C. F. HOPEWELL.

FABRIC COATING, DRYING, AND SOLVENT RECOVERY APPARATUS.

APPLICATION FILED OCT. 27, 1911.

1,212,643. Patented Jan. 16, 1917.

4 SHEETS—SHEET 1.

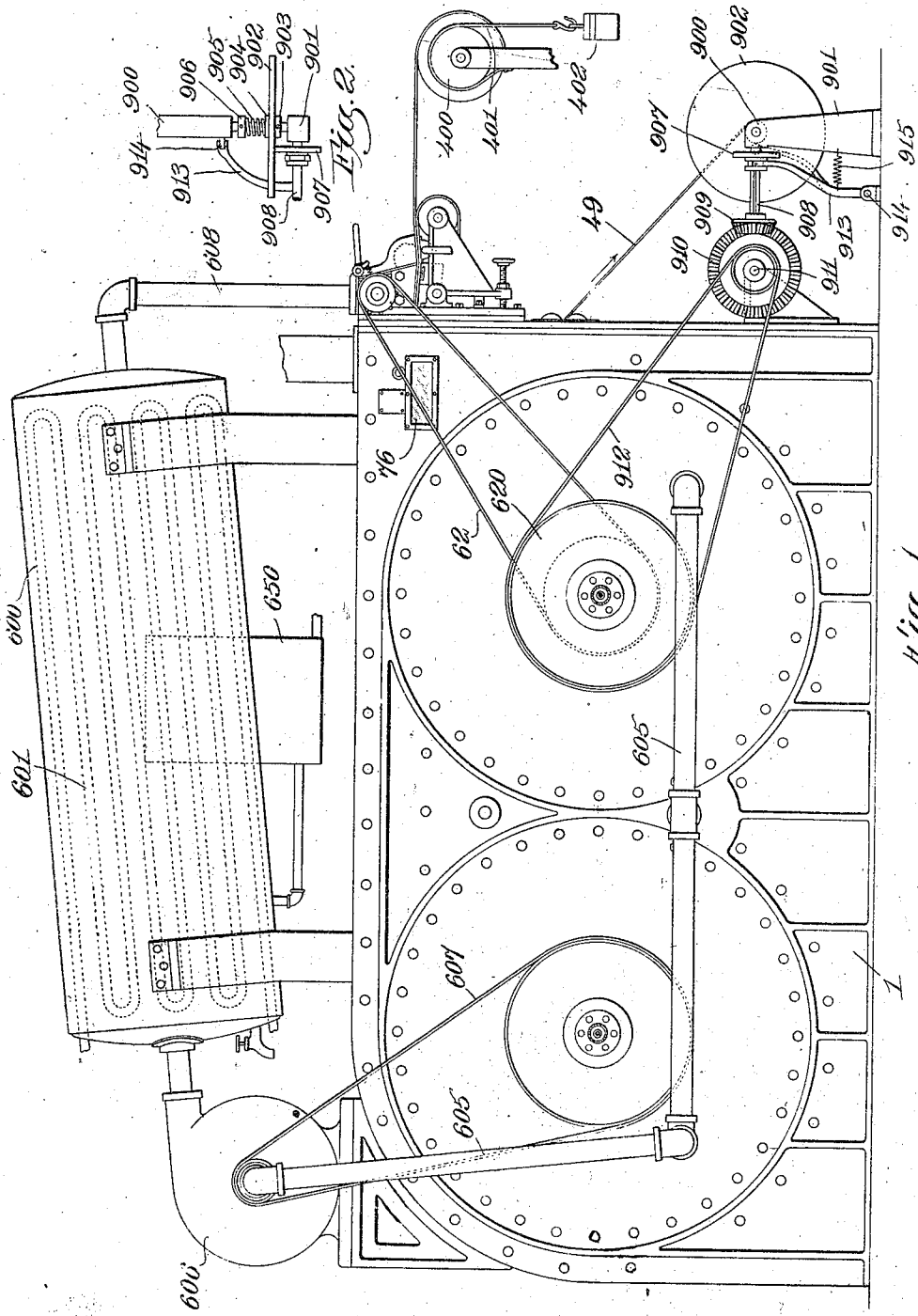


Fig. 1.

Fig. 2.

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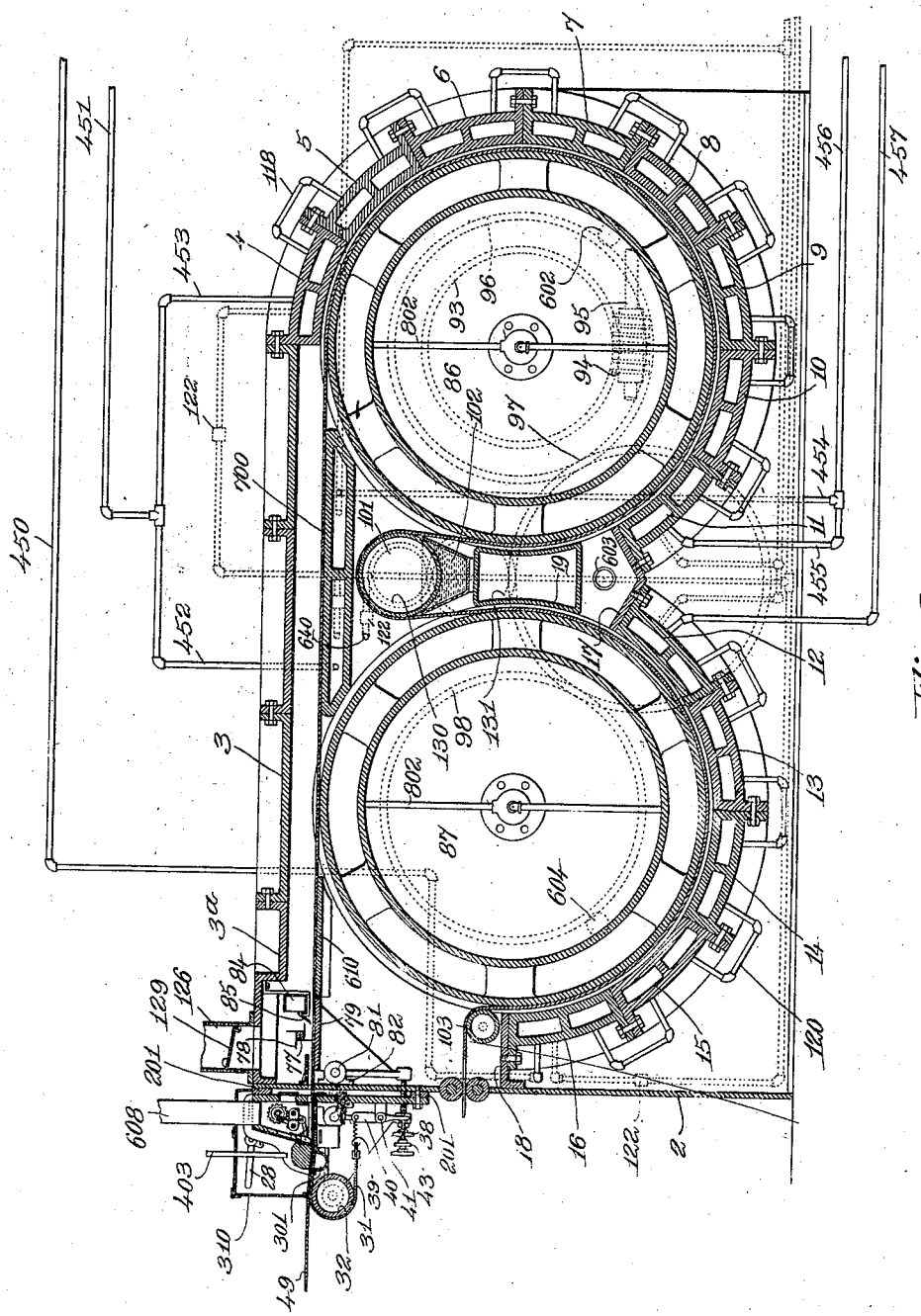


