May 5, 1964 E. J. BERGER ETAL 3,131,840

TEXTILE TREATING APPARATUS

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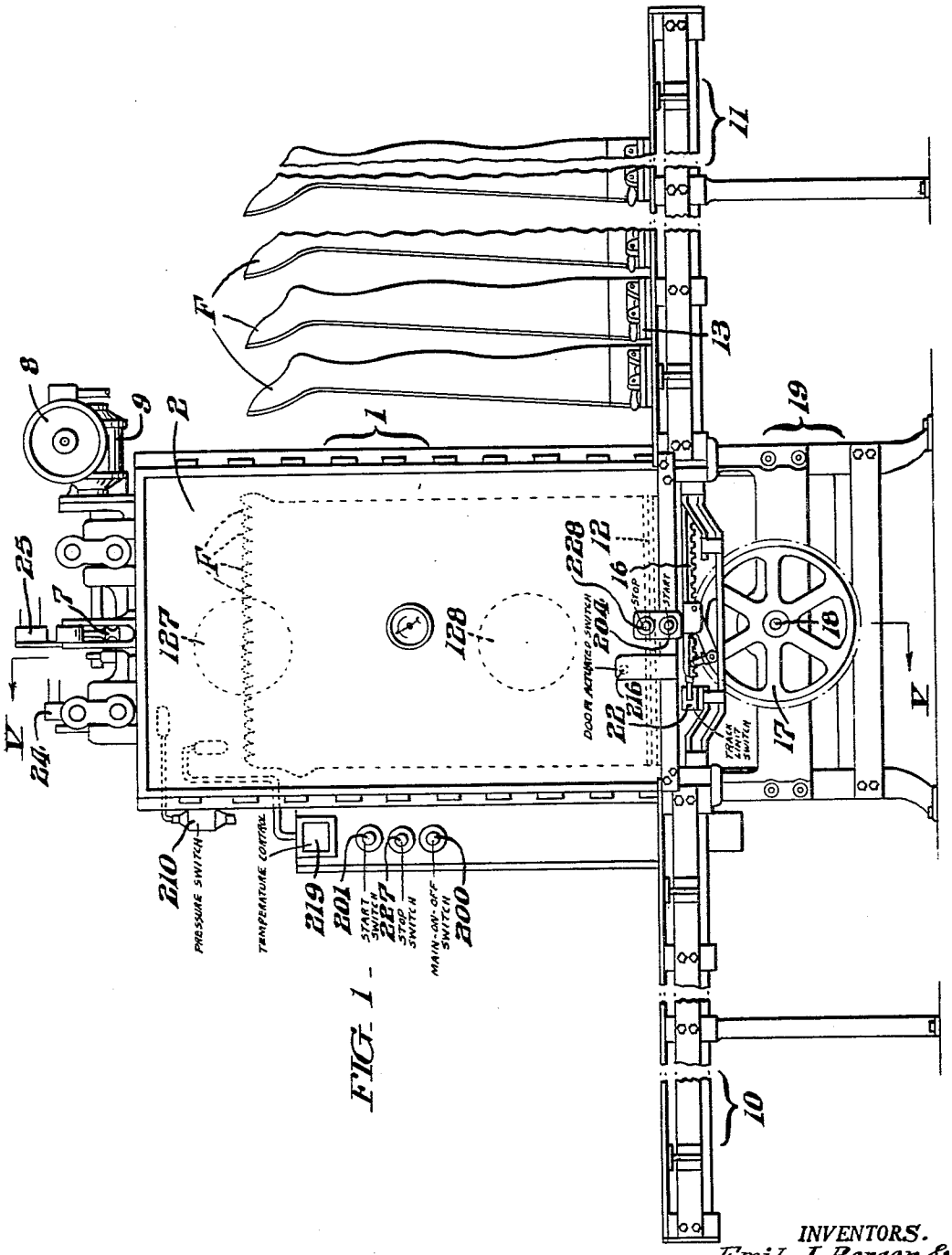


FIG. 1

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May 5, 1964 E. J. BERGER ETAL 3,131,840

TEXTILE TREATING APPARATUS

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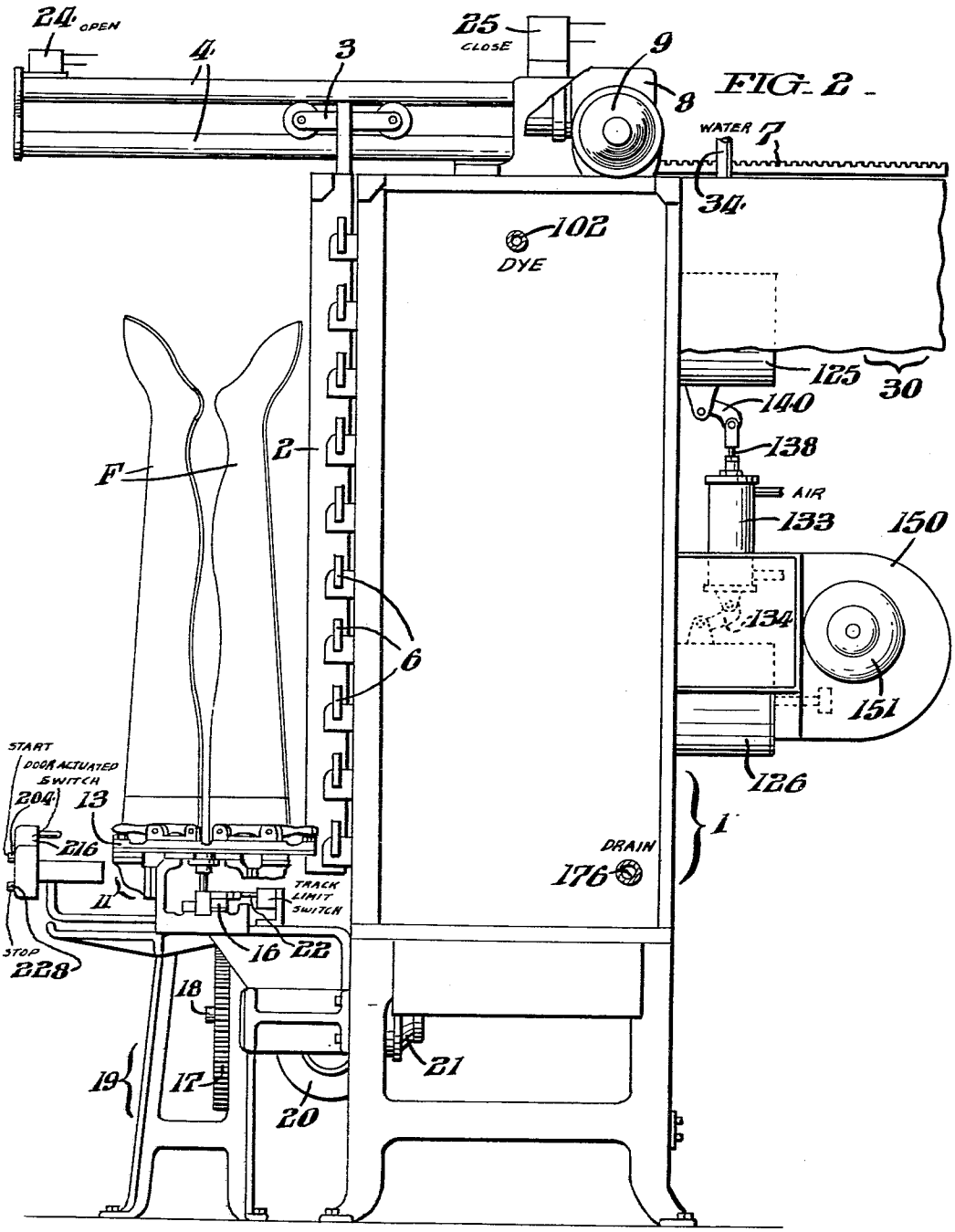


FIG. 2

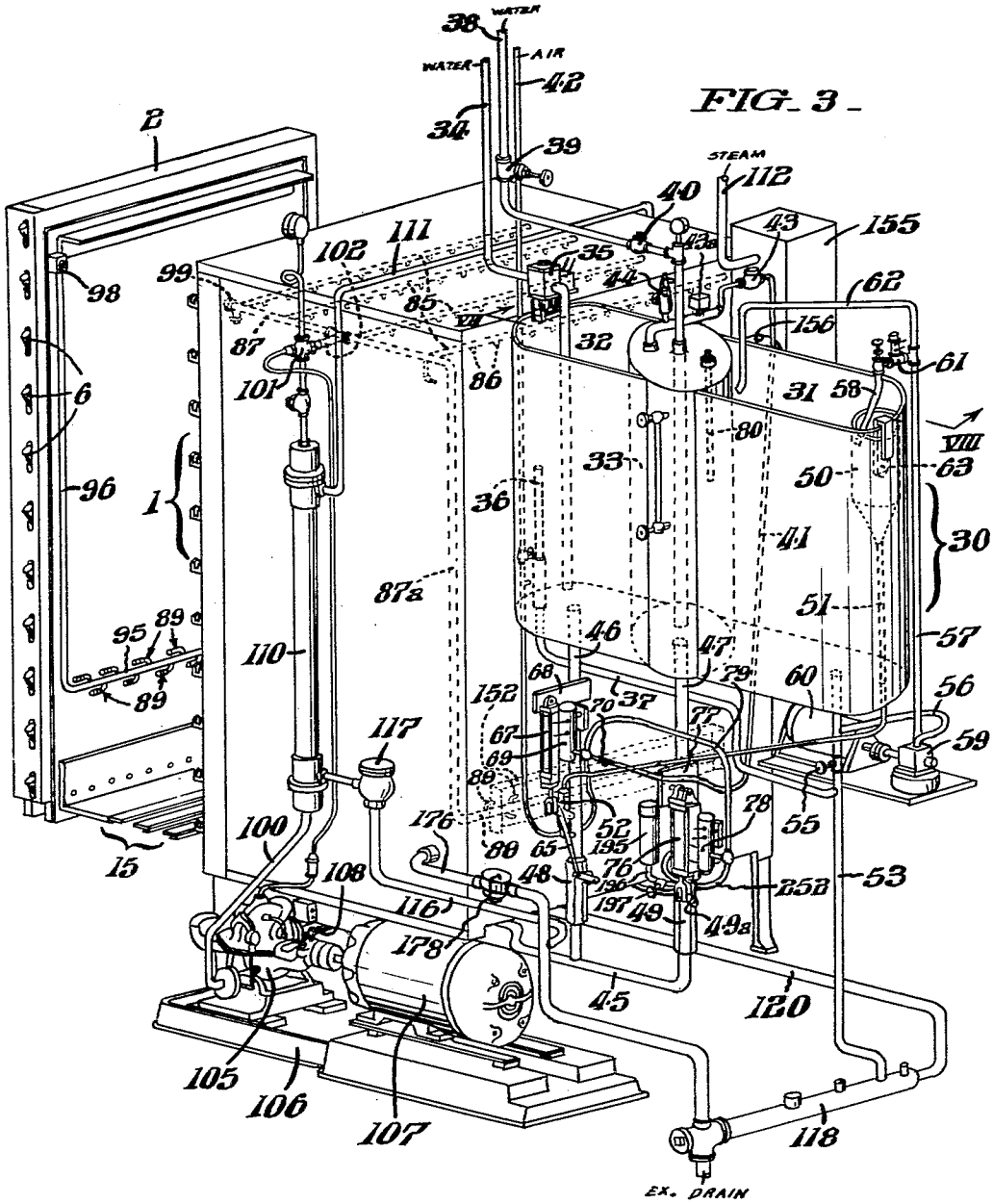
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TEXTILE TREATING APPARATUS

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FIG. 3



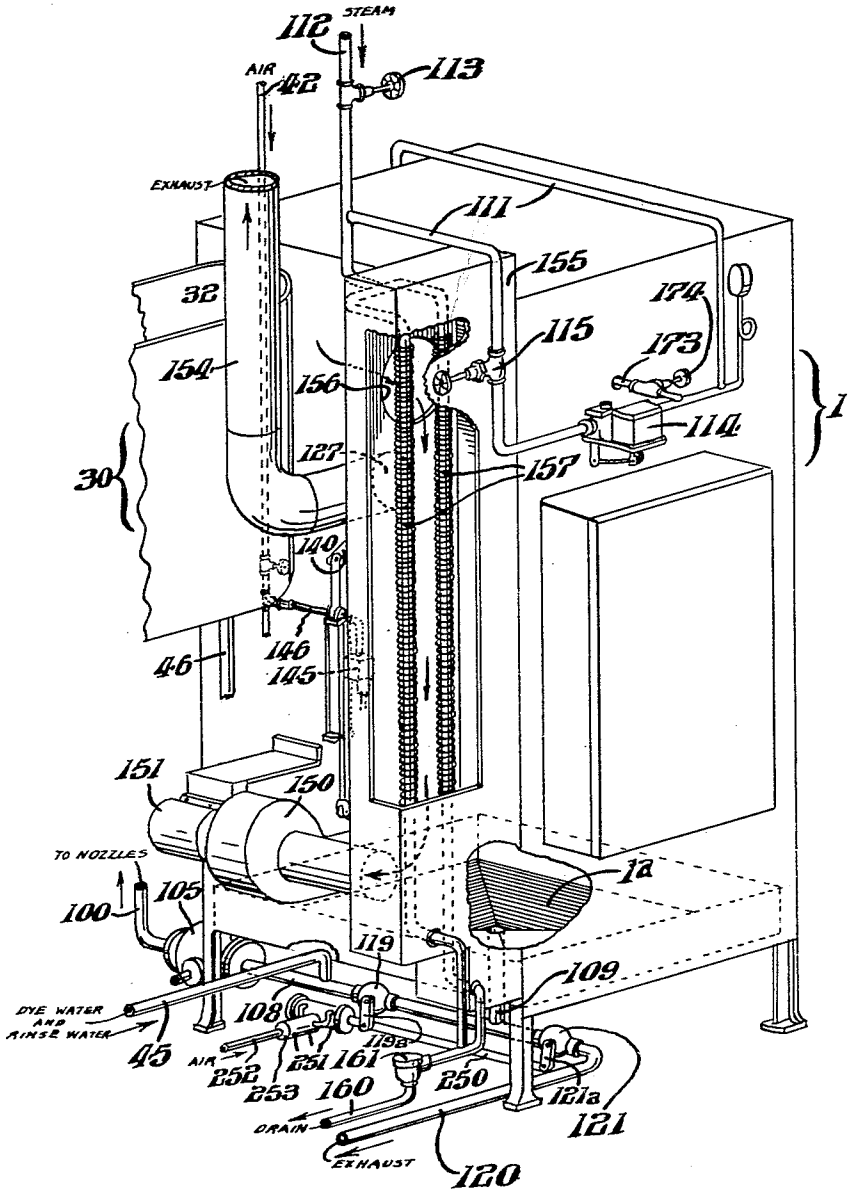
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May 5, 1964 E. J. BERGER ETAL 3,131,840

