

Oct. 16, 1923.

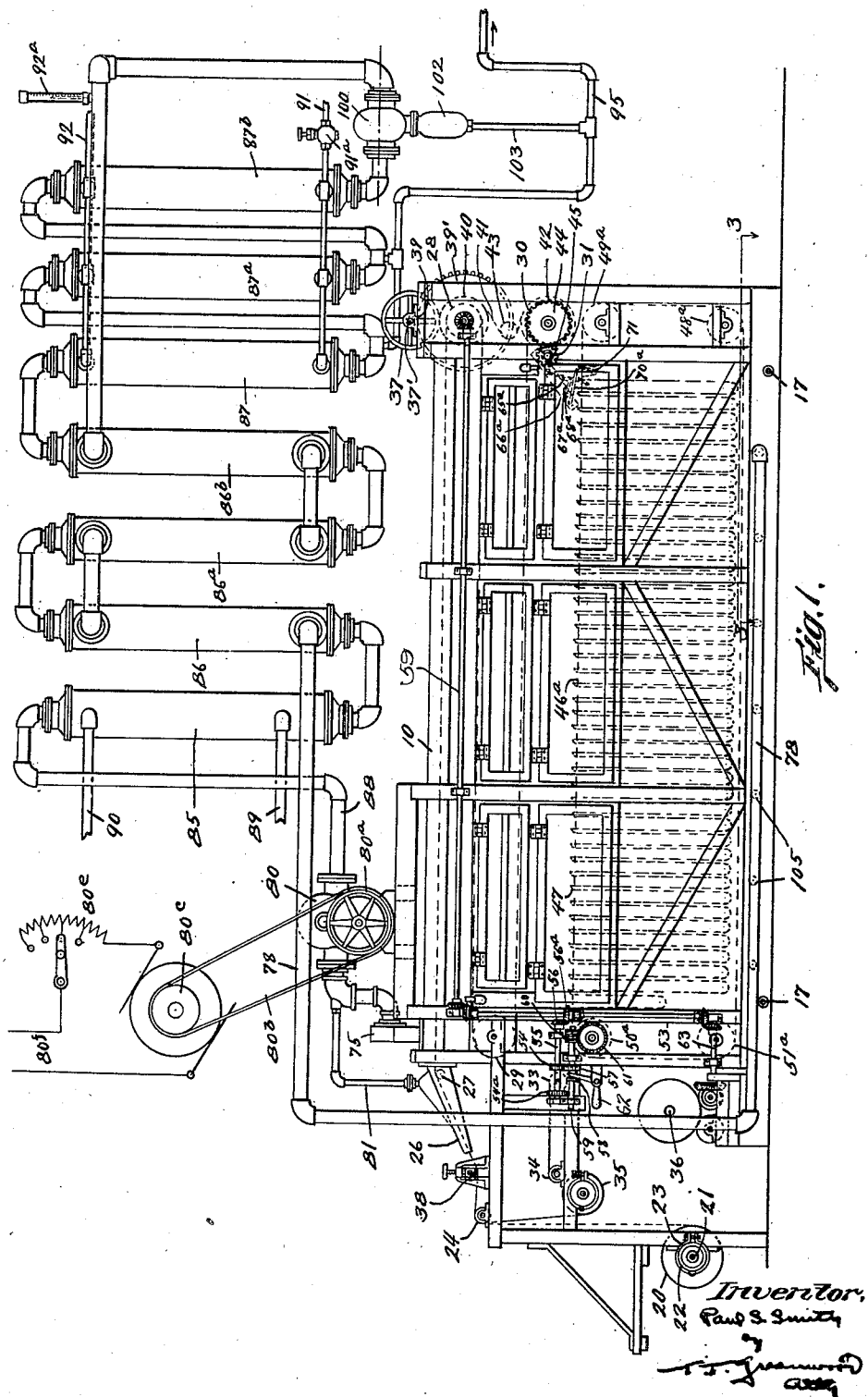
P. S. SMITH

1,470,650

METHOD AND APPARATUS FOR COATING AND DRYING FABRIC AND OTHER MATERIAL

Filed May 25, 1920

4 Sheets-Sheet 1



Oct. 16, 1923.