Fig. 3

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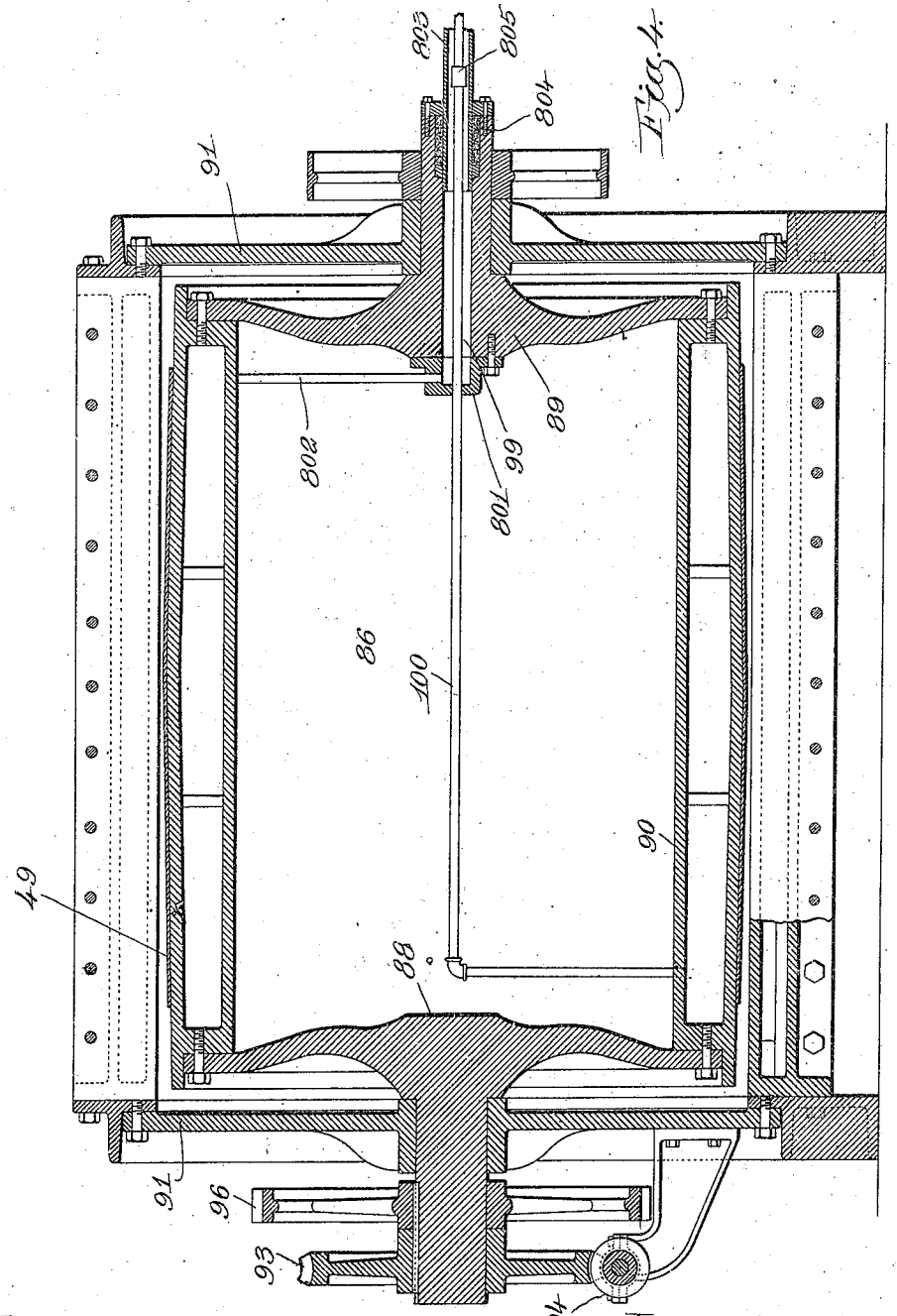
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4 SHEETS—SHEET 3.

Fig. 4.



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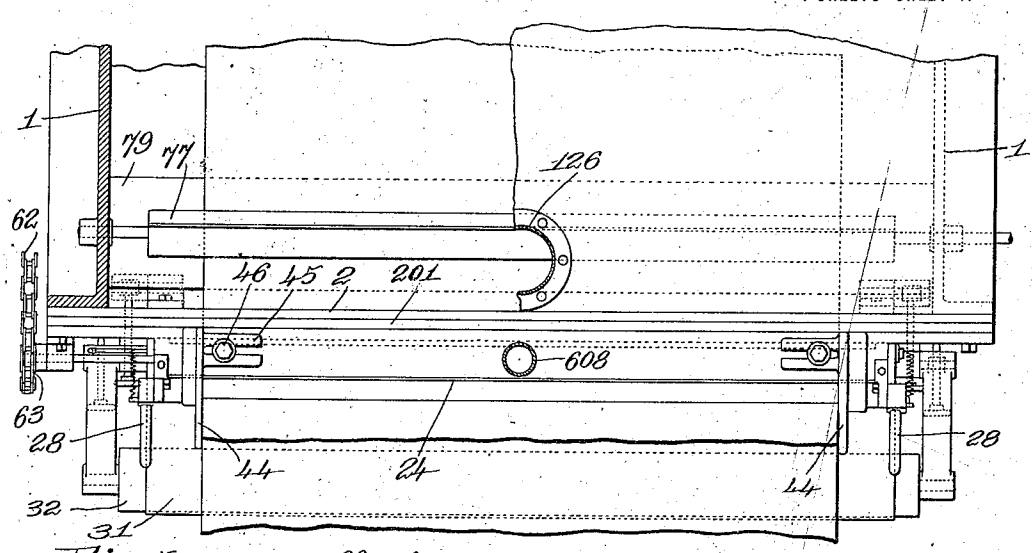


Fig. 5.