TEXTILE TREATING APPARATUS

Filed Aug. 29, 1960 15 Sheets-Sheet 4

FIG. 4



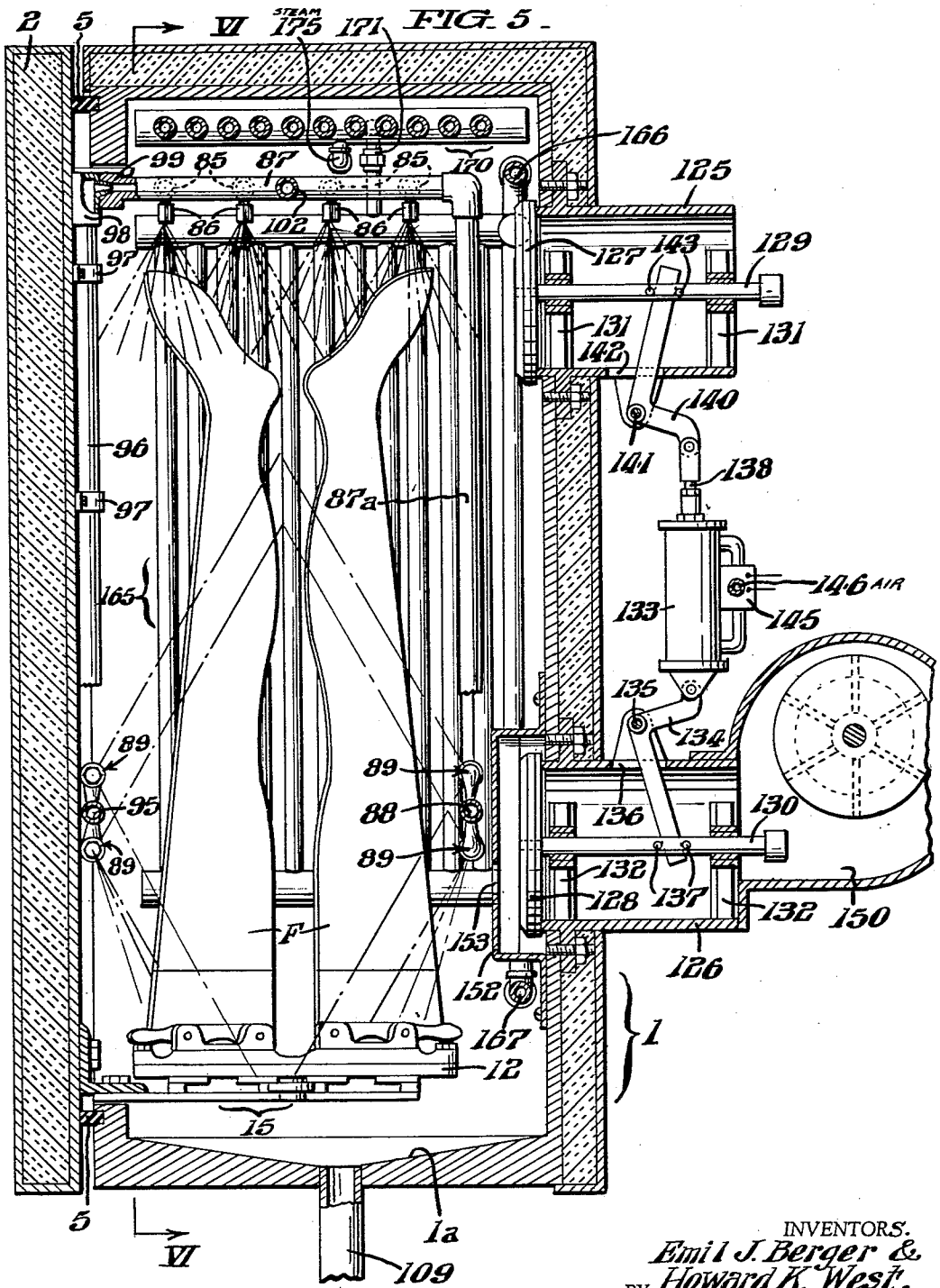
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TEXTILE TREATING APPARATUS

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FIG. 5.



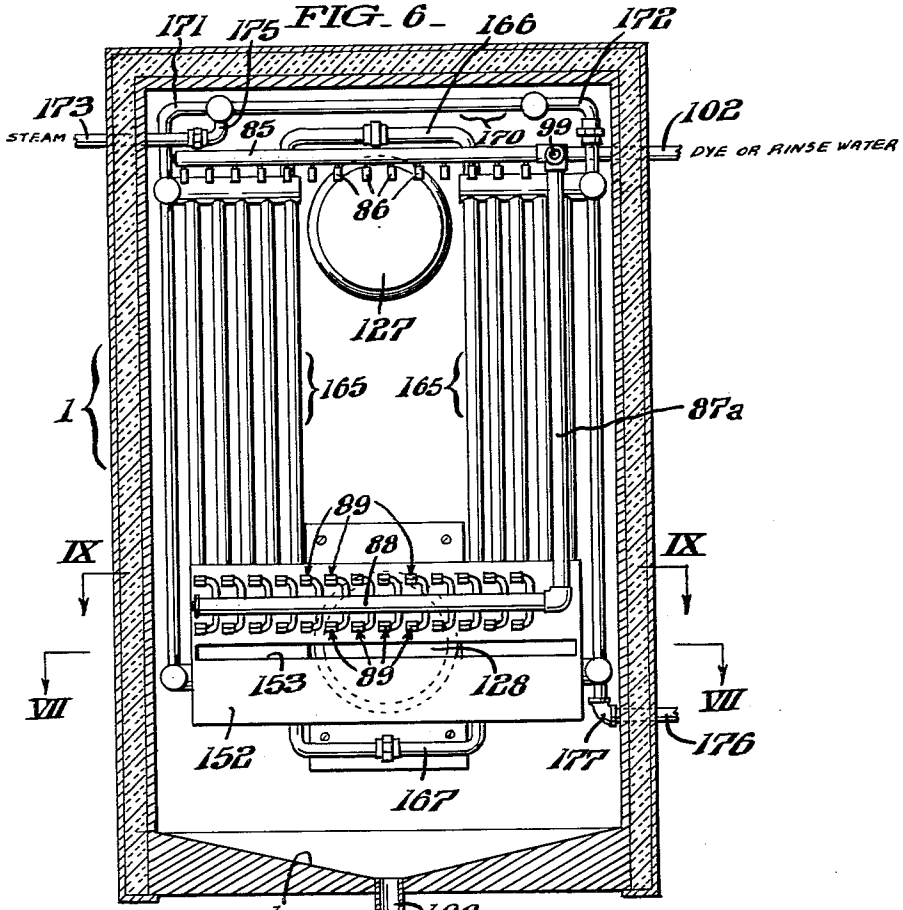
INVENTORS.
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TEXTILE TREATING APPARATUS

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FIG. 6



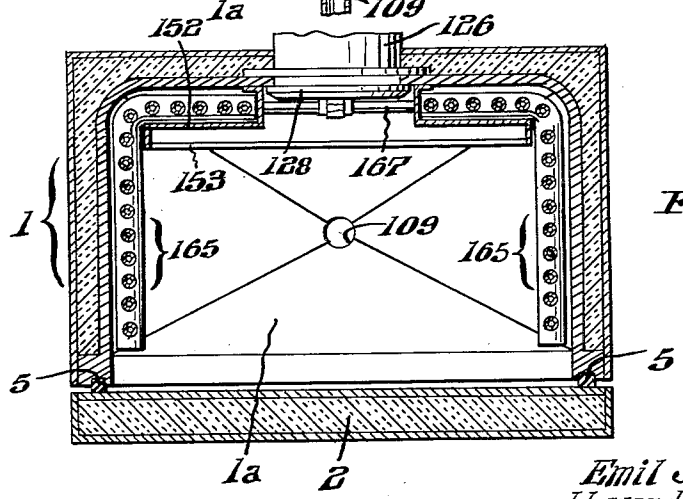


FIG. 7

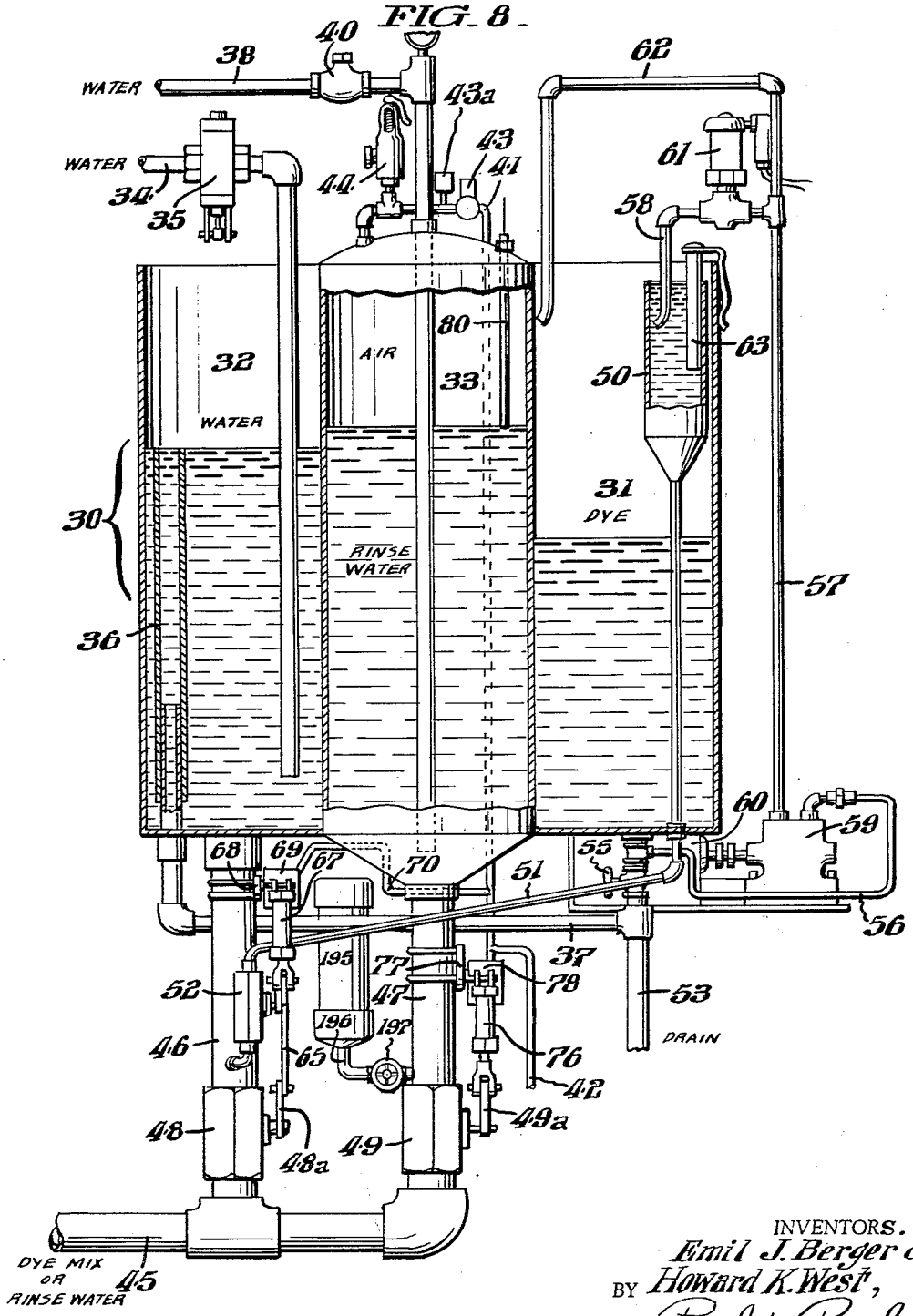
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TEXTILE TREATING APPARATUS

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FIG. 8.



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FIG. 9.

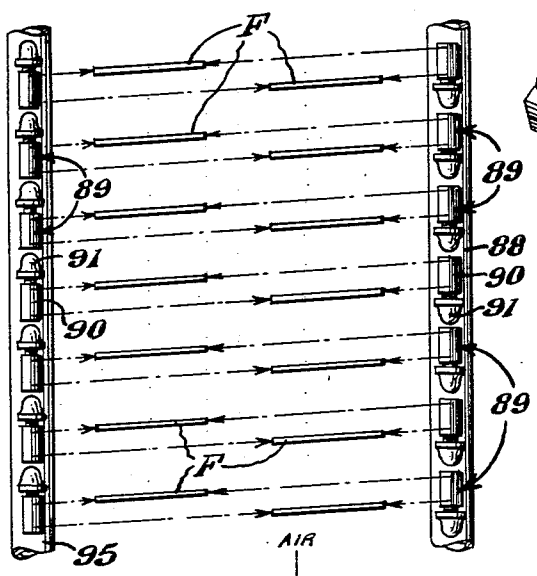


FIG. 10.

