POLISHING AND ABRADING MATERIALS

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Filed Mar. 24, 1964, Ser. No. 354,473

12 Claims. (Cl. 51—293)

The present invention relates in general to fibrous polishing and/or abrading materials and more particularly to such materials formed from continuous or substantially continuous synthetic filaments.

It has heretofore been proposed to form polishing pads with or without included abrasive materials from synthetic fibers and natural fibers of various kinds. The art has followed a trend toward the use of synthetic fibers as such materials have become more readily available since many of these fibers are not water-sensitive, are extremely tough and durable, and in general possess more desirable characteristics than do the natural fibers. Early efforts to produce polishing materials utilized cotton, jute, sisal fibers or the like as illustrated in the patents to Hurst, U.S. 2,284,738 and to Loefler, U.S. 2,327,199. Following the development of equipment capable of producing randomly oriented fiber webs such as the "Rando-Webber" machine marketed by the Curlator Corporation of Rochester, New York and described in U.S. Letters Patent Nos. 2,541,915; 2,700,188; 2,701,441 and 2,744,294 commercial webs produced on this machine for various textile purposes (as illustrated by Maisel, U.S. 2,784,132) were adapted for polishing pads as illustrated by Hoover et al. U.S. 2,958,393.

All of these webs suffered from various defects—chief among which was the tendency for delamination or separation of the fibers or layers of fibers from one another in use. Efforts to overcome this lack of strength by the use of a binder adhesive for the fibers and a roll-coated harder adhesive overlying the former adhesive as shown in Camp et al. U.S. 3,020,139, while imparting definite improvements in life and performance did not completely solve the problem. Polishing pads still tended to tear rather readily and, in the case of polishing or scouring pads used under rotating floor machines, the problem of destruction of the pads when a sharp or projecting edge was encountered by the edges of the pad remained acute.

An object of the invention is the provision of a new and improved method of making non-woven polishing materials.

An additional object is the provision of an improved method of making high loft non-woven material.

It is also an object of this invention to provide a method for increasing the impregnation of non-woven polishing pads with adhesive and/or adhesive and abrasive particles.

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 perspective view, in partial section, of a circular polishing pad made by the method of the present invention.

FIGURE 2 is an enlarged plan view of a small section of the surface of the pad shown in FIGURE 1, illustrating the directional nature of the filaments and the degree of interlocking achieved.

FIGURE 3 is a schematic diagram of one apparatus set up for practicing the method of the present invention.

Generally, the present invention resides in the formation of a non-woven polishing material from substantially continuous filaments wherein such filaments are treated to impart a permanent crimp or curl thereto, straightened out under tension into a substantially parallel relationship with one another, uniformly coated while under tension with an adhesive which may or may not contain abrasive particles, interlocked one with another by release of such tension and then set in a permanently interlocked and lofty, open, three-dimensional state by curing or setting-up of the adhesive.

More specifically, the use of long continuous filaments instead of the short or relatively short fibers of the prior art imparts a high degree of internal strength to the non-woven polishing materials of the present invention. While preferably directional in the sense that the filaments of any given layer in a multi-layer product made in accordance with this invention extend generally in the same direction, the non-woven material has all of the interlocking or intersecting of one filament with the others necessary to achieve the advantages of prior art random webs due to the interconnection of the crimps or curls imparted to each of the filaments prior to coating with the bonding adhesive. Because the adhesive binder is applied to the filaments while they are in a stretched, relatively parallel and non-intersecting relationship, each filament receives a uniform coating of the binder and, if abrasive particles such as abrasive grains are included in the adhesive, the distribution of the abrasive is much more uniform than can be achieved by spraying or otherwise incorporating abrasive into a pre-formed web. The webs so formed are lofty and three-dimensional in nature since the filaments, when tension is released, expand both laterally and vertically as the crimps imparted to the filaments spring back into existence. The degree of loftiness can be controlled by the filament density, i.e., the number and diameter of the filaments per linear unit in the width direction of the web.

