April 13, 1937. E. C. SCHACHT 2,077,015

PAPER MAKING PROCESS

Filed Oct. 27, 1932 2 Sheets-Sheet 1

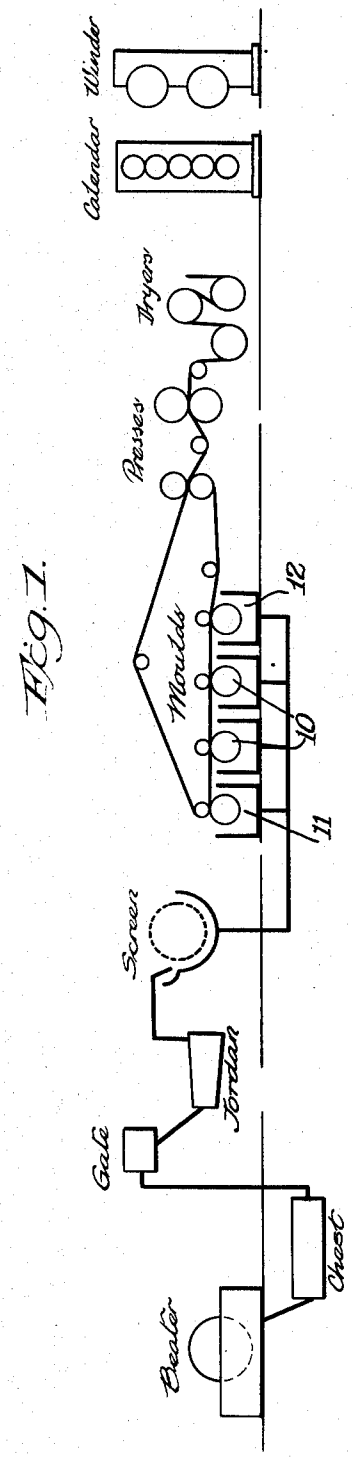


Fig. 1.

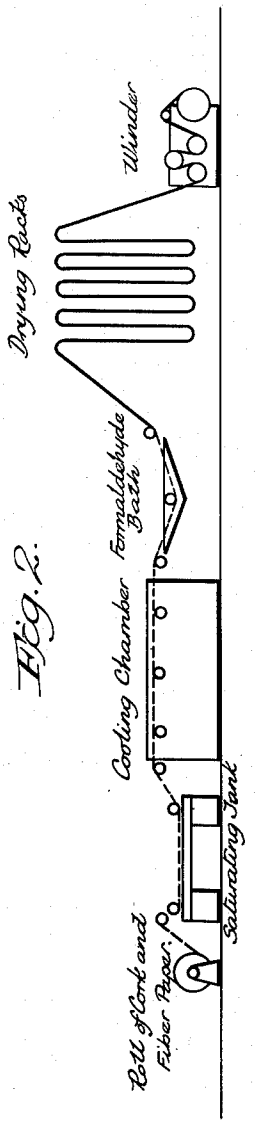


Fig. 2.

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Fig. 5.

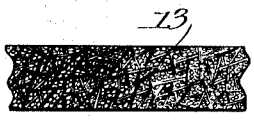


Fig. 9.

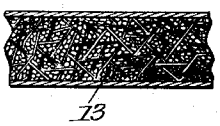


Fig. 6.

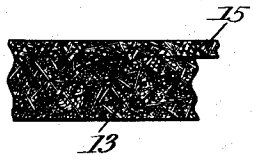


Fig. 7.

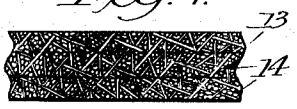


Fig. 10.



Fig. 8.

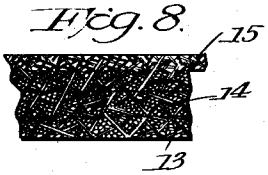


Fig. 3.

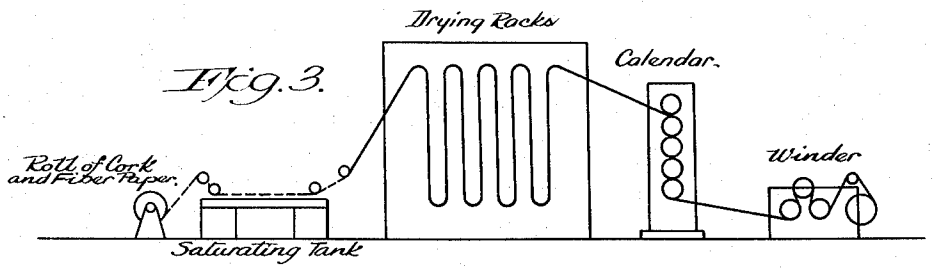
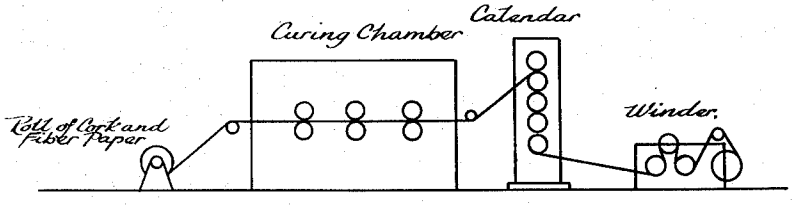


Fig. 4.



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Patented Apr. 13, 1937 2,077,015

UNITED STATES PATENT OFFICE

2,077,015

PAPER MAKING PROCESS

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Application October 27, 1932, Serial No. 639,905

7 Claims. (Cl. 92—21)

The present invention relates to the method of manufacturing paper-like or sheet material products, particularly the products of my Patents Nos. 1,888,409, November 22, 1932; 1,888,410, November 22, 1932; and 1,904,087, April 18, 1933, and this application is a continuation in part of the applications which matured into said patents.

The principal object of the invention is to produce sheet materials and particularly the sheet materials of my aforesaid applications, that is, flexible materials comprising (1) a web of a mixture of separators such as comminuted cork and fibre having a flexible binder incorporated therein in accordance with my earliest application and (2) a web the laminae of which comprise cork or other separator and fibre and fibres respectively and in which is likewise incorporated a flexible binder in accordance with the second of the above-mentioned applications. To obtain these sheet materials, I have developed a method which is efficient for large scale production and enables uniformity to be obtained in the final product.

Broadly speaking, I am particularly concerned with producing these various paper-like materials by a method wherein the sheets are formed as single ply webs, i. e., non-laminated webs, on the usual single Fourdrinier machine or are built up of plies after the manner of paper making practice in which a cylinder paper making machine or multiple Fourdrinier machine is employed and wherein the respective stocks are formed into laminated webs and felted together in the machine.