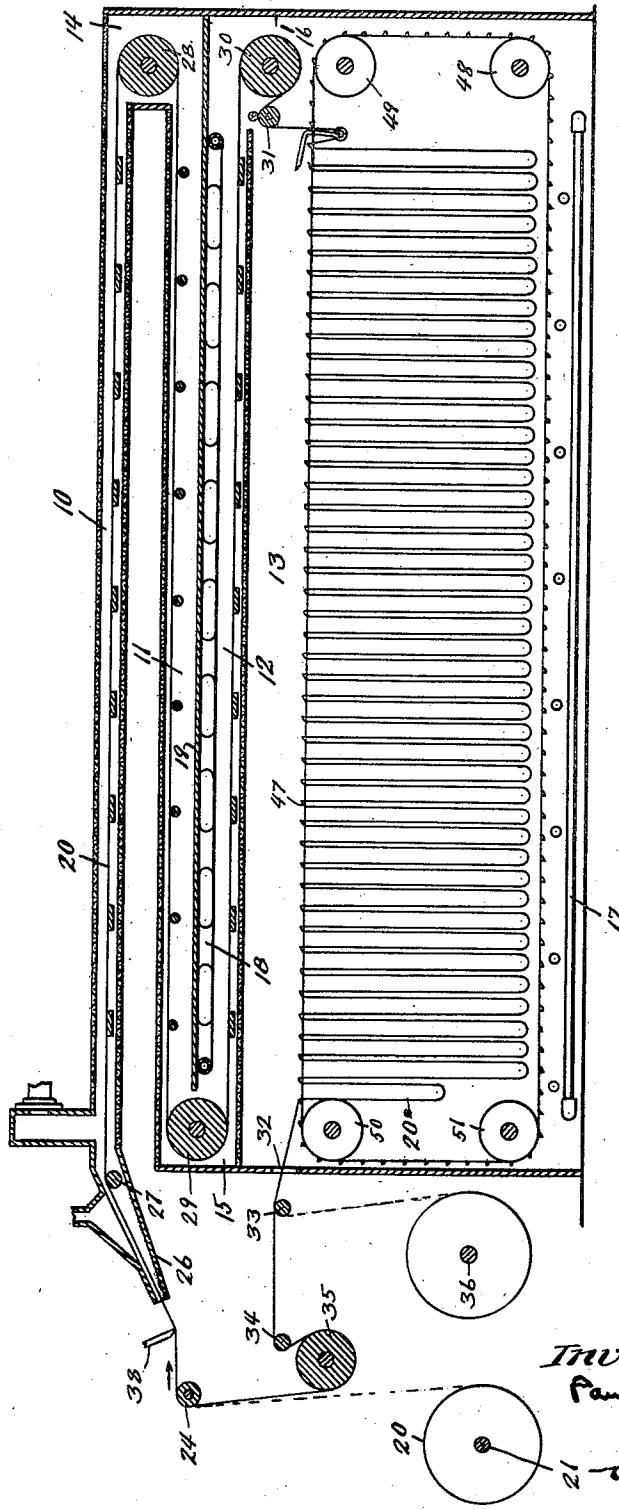
P. S. SMITH

**1,470,650**

# METHOD AND APPARATUS FOR COATING AND DRYING FABRIC AND OTHER MATERIAL

Filed May 25 , 1920

4 Sheets-Sheet 2



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1,470,650

METHOD AND APPARATUS FOR COATING AND DRYING FABRIC AND OTHER MATERIAL

Filed May 25, 1920

4 Sheets-Sheet 3

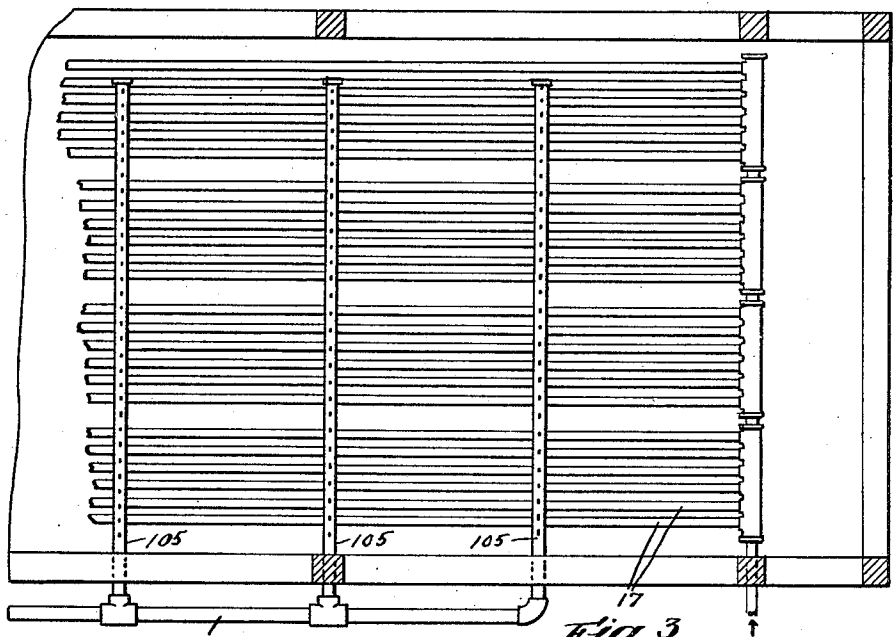


Fig. 3.

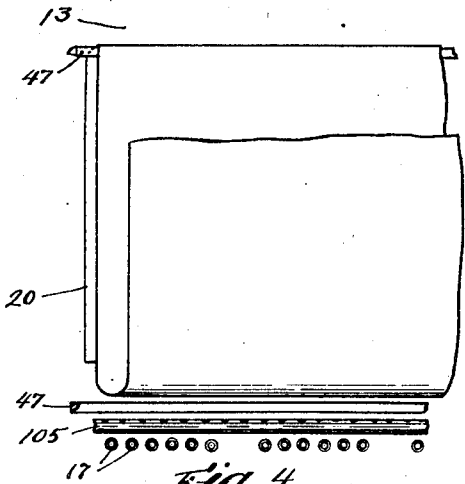
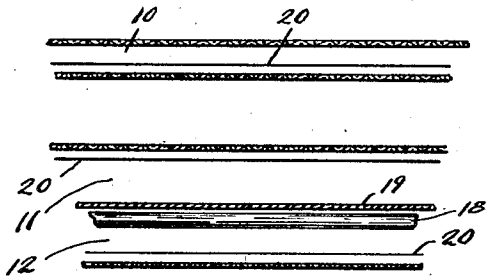


Fig. 4.

