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MANUFACTURE OF ABRASIVE MATERIALS

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MANUFACTURE OF ABRASIVE MATERIALS

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This invention relates to webs of flexible abrasive material and to methods of manufacture thereof. More particularly, the present invention is concerned with the manufacture of abrasive materials in which the fibers of a plurality of carded fibrous membranes are blended together by definite interengagement or interweaving to form a substantially non-lamellar web structure and abrasive grain included internally of the web and/or extending in part above the surface thereof. This invention is concerned further with the manner of introducing or including the abrasive material and an adhesive binder agent into the web so that the abrasive particles are anchored in the interstices of the fibers and the gussets made by fiber intersections and further cemented in place by the adhesive.

This application is a continuation-in-part of my copending application Serial No. 298,733, filed October 10, 1939.

Heretofore in the manufacture of flexible abrasive materials, such as sandpaper, and the like, the practice has been to apply a layer of adhesive to a paper or cloth backing member, apply a layer of abrasive thereover and then apply an additional sizing layer of adhesive to more firmly anchor the abrasive particles in position. The present invention should not be confused with the coated abrasives of the prior art, since it differs therefrom by the absence of the conventional backing member. It represents an improvement over such articles by reason of the elimination of the backing and the distinct line of demarcation which has existed heretofore between the backing member and the coating of abrasive granules. In addition, its fibrous structure lends a strength, flexibility and durability to the final product which meets the requirements for abrasive paper or cloth, or polishing wheel base material as well as many applications for which the conventional abrasive paper is not suited.

Methods have been proposed for the incorporation of abrasive grain into a paper base by mixing abrasive grains into a macerated, watery mass of paper pulp and then forming abrasive articles from the mixture. Such methods have been unsatisfactory because of the fact that a solid, densely matted body was formed which entirely masked the cutting edges of the abrasive particles, and also the absence of clearance spaces prevented the formation of chips.

I have found that the above difficulties can be overcome and flexible abrasive web mate-

rials produced with a substantial saving in time and operations by forming a web of a plurality of carded fibrous membranes, interlocking said membranes together by definite interweaving to form a strong non-lamellar web structure and applying abrasive granular material internally of said fibrous web said abrasive particles extending from the interior to the surface and projecting therefrom. A suitable adhesive agent is also incorporated within said web and the treated fibrous web is formed to a desired density. The present invention further provides a method of manufacture in which the abrasive grain and the adhesive binder may be applied simultaneously to the web and caused to penetrate and permeate throughout the fibrous web structure. The abrasive particles enter into the interstices between the individual fibers of the web, and when the web is consolidated, the individual fibers are pressed down and around the base of each individual abrasive particle to increase the anchorage thereof. This also causes the cutting edges of the uppermost grains to project above the surface of the web and a sharp abrading surface is produced. Furthermore, the abrading action is not confined to a superimposed layer of abrasive grains on the upper surface of the web, but the abrasive properties extend substantially all the way through said web, there being no distinct line of demarcation between the fibrous web and the abrading surface.

Abrasive grain can be introduced entirely or partially within the fibrous web structure in amount and character to suit the conditions and nature of the intended use. For example, the abrasive grain may be applied in such a manner that there is a maximum amount of abrasive particles at one surface of the web, with the amount of grain progressively diminishing as the distance from that surface of the web becomes greater, there being little or no abrasive grain at the opposing surface of the web. However, if desired, the abrasive may be applied into both surfaces of the web and an article produced in which the quantity of grain diminishes equally from both surfaces of the web toward the interior. A coating of abrasive grain may also be applied, if desired, and adhesively secured to the top surface of the web. A sizing layer of adhesive may be applied to the surface coating of abrasive material or to the surface of the abrasive-included web.

Various modifying agents, such as waterproofing compounds, anti-friction agents, em-

brittling materials, flexibilizers and other fillers, may be incorporated in the web during manufacture in order to render the web resistant to water or impart specific properties thereto.

