Oct. 30, 1956 E. HURST 2,768,483

ABRASIVE ARTICLE AND METHOD OF MAKING

Filed Jan. 19, 1953 2 Sheets-Sheet 1

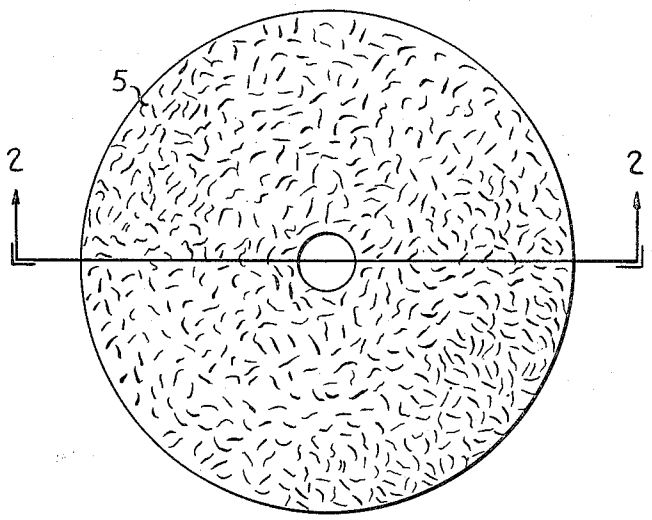


FIG. 1

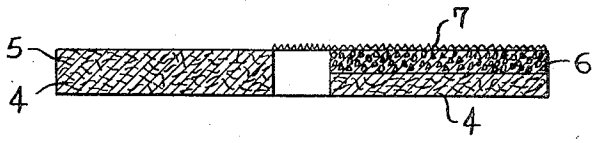


FIG. 2

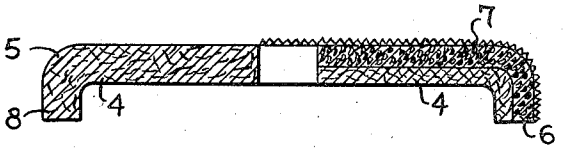


FIG. 3

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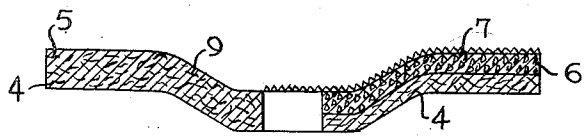


FIG. 4

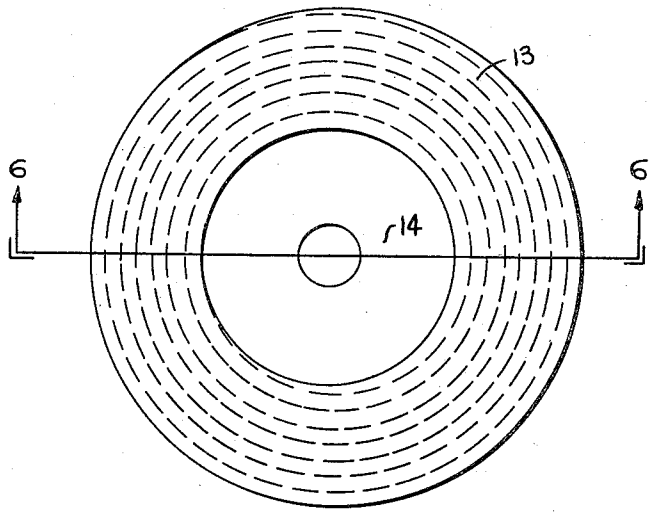


FIG. 5

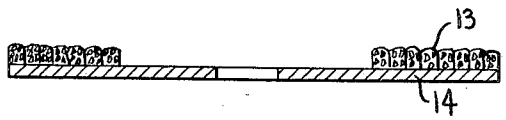


FIG. 6

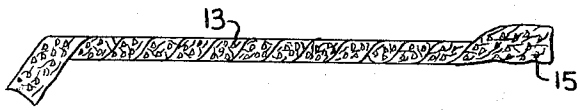


FIG. 7

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United States Patent Office 2,768,483 Patented Oct. 30, 1956

