

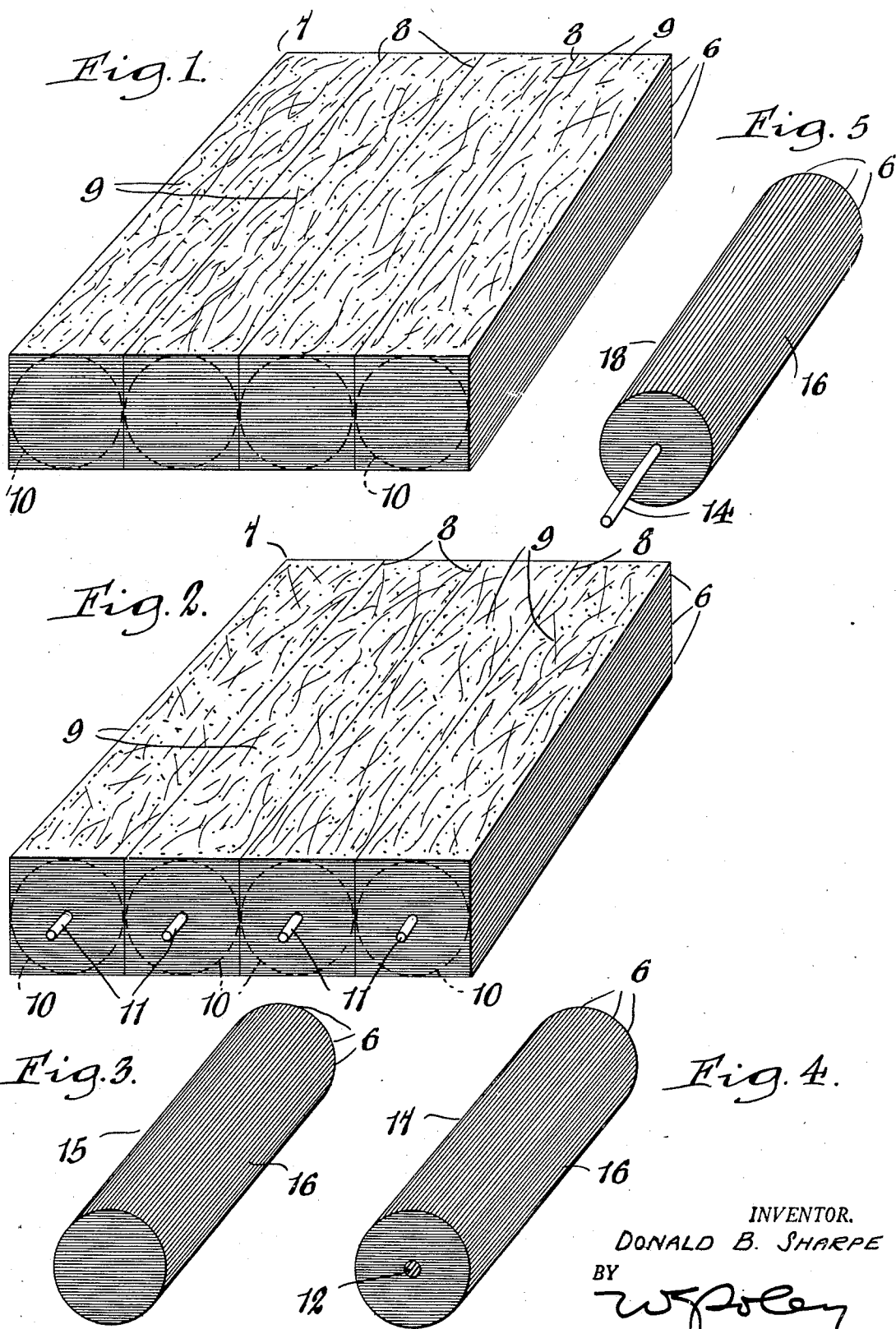
Aug. 28, 1945.