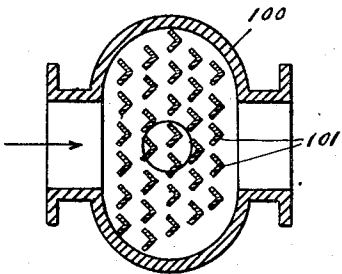


Fig. 5.

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*[Signature]*

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METHOD AND APPARATUS FOR COATING AND DRYING FABRIC AND OTHER MATERIAL

Filed May 25, 1920

4 Sheets-Sheet 4

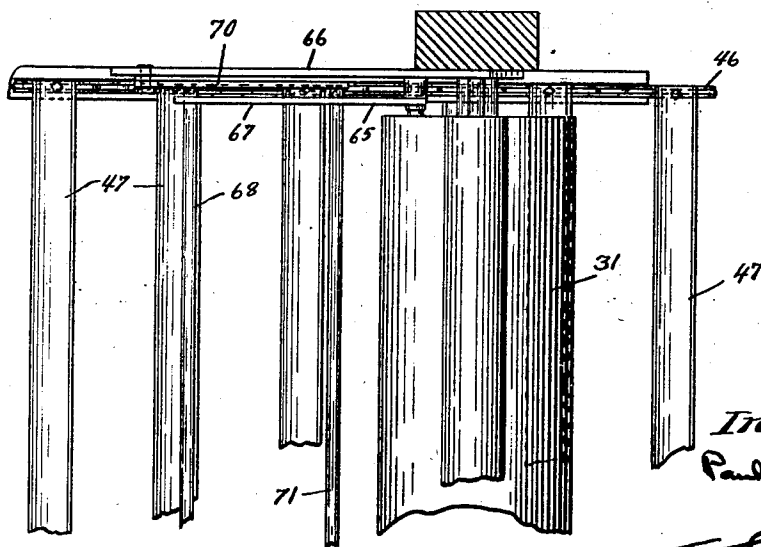
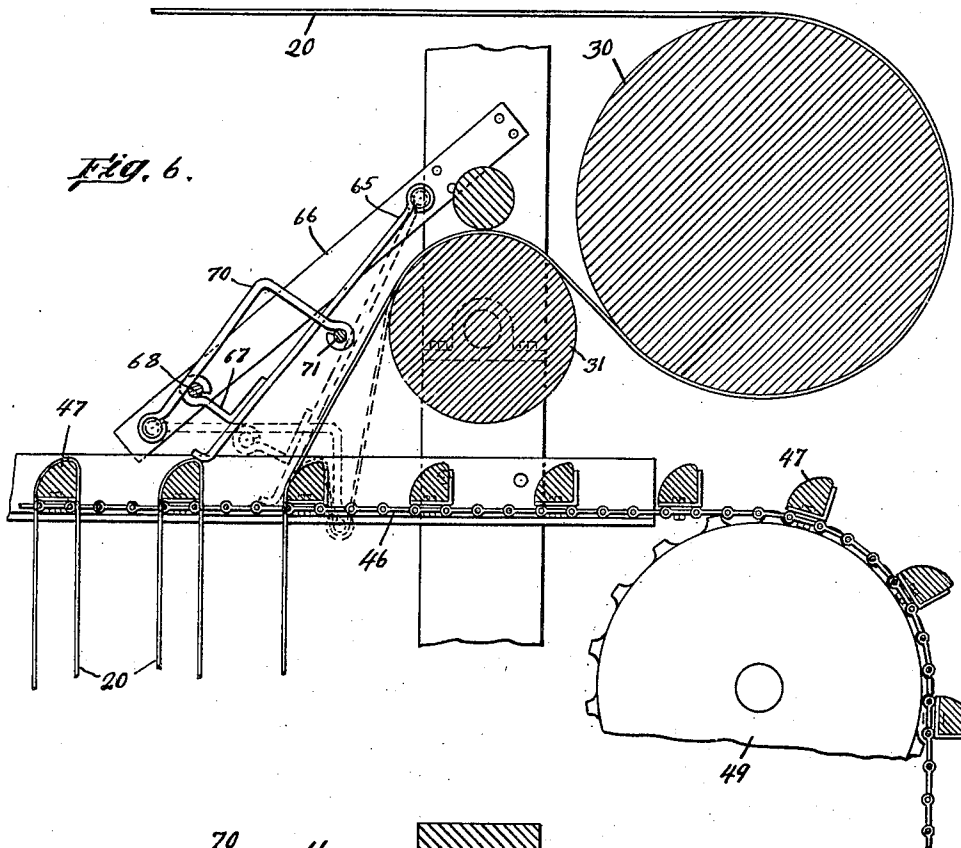


*FIG. 7.*

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## UNITED STATES PATENT OFFICE.

PAUL S. SMITH, OF WEST BARRINGTON, RHODE ISLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO O'BANNON COMPANY, OF WEST BARRINGTON, RHODE ISLAND, A CORPORATION OF MASSACHUSETTS.

## METHOD AND APPARATUS FOR COATING AND DRYING FABRIC AND OTHER MATERIAL.

Application filed May 25, 1920. Serial No. 384,228.