Referring now to the drawings, FIGURE 1 illustrates a circular polishing pad 10 formed of a plurality of continuous synthetic filaments 11, each having many crimps or curls 12 interconnecting and entwining with the crimps or curls of adjacent filaments. Each of the filaments 11 is uniformly coated with a layer of adhesive 13 which serves to hold the filaments bonded to one another at each point of intersection of one filament with another. As illustrated in FIGURE 1, the adhesive 13 contains a plurality of abrasive grains 14 which are uniformly distributed both along the filaments 11 and throughout the thickness of the pad 10. The abrasive grains 14 are held firmly to the filaments 11 by the adhesive 13.

The general relationship of the filaments 11 to each other is more clearly shown in FIGURE 2 wherein an enlarged section of the top surface 15 of pad 10 is shown. This view also clearly shows the uniform distribution of the adhesive 13 and abrasive grains 14 along the fibers 11.

While a number of variations of equipment for producing the non-woven polishing materials of the present invention may be employed, the schematic diagram of FIGURE 3 is illustrative of the preferred method. The filaments 11 are drawn directly from an extrusion bath or from a warp beam or from any suitable source (not shown) in the form of a plurality of substantially parallel strands through a set of idler rolls 16 and 17 and thence over a heated blade 18 which preferably consists of a sharp edged blade set at a sharp angle to the direction of travel of the filaments 11. The blade 18 may, if desired, be heated by any suitable means such as a resistance element heater 19, for example to a temperature of about 250° F, which has been found suitable for nylon filaments of 15—150 denier. Other temperatures may be used as desired for different synthetic filaments or filaments of different deniers, but generally the temperature must be low enough to avoid actual melting or thermal decomposition of the material. Since the contact with the blade
is for an extremely limited period of time (filament speeds of 25 ft./minute and over being preferred), the blade temperature generally is not too critical. Both temperature and speed are interdependent and will vary somewhat depending upon filament diameter. Contact of the blade to the filaments 11 imparts a pronounced and permanent crimp or curl to the filament. This "permanent" crimp or curl appears to result from straining the filaments or a portion thereof beyond the elastic limit but below the point of fracture. A filament, treated in this fashion may be stretched out straight but when tension is relaxed it will assume its crimped configuration once again. After passing over the crimping belts 15, the filaments 11 still in their substantially parallel relationship to one another are passed through an adhesive-applying station 20. This station may take the form of spray heads or, as is illustrated, a roll coating bath 20. The parallel filaments 11 pass over idler rollers 21 and 22 and through the bath 20 of adhesive 13. The filaments 11 now coated with adhesive 13 pass through squeeze rolls 25 and 26 which remove the excess adhesive and are then allowed to relax as they exit from the squeeze rolls. The crimps 12 built into the filaments now appear and in the filaments 11 to interlock with each other to form the lofty web 27. This web deposits on any suitable surface, preferably a conveyor 25 as shown in FIGURE 3 and is passed through a heating zone 29 to set up or cure the adhesive 13 which bonds filaments 11 together at each point of intersection of the crimps 12. The conveyor 28 operates at a speed slow enough to permit the desired depth of filament accumulation and since a single layer is generally not contemplated, additional lines of which 30 is merely representative feed their webs 27', made up of similarly coated filaments 11' having crimps 12', onto the web 27 on conveyor 28. These additional webs 27' may be fed by rolls 25' and 26' either parallel to the direction of web 27 or preferably at some angle thereto as illustrated in FIGURE 3 to impart multidirectional strength to the laminate of webs so formed. If desired the filaments in some or all of the subsequent layers of webs may be laid in a twisting or sinuous path dependent entirely upon the properties desired in the finished web. The crimps 12 coated with adhesive 13 act to interlock the superimposed web 27' with web 27' in the same manner that they act to interlock the adjacent filaments 11. While not shown in FIGURE 3, obviously the bath 23 may contain abrasive grains in the form of a slurry with the adhesive 13. Obviously, abrasive may also be added to webs produced in accordance with the above after the adhesive-only bonded web is cured when uniform abrasive distribution is not a requirement. The finished web 31 is rolled up as at 32 for conversion into finished products as described in connection with the Camp et al. patent, U.S. 3,020,139. Obviously, the cure in zone 29 may be left incomplete so that the web 31 is still tacky when rolled as at 32 so that upon completion of the adhesive cure the roll is self-sustaining and the convolutions thereof are adhesively bonded one to the other. Alternatively, the cure is completed in zone 29 and the web 31 is non-tacky and can readily be unwound from roll 32 for further conversion into sheets, discs or the like as desired.

