Nov. 24, 1942. B. CAMPBELL ET AL 2,303,257

METHOD AND APPARATUS FOR IMPREGNATING FIBROUS MATERIAL

Filed July 31, 1940. 3 Sheets-Sheet 1

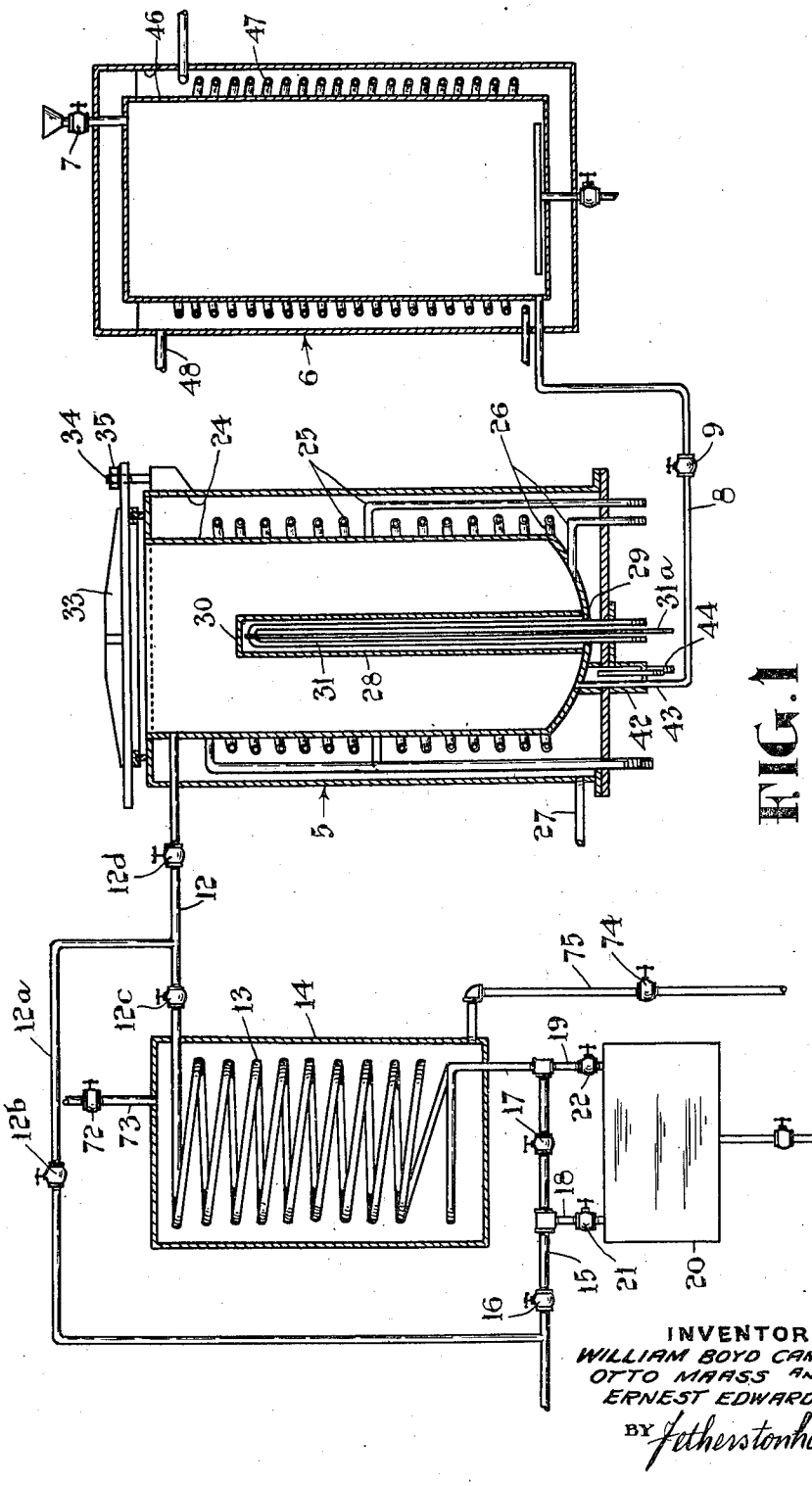


FIG. 1

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METHOD AND APPARATUS FOR IMPREGNATING FIBROUS MATERIAL

Filed July 31, 1940 3 Sheets-Sheet 2

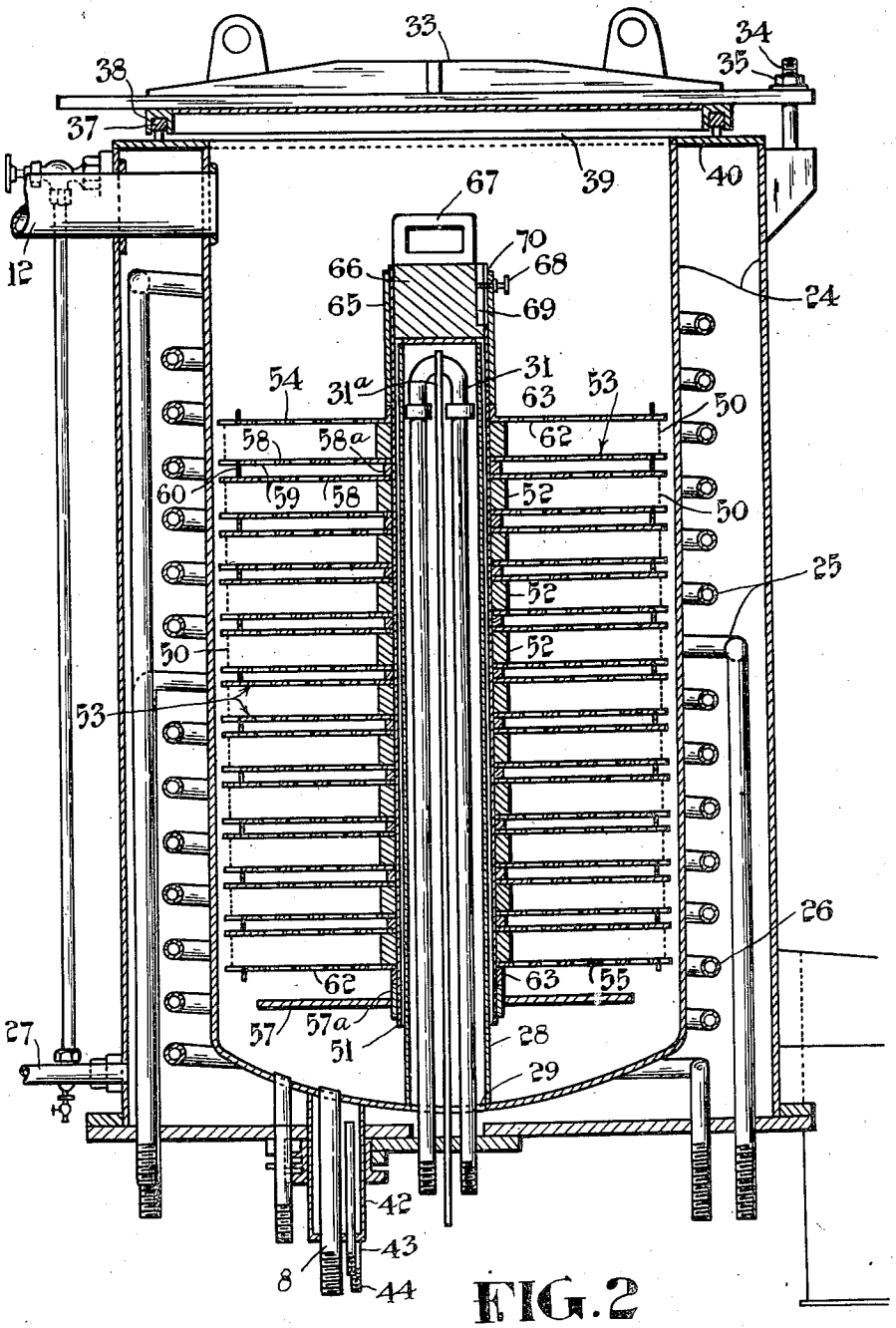


FIG. 2

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METHOD AND APPARATUS FOR IMPREGNATING FIBROUS MATERIAL

Filed July 31, 1940 3 Sheets-Sheet 3

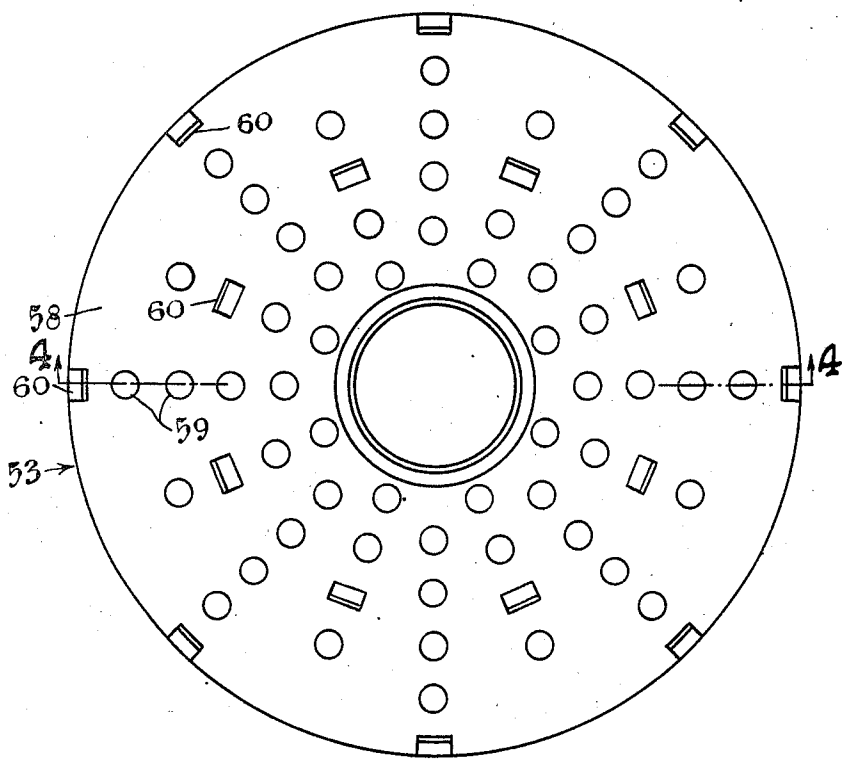


FIG. 3

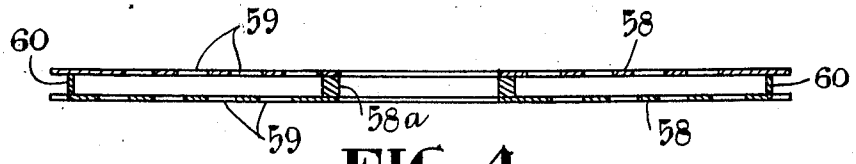


FIG. 4

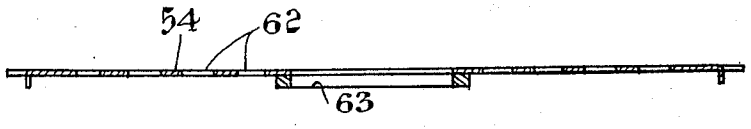


FIG. 5

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UNITED STATES PATENT OFFICE

2,303,257

METHOD AND APPARATUS FOR IMPREGNATING FIBROUS MATERIAL

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Application July 31, 1940, Serial No. 348,962

11 Claims. (Cl. 117—61)

This invention relates to the production of wax impregnated cigarette paper and is a continuation, in part, of the invention set forth in our co-pending application Serial No. 271,950, filed May 5, 1939.

The main object of the invention is to provide an efficient method and apparatus whereby rolls of cigarette paper may be uniformly impregnated with wax by soaking the rolls in a treating solution consisting of wax dissolved in a volatile solvent that will not swell or otherwise adversely affect the rolled paper. To this end the invention consists in subjecting the rolled paper to successive soakings in said solution with intermediate removal of the solvent from both the treating vessel and the paper by the application of heat and suction, the soaking treatments being carried out at a temperature above the boiling point of the solvent contained in said solution.

In the process described herein repetition of the soaking step is a necessary and important feature since a single stage soaking, no matter how prolonged, will not give uniform and satisfactory penetration of the paper by the wax when the paper is treated in the form of rolls. Complete removal of the solvent from the paper between soaking treatments is also a vital step, in the absence of which repetition of the soaking step is not effective to give the desired uniform and satisfactory penetration.

