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MANUFACTURE OF ABRASIVE MATERIAL

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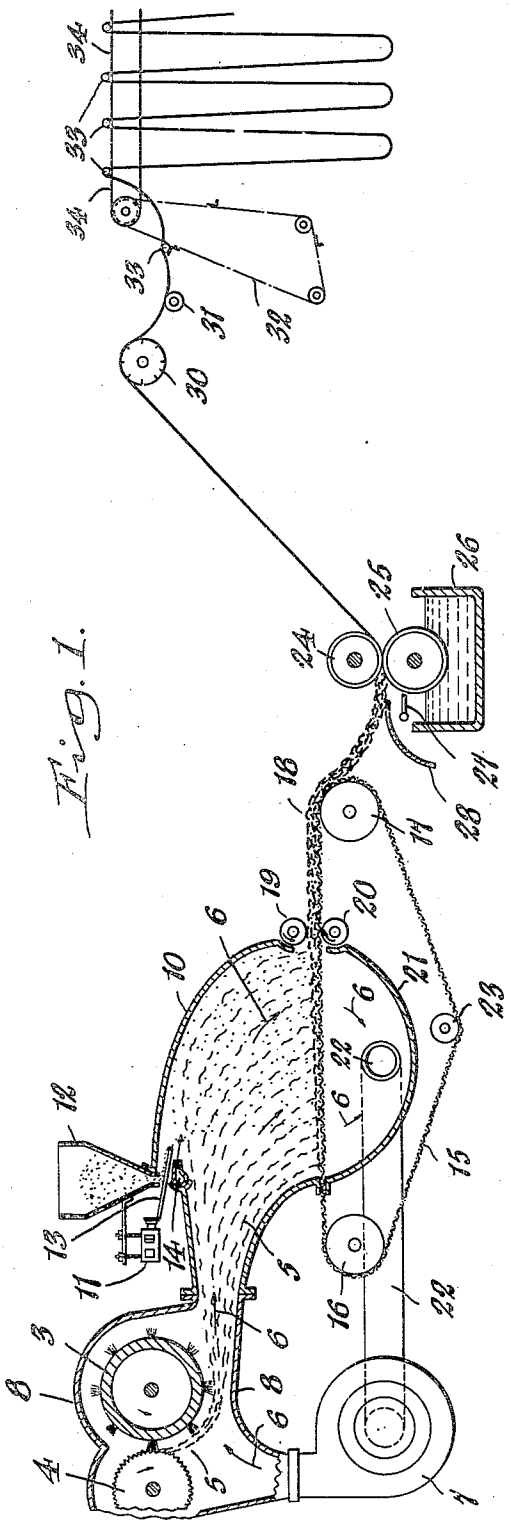

Fig. 1.

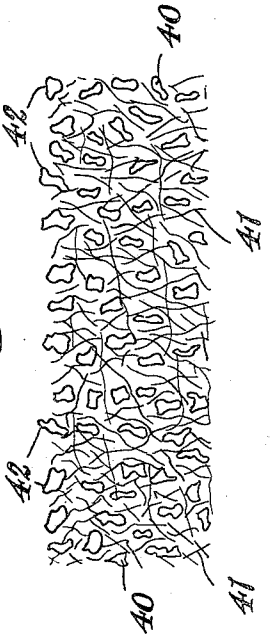

Fig. 2.

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MANUFACTURE OF ABRASIVE MATERIALS

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7 Claims. (Cl. 51—293)

This invention relates to flexible abrasive web material and to methods of manufacture thereof. More particularly, it relates to methods of making abrasive web material of a felted fibrous structure whereby abrasive grain is incorporated internally of the web structure simultaneously with the formation of the fibrous web itself. The abrasive grain may be distributed uniformly throughout the web or incorporated therein by a controlled distribution so that a greater proportion of abrasive resides in a predetermined portion of the web body, particularly that portion adjacent one face of the fibrous web.

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 grain 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 abrasive coated materials 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 other 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.

We have found that abrasive web materials can be produced by forming a web of a plurality of superimposed, carded fibrous membranes, incorporating abrasive material internally of the uncompacted web, applying a suitable adhesive binder and compacting the web to the desired density. The complete process for so doing is set forth in detail in our co-pending application Serial No. 375,514, filed January 22, 1941, which issued as U. S. Patent No. 2,284,716.

