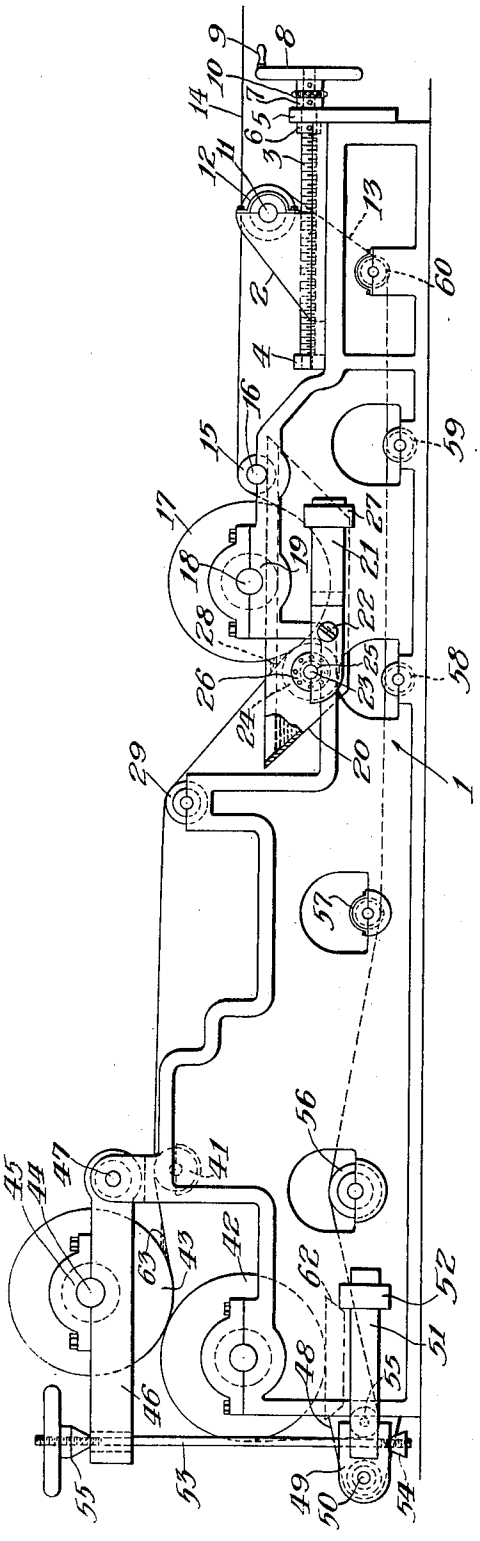
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PROCESS OF IMPREGNATING FIBROUS MATERIALS

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PROCESS OF IMPREGNATING FIBROUS MATERIALS

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11 Claims. (Cl. 92—40)

This invention relates to the manufacture of a thoroughly felted multi-ply fiber board comprising a binder, characterized in that the plies constituting said board are interfelted sufficiently to resist the tendency to delaminate.

My co-pending applications for United States Letters Patent, Serial No. 648,921 now Patent No. 1,966,458 and Serial No. 695,756 now Patent No. 2,022,687, describe processes of saturating newly formed wet fibrous webs and apparatus for carrying out said processes, wherein the web is thoroughly impregnated with a saturant. In one embodiment of the inventions described in said co-pending applications, multi-ply sheets may be made by leading a saturated web to a make-up roll on which the web rolls up upon itself to the desired thickness; the multi-ply sheet thus formed being then cut across and stripped from the make-up roll in a well known manner.

I have found that, when I allow thorough saturation to take place in a single pass in the saturation zone, whether because of the freeness of the stock, or the speed of running, or the viscosity of the saturant or any combination of these factors, the web, on meeting the make-up roll, either when the latter is uncovered or is carrying a previously condensed web, is compressed and the excess saturant passes therefrom without distortion of the web or appreciable motion of the fibers except in a vertical direction, that is, in a direction at right angles to the face of the web, and the multi-ply sheet made thereby sometimes exhibits ply structure allowing the individual plies to be separated and showing no appreciable interfelting of one ply with the adjacent plies.