In its preferred application the invention comprises the following steps: (1) introducing the treating solution into a storage chamber which is always under atmospheric pressure; (2) placing the rolls of paper in a treating chamber; (3) heating the treating chamber and its contents to a temperature above the boiling point of the solvent contained in the treating solution; (4) placing the treating chamber in communication with a source of suction during the latter part of the heating period of step 3 and disrupting said communication when a predetermined sub-atmospheric pressure is established in said chamber; (5) cooling the walls of said chamber to a temperature below the boiling point of the treating solution; (6) placing the evacuated treating chamber in communication with the storage chamber so that the treating solution is transferred from the storage chamber to the treating chamber by atmospheric pressure aided by the vacuum previously established in the treating chamber; (7) disrupting the communication between said chambers when the transfer of the treating solution is completed; (8) permitting the rolls of paper to soak in the treating solution for a suitable period of time while heating the treating chamber to a temperature above the boiling point of the solvent contained in the treating solution; (9) re-establishing communication between the treating chamber and the storage chamber whereby the unabsorbed treating solution is forced back to the storage chamber by the pressure of the evaporated solvent contained in the treating chamber; (10) disrupting communication between said chambers when the transfer of unabsorbed treating solution from the treating chamber to the storage chamber is completed; (11) removing all solvent from the treating chamber and from the treated material by exhausting the evaporated solvent from said chamber while simultaneously heating said chamber to a temperature above the boiling point of the solvent. Steps 5 to 11 inclusive are then repeated, following which the rolls of paper are removed from the treating chamber and allowed to cool.

The treating solution is preferably heated to a temperature of about 50 to 60° C. before being run into the treating tank. Due to the low pressure existing in the tank when the treating solution is introduced some of the solvent immediately volatilizes. This volatilization continues until the vapor establishes sufficient pressure to prevent further boiling or volatilization of the solution. If any temperature differences exist in the treating chamber the evaporated solvent will condense on the cooler places until equilibrium is established. Consequently, if the rolls of paper in the treating chamber are cold when the treating solution is introduced they will become soaked by pure solvent formed by condensation of the vapor coming in contact therewith. This, of course, prevents satisfactory penetration of the rolled paper by the treating solution. We have found that this difficulty is reduced to a minimum when the introduction of the solution into the treating chamber is preceded by the preliminary heating and cooling steps (steps 3 and 5) mentioned in the preceding paragraph. The result of these steps is to establish a temperature differential between the paper rolls and the walls of the heating chamber which favors condensation on the walls rather than on the rolls and thus ensures that the solution will penetrate a greater distance inwardly from the edges toward the center of the rolled paper than would otherwise be the case.

A further advantage of the procedure described herein is that the transfer of treating solution

between the storage and treating chambers (steps 6 and 9) is accomplished without pressure introduction of air or foreign gases into either of said chambers. As a matter of fact, the exclusion of air or foreign gases from the paper rolls facilitates the penetration of the paper by the treating solution.

The rolls of paper are preferably permitted to soak in the treating solution (step 8) for a period of about 45 minutes during which the treating chamber is heated to a temperature of about 100° C. In carrying out step (11) it is important that the maximum amount of heat be applied to each paper roll to assist in the evaporation and removal of the absorbed solvent. This is accomplished by loading the rolls on a hollow heat conducting mandrel which passes upwardly through the bobbin or central opening of each roll, suitable heat conducting spacers being arranged on the mandrel between adjacent rolls. The spacers and the bobbins of the rolls should be a snug fit on the mandrel to ensure the maximum conduction of heat to the central and side portions of each roll. After the paper rolls and spacers have been secured thereon the mandrel is fitted snugly over a hollow heatable core which is located in and forms part of the treating chamber, said core being preferably heated by means of a heating coil arranged therein.

The heat applied in step 11 serves to distill off the solvent contained in the treating solution which penetrated or was absorbed by the paper during the preceding soaking step (step 8). This distillation of the paper absorbed solvent is accelerated by the metal heat conducting elements in contact with the paper rolls and by the reduction in pressure in the treating chamber which is brought about by connecting the treating chamber to a source of suction to remove the evaporated solvent therefrom. The evaporation of the paper absorbed solvent serves to cool down the paper rolls, the extent of the cooling being proportional to the rate of evaporation. This cooling of the paper has two effects: first, the waxes being less soluble in the cold are deposited; secondly, the solvent evaporates much more slowly as it becomes colder. During the distillation of the solvent the pressure in the treating chamber gradually decreases as the evaporated solvent is removed. It has been found, however, that the solvent removal is not yet complete when the pressure gauge of the treating chamber indicates that the maximum vacuum has been obtained. Consequently, in order to ensure the requisite complete removal of all solvent from the treating chamber and its contents, it is necessary to apply heat during the evacuation of the heating chamber in step 11. In practice it takes about one hour to reach an absolute pressure of ¼" of mercury in the treating chamber during this step. The treating chamber is then heated for a further period of about one hour while still connected to the suction or vacuum apparatus. A temperature of 100° C. is maintained during this time.