*To all whom it may concern:*

Be it known that I, PAUL S. SMITH, a citizen of the United States, residing at West Barrington, in the county of Bristol and State of Rhode Island, have invented an Improvement in Methods and Apparatus for Coating and Drying Fabric and Other Material, of which the following is a specification.

This invention relates to the coating and drying of material in the web for the production of so-called artificial leather and the like, and the recovery of solvents from the coating, and has for its object to dry the coating and recover the highly inflammable readily vaporizable solvent therefrom and prevent the formation of an explosive mixture of the solvent and drying medium in the drying chamber of the coating apparatus.

However, this invention is not designed to prevent fire, due to ignition of the wet coating, as contrasted with the explosion of the gaseous mixture of solvent vapor and drying medium.

There are many types of apparatus for the recovery of solvent from the coating, wherein a minimum of drying medium, as air is employed which is caused to absorb a relatively large amount of solvent vapor and thereby become explosive; or wherein a relatively large amount of air is used which is given such a slow movement as to absorb a relatively large amount of solvent vapor and becomes explosive.

My method of preventing explosions consists generically in preventing the formation in the drying chamber of a mixture rich enough in solvent vapor to be explosive at any stage of the drying process.

In carrying out my invention I employ a relatively small volume of air at subnormal humidity and circulate it through my apparatus at such a relatively high speed that the proportion of solvent vapor absorbed thereby is too small to form an explosive mixture. Furthermore, I cool the air by artificial cooling means, to a relatively low temperature so that the air returned to the drying chamber is exceedingly dry and relatively cold. Heating means are arranged in the drying chamber, mainly to compensate

for the cooling effect of the solvent absorption, by which the humid solvent leaves the drying chamber but relatively slightly increased in temperature. The maintenance of a relatively low temperature aids greatly in reducing the possibility of formation of a mixture rich enough to explode. Both the speed of the air through the apparatus, and the temperature of the air, are regulated whereby any desired degree of saturation of the drying medium with solvent vapor may be maintained and the mixture kept below the explosive point.

My process may be used in any recovery apparatus which is not particularly designed to act differently, as, for instance, my co-pending application Serial No. 369,823, filed March 29, 1920, but not apparatus like May and Grosvenor, Patent No. 979,781, dated December 27, 1910, in which a large, slow moving body of air is used which necessarily becomes explosive, as is recognized in said patent by the provision of explosion doors which are arranged automatically to open to diminish the harmful effect of the inevitable explosion.

Fig. 1 is a side elevation of a drying and recovery apparatus well adapted for the performance of my invention.

Fig. 2 is a diagrammatic sectional elevation of the apparatus of Fig. 1.

Fig. 3 is a partial sectional plan view of the drying chamber along lines 3—3 of Fig. 1 showing air heating coils and dry air distribution pipes.

Fig. 4 is a detail, in transverse sectional elevation, of the drying chamber of Fig. 1.

Fig. 5 is a sectional plan view of the solvent separator along lines 5—5 of Fig. 1.

Figs. 6 and 7 are details in elevation and plan, respectively, of loop forming mechanism.

In the drying and solvent recovery apparatus here shown, which is well adapted for the recovery of solvent and prevention of the formation of an explosive mixture in accordance with my invention, the drying chamber is divided by partitions to form four different drying compartments 10, 11, 12, 13, on different levels, with connecting passages 14, 15, 16, through which the web

passes under tension from the upper to the next lower compartment around a guide roll until the solvent has substantially evaporated.

5 The drying medium passes in the contrary direction, preferably first to the lower compartment and then contrary to the movement of the web to the upper compartments of the drying chamber. After the drying medium  
10 has passed to the top compartment of the drying chamber, it passes out of the drying chamber at a point near the entrance of the web and thence through condensing apparatus for the recovery of the solvent.

15 The lower compartment 13 of the drying chamber forms what may be termed a loop chamber in which the coated and partially dried web, as it passes from the upper compartments is arranged in loops on a conveyor and carried to the exit from the drying chamber. Heating coils 17 are placed  
20 in said chamber and are adapted suitably to heat the air in the chamber to compensate for the reduction in temperature of the drying medium due to solvent absorption.

25 Heating coils 18 are placed at the top of the compartment 12 also suitably to heat the air therein.

The upper wall 19 of said compartment  
30 12 forms the lower wall of compartment 11 and is made of metal or other good conductor. Accordingly said compartment 11, owing to the close proximity of the heating coils 18 in the lower compartment, receives  
35 a considerable amount of heat from said heating coils. The upper compartment 10 I usually have free from artificial heating means, yet heating means may be introduced therein if desirable.

40 Nevertheless, the air in this upper chamber should not be allowed to become so cold as to interfere with the process of evaporation, and in case the evaporation cools the air in this upper chamber unduly, a moderate heat should be supplied to maintain  
45 the drying medium at a suitable temperature.

I prefer to make the top compartment 10 shallower than the compartments 11 and 12  
50 as there is a greater amount of solvent in the coating in said top compartment with the result that the velocity of the air therein is greater than in the lower compartments and the drying medium will absorb less  
55 solvent vapor.

The web may be passed as a continuous loop a successive number of times through the apparatus to receive and dry a successive number of coatings thereon, or the web  
60 may be passed but once through the apparatus and, with a single coating thereon, formed in a roll.