In said co-pending application, Serial No. 648,921 now Patent No. 1,966,458, I have shown that a wet web may be completely saturated while on a porous carrier and that the excess of saturant may be expressed from the web, which at the point of pressure may either be wound upon itself to form a multi-ply sheet or carried along therefrom as a single ply sheet. I have found that under conditions where saturation does not complete itself in the presence of excess of saturant, either in the saturating bath or on the carrier while the web is issuing therefrom, the application of roll pressure to this incompletely saturated web on the porous carrier serves to complete the saturation in a satisfactory manner and without substantial distortion of the web. In other words, the combination of subjection of the wet web to an excess of saturant followed by roll pressure serves to thoroughly impregnate the web when the web is less susceptible to distention and more difficultly saturable than in the case described above. Thus, more tightly bound wet webs may be saturated than was previously possible. It should be noted, however, that some still denser wet webs do not saturate even under these conditions without distortion, and these must be handled in a manner described in another application, Serial No. 714,118 now Patent No. 2,044,012.

As another feature of my present invention, when making multi-ply fibrous board of the character described, the conditions of operation of the apparatus are so controlled that inter-felting of adjacent plies is obtained and the tendency for the finished board to delaminate is reduced to a minimum.

The utility, objects and advantages of my present invention will be hereinafter more fully described in conjunction with apparatus which generally resembles the apparatus utilized in my above mentioned co-pending applications.

In the drawing, the figure is a diagrammatic, side elevational view of suitable apparatus for carrying out my invention.

Referring in detail to the drawing, 1 indicates a frame which is adapted to support instrumentalities utilized in carrying out my process. At one end of the frame 1, a block 2 may be slidably mounted, said block being threadedly engaged with screw 3. Screw 3 may be journalled at one end in support 4, which may be mounted upon frame 1 and the opposite end of said screw may be journalled in support 5 which may be mounted at the end of frame 1. A collar 6 may be positioned upon screw 3 and may be keyed thereto, said collar being adapted to abut support 5. A collar 7 may also be keyed to the projecting end of screw 3 and is adapted, in conjunction with collar 6, to prevent longitudinal movement of screw 3. A hand wheel 8 may comprise an integral portion of collar 7, said hand wheel being provided with handle 9 whereby screw 3 may be rotated to move block 2 longitudinally along the end portion of frame 1. A sprocket wheel 10 may be provided on the surface of collar 7 adapted to mesh with a sprocket chain (not shown), whereby a similar screw 3 (not shown) mounted on the opposite side of the frame 1 may be rotated in unison with screw 3 to move block 2 and its counterpart on the end of roll 12 opposite to the end shown.

A shaft 11 may be journalled in block 2 and may be adapted to carry cylinder or drum 12, over which an endless screen 13 is adapted to pass. Screen 13 is preferably constructed of stainless steel or other non-corroding metal and may be of mesh ranging between 20 and 80 openings to the square inch. It can readily be seen that by rotating screw 3 and thereby moving block 2, the tension of screen 13 may be adjusted.

Screen 13 in its forward travel after passage around drum 12 is adapted to carry a newly formed wet fibrous web 14 which may be continuously passed to screen 13 from a paper making

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machine (not shown). The wet web 14 carries as much moisture as is carried by a web coming from the press units of a Fourdrinier machine prior to passing the web to the driers. Fifty percent to sixty percent of the weight of the web is a fair average of moisture content. Of course, the quantity of moisture contained in the web 14 will depend on the characteristics of the fibers constituting the web, the type of impregnating material with which the web is adapted to be treated, the speed of the machine, and the characteristics desired in the ultimate product. Screen 13, after passing over drum 12, may travel around drum 15 which may be mounted upon shaft 16 which, in turn, may be journalled in frame 1.

