fig. 4.

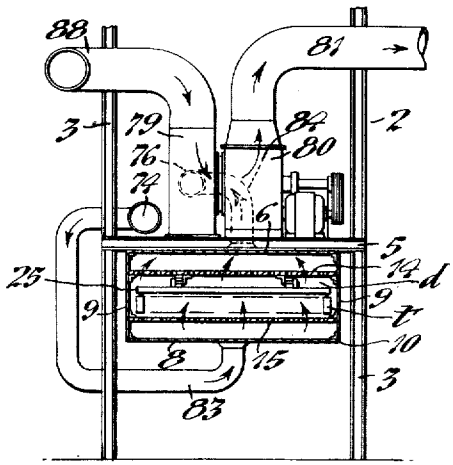


Fig. 3.

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MEANS FOR IMPREGNATING AND COATING ARTICLES

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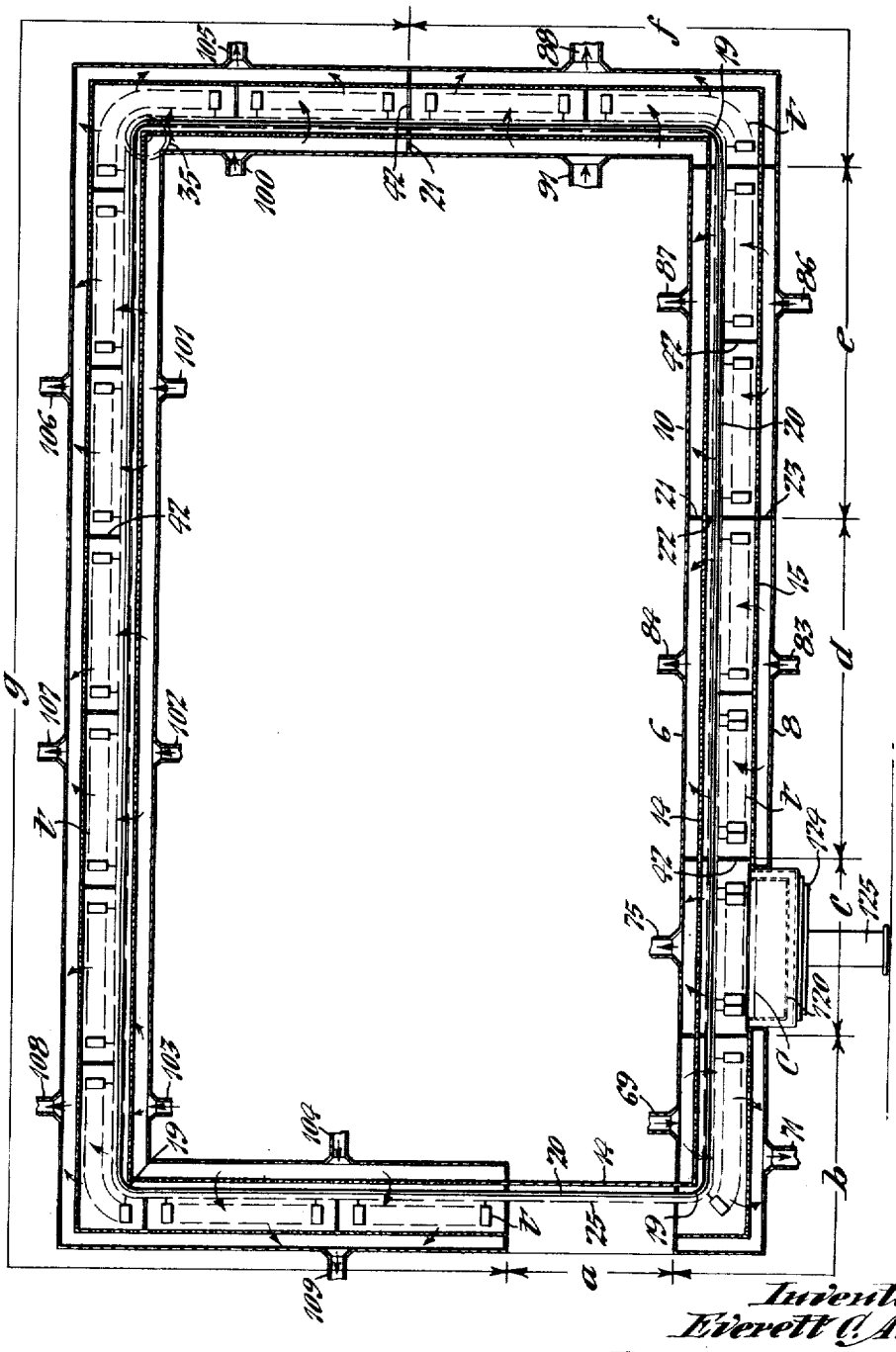


Fig. 5.

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MEANS FOR IMPREGNATING AND COATING ARTICLES

Filed Nov. 20, 1937 7 Sheets-Sheet 4

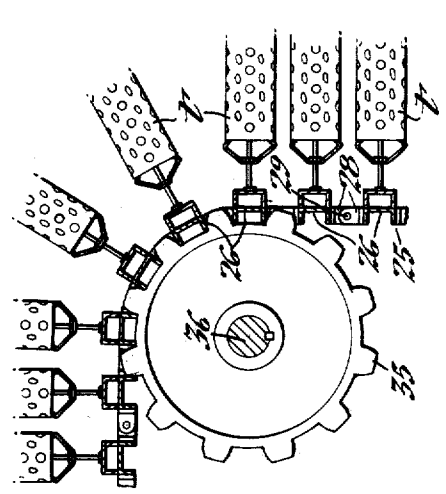


Fig. 13.

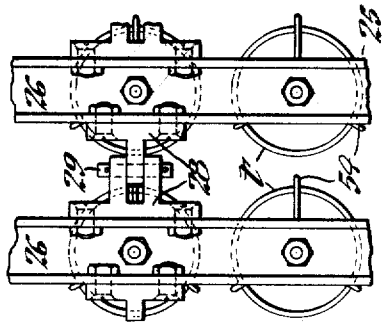


Fig. 12.

Fig. 6.

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MEANS FOR IMPREGNATING AND COATING ARTICLES

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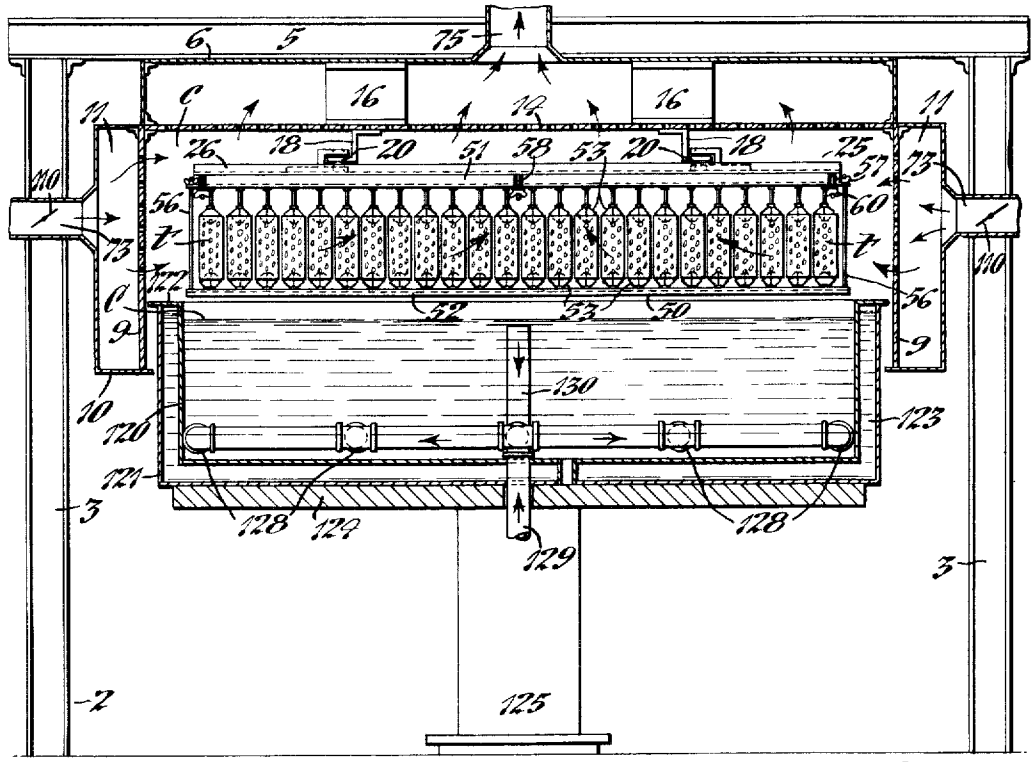


Fig. 7.

