Feb. 6, 1962 J. E. CAMP ETAL 3,020,139

ABRASIVE PRODUCT

Filed April 18, 1960 2 Sheets-Sheet 1

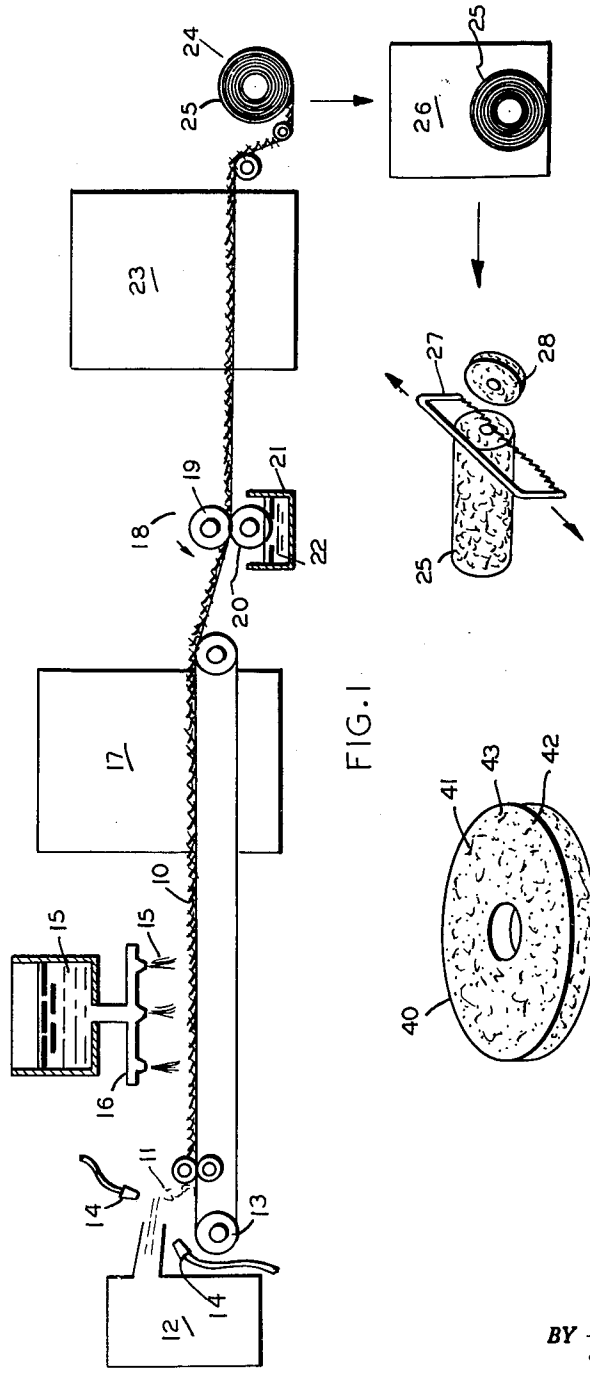

FIG. 1

FIG. 3

JOHN E. CAMP
JOSEF C. MUELLER, JR.
FREDERICK G. SANDHOLDT
GEORGE L. HAYWOOD
INVENTORS

BY Hugh R. Smith

ATTORNEY

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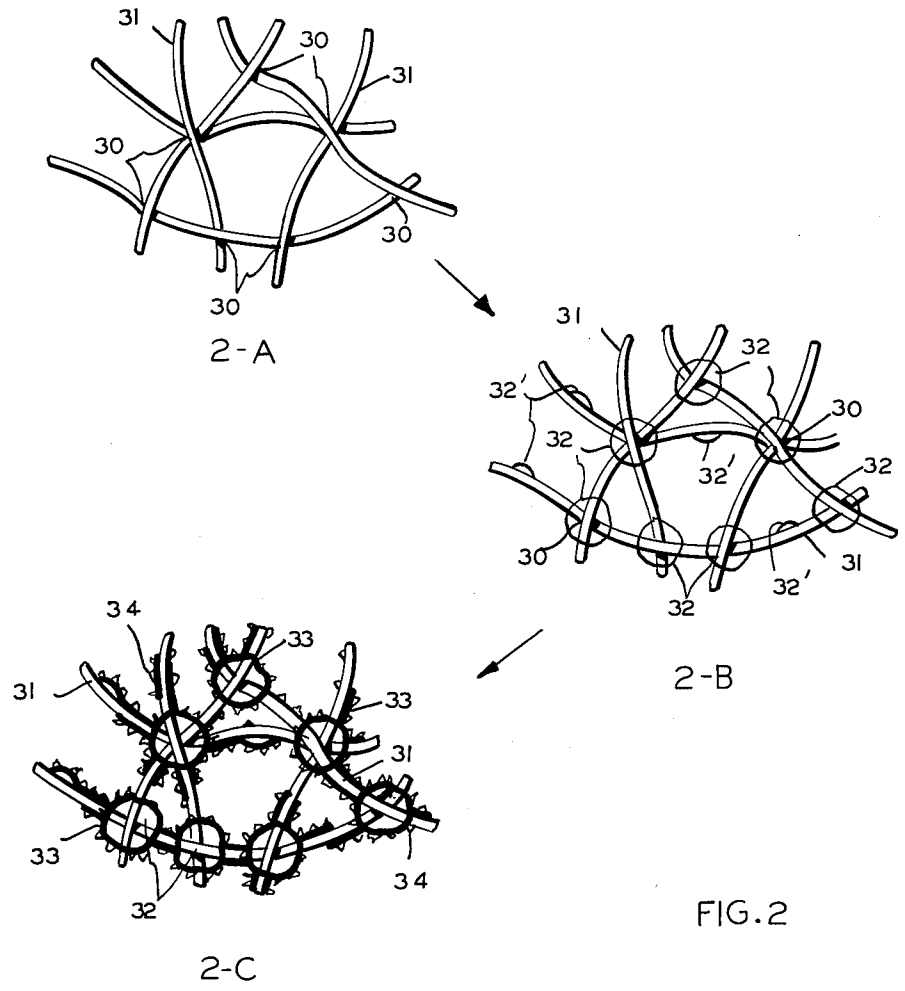

FIG. 2

JOHN E. CAMP
JOSEF C. MUELLER, JR.
FREDERICK G. SANDHOLDT
GEORGE L. HAYWOOD
INVENTORS

BY Hugh T. Smith

ATTORNEY

United States Patent Office 3,020,139 Patented Feb. 6, 1962

3,020,139

ABRASIVE PRODUCT

John E. Camp, Latham, Josef C. Mueller, Jr., Cohoes, Frederick G. Sandholdt, North Troy, and George L. Haywood, Latham, N.Y., assignors to Norton Company, Troy, N.Y., a corporation of Massachusetts

Filed Apr. 18, 1960, Ser. No. 22,947
19 Claims. (Cl. 51—295)

The present invention relates in general to polishing or abrading products and in particular to such products utilizing a non-woven textile material as a backing and to methods of making the same.

It has heretofore been proposed to utilize non-woven, felted materials as a media for carrying abrasive grain, the resulting product finding application as a component of a grinding wheel or as a polishing or scrubbing device. Examples of such products are disclosed in U.S. Patent No. 2,335,902 issued to Albert L. Ball, Raymond C. Benner and Romie L. Melton. It has been found, however, that for severe abrading or polishing operations such products find little application although the economics of using a relatively thick (compared to a conventional piece of coated abrasive) backing impregnated with abrasive grain should make such products very desirable for many uses.

Improved products of this general type have been disclosed and claimed in the copending applications of George L. Haywood, Serial No. 782,689, and Serial No. 807,892, filed December 24, 1958. and April 21, 1959, respectively.

Still further improvement has been found possible through the use of a radically different making technique which permits positive retention of the loft of the non-woven backing, accurate control of the amounts of grain and adhesive applied to the backing, improved adhesion between adjacent layers of the backing when convolute bodies thereof are formed, and most importantly, a more uniform dispersal of abrasive grain throughout the non-woven material.

