United States Patent [19]

Oliver

Best Available Copy

[11] **3,918,217**

[45] **Nov. 11, 1975**

[54] **ABRADING DEVICE WITH PROTRUSIONS ON METAL BONDED ABRASIVE GRITS**

[75] Inventor: **Lloyd R. Oliver,** Algonac, Mich.

[73] Assignee: **Lloyd R. Oliver & Company,** St. Clair, Mich.

[22] Filed: **Apr. 4, 1974**

[21] Appl. No.: **457,858**

Related U.S. Application Data

[63] Continuation of Ser. No. 274,225, July 24, 1972, abandoned.

[52] **U.S. Cl.** **51/295;** 51/309

[51] **Int. Cl.**[2] **B24D 3/08;** B24D 3/16

[58] **Field of Search** 51/293, 295, 298, 307, 51/308, 309

[56] **References Cited**

UNITED STATES PATENTS

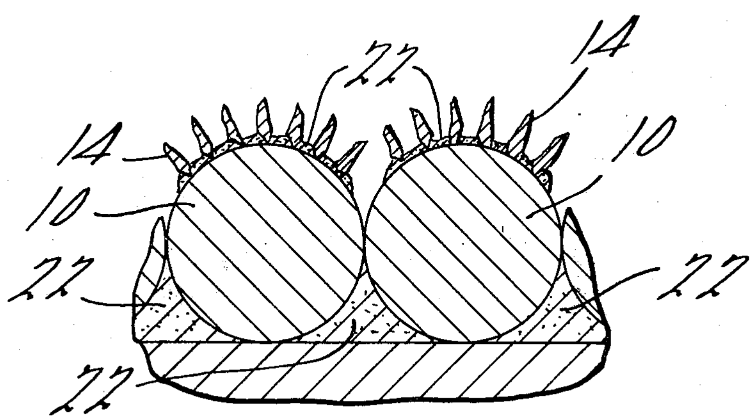
2,858,256	10/1958	Fahnoe et al.	51/309
2,904,418	9/1958	Fahnoe	51/309
3,048,482	8/1962	Hurst	51/298
3,248,189	4/1966	Harris	51/309
3,650,714	3/1972	Farkas	51/298

Primary Examiner—Donald J. Arnold
Attorney, Agent, or Firm—Harness, Dickey & Pierce

[57] **ABSTRACT**

Cutting and abrading devices made with special predetermined protrusions armed with metal bonded refractory metal grit.

9 Claims, 20 Drawing Figures



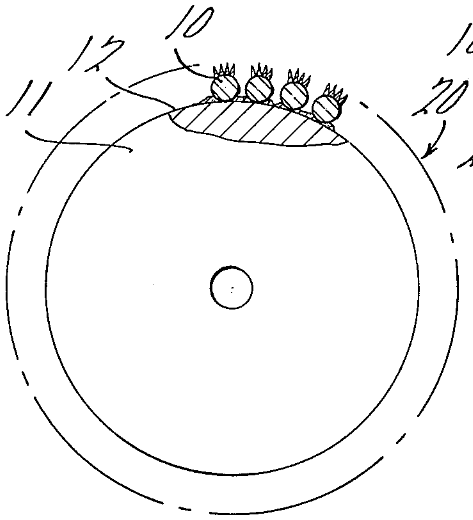


FIG. 1.

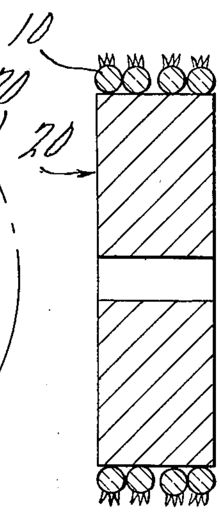


FIG. 2.

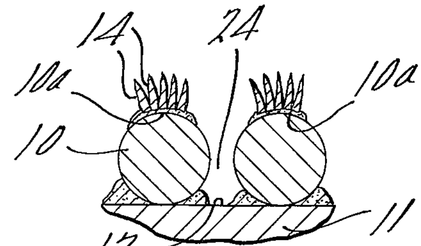


FIG. 2a.

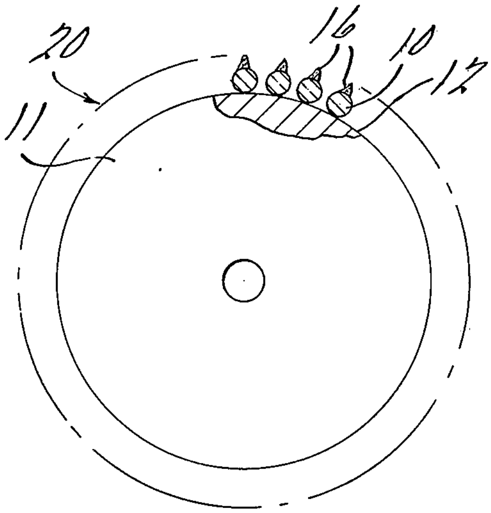


FIG. 3.

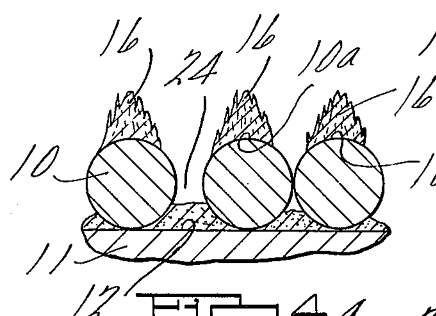


FIG. 4a.

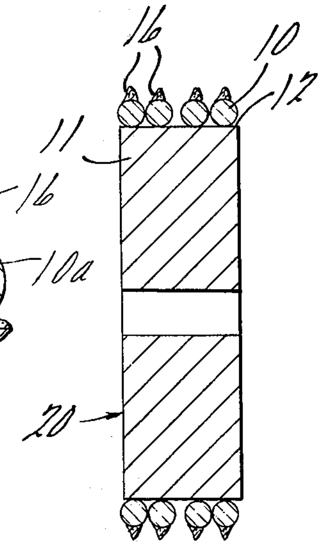


FIG. 4.

