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2,429,314

APPARATUS FOR PRODUCING SATURATED FIBROUS BODIES

Filed July 11, 1942

3 Sheets-Sheet 1

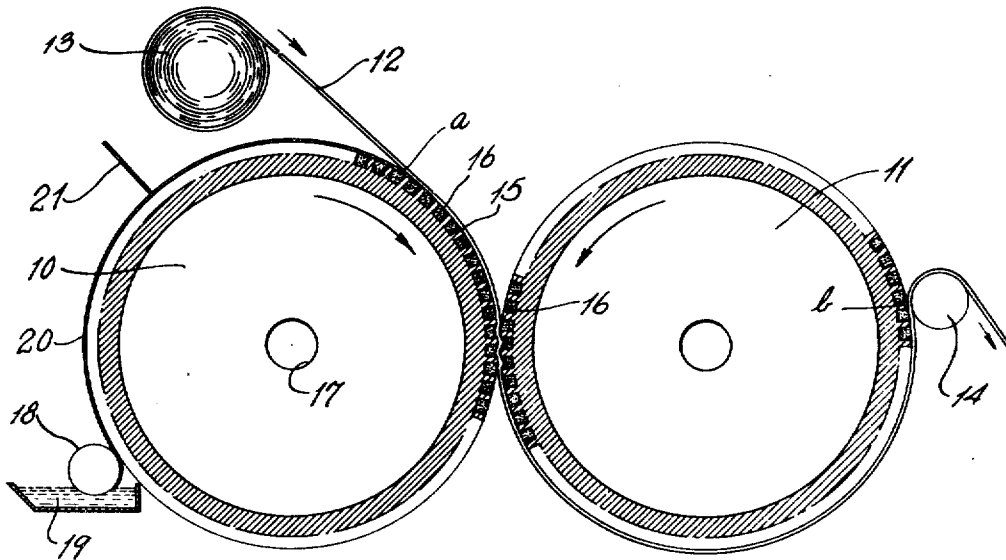


Fig. 1

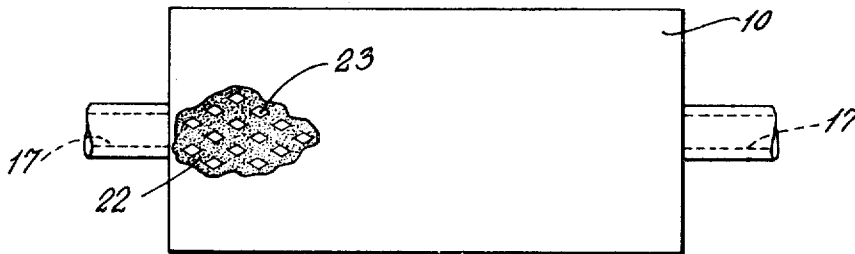


Fig. 2.

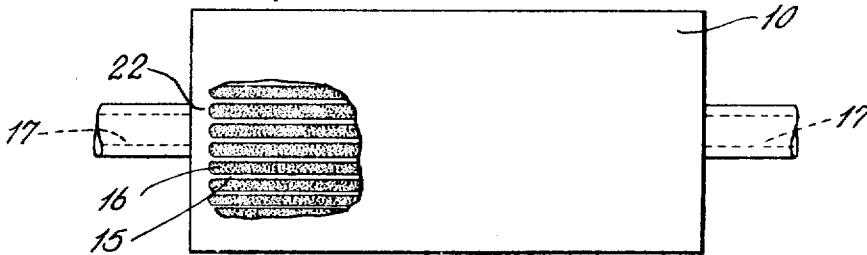


Fig. 3.

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3 Sheets-Sheet 2

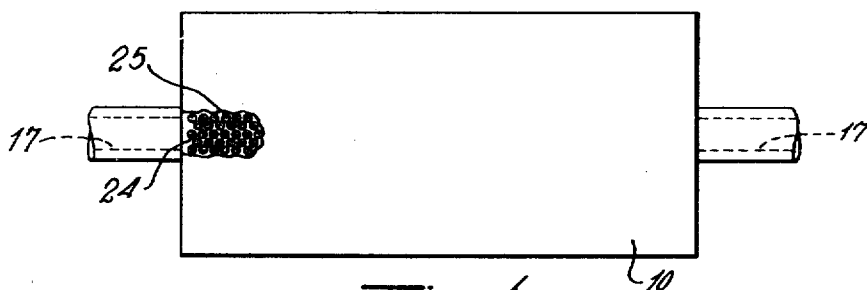


Fig. 4.

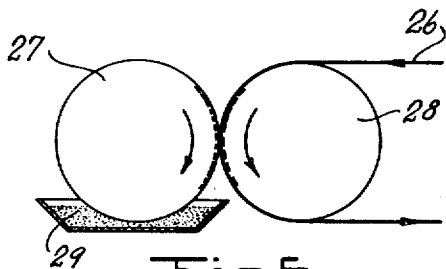


Fig. 5.

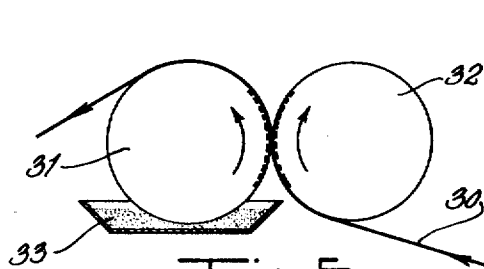


Fig. 6.

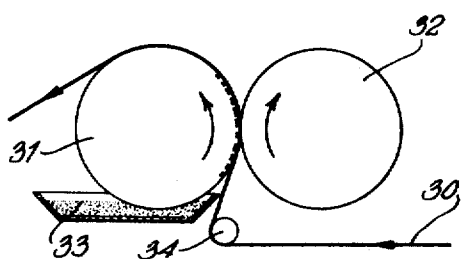


Fig. 7.

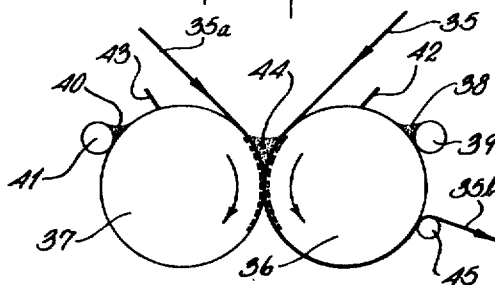


Fig. 8.

