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FABRICATED MATERIAL AND PROCESS FOR ITS MANUFACTURE

Willis A. Boughton, Cambridge, Mass., assignor to Bennett Box Company, Boston, Mass., a corporation of Massachusetts

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This invention relates to improvements in fabricated sheet or block materials and to processes for their manufacture. Material made according to the process of the invention may include sheets for uses similar to those for which linoleum, leather, waterproof sheeting and other sheets characterized by stiffness and thickness or toughness coupled with flexibility are used. It may also include block or molded formations where flexibility is of less consequence or even is absent. It will be herein described as it may be applied for sheet materials, which having various degrees of pliability and of resilience, are suited to the needs in many fields of art and manufacture.

The products that can thus be produced may be used for the manufacture of such articles as shoe toe boxes, linoleum substitutes, semipermeable membranes, leather substitutes, wood substitutes, the quality depending on such factors, obviously, as choice of binder and process, proportions of binder and wood pulp fibers, degree of intimacy of contact of binder and fibers, surfacing and finishing of product, etc.

It is a purpose of the invention to provide a process and a product for supplying such needs, with equal or superior results and quality, but with cheaper material and with an aggregate lower cost. The ligno cellulosic material obtained from the stems and branches of trees and plants, herein referred to by the general term, wood pulp, is commercially available in abundant quantity and at low cost as an ingredient of such a product. Commonly in wood pulp products the fibres are in close contact, being highly compressed in one stage or another of manufacture, and the material is utilized by impregnating it with some variety of liquid which is afterward dried into an uncompressed solid. The process of the present invention, in contrast with that, handles the cellulosic fibres in a loose unformed mass, having very different properties, especially as regards absorbability of liquids. I have found, however, that even loosely matted sheets of pulp can absorb binding liquids only up to a certain maximum viscosity, beyond which absorption is slow and incomplete; and similarly in the case of colloidal suspensions, such as rubber latex, the loosely matted sheet holds the colloidal particles chiefly on its surface. This has heretofore limited the extent to which a binder in liquid or solution form could be impregnated into the sheet, and often has made impossible the production of a composite sheet of the desired body and properties. My invention renders the cellulosic fibres available for the desired utilities by plasticizing the mass. The process calls for the use of ordinary mechanical or kraft pulp, and if this be in sheet form as usual the sheet formation is destroyed as it is repulped for the intimate physical mixing therewith of a suitable quantity of plastic solid in finely divided form, which may be of various sorts according to need or desire. For example, it may be a water-insoluble organic material, the subsequent treatment of which produces a solid sheet or other formation, as for example, a molded article according to methods already known in industry, or that may in future become known. As an illustration, to the wet pulp mass in a beater engine is added the desired organic binder in sub-divided form, as a powder, and the whole is beaten in a manner to cause uniform and complete mixing of the ingredients and dissemination of the binder particles throughout the mass. The organic binder above mentioned may be any of various water-insoluble organic materials that can be obtained in subdivided form, either dry or dispersed in aqueous liquids. Such organic materials include celluloid, cellulose esters, rubber, gelatin, glue, rosin, copal, etc., or any desired mixture of such substances. In each case the commercial pulp, which is composed of closely compacted fibers, is beaten with water to disseminate and separate the fibers, and to the mixture is added slightly more than the desired proportion of subdivided organic materials. The whole is then thoroughly beaten together with somewhat less water than is ordinarily used to disseminate wood pulp fibers in the manufacture of paper in order to keep as much of the added organic material in contact with the fibres as possible. The mixture, when thoroughly beaten, may be removed and dried in any desired way, as by placing it upon the usual wire screen and squeezing, pressing, or rolling it if necessary. As thus obtained the sheets have particles of the binder disseminated throughout, but because there has been no appreciable adhesion between the particles and the pulp fibres the sheets are comparatively weak and delicate.

It has been common practice for a long time for powdered material such as rosin, casein, talc, etc., to be added to the mixture of pulp and water used in the manufacture of paper, but for this purpose the amount of material so added is comparatively small, and is added primarily for the purpose of producing a calendered surface on the finished paper. My process dif-

fers from these established customs in that very much greater quantities of added materials are used in order to produce specific results that are not produced in the manufacture of paper and in order to obtain materials that could not by any construction be used for the purpose for which paper is employed.

In experiments upon wood pulp and sodium silicate I found that more than 15% by weight of water-insoluble inorganic powders could be beaten into a mixture of wood pulp and water, and that the pulp when taken off on wires would retain among and on its fibers the greater part of the added powders, giving when dried a sheet of loosely matted wood pulp fibers thoroughly and uniformly mixed and intermingled with the added powder. With certain organic binders the percentage can be higher.

