

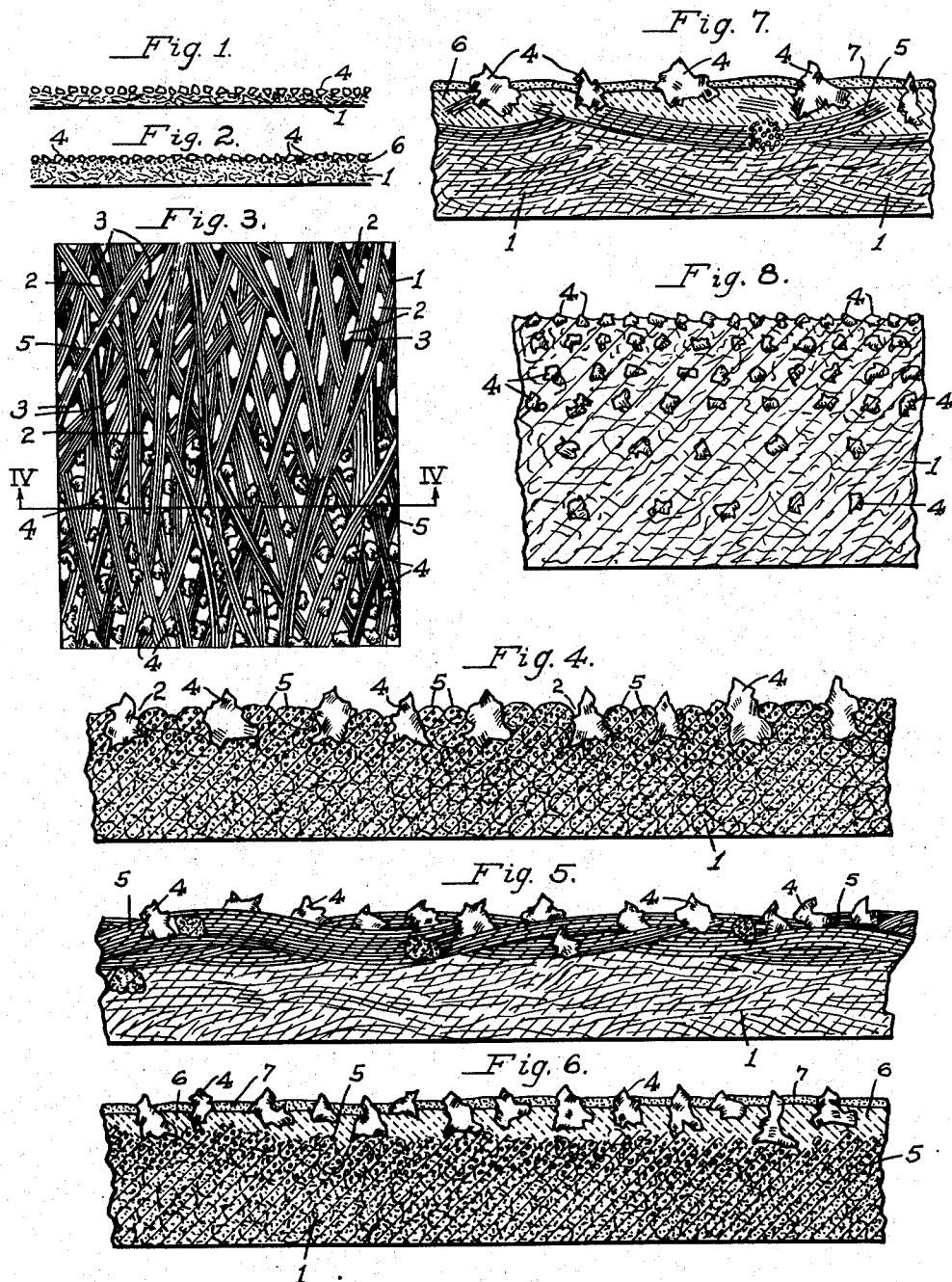
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E. HURST

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ABRASIVE MATERIAL

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INVENTOR.
EDWARD HURST.

BY

Al Berner
ATTORNEY.