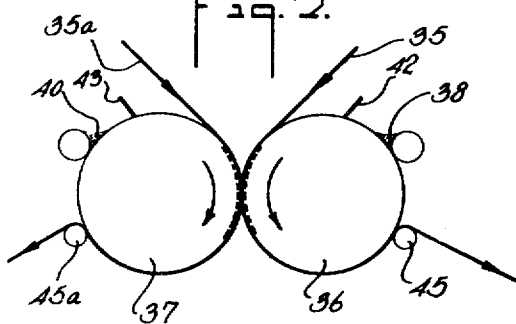


Fig. 9.

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APPARATUS FOR PRODUCING SATURATED FIBROUS BODIES

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3 Sheets-Sheet 3

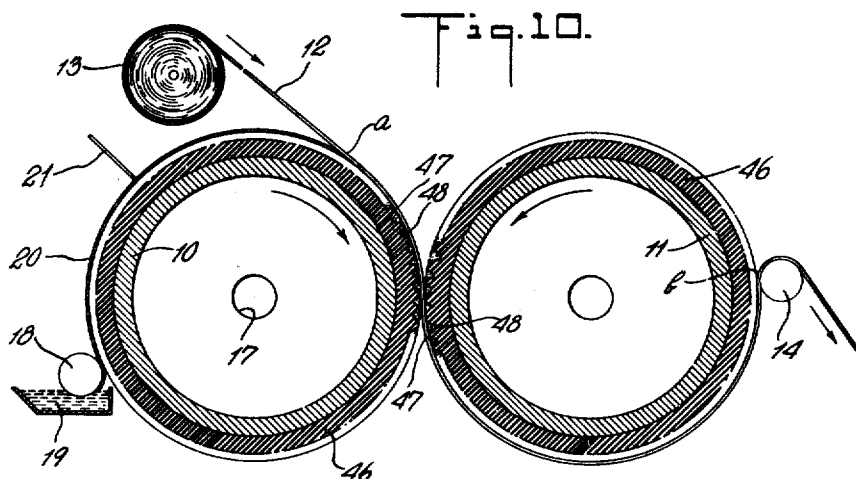
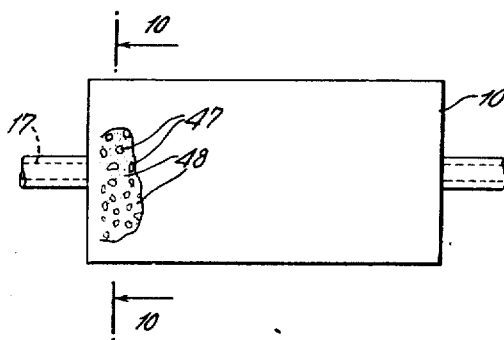


Fig. 11

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UNITED STATES PATENT OFFICE

2,429,314

APPARATUS FOR PRODUCING SATURATED
FIBROUS BODIESJoshua H. Goldman, East Haddam, Conn., as-
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Newark, N. Y., a corporation of New Jersey

Application July 11, 1942, Serial No. 450,640

6 Claims. (Cl. 91—50)

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This invention relates to an apparatus for producing saturated fibrous bodies. It relates especially to the application of saturant in liquid form to fibrous material in the production of fibrous bodies which may be in web form or in the form of formed articles such as boards, molded shapes, etc.

It is a purpose of this invention to provide an apparatus for application of saturant in liquid form to fibrous material which accomplishes thorough coating of the fibers with a minimum of operational steps and of power requirements. It is a further purpose of this invention to provide an apparatus for saturating thin webs of unspun fibers which have little structural strength and which heretofore have been regarded as incapable of being handled in a saturating operation without rupturing the web material. It is a further purpose of this invention to provide an apparatus for saturating fibrous web material which is much more economical to install and to operate than conventional types of saturating equipment used prior to this invention.

Heretofore it has been common practice to apply liquid material to fibrous material in either one of two ways. According to one method the fibrous material is mixed with the fiber while the fiber is in discrete form, the mixing being carried out in any suitable type of mixer usually with a beating or kneading action. Especially when the purpose is to mix fibrous materials with a thermoplastic material such as asphalt, the mass is very heavy and requires much power to work the material. Moreover, the fiber tends to form into matted masses and clots which are not completely broken up with the result that the mass is not homogeneous and that some of the fibers in the matted masses or clots may not become completely coated.

It has also been common practice heretofore to form fibers into a fabric of considerable structural strength such as a water-laid felt or a woven fabric and to saturate such fabrics by immersing the fabric in a bath of the liquid to be applied thereto. For this purpose a relatively large saturation tank for containing the saturant in liquid form is generally used and by means of a plurality of rolls the fabric is alternately immersed and removed from the bath of liquid material until most of the air has been expelled from the fabric and is replaced by the liquid saturating material. Such equipment is very extensively used in saturating materials, such as roofing felt or flooring felt, with a bituminous waterproof material in a heat-liquefied condition. Such equip-

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ment is, however, expensive and bulky, and requires continuous maintenance of a large quantity of saturant in liquid form in the container. With such equipment it is a very difficult matter to change the type of saturant inasmuch as the container has to be emptied and its contents replaced with a different saturant.

It has also been proposed heretofore to pass web material between the nip of a pair of ordinary smooth surface rolls and to maintain a bath of saturant or binder material in liquid form at the nip of the rolls so that, in passing between the nip of the rolls the fibrous web material will pick up some of the liquid material and become to a certain extent impregnated or coated therewith. This operation has the disadvantage, however, of tending to wring out the web material with a pushing of the liquid material back from the nip of the rolls in a manner that is typical of a wringing operation, rather than a saturating operation. For this reason it is difficult to saturate the web material thoroughly. Moreover, air that is carried with the dry web material is brought into the nip of the rolls and does not completely escape.

It is a feature of this invention that saturant in liquid form, e. g., a binder material such as a thermoplastic binder in heat-liquefied condition, or in solution or in an emulsion, is incorporated in a fibrous body by first making up discrete fibers into a web form by the rapid and convenient expedient of using a carding machine. The web thus produced, which may for example be a carded web of cotton fibers, is brought into contact with the saturant in liquid form to be applied to the web while the saturant is carried in a multiplicity of immediately adjacent recesses with small lands therebetween that are provided in the periphery of an embossed roll. The web while carried by the surface of the roll is then subjected to pressure which squeezes the web material into the recesses and, since the recesses carry the liquid saturant into the zone of compression, the liquid saturant is forced into the body of the web material when the web material is squeezed into the recesses thereby quickly coating the fibers in the web material. After the pressure is relieved the web is stripped from the embossed roll.