Accordingly, it is an object of the present invention to provide a new method for forming non-woven, abrading or polishing materials.

Another object is to provide an abrasive article of the type referred to above which has more uniform distribution of abrasive throughout.

Additional objects, if not specifically set forth herein, will be readily apparent to one skilled in the art from the following detailed description of the invention.

In the drawings:

FIGURE 1 is a schematic illustration of the method of forming the non-woven, abrasive-containing material of the present invention.

FIGURE 2 is an exploded, idealized view of the abrasive-containing material formed as shown in FIGURE 1, illustrating the disposition of the fibers, the bonding adhesive and the maker adhesive and grain coatings thereon.

FIGURE 3 is a perspective view of one type of abrasive article formed in accordance with the present invention.

Generally, the present invention resides in first treating a non-woven web with a bonding adhesive applied preferably in the form of a spray, resulting in a web capable of being handled without disintegration. Since, as mentioned below, the fibers forming the web are preferably nylon or other synthetic fibers, anti-wetting lubricants are generally present thereon. This resulting anti-wetting property is generally possessed by all such synthetic fibers and, as a result, the adhesive applied by the spray inherently tends to collect at the fiber intersections in the form of globules.

Accordingly, the web first formed consists of many interlaced, randomly dispersed, flexible, tough organic fibers bonded together essentially only at points where they

intersect and contact one another by globules of adhesive.

It has heretofore been proposed to form such a web for use as a polishing device by using an abrasive grain-adhesive mixture to form globules at the points of intersection of the fibers. However, to adequately bond abrasive particles to the synthetic fibers and to hold them firmly in place during subsequent abrading operations, the adhesive must be heat-resistant, tough and quite rigid in nature. When used to bond the fibers together, such an adhesive makes the product undesirably harsh and stiff. Likewise, the location of the abrasive particles substantially only at the points of intersection of the fibers is undesirable since the abrading action is much less than is the case of a more uniform distribution of the abrasive along each fiber length. Therefore, in the present case, it is desirable that the "bonding adhesive," as it is hereinafter called, be abrasive-free and that it be elastomeric in nature. The thus-formed web is then subjected to a roll coating operation utilizing an adhesive-abrasive slurry as the coating material. The solvent or dispersant for this second adhesive, which is hereinafter referred to as the "maker" adhesive and which is substantially harder and tougher than the bonding adhesive, is such that it has no or at most only a slight softening effect upon the first-applied bonding adhesive. As a result of these two factors, (1) the use of roll coating and (2) the use of a different solvent or dispersant system for the harder, tougher maker adhesive, an outstanding improvement in the non-woven abrasive product is achieved. The initial loft or three-dimensional characteristic of the web is retained since the bonding adhesive which holds the web in such three-dimensional form is not materially affected by the solvent used in applying the maker adhesive-abrasive coating. Secondly, through the action of roll coating, the maker adhesive tends to deposit along the fibers in the form of elongated strings rather than merely at the points of fiber intersection as is the case with the usual spray application. Some of the maker adhesive surrounds and reinforces the softer, more elastic bonding adhesive at the fiber intersections as well, thus giving a very widespread distribution of abrasive grain throughout the web.

More particularly, and referring now to FIGURE 1 of the drawings, reference numeral **10** designates a web or batt of non-woven material formed from flexible, tough, synthetic organic filaments **11** such as coarse nylon fibres having a diameter of up to about 300 microns. Other synthetic fibres or filaments or mixtures thereof such as "Dacron" (a condensate of dimethyl terephthalate and ethylene glycol). "Orlon" (polyacrylonitrile) or "Dynel" (a copolymer of 40% acrylonitrile and 60% vinyl chloride) may be used as desired and the diameter of the fibres used may also be varied within wide limits, e.g. 25 to 300 microns. As will be seen from the schematic drawing of FIGURE 1, the fibres **11** are formed into desired lengths, e.g. 2 inches or so, by a suitable cutter device generally shown at **12** and deposited upon a moving endless support **13**. As the fibres **11** fall to the surface of the support **13**, they may be agitated by an air blast from nozzles **14**. The fibres **11** tend to fall at various angles to one another and to criss-cross and interlace one with the other in a superposed, random fashion. However, it will be noted that the tendency still is for the length direction of the fibres to lie predominately in the horizontal plane. A web **10** of the desired thickness is built-up—either by regulating the speed of the support **13** and the rate of discharge thereon of the fibres **11** or by the use of additional fibre supplying stations (not shown). The fibres comprising the web **10** are then bonded to one another by a bonding adhesive which may be any of the adhesives discussed in detail below. The bonding adhesive **15** is applied by