In order that the invention may be more clearly set forth and understood, reference is made to the accompanying drawing, in which

Figure 1 is a diagrammatic side elevation, partly in section, of one form of apparatus which may be used in the practice of the present invention; and

Figure 2 is a greatly enlarged vertical-section through a fragment of a fibrous abrasive web made in accordance with the present invention.

Figure 1 of the drawing illustrates one form of apparatus which may be employed in the production of fibrous abrasive materials by the concurrent manufacture of a fibrous web material and the inclusion of abrasive grains and adhesive binder therein. The particular apparatus shown includes a plurality of card assemblies suitably spaced apart and consisting of carding cylinders 2, doffer cylinders 3 and combs 4 adapted to form and deliver a number of carded membranes 5, 6, 7 and 8 to the undulating conveyor 11. The carded membranes are formed webs of loosely adhering independent fibers and may consist of any animal, vegetable, mineral or synthetic fibrous material capable of being carded into web form. Such materials include natural fibers, such as cotton, wool, jute, flax and the like, or any of the newer synthetic fibers, such as glass wool, resinous or synthetic rubber-like fibrous materials. Any one of these fibrous materials may be used singly or two or more may be mixed in any desired proportion. Cotton fibers have been found to be highly satisfactory in the present process and consequently will be used as a specific example in connection with the detailed description of the apparatus and the method of manufacture.

The carding machines are well known in the textile art and no detailed description is deemed necessary. Although only four cards are shown in the drawing, any number of cards may be used, depending upon the desired weight or thickness required. The cards are arranged so that their longitudinal axes are parallel but offset slightly from each other, laterally of the carrier belt 11.

The carded membranes are delivered from the cards as light, but accurately formed webs and fed by gravity through orifices 9 in the floor 10 onto a moving carrier belt 11, which is slightly undulated or vibrated by suitable means not shown. This carrier belt is slightly wider than the width of the deposited membranes and may have cooperating flanges for guiding the oncoming membranes onto the traveling support. As the membranes pass through the orifices of the floor, they are shielded from any undesirable external influences, such as strong air currents, by protecting side walls or plates 12 and 13. The carrier belt 11 is supported at the opposite ends thereof by the rolls 14 and 15, which are driven by suitable driving means, not shown. The speed of the belt is synchronized with the rate of feed of the membranes in order to prevent any pull on the membranes during their deposition.

As the fibrous membranes pass down through the orifices 9 and are deposited onto the moving support, a gentle controlled current of air or other gas is caused to flow against the movement of the membranes and upwardly through the respective orifices 9. Since the fibers of the membranes are very light in character, this gentle current of air

causes a displacement and up-ending of the individual fibers in each membrane as it passes through the respective orifice. Thus the ends of the individual fibers are shifted from their normal longitudinal arrangement, which was assumed as a result of the carding operation, and caused to extend in a number of different directions, generally non-parallel. This displacement of the fibers is generally normal to the surface of the membranes and, as two or more membranes are brought together, the up-ended fibers of each membrane readily blend together by definite interengagement or interweaving in a multiplicity of planes. This action is called aerodynamic weaving.

The interlocked web is then passed between the rolls 17, 18 and back and forth between the series of rolls 20, which are arranged at successive lower levels. These rolls do not exert any appreciable pressure on the web and are preferably all driven at the same peripheral speed as the moving web in order to avoid any tension on the web. The back and forth or alternate bending of the web by the rolls 20 serves to alternately lengthen and contract opposite sides of the web, and this action further aids in interlocking the fibers of the successively applied membranes. The result of the various steps is a firm, homogeneous interlocking structure which is non-lamellar in final appearance and with the individual fibers extending in a multiplicity of different directions and disposed in a multiplicity of different planes.