The process contemplates a further step, whereby liquefaction of the binder and cementation of the mass is accomplished. This step, which is referred to herein as "plasticizing," may be done in one or more of several ways. The mass may be treated with a binder solvent whereby the binder is softened and spread throughout the sheet, heat or pressure, or both, being applied if necessary to ensure uniform and complete distribution of the dissolved or partially dissolved binder. Application to the mass of heat alone will in some cases be sufficient to effect plasticization, but ordinarily it will be found preferable to apply the heat to the mass in conjunction with the addition of a binder solvent, as above suggested. In any event, by the step of plasticizing the organic binder is brought into more intimate contact with the pulp fibres and when the sheet is dried, if drying is necessary, the fibres will be embedded in or surrounded intimately by a predetermined high percentage of the binder and held securely within the sheet. The resulting sheet may have various characteristics depending upon the particular binder material that is used and the proportion in which it is used, the properties of the sheet being a combination of those of wood pulp and those possessed by the binder and a combination of the strength of both.

The following are examples of the procedure for making certain kinds of product to which the invention relates.

A sheet material combining the properties of toughness and resilience and having great wear resisting qualities may be produced by a union of wood pulp and rubber in desired proportions according to the process of the invention. A mixture of wood pulp and water having been thoroughly beaten, rubber dust or powdered rubber is added and the whole beaten until the rubber particles are uniformly distributed in the mass. It is an important feature of this particular application of the process that devulcanized rubber may be conveniently used and will lend itself to the making of an inexpensive and commercially practicable product, as also rubber substitutes of which a sulphurated oil is an example, all of which are herein included in the general term "rubber." The ingredients being thoroughly mixed as described, the mass is laid in sheet form on the ordinary wire screen used for separating wood pulp from its water. If necessary or desired the sheet may be squeezed, pressed or rolled while drying to assist in the removal of the water and to render the sheet of the desired compactness.

At this stage the rubber particles are disseminated throughout the sheet but there has been no appreciable adhesion of the binder and pulp fibres. To effect adhesion the mass may be treated with a rubber solvent or plasticizer such as benzole or commercial benzene, such treatment softening the binder and causing it to spread among the pulp fibres, and into intimate contact with them, the solvent selected being one capable of wetting the fibres by adsorption. While the binder is soft and sticky the sheet may be pressed or rolled to cause further spreading of the binder and to form it into a desired thickness and compactness, after which it is dried in any suitable manner. The solvent will evaporate during the drying and may be removed by any of the known solvent recovery processes.

The resulting sheet being composed of wood pulp fibres cemented together and more or less coated by plasticized rubber, when suitably vulcanized will have the body, strength and cheapness of the wood fibre, the resilience and toughness of rubber and the wear resisting qualities of both of these materials. The extent to which the completed sheet will have the respective properties will vary according to the relative proportions of ingredients used. In a material combining these particular ingredients the possible range in relative proportions is great. As little rubber as desired may be used or as much up to seventy-five per cent of the whole may be used with satisfactory results. Sheets made in the manner described may be put to numerous uses but are particularly well adapted for floor coverings, roofings, and the like.

Another application of the process contemplates combining wood pulp and celluloid in desired proportions. Celluloid in the form of fine shavings or powder is in this instance physically mixed with pulp and water in the same way as was described in the case of rubber. The process is carried on in the same way except that the solvent or plasticizer must be one capable of softening the celluloid. Acetone or benzene are suitable for this purpose. A composite sheet material combining wood pulp and celluloid will have the toughness of wood pulp and the resilience of celluloid, to a degree depending upon the relative proportions of these ingredients which are used, and it may be cut or skived or otherwise treated as desired. It may be softened by the application of more plasticizing liquid. This process may be used with dry cellulose esters of any kind, or mixtures of gum and these esters such as form the basis of lacquers recently introduced to the market.

Still another application of the process of the invention calls for the combining of wood pulp and gelatin or glue in a sheet material. Since it is necessary only that the material incorporated with the wood pulp be insoluble in water at a working temperature, gelatin or glue may be used in the process by keeping the temperature of the pulp and water sufficiently low. Gelatin or glue will swell, but will not dissolve in water below about 80° Fahrenheit. The process is carried on in like manner as in the previously mentioned cases except that the mixture of pulp and water is if necessary cooled preferably to 50° or less, before adding the gelatin or glue in powdered form. After the thorough beating excess water may be removed, the mixture being laid on wires followed by suction and squeezing, rolling, simple evaporation or any other desired method while the sheet is still

moist and the particles of gelatin contain adsorbed water; the sheet may be heated, when the gelatin dissolves in its adsorbed water producing a viscous solution or suspension that cements together the fibers in contact with it. Thus simple heat is the means for causing plasticization. The material when dried combines the toughness of wood pulp with the resilience and horn-like brittleness of gelatin in the proportion in which the respective constituents are used. It may be softened for molding by immersion or soaking in cold water. If it is not desired to produce a finished sheet at once the sheeted mixture of pulp and gelatin granules may be dried at a temperature below that required for dissolving the gelatin, and the dried sheet cut or skived into any desired shape, then at will softened by treatment with water, the gelatin melted by application of heat and the article pressed or molded to give it form and to insure thorough contact of fiber and binder.