An impregnating roll 17 may be mounted upon shaft 18, which latter may be supported in bearings 19, positioned adjacent drum 15. Roll 17 may be of hollow construction, its peripheral surface comprising a screen or other foraminated body having a mesh similar to that of wire 13. A vat 20 may be positioned immediately beneath roll 17, a portion of said roll being adapted during rotation thereof to dip into the interior of said vat. Vat 20 may be adapted to carry a quantity of impregnating material, coating material, sizing material, such as casein solution, glue solution, rubber latex, sodium silicate solution, glue glycerine solution, rosin size, or any other substance with which it is desired to treat web 13.

It can readily be seen that when screen 13 and web 14 pass over drum 15, web 14 will be confined between screen 13 and the screen comprising the peripheral surface of the roll 17. Confined in this manner between the two foraminous surfaces mentioned, web 14 is passed through the bath carried in vat 20.

As has been hereinbefore described, web 14 contains an appreciable quantity of water and when immersed in the liquid impregnant comprising the bath, said web would normally tend to disintegrate. However, said web being positively confined between the foraminated surfaces mentioned, will not disintegrate nor will its fibrous formation be disturbed. When said web passes through the bath, its entire surface area is exposed to the liquid comprising the bath and, hence, a degree of substitution takes place, that is, the material comprising the bath tends to replace a portion of the water originally present in the web, and the air surrounding the fibers of the web may be replaced by a quantity of liquid impregnant.

Bars 21 may be mounted upon each side of frame 1 adjacent vat 20, the mounting means comprising pin or pivot 22, whereby said bars may be free to rock about said pivot. The forward ends of bars 21 may be adapted to support the ends of shaft 23 which, in turn, carries roll 24, said ends projecting through apertures 25 provided in the side walls of vat 20. Apertures 25 may be relatively larger in diameter than shaft 23 so that roll 24 may be adjustable a limited degree toward or away from roll 17. To prevent excessive leakage of liquid through apertures 25, gaskets 26 may be secured to each face of the side walls of the vat adjacent said apertures, shaft 23 passing through the center of said gaskets. Gaskets 26 may be constructed of flexible material such as rubber, leather or the like. Roll 24 is adapted to be positioned within vat 20 and screen 13 together with web 14 is adapted to pass between roll 24 and roll 17, the normal pressure of roll 24 against the screen and web being controlled by weights 27 which may be adjustably positioned along the opposite ends of bars 21. Roll 24 may be constructed of rubber or other relatively resilient material so as to provide complete contact of the web on the line of osculation of the two rolls 24 and 17.

During the period that web 14 passes through the bath within vat 20, the tendency of said web is to expand due to it being in the presence of an excess of liquid. However, inasmuch as the web is confined between screen 13 and the surface of roll 17, substantial expansion or distention of said web is prevented. As screen 13 and web 14 pass from the bath within vat 20, said screen and web passing between roll 24 and roll 17, the web is slightly compressed by the pressure of roll 24 upon the screen and web. Immediately after passing between roll 24 and roll 17, web 14 is stripped or carried away from the surface of roll 17 by the normal tendency of a wet web after compression to adhere to the least porous compression surface which in this case is the carrier screen with the solid roll backing. Consequently, due to the tendency of the web to expand because of its passing through the bath, and due to the fact that the web is compressed between roll 24 and roll 17, the web when stripped as has been hereinbefore described, expands. In certain cases where there is no need for perfectly uniform stripping, the roll 24 may be set back out of contact, especially if the roll 17 is made highly porous as, for example, with a screen having a mesh larger than 14 mesh, or even with only a spiral bed wire and no screen thereon.

A pool 28 of the material constituting the bath accumulates at the nip of the rolls due to the presence of that portion of the liquid carried out of the bath by the periphery of roll 17 and also due to the presence of that liquid absorbed by and adhering to web 14 being compressed between rolls 24 and 17. In addition, screen 13 upon emerging from the bath in vat 20 carries a quantity of liquid constituting the bath upon its surface. Some saturation due to expansion takes place at the pool 28 and some of the liquid upon said screen is also drawn into the web, but the web is of such a character that a large surplus of saturant is carried on its two surfaces later to be forced into and through the web by the pressure of the condensing roll hereinafter described.

After emerging from vat 20, screen 13 carrying web 14 passes over guide roll 29, which may be journalled upon frame 1. Although a major portion of the expansion of web 14 after it leaves the bath takes place in the vicinity of the nip of the rolls 24 and 17, expansion of web 14 continues during its passage from the bath to the condensing roll 43.

Screen 13 and web 14 are carried over drum 41 and are thereafter passed between rolls 42 and 43. Roll 43 may be mounted upon shaft 44 which may be journalled in bearing 45 mounted upon lever 46. Lever 46 may be pivoted at one end as at 47 to a portion of frame 1. Bracket 48 may extend from a lower end portion of frame 1 and member 49 may be pivoted thereto as at 50. Member 49 may carry an extension 51 upon which may be mounted a movable weight 52. Rod 53 may connect a free end of lever 46 and an intermediate portion of the assembly comprising member 49 and extension 51, the effective length of said rod being variable by means of conical nut 54 and hand wheel 55, which are respectively threadedly positioned at the lower and upper end of rod 53. The arrangement is such that the normal pressure of roll 43 upon roll 42 may be changed by changing the position of weight 52 along the length of extension 51.

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After passage of screen 13 and web 14 between rolls 42 and 43, web 14 may be stripped from screen 13 and adhere to roll 43 and said screen may be carried around roll 42 and returned over guide rolls, 55, 56, 57, 58, 59 and 60 to roll 12, all of said guide rolls being mounted on the lower portion of frame 1.

In carrying out my present invention, web 14, after being stripped from screen 13 upon passage between rolls 42 and 43, may be wound upon roll 43. In other words, roll 43 functions as a make-up roll upon which a desired number of plies of web 14 may be wound. When a suitable number of plies have been so wound, the composite structure thus formed may be stripped from the roll by first slitting the sheet by means of an awl forced across the roll in a slot provided therein and then the sheet removed in the well known manner common to wet machine operation.

It is highly desirable in fiber board which is made on wet machines according to ordinary paper making practice, to show as little tendency to delaminate as possible; it is also valuable in making a saturated fiber board to have good inter-felting of plies. I have found, however, that the method of attaining good felting according to the present invention, while similar in many respects to the processes disclosed in my said co-pending applications as to the phenomena occurring at the make-up roll, is different in the method of causing these phenomena to occur.

As has been hereinbefore stated, when the web arriving at the make-up roll 43 compresses and merely winds upon the roll without appreciable distortion other than motion of the fibers at right angles to the face of the web, indifferent adhesion of the plies occurs. However, when the liquid content of the web at the pressure zone, that is, between rolls 42 and 43, is high or the combination of liquid, fiber and pressure is such that slight distortion and horizontal motion of fibers occurs, the web already on the make-up roll is softened by excess liquid and the fibers of adjacent faces of the web actually mix or inter-felt slightly with the web arriving at the pressure area, which may also tend to crush slightly. It is to be understood that this tendency to crush must be controlled so that no appreciable distortion of the entire web takes place and the intermingling of plies takes place only between the entering web and the adjacent ply already on the roll.

Desired felting of adjacent plies of the web upon the make-up roll 43 may be attained by arranging the conditions of degree of saturation, freeness of stock, speed of travel of the web and pressure at the make-up roll so as to cause a pool 63 of saturant liquid to collect upon the web at the point where the wet web reaches the stock already on the make-up roll.

The pool 63 is relatively stable and of uniform length for any given set of conditions. It is increased by (1) greater pressure at the make-up roll, (2) lower direct saturability of the web, which is influenced by thickness of the web, fineness of fibers, hydrated condition of the fibers, density of the web, percent of water in the web, and other factors which affect the permeability of a wet web to a saturant, (3) greater speed of web travel, (4) higher viscosity of the saturant, and (5) lower angle of the incoming web and carrier.