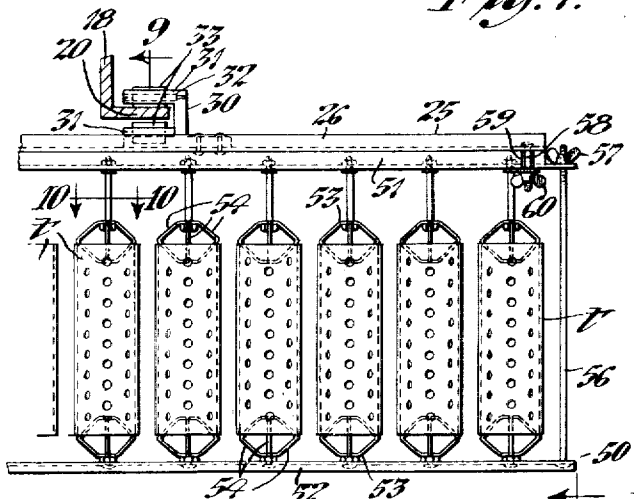


Fig. 8.

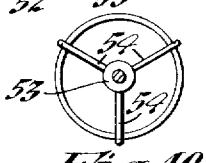


Fig. 10.

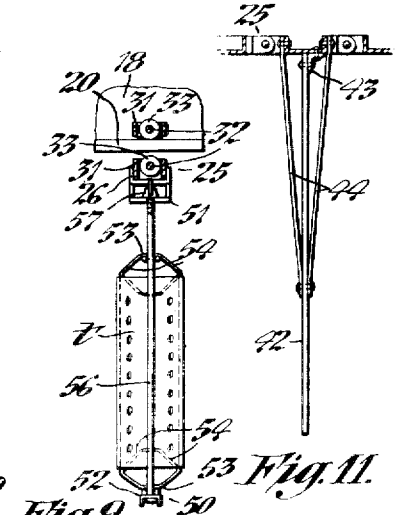


Fig. 9.

Fig. 11.

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MEANS FOR IMPREGNATING AND COATING ARTICLES

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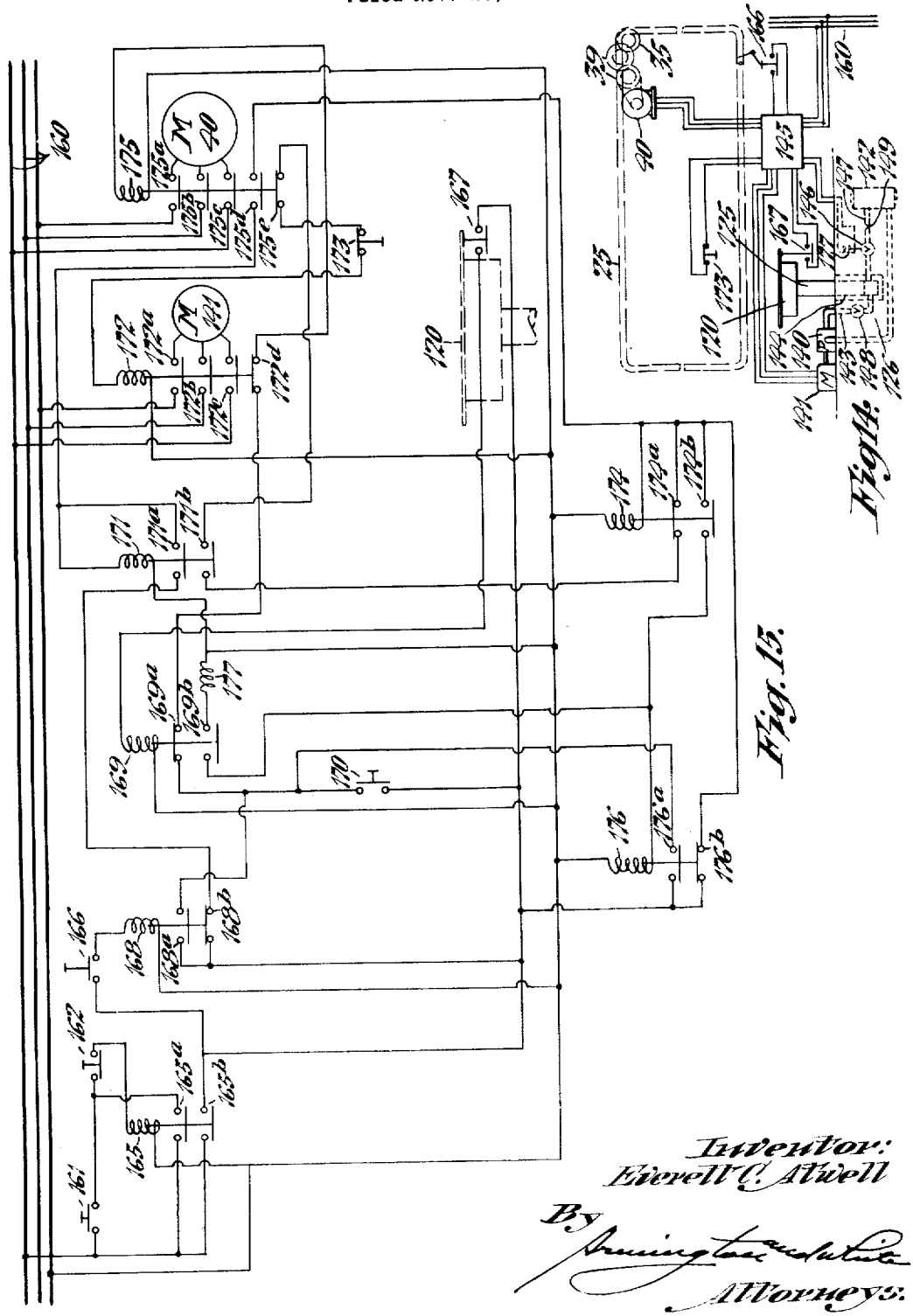


Fig. 15.

Fig. 16.

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MEANS FOR IMPREGNATING AND COATING ARTICLES

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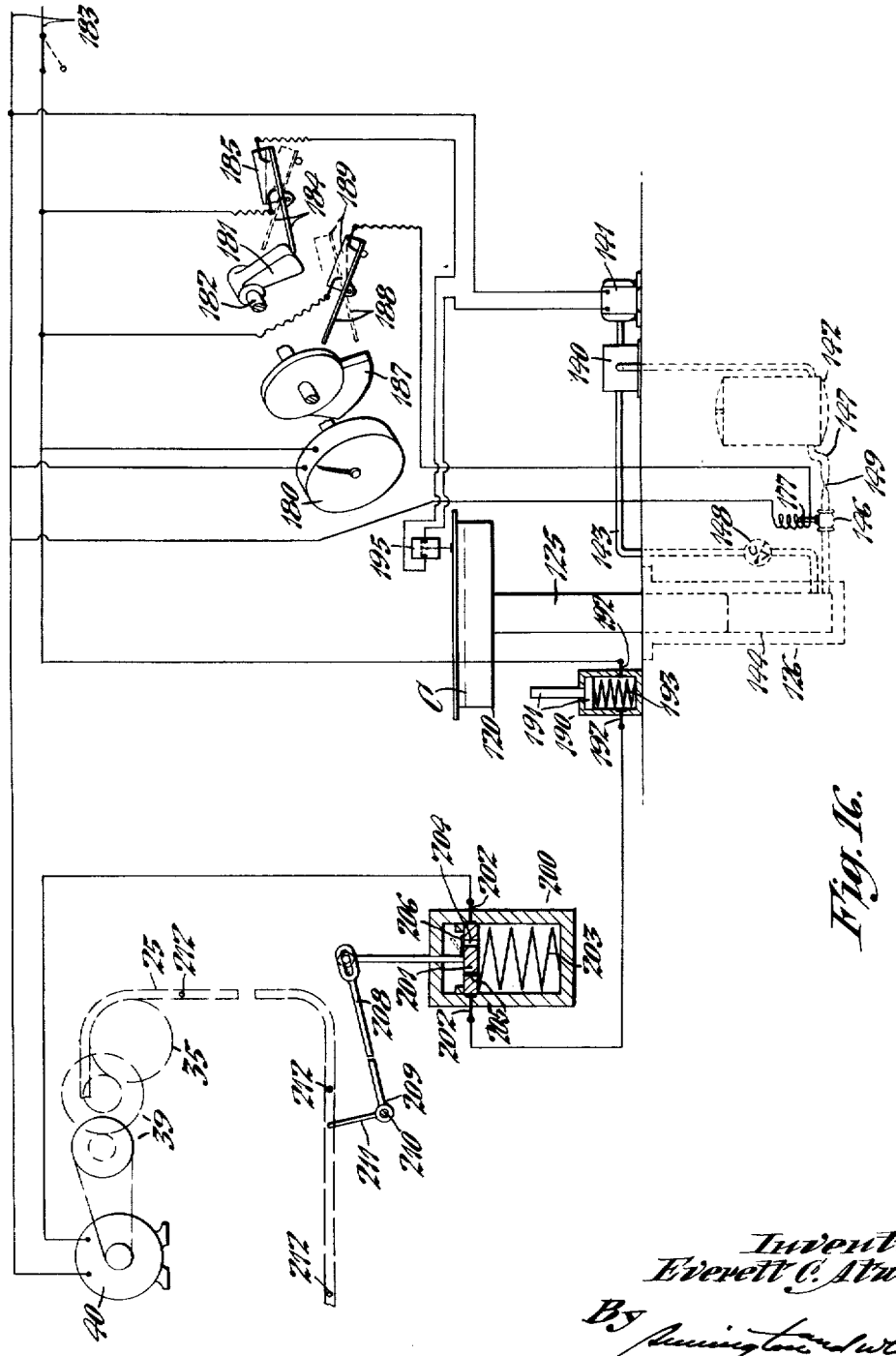


Fig. 16.