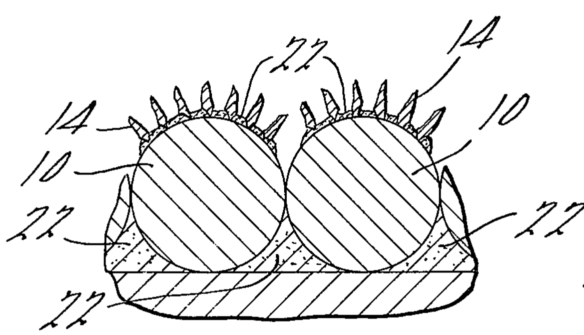


FIG. 5.

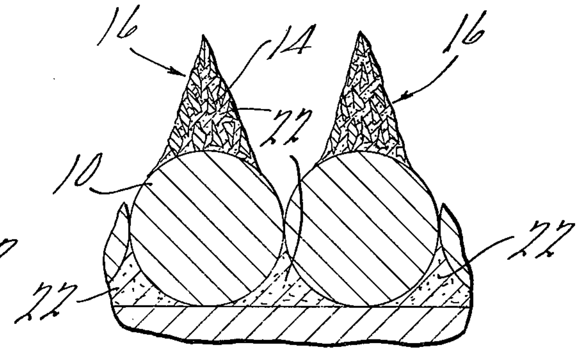


FIG. 6.

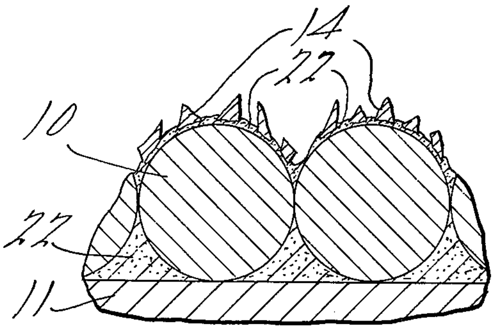


FIG. 7.

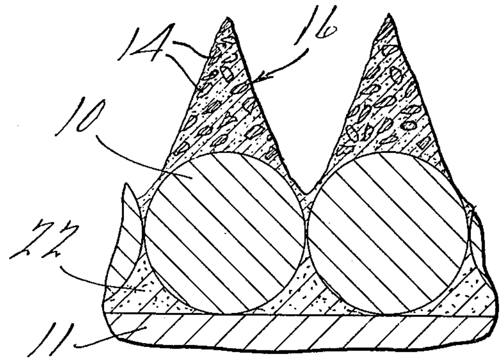


FIG. 8.

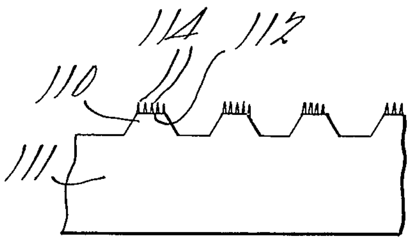


FIG. 9a.

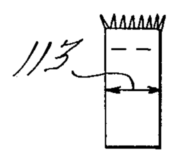


FIG. 9b.

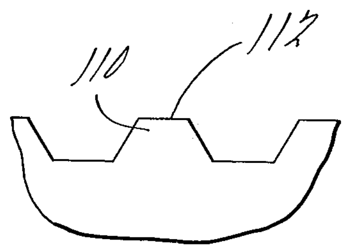


FIG. 9c.

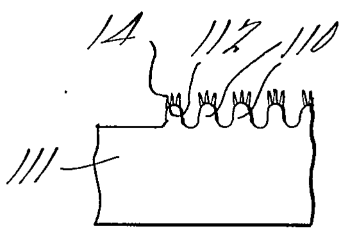


FIG. 10a.

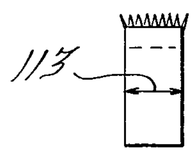


FIG. 10b.

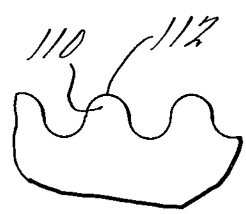


FIG. 10c.

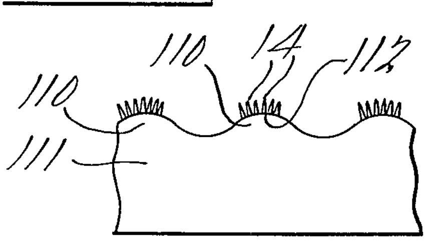


FIG. 11a.

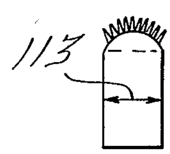


FIG. 11b.

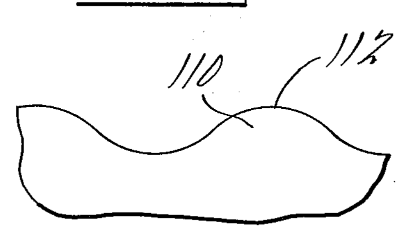


FIG. 11c.

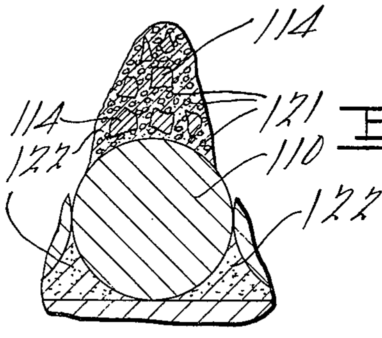


FIG. 12.