D. B. SHARPE

2,383,519

MANUFACTURE OF ABRASIVE ARTICLES

Filed June 27, 1944



INVENTOR.
DONALD B. SHARPE
BY *W. J. Foley*
Attorney

UNITED STATES PATENT OFFICE

2,383,519

MANUFACTURE OF ABRASIVE ARTICLES

Donald B. Sharpe, North Tonawanda, N. Y., assignor to The Carborundum Company, Niagara Falls, N. Y., a corporation of Delaware

Application June 27, 1944, Serial No. 542,326

8 Claims. (Cl. 51-297)

This invention relates to the manufacture of abrasive articles. More particularly, it relates to the manufacture of bonded resilient abrasive articles of a cylindrical shape, mounted or unmounted, having a mild or "soft" abrading action and formed of a composite of felted fibrous sheets having abrasive grains, and usually an adhesive binder therefor, included internally of the fibrous sheets. The invention especially pertains to improved methods of making such abrasive articles from a plurality of adhesively combined flexible fibrous, abrasive-containing sheets or web material, and especially articles of relatively small size, whereby large numbers of the articles can be more readily and quickly formed and in which the resultant products are characterized by a more uniform density and hardness grade throughout, a freedom from defects, and a mild or "soft" abrasive action which combines an effective cutting rate with an efficient and satisfactory polishing action.

There has always been a need for abrasive articles of the bonded type which would combine an effective cutting action with satisfactory finishing or polishing whereby a reasonable amount of material would be removed from the work being abraded and at the same time the article would be left with a desirable surface finish or polish. For a long time abrasive articles provided for such dual purposes failed to be completely satisfactory in accomplishing both goals and have been found to be defective in one respect or another. Among the reasons for their unsatisfactoriness have been the failure to combine an appreciable degree of cutting ability with a resilience or "softness" of cutting action, non-homogeneity of the abrasive article, lack of permanency of the abrasive content (i. e., failure of the abrasive wheel structure to retain the abrasive particles within the abrading body), non-uniformity of abrasive action, inflexibility, etc. Provision of satisfactory properties in one respect has usually been at a sacrifice of one or more of the other characteristics desirable in such products.

Ordinary bonded abrasive articles of the prior art consisting of abrasive grains and a binder therefor in which various fibers have been incorporated for reinforcing means or for other purposes, on account of their harsh, hard cutting behavior, have never been found suitable for the purposes herein set forth. They do not provide an action equivalent or comparable to the combined "soft" cutting and polishing action of the present articles.

Recently, abrasive articles having a combined

cutting and polishing action have been made from a plurality of felted fibrous abrasive-containing sheets superimposed one on the other and adhesively or otherwise secured in position for grinding and polishing use. Such articles and methods of making them have been set forth and fully described in copending application Serial No. 408,936, filed August 30, 1941, which has issued as Patent 2,355,667, August 15, 1944. According to the procedure described therein, abrasive wheels and shapes are formed by cutting pieces of the abrasive-containing fibrous sheet material of the size and shape of the desired article from a roll of the abrasive web material and assembling the pieces directly to form the desired article. While the resultant articles have shown a resilient cutting action of the desired type, the methods of making them have been fraught with numerous procedural difficulties when applied to a carrying out of the invention on a large or commercial scale. The making of abrasive wheels and bodies of relatively small size having a cylindrical shape, that is, an abrasive body in which the thickness transversely of the cylindrical or peripheral grinding surface is in excess, and usually as much as twice or more, of the diameter of the cylindrical shape, has posed numerous problems. The difficulties of handling large numbers of small individual pieces for making such small cylindrical articles are at once apparent.

Heretofore the only practical and economical method known for making such cylindrical shapes has been a process in which the fibrous sheet material has been cut in the form of long strips which have been spirally wound in convolutions and compacted between two semi-circular plungers to mold and compact the convoluted material to substantially the desired diameter. The portions of the material extruded at the sides have then been trimmed off and the abrasive article remolded and dressed to the final shape. While these articles have shown a resilient cutting action of the desired type they have retained a defect of the convoluted structure which it is desirable to avoid, namely, that the articles have flash markings along the sides, i. e., areas on opposite sides of the article where the convolutions of sheet material have been compressed to a higher degree than the rest of the body. As a result, those parts of the article are one or more grades harder in grinding action than the remainder of the article.