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UNITED STATES PATENT OFFICE

2,233,069

MEANS FOR IMPREGNATING AND COATING ARTICLES

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Application November 20, 1937, Serial No. 175,687

32 Claims. (Cl. 91—55)

This invention relates to an apparatus for impregnating and coating fibrous articles, particularly perforated paper tubes used as supports for textile filaments, yarn and the like during various wet and dry processes.

In the following specification and claims the word "tube" is used in a generic sense to indicate any form of yarn-receiver or -carrier constructed from fibrous material or the like and the term "coating solution" is used broadly to designate any composition suitable for impregnating or coating the tubes to substantially fill and seal all voids and render them smooth of surface and impervious to fluids.

One object of the invention is to provide an apparatus for impregnating and coating the tubes with a resinous or equivalent compound, removing the volatile solvents from the coating and finally baking the residual resin solids to a desired degree of hardness, insolubility and infusibility.

Another object of the invention is to provide means for continuously impregnating fibrous tubes consisting in preheating the tubes to expel air and moisture from the interstices or voids therein and replacing the air with the compound, while at the same time lightly coating the external faces of the tubes with a minimum amount of resin to secure a smooth continuous surface thereon.

Another object of the invention is to provide means for removing the solvent contained in the solution on the impregnated and coated tubes in a manner which avoids the formation of pinholes and blisters and which consists in circulating air at gradually rising temperature around the tubes, and thereafter causing the remaining resin solids of the applied solution to be converted into an insoluble and infusible state by the circulation of air at high temperature.

Another object of the invention is to provide an apparatus for continuously carrying out the above in which all of the several operations are effected automatically.

Another object of the invention is to provide an apparatus of the type indicated adapted to operate efficiently on a large number of tubes treated simultaneously and one which is simple and compact in structure, requiring a minimum floor area.

Further objects of the invention are set forth in the following specification which describes, by way of example, the steps of a preferred method and an apparatus adapted therefor as illustrated by the accompanying drawings. In the drawings:

Fig. 1 is a side elevational view of the improved tube-impregnating and -coating apparatus;

Fig. 2 is a transverse sectional view of the apparatus taken on line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view of the apparatus taken on line 3—3 of Fig. 1;

Fig. 4 is a transverse sectional view of the apparatus taken on line 4—4 of Fig. 1;

Fig. 5 is a longitudinal sectional view of the chambered housing of the apparatus showing, more or less diagrammatically, the manner in which the tubes are conveyed through the different compartments thereof during the various steps in their treatment;

Fig. 6 is an enlarged longitudinal sectional view illustrating a portion of the interior of the apparatus and showing the loading, preheating, and impregnating-and-coating compartments;

Fig. 7 is an enlarged transverse sectional view of the impregnating-and-coating compartment taken on line 7—7 of Fig. 6;

Fig. 8 is a side elevation of a portion of a tube-carrying or supporting frame;

Fig. 9 is an end view of the same part-sectional on line 9—9 of Fig. 8;

Fig. 10 is a detailed plan view of one of the holders of the carrying frame taken on line 10—10 of Fig. 8;

Fig. 11 is an edge view of one of the baffle-plates carried by and movable with the tube-conveying means;

Fig. 12 is a fragmentary plan view of a portion of the tube-conveyor;

Fig. 13 is a side view of one of the driving sprockets for the conveyor;

Fig. 14 is a diagrammatic view showing the main operating parts of the apparatus and illustrating the controlling means therefor;

Fig. 15 is a diagrammatic view showing the electrical circuit for the controlling unit in detail; and

Fig. 16 is a diagrammatic view showing an alternative electrical circuit for controlling the action of the main operating parts of the apparatus.

In dyeing and otherwise treating yarn masses with fluids the yarn is sometimes wound onto perforated paper or fiber tubes and processed in package form. For the sake of economy it is desirable to reuse these tubes. It is therefore important that the tubes be impervious to fluids and free from projecting fibers or other protuberances liable to catch and injure the yarn as it shifts on the tube in wetting out, or as it is un-

wound therefrom after treatment and drying. To adapt the tubes for reuse, it is necessary that the voids or interstices therein be substantially filled and sealed and that the filling or sealing material be strong, yet sufficiently flexible to withstand deformation without cracking. In this manner the formation of cracks which would permit penetration of dye-liquid or other fluids into the fibers of the tubes is prevented. Tubes provided with a continuous coating but without impregnation invariably crack when deformed slightly, thereby permitting the fluids to enter the voids and render them unfit for continued reuse.

In practically all previously used methods of coating and impregnating articles a large floor space is required for the several units including a loading position, a preheating chamber, a dip tank, a drain board, a solvent-removing chamber and a baking oven. In addition to the high cost of floor space is the added expense of separate large units and the large number of operators required to handle the apparatus.

It is the aim of the present invention to provide an efficient apparatus constituted as a single machine for continuously and automatically carrying out the separate steps of the improved process herein described. The first step in the improved method is that of preheating the tubes to expel the normal regain of moisture and part of the air pocketed in the interstices between the fibers of the material of the tubes to create a partial vacuum therein. The relatively hot tubes are thereafter immersed in a resinous solution at a temperature lower than that of the tubes to cause the solution to be rapidly drawn into the interstices or voids between the fibers to completely impregnate the material of the tubes and coat the surface thereof. The surplus solution is then permitted to drain from the tubes under control by gradually removing the supply of solution from contact with the tubes. The impregnated and coated tubes are finally subjected to a series of drying operations by circulation of heated air to evaporate the solvent at a slow rate to prevent blistering and to cause the deposited resin to adhere firmly to the surfaces of the tubes. The temperature of the circulating air is gradually raised during the solvent removal process until it finally reaches a degree capable of baking the resin solids. The tubes are baked for a period to render the deposited resin insoluble and infusible. This cycle of operations may be repeated automatically to apply the necessary number of impregnations and coatings to the tubes, after which they are ready for immediate use. Through the use of the improved method and apparatus, to be next described in detail, the tubes are impregnated and coated thoroughly and evenly and their coating prevented from cracking.

Referring to Figs. 1 to 4 of the drawings, the apparatus proper is supported by a framework 2 comprising pairs of opposite stanchions or columns 3 which rest upon the floor and are connected by upper and lower cross-struts 4 and 5. The pairs of uprights 3 are joined together by a track 20, to be later described, and a plate 6 which is fastened to the top of the cross-struts 4 and extends downwardly along the outer pairs of uprights 3 to which it is secured. The plate 6 is also fastened to the bottom of the cross-struts 5 to provide a rigid rectangular structure. Extending in spaced, parallel relation to the plate 6 is a second, outer plate 8 joined to the plate 6 by side plates 9 to form a housing 10 of rectangular cross-section, see Fig. 2. Through the described construction a continuous rectangular duct is provided through which the paper tubes are progressively advanced in a closed circuit, see Figs. 5 and 6, in the manner and for the purpose as later explained.

Spaced a short distance from the inner and outer plates 6 and 8 of the housing or duct 10, in parallel relation thereto, are perforated plates 14 and 15 suitably attached to the side plates 9. The cross-struts 4 and 5 carry I-beam sections 16 to which are secured a pair of spaced angle-irons 18, see Figs. 5, 6 and 7, the outer laterally-extending flanges 20 of which cooperate to form a closed rectangular track extending throughout the full length of the duct or housing. The vertical and horizontal extensions of the rectangle are joined by arcuate sections indicated at 19. The track 20 aids in adding strength and rigidity to the frame 2. Suitably fastened to the various plates forming the housing or duct 10 are fixed partition baffle-plates 21, 22 and 23 which are spaced along the interior of the duct in the order illustrated in Fig. 5 to adapt them to cooperate with baffles on the conveyor 25 to form a series of compartments into which groups of the tubes are progressively conveyed to receive various treatments.