As here shown, the web 20 in the form of a roll is arranged on a horizontal shaft  
65 21 journaled in suitable bearings secured

to the frame of the drying chamber. Said shaft is provided with a brake drum 22 which is adapted to be engaged by a brake band 23 to adjust the tension of the web as it is unwound from the roll.

The end portion of the web is drawn from the roll as represented by the dotted line and passed over the horizontal roll 24 under the doctor 38 at which point the coating is applied. From the doctor the web is passed  
75 through the entrance slot or opening in the hood 26 of the drying chamber and over a roll 27 at the entrance to the first passage or compartment 10 of the drying chamber.

The coated web is extended under tension through said compartment and passed over an upper driving roll 28 disposed in the connecting passage 14 between the upper compartment 10 and the next lower compartment 11 and extended through said  
80 lower compartment and passed around a guide roll 29 disposed in the connecting passage 15 between said compartment 11 and the next lower compartment 12. After leaving said guide roll 29 the web is extended under tension through said compartment 12 and passed over the lower driving roll 30 disposed in the passage 16 connecting said compartment 12 with the loop chamber 13. From said driving roll 30 the web is passed around a nip roll 31 disposed in the loop compartment 13 from which it falls by gravity onto a conveyor arranged in said compartment and by which it is carried to the exit from the drying chamber.

After passing through the exit slot 32 in the drying chamber the web is extended over the guide rolls 33 and 34 and around the tension drum 35 and over the roll 24 to the doctor to receive another coating. After  
105 the web has received a sufficient number of coatings the ends of the web may be separated, preferably between the rolls 33 and 34, and formed in a roll on the shaft 36.

The power for driving the various rolls to move the web through the machine is applied at a pulley 37 fixed to a shaft 37' conveniently disposed at the top of the drying chamber. A gear 39 secured to said shaft is in mesh with a gear 39' fixed to the shaft carrying the upper web driving roll 28 and serves to drive said roll at such speed as to cause the most effective movement of the web through the drying chamber.

The shaft carrying roll 28 is also provided with a pulley 40, and a belt 41 is passed over said pulley and a pulley 42 of slightly smaller diameter secured to the shaft bearing the lower web driving roll 30 whereby the lower drying roll maintains a suitable tension on the web. A belt tightener 43 is or may be arranged in contact with said belt to maintain it in proper driving contact with the pulleys.

The roll 31, over which the web passes 120

from roll 30, is driven from the shaft bearing the roll 30 by the meshing gears 44 and 45. Said roll 31 is adapted to be driven at a slightly greater peripheral speed than the web driving rolls to aid in keeping a taut web extended through the upper drying compartments.

From roll 31 the web falls by its weight onto a conveyor where it is arranged in loops thereon and conveyed to the exit end of the drying chamber.

The conveyor includes two spaced-apart endless chains 46 and 46<sup>a</sup> connected at regular intervals by the cross-bars 47 on which the loops of web are adapted to be hung. Said chains are arranged over sprockets 48 and 48<sup>a</sup>, 49 and 49<sup>a</sup>, 50 and 50<sup>a</sup>, 51 and 51<sup>a</sup> disposed at the corners of the loop chamber 13.

The conveyor is driven by the sprockets 50 and 50<sup>a</sup> which are driven from the shaft bearing the roll 28 through the horizontal shaft 59 and vertical shaft 53 which are operably connected through gears with said roll shaft.

Change speed gearing is interposed between the shaft 53 and the sprockets 50 and 50<sup>a</sup> whereby more than a single speed of the conveyor may be obtained, whereby different lengths of coated web may be made to occupy substantially the entire length of the chamber.

As here shown, gear 54 and 54<sup>a</sup> of said gearing are fixed to a shaft 55 driven through bevel gears 56 and 56<sup>a</sup> from the vertical shaft 53. Other gears 57 and 58 of said change speed gearing are fixed together or are integrally formed and are slidably arranged on a shaft 59 which is connected through a worm 60 and gear 61 to the shaft carrying sprockets 50 and 50<sup>a</sup>. A pivoted handle 62 is provided which is in engagement with said sliding gears 57 and 58 to cause said gear 57 to engage with the gear 54, or gear 58 to engage with gear 54<sup>a</sup>, and said pairs of gears are arranged to drive said sprockets 50 and 50<sup>a</sup> at differing speeds to correspondingly drive the conveyor at differing speeds.

Said vertical shaft is extended downward beyond its connection with the change speed shaft 55 and, at its lower end, is connected with a shaft 63 through which the roll of web is driven and wound on shaft 36.

As the web passes from the roll 31 it is arranged to fall downward and pass between the cross-bars 47 of the conveyor and, as the conveyor is at the same time moved forward, to form loops on said cross-bars.

In order that the loops may be more effectively and positively formed, means are provided for definitely folding the web over the cross-bars as they are successively moved under the roll 31.

The loop forming means includes rods 65

and 65<sup>a</sup> which are pivoted to beams 66 and 66<sup>a</sup> arranged at the sides of the conveyor and secured to component parts of the drying chamber. Said rods extend downward into the path of movement of the cross-bars of the conveyor and are adapted to be moved upward by the individual bars as they pass under said rods and to permit said rods to drop by gravity as they pass from under the rods.