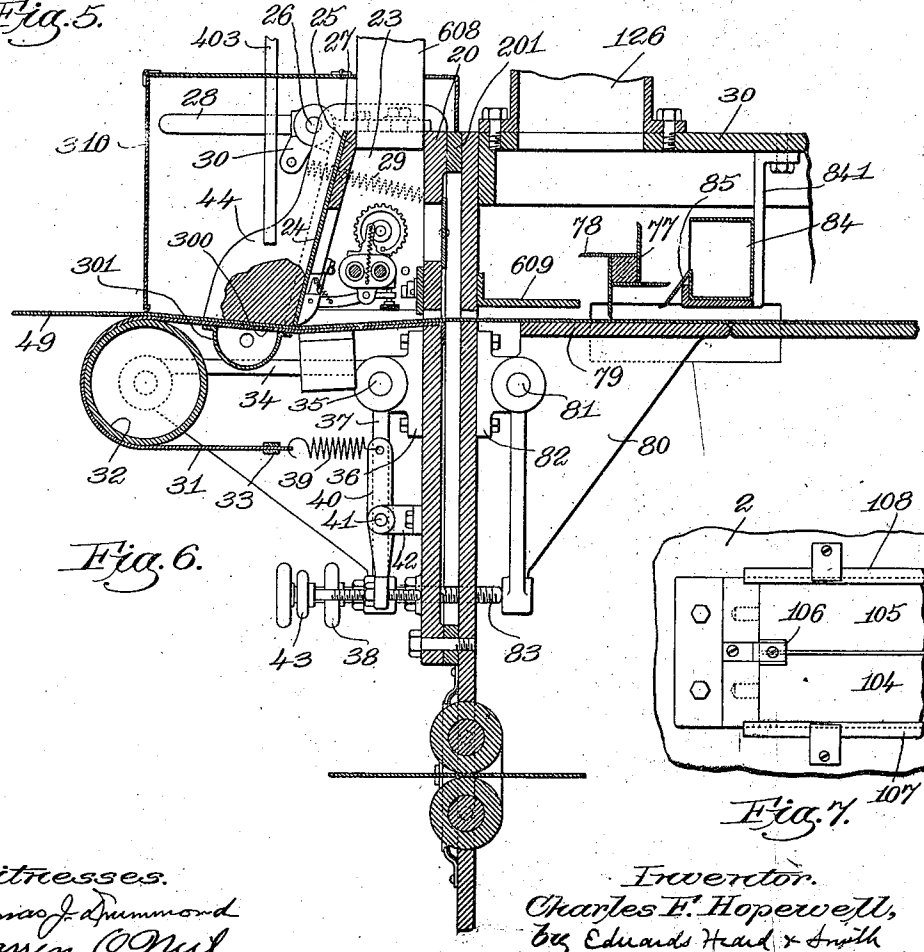


Fig. 6.

Fig. 7.

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UNITED STATES PATENT OFFICE.

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FABRIC COATING, DRYING, AND SOLVENT-RECOVERY APPARATUS.

1,212,643. Specification of Letters Patent. Patented Jan. 16, 1917.

Application filed October 27, 1911. Serial No. 657,176.

To all whom it may concern:

Be it known that I, CHARLES F. HOPEWELL, a citizen of the United States, residing at Newton, county of Middlesex, State of Massachusetts, have invented an Improvement in Fabric Coating, Drying, and Solvent-Recovery Apparatus, of which the following description, in connection with the accompanying drawing, is a specification, like characters on the drawing representing like parts.

This invention has for its object to provide an apparatus for drying coated fabric in which the coating composition contains solvents which are usually lost in drying, but which are of value when recovered, and to reclaim these solvents so that they may be used again or for any other desired purpose.

The invention provides an apparatus in which air is practically eliminated as a drying or absorbing agent, and in which the only material function of the air entering the apparatus is to equalize external and internal pressures upon and within the vaporizer. This renders the apparatus of high efficiency because no useless heat is required to heat the air and because the consequent loss by refrigeration is proportionately lessened.

In the apparatus of this invention heating is performed by direct contact or by immediate proximity instead of by air convection and preferably rotary mangles are employed enabling the drying operation to be carried on at maximum speed.

The apparatus also involves means for applying the heat at successively higher degrees of temperature, thus gradually heating the fabric to the maximum temperature without injuring the fabric by the sudden formation of steam or vapor. In the apparatus the heat is also chiefly applied from the back of the fabric and drying is thus from the back to the face of the coating.

The apparatus also provides means for controlling the feed of the fabric so as to maintain it in smooth and taut condition longitudinally and laterally, or throughout its surface as it passes therethrough. For this purpose suitable let-off and take-up devices are provided, the goods are fed at constant speed, and the mangles are crowned on their peripheral surfaces.

In this apparatus danger from explosion due to static differences of electric potential are practically eliminated because the apparatus is made of metal and grounded by its connection through the heating circulatory systems. In addition provision may be made for the discharge of a jet of steam into the apparatus, and safety devices are provided allowing gases from any possible explosion to pass into a flue without injury to the apparatus.

The apparatus provides for the drying of the entire length of the fabric by the use of a wrapper or apron, which being attached to the end of the fabric allows the entire length to pass through the machine, and which remains in the machine to enable subsequent lengths to be drawn in.

The apparatus is further so arranged that the fabric enters and leaves at the same end.

The apparatus is entirely automatic in its action, so that a minimum amount of attendance is required.

The apparatus also provides for the coating of the fabric just prior to its entrance to the vaporizing chamber, which also preferably serves as means for sealing the entrance to the vaporizing chamber against the passage of vapor or air out of or into the chamber.

Viewed as an entirety the apparatus handles the entire operation automatically in a minimum amount of space, with a maximum amount of efficiency, and with a minimum amount of labor.

These and other features of the invention will more fully appear from the accompanying description and drawings, which illustrate the preferred but not the only form of apparatus embodying the invention, and will be more particularly pointed out in the appended claims.

The drawings illustrate the preferred form of apparatus embodying the invention, but it is obvious that the invention is not to be restricted to the particular construction and arrangement illustrated.

Various changes may be made in accordance with the principles of the invention set forth in the specification and within the limits defined by the claims.