The tubes are advanced into and through the various compartments by means of an endless conveyor 25 adapted to travel along the track 20. As shown in Figs. 7, 8, 12 and 13, the conveyor 25 is in the form of an endless chain comprising a series of channel-iron bars or battens 26 extending laterally within the housing or duct 10 and hingedly connected by links 28 pivotally joined by pins 29, see Fig. 12. As shown in Figs. 8 and 9, the channel-iron bars 26 carry bifurcated brackets 30 in the opposite forked arms 31 of which are bearing pins 32. Journaled on the pins 32 are rollers 33 straddling the track 20 to adapt them to roll therealong as the conveyor 25 travels in the housing or duct 10. The rollers 33 are constructed from bronze or other static-eliminating material to prevent frictional sparks and thereby avoid a fire hazard. The conveyor 25 may be driven by pairs of sprockets 35, one of which is shown in Fig. 13, the sprockets being keyed to a transverse shaft 36 and adapted to receive the channels 26 in the spaces between their teeth. The shaft 36 is journaled in bearings 37 secured to a platform 41 projecting laterally from the upper cross-struts 4 of the framework 2, see Fig. 1. The shaft 36 carries a spur-gear 38 which is driven from a train of speed-reduction gears indicated at 39 in Fig. 1, the gear-train being driven in any suitable manner from an electric motor 40 or other source of power. Although the conveyor 25 is herein shown as arranged to be driven at one location in its path of travel it may be driven at a plurality of points. The travel of the conveyor 25 within the duct 10 is intermittent to successively present the batches of tubes to the spaced stations or compartments where they halt for a predetermined interval, and for this purpose the motor 40 is periodically energized by means of a time-control unit to be later described.

The conveyor 25 carries baffle-plates 42 which register with the baffles 21, 22 and 23 of the duct 10 when the conveyor is at rest to completely enclose the spaces between the perforated plates 14 and 15 of each pair to form four-walled closed compartments. As shown in Fig. 11 the plates 42

are riveted to angle-irons 43 carried by the bars 26 of the conveyor 25 and braced by angular strips 44.

The tubes to be coated are carried by the conveyor 25 arranged in multiple rows between the baffle-plates 42, being supported on frames 50 suspended from the conveyor-bars 26. The frames 50, shown in detail in Figs. 8 and 9 comprise upper and lower horizontal channel-irons or bars 51 and 52 mounting a series of tube-holders 53. The tube-holders 53 may take various forms and, as herein shown, each holder comprises three equally spaced V-shaped wire arms 54, having their ends suitably connected together and fastened to the channels 51 and 52, see Fig. 10. The tapered sides of the wires 54 are adapted to enter the interior of the tubes *t* to contact the inner rim at their ends at three points only. In this manner the outer yarn-engaging surfaces are fully exposed to the coating material and left free from irregularities of marks made by contact with the holder. The points of contact of the holder on the inner rims at the ends of the tubes are small in area so that the holders are readily freed from the tubes after dipping and baking.

To load the tubes *t* onto a frame 50 the channel-bar 52 is placed on a support with its holders 53 projecting upwardly as indicated in Figs. 8 and 9. Tubes *t* are then applied to the holders 53 and the bar 51 placed thereover with its holders 53 engaging the upper rims of the tubes. At the ends of the bar 52 are rods 56 having their upper ends threaded and adapted to project through slots at the ends of the upper bar 51. Wing-nuts 57 are screwed onto the threaded ends of the rods 56 to tie the bars 51 and 52 of the frame 50 together and retain the tubes *t* securely in place on their holders. Each complete frame 50 carrying a series of tubes *t* is attached to one of the conveyor-bars 26, at a station to be later designated, by means of studs 58 on the bar 26 passing through slots 59 in the upper bar 51 with wing-nuts 60 screwed onto the studs, see Figs. 7 and 8.

It has been explained that the rectangular conduit or duct 10 is divided into a plurality of compartments by the baffle-plates before described. In the present embodiment of the invention seven compartments are provided as indicated in the drawings by the reference characters *a*, *b*, *c*, *d*, *e*, *f* and *g*. The compartment *a* constitutes the loading and unloading station at which point the loaded frames 50 are attached to and removed from the conveyor 25. For this purpose the front wall 8 and the perforated plate 15 are omitted from this compartment to permit entrance of the tube-carrying frames 50. The opening in compartment *a* may be closed when desired by means of a sliding door indicated generally at 62 in Fig. 1. At compartment *a* the perforations in the upright plate 14 are omitted, see Fig. 6, to seal the interior from the atmosphere when the door 62 is closed as illustrated in Fig. 1.

Compartment *b* constitutes the preheating chamber in which the tubes *t* are first heated to a relatively high temperature to drive off the normal moisture content or regain and a portion of the air which is pocketed in the interstices between the fibers of the material of the tubes. Heated air is introduced into the top of the compartment *b* through a pipe or duct 69 forming a continuation of a larger pipe or header 70 which is connected to an air-heater and fan to be later described. Upon entering the chamber *b* the hot air is drawn downwardly through the perforations in the plate 14, circulated around the tubes *t* suspended therein, and thence drawn downwardly through the perforations in the plate 15, from which point it exhausts through a return pipe 71.

After preheating, the tubes *t* are transported to compartment *c* where they are impregnated and coated in the manner as later explained. During the impregnating and coating operation, air at room temperature is circulated through the chamber *c* to carry away the explosive admixture of solvent vapor and air. The air enters manifolds 11 formed by the extended sides of the compartment *c* through pipes 73 connected to a fresh air duct or header 74 and thence passes through perforations in the side walls 9 provided at this station, see Fig. 7. The air circulates around the tubes *t*, passes upwardly through the perforations in the plate 14 and exhausts through a pipe or duct 75 which is connected to an exhaust header 76. Fresh air is supplied to the intake header 74 by means of a motor-driven fan 77, see Figs. 1 and 2, which draws from the room atmosphere through a filter 78. The saturated air upon entering the exhaust-header 76 is drawn into a housing 79 by a motor-driven fan 80 and forced into an exhaust pipe 81 leading to a stack communicating with atmosphere above the building, in which the apparatus is located, see Fig. 3.

After being impregnated and coated the tubes *t* are conveyed to compartment *d* where air at room temperature is circulated around the tubes to evaporate part of the solvent thereon and cause the resin to congeal. The compartment *d* is twice the size of each compartment *a*, *b* and *c* and adapted to enclose two lots or batches of tubes. Fresh air is forced into the compartment *d* by way of a pipe 83 connected to the air-supply duct or intake-header 74 and passing upwardly through the perforated plate 15, circulates around the tubes *t* and is thence drawn upwardly through the plate 14 and into a pipe 84 connected to the exhaust-header 76.

The tubes *t* are next conveyed to compartment *e* which is similar to compartment *d* in that it is adapted to contain two lots of tubes. Air heated to a temperature of approximately 150° F. is circulated around the tubes while they remain in compartment *d* to cause more solvent to pass off from the tubes and leave a deposit of resin thereon, the applied heat tending to further aid in hardening the coating. Fresh air in the header 74 passes through a heater 85 comprising steam-coils and is forced into a pipe 86 leading to compartment *e*. The heated air is then drawn upwardly through the perforated plates 15 and 14, circulating around the tubes *t* and passing through a pipe 87 connected to a larger pipe or duct 88 leading to the housing 79, fan 80 and exhaust-pipe 81.

After being treated in compartment *e* the tubes *t* are conveyed to a double compartment *f*. Air heated to a temperature of approximately 300° F. by steam-coils in a heater 90 is forced into the header 70, previously mentioned, and through a pipe 91 connected thereto and communicating with the compartment *f*. The hot air upon entering the compartment *f* is forced through the perforated plate 14, circulated around the tubes *t* and then drawn outwardly through the plate 15 into the exhaust-pipe or duct 88. Fresh air is drawn through a filter 93 and into the heater 90 by means of a motor-driven fan 94, see Figs. 1 and 4. An exhaust-pipe 95 connected to the lower

end of the heater 90 is provided with a damper 96 which by changing its position regulates the amount of fresh air introduced into the system in accordance with requirements. The remaining solvent of the deposited resinous solution is completely evaporated in compartment *f* and the solvent-free resinous coating remains as a sticky and viscous mass.

A relatively long compartment *g* extends from compartment *f* upwardly, thence horizontally and then downwardly to connect with the loading compartment *a*, this compartment being capable of containing for example, ten lots or groups of tubes *t*. In compartment *g* the deposited resin is baked onto the tubes *t* to the required degree of hardness, insolubility and infusibility. Since all the solvent is removed from the tubes before they enter compartment *g*, the hot air introduced into this compartment may be partially recirculated without danger of its becoming saturated with combustible solvent to present a fire hazard. The air heated to a temperature of approximately 300° F. in the heater 90 is forced upwardly into the header 70 by means of the blower or fan 94 and enters the compartment *g* at spaced intervals therealong by way of branches or intake-pipes 100, 101, 102, 103 and 104 communicating with the header and compartment. The hot air passes through the compartment *g* in the same manner as previously explained and exhausts into return pipes or branches 105, 106, 107, 108 and 109 connecting the compartment with the exhaust header 71 which returns it to the heater 90 to be recirculated.

The heated air which is recirculated through the compartment *g* contains vapors of resin-reaction products but no solvent, and to effect maximum efficiency this air, instead of being exhausted directly into the atmosphere, is passed through the compartment *f* to evaporate solvent from the tubes stationed therein and through the compartment *b* to preheat the tubes.