Said rods are provided, near their free ends, with outwardly extended members 67 and 67<sup>a</sup> in the ends of which is arranged the cross-member 68 which extends above and across the conveyor and which is adapted to be brought into contact with the web to form the loops.

Other rods 70 and 70<sup>a</sup>, bent into substantially right-angled shape, are pivoted to said beams 66 and 66<sup>a</sup> at points adjacent to and above the conveyor, and a rod 71 is extended between and connected to the free ends thereof.

As the ends of rods 65 and 65<sup>a</sup> are moved upward by each cross-bar 47 as it passes underneath, the cross-rod 68 connected to said rods engages the rods 70 and moves them upward thereby also moving upward the rod 71 connected to the ends thereof. When the cross-bars pass from under said rods 65 and 65<sup>a</sup> the rods rapidly drop by gravity and consequently permit the rods 70 and 70<sup>a</sup> bearing the cross-rod 71 to drop. As said rod 71 falls it strikes against the web which passes in a more or less downwardly slanting direction from the roll 31 to a cross bar 47 in the rear of the one employed in raising the rods 65 and 65<sup>a</sup>, and by its weight and momentum bends or folds the web over said cross-bar and so initiates the formation of a loop between said cross-bar and the next succeeding one. The same operation is repeated as each cross-bar passes under the rods 65 and 65<sup>a</sup>.

A blower or compressor 80 of any suitable or desirable construction is employed to ensure a positive circulation of the drying medium through the drying chamber and the condensing system and solvent bearing air is drawn from the top compartment of the drying chamber through the conduit 75 into the intake end of the blower or compressor. A pipe 81 also leads from the hood 26 to the compressor intake to collect the vaporized solvent in the hood. From the blower or compressor the solvent bearing air is forced through the cooling and condensing apparatus.

Although I have shown the blower or compressor as connected between the drying chamber and the condensing apparatus, yet it may be otherwise connected and insure a positive circulation of drying medium and, for some purposes, another position than the one illustrated may be desirable.

An important feature of my invention is the control of the speed of circulation of the drying medium by which the absorption of the solvent may be regulated and the formation of a mixture of the drying medium and vaporized solvent rich enough in solvent vapor to explode prevented.

As a convenient means for controlling the circulation of the drying medium, I govern the speed of the blower 80. Said blower has a pulley 80<sup>a</sup> fixed to the blower shaft over which a driving belt 80<sup>b</sup> is passed. Said belt is also passed over the pulley 80<sup>c</sup> which supplies the power to operate the blower. A controller 80<sup>e</sup> arranged in the motor circuit 80<sup>f</sup> provides means by which the rate of rotation of the motor may be governed at will and consequently the rate of circulation of the drying medium through the apparatus will be governed. Obviously, however, other means of blower-driving and air circulation control may be provided.

I prefer to pass the warm air from the drying chamber through a heat exchanging device through which the air from which the solvent has been extracted is passed in the reverse direction before being returned to the drying chamber.

I also prefer to pass the air from which the solvent has been condensed and before it has been reheated through a mechanical separator which may have a series of baffle-plates or similar collecting devices as I have found that the air from the condenser even when chilled contains a considerable amount of condensed solvent in the form of fine spray which, if not removed, would be returned to the drying chamber and render the returned air less effective as a drying and absorbing medium.

The condensing system includes a pre-cooler 85, heat exchangers 86, 86<sup>a</sup>, 86<sup>b</sup>, and condensers 87, 87<sup>a</sup>, 87<sup>b</sup> through which the air is successively forced through the pipe 88 from the blower 80. The pre-cooler, heat exchangers and condensers may be of any ordinary or suitable construction and as many units as are desirable may be employed.

In the pre-cooler 85 water is introduced at the bottom of the shell through the pipe 89 and flows upward in a direction contrary to the downward flow of solvent laden air therethrough and leaves the shell by the pipe 90. In its passage therethrough the water absorbs some of the heat of the air and causes the air to become more nearly saturated with the absorbed solvent.

The somewhat cooled air passes from the pre-cooler successively through the heat exchangers 86, 86<sup>a</sup>, 86<sup>b</sup>. The cold, dry air from the condensers is circulated through the shells of said heat exchangers in a direction contrary to the flow of moist air therethrough and serves to extract heat from

said moist air and to become somewhat heated in itself and in its heated condition passes by the pipe 78 to the loop compartments 13 of the drying chamber.

The moist air, as it leaves the heat exchangers, is cool and in a more or less saturated condition and enters the condensers 87, 87<sup>a</sup>, 87<sup>b</sup> through which it successively passes. The condensers are maintained cold by means of a solution of brine or other suitable refrigerating medium supplied to the shell of the condensers through the pipe 91 and flowing from said condensers in a partially heated condition through the pipe 92, having extracted heat from the drying medium in its passage therethrough. The brine or other refrigerant may be cooled by any suitable artificial cooling means. Preferably the temperature of the brine is such that the temperature of the dry air is relatively low, say about 0°F., when it leaves the condensers.

As the air passes through the condensing units it becomes successively cooler and the evaporated solvent absorbed therein becomes condensed and separates from the air and collects at the bottom of the condensing units or at the bend in the pipes serially connecting the units. Connections are made with the lower parts of the units and 95 for the recovery of the condensed solvent.

After passing from the last condensing unit 87<sup>b</sup> the major part of the absorbed solvent has been condensed and recovered yet the cold air contains a substantial amount of mechanically entrained solvent in the form of a fine spray.

