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L. R. BUSCHE ETAL

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PAPER PRODUCT

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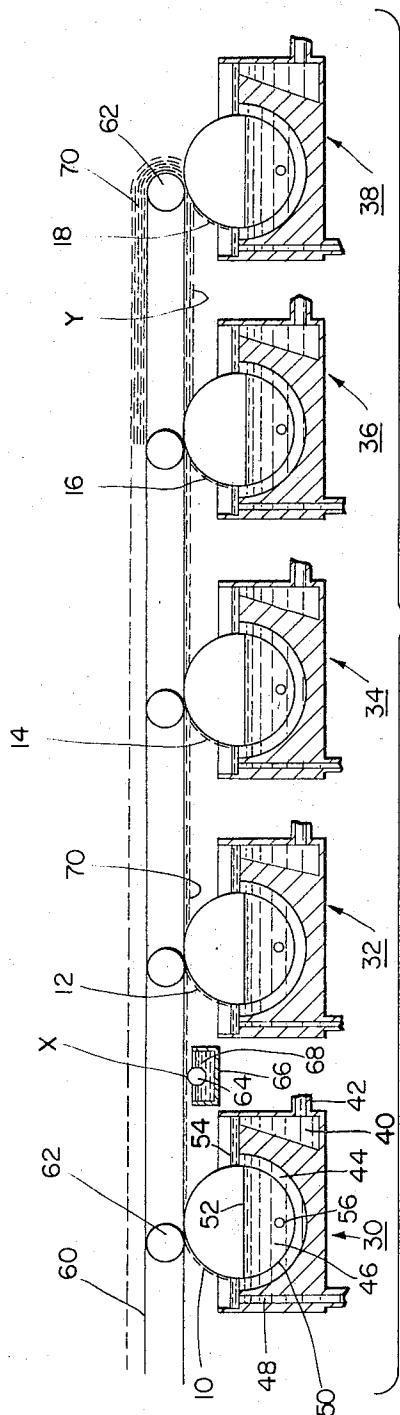


FIG. 3

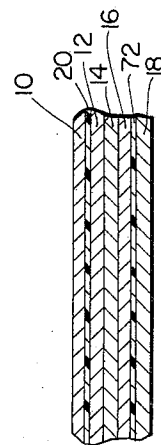


FIG. 2

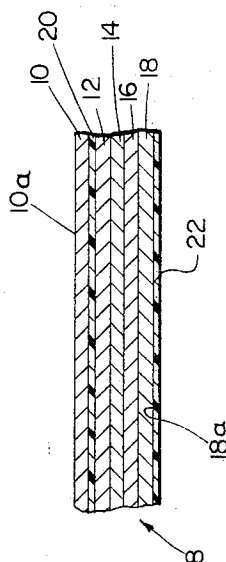


FIG. 1

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3,294,618 PAPER PRODUCT

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Continuation of application Ser. No. 219,329, Aug. 24, 1962. This application Apr. 22, 1965, Ser. No. 450,098
6 Claims. (Cl. 161—97)

This invention relates to an improved fibrous sheet of the type subject to the effects of a wetting agent or the like. More specifically, it relates to a sheet of paper or similar material incorporating an impervious resin film immediately adjacent to one or both of its surfaces. Thus, a surface close to the film can be subjected to the effects of agents having a deleterious effect on paper without materially degrading the characteristics of the sheet as a whole.

Certain characteristics of paper such as its relatively low cost, the ease with which it can be folded into various shapes, its adherent properties with low cost adhesives and its dielectric strength make it highly useful in such applications as packaging, electrical insulation and wallpaper. In wallpaper, for example, the paper provides a backing for a decorative surface finish and at the same time it is readily secured to a wall by means of common paste. However, when the paste is applied to the paper, it wets it and thereby sufficiently weakens it to materially reduce its resistance to tearing and stretching when it is handled. Furthermore, in some wallpaper, the decorative surface is covered by a thin plastic film to make the paper washable. Wetting of the paper when the paste is applied causes differential expansion of the paper and the film, and the resulting curling of the wallpaper makes it difficult to apply it to a wall.

Because of its dielectric properties, paper is often used as electric insulation. However, because of its hygroscopic nature, its dielectric strength decreases markedly under conditions of high humidity. This results in a requirement for thicker paper insulation than may be desirable, particularly in miniaturized apparatus.

Paper exhibits many of the desirable qualities of a wrapping or packaging material. However, its use in this field is limited to applications where it is not subject to moisture. Thus, it is not used as an exterior wrapping material for articles stored in unsheltered locations, since precipitation will cause it to lose almost all its tensile strength and abrasion resistance, and also because the moisture will penetrate through to the interior of the package, thereby in many cases damaging the contents thereof. The same problem is encountered in wrapping articles which are in themselves wet. The moisture affects the strength of the paper wrap and also, in some cases, penetration of the paper by the moisture causes desirably moist contents to dry out.

Various solutions to this problem have been proposed, without significant success. For example, some moist materials packaged in large bags are first enclosed in a plastic liner which serves as a vapor barrier. This requires the handling of an extra element, the liner, in addition to the bag, and, moreover, the liner must be fairly thick in order to resist puncture and tearing during handling, thereby materially increasing the packaging cost if these effects are to be eliminated.

It has also been proposed to laminate a thin plastic film to one surface of a paper sheet. However, material of this type is also prone to puncture and abrasion damage. Moreover, the surface covered by the film can no longer be secured to other surfaces with low cost

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adhesives such as flour paste, which requires rough or penetrable surfaces.

Accordingly, a principal object of the invention is to provide an improved fiber product of paper or the like having improved resistance to the action of wetting agents and similar materials and yet retaining the desirable properties of the fibrous materials.

Another object of the invention is to provide a fibrous sheet of the above type suitable for use as a packaging material in packages exposed to the effects of rain, snow, etc.

A further object is to provide a material of the above type having improved dielectric characteristics under conditions of high humidity.

Yet another object of the invention is to provide a product of the above type having the adherent qualities of the fibrous material incorporated therein.

A still further object of the invention is to provide products of the above type which are economically feasible for common commercial applications.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises articles of manufacture possessing the features, properties, and the relations of elements which will be exemplified in the articles hereinafter described, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary cross section of sheet material embodying my invention,

FIG. 2 is a fragmentary cross section of a second embodiment of the invention, and

FIG. 3 is a schematic view of apparatus which may be used in manufacturing the sheet materials of FIGS. 1 and 2.

In general, my invention makes use of a multiply fibrous sheet or web of pervious material with an impervious resin or plastic film disposed between a pair of the plies and located substantially closer to one surface of the sheet than to the other surface. The film is suitably bonded to the plies engaging it. Thus, when the surface close to the film is exposed to a liquid or other agent having a deleterious effect on the fibrous material, the permeating agent travels only a short distance through the sheet, the film preventing further penetration. Most of the sheet is therefore unaffected, and the sheet as a whole retains its strength and other desirable properties which would otherwise be affected. Where the sheet is subject to penetrating agents on both surfaces, a pair of resin films may be utilized, one immediately adjacent to each surface.

The impervious film is preferably a plastic, since many such materials do not interfere with the desirable properties of the final product. In order to obtain sufficient strength in the sheet it is generally necessary that the plastic film be well bonded to the plies on both sides of it. For this and other reasons, in the case of paper and other water-laid products we prefer to use the manufacturing process disclosed by J. Welch et al. in copending application Serial No. 436,401, filed Feb. 8, 1965, for Improved Laminated Fiber Product and Method of Making It. However, other well-known bonding techniques, e.g., off-machine lamination of paper and preformed resin film, may in many instances be used.

It should be noted that the invention is applicable to thermosetting as well as thermoplastic materials, and the terms "plastic" and "resin," as used herein, include both types. "Plastic" and "resin" are used interchangeably

herein because most plastics are resins. However, it will be understood that other materials having plastic properties, e.g., cellulose derivatives, are within the scope of the invention and are therefore included within these terms.

FIG. 1 illustrates in cross section a 5-ply cylinder sheet 8 embodying our invention. By way of example, the paper sheet may be in a weight basis of 130 pounds per ream (480 x 24 inch x 36 inch). The sheet comprises plies 10, 12, 14, 16 and 18, with an impermeable film 20 disposed between and bonded to the plies 10 and 12.

The sheet 8 may be used in a manner similar to ordinary wrapping paper to wrap articles which must be kept dry and yet are desirably stored out of doors or in other locations subject to the precipitation of moisture. In such case, the wrapping is accomplished with the surface 10a closest to the film 20 on the outside of the package. Thus, the film 20 prevents moisture from reaching the bulk of the paper in the sheet 8 while the outer paper ply 10 protects the film from abrasion and puncture damage. Moreover, the paper surface is more suitable for the imprintation of various markings than the smooth surface of a plastic outer wrap would be.

Where wet materials such as foods are being packaged, the surface 10a will ordinarily face inwardly so as to prevent the internal moisture from affecting the strength of the wrap.

The sheet 8, when cut into strips, also provides a superior electrical insulation in applications where moisture reaches the insulation from one surface only. An example of this is the use of the material as a spiral wrapped insulator around an electrical conductor or cable. In this case, the surface 10a will face outwardly from the conductor.

Another use to which the sheet 8 may be put is as a backing for sandpaper. The resulting product, which is disclosed in United States Patent Number 3,176,437, exhibits a marked resistance to the deleterious effects of the glue used to anchor an abrasive to the surface 10a.

The sheet 8 of FIG. 1 may also be used to provide an improved surface covering material such as wallpaper. In this case, the bottom surface 18a is covered with suitable decorative material, indicated at 22. The surface 10a is then used for the application of conventional paste used to secure the wallpaper in place. The film 20 prevents the water in paste from reaching the bulk of the paper in the sheet, and, with the bulk of the strength of the sheet thus retained, the wallpaper is less subject to tearing, puckering and sagging.

Moreover, the decorative material 22 may include a plastic film which, as pointed out, has resulted in curling of prior wallpapers when the paste is applied. The construction illustrated in FIG. 1 materially reduces the tendency to curl, again because the bulk of the paper remains dry.

The preferred process for manufacturing the sheet 8 is based on the discovery that finely divided, water-insoluble resin particles may be applied to a wet web of paper from the wire of the paper machine. In this way, a wet sheet is produced with a layer of discrete particles of resin between two wet plies. The wet sheet is wet pressed and dried according to well-known papermaking techniques. The dried sheet, still on the paper machine, is heated to a temperature previously determined to be adequate for softening and causing incipient flow in the particular resin used. It is then immediately calendered, whereupon the resin flows and forms a continuous film internally laminating the two sheets with a bond strength exceeding the internal strength of the adjacent plies.

FIG. 3 is a diagrammatic representation of a 5-mold cylinder machine which may be used in applying the preferred manufacturing technique to multi-ply paper embodying the invention. The machine includes a series of vats 30, 32, 34, 36 and 38. Since the vats may have an

identical construction, only the vat 30 will be described in detail.

Stock consisting of a dilute suspension 40 of paper-making fibers and water is introduced into the vat 30 at an inlet 42. It then flows through an arcuate passageway 44 around a cylinder 46 and out through an overflow 48. The cylinder, which is hollow and covered with fine wire mesh 50, turns with the flow of the stock.

The level 52 of water inside the cylinder 46 is kept below the level 54 of the stock on the outside by means of an outflow opening 56. Hence, a pressure gradient exists which forces the stock to flow from the outside of the cylinder to the inside. The fiber in the stock is trapped on the wire mesh, thus forming the ply 10, which moves out of the vat 30 and is transferred to the underside of a traveling wet felt 60 by means of a pressure roll (couch) 62.

The resin dispersion is applied at point X by means of a dandy roll 64, which revolves in a trough 66 containing a dispersion of resin particles 68 in a suitable liquid, e.g., water. The roll 64 is turned by contact with the wet ply 10 traveling on the underside of the belt 60. The roll 64 ordinarily takes the form of a hollow cylinder whose surface is comprised of cylinder or Fourdrinier wire (30-80 mesh).

After the application of the resin particles 68, the second ply 12 is added at the vat 32 to form a composite web 79. The web 70, in which the paper plies 10 and 12, essentially integral with each other, sandwich a layer of the particles, then continues to the vats 34, 36 and 38 where the plies 14, 16 and 18 are added. From the vat 38, the web continues around the roll 62 associated therewith and on to the subsequent paper-making operations. The latter include the conventional steps of wet pressing, drying and calendering.

Prior to calendering, the web is heated to a point at which the resin particles are tacky, and the subsequent calendering operation causes the particles to flow together and thus consolidate into a continuous film strongly bonded to the plies 10 and 12. The strength of a bond formed in this manner is due in large part to the fact that the fibers of the plies 10 and 12 penetrate into the plastic film 20 (FIG. 1) and are gripped by the film which is, in essence, formed around them.

If desired, the resin suspension may also be applied at point X by means of a spraying device or other suitable method. The amount of resin that is applied can be controlled by varying the concentration of the suspension in the trough 66; by changing the characteristics of the dandy roll 64, if this is used; by changing the spraying pressure, if this method of application is preferred; or by other means which are obvious to those skilled in the art.

It will be apparent that the resin particles need not be applied at the wet end of the paper machine, although this is preferred for reasons of economy and also because a somewhat better quality product is obtained. Thus, they may be applied to already formed and dried paper webs, which are then heated and pressed to convert the discrete particles into a continuous film. Also, as mentioned above, a preformed resin film may be used.

The resin used to form the film 20 in the preferred method should be of a type which, after it starts to soften, remains very viscous over a rather extensive temperature range. That is, the fused resin should retain substantial body and viscosity after heating, since, if it becomes too fluid, it will strike into the paper and a continuous film may not be produced. Preferably, the temperature at which it becomes fluid is substantially above the boiling point of water, so that drying of the paper can be readily accomplished without liquefying the resin.

The particle size is also of importance. The particles should not be too fine. Otherwise they will penetrate the wet web and not form a uniform coating of discrete resin particles. If they are too coarse, they may not flow out under heat and pressure to develop the film.

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Among the resins which may be used for the film 20 are polyethylene, polypropylene, nylon, fluor-halocarbons, polycarbonate and epoxy. Mixtures of these resins can also be employed. However, while a large number of resins are usable, we prefer to use, partly because of their low cost, polyolefins such as polyethylene or polypropylene extended with fillers and cross-linked with organic peroxide, e.g., dicumyl peroxide. Mixtures of epoxy resins with polyethylene or mixtures of nylon and polypropylene are also among the preferred materials. The preferred materials have the added advantages of producing flexible, tough sheets which do not require heating to as high a temperature as some other resins to fuse the resin and cause the individual particles thereof to coalesce into a continuous film.

The film should not be so thin as to be susceptible to rupture or so thick as to cause undue stiffness in the sheet 8. A thickness range of from 0.5 to 5 mils is generally acceptable, although we prefer a range of 0.5 to 2 mils for sandpaper.

A specific example of the manufacture of a paper sheet embodying the invention will now be described in detail, it being understood that this example is given by way of illustration and not limitation of the invention:

A five-mold cylinder machine similar to that illustrated in FIG. 3 is used. The fiber furnish for the paper consists of unbleached kraft beaten to 30 Slowness (3 grams Schopper-Riegler) and used to produce a 5-ply sheet with a combined basis weight of 130 pounds (480 sheets, 24 inch x 36 inch). A 20 percent aqueous slurry of polyethylene marketed by U.S. Industrial Chemicals Co. under the trade designation "Microthene 608" (density 0.916, melt index 22, 200 mesh) is applied at point X in FIG. 3 with an air operated spray gun. The spray is directed upward to obtain uniform coverage.

After passing through the dryer section in the usual way, the paper is conducted to a small calender stack where it passes through a single nip with a loading of 50 pounds per lineal inch. Immediately before entering the calender stack, the sheet is passed under a gas fired infrared heater which raises the temperature of the web to approximately 150° C. The finished product is finally wound on the reel at the end of the paper machine in the usual way.

The sheet exhibits abrasion characteristics, on the surface 10a nearest the film 20, similar to those of paper which does not contain a film. Furthermore, water applied to the surface 10a does not pass through the film 20. The folding and creasing properties of the paper are found to be similar to those of conventional heavy wrapping paper.

In some cases, a fibrous sheet may be subject to harmful penetrating agents on both surfaces. In such instances, the principles embodied in the sheet 8 of FIG. 1 may be carried forward as illustrated in FIG. 2. As shown therein, a second impervious film 72, similar to the film 20, is disposed between the plies 16 and 18. Thus, the bulk of the sheet 8 is between the films 20 and 72, so as to minimize the effects of such agents on the sheet 8.

The sheet of FIG. 2 may be manufactured by applying resin particles to the web 70 at point Y, immediately before the addition of the ply 18, in the same manner as the particles are applied at the point X. The subsequent papermaking operations, i.e., drying and calendering, are carried on as before. In this connection it is noted that the drying step is carried out before the resin particles are coalesced into a film, and therefore, the moisture within the interior plies can readily escape to the exterior of the web.

The construction of FIG. 2 is particularly useful as electrical insulation subject to moisture on both surfaces thereof. Another important application is in the wrapping of foods containing moisture which must not be allowed to escape, in cases where contaminating moisture also must be prevented from entering the package.

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It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above article without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

This application is a continuation of our co-pending application, Serial No. 219,329, filed August 24, 1962, now abandoned.

Having described the invention, what we claim as new and secure by Letters Patent is:

1. A pliable multilayer fibrous sheet having first and second outer surfaces and characterized by substantial resistance to degradation by wetting agents acting on at least said first surface, said sheet comprising

(A) at least first and second pliable water-laid layers of fibrous material,

(1) said layers being subject to degradation by wetting agents,

(2) said first layer forming said first surface,

(3) said second layer being adjacent said first layer, and

(4) the thickness of said first layer being substantially less than the combined thickness of the other layers in said sheet, and

(B) a pliable water-impervious resin film disposed between and bonded to said first and second layers and preventing the passage of wetting agents from said first layer to the bulk of said fibrous material in said sheet on the opposite side of said film from said first layer.

2. The article defined in claim 1 in which said layers consist essentially of water-laid papermaking material.

3. The article defined in claim 1 wherein

(A) a third water-laid layer of fibrous material forms said second surface,

(B) the thickness of the fibrous material between said first and third layers is substantially greater than the combined thickness of said first and third layers, and

(C) a second pliable water-impervious resin film is between and bonded to said third layer and the fibrous layer adjacent thereto.

4. A pliable sheet of wallpaper according to claim 1 and further comprising a decorative layer forming said second outer surface.

5. A pliable multilayer paper sheet having first and second outer surfaces and characterized by substantial resistance to degradation by wetting agents acting on at least said first surface, said sheet consisting of

(A) first, second and third pliable layers of water-laid fibrous papermaking material,

(1) said layers being devoid of water-impervious plies and being subject to degradation by wetting agents,

(2) said first and third layers forming said first and second outer surfaces respectively,

(3) each of said first and third layers comprising a single ply only of said material,

(4) said second and third layers having a combined strength greater than said first layer, and

(B) a pliable water-impervious resin film disposed between said first and second layers with the resin material of said film bonding the film to said first and second layers, and said film substantially preventing water in said first layer from passing to said second and third layers.

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6. A pliable multilayer paper sheet having first and second outer surfaces and characterized by substantial resistance to degradation by wetting agents acting on either of said outer surfaces, said sheet consisting of

(A) first, second and third pliable layers of water-laid fibrous papermaking material, 5

(1) said layers being devoid of water-impervious plies and being subject to degradation by wetting agents,

(2) said first and third layers forming said first and second outer surfaces respectively, 10

(3) each of said first and third layers comprising a single ply only of said material,

(4) said second layer having a strength greater than the combined strength of said first and third layers, 15

(B) a first pliable water-impervious resin film disposed between said first and second layers with the resin material of said film bonding the film to said first and second layers, said first film substantially pre- 20

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venting water in said first layer from passing to said second layer, and

(C) a second pliable water-impervious resin film disposed between said second and third layers with the resin material of said second film bonding it to said second and third layers, said second film substantially preventing water in said third layer from passing to said second layer.

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