April 6, 1965 C. E. LANYON 3,176,437

FIBER PRODUCT

Filed July 12, 1962

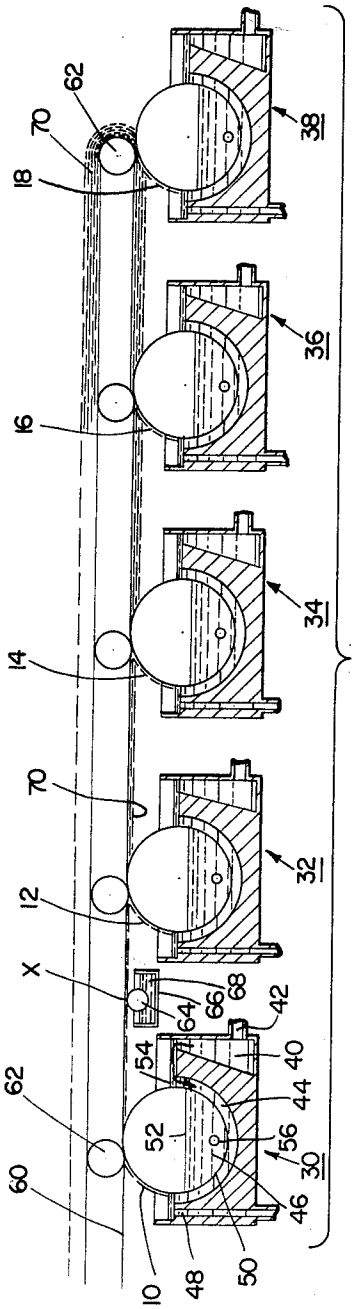


FIG. 3

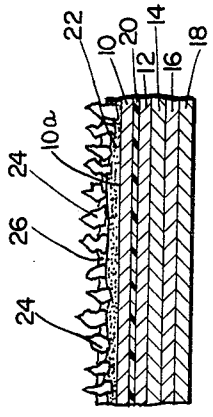


FIG. 2

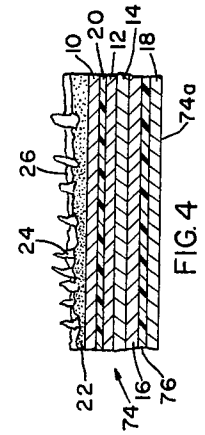


FIG. 4

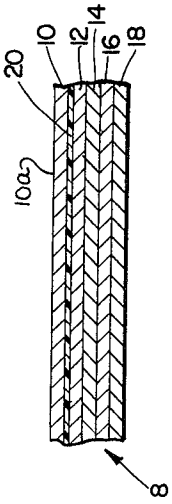


FIG. 1

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United States Patent Office 3,176,437 Patented Apr. 6, 1965

3,176,437

FIBER PRODUCT

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Filed July 12, 1962, Ser. No. 209,383
14 Claims. (Cl. 51—408)

This invention relates to an improved coated abrasive. More particularly, it relates to a coated abrasive incorporating a backing which resists the distortion often resulting from application of the various coatings. The finished product also displays an improved resistance to the curling which, in prior products of this type, ensues from differential expansion of the coating and the backing under varying humidity conditions.

A coated abrasive sheet, or "sandpaper" as it is commonly known, is made by applying to one side of a paper backing a heavy coating or adhesive, known as the "making" coat, usually, but not always, a hot concentrated solution of hide glue in water. While the adhesive coat is still hot and fluid, the abrasive grain is applied and the coated sheet festooned in racks and partially dried. A second adhesive coat, known as the "sizing" coat, is then put on to anchor the abrasive grain. The sizing coat may be the same as the previous coat, i.e., a hot solution of hide glue in water, although more dilute. It may also be of a different nature such as a synthetic resin. The composite is then festooned, dried and taken down in rolls for further processing or converting.

While the material is hanging festooned in the racks, the water in the adhesive coat or coats penetrates through the backing, softening it so that, because of the weight of the coated material hanging in the loops, it tends to distort. Stresses in the backing are relieved by the dampening action of the water, which may cause the backing to pucker, cockle, or welt. These defects usually carry through to the finished roll, resulting in increased waste and scrap.