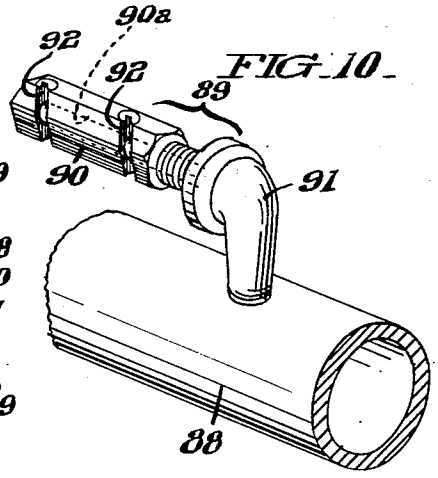
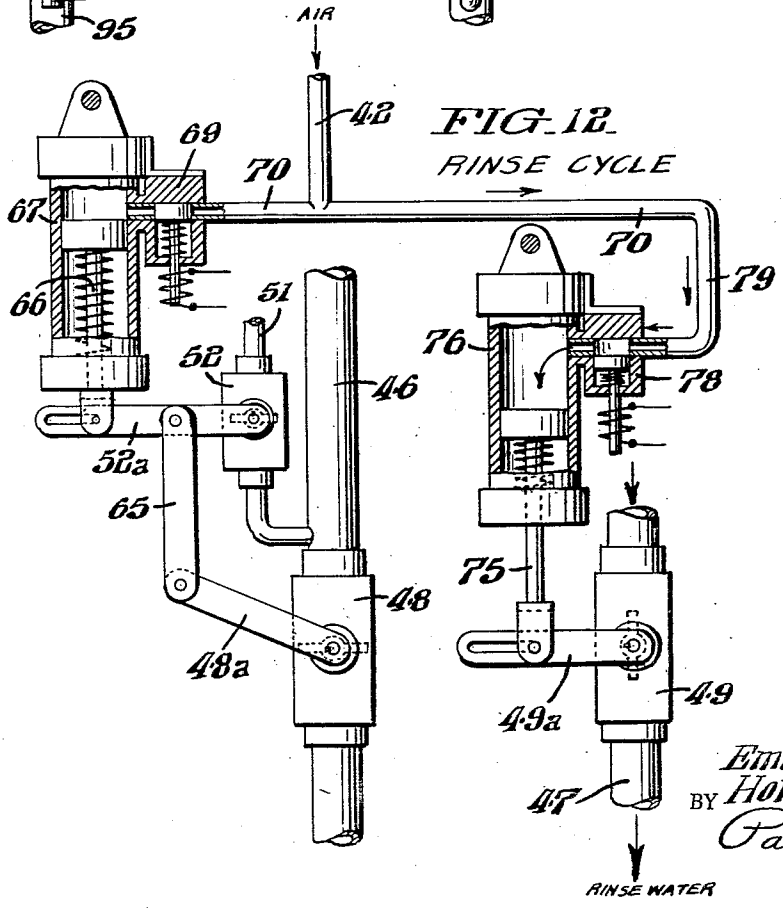


FIG. 12.



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FIG. 16.

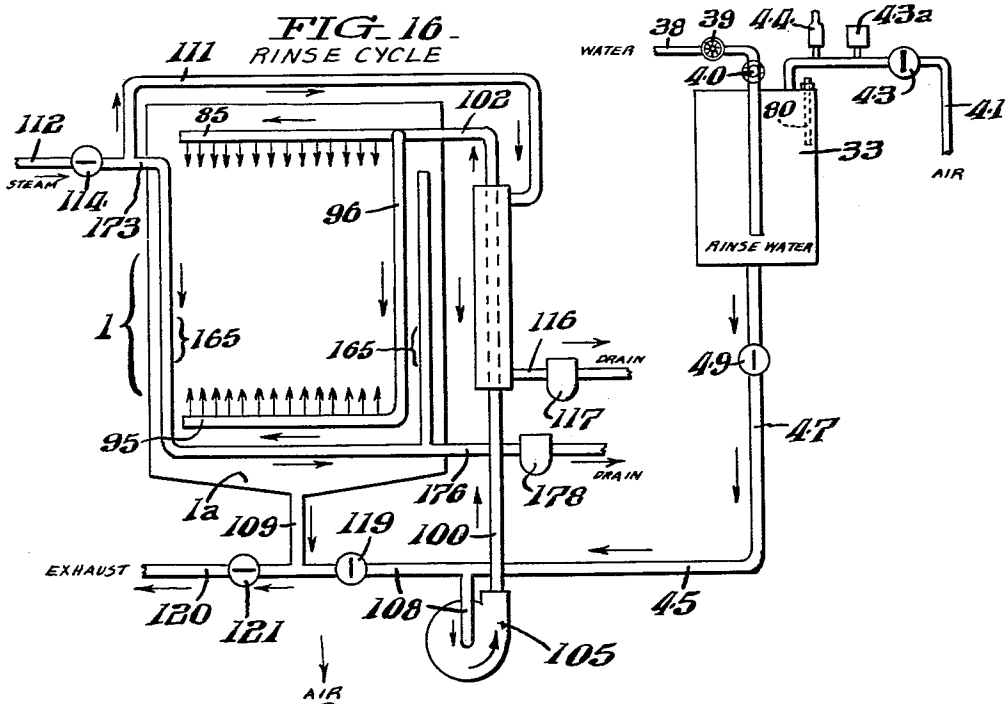
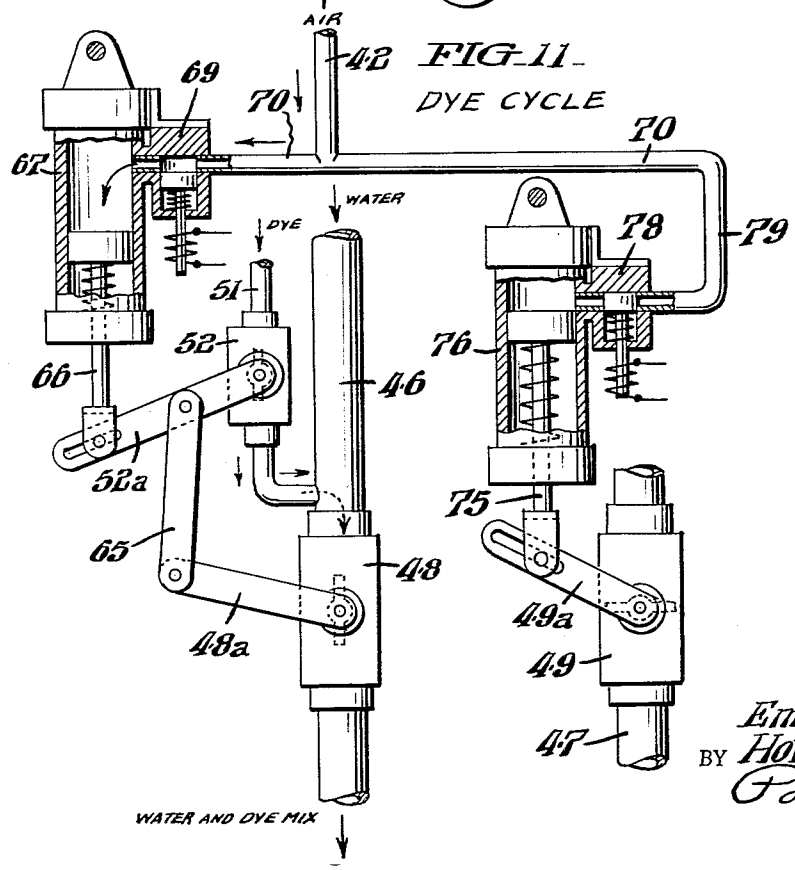


FIG. 11.



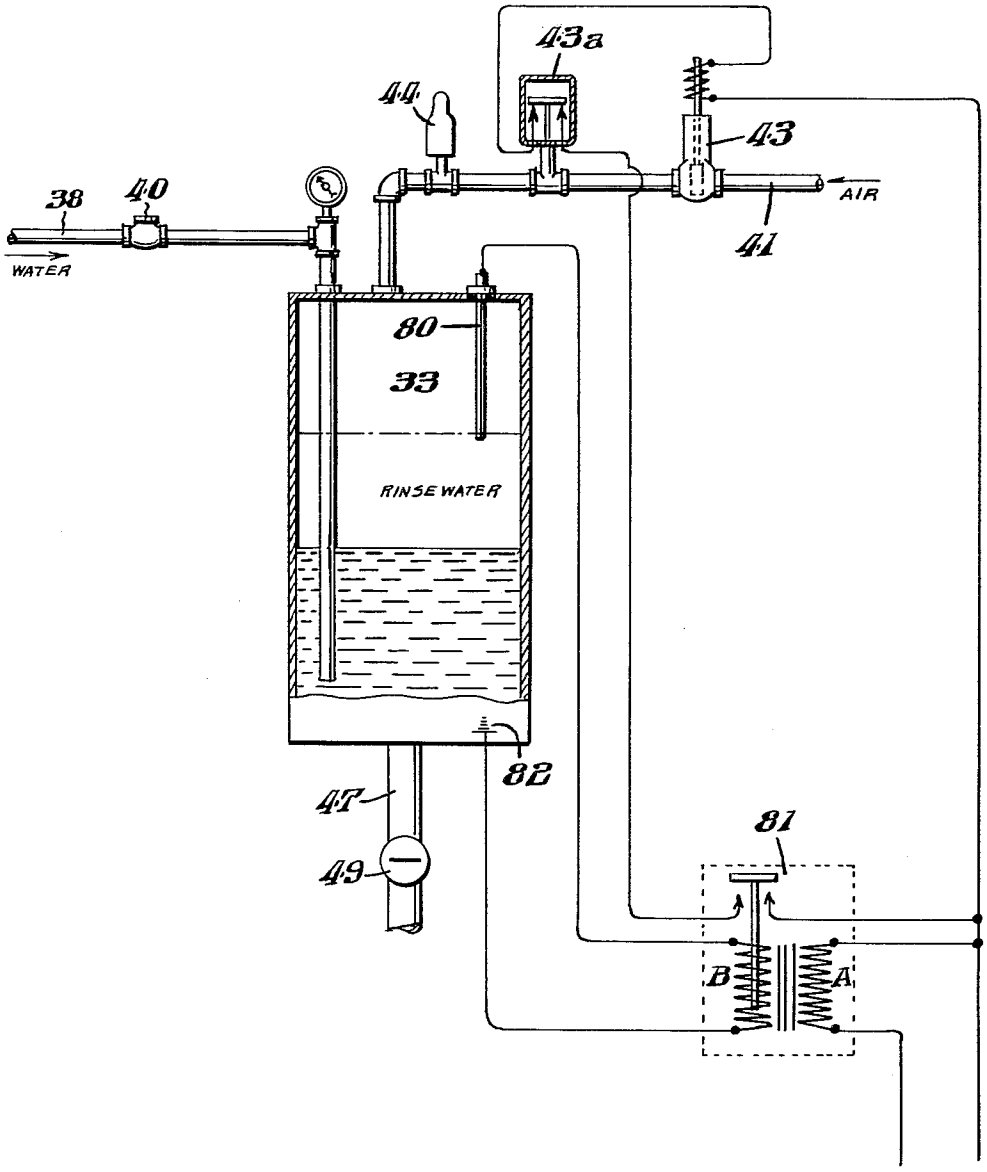
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TEXTILE TREATING APPARATUS

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FIG. 13



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TEXTILE TREATING APPARATUS

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FIG. 14.

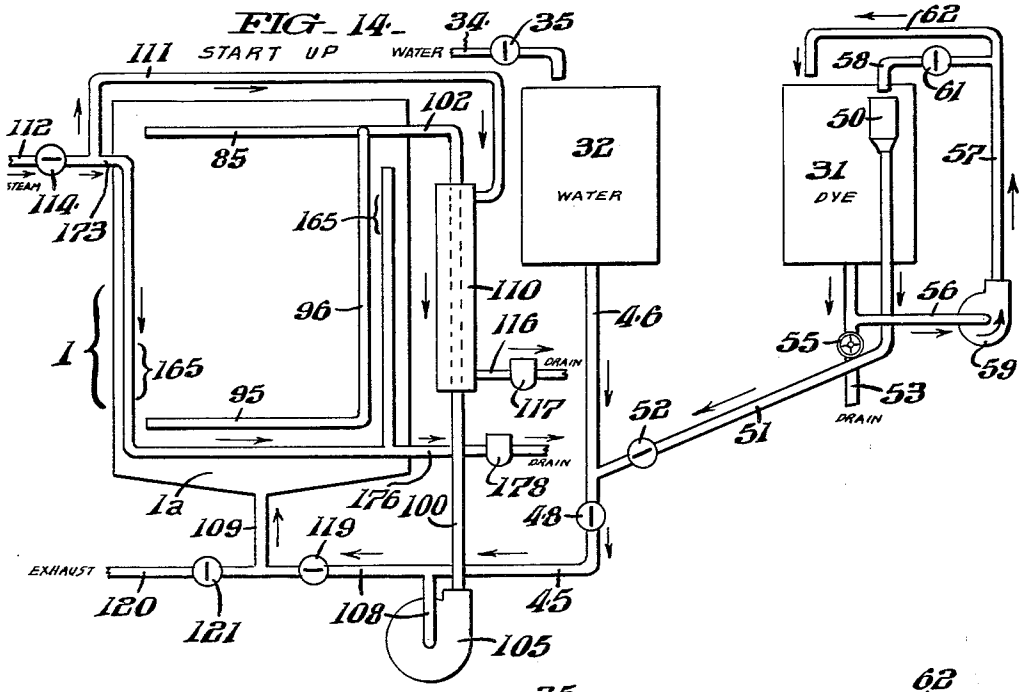
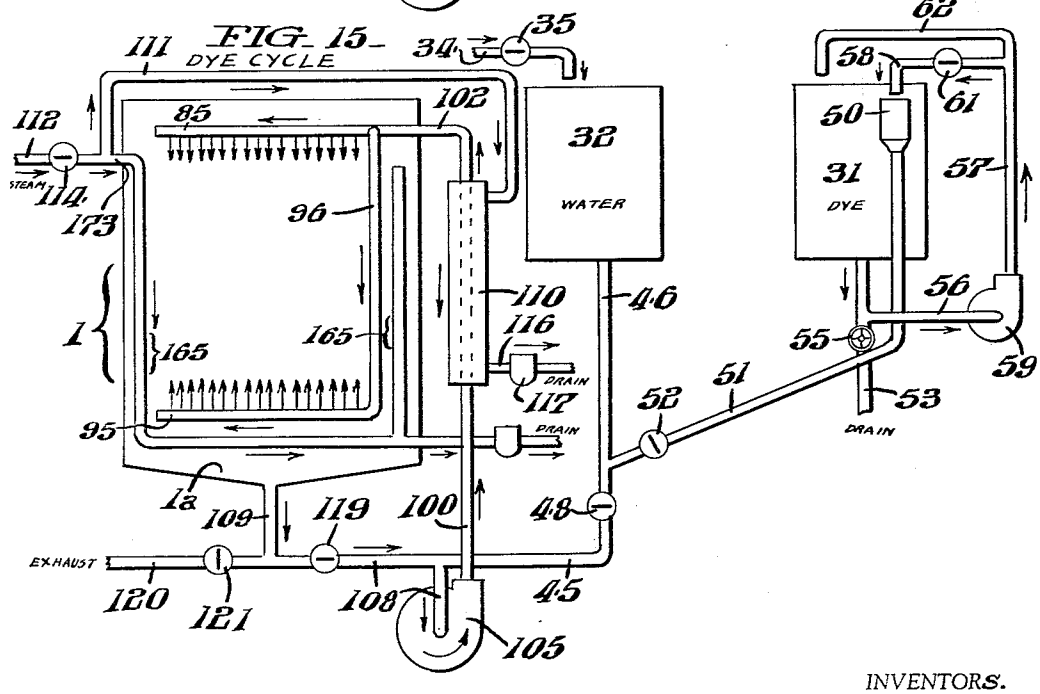


FIG. 15.