It will be seen that the process of the invention may be used to produce a variety of sheet materials, each having properties more or less governed by the particular binder material that is used. All of the sheets include wood pulp in their make-up and consequently are cheaply constructed while still maintaining a high quality. Should some specific additional property be desired this may be secured by the addition of other suitable materials with the binder during the pulping process. Thus color may be produced by adding a water-insoluble, binder (or solvent)—soluble dye; porosity can be produced by adding a substance such as a water insoluble inorganic substance and dissolving the latter from the finished sheet with a suitable binder-insoluble solvent.

I claim as my invention:

1. A fabrication process comprising the steps of mixing, in a liquid medium, a fibrous material and a dispersible binder in a non-binding state; segregating the non-liquid constituents of the mixture, in the form of a loosely-matted mass in which the binder is uniformly dispersed but is otherwise unchanged; plasticizing the binder in said loosely-matted mass without subjecting said loosely-matted mass to other treatment; and thereafter solidifying the plasticized portion of the mass.

2. A fabrication process comprising the steps of mixing, in an aqueous medium, a fibrous material and a dispersible binder in a non-binding state; segregating the non-aqueous constituents of the mixture in a form of a loosely-matted sheet in which the binder is uniformly dispersed but is otherwise unchanged; plasticizing the binder in said loosely-matted sheet without subjecting said loosely-matted sheet to other treatment; and thereafter solidifying the plasticized portion of the sheet.

3. A fabrication process comprising the steps of mixing, in an aqueous liquid, a cellulosic pulp and dispersible binder in a non-binding state; segregating the non-aqueous constituents of the mixture in the form of a loosely-matted sheet in which the binder is uniformly dispersed but is otherwise unchanged; plasticizing the binder by subjecting said loosely-matted sheet, as such, to the action of a plasticizing liquid; and thereafter solidifying the plasticized portion of the sheet.

4. A fabrication process comprising the steps of mixing, in an aqueous liquid, a cellulosic pulp and dispersible rubber in a non-binding state; segregating the non-aqueous constituents of the mixture in the form of a loosely-matted sheet in which the rubber is uniformly dispersed but is otherwise unchanged; plasticizing the rubber by subjecting said loosely-matted sheet, as such, to the action of a plasticizing liquid; and thereafter solidifying the plasticized portion of the sheet.

5. A fabricated product comprising an intimate mixture of a loosely-matted pulp and a plasticized binder, the product as a whole being a substantially continuous mass wherein the pulp remains in its original loosely-matted relation.

6. A fabricated product comprising an intimate mixture of a loosely-matted lignocellulosic pulp and a plasticized binder, the product as a whole being a substantially continuous mass wherein the pulp remains in its original loosely-matted relation.

7. A fabricated product comprising an intimate mixture of a loosely-matted lignocellulosic pulp and plasticized rubber, the product as a whole being a substantially continuous mass wherein the pulp remains in its original loosely-matted relation.

8. A fabrication process comprising the steps of mixing, in an aqueous medium, a cellulosic pulp and dispersible binder in a non-binding state; segregating the non-aqueous constituents of the mixture in the form of a loosely-matted mass in which the binder is uniformly dispersed but is otherwise unchanged; plasticizing the binder by subjecting said loosely-matted mass, as such, to the action of a plasticizing agent; and thereafter solidifying the plasticized portion of the mass.

9. A process which comprises impregnating fibrous material with an aqueous rubber dispersion, impregnating the rubber-impregnated product with a rubber solvent to effect a swelling of the rubber, and removing the solvent.

10. A process which comprises impregnating fibrous material with an aqueous rubber dispersion, drying, impregnating the dry product with a rubber solvent to effect a swelling of the rubber, and removing the solvent.

11. A product comprising dried, rubber-dispersion-impregnated fibrous material, the rubber content of which has been treated with a rubber solvent.

12. A product comprising a dried, latex-impregnated web of interfelted cellulose fibre, the rubber content of which has been treated with a rubber solvent.

13. A process which comprises impregnating fibrous material with an aqueous rubber dispersion, coagulating the rubber in the fibrous material, impregnating the product with a rubber solvent to effect a swelling of the rubber, and removing the solvent.

14. Steps which comprise impregnating a web containing rubber coagulated from a rubber dispersion with a rubber solvent to effect a swelling of the rubber, and removing the solvent.

WILLIS A. BOUGHTON.