A mechanical separator 100 is inserted in the pipe for the cooled air as it passes from the last condensing unit 87<sup>b</sup> to extract this remaining moisture. The separator is provided with a plurality of baffle-plates 101 or equivalent devices arranged in the path of flow of the cold air which serve to abstract the moisture from the air as it impinges thereon and to collect it in the receiver 102 from which it flows through the pipe 103 to the solvent pipe 95.

The cold and dry air is now directed through the heat exchangers where its temperature is raised in lowering the temperature of the moist air and passes through the pipe 78 to the bottom of the loop chamber 13 in which it is uniformly distributed by the plurality of perforated distributing pipe 105 placed therein over the heating coils 17.

A further important feature of this invention is the control of the temperature of the dry drying medium, by the maintenance of a low temperature for it, a relatively lean and therefore unexplosive mixture results especially when used in combination with the regulation of the rate of circulation of the drying medium. For this pur-

pose, a regulating valve 91<sup>a</sup> is arranged in the brine pipe 91 by which the rate of circulation of the cold brine or other refrigerating medium may be regulated thereby to vary the rate of cooling, and the final temperature, for the drying medium in the condensers.

A thermometer 92<sup>a</sup> placed in the pipe which serves to direct the cold dry drying medium to the heat exchangers and thence to the drying chamber will indicate the temperature of the dry drying medium, whereby proper regulation of the cooling effect may conveniently be effected.

It will be noted that the drying sections of the drying chamber, with the exception of the loop compartment, are restricted in vertical extent so that the drying medium flows therethrough at a relatively rapid rate, which is desirable, as it assists in preventing the formation of mixture rich enough in solvent vapor to explode.

While it is possible to maintain the mixture of solvent vapor and drying medium at a point below that at which explosions will occur, by regulation of velocity of flow of drying medium alone, or by temperature control alone, yet I prefer to govern both the temperature and speed of the drying mixture as productive of more satisfactory results.

With a fixed rate of input of solvent into the drying chamber, as by a fixed speed of the wet coated web through the chamber, a certain speed of drying medium and temperature of drying medium will result for the performance of the invention.

An appreciable variation of the rate of input of solvent, as by varying the speed of the material through the drying chamber, or varying the thickness of the coating applied thereto, or varying the proportion of solvent therein, may necessitate variation of temperature and speed of the drying medium in the drying chamber. Ordinarily, however, the substitution of one solvent for another, so far as the common solvents, as benzol, ethyl acetate, wood alcohol and the like are concerned, will not necessitate varying the speed or temperature of the drying medium in the drying chamber.

Usually, and as herein shown, the speed of the wet material through the drying chamber will be fixed at some predetermined value, and the speed of the drying medium through the chamber, and its temperature, when once determined, usually need not be changed; so that with the speed of the web, and the cross-section of the passages in the drying chamber known, the capacity and speed of rotation of the blower, and the temperature of the drying medium, may be predetermined in advance, so that no speed or temperature adjustments need be

made for the commercial operation of the apparatus.

My invention relates only to the treatment of coating mixtures containing a solvent, the vapor of which becomes explosive when mixed with certain proportions of air, and the specification and claims should be read with that understanding.

In case, in a coating apparatus, a moist air is supplied to the drying chambers and permitted to condense on the goods, the coating material may be precipitated, causing a defect in the product, called "blushing." This danger I avoid by reason of the fact that the moisture is so completely condensed from the drying medium before the drying medium is returned to the apparatus that no water vapor will be condensed at any temperature reached in the drying process.

I claim:

1. The method of recovering the solvent from the coating of fabrics such solvent consisting of a mixture containing a highly volatile solvent the vapor of which is explosive when mixed with a critical proportion of air, which consists in passing a current of drying medium in a drying chamber counter to the direction of movement of the moving coated fabric in the chamber until the fabric is dry, at such a speed that the proportion of explosive solvent vapor in the drying medium is not great enough to form an explosive mixture, removing the drying medium containing the solvent to a condensing apparatus and condensing the solvent by refrigeration and again passing the drying medium from which the solvent has been recovered into contact with the coated fabric.

2. The method of recovering the solvent from the coating of fabrics such solvent consisting of a mixture containing a highly volatile solvent the vapor of which is explosive when mixed with a critical proportion of air, which consists in passing a current of drying medium in a drying chamber counter to the direction of movement of the moving coated fabric in the chamber until the fabric is dry, at such speed that the proportion of explosive solvent vapor in the drying medium is not great enough to form an explosive mixture, removing the drying medium containing the solvent to a condensing apparatus and condensing the solvent by refrigeration and again passing the drying medium from which the solvent has been recovered into contact with the coated fabric and maintaining the temperature of the drying medium while in contact with the coated fabric at a suitable value.

3. The method of recovering the solvent from the coating of fabrics such solvent consisting of a mixture containing a highly

volatile solvent the vapor of which is explosive when mixed with a critical proportion of air, which consists in passing a current of drying medium in a drying chamber counter to the direction of movement of the moving coated fabric in the chamber until the fabric is dry, at such speed and temperature that the proportion of explosive solvent vapor in the drying medium is not great enough to form an explosive mixture, removing the drying medium containing the solvent to a condensing apparatus and condensing the solvent by refrigeration and again passing the drying medium from which the solvent has been recovered into contact with the coated fabric.