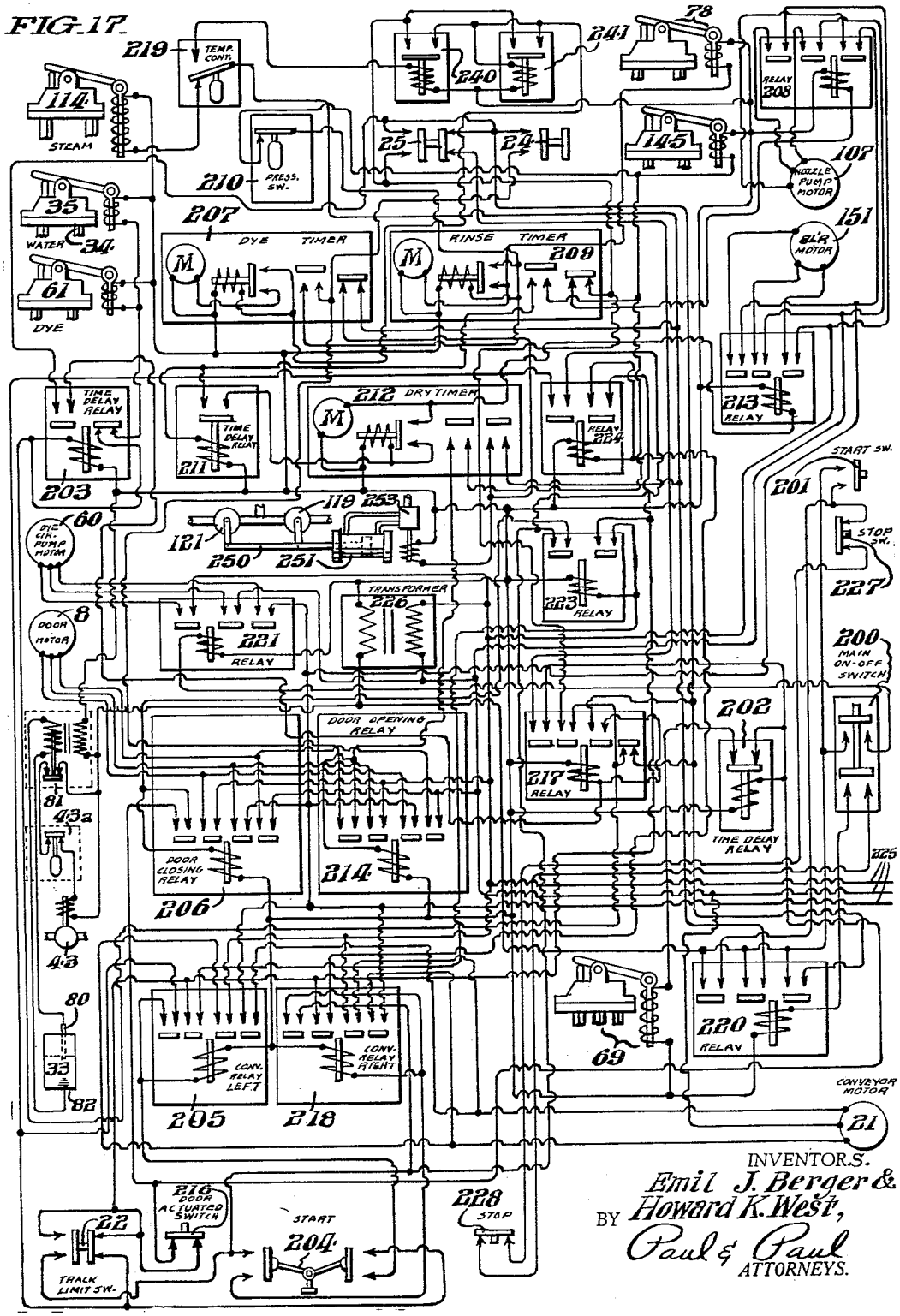
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TEXTILE TREATING APPARATUS

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FIG-17



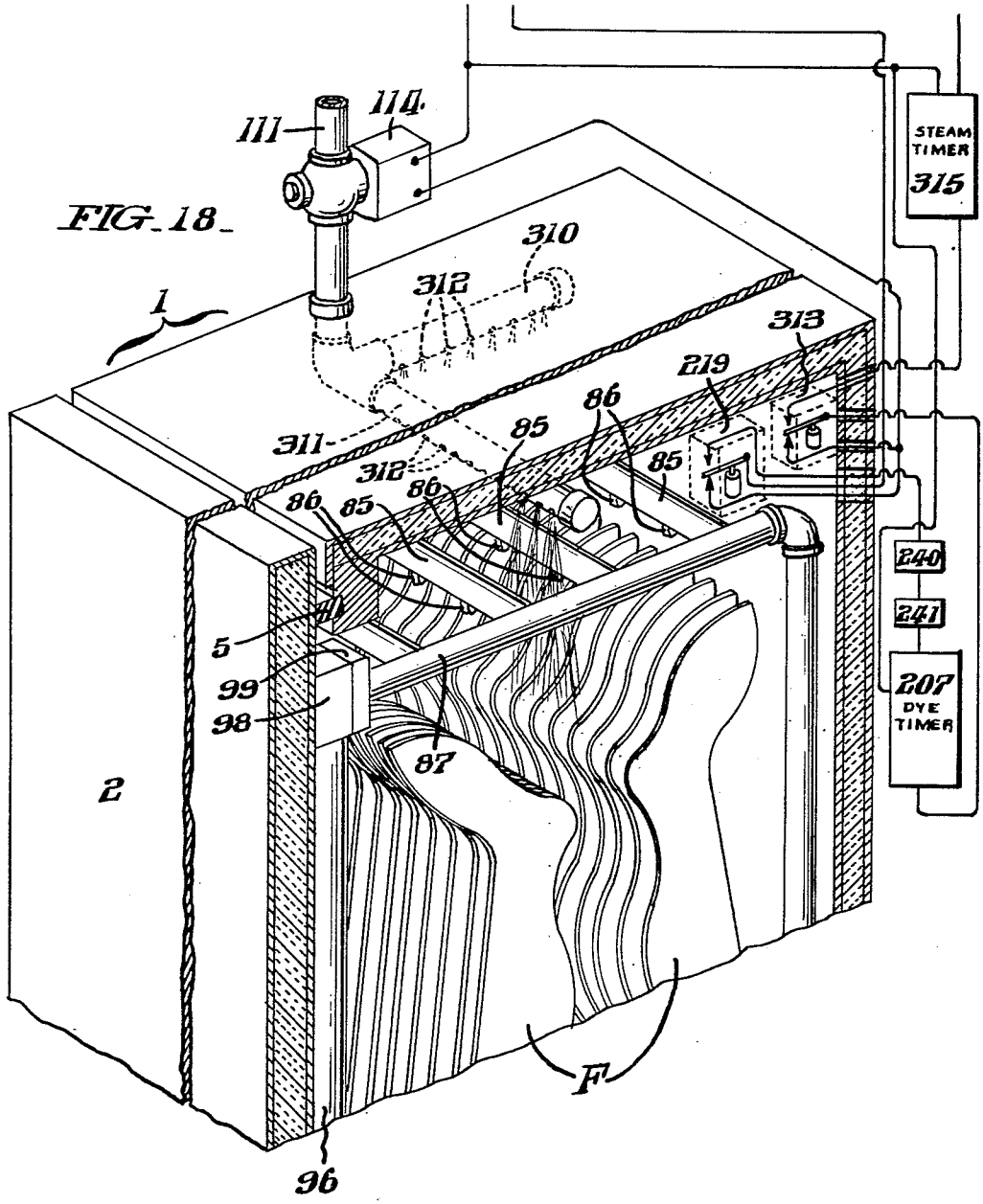
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TEXTILE TREATING APPARATUS

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FIG. 18



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FIG. 19.

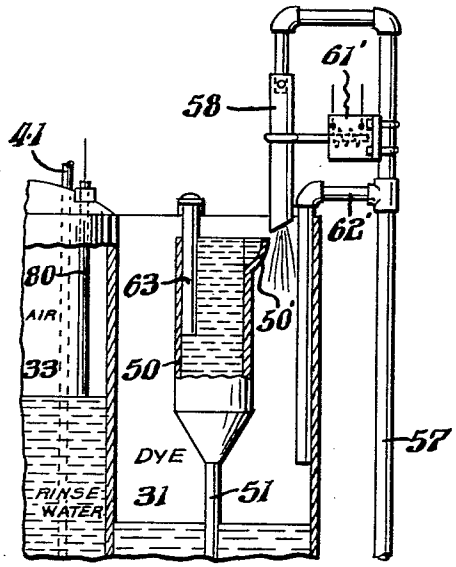


FIG. 20.

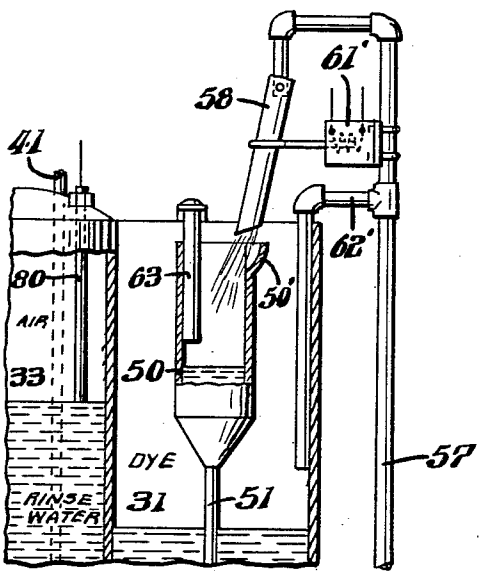
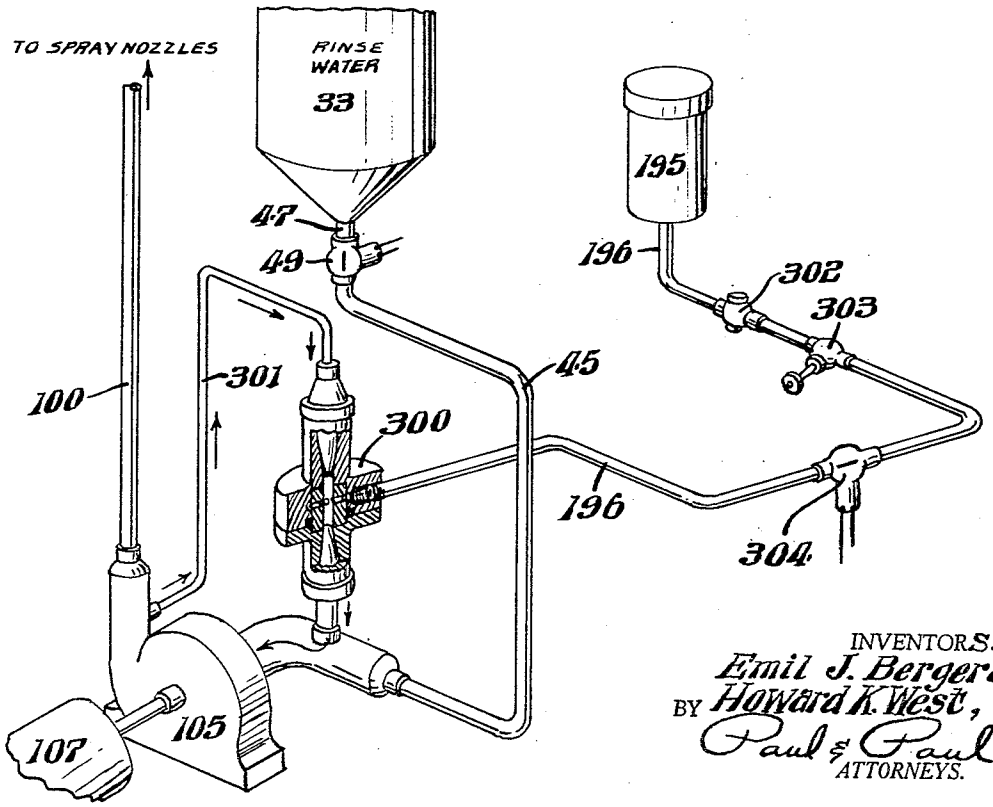


FIG. 21.



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TEXTILE TREATING APPARATUS

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FIG. 22.

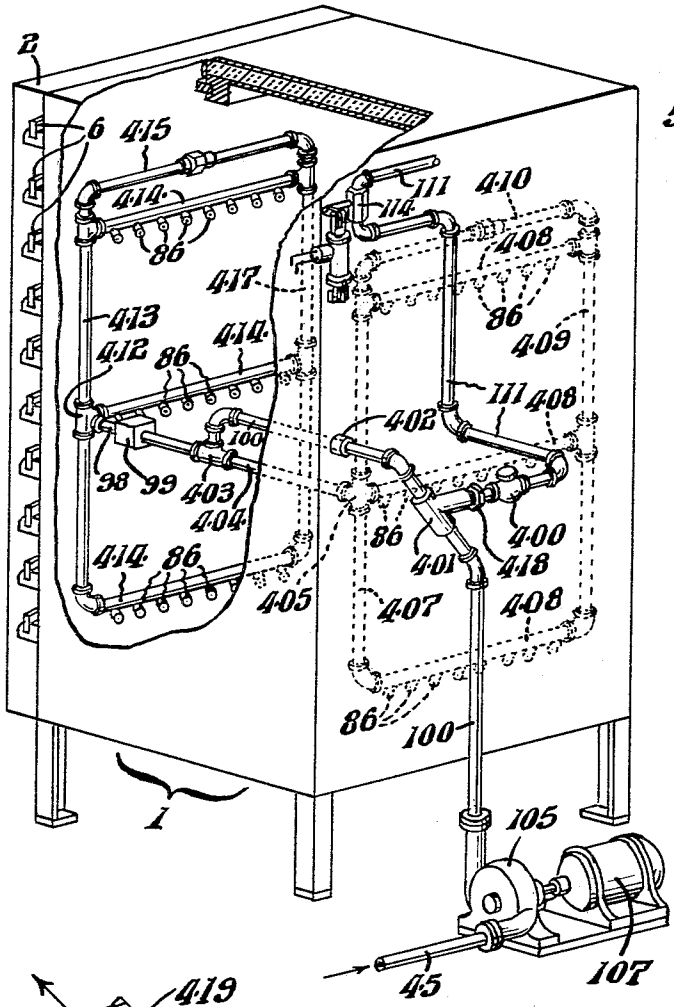


FIG. 23.