ABRADING DEVICE WITH PROTRUSIONS ON METAL BONDED ABRASIVE GRITS

This is a continuation of application Ser. No. 274,225, filed July 24, 1972, and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates primarily to the utilization of crushed, sintered refractory metal grits such as sintered tungsten carbides and like hard particle substances which can be braze metal joined (or joined by other suitable heat bonding material) to suitably formed metal protrusions on a supporting base member. Such hard metal or other abrasive particles are caused to be armed to various protruding metal shapes of predetermined size, height or configurations preplaced upon the base metal surface. The invention also relates to the use of other refractory grit or particle substances such as diamond, borides, oxides and other refractory substances, compositions, or crystals or particle agglomerations which can be joined to the predetermined metal protrusions extending from a base member support means. Further, the invention relates to the use of such abrasive grit or other hard substances that are not wettable by a braze metal but which materials can be encased in a gripping enclosure of metallic particles which can be brazed or infiltrated by a braze metal and joined to base member protrusions.

In the following disclosure the term "refractory metal grit" is intended to include not only refractory metal grit and hard metals such as sintered tungsten carbide grades but any of the various refractory grit or other hard substances that can be wetted by a brazing metal. Those like hard refractory substances, which cannot be wetted (joined) by a brazing metal, but which can be encased by an infiltrated metal particle envelope (and thus mechanically gripped and brazed to the protrusions) are also considered to fall under this invention. Hence the term refractory metal grit is meant to include all hard abrasive substances and other particles that can be brazed or otherwise gripped in a metal encasement and joined to the protrusions.

This invention presents improved means for more effective utilization of costly materials, and great economy of use of such materials compared to that of the prior art. These advantages and others will be shown and described or otherwise become evident from the following disclosure.

Definitions and Terminology

Base Member: The main body made to appropriate size, shape and configuration which is to be finally armed with refractory metal grit. Material: Usually mild steel or other iron base alloy which has a high enough melting temperature beyond that of the brazing metals used to bond the various constituents of the finally processed device.

Protrusions: The predetermined uniformly shaped and sized metal structures brazed to or made from the base member stock. Preplaced Protrusions: Any preformed shapes of uniform size which are placed to and subsequently joined to the base member with a brazing metal. Formed from Base Member Stock: Any means employed to form the finally armed protrusions from the base member stock itself.

Braze or Bond Metals: Any metal or alloy employed to braze or bond all the constituents of the finally armed device. Brazing metal of necessity has a lower melting temperature than any of the non-melting structural members of the device. It is used to braze bond the unmelted consituents wherever these are in preplaced contact with one another or to infiltrate and fill voids within the predetermined and preplaced grit structures.

Armor: The individual grits brazed directly to the protrusions and the grit structures brazed to the protrusions consisting of braze metal and grit. It also of course includes any of the grits which are held in a mechanical grip of infiltrated metal in turn held to the protrusion with the infiltrant or braze metal.

Protrusion Zone: That individual protrusion surface to be armed with a refractory grit, grits, or a grit structure. Such zones after arming are many, like, individual zones for exerting stress to the work piece. Each zone is surrounded by an encircling void to provide cuttings clearances from about the whole protrusion zone, whether the zone be armed with a multiple number of small grits in a single layer or a structure of grits.

Close Coat: This refers to the maxiumum number of grit or protrusions which can be deposited in a single layer or any unit of surface.

Open Coat: This indicates fewer number of grits or protrusions in a single layer layed on a given unit of surface. The individual grits or protrusions are substantially spaced apart from one another.

Cuttings Clearance: The void surrounding individual grits or protrusion zones which allow cuttings from the work piece to clear from about the penetrating armed grit edges or grit structures.

In the prior art, a steel base member formed to desired size and shape is caused to be overlayed with a layer of refractory hard metal or other grit substance of predetermined particle size distribution. Subsequently or during the process of applying such refractory metal or other grit to the base member a brazing metal is caused to locate at or near the area of contact of grit to the base member. Subsequently or during these processes, the base member and the grit to be brazed to it as well as the brazing metal are heated to the melting point of the braze metal which flows to the areas of contact among the grits and to the base metal and upon cooling, the grit and base member are braze joined together. The prior art depended upon selecting various specific size distributions of refractory metal grit to establish the degree of aggressiveness and cuttings clearances by virtue of the size of the grit to protrude a random edge or corner a determined distance from the base member surface. In the prior art at least a portion of the number of grits so applied would protrude an edge or corner outwardly from the surface of the base member to the working plane or periphery of the armed device.

The spacing between such grit sizes in but one layer thickness in "close" to "open" coats determines the number of actual grits protruding over a given surface area. That is, a close coat produced the maximum number of grits so placed with each grit assumed to be capable of exposing but one potential edge surface or corner outwardly.

The distance or outward measurement of the exposed grit edges or surface is no more than the grit dimension from the base member or underlying layers of grit, when grit is armed to base member surfaces. Processes such as flame sprayed deposits (e.g., Harris Pat. No. 3,248,189) of refractory metal grit and braze metal involve the building up of grit in applied layers or groups exceeding the cross sectional size of the grit so processed. Such grits so deposited are not specifically oriented or constructed one to another and to the base member to provide for accurately controlled spacing or structures among the built up layers or grit or structures as in the discovery underlying this invention.

The refractory hard metal grits commonly employed in past devices such as tungsten carbide or crushed sintered tungsten carbide grades, tend to be most irregular in shape and configuration within any given grit size distribution. When applied according to prior art techniques, a great many of the grit edges or corners do not protrude at all or are not of sufficient outward dimension relative to the desired working plane or periphery. Due to the varying length of each grit's longest axis or cross section, such depositions of grit tend to position the grits with their longest axis parallel to or tending to be positioned parallel to the surface of the base member. This results in a great proportion of the grits' edges never being efficiently used to accomplish intended work. As a result, only the furthest protruding grit's edges do work and become dulled to lessen the effectiveness of the whole device, and those grit edges lying beneath the actual plane or periphery of contact with the work piece are never effectively exposed to do work. When the aforementioned grit is used, only those grits' edges with the longest axis are brought into contact with the work piece. When these furthest protruding edges are sufficiently worn, a substantial number of the grit edges are never caused to do work since they lay beneath the effective working plane or periphery of the device.