The inlet pipes 69, 73, 83, 86 and 91 leading to the compartments *b*, *c*, *d*, *e* and *f*, respectively, are provided with manually-operable dampers 110, see Fig. 1, by means of which the flow of air through the various compartments may be regulated to obtain the desired distribution of air volumes. The compartments may also be provided with automatic temperature-control units, not herein shown, for maintaining the proper degree of heat by regulating the amount of steam introduced into the air-heaters 85 and 90. As a safety measure, steam pipes 111, indicated in Fig. 1, having thermostatic valves may be connected to the interior of each compartment to introduce steam thereinto should the temperature rise sufficiently to cause fire from combustion of the solvent. The temperature control units may be connected to operate a bell, light or other signal to indicate to the attendant which of the compartments is overheated. In the impregnating and coating compartment *c* is a pipe 112, see Fig. 1, which may be connected to a supply of carbon dioxide or other fire-extinguishing gas and provided with a fusible link adapted to rupture and release CO_2 gas when the temperature rises to a predetermined degree. These latter connections are not herein shown in detail, however, as they form no part of the present invention.

It has been stated that the invention contemplates an improved method and means for impregnating and coating the tubes. Figs. 6 and 7 illustrate the improved tube-immersing means as comprising a rectangular tank 120 for containing a supply of coating compound arranged to move upward into position to dip the tubes therein. The tank 120 seats in a larger enclosing tank 121 with its flanged rim 122 resting upon the upper edges of the latter. Through this arrangement a space 123 is provided between the two tanks 120 and 121 for containing cold water which is employed for cooling the coating solution. The tanks 120 and 121 are supported by a table or platen 124 at the upper end of a piston 125 operated by a hydraulic lift of usual construction indicated at 126 in Fig. 14 as built into the floor on which the apparatus is erected. The raising and lowering of the piston 125 is controlled by a suitable time-controlled switch to be later described. The coating compound, indicated at C, is forced into the tank 120 through perforations in branches 128 of a pipe 129 connected to a motor-driven pump 127 supported on an extension of the platen 124, see Figs. 1 and 6. The coating compound C is recirculated to the pump 127 by way of a vertical standpipe 130 and as the liquid is depleted during the operation of the apparatus it is replenished from a suitable storage tank connected to the pipe 130 by means of a flexible pipe 131, see Fig. 1. The liquid compound C flowing to the pump 127 is preferably strained through a suitable filter 132. By constantly recirculating the compound C the viscosity and temperature of the supply in the tank 120 is maintained substantially uniform from top to bottom. The cold water used for cooling the coating compound C in the tank 120 is circulated through the tank 121 under pressure and is connected to inlet and outlet pipes 135 and 136 communicating with the interior of the tank.

Fig. 14 illustrates diagrammatically the means for operating the tank 120 and intermittently driving the conveyor 25. The means for operating the tank 120 consists of a pump 140 driven from an electric motor 141. The pump 140 draws liquid from a tank or reservoir 142 and forces it through a pipe 143 into the cylinder 144 of the hydraulic lift 126 to raise the piston 125 and elevate the tank 120 into position to cause immersion of the tubes *t* in the solution C contained in the tank. Intermittent operation of the pump-motor 141 is effected by a controlling unit indicated at 145. The controlling unit, which will be later described more in detail comprises, in general, a series of coils which are intermittently energized during the operation of the apparatus to close and open the circuits for the conveyor-driving motor 40, tank-elevating motor 141 and other instrumentalities.

Incorporated in the controlling unit 145 is a timing device which, through means to be later described, operates a valve 146 in the pipe 147 connected between the cylinder 144 and the reservoir 142. When the valve 146 is opened the liquid flows from the cylinder 144 through the pipe 147 at a reduced rate as controlled by a restricted opening 149 in the pipe whereby to cause the tank 120 to descend slowly and the surplus solution on the tubes *t* to drain directly into the supply C in the tank. During the lowering of the tank 120 a check-valve 148 in the inlet-pipe 143 closes. The raising of the tank 120 is also controlled from the timing device which acts, when the conveyor 25 is at rest to energize the pump-motor 141 to elevate the tank. Operation of the timing device is intermittently effected by two electrical switches or

circuit-breakers 173 and 167 positioned in the path of movement of the tank 120 and adapted to be opened and closed thereby as the tank ascends and descends. Through the provision of the switches 173 and 167 operation of the conveyor-driving motor 40 can be effected only when the tank 120 is in lowermost position.

In operation, the conveyor 25 is caused to travel within the conduit 10 by energizing the motor 40 and after the conveyor has positioned the tubes *t* within the various compartments its movement is automatically interrupted by a switch 166 operated by movement of the conveyor, the switch acting to open the circuit to the motor. The tank is then elevated by the motor-driven pump 140 and the tubes immersed in the solution C contained in the tank, the extent of upward movement being controlled by the limit-switch 173. The timing device acts to maintain the tank 120 elevated for a predetermined period after which the solenoid-operated valve 146 is opened to permit the tank to descend. When the tank 120 reaches its lowermost position the switch 167 acts to close the circuit to the conveyor-driving motor 40 and the timing switch restarts the cycle of operations above explained at any predetermined time period after the opening of the solenoid-valve 146.

In the electrical diagram illustrated in Fig. 15 are magnetic coils 165, 168, 169, 171, 172, 175 and 177 whose function is to operate suitable circuit-breakers for opening and closing contacts 165^a—165^b, 168^a—168^b, 169^a—169^b, 171^a—171^b, 172^a—172^b—172^c—172^d, 175^a—175^b—175^c—175^d—175^e and the valve 146 respectively. Timing relay coils 174 and 176 are also provided for opening and closing contacts 174^a—174^b and 176^a—176^b respectively.

Assuming that the apparatus is at rest, the various coils above described will be deenergized and the circuit-breakers which are operated by the respective coils will assume the positions shown in Fig. 15 to open and close the various contacts and the circuits in which the contacts are positioned. The tank 120 will be in lowermost position to open the switch 167, the conveyor will be at rest, the conveyor-switch 166 open and both electric motors 40 and 141 will be idle.

To start the cycle of operation of the apparatus the switches 161, 162 and 170 are closed. Electric current will then flow from the power-line 160 through 161 and 162 and coil 165 to energize the latter and cause bridging of the contacts 165^a and 165^b. Closing of contact 165^a maintains the coil 165 energized even though the switch 161 is again opened. When contact 165^b is closed electric current passes therethrough to the various circuits. It will be noted by reference to the diagram that contacts 169^a and 172^d are closed, so that current will pass to and energize the coil 175 thereby closing contacts 175^a, 175^b and 175^c to energize and cause the conveyor-driving motor 40 to travel the conveyor 25 within the conduit 10 to position the groups of tubes *t* within the several compartments for treatment. As the conveyor 25 starts its travel the limit-switch 166 is closed to energize coil 168 and thereby close contact 168^a whereby to permit flow of current to the coil 175 even though switch 170 is opened.

As soon as the tubes *t* are properly positioned within the compartments limit-switch 166 is opened by the conveyor 25 to deenergize coil 168 and open contact 168^a thereby deenergizing coil 175 to permit contacts 175^a, 175^b and 175^c to open and arrest the operation of the motor 40 and the travel of the conveyor 25. During the operation of the motor 40 and the travel of the conveyor 25 electric current passes through contact 176^b and 175^d to energize the coil 171 and close contacts 171^a and 171^b. When the coil 175 is deenergized current may still flow to the coil 171 by way of closed contacts 168^b and 171^a. The circuit through contacts 176^b, 174^a, 171^b, 175^e and closed switch 173 to the coil 172 is closed to energize coil 172. As coil 172 is energized it acts to close contacts 172^a, 172^b and 172^c to connect the tank-elevating motor 141 with the power-line 160. In this manner the motor 141 drives the pump 140 to force liquid into the cylinder 144 and raise the tank into operative position. The tubes *t* are thus immersed in the solution C and the switch 173 is opened by engagement with the tank 120 to disrupt the flow of current to the coil 172. Contacts 172^a, 172^b and 172^c will then open to stop the motor 141. As before explained the conveyor driving motor 40 has already stopped so that for the moment the complete apparatus is at rest and the tubes *t* remain immersed in the solution C. At the start of the upward movement of the tank 120 the limit-switch 167 is closed and current flows to and energizes coil 169 to open contact 169^a and close contact 169^b.

When the operation of the apparatus was initially started by pressing the start button 161 current flowed through contact 176^b to energize the timing-relay coil 174. However, until the proper time the adjustable relay 174 does not operate on the contacts 174^a and 174^b and the tank 120 remains in uppermost position to coat the tubes. After the tank 120 has remained elevated for a predetermined period of time the timing-relay 174 acts to open contact 174^a and close 174^b to complete the circuit to the solenoid coil 177 by way of closed contact 169^b. As before explained coil 177 when energized, opens valve 146 to permit the tank 120 to descend slowly. When the tank 120 reaches its lowermost position the limit-switch 167 is again opened to deenergize coil 169 and cause contact 169^a to close and 169^b to open. When 169^b opens the tank-lowering control-coil 177 is deenergized.