Thus I will follow this invention in producing (1) single ply webs; and (2) multi-ply webs, the latter having its laminae composed of (1) a mixture of separators and fibres; (2) fibres exclusively, and (3) certain laminae composed of fibres and separators and other laminae of fibres exclusively. I incorporate in the webs of these various structures binder materials in predetermined percentages, so that the respective laminae of the ultimate sheet will contain:

(*a*) The same percentages of the same binder;

(*b*) Different percentages of the same binder;

(*c*) The same percentages of different binders; and

(*d*) Different percentages of different binders, whereby the characteristics of the respective plies can be controlled.

Again, I obtain a single ply or integral stratified web in which the lamination or laminations of the built-up structure are controlled as to (1) relative density, and (2) components, that is the kind and amount of (*a*) fibres, (*b*) comminuted cork or other separator, and (*c*) binder present. The relative densities of the layers will be controlled by the size of the cork particles, the type of fibre used, and the length of time that the stock is subjected to beater action and the percentage of the respective components. The structural components of one layer may be composed solely of fibres and that of another layer of comminuted cork and fibres; the layers may be formed solely of fibres and of respectively different types, or solely of a mixture of cork and fibres and of variable mixtures respectively. The binder employed may be the same throughout the stratified web or each layer may have a different binder incorporated therein. The amount of binder present is regulated with respect to concentration and also with relation to the density of the web.

In this way, control of the coefficients of (1) absorbency, (2) strength, and (3) resiliency, i. e., compressibility and rebound, may be had and varied at will (as well as relative flexibility and stiffness) in the ultimate product.

A very important object of the invention, therefore, is to produce sheet materials of the character of my aforesaid applications wherein a very precise control may be had of the structure of the sheet.

The method embodies paper making practice as described with either of several final or intermediate steps which are each efficient to incorporate the binder. Thus I produce (1) by a method of saturation after the web is formed; (2) by recourse to pre-mixing, i. e., mixing the binder with the other components before the stock is beaten, or (3) by beater addition, that is adding the binder to the stock in the beater.

In each case the control features outlined above are available, can be operated with exactness and enable a uniform sheet to be obtained.

Sheet material according to this invention may be formed to have the following alternative structures:

(*a*) Facing layer and bottom layer.

(*b*) Facing layers and intermediate layers.

(c) Alternate layers corresponding to the respective facing layers and bottom or intermediate layers.

(a) (b) (c) Wherein the facing layers are

(1) Thin, equal to or of less thickness than the bottom layer or intermediate layers, or vice versa.

(2) Of less density than the bottom layer or intermediate layers, or vice versa.

(3) Of the same structural components or mixtures as the bottom layer or intermediate layers or vice versa.

(4) Of a different structural component or mixture than the bottom layer or intermediate layers, or vice versa.

(5) Permeated with the same binder as the bottom layer or intermediate layers, or vice versa.

(6) Permeated with a different binder than the bottom layer or intermediate layers, or vice versa.

(7) Permeated with a greater amount of binder than the bottom layer or intermediate layers, or vice versa.

(8) Permeated with a binder of greater concentration, i. e., having a higher percentage of binder than the bottom layer or intermediate layers, or vice versa.

(9) Permeated with a binder compatible or harmonious with a desired surface coating or finish.

(d) Each of the products of (1) to (9) inclusive provided with (1) a facing, (2) a backing, (3) a facing and backing and (4) a core of flexible or stiff preformed material such as paper, cardboard, vulcanized fibre, cloth or open mesh fabric, synthetic resin, or vulcanized latex or rubber, forming a flexible or stiff permeable or impervious reinforcement.

It is an object of the present invention to produce sheet material capable of wide application, which may be decorated, is light in weight, soundproof, abrasion or wear resistant, inert with respect to the action of water or organic and inorganic solvents, and porous and absorbent or impervious and non-absorbent.

The products of the present invention are useful in the manufacture of gaskets and sealing material, rug anchors, press blankets for impression cylinders of printing machines, floor coverings, artificial leather, wall board, panel material, breaker strips for doors and jambs, i. e., for refrigerators, electric and heat insulating material, anti-squeak material, channel material, soundproof material, insoles, and tops, as well as numerous other applications. The sheet materials are characterized by (1) high tensile strength, (2) resilience, i. e., compressibility and rebound, and (3) flexibility and pliability in that the sheets may be sharply flexed or creased without cracking or the formation of weakened areas.

I attribute the excellent qualities of these products in part to the method employed in their manufacture. Webs of the structure described without a specially incorporated material will be resilient and cellular by reason of the presence of the cork, and strengthened because of the fibres, but are subject to cracking and formation of permanent weak areas under sharp flexing.

I prefer paper making practice because the web obtained may be controlled very exactly, and likewise the incorporation of the binder which is essential to the production of my sheeted articles can be precisely regulated and accomplished. In addition to these advantages, the paper making practice enables a sheet to be obtained wherein the fibres and cork are interlaced and intimately associated in what may be described as hinging or pivoting of the fibres on the cork particles, thereby forming a strong and resilient web characterized by numerous voids and interstices. In other words, from a careful examination of the sheeted articles having the binder incorporated therein and formed by this method, it has been determined that when the cork fibre sheet is bent, cracked, or deformed, what actually occurs is that the fibres at the point of deformation are relieved to cause the cork particles which separate the fibres to compress. This allows the fibres to accommodate themselves or become aligned instead of being forced to absorb the entire strain and therefore become ruptured. The cork being highly compressible, returns to its original shape after the strain has been removed, and this causes substantially all of the fibres to resume their original positions in an unbroken state. Thus the sheeted articles under abnormal strains will not retain permanent lines of cracking or breakage. The sheet materials are moreover cellular and absorbent, i. e., capable of exerting capillary effect and the web may be treated uniformly throughout its interstitial mass to improve the inherent characteristics and enhance its flexibility, strength and resistance to bending strains. By reason of the method of this invention, the stratified web will have its respective layers simultaneously produced and bonded together as by felting. In other words, I find that by controlling the make-up of the web and the incorporation and selection of the binder, that the normal characteristics of the web are improved and such weaknesses as lack of resistance to bending strains and tearing strains are effectively corrected.

It is an aim of the invention to produce a web or sheet adaptable for floor coverings or other applications where a wear resistant surface is required. In such a case the facing layer will be provided with a binder having (1) a very strong bonding coefficient, (2) abrasion resistant and resistant to the effect of water, solvents or chemical action and (3) present in large enough amount to insure the desired result. The bottom or intermediate layer may have any suitable type of binder or the same binder, but the binder will be present preferably in much less amount in the unexposed portion of the web.