The fibrous web 1 is still light and uncompacted as it leaves the rolls 20 and passes down to and between the rolls 23 and 24 where abrasive grains and an adhesive binder are applied concurrently to the web and included internally thereof. The abrasive grains are mixed with the adhesive binder and this mixture 25 or suspension of particles of abrasive material in a liquid adhesive is contained in a pan 26, which may be water-jacketed and heated as required. The adhesive roll 23 is partially immersed in this mixture and as the roll revolves it carries a uniform film of the abrasive-adhesive mixture into contact with the fibrous web 1. The quantity of such mixture applied to the web is regulated by the adjustable scraper bar 27, which limits the thickness of the layer carried by the roll 23. These two rolls are preferably driven at substantially the same speed as the web passing therebetween and are provided with a surface covering of resilient absorption material. The mixture of abrasive grain and adhesive binder readily penetrates the interstices of the web and permeates throughout.

Roll 24 is held in closely spaced relationship with respect to the adhesive roll 23 and serves to consolidate the loosely adhering open structure web to a fraction of its former thickness. As the web is consolidated to a desired density the abrasive-adhesive mixture is caused to penetrate therethrough, and the liquid adhesive bonds the interwoven fibers together to produce a dense web having a strength comparable to that of paper or cloth.

As the abrasive-adhesive mixture penetrates through the fibrous web the liquid adhesive wets the surface of the individual fibers, particularly at the gusset junctions and the fibers become adhesively joined. This adsorption of the liquid adhesive causes the abrasive particles to be deposited out of suspension and distributed internally of the web. The grains are dispersed

between the fibers of the membranes and in the interstices thereof and when the web is consolidated the individual fibers of the several membranes are pressed down the base of each individual abrasive particle, securely anchoring it in position, and causing the outermost grains to project above the web surface to form a sharp and fast cutting abrasive material. The degree of penetration of the liquid adhesive and abrasive particles suspended therein can be regulated to any desired degree by the use of various textile wetting out agents which are well known in the industry. Thus the abrasive grains can be caused to penetrate substantially uniformly through the web or they may be non-uniformly distributed with a maximum amount at one surface of the web and progressively diminishing toward the opposite surface.

After inclusion of the abrasive and the adhesive binder, and the fibrous web has been consolidated to the proper thickness and density, by passage through the rolls 23, 24, it is passed to a suitable drying chamber or rack 30. The fibrous abrasive material is moved through this chamber at such a rate of speed that the adhesive binder is properly set or cured by the time the web reaches the end of the chamber. The abrasive web is then taken down from the rack and cut up into discs, sheets or belts of suitable size for sale.

In a modified form of the present process, I may apply an additional surface layer of abrasive grains to the surface of the included abrasive web. In carrying out this additional step of the process, an additional layer of adhesive may be supplied to the surface of the consolidated web by any conventional adhesive applying means, such as the adhesive roll 23, contacting pressure roll 24 and pan 26 of Figure 1 of the drawing. A layer of abrasive grains may be applied to the adhesive coating by gravitational means, in which a given quantity of grain is uniformly distributed from a suitable hopper and permitted to fall thereon. Or, if desired, any of the more recently developed electrical and mechanical methods of grain deposition and orientation may be utilized. This surface coating of abrasive grain may be applied at any time before or after partial or complete drying or curing of the included abrasive web. The conventional sizing coating of adhesive is applied over the deposited layer of abrasive grains. In certain instances it is desirable to apply a sizing coating of adhesive or filled to one or both surfaces of the fibrous web to impart specific properties thereto.

Any of the abrasive materials in common use may be employed in practicing my invention. Such materials include silicon carbide, fused aluminum oxide, flint, emery, rouge and similar substances. The size of the abrasive particles may vary from the finest polishing or buffing powders to the largest grains now used in the manufacture of sandpaper. With the coarser grains it may be necessary to continually agitate the mixture in order to keep the grains in suspension or control the viscosity by temperature or incorporating inert matter such as starch or clay etc.

Figure 2 is a greatly enlarged vertical cross-section of a fragment of an included abrasive fibrous web made according to the process of the present invention. The individual fibers of the several membranes have been interlocked to form a nonlamellar web structure and the abrasive

granules 29 have been distributed internally of the fibrous web. Due to the filtering action of the fibrous web, during the application of the abrasive-adhesive mixture, the number of abrasive particles per cubic unit is greater near the top of the fibrous web than near the bottom, the number per cubic unit gradually decreasing towards the bottom. The granules 29 are firmly anchored in position by being intertwined by the long fibers whose lengths are several times the dimension of the individual grit diameters. While the uppermost granules penetrate through and above the surface of the fibrous web, they are also securely attached by the intertwined fibers, which with the aid of the adhesive binder anchors them in such position that the upper cuttings edges are free for grinding and polishing operations.