When contact 174^b was closed by the action of the timing-relay 174, the circuit for the second timing-relay 176 was closed. The relay 176 is so adjusted that after the tank 120 has remained in its lowermost position for a predetermined period the relay closes contact 176^a and opens 176^b. Closing of contact 176^a completes the circuit to the coil 175 by way of contacts 169^a and 172^d. As coil 175 is reenergized contacts 175^a, 175^b and 175^c are closed thereby and the mottor 40 again acts to drive the conveyor 25 to advance the groups of tubes within the conduit 10. As the conveyor 25 starts its movement limit-switch 166 is again closed to energize coil 168, thereby closing contact 168^a to complete the circuit to coil 175 to maintain the motor 40 operative.

Due to the fact that contacts 176^b and 168^b are opened by the relay-coil 176 and coil 168, respectively, coil 171 is deenergized to open contact 171^b. It is then impossible for current to pass to the energizing coil 172 for the tank-motor 141. Contact 171^a in opening prevents flow of current to the timing-relay 174 by way of contact 175^d. Flow of current to the relay-coil 174 is further disrupted by the opening of contact 176^b as effected by the timing-relay 176. Due to the fact that the circuit for the relay 176 is opened the latter is rendered inoperative.

As the conveyor 25 travels within the conduit 10 the electrically-operated controlling means

acts periodically to arrest its motion, whereafter it functions to elevate the tank 120, time the period the tank remains elevated, lower the tank, time the period the tank remains in lowermost position, and finally restart the conveyor in the manner and for the purpose as before explained.

Fig. 16 shows an alternative means for controlling the operation of the apparatus. With this latter form of controlling means intermittent operation of the pump-motor 141 is effected by a cam 181 fast on a shaft 182 which is slowly and continuously rotated during operation of the apparatus by a synchronous clock or timing-device 180 in circuit with an electrical power-line 183. The cam 181 is adapted to contact with a rockable lever 184 carrying a mercury-type switch 185 to cause the latter to tilt and close the circuit from the power-line 183 through a normally closed switch 195 whereby to energize the motor 141. As the tank 120 is raised to immerse the tubes in the solution it operates the switch 195 to open the circuit to the motor 141. After a predetermined period the piston 125 is slowly lowered by gravity through the relief means described in connection with the embodiment illustrated in Figs. 14 and 15.

The tank 120 is held in raised position for a definite interval to cause the solution to thoroughly penetrate into the material of the tubes *t*. A second cam 187 on the rotating shaft 182 is adapted to tilt a lever 188 carrying a mercury-type switch 189 to close a branch circuit from the power-line 183 to the solenoid 177. The solenoid 177 operates to open the relief valve 146 in the return-pipe 147 to permit the liquid in the cylinder to return to the reservoir 142 through the restricted passage 149. The valve 146, which is normally closed, serves to prevent the return of liquid from the cylinder 144 to the reservoir 142 during the operation of the pump 140.

The shaft 182 is rotated once during a predetermined period of time, for example, fifteen minutes, and the cam 181 is so designed that it holds the switch-lever 184 depressed for approximately one minute during each fifteen-minute period to raise the tank 120 into operative position. During the one-minute interval and for ten minutes thereafter the switch 189 remains open and flow of current to the solenoid 177 is consequently disrupted. The flow of liquid through the pipe 147 is prevented during this time by the solenoid-valve 146 which is held closed by suitable mechanism within its housing.

After the tank 120 has remained elevated for the required ten minutes, or any other predetermined interval, the cam 187 contacts the arm 186 of the switch 189 and rocks the latter to the position indicated by the dotted lines in Fig. 16 to close the circuit to and energize the solenoid 177 whereby to open the valve 146. The solenoid 177 is energized for approximately three and one-half minutes, this period of time being sufficient to cause lowering of the tank 120 to inoperative position. As before explained, the slow downward movement of the tank 120, as controlled by the restricted passage 149, causes the surplus solution on the tubes *t* to drain back into the supply C in the tank.

As indicated at the left in Fig. 16, the motor 40 for driving the conveyor 25 derives its energy from the power-line 183, one branch of the circuit leading directly to the motor. Two switches or circuit-breakers 190 and 200 are connected in series in the other branch leading to the motor 40. The switch 190, which may be of any suitable construction, is herein shown, by way of example, as of the plunger type having a piston 191 slidable in a casing and adapted to contact with opposite terminals 192. The piston 191 is normally held raised from contact with the terminals 192 by a coil-spring 193 pocketed in the switch-casing. The switch 192 is located directly beneath the tank 120 and as the latter is lowered to inoperative position it engages and depresses the piston 191 to cause the latter to contact with the opposite terminals 192 and thereby complete the circuit to the switch or circuit-breaker 200.

The switch 200 is herein shown as of the plunger-type having a piston 201 slidable in a bore in the switch-housing and adapted, when in uppermost position, to bridge the gap between opposite terminals 202 to complete the circuit to the conveyor-driving motor 40. The piston 201 is held raised by a coil-spring 203 pocketed in the housing beneath the plunger. The switch 200 is preferably constructed in the form of a dash-pot, the housing containing a supply of dielectric fluid adapted to pass quickly through an opening 204 in the piston when the latter is depressed and to flow slowly through a restricted opening 205 therein when the piston is raised by the spring 203 whereby to retard its upward movement. A suitable check-valve 206 may be provided for closing the larger opening 204 in the piston during the upward movement thereof.

The piston 201 of the switch 200 is connected to one arm 208 of a bell-crank lever 209 pivoted at 210. The other arm 211 of the lever 209 is adapted to be engaged by pins 212 spaced along and projecting from the conveyor 25 as the latter travels within the housing or conduit.

Assuming that the piston 201 of switch 200 is in uppermost position and the piston 191 of switch 190 is in lowermost position, the circuit to the motor 40 is closed and the motor drives the sprockets 35 through the gear-train 39 to cause the conveyor 25 to travel within the housing 10. After a group of tubes *t* has entered the coating compartment *c* one of the pins 212 on the conveyor 25 will engage the arm 211 of the bell-crank lever 209 to rock the latter to force the piston 201 of the switch 200 downwardly whereby to break the circuit to the motor 40. Due to momentum of the conveyor the pin 212 is carried past the point of contact with the lever-arm 211 and the piston 201 starts to move upwardly toward the terminals 202. This return motion is delayed by the action of the dash-pot, however, and before the piston 201 is alined with the terminals 202 the time-control unit 180 acts through the cam 181 and switch 185 to energize the motor 141 and pump 140 to cause elevation of the tank 120 into operative position. As the tank 120 is elevated the piston 191 of the switch 190 rises and breaks the contact between the terminals 192 to open the circuit to the conveyor-driving motor 40 so that when the switch 200 is eventually closed the switch 190 is open and the motor 40 remains idle. The complete apparatus having been described in detail its method of operation will next be explained.

To prepare the apparatus for operation the operator first closes a suitable manually-operated switch in the electrical control-circuit of the type shown in Figs. 14 and 15 or Fig. 16, and takes a position in front of the loading compartment *a* to attach the frames 50 carrying the tubes *t* to the conveyor 25 in the manner before explained and illustrated at *x* in Fig. 6; it being understood that the tubes have previously been mounted on

the frames. A fifteen-minute period may be provided for loading a complete group of tubes, comprising, for example, fifteen frames each holding twenty-four tubes, onto the conveyor 25 and at the end of this period the tank 120 has been lowered to close the circuit to the conveyor-driving motor 40 which transports the first group of tubes *t* into compartment *b*. Through the instrumentalities before described in connection with either form of electrical controlling means the circuit to the motor 40 is then opened to arrest the travel of the conveyor. When the conveyor comes to rest the baffle-plates 42 carried thereby will register with the baffle-plates 21, 22 and 23 to close the ends of the compartments. The heated air circulated through the compartment *b* preheats the tubes *t* and drives off the normal content of moisture and part of the air contained in the interstices between the fibers of the material thereof. During this preheating period another group of frames with tubes mounted thereon are attached to the conveyor 25.

At the end of a predetermined period of time, for example, eleven minutes, the controlling means acts to energize the solenoid 177 to open valve 146 and permit the tank 120 to descend. After the tank 120 has remained in its lowermost position for a predetermined period the timing means operates to close the circuit to the conveyor-driving motor 40 and the first group of heated tubes is moved into compartment *c*. The tubes are transported into the compartment in approximately one-half minute and at the end of this time the controlling means again acts to energize the motor 141 to elevate the tank 120, it being understood that the intermittent raising and lowering of the tank is automatically regulated during the entire operation of the apparatus by the time-control units.

As the hot tubes *t* depending from the conveyor 25 are immersed in the cool impregnating compound C contained in the tank 120 the vacuum occurring in the interstices of the material of the tubes causes the solution to be drawn into the voids to impregnate the inner fibers of the material. The outer surfaces of the tubes also receive an initial coating which tends to cover the outer fibers and bind them in place against the tubes. After the required ten minute coating and impregnating period the tank 120 is automatically lowered at a slow rate to permit the liquid to drain therefrom. Through this provision the surplus solution is permitted to drain slowly and evenly down the surfaces of the tubes and directly into the supply in the tank 120 without excessive dripping. During the lowering of the tank 120 the exposed parts of the tubes are contacted by the air circulating through the compartment. The air serves to evaporate part of the volatile solvent therefrom and thereby congeal the solution to a slight degree so that "streaks" or "runs" and "bottom rings" usually appearing on tubes which are coated or impregnated by usual methods, are avoided. The fresh air replacing the saturated air and combustible gases in the compartment prevents any fire hazard.