Such refractory metal grits are not readily broken in application service to expose new fractured, ragged edges as the device is made to do work such as the grits in a conventional resin or vitreous bonded griding wheel may be designed to do. The sintered refractory hard metal grits are particularly dense and tough to resist shattering from shock or impact. As a result, the most outwardly exposed grit edges tend to wear and erode until the wear lands rubbing on the work piece create excessive heat. Therefore a major amount of the costly grit material is never consumed in use for those applications required essentially exposed sharp edges or minute hard nodes at the working surface.

The prior art depended upon grit which exposes essentially but one working corner or edge per grit and it depended on the achieving of increasing aggressiveness by increasing the grit size for height of edge protrusion from the base member, and resultant cuttings clearances all related to the grit size had required a relatively high materials cost greatly exceeding that required in the present invention to support but one edge per grit. These prior art devices when worn to disuse of the device usually represent substantially less than 20 percent of the costly grit material actually being worn away in use, leaving substantially more than 80 percent of the costly individual grit content ineffectively applied and uneconomically employed, as compared to the use of grit in the present invention. The articles made according to the prior art exhibit exposed grit edges which cannot be effectively worn or dressed to removed but a few of the outwardly protruding edges, nor without creating edge or corner wear lands that greatly reduce the effective wear life of the device.

Accordingly, the object of the invention is to provide a new abrading means or cutting device.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appended claims taken in conjunction with the accompanying drawings, wherein like numerals in different drawings indicate like elements.

SUMMARY OF THE INVENTION

The present inventive discovery demonstrates usage of the fine grits and edges to effectively arm what are termed herein "protrusions" to secure penetration, cuttings clearances, reduced friction, and other unique design advantages. The result is a markedly more effective device than heretofore possible from the prior art. This invention makes it possible to create definite structures of many exposed or special directionally positioned grits or protruding zones, or grit structures on low cost preformed protrusion zones. Such a protrusion surface (or zones) armed with smaller grits are constructed in accordance with this invention so as to allow the manufacture of articles armed more accurately, with improved, predetermined surface cutting designs of carbide grit and grit structures placed on the predetermined protrusions from a base member.

Such articles of manufacture according to the present invention allow the wearing in or dressing of grit structures of relatively finer grits so that the wear lands of the grit structures or grits contained therein can be predetermined and hence controlled in size or nature to greatly extend the wear life and effectiveness of such devices so armed, and to maximize utilization of most or all of the whole grits or grit structures so armed to the protrusions.

The present inventive discovery of predetermined protrusions of predetermined size, shape, height and ocnfiguration subsequently armed with specifically oriented grit structures on the plane or periphery of the effective working surface provides for greatly enhanced capacity to cut and abrade materials, to clear cuttings, to use coolants and to achieve improved surface finish on the work piece as well.

This invention improves upon the limitations and disadvantages imposed by prior art use of whole and erratic shapes of refractory metal grits of a specific size range to establish an abrading surface on steel base member surfaces. The inventive discovery herein makes use of various preformed and uniform protrusions of steel or other alloys and it allows the manufacture of more effective devices with great economy in use of costly refractory grit (of finer sizes) more effectively applied and employed on the protrusion surfaces for intended work performance.

Instead of using an irregularly shaped refractory metal grit size to establish the degree of aggressiveness on any base member to be armed as in prior art, this invention first establishes preformed protruding bases of relatively low cost steel or other appropriate metals that are preferably applied to, or formed from, the base member in uniform and predetermined shapes, sizes and patterns. The protrusion surfaces are than armed with special magnetically oriented small grits or structures of small grits, which are brazed to the protrusions. However, the refractory metal grits used to arm the protrusion surfaces are of relatively reduced size to reflect the individual protrusion surface form, or to provide the means for constructing individual grit structures containing relatively reduced grit sizes. In all cases the protrusion surfaces can be uniformly armed with single layers of metal brazed grits each exposing a corner or edge, or armed with metal brazed uniform grit structures containing relatively fine grits brazed to the protrusion surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** illustrate one embodiment of the invention herein involving a new abrading wheel;

FIG. **2***a* illustrates an exploded view showing the surface of the wheel of FIGS. **1** and **2** in cross section;

FIGS. **3** and **4** illustrate another embodiment of the invention herein involving a new abrading wheel;

FIG. **4***a* illustrates an exploded view in cross section of the surface of the abrading wheel of FIGS. **3** and **4**;

FIGS. **5, 6, 7,** and **8** illustrate in various embodiments certain surface configurations used for the abrading means of this invention, by way of enlarged illustration;

FIGS. **9***a* through **11***c* illustrate other embodiments of the invention wherein certain protrusion means described hereinafter are formed from the base member of the abrading means for subsequent arming of abrasive grit particles in accordance with this invention; and,

FIG. **12** illustrates still another embodiment of the present invention wherein the abrading means surface is shown in exploded view to show infiltrated metal encasement gripping of the grit particles on the surface of the abrading device.

DESCRIPTION OF PREFERRED EMBODIMENTS

Looking now to FIGS. **1–6**, one effective means for forming the protrusions **10** is the use of more or less accurately sized steel (or other metals or alloys) in the form of spheres which are placed on the base member **11** at the outer surface **12** thereof in open to closed spacing. This use of preformed spheres of uniform size and location on the base member surfaces **12** to be armed provides a means to achieve individual protrusions of uniform height and potential clearances for cuttings as well. Preferably each steel sphere's outermost surface only is unformly armed with a predetermined single layer of smaller grits **14** of uniform shape and size, or structures **16** comprised of a plurality of combined small grits. The outermost surface **10***a* of the individual steel sphere **10** provides an economical and unique protruding surface shape for this subsequent grit armoring of the device, such as the abrasive wheel **20** shown.