Filaments bulked by methods other than the knife-edge curling described above are also suitable for use in this invention. For example, the crimp may be produced by passing the filaments through a stuffer box (a device which receives and feeds to a crimping chamber which is maintained full of filaments under a predetermined back pressure and temperature) wherein the filaments, as they are forced into the crimping chamber, are laid in zig-zag form and pressed to form angular bends or crimps with intervening straight portions. When the filaments emerge from the stuffer box they are cooled to set the crimp and then stretched under tension to disentangle the filaments and temporarily remove the crimp for further processing in accordance with the present invention. Some differential motion along the length direction of the filaments at this point greatly aids in disentanglement and in randomizing the pattern of the localized filament crimps. As a still further example, the filaments may be crimped by mechanical distortion through a pair of gears (so-called gear crimping) especially if the filaments are subjected to a torque distortion below the elastic limit of the filaments just prior to entering the gear crimping. This imparts a three-dimensional crimp to the filaments which otherwise would acquire a largely two-dimensional crimp. In general, the type of crimping methods used in the practice of the present invention is not critical except that it is preferred that at least a portion of the crimp imparted to the filaments be of relatively high amplitude and three-dimensional in character. Further, in order that the filaments intermesh and cross one another and form many contact points for subsequent adhesive bonding, it is desired that the stretched filaments have crimps or curl of such character as to cause, on relaxation of tension, the length direction to shrink at least about 10% and preferably more.

While the present invention contemplates preferably using only continuous filaments in forming the non-woven web it is within the scope of the invention to add other textile materials in the form of short fibers, flock or the like to the web along with the continuous filament in those instances where it may be so desired. These additive fibers may range in length from a fraction of an inch to several inches or more and will be adhesively bonded to the continuous filaments and to each other at their points of intersection.

Also, while the process is described above in conjunction with the crimping of the filaments, obviously precoated filaments may be used and the crimp temporarily pulled out under tension as the adhesive or adhesive and abrasive grain Shirley in applied. The preferred filaments used in the present invention are polyamides, such as nylon, or polyester filaments. Other flexible, tough, synthetic, organic filaments capable of being thermofomed and which can be used include the vinylidines, oleins, fluorocarbons, acrylonitriles and cellulose. The filament diameter is not critical and any desired denier or mixture of deniers may be employed as desired. Generally, the filaments found most useful are of 15 denier or coarser up to about 300 microns in diameter.

The adhesives used to bond the filaments may vary from the elastomeric to the hard, heat-advancing resinous type. Generally, where the web is relatively low in adhesive content, the adhesive type will depend upon the degree of firmness or stiffness desired in the finished product with the elastomeric adhesives giving the most flexible web. Where the adhesive used to bond the filaments is also to be used to hold abrasivestain to the filaments or to a relatively stiffer web is desired, such adhesive generally is selected from the heat-advancing resinous types such as the polyurethane or phenol-aldehyde-based adhesives. The adhesives, abrasive grain types and sizes, chemical nature and diameters of the filaments are all of the general character known to the art and as described in the aforesaid Camp et al. patent, U.S. 3,020,139.

The term "continuous filaments" as used herein is intended to indicate that the filaments are substantially continuous and much longer than the ½" to 3" fibers heretofore used in commercial products of this general nature. Obviously, when the adhesives used in accordance with this invention are cut or died out to form fibrous articles, the filaments are cut and cease to be continuous. It can therefore be generalized that products made in accordance with the present invention are characterized by the presence of continuous adhesive-coated filaments at all portions thereof other than the peripheral boundaries of the product.