With the tank 120 in lowermost position the controlling means acts through the instrumentalities previously described to energize the motor 40 to again travel the conveyor 25 to transport the group of tubes *t* into the double compartment *d* where fresh air at room temperature is circulated around the tubes to evaporate the solvent and exhaust it into the pipe 81. At the next indexing movement of the conveyor 25 the first group of tubes moves into the second half of the compartment *d* to receive a continuation of the treatment just described, it being understood that during each treatment of the first group of tubes *t* a fresh group is placed on the conveyor and the succeeding groups follow in order to receive the successive steps in the treatment.

The first group of tubes *t* is transferred from compartment *d* into the double compartment *e* where it is subjected to treatment with fresh air preheated to 150° F. during a double-length period. The warm air passing around the tubes *t* further aids in evaporating the solvent without causing blistering of the residual solids. When the tubes have remained in compartment *e* for a double-length period most of the solvent is evaporated and it remains only necessary to remove the small remaining portion thereof and bake the resin solidly by applying a relatively high degree of heat thereto. The passing of hot air of 300° F. through the next double compartment *f* and multi-station compartment *g* causes evaporation of the remainder of the solvent and the residual solids are meanwhile baked and solidified to the desired degree.

After completing the cycle of operations as above explained as the first batch of tubes is about to reenter the loading compartment *a* the sliding door 62 is closed to seal this compartment from the atmosphere to maintain the tubes hot. The cycle of operations may then be repeated with little or no attention on the part of the operator to automatically apply a second coat of resinous material to the tubes whereby to fill in or seal any voids left by the evaporation of solvent in the previous operation.

Two coating operations are preferably performed using a solution of maximum viscosity and a solid content commensurate with complete and rapid impregnation to build up a nearly continuous exterior coating. This coating, however, may be insufficient to present a perfectly smooth and impervious surface; in which case a third coating is applied to fill up and seal the voids caused by the last solvent evaporation and to build up an exterior film of sufficient depth to cover any remaining fibers or other projections liable to catch and injure the delicate fibers of the yarn wound on the tubes. As the final coating is completed the tubes are removed from the conveyor as they reach the loading station, being replaced with new tubes to render the operation of the apparatus continuous. It will be readily understood that the number of impregnating and coating operations depends upon the porosity of the tubes and the solids content of the impregnating and coating solution. Likewise, the temperatures of the heated air circulated through the various compartments and the period which the tubes remain in the compartments may be varied in accordance with the type of impregnating and coating solution employed.

It will be observed from the foregoing that the present invention constitutes an important improvement in the manufacture of coated paper or fibrous tubes used as carriers for yarn and the like during various wet and dry processes. Through the method and means herein disclosed the tubes are automatically and expeditiously caused to be impregnated and coated more thoroughly and evenly without handling. The systematic method explained insures that all of the tubes will be coated completely and uniformly

and that the coating material will be treated in such a manner as to render it hard, impervious, insoluble and infusible.

By use of the improved apparatus a thorough impregnation of the inner fibers of the material of the tubes is effected and finished tubes produced in a continuous operation with economy in time and labor. The improved method of immersing the tubes and slowly draining the solution therefrom provides for an even distribution of the coating material without "runs" or "streaks" appearing on the surface of the tubes or the formation of "rings" at the ends thereof. Moreover, the solvent is removed slowly from the tubes whereby to prevent blistering or otherwise roughing up the applied coat which would cause injury to the delicate filaments of the yarn wound on the tubes.

Furthermore, the apparatus is of simple, compact construction, requiring a minimum of floor area, and is automatic in operation, it being only necessary to load the tubes onto and remove them from the conveyor.

While a preferred form of apparatus is herein shown and described and a preferred method of carrying out the process explained, it is to be understood that modifications may be made in the construction of the apparatus and changes made in the steps of the method without departing from the spirit or scope of the invention.

Therefore, without limiting myself in this respect, I claim:

1. An apparatus for coating articles comprising an endless conduit divided into separate compartments, means travelable in the conduit for conveying groups of articles successively to the several compartments, means for coating the articles, means for circulating air around the articles to evaporate the solvent from the coating solution, and means for effecting a gradual rise in the temperature of the circulating air in successive compartments to slowly bake the residual solids of the solution onto the articles.

2. An apparatus for impregnating and coating articles comprising an endless conduit divided into separate compartments, means travelable in the conduit for conveying groups of articles successively to the several compartments, means for preheating the articles, means for impregnating and coating the preheated articles, means for circulating air around the coated articles to evaporate the solvent from the coating solution, and means for effecting a gradual rise in the temperature of the circulating air in successive compartments to slowly bake the residual solids of the solution onto the articles.

3. An apparatus for impregnating and coating articles comprising an endless conduit divided into a plurality of compartments, an endless conveyor within the conduit, means for mounting groups of articles on the conveyor, means for automatically and intermittently operating the conveyor to successively position the groups of articles within the several compartments, and automatically-operated means for successively preheating the articles, immersing them in an impregnating and coating solution, draining the surplus solution from the articles, circulating air around the coated articles to evaporate the solvent from the solution, and baking the residual solids of the solution onto the articles during the complete travel of the articles through the several compartments of the conduit.

4. An apparatus for impregnating and coating articles of a fibrous nature comprising an endless conduit divided into a number of separate compartments, an endless conveyor within the conduit for conveying groups of articles therethrough, means for intermittently driving the conveyor to successively position the groups of articles within the several compartments, means for circulating heated air through one compartment to heat the articles to extract the normal moisture content and a portion of the air present in the interstices between the fibers, means operable in the next compartment for immersing the articles in an impregnating and coating solution to cause the latter to fill the voids and cover the surfaces of the articles, said last-named means operating to slowly drain the surplus solution from the articles, means for circulating air within the coating compartment and the remainder of the compartments to evaporate the solvent from the articles, and means for varying the temperature of the circulating air in successive compartments, one with respect to another.

5. An apparatus of the type indicated comprising an endless conduit, fixed baffle-plates spaced at intervals within the conduit, an endless conveyor travelable within the conduit and adapted to support a plurality of articles, spaced baffle-plates on the conveyor, driving means for intermittently advancing the conveyor to aline its baffle-plates with those in the conduit to divide the latter into a plurality of compartments, means for circulating heated air through one compartment to heat the articles, means in an adjacent compartment for immersing the articles in an impregnating and coating solution and thereafter draining the surplus solution therefrom, means for circulating air through the last-named compartment and the remainder of the compartments of the conduit to evaporate the solvent from the solution on the articles, and means for progressively increasing the temperature of the circulated air in the successive compartments to cause the residual solids to be baked onto the articles.

6. An apparatus of the type indicated comprising an endless conduit, an endless conveyor travelable within the conduit, means for supporting groups of articles on the conveyor, means carried by the conveyor for closing the conduit at points between the groups of articles to form compartments for enclosing the articles, and means for supplying a drying medium at progressively increasing temperatures in successive compartments in the conduit.

7. An apparatus of the type indicated comprising an endless conduit divided into a plurality of open end compartments, an endless conveyor travelable within the conduit, means for supporting groups of articles on the conveyor, means for intermittently traveling the conveyor within the conduit to position the groups of articles within the compartments for treatment, means on the conveyor for closing the ends of the compartments, and means for supplying a drying medium at varying temperatures in successive compartments.

8. An apparatus of the type indicated comprising an endless conduit having baffle-plates, a track extending longitudinally within the conduit, an endless conveyor of articulated structure travelable on the track within the conduit, baffle-plates carried by the conveyor, means on the conveyor for supporting groups of articles be-

tween its spaced baffle-plates, and means for intermittently traveling the conveyor along the track to aline its baffle-plates with those of the conduit to form compartments for containing the different groups of articles.

9. An apparatus of the type indicated comprising an endless conduit provided with spaced plates dividing its interior into a plurality of compartments, an endless track within the conduit, an endless conveyor within the conduit comprised of lateral bars hingedly joined together, rollers engageable between the conveyor and track to adapt the conveyor to move therealong, spaced baffle-plates carried by the conveyor, means for intermittently traveling the conveyor along the track to aline its baffle-plates with the baffle-plates in the conduit to close the compartments, and means for supporting groups of articles on the bars of the conveyor between the baffle-plates.

10. An apparatus of the type indicated comprising an endless conduit, spaced plates within the conduit dividing the latter into compartments, an endless track within the conduit, an endless conveyor travelable on the track, spaced baffle-plates carried by the conveyor, automatically-operated means for intermittently traveling the conveyor along the track to aline its baffle-plates with the plates of the conduit to close the compartments, and frames pendent on the conveyor for supporting groups of tubes between the baffle-plates to adapt them to enter the compartments for progressive treatment therein.