Thus a floor covering made as a cork fibre product will have its top layer made as a highly absorbent structure which would, in a saturating process, take up a great deal of resin, rubber latex, or some glutinous adhesive so as to give the covering a high wear coefficient, and plain fibres will also in some cases be used in this top ply so as to also get a smooth surface for coating with ornamental designs with such material as enamel, paint or lacquer. The center section will be more dense so as to be less absorbent during the saturating process and thereby save on the cost of the saturant during the manufacturing process. The bottom layer will be composed of coarse cork particles and fibre so as to have a good non-slip surface, as where it is used for small rugs.

Similar floor coverings would likewise be made by introducing a high percentage of resin or rubber by pre-mixing or beater addition during the paper making process in the top ply at which time a lower concentration of resin or rubber will

be introduced in the intermediate or bottom plies, thus saving on the cost of saturant, while producing a very acceptable product that has a high wear coefficient on its surface.

In the manufacture of artificial leather I will preferably resort to the laminated structure having a cork and fibre mixture layer or layers and wherein the top surface is composed exclusively of fibre and of high density, so as to absorb just as little of the saturant as necessary and give the high native paper strength. This all-fibre ply may be calendered so as to give a very nice surface for coating or embossing and the cork fibre ply gives a fine suede-like or leathery surface after saturation with glue, glycerine and formaldehyde. This product will be pliable like leather, will have a smooth surface for receiving a finishing coating, will have a leathery appearance on the exposed side, and will have considerable resistance to tear because of the high native tensile strength of the all-fibre ply which is enhanced during the saturating process. A very acceptable artificial leather is made in the same manner by the use of rubber latex or resins introduced either during the paper making process by pre-mixing or beater addition or by subsequent saturation.

A further important object of the invention is to produce press blankets for impression cylinders in the printing industry. Thus I use a single ply web of cork and fibres as produced on the single Fourdrinier, or a built-up web obtained by using a multiple Fourdrinier or cylinder paper-making machine and permeated with a suitable binder, i. e. glutinous adhesive, resin, etc., in accordance with this invention. With one or preferably both sides of the resilient web of appropriate flexibility will be combined a backing of preformed material such as paper, cloth, and/or vulcanized fibre, i. e., hard fibre or fish paper, if desired.

In the manufacture of insole material, I will produce either a single ply web of cork and fibres, a multi-ply web of cork and fibres, or a multi-ply web of layers of cork and fibres and fibres respectively, and having an incorporated binder such as resin, latex or glutinous adhesive as herein recited. The principal requirements of such material are (1) strength and ability to withstand stitching and sewing, (2) flexibility to maintain the shape of the insole in use, (3) resilience and smoothness so as to be comfortable, and (4) absorbency to take care of perspiration, and all of which I obtain with this invention. The surface layer, whether of cork and fibres or fibres alone, will be controlled as to density, i. e., absorbency, and may be calendered if required. Also a layer of pressure sensitive or heat sensitive adhesive applied to the undersurface of the sheet or any suitable adhesive or gummed surface will be desirable in some cases. Again a backing or facing, or both, of muslin or other open web fabric, may be combined with the sheet and in fact thin leather, paper or cloth may be utilized. The backing of course in such case may carry the adhesive.

A further object of the invention is to produce sheet material for anti-slip rug anchors or bases for floor coverings. Thus a thin sheet of cork and fibre permeated with a binder in accordance with this invention is highly satisfactory to prevent slipping of small rugs on highly polished floors. If desired, the upper surface of the anchor may have a backing or reinforcement of cloth or paper, the cork fibre surface being presented to the floor and by reason of the cellular or porous nature of the web, firmly grips the floor surface. I believe that this may be due to the compressibility and porosity of the web forming a multiplicity of vacuum cups or to the frictional coefficient of the cork and fibre layer and its relative spongy roughness.

It is a further aim of this invention to produce a decorated finish on the sheet as described in my Patent No. 1,888,410. For example, the web will have a facing layer composed solely of beaten fibres and a bottom or intermediate layer of cork and fibre mixture. With such a facing layer there results a product which is particularly useful in receiving finishing coatings on the fibre facing. I have discovered that the saturation or permeation of a laminated product of this type affords a means of producing a very improved coated sheet material. Some saturants, such as rubber, interfere with the application of certain finishing coatings. However, the fibre facing layer when applied to the cork fibre may be readily regulated in characteristics which affect the condition of its surface intended to receive a finishing coating. For example, it may be regulated as to density, as by selection of proper fibres or control of the period of working the mass in the beater. This permits the permeation thereof by the binder to be reduced to a minimum or otherwise regulated by controlling the density of the fibre layer. Again the condition of the surface of the fibre facing layer, as well as the condition of its body, may be varied as desired in any other respects independently of the cork fibre layer, since its mass is prepared and may even receive its binder, in whole or in part, separately from the cork fibre layer, as described. The combination, therefore, of the paper fibre layer with the cork fibre layer in a product saturated with a binder, enables me to produce a surface which may receive a finish unimpaired in character by the saturant or binder, regardless of the nature of the finish or of the saturant. For example, if the finish to be applied is one which does not coact well with the binder, the fibre facing may be made very dense, so that it has a very small amount of the saturant therein, or may be separately impregnated, e. g., in the beater or by pre-mixing with a binder harmonious with the finishing material, as well as with the binder of the cork fibre layer. On the other hand, if the finish to be applied is one which is improved by or is compatible with the binder, a fibre facing less dense than in the former instance may be utilized and having a proportionately increased amount of saturant therein. In any event, a fibre facing denser than the cork fibre layer is usually preferred.

The above and additional objects and advantages will appear as the description of the invention proceeds.

Figure 1 is a diagrammatic view of a paper-making machine of the cylinder type.

Figure 2 is a diagrammatic view of one method of impregnating the material formed on the machine of Figure 1.

Figure 3 is another view of a method of impregnation.

Figure 4 is a view showing diagrammatically the method of curing and drying the web when subsequent saturation is not resorted to.

Figure 5 is a view showing a single ply web of cork and fibre.

Figure 6 is a view showing a built-up web, one

layer of which is formed of fibres and the other layer of cork and fibre mixture.

Figure 7 is a view of a multi-ply web of cork and fibres.

Figure 8 is a view of a multi-ply web of cork and fibres and a facing layer of fibres.

Figure 9 is a view showing facing layers of preformed material and a core of material made in accordance with any of the forms of Figures 5 to 8.

Figure 10 is a similar view of a laminated web having a core of the preformed material.

In referring to paper making machines, it will be understood that while I have represented for purposes of illustration in the drawings a cylinder type of machine, a multiple Fourdrinier may be used with equal facility and I use a regular or single Fourdrinier machine where single ply webs are being produced.