The present invention permits, as described above, both more uniform and also greater quantities of adhesive
and/or adhesive and abrasive to be incorporated into the finished web. Prior art pre-formed webs (as for example that disclosed in Hoover et al. U.S. 2,958,593) do not permit uniform abrasive distribution since the web fibers act as a filter, straining out the grain and keeping its concentration much higher at the outside surface of the web. Likewise, binding is non-uniform in such webs with the result that the adhesive and abrasive components are distributed unevenly and cause a tendency to delaminate. The present invention uniformly coats each filament prior to forming the web and thus much greater uniformity of coat is possible. Furthermore, whereas prior art webs must be limited in thickness due to the need to pass adhesive or slurry through the coating unit, the present invention is completely unlimited as to web thickness.

Obviously, many variations and modifications can be made without departing from the spirit and scope of the invention as disclosed herein so that the only limitations to be inferred are those set forth in the appended claims.

5. A method for the manufacture of a non-woven polishing material which comprises: holding under tension a plurality of continuous pre-crimped synthetic filaments arranged in substantially parallel relationship with one another; imparting a substantially uniform coating of adhesive to said filaments while under tension; relaxing the tension on said adhesive-coated filaments before said adhesive dries to permit said filaments to return to their crimped state with the crimps in each filament intersecting and entwining with the crimps of adjacent filaments; and setting the adhesive coating to anchor said filaments to each other at their points of intersection.

6. A method for the manufacture of a non-woven polishing material which comprises: arranging a plurality of continuous, synthetic filaments in a closely spaced parallel relationship; imparting a tendency to crimp to said filaments while held in said parallel relationship; applying tension to said filaments to temporarily keep said crimp from developing; applying a substantially uniform coating of adhesive to said filaments while under tension; relaxing the tension on said adhesive-coated filaments before said adhesive dries to permit said filaments to return to their crimped state with the crimps in each filament intersecting and entwining with the crimps of adjacent filaments, the crimps of said first-mentioned filaments; and setting the adhesive coating to anchor said filaments to each other and to the filaments of adjacent layers.
from developing; applying a substantially uniform coating of adhesive and abrasive grains to said filaments while under tension; relaxing the tension on said adhesive-coated filaments before said adhesive dries to permit the development of crimps therein with the crimps of adjacent filaments; and setting the adhesive coating to anchor said filaments to each other at their points of intersection and to bond the abrasive grains along each of said filaments.

10. A method for the manufacture of a non-woven polishing material which comprises: holding under tension a plurality of continuous pre-crimped synthetic filaments arranged in substantially parallel relationship with one another; applying a substantially uniform coating of adhesive and abrasive grains to said filaments while under tension; relaxing the tension on said adhesive-coated filaments before said adhesive dries to permit said filaments to return to their cramped state with the crimps in each filament intersecting and entwining with the crimps of adjacent filaments; repeating this procedure with at least one other layer of filaments arranged in parallel relationships out of phase with said first-mentioned filaments, depositing said other layer of filaments on top of said first-mentioned filaments, the crimps of said other layer interlocking with the crimps of said first-mentioned filaments; setting the adhesive coating to anchor said filaments to each other and to the filaments of adjacent layers and to bond the abrasive grains along each of said filaments.

11. A method for the manufacture of a non-woven polishing material which comprises: arranging a plurality of continuous, pre-crimped synthetic filaments in closely spaced parallel relationship; applying tension to said filaments to temporarily remove the crimps therefrom; applying a substantially uniform coating of adhesive and abrasive grains to said filaments while under tension; relaxing the tension on said adhesive-coated filaments before said adhesive dries to permit said filaments to return to their cramped state with the crimps in each filament intersecting and entwining with the crimps of adjacent filaments; repeating this procedure with at least one other layer of filaments arranged in parallel relationships out of phase with said first-mentioned filaments; depositing said other layer of filaments on top of said first-mentioned filaments, the crimps of said other layer interlocking with the crimps of said first-mentioned filaments; setting the adhesive coating to anchor said filaments to each other and to the filaments of adjacent layers and to bond the abrasive grains along each of said filaments.

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