The trend in the coated abrasive industry is to coat wider and wider sheets, but the difficulties enumerated increase out of proportion to the increase in width. Therefore, an improved product which would overcome these difficulties would find a ready sale.

It has been suggested in the prior art to apply a water-impermeable coating on the side of the paper designed to receive a subsequent coating, in order to prevent strike-through of adhesive or to reduce curl. However, this expedient forms a surface to which the making coat adheres with difficulty, causing shedding of the abrasive-adhesive coating from the backing during use.

Accordingly, a principal object of my invention is to provide an improved coated abrasive and an improved backing sheet therefor.

A more specific object of the invention is to provide a coated abrasive which is less subject than prior coated abrasives to distortion caused by wetting of the backing by the glue coats.

Another object is to provide a coated abrasive of the above type which is economical to manufacture.

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

The invention accordingly comprises an article of manufacture possessing the features, properties, and the relation of elements which will be exemplified in the article 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 drawing in which:

FIG. 1 is a fragmentary cross section of sheet material

used as a backing for a coated abrasive embodying my invention,

FIG. 2 is a fragmentary cross section of a coated abrasive incorporating the sheet material of FIG. 1 as a backing,

FIG. 3 is a schematic view of apparatus which may be used in manufacturing the sheet material of FIG. 1, and

FIG. 4 is a fragmentary cross section of another coated abrasive embodying the invention.

In general, a coated abrasive embodying my invention includes as a backing a multiply fibrous sheet or web of pervious material with an impervious resin or plastic film disposed between a pair of the plies and preferably located substantially closer to the coated 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 the glue coats, the glue 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 by the wet coats.

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. 233,508, filed October 25, 1962, 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**, used in my 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), which is a popular weight in the coated abrasives field. 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**. In further manufacturing processes, the upper surface **10***a* of the ply **10** is coated with a water solution of adhesive, the moisture being prevented by the film **20** from reaching the 80 percent of the sheet comprising the four plies **12–18**.

For example, as shown in FIG. 2, the abrasive layer may be added to the sheet **8** by first applying a "making" coat **22** to the surface **10***a*. The water in the coat **22** saturates the ply **10** and thereby weakens it. However, the film **20** prevents it from reaching the bulk of the paper in the sheet, and with the strength of the sheet preserved, distortion thereof during the later drying operation is largely eliminated. Moreover, the surface to which the abrasive coating is to be applied is paper. Hence, problems of adhesion of the abrasive coating to my improved sheet are no different than they are with conventional paper.

Following the making coat **22**, abrasive grain illustrated at **24** is added, and the grain **24** is covered by a sizing

coat 26. Finally, the sheet is hung to dry as described above.

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, which can then be used to couch a second wet web or ply 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 technique. 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 two 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 multiply paper embodying the invention. The machine includes a series of vats 30, 32, 34, 36 and 48. 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 papermaking 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 70. The web 70, in which the paper plies 10 and 12 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 papermaking operations. The latter are conventional operations, including 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 the 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 into a continuous film. Also, as mentioned above, a pre-formed 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.

Among the resins which may be used for the film 20 are polyethylene, polypropylene, nylon, fluorhalocarbons, polycarbonate and epoxy. Mixtures of these resins can also be employed. However, while a larger 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.

While it is preferable, for the reasons given above, that the resin film be close to the coated surface of the backing, it is not necessary that this be so. For example, if the film is centrally located within the sheet, over 50 percent of the dry strength of the backing is retained when the coating is applied.

In some cases it will be advantageous to incorporate a second resin film near the uncoated surface of the backing. This provides a means of controlling the rate of moisture vapor penetration into the sheet and regulating its curling propensities. FIG. 4 shows a coated abrasive utilizing such a sheet 74 incorporating a second resin film 76 near the surface 74*a* remote from the abrasive grains 24. Specifically, the coated abrasive, which is similar to the coated abrasive of FIG. 2, comprises plies 10, 12, 14, 16 and 18, with the film 20 between the plies 10 and 12 and the film 76 disposed between and bonded to the plies 16 and 18. The making coat 22 and the sizing coat 26 anchor the abrasive grains 24 to the outer surface of the ply 10.

A specific example of a coated abrasive embodying my 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.