2,768,483

ABRASIVE ARTICLE AND METHOD OF MAKING

Edward Hurst, West Newton, Mass., assignor, by mesne assignments, to Rexall Drug Company, Los Angeles, Calif., a corporation of Delaware

Application January 19, 1953, Serial No. 331,883

9 Claims. (Cl. 51—195)

This invention relates to abrasive articles and to methods for their manufacture. More particularly it relates to an abrasive article of integral fibrous structure wherein the fibers are interwoven and interlocked to form a strongly integrated fibrous body held together by a resinous adhesive binder. The fibrous body constitutes both the backing element of the article and the abrading element thereof, the abrasive particles being distributed throughout and projecting from a portion of the fibrous body extending inwardly from one flat surface while that part of the fibrous body extending inwardly from the opposite surface is free of abrasive material. The articles of the present invention can be made with any degree of flexibility or rigidity depending upon the thickness of the fibrous body and/or the type and amount of resinous binder used to bond the fibrous structure. The invention also pertains to improved methods for making the aforesaid articles.

The present invention is especially applicable to the making of flexible abrasive articles such as abrasive discs although, as already pointed out, it is not confined to the making of flexible discs since similar abrasive articles of fibrous body structure can be made with any degree of rigidity depending upon the thickness of the fibrous body and/or the type and amount of adhesive binder.

Heretofore the manufacture of flexible abrasive discs having the requisite strength and thickness for heavy duty grinding has required the use of backing materials of vulcanized fiber. Such vulcanized fiber is expensive to manufacture because of the long drawn-out chemical treatment required. Furthermore, it has been found extremely difficult, if not impossible, to adhesively attach abrasive grains directly to the surface of vulcanized fiber sheet materials with sufficient tenacity for the grains to be retained during the course of heavy duty grinding operations. For that reason it has been customary practice to use as the backing a layer of vulcanized fiber in conjunction with an adhesively attached layer of a cloth or fabric having greater ability for retention of a surface coating of adhesive and abrasive granules, the resulting combined use of cloth and vulcanized fiber being usually referred to as a combination backing. Obviously, the necessity of not only using vulcanized fiber having an initial high cost, but also the use of various fabrics in combination therewith, has made the manufacture of abrasive coated discs a highly expensive procedure.

In addition to the undesirability of using vulcanized fiber alone or in combination with other materials as a backing for abrasive discs because of the unduly high expense involved, the resulting discs embodying such vulcanized fiber backings have not been entirely satisfactory due to the dimensional instability of such vulcanized fiber backings in the presence of atmospheric moisture often found under humid atmospheric conditions whereby the abrasive discs tend to curl and warp excessively so that they are often difficult and sometimes unfit to use. Moreover, such discs have been limited to a single or double

coating of abrasive grains, with the result that they do not last very long in service.

The manufacture of abrasive discs by previously known methods whereby a flexible backing material is coated with a layer of liquid adhesive, the granular abrasive applied to the adhesively-coated surface, and a second layer of adhesive known as the sizing adhesive applied to the granular abrasive-coated surface, has furthermore entailed a number of operations and costly machinery for coating the backing with the necessary adhesive and abrasive materials, as well as requiring a considerable amount of floor space.

Likewise, rigid abrasive articles such as discs provided with non-abrasive backings have not been entirely satisfactory for one reason or another. For example, considerable difficulty has been experienced in securing the rigid bounded abrasive body to the backing so that the joint between the two is strong enough to resist the torsional stresses and the shocks involved in heavy duty grinding to which such articles are subjected in use. Also, rigid abrasive articles of the above described type as heretofore made have always lacked any ability of the abrasive body to give or yield by the compression of the abrasive particles during use, so that consequently such articles have been harsh in their cutting behavior.

It is an object of the present invention to provide improved abrasive articles in which the undesirable features and disadvantages inherent in backed abrasive articles and their manufacture as known to the prior art as briefly outlined above are avoided. It is a further object to provide new and improved methods for making abrasive articles of improved characteristics. Other objects and advantages accruing from the present invention will become obvious as the description proceeds.

I have found that abrasive articles, either flexible or rigid, of highly satisfactory performance can be made by dispensing with the use therein of vulcanized fiber or combinations of vulcanized fiber with other fabrics, and that such improved articles can be made by processes that are inexpensive to carry out and which do not require the use of expensive equipment.