I have discovered improved methods of making these small sized abrasive articles of cylindrical shape whereby the above-mentioned and other difficulties are obviated and by which large num-

bers of abrasive articles can be fabricated efficiently and effectively with an ease and simplicity of manufacture not heretofore attained. By my improved process the need for molds is eliminated and the material requires but a single pressing operation. Furthermore, the peripheral cutting faces of the resulting cylindrical bodies as herein made have an improved uniformity and are retentive of all the soft cutting and polishing characteristics so desirable in such articles. The herein-described methods, by reason of the increased rate of production made possible and the improved uniformity of products obtained thereby, result in economic savings as well as the accrual of other advantages, all of which will become apparent as the description proceeds.

In accordance with the present invention, sheets of felted fibrous abrasive-containing web material are initially formed into a relatively large slab of compacted and matured material which is cut into rectangular sections each of which has a thickness and width equal to or slightly greater than the diameter of the cylindrical shape desired, and the rectangular sections are finally dressed or trimmed, as on a lathe, to a cylindrical shape and, if necessary, cut to length. In forming cylindrical wheels provided with a central arbor hole, the arbor hole may be formed in each rectangular segment at the time the entire slab is formed by the insertion of metal or similar rigid rods midway and as part of the assembly of sheet material in the manner described in detail later. Mounted cylindrical shapes are similarly formed in which the cylindrical body is provided with a mounting spindle, as will also be described.

In order to better understand the nature of the invention, reference is made to the accompanying drawing in which:

Figure 1 is a perspective view of a compacted and matured slab, composed of a number of superimposed sheets of felted fibrous abrasive-containing web material; the slab depicted is marked to show the manner in which a number of abrasive cylinders can be obtained therefrom;

Figure 2 is a perspective view of a slab similar in composition to the slab shown in Figure 1 but which is adapted to the making of cylindrical abrasive wheels having centrally located arbor holes formed by the provision in the slab of a number of rigid metal rods suitably positioned therein;

Figure 3 is a perspective view of an abrasive cylinder representative of those to be obtained from a slab such as that shown in Figure 1;

Figure 4 is a perspective view of an abrasive wheel of the type obtained from the slab shown in Figure 2; and

Figure 5 is a perspective view of a cylindrical mounted abrasive point such as is made from a slab of the type shown in Figure 1.

The abrasive-included fibrous web material used in making the products of the present invention can be manufactured in several ways. The abrasive and adhesive content of the fibrous material is incorporated and distributed throughout the fibrous web at the time of its manufacture and constitutes an integral part thereof. A very satisfactory method of making included abrasive sheet material of the herein required type is that set forth and fully described in U. S. Patents Nos. 2,284,715 and 2,284,716. Briefly, the felted 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 super-

imposed upon the preceding membranes until a web of loosely felted fibrous material of the desired thickness is built up on the traveling support. A number of abrasive grain hoppers are also disposed between the carding assemblies and above the traveling conveyor. Abrasive grain is fed from the hoppers onto the fibrous membranes at various stages in the building up of the final web, so that, as a result, the abrasive material is applied between the individual membranes making up the web and so is internally distributed throughout the fibrous web or sheet. A suitable adhesive binder is then incorporated within the fibrous-abrasive web and the web is consolidated to a desired density and passed to a curing zone, where the adhesive is matured or set. The included abrasive web is then wound into rolls for use as a source material for the manufacture of the products herein described.

In practicing the invention, any of the abrasive materials in common use may be employed, such as silicon carbide, diamonds, boron 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.

Other methods of incorporating abrasive material internally of the fibrous sheet material during its manufacture may be employed. For example, the abrasive binder and the mixture applied to the uncompacted web by the usual adhesive-applying rolls. This method has been found to be particularly satisfactory for the inclusion of the finer abrasive materials of the size employed in buffing and polishing operations.

Another method is to project the abrasive material into the web or sheet after it has been built up to the desired thickness and immediately prior to consolidating the web. The projection of grain is suitably carried out by means of a blast of air or gas against one or both surfaces of the fibrous web, the air stream being laden with the abrasive material to be included internally of the web. The other steps in the formation and consolidation of the web are carried out in a manner similar to that used in the previous procedures.