The conditions obtaining in the treating chamber during the second soaking treatment are slightly different as compared with the conditions obtaining during the initial soaking. The solvent vapors which condense on the paper at the beginning of the second soaking treatment will dissolve the wax already present in the outer portions of the rolled paper strips and it is this solution, rather than pure solvent, which penetrates to the center of the rolled material as the second soaking treatment progresses to completion.

When step 11 is repeated, the duration of the heating period following the establishment of an absolute pressure of ¼" of mercury in the treating chamber may be reduced to about 10 minutes.

Reference will now be had to the following detailed description taken in connection with the accompanying drawings, in which—

Fig. 1 is a diagrammatic view, partly in section, of one form of apparatus which may be used in carrying the invention into effect. In this view the treating chamber is shown as it appears prior to the introduction of the paper rolls.

Fig. 2 is an enlarged vertical sectional view of the treating chamber with the paper rolls arranged therein.

Fig. 3 is a top plan view of one of the heat conducting spacers which are arranged on the mandrel between adjacent rolls.

Fig. 4 is a sectional view taken substantially along the line 4—4 of Fig. 3.

Fig. 5 is a sectional view of one of the heat conducting plates which are employed in conjunction with the heat conducting spacers shown in Figs. 3 and 4.

Referring more particularly to the drawings, 5 designates the treating tank in which the paper rolls are treated in accordance with this invention. The treating solution, consisting of waxes dissolved in a suitable volatile solvent, is prepared in or introduced into the treating solution storage tank 6. In practice we prefer to prepare the solution in tank 6 by introducing the necessary ingredients through valve 7 which is left open during subsequent operations so that tank 6 is under atmospheric pressure. Alternately, the treating solution may be prepared in a separate mixing vessel (not shown) and then introduced into tank 6 through said valve.

When the apparatus is in use the treating solution is passed from tank 6 to tank 5 and vice versa through line 8 and valve 9. The upper portion of tank 5 is connected, through line 12, to one end of a condenser coil 13 arranged in condenser tank 14. The remaining end of coil 13 is connected, through line 15, to a vacuum pump (not shown). Line 15 is provided with valves 16 and 17. This line is also provided, at opposite sides of valve 17, with branches 18 and 19 leading to a solvent tank 20. Branches 18 and 19 are provided, respectively, with valves 21 and 22. Lines 12 and 15 are also directly connected through bypass line 12*a* equipped with a valve 12*b*. Line 12 is equipped with valves 12*c* and 12*d*, the former being located between bypass connection 12*a* and coil 13 and the latter being located between bypass connection 12*a* and tank 5.

Tank 5 is provided with a water jacket 24 containing two steam heating coils 25 and 26. Water is supplied to and withdrawn from jacket 24 through pipe 27. A hollow heatable core 28 is centrally located in tank 5. The lower end of core 28 is open and is welded or otherwise secured in place around an opening 29 by which the interior of the core is placed in communication with the water space of jacket 24. The upper end of core 28 is closed off as indicated at 30. The water entering core 28 from jacket 24 is heated, at times, by a steam heating coil 31.

A vent pipe 31a also extends upwardly within core 28.

Tank 5 is also provided with a removable top cover 33 secured in place by the swinging eye bolts 34 and clamping nuts 35. A compressible sealing member 37 is secured in a channel shaped holder 38 fastened to the underside of cover 33. When cover 33 is secured in place by bolts 34 and nuts 35, sealing member 37 is pressed tightly against a sealing rib 39 projecting upwardly from the top wall 40 of jacket 24.

A portion of the treating fluid transfer pipe 8 is enclosed by a heater casing 42 welded or otherwise secured to the bottom of tank 5. Casing 42 is provided with steam inlet and outlet pipes 43 and 44 through which steam is passed through said casing whenever it is necessary or desirable to raise the temperature of the treating solution during its passage from tank 6 to tank 5.

As diagrammatically indicated in Fig. 1, the solution storage tank 6 is also provided with a water jacket 46 containing a steam heating coil 47, water being supplied to said jacket through pipe 48.

The rolls of paper to be treated in accordance with this invention are indicated at 50 in Fig. 2. These rolls are arranged, one above the other, on a hollow heat conducting mandrel 51 which is fitted over the heatable core 28 contained in treating tank 5. The rolls are loaded on the mandrel so that the latter extends upwardly through the bobbin 52 of each roll and through the central openings of suitable heat conducting spacers 53 interposed between adjacent rolls. Additional heat conducting elements are also indicated at 54 and 55, the element 54 being arranged on the mandrel 51 in contact with the upper side of the top roll 50 and the element 56 being interposed between the lower side of the bottom roll 50 and the hub 57a of the mandrel flange 57.