spray nozzles 16 which may be stationary or preferably so mounted as to reciprocate back and forth across the web 10. The bonded web 10 then passes through a heating zone 17 to set or cure the adhesive 15. At this point the bonded web has a loft, or three-dimensional characteristic, maintained through the location of the globules of bonding adhesive at primarily the points of intersection of the fibres. It may be and is, in many instances, desirable at this point to reverse the web and again pass it through to spray coat the opposite side of the web with the bonding adhesive.

Experimentation has determined that if the bonding adhesive is substantially softened by subsequent application of additional adhesive, the loft is materially reduced. Accordingly, the next step in the illustrated process, which is the application of abrasive grain to the web is accomplished through the use of a maker adhesive having little or no softening action on the bonding adhesive. Examples of the types of adhesive systems for use in the present method—both maker and bonding adhesives—are given below. Further, it has been determined that much improved adhesive distribution is achieved if the maker adhesive is applied by a roll coater rather than through the use of the conventional spray application. As illustrated, the bonded web 10 is passed through roll coater 18 which consists of a pair of calender rolls 19 and 20, the lower roll 20 rotating in a bath 21 of adhesive-abrasive slurry 22. The maker coat of adhesive and grain thus applied, thoroughly penetrates the web 10 and tends to spread out along the fibers 11 thereof. This is more clearly illustrated in FIGURE 2 of the drawings, hereinafter referred to. The web 10 is then passed through a heating zone 23 to set the maker adhesive. Depending upon the final form in which the web is to be used, the maker adhesive is completely or only partially dried in zone 23. If the material is to be used in flat form, e.g. as discs die-cut from the web, the maker coat is completely dried in zone 23. If, as we prefer, the material is to be formed into convolute discs, the maker adhesive is partially dried so as to remain tacky. As illustrated, the tacky material is then wound into a tight convolute roll 25 as shown at 24 and subjected to further heating in zone 26 to finally cure and dry the maker adhesive. When so treated, the adjacent convolutions are tightly bonded one to the other to essentially form a homogeneous mass. The roll 25 is then cut transversely as shown at 27 to form abrasive articles 28 of the type shown and described below in connection with FIGURE 3 of the drawings.

Referring now to FIGURE 2 of the drawings, an exploded idealized view of the materal 10 described in connection with FIGURE 1 is shown. FIGURE 2A shows the general relationship to one another of a group of fibres as laid down to form the web; FIGURE 2B shows the same group of fibres after the spray-applied bonding adhesive has dried thereon; and FIGURE 2C shows the same group of fibres after the roll-coat application of the maker adhesive-abrasive slurry. At the points of intersection 30 of the fibres 31, it will be seen from FIGURE 2B that globules 32 of the bonding adhesive have effectively encased such intersections with a flexible bond. It will be noted that the bonding adhesive 32 tends to settle at the fiber intersections 30 or junctions of the fibers since this adhesive was applied, as described above, by a spray application (usually as a water dispersion). While the bonding adhesive tends to settle substantially at the fiber intersections, occasional globules will adhere along the fibers as indicated at 32'. The maker adhesive 33, on the other hand, is applied by roll coating from a solvent slurry of adhesive and abrasive grain. This adhesive 33 has better wetting properties and the roll coat application tends to coat the maker-adhesive along the fibers as well as at the junctions thereof. Accordingly, as shown in FIGURE 2C the fibers 31 tend to be fairly well coated throughout their length with the maker adhesive 33 and abrasive grain 34. As illustrated, the maker adhesive-abrasive grain mixture 33—34 tends to form a coating over the globules 32 of the bonding adhesive as well as coating the major portion of each fiber 31.

FIGURE 3 illustrates one form into which the abrasive material of the present invention may be shaped for ultimate use. The article 40 is formed from the roll 25 described in connection with FIGURE 1 by slicing a section normal to the major axis of the roll. As illustrated, the convolutions of material are not visible which is quite common since proper control of tension can vary the roll density to the point where a section such as 40 appears quite homogeneous in nature. The fibers 41 with the abrasive grains 42 held thereto by the maker adhesive 43 provide an excellent abrading or polishing surface. This particular structure is particularly adapted for use as a floor scrubbing pad. Other forms such as rolls or drums for industrial polishing, segments for pot and pan scrubbers, etc, may be formed as desired.

The character of the present product depends upon the two-step adhesive application described above with the second adhesive application being that which bonds the abrasive to the fibers. The second adhesive or "maker" adhesive must, of necessity, be hard, tough and heat-resistant in order to hold the abrasive grain in place on the fibers during the subsequent use of the product in abrading or polishing. The maker adhesive therefore tends to stiffen the fibers. Accordingly, to counteract this tendency, it is essential that the bonding adhesive, which is applied to the fibers before the maker adhesive, be flexible enough to permit flexing and temporary deformation of the product while in use. For example, if the bonding adhesive used is a heat-convertible resin such as a stiff melamine or urea-formaldehyde resin, epoxy-phenolic blend, or the like, a non-resilient, friable product results. Therefore, the bonding adhesive must be relatively flexible and preferably elastomeric in nature. It must also be relatively insoluble in the solvent employed in dissolving the maker adhesive and preferably resistant to alkalis. Accordingly, elastomers must be selected for their relative insolubility in such solvents as methyl isobutylketone, solox, cellosolve acetate and xylene. Preferably, the bonding adhesive is based on a nitrile rubber latex modified to impart solvent resistance. The latices may be modified by the use of curing agents such as zinc oxide, sodium aluminate or by the addition of resins such as phenolics, melamine or urea-formaldehyde. For example, the elastomeric bonding adhesive used in Example 1, below, was a medium butadiene acrylonitrile latex (Hycar 1572 prepared by the B. F. Goodrich Company) having a pH of 8.5 and a particle size of 1000 angstroms. This was blended with a water soluble melamine formaldehyde resin (Resloom HP prepared by Monsanto Chemical Company). Other Hycar latices which may be used include Hycar 1512, 1562 and 1551. Other elastomeric materials such as natural rubber, neoprene or the like may also be used if desired.

The maker adhesives used may vary widely but generally are heat-advancing resinous adhesives based on polyurethanes, phenolics, epoxy resins or the like which adhere well to the synthetic fiber used and which utilize a solvent system to which the bonding adhesive is resistant. Preferably, for use in floor pads or the like, the maker adhesive is also alkali-resistant and is substantially harder and tougher than the bonding adhesive.

Any of the known abrasive grains may be used in making the product of the present invention, e.g. silicon carbide, aluminum oxide, flint, emery, garnet and the like. Generally, the most satisfactory abrasives are silicon carbide, garnet and aluminum oxide. The grain size may likewise be varied within wide limits, with grades 180, 240 and 400 being the most commonly employed sizes for commercial use.

The fibers employed in the present invention are preferably synthetic fibers formed from flexible, tough, alkali-

resistant, organic materials such as the polyamides, acrylates, polyesters, polypropylenes, polyethylene and vinylidene chloride derivatives. The preferred fiber is nylon as discussed above.

The following specific examples of products formed in accordance with the present invention are intended to be illustrative only and therefore only such limitations are intended as may appear in the appended claims.

EXAMPLE I

A 40 inch wide web of non-woven coarse nylon fibers—partially drawn producers' waste ranging from 15 to 180 denier and about 1½" in length—was prepared as described above in connection with FIGURE 1, using a conventional Rando-Webber machine and applying a spray coating of an alkali-resistant acrylonitrile-butadiene elastomer in latex form blended with a melamine-formaldehyde resin. The web prior to application of the bonding adhesive weighed 3.6 oz./sq. yd.

Bonding adhesive

	Parts by weight (dry basis)
Hycar 1572 latex	100
Melamine formaldehyde resin	15
Stabilizer (Emulphor ON870)	1
Amine catalyst AC (Monsanto)	1½

The wet web was then passed through an infra-red oven to make the web tack-free. The reverse side was then sprayed with the same bonding adhesive and given a similar heat treatment. Heating was carried out on each pass for approximately 1 to 3 minutes at 250°–350° F. This effectively drove off the water and cured or partially cured the bonding adhesive to the point where it was relatively solvent-resistant. A total weight of 1.8 oz./sq. yd. of bonding adhesive was applied. Examination of the bonded web indicated that the bulk of the adhesive was deposited in the form of globules at the junctions of the fibers.

The bonded web was then passed at a rate of 10 feet/minute through a padder or roll coater as described above in connection with FIGURE 1 and the maker-adhesive-abrasive slurry applied. In this case the maker adhesive was a polyester-isocyanate prepolymer blend in a solvent system containing methyl isobutylketone, xylene and celiosolve acetate. The abrasive grain (Grit No. 180, silicon carbide) was mixed with this adhesive (Brookfield viscosity of 135 centipoises at 80° F.) in the ratio of about 150% abrasive grain based on the resin solids to form the slurry. The viscosity of the slurry was adjusted to around 950 centipoises at 80° F. at the coating unit with solvent so that good fiber coverage was obtained. Too dense or viscous a slurry would tear or distort the web as it passed through the rolls. About .097 pound of slurry per square foot of material was applied.

Maker adhesive—Abrasive slurry

Mondur CB–60 (Mobay Chemical Co.)	128.8 pounds (poly-isocyanate formed by reacting toluene diisocyanate with a tri-functional polyol).
Fomrez 50 (100% solids) (Witco Chemical Co.)	38.5 pounds (polyester).
Methyl isobutylketone	52.0 pounds.
180 grit silicon carbide	220.5 pounds.

The web was then rolled into jumbo roll form and put into a curing oven. Hot air at 250° F. was blown through the roll for three hours to effect cure of the adhesive. The roll was then ready for processing into such form as might be desired for ultimate use.

EXAMPLE 2

In some instances, particularly for fine polishing or buffing operations, the non-woven material formed in accordance with the present invention is utilized without abrasive grain present. Such a product was formed by laying down fifteen denier 1½" staple nylon fibers in the manner described in Example 1 to form a loose non-woven web weighing approximately 2.4 oz./sq. yd. This web was then spray-bonded with an acrylonitrile-butadiene elastomer blended with a melamine-formaldehyde resin as in Example 1. The wet web was heated by passage through an infra-red oven for 1–3 minutes at 300°–350° F. (time dependent upon web speed—usually about 18 feet/minute). The reverse side of the web was then given a similar treatment.

The bonded web was then roll coated with a phenolic resin adhesive (no abrasive) in an alcohol-water solvent system (Brookfield viscosity of 285 centipoises at 80° F.) applied at a web speed of 10 feet/minute and at an amount of about 7¾ pounds resin, on a solids basis, per sandpaper ream (i.e. per 330 square feet). The phenol formaldehyde resin used had a water tolerance of 20 and a gel time at 250° F. at 5.25 seconds. The wet web was then rolled into jumbo roll form and put into a curing oven for 5 hours at 250° F. The finished product was found to be quite satisfactory as a polishing medium for tile floors after being cut into pads of the type illustrated in FIGURE 3.