Felted fibrous webs having abrasive material included within the web and which are suitable for use in the fabrication of the herein-described products can also be made by a modification of the above processes in which the individual fibers are interwoven and interlocked by a gentle air or gaseous agitation of the thin carded membranes during their deposition. This process is termed "aerodynamic weaving" and is used to promote the strength and eliminate any laminations from the web. For a more complete description of such a process and product, reference is made to U. S. Patents Nos. 2,284,738 and 2,284,739 in which further details are also given of the above procedures for including abrasive materials within the fibrous structures.

Abrasive-included sheet material of the herein-required type can also be made by certain felting procedures employing the various types of paper-stock fibers and including abrasive therein at the time of making the sheet materials. One satisfactory method of making the abrasive-included sheet material by wet felting procedure is that set forth and fully described in copending application Serial No. 461,139, filed October 7, 1942.

Briefly, the felted fibrous paper-stock material having abrasive grain incorporated internally

thereof is made by first forming a liquid, usually aqueous, suspension of fibrous material, the fiber content of the suspension being very low and in the neighborhood of 0.5 to 5% of the suspension, collecting the fibrous suspension on a suitable support, introducing abrasive grains with or without an adhesive binder into the fibrous web while it is in a highly aqueous, or fluid, condition, extracting the water or other liquid medium from the web, and further drying and compacting the web to the desired density. Optionally, the abrasive grains can be given a preliminary coating of a suitable adhesive, which is preferably soluble or softenable in the liquid suspending medium or a component thereof, to assist in holding the fibrous abrasive-containing web in compacted form after it has been compressed. The process can be carried out in a number of ways.

In one such modification the fibrous suspension of paper stock is deposited upon a foraminous support in one step and the abrasive grain is deposited in several increments while the web is still in a highly aqueous or fluid condition. That portion of abrasive applied first penetrates deepest into the web structure, and the abrasive of each succeeding deposition penetrates the web to a lesser degree by reason of the continually decreasing amount of water present and the consequent thickening of the fibrous body. The distribution of abrasive within the web can thus be controlled by variation of the amounts and places of deposition during the dewatering of the web so as to obtain any desired effect.

In a modified form of the process a fluid fibrous suspension is collected upon a plurality of revolving foraminous supports, such as cylinders, which are partially immersed in the fibrous suspension. The thin fibrous membranes collected upon the foraminous supports are then successively transferred to a common carrier, usually a moving endless felt blanket or belt, in superimposed relationship to form a fibrous web structure. Abrasive grain is incorporated into the fibrous web structure by deposition or projection between and into the various individual membranes as they are deposited on the carrier support. This method has the advantage that since the fibrous suspensions can be varied, the composition or structure of various portions of the web can be varied if desired. Adhesive binders can be incorporated in the fibrous web, regardless of the procedure used, at various stages in the process, such as by inclusion in the fibrous suspension, introduction during dewatering of the web, with the abrasive grains as a coating thereon, or after the web has been substantially dewatered and prior to the final compacting and drying of the web.

A still further modification which can be used to make fibrous abrasive materials is the process of forming a web fibrous abrasive lap by a cylinder wet-press process, in which a fibrous suspension similar to that used in the cylinder method above is fed, usually from a single cylinder mold, onto a traveling wet felt carrier belt. The thin fibrous membrane is conveyed over one or more suction boxes to remove a portion of the water and passed between a pair of pressure rolls. As the fibrous material passes between the pressure rolls it is transferred to the upper pressure roll upon which it is wound in a series of successive layers until the desired thickness of fibrous material is obtained, whereupon the material is removed by hand or by a suitable knife or doctor blade. Abrasive grain is fed onto the

fibrous sheet previous to its passage between the pressure rolls and is thereby incorporated within the fibrous structure.

Another satisfactory method of making included abrasive paper-stock web material is that set forth and fully described in copending application Serial No. 461,140, filed October 7, 1942.

In accordance with the process therein set forth, fibrous paper stock abrasive sheet material is made from an aqueous suspension of around 3% fiber content in which the fibers are distributed in the suspension as substantially individually separated fibers. This fibrous suspension is agitated, beaten, or otherwise mechanically treated, with sufficient vigor to render the fibers partially gelatinous, abrasive grain being incorporated in the suspension to the desired extent. A sufficient amount of abrasive grain is added to provide an abrasive grain content of over 40%, and preferably 60-70% or more by weight, of the final product after the water has been extracted. The agitation of the fibrous suspension previous to and/or during the addition of abrasive grain is very important in preparing a liquid in which the abrasive particles will remain uniformly in suspension. The stability of suspension is believed to be due, at least in part, to the adherence of the abrasive particles to the partially gelatinized fibers. The amount of agitation or heating of the fibrous suspension necessary to provide a suitable stable mixture of abrasive and fiber of the proper consistency depends upon the size of the abrasive particles. For example, a very slight agitation serves the purpose when the finest abrasive polishing powders are used whereas with the use of 60 or 80 grit abrasive grains, it is desirable to subject the suspension to a much longer and/or more vigorous agitation. Suspension of the abrasive particles may be assisted by incorporating an adhesive in the fluid mass, either in the form of a preliminary coating of the abrasive particles or by the addition of the adhesive to the liquid. In either case, the adhesive should preferably be soluble in the liquid medium of the suspension or at least softenable or soluble in a component thereof.

After a fiber-abrasive suspension of suitable consistency has been prepared as above outlined, it is flowed or otherwise deposited on a suitable foraminous support in the form of a continuous, highly aqueous layer from which the water or other liquid suspending medium is extracted, and the resulting film is further dried and compacted to the desired density. These operations can be performed by flowing the suspension onto a moving endless wire screen or by collecting a plurality of thin membranes onto cylinder molds and transferring them to a suitable felt blanket in superimposed relation to form a web of the desired thickness. While it is usually desirable to proceed in the described manner of forming continuous fibrous webs by this particular method, the process can be practiced in modified form by using the same thin suspension of fibers and abrasive to form individual abrasive-included sheets by a series of discontinuous steps. Adhesive binders can be incorporated in the fibrous web, regardless of the procedure used, at various stages in the process, such as by inclusion in the fibrous suspension, introduction during dewatering of the web, as a coating on the abrasive grains, or after the web has been substantially dewatered and prior to the final compacting and drying of the web.

Modifying agents such as waterproofing compounds, anti-friction agents, flexibilizers, plasticizers and other fillers may be incorporated in the web at the time of making irrespective of the particular procedure followed, in order to render the web resistant to water or impact other specific desirable properties to all or certain controlled portions of the web.

Abrasive-included felted fibrous web material such as that made by any one of the aforementioned methods is used as a source or raw material for the making of abrasive articles in accordance with the present invention. 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.

A flexible, felted fibrous sheet material made in accordance with the teachings of U. S. Patents Nos. 2,284,738 and 2,284,739, and containing approximately 75% of fused alumina particles of 80 mesh grit size, 15% cotton fibers and 10% natural rubber derived from latex is sized with a 20% aqueous solution of casein glue (such as "Casco" glue marketed and sold by Casein Corporation of America) to provide about 10% casein by weight based on the fibrous sheet material.

Referring further to the drawing as a means of illustrating more clearly the manner in which the present process is carried out, the roll of adhesively-sized abrasive-included fibrous web material is cut into the form of individual sheets of the material. In the particular form shown in Figure 1 a number of square sheets 6, measuring $5\frac{1}{2}$ " on a side, are assembled in superimposed relation, pressed between the platens of a hot press and subjected to a pressure of approximately 5000 pounds per square inch and a temperature of 260° F. for 30 minutes for a 1" thick slab. A sufficient number of the individual sheets 6 are used to obtain a slab 7 which, when compressed, has a thickness through the sheet material at least equal to and usually slightly greater than the diameter of the cylindrical abrasive body to be formed therefrom. The slabs are then usually given an oven cure as by heating for 10 hours at 260° F.