We have further found that such abrasive web materials having abrasive grain distributed internally of the web can be readily and quickly produced by a dry-laid process which obviates the need for a number of carding assemblies as in the aforementioned process and therefore requires considerably less floor space and entails a lower expenditure for machinery. It also provides a process of forming long continuous webs of any desired thickness, and at the same time a process which by slight modification can be used to form small amounts of sheet material in the nature of intermittent sheets of relatively small area.

In accordance with the present invention flexible fibrous abrasive sheet material having abrasive grain distributed internally thereof is made by separating a mass of cardable fibrous material into individually separated fibers and introducing the separated fibers into an air stream to form a dry, air suspension or cloud of fibrous material, projecting or otherwise introducing an abrasive material into the cloud of fibers in suspension, and simultaneously collecting the mixture of fibers and abrasive particles upon a suitable support until a loosely felted web or bat of the material of the desired thickness has been built up. When desired the abrasive content is projected into the cloud of suspended fibers with a controlled direction and velocity whereby the abrasive content of the resulting web is progressively greater from one face to the opposite face. A suitable adhesive binder is then applied to the web or sheet of material thus formed, and the fibrous-abrasive web consolidated to the desired density.

Various modifying agents, such as waterproofing compounds, anti-friction agents, embrittling materials, flexibilizers and other fillers, may be incorporated in the web during some stage of its 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, showing one form of apparatus for manufacturing included abrasive webs according to the present invention; and

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

Figure 1 illustrates one of several forms of apparatus which may be employed in manufac-

turing included abrasive web materials by the simultaneous deposition of separated fibers and abrasive granules onto a suitable support such as a continually moving foraminous belt retaining member. The particular apparatus shown comprises a machine for separating the fibers one from another and dispersing the separated fibers into a current of air where the abrasive granules are admixed therewith and the airborne mixture of fibrous material and abrasive grain is deposited simultaneously onto a moving, endless foraminous belt until a fibrous included abrasive web or bat of desired thickness is built up. A suitable adhesive binder is then introduced into the fibrous-abrasive web and the web consolidated to the desired density.

Fiber separating machines such as card rolls, gins, and the like are well known in the trade and detailed description is not considered necessary. For this reason only a portion of such a machine is shown which comprises a doffing brush 3 coacting with a fiber separating saw cylinder 4, and adapted to deliver the separated fibers 5 into an induced air current indicated by the arrows 6 and produced by the fan blower 7. The doffing brush 3 and saw 4 are enclosed by a shell 8 which also serves as a conduit through which the air-dispersed fibers are carried into the deposition chamber 10.

The fibrous material thus dry-processed to provide an air suspension of separated fibers 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.

Abrasive grains are fed from the hopper 12 over the feed gate 13, and into the air suspended cloud of fibers 5. A uniform, steady flow of abrasive grain is maintained through the feed gate 13 by means of a magnetic vibrator 11 attached thereto for setting up a vibratory action to the feed gate. An air jet 14, located beneath the grain feed gate 13 and extending the full width thereof, provides suitable control means for regulating the direction and velocity of introduction of the abrasive grains into the fibrous cloud.

The air jet 14 is not essential as the gravity introduction of abrasive grain at this point distributes the abrasive particles substantially uniformly throughout the cloud of fibers by reason of the currents of air shown by the arrows 6. But by use of the auxiliary air currents set up by the air jet 14 the introduction of the abrasive grain can be controlled in direction and velocity so that it is deposited in greater amounts among those fibers deposited uppermost upon the moving support and therefore provides a progressively greater amount of abrasive material throughout the final web from its under surface to its upper face. The same effect may be obtained by other means as, for example, the introduction of abrasive grains from a secondary hopper positioned near the exit end of the chamber 10 in proximity to the rollers 19, 20.

A mixture of fibers and abrasive grain is then collected simultaneously upon a suitable support until a web 18 of the desired thickness is formed. As shown, the support consists of a moving, endless foraminous belt 15, supported at opposite ends thereof by the rolls 16 and 17 and held under proper tension by roll 23. The belt 15 is operated by driving means (not shown) at a speed at which sufficient deposition of fibers takes place to form the necessary thickness of material. The foraminous nature of the moving belt permits the air to pass on through the support into the lower part 21 of the chamber 10 and into the conduit 22 back to the fan blower 7. Rolls 19, 20 at the outlet side of the chamber 10 provide an initial compacting of the web after which the web is conveyed to the adhesive-applying means.