The fiber furnish for the backing may consist of rope, jute, wood pulp, cotton or mixtures of these. The required amounts of the fibrous constituents are introduced into a beater and beaten to the requisite degree. In the beater the fiber may also be dyed and additives such as rosin size, elastomers, etc., may be added. After beating, the material is dropped to storage chests and passed

through Jordans to a paper machine which may be a 5-mold cylinder machine as illustrated in FIG. 3.

The paper machine is adjusted to provide a backing sheet weighing 130 pounds per ream (480 sheets, 24 inch x 36 inch). In the vat **30**, the consistency of the stock is set so that, at the speed selected, a ply **10** weighing about 26 pounds is formed. This constitutes about 20 percent of the total weight of the fiber furnish. At the point X, a water suspension of finely divided resin particles **68** is applied in the manner described above. The particles are of polyethylene resin manufactured by United States Industrial Chemical Co. and marketed under the trade designation "Microthene 700." They are ground to pass through a screen having 150 openings per lineal inch, and the concentration of the finely divided polyethylene in the water is about 9 percent. At the speed selected, this concentration results in the application of about 1.8 grams of resin per square foot of paper.

After drying, the web **70** is heated to a temperature of 275° F. and then calendered under a pressure of 100 lbs. per lineal inch. Under the calendering pressure, the resin particles fuse and form a film about 0.8 mil thick.

The paper is then slit to width and coated with abrasive. To accomplish this, a heavy coat of hot concentrated hide glue is first applied to the coat side of the backing (I define the coat side as that surface (**10***a*) of the sheet **8** closest to the impermeable film **20**). While the glue is still hot and fluid, abrasive grain is applied by conventional methods. The composite is then festooned in racks and partially dried. A more dilute solution of hot hide glue is then applied to the abrasive coat to anchor and hold the grain in place, after which the composite is again festooned in racks and dried. Finally, it is taken down in rolls for further processing.

Coated abrasives made according to the present invention are handled with much less trouble through the coating operation, during drying and through subsequent operations. The bulk of the backing remains dry and retains body and stiffness. Distortion, wrinkling and puckering are noticeably less with the improved backing than with conventional paper.

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 drawings 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.

I claim:

1. A coated abrasive comprising abrasive grains anchored by an adhesive to a fibrous backing comprised of multiple fibrous layers and a resin film between and bonded to first and second ones of said layers said adhesive being contiguous with a fibrous layer of said backing and anchoring said grains directly thereto.

2. The article defined in claim 1 in which said film is substantially closer to a first surface of said backing to which said grains are anchored than to a second surface opposite said first surface.

3. The article defined in claim 1 in which the fibers in said first and second layers penetrate into said film.

4. The article defined in claim 3 in which said first and second layers are integral.

5. The article defined in claim 1 including at least five fibrous layers, said first layer being adjacent to said grains.

6. The article defined in claim 1 including at least three of said layers, said layers having substantially equal thicknesses, there being a fewer said layers on the side of said film facing said grains than on the other side of said film.

7. A coated abrasive comprising abrasive grains anchored by an adhesive directly to a fibrous layer of a backing comprised of multiple fibrous layers, said backing including a first resin film close to a surface of said backing to which said grains are anchored and a second resin film close to the opposite surface of said backing, each of said films being disposed between and bonded to an adjacent pair of said layers.

8. The article defined in claim 7 in which said backing is comprised of paper.

9. The article defined in claim 8 in which the fibers in the layers adjacent to said film penetrate into said film.

10. In a coated abrasive of the type comprising abrasive grains anchored to a paper backing by a glue having a paper-weakening base of water or the like, the improvement in which said backing comprises a plurality of paper layers and a resin film disposed between and bonded to first and second ones of said layers, said glue being contiguous with said first fibrous layer of said paper backing and anchoring said abrasive grains directly thereto.

11. The article defined in claim 10 in which said film is substantially closer to a first surface of said backing to which said grains are anchored than to a second surface opposite said first surface.

12. The article defined in claim 11 including a second resin film disposed between and bonded to a pair of said layers, said second film being substantially closer to said second surface than to said first surface.

13. The article defined in claim 10 in which a substantial portion of the fibers in said first and second layers penetrate into said film.

14. The article defined in claim 13 in which said first and second layers are integral with each other.

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