4. The method of recovering the solvent from the coating of fabrics such solvent consisting of a mixture containing a highly volatile solvent the vapor of which is explosive when mixed with a critical proportion of air, which consists in passing a current of drying medium in a drying chamber counter to the direction of movement of the moving coated fabric in the chamber until the fabric is dry, at such speed and temperature that the proportion of explosive solvent vapor in the drying medium is not great enough to form an explosive mixture, removing the drying medium containing the solvent to a condensing apparatus and condensing the solvent by refrigeration and again passing the drying medium from which the solvent has been recovered into contact with the coated fabric and maintaining the temperature of the drying medium while in contact with the coated fabric at a suitable value.

5. In a coating apparatus for material in the web, including a drying chamber through which the wet coated material is moved to be dried, and solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the material therein and thence through the solvent recovery apparatus to extract solvent therefrom and back to the drying chamber with solvent extracted therefrom, and means to maintain the proportion of solvent vapor in the drying medium in the drying chamber below that at which a mixture of the solvent vapor and drying medium will explode.

6. In a coating apparatus for material in the web, including a drying chamber through which the wet coated material is moved to be dried, and solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the material therein and thence through the solvent recovery apparatus to extract sol-

vent therefrom and back to the drying chamber with solvent extracted therefrom, and means to maintain the proportion of solvent vapor in the drying medium in the drying chamber below that proportion at which a mixture of the solvent vapor and drying medium will explode comprising means to govern the rate of circulation of drying medium in the drying chamber.

7. In a coating apparatus for material in the web, including a drying chamber through which the wet coated material is moved to be dried, and solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the material therein and thence through the solvent recovery apparatus to extract solvent therefrom and back to the drying chamber in cold and dry condition, and means to maintain the proportion of solvent vapor in the drying medium in the drying chamber below that proportion at which a mixture of the solvent vapor and drying medium will explode, comprising means to govern the temperature of the drying medium in the drying chamber.

8. In a coating apparatus for material in the web, including a drying chamber through which the wet coated material is moved to be dried, and solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the material therein and thence through the solvent recovery apparatus to extract solvent therefrom and back to the drying chamber in cold and dry condition, and means to maintain the proportion of solvent vapor in the drying medium in the drying chamber below that proportion at which a mixture of the solvent vapor and drying medium will explode comprising means to maintain a reduced temperature of the drying medium in the drying chamber.

9. In a coating apparatus for material in the web, including a drying chamber through which the wet coated material is moved to be dried, and solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the material therein and thence through the solvent recovery apparatus to extract solvent therefrom and back to the drying chamber in cold and dry condition, and means to maintain the proportion of solvent vapor in the drying medium in the drying chamber below that proportion at which a mixture of the solvent vapor and drying medium will explode, comprising means to govern the rate of circulation of drying medium in

the drying chamber, and means to govern the temperature of the drying medium in the drying chamber.

10. In a coating apparatus for material in the web, including a drying chamber through which the wet coated web is moved arranged to guide a current of drying medium over the web counter to the direction of movement of the web, means to prevent explosion of the mixture of solvent vapor and drying medium therein comprising means to circulate the drying medium through the drying chamber at such a rapid rate as to prevent the formation of a mixture of solvent vapor and drying medium rich enough in solvent vapor to explode.

11. In a coating apparatus for material in the web, including a drying chamber through which the wet coated web is moved arranged to guide a current of drying medium over the web in a direction counter to the movement of the web in the chamber, a solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the wet coating, thence through the recovery apparatus and back to the drying chamber in cold and dry condition, means to prevent explosion of the mixture of solvent vapor and drying medium in the drying chamber comprising means to maintain a reduced temperature of the drying medium in the drying chamber of such a value as to prevent the formation of a mixture rich enough in solvent vapor to explode.

12. In a coating apparatus for material in the web, including a drying chamber through which the wet coated web is moved arranged to guide a current of drying medium over the web in a direction counter to the movement of the web in the chamber, a solvent

recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium through the drying chamber to abstract solvent from the wet coating, thence through the recovery apparatus and back to the drying chamber in cold and dry condition, means to prevent explosion of the mixture of solvent vapor and drying medium in the drying chamber comprising means to circulate the drying medium through the drying chamber at such a rapid rate, and other means to maintain a reduced temperature of the drying medium in the drying chamber of such a value, as to prevent the formation of a mixture rich enough in solvent vapor to explode.

13. In a coating apparatus for material in the web, including a coating device, a drying chamber having restricted passages through which the wet coated web is moved to be dried, solvent recovery apparatus in which the drying medium is cooled and solvent condensed, means to circulate the drying medium rapidly through the restricted passages in the drying chamber in a direction counter to the movement of the material therein to abstract solvent from the coating, thence through the recovery apparatus for cooling and extraction of solvent, and back to the drying chamber in cold and dry condition, and means to prevent explosions of the mixture of solvent vapor and drying medium in the drying chamber comprising the combination of means so to regulate the speed of the drying medium through the drying chamber, and other means so to govern the temperature of the drying medium in the drying chamber as to prevent the formation of a mixture rich enough in solvent vapor to explode.

In testimony whereof I have signed my name to this specification.

PAUL S. SMITH.