Each of the heat conducting spacers 53 comprises spaced upper and lower ring shaped plates 58 made of stainless steel, the inner circular edges of said plates being substantially flush with the inner periphery of an interposed spacing ring 58a which surrounds the mandrel and is welded or otherwise secured to the opposing surfaces of said plates. Each plate is provided with a multiplicity of small openings 59 and the top plate 58 is also provided with struck out spacer tongues 60 which are bent downwardly into engagement with the bottom plate to serve as additional spacers between the plates. Obviously, the tongues 60 may be struck from the bottom instead of the top plate 58 or they may be struck from both of said plates at suitable points.

Each of the heat conducting elements 54 and 55 comprises a single ring shaped plate provided with a multiplicity of small openings 62 and having its inner peripheral portion welded or otherwise secured to a spacer ring 63 surrounding the mandrel. The bobbins 52 and the heat conducting elements 53, 54 and 55 should be a snug fit on the mandrel to ensure the maximum conduction of heat to the center and side portions of each roll. For the same reason it is desirable that the mandrel be a snug sliding fit on the heatable core 28, the slight clearance shown between these elements being preferably omitted in actual practice.

The rolls 50 and the associated heat conducting elements 53, 54 and 55 are secured in place between the manual flange hub 57a and a removable retaining sleeve 65 which is fitted on and fastened to the upper portion of the mandrel tube. In this connection it will be noted that the mandrel comprises a metal tube having its upper end closed by an inserted plug 66 provided with a lifting bail 67. Sleeve 65 carries a clamping screw 68 which is screwed tightly against the bottom wall of a groove 69 provided in plug 66, said groove registering with a screw receiving slot 70 extending downwardly from the upper end of the mandrel tube.

Paper disks (not shown) are preferably placed between the rolls 50 and the heat conducting elements 53, 54 and 55, to serve as filters and to assist in keeping the paper rolls clean. The rolls 50 and the associated heat conducting elements 53, 54 and 55 should be packed as tightly as possible on the mandrel to ensure good heat conducting contact between the heat conducting elements and the paper. In practice the rolls and associated heat conducting elements are secured in place on the mandrel before the latter is fitted over the heatable core 28.

The apparatus is put into operation in the following manner: The treating tank 5 is loaded with the paper rolls as shown in Fig. 2 and the treating solution is prepared in or introduced into tank 6. At this time valves 7, 16, 17, 12b and 12d are open but valves 21, 22, 9 and 12c are closed. The preliminary heating of the tank (step 3) is then effected by supplying steam to heating coil 31 contained in core 28 and to one or both of the heating coils 25 and 26 contained in the water jacket 24. The tank and its contents are thus heated to a temperature of 95–100° C. which is maintained for a period of about 55 minutes. Toward the end of this preliminary heating period valve 12c is opened so that a vacuum is drawn on tank 5 to establish a predetermined absolute pressure therein. When this is accomplished valve 12c is closed and the walls of the treating chamber are quickly cooled (step 5) by shutting off the steam supplied to the coils 25, 26, and 31 and replacing the hot water in jacket 24 by cold water. The walls of the tank, being of greater thermal conductivity, will cool down more rapidly and to somewhat lower temperature than the rolls 50 so that the temperature conditions thus established in the tank will favor condensation of vapors on the walls rather than on the rolls as previously explained in connection with steps 3 and 4. The evacuated treating tank 5 is now placed in communication with the storage chamber so that the treating solution is transferred from the storage chamber 6 to the treating chamber by atmospheric pressure. Valves 16 and 12d are now closed and valve 9 is open. Since tank 6 is under atmospheric pressure (the valve 7 being still open) the solution contained therein is quickly drawn into the previously evacuated treating tank 5 through line 8 and valve 9. When this transfer is completed valve 9 is closed and the paper rolls are allowed to soak in the treating solution for a period of about 45 minutes, during which the treating chamber is again heated to a temperature of about 100° C. by the heating coils 25, 26, and 31. Owing to resulting vaporization of the solvent contained in the treating solution, the pressure in tank 5 becomes greater than that in tank 6 which is still under atmospheric pressure. At the end of the soaking period valve 9 is opened and the unabsorbed treating solution is forced back to the storage chamber 6 by the pressure of the evaporated solvent contained in the treat-