The physical and abrading properties of the included abrasive webs can be altered to any desired degree by variations in the quantity and character of the adhesive binder agent. The particular adhesive therefor depends upon the specific requirements of the final abrasive product. Latex has been found to be particularly effective as a binder in forming articles of the present invention since it is resistant to water and is also resilient and flexible. Other adhesives, however, which may be used instead of, or along with, latex include liquid animal glue, a waterproof resilient binder such as a synthetic or natural rubber binder or the like, a resinous adhesive in liquid or powdered form, sodium silicate and the like.

One of the important advantages of the invention is that an abrasive article made in accordance with the invention has a resiliency and flexibility which it is impractical to obtain with either paper or cloth. The arrangement of fibers in the base material aided by the latex or other adhesive therein, inherently provides a resilient cushioning which insures that, when the abrasive article is applied to the surface of the work, each abrasive particle will successively contact with the work, the base material yielding so that such contact will be obtained. This property is still further enhanced by proper addition of suitable plasticizers, flexibilizers and the like within the web. Moreover, it has been found that when using the present base material it is possible to use an abrasive which is much coarser and therefore faster cutting to obtain a finish which is as fine or smooth as that obtained by a much finer and therefore much slower cutting abrasive when the latter is backed by paper or cloth. This is a very definite advantage, particularly in the wood sanding operations where fine abrasives clog much more quickly than coarse abrasives.

Another result of the resiliency of the base material is that each particles will have a continuity of contact with the work, thus avoiding chattering of the individual particles against the work and the consequent breaking of those particles. The result, of course, is the more efficient functioning of each particle and consequently for the abrasive article as a whole, resulting in smoother finish and longer life for the abrasive particles.

Alternatively, very brittle characteristics can be imparted to an included abrasive web by the use of a resinous adhesive, which cures to a brittle stage. When the fibers are impregnated with a resin such as, that sold under the trade name "Durite S-2143," they become quite brittle and as the surface grains become dulled and break

away the exposed embrittled fibers also break away and present a fresh layer of sharp abrasive grains at the grinding surface. Obviously the rate of breakdown of the fibrous membrane can be regulated and controlled to any desired degree by change in the character and quantity of the embrittling agent and the degree of penetration into the individual fibers.

Included abrasive articles can be produced in which the outer surface, containing the maximum quantity of abrasive grain, is of a brittle character and the opposite side is of a flexible character. Thus one surface of the article functions most efficiently as an abrading device, while the opposite surface provides the necessary flexibility and strength to permit use as a grinding belt, disc and the like. Abrasive materials of such character may be produced by applying an embrittling impregnant to one side of the web and applying a flexibilizing impregnant to the opposite side.

Many advantages accrue from practice of the present invention. For example, as is readily apparent from the description the present invention readily lends itself to the creation of abrasive articles of specific properties in definite controlled portions of the article without spreading such properties to other parts of the web where they are unnecessary or even undesirable.

Furthermore, the present invention provides an abrasive article which obviates the need for a separate backing or other form of lamination, eliminating the weakness of having a plurality of layers which are liable to split apart during use. The base material is a strong, interwoven structure, especially when internally reinforced by binding materials or like strengthening agents, but at the same time has interstices which serve to anchor the abrasive particles much better than can be done when they are superposed upon the face of a backing and are entirely above the surface. Thus the particles are held in place or anchored by what may be termed a double anchorage, achieved by engagement of the particles with the fibers themselves or by engagement of the particles in the adhesive which in turn is anchored to the fibers. Moreover the abrading action of the present products does not stop when a single upper coating of abrasive grain has been removed or destroyed, but continues through a large portion of the base material itself.