The vats for the stock are indicated at 10, 11 and 12, and feed the respective cylinders, the web being felted together and built-up as understood in the art. In other respects, the various parts of the apparatus have been lettered to describe their function.

With reference to Figure 2, it will be noted that two baths are employed in the first of which I place glue and glycerine and the second the tanning agent for the glue such as formaldehyde. In Figure 3 only a single bath is used as where resin or rubber saturants are employed.

The present invention is not restricted to immersion or impregnation since I have found it equally satisfactory to incorporate the binder by pre-mixing or beater addition as above described. In Figure 4 I have illustrated a curing and drying chamber wherein instead of festooning the web, which I also do in some cases, it is passed between rolls which may be hot or cold as desired, and this procedure is adopted where the web as completed on the machine contains the incorporated binder. Of course, in some cases I may incorporate the binder by pre-mixing or beater addition, and thereafter give the web a saturating treatment, from whence it may be carried over drying racks or drying rollers, as desired. The curing chamber, of course, may take various forms, depending upon the particular binder utilized, and its temperature will be suitably controlled to effect a setting of the binder.

As a further condition of the method of operation, the speed of travel of the web through the drying and curing station can be controlled, and likewise in the case of the saturating treatment, the web may be wound onto rolls and thereafter, at any suitable time, passed through the bath, or the web may be formed and continuously fed through the saturating apparatus.

With respect to the vats 10, 11 and 12, there may be any number of these, and I have simply shown four by way of illustration. The vats 11 and 12 will contain the stock for the surface layers, while the vats 10 will feed the cylinders to produce the intermediate layer or plies. Thus I may control the stratified or laminated structure of the web by disposing in the various cylinder vats such wet stocks with or without incorporated binder as will produce the desired web.

It will be understood that by "wet stocks" I mean a mixture of fibres or pulp or fibres and cork in water. All such paper-making components are thoroughly mixed with water and put in suspension before being made into a felted sheet.

For example, the vats 10 may contain a stock composed of a mixture of cork and fibres while the end vats 11 and 12 will contain a stock which is exclusively fibres. Such a disposition may be reversed, and also each of the vats may contain a stock composed of a mixture of cork and fibres or of fibres alone to produce the stratified web and the nature of the respective stocks can be varied to accord with the ultimate product desired.

It will be understood that the web is built-up, i. e., simultaneously formed and bonded by felting to produce a substantially integral structure, characterized by the nature of the stocks fed to the respective cylinders. As I have hereinbefore set forth, webs which are not provided with a binder are resilient, cellular, and strong, but in accordance with the present invention these inherent characteristics are materially enhanced, and more important, the web is rendered strongly resistant to tearing strains and bending and creasing strains.

In carrying out the invention, I prepare the various stocks and feed them to the cylinder vats. For example, I will prepare the stock consisting of a separator, that is, comminuted cork, fibres and sufficient water, and feed such stock to the intermediate vats 10; also I will prepare a stock composed substantially exclusively of paper fibres and feed the same to either of the end vats 11 and 12 to produce a surface layer or layers.

The broader phases of the process defined in the claims appearing hereinafter, may be carried out with the use of other separators than comminuted cork having substantially similar characteristics, for example comminuted barks other than cork, leather chips and rubber particles. By separators, I mean materials of low specific gravity which are compressible and/or elastic, which preferably can be screened to a size and which are of a character which retain compressibility and size when wet or compressed and which continue to separate the contiguous fibres and tend to cause these fibres to return to their original position when pressure has been released.

The separator or comminuted cork should be of a size which may be termed "effective". That is to say, the cork granules to be effective should not exceed, in cross-section, the desired thickness of the finished sheet, nor should they be smaller in cross-section than the cross-sectional diameter of the fibres. Finer cork than this will act as a filler, thereby preventing the formation of voids and air cells, and also will be lost to a larger extent in the paper making process; likewise smaller particles would be ineffective in acting as separators and hinges about which the fibres can flex. I have used successfully cork particles of a grade from 50 to 150 mesh and 30 to 50 mesh.

The fibres with which the cork particles are mixed to form the web 10, should be sufficiently long (*a*) to contribute tearing strength to the finished product, (*b*) to mesh and hold the "separating" particles, i. e., the cork, and (*c*) to make an absorbent paper, quickly permeable to saturating solutions. Specific examples of the fibres which I employ are:

Jute	Absorbent alpha cellulose
Rope	Wood pulp fibres
Hemp	Cotton
Sisal	Linen
Kraft pulp fibres	Asbestos
Long wood pulp fibres	

flexibility and resilience of the laminated base.

I have set forth above the various components of the web, namely the fibres, the cork and fibre mixture, the binders, and examples of coating materials and finishes.

The method of carrying out the invention to produce the final binder incorporated sheet will now be described. I will have recourse to any one of three steps, and in some cases will combine one or more of these steps in accordance with the type of sheet desired.

In the drawings I have illustrated in Figures 2 and 3 a saturating treatment. That is to say, the web either formed on a single or multiple Fourdrinier machine, or upon a cylinder type machine, is entrained through several saturating baths as shown in Figure 2 or a single saturating bath as shown in Figure 3.

In this method, the density of the web will be controlled and moreover its character will be determined by the nature and size of the cork, the nature of the fibres, and the amount of beating to which the mixture is subjected. Also the structure of the web will be regulated by the percentage of cork to fibre or vice versa, and it will be understood that I may produce a web in which either of these components predominates.

Another step, and one equally preferable to the saturating treatment for incorporating the binder, is pre-mixing. By pre-mixing I mean incorporating the binder with the components of the stock before they are submitted to the beater action. In this manner not only may the structure of the web be controlled as above described, but also in the case of the stratified sheet, the percentage of binder and the type of binder may be controlled for the respective layers of the web.

A further step of equal value for incorporating the binder comprises beater addition. That is to say, the stock will have admixed with it in the beater the proper percentage and type of binder for the final article. It is to be observed that in each case I am enabled to control density of the web, the character of the components, their amount, i. e., their relative percentage with respect to each other, and the amount and character of the binder present in the final web.

With respect to pre-mixing and beater addition, it will be understood that the components may be individually pre-mixed with the binder, or a mixture of the components pre-mixed with the binder and the same procedure followed in the beater.

I may also add one or more of the components of the binder to the cork and/or fibres before mixing or to the beater mass, and the further treatments may take place during the formation of or after the web is formed. In other words, I may resort to the single use of pre-mixing, beater addition, or subsequent bath saturation in order to impregnate the web with the binder, or I may utilize a combination of any two or three of the above processes. As an illustration, I may add a binder by premixing and add more of the same binder or another or a modifying agent in the beater or by subsequent immersion in the bath. In other words, independent consecutive treatments with the components of the saturant may be resorted to according to the binder employed and the specific qualities required in the resultant product.