ing chamber. When this transfer of the unabsorbed treating solution from tank 5 to tank 6 is completed, the valve 9 is again closed. The next step consists in removing all solvent from the treating chamber and from the paper rolls by exhausting the evaporated solvent from said chamber while simultaneously heating said chamber to a temperature above the boiling point of the solvent. To this end a vacuum is drawn on solvent tank 20, coil 13, and line 12 by opening valves 16, 17, 21, 22, and 12c while valves 12b and 12d are closed. When the desired vacuum conditions are thus established in tank 20, coil 13 and line 12, the valves 16 and 17 are closed and valve 12d is opened. At this time water from a cooling tower or other source is circulated through the condenser tank 14 by opening valve 72 in the water supply line 73 and valve 74 in the drain line 75. With this particular setting of the valves (valves 16, 17, and 12b being closed and valves 21, 22, 12c, and 12d being open) the evaporated solvent is drawn from treating tank 5 into the solvent tank 20 through line 12, valves 12d and 12c, condensing coil 13, line 19, and valve 22. During this solvent evacuation step, the temperature of tank 5 is maintained above the boiling point of the solvent by the heating coils 25, 26, and 31 to ensure that all the solvent contained in the treating solution absorbed by the paper rolls will be distilled off and withdrawn into the solvent tank 20. The last traces of solvent are preferably removed from tank 5 by closing valve 16 and opening valve 12b to place the tank in direct communication with the suction line 15. The operations involved in carrying out steps 5 to 11 inclusive are then repeated to ensure the desired uniform and complete penetration or coating of the paper by the wax. Following this repetition of steps 5 to 11 inclusive the paper rolls are removed from the treating tank and allowed to stand separately in the air for several hours to cool.

In one instance in which the invention was used for the production of wax impregnated cigarette paper the treating solution was composed of the following ingredients mixed together in the following proportions, by weight:

	Pounds
Carbon tetrachloride	150
Beeswax	2
Carnauba wax	1½

In preparing this solution the waxes were melted and poured into the solvent which had previously been heated to 45 to 50° C. The mixture was then stirred to ensure complete solution. When any appreciable interval of time is permitted to elapse between the preparation and use of the solution it is usually necessary to reheat the solution to 45° C., since some wax may separate from the solution during such interval.

The initial heating of the solvent during the preparation of the solution, as well as any subsequent heating of the solution, may be accomplished by supplying steam to the steam heating coil 47 contained in the jacket 46 of the solution storage tank 6.

While the present invention is primarily concerned with the production of wax impregnated cigarette papers and has been found peculiarly useful in this relation, it is obvious that certain features of the invention are not limited to this application but may also be employed in other relations where it is desirable to impregnate material with waxes or other solids dissolved in a volatile solvent. However, in the application of the invention to the wax impregnation of paper, especially in roll form, it is essential that the solution used be such that it does not swell the paper or cause it to deteriorate in any material respect and the solvent employed in making up the solution should be selected accordingly

Having thus described our invention, what we claim is:

1. The method of impregnating paper in the form of rolls with a treating solution which does not swell the paper which comprises (1) introducing the treating solution into a storage chamber which is always under atmospheric pressure; (2) placing the rolls of paper in a treating chamber; (3) heating the treating chamber and its contents to a temperature above the boiling point of the solvent contained in the treating solution; (4) placing the treating chamber in communication with a source of suction during the latter part of the heating period of step 3 and disrupting said communication when a predetermined sub-atmospheric pressure is established in said chamber; (5) cooling the walls of said chamber to a temperature below the boiling point of the treating solution to establish a temperature difference which favors condensation of evaporated solvent on said walls rather than on the paper rolls when the treating solution is introduced into the treating chamber; (6) placing the evacuated treating chamber in communication with the storage chamber so that the treating solution is drawn into the treating chamber by the vacuum previously established therein; (7) disrupting communication between said chambers when the transfer of the treating solution is completed; (8) permitting the rolls of paper to soak in the treating solution for a suitable period of time while heating the treating chamber to a temperature above the boiling point of the solvent contained in the treating solution; (9) re-establishing communication between the treating chamber and the storage chamber whereby the unabsorbed treating solution is forced back to the storage chamber by the pressure of the evaporated solvent contained in the treating chamber; (10) disrupting communication between said chambers when the transfer of unabsorbed treating solution from the treating chamber to the storage chamber is completed; (11) removing all solvent from the treating chamber and from the treated material by exhausting the evaporated solvent from said chamber while simultaneously heating said chamber to a temperature above the boiling point of the solvent; and then repeating steps 5 to 11 inclusive.