11. An apparatus of the type indicated comprising an endless conduit, fixed plates extending transversely within the conduit to divide the latter into a plurality of compartments, an endless track extending longitudinally within the conduit, an endless conveyor of articulated structure travelable along the track, baffle-plates carried by the conveyor, means for supporting groups of tubes on the conveyor between the baffle-plates, means for intermittently moving the conveyor along the track to aline its baffle-plates with the plates in the conduit to provide closed compartments with the groups of tubes positioned in the compartments for treatment, an opening at the side of one compartment through which the groups of tubes may be placed onto the conveyor, and means for closing said opening.

12. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, an endless conveyor travelable within the conduit, means for supporting groups of articles on the conveyor, means for driving the conveyor to position the groups of articles within the compartments, means for circulating air through certain of the compartments, and means for effecting uniform distribution of the air during its circulation through the compartments.

13. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, an endless conveyor travelable within the conduit, means for supporting groups of articles on the conveyor, means for intermittently driving the conveyor to position the groups of articles within the compartments for treatment, means for supplying air to and exhausting it from certain of the compartments, and means for uniformly distributing the air during its passage through the compartments comprising spaced plates within the compartments between which the articles are positioned, said plates provided with perforations through which the air passes.

14. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, an endless conveyor travelable within the conduit, means for supporting groups of articles on the conveyor, means for intermittently traveling the conveyor to position the articles within the different compartments, and means in one of said compartments for immersing the articles to impregnate and coat the same comprising a receptacle for containing a supply of impregnating and coating solution, and means for raising and lowering the receptacle to cause the solution to submerge and drain the articles.

15. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, an endless conveyor travelable within the conduit, means for supporting groups of articles on the conveyor, means for intermittently traveling the conveyor to position the groups of articles within the different compartments, and means within one compartment for impregnating and coating the articles comprising a tank for containing a supply of coating solution, a second tank surrounding the first tank, means for circulating a cooling medium in the space between the two tanks, and elevating means for raising the tanks to submerge the articles in the coating solution.

16. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, means travelable within the conduit for supporting groups of articles to position them in the different compartments for treatment, means for circulating heated air around the articles within one compartment, and means for immersing the heated articles in an impregnating and coating solution while positioned in an adjacent compartment comprising a tank for containing a supply of the coating solution, means for maintaining the solution cool, means for circulating the solution through the tank to maintain all parts thereof of uniform viscosity, and means for elevating the tank to submerge the articles in the solution.

17. An apparatus of the type indicated comprising a conduit divided into a plurality of compartments, means travelable within the conduit for supporting groups of articles of fibrous material to position them within the various compartments, means for preheating the articles in one compartment, and means for impregnating and coating the articles with a solution and draining the surplus solution therefrom within an adjacent compartment comprising a tank for containing the solution, means for maintaining the solution cool, means for quickly raising the tank to submerge the heated articles in the cool solution, and means for gradually lowering the tank to permit the surplus solution to drain from the articles directly into the supply of solution in the tank.

18. An apparatus of the type indicated comprising a conduit divided into a plurality of compartments, article-supporting means travelable within the conduit to position the articles for treatment within the various compartments, means for circulating heated air through one compartment to preheat the articles, and means for impregnating and coating the articles and draining the surplus solution therefrom in an

adjacent compartment comprising a water-jacketed tank for containing a supply of the solution, means for circulating water through the jacket to maintain the solution cool, means for circulating the solution in the tank to maintain the temperature and viscosity thereof uniform, means for elevating the tank to submerge the articles in the solution, means for slowly lowering the tank to permit the surplus solution on the articles to drain directly into the solution in the tank, and means for circulating air through the impregnating-and-coating compartment and around the articles during the draining operation.

19. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, means movable within the conduit for supporting and conveying groups of articles to the various compartments, means for circulating heated air through one compartment to preheat the articles, means for impregnating and coating the articles with a resinous solution and draining the surplus solution therefrom in an adjacent compartment, means for circulating air around the articles in the next compartment to evaporate the solvent from the applied solution, means for circulating air at a higher temperature in the next compartment to further evaporate the solvent and cause the solution to congeal on the articles, and means for circulating air at still higher temperature in one or more compartments to bake the residual solids firmly in place on the articles.

20. An apparatus of the type indicated comprising an endless conduit of rectangular configuration divided into a plurality of compartments, said conduit having two of its sides extending horizontally and the other two sides vertically, guiding means within the conduit, an endless conveyor movable along the guiding means, means for suspending the articles on the conveyor, a receptacle for containing a supply of coating solution arranged beneath one of the compartments, and means for moving the receptacle into the compartment to submerge the articles in the solution.

21. An apparatus of the type indicated comprising a conduit divided into a plurality of compartments, means within the conduit for supporting and conveying groups of articles into the several compartments for treatment by drying and baking, means for actuating the article-conveying means, means for supplying a drying medium at progressively increasing temperatures in successive compartments in the conduit, and a time-control unit for intermittently energizing the conveyor-actuating means.

22. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, an endless conveyor for supporting groups of articles and movable to transport them into the compartments for treatment, movable means for immersing the articles in an impregnating and coating solution while in one compartment, means for intermittently actuating the conveyor, means for intermittently operating the article-immersing means, and means for synchronizing the movement of the conveyor and article-immersing means.

23. An apparatus of the type indicated comprising an endless conduit divided into a plurality of separate compartments, an endless conveyor for supporting groups of articles and transporting them into the compartments for treatment, an electric motor for driving the conveyor, a movable tank for containing a supply of coating solution, means for moving the tank into position to immerse the articles in the solution, a time-control unit for regulating the periods of operation of the tank-moving means, and means operated by the movement of the tank for energizing and deenergizing the conveyor-driving motor to cause the latter to intermittently move the conveyor within the conduit to successively present different groups of the articles to the immersing tank.

24. An apparatus of the type indicated comprising an endless conduit, an endless conveyor travelable within the conduit, and means for supporting articles on the conveyor comprising carriers, means for mounting the articles on the carriers, and means for removably attaching the carriers to the conveyor.

25. An apparatus of the type indicated comprising an endless conduit, an endless conveyor travelable within the conduit, and means for supporting articles on the conveyor comprising carriers, means for removably attaching the carriers to the conveyor, and holders on the carriers for engaging the opposite ends of the articles.

26. An apparatus of the type indicated comprising an endless conduit, tube-conveying means travelable within the conduit, frame-members consisting of opposite parallel bars, tube-holders carried by the bars, said holders having means engageable with the ends of the tubes, and means for removably attaching the frame-members to the tube-conveying means.

27. An apparatus of the type indicated comprising an endless conduit, tube-conveying means travelable within the conduit, frame-members consisting of opposite parallel bars, means connecting the ends of the bars, means for supporting tubes in the frame-members comprising holders on the bars, means on the holders for engaging the inner rims at the ends of the tubes at spaced points, means for drawing the bars of the frame-members together to cause the holding means to engage the tubes, and means for removably attaching the frame-members to the tube-conveying means.

28. An apparatus of the type indicated comprising an endless conduit, conveying means travelable within the conduit, frame-members, means for removably attaching the frame-members to the conveying means, and means for supporting tubes on the frame-members comprising holders arranged on opposite sides of the frames, said holders provided with relatively narrow arms for engaging the inner rims at the ends of the tubes at spaced points therearound.

29. An apparatus of the type indicated comprising an endless conduit, a conveyor travelable within the conduit, carriers detachably mounted on the conveyor, and means for mounting tubes on the carriers comprising opposite holders, said holders constructed from wire and formed with narrow inclined arms engageable with the inner rims at the ends of the tubes at spaced points therearound, and means for attaching the tube-holders to the carriers.

30. An apparatus of the type indicated comprising an endless conduit, an endless conveyor travelable within the conduit, means for supporting tubes on the conveyor comprising tube-holders having inclined arms engageable with the inner rims at the ends of the tubes at spaced points therearound, means for drawing the tube-holders toward each other to support the tubes

therebetween, and means for removably attaching the tube-holders to the conveyor.

31. An apparatus for coating articles comprising an endless conduit, an endless conveyor for supporting groups of articles in the conduit, means in the conduit for preheating the articles, a tank containing a supply of coating solution, means for relatively moving the tank and conveyor for immersing the preheated articles in the solution, means for intermittently actuating the conveyor to advance the articles through the conduit, means for circulating air around the coated articles in the conduit, and means for effecting a gradual rise in the temperature of the circulating air at different points along the conduit to bake the solution on the articles.

32. An apparatus for coating articles comprising an endless conduit, an endless conveyor travelable within the conduit, means for supporting articles on the conveyor comprising carriers, means for removably attaching the carriers to the conveyor, means in the conduit for preheating the articles, means for impregnating and coating the preheated articles, means for circulating air around the coated articles to evaporate solvent from the coating solution, and means for effecting a gradual rise in the temperature of the circulating air at predetermined points along the conduit to slowly bake the residual solids of the solution on the articles.

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