Immersion treatment

The web will be produced on the apparatus shown in Figure 1 or a multiple or single Fourdrinier. In the case of a single ply web of cork and fibres, its density will be controlled and the speed of travel through the bath regulated whereby the amount of impregnation, i. e., percentage of binder present, will be accurately and uniformly maintained. If the web is dense, a smaller amount of binder will be absorbed. The quantity of binder absorbed will vary in inverse proportion to the density of the web and the speed of travel of the web.

In the case of the laminated integral and composite web, i. e., built-up web, the same conditions apply except that the layers will usually be of different density and therefore less binder will be present in the layer or layers of greater density than in the one or more of less density, subject, of course, to the limitation that I could not efficiently in all cases introduce a high percentage of binder in the inside plies by the saturating process, where the outside plies are very dense, since these would present some difficulty to the introduction of the binder through them into the more absorbent inner plies. Therefore, in a final product of this kind, I preferably resort to beater addition or pre-mixing in order to introduce a high percentage of binder in the core and lower percentages in the outside plies. As an alternative, of course, I will resort to pre-mixing or beater addition to introduce the binder into the plies of the core and introduce the binder in the surface layers by an immersion treatment.

Specifically, and for purposes of illustration, since I have saturated webs of the various structures above set forth, (see (*a*) (*b*) (*c*)) and have employed the various binders exemplified, the web will comprise a thin surface layer of fibres constituting a paper-like web and a layer of cork and fibre mixture. The thin paper-like layers are of greater density than the cork and fibre layer or vice versa.

The web will be fed either continuously from the paper making machine or from storage rolls of the untreated material as shown in the drawings.

In Figure 2 the first tank contains glue and glycerine in the proportions of one part of glue, three and one-half parts of glycerine and seven and one-half parts of water. The web is lead through this bath, thereafter through a cooling zone to jell the glue without freezing it, and then through a tank containing a solution of one part glycerine, one part formaldehyde and six parts water. The respective proportions indicated may be departed from as desired and are simply given by way of illustration.

Also by way of illustration I will treat similarly a single ply web of cork and fibres as herein described, the density of which has been suitably controlled.

The webs so treated are dried in any suitable manner, as on the drying rack shown, or rolls, and it is noted that this festooning does not produce cracks or lines of fold in the web, indicating the remarkable flexibility and strength of the web.

The web is thereupon wound up into commercially distributable rolls. The final products are excellent for sealing material and gaskets, being resistant to mineral oils and water.

The web treated by immersion, as just described, has permanently and insolubly incorporated throughout its cellular structure, the flexible binder. This complete saturation is attained by reason of the interstitial nature of the web. That is to say, the presence of the separator, i. e., the cork particles, and their interlaced relation

with the fibres, produces cells, air spaces and voids, whereby the web exerts a maximum capillary effect and the fibres are impregnated and the cork particles coated. In fact, both the fibres and cork are encased in the binder, and the thorough permeation of the web assures the presence uniformly throughout the web structure of sufficient binder to obtain and preserve the qualities of strength, resilience and flexibility or stiffness.

In the case of the stratified web having a layer or layers 15 exclusively of fibres, i. e., a paper-like web, this thorough and uniform permeation is obtained, since such layers are porous in accordance with their density, permitting capillary action and the fibres are absorbent and capable of impregnation.

Any of the above mentioned binders may be used, as determined by the product desired, and prepared as a bath with their modifying agents, through which the sheet is passed.

In this connection a single bath may be employed or several independent immersions resorted to. Thus, I may incorporate the glue, glycerine and paraformaldehyde in a single bath, with a suitable retardant, i. e., oxalic acid to delay the glue-formaldehyde reaction.

Further, the resinous and latex binders are capable of being cured in the sheet by means of heat and pressure or heat alone without producing any deleterious results. This is particularly true with bakelite resins as well as the rubber saturants, and I have described above specific baths composed of these two materials.

Therefore, without describing them in detail, I refer to Figure 3 wherein the single ply or multiple ply web is passed through a single bath of a rubber or resin saturant and then through a curing and drying chamber over racks or rolls. The temperature of the chamber or the temperature and/or pressure of the rolls, will be regulated in accordance with the particular saturant solution or mixture employed, its determined amount in the sheet and the setting or hardening required.

By way of illustration, since I use any of the structures mentioned above, (see (*a*) (*b*) (*c*) (*d*)) and the binders exemplified, in the impregnating method, the cylinder forming the top ply of paper is fed with a mixture of cork and fibre which has been subjected to a severe beating in order to decrease the porosity and subsequent absorption of this part of the web. The paper web is formed and dried in the usual manner and then passed through a bath containing a solution of a suitable resin composition as described above to saturate the web and then passed to a suitable drying arrangement as shown to evaporate the solvent and cure the binder.

With respect to saturation with a bath of a rubber composition as herein described, the respective plies of the sheet will be controlled as to density, i. e., absorbency. As for instance, a more absorbent furnish may be supplied to the vats feeding the cylinders to form the surface ply or plies. The resulting web when subjected to the rubber impregnating bath will absorb a higher percentage of rubber in the surface layer or layers than in the intermediate or concealed layers, thus furnishing resistance to wear at the point of contact when the product is in use.

In other words, the density of the outer layers would be so low, so as to permit the introduction of a high percentage of rubber in the surface. The density of the inner or intermediate plies could be increased so that less rubber would be located in the center section where it is not needed.

Thus by controlling the density of the outer layers, I increase the rate of absorption during the saturating process, so as to get a high percentage of rubber on the surface.

For wear resistant material, as floor coverings, I select a resin or rubber saturant as above mentioned. These can be cured in the sheet to give a hard finish, and a sheet which will be abrasion resistant and resistant to the action of water, mineral oils, as well as organic and inorganic solvents. The amount present will be determined by the density of the web and the method of binder incorporation employed. Thus when wear resistant material is desired, it can be made by putting a high percentage of the selected binder in the top surface which can be accomplished by making the surface ply very absorbent if saturation is to be resorted to or by putting in a high percentage of binder in the top ply during the paper-making process by beater addition or pre-mixing. In other words, I rely on density control to get the high percentage of binder on the top ply when saturation is employed whereas I preferably put the binder in during the paper-making process by pre-mixing or beater addition in most other instances to accomplish the result. As above explained, I also resort to a combination of both methods.

Pre-mixing

By pre-mixing, the binder is mixed with the components of the web individually, as a mixture or both, before being beaten.