In the conditions where thorough saturation of the saturated wet web during passage through the bath within vat 20 does not take place, thorough impregnation and mixing of the saturant with the fibers is accomplished when the webs unite under slight crushing of their original fiber alignment at the make-up roll and relatively even saturation is here obtained. Undoubtedly, the pressure to which the web is subjected while in the presence of the saturant forces the saturant between the fibers and assists even distribution of it. Thus, uniform saturation may be attained when making a multi-ply sheet on a make-up roll even when the original web approaching the make-up roll is not thoroughly saturated and distended by saturant. The crushing of the web and the presence of the pool described above is also not essential to good felting in cases where the web itself is of such a nature that it normally tends to adhere to the contacting web, as for example, highly hydrated cellulose fibers, or asbestos fibers carrying alkalin starch size.

It is often highly desirable to utilize the present invention in the manufacture of a well felted board rather than to have the web previously thoroughly saturated, as it provides a method of obtaining both saturation and good web felting.

A set of conditions which gave good results was as follows: A paper web comprising rag fibers which had been beaten hard for eight hours with a pressed thickness of .008 inch was led through a 30% rubber latex bath in vat 20 on screen 13 of 40 mesh. After passing through the bath the web was not completely saturated and latex remained on both surfaces thereof. On reaching the make-up roll 43 and winding thereon, a pool 63 of about 5 inches in length was formed on the web at the nip of the make-up roll and remained there during the entire run. The necessity for the pool could also be eliminated by using more highly hydrated stock, equivalent adhesion of the plies resulting. Sheets were formed under a pressure of approximately 40 pounds per lineal inch of make-up roll contact to a wet thickness of .135 inch to a .145 inch. The sheets thus formed were slightly wrinkled, the wrinkles having a crest to crest distance of about ⅛ inch but were of slight depth. On attempting to delaminate the wet board or sheet by "skinning off" several plies, the tear "feathered off" in a few inches, indicating a high degree of felting. In poorly felted board, starting a ply frequently allows the whole sheet to be split apart. When the above mentioned sheets were dried and calendered, no ply separation was noted even when a square corner was folded tightly on itself one half inch from the point and then reversed several times. This sheet when waterproofed with 10% of the fiber weight of soap size applied in the beater engine was highly acceptable as a midsole for shoes where high resistance to ply separation on flexing is necessary. The finished sheet after calendering was .085 inch–.090 inch in thickness and showed a hydrostatic resistance of over 250 on the Mullen test, the machine being filled with water instead of glycerine or oil and the water being in direct contact with the test specimen.

The above example is given for purposes of illustration and is not intended to serve as a limitation upon my process. Further, the sheet or board constructed according to my process may find many other uses than for midsoles, as for example, heel taps, soft counters, automobile gaskets, shims, outsoles, et cetera, and consequently, I do not wish to be limited to this specific use of the product of my invention.

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"Incomplete saturation" as used herein is intended to define that condition where the web does not reach its full distention in the presence of the saturant or where the saturant does not penetrate to the center plane of the web.

Other waterproofing agents such as Montan wax, paraffine, dissolved manila chip precipitated with alum, rosin size and the like may be used as alternatives to soap size.

I claim as my invention:

1. In a process wherein a wet fibrous web is passed through an impregnating bath and subsequently passed between pressure rolls and wound upon one of said rolls in a continuous manner to make an impregnated multi-ply fibrous sheet, the improvement which comprises causing a pool of impregnant expressed from said web to collect upon the web adjacent the nip of the rolls, and slightly crushing the moving web at said nip to move fibers of the web out of the plane of the web to interfelt these fibers with the fibers of the previously condensed web, and produce a product wherein the dried saturant is distributed substantially uniformly throughout the entire multi-ply structure.