The slab is then cut along the parallel lines 8 into a number of rectangular shaped segments 9 of square cross-section, the width across the segments being substantially the same as the thickness through the segments. Each of these rectangular segments 9 is centered on a lathe and trimmed and dressed to a cylindrical shape as shown by the dotted outline 10 of Figure 1. If the length of the slab is greater than the length of the cylindrical abrasive article to be formed, the rectangular pieces can be cut to the proper length before or after trimming to shape. The slab illustrated, if given a thickness of $1\frac{1}{4}$ ", can be cut into four rectangular pieces $5\frac{1}{2}$ " long and of approximately $1\frac{1}{4}$ " square cross-section, each of which can be trimmed in a lathe to provide an abrasive cylinder of the same length, or shorter if desired, and having a diameter of $1\frac{1}{4}$ ". It is desired to hold the thickness and width of the rectangular pieces as close as possible to the desired diameter of the cylindrical grinding shape to be formed in order to avoid an excessive amount of trimming.

Cylindrical abrasive wheels having a centrally located arbor hole for mounting can also be made by modifying the procedure given above for the

making of solid cylindrical articles. A slab for forming an arbored abrasive wheel of cylindrical shape is shown in Figure 2. In forming such a slab, after assembling one-half the number of individual sheets 6 of abrasive web material, a number of small metal rods 11 are equally positioned parallel to one another and spaced so as to be located centrally of the ends of the rectangular segments 9 to be cut from the slab and protruding from both sides of the sheet material. These metal rods are usually wrapped in paper or given a coating of other disintegrable material to facilitate their removal after the surrounding sheet material has been compacted. Notched end templates or similar means can be used to maintain the rods in correct alignment. After carefully positioning the metal rods the remainder of the sheets is placed over the rods and the entire assembly subjected to heat and pressure to consolidate the sheet material into slab form and set the adhesive binder, following which the slabs are usually given an oven cure as described above. The metal rods then are removed to provide a number of holes 12 suitably located to serve as mounting arbors in the finally formed abrasive wheels. The slab is then cut along the parallel lines 8 to provide a number of rectangular pieces of square cross-section, each having an arbor hole 12 centrally located with respect to the cross-section and running lengthwise of the piece. These pieces are then trimmed to cylindrical shape and cut to length if necessary the same as is done in forming the cylindrical abrasive sticks.

Mounted articles of cylindrical shape can also be made by the present process, in which case a slab of the type shown in Figure 1 is formed and the same procedure is followed as that for making a solid cylindrical grinding stick except that just prior to trimming the rectangular piece to cylindrical shape a hole centrally located of the end cross-section of the piece is drilled in from one end of this piece to the required depth and the desired mounting spindle 14 inserted and adhesively secured therein by means of a suitable cement. Although a cold-setting type cement can be used, a heat-hardenable cement is preferred in which case the article is given an oven cure. A satisfactory heat-hardenable cement can be made by mixing a thermo-setting liquid phenolic condensation product with a suitable filler such as powdered quartz to provide a material of the desired consistency for use.

Figures 3, 4, and 5 illustrate the type of abrasive articles obtained by practicing the present invention.

Figure 3 shows a solid cylindrical abrasive stick 15 formed from a large slab in accordance with the procedure described above and composed of portions of a plurality of abrasive-included felted fibrous sheets 6 which have been adhesively combined and compacted. It is to be observed that the edges 16 of the sheet material extend transversely of the cylindrical grinding surface to provide a high degree of uniformity in cutting action over the entire grinding area. The advantages of such a disposition of the sheet material to the grinding edge are obvious. For example, when so presented to the work being surfaced, there is considerably less tendency for the work to be striated than is the case when the sheeted material is placed otherwise with respect to the grinding surface.

Figure 4 shows a cylindrical abrasive wheel 17 of similar construction but provided with an arbor hole 12. Figure 5 shows a mounted cylindrical abrasive tool 18 mounted on a spindle 14. It can

be seen that both articles possess the same structural advantages of the abrasive stick shown in Figure 3 in view of the similar disposition of the sheet material with respect to the abrading surfaces.