Any other suitably sized steel or other metal, alloy, or sintered metal pieces may be used as the preplaced protrusion bases such as cubes, pyramids and cylinders or any other uniform shape which can be uniformly placed as to positioning and location on the base member **11.** The outermost and uniformly protruding surfces of the protrusions **10** are the basis for creating the specific final shape, location and size of the finally armed abrasive device **20.** In all the above cases the protrusions may be heated bonded, by the brazing metal **22,** in place to the base member **11** before armoring with refractory metal grit **14** or other substances; or, such may be heat bonded or brazed to the base member at the same time that the armor is bonded to the protrusions. The surfaces of the protrusions may if desired be altered before arming with the grit.

In the above cases the outermost surfaces so armed are not necessarily joined one to another at the intended working plane or periphery. It is unique that each armed protruding surface may be desirably surrounded by open voids **24** among substantially all the protrusions to provide maximum penetration and cuttings clearances for the individual grits or structures armed to the protrusion.

The exposed surface of each protrusion may be armed with but a single grit, a plurality of grits, or a grit structure: or, the surface may be armed up to substantially all of the outermost exposed hemisphere of a spherical protrusion.

All protrusions made to expose a flat or arced outermost surface are armed essentially on the plane, flatted or arced protruding surface. Such protrusions shaped as a two or more sided apex or flatted apex may be armed at the surface vertex, or down the sides as well, depending upon the desired final article.

Protrusions - Formed from the Base Member: Certain base members may have the protrusions formed from the base member (e.g. steel) itself as disclosed in FIGS. **9–11.** Specifically this applies to base members **111** having an armed edge or periphery of relatively thin base metal such as circular saw blades, straight or curved blades or segments as well as holesaws and core bits. In such cases, the metal thickness establishes the width of the protrusion **110** to be armed to finally establish the protrusion or cutting tooth width. The invention herein is also applicable for use on raised continuous or interrupted file teeth which have protrusions formed from base members of the file or with separate protrusions being first placed on the file.

In all cases the overall length of the individual protrusion surfaces **112** to be armed should not exceed about 1 ½ times the metal thickness **113** of the blade or tooth and should preferably be of less length than the metal thickness. If the individual preformed protrusions have an arc (FIGS. **10** (*a*), **10**(*b*), **10**(*c*)) established along their length parallel to the direction of use, the arced radius should be preferably no less than one half the metal thickness of the blade and the arc radius should preferably not exceed the radius of the final device in use (i.e. radius of the wheel). If the protrusion be of spherical shaped (FIGS. **11**(*a*), **11**(*b*), **11**(*c*)) or near spherical shape the radius of the spherical outer area to be armed should preferably be at least one half the metal thickness of the base member. The height of the protrusions should be at least equal to the minimum cross section of the grit size armed to the protrusion surface or greater. Also, the pitch or spacing between the protrusion surface centers should generally not be less than one half the base metal thickness.

Protrusion Material and Hardenability: By using a hard or hardenable steel, or other hard metal, from which the protrusions are made, a stronger, more stress resistance base between the armoring grits or grit structures and the base member can be achieved. This allows subjecting the armored protrusion surfaces to greatly increased shock and stress without rupturing the brazed joint of grit to the protrusion surface which may occur since use of smaller grit or grit structures greatly increase the unit stresses via the smaller grit to the protrusion under a given load. The stresses imparted to the armored protrusion are than transferred through the protrusion to the softer, more deformable base member without rupturing the brazed unions by virtue of the less deformable hardened condition of the protrusion and the greater area of brazed joint of the protrusion to the base member. The protrusion may be hardened to any hardness required, or selected from inherently hard metals, to provide optimum resistance to stress and deformation.

Protrusion Sizes: The substantially uniform size of the protrusions preplaced to base member surfaces is preferably a maximum of about ⅛ inch cross section (for example spheres of ⅛ inch diameter). The uniform protrusion size may be reduced to as small as about 0.010 inch or less depending upon the required final grit sizes employed and the cuttings clearances required to established by the clearances to be achieved with a given sized protrusion and spaced thereof.

The purpose of the uniform preformed and preplaced protrusions to be armed are one or more of the following. (1) To form a protruding base for subsequent armoring that is of predetermined uniform shape, size, and height not possible in the prior art use of whole equivalent grit sizes of relatively odd shape with randomly located and exposed edges or corners. (2) To provide protrusion surfaces of a controlled design, size, and location to provide for exerting maximum stress concentration to the work piece via the grits or grit structure subsequently armored to each protrusion surface. (3) To allow a controlled design of individual protrusions located so as to provide adequate and predetermined cuttings clearances from all about the subsequently armed individual protrusions. (4) To provide a basis for controlled armoring of each protrusion with armorings of grit or structures of grit all made to substantially extend to, near, or toward the working plane or periphery. (5) To provide uniform individual bases of reference for locating a multiple number of grit edges from grits reduced sizes than the outermost protrusion surface dimension to achieve individual protruding zones armed with a multiple number of exposed small grit edges by themselves exposed from each protrusion surface in close proximity to the intended working plane or periphery. (6) To provide uniform individual bases of reference for locating a uniform structure of refractory metal grits containing grits of relatively small size, bonded with a braze metal of lesser wear resistance than the refractory metal grit. (7) To provide a basis of structural design to predetermine the overall uniform final design of the many individual armored protrusions to create a penetrating effect of near zero degrees or rake angle of the overall armed protrusion to the work piece. (8) To provide a hard or hardenable protruding base from a more soft base member, which may be required to support brazed joined refractory grits and structures with greater resistance to deformation than with a more soft condition in the protrusion base. (9) To provide controlled patterns, shapes and sizes or protrusion zones for exerting variations of stress to work pieces via the armed protrusions. (10) To provide for predetermined and adequate cuttings clearances among the protrusion zones armed with grit or grit structures, not possible with the limitations of the use of whole grits or grit structures as in the prior art. (11) To provide for predetermined and greatly increased spacing among the armed protrusions for introducing existent atmospheric air and other gaseous or liquid coolants to: (a) inhibit hot cuttings adhering to the armed protrusions, (b) enhance the removal of cuttings, (c) and to abstract (or remove) heat from the armed protrusions and the base member, as well as the surface of the work piece.

