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METHOD OF MAKING ABRASIVE ARTICLES

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Fig. 1.

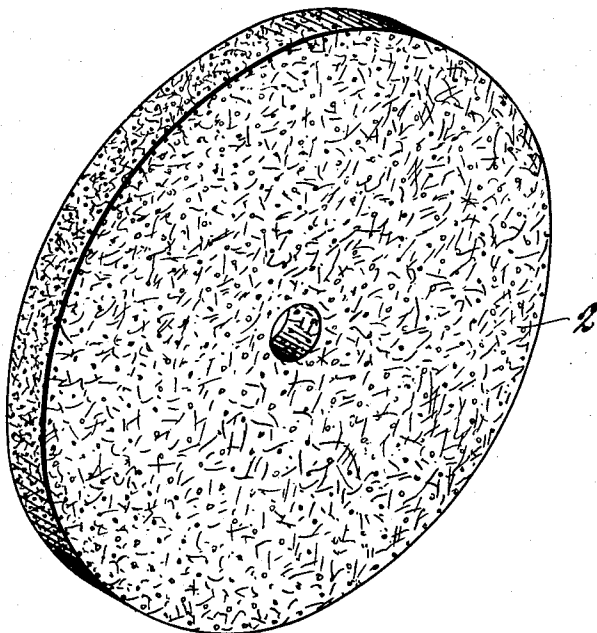
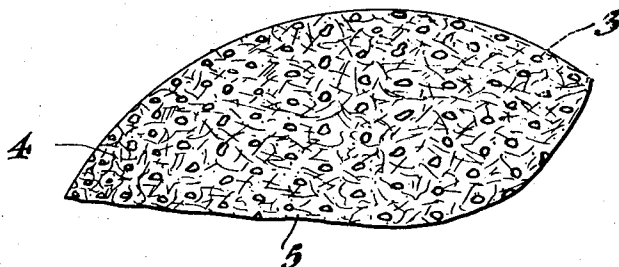


Fig. 2.



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METHOD OF MAKING ABRASIVE ARTICLES

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4 Claims. (Cl. 51—293)

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This invention relates to the manufacture of abrasive articles. More particularly, it relates to bonded abrasive articles having a soft, resilient cutting action combined with an effective polishing value, and to methods for the manufacture of such articles. The invention is especially concerned with bonded abrasive articles of the aforesaid type in which the abrasive grains of the article are supported and held within a surrounding fibrous matrix which is held firmly together by a relatively minor amount of an interstitial bonding medium.

It is recognized that in the past grinding wheels and similar bonded abrasive articles have been made in which the abrasive body of abrasive grains and bond has been strengthened by the inclusion in the mix from which the article has been made of a relatively small amount of fibers as a reinforcing means for the bond. However, it has always been the primary purpose to employ the fibers as a reinforcing element for the bond and the proportions of the various ingredients to one another, such as the proportion of fibers to bond, abrasive grains to fibers and abrasive grains to the bond, have been such as to leave the abrasive article with substantially the same grinding characteristics that it might have had without the use of fibers. In fact, the purpose has been to so use the fibers as not to influence or interfere with the normally high cutting rate of the article.

Past experience has been that in attempting to incorporate fibers within an abrasive mixture the fibers suffered repeated severing by being pinched between the hard abrasive grains during processing and consequently are reduced in length to the point where they lose the greater part of their value as a reinforcing material. When incorporated into abrasive mixtures according to prior art practices the fibers which have not been repeatedly cut to extremely short lengths usually become matted together or balled to a lumpy condition instead of being uniformly dispersed throughout the mixture as individual fibers which are capable of interlocking one with the other so as to act as an effective means of reinforcing the bond. Consequently, the use of fibers as a reinforcing material in bonded abrasive articles has never been received favorably by the art.

It is an object of the present invention to provide a new and improved type of bonded abrasive article having a soft or resilient cutting behavior coupled with a satisfactory polishing action. It is also an object to provide abrasive articles of

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fibrous structure in which the fibrous material is uniformly dispersed throughout the article in sufficient quantity to provide a highly resilient background or surrounding matrix for the abrasive grains of the article. It is a further object to provide abrasive articles of resilient character and of the requisite strength with the use of a minimum of bonding material. Still another object is to provide a rubber bonded abrasive article containing a relatively small amount of bond and a prominently fibrous structure, which article will have a highly desirable combination of cutting and polishing abilities. Another object is to provide a method of facilely making articles of the herein described type. Other objects and advantages accruing from the present invention will become apparent as the description proceeds.

In accordance with the present invention abrasive articles of the desired type are made by milling a mass of resilient bonding medium, such as a mass of natural or synthetic rubber, to plasticize it, after which the abrasive and fibrous material in sheet form, together with any other desired ingredients such as sulfur or other vulcanizing agents for the rubber, are milled into and blended with the plasticized mass by further milling. The abrasive granules and fibers are introduced into the plasticized mass in the form of a relatively thin, carded fibrous sheet material having the abrasive particles included within and dispersed throughout the fibrous web structure, usually with sufficient adhesive to maintain the material in sheet form. The abrasive-fibrous sheet material is added to the originally plasticized mass until the latter amounts to only 4-8% of the total bulk of material. The continued milling operation breaks down the sheet material and disperses the fibers and abrasive grain thereof uniformly throughout the mass of plasticized resilient bonding medium to provide a homogeneous mass. The breakdown of the abrasive-included, fibrous sheet material is so complete that all resemblance to a sheet-like structure is lost, and substantially all the fibers thereof are separated and dispersed with the abrasive granules throughout the plasticized mass. Any bonding materials originally contained in or on the fibrous sheet material is assimilated by and becomes a part of the plasticized rubber with which the sheet material is milled. During the milling operations the fibers of the sheet material are repeatedly severed to a comminuted form so that in the final milled condition the bulk of the fibrous

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material has a fiber length in the neighborhood of .2 to .4 millimeter or less. This comminution of the fibers does not interfere with the cushioning action of the fibrous material, and with the amounts used the comminuted fibers provide a resilient background for the abrasive material contained in the mass.

When the operation is carried out on a pair of ordinary rubber mill rolls the resulting mass is removed from the mill rolls in the form of a slab of material, the rolls being spaced to provide a slab of the desired thickness. The desired articles, such as abrasive wheels, are obtained by dieing or otherwise cutting pieces of the required size and shape from the slab and subjecting them to heat and pressure to form the desired article. The resulting article is usually then given further heat treatment such as an oven cure to mature the bonding medium.

An abrasive-included fibrous sheet material which has been found highly satisfactory for carrying out the present invention is that produced in accordance with the teachings of U. S. Patent No. 2,284,739 and fully described in U. S. Patent No. 2,284,738. Briefly, such material comprises a relatively thin sheet or web composed of a number of superimposed carded fibrous membranes having the fibers of the various membranes interwoven and interlocked to provide a substantially non-laminated felted fibrous structure. During the process of forming the web and prior to the step of compacting the material the fibrous structure is charged with granular abrasive material and usually an adhesive binder to provide a substantial amount of included abrasive which is held in place to a large extent by the interlocking carded fibrous structure as well as by means of the adhesive binder. A typical fibrous material made in accordance with the aforementioned patents comprises approximately 29% by volume of cotton fibers, 50% by volume of used alumina granular abrasive and 21% by volume of a resilient rubber base bonding adhesive, although these proportions may be varied somewhat to suit the purpose for which the material is to be used. For details pertaining to the described abrasive-included, fibrous sheet materials and methods of making them reference is made to the aforesaid patents which are to be considered as part of the present disclosure.

The present invention is not necessarily limited to the use of the specific fibrous sheet material described above. Other abrasive-included, fibrous sheet structures may be employed such as, for example, those described fully in U. S. Patents Nos. 2,284,715 and 2,284,716.

In order that the nature of the present invention may be more fully understood, reference is made to the drawing, in which

Figure 1 is a perspective view of an abrasive wheel 2 made in accordance with the present invention; and

Figure 2 is a highly enlarged fragment of the abrasive wheel shown in Figure 1, and schematically shows the structure of the abrasive wheel. As therein shown, the wheel is composed of abrasive particles 3 embedded in a fibrous matrix 4, the wheel being strengthened by an interstitial bonding material 5.

In making abrasive articles such as abrasive grinding and polishing wheels according to the present invention in which abrasive-included, fibrous sheet material such as that above described is used, a mass of the desired resilient binding medium is placed in a mill and sub-

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jected to a preliminary milling procedure to plasticize it. Substances which have been found satisfactory as the resilient binding medium include not only natural rubber but also such synthetic rubbers or elastomers as the various butadiene type polymers and copolymers such as butadiene-acrylic nitrile copolymers, butadiene-styrene copolymers, polychloroprene, copolymers of butadiene with acrylic and methacrylic acids or esters, butadiene-dichlorostyrene copolymers, and the like. These various elastomers may be used singly or in combination with one another to provide the desired resilient binding medium.

It is preferred to carry out the milling operation on a roll mill of the type commonly used for milling rubber stocks since the resulting mass is obtained in a slab form most convenient for dieing out disc shaped pieces and the like for forming abrasive articles. However, if roll mill equipment is not available a Banbury mill or similar milling equipment may be used to plasticize the material and also for later admixing and blending of the fibrous and abrasive ingredients, although with the latter equipment the resulting mass is not obtained in a form most convenient for making abrasive wheels and like shapes. Furthermore, this equipment becomes worn more quickly to the point of requiring repair, especially when used for admixing the abrasive-fibrous material.

After the rubber or elastomer has been milled to the desired degree of plasticity the abrasive-included, fibrous sheet material is gradually milled into the plasticized mass with continued milling. At the same time any other ingredients to be incorporated into the mass, such as sulfur or other vulcanizing agents, accelerators, fillers and the like, are added and likewise milled into the material. The percentage of sulfur added depends upon the degree, or grade, of hardness desired in the finished article and upon the grit size of the abrasive grains contained in the sheet material. Usually in making abrasive wheels of the herein described, resilient cutting type highly satisfactory results have been obtained with 5, 10, and 20% sulfur by weight, based on the weight of the rubber or other resilient binder, for 36, 50 and 80 grit size abrasive grains, respectively. Generally speaking, less sulfur is required in articles containing coarser grit size abrasive grain.

Abrasive-included, fibrous sheet material is added until the originally plasticized rubber or other binding medium constitutes only a minor part of the entire mixture, usually amounting to 4-8% of the total mass. When combined with the binder or bonding materials originally present in and/or on the abrasive-included fibrous sheet material and which becomes assimilated by the original plasticized mass of rubber, the total bonding matrix is in the neighborhood of 7 to 12%, by weight, of the milled mass. Milling is continued until the fibrous sheet material has been completely broken down and lost all semblance to sheet material or fragments thereof and the mixture becomes homogeneous throughout. When the milling operation is performed on rolls the material is removed from the rolls in the form of a slab of the desired thickness and the required shapes died or otherwise cut from the slab material. The died-out pieces are placed in a hot press and subjected to a short heat treatment under pressure followed by an oven cure over a period of hours to finally mature the binder. After the customary dressing and edg-

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ing operations, which are performed according to standard procedure, the article is ready for use.

In order that the nature of the present invention may be fully understood, and for purposes of illustrating the manner and types of material which may be used, the following specific examples are given.

Example I

	Parts by weight
Butadiene-acrylic nitrile copolymer rubber stock (such as that known and sold by B. F. Goodrich Company of Akron, Ohio, under the trade-mark name of "Hycar" OR-15) -----	50
Abrasive-included, cotton fiber sheet material -----	940
Sulfur -----	10

The abrasive-included fibrous sheet material is of the type described in U. S. Patent No. 2,284,738 and comprises about 29% by volume of felted cotton fibers in the form of a thin, substantially non-laminated, carded fibrous web containing around 50% by volume of 50 mesh size fused aluminum oxide abrasive grain held within and distributed throughout the fibrous structure, together with about 21% by volume of an adhesive binder comprising a rubber base adhesive.

In processing the above materials according to the teachings of the present invention, the butadiene-acrylic nitrile copolymer is first milled alone on a pair of water-cooled rolls until it is sufficiently plasticized to receive the remaining ingredients. This preliminary plasticizing takes at most only a few minutes. The sulfur and the abrasive-included fibrous sheet material are then slowly added to the plasticized mass of rubber material with continued milling until the entire amount has been added to the mass on the rolls. The milling operation is continued until the abrasive-included, fibrous sheet material has been broken down or disintegrated and homogeneously blended into the plasticized mass of butadiene-acrylic nitrile stock. The fibrous sheet material in the course of this milling operation is so completely disintegrated that it loses all semblance to a sheet structure. The fibers become separated and comminuted and with the abrasive are dispersed throughout the plasticized mass and any original binder in the sheet material is assimilated and becomes an integral part of the plasticized rubber mass. The milling time for the breaking down and blending operation is around 20 minutes. The resulting homogeneous mass is removed from the rolls in the form of a slab $\frac{1}{8}$ of an inch thick. Disc-shaped pieces are then died out from a slab of the material and pressed in a hot press at 2000 pounds per square inch pressure at a temperature of 260° F. for 15 minutes, after which the pressed pieces are given an oven cure at 300° F. for 8 hours to finally mature the binder. After dressing and edging in the usual manner the resulting abrasive wheels are ready for use.

Example II

	Parts by weight
Butadiene-acrylic nitrile copolymer rubber stock (such as that known and sold by B. F. Goodrich Company of Akron, Ohio, under the trade-mark name of "Hycar" OR-15) -----	50
Abrasive-included, cotton fiber sheet material -----	945
Sulfur -----	5

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The above mixture is processed in the same manner as that set forth in Example I. The abrasive-included, fibrous sheet material is the same in type as that used in Example I. As a result of the lower amount of sulfur the finished articles are of a softer grade and are more resilient in character than the articles made of the mixture of Example I.

Example III

	Parts by weight
Butadiene-acrylic nitrile copolymer rubber stock (such as that known and sold by B. F. Goodrich Company of Akron, Ohio, under the trade-mark name of "Hycar" OR-15) -----	50
Abrasive-included, cotton fiber sheet material -----	947½
Sulfur -----	2½

The above mixture is processed in the same manner as that set forth in Examples I and II. The abrasive-included, fibrous sheet material is of the same type as that used in Example I. As a result of the reduced amount of sulfur the finished articles will be of softer grade and greater resilience than the articles made from the mixtures of Examples I and II.

Example IV

	Parts by weight
Polychloroprene rubber stock (such as that known and sold under the trade-mark "Neoprene" by E. I. du Pont de Nemours & Co.) -----	100
Abrasive-included, cotton fiber sheet material -----	2000
Zinc oxide -----	5

The abrasive-included fibrous sheet material is of the type described in U. S. Patent No. 2,284,738 and comprises about 29% by volume of cotton fibers in the form of a thin substantially non-laminated carded fibrous web containing around 50% by volume of 180 mesh size fused aluminum oxide abrasive grain held within and distributed throughout the fibrous structure together with about 21% by volume of an adhesive binder comprising a rubber base adhesive.

The mixture is processed in the same manner as that set forth in the preceding examples. This mix, however, tends to become hot in processing and therefore the mill rolls must be continuously cooled to prevent the mass being plasticized from becoming overheated.

Example V

	Parts by weight
Polychloroprene rubber stock (such as that known and sold under the trade-mark "Neoprene" by E. I. du Pont de Nemours & Co.) -----	50
Butadiene-styrene copolymer rubber stock (such as that known and sold under the trade-mark "Hycar" OS-10 by B. F. Goodrich Company of Akron, Ohio) -----	62.5
Abrasive-included, cotton fiber sheet material -----	2120
Sulfur -----	12.5
Zinc oxide -----	5

The abrasive-included fibrous sheet material is of the type described in U. S. Patent No. 2,284,738 and comprises about 29% by volume of cotton fibers in the form of a thin, substantially non-laminated, carded fibrous web containing around 50% by volume of 320 mesh size fused

aluminum oxide abrasive grain held within and distributed throughout the fibrous structure together with about 21% by volume of an adhesive binder comprising a rubber base adhesive.

The mixture is processed in the same manner as that set forth in the preceding examples.

Throughout the specification and claims, where reference has been made to an abrasive-included, fibrous sheet material it is intended to include not only the sheet material in the form of complete, continuous sheets of the described material, but also fragments or scrap pieces of the same sheet material such as may result from or remain after cutting out disc-shaped pieces or other shapes from a roll or sheet of the material for other usage. Also, such scrap fragments, or even the complete sheets of fibrous sheet material may have a surface sizing of adhesive substance without detracting from its usefulness and without excluding it from the sheet material found satisfactory and intended for use within the scope of the present invention.

The resulting abrasive articles, such as those illustrated in the examples set forth above, are characterized by a resilient or soft cutting action combined with a polishing ability obtained as a result of the fibrous structure of the body of the article. The relative proportions of the various components of the abrasive body one to another is an important element in providing the desired combination of properties. It has been found that the fibrous component of the final product should amount to at least 20% by volume of the finished article, and is usually in the neighborhood of 25 to 35% by volume. The highly fibrous structure of the abrasive bodies provides a naturally resilient surrounding or background for the individual abrasive particles so that each particle is cushioned in a yielding support so that it is free to give slightly when subjected to pressure although it is at the same time sufficiently supported to maintain firm contact with any object being ground and polished. Consequently, each abrasive particle is permitted to perform a maximum amount of cutting work without having any harshness of action such as would produce scratching. The retentive qualities of the fibrous structure itself permits the amount of binder in the article to be held within relatively low limits, the amount of resilient binder in the final article being from about 7-12% by weight of the finished product. These various factors dealing with the specific proportions of the different ingredients to one another as well as the method of processing the composition and fabricating the abrasive article combine to provide an abrasive article of highly valuable properties and characteristics.

It is to be understood that the term "rubber" as employed herein and in the claims is intended to include within its scope not only natural rubber but also those various synthetic rubbers or elastomers developed for use in place of rubber, including the various polymers and copolymers of butadiene and the like, polychloroprene, butadiene-styrene copolymers, butadiene acrylic nitrile copolymers, and the like.

Having described the invention in detail, it is desired to claim:

1. The method of making bonded abrasive articles which comprises milling a mass of rubber to plasticize it, adding to the plasticized mass granular abrasive and fibers in the form of a sheet material composed of abrasive grains, fibers and adhesive binder, continuing milling to break down said sheet material and uniformly blend it with the plasticized rubber, continuing the addition of the abrasive-fiber sheet material with further milling until the original rubber mass amounts to only about 5% of the total mass, removing the mixture from the mill and subjecting it to heat and pressure to form an abrasive article.

2. The method of making bonded abrasive articles which comprises milling a mass of rubber to plasticize it, adding to the plasticized mass granular abrasive and fibers in the form of a sheet material composed of abrasive grains, fibers and adhesive binder, continuing milling to break down said sheet material and uniformly blend it with the plasticized rubber, continuing the addition of the abrasive-fiber sheet material with further milling until the original rubber mass amounts to only 4-8% of the total mass, removing the mixture from the mill and subjecting it to heat and pressure to form an abrasive article.

3. The method of making bonded abrasive articles which comprises milling a mass of rubber to plasticize it, adding to the plasticized mass granular abrasive and fibers in the form of a sheet material composed of abrasive grains, fibers and adhesive binder, continuing milling to break down said sheet material and uniformly blend it with the plasticized rubber, removing the mixture from the mill and subjecting it to heat and pressure to form an abrasive article.

4. The method of making bonded abrasive articles which comprises milling a mass of rubber to plasticize it with the addition thereto of a vulcanizing agent and a sheet material composed of abrasive grain, fibers and adhesive binder, continuing milling to break down said sheet material and uniformly blend it and the vulcanizing agent with the plasticized rubber, continuing the addition of the abrasive-fiber sheet material with further milling until the original rubber mass amounts to only 4-8% of the total mass, removing the mixture from the mill and subjecting it to heat and pressure to form an abrasive article.

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