ABRASIVE WHEELS AND METHOD OF MAKING THE SAME

Filed Sept. 23, 1960 2 Sheets-Sheet 1

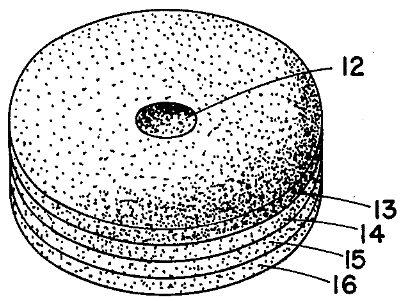

Fig. 1

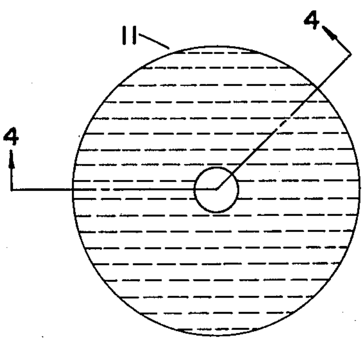

Fig. 2

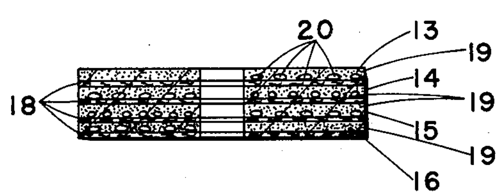

Fig. 4

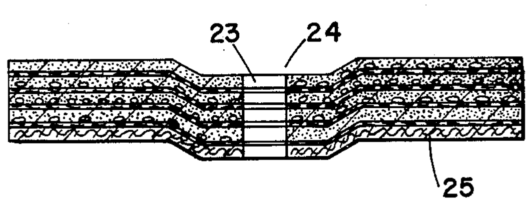

Fig. 5

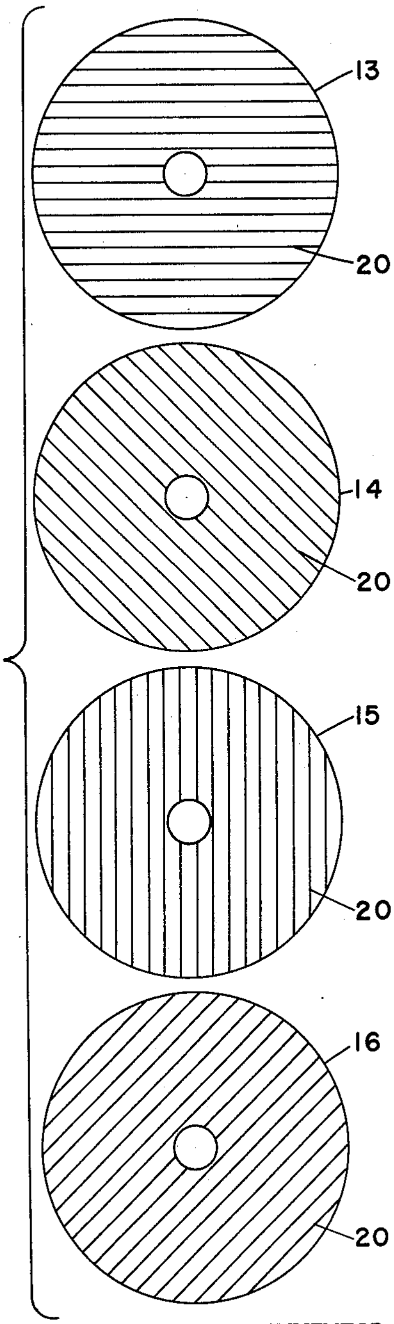

Fig. 3

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ABRASIVE WHEELS AND METHOD OF MAKING THE SAME

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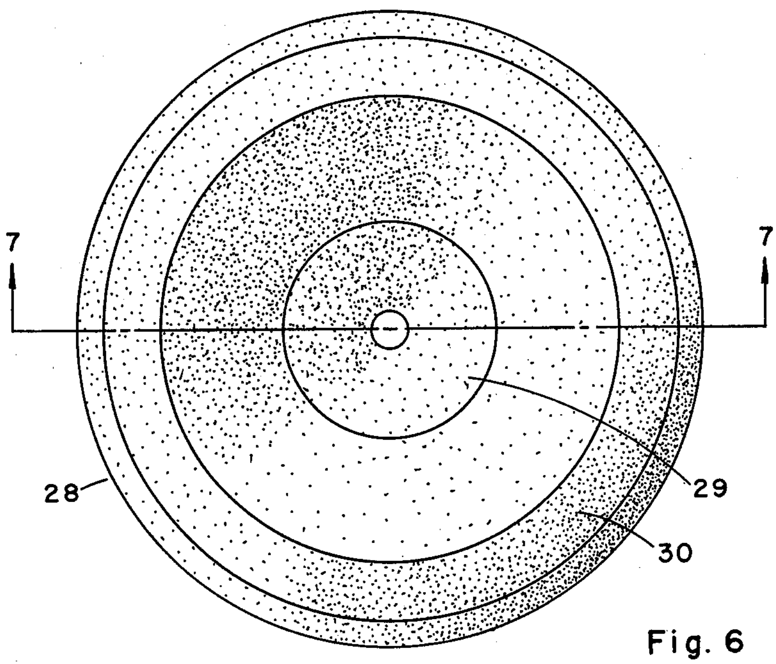

Fig. 6

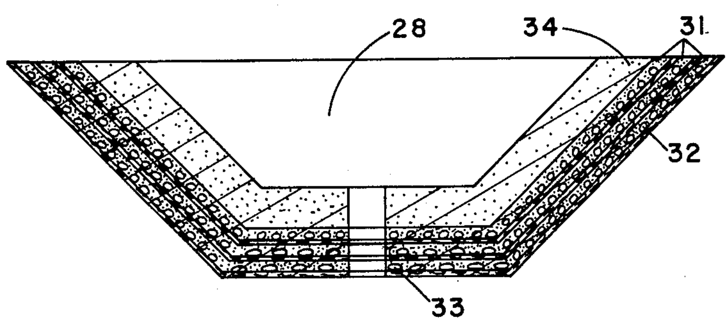

Fig. 7

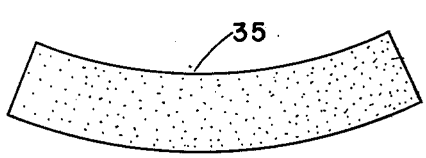

Fig. 8

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3,121,981

Patented Feb. 25, 1964

3,121,981

ABRASIVE WHEELS AND METHOD OF MAKING THE SAME

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Filed Sept. 23, 1960, Ser. No. 58,062
11 Claims. (Cl. 51—207)

This invention relates to abrasive articles of manufacture. It is primarily concerned with abrasive wheels of the type which are used for cutting at or on the periphery of the wheels. Such wheels are often relatively thin with fairly expansible flat side surfaces. One wheel of this latter type is that commonly known to the trade as an abrasive cut-off or cutting-off wheel, and is used for cutting through rod, bar or sheet stock as well as for other grinding or cutting operations. Other wheels of somewhat similar structure, known as depressed center wheels or discs, are often used for dressing operations in the finishing of metal articles, grinding out fillets and the like, although due to their thinness they can also be used for cutting-off purposes.