I have found that the saturation of fibrous materials can be accomplished thoroughly, quickly and economically in the manner above described. I have also found that using the method and apparatus referred to it is possible to saturate thin webs such as carded cotton webs that are so fragile as to tend to fall apart merely

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under their own weight. Such fragile web materials obviously cannot be passed through saturating equipment used in saturating roofing felt or flooring felt, for example, with an asphalt waterproofing, because the delicate web material could not be passed through the saturating tank. Moreover, if such delicate web materials were to be passed between ordinary rolls carrying a saturant the web material would pull apart and wind up on the rolls. In handling delicate web materials such as carded cotton fibers I have found that by the provision of a multiplicity of minute and immediately adjacent recesses on the periphery of an embossed roll, the recesses not only cause liquid saturating material to be pushed into the body of the web material to accomplish good saturation but also enables the delicate web material such as a carded cotton web weighing only about 60 to 200 grains per sq. yard to be fed into the apparatus and stripped from the roll after saturation without rupturing or winding up on the roll. Considering the flimsy character of such web materials, it is surprising indeed that they can be successfully saturated with a heavy material such as saturating asphalt or even with more fluid liquids and separated from the embossed roll while preserving the web material intact. So far as I am aware it has not been regarded prior to this invention as possible to saturate thin web materials of this sort in a continuous saturating operation.

It is preferable in the practice of this invention that the web material be compressed between a pair of roll surfaces each of which carry a multiplicity of recesses even though the liquid to be applied is carried by the recesses of only one of the rolls.

It is a further feature of this invention that the web material is carried on the periphery of the embossed roll that carries the binder material for a substantial distance before the squeezing pressure is applied, thereby permitting the binder material to be absorbed into the web material with the displacement of air from the other side of the web material before the squeezing is applied. Preferably, the roll is heated so as to accelerate the expulsion of air and moisture from the web material as the web material is carried by the embossed roll. Moreover, instead of stripping the web material from the rolls as the web material emerges from the nip of the rolls, the web material is caused to be carried on the surface of one of the rolls throughout a substantial distance of travel, thereby permitting the binder material to become uniformly distributed through the fibrous web material with elimination of any residual air or vapor. Furthermore, by carrying the web a substantial distance beyond the nip on the surface of one of the rolls and then stripping the web material from the surface of the roll on which it is being carried, the stripping of the web material from the roll without lamination or rupture of the web material is facilitated, due to diminution of the interfacial tension between the roll surface and the web material so that such interfacial tension becomes less than the cohesion of the fibers inter se of the web material.

It is a further feature and advantage of this invention that a dry bibulous web may be saturated to any desired extent in a single continuous operation, and that the amount or per cent. of saturation can be controlled by controlling, as by the use of a doctor blade, the amount of liquid carried by the saturating roll.

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In the manner above described a fibrous body may be produced wherein a saturant is commingled very uniformly with the fibers and so as to very completely cover the surface of the individual fibers. If, for example, it is desired to produce a mass of cotton fibers uniformly saturated with a binder such as asphalt, the fibers may, according to this invention, first be subjected to a carding operation to form them into a thin web wherein the unspun fibers are distributed quite uniformly throughout the lateral extent of the web. This web is then contacted with the periphery of an embossed roll carrying the asphalt in a heat-liquefied condition in the multiplicity of small recesses, the hot asphalt having previously been applied to the surface of the roll. The web, preferably after having been carried by the roll for a substantial distance and while the surface of the roll is maintained in a heated condition, is then subjected to compression, preferably by pressure applied by the periphery of another roll presenting a multiplicity of immediately adjacent recesses with small lands therebetween. During the compression the web material is squeezed into the recesses containing the liquid saturant and by what is analogous to a pumping action the liquid saturant entrapped in the recesses is forced into the body of the web, thus saturating the web, e. g., to an extent of about two or three hundred per cent. based on the weight of the fiber. Preferably the web is carried for a substantial distance on one of the rolls and then is stripped off.

The resulting saturated fibrous material can be used in a variety of different ways. Thus, for example, the web material may merely be folded or wadded up to produce a mastic which can be compressed to desired shape, extruded, rolled, or the like, into sheets, boards, and other shapes. In such case saturation according to the present invention takes the place of mixing methods heretofore employed wherein melted asphalt and fibers are kneaded and mixed by means of mixing blades in a mixer. As compared with such prior methods of mixing, the method of the present invention results in considerably more uniform distribution of the fibers in the asphalt for according to the present invention each fiber is in effect individually coated with its desired predetermined quantity of asphalt. In the conventional mixer the fibers tend to form into clots or masses, which are very persistent and as aforesaid prevent, even after very prolonged mixing, homogeneous distribution of asphalt and fibers. Moreover, the method of the present invention requires much less power and is more rapid.

It is also possible in the practice of this invention to use the saturated web material, e. g., asphalt saturated web material, in sheet form. Thin webs of fiber such as carded cotton fibers when impregnated with a binder, e. g., an asphaltic binder, have a number of useful commercial applications, but heretofore it has been regarded as impossible commercially to saturate such flimsy webs with liquid saturant, e. g., heat-liquefied asphalt. One possible commercial use of such web materials is described in my application for Waterproofing sheet material and the manufacture thereof executed by me on even date herewith (application Ser. No. 450,639, filed July 11, 1942). Also the saturated web material can be used in other ways. For example, a web saturated with bituminous waterproofing material may, after the saturation operation, be rolled up into rolls and used in single or plural ply thickness

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for the manufacture of various water-resistant products of varying degrees of water impermeability. It is therefore apparent that the present invention opens up a field of many new products that heretofore could not be produced due to the inability of the art to handle delicate webs of unspun fibers in a saturating operation.

This invention may also be practiced in connection with the saturation of webs of greater structural strength such as water-laid felts, e. g., roofing and flooring felts as well as woven fabrics. In such case the dry bibulous material can be quickly and continuously saturated with a liquid, e. g., heat-liquefied asphalt or the like. The method of the present invention represents a substantial improvement as compared with prior methods wherein the material to be saturated is immersed in a tank containing liquid to be applied to the fibrous web material, which prior methods are capable of less accurate control and require much more costly equipment and are less rapid. In this connection it may be pointed out that the invention of the present application is a saturation method wherein the liquid is caused to penetrate and impregnate the body of a bibulous fibrous web and to coat the fibers in the body of the web as distinguished from merely applying a coating or providing an occasional application to the surface of the web material.

