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A. O. BUSH ET AL

2,006,308

GRINDING WHEEL

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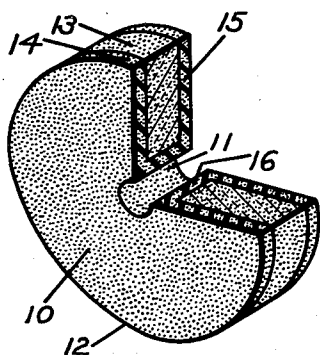


FIG. 1

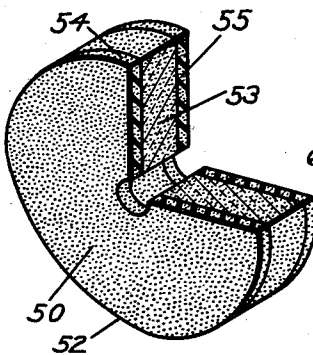


FIG. 4

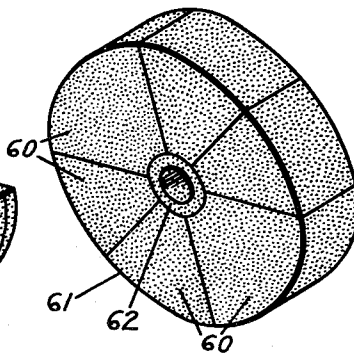


FIG. 6

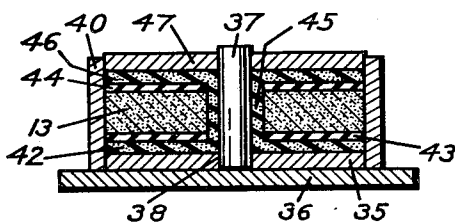


FIG. 5

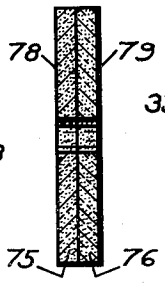


FIG. 8

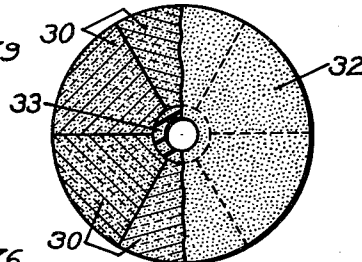
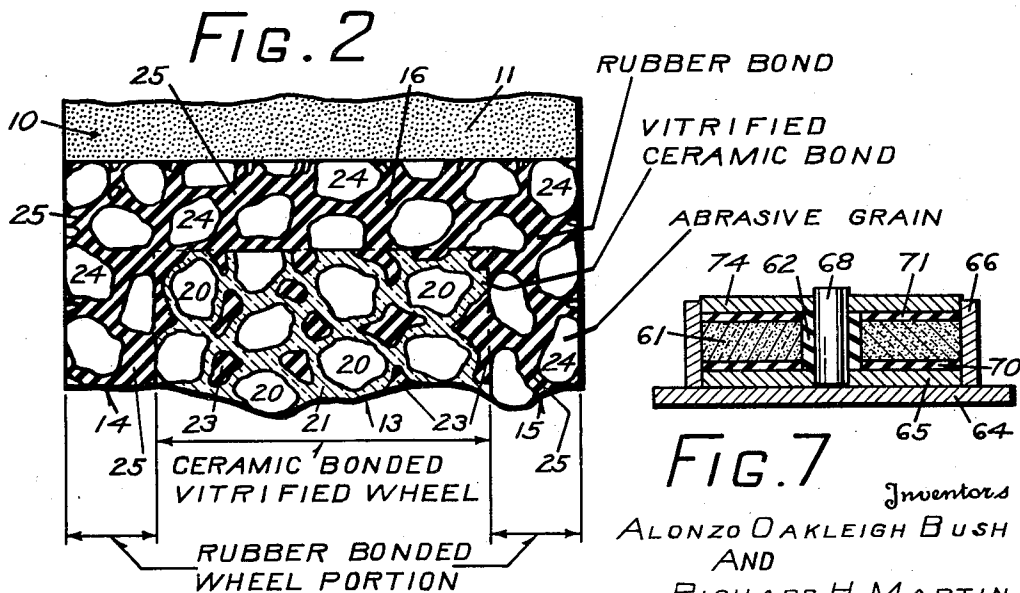


FIG. 3



WITNESSES

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GRINDING WHEEL

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17 Claims. (Cl. 51—206)

This invention relates to abrasive articles, and particularly to grinding wheels especially adapted for high speed grinding operations.