In accordance with the present invention, abrasive articles are composed of an integrated fibrous structure throughout, the fibrous structure being permeated and unified by a resinous binder and constituting both the backing element and the abrading element of the article. While the entire article including the backing is of an integrated fibrous structure, the granular abrasive of the abrading element of the article is confined to the stratum or portion of the entire article extending inwardly from one face of the article with the outermost granules of abrasive protruding above that surface of the fibrous structure so as to provide an effectively fast cutting abrasive face.

According to the processes of the present invention that part of the fibrous structure which is to constitute the backing portion of the ultimate disc or article is made in the form of a long continuous sheet or web material composed of a plurality of carded fibrous membranes in which the individual carded membranes are agitated during their deposition by a gentle stream of air so that the various membranes making up the fibrous body are interwoven and interlocked with one another to form a substantially non-lamellar fibrous structure. During the forming of this fibrous sheet material and prior to its final compacting, it is impregnated with a resinous binder, such as a phenol formaldehyde resin, the binder being temporarily left in a relatively dry, non-tacky but substantially unpolymerized, or at most only partially polymerized, condition.

A similar fibrous sheet material is also fabricated by similar methods differing only in that the fibrous struc-

ture is filled with a granular abrasive material of the desired grit size. This second fibrous web structure containing abrasive particles also contains a resinous adhesive which may be the same as that incorporated in the first fibrous sheet material, the adhesive also being left in an uncured or partially cured condition.

The two fibrous sheet materials are then combined and subjected to heat and pressure to adhesively unite the non-abrasive fibrous structure with the abrasive-containing fibrous structure to form an integrated sheet material of substantially non-lamellar construction. The combining operation is so carried out, as will be further explained later, that the abrasive particles of the abrasive-containing sheet material are not only distributed throughout that portion of the ultimate fibrous body but the outermost abrasive particles project above the surface of the fibrous structure to the extent that they provide a sharp, fast-cutting abrasive surface. The thusly-formed, abrasive-surfaced fibrous sheet material is cut up into abrasive discs of the desired size.

Obviously, without departing from the present invention, the process is subject to a number of modifications. For example, the separate abrasive and non-abrasive sheet materials can be died or cut into abrasive discs or other shapes separately, and then combined under the necessary heat and/or pressure to integrally unit them to form the final abrasive article, or the two said materials can be initially combined at which time the material is not subjected to sufficient heat and/or pressure to finally cure the adhesive binder, the adhesive binder being given its final cure after the articles are cut from the combined but uncured sheet or web.

A further specific modification of the present invention is the process for making abrasive discs from the aforesaid abrasive and non-abrasive fibrous sheet materials as follows. The non-abrasive fibrous sheet material is cut into disc form whereas the abrasive-containing fibrous sheet material, while the resinous binder thereof is still uncured, is cut in the form of long, narrow strips. The abrasive-containing fibrous strip is then twisted to form an abrasive loaded fibrous rope which is coiled about itself to form a flat annular or disc-shaped coil of material. This coil of material is then placed upon a disc of the non-abrasive fibrous material which may or may not have been previously treated to mature the resinous binder therein, and the entire assembly subjected to sufficient heat and/or pressure to compact the constituent parts and mature the resinous adhesive therein.

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

Figure 1 is a plan view of an abrasive disc made in accordance with the present invention;

Figure 2 is a vertical section through the line 2—2 of Figure 1;

Figure 3 is a vertical sectional view similar to that of Figure 2, but showing a modified form of abrasive disc made in accordance with the present invention;

Figure 4 is a vertical sectional view similar to that of Figure 2, but showing a further modified form of abrasive disc made in accordance with the present invention;

Figure 5 is a plan view of still another modified form of abrasive disc made in accordance with the present invention;

Figure 6 is a vertical section through the line 6—6 of Figure 5; and

Figure 7 is a plan view of a strip of abrasive-included fibrous material depicting it after it has been twisted into rope form, showing one end remaining untwisted to more clearly show the nature of the strip material and the manner in which the rope is formed.