2. A method according to claim 1, in which the central and side portions of each roll are heated during steps 8 and 11 by heat conductors arranged in contact therewith.

3. A method according to claim 1, in which heat is conducted directly to each paper roll during steps 8 and 11.

4. A method according to claim 1, in which the paper rolls are arranged in the treating chamber with heat conducting spacers interposed between adjacent rolls.

5. A method according to claim 1, in which the paper rolls are arranged in the treating chamber in heat conducting relation with a heat conductor extending upwardly through the center of the rolls.

6. A method according to claim 1, in which the paper rolls are arranged in the treating chamber in heat conducting relation with a heat conductor

extending upwardly through the center of the rolls and with additional heat conductors interposed between adjacent rolls.

7. The method of impregnating material in the form of rolls which comprises loading the rolls alternately with metallic heat conducting plates on a hollow heat conducting mandrel, fitting the mandrel over a heatable hollow core contained in the treating chamber which is closed during the impregnating operation, heating the chamber and its contents to a temperature above the boiling point of the solvent contained in the treating solution, then cooling the walls of the treating chamber to below the boiling point of the solution, drawing a vacuum in the treating chamber and then placing said chamber in communication with a storage tank in which the treating solution is maintained under atmospheric pressure whereby said solution is drawn from the storage tank to the treating chamber by the vacuum previously established in the treating chamber, allowing the treating solution to remain in contact with the rolls of material for a predetermined period of time during which the treating chamber is heated to a temperature above the boiling point of the solution, re-establishing communication between the treating chamber and the storage tank so that the treating solution is forced back to the storage tank by the pressure of the evaporated solvent contained in the treating chamber, disrupting communication between the treating chamber and the storage tank when the transfer of treating solution from the treating chamber to the storage tank is completed and then placing said chamber in communication with a prevously evacuated condenser while heating said chamber to a temperature above the boiling point of the treating solution.

8. The method of impregnating paper in the form of rolls which comprises (1) introducing the treating solution into a storage chamber which is always under atmospheric pressure; (2) placing the rolls of paper in a treating chamber; (3) heating the treating chamber and its contents to a temperature above the boiling point of the solvent contained in the treating chamber; (4) placing the treating chamber in communication with a source of suction during the latter part of the heating period of step 3 and disrupting said communication when a predetermined sub-atmospheric pressure is established in said chamber; (5) cooling the walls of said chamber to a temperature below the boiling point of the treating solution to establish a temperature difference which favors condensation of evaporated solvent on said walls rather than on the paper rolls when the treating solution is introduced into the treating chamber; (6) placing the evacuated treating chamber in communication with the storage chamber so that the treating solution is drawn into the treating chamber by the vacuum previously established therein; (7) disrupting communication between said chambers when the transfer of the treating solution is completed; (8) permitting the rolls of paper to soak in the treating solution for a suitable period of time while heating the treating chamber to a temperature above the boiling point of the solvent contained in the treating solution; (9) re-establishing communication between the treating chamber and the storage chamber whereby the unabsorbed treating solution is forced back to the storage chamber by the pressure of the evaporated solvent contained in the treating chamber; (10) disrupting communication between said chambers when the transfer of unabsorbed treating solution from the treating chamber to the storage chamber is completed; (11) removing all solvent from the treating chamber and from the treated material by exhausting the evaporated solvent from said chamber while simultaneously heating said chamber to a temperature above the boiling point of the solvent.

9. Apparatus for impregnating material in the form of rolls comprising, in combination, a treating chamber in which the rolls are soaked in the treating solution, a hollow heat conducting core extending upwardly from the bottom wall of said chamber and a removable heat conducting mandrel in said chamber on which the rolls are arranged one above the other, said mandrel being fitted on said core.

10. Apparatus for impregnating material in the form of rolls comprising, in combination, a treating chamber in which the rolls are soaked in the treating solution, a removable heat conducting mandrel in said chamber on which the rolls are arranged one above the other and heat conducting members arranged on the mandrel between adjacent rolls.

11. Apparatus for impregnating material in the form of rolls comprising, in combination, a treating chamber in which the rolls are soaked in the treating solution, and a removable heat conducting mandrel in said chamber on which the rolls are arranged one above the other, said mandrel being equipped with clamping means for clamping the rolls in place thereon.

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