In the case of a single ply cork and fibre web, the binder is mixed (1) with the fibres, (2) with the cork, (3) with both, and (4) with a mixture of cork and fibre. The stock, i. e., mixture of structural components and binder, thereafter is beaten to the desired extent and fed to the paper machine or respective vats for the cylinders.

Where a paper-like layer forms a part of the web, it likewise is pre-mixed with the binder, beaten and fed to the proper cylinder vats to form, for example, an integral web having a paper-like layer of fibres and a layer of cork and fibre mixture.

Thus I form stocks of various components, regulate their density by the nature and percentage of the components and the beating action, control the percentage of binder present and the character of binder to form any of the sheets mentioned under (*a*), (*b*) and (*c*) above by feeding the respective stocks to the vats in accordance with the desired structure of sheet.

By way of illustration, where the pre-mix process is used to incorporate different percentages of binder in the respective layers, the following is a specific illustration of the method of carrying out the invention. For the surface layer 50 parts by weight of rope fibre is saturated with an equal amount of water and placed in a steam jacketed mixer, together with 60 parts by weight of a phenolic resin having a flow point of 70 to 80° C., and 50 parts by weight of cork, 30 to 150 mesh. The entire mass is then mixed at a temperature of 90° C. for forty-five minutes. Hot water, 50 parts by weight is added and the mixing continued for fifteen minutes, whence the entire mass is removed and placed in a suitable beater. The concentration in the beater is so adjusted as to give the proper beating con-

sistency, that is, approximately 5% solids and beaten for one-half hour. The resulting furnish is then suitably diluted and used to feed the cylinder forming the surface ply in the final paper-like material. The other cylinders may be fed with a stock prepared as follows: 50 parts by weight of rope fibre is saturated with an equal amount of water and placed in a steam jacketed mixer, together with 25 parts by weight of a phenolic resin having a flow point of 70 to 80° C. and 50 parts by weight of cork, 30 to 150 mesh. The entire mass is then mixed at a temperature of 90° C. for forty-five minutes. Hot water, 50 parts by weight is added and the mixing continued for fifteen minutes, whence the entire mass is removed and placed in a suitable beater. The concentration in the beater is so adjusted as to give the proper beating consistency, that is, approximately 5% solids, and beaten for one-half hour. The resulting furnish is then suitably diluted and used to feed the cylinders with the exception of the cylinder forming the surface ply. The cylinders fed, as described above, are operated to give a paper-like product with a surface layer containing a high percentage of resin. The resulting paper is dried and subsequently passed through the heated curing chamber maintained at 125° C. in order to set up the binder. After the binder has been set, the web may be subjected to calendering and/or hot pressing to produce the desired finish.

In lieu of using different percentages of the same binder in the stock in various vats feeding the cylinders on a cylinder machine, we may use entirely different binders in the respective stocks supplied to the separate vats, since it is possible to prepare the stock for each vat by a separate pre-mixing and beater operation. As an example of this method of operation, a top or surface ply of paper may be formed in the same manner just given for the top surface ply in the first pre-mix example. The other plies of paper may be made of a furnish prepared by premixing and consisting of 40 parts by weight of petroleum base asphalt, flow point approximately 180° F., 30 parts by weight of 30 mesh cork and 30 parts by weight of suitable rag fibre. The resulting mix or furnish after proper dilution is then beaten for one-half hour in an ordinary beater and the respective stocks fed to the vats in the usual way.

In the manufacture of floor coverings and the like, a low percentage of the binder may be placed in the cork fibre mixture used to feed the vat forming the center and, in some cases, the bottom layers, while a high percentage of a hard finishing binder may be placed in the stock fed to the vats forming the surface layer so as to offer sufficient resistance to wear. Also where a high percentage of the hard binder is used in all the plies, then the material will be relatively stiff. Thus equal or different percentages of a similar binder or a different one may be incorporated in the separate plies by the pre-mixture process.

It will be observed that by the pre-mix process I am able to have a relatively thin paper-like layer provided with a relatively small percentage of one of the binders above referred to, and of high or low density, and a layer of cork and fibre mixture of greater or less density than the paper-like layer and containing a greater or less percentage of the binder. Furthermore, I will incorporate any of the several binders above referred to, and in addition the concentration of the binder, that is, its adhesive effect, may be different for the respective layers.

Also, I will use for some of the layers a binder capable of giving a hard finish, and I may incorporate in the respective layers different binders selected from those listed above, whereby when the sheet is subjected to a curing action, one thereof will become hard and wear resistant while the other will be resilient.

By the pre-mix process I am enabled to produce flexible materials, absorbent materials, materials having a hard finish and abrasion resistance, and also I am enabled to produce a relatively stiff product as where substantial or equal percentages of some of the binders, i. e., hard binders, permeate all layers of the composite web.

To obtain the proper adherence for a finishing coating which may not be harmonious with the binder employed as an impregnating medium, the binder will be introduced by the pre-mix method in minimum quantities in the surface layer which is to come in contact with the coating material, while the inside layer or layers will have a higher percentage of binder present.

Beater addition

With respect to beater addition, the same control is available as just described in connection with pre-mixing. The step of beater addition, however, comprehends adding the binder to the beater mass or mixture, and is applicable with any of the binders above mentioned.

Likewise, the curing treatments will be substantially the same, that is, the web will be formed from the respective stocks and thereafter presented to the curing chamber over racks or rolls and at appropriate temperatures and pressures or both to obtain the desired setting of the binder.

By resorting to pre-mixing and/or preferably beater addition, a product desirable for insoles can be formed which has high resistance to tear due to a high percentage of rubber or other binder in the inner layers but which has absorbent surface layers due to the decreased percentage of rubber added to the beaters supplying the vats which make up these particular plies. For example, on the paper-making machine, I would produce by beater addition or pre-mixing a laminated sheet having a small percentage of rubber on the top layer which would insure the insole absorbency as required. I could not efficiently introduce a high percentage of rubber in the inside plies by the saturating process because where the outside plies were very dense, they would present some difficulty to the introduction of the binder through them into the more absorbent inner plies. Therefore, if the final product is to have absorbent outside plies and still contain the binders, I preferably resort to beater addition and make the completed product on the paper-making machine, so that its outside layers will contain less binder and therefore be more absorbent as to perspiration when used as inner soles, for example.

In this way a product is formed having high resistance to tear, but with absorbent surface layers. Such a product is of use for inner soles where some absorption of perspiration is desirable. Where heretofore it has been customary to produce a laminated article of this type by forming the layers individually and by bonding them by a rubber or other cement, the effect has been that the cement between the respective preformed layers acts as a seal between the respective layers and prevents moisture from pass-

ing from one side to the other, which is corrected by the present process and article.