It is a feature and advantage of certain embodiments of this invention that a plurality of webs may be simultaneously saturated using but a single pair of rolls. It is a further feature and advantage of this invention that a plurality of webs may be simultaneously saturated and at the same time bonded together.

Having thus indicated in a general way the nature and scope of this invention, further purposes, features and advantages of this invention will be apparent in connection with the following description of certain illustrative embodiments thereof which are described for purposes of exemplification and which are shown in the accompanying drawings, wherein

Figure 1 is a sectional end elevation of a preferred embodiment of a saturating apparatus according to this invention taken on the line 1—1 of Fig. 3 with a portion of the surface of the rolls greatly enlarged;

Fig. 3 is a front view of one of the rolls shown in Fig. 1 with a portion of the surface greatly enlarged to show the multiplicity of recesses therein;

Figs. 2 and 4 are respectively front views of alternative rolls which may be used in apparatus according to this invention with a portion of the surface of each of the rolls greatly enlarged;

Figs. 5, 6 and 7 are end elevations largely schematic of alternative embodiments of this invention;

Fig. 8 is a schematic end elevation of a further alternative embodiment of this invention suitable for saturating and uniting a pair of webs;

Fig. 9 is a schematic end elevation of a further alternative embodiment of this invention suitable for saturating two webs using a single pair of saturating rolls;

Fig. 10 is a sectional end elevation of the embodiment of this invention shown in Fig. 1 modified by the provision of resilient material presenting a rugose surface, a portion of the rugose surface being greatly enlarged and Fig. 10 being taken on the line 10—10 of Fig. 11, and

Fig. 11 is a front view on a somewhat smaller

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scale of one of the rolls shown in Fig. 10 with a portion of the surface greatly enlarged to show the multiplicity of recesses in the rugose surface.

Referring to the apparatus shown in Figs. 1 and 3, a pair of rolls 10 and 11 are driven in the direction of the arrows by any suitable means (not shown). The web material 12 from a reel 13 or other suitable feeding means is brought in contact with the surface of the roll 10 at the point *a* and is carried on the surface of the roll 10 to the nip between the rolls 10 and 11. Thereafter the web material 12 is carried on the surface of the roll 11 to the point *b* where it is stripped from the surface of the roll 11 over a guide roll 14. If desired, the guide roll 14 may be omitted in certain cases where the drag provided by the web material being stripped from the roll 11 overcomes the adhesion of the web material to the surface of the roll 11 at a point on the roll 11 adjacent where it is desired to have the stripping take place.

The rolls 10 and 11 preferably are hollow and are provided with passage means 17 so that a heating fluid such as oil, steam or the like may be circulated through the interior of each of the rolls so as to maintain the surface of the rolls at a predetermined elevated temperature. The saturant in liquid form with which the web 12 is to be saturated may be applied to the surface of the roll 10 in any suitable manner as by the use of a feeding roll 18 which is rotated by any suitable means not shown, so as to transfer the liquid material from the reservoir 19 and apply it as a film 20 to the surface of the roll 10, filling the recesses 16 in the peripheral surface thereof. In the usual case the amount of liquid material carried by the surface of the roll 10 is determined by the doctor blade 21 so that the amount of liquid material to be applied to the web material 12 may be accurately controlled in order to produce a uniform and predetermined degree of saturation of the web 12.

In Fig. 3 a portion of the surface of the roll 10 is shown on a greatly enlarged scale. In this embodiment of the invention the surface of the roll is fluted so as to provide a multiplicity of recesses 16 extending lengthwise of the roll with a multiplicity of smaller lands 15 therebetween. By way of example, the lands 15 may be approximately 20 thousandths of an inch in width while the recesses 16 may be about 45 thousandths of an inch in width. The recesses may be, for example, 10 thousandths of an inch in depth. As shown in Fig. 3, the roll 10 preferably comprises at each end an annular portion 22 which closes the ends of the recesses 16 so that liquid material entrapped in the recesses 16 cannot be squeezed laterally beyond the ends of the roll. It may also be pointed out that the annular portion 22 serves to prevent the embossed surface of rolls 10 and 11 from possible intermeshing which would destroy the web material. The rolls 10 and 11 preferably have a diameter that is relatively large and may, for example, have a diameter of 12 or more inches.

The operation of the apparatus hereinabove described and shown in Figs. 1 to 3 may be illustrated in connection with the saturation of a web material with a bituminous waterproofing material, e. g., asphalt having a softening point of about 140° F. The bituminous waterproofing material is maintained in reservoir 19 in a heat-liquefied condition, e. g., at a temperature of about 350° F. This heat-liquefied bituminous material is fed by the feed roll 18 to the surface of the

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roll 10 which roll may, for example, be maintained so that the surface temperature will be about 350° F. A web of cotton fibers such as in a web produced by an ordinary carding operation and which weighs for example 250 grains per square yard is fed onto the surface of the roll 10. The doctor blade 21 controls the amount of asphalt on the surface of the roll 10 so that, for example, the amount of asphalt may be sufficient to saturate the web material to the extent of about 200% by weight of fiber with the asphalt saturant. As soon as the web material strikes the surface of the roll 10, it comes in contact with the heat-liquefied bituminous material carried by the heated roll surface and the heat thus applied to the web material serves to drive off both air and any moisture contained in the web material between the point where the web 12 strikes the roll 10 to the nip between rolls 10 and 11. During this interval the heat-liquefied asphalt is absorbed to some extent into the web material and thus cooperates with the multiplicity of recesses in the surface of the rolls in preventing the saturant from being squeezed away from the nip of the rolls when the web material is squeezed between the rolls.