Passing from the initial compacting rolls 19, 20 the web is delivered to the adhesive binder applying rolls 24, 25. The liquid adhesive binder is contained in a pan 26, which may be water-jacketed and heated as required. Revolving roll 25 is partially immersed in the adhesive and with each revolution transfers a quantity of adhesive binder, determined by the setting of the adjustable scraper bar 27, into the fibrous web. Roll 24 applies sufficient pressure to finally compact the loose fibrous web and aids in forcing the binder adhesive to permeate throughout the web. The surfaces of both rolls 24, 25 are covered with a resilient layer of absorbing material.

An adjustable baffle or shield 28 is provided to cover the front portion of the adhesive pan 26 and prevent any grain falling from the web 18 into the adhesive.

After the included abrasive web is compacted and the proper amount of adhesive binder applied therethrough, it is passed over a suction drum 30 and idler roll 31 to a suitable chamber where it is dried or cured. This chamber contains an endless conveyor 32 which serves to festoon the web onto supporting sticks 33 and to transport these sticks and looped material to the moving rack 34. The speed of this moving rack 34 is so adjusted that the material is properly set or cured by the time it reaches the end of the chamber.

When the abrasive material is taken down from the rack it may be cut into sheets, discs or belts of suitable size or additional coatings in the nature of sizing adhesives may be applied.

In a modified form of the present process the cloud of air-suspended fibers and abrasive material can be collected upon a suitable support in a series of intermittent operations to form a number of separately formed bats of fibrous material which can then be removed, treated with adhesive binder and passed through compacting rolls or otherwise pressed to the desired density. In such a modified procedure the moving conveyor belt 15 is replaced by a suitable wire screen or otherwise foraminous insert-shelf which can be slid into position for reception of the fibers and abrasive. After a bat of material of suitable thickness has been formed it is withdrawn and replaced by another clean support and the operation repeated. Such supporting shelves are best removed when loaded with a loose fibrous bat by pushing it on through the chamber by the insertion of the replacement shelf. The continuous process is normally used but the modified procedure can be adopted to advantage in the preparation of small amounts of fibrous abrasive sheet material in individual bats of

relatively small area, or considerable thickness, or when it is desired to fabricate comparatively small amounts of the desired abrasive product.

Figure 2 is a greatly enlarged vertical cross-section of a fragment of an abrasive fibrous web made in accordance with the present invention. This web has been formed by simultaneous deposition of the mixture of abrasive grain and fibres and the abrasive grains have been uniformly dispersed throughout the fibrous web. The abrasive grains 40 are included internally of the web and distributed throughout its structure and held in place by being intertwined by the individual, long fibers 41 whose lengths are several times the dimensions of the abrasive grit diameters and also by the presence of the adhesive binder used in holding the web in compacted condition. Furthermore, the uppermost granules 42 penetrate through and above the uppermost fibers, which with the aid of an adhesive binder anchors them in such position that the upper cutting edges are free for grinding and polishing operations.

In practicing our invention any of the abrasive materials in common use may be employed, such as silicon carbide, fused aluminum oxide, flint, corundum, emery, rouge and similar substances. The size of the abrasive particles may vary from the finest polishing or buffing powders to the coarser grit sizes used in grinding.

Various modifying agents, such as water-proofing compound, anti-friction agents, embrittling materials, flexibilizers and other fillers, if in dry, pulverized form, may be incorporated in the web during its manufacture in a manner similar to that employed for introduction of abrasive grain therein and thus render the web resistant to water or impart specific desirable properties to the web. Dry, powdered binder elements may likewise be added to the suspended mixture and so be incorporated internally of the resulting structure. The amount and distribution of such specific modifying agent depends upon the desired web properties and the particular portions of the web to be affected thereby.

The physical and abraiding 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. Animal glue, especially when suitably plasticized, has been found to be particularly effective as a binder in forming articles of the present invention since it is strong and tough, non-smearing, inexpensive and is also relatively resilient and flexible. A plasticized glue solution comprised of approximately equal parts of a high grade animal glue and glycerine has been found very satisfactory. Other adhesives, however, which may be used instead of, or along with, glue include a water-proof resilient binder such as a partially vulcanized latex, a synthetic or natural rubber binder or the like, a resinous adhesive in liquid 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 is impractical to obtain with either paper or cloth. The arrangement of fibers in the base material aided by the 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 abrasive clog much more quickly than coarse abrasive.

Another result of the resiliency of the present fibrous, abrasive material is that each particle 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 phenol formaldehyde 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 structure 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 portion, containing a maximum quantity of abrasive grains, 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 articles without spreading such properties to other parts of the web where they are unnecessary or even undesirable.

Furthermore, the present invention provides an efficient and inexpensive method of making an abrasive material 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 material is a strong, uniformly interwoven structure, especially as 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 par-

ticles 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.

We claim:

1. The method of making a flexible abrasive sheet material having abrasive particles included internally thereof which comprises suspending in air a mixture of abrasive particles and fibrous material, collecting said mixture of abrasive particles and fibrous material upon a suitable support to form a loosely felted web containing sufficient abrasive material to impart an effective abrading capacity to the finally formed web, removing the loosely felted web from said support, introducing an adhesive binder into the felted web and consolidating it to the desired density.

2. The method of making a flexible abrasive sheet material having abrasive particles included internally thereof which comprises forming a dry gaseous suspension of individually separated dry fibers, mixing abrasive particles therewith in an amount sufficient to impart an effective abrading capacity to the finally formed sheet material, collecting said mixture of abrasive particles and fibrous material upon a suitable support to form a loosely felted abrasive web, removing the loosely felted web from said support, applying adhesive to the felted web and consolidating to the desired density.

3. The method of making a flexible abrasive sheet material having abrasive particles included internally thereof which comprises forming a dry gaseous suspended cloud of individually separated fibers, introducing abrasive particles into said suspended cloud of fibers in an amount sufficient to impart an effective abrading capacity to the finally formed sheet material, controlling the distribution of abrasive particles by regulating the direction and velocity of their introduction into the suspended cloud of fibers whereby the amount of abrasive included within the resulting web when deposited will be progressively greater from one face to the opposite face, collecting said mixture of abrasive particles and fibers upon a suitable support to form a loosely felted abrasive web, removing the loosely felted web from said support, applying adhesive to the felted web and consolidating to the desired density.

4. The method of making a flexible abrasive sheet material having abrasive particles included internally thereof which comprises passing a stream of air through a substantially closed chamber, introducing a fibrous material in the form of individually separated fibers into said air stream within the chamber to form an air-suspended cloud of fibers, adding abrasive particles to the suspended cloud of fibers in an amount sufficient to impart an effective abrading capacity to the finally formed sheet material, passing a foraminous support through said chamber, simultaneously collecting said fibrous material and abrasive particles upon the moving support to form a loosely felted web containing abrasive particles distributed internally thereof, removing the loosely felted web from said support applying adhesive to the felted web and consolidating it to the desired density.

5. The method of making abrasive materials comprising forming a dry gaseous suspension of individually separated fibers and abrasive grain, simultaneously collecting the fibers and abrasive grain of said dry gaseous suspension on a suitable support to form a fibrous layer thereon, said fibrous layer containing abrasive grains distributed internally thereof in an amount sufficient to impart an effective abrading capacity to the finally formed material, removing the fibrous layer from said support incorporating an adhesive binder in said fibrous layer and consolidating it to the required density.

6. The method of making a flexible abrasive sheet material having abrasive particles included internally thereof which comprises suspending in a gas a mixture of abrasive particles in an amount sufficient to impart an effective abrading capacity to the finally formed sheet, individually separated fibers, and a powdered adhesive, collecting said mixture of abrasive particles, fibers and adhesive upon a suitable support to form a loosely felted abrasive web, removing the loosely felted web from said support and consolidating it to the desired density.

7. The method of making a flexible abrasive sheet material, having abrasive particles included internally thereof, which comprises forming a dry, gaseous suspension of individually separated dry fibers, introducing abrasive particles into the said suspension of fibers in an amount sufficient to impart an effective abrading capacity to the finally formed sheet material, controlling the distribution of abrasive particles by introducing the greater portion of the abrasive grains into that part of the fibrous suspension adjacent the terminal walls of the mixing chamber whereby the amount of abrasive included within said fibrous sheet when deposited will be progressively greater from one face to the opposite face, depositing said mixture of abrasive particles and fibrous material upon a suitable support to form a loosely felted abrasive web, removing the loosely felted web from said support, applying adhesive to the felted web and consolidating to the desired density.

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