UNITED STATES PATENT OFFICE

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ABRASIVE MATERIAL

Edward Hurst, West Newton, Mass., assignor to
United Cotton Products Company, Fall River,
Mass., a corporation of Massachusetts

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This invention relates to abrasive articles and to methods for manufacturing said articles. More particularly, the present invention is concerned with abrasive webs composed of a plurality of carded fibrous membranes the individual fibers of which are interwoven to form a substantially unlaminated fibrous structure with abrasive grains included internally of the web and/or extending in part above the surface thereof. Abrasive articles of the present invention include webs in which abrasive grains and an adhesive binder are included within the fibrous web and the individual abrasive particles are anchored in the interstices of the fibers and the gussets made by the fiber intersections and further anchored 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 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 and the adhesive. In addition, its fibrous structure lends a strength, flexibility and durability to the final product which meets the requirements for abrasive paper, cloth or polishing wheel base material, as well as many applications for which the conventional abrasive paper or cloth 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, however, 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 abrasive web materials produced with a substantial saving in time and operations by forming a web from a plurality of thin 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 the fibrous web. Suitable adhesive binders and, when desired, various other modifying agents, are also incorporated within the web after which the treated web is consolidated to the desired density.

My method of forming the unlaminated fibrous base structure from a plurality of carded membranes and the manner in which the fibers of the various membranes are interwoven and interlocked one with the other is set forth in complete detail in Patent Nos. 2,055,410 and 2,055,411 granted September 22, 1936 to Edward Hurst and Myrick Crane and to Edward Hurst respectively. 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 included 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 this process and have been most generally used.

Briefly, as the membranes come from the various cards, they are superposed one on another on a traveling conveyor in such a way that one membrane is offset from the other and between each card and the conveyor the membrane is passed through an orifice and subjected to what for convenience may be referred to as "aerodynamic weaving."

In such aerodynamic weaving a slight differential of pressure is maintained on opposite sides of the membrane, particularly as it passes through the orifice, and a slight differential of pressure is provided on each side of the orifice, so that there is a gentle current of air passing through the membrane and along it as it passes through the orifice. By this method, the fibers in each membrane are rearranged with respect to each other and caused to interlock or interweave to a substantial degree. The superposed membranes on the conveyor are given a gentle undulation to increase the interlocking and interweaving action of the individual fibers, after which the web is flexed back and forth between vertically spaced rolls without substantial ten-

sion being applied thereto, with the result that, when the web has finished the above treatment, the fibers thereof are interlocked with each other to such an extent that they are completely displaced and up-ended from the positions they occupied in the membranes leaving the cards and are also substantially uniformly arranged throughout the thickness of the web to produce an unlaminated structure. Generally, a suitable adhesive binder is then applied to the web to bond the consolidated fibers together at their intersections and produce adhesive gussets at such intersections.

In the manufacture of abrasive articles according to the present invention the abrasive grain, as well as any other modifying agents, may be included in the web after it is formed, or, the abrasive and adhesive binder may be included within the fibrous web structure prior to the consolidation of the web and while the interlocked membranes present numerous interstices between the fibers for reception of the grain and adhesive.

Any of the abrasive materials in common use may be employed in practicing my invention. Such materials include silicon carbide, fused aluminum oxide grains, flint, natural corundum, emery, rouge and similar substances. The size of the abrasive may vary from the finest polishing or buffing powders to the coarser grit sizes used in grinding.

The abrasive grains may be introduced into the loosely woven web structure by first mixing the abrasive grains with a suitable liquid adhesive and applying the abrasive-containing adhesive to the web. This method is fully described in my copending application Serial No. 375,516 filed January 22, 1941.