Upon reaching the nip between the rolls 10 and 11, the web material is squeezed into the recesses 16 in the surface of the roll 10 and is also compressed into the corresponding recesses 16 in the surface of the roll 11. When this action takes place, the heat-liquefied asphalt being entrapped in the recesses is forced into the body of the web material by a positive action in the nature of a pumping action. The effect of this action is to thoroughly and uniformly impregnate the web material with the hot asphalt. Moreover, since the recesses and lands are sequentially arranged and the lands which support the web are individually very small the web material is continuously saturated throughout the lateral extent thereof with the saturant in liquid form. After the web material has passed the nip between the rolls 10 and 11, the web material is carried on the surface of the roll 11, which roll likewise is preferably maintained in a heated condition, e. g., at about 350° F. While on the surface of this roll the heat-liquefied bituminous material tends to become equalized throughout the web material and when the web material reaches the point b, it is stripped from the surface of the roll. I have found that when the surface of the roll from which the web material is being stripped is embossed so as to provide a multiplicity of recesses with small lands therebetween which are of less surface area than the extent of the recesses but which serve to carry the fibrous web thereon, the web material can be readily stripped from the roll without rupturing and without having the web material or some portion thereof adhere to the surface of the roll. It is to be noted that the web material is taken off at a relatively sharp angle inasmuch as when the web material is stripped from the surface of the roll 11 at a sharp angle the stripping operation is facilitated. On the other hand, when the web material 12 in a dry and bibulous condition is brought into contact with the surface of the roll 10, the angle of incidence is as small as possible. By having the diameter of the roll 10 relatively large, i. e., over 6 inches in diameter and preferably over 10 inches in diameter, the angle between the surface of the roll 10 and the web 12 tangentially contacted therewith is relatively small. This is to be desired in the practice of my invention inasmuch

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as when the angle between the surface of the roll and the web brought in contact therewith is relatively small there is a reduced tendency to push the film of saturating liquid carried by the surface of the roll backwardly where the web material is brought into contact with the surface of the roll. By keeping the angle between the web material brought in contact with the surface of the roll that carries the liquid material with which the web is to be saturated relatively small and by utilization of the multiplicity of recesses in the surface of the roll 10, the material with which the web 12 is to be saturated becomes uniformly entrapped underneath the web material 12 and between the web material 12 and the surface of the roll. This entrapped liquid material is thereafter carried to the nip between the rolls where the squeezing and pumping action above described takes place and the liquid material is forced into and through the body of the web material so as to thoroughly saturate it with the liquid material. The employment of rolls of the relatively large diameter mentioned above likewise is advantageous in promoting the forcing of the saturant into the web material at the region of the nip between the rolls.

In Fig. 2 an alternative surfacing for the embossed roll 10 is shown. In this modification the recesses 22 form a continuous network with diamond-shaped lands 23 therebetween. The width and depth of the recesses 22 and the width of the lands 23 may, for example, be similar to that of the recesses 16 and lands 15 respectively, hereinabove described in connection with the embossed roll shown in Fig. 3.

In Fig. 4 an alternative surfacing for the roll 10 is shown. In this instance, the recesses 24 are in the form of small holes or cups that are spaced from each other by the lands 25 which form a continuous network on the surface of the roll. The relative widths of the recesses 24 and lands 25 as well as the depth of the recesses 24 may correspond, for example, with the figures hereinabove mentioned in connection with the embodiment of this invention shown in Fig. 3. The different configurations for the recesses and lands for the surface of the rolls that are shown in Figs. 2, 3 and 4 are merely illustrative and may be of any other suitable contour.

The recesses in the rolls 10 and 11 may be produced in any suitable way. One convenient method for embossing the surface of the rolls is to first knurl the surface of the roll and thereafter turn the surface of the roll so that the top surfaces of the lands will be smooth and uniform. Of course other methods of manufacture may be used, e. g., machining, etching, etc.

Using the apparatus shown in Fig. 1 and any of the rolls shown in Figs. 1, 2 or 3, the result of the operation hereinabove described by way of example, is a thin web of cotton fibers very uniformly saturated with asphaltic saturant, e. g., to the extent of about 250%. This material as aforesaid may be used in web form for many different purposes, e. g., in the manufacture of articles utilizing one or more of the webs as a structural element therein or the web material may be worked into a mastic of fibers that are very uniformly dispersed in the bituminous material and thoroughly coated therewith. If, for example, a mastic is prepared using an asphalt having a softening point of about 160° F., and the mastic is subjected to a pressure of about 200 pounds per square inch, a very tough, strong

material suitable for bituminous board material and other formed articles is afforded.

While in the foregoing example the use of an asphaltic saturant has been mentioned, it is apparent that other bituminous materials such as tar, pitch and the like may be used. Moreover, other thermoplastic materials may be used, for example, cellulose ethers such as ethyl cellulose, methyl cellulose, etc., cellulose esters such as cellulose acetate, cellulose nitrate, etc., vinyl resins, such as a vinyl acetate-vinyl chloride copolymer, naval stores such as rosins and the like. Moreover, components of heat setting resins such as the phenol-aldehyde resins, alkyd resins, etc., may be applied to the web material in a liquid condition and after saturation of the web material may be set in situ by heating. Alternatively, for example, a binder material can be applied to the web material while dissolved in a suitable solvent. For example, materials such as asphalt, resins, rubber, etc., may be dissolved in a solvent and applied to the web material in a dissolved condition. After a web material has been saturated, the solvent may be removed by a conventional drying operation. Binder materials or the like may also be applied in the form of an aqueous dispersion, e. g., latex, emulsified sulphonated oil, emulsified bitumen and the like. It is normally preferable, however, to apply the saturating material to the web by an operation wherein heat is employed, e. g., as in the application of thermoplastic materials to the web materials for the purpose of saturating the web material. For in such case the maintenance of elevated temperatures facilitates the expulsion of air and water vapor from the web material and this in turn facilitates the thorough saturation of the web material. Maintenance of the roll that carries the saturant, and preferably both of the rolls at a temperature of about 300° F. to about 400° F. is usually preferable. The saturating material may be merely water or may be a solution of starch, casein or the like. All materials of the character aforesaid are referred to herein as saturants and when it is said that the saturant is applied in liquid form the saturant may be one which is liquid at normal temperatures or may be a material that is solid at normal temperatures but is rendered liquid by heating, use of a solvent, dispersion as an emulsion or the like.

Various types of web materials may be saturated according to this invention. Hereinabove reference has been made to the saturation of a thin web of cotton fibers in the form produced as a result of a carding operation. This ordinarily constitutes preferred practice of this invention, inasmuch as cotton fiber or the like may be very inexpensively and rapidly carded into web form. Moreover the cotton fibers in such a case are fibers which may be subjected to a carding operation, namely are fibers about 1/4" in length or longer. It is an advantage of this invention, however, that relatively low grades of cotton fiber such as cotton linters may be made into web form and saturated according to this invention. Especially when fibers which are somewhat longer are used, namely, fibers about 1/2" or more average length, the fibers may be brought into a condition of substantial straightness and parallelism in one direction. Web materials of this sort wherein the fibers have been combed or drawn so as to be straightened and extend in one direction are very difficult to handle due to the fragile and flimsy character of the web material. Notwithstanding this condition of the web material, such

web materials may be saturated with a liquid saturating material such as heat-liquefied asphalt without difficulty in the practice of this invention. Webs of unspun fibers of the character aforesaid that are produced by a carding operation or by combing, drawing or the like are referred to herein for the sake of brevity as machine oriented webs of unspun fibers in order to distinguish from felted fabrics wherein the fibers are laid indiscriminately as by a water laying operation and in order to distinguish from woven fabrics of spun yarns.

While this invention is particularly suitable for the saturation of webs composed of cotton fibers, the web material may be composed of any animal, vegetable, mineral or synthetic fibers such as hair, wool, bast fibers, musa fibers, asbestos, glass, rock wool, cellulosic synthetic fibers, proteinous synthetic fibers, etc. Also, of course, web materials composed of mixtures of fibers may be saturated according to this invention.

In addition to the foregoing, fabrics having considerable structural strength may be saturated with saturant in liquid form using the method and apparatus of this invention. Thus, for example, woven fabrics such as cotton sheetings may be readily saturated. Also paper materials which contain relatively little size and which are of a bibulous and absorptive character may be saturated according to this invention. It is an advantage of this invention that very thin and relatively fragile paper materials may be readily saturated with saturating material, e. g., a heat-liquefied asphaltic material, using the method and apparatus of this invention. Moreover, relatively heavy fibrous material such as roofing or flooring felts may be saturated using the method and apparatus of this invention.

The dimensions of the recesses and lands in the roll which carries the liquid saturating material and applies it to the web to be saturated depends somewhat upon the type of material which is to be saturated. Ordinarily, the recesses constitute the major proportion of the surface of the roll and preferably constitute about 70 to about 85% of the surface of the roll, the lands constituting about 15% to about 30% of the surface of the roll. The lands ordinarily vary from about 10 thousandths of an inch in width to 30 thousandths of an inch in width and the recesses may vary from about 5 to about 30 thousandths of an inch in depth. For saturating relatively heavy web materials, the recesses are preferably somewhat wider and more deep than when a light fibrous material such as a thin web of carded cotton fibers is to be saturated. The roll which applies the material may be made of any suitable material such as metal or it may be made of some suitable composition, e. g., a thermosetting resinous composition or the like. Any roll the periphery of which presents recesses and lands of the order of size and arrangement above mentioned is to be regarded as presenting a multiplicity of immediately adjacent recesses with lands therebetween. While reference is thus made to a multiplicity of recesses with lands therebetween it is not to be implied that the recesses necessarily are completely isolated from each other as in Figs. 3 and 4, for example, for they may merge with each other as shown in Fig. 2, for example. Conversely, when reference is made to a multiplicity of lands, the lands are not necessarily completely isolated from each other as in Fig. 2, for example, but may merge with each other as shown in Fig. 4, for example. In any such case the recesses

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and lands are arranged in essentially sequential or alternate relation so that the surface of the roll presents a multiplicity of essentially adjacent small land portions and recess portions.

The pressure that is applied to the web material in order to squeeze the web material into the recesses in the periphery of the roll that carries the material to be used in saturating the web material may be applied by any suitable means, but ordinarily for this purpose a second roll is used adapted to exert pressure at the nip between it and the other roll. The backing roll used for applying pressure may have a smooth surface but better saturation of the web material is effected when the roll used for applying pressure is likewise provided with a multiplicity of recesses in the periphery thereof due to the fact that the recesses in the backing roll provide an escape for air and vapors that are drawn out of the web material when the saturant is forced into the web material. The rolls between which the web material is compressed may, if desired, be alike, but this is not necessary. For example, referring to the apparatus shown in Fig. 1, the surface of the roll 11 may be different from the surface of the roll 10. If, as in the apparatus shown in Fig. 1, the roll 11 is not coated with the liquid saturating material applied to the web and, therefore, operates in a "dry" condition, the recesses in the periphery thereof may be somewhat smaller and shallower than the recesses in the roll 10. Moreover, the lands between the recesses in the periphery of the roll 10 may be smaller. By providing the surface of the roll 11 with a multiplicity of minute lands, the stripping of the saturated web material from the surface of the roll 11 is facilitated. Moreover, the roll 11 may be smaller or larger than the roll 10. The pressure at the nip of the rolls may be regulated as desired and ordinarily runs from about 2 to about 20 pounds per inch of line contact between the rolls, light webs such as carded cotton fibers usually being subjected to a pressure of about 3 or 4 pounds per inch of line contact while heavier webs are usually subjected to somewhat greater pressures at the nip between the rolls.

The embodiment of this invention shown in Fig. 1 and using rolls such as the rolls shown in Figs. 2, 3 and 4 or the equivalent, is regarded as a preferred embodiment of this invention. It is obvious, however, that this invention may be practiced in many different ways in order to produce the saturating action that is characteristic of this invention and that is described herein. Thus, for example, referring to Fig. 1, instead of applying the saturant in liquid form, which is to be used in saturating the web 12, to the roll 10 by means of an applicator roll 18, it is apparent that the lower portion of the roll 10 may be immersed in a bath of the liquid material and then doctored to desired thickness by doctor blade 21. Alternatively, one may apply the saturant in liquid form to each of the rolls 10 and 11 and this may be desirable in saturating relatively heavy webs. Other illustrative variations in the practice of this invention are shown in Figs. 5-9.

Referring to Fig. 5, the web material 26 is contacted with the roll 28, which in this case is merely a carrier roll. The saturant in liquid form that is to be applied to the web 26 is contained in a reservoir 29 and is carried by the surface of the roll 27. In this instance, reliance is placed upon the drainage of the roll 27 during its rotation to produce a film of desired thickness on the surface of the roll. The film on the surface of

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the roll 27 is carried to the nip between the rolls 27 and 28 where, by the squeezing and pumping action above described, it is forced throughout the body of the web material to effect saturation thereof. The web 26 continues to be carried by the roll 28 and is eventually stripped therefrom and may be availed of in any manner that is desired, e. g., as described hereinabove. In connection with Fig. 5, it may be mentioned that the roll 27, and preferably both the roll 27 and roll 28, present on the surface thereof a multiplicity of minute recesses and lands of the character hereinabove described. The method and apparatus referred to in connection with Fig. 5 is not a preferred means for practicing this invention, but is merely shown in order to illustrate a possible modification of this invention which is operable in effecting saturation of web materials.