The following description in accordance with the invention illustrates the placement of relatively small grits in single layers of grit edge exposure bonded to the predetermined protrusions; or, such relatively small grits contained within a structure of grits of braze (or with binder material) bonded to individual protrusions. In effect this invention presents a means to more effective and efficient utilization of more and smaller grit edges with use of greatly reduced amounts of the costly grit material.

Refractory Metal Grit - Properties, Size and Edge Utility: Refractory metal grits such as crushed sintered tungsten carbide grades have unique physical properties of great shock resistance or toughness, high red hardness, and high edge wear characteristics exceeding those of most other commercially available economical cutting edge materials that can be brazed or wetted with various braze metals. Physical properties of such refractory metals limit their usefulness in grit form to the use of essentially only their edges for cutting and abrading. The massive portion of such larger grit sizes as used in the prior art are not used in service other than to support an edge or corner out from the base member to the working periphery of the armored device. The massive portion of the relatively larger grit (brazed in single layers) required in prior art is not of utility after the exposed edge or corner is eroded or worn up to about 5 percent of the whole volume of the grit armed to the base member. Unlike the prior art, that is, the use of whole massive grits of refractory metal to expose but one randomly positioned edge or corner, this invention provides for the creation of predetermined armoring of more effective finer grit and more of the smaller edges individually exposed from a protrusion surface.

The composition of the grit structure is such that the bonding or brazing metal which bonds the grits to one another wears away more rapidly than the small grits in the braze matrix hence tending to expose more edges of or cross sections of more fine grits of the work piece.

The present invention usage of relatively fine sized grits armed to the more massive protrusions makes it possible to easily dress or fracture those furthest protruding grits to expose more of the finer grits on the drive to the effective working plane or periphery in contact with the work piece. As indicated previously, this invention not only includes those wettable refractory metal grits or other wettable substances that are suitable for brazement directly between the grit and protrusion, but it also includes all substances which by virtue of their various physical and chemical properties must of necessity or by intent be encased in a subsequently infiltrated grip of wettable (e.g., brazeable) metal particles **121** surrounding such grit **114** and bonded (brazed) at **122** to the protrusions **110.** (Refer to FIG. **12.**)

Unlike refractory metal grits, many hard abrasive grains or crystals cannot be "wetted" with a braze metal joint to form a strong brazed joint. However, by creating a mechanical grip about most of such grains a sufficiently strong attachment of the grains may be derived. This may be acomplished with the use of single layers of grits or structures of such grits armed to the protrusions.

Grits Armed to Protrusions in Single Layers:

Grit Size: The refractory metal grit armed to the protrusion's surface should be of a generally uniform smallest cross section size and of smaller cross section than the protrusion itself in order to more closely reflect the size, and duplicate the form of the underlying protrusion surfaces.

For protrusions of ⅛ inch cross section or less the largest sized grit used to arm the protrusion should generally be no larger than ⅞ maximum cross section of the protrusion or smaller. That is, if a protrusion of ⅛ inch cross section is armed, the largest grit size if 1/24 inches measured through the grits smallest cross section. Normally in cases involving the use of smaller protrusion sizes, the maximum grit size should not exceed about ⅞ the maximum cross section of the protrusion. And the grit size distribution may be of any size smaller than ⅞ the cross section of the selected protrusion size.

Grit Position — Magnetically Oriented Position: Due to the fact that substantially all grits have a typical length exceeding their smallest cross section, it has been unexpectedly discovered that the grit can be uniquely magnetically oriented (FIG. **5** or **6**) or preplaced and brazed in a position, whereby substantially all the grits' longest axes extend outwardly from the individual protrusion surfaces at an angle of generally 90° from a flat protrusion surface, or generally radially out from a curved or spherical surface. Such magnetically oriented positioning of the grit makes for markedly increased cuttings clearances between and among the grits armed to an individual protrusion zone and allows controlled dressing or breaking off of wild or long grits before the device is applied to the work piece. The novel use of the individual protrusions herein, regardless of their outwardly exposed surface configuration, makes it uniquely possible to control the predetermined positioning of nearly all grits in a close or open coat, to and extending outwardly from the protrusion to the working plane or periphery or face configuration or the armed device.

Random Positioning: It is also considered novel in accordance with this invention that the grits may be placed on the special protrusions disclosed so that their longest axes lie generally parallel to or in random position (FIG. **7** or **8**) relative to the protrusion surfaces whether they be flatted, arced or spherical.

The purposes of single layered grit in accordanace with the invention are as follows: (1) To more accurately reflect the uniform size and surface configuration of each protruding surface zone as part of a predetermined pattern or armed zones on the final device. (2) To bring more of the smaller grit edges, corners and surfaces to the intended working plane or periphery of the finally armed device. (3) To allow dressing of more of the finer grits to the common working plane or periphery or configuration of the device. (4) To acheive more accurately armed individual protruding grit edges or surfaces all more closely placed to a common working plane, periphery or configuration than with the prior art. (5) To allow more accurate final predetermined dimensions with many more fine grits or edges on the working plane, periphery or configuration as compared to prior art. (6) To employ more small grit edges or cross section on a protrusion to increase penetration rates into the work piece by virtue of increasing the stress concentration of more small sized individual grits than possible with prior art usage of larger grit sizes. (7) To provide for predetermined and adequate cuttings clearances among the protrusion zones armed with grit not possible with limitations of the use of whole grits or grit structures as in the prior art.