It has been found that the character of the abrasive articles produced by the herein-described process, as for example the grade of hardness, can be altered by variations in the quantity and character of the adhesive binder employed in making the abrasive-containing, fibrous sheet material, and particularly by the choice of auxiliary or supplemental adhesive substance which is admixed with the sheet material as a size thereto. It is desirable that the adhesives selected for making the aforesaid articles do not smear during grinding operations. This is especially true in polishing wheels and devices where smearing of the bond tends to produce a "hot cutting" or burning action which is ruinous to the finish being produced.

Among those substances which can be satisfactorily used as bonding materials herein in addition to the specific adhesive sizing composition set forth above, and which are non-smearing, are included glue adhesives, particularly when treated with plasticizing agents such as ethylene glycol, sorbitol, glycerine and the like. The plasticizer may amount to as much as 40% by weight of the total adhesive binder. Other non-smearing adhesives which can be used are casein glues, natural or synthetic rubber latices, urea resins, phenol-aldehyde resins and other natural or synthetic resins, or mixtures of two or more of such adhesives.

The herein-described invention offers numerous improvements and advantages over the prior art. It provides a practical method of fabricating small sized abrasive articles of the mounted or unmounted type such as grinding and polishing wheels, abrasive sticks, mounted points and the like, having a "soft" or resilient combined cutting and polishing action.

The articles of the present invention have a relatively high rate of stock removal from the material being ground and at the same time produce a surface finish equal to that obtained by an ordinary bonded abrasive article embodying abrasive particles several grit sizes smaller. Abrasive products made as herein described cut both efficiently and effectively, with an accompanying polishing action, and are capable of high operating speeds without chattering, operating smoothly to remove burrs and produce very high finishes on metal castings when operated at 6000 to 9500 surface feet per minute. It is theorized that the "soft" cutting action of such abrasive articles is the result of the abrasive grains being cushioned by the surrounding felted fibers and binder so as to prevent gouging and scratching and to provide the abrasive grains with a yielding background by which they are caused to maintain individually more effective contact with the work and at the same time absorb and take up inequalities of surface so as not to scratch or mar the surface being finished.

Although I have set forth, in the specific example, certain specific conditions, it will be understood that my invention is not limited to the conditions there described. Generally speaking, I have found it to be desirable to mold the slabs under pressures of the order of 1000-2000 pounds per square inch. The length of time that the slab is subjected to heat and pressure is determined to some extent by the size and thickness of the slab being molded but is usually in the

range of 20-60 minutes. Likewise, articles of different grades can be made by varying the fiber, abrasive and adhesive content of the abrasive-containing felted fibrous material, the amount and kind of adhesive applied thereto as a size, and by the density to which the slabs from which the articles are made are compacted. In general the sheet material contains 5-20% adhesive, 5-20% fibers, usually cotton, and 65-90% abrasive.

Having described and set forth the invention in detail, the scope of the invention is not to be confined other than by the appended claims.

I claim:

1. The method of making an abrasive article having a cylindrical shaped, bonded abrasive body from a plurality of superimposed sheets of felted fibrous abrasive-containing web material which comprises assembling a plurality of sheets of felted fibrous, abrasive-containing web material in superimposed relation, subjecting the assembly of said web material to pressure to compact it into a slab having a thickness at least equal to the diameter of the cylindrical shaped body to be made, cutting a strip from said slab, said strip having a width at least equal to the diameter of the cylindrical shaped body to be made, and trimming the resulting strip to the desired cylindrical shape.

2. The method of making an abrasive article having a cylindrical shaped bonded abrasive body from a plurality of superimposed sheets of felted fibrous abrasive-containing web material which comprises assembling a plurality of sheets of felted fibrous abrasive-containing web material in superimposed relation, subjecting the assembly of said web material to heat and pressure to compact it into a slab having a thickness at least equal to the diameter of the cylindrical shaped body to be made, cutting a strip from said slab, said strip having a width at least equal to the diameter of the cylindrical shaped body to be made, and turning the resulting strip to the desired cylindrical shape.

3. The method of making an abrasive article having a cylindrical shaped bonded abrasive body from a plurality of superimposed sheets of felted fibrous abrasive-containing web material which comprises assembling a plurality of sheets of felted fibrous abrasive-containing web material in superimposed relation, subjecting the assembly of said web material to pressure to compact it into a slab having a thickness at least equal to the diameter of the cylindrical shaped body to be made, cutting a strip from said slab, said strip having a width at least equal to the diameter of the cylindrical shaped body to be made, and trimming the resulting strip to the desired cylindrical shape and cutting the cylindrical shape to the required length.

4. The method of making a bonded abrasive wheel having an axial length at least as great as the diameter of said wheel which comprises assembling a plurality of sheets of felted fibrous abrasive-containing web material in superimposed relation, placing smooth cylindrical rods within the said assembly of sheet material midway from top to bottom of the assembly of sheet material and positioned parallel to one another and spaced at a distance from one another slightly greater than the diameter of the abrasive wheel to be so made, said rods having a diameter substantially equal to the diameter of the arbor hole of the abrasive wheel being made, subjecting the said assembly to pressure to compact it into a slab

having a thickness at least equal to the diameter of the abrasive wheel being made, removing the said rods from the compacted slab, cutting the said slab into rectangular strips along lines parallel to and equidistant from the holes formed by the said rods, and trimming the resulting rectangular strips to a cylindrical shape.

5. The method of making a mounted abrasive article comprising a mounting spindle and a bonded abrasive body of cylindrical shape which comprises assembling a plurality of sheets of felted fibrous abrasive-containing web material in superimposed relation, subjecting the assembly of said web material to pressure to compact it into a slab having a thickness at least equal to the diameter of the cylindrical shaped body to be made, cutting a rectangular strip from said slab, said strip having a width at least equal to the diameter of the cylindrical shaped body to be made, reducing the length of the rectangular shape to the length of the cylindrical body to be made, boring a hole in the center of one end of the resulting rectangular piece, inserting and adhesively securing a mounted spindle therein, and trimming the mounted rectangular piece to a cylindrical shape.

6. The method of making a bonded abrasive wheel having an axial length at least as great as the diameter of said wheel which comprises assembling a plurality of sheets of felted fibrous abrasive-containing web material in superimposed relation, encasing a number of rigid rods individually in paper sheaths to facilitate the extraction from the surrounding compacted mass, placing said encased cylindrical rods within the said assembly of sheet material midway from top to bottom of the assembly of sheet material and positioned parallel to one another and spaced at a distance from one another slightly greater than the diameter of the abrasive wheel to be so made, said rods having a diameter substantially equal to the diameter of the arbor hole of the abrasive wheel being made, subjecting the said assembly to heat and pressure to compact it into

a slab having a thickness at least equal to the diameter of the abrasive wheel being made, removing the said rods from the compacted slab, cutting the said slab into rectangular strips along lines parallel to and equidistant from the holes formed by the said rods, and trimming the resulting rectangular strips to a cylindrical shape.

7. The method of making a bonded abrasive wheel having an axial length at least as great as the diameter of said wheel which comprises assembling a plurality of sheets of felted fibrous abrasive-containing web material in superimposed relation, encasing a number of rigid rods individually within a thin film of material so that said rods can be easily removed from the surrounding compacted mass, placing said rods within the said assembly of sheet material midway from top to bottom of the assembly of sheet material and positioned parallel to one another, and spaced at a distance from one another slightly greater than the diameter of the abrasive wheel to be so made, said rods having a diameter substantially equal to the diameter of the arbor hole of the abrasive wheel being made, subjecting the said assembly to heat and pressure to compact it into a slab having a thickness at least equal to the diameter of the abrasive wheel being made, removing the said rods from the compacted slab, cutting the said slab into rectangular strips along lines parallel to and equidistant from the holes formed by the said rods, and trimming the resulting rectangular strips to a cylindrical shape.

8. An abrasive article of manufacture comprising a cylindrical abrasive body comprising a plurality of adhesively combined sheets of superimposed felted fibrous abrasive-containing web material in compacted condition, the edges of said sheets lying transversely of the cylindrical cutting surface of said abrasive body and substantially parallel to the longitudinal axis of said cylindrical body.

DONALD B. SHARPE.