In Fig. 6, a further modification of this invention is shown. In this modification, web material 30 is fed upwardly between the nip of the rolls 31 and 32. The liquid material used for saturating the web 30 is contained in the reservoir 33 and is carried by the roll 31 to the nip between rolls 31 and 32 where, by the squeezing action above described, it becomes impregnated throughout the fibers of the web 30. In this case, the web 30, after release of the pressure imposed thereon at the nip between rolls 31 and 32, is carried by the roll 31 and is stripped on this roll. Preferably, as shown, both of the rolls 31 and 32 present the multiplicity of immediately adjacent recesses with small lands therebetween as described hereinabove.

The apparatus shown in Fig. 7 is identical with the apparatus shown in Fig. 6, except that in this case the web material 30 is directed by the guide roll 34 so that it will come in contact with liquid material carried by the surface of the roll 31 from the reservoir 33 before the web material is brought to the nip between the rolls 31 and 32. This constitutes preferred practice as compared with the practice illustrated in connection with Fig. 6 inasmuch as the web material is brought into contact with the roll that carries the liquid that is used in saturating the web material prior to the squeezing action, thereby permitting the liquid material to strike into the web with expulsion of air and vapor from the web before the squeezing action takes place. In this particular embodiment, the roll 32 is shown as having a smooth surface, but it is preferable that the surface of both of the rolls 31 and 32 be provided with a multiplicity of recesses and lands of the character hereinabove described.

When the backing roll, namely the roll that does not carry the saturant, has a smooth surface its effectiveness can be enhanced by utilizing as the surface of the roll a resilient material such as natural or synthetic rubber as such material promotes the forcing of the saturant into the fibrous web material at the nip between the rolls. Alternatively, the surface of a backing roll provided with a resilient surface may be embossed in any of the manners above referred to or may be provided with a rugose surface as by rough grinding a roll that has been surfaced with a material such as vulcanized rubber. An embossed or rugose roll having a resilient surface may also be employed as the applicator roll for applying the saturant to the web material and rolls of this type are particularly suitable in applying saturants such as water, aqueous and other solutions, emulsions, etc., to the web

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material. Moreover, both the applicator roll and the backing roll may be provided with a resilient surface. The provision of resilient material at and adjacent the roll surface is illustrated in Figs. 10 and 11 wherein the elements are the same as shown in Figs. 1 and 3 and are indicated by the same reference characters, except that each of the rolls 10 and 11 is provided with a surfacing 46 composed of resilient material, e. g., rubber, in which the lands 47 and the recesses 48 occur. The lands 47 and the recesses 48 are shown as being somewhat irregular in outline and in distribution in order to illustrate the presentation of a rugose surface, which, as mentioned above, may be produced by rough grinding the resilient material of the surfacing 46. Of course, more regularly distributed lands and recesses, such as those illustrated in Figs. 2, 3, and 4, may be produced in the resilient surfacing 46 by embossing.

In Fig. 8, there is shown the employment of this invention to simultaneously saturate two webs of fibrous material and bond the two webs together. The fibrous webs 35 and 35a are contacted with the surface of rolls 36 and 37 respectively. Material to be used in saturating the webs is maintained in a bath 38 on the surface of the roll 36 by means of a retaining roll 39 and a bath 40 on the surface of the roll 37 by means of the retaining roll 41. The feed for the baths of material 38 and 40 may be maintained by any suitable feed means (not shown). Any surplus material carried by the surface of the rolls 36 and 37 is distributed as a layer of predetermined and desired thickness on the rolls 36 and 37 by the doctor blades 42 and 43 respectively. The rolls 36 and 37 are provided with a multiplicity of immediately adjacent recesses with lands therebetween of the character above described. At the nip between rolls 36 and 37 there is maintained a bath 44 of liquid material to be used in bonding the webs together, the feed for the bath 44 being maintained by any suitable means (not shown). In using the apparatus shown in Fig. 8, it is to be noted that each of the webs 35 and 35a contacts the surface of the rolls 36 and 37 respectively before the web material reaches the bath 44, thereby permitting liquid material from the baths 38 and 40 respectively to strike into the webs 35 and 35a and expel air and vapor therefrom before the webs reach the bath 44. At the nip between the rolls 36 and 37, there is the squeezing action hereinabove described wherein the web materials are squeezed into the recesses in the surface of each of the rolls 36 and 37, thereby effectively forcing the liquid saturating material into the body of the fibrous webs. By virtue of the employment of the bath 44 of liquid binder material, a substantial amount of the material is deposited between the webs 35 and 35a so as to provide a bonding film between the webs. The resulting composite web material 35b is carried on one of the rolls, e. g., on the roll 36 as shown, and is then stripped from the surface of the roll 36 as by means of a stripping roll 45. If, for example, the liquid material is a thermoplastic material such as asphalt having a softening point substantially above atmospheric temperature, very highly impregnated composite web material can be produced in the manner above described and there will be produced between the webs of the composite web material a film of the thermoplastic binder that bonds the webs together and that, in the case of an as-

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phaltic material or the like, provides a waterproofing membrane.

In Fig. 9, the apparatus is identical with the apparatus shown in Fig. 8 and the different parts thereof are indicated by the same reference characters. In Fig. 9, the apparatus, instead of being used to combine two webs to form a composite web, is used to simultaneously saturate two webs of fibrous material and then take off the webs without bonding them together. In order to carry out such an operation, the bath 44 shown in Fig. 8 is omitted, and the only liquid saturating material that is applied to the webs 35 and 35a is supplied from the baths 38 and 40. This liquid saturating material is first brought in contact with the webs 35 and 35a a substantial distance in advance of the nip of the rolls for the reasons hereinabove mentioned, and then is subjected to a squeezing action at the nip between the rolls 36 and 37, thereby thoroughly saturating each of the webs. After the webs emerge from the nip between the rolls 36 and 37, the web 35 is carried by the roll 36 and stripped therefrom by the stripping roll 45. The web 35a is carried by the surface of the roll 37 and is stripped therefrom by means of the stripping rolls 45a. Using the apparatus shown in Fig. 9, it is therefore possible, using a single pair of rolls, to simultaneously saturate two fibrous webs according to this invention and thus double the capacity of the equipment as compared with the saturating of a single web of fibrous material. Of course, if desired the apparatus shown in Fig. 9 may be employed in saturating only a single web and in such case one or the other of the baths 38 or 40 may be omitted, but as aforesaid both of the baths 38 and 40 may be used even though a single web is being saturated.

By any of the operations above described it is apparent that saturated fibrous bodies such as webs, formed articles and the like may be conveniently, economically produced with a high degree of uniformity of saturation. As to the extent of saturation, this may be controlled as desired. On the one hand, saturation as high as about 700% by weight of the fiber can be obtained using an asphaltic saturant, for example. On the other hand, the saturation may be relatively light and in the case of heavy web materials may only extend partly through the thickness of the web material. But in any case a high degree of uniformity and continuity of saturation laterally of the web material carried through the saturating operation can be obtained. In this connection it may again be emphasized that the recesses in the saturating roll are in substantially immediately adjacent relation so that the saturant material is applied in effect continuously to the web material while the multiplicity of small lands between the recesses form a support for the web material that does not interfere with the saturation of the web but on the other hand permits the web material to be squeezed into the recesses with a working and pumping action that causes the saturant in liquid form to be taken up and retained by the bibulous web material being saturated. While the minute lands serve the double purpose of creating recesses which carry saturant into the squeezing zone at the nip of the rolls and at the same time cause the saturant to be squeezed into the web (instead of being squeezed out of the web as with a wringer), they nevertheless have substantial area and serve as the carriers for the web so that instead of causing the web material

to be retained on the surface of the roll as would be the case if a multiplicity of pins were used, they have the opposite effect and greatly facilitate stripping of saturated web material from the surface. As mentioned above, delicate webs which could not be stripped from a smooth surface roll can be readily stripped away in a saturated condition in the practice of this invention.

While this invention has been described in connection with certain examples of the practice thereof, it is to be understood that this has been done for illustrative purposes only and that the practice of this invention may take a variety of different forms within the scope thereof as determined by the language of the following claims.

I claim:

1. Apparatus for saturating a bibulous fibrous web with a saturant in liquid form which comprises an embossed roll presenting a multiplicity of immediately adjacent and sequentially arranged lands and recesses, the lands being about 10 thousandths to about 30 thousandths of an inch in width and occupying about 15% to about 30% of the periphery of the roll, the roll being at least about 6 inches in diameter, means for rotating the roll, means for applying the saturant in liquid form to said roll to distribute said saturant over the surface of said roll and fill said recesses, means for squeezing said web against the surface of said lands and into said recesses to force saturant carried by said recesses into said fibrous web, and means for stripping said web from said roll.

2. Apparatus for saturating a bibulous fibrous web with a saturant in liquid form which comprises a pair of embossed rolls each presenting a multiplicity of immediately adjacent and sequentially arranged lands and recesses, the peripheral extent of the lands being less than that of the recesses, means for applying saturant to at least one of said rolls to distribute the saturant over the surface of said roll and fill said recesses, means for feeding the fibrous web onto surface of said roll carrying said saturant, means for rotating said rolls to squeeze the web between the nip of said rolls and into the recesses in said rolls to force saturant in said recesses into the body of said web, and means for stripping the web from one of said rolls, at least one of said rolls being provided with an annular marginal portion that prevents intermeshing of the lands and recesses on the surfaces of said rolls.

3. Apparatus for saturating a bibulous fibrous web with saturant in liquid form which comprises a pair of embossed rolls, each presenting a multiplicity of adjacent and sequentially arranged lands and recesses and arranged for compression of said web at the nip therebetween the lands being about 10 thousandths to about 30 thousandths of an inch in width and occupying about 15% to about 30% of the periphery of said rolls, means for rotating said rolls, means for applying liquid binder to at least one of said rolls to distribute said binder over the periphery of said roll and fill said recesses, means for feeding said web through the nip between said rolls and squeezing said web against the surface of said lands and into said recesses to force binder into said web, and means associated with one of said rolls for stripping the web from said one of said rolls at a point spaced from the nip between said rolls.

4. Apparatus according to claim 3 which includes means for applying the binder to one only of said rolls, means for contacting the web with

the roll to which the binder is applied before the web reaches the nip between the rolls, and stripping means associated with the other roll adapted to strip the web from said other roll at a point spaced from the nip between said rolls.

5. Apparatus for saturating a bibulous fibrous web with a saturant in liquid form which comprises an embossed roll presenting a multiplicity of immediately adjacent and sequentially arranged lands and recesses, the lands being about 10 thousandths to about 30 thousandths of an inch in width and occupying about 15% to about 30% of the periphery of the roll and providing surfaces of the width aforesaid at essentially the same radial distance from the axis of said roll for supporting said web when said web is disposed on the periphery of said roll but not in pressure contact therewith, said recesses being from about 5 to about 30 thousandths of an inch in depth, and said roll being at least about 6 inches in diameter, means for applying saturant in liquid form to said roll to distribute said saturant over the surface of said roll and fill said recesses, means for squeezing said web against the surface of said lands and into said recesses to force saturant carried by said recesses into said fibrous web, and means for stripping said web from said roll.

6. Apparatus for saturating a bibulous fibrous web with a saturant in liquid form which comprises a roll which is composed of resilient material at and adjacent the surface thereof and which presents a multiplicity of immediately adjacent and sequentially arranged lands and recesses, said lands providing a multiplicity of surfaces about 10 thousandths to about 30 thousandths of an inch in width and occupying about 15% to about 30% of the periphery of the roll for supporting said web when said web is in contact with the periphery of said roll, and said roll being at least 6 inches in diameter, means for applying saturant in liquid form to said roll to distribute said saturant over the surface of said roll and fill said recesses, means for squeezing said web against the surface of said lands and into said recesses while compressing said lands to decrease the depth of said recesses and thereby force saturant carried by said recesses into said fibrous web, and means for stripping said web from said roll after the squeezing pressure is released.

JOSHUA H. GOLDMAN.

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Number
2,067,488
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Name	Date
Hough	Jan. 12, 1937
Bucy	Jan. 3, 1939
Massey	Jan. 2, 1940

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Number	Country	Date
450,909	Great Britain	July 27, 1936

Certificate of Correction

Patent No. 2,429,314.

October 21, 1947.

JOSHUA H. GOLDMAN

It is hereby certified that the address of the assignee in the above numbered patent was erroneously described and specified as "Newark, New York", whereas said address should have been described and specified as *Newark, New Jersey*, as shown by the record of assignments in this Office; in the specification, column 3, line 44, for the words "or air" read *of air*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of February, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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