As an alternative method of including the abrasive grain and adhesive binder to the web, I may introduce the abrasive grain in dry, granular form into the loosely woven web, after which the adhesive binder is applied to the abrasive-laden web to further anchor the abrasive grain in place and strengthen the web in its consolidated form. Dry inclusion of the abrasive grain may be carried out in one of several ways. It may be allowed to drop onto the traveling web from above, which is adjusted to receive the grain at a selected angle whereby the degree and amount of penetration of the web is controlled. Alternatively, the dry grain may be introduced into an air stream and thereby projected into the interstices between the fibers to become anchored internally of the fibrous base. By such projection methods the abrasive can be introduced into the web from both sides, or a modifying agent may be placed internally of the web from one side concurrently with the reception of abrasive grain from the opposite side of the web. Regardless of the manner of introducing the dry abrasive grain, the adhesive is applied later, followed by the step of consolidation. These dry inclusion methods of adding abrasive grains to the web are set forth fully in my co-pending application Serial No. 375,517 filed January 22, 1941.

Another type of included fibrous web, which is suitable for many purposes, may be produced by the application of abrasive material into the surface of a previously formed and consolidated web. The abrasive particles may be distributed over the surface of the web and permitted to filter into the interstices thereof or the grain may be projected therein. In either case the

grains penetrate the surface and into the interstices where they become lodged between the interwoven fibers and sufficiently well anchored for many abrading operations.

By using the methods briefly outlined above and more fully set forth in the above co-pending applications, 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 introduced from 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, embrittling 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.

The invention will be best understood from the following description and the annexed drawing, in which I have shown several embodiments of the invention and in which:

Figure 1 is a section on an enlarged scale through a sheet of material constructed according to one embodiment of the invention;

Figure 2 is a view similar to Figure 1, showing another embodiment of the invention;

Figure 3 is a face view of a piece of fibrous base material showing a part thereof having the abrasive applied thereto as in Figure 1, this view being taken on a greatly enlarged scale;

Figure 4 is a view on the line 4-4 of Figure 3, taken on a still more greatly enlarged scale;

Figure 5 is a section taken at right angles to Figure 4;

Figure 6 is a view similar to Figure 4 but showing another embodiment of the invention;

Figure 7 is a view similar to Figure 5 but showing the same embodiment as the invention appearing in Figure 6;

Figure 8 is a diagrammatic section on a greatly enlarged scale illustrating still another embodiment of the invention.

A fibrous base constructed in the manner briefly described above is the type used in forming the abrasive products of the present invention and has the appearance shown in the upper half of Figure 3, in which it will be seen that a multiplicity of the fibers 5 of the base are interwoven and interlocked, leaving between them, however, a multiplicity of interstices 2, generally of diamond shape, and substantially all of which have gussets 3 formed by the adhesive binder, these gussets filling in the angles between the fibers although leaving the interstices. The present type of fibrous web material is distinct from a matted base of macerated fibers such as is formed from a watery pulp, in which type of base the fibers are softened and weak from the effect of the water and macerating, and also are

matted together with little or no interstitial spaces.

Referring further to the drawing, Figure 1 depicts in enlarged form a fibrous web 1 in which the abrasive grain 4 is held in position at the top surface of the web,—although it is wished to emphasize, not entirely above or upon the above said surface,—solely by engagement in the interstices of the base material. The same embodiment of the invention is shown under still greater magnification for better detail in the lower half of Figure 3, as well as in Figures 4 and 5, wherein it is seen how the abrasive grains 4 penetrate the web by dropping into or by otherwise being positioned in the interstices 2 between the fibers 5 which surround the abrasive grains and hold them in place. This filtering of the grain down among the loosely woven and interlocked fibers in itself is sufficient to retain the abrasive for many purposes.

Figures 2, 6 and 7 show another embodiment of the invention in which the abrasive grain 4 is held within, as well as at the surface of, the fibrous web not only by the interlocking fibers 5 but also by incorporating an adhesive binder within the web. Although the adhesive surrounds the fibers of the web and forms gussets in the angles between adjoining fibers, it is not present in sufficient amounts to fill the interstices of the web. These interstices are left substantially open for reception of the abrasive grain. When desired, an additional sizing or final coating of adhesive 7 may be applied to the upper surface of the web, as an additional means of retaining the abrasive grains.

Figure 8 is a greatly enlarged vertical cross-section of a fragment of an included abrasive fibrous web made according to process of the present invention. The individual fibers of the several membranes have been interlocked to form a non-lamellar web structure and the abrasive granules 4 have been distributed internally of the fibrous web. Due to the filtering action of the fibrous web, during the application of the abrasive material, 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 4 are firmly anchored in position by being surrounded 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 surrounding fibers, which with the aid of the adhesive binder anchors them in such position that the upper cutting edges are free for grinding and polishing operations.

The main adhesive binder is usually applied after the fibrous web has been built up and either before or at the immediate stage of consolidating the web. Whether the abrasive or the adhesive is applied first depends upon the type of article being formed and the degree of penetration of the abrasive into the interstices of the web structure. It is obvious that adding the abrasive prior to applying the adhesive will permit of deeper infiltration of the abrasive into the web than otherwise. 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 glue, a waterproof resilient binder such as a

synthetic or natural rubber binder or the like, or a resinous adhesive in liquid or powdered form.

The abrasive-containing fibrous web may be further modified by the application of various modifying agents during various stages of the building up of the web in the same way in which the adhesive is added and in any required amount. For example, anti-friction ingredients of soapstone, graphite, and the like, can be incorporated in those membranes making up the portion of the web immediately adjacent to the back surface. Likewise, flexibilizing agents can be introduced into the lower portions or throughout the web structure. Similarly the uppermost membranes may be impregnated with an embrittling agent to render them friable in use and thus provide a breakdown of the fibrous material as the abrasive particles become dulled.

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 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 particle will have 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 changes 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 re-inforced 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 superimposed 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. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web structure, the interstices of said web containing included abrasive grains anchored with a suitable adhesive.

2. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web structure, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, the upper surface of said web having a substantially external coating of abrasive grains adhesively secured thereto.

3. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, said web being rendered substantially resistant to water by incorporation of a waterproofing agent within the web.

4. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated

web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, the upper surface of said web having a substantially external coating of abrasive grain adhesively secured thereto, said web being rendered substantially resistant to water by the presence of a waterproofing agent within the web.

5. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a resilient waterproof adhesive.

6. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a resilient waterproof adhesive, the upper surface of said web having a substantially external coating of abrasive grain adhesively secured thereto.

7. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with latex.

8. An abrasive article comprising a fibrous web according to claim 1, and being further characterized by the presence in at least portions thereof of limited amounts of suitable modifying agents.

9. An abrasive article comprising a fibrous web according to claim 2, and being further characterized by the presence in at least portions thereof of limited amounts of suitable modifying agents.

10. An abrasive article comprising a fibrous web according to claim 1 and being further characterized by the presence therein of a flexibilizing agent to render the web pliable in use.

11. An abrasive article comprising a fibrous web according to claim 1, and being further characterized by the presence therein of an embrittling agent to render the fibers of said web appreciably friable in use.

12. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, said web having an abrasive grain content progressively greater from one surface of the web to the opposing web surface.

13. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, said abrasive grain being so distributed that the amount of abrasive grain within said web varies inversely as the distance from the upper surface of said web.

14. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous

membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, said abrasive grain being so distributed that the amount of abrasive grain within said web varies inversely as the distance from the upper surface of said web, the upper surface of said web having a substantially external coating of abrasive grain adhesively secured thereto.

15. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, said abrasive grain being so distributed internally of the web that the amount of abrasive grain within the web varies inversely as the distance from the upper surface of said web, said web being rendered substantially resistant to water by incorporation of a waterproofing agent within the web.

16. An abrasive article comprising a fibrous

web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, the abrasive grain being so distributed internally of the web that the amount of abrasive grain within said web varies inversely as the distance from the upper surface of said web, the upper surface of the web having a substantially external coating of abrasive grain adhesively secured thereto, said web being rendered substantially water resistant by the presence of a waterproofing agent in the web.

17. An abrasive article comprising a fibrous web formed from a plurality of carded fibrous membranes the individual fibers of which are interlocked and interwoven forming interstices therebetween and making a substantially unlaminated web, the interstices of said web containing included abrasive grains anchored with a suitable adhesive, said abrasive grain being so distributed that the size of the abrasive grains within said web varies inversely as the distance from the upper surface of said web.

EDWARD HURST.