The invention having been fully described and explained in its preferred embodiments, it is to be understood that the invention may be embodied and practiced within the scope of the appended claims.

I claim:

1. The method of manufacturing abrasive webs which comprises feeding a plurality of carded fibrous membranes onto a moving support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlocking engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and a suitable adhesive binder, applying said mixture to the surface of the fibrous web, allowing the abrasive grain and adhesive to permeate into the interstices between the fibers of the loose web structure, and consolidating the web to the desired density.

2. The method of manufacturing abrasive webs which comprises feeding a plurality of carded fibrous membranes onto a moving support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlock-

ing engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and a resilient waterproof adhesive, applying said mixture to the surface of the fibrous web, allowing the abrasive grain and adhesive to permeate into the interstices between the fibers of the loose web structure, and consolidating the web to the desired density.

3. The method of manufacturing abrasive webs which comprises feeding a plurality of carded fibrous membranes onto a moving support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlocking engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and latex, applying said mixture to the surface of the fibrous web, allowing the abrasive grain and latex to permeate into the interstices between the fibers of the loose web structure and consolidating the web to the desired density.

4. The method of manufacturing abrasive webs which comprises feeding a plurality of carded fibrous membranes onto a moving endless support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlocking engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and a suitable adhesive binder, applying said mixture to the surface of the fibrous web, allowing the abrasive grain and adhesive to permeate and penetrate into the interstices between the fibers of the loose web structure, consolidating the web to the desired density, and applying an additional surface coating of abrasive grain and adhesive to one surface of the web.

5. The method of manufacturing flexible abrasive webs of fibrous structure which comprises feeding a plurality of carded fibrous membranes onto a moving support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlocking engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and a suitable adhesive binder, forcing said mixture into the web structure so that it permeates and penetrates the interstices between the fibers and consolidating the web to the desired density.

6. The method of manufacturing flexible abrasive webs of fibrous structure which comprises feeding a plurality of carded fibrous membranes onto a moving support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlocking engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and a resilient waterproof adhesive, forcing said mixture into the web structure so that it permeates and penetrates the interstices between the fibers, and consolidating the web to the desired density.

7. The method of manufacturing flexible abrasive webs of fibrous structure which comprises feeding a plurality of carded fibrous membranes onto a moving support, agitating the fibers of said membranes to bring the fibers of each of said membranes into interlocking engagement with the fibers of adjoining membranes, forming a mixture of abrasive grain and latex, forcing said mixture into the web structure so that it permeates and penetrates the interstices between the fibers, and consolidating the web to the desired density.

8. In the manufacture of flexible fibrous abrasive webs the steps which comprise forming a substantially unaminated fibrous structure of

loose form from a plurality of thin carded fibrous membranes, applying adhesive binder to the fibrous web, introducing abrasive grains internally of said web structure by means of said adhesive binder, and then consolidating the web.

9. In the manufacture of flexible fibrous abrasive webs the steps which comprise forming a substantially unlaminated fibrous structure of loose form from a plurality of thin carded fibrous membranes, forming a suspension of abrasive grain in an adhesive binder, forcing said suspension into the interstices between the fibers whereby the abrasive grain is flowed and carried internally of the web structure, and consolidating the web.

10. In the manufacture of flexible fibrous abrasive webs the steps which comprise forming a substantially unlaminated fibrous structure of loose form from a plurality of thin carded fibrous

membranes, forming a suspension of abrasive grain in an adhesive binder, forcing said suspension into the interstices between the fibers from both sides of the web whereby the abrasive grain is flowed and carried internally of the web structure from both sides inwardly, and consolidating the web.

11. In the manufacture of flexible fibrous abrasive webs the steps which comprise forming a substantially unlaminated fibrous structure of loose form from a plurality of thin carded fibrous membranes, forming a suspension of abrasive grain in an adhesive binder, forcing said suspension into the interstices between the fibers whereby the abrasive grain is flowed and carried internally of the web structure, consolidating the web, and applying a top coating of abrasive grain and adhesive binder to one surface of the web.

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