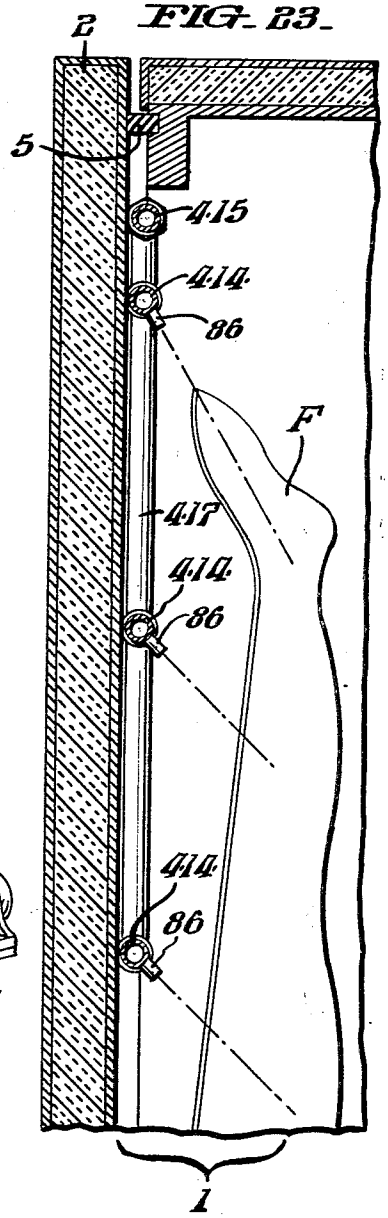
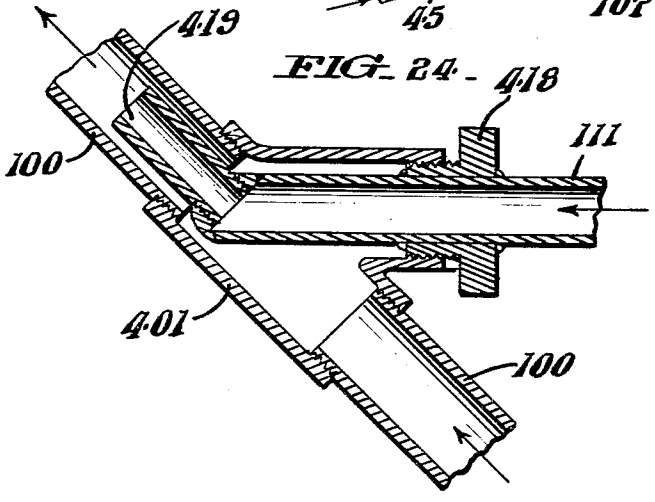


FIG. 24.



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United States Patent Office

3,131,840

Patented May 5, 1964

3,131,840

TEXTILE TREATING APPARATUS

Emil J. Berger and Howard K. West, Lansdale, Pa., assignors to Turbo Machine Company, Lansdale, Pa., a corporation of Pennsylvania

Filed Aug. 29, 1960, Ser. No. 57,098
7 Claims. (Cl. 223—76)

This invention relates to apparatus and methods for treating textiles. More particularly, it is concerned with apparatus and methods for treating textile articles, such as hosiery, sweaters and the like, knitted from thermoplastic yarn, such as nylon, while stretched upon flat profiled shaping forms.

This application comprises a continuation-in-part of our pending patent application Serial No. 830,678, filed July 30, 1959 for "Textile Treating Apparatus and Method," now abandoned, in turn, comprising a continuation-in-part of our now abandoned patent application Serial No. 779,113, filed December 9, 1958 for "Textile Treating Apparatus," now abandoned.

In the treatment of textile articles knitted from thermoplastic yarns, many separate process steps are required in order to convert goods in the greige into finished products ready for sale. With respect to ladies' hosiery, for example, between the time that the articles are examined in the greige and then are paired in their finished condition, they are subjected to the steps of presetting, scouring, dyeing, finishing and final setting, all of which involves many separate handlings. With goods knit from fine denier yarns, such multiple handling subjects them to a high risk of irreparable damage such as runs and tears, resulting in a high loss factor. While numerous attempts have been made to reduce or combine a number of the processing steps necessary to convert greige goods into finished goods, and otherwise reduce the extent to which the articles are handled, such attempts have not proven to be commercially successful.

A chief object of this invention is the provision of apparatus whereby the various process steps necessary for converting knitwear from the greige into finished articles may be combined in a single machine processing cycle involving a minimum of handling of the articles.

Another important object of this invention is the provision of apparatus whereby the presetting, scouring, dyeing, finishing, final setting, rinsing and drying of textile articles may be accomplished in a single machine processing cycle in a minimum of time within an autoclave or treating chamber.

A further object of this invention is to provide such apparatus having an automatic control system whereby the presetting, dyeing, finishing, final setting, rinsing and drying operations are carried out during controlled, predetermined intervals.

A further object of this invention is to provide such apparatus wherein the scouring, dyeing, finishing and setting operations may occur simultaneously, or where one or more of such operations may occur successively to one or more of the other such operations within the time interval of the machine processing cycle.

A further object of this invention is to provide apparatus for treating textile articles wherein dyeing of the articles may take place at a certain predetermined temperature and final setting thereof may thereafter take place at a higher predetermined temperature, and wherein presetting of the articles may take place either prior to or during dyeing thereof, all during a single machine processing cycle.

A further object of this invention is to provide apparatus which may be used for carrying out the aforementioned multi-purpose objectives, and which may also be

used as either a preboarding or a final boarding machine for textile articles knitted from thermoplastic yarns.

A further object of this invention is to provide apparatus of the type aforementioned wherein finishing and rinsing may occur simultaneously.

A further object of this invention is to provide a method of treating textile articles wherein the articles may first be scoured, dyed and heat set during a definite time interval, and thereafter rinsed during a definite time interval.

A further object of this invention is to provide a method of treating textile articles wherein the articles may first be dyed at a predetermined temperature and thereafter set by heat at a higher predetermined temperature during a single processing cycle.

A further object of this invention is to provide a method of treating textile articles wherein the articles, during a single processing cycle, may be preset at a predetermined temperature prior to dyeing and final setting.

How the foregoing as well as other important objectives and attendant advantages of our invention are realized in practice will appear from the following detailed description of a preferred embodiment thereof shown in the attached drawings, wherein:

FIG. 1 is a fragmentary view in front elevation of an integrated textile treating apparatus embodying our invention.

FIG. 2 is a fragmentary view in end elevation as seen when looking from the right of FIG. 1.

FIGS. 3 and 4 are fragmentary perspective views from different angles of the rear of the apparatus.

FIG. 5 is a fragmentary sectional view of the treating chamber taken as indicated by the angled arrows V—V in FIG. 1.

FIG. 6 is a transverse sectional view taken as indicated by the angled arrows VI—VI in FIG. 5.

FIG. 7 is a horizontal sectional view taken as indicated by the angled arrows VII—VII in FIG. 6.

FIG. 8 is a fragmentary view in elevation, partly in section, taken as indicated by the angled arrows VIII—VIII in FIG. 3 showing storage reservoirs for the various liquids used in treating textiles.

FIG. 9 is a fragmentary view in plan taken as indicated by the angled arrows IX—IX in FIG. 6.

FIG. 10 is an enlarged fragmentary view in perspective showing one type of nozzle for spraying textile articles with the treating liquids while in the treating chamber.

FIGS. 11 and 12 are diagrammatic views, partly in section, of the control valves used in the treating liquid spraying system.

FIG. 13 is a diagrammatic view of the electric controls for governing the admisison of rinse liquid and air to the rinse reservoir.

FIGS. 14, 15 and 16 are diagrammatic views showing successive stages in the treatment of textile articles.

FIG. 17 is a wiring diagram showing the various electrically actuated instrumentalities by which automatic operation of the apparatus is controlled.

FIG. 18 is a fragmentary sectional view in perspective, and partially diagrammatic, of a modification of the treating chamber and of the automatic control system of the apparatus.

FIGS. 19 and 20 are fragmentary sectional views in elevation showing modified means of measuring controlled quantities of the dye solution used in the apparatus.

FIG. 21 is a fragmentary perspective view showing means for introducing controlled quantities of a textile finishing compound into the rinse liquid.

FIG. 22 is a fragmentary perspective view of a second modification of the treating chamber with the outside wall partly broken away.

FIG. 23 is a fragmentary sectional view in side eleva-

tion of the chamber, with the door closed, of said second modification.

FIG. 24 is an enlarged fragmentary sectional view in side elevation of the means of said second modification whereby steam is introduced directly into the dye solution as it travels through the liquid spraying system.

Basic Apparatus

Basically, the apparatus herein illustrated is generally of the construction disclosed in E. J. Berger and H. W. Matthews U.S. Patents Nos. 2,321,452 and 2,736,105, issued June 8, 1943 and February 28, 1956, respectively. It includes an upright rectangular treating chamber or autoclave **1** (FIGS. 1 and 2) having a retractable door **2** at the front hung from suspension trolleys **3** which are constrained to travel back and forth upon track bars **4** extending forwardly from the top of said chamber. When closed, as in FIGS. 2 and 5, door **2** is held fluid tight by retractable latches **6** against strip packing **5** disposed perimetrically about the opening of chamber **1**. Through rack and pinion means designated **7** in FIGS. 1 and 2, the door **2** is moved to opened and closed positions by a reversible electric motor **8** and an associated speed reduction unit **9** mounted atop the chamber **1**.

Extending longitudinally of the front of chamber **1** beyond the opposite side walls thereof are aligned stationary tracks **10** and **11** for the guidance, respectively, of collapsible carriages **12** and **13** upon each of which multiple upstanding textile forms F are mounted. Supported on the back of the door **2** is a track section **15** (FIGS. 3 and 5) which, when the door is fully open, registers with said stationary tracks. The carriages **12** and **13** are propelled along the stationary tracks **10** and **11** to and from the track section **15** on door **2**, when the latter is open, by a conveyor means, similar to that of the aforesaid Patent No. 2,736,105, which includes a rack bar **16** (FIG. 1) having teeth in mesh with a spur gear **17** on a transverse shaft **18** suitably journalled in the open base frame **19** on which the treating chamber **1** is supported. As shown in FIG. 2, shaft **18** is driven, through a speed reducer **20**, by a reversible electric motor **21** mounted within base frame **19**.

By means similar to that described in the aforesaid Patent No. 2,736,105, the carriages **12** and **13** are automatically disconnected from the rack bar **16** upon being advanced to position upon the track section **15** at the back of the retractable door **2**. In the use of the apparatus, textile articles are drawn downwardly over the forms F on one carriage when such carriage is expanded and positioned on its stationary track while the other carriage, with its forms loaded, is collapsed and positioned within the chamber **1** for treatment of the articles. The apparatus is provided with a limit switch **22** (FIG. 1) adapted to be operated by the carriages **12** and **13**, and with door actuable limit switches **24** and **25** (FIG. 2), all of which will be referred to again hereinafter. For the purposes of illustration, the forms F on the respective carriages **12** and **13** are adapted for the treatment of ladies' hosiery and are arranged in two rows, as shown in FIGS. 2 and 5. When the carriages are collapsed, as shown in FIG. 9, the forms F of one row are staggered with respect to the forms F of the other row.

Supply Equipment for the Treating Liquids

The supply equipment for the treating liquids includes a tank **30** which is subdivided, as shown in FIG. 8, into three compartments **31**, **32** and **33** which serve as reservoirs, respectively, for a concentrated dye solution, a dye diluting liquid (which may be water) and a wash or rinse liquid (which likewise may be water). The dye solution preferably includes a detergent for scouring the textiles, a dye and a wax. If desired, the dye solution may also contain a textile finishing compound whereby the textile articles to be treated in the apparatus may be simultaneously scoured, dyed and finished. By suitable framing, which has been omitted from the drawings, the tank **30** may be supported at the rear of the chamber **1** (FIG. 3) at an elevation above a well **1***a* in the bottom of said chamber. The dye diluent, which is indicated in the drawings to be water, is introduced into reservoir **32** through a pipe **34** under control of a solenoid valve **35**. A predetermined quantity of such water is maintained in reservoir **32** by overflow of the excess through an adjustable stand pipe **36** which, at its bottom connects with a waste pipe **37** leading to drain pipe **53**. Similarly, rinse liquid, also indicated in the drawings to be water, is introduced into the reservoir **33** through a pipe **38** having a hand valve **39** and a check valve **40** interposed therein. Connecting into the top of the reservoir **33** is a branch **41** of a pipe **42** which leads from a source of compressed air (not shown), said branch **41** being fitted with a normally closed solenoid valve **43**, a pressure switch **43***a* and a relief valve **44**. An electric probe **80** is disposed in reservoir **33** for a purpose presently to be explained.

A horizontal conduit **45** is connected, through vertical branches **46** and **47**, respectively, to the bottoms of reservoirs **32** and **33**. Branches **46** and **47** have valves **48** and **49**, respectively, interposed therein.

Within the reservoir **31**, at the top thereof, is a small measuring vessel **50**. Leading downwardly from vessel **50** and connecting into branch **46** of the conduit **45** above valve **48** is a tube **51** in which a normally closed valve **52** is interposed. The drain pipe **53** leads from the bottom of the reservoir **31**. Flow through pipe **53** from tank **31** is prevented by keeping the hand valve **55** closed. Connecting to the pipe **53** immediately above hand valve **55** is a pipe line **56**, **57**, **58** through which the dye solution is drawn from the reservoir **31** by a pump **59** and discharged into the top of the measuring vessel **50**, said pump **59** being constantly driven by an electric motor **60** during use of the apparatus. Interposed in the delivery section **58** of the piping is a solenoid valve **61**. At certain times during the operation of the apparatus, as hereinafter explained, the valve **61** is closed whereupon the circulated dye solution is diverted upward through pipe **62** and discharged directly into the reservoir **31**. The measuring vessel **50** is provided with a vertically adjustable depth gauge **63** for regulation of the amount of dye solution retained therein.

As an alternative, pipe **58** may be connected to the plunger of a solenoid **61'**, as shown in FIGS. 19 and 20, in a manner to position pipe **58** so that dye solution normally is discharged directly into the top of reservoir **31**. In such arrangement, when the coil of the solenoid **61'** is energized, its plunger is actuated to position pipe **58** over vessel **50** (FIG. 20) and thus permit dye solution to discharge into the vessel. The solenoid **61'** is electrically controlled so as to remain energized for a period of time sufficient to ensure the filling of vessel **50** with dye solution. When the coil of solenoid **61'** is deenergized, the plunger thereof returns pipe **58** to its normal position (FIG. 19). In the foregoing arrangement, of course, the distal end of pipe **58** must be shortened sufficiently to clear the top of vessel **50**, and vesesl **50** may be formed with a lip **50'** to aid in the discharge of dye solution into said vessel. In such arrangement also, pipe **62** is dispensed with, and a by-pass pipe **62'** may be interposed in pipe **57** below pipe **58**.

As best seen in FIGS. 11 and 12, operating arms **48***a* and **52***a*, respectively, of the valves **48** and **52** are coupled for simultaneous actuation by a link **65**. Arm **52***a* is connected to the spring retracted piston rod **66** of an air air cylinder **67** pivotally suspended from a bracket **68** (FIG. 8) clamped to the branch conduit **46**. Admission of compressed air into the cylinder **67** is controlled by an attached solenoid valve **69** which is in communication, through a branch **70**, with the air pipe **42**. Similarly, the operating arm **49***a* of the valve **49** is connected to the spring retracted piston rod **75** of an air cylinder **76** pivotally suspended from a bracket **77** (FIG. 8) clamped to the branch conduit **47**. Admission of com-

pressed air into the cylinder 76 is controlled by an attached solenoid valve 78 which is in communication, through a sub-branch 79 of the branch 70, with the air pipe 42.

Flow of compressed air into the top of the reservoir 33 by way of the branch pipe 41 is controlled by the electrical system diagrammatically illustrated in FIG. 13 comprising a relay-transformer 81, probe 80, pressure switch 43*a* and solenoid valve 43. The A side of relay-transformer 81 is connected to a source of electric power (not shown in FIG. 13) while its B side is connected to probe 80 and grounded at 82. Compressed air is introduced into reservoir 33 for the purpose of shutting off flow of rinse liquid from pipe 38 and also to facilitate the flow of rinse liquid from reservoir 33 through branch 47 when valve 49 is open. As will be readily understood, when the air pressure in reservoir 33 exceeds the water pressure in pipe 38 check valve 40 will close to shut off further flow from pipe 38. In the event the liquid level of reservoir 33 should rise so as to contact probe 80, as indicated by the dot-dash line in reservoir 33 in FIG. 13, a circuit is completed to the B side of relay-transformer 81 thereby closing the relay thereof. The closing of this relay completes a circuit through pressure switch 43*a* to solenoid valve 43 to open that valve and thereby admit compressed air from pipe 41 into reservoir 33. When the air pressure in reservoir 33 reaches a predetermined amount, sufficient to shut check valve 40, pressure switch 43*a* opens to break the circuit to valve 43 whereupon that valve closes shutting off further flow of compressed air to reservoir 33. The relay of relay-transformer 81 remains closed so long as the rinse liquid remains in contact with probe 80. If, in the meantime, the air pressure in reservoir 33 should drop to a point sufficient to cause check valve 40 to open and admit more rinse liquid to the reservoir, pressure switch 43*a* will again close to complete the circuit to solenoid valve 43 to open that valve and again admit compressed air into reservoir 33.

If desired, the textile finishing compound may be mixed with the rinse liquid as it is discharged from reservoir 33, instead of being mixed with the dye solution. For this purpose, a supply of such finishing compound may be maintained in a tank 195 (FIG. 8) connected to branch 47 by a pipe 196. The amount of finishing compound discharged from tank 195 into branch 47 is controlled by a valve 197.

In FIG. 21 there is shown more detailed means for introducing controlled quantities of the finishing compound into the rinse liquid. Such means includes a venturi 300 connecting pipe 196 to the suction side of pump 105 and a bleeder pipe 301 interposed between the discharge side of pump 105 and the venturi 300. Interposed in pipe 196 are a check valve 302, a needle valve 303 and a solenoid valve 304. Solenoid valve 304 is connected in parallel in the circuit of solenoid valve 49, and thus the two valves will operate simultaneously. By suitable adjustment of needle valve 303, controlled quantities of finishing compound will flow through pipe 196 from tank 195 to venturi 300 when solenoid valve 304 is open. As pump 105 discharges rinse liquid through pipe 100, a small quantity of such liquid is by-passed through bleeder pipe 301 and venturi 300 to the suction side of pump 105. As a result of the venturi action upon the by-passed liquid, the finishing compound in pipe 196 is drawn through the venturi to the suction side of pump 105 where it is mixed with the rinse liquid drawn from reservoir 33.

Liquid Spraying System

As shown in FIGS. 5 and 6, arranged crosswise within the treating chamber 1 at the top thereof are spaced spray manifolds comprising tubes 85 each of which is provided with a series of downwardly directed jet nozzles 86. The tubes 85 are closed at one end and are connected at the other end to a supply manifold 87.

Similarly arranged crosswise within the treating chamber 1 at the back thereof, and at a level somewhat above the bottom of said chamber, is a spray manifold comprising a tube 88 which is provided along both its top and bottom with a series of jet nozzles 89 of the type illustrated in FIG. 10. Tube 88 is closed at one end and is connected at its other end to a downward extension 87*a* of supply manifold 87. As shown in FIG. 10, each nozzle 89 of tube 88 has an elongated body 90 whereof one end is closed and the other end is screwed to an elbow 91 that connects into the tube 88. The nozzle body 90 preferably is disposed in substantially parallel relation to the tube 88, and is formed with axial flow bore 90*a* in communication with tube 88 through elbow 91. Disposed in the body 90 of the nozzle 89 are two axially spaced, elongated, radial spray notches 92 in communication with the axial flow bore 90*a* of the nozzle.

Another spray manifold comprising a tube 95 (FIGS. 3 and 5) also having nozzles 89 of the type shown in FIG. 10 is mounted on the back of the door 2 at the same level as tube 88. Tube 95 is closed at one end and is connected at its other end to a vertical tube 96 secured to the door 2 by straps 97. As best shown in FIG. 5, a fitting 98 at the top of the tube 96 has a protruding nipple which is tapered to engage into the complementally tapered mouth of a fitting 99 at one end of the supply manifold 87 to form a fluid tight connection. Thus, liquid is conveyed from manifold 87 through fittings 99 and 98 to tube 96 for delivery to nozzles 89 of tube 95.

The sprays from the two opposing banks of nozzles 89 are directed toward the forms F in the manner indicated by the broken lines in the lower portion of FIG. 5 and in FIG. 9. The sprays from the nozzles 86 are directed downward toward the forms F in the manner indicated by the broken lines in the upper portion of FIG. 5.

Disposed exteriorly of one side wall of the chamber 1 is a vertical pipe 100 (FIG. 3) which is provided at its upper end with a fitting 101 from which a horizontal branch pipe 102 extends into the chamber 1 for connection to the nozzle supply manifold 87 in the top of said chamber. At its lower end, pipe 100 is connected to the discharge end of a rotary pump 105 which, together with its electric driving motor 107, is mounted on a floor base 106. As shown in FIG. 4, the intake end of the pump 105 is connected by a pipe 108 to the vertical branch 109 which extends down from the well 1*a* in the bottom of treating chamber 1. A solenoid valve 119 is interposed in the pipe 108 between pump 105 and branch 109. Beyond branch 109, pipe 108 is connected to an exhaust pipe 120 by a solenoid valve 121. The horizontal conduit 45 is connected to pipe 108 between pump 105 and valve 119.

The valves 119 and 121 are connected by operating arms 119*a* and 121*a*, respectively, to a common link 250 (FIG. 4) which, in turn, is connected to the spring retracted piston (not shown) of an air cylinder 251. Admission of compressed air from branch 252 of air pipe 42 into cylinder 251 is controlled by a normally closed solenoid valve 253. When valve 253 is closed, the piston of cylinder 251 is retracted to retract link 250 and thereby open valve 121 and close valve 119. When solenoid valve 253 is energized, it opens to admit compressed air into cylinder 251 and thus actuate link 250 to close valve 121 and open valve 119. Thus, valves 119 and 121 operate in tandem, the one always being open while the other is shut, and vice versa.

Surrounding the vertical pipe 100 may be a heat exchanger jacket 110 (FIG. 3) into the top of which steam is introduced by way of a branch pipe 111 leading from a steam supply main 112 under regulative control of a hand valve 113 (FIG. 4). The supply of steam to the heat exchanger 110 is controlled by a solenoid valve 114

(FIG. 4) interposed in the branch pipe **111**. A hand valve **115** is also interposed in pipe **111**. After traversing the heat exchanger **110**, the steam is conducted from the bottom thereof through an exhaust pipe **116**, having a trap **117** interposed therein, to drain pipe **176** and thence to the waste manifold **118**.

In the embodiment of FIGS. 5, 6 and 7, the treating chamber **1** is shown as having internal steam radiators **165** or equivalent heat exchanger means which are arranged vertically along opposite side walls of the chamber and along the back wall thereof on each side of the poppet valves **127, 128**. The radiators **165** are connected at their tops and bottoms by crosswise tubes **166** and **167**, as best seen in FIG. 6. Additionally, in this embodiment, a horizontal radiator **170** also is disposed within the chamber **1** immediately below the roof thereof and is connected by tubes **171** and **172** to the tops of the radiators **165**. Steam is conducted through a pipe **173** and an elbow **175** to the radiator **170** from whence it passes through the tubes **171** and **172** to the radiators **165**. Pipe **173** has a hand valve **174** (FIG. 4) interposed therein and is connected to main steam line **112** by branch pipe **111**. The condensate from the radiators **165** is carried off through a pipe **176** connected to one of the radiators **165** by an elbow **177**. Pipe **176** has a trap **178** (FIG. 3) interposed therein and connects to the waste manifold **118**.

The embodiment of FIGS. 5, 6 and 7 is adapted for the simultaneous scouring, dyeing and heat setting of the textile articles. To ensure proper treatment of the textiles, the sprays of the nozzles **86** and **89** preferably are directed so that a portion of the liquid being sprayed strikes the radiators **165** and thus is vaporized. The vaporization of the dye liquid in this manner brings the heat in chamber **1** up to heat setting temperature which is determined, of course, by the character of the textile articles being treated. If desired, jacket **110** may be dispensed with, in which event the liquids being sprayed would be heated solely by the radiators **165, 170**.

Drying Facilities

As shown in FIG. 5, there are disposed within the back wall of the chamber **1**, adjacent the bottom and top thereof, two spaced tubular housings **125** and **126** for poppet valves **127** and **128**, respectively. The valves **127** and **128** open inwardly and close against the inner ends of their housings **125** and **126**. The stems **129** and **130** of the poppet valves **127** and **128** are slidingly supported in bearings sustained by spiders **131** and **132** disposed within the housings **125** and **126**, respectively.

The valves **127** and **128** are arranged to be actuated by an air cylinder **133** which is pivotally connected to one arm of a bell crank lever **134** fulcrumed at **135** to a lug on the housing **126**. The other arm of the lever **134** extends through a clearance slot **136** in housing **126** and engages between two studs **137** on the stem **130** of the valve **128**. The piston rod **138** of the cylinder **133** is pivotally connected to one arm of another bell crank lever **140** fulcrumed at **141** to a lug on the housing **125**. The other arm of the lever **140** extends through a clearance slot **142** in housing **125** and engages between two studs **143** on the stem **129** of the valve **127**. Affixed to the side of the cylinder **133** is a solenoid valve **145** for controlling admission of compressed air into the top of the cylinder when the poppet valves are to be opened and to the bottom of the cylinder when said valves are to be closed, said solenoid valve being connected by a branch pipe **146** to the air line **42** (FIG. 4).

Connected to the outer end of the housing **126** is a rotary air blower **150** which is arranged to be driven by an electric motor **151** (FIGS. 2, 5). To the inner side of the rear wall of chamber **1** is secured an elongated, transversely-extending, box-like structure **152** which serves as a shroud about the poppet valve **128** and which has a longitudinal slit **153** in its front wall. As best shown in FIG. 7, the shroud **152** is offset at its opposite ends to overlap the rear wall portions of the radiators **165**. Connected to the outer end of the housing **125** is an air exhaust pipe **154** (FIG. 4). When the poppet valves **127** and **128** are open and the blower **150** is started, air is forced past the valve **128** and through the slit **153** of the shroud **152** toward the forms F. The air is diffused upwardly about the forms F to absorb moisture from the textile articles thereon and finally escapes through the open poppet valve **127** to exhaust pipe **154**.

Before reaching the blower **150**, the air is drawn through a vertical casing **155** (FIG. 4) attached to the exterior of one side wall of the treating chamber **1** adjacent the back thereof. The casing **155** has an air inlet opening **156** adjacent the top thereof. Extending down through the casing **155** are finned tubes **157** which, at their upper ends, are connected to the steam supply pipe **112** and which, at their lower ends, are connected to a steam exhaust pipe **160** having a trap **161** interposed therein. Thus, by the means just described, the air is heated before being introduced by the blower **150** into the treating chamber **1**.

While heated air is the preferred drying medium used in the practice of this invention, any equivalent gaseous drying media, including superheated steam, may be utilized.

Start Up

The commencement of the operative cycle of the apparatus is illustrated diagrammatically in FIG. 14. With reservoir **32** and vessel **50** properly filled, valves **35, 55, 61** and **121** are closed and valves **48, 52** and **119** are opened whereby the dye solution in vessel **50** passes through tube **51** into branch **46** where it is mixed with dye diluent from reservoir **32**. The resulting dye mixture passes through valve **48**, conduit **45**, pipe **108**, branch **109** to the well **1***a* in the bottom of chamber **1**.

At the same time, valves **113, 114, 115** and **174** in the steam supply lines **112, 111** and **173** are opened, permitting steam to pass through the heat exchanger jacket **110**, through the radiators **165** and **170** in chamber **1** and through the air heating tubes **157**. Since valve **61** is closed, pump **59** draws dye solution from the bottom of reservoir **31** and circulates it through pipes **56, 57** and **62** directly to the top of reservoir **31**.

Dye Cycle

The dye cycle of the apparatus is diagrammatically illustrated in FIG. 15. After the predetermined quantities of dye solution and dye diluent have been delivered to well **1***a*, valves **48** and **52** are closed, shutting off further flow of these liquids. Valve **61** is opened to permit resumption of delivery of dye solution to vessel **50** by pump **59** and valve **35** is opened to permit resumption of flow of diluent to reservoir **32**.

Following the closing of valves **48** and **52**, the pump **105** is started. The mixture of dye solution and dye diluent is then circulated by pump **105** from well **1***a* through branch **109**, pipe **108**, pump **105**, pipe **100**, branch pipe **102** to the nozzles **86** and **89** via their respective manifolds and supporting tubes. The dye mixture sprayed by the nozzles on the textile articles mounted on the forms F drains to the well **1***a*, from whence it is recirculated by pump **105**, in a closed system, during a time interval sufficient for the proper setting, scouring and dyeing of the articles.

By reason of steam passing through the jacket **110** and the radiators **165** and **170**, a portion of the dye mixture is vaporized, thereby bringing the chamber **1** up to setting temperature. In treating ladies' nylon hosiery, the temperature in the chamber **1** for proper simultaneous setting, scouring and dyeing preferably should be on the order of 230° F. for a dye cycle of two minutes' duration. This temperature range is achieved in practice when the steam passing into pipe **173** is under approxi-

mately 100 pounds pressure and at a temperature of approximately 300° F.

Following the lapse of the time interval required for proper setting, scouring and dyeing, valve **121** is opened and the dye mixture is carried off through exhaust pipe **120**. The dye cycle is now completed.

Rinse Cycle

The rinse cycle of the apparatus takes place next, and is diagrammatically illustrated in FIG. 16. At the completion of the dye cycle, when valve **121** is opened, valve **119** is closed and valve **49** also opens.

Upon the opening of valve **49**, pump **105** draws rinse liquid from tank **33** through branch **47**, conduit **45** and pipe **108** and pumps the rinse liquid through pipe **100** and pipe **102** to the nozzles **86** and **89** where it is sprayed on the textiles mounted on the forms F. The rinse liquid drains to well **1***a* and immediately is exhausted from the chamber **1** through branch **109** and exhaust pipe **120**. Valve **121** remains open during rinsing.

Rinse liquid is pumped to the nozzles **86** and **89** for a predetermined period of time. During the rinse operation, the discharge of rinse liquid into branch **47** causes the air pressure to drop in reservoir **33**, thus permitting check valve **40** to open for resumption of flow of rinse liquid from pipe **38**.

Following the lapse of the predetermined time interval, sufficient to ensure thorough rinsing of the textile articles, valve **49** is closed and the operation of pump **105** ceases. After the remaining rinse liquid is drained from the well **1***a*, valve **121** is closed.

Following the rinse cycle, the drying cycle takes place with the passage of heated air through the chamber **1** in the manner previously described. After a predetermined time interval, the drying cycle is completed, the door **2** opens and the forms F are delivered to their corresponding stationary track for removal of the finished articles.

It is to be noted that both rinsing and drying take place at atmospheric pressure.

Automatic Control Means

An electrical system for automatically controlling the operation of the apparatus is illustrated diagrammatically in FIG. 17. Power is supplied to the system by main lines **225** having a transformer **226** interposed therein. Transformer **226** is electrically connected to the control system through a starting relay **220**.

In describing the operation of the electrical system, it will be assumed that the empty forms F of carriage **13** are positioned on track **11**, to the right of the apparatus, in the manner illustrated in FIG. 1. Door **2** is open with the forms F of carriage **12** positioned on the track section **15** thereof.

Operation of the apparatus is commenced upon the closing of main switch **200** which completes a circuit through relay **221** to the motor **60** of the dye circulating pump **59**. Pump **59** commences circulation of dye solution from the bottom of reservoir **31** through pipes **56**, **57** and **58** to the vessel **50**.

Next, starting switch **201** is closed to complete a circuit to the starting relay **220** which thereupon closes. Relay **220** remains closed throughout the operation of the apparatus. The closing of relay **220** completes a circuit through temperature switch **219** to steam solenoid valve **114** and thereby opens that valve. With the hand valves also open, steam passes through supply main **112** and pipes **111** and **173** to the heat exchanger jacket **110**, radiators **165** and **170** and air heating tubes **157**.

The closing of relay **220** also completes several other circuits. A circuit is completed through a contact of dye timer **207** to solenoid valve **253** to open that valve. As a result, compressed air is admitted to cylinder **251** to actuate the piston rod thereof and link **250** to open valve **119** and close valve **121** simultaneously. A circuit also is completed through a contact of relay **217** and through time delay relay **203** to solenoid valves **35** and **61**. After a predetermined period of time, sufficient to ensure the filling of dye diluent tank **32** and dye solution vessel **50**, valves **35** and **61** are closed by time delay relay **203**, thereby shutting off flow of dye solution to vessel **50** and flow of dye diluent to reservoir **32**. At the moment that time delay relay **203** closes valves **35** and **61**, it completes a circuit to the coil of relay **217**, whereupon relay **217** closes. The closing of relay **217** completes a circuit through time delay relay **202** to solenoid valve **69** whereby valve **69** is opened to permit passage of compressed air into the cylinder **67**. The entry of compressed air into cylinder **67**, as shown in FIG. 11, depresses piston rod **66** to open dye diluent supply valve **48** and dye solution supply valve **52** and permit these liquids to discharge to chamber well **1***a*.

Valves **48** and **52** remain open for a predetermined period of time under the control of time delay relay **202** after which they are closed. Meanwhile, valves **35** and **61** remain closed for a predetermined period of time under the control of time delay relay **203** following which they are opened. Valves **35** and **61** do not open until after valves **48** and **52** have been closed.

The forms F of carriage **13** now are loaded with the textile articles which are to be treated. Following loading, switch **204** is pressed to complete a circuit through relay **205** to conveyor motor **21** which operates to move carriage **13** to the left, as viewed in FIG. 1, onto track section **15** of door **2**. At the same time, the forms F of carriage **12** are moved from track section **15** onto stationary track **10**. The closing of switch **204** also completes a circuit to relay **223** which thereupon closes.

As the loaded forms F of carriage **13** move onto track section **15**, they actuate track limit switch **22** to open the circuit to motor **21**, thereby halting the carriage **13**, in its collapsed condition, on track section **15**. The actuation of limit switch **22** closes a circuit through relays **223** and **206** to door motor **8** whereupon that motor operates to close door **2** through the interposition of rack and gear **7**.

When door **2** closes, it actuates switch **25** to open the circuit to motor **8** and stop that motor. The actuation of switch **25** sets up an open circuit through temperature switch **219** and relays **240** and **241** to the motor M of the dye timer **207**. Following the closing of door **2**, the temperature in chamber **1** rises rapidly. When this temperature rise reaches a predetermined point, sufficient for proper setting, scouring and dyeing of the textile articles, temperature switch **219** is actuated to open the circuit to solenoid valve **114**, thus closing that valve to shut off further flow of steam. The actuation of switch **219** also energizes the circuit through relays **240** and **241** to the motor M of dye timer **207** to start that motor and thus commence the dye cycle. Should the temperature in chamber **1** drop to a predetermined low point, switch **219** is thereupon actuated to close the circuit to solenoid valve **114** to open that valve and again admit steam to the radiators **165** and **170** and the jacket **110**. The actuation of switch **219**, as a result of the temperature drop in chamber **1**, deenergizes and hence opens relay **240**. Because of relay **241**, however, a circuit to the motor M of the dye timer is maintained, and thus the dye cycle is not interrupted.

In addition to the foregoing, the actuation of switch **25** by door **2** completes a circuit through a contact of rinse timer **209** and relay **208** to the nozzle pump motor **107** to start pump **105**. With valves **48** and **52** now closed (by time delay relay **202**), pump **105** continuously circulates the mixture of dye solution and dye diluent from well **1***a* to the nozzles **86** and **89**.

The closing of switch **25** also completes a circuit to time delay relay **203** which opens valves **35** and **61** to resupply dye diluent to reservoir **32** and dye solution to vessel **50**, in the manner diagrammatically illustrated in FIG. 15.

Upon termination of the dye cycle, timer **207** opens the circuit to solenoid valve **253** to close that valve and

thereby open exhaust valve 121 and simultaneously close nozzle pump valve 119. At the same time, timer 207 closes a circuit to the motor M of rinse timer 209 to start that timer. A contact of timer 209 now closes to complete a circuit to solenoid valve 78 and thereupon open that valve. As shown in FIG. 12, compressed air passes through valve 78 into cylinder 76 to thereby depress piston rod 75 and open rinse liquid supply valve 49.

Pump 105 now pumps rinse liquid through the nozzles 86 and 89 in the manner diagrammatically illustrated in FIG. 16. With valve 121 open, the rinse liquid is drained of through exhaust pipe 120. Pump 105 continues to pump rinse liquid for a predetermined period of time under the control of rinse timer 209.

At the close of the rinse cycle, solenoid valve 78 is closed under the influence of rinse timer 209, whereupon the supply of compressed air to cylinder 76 is closed off resulting in the closing of rinse liquid supply valve 49. At the same time, the circuit to motor 107 is opened by rinse timer 209 to stop pump 105.

A pressure switch 210 (FIG. 1) remains open so long as the pressure in chamber 1 remains above atmospheric pressure. Following completion of the rinse cycle, pressure in the chamber 1 drops to atmospheric pressure whereupon switch 210 closes to complete a circuit to solenoid 145 and thereby open poppet valves 127 and 128. The closing of switch 210 also completes a circuit through timer 209 to time delay relay 211 which, after an interval sufficient to permit complete exhaustion of steam and condensation from chamber 1, closes the circuit to the motor M of the dry timer 212. Timer 212, through a contact thereof, closes a circuit to solenoid valve 253 to operate that valve to close exhaust valve 121 and open valve 119, and through a different contact thereof closes a circuit through relay 213 to blower motor 151 to thereby start the hot air blower 150. Hot air is blown into the chamber 1 through poppet valve 128 for a predetermined period of time under the control of timer 212. At the close of the drying period, timer 212 opens the circuit to blower motor 151 to stop the blower 150.

Simultaneously, with the opening of the blower motor circuit, a contact is closed in timer 212 to complete a reverse circuit through relay 214 to door motor 8 to start that motor and thereby open door 2. As door 2 opens, switch 25 is actuated to complete a circuit through relay 217 and time delay relay 203 to thereby close valves 35 and 61 for a predetermined period of time. The actuation of switch 25 by door 2 also completes a circuit through relay 217 and time delay relay 202 to solenoid valve 69 to open that valve and thereby open dye diluent supply valve 48 and dye solution supply valve 52 to furnish a new supply of dye mixture to well 1*a* of chamber 1. As mentioned above, after a predetermined period of time, valves 48 and 52 are closed under the influence of relay 202.

When door 2 is fully opened, it opens switch 24 and closes door safety switch 216 (FIGS. 1 and 2). The opening of switch 24 opens the circuit to solenoid valve 145, thereby closing poppet valves 127 and 128, and opens the circuit to door motor 8 to stop that motor. The closing of switch 216 completes a circuit through relay 218 to close relay 224 in preparation for the next operative cycle, which begins by again pressing switch 204.

Stop switches 227 and 228 (FIG. 1) are provided to stop the operation of the apparatus at any time during its operative cycle.

The circuit for controlling the admission of compressed air into reservoir 33 has been explained previously. As will be seen in FIG. 17, this circuit is connected to the transformer 226.

Modified Treating Chamber

In FIG. 18 there is shown a modified construction of the treating chamber 1 together with a partial diagrammatic illustration of a modified electrical control system whereby the dyeing and heat setting operations may be carried out separately. In the chamber of FIG. 18, the radiators 165 and 170 and the steam jacket 110 are omitted and the steam supply line 111 is directly connected, through solenoid valve 114, to steam manifolds 310 and 311 disposed internally of the chamber 1 above the spray manifolds 85. The steam manifolds preferably are mounted at right angles to each other and are each formed with a plurality of ports 312 for the emission of steam into the chamber 1. In addition to temperature switch 219, a second temperature switch 313 is disposed within chamber 1. Switch 313 is electrically connected to dye timer 207, switch 219, solenoid valve 114 and a steam timer 315.

As will be readily understood, the electrical control system of the embodiment in FIG. 18 is modified so that the steam solenoid valve 114 remains closed until door 2 of the chamber 1 is closed. Upon the closing of the door 2, switch 25 is actuated to open the valve 114 at the same time that it starts pump 105. Thus, steam is introduced into chamber 1 through the ports 312 as soon as spraying of the dye solution commences. When the steam temperature in chamber 1 reaches a predetermined level, sufficient for proper scouring and dyeing (and finishing, if desired) of the textile articles, temperature switch 219 is actuated to open the circuit to valve 114 to close that valve and shut off further flow of steam to the chamber. At the same time, switch 219 starts the motor of the dye timer 207 to commence the dye cycle. In the manner previously described, switch 219 will maintain the steam temperature in chamber 1 within predetermined limits during the dye cycle.

Upon termination of the dye cycle, timer 207 closes a circuit to temperature control switch 313 to thereby complete a circuit to solenoid valve 114, whereupon valve 114 opens to again introduce steam from pipe 111 into chamber 1. After the steam temperature in chamber 1 reaches a predetermined level, sufficient for proper heat setting of the textile articles, temperature switch 313 is actuated to open the circuit to valve 114 to close that valve and shut off further flow of steam to the chamber. At the same time, switch 313 starts the motor of the steam timer 315 to commence the heat setting cycle. In a manner similar to that previously described with respect to switch 219, temperature switch 313 will maintain the steam temperature in chamber 1 within predetermined limits during the heat setting cycle.

During the heat setting cycle, valve 121 remains closed and the dye solution in the chamber drains to the well 1*a*. Upon termination of the heat setting cycle, the steam timer 315 closes the circuit to the motor of the rinse timer 209 to start that timer and commence the rinse cycle. The operation of the apparatus proceeds in the manner previously described. In the operation of the embodiment of FIG. 18, the steam solenoid valve 114 remains closed during the rinse cycle, and the rinse liquid is sprayed upon the textile articles in an unheated condition with valve 121 open. If desired, the rinse cycle may follow immediately upon the dye cycle, in which event valve 121 is opened at the close of the dye cycle and then is closed upon commencement of the heat setting cycle.

It has been found in practice that improved results often are obtained when dyeing takes place at a temperature lower than that utilized during heat setting. For example, in the treating of ladies' nylon hosiery, highly satisfactory results have been achieved when the steam temperature is maintained at approximately 220° F. during the dye cycle and at approximately 240° F. during the heat setting cycle. During the dye cycle, with the steam temperature at approximately 220° F., a partial setting of the hosiery takes place, resulting in the stabilization of the loop formations of the fabrics. Such partial setting does not, however, effect the boarding or setting necessary to place the hosiery in marketable condition.

Second Modification of the Treating Chamber

In FIGS. 22, 23 and 24 there is shown a second modified construction of the treating chamber **1**, together with a modification of the liquid spraying system. In the chamber of FIG. 22, the radiators **165** and **170** and the steam jacket **110** are omitted, and the steam supply line **111** is directly connected, through solenoid valve **114** and check valve **400**, to the pipe **100** by means of a Y fitting **401**. In this embodiment pipe **100** and pump **105** are disposed at the back of chamber **1**. Pipe **100** enters chamber **1** through a fluid tight opening **402** and is connected, by a T fitting **403**, to a horizontal pipe **404** extending along the inside of one side wall of the chamber **1**. It will be understood, of course, that the drying facilities and other portions of the apparatus are not shown in FIG. 22 in order to simplify explanation of the modification shown.

Pipe **404** is connected at its rear end, by means of a fitting **405**, to a vertical supply manifold **407** mounted on the back wall of chamber **1**. Connected to the supply manifold **407** are three horizontal, vertically spaced spray manifolds **408**, each of which is provided with a series of jet nozzles of the type **86** shown in FIG. 5. The spray manifolds **408** are also connected to a second vertical supply manifold **409** spaced from manifold **407**. A horizontal pipe **410** connects the two supply manifolds **407** and **409** above the spray manifolds **408**, and serves as a bypass between the two supply manifolds. By means of the bypass **410**, fluid enters manifolds **408** from both manifolds **407** and **409**, whereby fluid pressure at the nozzles **86** will be equalized, resulting in uniform spraying of liquid from all the nozzles. It will be noted that manifolds **408** and **409** and bypass **410** are also mounted on the rear wall of chamber **1**.

The forward end of pipe **404** is connected to the fitting **99**, such fitting, as previously explained, being provided with a tapered mouth for fluid tight engagement with the complementally shaped protruding nipple of the fitting **98** when door **2** is closed. A T connection **412** connects fitting **98** to a vertical supply manifold **413** secured to the inside of door **2**. Supply manifold **413** is connected to three horizontal, vertically spaced spray manifolds **414** which are suitably secured to the inside of chamber door **2**. A horizontal bypass pipe **415** connects supply manifold **413** to a second vertical supply manifold **417** mounted on the inside of door **2**. The spray manifolds **414** are also connected to the supply manifold **417**. Thus, by means of bypass pipe **415**, fluid is delivered to nozzles **86** by both manifolds **413** and **417**, and liquid pressure at the nozzles **86** is equalized to produce uniform spraying pressures.

As best shown in FIG. 23, the nozzles **86** of this embodiment of the invention are positioned to direct their sprays downwardly at an acute angle to the vertical. The incidence of such spray angle to the vertical is dependent upon the type, height, size and other characteristics of the boarding forms upon which the textile articles are mounted. It is important, however, that the uppermost of the opposing spray manifolds **408**, **414** be disposed above the tops of the forms F, to ensure that the articles on such forms will be thoroughly and uniformly sprayed by the liquors emitted from the nozzles **86**. It is to be noted from FIGS. 22 and 23 that all overhead spray manifolds **85** are omitted from the chamber **1**, and that the spray nozzles **86** are mounted on opposite sides of the chamber in opposing relation to each other.

In FIG. 24 there is shown an enlarged sectional view of the juncture of steam line **111** with the discharge line **100** from pump **105** by means of Y fitting **401**. Steam line **111** is secured to fitting **401** by a fitting **418**, while pipe **100** is directly secured to opposing ends of fitting **401**. A nipple **419** is secured to the distal end of steam line **111**, internally of Y fitting **401**, and extends telescopically upward within pipe **100**. Thus, steam passing through steam line **111** and nipple **419** will pass into pipe **100** in the direction of flow of the liquid therein. By this means, steam from line **111** will serve to heat liquids passing through the pipe **100** to the nozzles **86**. It is important that the clearance between the inside diameter of pipe **100** and the outside diameter of nipple **419** be such as not to constrict the flow of liquid through pipe **100**, for otherwise "bucking" of the liquor in pipe **100** will result.

In practice, it is preferred that steam solenoid valve **114** remain closed until door **2** of the chamber **1** is closed. Upon the closing of the door **2**, switch **25** is actuated to open the valve **114** at the same time that it starts pump **105**. Thus, steam is introduced through steam line **111** and nipple **419** into pipe **700** as soon as pumping of the dye solution through pipe **100** commences. As the dye solution circulates through the liquid spraying system, it is heated by the steam. When the temperature of the dye solution reaches a predetermined level, sufficient for proper dyeing of the textile articles, temperature switch **219** is actuated to open the circuit to valve **114** to close that valve and shut off further flow of steam to the dye solution pipe **100**. At the same time, switch **219** starts the motor of the dye timer **207** to commence the dye cycle. In a manner similar to that previously described, switch **219** will maintain the temperature of the dye solution sprayed into chamber **1** within predetermined limits during the dye cycle to ensure proper dyeing.

Upon termination of the dye cycle, heat setting of the textile articles on the forms takes place in a manner similar to that described with respect to the modification shown in FIG. 18. More specifically, following the dye cycle, with pump **105** shut off, solenoid valve **114** is again opened, by the appropriate controls previously described, to permit steam to be introduced through steam line **111** directly into chamber **1** by way of pipe **100**, pipe **404**, the supply and spray manifolds in chamber **1** and the nozzles **86**. Heat setting of the textile articles takes place, preferably at a temperature higher than that maintained during dyeing, for a predetermined period of time under the control of the steam timer **315** (FIG. 18). Following heat setting, rinsing and drying take place, and the apparatus otherwise functions in the manner previously described.

In most cases it is preferable that the rinse liquid be sprayed on the textile articles on the forms at room temperature. This results in cooling of the forms F, and tends to prolong the drying period as a result. In order to shorten the drying period, control means of the type previously described may be incorporated into various modifications of this invention to introduce steam once again into the chamber **1**, for a brief period of time following rinsing, to reheat the forms F. With the apparatus shown in FIG. 22, where steam is introduced by way of nozzles **86** into chamber **1**, it has been found that the reheating period requires only about five seconds to heat the forms F to a temperature sufficient to expedite the drying of the textile articles thereon. Alternatively, rinsing may follow dyeing and precede heat setting. In such event, the forms F are reheated by the steam which effects heat setting, thereby expediting the drying of the textile articles. In all embodiments, both rinsing and drying take place at atmospheric pressure.

If desired, the modifications of FIGS. 18 and 22 may be provided with control means to permit the introduction of steam into the chamber **1** prior to the commencement of circulation of the dye solution to effect a partial setting of the textile articles. Such partial setting would be subject to electrical time and temperature controls of the type previously described, to permit the introduction of steam into the chamber in such manner as to maintain an appropriate presetting temperature for a predetermined period of time. Also, if desired, the modifications of FIGS. 18 and 22 may each be used solely as preboarding machines for the purpose of heat setting the textile articles only. Only minor adjustments to the machine controls are required to use such modifications either as pre-

boarders for heat setting purposes only, or as dye-boarders for the complete finishing of the textile articles.

While certain preferred embodiments of this invention have been described in detail, it will be obvious to one skilled in the art that various modifications may be made therein without departing from the invention as hereinafter claimed. For example, when textile articles other than hosiery are treated in the chamber **1**, the shroud **152** disposed about the poppet valve **128** may be eliminated. The shroud **152** with the slit **153** therein is particularly adapted to the drying of hosiery since it concentrates the flow of heated air about the welts of the stockings which, due to the doubled fabric thereof, contain more moisture than the other portions of the stockings. The concentration of heated air in this manner expedites the drying of the stocking welts.

It will be readily apparent to one skilled in the art that with the present invention it will be possible to introduce textile articles in the greige into the treating chamber **1** and, following the complete operative cycle of the apparatus, to remove such articles in a completely finished condition ready for packaging and sale.

Having thus described our invention, we claim:

1. In textile treating apparatus, for heat setting and finishing textile articles while mounted on shaping forms, having a chamber with a well disposed at the bottom thereof, a plurality of shaping forms for textile articles, means for introducing the shaping forms, with textile articles mounted thereon, into the chamber and then closing the chamber to the atmosphere, and an automatic spraying system, including a pump and piping connecting the well with a set of nozzles in the chamber, for spraying predetermined quantities of a plurality of treating liquids in sequential relationship on the textile articles mounted on the forms,
   (1) a reservoir for containment of a treating solution,
   (2) a reservoir for containment of a diluent,
   (3) conduit means connecting the reservoirs to the well,
   (4) normally closed valve means in said conduit means and
   (5) an automatic control system operative to open the valve means for release of selected quantities of the treating solution and diluent to intermix in the conduit means en route to the well to form a treating liquid and thereafter to close the valve means and, following closing the valve means and of the chamber to the atmosphere, to start the pump for circulation of said treating liquid between the well and the nozzles for a predetermined time interval.

2. The apparatus of claim 1 further including
   (1) a supply of rinse liquid,
   (2) conduit means connecting the rinse liquid supply to the nozzles,
   (3) a normally closed valve in said conduit means and
   (4) an automatic control system operative to open the valve for release of a selected quantity of rinse liquid for delivery to the nozzles, following termination of the time interval, and thereafter to close said valve.

3. In textile treating apparatus, for heat setting and finishing textile articles while mounted on shaping forms, having a chamber with a well disposed at the bottom thereof, a plurality of shaping forms for textile articles, means for introducing the shaping forms, with textile articles mounted thereon, into the chamber and then closing the chamber to the atmosphere, and an automatic spraying system, including a pump and piping connecting the well with a set of nozzles in the chamber, for spraying predetermined quantities of a plurality of treating liquids in sequential relationship on the textile articles mounted on the forms,
   (1) a reservoir for containment of a treating solution,
   (2) a measuring vessel for the treating solution,
   (3) means for delivering treating solution from said reservoir to the measuring vessel,
   (4) a reservoir for containment of a diluent,
   (5) a conduit connecting the diluent reservoir to the well,
   (6) a normally closed valve in said conduit,
   (7) a conduit connecting the measuring vessel with the first mentioned conduit,
   (8) a normally closed valve in the second mentioned conduit and
   (9) an automatic control system operative to open both valves for release of selected quantities of the treating solution and diluent to intermix in the first mentioned conduit en route to the well to form a treating liquid and thereafter to close the valves and, following closing of the valves and of the chamber to the atmosphere, to start the pump for circulation of said treating liquid between the well and the nozzles for a predetermined time interval.

4. In a textile treating machine, for heat setting and finishing textile articles while mounted on shaping forms, having a chamber for containment of the shaping forms, a well below said chamber and a plurality of nozzles in the chamber for spraying liquids on textile articles mounted on the forms,
   (1) dye liquid supply and control means for furnishing a predetermined quantity of dye liquid to the chamber well,
   (2) rinse liquid supply and control means for furnishing a predetermined quantity of rinse liquid to the nozzles,
   (3) steam supply and control means for furnishing steam to the chamber to heat set the articles to final shape,
   (4) first automatic control means operative to continuously circulate the dye liquid from the well to the nozzles for a period of time sufficient to dye the articles,
   (5) second automatic control means, responsive to termination of circulation of the dye liquid, operative to spray the articles with the rinse liquid following circulation of the dye liquid and
   (6) third automatic control means, responsive to termination of spraying of the rinse liquid, operative to introduce steam into the chamber to heat set the articles to final shape following spraying of the rinse liquid.

5. The machine of claim 4 further including
   (1) a reservoir for containment of a dye solution,
   (2) a second reservoir for containment of a diluent for the dye solution and
   (3) automatic control means operative to release selected quantities of the dye solution and diluent from their respective reservoirs to intermix en route to the well to form the dye liquid, and thereafter to close the chamber to the atmosphere and commence circulation of the dye liquid from the well to the nozzles.

6. The machine of claim 4 further including conduit means for introducing steam into the dye liquid as it circulates from the well to the nozzles.

7. In a textile treating machine, for heat setting and finishing textile articles while mounted on shaping forms, having a chamber for containment of the shaping forms, a well below said chamber and a plurality of nozzles in the chamber for spraying liquids on textile articles mounted on the forms,
   (1) dye liquid supply and control means for furnishing a predetermined quantity of dye liquid to the chamber well,
   (2) rinse liquid supply and control means for furnishing a predetermined quantity of rinse liquid to the nozzles,
   (3) steam supply and control means for furnishing steam to the chamber to heat set the articles to final shape,

(4) first automatic control means operative to continuously circulate the dye liquid from the well to the nozzles for a period of time sufficient to dye the articles,

(5) second automatic control means, responsive to termination of circulation of the dye liquid, operative to introduce steam into the chamber to heat set the articles to final shape following circulation of the dye liquid and

(6) third automatic control means, responsive to completion of heat setting of the articles, operative to spray the articles with the rinse liquid following heat setting of the articles to final shape.

References Cited in the file of this patent

UNITED STATES PATENTS

1,271,549 Dudley ---------- July 9, 1918
1,646,142 Fassio ---------- Oct. 18, 1927
2,219,663 Schuster ---------- Oct. 29, 1940
2,321,452 Berger et al. ---------- June 8, 1943
2,333,160 Dunn ---------- Nov. 2, 1943
2,572,893 Richter ---------- Oct. 30, 1951
2,630,694 Creswick ---------- Mar. 10, 1953
2,641,120 Bailey ---------- June 9, 1953
2,678,868 Drum ---------- May 18, 1954
2,736,105 Berger et al. ---------- Feb. 28, 1956
2,750,781 Bailey ---------- June 19, 1956
2,856,108 Richter ---------- Oct. 14, 1958
2,857,922 Effinger ---------- Oct. 28, 1958
2,915,230 Brewin et al. ---------- Dec. 1, 1959
2,985,502 Kronsbein et al. ---------- May 23, 1961
2,990,087 Brewin et al. ---------- June 27, 1961
3,022,926 Bailey ---------- Feb. 27, 1962