2. In a process wherein a wet fibrous web is passed through an impregnating bath and subsequently passed between pressure rolls and wound upon one of said rolls in a continuous manner to make an impregnated multi-ply fibrous sheet, the improvement which comprises correlating the normal pressure of said rolls, the speed of travel of the web, the saturability of the web, and viscosity of the saturant to cause a pool of impregnant expressed from the web to collect on the web adjacent the nip of the rolls to form a well felted multi-ply sheet, and produce a product wherein the dried saturant is distributed substantially uniformly throughout the entire multi-ply structure.

3. In a process wherein a wet fibrous web is passed through an impregnating bath and subsequently passed between pressure rolls and wound upon one of said rolls in a continuous manner to make an impregnated multi-ply fibrous sheet, the improvement which comprises adjusting and correlating the normal pressure of said rolls, the speed of travel of the web, the saturability of the web and viscosity of the saturant whereby to slightly crush the moving web adjacent the nip of said pressure rolls and to move the fibers out of the normal plane of the web to interfelt these fibers with the fibers of the previously condensed web, and produce a product wherein the dried saturant is distributed substantially uniformly throughout the entire multi-ply structure.

4. A method of making multi-ply fibrous sheets wherein the fibers of adjacent faces of the plies are interfelted, which comprises passing a wet fibrous web through an impregnating bath wherein the web is saturated with impregnant, passing the saturated web between pressure rolls, continuously winding said web upon one of said rolls to form a multi-ply sheet, and causing a pool of impregnant expressed from said web to collect upon said web adjacent the nip of said rolls.

5. A method of making multi-ply fibrous sheets wherein the fibers of adjacent faces of the plies are interfelted, which comprises passing a wet fibrous web through an impregnating bath and partially saturating said web with said impregnant, passing the partially saturated web between pressure rolls and continuously winding said web upon one of said rolls to form a multi-ply sheet, and causing a pool of impregnant expressed from said web to collect upon said web adjacent the nip of said rolls.

6. In a process of the character described, the improvement which comprises incompletely saturating a forwardly advancing wet fibrous web with a saturant by feeding said web into contact with said saturant, passing said saturated web between pressure rolls and winding said web upon itself on one of said rolls in the presence of an excess of the saturant expressed from said web whereby to cause an interfelting of the adjacent plies.

7. A multi-ply fibrous sheet of the wet machine type comprising rubber impregnated interfelted plies, wherein the rubber is substantially uniformly distributed throughout the thickness of the sheet, possessing the characteristics of having had the rubber incorporated before the plies were united.

8. A waterproofed multi-ply fibrous sheet of the wet machine type comprising rubber impregnated interfelted plies and containing a waterproofing substance, wherein the rubber exists as a continuous film throughout the thickness of the sheet, the fibers at the interfaces of the plies being interfelted to form a fibrous bond therebetween independent of the bond resulting from the rubber.

9. In a process of making multi-ply fibrous sheets, the improvement which comprises treating a wet fibrous web with a saturant to incompletely saturate the same and leave an excess of saturant adjacent the surface thereof and winding said web upon itself under sufficient pressure to drive said excess saturant into the plies and to cause interfelting of the plies to produce a product having the saturant substantially uniformly distributed throughout the entire thickness of the sheet and the fibers of adjacent plies interfelted.

10. In a process of making multi-ply fibrous sheets, the improvement which comprises treating a wet fibrous web with rubber latex to incompletely saturate the same and leave an excess of rubber latex adjacent the surface thereof and winding said web upon itself under sufficient pressure to drive said excess rubber latex into the plies and to cause interfelting of the plies to produce a product having the rubber of said latex substantially uniformly distributed throughout the entire thickness of the sheet and the fibers of adjacent plies interfelted.

11. In a process of making multi-ply fibrous sheets, the improvement which comprises treating a wet fibrous web with a saturant to incompletely saturate the same and leave an excess of saturant adjacent the surface thereof and winding said web upon itself upon a make-up roll under sufficient pressure to drive excess saturant into the plies and to cause interfelting of the plies without materially distorting the web to produce a product having the saturant substantially uniformly distributed throughout the entire thickness of the sheet and the fibers of adjacent plies interfelted.

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