In the drawings: Figure 1 is a side elevation of the apparatus embodying the invention. Fig. 2 is a detail in plan of a portion of the take-up roll and its driving mechanism. Fig. 3 is a central vertical cross section of the construction shown in Fig. 1, omitting the condenser, let-off and take-up. Fig. 4 is a transverse vertical cross section

of the vaporizing box taken through the axis of the rear mangle. Fig. 5 is a top plan view partially in cross section of the forward end of the apparatus with the hood covering the spreading devices removed. Fig. 6 is an enlarged detail view in vertical cross section of the forward upper portion of the construction shown in Fig. 3. Fig. 7 is an enlarged detail in front elevation showing the construction for sealing the lower opening for the fabric of the vaporizing box.

The vaporizing box through which the fabric is passed and in which the fabric is heated to dry the coating, is constructed to inclose a space for the collection of the evaporated vapors which shall be of a minimum size in order to secure efficiency and economy. In the construction illustrated the vaporizing box is shown as a generally rectangular elongated box, while the heating appliance comprises a pair of heated rotary mangles comprising rotary heated drums and coöperating heated backing plates. These mangles located in the box reduce the size of the chamber and the chamber is still further reduced in its size by other devices which will appear. The vaporizing box is preferably made of boiler iron or other suitable metallic construction, so that it is of sufficient strength to protect the operator from any minor explosion which might possibly occur, and it is also provided with an automatically acting vent pipe to relieve the pressure due to an explosion. In the preferred form of the device hot water is circulated through the rotary mangles and backing plates, and this stream of water circulating through the metallic construction of the vaporizing box serves as a ground connection to dissipate any differences of potential which may take place in the operation of the device, and which would otherwise lead to the formation of electric sparks, but other positive grounding connections may be made if desired. In addition a steam jet is provided to spray the steam into the vaporizing chamber to guard against danger from electric sparks. The comparatively small size of the vaporizing chamber, the small quantity of air present in the chamber and the safeguards employed render an explosion of any consequence well nigh impossible.

While the apparatus is preferably heated by hot water, steam may be employed, and the construction illustrated is practically equally available for use with either heating agent. Other heating agents may be employed so long as the elements of the apparatus are heated to the required degree, which is usually not over 180 degrees in the drying of fabric coated with a composition containing one or more volatile solvents. While the heating elements are shown as two heated rotary mangles and suitably disposed backing plates, the number and character of these elements may be varied, provided that the essential feature of drying the fabric from the back out through the coating by direct or radiated heat as distinguished from air convection, is retained.

In the particular construction illustrated the vaporizing box comprises vertical ribbed side plates 1, resting upon the floor or other suitable support, and secured together at their forward ends by a rectangular front plate 2. At their tops the side plates are secured together by a top plate 3 shown as formed in sections, the foremost section 3^a formed in two different planes to increase the height of the vaporizing chamber at the forward end. This foremost section is also secured to the front plate 2. The side plates 1 are further secured together at the back and the bottom of the chamber by sectional hollow mangle back plates 4 to 16 inclusive. The sectional plate 4 is bolted directly to the rear transverse section of the top plate. The sectional plates 11 and 12 are bolted to the transverse plate 17, and the sectional plate 16 is bolted to the transverse bracket plate 18 which is bolted to the front plate 2 and to the side plates, while the flanges of the several sectional plates 4 to 16 inclusive are bolted together as shown, and at their ends to the side plates 1. The vaporizing chamber is, therefore, that inclosure which exists between the side plates 1, the upper portion of the front plate 2, the top plate 3, the transverse plates 17 and 18, and the several sectional plates 4 to 16 inclusive, but the area of this chamber is very materially reduced by the rotary mangles, by an additional heating section, a drum and moistening tank therefor, and other appliances contained therein, all to be described, as well as by the hollow transverse filler 19 inserted between the side plates 1 for the purpose of reducing the area of the chamber.

The only openings into the chamber are those which will be described for specific purposes, and the openings for the admission and exit of the fabric are sealed by appliances to be described, so that there is little opportunity for the escape of vapor from or admission of air to the chamber. Only so much air is allowed to enter the chamber as is sufficient to maintain the pressure in the chamber at substantially that of the atmosphere.

The fabric in its passage through the vaporizing chamber is maintained in a taut condition so that it may be perfectly smooth and unwrinkled while the coating is being dried. This result is secured by let-off and take-up devices for the fabric as it enters and leaves the vaporizing chamber, and these devices will be described in detail. In addition, the peripheries of the mangles are crowned in the center as shown

in the drawings, which aids in keeping the fabric smooth and maintaining it in a straight direction during its passage.

In the form of apparatus shown the fabric is coated immediately prior to its admission to the vaporizing chamber, and a spreading mechanism is employed to seal the admission opening against any material passage of air or vapor, the body of dope being applied to the fabric acting as an effective seal. The exit opening is sealed by mechanical means.

The spreading mechanism by which the fabric is coated and which is made use of to seal the admission opening of the chamber in which the coating is dried and the vapor of the solvents collected is supported by a separate frame 20 bolted to the forward upper end of the vaporizing chamber, but slightly separated therefrom by the rectangular frame 201 formed of suitable heat insulating material. Alined slots 21 and 22 in this frame 20 and the front plate 2 of the vaporizing chamber permit the passage of the fabric into the vaporizing chamber. The frame 20 presents in its upper portion a chamber 23, the front wall of which is completed by the spreading knife 24 which is supported on a cross bar 25 journaled at its ends in bearings 26 in brackets 27 bolted to the frame 20. Hand levers 28 extend forwardly from the cross bar 27 by means of which the spreading knife 24 may be swung upwardly and away from the frame 20 in the bearings 26. Coiled springs 29 connected to the frame 20 and to arms 30 depending from the cross bar serve normally to maintain the knife in its operative position against the frame, as shown in the drawings.

The chamber 23 is closed at the bottom by a yielding fabric-supporting plate shown as a strip of metal 31. This strip 31 at one end extends through the slot 21 and is fastened to the back of the frame 20. From this point it extends beneath the spreading knife 24, thus forming the bottom of the chamber 23, and around a roller 32 to a bar 33. The roller 32 is journaled in the horizontal arms 34 of a bell crank lever fulcrumed at 35 in bearing blocks 36 bolted to the frame 20. Depending arms 37 of this bell crank lever carry in their lower ends adjustable screws 38 abutting against the frame 20, and by means of these screws the bell crank lever may be swung about its fulcrum 35 to raise and lower the roll 32, and consequently adjust the horizontal position of the sheet metal plate 31 with respect to the edge of the spreading knife. The cross bar 33 is connected by helical springs 39 to levers 40 fulcrumed at 41 on brackets 42 bolted to the frame 20, and these levers 40 carry in their lower ends adjusting screws 43 also abutting against the frame 20, whereby the longitudinal tension on the sheet metal plate may be varied to secure the proper coöperation of the plate with the spreading knife.

Directly in front of the spreading knife and below the dope the sheet metal plate 31 is perforated as indicated at 300. A closed metal casing 301 is secured to the bottom of the plate 31 beneath these perforations and connected by a tube and a suitable suction device whereby a partial vacuum is produced beneath the perforations. Hence if any pit marks or pin holes appear in the fabric after coating, the next time the fabric passes through the apparatus the dope will be drawn by suction into these pit marks or pin holes and fill them.

A generally rectangular hood 310 of sheet metal or other suitable material fits over and completely incloses the entire upper portion of the frame 20 and its connected parts. The front lower edge of the hood rests upon the top of the fabric as it is fed over the plate 31, and the sides of the hood fit against the edges of the plate 31. This hood acts as an additional check to the escape of vapors from and the admission of air to the vaporizing chamber and an extension of the vaporizing chamber formed in the frame 20.

A suitable let-off device for the fabric is shown in Fig. 1 mounted in front of the spreading apparatus. This let-off device is shown as comprising a roll 400, upon which the fabric is wound, and a friction brake 401 provided with adjustable weights 402, so that the friction on the roll may be varied to place more or less tension on the fabric. The fabric 49 passes from the let-off device over the sheet metal plate 31 beneath the spreading knife and through the slots 21, 22 into the vaporizing chamber. The dope is fed through a pipe 403 in front of the spreading knife and the amount spread upon the fabric as it passes is accurately controlled by adjusting the sheet metal plate 31 with respect to the spreading knife by means of the set screws 38 and 43. The dope extending across the fabric where it contacts with the spreading knife seals the chamber 23 along this line, while the felt plates 47 resting against the flexible plate 31 at each side of the fabric seal the chamber 23 along the side lines so that any material escape of vapor from the chamber 23 is prevented, while the hood 310 extending over all acts to still further minimize the escape of any vapor into the surrounding atmosphere. The chamber 23 in effect forms part of the vaporizing chamber, being connected thereto by the slots 21 and 22, and the vaporizing chamber as a whole is thus securely sealed against any material escape of vapors at the opening for the admission of the coated fabric.

The fabric upon receiving the coating passes immediately into the vaporizing chamber and no opportunity is afforded for the removal of superfluous dope from the back of the spreading knife, or for inspecting or cleaning or removing imperfections from the freshly coated fabric. To obviate this mechanical devices are provided automatically operated for that purpose. Convenient mechanisms for effecting this purpose are disclosed in my co-pending application No. 621,967, filed April 19, 1911.

A shaft 77 extends transversely through the vaporizing box near the front wall and is driven at high speed by any suitable connection with one of the driven parts of the apparatus. This shaft carries extending tangentially therefrom a series of knives 78 which extend across the fabric and are so arranged as to swing against the upper surface of the fabric and remove therefrom any foreign matter or imperfections.

The fabric is supported accurately in the path of the knives 78 by means of a table 79 extending beneath the fabric and carried by a bracket frame 80 pivoted at 81 to stands 82 bolted to the front plate 2. The rear of the bracket frame 80 abuts against an adjustable set screw 83 extending out through the front plate 2, and by means of this set screw the table 79 can be raised and lowered to bring the fabric into proper relation with the revolving blades 78.

A receptacle shown as a rectangular box 84 is mounted in bracket arms 841 depending from the top plate section 3^a in the rear of the revolving knives. An inclined apron 85 leads from a point adjacent the fabric out into the mouth of the receptacle which faces the knives, so that any matter removed by the knives from the fabric is thrown upward and deposited in the receptacle 84. As required this receptacle may be cleaned out.

The fabric with its freshly spread coating, inspected and cleaned of foreign matter and imperfections, is now in the vaporizing chamber, and the apparatus now to be described has for its function the drying of the coating and the recovery of the volatile solvents, which come from the coating in the form of vapors during the drying process; or the recovery of so much of these solvents as is commercially practicable. The drying operation, as has been set forth, is performed by bringing the back or uncoated side of the fabric into direct contact with, or close proximity to, heated surfaces, preferably rotary mangles heated by hot water, and preferably at the same time exposing considerable areas of the coated face in proximity to similarly heated backing plates. The result is that the fabric is dried mainly from the back outwardly through the coating, thus causing the solvent vapors to pass off at the coated surface as the coating dries. The heating appliances are also preferably arranged so as to apply the heat to the fabric at successively and progressively higher degrees of temperature, thus enabling the drying operation to be more speedily effected, and preventing injurious results which would occur by passing the fabric immediately into contact with or proximity to heating appliances at the highest degree of temperature.

It has already been explained that in the preferred construction illustrated the rear and lower portions of the vaporizing box are made up of a series of hollow segmental backing plates secured together. This construction combines therewith two rotary heated mangle drums 86 and 87. The construction of each of these drums is similar and is shown in detail in Fig. 4. The drum 86 which is therein shown is formed with two heads 88 and 89, and a circumferentially hollow cylinder 90 bolted thereto. The head 88 extends out through bearings in one of the circular sections 91 of the side plate 1. This drum 86, which is the rearward one, carries on the hub of the head 88 and keyed thereto a worm wheel 93. A worm 94 carried by a shaft 95 driven from any suitable motor secures the rotation of the drum. The hub of the head 88 also carries a gear 96 which through an intermediate gear 97 intermeshing with a similar gear 98 on the shaft of the drum 87 secures the rotation of the latter from the rear drum 86. The opposite head 89 of the drum 86 extends out through a bearing in the opposite circular section 91 of the opposite side plate 1. The hub of the head 89 is axially apertured as shown at 99, and the inner end of this aperture is covered by a cap 801. A pipe 802 connects this cap and through it the aperture 99 with the circumferential chamber of the cylinder 90. A tube 803 extends to the boiler or other source of heating agent, and is connected by a stuffing box 804 within the aperture 99 so that the heating agent may pass directly into the circumferential chamber of the cylinder 90. The exhaust from this chamber takes place through the pipe 100 which extends through the cap 801, the aperture 99, and the interior of the tube 803, to a condenser or discharge. A suitable joint 805 to allow for the rotation of the inner section of the pipe 100 is provided at any desired point.

The drum 87 is similarly constructed and operated, being driven, as has been shown, from the drum 86 through the medium of the gearing described. For the purpose of reversing the fabric so as to keep the uncoated side against both drums, a small drum 101 is located intermediate the drums 86 and 87, and journaled in the side plates of the chamber, and may be driven by the

gears 130 and 131 from the intermediate gear 97. It will be observed that the coated face of the fabric passes over the intermediate drum 101 and a tank of water 102 is therefore provided in which the drum 101 runs to keep its surface moist and prevent the coating from adhering thereto and being injured.

The fabric runs from the drum 87 over an idler roll 103 to the exit opening from the vaporizing chamber. This exit opening, shown in detail in Fig. 7, is formed between two rolls 104 and 105 journaled in the front plate 2. The fabric being thoroughly dried at this point, these rolls may contact with the opposite faces thereof. Sealing blocks 106 of felt or suitable material seal the space between the rolls at the edge of the fabric, and sealing strips 107 and 108 of felt or other suitable material seal the lines where the rolls come adjacent the face plate 2.

The fabric passes from the exit opening to a suitable take-up device, a simple form of which is sufficiently shown in Figs. 1 and 2. The take-up roll is indicated at 900, journaled in the stand 901. A friction disk 902 is loosely mounted on the axis of the roll. A collar 903 is made fast to the axis at the outside of the disk 902, and a second collar 904 is pressed against the opposite surface of the disk by a spring 905 abutting against a collar 906 adjustably mounted on the axis of the roll. Thus upon the rotation of the disk 902 the take-up roll 900 will be rotated, but the construction described allows for a slip between the disk and the roll when necessary. The disk 902 is driven by frictional engagement from a disk 907 keyed to a shaft 908, which shaft is driven by means of beveled gears 909 and 910 from a shaft 911, the shaft 911 being in turn driven by a belt 912 running over a pulley on the shaft of the drum 87. The friction drive disk 907 is shifted along its shaft 908 to vary the speed of the take-up roll according to the amount of fabric wound thereon by means of a lever 913, the free arm of which has an antifriction roll 914 resting against the periphery of the wound-up cloth, while the other end is forked and fits a slotted collar forming a part of the friction disk 907. This lever 913 is fulcrumed at 914 and a spring 915 holds it up against the cloth. By the use of a take-up such as just described, and by driving the friction disk 902 at a slightly greater speed than that required to roll up the cloth, the cloth is pulled as it diverges from the machine. The let-off device also pulls upon the cloth, the amount of pull being governed by the weights hung upon the friction brake 401. As a result, the cloth is kept snugly stretched in its travel through the vaporizing box. The mangle rolls are run at the same rate of peripheral speed, so that the cloth at all points is moving at the same linear speed through the machine. Furthermore, the periphery of the mangle drums is crowned, as will be seen by reference to Fig. 4; the drums being of greatest diameter in the center and gradually lessening in diameter toward the ends. Thus the cloth is centered and kept smooth and even in the direction of its width.

A hollow beating plate 700 is mounted between the side frames 1, with its top surface substantially in line with the tops of the drums 86 and 87.

The heating and drying of the coating is preferably performed by the agency of hot water, although any other desired heating agent may be circulated through the heating elements. Steam may also be used with satisfactory results, and connections are indicated in dotted lines to show how the steam may be circulated through the apparatus. A temperature of 180 degrees is about as high as is desired to dry some artificial leather fabric and release the solvent vapors. If steam be used the temperature of the steam has to be reduced to effect the desired results. Water may be kept more readily at the required temperature, but either steam, water or other heating agent may be readily connected and circulated in the apparatus by any suitable circulating system, which forms no part of the present invention.

If the freshly coated fabric be suddenly brought to a high degree of temperature the moisture and solvents suddenly turn into vapor and burst through the coating, forming pin holes and imperfections therein. In the present construction, therefore, the apparatus is arranged so that the successive sections thereof reached by the fabric in its travel are at successively higher degrees of temperature. The sections of the apparatus may be varied as desired to secure this result, but for convenient illustration of the principle the apparatus herein shown is provided with but two such sections. The hollow heating plate 700 and the hollow backing plates 4 to 11 inclusive are maintained at one temperature, while the hollow backing plates 12 to 16 are maintained at a different and higher degree of temperature. The two drums are also capable of being maintained at independent and desired temperatures according as the results of practice may require.

The piping shown in full lines in the drawings, particularly Fig. 3, is designed for the use of water as the circulating heating agent. In this case the pipes 450 and 451 are supply pipes. The pipe 451 branches, being connected by the branch 452 to the hollow heating plate 700 and by the branch 453 to the hollow backing section 4. The

hollow backing sections 4 to 11 inclusive are connected by the pipes 118. The exhaust pipes 454 and 455 connect respectively with the hollow heating plate 700 and the hollow back plate section 11, and these pipes converge into the exhaust pipe 456.

The pipe 450 is connected to the hollow back plate section 16; the hollow back plate sections 12 to 16 inclusive are connected by connecting the pipes 120; and the exhaust pipe 457 extends out from the opposite hollow back plate section 12. Suitable circulatory systems are provided connecting the pipes 451 and 456 on the one hand and 450 and 477 on the other hand, to maintain the temperature in the latter at a higher degree than that in the former. By means of the connections described in considering the drum 86 and the similar connections employed in connection with the drum 87, water is circulated through the hollow circumferential chambers of the drum at required and desired temperatures, either the same as or different from the temperatures of the corresponding backing plates.

If steam be employed the connections shown in dotted lines may be used instead of those shown in full lines, and the same general result be produced. In the case of the drums, however, the same connections may be used for either steam or water. In the case of the use of steam there need be but one circulatory system, and the regulation of the temperatures for different sections may be effected by the use of reducing valves indicated diagrammatically at 122 throughout the system.

A prominent feature of this invention, as has been pointed out, is the carrying on of the process of reclamation of the solvent vapors with the use of air to an immaterial extent as an absorber of the vapor or as a drying agent. By immaterial it is meant that the amount of vapor absorbed by the air is a very small fraction of that recovered. To secure this result the vaporizing box is connected with a suitable condenser, and the circulation from the vaporizing box through the condenser and back to the vaporizing box is aided if necessary by means of a fan. The drying of the fabric being effected by the direct action of the heating surfaces, and the space inclosed in the vaporizing box being kept small, the solvent vapors are given off rapidly and in large volume. Passing into the condenser these vapors are condensed and the vacuum which tends to form in the condenser is practically neutralized in the rush of the incoming vapors. There is little need, therefore, of air in the apparatus to maintain the interior at substantially atmospheric pressure, but enough leakage of air into the vaporizing chamber takes place to prevent the formation of any substantial vacuum therein, and this is all the air which is requisite in the carrying on of the process. The result is that the machine carries out the process in a highly efficient manner, and the air so far as it is used serves merely to carry the vapors around and maintain the pressure within the chamber at about atmospheric pressure, and without material absorption of the vapors.

The outlet from the condenser is carried to a point immediately over the fabric where it first enters the apparatus, so that the circulation of vapors and such air as there may be is at its lowest temperature when it strikes the fabric, and the outlets from the vaporizing box to the condenser are arranged to take the vapors directly into the condenser.

The constructions for securing these results may be various, but in the form illustrated an ordinary form of condensing tank of sufficient dimensions is shown at 600 mounted upon or directly over the vaporizing box, sloping slightly toward the rear end, and provided with coils of piping 601 through which a suitable refrigerating agent is circulated. Outlets are provided in the vaporizing box at 602, 603 and 604; that is, respectively at the end of the drum 86, after the fabric has traveled about half its distance around the drum in the space between the two drums, and at the end of the drum 87 as the fabric is about to leave the drum. These outlets are connected by the pipes 605 to a fan or blower 606 of any suitable material, and located on top of the vaporizing box and at the lower end of the condenser. The fan 606 is driven in any suitable manner, as by a belt 607 running over a pulley on the shaft of the drum 86. The outlet from the condenser is by a pipe 608 which passes through the hood 301 and enters the chamber 23 from the top. The circulation from the condenser coming through the pipe 608 then passes through the slots 21 and 22 into the vaporizing box and follows the top surface of the fabric, being directed by suitable baffle plates 609 and 610, as well as by the table 79 and the top of the vaporizing box to the outlets which are located at the ends of the drums. By reason of this construction the air which enters the vaporizing device substantially freed from volatile solvents passes in a general longitudinal direction along the coated face of the fabric but gradually is diverted toward the opposite sides to the outlets, so that the action of the circulating current is both longitudinal of the web of fabric and laterally thereof, a greater uniformity in drying consequently being effected than if the outlets were above the central portion of the web. By thus maintaining a current of gas laden with solvent material in contact with the face of the coating the surface of the coating will not only be prevented from searing but will be maintained in a plastic or semi-plastic

condition so that the volatile contents of the coating may be driven out through this plastic surface as the coated fabric passes over the heating device without producing pits and pinholes such as are produced when an escaping bubble of volatile material punctures the seared surface of the coating as is usual in fabric coating apparatus. By reason of the fact that the coated fabric is carried around a drum the outer face of the coating is slightly stretched as the fabric is bent about the drum. This action tends to separate slightly the molecules of the coating at or near the surface of the coating and the tension upon the surface caused by this bending action aids in expelling the small bubbles of volatile material which are produced by the application of the heat through the drum. When the blade 73 is employed as an auxiliary scraping knife this passageway for the circulation is blocked. An opening from the chamber 23 is accordingly provided in the back of the frame at 620 which opening is otherwise closed by a gate 621, operated from the outside of the apparatus. From this opening 620 the circulation passes between the frame 20 and the front plate 2 through the slot 22 and on through the vaporizing chamber as before.

The condensed solvent vapors may be drawn off from the condenser in any suitable manner, and for that purpose an ordinary trap on the principle of an ordinary steam trap is provided, indicated diagrammatically at 650.

The entire apparatus is made of metal, as has been before pointed out, and danger from sparking is practically eliminated because of the metal construction and the ground connections through the steam or water pipes. In addition, a steam spray is admitted at 640 near the middle of the chamber, and this serves to prevent further sparking and a still further safeguard is provided in the vent pipe or flue 126 of large size opening directly into the top of the chamber, and provided with a suitable check valve 129, so that in case of any explosion this check valve will open and provide a vent so that no injury will be done to the apparatus or the building in which it is located.

Windows or lights may be provided at suitable places in the walls of the chamber for inspecting the interior, such as shown for example at 76.

It will thus be seen that the apparatus is one which while having high efficiency in the drying of the goods, the condensing of the vapors and the handling of the fabric in large quantities, requires but little attention because of its automatic action. The fabric enters and leaves the apparatus at the same end so that it may be watched and controlled by a single operator. The entire length of the fabric may be dried and the solvents recovered. A wrapper, that is a piece of plain uncoated fabric, is attached to the end of the coated fabric as it passes into the chamber, and may be left in the apparatus so that succeeding lengths of the fabric may be readily drawn through the machine. If any reason occurs for running the fabric backward, the spreading knife may be raised and the direction of feed reversed by simply reversing the driving mechanism of the apparatus.

The apparatus occupies but a comparatively small space. Air not being used as a drying agent the space required for the collection and circulation of the solvent vapors is reduced to a minimum. Furthermore, since little of the vapors is absorbed by the air present, the maximum of solvent vapors is condensed and recovered. Owing to the fact that the air present has an immaterial function as a drying agent or as an absorbent of the vapors, the maximum amount of efficiency is obtained in this apparatus. The heat required to vaporize the solvents is not expended and wasted in heating the air, nor is the energy required for refrigeration wasted by re-cooling the air.

The invention having been fully described, what is claimed as new and desired to be secured by Letters Patent, is:

1. An apparatus of the class described comprising a rotary heated drum, means for guiding the coated fabric around said drum with its back against the same and means for maintaining a volume of gas containing a solvent in contact with the face of said coating whereby the drying of the face of the coating will be retarded and the expulsion of volatile material from the coating will proceed from the fabric toward the face of the coating.

2. An apparatus of the class described comprising a rotary heated drum, means for guiding the coated fabric around said drum with its back against the same and means for maintaining a volume of gas containing a solvent in contact with the face of said coating throughout the entire heated area whereby the drying of the face of the coating will be retarded and the expulsion of volatile material from the coating will proceed from the fabric toward the face of the coating.

3. In an apparatus of the class described comprising a vaporizing chamber, a rotary heated drum located in said vaporizing chamber, means for guiding the coated fabric around said drum with its back against said heated drum and means for maintaining in contact with the face of said coating a circulating current of gas containing a solvent whereby the drying of the face of the coating will be retarded and the expul-

sion of volatile materials from the coating will proceed from the fabric toward the face of the coating.

4. In an apparatus of the character described comprising a vaporizing chamber and heating means in said chamber consisting of a series of heating elements of progressively increasing temperature, means for guiding the coated fabric over said heating means with its back toward the same and in a direction whereby the fabric will be subject to the influence of gradually increasing temperature and means for maintaining in contact with the face of said coating a volume of gas containing a solvent whereby the drying of the face of the coating will be retarded and the coating will proceed from the fabric toward the face of the coating.

5. In an apparatus of the class described, a vaporizing chamber, a plurality of rotary heated mangles located within said vaporizing chamber, means for maintaining successive sections of said mangles at successively higher temperatures, means for guiding the coated fabric through said vaporizing chamber with its back against the rotary elements of said mangles, means for maintaining in contact with the face of said coating a circulating current of gas containing a solvent whereby the drying of the face of the fabric will be retarded and the expulsion of volatile materials from the coating will proceed from the fabric toward the face of the coating.

6. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back toward said heating means, and means for inducing a circulation directly from the face of the fabric through the condensing chamber and back to the face of the fabric adjacent to the inlet through which the fabric is introduced into the vaporizing chamber.

7. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means located within said vaporizing chamber, means for maintaining successive sections of said heating means at successively higher temperatures, means for guiding the fabric through said vaporizing chamber in proximity to said heating means, and means for inducing a circulation directly from the face of the fabric through the condensing chamber and directly back to the face of the fabric adjacent to the inlet through which the fabric is introduced into the vaporizing chamber.

8. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, a rotary heated mangle located in said vaporizing chamber, means for guiding the fabric through said mangle with its back against the rotary element thereof, and means for inducing a circulation directly from the face of the fabric through the condensing chamber and directly back to the face of the fabric and in the same direction as that of the movement of the fabric.

9. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, a plurality of rotary heated mangles located within said vaporizing chamber, means for maintaining successive sections of said mangles at successively higher temperatures, means for guiding the fabric through said vaporizing chamber with its back against the rotary elements of said mangles, and means for inducing a circulation directly from the face of the fabric through the condensing chamber and back to the face of the fabric and in the same direction as that of the movement of the fabric.

10. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, a mechanical circulation inducer having a direct connection with the fabric inlet of said vaporizing chamber, condensing chamber and inducer whereby a constant circulation is maintained therethrough, heating means located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back toward said heating means.

11. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, a mechanical circulation inducer and direct connections between said vaporizing chamber condensing chamber and inducer whereby a constant circulation is maintained therethrough, heating means located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back against said heating means, and means for maintaining the fabric under tension during its passage through the vaporizing chamber.

12. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, a mechanical circulation inducer and direct connections between said vaporizing chamber, condensing chamber and inducer

whereby a constant circulation is maintained therethrough, heating means located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back against said heating means, and means for maintaining the fabric centered during its passage through the vaporizing chamber.

13. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, means located within the vaporizing chamber for drying the coating and vaporizing the solvents thereof without the aid of air as a material drying and vaporizing agent, and means for guiding the fabric into and out of said vaporizing chamber and means for causing a circulation of the gaseous contents of the vaporizing chamber in the direction of movement of said fabric as it approaches the heating means.

14. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, means located within the vaporizing chamber for drying the coating and vaporizing the solvents thereof without the aid of air as a material drying and vaporizing agent, and means for guiding the fabric into and out of the vaporizing chamber at the same end thereof and means for causing a circulation of the gaseous contents of the vaporizing chamber in the direction of movement of said fabric as it approaches the heating means.

15. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, means located within the vaporizing chamber for drying the coating and vaporizing the solvents thereof without the aid of air as a material drying and vaporizing agent, means for guiding the fabric into and out of the vaporizing chamber at the same end thereof, and a let-off and take-up device for said fabric located adjacent said end of said chamber whereby the tension of the fabric in passing through the chamber is controlled.

16. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, an automatic trap for automatically removing the condensate from said condensing chamber, a rotary heated drum located within said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back against the periphery of said drum, means for closely inclosing the periphery of the drum covered by said fabric, and means for inducing a circulation directly from the face of the fabric at the periphery of said drum through the condensing chamber and directly back to the face of the fabric.

17. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, an automatic trap for automatically removing the condensate from said condensing chamber, a rotary heated drum having a crowned periphery located within said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back against the periphery of said drum, means for closely inclosing the periphery of the drum covered by said fabric, and means for inducing a circulation directly from the face of the fabric at the periphery of said drum through the condensing chamber and directly back to the face of the fabric.

18. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means located in said vaporizing chamber and comprising a rotary drum having a hollow circumferential chamber and hollow backing plates in close proximity to said drum, means for circulating water at high temperature through said circumferential chamber and through said backing plates, means for guiding the fabric around into and out of the vaporizing chamber and around the periphery of said drum with its back thereagainst, and means for passing the solvents vaporized from the fabric at substantially atmospheric pressure from the vaporizing to the condensing chamber with immaterial absorption by the air.

19. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, hollow sectional heating elements located in said vaporizing chamber, means for passing fluid through successive sections of said heating elements at successively higher degrees of temperature, means for guiding the fabric into and out of said vaporizing chamber and in proximity to said heating elements, and means for passing the vaporized solvents at substantially atmospheric pressure from the vaporizing to the condensing chamber with immaterial absorption by the air.

20. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber in proximity to said heating means, means for passing the

vaporized solvents at substantially atmospheric pressure from the vaporizing to the condensing chamber with immaterial absorption by the air, and piping connected to the heating means and serving as electrical connections to ground the apparatus and prevent sparking.

21. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber in proximity to said heating means, means for passing the vaporized solvents at substantially atmospheric pressure from the vaporizing to the condensing chamber with immaterial absorption by the air, piping connected to the heating means and serving as electrical connections to ground the apparatus and prevent sparking, and means for maintaining the fabric under tension during its passage through the vaporizing chamber.

22. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means located in said vaporizing chamber, direct connections between said vaporizing chamber and condensing chamber, and means for passing the vaporized solvents at substantially atmospheric pressure through said connections with immaterial absorption by the air.

23. An apparatus of the class described comprising a vaporizing chamber, and heating means in said chamber consisting of a plurality of heating elements of different temperatures, means for guiding the coated fabric adjacent to said heating means, means for maintaining in contact with the face of said coating a volume of gas containing a solvent vapor, whereby the drying of the face of the coating will be retarded so that the drying will proceed from the fabric toward the face of the goods.

24. An apparatus of the character described, comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means in the vaporizing chamber, means for guiding fabric through said chamber, means for inducing a circulation directly from the face of said fabric through the condensing chamber, and means for passing vaporized solvents at substantially atmospheric pressure from the vaporizing to the condensing chamber without material absorption by the air.

25. An apparatus of the class described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, heating means in said vaporizing chamber, means for guiding the fabric through said chamber, means for inducing a circulation longitudinally and laterally of the direction of movement of the fabric and thence through the condensing chamber and back to the face of the fabric adjacent to the inlet through which the fabric is introduced into the vaporizing chamber.

26. An apparatus of the character described comprising a vaporizing chamber, condensing means connected with said vaporizing chamber, a rotary heated drum located in said vaporizing chamber, means for guiding the fabric through said vaporizing chamber with its back against said rotary heating drum, outlets leading from adjacent the ends of said drum to said condensing chamber and means for inducing the circulation directly from the face of the fabric through said outlets to the condensing chamber and back to the face of the fabric adjacent the inlet through which the fabric is introduced into the vaporizing chamber.

27. An apparatus of the character described comprising a vaporizing chamber, a condensing chamber, condensing means connected with said condensing chamber, means located within the vaporizing chamber for drying the coating and vaporizing the solvent thereof without the aid of air as a material drying and vaporizing agent, means for guiding the fabric into and out of said vaporizing chamber, means for inducing a circulation of the solvent vapor toward the condenser by the use of air to carry the vapors and to maintain atmospheric pressure within the vaporizing chamber.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

CHARLES F. HOPEWELL.

Witnesses:
JOHN C. EDWARDS,
NATHAN HEARD.