Heretofore, heavy duty grinding operations, such as the snagging of large castings, have been accomplished by two types of grinding wheels, namely, vitrified grinding wheels such as ceramic bonded wheels, and organic bonded grinding wheels such as those composed of abrasive grains bonded by vulcanized hard rubber, each wheel type having certain advantages.

A rubber bonded grinding wheel has an inherent advantage in that it may be safely rotated at a very high rate of speed, while a vitrified wheel made of ceramic bonded abrasive grains, which is ordinarily rotated at a lower speed than a rubber bonded wheel, has certain desired characteristics, which make it more useful than the rubber wheel for withstanding the grinding pressures frequently required in snagging and other heavy duty grinding operations. The friction of grinding often produces wheel surface temperatures sufficiently high to soften and burn the rubber bonding medium and cause the wheel to smoke. This softening of the rubber bond permits the surface abrasive grains to tear loose and results in a change of grinding characteristics of the wheel and distortion of the wheel face, thereby producing an unsatisfactory and expensive grinding operation.

It is accordingly the principal object of this invention to overcome the difficulties inherent in prior constructions and to provide an abrasive article especially adapted for heavy pressure grinding, which will not readily break and will give a high grinding production.

It is a further object of this invention to provide a construction wherein a grinding wheel, whether a unitary or a segmental structure, may be rendered more resistant to differential heat stresses and the operating stresses, such as centrifugal force, which tend to disrupt the wheel.

With these and other objects in view, as will appear more fully in the following disclosure, this invention resides in the combination of parts and the steps of a process herein disclosed and covered by the appended claims.

In the accompanying drawing illustrating this invention:

Fig. 1 is a perspective view partly broken away to show the preferred embodiment of this invention;

Fig. 2 is a greatly enlarged sectional view diagrammatically illustrating the grinding wheel

structure in the preferred embodiment of this invention;

Fig. 3 is a view in elevation partially broken away to show a modified form of the preferred type of this invention;

Fig. 4 is a perspective view showing a further modification of the present invention;

Fig. 5 shows the method of making the types of grinding wheels illustrated in Figs. 1, 3 and 4;

Fig. 6 shows a still further modification of this invention;

Fig. 7 shows one method of manufacturing the grinding wheel illustrated in Fig. 6; and

Fig. 8 shows a laminated wheel structure embodying this invention.

According to this invention, an abrasive article made of abrasive grains bonded by a suitable wheel bond and having an open pore structure, such as a vitrified grinding wheel, is strengthened and made more resistant to the operating forces and differential heat stresses by supplementing the bond with a vulcanized hard rubber bond which impregnates the pores of the body. This supplemental bond preferably comprises a vulcanizable rubber mixture of the character of vulcanite or ebonite which impregnates or fills the open pore spaces of the body and so gives the maximum resistance to the stresses set up in a rotating grinding wheel.

As a further feature of this invention, a grinding wheel of abrasive grains bonded by a suitable wheel bond and having vulcanized rubber within its pores may be further strengthened and its abrading action supplemented by sides of rubber bonded abrasive grains. Such a wheel will give the grinding effects of a rubber and abrasive mixture at its corners, while the central portion will have the abrasive characteristics of a strengthened vitrified wheel.

Furthermore, a grinding wheel may be greatly strengthened in its resistance to the centrifugal forces of wheel rotation and the stresses set up by the frictional heat of grinding at the surface of a wheel by means of a core of vulcanized hard rubber located within the central hole of the abrasive wheel and integrally united thereto by the rubber of the core entering the pores of the wheel body and adhering to the walls thereof. If desired, the rubber core may have abrasive particles or other suitable fillers embedded therein to further strengthen it or add desired properties thereto. It has been found that a rapidly rotating grinding wheel tends to break from the edge of its central hole when subjected to centrifugal force and differential heat stresses; and

by using a strong rubber compound, the wheel may be provided with a central core portion which is more resistant to such stresses than is the vitrified material itself. Such a wheel is strengthened not only at the center where the major stress is met, but also throughout the entire body of the vitrified portion.

A further feature of this invention involves the provision of a grinding wheel or other abrasive body made up of segments which are integrally united into a unitary structure by a vulcanized hard rubber bond which impregnates substantially all of the pores of the abrasive body and fills the interstices between the segments, thus serving the dual function of a cement between the adjacent members and a supplemental bond within their body portion. The segments may be of any suitable shape, as required for making a composite wheel, such as the sectors shown in Fig. 6 or the laminae or disks of Fig. 8, which are made of ceramic bonded abrasive material. It is to be understood, however, that this invention applies equally well to the strengthening of a unitary, single-piece abrasive body or of segments united by a strengthening medium; and the claims are to be interpreted accordingly.

In order that the different features of this invention may be more fully appreciated, reference is to be had to Figs. 1, 2 and 5 of the drawing, which illustrate all of these features combined in a single grinding wheel; but it will be understood that various aspects of this invention may be employed independently of the other features therein illustrated. As illustrated, there has been provided an integral grinding wheel 10 of suitable shape, such as a disk provided with a central hole 11 and having a peripheral grinding face 12. The wheel 10 has a central grinding portion comprising a separately manufactured grinding wheel 13 of abrasive grains, such as crystalline alumina or silicon carbide, bonded by a vitrified ceramic material, which has been made in any suitable standard method. On each side thereof are two grinding portions 14 and 15 of a standard type rubber bonded grinding wheel, which may be composed of hard rubber bonded abrasive grains, such as grains of crystalline aluminum oxide or silicon carbide, intimately mixed with a plastic compound of raw rubber and sulphur which may be vulcanized to form a hard bond. The grinding portions 14 and 15 are preferably intimately united by a core 16 of hard rubber, or preferably of the same rubber bonded wheel mixture, thereby forming a rubber bonded abrasive wheel with a ceramic bonded grinding wheel therein, forming a central grinding portion which is an integral part therewith.

In accordance with this invention, a vulcanized hard rubber bond permeates, and preferably substantially fills, the entire open pore structure of the vitrified wheel 13; thus serving as a supplemental bond as well as to cement the entire wheel structure into an integral unit. As diagrammatically illustrated in Fig. 2, a standard type of porous vitrified grinding wheel 13 has its individual abrasive grains 20 bonded together by any suitable vitrified ceramic bond 21 to form a structure having open pore spaces interspersed throughout. These pore spaces in the vitrified wheel are substantially filled with a raw vulcanized rubber or rubber compound 23. The side faces of the vitrified grinding wheel are flanked by or coated with strengthening portions 14 and 15, which are composed of abrasive grains 24 of suitable size and material bonded by a suit-

able vulcanized rubber compound 25, which is intimately united with the rubber bond 23 within the vitrified wheel. Also, a strengthening core 16 of hard rubber, or preferably a composition of rubber bonded abrasive grains of the type employed for the sides 14 and 15, is integrally united with the inner peripheral surface of the wheel hole, as well as with the sides 14 and 15. The rubber of the core 16 and the rubber bond 25 are integrally united with the rubber skeleton 23 which lies within the open pore structure of the vitrified wheel body 13.

It is difficult to manufacture the larger sizes of abrasive wheels of the vitrified type, but the present invention makes it practicable and convenient to make such wheels by assembling preformed, separately fashioned abrasive wheel segments as a grinding annulus and bonding them together and to rubber bonded wheel sides. For example, as illustrated in Fig. 3, one modification of this invention comprises a plurality of preformed, separately manufactured vitrified abrasive wheel sectors 30 which may be of any desired size and shape. These ceramic bonded sectors are assembled as an annulus and thoroughly impregnated with a vulcanized rubber bond which substantially fills their entire open pore structure, as diagrammatically shown in the ceramic bonded wheel portion of Fig. 2. The assembled sectors may be provided with rubber bonded abrasive wheel sides 32 and a rubber bonded abrasive wheel core 33, corresponding to the wheel portions 14, 15 and 16 of the preferred construction (Fig. 1).

In the manufacture of these composite wheels, the supplemental rubber bond 23 may comprise a plastic raw rubber intimately mixed with sulphur and other ingredients to form a vulcanizable compound, and it may be forced into the pore structure of the vitrified wheel 13 by any suitable method, such as the combined application of heat and pressure within a suitable mold. It is preferable to force the rubber compound 23 into the open pore structure of the vitrified wheel at the same time that the side portions 14 and 15 and the core 16 are shaped in the mold, thereby uniting all of the rubber portions into a unitary body. Thereafter, all of the rubber is vulcanized at once throughout the entire wheel structure.

Fig. 5 of the drawing diagrammatically illustrates one simple method of quickly and easily producing the preferred type of grinding wheel construction shown in Fig. 1 or the modified construction of Fig. 3. As illustrated, a suitable type of pressed wheel mold is provided wherein a cylindrical press plate 35 of required diameter and thickness is rigidly supported upon a press bed 36. A cylindrical post or hub 37 having a diameter the same as that of the desired finished wheel hole is slidably and coaxially fitted within a central hole 38 in plate 35 and supported by the bed 36. A ring member 40 of desired size slidably engages the periphery of press plate 35 and is firmly supported on bed 36. This ring member is of such size that the vitrified grinding wheel 13 or the assembled annulus of vitrified segments 30 may slidably fit therein and the hub 37 is smaller in diameter than the vitrified wheel hole to allow space for inserting the rubber bonded wheel hub 16 or 33.

A suitable amount of abrasive grains incorporated in a vulcanizable sheet 42 of plastic rubber compound of desired thickness is first placed upon the press plate 35. This sheet of rubber and abrasive mixture is preferably cut to be disk-

shaped so that it may slidably fit within ring 40 and over hub 37. A circular disk of vulcanizable raw rubber 43, having approximately the same hole size and outside diameter as the vitrified grinding wheel 13 or the assembled annulus of segments 30, is next placed on top of the rubber wheel mixture, as shown in Fig. 5. The vitrified wheel or abrasive annulus of segments is then slidably fitted within the ring 40 and permitted to rest upon the rubber disk 43. Another sheet of raw rubber 44 of the same dimensions and character as the disk 43 is placed upon the upper face of the vitrified wheel or annulus. A sheet 45 of plastic rubber bonded wheel mixture of the same nature as the sheet 42 is then placed around the hub 37 in such a manner as to completely fill the space between said hub and the vitrified wheel to form the core 16 or 33, and a further required amount of rubber wheel mixture 46, which is preferably in the form of a sheet of the same approximate dimensions as sheet 42, is placed upon rubber disk 44.

It will be apparent that at this point of the wheel construction, there has been provided a rubber bonded grinding wheel mixture having a vitrified grinding wheel central portion whose side faces are separated from the rubber bonded wheel by sheets of raw rubber 43 and 44. These sheets of raw rubber are preferably of such thickness that they will occupy approximately the total open pore structure within the vitrified wheel and will be wholly absorbed by the vitrified wheel.

To cause the vitrified wheel pores to become saturated with rubber and to compress the rubber wheel mixture to the desired final volume and pore structure, a top pressure plate 47 engaging the wheel mixture 46 and slidably engaging ring 40 and post 37 is provided, and it is forced toward the bed 36 by any suitable mechanism, such as that commonly employed in pressed wheel manufacture. Sufficient heat is applied to the mold in any convenient and well-known manner to cause the plastic rubber bond within the wheel mixture and the raw rubber sheets 43 and 44 to flow into and permeate the open pore structure of the vitrified wheel. The application of heat and pressure to the mold is so controlled that the rubber in the sheets 43 and 44 is completely absorbed by the vitrified grinding wheel and substantially fills all of its open pore structure. At the same time, this rubber unites intimately with the rubber bond in the wheel portions 42, 45 and 46. When the wheel has been pressed to the desired size and shape, application of further heat serves to vulcanize and harden the rubber bond throughout the entire wheel structure, thereby forming an integral rubber bonded grinding wheel having a vitrified ceramic bonded central portion.

A further modification of this invention, as illustrated in Fig. 4, comprises an integral grinding wheel 50 of the familiar disk shape having a peripheral grinding face 52, which has a central grinding portion comprising a separately manufactured vitrified ceramic bonded grinding annulus 53, intimately secured between two grinding portions 54 and 55 which may be composed of abrasive grains bonded together by vulcanized hard rubber. As in the case of my preferred construction, the pore structure of the vitrified annulus 53 is substantially filled with a vulcanized rubber bond which serves to hold the entire wheel structure together as an integral unit. It will be appreciated that the vitrified grinding annulus

53 may be either a segmental or a unitary construction, as desired, and the grinding wheel may be assembled and manufactured by the same method as used for the preferred type of wheel construction, as illustrated in Fig. 5. However, it should be noted that in this modified construction, the hub 37 (Fig. 5) is of such diameter that it will substantially fill the hole in the vitrified wheel 53. This modified wheel construction, as illustrated in Fig. 4 is identical with that shown in Figs. 1 or 3, with the exception that there is no central rubber bonded wheel core such as shown at 16 or 33.

A still further modification of this invention is illustrated in Fig. 6. As shown therein, there has been provided a grinding wheel composed of a plurality of separately manufactured, vitrified, ceramic bonded abrasive segments 60 assembled as a grinding annulus 61. Each of these segments has its open pore structure substantially filled with a vulcanized rubber or rubber compound, as illustrated in the ceramic bonded vitrified wheel portion of Fig. 2. A rubber bonded wheel core 62, which may comprise any suitable rubber and abrasive mixture or a vulcanized rubber compound, is further provided to strengthen the assembled grinding wheel. Application of heat and pressure in accordance with accustomed manufacturing procedure for any rubber bonded pressed grinding wheel in a standard type of wheel mold causes the rubber bond to flow throughout the wheel pore structure and into the interstices between the adjacent segments and unite and be vulcanized into a hard, supplemental bond which secures the entire structure together as an integral abrasive wheel unit. It will be appreciated that the ceramic bonded vitrified abrasive annulus 61 may also be of unitary construction and remain within the scope of this invention.

One convenient method of producing this type of grinding wheel is illustrated in Fig. 7, wherein a rigid bed 64 is arranged to support a press plate 65, retaining ring 66 and a hub 68. For convenience of assembly, the hub 68 and retaining ring 66 slidably engage the press plate 65. A disk of raw vulcanizable rubber 70 having approximately the same outside and inside diameters as the assembled grinding annulus 61 is first placed in the bottom of the mold upon press plate 65. The assembled grinding annulus 61, or if preferred a unitary vitrified grinding wheel of the same size, is next placed in the mold upon the rubber disk 70, and a similar rubber disk 71 is placed on top of the annulus 61, after which a wheel core 62 composed of a suitable vulcanizable rubber compound or sheet of rubber wheel mixture is placed around the hub 68 in such manner as to substantially fill the space between said hub and the ceramic bonded grinding annulus. A top press plate 74 slidably engageable with hub 68 and within ring 66 is placed upon rubber disk 71 and sufficient pressure and heat are applied in any well known manner to cause the rubber bond to flow throughout the vitrified wheel structure. The thickness of each of the rubber disks 70 and 71 has preferably been so chosen that their combined volume will be substantially absorbed by and fill the entire open pore structure of the vitrified abrasive annulus. Hence, the press plates 65 and 74 will relatively move toward each other until they are both engaged by the side faces of the vitrified annulus 61 and the raw rubber is absorbed within the entire wheel. Application of further heat serves to vulcanize all

of the rubber and form a hard wheel bond which secures the entire structure together as an integral unit.

A further feature of this invention, as illustrated in Fig. 8, contemplates a plurality of adjacent unitary or segmental vitrified ceramic bonded grinding wheels, such as the wheels 75 and 76, having their open pore structures substantially filled with a vulcanized rubber compound, such as the bond 23 of Fig. 2, and which serves the dual purpose of a supplemental wheel bond and a cement securing the adjacent abrasive members together as an integral grinding wheel. Each member 75 and 76 may be made as a unitary disk, or it may be made up of a plurality of separately fashioned abrasive sectors or segments of suitable shapes.

A grinding wheel of this type may easily be produced by assembling the disks 75 and 76, or the segments forming the same, with a layer or layers of vulcanizable rubber or rubber compound therebetween and a similar layer of rubber contacting with each of the outer faces 78 and 79 respectively. The thickness of each of these rubber layers has preferably been so chosen that the combined volume when the rubber is plastic may be absorbed by and substantially fill the entire open pore structures of the assembled disks. The wheel assembly is then placed in any standard type of wheel mold such as, for example, that illustrated in Figs. 5 and 7, and subjected to sufficient heat and pressure, in the same manner as employed in the other wheel manufacturing methods heretofore described, to cause the rubber bond to flow into the various open wheel pore structures and intimately unite. Further application of heat serves to vulcanize the rubber in position and form a supplementary wheel bond which holds the various ceramic bonded bodies together as an integral grinding wheel. Sides and a core of rubber and abrasive may also be applied, if desired, as above described.

To illustrate the advantages of the various types of grinding wheels embodying this invention, the following experimental tests may be cited.

Several vitrified ceramic bonded grinding wheels 24" in diameter were impregnated with a supplemental rubber bond and provided with rubber and abrasive wheel sides and core, as shown in the Fig. 1 type of construction. In these wheels, the central vitrified portion comprised approximately 75% of the total finished wheel width and 84% of the total wheel radius. These wheels, when tested for maximum rotational speed, were found to show an increase in breaking speed of 49 to 55% over that of the rubber impregnated annulus, which composed the central vitrified wheel portion.

The Fig. 1 type of grinding wheel was found to produce a better finish, more economy and faster cutting action than the ceramic bonded vitrified wheel 13. In comparing this new wheel with a rubber bonded grinding wheel, it was found that the new wheel would withstand an equally high operating speed and provide a much cooler cutting action with approximately twice the wheel life and a much greater stock removal per wheel life.

The following tabulation of results shows the advantages of the Fig. 1 type of grinding wheel construction over that of a standard type of vulcanized rubber bonded grinding wheel of the same size and having the same bond and grit

size as found in the rubber bonded wheel sides of the new vitrified center wheel:

Wheel used	Wheel life	Material removed per hour	Total material removed
#1 Vitrified center (Fig. 1 type)	Hours 15.5	Pounds 13.75	Pounds 213
#2 Standard rubber bonded wheel	8.7	16.5	143

It was also found that the wheels of the Fig. 1 and Fig. 3 types would withstand a surface heat temperature rise without breaking of more than twice that which would break an ordinary vitrified grinding wheel of the same grade and size. A grinding wheel of the type shown in Fig. 4, having a vitrified wheel width approximately 75% of the total wheel width, was found to withstand a surface speed of 34 to 40% increase, due to the rubber bonded wheel sides. In a wheel of the type shown in Fig. 6, the rubber bonded wheel core 62 raised the breaking speed 15 to 20% over that of wheels without rubber bonded cores, each wheel having a porous body of ceramic bonded abrasive grains strengthened by a supplemental rubber bond within its pores, according to this invention.

In another test, a unitary vitrified grinding wheel was broken along two diameters and thereafter assembled with the sectors spaced approximately $\frac{1}{8}$ of an inch apart at the lines of breakage. The open pore structure and interstices between the adjacent sectors were filled with a rubber compound which was vulcanized in place, thereby providing an integral grinding wheel structure. It was found that this grinding wheel would withstand a high rotational speed and that its final lines of breakage did not necessarily occur along the lines of initial breakage.

It will be appreciated that many types of impregnated grinding wheels having an open pore structure filled with a supplemental rubber bond lie within the scope of this invention. For example, a wheel made of abrasive grains bonded by sodium silicate, with or without various fillers, such as zinc oxide, is not sufficiently strong for many types of grinding operations where a high grinding speed and frictional heat are indicated, and such a wheel may be greatly strengthened and improved by the methods herein described. Also, various other porous wheels, such as the softer grades of wheels having synthetic resinoid bonds of the type of "Bakelite" resinoid, may be treated in the same way. Hence, the term "wheel bond" as employed in the claims is to be interpreted as covering those bonds, other than rubber, which are suitable in this art for uniting the abrasive grains into a serviceable grinding body.

Having thus described the invention, what is claimed as new and desired to obtain by Letters Patent is:

1. A grinding wheel comprising granular abrasive material secured together by a vitrified ceramic bond as an integral abrading body having an interconnected open pore structure and a supplemental wheel bond composed of an interconnected unitary honeycombed body of a hard rubber compound vulcanized in position which substantially completely fills all of the open pore structure, said rubber bond rendering the wheel cooler cutting and more resistant to

the stresses set up by frictional heat and centrifugal force.

2. An abrasive article comprising a body of abrasive grains bonded by vitrified ceramic material and an adjacent strengthening body comprising vulcanized hard rubber, which bodies are secured together as an integral unit by a vulcanized rubber bond which fills the pores of the vitrified body and intimately unites with the bond in the rubber bonded body.

3. An abrasive wheel comprising a porous body of ceramic bonded abrasive grains and an adjacent body of abrasive grains bonded by vulcanized hard rubber and united to the ceramic body by a vulcanized hard rubber compound applied in a plastic condition to and substantially filling the entire open pore structure of the ceramic body.

4. A laminated abrading wheel comprising a preformed, porous body of abrasive grains united by a wheel bond, a lamina of vulcanized hard rubber bonded abrasive grains on one side of the ceramic bonded abrasive body, and a vulcanized hard rubber bond permeating the porous ceramic bonded body which serves to unite the rubber bonded lamina integrally therewith.

5. A grinding wheel comprising a ceramic bonded porous abrasive body and a vulcanized hard rubber bonded abrasive annulus secured on each side thereof by a supplemental hard rubber bond which enters the pore structure of the ceramic bonded wheel when in a plastic condition and is vulcanized in place.

6. A grinding wheel comprising abrasive grains united by a wheel bond into a porous annulus of required abrading characteristics and having an inner peripheral surface, a vulcanized bond which permeates substantially the entire open pore structure of the annulus, and a core comprising a vulcanized rubber compound located within the inner peripheral wheel surface and integrally united with the rubber bond which increases the strength of the abrasive annulus and renders it more resistant to breakage due to centrifugal forces and differential heat stresses within the wheel.

7. A grinding wheel comprising abrasive grains united by a vitrified ceramic bond into a porous annulus of required abrading characteristics and having an inner peripheral surface, a vulcanized rubber bond permeating substantially the entire open pore structure of the annulus, and a core of vulcanized rubber bonded abrasive particles located within the inner peripheral wheel surface and integrally united with the rubber bond therein which strengthens the abrasive annulus and makes it more resistant to centrifugal forces and differential heat stresses within the wheel.

8. A grinding wheel comprising abrasive grains united by a vitrified ceramic bond into a porous annulus of required abrading characteristics and having an inner peripheral face, a vulcanized rubber bond which permeates substantially the entire open pore structure of the annulus, a core of vulcanized rubber bonding abrasive particles within the inner peripheral wheel face and integrally united with the rubber bond therein, and a vulcanized hard rubber bonded body of abrasive grains united to a side face of the vitrified abrasive body by the rubber bond therein which strengthens the abrasive annulus and renders it more resistant to centrifugal forces and differential heat stresses within the wheel.

9. A grinding wheel comprising abrasive grains united by a vitrified ceramic bond into a porous

annulus of required abrading characteristics and having an inner peripheral surface, a vulcanized hard rubber supplemental bond permeating substantially the entire open pore structure of the annulus, a core of vulcanized hard rubber bonded abrasive particles within the inner wheel periphery and integrally united with the supplemental bond, and a vulcanized hard rubber bonded body of abrasive grains on each side of the vitrified abrasive wheel integrally united to the supplemental bond and to the rubber bonded wheel core.

10. A grinding wheel comprising a preformed vitrified ceramic bonded abrasive body, a wheel core and wheel sides of vulcanized rubber bonded abrasive particles secured to the wheel and providing an integral grinding annulus having a peripheral grinding face composed of adjacent rubber bonded and ceramic bonded grinding zones.

11. A grinding wheel comprising a plurality of separately manufactured sectors of bonded abrasive granules arranged in spaced relationship, each sector having an open pore structure, a vulcanized hard rubber compound substantially filling the open pores and supplementing the wheel bond, and rubber compound vulcanized in position within the spaces between each of the adjacent sectors which secures them together and forms an integral grinding unit.

12. A grinding wheel comprising a plurality of separate ceramic bonded porous abrasive sectors arranged in spaced relationship as a disk, a unitary body of vulcanized hard rubber which both fills the spaces between the sectors and permeates substantially all of the pores within the sectors and thus supplements the ceramic bond and serves to unite the sectors as an integral grinding unit.

13. A grinding wheel comprising a plurality of separately manufactured ceramic bonded porous abrasive segments assembled in the form of a grinding annulus having an inner peripheral grinding face, a vulcanized hard rubber supplemental bond permeating the pore structure and cementing the segments together into an integral wheel structure, and a core of vulcanized rubber bonded abrasive grains within the inner wheel periphery integrally united with the supplemental bond.

14. The method of producing an abrasive article comprising the steps of providing a porous body of bonded abrasive material having two opposed side faces, placing a layer of plastic vulcanizable hard rubber bonding compound on each side face, and applying sufficient pressure to the assembly to cause the rubber bond to flow into and fill substantially the entire porous structure of the abrasive article, and thereafter vulcanizing the rubber to form a supplemental bond which strengthens the bonded body and makes it resistant to differential heat and operating stresses during an abrading operation.

15. The method of producing a grinding wheel comprising the steps of providing an annular porous body of ceramic bonded abrasive particles having an inner peripheral surface and two opposed sides, assembling the ceramic body with layers of abrasive grains and a vulcanizable rubber bond on each side thereof and an interposed layer of vulcanizable plastic rubber, subjecting the assembly to the influence of sufficient heat and pressure to cause the plastic rubber to flow and permeate the open pore structure of the ceramic body and thereafter vulcanizing all of the rubber to form

a hard supplemental bond which renders the wheel more resistant to centrifugal force and differential heat stresses.

16. The method of producing an abrasive wheel comprising the steps of providing an annular porous body of vitrified ceramic bonded abrasive grains having an inner peripheral surface and two opposed side faces, placing vulcanizable rubber compound in engagement with each side face of the ceramic body and a core of vulcanizable rubber bonded abrasive particles within the inner peripheral surface of the annulus, subjecting the entire assembly to the influence of heat and pressure to cause the rubber bond to permeate substantially all of the open pores of the body and

thereafter vulcanizing the rubber in place and forming a supplemental wheel bond.

17. The method of producing an abrasive article comprising the steps of forcing a layer of heated, plastic, vulcanizable, hard rubber compound into and permeating substantially the entire open pore structure of a bonded porous abrasive body and thereafter subjecting the article to a sufficiently high temperature to vulcanize the rubber compound in position into a rigid interconnected body which forms a supplemental bond filling the pores and greatly strengthening the abrasive body.

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