As pointed out above, the abrasive articles as herein constructed are composed of an integrated fibrous structure impregnated throughout with a resinous binder and containing abrasive in a portion of the article extending

inwardly from one face of the article with the outermost abrasive particles projecting from the surface thereof whereas the opposite face and adjoining portion of the fibrous body is free of abrasive. Such abrasive articles are obtained by first separately forming a non-abrasive fibrous structure, and also forming a similar fibrous structure containing abrasive, both the abrasive-containing and the non-abrasive structures containing resinous adhesive binders in unpolymerized, or partially polymerized, condition. The two thusly formed sheet materials are then combined under the proper conditions to form the ultimate article.

The operational steps and apparatus for forming the herein-described fibrous sheet materials are substantially the same as those set forth in U. S. Patent No. 2,055,412 issued to myself and Myrick Crane, and reference is made thereto for a detailed description of the requisite apparatus and manner of using the same. Briefly, the fibrous web is formed by feeding a plurality of thin carded fibrous membranes from a number of carding assemblies onto a moving endless support so that each membrane is deposited or superimposed upon the preceding membranes until a web of loosely interlocked fibrous material of the desired thickness is built up on the travelling support. During the deposition of the individual fibrous membranes, the individual fibers of each membrane thereof are interwoven and interlocked with one another and with the fibers of the adjoining membranes by subjecting the membranes to a gentle air or gaseous agitation during their deposition so that throughout the fibrous body interstices are formed by the interlocking fibers. The size of the interstices and openness of the fibrous structure are controlled by the extent of interweaving and interlocking of the fibers, the more open structures being highly adapted for reception of abrasive particles which are lodged in the interstices and retained therein by the surrounding fibers which, upon further compacting, close about the abrasive grains to provide a strong body. This process of forming an interlocking fibrous body of substantially non-lamellar structure is termed "aerodynamic weaving" and is used to promote the strength and eliminate laminations from the web and, in the case of the abrasive-filled material, provide a structure capable of receiving and retaining abrasive grains of the desired size. While the thusly built up fibrous web material is in a substantially uncompacted condition, a resinous adhesive as, for example, a phenol formaldehyde resin, is incoporated within the fibrous web, after which the web is at least partially consolidated to the desired density. The thusly-formed sheet material is then dried, if necessary, to a non-tacky condition suitable for winding into roll form, although the material is not subjected to sufficient heat to fully mature or set the adhesive binder.

Similarly, a second fibrous sheet material is made in web form, this second sheet material being filled with a granular abrasive of the desired grit size. The procedures for forming the fibrous foundation structure are substantially the same as those employed in forming the non-abrasive fibrous sheet materials above described. Processes for incorporating the abrasive material into the fibrous structure are set forth in full detail in my U. S. Patents Nos. 2,284,739 and 2,369,462. As in the making of the non-abrasive fibrous sheet material, the adhesive is again one of a resinous nature which, at the time of the fabrication of the fibrous web structure, is left in a substantially uncured, or partially cured, condition.

The two fibrous sheet materials made as hereinabove described, one of which is to constitute the backing portion of the abrasive article and the other of which is to constitute the abrading portion of the abrasive article, are then combined and subjected to sufficient heat and/or pressure to fully mature the adhesive contained therein and unite the two sheet materials to form an abrasive material of integrated fibrous structure. The sheet material

can be optionally cut into the form of abrasive discs or other shapes either before or after the combining operation and before or after the adhesive content has been fully matured. According to an alternative procedure the abrasive-containing fibrous sheet material, instead of being directly combined to the fibrous backing portion in the form of a flat sheet, can be further processed to the form of a twisted and coiled rope material before being combined to the fibrous backing. The thickness of the abrasive and non-abrasive fibrous strata, as well as the nature and extent of the resinous binder, determines the rigidity or flexibility of the resulting article. However, regardless of how rigid or flexible the resultant abrasive article may be made, the fibrous base structure of the entire article including that part containing the abrasive content, provides the abrasive particles with a resilient or yieldable background which gives the article a smoothness of operation and lack of vibration peculiarly characteristic of articles of the present invention.

It is essential in subjecting the components of the disc or other article to the heat and/or pressure necessary to mature the adhesive binder and unite the parts to carry out the operation in such a way that the outermost abrasive particles contained in the abrasive-charged sheet material are preserved at the upper surface in a partially submerged position. That is, it is essential for most satisfactory results that the abrasive particles at the surface of the article project substantially above the surface of the fibrous structure so that they present sharp and unencumbered cutting surfaces to the work. This can be accomplished by interposing a thin layer of sponge rubber, felt, or other similar compressible material between the top surface of the abrasive-containing fibrous sheet material and the top press platen or roll during any pressing operation employed to combine or compact the two sheet materials. If the combining operation is carried out by means of passing the two sheet materials jointly between a pair of heated rolls, the upper roll may be provided with a compressible covering of the required character. The abrasive particles at the surface of the fibrous structure are then, when subjected to pressure, temporarily pushed partially into the yieldable surface thus provided instead of being pushed down further into the fibrous structure. When two layers of the fibrous material as hereinbefore described are thusly compressed together, and the two adjoining portions are charged with abrasive particles, the projecting points and edges of the outermost abrasive grains of each layer intermesh with the projecting points and edges of the abrasive grain of the opposing layer and are forced partially into the fibrous structure of the opposing fibrous layer to provide a full interlocking and meshing of the two layers to form a substantially integral fibrous body. This action can be briefly referred to as constituting a lateral telescoping of the fibrous layers.

As a specific example of the manner in which the present process has been carried out and abrasive articles made in accordance with the teachings of the present invention, the following procedure is given for making an abrasive disc, such as that shown in Figures 1 and 2 of the drawing.

A flexible fibrous sheet material was first prepared in accordance with the procedural steps and apparatus of U. S. Patent No. 2,055,412 composed of a plurality of carded membranes of cotton fibers and consisting of a sufficient number of membranes to give a compacted thickness of ⅛ inch was prepared. The impregnating adhesive introduced into the fibrous sheet material was a heat-hardenable, phenol formaldehyde resin such as that known and sold under the trademark "Bakelite" BR5995, the final sheet containing 8–10% by weight of the adhesive based on the dried weight of the sheet material. The adhesive was incorporated into the fibrous sheet material by saturation. After impregnating with the adhesive binder and consolidating the fibrous structure to the desired thickness, the sheet material was dried to a non-tacky condition suitable for winding into roll form by being heated at a temperature of 125° F. for 30 minutes, the adhesive as a result of such heat treatment remaining in a substantially unpolymerized condition.

A second felted fibrous sheet material was then prepared in accordance with the general teachings of U. S. Patent No. 2,369,462, containing approximately 85 parts by weight of fused alumina particles of 24 mesh grit size, 10 parts cotton fibers and 8–10 parts of a heat hardenable phenol formaldehyde resin similar to that used in preparing the aforementioned non-abrasive fibrous sheet material. The abrasive was introduced entirely from one side of the uncompacted fibrous sheet material so that the granular abrasive material was concentrated at and adjacent to the one surface of the fibrous sheet material with the uppermost abrasive particles only partially embedded in the fibrous structure and projecting above the top surface thereof.

As a result of introducing the abrasive particles into the fibrous structure in the aforesaid manner, the abrasive particles project or protrude above the surface of the integrated structure so as to present an unencumbered, fast cutting surface, although the grains extending above the surface extend down into the fibrous structure sufficiently to be held firmly therein by the surrounding fibers and adhesive binder. The resulting integrated fibrous, abrasive-charged web structure is then compacted to an approximate thickness of ⅛ inch between a pair of rolls, at least one of which is provided with a yieldable surface so that the grains are not forced completely into the fibrous structure. The resulting sheet material is then heated at 125° F. for 30 minutes in order to dry the web to a non-tacky condition suitable for winding in roll form or otherwise processing with the adhesive in a substantially unpolymerized condition.

The two thusly prepared fibrous sheet materials, namely, the resin-impregnated, non-abrasive fibrous structure and the resin-impregnated, abrasive-included, fibrous structure, are then combined by passing the two in superimposed relationship jointly through a pair of heated rolls under sufficient pressure to unite the two sheet materials into a single strip of material. Again, precautions must be taken against forcing the uppermost abrasive grains completely into the fibrous structure by using a pair of rolls wherein the roll adjacent the abrasive-charged sheet material is faced with a peripheral layer of yieldable material. Sponge rubber has been found to be a suitable material for facing the roll. The thusly combined sheet material is then died or otherwise cut into abrasive discs of the desired size.

The resulting abrasive discs are then subjected to a further cure in a press at a temperature of 300° F. for 5 minutes to complete the polymerization of the resin binder to a final heat-hardened condition whereupon the abrasive discs are ready for storage or use.

Instead of forming the final abrasive article by directly combining the abrasive sheet material in flat sheet form to the non-abrasive fibrous structure, the abrasive-containing fibrous sheet material can be first cut into long, narrow strips which are twisted into the form of a fibrous rope and coiled to form a flat fibrous coil of the rope of annular or disc shape. The non-abrasive fibrous sheet material is then cut into the form of discs of a diameter substantially equal to the outside diameter of the coil of abrasive-containing fibrous rope. The coiled material is placed upon the disc of fibrous material and the two subjected to sufficient heat and/or pressure to compact and unite the two into a substantially integrated structure. If desired, the fibrous structure constituting the backing element of the abrasive article may be compacted prior to the attachment thereto of the coiled fibrous, abrasive rope.

Although I have set forth specific details for carrying out the present invention, various other procedural modifications thereof can be made without departing from

the principles of the present invention. For example, the separate sheet materials can be first died into disc or other form and the final abrasive articles individually formed by combining the shaped piece of non-abrasive material with the shaped pieces of abrasive material, the two being subjected to sufficient heat and/or pressure to unite the two into an integrated fibrous structure with the abrasive particles projecting from the upper fibrous surface. In fabricating discs by this latter method a multiple platen press may be used wherein a number of discs can be fabricated simultaneously. However, as in the previous method of formation, it is essential that precautions be taken against forcing the abrasive particles completely into the fibrous structure during any pressing operation.

Particularly when the latter method of formation is employed in making discs, further features may be embodied within the scope of the present invention. For example, the fibrous sheet constituting the backing portion of the disc can be cross-piled with the abrasive charged fibrous portion of the disc whereby a high degree of uniformity of strength in all directions throughout the disc is obtained. Also, in molding individual discs, a disc such as that shown in Figure 3 can be formed by molding the disc between shaped platens whereby the outer periphery of the disc is given a curved deflection to provide the disc with a safety edge which is highly adaptable for the sanding of fillets and similar operations, or the disc can be made with a depressed or offset hub or center portion, such as that shown in Figure 4.

It is to be also understood that the present invention is not limited to the use of a single layer of fibrous material for the backing element or for the abrasive portion of the articles since it is fully within the scope of the present invention to form the final article from more than one layer of the non-abrasive fibrous material as the backing element of the article and/or more than one layer of the abrasive-included fibrous material as the abrading element thereof. It is furthermore not necessary that the area of the abrasive-containing fibrous structure be coextensive in area with that of the fibrous backing. For example, an annular shaped abrasive-containing fibrous body can be integrally united to a disc shaped fibrous backing structure.

Referring further to the drawing, Figures 1 and 2 depict an abrasive disc as herein constructed consisting of a non-abrasive fibrous body **4** integrally united to a fibrous body **5**, the fibrous structure **5** being filled with granular abrasive material **6**. Many of the abrasive particles **7** are seen to project above the surface of the fibrous structure. The heat-hardened adhesive binder, by reason of its being in a substantially unpolymerized condition at the time of combining the two portions of the disc, serves to integrally unite the backing portion and the abrasive portion into a single integrated fibrous structure which is practically inseparable under all normal conditions of use, certain of the abrasive particles of the abrasive-included layer being laterally telescoped into the fibrous, non-abrasive layer in the manner previously described. The abrasive particles have been omitted from the left hand half of the disc as depicted in Figure 2 for illustrative purposes only in order to clearly show how the fundamental fibrous structure of the disc is substantially the same for the abrasive and non-abrasive portions of the disc.

The modified form of disc shown in Figure 3 is of a fibrous structure similar to that shown in Figures 1 and 2 but differs therefrom in that it is provided with a safety edge by molding the disc with an annular portion **8** at the periphery deflected from the plane of the balance of the disc. Although in the specific disc shown in Figure 3 the rim of the disc has been deflected so that it lies at almost right angles to the plane of the balance of the disc this deflection of the rim can be set at any lesser degree of angle to the main portion of the disc. Discs of this type are highly adaptable to the grinding and polishing of fillets and similar reentrant surfaces otherwise difficult to reach.

The modified form of disc shown in Figure 4 is likewise of a fibrous structure similar to that shown in Figures 1 and 2 but differs therefrom in that the hub or center portion **9** has been depressed or offset from the plane of the main part of the disc by molding so that when the disc is mounted the mounting nut or bolt thereof does not project above the level of the abrasive surface of the disc.

Referring to Figures 5, 6 and 7, the disc shown in Figures 5 and 6 is composed of an annular coil of abrasive-included fibrous rope compressed and adhesively united to a non-abrasive fibrous body **14**. The abrasive-included fibrous rope **13** which is shown in greater detail in Figure 7, is formed by twisting a narrow strip **15** of abrasive-included fibrous sheet material saturated with a resinous binder into rope form. The twisted rope is wound about itself to form a flat coil of the desired size for mounting upon the fibrous disc backing. As shown in Figure 6 the abrasive surface of the resulting article, as a result of the form in which the fibrous abrasive body is mounted on the backing, is provided with a series of approximately annular depressions formed by the spiralling of the rope and which serve to further enhance the cutting action of the article. Under sufficient pressure, these annular depressions can be caused to practically disappear since under both heat and pressure the abrasive-containing fibrous rope material is subject to a certain degree of plastic flow.

Abrasive articles as herein made exhibit numerous advantages accruing from the method of manufacture and the structure resulting therefrom. For example, the fibrous backing structures of abrasive articles made as herein proposed will not only have a tensile strength comparable to the strength of vulcanized fiber backings but the abrasive portion of the article will be so tenaciously combined with the fibrous body of the backing that there will be no tendency for delamination during any normal conditions of use even though such use may be of the most rugged type. Furthermore, the service life of abrasive articles as herein made will be considerably greater than that provided by discs as heretofore made in which the service life is limited to the life of a single surface coating. This is readily realized by a consideration of the multiplicity of strata of abrasive particles extending at right angles from the original surface and through the body of the abrasive-containing fibrous structure of the disc. The economic saving obtained by being able to eliminate the use of vulcanized fiber backings or other combinations of fabrics equally expensive is also of considerable value. Other advantages and benefits accruing from the present invention will be apparent and obvious from the above description and explanation.

In practicing the invention any of the abrasive materials in common use may be employed, such as silicon carbide, fused aluminum oxide, flint, corundum, emery, and similar substances. The size of the abrasive particles may vary depending upon the type of grinding or polishing operation to which the abrasive article is to be put.

While I have specifically disclosed the use of heat-hardenable phenolic resins as the adhesive binder for the abrasive articles herein described, in the specific and illustrative examples, other resinous adhesives may be similarly employed, alone or in combination, including heat-hardenable or thermosetting resins such as resinous condensation products of monohydric or polyhydric alcohols with various aldehydes such as the various phenol aldehyde resins, resorcinol aldehyde resins, furfural-based resins, urea resins, melamines, and the like. Also other adhesive materials may be used to replace part or all of the thermo-setting resins, such as the various thermo-

plastic resin adhesives, natural and synthetic rubber base adhesives, casein, shellac and the like.

As has been previously pointed out, abrasive articles made in accordance with the methods herein described can be obtained ranging from articles of substantially rigid character to articles which are highly flexible, depending upon the thickness of the fibrous structure composing the article and/or the type and amount of adhesive binder employed. However, irrespective of the overall flexibility or rigidity of the article, the individual abrasive particles are provided with a cushioned support or background which permits the abrasive particles to yield or give under the pressures of grinding, thereby providing a resiliency of cutting action highly beneficial and conducive to a smoothness of operation, freedom from vibration, and enhanced cutting action.

While the preferred embodiments of the invention have been specifically illustrated and described, it is to be understood that the invention may be otherwise embodied and practiced within the scope of the appended claims.

I claim:

1. A method of making abrasive articles which comprises forming a layer of non-abrasive fibrous sheet material, impregnating said sheet material with a resinous binder, independently forming another layer of fibrous sheet material containing granular abrasive, impregnating said abrasive-containing fibrous sheet material with a resinous binder, combining the abrasive and non-abrasive fibrous sheet materials, subjecting the combined sheet materials to sufficient heat and pressure to polymerize the resinous adhesive therein and form an integral fibrous sheet material, and cutting abrasive articles of the desired shape therefrom.

2. A method of making abrasive articles which comprises forming a layer of non-abrasive fibrous sheet material from a plurality of superimposed carded fibrous membranes, impregnating said sheet material with a resinous adhesive, similarly but independently forming another layer of fibrous sheet material containing granular abrasive, impregnating said abrasive-containing sheet material with a resinous adhesive, combining the abrasive and non-abrasive fibrous sheet materials, subjecting the combined sheet materials to sufficient heat and pressure to polymerize the adhesive therein and form an integral fibrous sheet material, and cutting abrasive articles of the desired shape therefrom.

3. A method of making abrasive articles which comprises forming a layer of non-abrasive fibrous sheet material, impregnating said sheet material with a resinous adhesive, independently forming another layer of fibrous sheet material containing granular abrasive in which a portion of the abrasive projects above the fibrous structure of said sheet material, impregnating said abrasive-containing sheet material with a resinous binder, combining the abrasive and non-abrasive fibrous sheet materials, subjecting the combined sheet material to sufficient heat and pressure to polymerize the resin therein and form an integral fibrous sheet material, and cutting abrasive articles of the desired shape therefrom.

4. A method of making abrasive articles which comprises forming a layer of non-abrasive fibrous sheet material, impregnating said sheet material with a resinous binder, independently forming another layer of fibrous sheet material containing granular abrasive in which a portion of the abrasive projects above the fibrous structure of said sheet material, impregnating said abrasive-containing sheet material with a resinous binder, combining the abrasive and non-abrasive fibrous sheet materials, subjecting the combined sheet material to sufficient heat and pressure with a layer of yieldable material against the exposed face of the abrasive-containing fibrous sheet material whereby the uppermost abrasive particles thereof are not forced from their projecting positions completely into the fibrous structure to polymerize the resin therein and form an integral abrasive-surfaced fibrous sheet material, and cutting abrasive shapes therefrom.

5. A method of making abrasive articles which comprises forming a layer of non-abrasive fibrous sheet material, impregnating said sheet material with a resinous binder, independently forming another layer of fibrous sheet material containing granular abrasive, impregnating said abrasive-containing sheet material with a resinous binder, cutting pieces of the desired size and shape from each of the aforesaid sheet materials, combining at least one of the non-abrasive fibrous pieces with at least one of the abrasive-containing fibrous pieces, and subjecting the combined pieces to sufficient heat and pressure to polymerize the resin therein and form an integral abrasive article.

6. A method of making abrasive discs which comprises forming a layer of non-abrasive fibrous sheet material, impregnating said sheet material with a resinous binder, independently forming another layer of fibrous sheet material containing granular abrasive, impregnating said abrasive-containing fibrous sheet material with a resinous binder, cutting said abrasive containing fibrous sheet material into narrow strip form, twisting said fibrous strip material into the shape of a fibrous rope, coiling said rope to form a flat annular fibrous body, cutting a disc shaped piece of the desired size and shape from the aforesaid non-abrasive fibrous sheet material, superposing the fibrous body composed of the coiled rope material and the said disc-shaped piece one on the other, and subjecting the assembly to sufficient heat and pressure to polymerize the resinous adhesive and form an integral abrasive disc.

7. An abrasive article in which the backing element and the abrading element constitute a single, substantially integral fibrous structure, the backing element thereof being combined with the abrasive element by an interlocking and meshing of the backing element and the abrasive element into an integral non-laminated structure, the entire structure being held together by means of a resinous binder contained in both elements.

8. An abrasive disc composed of an annular abrasive-containing, resin-impregnated fibrous mass adhesively united to a non-abrasive resin-impregnated fibrous backing structure, said backing structure being interlocked and meshed with the abrasive-containing fibrous mass to form a non-lamellar integral fibrous structure.

9. An abrasive disc comprising a coil of abrasive-containing, resin-impregnated fibrous rope compacted and adhesively combined to a resin-impregnated fibrous backing in the form of a non-lamallar structure.

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