Grit Structures Armed to the Protrusions: The protrusions may also serve as a means for location of, and construction of grit structures containing relatively small grit particles which are braze bonded as a unified structure to the individual protrusions (see FIGS. **3, 4,** **4***a*, **6, 8,** and **12**).

The braze metal used to form the grit structure should be less hard than the grits within the grit structure. During application usage of the device the braze metal is gradually worn away at a faster rate than the grit edges or whole grits. This then allows the grit structures in service to yield a predetermined and controlled armed protrusion surface zone containing many exposed small grits or edges during wear as opposed to the relatively large wear land of single large grits as in the prior art.

Grit Position Within a Grit Structure: The grit structures may contain random positioning (FIG. **8**), or specific magnetically oriented positioning, (FIG. **6**) to and outwardly from each protrusion with respect to each grits longest axis extending generally outwardly from the device.

Grit Structure - Density: The structures may be of a porous nature with grits or metal covered grains brazed substantially only at their points of contact to one another and to the protrustion surface. The structures may also be caused to be filled completely with brazing or infiltrate metal to achieve maximum strength with any selected grit and braze metal.

Grit Sizes in the Grit Structure: As with grit placed in single layers, the maximum grit size employed in the grit structures is generally not greater than ⅞ the size, or smaller than, the maximum cross section of the protrusion. However, the grit sizes used in the grit structure may be mixtures of various predetermined sizes or of uniform size in order to predetermine the density of grit in the final structure or to produce various cutting effects and strengths in the grit structures.

Grit Structure - Directional Orientation: The grit, as mentioned above, may be uniquely magnetically oriented or positioned and placed with each grits' longest axis generally aligned with one another and extending generally outwardly from the spherical arced or flat surface of the protrusion, and the center or intended center of the finally armed wheel or portion of a wheel. Likewise the final individual grit structures themselves on the protrusions are so oriented outwardly. On a device to be operated in a working plane the individual grits within and the grit structure as a whole are oriented to a condition where their longest axis generally point outwardly at about 90° from the plane of the base member or the working plane. The grit angle can be positioned at any angle up to about 45° from perpendicular to the tangent of the cutting plane.

Grit Structure - Shapes: (1) Conical Shape: The basic structures may be magnetically oriented conically (e.g., FIG. **6**) with the base being no larger than the surface area of a flat, arced or spherical protrusion. In all cases, the individual cone height is no more than about twice the maximum cross section of the protrusion. (2) Cluster Shape: The structure of the grits may also be preplaced and magnetically oriented along the grits longest axis generally radiating outwardly from each protrusion surface to make a cluster of extending tendrils of carbide grits protruding two or more times the lengths of the grit from the individual protrusion surface. (3) Random Shape: The structure may also be a random arrangement of grits (e.g., FIG. **8**) stacked together and piled to a height of no more than twice the maximum cross section of the protrusion.

Purpose of the Grit Structures: (1) To achieve a more uniform predetermined armed protrusion as to its armed shape and size and structure by using more and finer grits as compared to the prior art's limitation to use of single pieces of inefficiently utilized refractory metal grit or erratic shape. (2) To create armed protrusions with uniform pointed shaped (conical) grit structures to greatly increase the penetrating ability of the device into work pieces. (3) To provide an armor structure containing relatively fine refractory metal grits held in a less wear resistant metal matrix wherein as the surface of the armed protrusions wear in service, the exposed worn armor presents succeedingly smaller grits and edges to the work piece. (4) Also the structures (as in 3 above) allow the dressing of the protruding armor to produce a more uniform exposure of substantially all of the armored protrusions to the working plane, periphery, and configuration of the work piece. (5) To provide for greatly increased cuttings clearances about the extended structural armoring from the protrusion substantially beyond that of single layered protrusions or the single layered grits as employed in the prior art. (6) The use of uniform protrusions to allow the creation of various uniform grit structures to be armed to the protrusions. (7) The use of the protrusions to allow the generally radial or vertical alignment of substantially all grit axis in the armored structure whether the armored structure be a solid cone or a cluster of grits preplaced and subsequently brazed bonded to a solid more or less uniform structure. (8) The use of protrusions to allow building the armored structures so that the structures as a whole are oriented substantially outwardly 90° to the working plane or radially out from a base member surface. (9) To achieve substantially greater economy of final utilization of all or most all of the refractory metal grit armed to a device, as compared to the use of only the limited edges of relatively coarse grit in the prior art.