As modifications of the three methods which are embodied in the paper making process, I may subject the respective stocks or any one of them to a pre-mixing or beater addition treatment and thereafter to a saturating treatment using different types of the binders herein mentioned.

Summing up the control features of the invention and regardless of the components, the control of the qualities of the finished sheet are secured by—first, the regulation of the density of the individual layers, second, by the control of the percentage and type of binder present in the layers, and third, by the combination of these two control features. The density of a layer of paper composed of plain fibre or of cork and fibre or any other components from which the paper will be made, can be varied in the paper-making process (without the introduction of a binder of any kind) by varying the time of beating, length of fibre, size of cork particles and relative proportions of these or other components employed. A multiple ply paper made on a cylinder paper-making machine can therefore be made by laminating several plies of paper having a different density in each ply. When this completed sheet is saturated, the amount of saturant which the various plies will absorb will be different, depending upon the varying rates of absorption resulting from the variation in density from ply to ply, subject to the practical limitations heretofore disclosed. That is, for example, a large amount of binder cannot be introduced into a porous center ply if the outside plies are of greater density. Therefore, a means of controlling the amount of binder or saturant present in the different plies is presented by the density control of the individual plies, although as in the illustration just given, no binder is introduced into the plies during the paper-making process.

Where pre-mixing and/or beater addition are resorted to, I not only vary the amount of binder present in the individual plies but vary as well the type of binder or binders in the individual layers. For example, I use different amounts of the same binder in vats 11—10 and can use different percentages of an entirely different binder in vats 10—12. The binder is incorporated in the paper-making process either by pre-mixing or beater addition or both.

As a third variation, I can have a combination of the cases just outlined above whereby I control the density of one or more plies of paper (unimpregnated) and combine these plies on the paper-making machine with other plies containing controlled amounts of binder or binders, added by pre-mixing or beater addition or both. This product is then passed from the paper-making machine and saturated, in which process the controlled densities of the plies which were not impregnated with a binder in the paper-making process, will control the final amount of saturant absorbed by these plies during the saturating process.

In other words, we have three definite means of control—

1st.—That, presented as in the bath treatment by regulating the amount of binder absorbed due to varying the densities of the paper plies during the paper making process.

2nd.—By varying the percentages or amounts of binders and the type or types of binders present in the individual plies or layers when such binder or binders are added by the pre-mixing and/or beater addition processes, and

3rd.—By the combination of these two methods.

It will be understood that the coating treatment will preferably take place after the binder incorporated web has been formed and the coating may be applied by immersion, brushing, spreading or spraying.

With each of the several methods I am enabled to obtain a flexible product, and by varying the type and percentage of binder and the curing treatment, one which will have relatively greater stiffness.

It will be seen that by the control of the density of the stock, the nature of the cork particles and fibres and the beating action, as well as the percentage relationship of the components there is produced the structures herein described. In other words, I obtain a uniform product having the requisite amount of binder distributed throughout the interstitial structure in exactly the amount required to form the finished sheet.

Another very acceptable product which I make in accordance with this invention is a new gasket material and I use any or a combination of the steps of finder incorporation explained above. Thus I will prepare a web composed exclusively of asbestos fibres having relatively dense and impervious surface layers and intermediate layers of less density and greater compressibility. This structure may be reversed and the gasket provided with a core of dense, impervious layers and surface layers of greater compressibility and less density and impermeability. The relatively dense layers will be relatively thin with respect to the more compressible layers although they may be equal to or of greater thickness, or the more compressible layers of less thickness than the relatively denser layers.

A single binder may be used or several different distinct ones for the respective laminae, and selected from those above mentioned, preferably in accordance with physical and chemical conditions surrounding the particular gasket application.

The gasket material may have any desired surface coating, as for example, a layer of graphite as well known in the gasket art.

A similar structure, i. e., one having a relatively dense, incompressible and impervious layer or layers and a layer or layers of less density, greater compressibility and less imperviousness, is formed exclusively from any of the fibres herein listed, asbestos being given as a further concrete example, and likewise the exact structure can be formed exclusively from mixtures of cork and fibres. Again the structure is formed from layers composed of asbestos fibres mixed with one or more of the other fibres mentioned, as rope fibre, or mixed with comminuted cork, or comminuted cork and rope fibre or one or more of said other described fibres. Furthermore, the structure is formed with layers respectively exclusively of asbestos fibres and (1) layers exclusively of one or more of the other fibres mentioned or of cork and fibres and (2) of the asbestos mixtures just described.

As one concrete example the surface layers may be of asbestos and the compressible intermediate layers of cork and fibre mixture.

In each case the product will have a suitable binder incorporated therein, if required, a surface coating where desired, and/or a layer of graphite or similar material.

The specific binder compositions per se mentioned herein are all commercial products and I have set them forth as illustrative instances of binders which I have utilized with success. The same is true with the coating materials.

In some instances, as where the surface layer is not required to be smooth, calendering may be omitted, and in other instances the thin paper-like web of the thin surface layer of cork and fibre will not require any calendering. However, for certain decorative purposes where a very high finish is required, I resort to calendering.

Referring to Figures 9 and 10, the sheets in accordance with this invention are combined with a preformed material 16, such as a layer of cloth, paper, synthetic resin, vulcanized fibre or rubber. Such layers will be flexible or relatively stiff, as desired, serving as a reinforcement for the web and may be permeable or impervious. The preformed material will be (see Figure 9) (1) a backing, (2) a facing, and (3) both, or (see Figure 10), a core. As to the core structure, this also may have a facing or backing, or both, of the preformed material.

That is to say, the sheets will be constructed in accordance with either of the webs of Figures 5 to 8. The combining may take place on any suitable combining machine, as for example, between opposed rolls.

A preformed facing and backing material may be applied as the permeated webs issue from the paper making machine or bath and the combining take place simultaneously with the curing of binder and the drying of the web, i. e., the combining rolls will be suitably heated.

The adhesive may be applied to the surface of the preformed material or the surface of the web. Pressure or heat sensitive adhesives are employed as well as glues and binders of the type recited above. In certain cases the web will have excess binder present on its surface so that additional adhesive will not be required. Again the web and preformed non-permeated material will be combined and then the composite sheet saturated in a bath of the binders herein described. Also the permeated or non-permeated webs may be formed and wound into rolls, and thereafter combined with preformed material as required, or the combining will be a continuous or consecutive step after or before permeation or after or before drying of the web. Also, the combining may be accomplished with pre-cut sheets as with the manufacture of veneers.

These faced and backed products have a variety of uses and particularly are useful for printing press blankets, insoles and rug anchors, as well as floor coverings. They may be suitably coated for any desired purpose with lacquers or varnishes as herein described.

For press blankets I may use any of the permeated webs herein described, but I prefer to use for printing press blanket material a single or double ply web of cork and fibre in accordance with this invention. I saturate the web with a glutinous adhesive, i. e., glue and glycerine and set the glue with formaldehyde. This will give a flexible blanket of required strength and resilience.

I will in some cases, where added strength is needed, apply a flexible backing of paper, cloth or vulcanized fibre. Also I apply the backing to both surfaces of the web as shown in Figure 9 as a further reinforcement.

While I have indicated a glutinous adhesive, I also find the resin binders satisfactory.

As a modification, a non-permeated web of cork and fibre has one or both surfaces united to a backing as above described.

As a further modification a core of the backing material will be employed such as cloth or paper and the webs united to opposite sides thereof. A backing and/or facing will also be used in some cases.

As a further form of printer's blanket or make ready, and particularly with reference to the use of vulcanized fibre, I will employ a relatively thin sheet of this material, and adhesively unite it to one of the sheeted products of this application, or to a layer wholly of comminuted cork particles and a binder, preferably one of those herein mentioned. This material (i. e., cork and binder) may be sheeted or may be spread upon the vulcanized fibre sheet.

The outside surfaces of the blanket material will be treated in such manner as to be smooth and impervious and non-adhesive to printing ink.

For insole material I will use any of the various webs herein described and any of the several binders to obtain a flexible, strong and absorbent material which likewise is resilient.

Preferably the exposed portion or tread surface will be freely absorbent to perspiration and hence will have only a minimum of binder present.

A permeable facing or backing such as muslin or other open web fabric will sometimes be applied to one or both surfaces of the web as a reinforcement.

The undersurface will also in some cases carry a pressure sensitive or heat sensitive adhesive of which many varieties are commercially available.

The insoles will be stamped out of the sheet in the usual manner.

As one illustration, I will, by pre-mixing or beater addition, put a small percentage of binder such as rubber latex in the top plies (fibre alone or cork and fibre) in order to produce absorbency of the finished insole on account of perspiration. In the intermediate and bottom plies I introduce a high percentage of a binder such as rubber latex in order to increase the strength of the product, its resistance to wear and ability to stand sewing.

Other of the binders are equally applicable.

A new and important use for treated cork fibre (single ply or multi-ply) resides in its application as a rug anchor. Tests with a sheet of cork fibre impregnated with glue, glycerine and formaldehyde under small rugs on polished floors were very satisfactory. The rug does not slip on the cork fibre surface and the cork fibre grips the polished floor so that there is no movement of the rug relative to the cork fibre or the cork fibre relative to the floor, or both the cork fibre and the rug relative to the floor.

Cork fibre treated with glue, glycerine and formaldehyde produces a very acceptable rug anchor with or without the addition of a reinforcing material such as a layer of paper or cloth. This expedient is used in some cases in order to prolong the life of the anchor because small rugs are constantly being removed from the floor for cleaning purposes, and in the handling, a thin sheet of cork fibre might ultimately become torn. I use a combination of cork fibre and cloth, and cement the cloth on the side of the cork fibre which is in contact with the bottom side of the

rug. I also put two layers of cork fibre on either side of a core of reinforcing cloth. Instead of impregnating with glue, glycerine and formaldehyde, I use either a resinous or rubber binder.

The products of this invention, especially treated cork and fibre, are adapted for use as anti-squeak material on automobiles. In this application, the compressibility and resilience of the product insure a tight joint between the adjacent surfaces and at the same time due to sound absorbency prevent noise and squeaking. It is readily processed into the desired form, that is, cut, slit, or folded. It is also substantially weatherproof and does not disintegrate when wet.

Another automotive application is the use as window channel material. The compressibility and resilience of the cork and fibre products make possible a tight joint with glass and at the same time afford a yielding or cushioning support to prevent window breakage. Other desirable attributes for this purpose are availability in various colors, weatherproofness, resistance to disintegration when wet, sound absorbency and ease of processing.

It will be understood that the various structures set forth herein will be permeated with various of the binders, for example, the surface layer will be permeated with a glutinous binder, i. e., glue, glycerine and formaldehyde, and the intermediate plies and bottom plies with a resinous material or a rubber-like material. Thus also one layer will contain a rubber-like binder and another layer a resinous binder. Similarly other sheets will be formed in which either the resinous binder or the rubber-like binder will permeate the surface layers and the other binders the intermediate and bottom layers. In some cases the top and bottom layers will be permeated with the same binder.

In referring herein to a resinous binder, I mean various natural and synthetic resins and compositions thereof which are well-known commercial articles, and in connection with rubber-like materials, I mean latex and similar latices, i. e., balata and gutta percha and various rubber compositions, all of which are available in the trade.

The term "paper-like" is intended to cover the webs produced in accordance with this invention on a paper-making machine.

I claim:—

1. The process of making sheet material comprising a laminated web having paper-like layers felted to produce an integral composite structure which comprises preparing separate stocks of different densities, each of a mixture of separator and fibres, felting the stocks on a paper making machine into an integral web, the laminæ of which have different coefficients of absorbency and saturating the web with a binder to include such binder in the web in accordance with the absorbency of the layers thereof.

2. The process of making sheet material comprising a laminated web having paper-like layers felted to produce an integral composite structure which comprises preparing separate stocks of different densities, each of a mixture of comminuted cork and fibres, felting the stocks on a paper making machine into an integral web, the laminæ of which have different coefficients of absorbency and saturating the web with a binder to include such binder in the web in accordance with the absorbency of the layers thereof.

3. The process of making a paper-like material which comprises preparing a mixture of comminuted cork and fibres with sufficient water to form a stock, preparing a stock composed exclusively of fibres, forming the respective stock masses into webs and bonding them together to form a substantially integral web, and incorporating a flexible binder through the composite web and in amount sufficient to increase the inherent strength and resilience of the web and render it flexible so that it is resistant to creasing and flexing, and combining with the web a layer of preformed material.

4. Sheet material comprising a paper-like web comprising an integral structure having at least one layer of cork and fibres and at least one layer composed exclusively of fibres, said web being permeated with a binder and having a layer of preformed material united to one of its surfaces.

5. Artificial leather comprising a paper-like web of comminuted separator and fibres permeated with a binder, and a smooth substantially flexible coating on one surface of the web.

6. Artificial leather comprising an integrally laminated paper-like web having layers of fibres and comminuted cork and fibres, respectively, one surface laminæ of said web having a binder in character and percentage to render the same capable of harmoniously receiving a finishing coating, and a finishing coating applied to said web.

7. Artificial leather comprising a paper-like web of comminuted cork and fibres permeated with a binder, and a smooth substantially flexible coating on one surface of the web.

ELMER C. SCHACHT.