EXAMPLE 3

A web of coarse nylon fibers was made as in Example 1, using as the spray-applied bonding coat a commercial acrylonitrile-butadiene latex binder with no resin modification. The maker adhesive in this case was an epoxy resin (Epon 815 prepared by Shell Chemical Company), and only enough solvent (xylene) was added to the adhesive-abrasive mixture to slightly adjust the viscosity for uniform coating. The adhesive had a Brookfield viscosity of 120 centipoises at 88° F. before the abrasive was added, increasing to 1075 centipoises at 94° F. after the grain was added. The ratio of abrasive to resin and the amounts of slurry coated were as described in Example 1. The epoxy resin adhesive in the present case was of the low temperature curing type and curing was therefore effected by standing at room temperature after the web had been rolled up into jumbo roll form. This product was then mounted upon suitable bearings and used intact as a wide polishing drum.

From the above description of the present invention, it will be seen that the spray application of a flexible, elastomeric bonding adhesive followed by the roll coat application of a tough, hard, resinous maker adhesive permits the retention of loft and resilience in the resulting non-woven web while at the same time resulting in an improved dispersion of the maker adhesive over the surfaces of the synthetic fibers used in forming the web. Obviously other modifications and variations may be made without departing from the spirit and scope of the invention described therein.

We claim:

1. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a harder, more rigid adhesive applied by roll coating without substantial softening of said elastomeric adhesive.

2. An aricle of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers sub-

stantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a hard, tough, resinous adhesive applied by roll coating without substantial softening of said elastomeric adhesive.

3. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a harder, more rigid adhesive, said harder, more rigid adhesive being applied by roll coating from a solvent system having relatively little softening effect upon said elastomeric bonding adhesive.

4. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a hard, tough, resinous adhesive, said hard, tough, resinous adhesive being applied by roll coating from a solvent system having relatively little softening effect upon said elastomeric bonding adhesive.

5. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a harder, more rigid adhesive applied by roll coating without substantial softening of said elastomeric adhesive; and a plurality of abrasive grains distributed along said fibers and bonded thereto solely by said harder, more rigid adhesive.

6. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intresection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a hard, tough, resinous adhesive applied by roll coating without substantial softening of said elastomeric adhesive; and a plurality of abrasive grains distributed along said fibers and bonded thereto solely by said hard, tough, resinous adhesive.

7. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a harder, more rigid adhesive, said harder, more rigid adhesive being applied by roll coating from a solvent system having relatively little softening effect upon said elastomeric bonding adhesive; and a plurality of abrasive grains distributed along said fibers and bonded thereto solely by said harder, more rigid adhesive.

8. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a hard, tough, resinous adhesive, said hard, tough, resinous adhesive being applied by roll coating from a solvent system having relatively little softening effect upon said elastomeric bonding adhesive; and a plurality of abrasive grains distributed along said fibers and bonded thereto solely by said hard, tough, resinous adhesive.

9. An article of manufacture comprising: a three-dimensional open non-woven web having substantial loft and a high proportion of internal voids formed by laying down in superposed random fashion a plurality of relatively short flexible tough synthetic organic fibers; an elastomeric bonding adhesive adhering to said fibers substantially at the points of intersection of said fibers with one another, said adhesive bonding said fibers one to the other so as to form a resilient web; and overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the length of said fibers, a harder, more rigid adhesive, said harder, more rigid adhesive being applied by roll coating from a solvent system having relatively little softening effect upon said elastomeric bonding adhesive; and a plurality of abrasive grains distributed along said fibers and bonded thereto solely by said harder, more rigid adhesive; said non-woven web being tightly wound upon itself in convolute form while said harder, more rigid adhesive is still tacky to form a self-sustaining cylinder.

10. An article as in claim 9 wherein said cylinder is cut transverse and normal to the long central axis thereof to form a circular pad of non-woven, abrasive-containing material.

11. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; applying to said fibers an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers and to bond said fibers one to the other; and applying by roll coating over said elastomeric bonding adhesive without substantially softening the same a harder, tougher adhesive.

12. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; applying to said fibers an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers and to bond said fibers one to the other; and applying by roll coating over said elastomeric bonding adhesive without substantially softening the same a harder, tougher adhesive,

said harder, tougher adhesive extending along said fiber lengths as well as overlying said elastomeric bonding adhesive at said points of intersection of said fibers.

13. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; applying to said fibers an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers and to bond said fibers one to the other; drying said elastomeric bonding adhesive to a non-tacky state; and thereafter applying by roll coating over said dried elastomeric bonding adhesive without substantially softening the same a harder, tougher adhesive.

14. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; applying to said fibers an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers and to bond said fibers one to the other; drying said elastomeric bonding adhesive to a non-tacky state; and thereafter applying by roll coating over said dried elastomeric bonding adhesive without substantially softening the same a harder, tougher adhesive, said harder, tougher adhesive extending along said fiber lengths as well as overlying said elastomeric bonding adhesive at said points of intersection of said fibers.

15. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; applying to said fibers an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers and to bond said fibers one to the other; and applying by roll coating over said elastomeric bonding adhesive without substantially softening the same a harder, tougher adhesive containing a plurality of abrasive grains, said harder, tougher adhesive-abrasive grain mixture extending along said fiber lengths as well as overlying said elastomeric bonding adhesive at said points of intersection of said fibers.

16. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; applying to said fibers an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers and to bond said fibers one to the other; drying said elastomeric bonding adhesive to a non-tacky state; and thereafter applying by roll coating over said dried elastomeric bonding adhesive without substantially softening the same a harder, tougher adhesive containing a plurality of abrasive grains, said harder, tougher adhesive-abrasive grain mixture extending along said fiber lengths as well as overlying said elastomeric bonding adhesive at said points of intersection of said fibers.

17. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; spraying said fibers of said web with an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers whereby said fibers are bonded one to the other and the loft of said web is maintained; drying said elastomeric bonding adhesive to a substantially non-tacky state; and thereafter applying by roll coating a harder, tougher adhesive containing a plurality of abrasive grains to said web without substantial softening of said elastormeric adhesive; said adhesive-abrasive mixture overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the lengths of said fibers.

18. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; spraying said fibers of said web with an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers whereby said fibers are bonded one to the other and the loft of said web is maintained; drying said elastomeric bonding adhesive to a substantially non-tacky state; and thereafter applying by roll coating a harder, tougher, adhesive containing a plurality of abrasive grains to said web without substantial softening of said elastomeric adhesive, said adhesive-abrasive mixture overlying said elastomeric bonding adhesive and extending further than said bonding adhesive along the lengths of said fibers.

19. A method for the manufacture of a non-woven polishing material which comprises: forming a lofty, open, three-dimensional web of flexible, tough, synthetic organic fibers by laying down in superposed random fashion a plurality of relatively short lengths of such fibers; spraying said fibers of said web with an elastomeric bonding adhesive, said adhesive tending to concentrate substantially at the points of intersection of said fibers whereby said fibers are bonded one to the other and the loft of said web is maintained; drying said elastomeric bonding adhesive to a substantially non-tacky state; and thereafter applying to said web by roll coating from a solvent system having relatively little softening effect upon said elastomeric bonding adhesive a harder, tougher adhesive containing a plurality of abrasive grains; said adhesive-abrasive mixture extending along said fiber lengths as well as overlying said elastomeric bonding adhesive.

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UNITED STATES PATENT OFFICE

Certificate

Patent No. 3,020,139 Patented February 6, 1962

John E. Camp, Josef C. Mueller, Jr., Frederick G. Sandholdt, and George L. Haywood

Application having been made jointly by John E. Camp, Josef C. Mueller, Jr., Frederick G. Sandholdt, and George L. Haywood, the inventors in the patent above identified, and The Norton Company, Troy, New York, a corporation of Massachusetts, the assignee, for the issuance of a certificate under the provisions of Title 35, Section 256 of the United States Code, deleting the names of John E. Camp, Frederick G. Sandholdt, and George L. Haywood from the patent as joint inventors, and a showing and proof of facts satisfying the requirements of the said section having been submitted, it is this 4th day of March 1969, certified that the names of John E. Camp, Frederick G. Sandholdt, and George L. Haywood are hereby deleted from the said patent as joint inventors with the said Josef C. Mueller, Jr.

[SEAL]

EDWIN L. REYNOLDS,
First Assistant Commissioner of Patents.