As presently preferred, the method of manufacturing abrading devices as discovered and disclosed herein is as follows. First the substrate material or metal is coated with a temporary binder means such as a film resin binder, similar plastic resin binder, or the like. Next a layer of the protrusion means such as the layer of steel shot is applied over the temporary binder and held in place thereby due to the adhesive nature of the temporary binder. Then a brazing metal or bonding material usually in finely powdered form (such as a mickel-chromium alloy brazing metal) is applied as the next layer of the device. Following this, additional temporary binder material may be added if desired; and, then a suitable magnet means (such as an elongated bar magnet) is contacted with a central base portion of the metal base member. Subsequent to contacting the steel base member with the magnet as referred to the grit material is applied to the device by contacting or dipping the device into a body of, for example, tungsten carbide grit, and as the grit is positioned on the temporary binder material of the device, the magnetic force field caused by the magnetic means uniquely causes the tungsten carbide grit to in effect stand up or orient itself on the protrusion means such that the grit is oriented outwardly from the protrusion means generally in each grit's long axis direction. Additional brazing metal may than be applied if desired over the top of the grit. The device is then subjected to heating to the braze metal melting range. In accordance with this invention, the grit particle means used herein, such as tungsten carbide contain a certain amount of cobalt alloyed into the tungsten carbide to render same magnetizable. However, other grit particle means may be used herein so long as there is a magnetizable metal means associated therewith such as iron, cobalt, or nickel. In certain instances the grit means may have the magnetizable metal applied as a very thin coating over the outside of the individual grits in order to render same such that they may be magnetically oriented in accordance with this invention. The abrasive particle grit means for use herein may be selected from at least one material of group consisting of tungsten carbide, silicon carbide, titanium carbide, aluminum oxide, refractory oxides, refractory borides, garnet, and diamond. The protrusion means herein or the spherical particles used for same may be selected from at least one material of the group consisting of steel, metal, or ceramic particles.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation, and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. An abrading tool structure comprised of,
- a base support member,
- a plurality of spherical steel shot particles forming protrusions fixedly positioned on a surface of the base member,
- magnetically oriented abrasive grit particles positioned on an outer surface of the steel shot particles,
- a metal bonding material holding the abrasive grit particles and steel shot particles in proper position, and
- said abrasive grit particles being selected from at least one material of the group consisting of refractory metal carbide and metal boride grit particles, and
- said grit particles including a magnetizable metal therewith selected from at least one material from the group consisting of iron, cobalt or nickel to provide for magnetically orienting said grit.

2. An abrading device for abrading various objects, comprising,
- a base member serving as a base for the device,
- a plurality of relatively small sized protrusions supported on the base member and fixed thereto,
- magnetically oriented abrasive grit particles metallically bonded on the outer surfaces of the protrusions for abrading contact with said various objects,
  - said grit particles being magnetically oriented to generally render the longest axes of each particle to an outwardly directed orientation relative to the outer surface of the protrusion,

and,
- metal bonding material for holding said grits and said protrusions in proper position, and
  - said abrasive grit particles being selected from at least on material of the group consisting of refractory metal carbide and metal boride grit particles,
  - said grit particles include a magnetizable metal therewith selected from the group consisting of iron, cobalt or nickel to provide for magnetically orienting said grits.

3. An abrading device for abrading various objects, comprising, a base member serving as a base for the device,

a plurality of relatively small sized protrusions supported on the base member and fixed thereto,

magnetically oriented abrasive grit particle supported on the outer surfaces of the protrusions of abrading contact with said various objects,

said grit particles being magnetically oriented to generally render the longest axis of each particle to an outwardly directed orientation relative to the outer surface of the protrusions,

and,

metal bonding material for holding said grits and said protrusions in proper position, and

said abrasive grit particles being diamond abrasive grit particles, with said diamond grit particles including a magnetizable metal coated thereon and selected from the group consisting of iron, cobalt or nickel to provide for magnetically orienting said diamond grit particles.

4. The invention of claim **2** wherein,

said magnetizable metal is included within the abrasive particle material.

5. The invention of claim **2** wherein,

said magnetizable metal is coated on the abrasive particle material.

6. The invention of claim **2** wherein,

said protrusions are formed of generally spherical particles selected from at least one material of the group consisting of steel, metal or ceramic particles.

7. The invention of claim **2** wherein,

said grit particles are generally applied in a single layer to said surfaces of the protrusions.

8. The invention of claim **2** wherein,

said grit particles are generally applied in the form of a cone shaped structure to said surfaces of the protrusions, with said structure being bonded together with said bonding material.

9. The invention of claim **2** wherein,

said protrusions are formed by relatively small protruding elements which project out from and constitute a part of the same material as the base member is formed of.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,918,217

DATED : November 11, 1975

INVENTOR(S) : Lloyd R. Oliver

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 58, the word "close" should read as -- "close" --; Column 3, line 64, the word "removed" should read as -- remove --; Column 4, line 36, the word "ocnfiguration" should read as -- configuration --; Column 4, line 60, the word "than" should read as -- then --; Column 5, line 50, the phrase "sintered metal pieces" should read as -- sintered metal shaped pieces --; Column 5, line 55, the word "surfces" should read as -- surfaces --; Column 5, line 58, the word "heated" should read as -- heat --; Column 5, line 65, the phrase "the outermost surfaces" should read as -- the outermost protruding surfaces --; Column 6, line 12, the word "surface" should read as -- surfaces --; Column 6, line 41, the word "shaped" should read as -- shape --; Column 7, line 10, the word "spaced" should read as -- spacing --; Column 7, line 31, the phrase "grits reduced sizes" should read as -- grits of greatly reduced sizes --; Column 7, line 51, the word "or" should read as -- of --; Column 8, line 1, the words "of braze" should read as -- and braze --; Column 8 line 30, the words "smaller edges" should read as -- smaller grit edges --; Column 9, line 3, the figure "7/8" should read as -- 1/3 --; Column 9, line 9, the figure "7/8" should read as -- 1/3 --; Column 9 line 11, the figure "7/8" should read as -- 1/3 --; Column 9, line 33, the word "or" should read as -- of --; Column 9, line 44, the phrase "or armed zones" should read as -- of armed zones --; Column 9, line 57, the words "on a protrusion to" should read as -- on a protrusion surface to --; Column 10, line 24, the word "infiltrate" should read as -- infiltrant --; Column 10, line 28, the figure "7/8" should read as -- 1/3 --; Column 11, line 4, the phrase "or erratic shape"

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,918,217 Dated November 11, 1975

Inventor(s) Lloyd R. Oliver Page 2 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

should read as -- of erratic shape --; Column 11, line 47, the word "mickel" should read as -- nickel --; Column 12, Claim 2, line 60, the words "on material" should be -- one material --; Column 13, line 5, the words "of abrading" should be -- for abrading --; Column 13, line 8, the word "axis" should read as -- axes --.

Signed and Sealed this

seventeenth Day of *February 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks