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ABRASIVE STRUCTURES AND REINFORCING THEREFOR

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FIG. 1

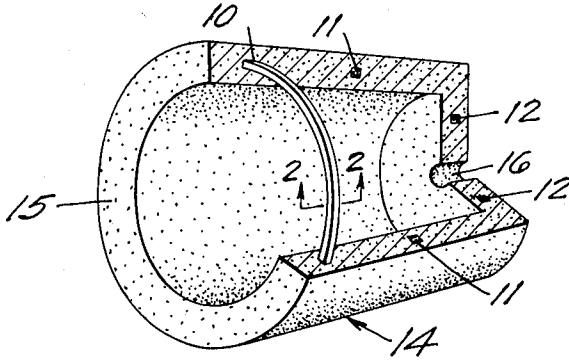


FIG. 2

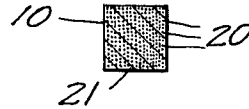
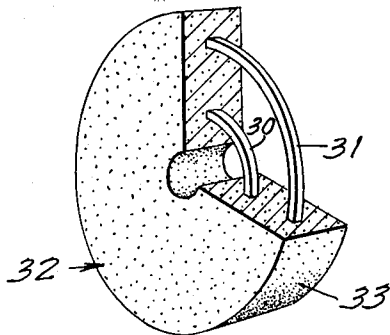


FIG. 3



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ABRASIVE STRUCTURES AND REINFORCING THEREFOR

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The present invention relates to the reinforcing of rotative abrasive structures such as grinding wheels and the like. More particularly, the present invention relates to the reinforcing of abrasive wheels such that said wheels, when accidentally cracked or weakened, will not fly apart during high-speed rotation; to the methods and products employed in making such reinforced wheels; and to the resulting reinforced rotative abrasive products.

Abrasive wheels, under normal operating conditions, are rotated at extremely high angular velocities while being subjected to severe stresses during grinding operations. Since such wheels are not immune from structural failure, grinding operations are often looked upon as being inherently dangerous. Pieces thrown out from a broken grinding wheel, which has cracked during rotation, have tremendous momentum, have been known to cause extensive damage and have even been lethal. Therefore, means for preventing the breaking up of wheels during rotation are necessary to the confident, safe operation thereof.

Rigid rotative abrasive structures, employed for most high-speed heavy-duty grinding operations, such as cut off wheels, snagging wheels and cup-shaped wheels, generally comprise essentially abrasive mineral grains rigidly and compactly bonded together by a cured binder. The strength of these abrasive wheels depends on a high degree of adhesion between the mineral grains and the binder. The articles are often brittle and highly inelastic. Upon localized failure of the adhesive bond within the wheel, cracks appear which tend to enlarge in a radial direction. As the radial cracks enlarge, additional stresses are applied to other sections of the wheel with progressive appearance of additional fractures and, unless restrained, the wheel eventually breaks up or bursts and flies apart during rotation.

I have found means for providing improved abrasive wheels which have the highly desirable safety feature of reinforcement against bursting or breaking up and flying apart during rotation even though partial failures and cracks should occur therein. They may be manufactured economically and competitively while avoiding imbalance therein. Further, I am able to conveniently position the reinforcing in the outer portions of wheels, where centrifugal forces are highest and thus where the need for reinforcement is greatest, as well as near the center. The reinforcement is accomplished without substantial reduction in abrading rate and total abrasive cut, without reduction in wheel life, and without replacement of a comparatively large volume of abrasive mineral by the reinforcing.

These and other advantages may be obtained by incorporating into the wheel one or more pre-formed reinforcing rings which comprise convolutely wound lineally aligned continuous glass monofilaments adherently embedded within and individually surrounded by a strong abrasion-resistant binder matrix and prepared as hereinafter described. The rings may easily be removed by abrasive action upon exposure at the receded grinding surface without substantially deleteriously affecting the abrasive characteristics of the wheel. Imbalance may be avoided in the finished wheel without necessity of ex-

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act concentric placement of the rings therein. Due to the extremely high tensile strength of the fine hair-like continuous glass monofilaments, a high degree of reinforcement is obtained with a relatively slight amount of reinforcing.

The invention may be further and more clearly illustrated by referring to the accompanying drawings and to the specific but non-limiting examples which follow. Referring now to the accompanying drawings:

FIGURE 1 represents a perspective view partially in section of a cup-shaped rotative abrasive wheel which is reinforced with a number of my novel pre-formed reinforcing rings;

FIGURE 2 is a greatly enlarged sectional view taken along the line 2-2 of FIGURE 1 showing the cross-section of a pre-formed reinforcing ring;

FIGURE 3 is a perspective view, partly in section, of a standard flat disc-type high-speed rotative abrasive wheel which is reinforced with my novel pre-formed reinforcing rings.

Referring now to FIGURE 1, pre-formed reinforcing rings 10, 11 and 12, the latter two indicated in cross-section, have been incorporated into the wheel 14, having an abrading surface 15, in a manner such that adequate reinforcing will be present even after abrading surface 15 has receded through use past the position of rings 10 and 11. Reinforcing ring 12 serves to reinforce the portion of the wheel near the central mounting hole, the latter being indicated at 16.

I have found that my new and novel pre-formed reinforcing rings have particular utility in cup-shaped type abrasive wheels. Incorporation thereof into the outer portion of a cup-shaped wheel adequately prevents a centrifugal "fan-like" separation at the open end of the wheel even if a crack occurs which would otherwise cause complete separation of the wheel into several pieces. Further, when the grinding surface 15 has receded such that ring 10 is ground away, rings 11 and 12 still adequately reinforce the wheel against failure. Upon further receding of the grinding surface to a point beyond where ring 11 is consumed, ring 12 gives fully adequate reinforcement against failure.

Rings not having the unique characteristic of being easily abraded away could not be incorporated in place of rings 10 and 11 of the wheel represented by FIGURE 1 without necessitating removal thereof by hand upon exposure at the receded grinding surface. Hand removal of reinforcing rings from the wheel would be dangerous, slow and tedious, resulting in wastage of considerable production time.

As may be seen in FIGURE 2, the ring 10 of FIGURE 1, here shown in cross-section, is composed of many fine hair-like glass monofilaments 20 adherently embedded in and substantially surrounded by the binder matrix material 21. Each of the monofilaments is substantially continuous throughout the several convolutions of the ring thus imparting thereto the extremely high tensile strength inherent in glass fibers. The several monofilaments are under substantially equal tension and thus will exhibit approximately equal reinforcement value.

The binder matrix material 21 serves to combine the fine monofilaments into a unitary structure as well as to provide a cushioning medium for transferring stresses from the wheel to the reinforcing; the matrix is at least of sufficient hardness and firmness to provide a ring which may be incorporated into the rotative abrasive article without becoming extensively damaged during the pressing operation. It may be noted that although the rings as shown in the illustrations have rectangular cross-sections,

rings having round or otherwise rounded cross-sections will serve as reinforcing for abrasive wheels in an equivalent manner.

When my reinforcing ring becomes exposed at the abrading surface, the abrasive cutting rate is substantially unimpaired. The glass filaments embedded within the binder matrix are easily abrasively removed by being ground into fine particles. Some abrasive action is exhibited by the filaments during the removal thereof. The binder matrix originally protecting, supporting and uniting the glass monofilaments is also easily abraded away, whether by being ground into fine particles, by decomposing under the surface heat of the abrading operation, by liquefaction, or by a combination of these.

The wheel may be safely operated during the time when the reinforcing ring is exposed at the surface. Due to the continuity of adhesion between the components of the wheel and rings, i.e. between the strongly cohesive binder matrix and abrasive binder and between the continuous glass filaments and the binder matrix, there is no separation and emission of loosened sections of reinforcing ring from the wheel. Rather, the rings are gradually abraded away. Further, considerable reinforcing strength is exhibited by the partially consumed ring as a result of the high individual tensile strength shown by the continuous monofilaments.

I have found that reinforcement of the outer portions of standard flat disc-type abrasive wheels, such as illustrated in FIGURE 3, is highly desirable and necessary. Reinforcing rings 30 and 31 are incorporated into wheel 32 approximately concentrically with the axis of rotation thereof. When normal abrasive surface 33 has receded through use past outer ring 31, the abrasive wheel will still be adequately reinforced against bursting and flying apart by more centrally positioned ring 30.

Although the pre-formed reinforcing rings shown in FIGURE 3 are shown as being substantially coplanar and in the middle of the wheel, they may be positioned anywhere approximately concentrically within the wheel. Any number of reinforcing rings may be incorporated depending on the degree of reinforcing required, although with some reduction in total abrasive cut where an extreme number is used. I have found that for most uses, a straight abrasive wheel reinforced as illustrated in FIGURE 3 is adequate and safe, and additional rings are necessary only where additional reinforcing near the grinding surface is desired. However, substantial reinforcement will be obtained if only one ring is placed in a standard flat abrasive wheel.

The density of my reinforcing rings is so closely similar to that of the composite abrasive article that an unbalanced wheel will not result even if the rings are positioned somewhat eccentrically with respect thereto. This feature enables quick placement of the pre-formed rings of the present invention in abrasive wheels while still maintaining good quality control.

Therefore having shown and described the nature and purpose of my invention, the following non-limitative examples will more specifically illustrate the same. Unless otherwise noted, proportions shown denote parts by weight.

Example 1

A liquid binder composition was first prepared of the following formula:

	Parts
Liquid epoxide resin -----	90
Diethylene triamine -----	10

The epoxide resin was a reaction product of bisphenol A and epichlorohydrin having a softening point of about 10° C., and was liquid at normal room temperature, i.e. about 25° C. It currently is marketed and sold under the trade name of "Bakelite BR 18774." The liquid resinous composition was prepared by intimately hand mixing the

epoxide with the amine accelerator, and put into use immediately.

Glass rovings were used as the reinforcing material in the present example. The glass rovings consisted of a plurality of glass yarns lineally placed together in more or less parallel aligned fashion. Each yarn consisted of a large number of loosely twisted continuous mono-fiber filaments, a loosely twisted yarn being used so as to facilitate penetration by the matrix resin.

The ring was made in a mold formed by cutting a circumferential groove in a disassemblable circular mandrel. The groove was 1/8 of an inch wide and 1/8 inch deep, and its outside diameter was 4 inches. In making the ring, a small amount of the liquid resinous composition was first uniformly coated over the bottom of the groove. The rovings were then wound in convolute fashion on the mandrel in the groove section as the mandrel was continuously slowly revolved. Additional composition material was added as a bead resin simultaneously with the winding so as to allow penetration thereof around substantially every monofilament. Penetration was further effected by winding under firm tension so as to squeeze the resin around the fibers.

When the groove had been filled with the composite, excess rovings were cut away and a thin outside coat of the resin applied. The mandrel was continuously slowly rotated until the resin was substantially cured. The purpose of this latter rotation was to prevent uneven running of the resinous matrix while it was still in a fluid state. After the resin was cured to a firm, hard state the mandrel was disassembled and the finished reinforcing ring removed.

The finished cured ring contained approximately 50 percent glass and 50 percent polymeric matrix material. It was firm and tough when handled. A second ring having the same cross-sectional dimensions but having an internal diameter of 2 inches was separately made in an appropriate mold by the same procedure.

The two rings were incorporated into a disc-type abrasive wheel in the following manner.

Powdered solid phenolic resin abrasive binder and furfural-wet abrasive grains were intimately mixed. One half of the mix necessary to form a 5 inch diameter, 3/4 inch thick wheel having a 3/4 inch center hole was added to a mold of a size to produce such a wheel. The mold was horizontally positioned such that the axis of the formed wheel was vertical. The mix in the semi-filled mold was carefully leveled and the two rings placed in the mix in approximate concentric position with respect to the wheel. The remainder of the mix was added and leveled. Pressure was next applied to the mix in an axial direction to compact the mix and form the green uncured wheel blank. The blank was then removed from the mold and fired at 390° F. in an oven to effect complete cure of the binder.

The wheel was then intentionally cracked and rotated for several minutes in the cracked condition at about 6200 revolutions per minute (100 r.p.m. above normal operating speed). The wheel did not fly apart even though held intact only by the reinforcing rings. The speed of rotation was then slowly increased until the wheel failed at a rate approximately twice that of normal operating speed.

An identical uncracked wheel was employed in prolonged abrading operations to wear away the abrasive surface and expose the ring. The abrasive cutting rate remained substantially the same during the time my reinforcing ring was exposed. No large pieces of the ring were emitted or thrown out from the rotating wheel during exposure.

Another method of preparing my preformed reinforcing ring is to form the member from convolutely wound pre-formed thin lineally aligned glass fiber reinforced sheet which is cured to a unitary structure. Such a ring may be prepared as described below.

Example II

A second liquid binder composition was prepared of the following formula:

	Parts
Rubbery butadiene-acrylonitrile copolymer -----	100
Zinc oxide -----	10
Oil soluble phenol-aldehyde resin -----	50
Esterified gasoline-insoluble pinewood resin ("Vin-sol") Ester gum) -----	50
Salicyclic acid -----	15
Dibutyl phthalate -----	8
Methyl ethyl ketone to 40% solids.	

The rubbery copolymer was milled on a cold mill until smooth and then the zinc oxide was blended in. The blend was removed from the mill and dissolved in the methyl ethyl ketone solvent. The salicyclic acid and dibutyl phthalate were next added in that order. After this, the phenol aldehyde resin was added and dissolved to provide a smooth uniform solution. The resulting solution was capable of being dried to a non-tacky state and exhibited thermoplastic characteristics until cured, but could be completely cured in a relatively short time at fairly low temperatures, i.e. in about two hours at 200° F.

The resin solution prepared as above described was coated at a coating weight of 5-6 grains per 4" x 6" sheet on a polyethylene coated kraft paper lining and allowed to dry at low temperature, i.e. less than 150° F., until tack-free. The exposed surface of the coating was then reactivated with a small amount of methyl ethyl ketone solvent, and while the adhesive surface was in a tacky state, a mono-layer of contiguous aligned glass yarns formed of many hair-like continuous glass filaments and having approximately 100 yarns (or ends) per inch of width was laminated thereto. Each yarn contained nominally 204 continuous filaments, each filament being 0.00038 inch in diameter.

These yarns ran lengthwise along the sheet, and were parallel to each other and referred to as being lineally aligned. The yarns were laid down in a mono-layer (a layer having a thickness of one yarn) with adjacent yarns nearly touching each other. A wider spacing may be used, depending upon the amount of glass filaments desired. The number of continuous mono-fiber filaments twisted together in the yarns and the size of the filaments may vary. A loosely twisted yarn was used, as distinguished from a tightly twisted yarn or thread, so as to facilitate penetration by the resinous matrix materials.

The yarns were drawn from warp beams. The "sheets" of yarns drawn from each warp beam were passed through condensing combs, whereby the desired concentration of "ends" per inch of width was obtained.

The sheet was then coated with additional rubbery adhesive matrix material at a wet coating weight of about 5-6 grains per 4" x 6" sheet to embed the lineally aligned yarns therein, and to introduce the adhesive between the loosely twisted monofilaments. The fully coated sheet was then oven dried at a temperature below 150° F. until tack-free.

The liner was stripped from an 8 inch wide reinforced sheet material of desired length. The sheet material was then convolutely wound under slight tension to a thickness of about 20 ply on a disassemblable 4½ inch diameter aluminum mandrel, which had been preheated to about 200° F. Sufficient heat energy stored in the mandrel transferred to the still thermoplastic sheet material to cause cohesion and blocking between adjoining plies. The mandrel with the winding thereon was then cured fully by heating in a 200° F. oven for about 2 hours.

The mandrel was allowed to cool slowly, disassembled and the formed cylinder removed. The removal of the ring was facilitated by the precoating of the core with a silicone polymer release agent. Upon removal, the cylinder was slit along planes perpendicular to the axis there-

of into rings ¾ inch in width, the wall thickness being approximately ¼ inch. I prefer this means for mass producing rather narrow rings. However, as may be readily seen, the rings may be originally fabricated to the desired width.

The reinforcing ring of the present example was then incorporated with another ring of similar nature into a cup-shaped abrasive wheel. The mold consisted of a cylindrical section of greater length than that of the wheel. A core having the shape of the varying diameter central section of the wheel was positioned on the bottom of the cylinder forming an annular space in the bottom portion thereof. Approximately one-fourth of the total abrasive mix was added to the mold, leveled and pressed to compaction. A circular groove having the shape of a ring to be placed therein was carefully placed in the surface of the compressed mix concentrically with the core. The ring was inserted such that it was flush with the surface. Sufficient additional mix was then added, which when compacted would extend flush with the flat top of the core. Next, after the second portion of mix had been leveled and pressed to compaction, one-half the remaining mix was added, leveled and pressed. A groove corresponding to the shape of the second ring was concentrically placed in the surface of the mix and the ring was placed therein in flush position. The remainder of the mix was added and the mass finally pressed. The uncured blank was then removed from the mold and fired at 390° F. in an oven to effect final cure of the abrasive binder. The wheel was then dressed down on the external surface to the shape desired by means of a rotating dressing tool.

The finished cup-shaped wheel was successfully safely rotated at speeds substantially exceeding that of normal operation even though intentionally cracked throughout. Efficient abrasive characteristics were exhibited by a similar uncracked wheel throughout consumption of the reinforcing ring upon exposure at the receded worn abrasive surface.

The monofilaments are continuous over more than one convolution. Sufficient continuity is then present to allow the filaments to exhibit maximum tensile strength. As may be seen in the example where glass rovings are used, several yarns of approximately equal length are used containing filaments which are continuous over the entire length of the wrap. And where a reinforced convolutely wound sheet is used, the monofilaments are substantially coterminous with the sheet.

In order to obtain a ring having the highest amount of reinforcing capabilities with the least volume, I prefer to use the maximum ratio of glass yarns to resinous matrix material allowable and yet have substantially complete encasement of the yarn within the matrix. I find that about 60% glass to about 40% of resinous matrix material by weight is a desirable ratio. If the proportion of glass exceeds the maximum such that complete encasement is no longer possible, the degree of reinforcement exhibited by the ring when incorporated in a wheel is considerably lessened. Presumably, certain of the glass filaments are severed during the pressing operation as the bare yarns come in contact with themselves or with the sharp edges of the mineral particles. At lesser proportions of glass to resin, the strength of the ring is also reduced.

Other binder matrix materials may be used. For example, the solid thermosetting phenolic type resins which are generally used as the binder in most rigid abrasive wheels may be used by heating the resin powder to the melting point and then applying and forming the ring in a manner similar to that described in Example I. However, a binder matrix must be chosen which will not char during the firing of the wheel.

The cured epoxide resin of Example I is substantially as hard as the cured abrasive binder. A binder matrix of identical nature with that of the abrasive binder of the

wheel is, of course, identically as hard. I refer to those types of binder matrix having such a final hardness as being at least approximately as hard as that of the abrasive binder. Rings formed of such materials may be incorporated into abrasive wheels by any of the methods described and suggested herein. However, where the binder matrix of the ring is softer than the cured abrasive binder, such as that employed as the binder matrix in Example II, a method which allows incorporation of the ring into the wheel without damage thereto and without other deleterious effects should be used. Such a method is described in Example II.

Example III

My pre-formed rings are suitable for reinforcing those types of abrasive wheels known as rubber-bond wheels as well as the previously described resin-bond type. A reinforcing ring prepared as described in Example I was incorporated into a 5 inch diameter abrasive wheel of the low temperature rubber-bond type which was $\frac{3}{4}$ inch thick and had a $\frac{3}{4}$ inch diameter center hole. The bond composition of the wheel contained 100 parts of smoked sheet natural rubber, 50 parts of sulfur, 100 parts of polysulfide polymer, and 20 parts of zinc oxide together with desired amounts of accelerators and antioxidants. The composition was then compounded on a mill roll. Then 20 parts of the bond composition was sheeted on a mill with 80 parts of abrasive. One portion of the composition sheet was milled to a thickness of $\frac{5}{16}$ inch from which was die-cut 2 annular sections each being 5 inches in diameter and having a $\frac{3}{4}$ inch center hole. A second portion of the composition sheet was milled to a thickness of $\frac{1}{8}$ inch from which was die-cut two thin annular sections, the first having an inside diameter of $\frac{3}{4}$ inch and an outer diameter of $3\frac{3}{4}$ inches. The second section had an inner diameter of 4 inches and an outer diameter of 5 inches.

The wheel was then formed by placing one of the thicker sections in a press mold. Then the two thin sections were placed on top of the bottom section concentrically therewith and with each other. My reinforcing ring was then laid between the two thin annular sections. The remaining section was placed concentrically atop the thin sections and ring. Close contact existed between the ring and the several sections. The laminate was then cured at 50 pounds steam pressure for about 3 hours.

After curing the wheel was unified with no trace of interface between laminae being present. The surfaces of the reinforcing ring were completely firmly adhered to the rubbery binder such that no voids were present along the surface of the ring as a result of the close fit throughout between the ring and the die-cut sections.

The reinforced rubber-bond wheel was found to exhibit not only the same extremely high resistance to bursting and flying apart as the wheels described in the previous examples, but also to show a marked increase in resistance to formation of initial cracks and ruptures over that of similar unreinforced wheels. The abrading rate was observed to remain substantially the same during exposure of the ring at the abrading surface when the wheel was subjected to prolonged tests. No separation of loosened sections of the ring was observed during exposure.

Other methods may be employed in incorporating my pre-formed reinforcing rings into rubber-bond type abrasive wheels. These include forming crumbs of the composition sheet and introducing a portion of the crumbs into the press mold, placing my reinforcing ring concentrically therein, adding the remainder of the crumbs, and pressing and curing. I prefer the de-cut method above described for most rubber-bond wheels or equivalent methods wherein the ring is closely and compactly surrounded by the abrasive binder.

Herein have been described a number of specific examples of pre-formed reinforcing rings and incorporation thereof into various types of rotative abrasive structures.

It will be appreciated that each of the specific reinforcing rings described, as well as other equivalent reinforcing rings may be used in any of the abrasive wheels specified or in similar abrasive wheels, cones, cups and other rotative abrasive articles. There are provided means for safely economically reinforcing rotative abrasive structures against flying apart at advanced rotative velocities without reduction in abrasive characteristics and without shortening the effective abrading life of the article.

Having now clearly described my invention, what I claim is:

1. A high-speed rotative abrasive article reinforced against bursting and flying apart at advanced rotative velocities comprising abrasive grains bonded by an abrasive binder and at least one pre-formed reinforcing ring adherently affixed within said article and approximately concentrically positioned therein, said ring comprising a plurality of convolutely wound lineally aligned continuous glass monofilaments adherently embedded within and individually surrounded by a strong abradable unifying binder matrix for uniting and protecting said monofilaments.

2. A high-speed rotative abrasive article reinforced against bursting and flying apart at advanced rotative velocities comprising abrasive grains bonded by an abrasive binder and at least one pre-formed reinforcing ring adherently affixed within said article and approximately concentrically positioned therein, said ring comprising a plurality of convolutely wound lineally aligned continuous glass monofilaments adherently embedded within and individually surrounded by a strong cured abradable unifying binder matrix for uniting and protecting said monofilaments.

3. A high-speed rotative abrasive article reinforced against bursting and flying apart at advanced rotative velocities comprising abrasive grains bonded by an abrasive binder and at least one pre-formed reinforcing ring adherently affixed within said article and approximately concentrically positioned therein, said ring comprising a plurality of convolutely wound lineally aligned continuous glass monofilaments adherently embedded within and individually surrounded by a strong abradable unifying binder matrix for uniting and protecting said monofilaments, said matrix binder being at least approximately as hard as said abrasive binder.

4. A high-speed rotative abrasive article reinforced against bursting and flying apart at advanced rotative velocities comprising abrasive grains bonded by an abrasive binder and at least one pre-formed reinforcing ring adherently affixed within said article and approximately concentrically positioned therein, said ring comprising a plurality of convolutely wound lineally aligned continuous glass monofilaments adherently embedded within and individually surrounded by a strong abradable unifying binder matrix for uniting and protecting said monofilaments, said matrix binder being substantially softer than said abrasive binder.

5. A pre-formed narrow reinforcing ring adapted for use in the manufacture of rotative abrasive articles highly resistant to bursting and flying apart at advanced rotative velocities, said ring comprising a plurality of convolutely wound lineally aligned continuous glass monofilaments adherently embedded within and individually surrounded by a strong abradable unifying binder matrix for uniting and protecting said monofilaments.

6. The article of claim 3 wherein said binder matrix is a cured epoxide resin.

7. The article of claim 4 wherein said binder matrix comprises rubbery butadiene-acrylonitrile copolymer and oil-soluble heat-advancing phenol-formaldehyde resin compatible therewith.

8. A method of manufacturing a high speed rotative abrasive article which is highly resistant to bursting and flying apart at advanced rotative velocities, and which may be utilized for abrading operations during exposure

of the reinforcing at the receding abrading surface of said article without substantial decrease in abrasive efficiency and without emission of dangerous pieces of said reinforcing, said method comprising forming an uncured blank of said article wherein is approximately concentrically positioned at least one pre-formed reinforcing ring consisting of a plurality of convolutely wound lineally aligned continuous glass monofilaments embedded within and individually surrounded by a strong abradable unifying binder matrix for uniting and protecting said monofilaments, and curing said blank.

9. In an annular rotatable abrasive article formed of abrasive grains held by a binder, reinforcing means comprising a ring around the central axis of rotation of the article concentric to said axis and embedded in said article, the ring including a plurality of force resisting glass fibers arranged in layers extending arcuately around said axis and reinforcing the article against disruption by centrifugal force, said fiber in each layer being arranged in a helix with succeeding coils being closely adjacent to each other and an adherent coating around said fibers of a material compatible with said article and said fibers being substantially entirely arranged transversely to the directions of centrifugal force to resist said force substantially entirely in tension.

10. In an annular rotatable abrasive article formed of abrasive grains held by a binder, reinforcing means comprising a ring around the central axis of rotation of the article concentric to said axis and embedded in said article, the ring including a plurality of force resisting continuous glass filaments extending arcuately around said axis and reinforcing the article against disruption by centrifugal force, said filaments being arranged in spirals with adjacent coils being closely compacted and an adherent coating around each of said filaments of a material compatible with said article and said filaments being substantially entirely arranged transversely to the directions of centrifugal force to resist said force substantially entirely in tension.

11. In an annular rotatable abrasive article formed of

abrasive grains held by a binder, reinforcing means comprising a ring around the central axis of rotation of the article concentric to said axis and embedded in said article, the ring including a plurality of force resisting continuous aligned glass filaments extending arcuately around said axis and reinforcing the article against disruption by centrifugal force, said filaments each being arranged in radially progressing convolutions with coils of adjacent filaments being closely compacted, and an adherent coating around each of said filaments of a material compatible with said article and said filaments being substantially entirely arranged transversely to the directions of centrifugal force to resist said force substantially entirely in tension.

12. In the manufacture of grinding wheels, the process comprising forming an annular structure consisting of a number of adjacent filament elements wound into the desired annular form to provide a compact body, incorporating a thermosetting resin into said annular structure, setting said resin until the structure is rigidified, embedding the resulting rigidified structure as a reinforcement into the interior of a mass formed of abrasive particles bonded together by a thermosetting resin and shaped to the form of the desired grinding wheel, and applying heat to the resulting mass until it is set in the desired shape.

References Cited in the file of this patent

UNITED STATES PATENTS

228,257	Hart	June 1, 1880
699,302	Fowler et al.	May 6, 1902
1,860,724	Schumacher	May 31, 1932
1,970,772	Schaefer	Aug. 21, 1934
2,134,738	Scheel	Nov. 1, 1938
2,147,438	Hassler	Feb. 14, 1939
2,178,855	Hassler	Nov. 7, 1939
2,643,494	Erickson	June 30, 1953

FOREIGN PATENTS

950,453	France	Sept. 28, 1949
---------	--------	----------------