The present invention is especially adapted to abrasive cutting-off wheels, depressed center discs or wheels, and wheels of similar structure and will therefore be primarily described as it pertains to such wheels although it is pointed out that it is also applicable to other types of grinding wheels of usually greater thickness such as snagging wheels wherein the grinding is performed at or on the periphery of the wheel. It is also applicable to the fabrication of other shaped wheels such as straight sided or flared cup wheels.

Conventional cut-off wheels of the prior art are usually composed of abrasive grains held together by a suitable resinous or rubber bond. They are used at high speeds of revolution but in order to provide the requisite hardness to produce a fast and cool cutting rate without excessive wheel wear the bond is necessarily cured or vulcanized to an extremely hard condition. As a result abrasive wheels so made are of very low flexural strength so that wheel breakage frequently occurs when the wheel is subjected to the least lateral stress or impact with not only the loss of the wheel before it has served its useful life but with considerable danger to the operator. This deficiency in impact and/or flexural strength has never been satisfactorily overcome.

Many types of wheels have been proposed in attempts to meet this long standing need for abrasive cut-off wheels and wheels of similar structure having greater flexural and impact strength as well as a satisfactorily high cutting rate. The art is replete with examples of wheels provided with various kinds of reinforcing means designed to enhance the strength characteristics of the wheel. However, such wheels are usually formed and/or the bond cured under elevated heat and pressure conditions detrimental to the reinforcing or the latter has interfered with the complete utilization of the wheel or lowered the desired high cutting rate of the wheel.

It is an object of the present invention to provide an abrasive wheel having a satisfactory performance life and an acceptable high cutting rate.

It is a further object to provide an abrasive wheel which not only has a satisfactory life and cutting rate but also is of high impact and flexural strength.

It is a still further object to provide an abrasive wheel which not only has a satisfactory life and cutting rate but also has a high bursting speed.

It is a still further object to provide a reinforced flared or straight sided cup grinding wheel of satisfactory performance life and high strength.

It is another object to provide practical methods for making reinforced abrasive wheels of the herein described type.

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

I have found that abrasive wheels with satisfactory performance life and cutting rate, having high impact and flexural strength, and high bursting speeds, can be made by forming the wheels by compaction of a plurality of layers of bonded abrasive material, each layer of abrasive material being reinforced by a multiplicity of parallel, or unidirectional fibrous or filamentary strands or cords. The wheel is so constructed in the case of flat wheels that the unidirectional reinforcing cords of one layer of abrasive material are oriented in a different direction than the directional disposition of the parallel or generally unidirectional reinforcing cords of other layers of abrasive material making up the wheel whereby the wheel is reinforced in a multiplicity of directions. As a result of the particular manner of construction of the wheels of the present invention, the final wheel body is effectively and adequately reinforced, by a plurality of individual separated series of parallel or unidirectional reinforcing cords disposed in different planes co-extensive with the lateral or side faces of the wheel. In other words, although the reinforcing cords provide a reinforcing action in a plurality of directions of the wheel, the unidirectional reinforcing cords of one series are not in direct contact at the points of crossing with the parallel or unidirectional reinforcing cords of the adjoining layers even when the latter are extending in other directions.

The fibrous or filamentary reinforcing cords or strands constituting the reinforcing elements can be any high tensile strength metallic or non-metallic, organic or inorganic, natural or synthetic fibrous or filamentary material of adequate tensile strength to effectively reinforce the abrasive body to the desired extent, such as fine steel wire of high tensile strength, nylon yarns or filaments, glass fiber yarn, all of which have been found satisfactory as high tensile strength fibrous or filamentary materials for the purposes of the present invention. The reinforcing cords, if desired, can be of composite character of the type described in detail in my U.S. Patent No. 2,826,016, issued March 11, 1958, in which the high tensile strength fibrous or filamentary material of the cord reinforcing is associated wtih a pyrophoric material, as for example a pyrophoric metal such as magnesium, aluminum, silicon or zirconium, whereby the reinforcing cord will be effectively disintegrated by the heat of grinding when it reaches the grinding surface of the abrasive wheel.

Reinforced abrasive wheels of the herein described type can be satisfactorily made in the following manner. A thin carrier web in the form of a fibrous sheet material, preferably containing abrasive material, is coated with adhesive and a series of unidirectional strands or cords of reinforcing material laid down on the resulting tacky surface. The reinforcing cords are then coated with a layer of an abrasive grain-organic bond mixture and the resulting abrasive-coated, reinforced sheet material dried to a non-tacky condition suitable for handling, although the bonding material is not advanced to a cured or matured condition. The resulting sheet stock is then cut to suitable form for making the abrasive article such as disc form and a plurality of the resulting abrasive discs assembled in superimposed relation with the individual discs arranged so that the reinforcing cords of each disc are oriented with respect to the direction of orientation of the reinforcing cords of the remaining discs of the assembly so that the reinforcing cords will provide a strengthening action in a multiplicity of directions in the resulting article. For example, in a flat sided wheel, such as a cut-off wheel, the wheel is effectively reinforced in all radial directions. The assembled discs of material are placed in a mold and compacted. The resulting article is cured by either compaction under heat and pressure or is compacted under pressure and subsequently subjected to an oven cure to provide the desired abrasive article. Some modifications of procedure are followed in the fabrication of cup wheels, as will be described in detail later herein.

One abrasive-containing fibrous sheet material which has been found highly suitable as the carrier web in making abrasive articles in accordance with the present invention is the abrasive-included felted fibrous sheet material disclosed and fully described in U.S. Patents Nos. 2,284,738 and 2,284,739.

In order to better understand the nature of the present invention, reference is made to the accompanying drawing depicting examples of abrasive products made in accordance therewith and in which:

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

FIGURE 2 is a top plan view of the abrasive wheel shown in FIGURE 1;

FIGURE 3 is an expanded view showing the component discs from which a wheel such as that shown in FIGURES 1 and 2 is made, the discs being separated in order to show clearly the orientation of the reinforcing cords of the discs with respect to one another;

FIGURE 4 is a grossly enlarged vertical sectional view through the line 4—4 FIGURE 2;

FIGURE 5 is a view similar to that of FIGURE 4, showing a modified form of abrasive wheel or disc;

FIGURE 6 is a top plan view of a reinforced flared cup wheel embodying principles and features of the present invention;

FIGURE 7 is a highly enlarged sectional view of the wheel shown in FIGURE 6 through the line 7—7 thereof; and

FIGURE 8 is a top plan view of one of the arcuate abrasive-included fibrous strips used in making the flared sides of a reinforced flared cup grinding wheel such as the type shown in FIGURES 6 and 7, all in accordance with principles of the present invention.

The exact manner in which abrasive wheels can be easily and economically made following the teachings of the present invention is most easily demonstrated by the following examples setting forth the specific procedures for the making of illustrative abrasive products.

Example 1

Abrasive cut-off wheels 9" in diameter and ¼" in thickness having a ⅞" arbor hole, and specifically composed of the number of layers depicted in FIGURES 1, 2, and 3 of the drawing, have been made as follows:

An abrasive-containing felted fibrous sheet material of the type described in U.S. Patents Nos. 2,284,738 and 2,284,739 and composed of a felted cotton fiber base sheet held together by a casein adhesive and containing approximately 80% by weight of 24 grit size aluminum oxide abrasive grain is first sized on one side with a thin sizing coat of liquid phenolic resin. While the resin is still wet and tacky, a series of glass fiber strands or cords of reinforcing material are laid down on the tacky side of the fibrous sheet material spaced ¼" apart and covering the surface of the sheet material and extending in a lengthwise direction thereof. The resin coating is then dried to a non-tacky condition to hold the glass fiber cords in position, after which a mixture of 24 grit size fused aluminum oxide abrasive grain and organic bond is spread over the surface of the reinforced fibrous sheet material, substantially filling the space between the glass fiber reinforcing strands and embedding the reinforcing strands in the mixture of abrasive grain and bond. One satisfactory abrasive grain-bond mixture consists of 85 parts by weight of 24 grit size fused aluminum oxide abrasive grain and 15 parts by weight of a powdered two stage phenolic resin such as that known and sold under the trademark "Bakelite" BRP–5417 containing a liquid phenolic resin plasticizer such as that known and sold as "Bakelite" No. BRL–1251. The resulting abrasive-coated and reinforced fibrous sheet material is then dried at 150° F. to a non-tacky condition suitable for handling, although the resin constituent of the bond remains in an uncured condition.

A number of circular discs 9" in diameter having centrally located arbor holes ⅞" in diameter are punched out of the resulting abrasive-loaded sheet material. One disc of the sheet material is placed on a steel wheel mold plunger of the conventional type with the abrasive-loaded and glass fiber reinforced side facing upwardly. A second disc of the same material is placed on top of the first disc with the abrasive-coated and glass fiber reinforced side facing upwardly and with the glass fiber cord reinforcing disposed at an angle of 45° to the directional disposition of the glass fiber reinforcing cords of the first disc. A third disc is then similarly placed on top of the second disc with the glass fiber reinforcing cords oriented in a direction 45° from the glass fiber reinforcing cords of the second disc and 90° from the direction of the glass fiber reinforcing strands of the first disc. Finally, a fourth disc of the material is placed on top of the first three discs with the glass fiber reinforcing strands disposed at an angle of 45°, 90°, and 135° from the the third, second and first discs respectively. The last disc is placed in the mold with the side bearing the glass fiber reinforcing cords and the layer of abrasive-bond mixture facing upwardly as in the previously deposited discs. The top mold plunger is placed in the mold on top of the assembly of discs and the mold and contents placed in a press and subjected to simultaneous heat and pressure at a temperature of 335° F. for three minutes, whereby the discs are compacted and united to form an integral abrasive body and the resin bond constituent cured to a heat-hardened condition. The molded wheel is then removed from the press, and dressed to size in accordance with conventional procedures, after which it is ready for use.

Referring further to FIGURES 1, 2, 3, and 4 of the drawing which illustrate an abrasive cut-off wheel such as that made in accordance with Example 1 above, the abrasive wheel **11** having an arbor hole **12** is composed of four plies of fibrous, abrasive sheet material **13**, **14**, **15**, and **16**. Each of the abrasive plies making up the body of the wheel, as more clearly shown in detail in the sectional view of FIGURE 4, consists of a fibrous carrier web **18** and a layer **19** of abrasive grain and phenolic resin bond. The layer of abrasive-bond mixture contains a series of unidirectional or parallel glass fiber cords **20**. It is noted that the thickness of the wheel as depicted in FIGURE 4 of the drawing has been greatly exaggerated in order to bring out more clearly the structural make-up of the wheel.

Referring to FIGURE 3 it is to be noted that the reinforcing cords of the four discs making up the wheel are oriented with respect to one another so that the resulting abrasive wheel body is reinforced by the four independent and separate systems of unidirectional cord reinforcings so that the wheel is strengthened in practically all radial directions to an equal extent.

Obviously, a cut-off or other flat-sided or depressed center grinding wheel or disc can be made in accordance with the procedure and using the same materials used in Example 1 with the exception that, instead of 4 plies of cord-reinforced, fibrous, abrasive sheet material, a greater number or less number of plies of the same material is used to form the wheel and the directional orientation of the plies relative to one another will change, depending upon the exact number of plies used to form the wheel. For example in similarly forming a wheel composed of three plies of cord-reinforced abrasive sheet material, each of the plies is disposed in the mold with the unidirectional reinforcing cords of the ply positioned to lie at an angle of 120° with respect to the adjoining ply or plies, whereby the reinforcing cords of the three series constituting the entire system of reinforcing for the wheel provide structurally a plurality of equilateral triangle reinforcements.

Cut-off wheels of the type described under Example 1 have been demonstrated to have highly satisfactory performance lives and high cutting lives. At the same time cut-off wheels of the described type have been found to have high impact and flexural strengths, as well as unusually high bursting speeds. For example, a representative 9" cut-off wheel made in accordance with Example 1 has been found to have bursting speeds ranging from over 26,000 s.f.p.m. to as high as 33,000 s.f.p.m.

Example 2

Depressed center disc wheels, such as that illustrated in FIGURE 5, of the drawing, 9" in diameter and 3/16" thick, with a 1" arbor hole 23 and having a depressed center portion 24, have been made following the same general operational procedure and materials set forth in Example 1 above, except that the mold is provided with top and bottom plungers having such contour as to mold the discs with the centers having a depressed contour and the provision of a layer of fabric 25 adhesively bonded to the back side of the abrasive disc. It is included by placing a layer of the desired fabric in the mold on the bottom with plunger or plate prior to the insertion of the several layers of abrasive sheet material. This backing fabric can be, for example, a resin-impregnated glass fiber cloth, a resin-impregnated nylon cloth, a canvas or drills cloth or any other suitable fabric, with or without resin impregnation. As in FIGURE 4, the thickness of the wheel shown in FIGURE 5 of the drawing has been highly exaggerated in order to make clear the actual structural character of the wheel. Such wheels possess the same improved impact and flexural strength secured in the case of the cut-off wheels described in Example 1 above. They are particularly adapted because of their specifiic design, for use in grinding out and dressing fillets and reentrant portions of metallic or non-metallic shapes wherein the grinding is done at, but not entirely on, the periphery of the wheel or disc and the abrasive wheel is continually subjected to lateral stresses so that as a result high flexural strength is of prime importance. Representative depressed center wheels, made in accordance wtih Example 2, when used in performing off-hand grinding, have shown a grinding rate of over 40 grams per minute and had bursting speeds in the neighborhood of 26,000 to 33,000 s.f.p.m.

Example 3

A flared cup abrasive wheel, such as that illustrated in FIGURES 6 and 7 of the drawing, having a diameter of 4" at the base and flared to a diameter of 5¾" at the top edge with a vertical wall depth of 2" and ½" arbor, can be made as follows.

An abrasive-included non-woven fibrous sheet stock such as that used as the carrier web in the making of abrasive wheels according to Example 1 above is cut into a series of arcuate strips, each strip having a width equal to the sloping depth or front-to-back width of the flared side of the grinding wheel to be made. Several of these arcuate strips are adhesively secured to one another in end-to-end relationship. The resulting continuous spiral of abrasive-included fibrous strip material made up of the several arcuate strips is coated with a film of adhesive and while the adhesive is still tacky, a series of substantially parallel or unidirectional glass cord reinforcing elements extending lengthwise from end to end of the spiral strip and covering the surface of the web from side to side and spaced apart about ¼" from one another, are laid down on the adhesively-coated surface. Alternatively, the reinforcing cords can be coated with adhesive and while the adhesive is still tacky, be similarly applied to one side of the spiral strip material. The resulting strip material is then coated on one or both sides with a layer of an abrasive-resin bond mixture similar to that used in coating the reinforced carrier web embodied in the wheels of Example 1 and the coated strips dried to a non-tacky condition. The resulting cord-reinforced abrasive-included fibrous strip material, with the coating of abrasive and organic bond, is coiled tightly to form a frusto-conical body having an outside diameter approximately equal to that of the wheel to be made, the number of plies of the material depending upon the wall thickness of wheel and amount of reinforcing desired. If the base of the wheel is to be reinforced also, as shown in the specifiic wheel depicted in FIGURES 6 and 7, cord-reinforced, abrasive-included fibrous sheet stock of the type used in making the flat wheels of FIGURES 1 and 2 is coated with a layer of abrasive-resin bond mixture, dried to a non-tacky condition and discs approximately equal in diameter to the base diameter of the wheel to be made died therefrom. Otherwise, a mixture of abrasive grain and organic bond is used for the entire base portion of the wheel. The frusto-conical coil of strip material, together with the reinforcing discs for the base where the base is to be reinforced are placed in a mold on the mold base plate or bottom plunger, an additional abrasive grain-bond mixture in sufficient amount to provide the balance of the base and side walls of the wheel body introduced into the mold between the center pin and the reinforcing cone, and the upper mold plunger brought down upon the assembled reinforcing members and mass of abrasive grain and bond, and the assembly subjected to sufficient heat and pressure at a temperature of 300° F. for 60 minutes to consolidate and mold the assembled material into the resultant wheel. The wheel is removed from the mold, and dressed in accordance with standard practice, after which it is ready for use.

Referring further to FIGURES 6 and 7, the resulting wheel 28 comprises a base portion 29 and flaring sides 30, each of which is made up of a mass 34 of abrasive grain and bond together with a plurality of layers 31 of abrasive and resin bond reinforced by a series of parallel glass reinforcing cords 32 which extend circumferentially of the annular side walls of the wheel and glass cords 33 disposed in the base of the wheel. The reinforcing for the flared side portion of the wheel is composed of a series of arcuate strips 35 of abrasive-included fibrous material (see FIGURE 8) assembled to form a spiral, reinforcing cords applied and an abrasive-bond mixture applied, all as above described. The parallel cords 33 in the base of the wheel are oriented directionally so that the cords in each layer are disposed in a direction 120° from the directional disposition of the cord in the remaining two layers, thereby providing a reinforcement of the base of the wheel in substantially all radial directions. The reinforcing in the base portions of the wheel is optional, and can be omitted if desired.

In practicing the invention it is obvious that any of the abrasive materials in common use can be employed as the abrasive contained in the fibrous body of the wheel structure, or as the abrasive in the abrasive-bond mixture applied to the abrasive-containing fibrous carrier web, such as silicon carbide, diamonds, boron carbide, fused aluminum oxide, zirconia, 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.

Although the examples given herein have specified a phenolic condensation product resin as the adhesive in the abrasive-bond mixture, other bonding materials may be used, such as melamine-formaldehyde resins, urea-formaldehyde resins, unsaturated polyesters such as polymerized glycol maleate or polymerized diallyl ester cross-linked with unsaturated monomers such as methyl methacrylate, styrene, or diallyl phthalate, and polyfunctional polyesters such as polymerized diallyl maleate or fumerate. Also, the organic bond may be a vulcanized natural or synthetic rubber bond such as a butadiene-styrene or butadiene-acrylic nitrile copolymer or other natural or synthetic rubber bonds, embodying the customary fillers, vulcanizers, and like modifying agents commonly used with such bonding materials.

While the specific examples herein set forth have employed four layers or plies of abrasive-bearing, reinforced fibrous sheet material, obviously the number of layers of abrasive sheet material embodied in the wheels constructed according to the present invention may vary from these exact figures, depending upon the thickness of the abrasive wheel being made.

Having described the invention it is desired to claim:

1. A reinforced abrasive wheel comprising a mass of granular abrasive held together by an organic bond and containing a plurality of separate spaced plies of cord reinforcement, each of said plies consisting of a series of parallel cords supported on an abrasive-included non-woven fibrous sheet, having a directional disposition of the cords different from the directional disposition of the cords of other reinforcing plies therein.

2. A reinforced abrasive wheel composed of several superimposed layers of organic bonded abrasive grain integrally bonded into a single integrated abrasive body, each of said layers comprising a thin layer of organic bonded abrasive grain supported on an abrasive-included non-woven fibrous carrier web and containing an embedded series of parallel reinforcing cords, the directional disposition of the reinforcing cords of one layer differing from the directional disposition of the cords of other layers of said abrasive wheel.

3. A reinforced abrasive wheel according to claim 2 in which the bond is a phenolic resinous condensation product.

4. A reinforced abrasive wheel according to claim 2 in which the reinforcing cords are glass fiber cords.

5. A reinforced abrasive wheel according to claim 2 in which the reinforcing cords are nylon.

6. A reinforced abrasive disc comprising a fabric backing, and a layer of substantial thickness of organic bonded abrasive grain bonded thereto, said layer of organic bonded abrasive grain having embedded therein a plurality of independent and separated layers of parallel reinforcing cords supported on an abrasive-included non-woven fibrous supporting web, each of said layers of reinforcing having the cords thereof disposed in a direction different from the directional disposition of the cords of the remaining layers.

7. A reinforced abrasive wheel composed of several layers of organic bonded abrasive grain integrally bonded into a single integrated abrasive body, each of said layers comprising a thin layer of organic bonded abrasive grain supported on a separate abrasive-included, non-woven fibrous carrier web and a series of parallel reinforcing cords secured to said carrier web and embedded in said thin layer of abrasive grain.

8. A flared cup grinding wheel, the flared side thereof being a reinforced molded integral body composed of a frusto-conical coil of reinforced abrasive material comprising a thin layer of organic bonded abrasive grain supported on a non-woven fibrous carrier web and containing a series of generally parallel reinforcing cords extending circumferentially of said material when coiled.

9. A method of making a flared cup grinding wheel which comprises providing a plurality of arcuate abrasive-included non-woven fibrous strips each having a width equal to the sloped depth of the flared wheel side, adhesively securing said strips end-to-end to form a continuous strip of material, adhesively securing a series of parallel reinforcing cords to one flat side of said strip material and extending lengthwise of said strip, coating said reinforced strip material with a layer of abrasive grains and organic bond, coiling said reinforced adhesive strip to form a frusto-conical shape, placing the coiled material in a mold together with a mass of an abrasive grain-organic bond mixture sufficient to form the base portion of said wheel, and subjecting the assembly to heat and pressure to compact the assembly into an integral reinforced flared cup wheel and mature the organic bond thereof.

10. A flared cup grinding wheel which comprises a reinforced base composed of a plurality of discs, each of said discs comprising a thin layer of organic bonded abrasive grain supported on a fibrous carrier web and containing an embedded series of parallel reinforcing cords, the directional disposition of the reinforcing cords of one disc differing from the directional disposition of the cords of the other discs of said base, said discs being approximately equal in diameter to the base diameter of the wheel, reinforced flaring side walls bonded to said base, said side walls containing a reinforcing element composed of a frusto-conical body having an outside diameter approximately equal to that of the wheel, said body comprising a thin layer of organic bonded abrasive grain supported on a fibrous carrier web and containing a series of generally parallel reinforcing cords extending circumferentially of said body and a mass of bonded abrasive grain integrally bonded to said base and side walls on the interior of said wheel.

11. The flared cup grinding wheel described in claim 10 in which the fibrous carrier web in the reinforced base and the reinforced flaring side walls is an abrasive-included, non-woven fibrous carrier web.

References Cited in the file of this patent

UNITED STATES PATENTS

1,515,818	Yerges	Nov. 18, 1924
2,375,263	Upper	May 8, 1945
2,540,112	Goepfert et al.	Feb. 6, 1951
2,800,754	Robertson	July 30, 1957
2,952,951	Simpson	Sept. 20, 1960
3,030,743	Raymond	Apr. 24, 1962

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,121,981 February 25, 1964

Edward Hurst

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 13, for "expansible" read -- expansive --.

Signed and sealed this 7th day of July 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents