

Sept. 3, 1957

E. HURST
ABRASIVE ARTICLE

2,804,733

Filed May 21, 1953

2 Sheets-Sheet 1

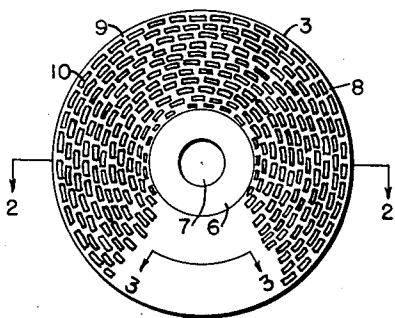


FIG. 1

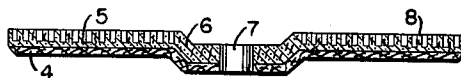


FIG. 2

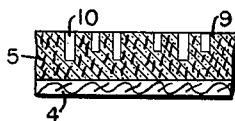


FIG. 2 A

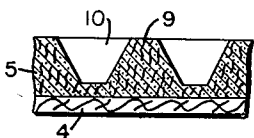


FIG. 3

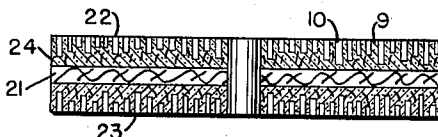


FIG. 4

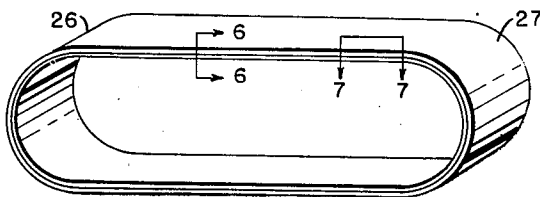


FIG. 5

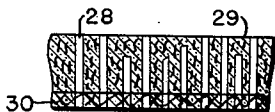


FIG. 6

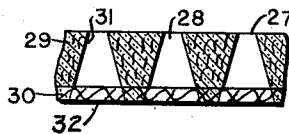


FIG. 7

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2,804,733

Filed May 21, 1953

2 Sheets-Sheet 2

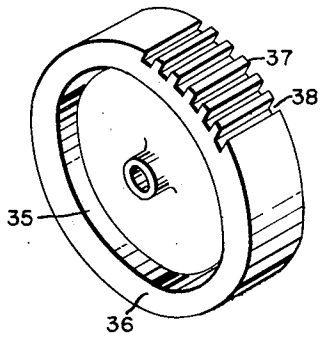


FIG. 8

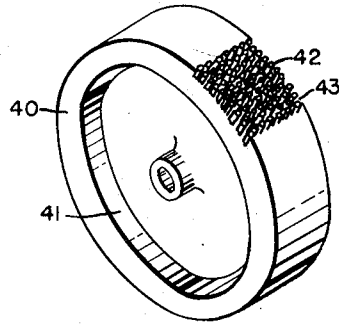


FIG. 9

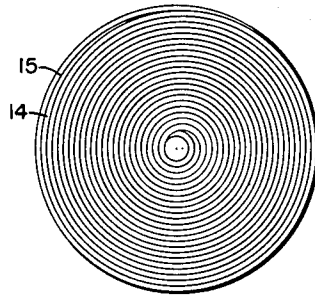


FIG. 10

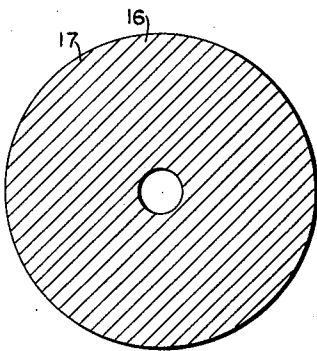


FIG. 11

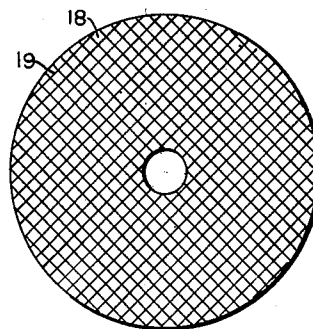


FIG. 12

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2,804,733

ABRASIVE ARTICLE

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Application May 21, 1953, Serial No. 356,557

5 Claims. (Cl. 51—206)

This invention relates to abrasive articles of manufacture. More particularly, it relates to abrasive articles such as abrasive discs, belts, grinding wheels, polishing devices such as buffing wheels, set-up wheels, discs, and the like, comprising a fibrous abrasive-containing abrading body reinforced with one or more layers of fabric and featuring a working face having a multiplicity of cutting areas interrupted by clearance areas which preferably are self-discharging in character.

Abrasive articles such as grinding wheels made by the time-honored methods of molding the desired shape from a mixture of granular abrasive material and suitable bonding ingredients have long been made and used for grinding and polishing operations on practically all known materials. The problems of reducing the amount of loading and glazing of the abrading surface of the article, particularly where certain thermoplastic or ductile materials are ground have been attacked by adjusting the character and/or the amount of the bond to render the abrasive body more friable and susceptible to breakdown in use and/or by rendering the abrasive article more porous and free-cutting.

More recently, there has been developed a line of abrasive articles such as abrasive wheels, discs, belts and other devices in which the abrasive article has been composed of an abrasive-included fibrous sheet material which has been assembled to form the various abrasive articles of conventional shape. These more recently developed abrasive products have been satisfactorily used in manifold grinding and polishing operations. However, the use of these articles in the grinding of certain ductile or thermoplastic materials especially, has presented a problem of loading of the abrading surface with the grinding or polishing detritus so that they have not always been as satisfactory in use as might be desired.

Due to the type and manner of construction of these abrasive-included fibrous abrasive products the solution of the problem of loading during use is not to be accomplished entirely by modification of the type and amount of bonding materials or the provision of a porous or friable body structure in the article.

My copending patent application Serial No. 306,379, filed August 26, 1952, now abandoned, discloses and describes a new type of mold structure and, inter alia, proposes the use of the disclosed mold structures for the making of various types of abrasive products. This application is a continuation-in-part of that application and is directed to the various types of abrasive articles which can be made by using the molds of my aforesaid application.

It is an object of the present invention to provide abrasive articles composed of abrasive-included fibrous material which will cut satisfactorily and effectively with a minimum amount of loading.

It is a further object of the present invention to provide abrasive articles of the aforesaid type which will

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not only perform efficiently in grinding and/or polishing operations with a minimum of loading but will be further featured by a self-discharging or non-loading ability.

It is a still further object to provide abrasive articles composed of abrasive-included fibrous material having a patterned or configurated abrading face or surface composed of a multiplicity of raised cutting areas separated by depressed clearance spaces.

It is a still further object to provide polishing and finishing devices such as buffing wheels, discs, belts and the like, provided with a working face composed of a multiplicity of individual flexible abrading members composed of abrasive-included fibrous material.

Other objects and advantages accruing from the practice of the present invention will become apparent as the description proceeds.

In accordance with the present invention, abrasive articles such as grinding and polishing wheels, abrasive discs and belts, set-up wheels, buffing wheels and devices, and similar types of abrasive articles composed of an abrasive-included fibrous material, and usually reinforced by one or more layers of reinforcing fabric to enhance the mechanical strength of the finished article, are provided with a patterned or configurated abrading surface whereby the abrasive functions of the article are enhanced and the tendency of the article to load with detritus is minimized. The functional or cutting surface of the article, instead of being substantially continuous and at a single performance level or plane is so molded that the cutting surface of the article comprises a multiplicity of raised cutting areas interspatial with depressions or depressed areas. The abrasive characteristics of the article when made according to the present invention will consequently depend not only upon the amount and grit size of the granular abrasive and other constituents of the abrasive-fibrous body of the article but will be controlled to a marked degree by the relationship as to distribution and proportion of one to the other of the raised cutting areas and the depressed areas of the working face of the article. The depth of the depressed areas may vary considerably depending upon the type of article being made and the purpose for which it is intended and may in some articles extend only part way into the abrasive-included fibrous body whereas in other articles, the clearance spaces may extend all the way to or through the backing fabric. In fact, in certain preferred embodiments of the present invention the self-unloading or discharging of detritus by the article in operation is enhanced by molding the abrasive-included fibrous body of the device in such a way that the depressed clearance areas of the cutting face extend all the way through the article and are provided with a reversed taper whereby the abrading body has a multiplicity of perforations or holes extending through from the working face to the rear or opposing side of the article with the holes tapered to provide an increase in clearance area progressively from the working face to the opposing face of the device.

I have had highly satisfactory results in the making of abrasive discs, buffs, and set-up wheels with configurated cutting surfaces, all in accordance with the present invention, by molding the abrasive devices, using a mold of the type described in detail in my aforementioned copending application Serial No. 306,379, filed August 26, 1952, now abandoned, from a plurality of layers of abrasive-included fibrous sheet materials, such as those disclosed and described in my U. S. Patent No. 2,284,738, issued on June 2, 1942. Such abrasive-included fibrous sheet material can be described as a non-lamellar web structure of individual cardable interlocked textile fibers, adhesive binder and abrasive granules which are distributed internally of and throughout the fibrous web and are firmly anchored in position by being sur-

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rounded by the long fibers. Although the uppermost granules penetrate through and above the surface of the web, they are also securely attached by the surrounding fibers, which with the aid of the adhesive binder anchors them in position. Using a mold such as that shown in Figures 1 and 2 of my pending application above-mentioned and embodying a strip material having an edge configuration such as that shown in Figure 13 of that application, the mold is placed upon the bottom platen of a hydraulic press with the configured face of the mold facing upwardly. Several layers of the abrasive-included fibrous sheet material cut in disc form are placed upon the upper face of the mold, and a layer or layers of suitable backing material such as rubber-sized or latex-sized canvas or duck superimposed upon the layers of abrasive-containing fibrous sheet material. A plain flat plate, or, if it is desired to omit the backing and make an abrasive disc or wheel and impart a configured surface to both sides of the abrasive wheel or disc a second mold member comparable to the lower mold member, is then placed on top of the assembly of materials to be molded, and pressure applied. The platens of the press are steam or electrically heated when it is desired to supply heat for the molding operation. The pressure and heat are applied and maintained for a sufficient period of time to heat- and pressure-set the material after which the pressure is released by withdrawal of the platens of the press. Supplementing oven curing can be employed, if desired. It is desirable at this point to call attention to the mobile characteristics of the disclosed type of molds, namely, that following release of the pressure and removal of the mold from the press the mold itself, by reason of the ability of the individual laminations or windings of strip material making up the mold face to telescopically move with respect to one another, greatly assists in the release of the material being molded from the patterned molding surface.

In order to understand better the nature of the herein-described articles and the methods of making and using the same, reference is made to the accompanying drawings showing specific examples of abrasive devices made in accordance with the present invention, and in which

Figure 1 is a plan view of a depressed center abrasive disc with an interrupted cutting surface made in accordance with the present invention;

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

Figure 2a is a highly enlarged fragmentary sectional view of a section taken along the same line as Figure 2;

Figure 3 is a fragmentary vertical section, highly enlarged, taken on the circumferential line 3—3 of Figure 1 in from the periphery and showing further details of the patterning of the abrasive-included fibrous body of the disc of Figure 1;

Figure 4 is a view similar to that of Figure 2 of a further embodiment of the present invention showing a double faced abrasive wheel having a configured cutting surface on both side faces of the wheel with an internal reinforcing fabric layer;

Figure 5 is a perspective view of an endless abrasive belt in which the depressed clearance spaces in the working face of the belt extend through the entire thickness of the belt including the fabric reinforcing or backing layer and are provided with a reverse taper;

Figure 6 is a vertical sectional view, highly enlarged, through the line 6—6 of Figure 5;

Figure 7 is a similar highly enlarged sectional view through the line 7—7 of Figure 5;

Figure 8 is a perspective view of a still further embodiment of the present invention in the form of a set-up wheel;

Figure 9 is a view in perspective of still another embodiment of the present invention in the form of a buffing wheel;

Figures 10, 11 and 12 are top plan views of abrasive discs showing the various forms of configured cutting

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faces which can be embodied in abrasive devices made in conformance with the present invention.

Figures 1—3, inclusive, depict a depressed center flexible abrasive disc which is representative, but illustrative only, of one of the many forms of abrasive articles which can be made in accordance with the present invention. As shown, the disc 3 comprises a fabric backing layer 4 and an abrasive-included fibrous body 5 having a depressed center portion 6 and a central mounting arbor 7. The disc is so molded that the working face 8 of the disc is patterned or configured to provide a discontinuous cutting surface made up of a plurality of small abrasive areas 9 separated by a multiplicity of depressions or clearance areas 10 which are distributed over the entire working face of the disc. In the specific disc shown in Figures 1—3, and particularly as is brought out in the detail views, Figures 2a and 3, the depressed areas 10 are disposed about the surface of the disc in a continuous spiral from the periphery in to the central depressed portion of the disc. Furthermore, the depressions 10 are narrow slots tapered in the wider direction (see Figure 3) and extend deeply into the disc almost through the abrasive-included fibrous body of the disc thereby providing ample clearance for grinding detritus which tends to be ejected from the clearance spaces by the action of the disc in use since the multiplicity of clearance areas are such that the disc is relatively highly flexible and the flexing action of the disc as it is presented to the workpiece and as it leaves the workpiece serves to free the clearance areas from any detritus which is lodged there in the course of grinding. While the disc shown illustrates clearly one specific embodiment of abrasive disc which can be made in accordance with the present teachings it is readily apparent that innumerable variations in the particular pattern of working face is possible without departing from the principles involved. The working characteristics of the disc can be selected and determined not only by the nature of the abrasive-included fibrous body 5, such as the amount and size of granules of abrasive material and the specific bonding ingredients embodied therein but also by the size and disposition of the clearance areas 10 over the working face of the disc as well as the depth and frequency of the individual indentations 10 and the relationship and proportion of raised cutting areas 9 and depressed or clearance areas 10 over the working face of the disc. For example, increase in the depth of the indentations tends to promote flexibility of the resulting article and increasing the amount and frequency of the indentations in relation to the raised areas 9, especially when combined with relatively deep indentations tends to promote greater softness of abrading action in the disc. For example, when it is desired to make an abrasive device in which the disc would have a buffing or polishing action the working face of the disc would be so molded with depressed areas separating a plurality of small individual raised cutting areas so that the disc surface would consist of a multiplicity of individual small raised portions similar to pile members separated by a surrounding depressed area. On the other hand, if an abrasive disc having more vigorous grinding action and stiffer operating properties is desired the indentations would not extend as deeply into the abrasive-included fibrous body of the disc and the area of the raised portions 9 would more likely exceed in surface area the combined areas of the depressed portions 10, the latter being isolated one from the other by the remaining raised portion of the cutting face of the disc.

Figures 10, 11 and 12 depict modifications of surface patterns or configurations which can be imparted to the cutting surface of abrasive discs to provide a multiplicity of raised cutting portions interspatial with depressed clearance portions of the disc.

Figure 10 shows a disc in which the raised cutting areas 14 of the disc surface are in the form of a continuous Archimedes spiral extending from the arbor to the periphery of the disc, the individual convolutions of the

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raised spiral portion being separated by the adjoining convolutions of an adjoining spiral groove 15.

Figure 11 shows an abrasive disc in which the raised areas and the depressed or clearance areas are in the form of a multiplicity of parallel ridges 16 and grooves 17 extending in straight lines across the working face of the disc.

Figure 12 diagrammatically shows a similar abrasive disc in which the working face of the disc is composed of a plurality of separated raised islands 18 formed by molding the disc with two series of parallel grooves 19 extending in directions at right angles to one another. Other surface configurations can be imparted to the working face of the disc, the above few examples being cited for illustrative purposes only.

Abrasive discs of the above-described types having configured cutting surfaces composed of raised cutting areas interspersed with depressed clearance spaces have been satisfactorily made as follows. Using molds of the type described in my copending application Serial No. 306,379, filed August 26, 1952, now abandoned, and using a fibrous abrasive-containing sheet material such as that disclosed and described in my U. S. Patent No. 2,284,738, issued on June 2, 1942, I have made such articles as follows. A mold plate is formed from one or more spiral coils of strip material with one edge of at least one of the spiral coils of strip material configured and/or by the use of two strips of material of different widths concurrently wound, convoluted or assembled and secured in position to provide the desired mold pattern surface. The resulting mold plate is placed upon the bottom platen of a hydraulic press with the configured face of the mold facing upwardly. Several layers of the fibrous abrasive-containing sheet material cut in disc form of a diameter equal to the diameter of the mold plate are placed upon the upper face of the mold and a similar size disc of a backing fabric such as a rubber-sized or latex-sized canvas or duck is placed upon the layers of abrasive-containing fibrous sheet material. A plain flat upper mold plate is placed upon the layer or canvas or duck and the assembly subjected to heat and pressure for a sufficient period of time to heat and pressure-set the material after which the pressure is released by withdrawal of the platens of the press. Satisfactory results have been obtained in the molding of a disc 9" outside diameter and having an abrasive fibrous body of overall thickness of around $\frac{1}{8}$ " secured to a fabric backing by molding at a pressure of 3,000 pounds per square inch and holding at a temperature of 260° F. for 15 minutes.

Figure 4 depicts an abrasive wheel made in accordance with the herein described principles in which a plurality of layers of abrasive-included fibrous sheet material are assembled with an intermediate fabric reinforcing layer and the entire assembly subjected to heat and pressure between upper and lower mold plates, each one of which is provided with a configured face so as to impart a pattern or configuration of the desired type in both side faces 22, 23 and extending into the abrasive-containing fibrous body 24 of the abrasive wheel.

Figures 5, 6 and 7 together show an endless abrasive belt 26 embodying a configured working face 27 according to the present invention. Furthermore, referring particularly to Figures 6 and 7, the belt embodies a further desirable feature in that the clearance areas 28 provided between the discontinuous cutting areas 29 of the working face of the belt extend all the way through the abrasive-included fibrous body and also the fabric backing 30 and are provided with an inverse taper 31 in one direction so that the individual openings are larger in size progressively as they progress from the working face 27 to the rear face 32 of the belt. Clearance holes of this type provide maximum opportunity for the grinding or polishing detritus to be released by passage directly through the holes thusly provided in the working face of the belt and the inverse taper of the hole makes it ex-

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remely difficult, if not impossible, for the detritus to lodge and become packed into the clearance space and thus load the belt. Consequently, it can be said that such abrading devices are self-unloading in principle since as soon as the detritus enters the clearance areas it is given the maximum opportunity to fall free and not become firmly embedded in the clearance holes. While this added feature of a self-discharging type of clearance area has not been embodied in the various examples of discs shown in the drawing it is obvious that these same self-discharging features can be similarly embodied in the discs and wheels or other forms of abrasive articles to provide advantages in respect of self-discharging action to those articles.

Figures 8 and 9 are perspective views of a set-up wheel and buffing wheel, respectively, embodying certain features and principles of the present invention. Such wheels can be made by molding a strip of abrasive-included fibrous material in a manner similar to that shown in connection with the abrasive discs presented in Figures 1-3 but in which the mold is rectangular and equal to the axial width of the desired wheel to be made in one direction and equal to the circumference of the supporting wheel structure or frame upon which the strip is to be mounted. The abrading element can be either adhesively secured or mechanically mounted upon the central structure of the wheel.

Figure 8 shows a set-up wheel comprising a supporting wheel frame 35 and an abrasive-containing fibrous rim element 36 which has been premolded in a manner similar to that described above for making other types of abrasive articles so as to have a peripheral working face made up of a plurality of raised abrasive ribs 37 separated by grooves 38.

Figure 9 shows a buffing wheel in which the rim portion 40 is premolded similarly to that proposed for Figure 8 and mounted upon a hub structure 41 but in which the periphery of the wheel is so molded as to be made up of a multiplicity of individual, radially extending buffing fingers 42 which are separated by a surrounding clearance area 43 although the fingers are integral with and similar to the remainder of the rim body 40 in composition and structure and are formed in the course of molding the rim of the wheel by the above-described procedure and constitute a part of the configured working face of the article.

While I have indicated that the abrasive rim of the devices illustrated in Figures 8 and 9 are to be made by flat molding techniques comparable to those used for compacting and forming disc and wheel structures of the herein described type, it is also possible to mold the rim directly in continuous annular form in the manner explained in greater detail in my copending application Serial No. 306,379 in connection with the making of endless belts.

Generically speaking, the present invention provides an abrasive article which can be made in manifold forms but in which in every case regardless of the specific shape, form or function of the article constitutes an abrasive-included fibrous body of material having a discontinuous working face which is provided with suitable depressed or clearance areas and, according to certain preferred embodiments of the invention, can be provided with a self-unloading type of clearance area whereby the resulting article is given the maximum unloading characteristics and any desired degree of flexibility depending, inter alia, upon the specific size, distribution and proportion of raised cutting areas to depressed or clearance areas, the height of the cutting areas or members above the base level of the clearance zones, etc.

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

1. An abrasive article comprising a fabric reinforcing and a layer of abrasive-containing fibrous material, said abrasive-containing fibrous layer having a working face

provided with a multiplicity of small holes distributed thereover and extending through the layer of abrasive-containing fibrous material and fabric reinforcing, each of said small holes being smaller in area at the working face of said article than at its opposing side, the abrasive being distributed internally of and throughout the layer of abrasive-containing fibrous material.

2. An abrasive article comprising a fabric reinforcing and a layer of abrasive-containing fibrous material, said abrasive-containing fibrous layer having a working face provided with a multiplicity of small holes distributed thereover and extending through the layer of abrasive-containing fibrous material and fabric reinforcing, each of said holes being outwardly flared in a direction extending away from the working face, the abrasive being distributed internally of and throughout the layer of abrasive-containing fibrous material.

3. An abrasive article of the grinding wheel type comprising a fabric reinforced abrasive-included fibrous body of a thickness substantially greater than the thickness of an abrasive coated article, the working face of said article having a multiplicity of holes extending through the body and of such size and frequency as to provide detritus removal spaces over the entire working face of said article and impart flexibility to said article.

4. An abrasive article of the grinding wheel type comprising a fabric reinforced abrasive-included fibrous body of a thickness substantially greater than the thickness of an abrasive coated article, the working face of said article having a multiplicity of deep depressions extending almost through the entire thickness of the abrasive-containing fibrous body but leaving the base portion of the abrasive-included fibrous body continuous and integral with those portions of the abrasive-included fibrous body constituting the working face of said article, said depres-

sions being of such size and frequency as to provide detritus removal spaces over the entire working face of said article and impart flexibility to said article.

5. An abrasive article of the grinding wheel type comprising a fabric reinforced abrasive-included fibrous body of a thickness substantially greater than the thickness of an abrasive coated article, the working face of said article having a multiplicity of deep interconnected depressions extending almost through the entire thickness of the abrasive-containing fibrous body but leaving the base portion of the abrasive-included fibrous body continuous and integral with those portions of the abrasive-included fibrous body constituting the working face of said article, said depressions being of such size and frequency as to impart flexibility to the raised portions of the body constituting the working face thereof.

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