TOOL STRUCTURES

Filed Oct. 10, 1967

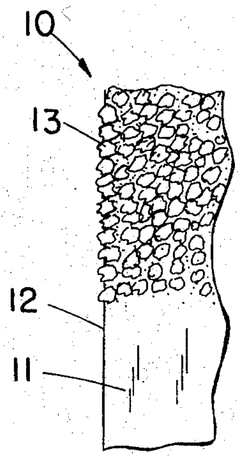

FIG. 1

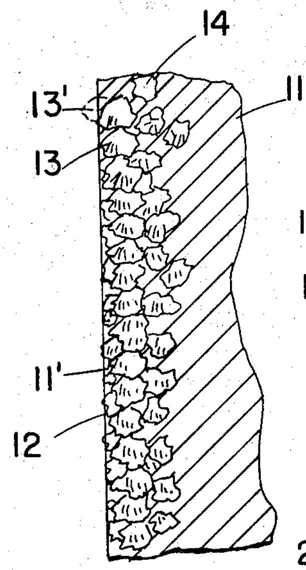

FIG. 2

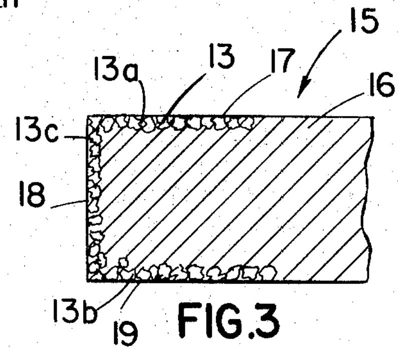

FIG. 3

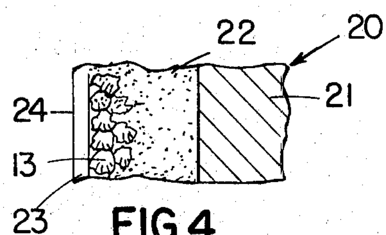

FIG. 4

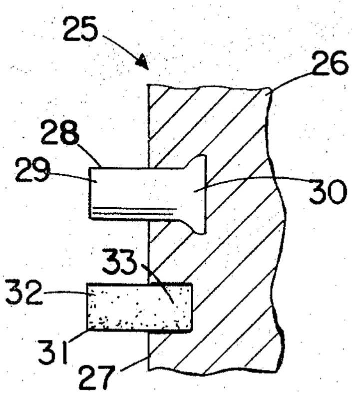

FIG. 5

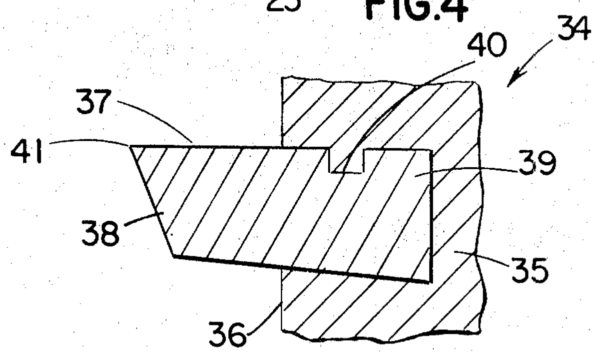

FIG. 6

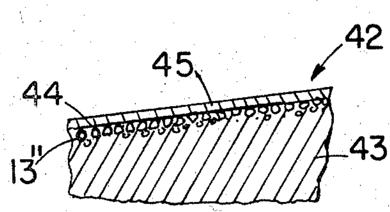

FIG. 7

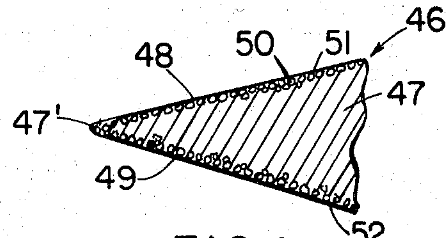

FIG. 8

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TOOL STRUCTURES

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Continuation-in-part of application Ser. No. 432,924, Jan. 8, 1965, now Patent No. 3,346,220, which is a continuation-in-part of application Ser. No. 641,101, Feb. 8, 1957, now Patent No. 3,173,195. This application Oct. 10, 1967, Ser. No. 674,330

Int. Cl. B24d *5/00;* B26d *1/12;* B28d *1/04*

U.S. Cl. 51—206 7 Claims

ABSTRACT OF THE DISCLOSURE

Composite cutting and grinding tool structures having a metal base and a hard surface material disposed along the cutting portion of the tool. In one form, a multitude of abrasive bits form an integral portion of the surface of the tool together with metal of the tool base interspersed between the bits. The bits may serve to provide both the actions of abrading work and resisting abrasion of the tool by the work. The bits may also serve primarily to provide a hard surface adjacent or along one or more cutting edges of the tool to resist wear during the cutting action and/or to finish or abrade the work surface machined by the cutting edge of the tool. In another form, a hard surfacing material is applied as a coating along or adjacent to the cutting edge(s) of the tool or on the abrasive bits to resist erosion and serve to lubricate the cutting surfaces during use.

RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 432,924, filed Jan. 8, 1965, now U.S. Pat. No. 3,346,220, which is a continuation-in-part of application Ser. No. 641,101 filed Feb. 8, 1957, now U.S. Pat. No. 3,173,195.

SUMMARY OF THE INVENTION

This invention relates to new and improved structures in cutting tools such as grinding wheels, files, saws, drills, tool bits, milling cutters and the like. The tool is formed of a composite material comprising a base defining its general shape and a suitable abrasive or wear resistant material coating or covering at least a portion of said base adapted to engage the work. The coating material may comprise a metal, hard alloy, carbide, nitride or oxide of hard metal applied as a plating or film and/or as a multitude of abrasive bits or chips thereof disposed along the abrading or cutting surface of the tool. Conventional grinding wheels are either made of bonded or sintered ceramic materials or contain abrasives dispersed throughout their structures which form discs or drum shapes containing inexpensive abrasives of relatively low-cutting efficiency as it is too costly to provide diamond and other abrasive particles throughout the matrix. Accordingly, the prior art has resorted to bonding or sintering such abrasive bits to the outer surface of the wheel base or drum.

The use of adhesive and sintering techniques in retaining abrasive bits to a support have obvious shortcomings which include strength and structural limitations and inability to resist heat corrosion.

Accordingly, it is an object of this invention to provide a new and improved structure in a grinding and abrading tool having a plurality of grinding bits which are held integral within a solid metal matrix.

Another object of this invention is to provide a new and improved cutting or abrasive tool structure which may be made at relatively low cost by casting, injection molding or otherwise providing a suitable material such

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as metal about the cutting member or members in such a manner as to mechanically join the two together.

Another object is to provide an improved cutting tool having components which are integrally cast or molded together by means of metal which defines the base support therefor.

Another object is to provide an improved cutting tool structure in which one or more cutting members or tools are integrally secured to a support by casting or molding the two together and simultaneously effecting a molecular bond or weld between the components so joined.

Another object is to provide an improved surface structure in a composite material which may be applied to produce new and improved tools with cutting edges such as milling cutters, knife blades, drills and the like whereby fine abrasive bits disposed along or adjacent to the cutting edge serve either or both the functions of abrading or finishing the cut surfaces of the work and resisting wear and erosion to said blade or tool.

Another object is to provide new and improved structures in cutting tools made of composite materials which will not easily loosen or come apart during use, thereby reducing maintenance and inspection functions relating to the tool.

Another object is to provide an improved composite abrasive containing metal structure or material capable of being shaped as or after it is formed into a variety of cutting tools such as cutting blades, drills, tool bits, cutting wheels, knife blades and the like and having an improved erosion resisting structure along or near the cutting edge thereof for reducing wear during operation of the tools.

Another object is to provide a new and improved structure in a grinding wheel.

Another object is to provide a new and improved structure in a file or grinding burr.

Another object is to provide a new and improved structure in a circular saw blade.

Another object is to provide a new and improved structure in a reaming tool.

Another object is to provide a new and improved structure in a rotary drill.

Another object is to provide an improved composite abrasive bit containing structure applicable to grinding wheels and other abrading tool fabrication yet capable of resisting greater forces during use which tend to damage or destroy the structure than conventional grinding wheel structures.

With the above and such other objects in view as may hereinafter more fully appear, the invention consists of the novel constructions, combinations and arrangements of parts as will be more fully described and illustrated in the accompanying drawings, but it is to be understood that changes, variations and modifications may be resorted to which fall within the scope of the invention as claimed.

In the drawings:

FIG. 1 is a side view of a fragment of a cutting tool or abrading device embodying features of the instant invention;

FIG. 2 is a cross sectional view of a fragment of a modified form of the device of FIG. 1 magnified in size;

FIG. 3 is a cross sectional view of a fragment of a grinding wheel made in accordance with the teachings of the current invention;

FIG. 4 is a cross sectional view of a fragment of a modified structure having features of the current invention;

FIG. 5 is a fragmentary view having parts shown in cross section of a modified form of the invention;

FIG. 6 is a cross sectional view of part of a cutting tool made in accordance with teachings of the current invention.

In FIG. 1 is shown a portion of a cutting tool **10** having any suitable configuration and comprising a solid base portion **11** shaped as a wheel, disc, drum, cone, rectangular blade, or triangular member or any other shape having at least a portion thereof adapted to conform to the surface of a workpiece to be cut, abraded or machined thereby as the device **10** and/or the workpiece move with respect to each other. In one form of the invention, the device **10** may comprise a grinding wheel having means (not shown) for rotationally supporting said wheel on a shaft adapted to rotate the wheel about its central axis for grinding metal, plastic, ceramics or other materials as the wheel rotates.

The base or supporting substrate **11** for the tool **10** is preferably made of metal which is molded or cast to shape and which contains embedded in the surface **12** thereof a multitude of abrasive bits **13** which are operative to effect the abrading or cutting of material against which the surface of said tool containing said bits is brought. The bits **13** in FIG. 1 are shown in FIG. 2 as being at least partially encapsulated within the surface stratum of the base **11**, the material of which base is cast in situ over and around a substantial portion of each bit to lock same securely to the base member. The abrasive bits **13** which may comprise such materials as aluminum oxide, boron nitride, the carbides or nitrides of tungsten, chromium or titanium, titanium carbide, diamond or other suitable hard, abrasive material, are locked in place by virtue of the base metal being cast, injection molded or forge flowed about the bits and solidified in situ thereagainst to provide a mechanical locking action for holding the bits in place. A number of means are described in my said copending application Ser. No. 432,924 for fabricating the tool **10**, one of which comprises disposing the abrasive members **13** as a layer in a suitable binder against the surface or surfaces of a mold and thereafter casting or injection molding materials such as metal in the mold to the shape defined at least in part by the surface of the molding cavity containing the bits adhered thereto.

If the bits **13** are made of boron nitride, such material will withstand temperatures in excess of 3500° F. without being destroyed, thereby permitting the base **11** to comprise a cast or injection molded metal such as steel which is cast in situ against the layer of bits which are disposed against the surface of the mold cavity wall so that the bits become locked within the surface stratum of the tool as illustrated in FIG. 2. The layer **14** of bits **13** may also comprise diamond chips or bits provided that the material of the base **11** cast thereagainst has a lower melting point than 1600° F. at which temperature diamond will oxidize. For example, aluminum and other white metals may be cast in situ against a layer of diamond chips or bits disposed against a surface to form a grinding or finishing wheel, reamer, file, circular or flat saw blade or other tool. The bits may be disposed integral with the material of the substrate **11** as a single layer of bits or a plurality of layers thereof defining a stratum of bits and base metal which may be used for abrading purposes after the outer layers of bits become worn or eroded therefrom. The surface **12** may be flat or irregular in shape and is composed of potions of the bits **13** and solid metal **11'** of the substrate **11** interspersed between the bits. Portions of the bits **13** may also protrude outwardly from the surface **12** defined by metal **11'** as illustrated at **13'** a condition which may result from the manner in which the bits are attached to the substrate, from etching away a layer of the base metal or by erosion of the outer stratum of the metal **11'** disposed between bits during use thereby permitting surface portions of the individual bits to engage a workpiece and effect machining or abrading thereof. To lubricate and reduce wear on the bits during abrading or machining, the surface **12** or the surfaces of the individual bits may be coated with a wear resistant material such as tungsten, chromium, titanium, molybdenum or other suitable hard metal or the carbides or nitrides of these metals. The abrading members **13** may also comprise fine chips or bits of the carbides or nitrides of these metals as well as the metals per se or alloys thereof and may vary in mean diameter from .0001" to .010" depending on tool use and function and the material to be machined therewith. A surface layer of fine abrasive bits of the types described may also be bonded to the surface(s) of a grinding or cutting tool such as a saw blade by flame spraying the bits and a binding metal such as tungsten, chromium, titanium, molybdenum or the like against the surface of the tool or wheel whereby the flame sprayed metal serves to bond and protect the bits by also coating same.

Whereas in FIG. 1 the abrasive bits **13** extend substantially as a single layer bonded to or mechanically held within the surface stratum of the substrate or tool base **11** and in FIG. 2 a plurality of layers of said bits are shown encapsulated within the surface stratum, said bits may also extend to a substantial depth of a selected portion of the substrate or substantially through and through the substrate as the result of being premixed with the metal of the substrate prior to molding or casting thereby permitting the substrate or base to be formed to shape and/or used for a substantial period of time regardless of the erosion and attrition to which the bits are subjected.

In FIG. 3 is shown a peripheral portion of a grinding wheel **15** comprising a base **16** of molded or forged metal having side walls **17** and **19** and a cylindrical peripheral wall **18**. Layers **13*a***, **13*b*** and **13*c*** of abrasive bits as described extend respectively along portions of the side walls and the end wall of the base **16** to define suitable grinding or machining surfaces. The bits **13** may also be applied to the areas indicated by flame spraying as described above and/or may be reapplied to the surfaces thereby as attrition wears off the previously applied bits. The outer surfaces of the integrally cast or flame plated bits may also be flame coated with suitable lubricating and protecting material such as the metal described or suitable carbides, nitrides or hard oxides thereof. Such coating materials may also be applied by flame or detonation plating after the bits have been molded or bonded integral with the base **16**.

The base **16** of FIG. 3 may have shapes other than the described disc shape and may comprise part or the entire formation of a circular or strip-like toothless or toothed saw blade drill bit or fluted portion of a twist drill, lathe tool bit, milling cutter, cutter insert, knife blade or other suitable cutting tool having the cutting portions thereof coated with a hard, wear resistant material with or without abrashive bits retained thereby.

In FIG. 4, a composite structure **20** is provided comprising a base **21** having a layer **22** of suitable metal or ceramic which is cast or welded in situ against the base **21** and contains a plurality of bits or particles **13** of suitable ceramic material provided in the outer stratum thereof. The bits **13** are cast or molded in an outer layer **23** in which they are disposed prior to forming the stratum **22** against said bits so that each bit is mechanically held within at least two layers **23** and **22**. The layer **23** may be removed by melting same and causing it to flow off the surface of the bits or by chemically etching same away from the bits thereby leaving the bits protruding from the outer surface of the material **22** to permit the bits to come into direct contact with the surface of the member to be machined thereby. The structure illustrated in FIG. 4 may also be utilized as shown, for other purposes, as will be hereinafter described.

FIG. 5 illustrates another form of the invention comprising a cutting tool **25** having a base portion **26** which is cast in situ about a plurality of cutting devices which are shown in two forms defined by notations **28** and **31**. The devices **28** and **31** may be made of any suitable hard material such as aluminum oxide, boron nitride, titanium carbide or the like and each protrude from the outer surface **27** of the base member **26**. Device **28** has an outwardly protruding portion **29** containing one or more cutting edges for cutting or abrading a work piece and a head portion **30** which is shown locked within the metal of ceramic material defining base **26**.

The cutting device **31** is shown having an outer portion **32** protruding outwardly from the surface **27** of base **26** and a second portion **33** which is shown encapsulated within and surrounded by the material of the base member **26**. The material comprising base **26** may be cast in situ against a surface containing sub-cavities in which portions **29** and **32** of members **28** and **31** are retained during the casting or molding operation and from which portions **30** and **33** protrude so as to become secured to the base member **26** by molding when the material thereof solidifies. The fastening of portions **30** and **33** of members **28** and **31** may be purely mechanical as the result of casting the material of the base **26** thereabout or may be further enhanced by effecting a bonding or welding action between the material of **26** and the surface portions of members **28** and **31** during the casting or molding operation.

FIG. 6 illustrates a tool assembly **34** comprising a base **35** and a tool bit or blade **37** having one or more cutting edges, one of which **41** is illustrated, for engaging the surface of a work piece as the assembly **34** is power driven and/or the work is rotated or otherwise moved relative to said tool. The tool bit **37** has an outer portion **38** projecting outwardly from the outer surface **36** of the base **35** and a second portion **39** which is secured within the base **35** by encapsulation as effected by molding or casting the material of **35** around the portion **39**. One or more cavities **40** are provided in one or more of the surfaces of a portion **39** of tool bit **37** into which cavities the material of **35** may be flowed during the molding or casting operation for more securely holding the tool bit in place and preventing its removal during the operation of the tool as the result of forces applied thereto.

FIGS. 7 and 8 show modified forms of tool structures embodying features of the invention. In FIG. 7 a composite structure **42** comprises a base or matrix **43** made of solid metal having a multitude of fine abrasive bits **13″** disposed in the outer stratum of the base **43** as described and forming a surface **44** with the metal of the base which surface defines an interface on which a further material is formed as a layer or film **45**. The material of layer **45** may comprise a hard plating or diffusion coating of metal such as chromium, tungsten or other hard material with the bits **13″** serving to strengthen the bond and to provide a hard interface to resist penetration of the base metal by radiation or objects. If the layer **45** is a film applied by gas or plasma plating or vacuum deposition it may serve to lubricate and protect the surfaces of the bits during the use of the device **42** as a cutting tool.

In FIG. 8 is shown a portion of a knife blade or otherwise shaped cutting tool **46** having a cutting edge **47′** terminating tapered side walls **48** and **49** of the base member **47** which is cast, molded or forged of solid metal to the desired shape. Disposed along the surface layers **51** and **52** of the walls **48** and **49** are a multitude of fine abrasive bits **50** which may be integrally cast in said layers during the formation of the base **47** as described or may be bonded to the respective surfaces of the blade or tool by suitable bonding material such as metal or ceramic material flowed with said bits against the surfaces and cast while in a molten state against the suitably heated base, flame sprayed against said surfaces from a plasma arc gun or otherwise applied thereto. The bits may comprise any of the described hard abrasive materials and may include chips or bits or boron nitride; tungsten, chromium or titanium carbide; diamond or other suitable material. The surfaces of the blade or tool **46** may thus be composed substantially entirely of hard bits **50** or bits which are interspersed with the metal of the base **46** in suitable density against the portions of the tool surfaces which are subjected to wear and erosion during cutting operation of the tool that they may serve to enhance the cutting action, protect the base **47** from damage and corrosion and reduce wear as well as maintain the desired cutting edge for a longer period of use than that which would result from using the base metal per se. To protect the fine bits **50** from erosion and from being torn away from the base **47** during severe use, a hard chromium or tungsten coating or plating may be flame sprayed or otherwise applied to the blade walls **48** and **49** up to and including the edge **47′** thereof.

Depending on the tool shape, size, the type of cutting or abrading action desired and the material to be machined, the abrasive members or bits defined in FIGS. 1 to 8 may vary in size from less than .0001″ to .010″ in diameter or greater. For example, while bits of the type shown in FIG. 8 may have an average size or diameter in the range of .0001″ to .001″, bits employed in grinding and cutting wheels, files and the like as illustrated in FIGS. 1 to 3 may vary in size between .001″ and .010″ or greater. Tool bits of the type shown in FIGS. 5 and 6 may of course be made in any suitable size depending on the type and degree of cutting action desired thereof. They may vary from a single cutter or tool bit of the type employed to cut work on a lathe or shaper to a plurality of tool bits or cutting blades anchored in solid metal as described to form rotary cutting heads and the like. While the cutting devices or tool bits **28** and **31** of FIG. 5 have been defined as being made of a hard ceramic material, they may also be made of metal which is integrally cast to the support or base **26** as described. A molecular bond or weld may be provided at the interfaces of the cutting tool bits of FIGS. 5 and 6 and the base material to which they are cast or welded during the molding of metal thereagainst or by preheating said bits to a suitable temperature to effect such welding or bonding just prior to casting or molding the base materials thereagainst.

As stated, thin coating of hard metals such as tungsten, titanium, tantalum, chromium, molybdenum, columbium, zirconium and the like or carbides or nitrides of these metals may be flame sprayed or otherwise deposited and bonded to the surfaces of the abrasive bits and metal interspersed with said bits by known techniques to impart wear resistance and lubrication to the described cutting and abrading tools. Such coating materials may be applied by known techniques of gas or plasma plating, vacuum plating or other means in thicknesses which vary from .00001″ to .001″ or greater not only to the abrasive bit containing structures shown in FIGS. 1–4, 7 and 8 but to other hard material cutting devices such as those illustrated in FIGS. 5 and 6, toothed or toothless saw blades, honing and reaming tools, drills including twist drills, tool bits, milling cutters, knife blades and the like with or without the application of abrasive bits, to these structures as described. The hard coating material may be applied just adjacent to and/or over the cutting edges of such tools or against an entire portion of the tool including all areas thereof subjected to abrasion and wear during the cutting action. Just the fluted or cutting edge portions of a twist drill may be flame coated or otherwise plated with such hard material. Just the teeth of a flat or circular power saw blade may be so coated. Just the portions of a tool bit, milling cutter or knife blade may be so coated to resist and reduce tool wear and substantially increase its useful life. Or these described portions of tools may be first coated or made to contain a multitude of small abrasive bits which may serve to resist erosion and dress or abrade the work by being applied per se or in combination with a hard coating material which serves the multiple functions of lubricating the cutting tool, bonding the abrasive bits to the base and protecting the surfaces of the bits against erosion.

I claim:

1. A cutting tool assembly comprising in combination:
a base for supporting a member adapted to remove material from an article when the base and article

are relatively moved with respect to each other, said base being made of steel metal and

at least one cutting member composed of an abrasive boron nitride particle protruding outwardly from said base and located so as to engage at the surface of said article for machining same to remove material therefrom when said base and article are brought proximate to each other,

said cutting abrasive boron nitride particle having a first portion which is completely surrounded by the metal forming said base in a manner to mechanically join and lock said abrasive particle to said base and to fixedly retain said abrasive particle in assembly with said base during a machining operation, and

a second portion of said abrasive particle protruding outwardly from said base and having at least one cutting edge free to engage the material of an article disposed proximate to said base.

2. A cutting tool in accordance with claim **1**, said steel of said base and said cutting member being welded together along the surface of said first portion of said abrasive particle.

3. A cutting tool in accordance with claim **1** including a plurality of said cutting members similarly secured to said base and each having at least one cutting edge protruding outwardly from said base and free to engage the material and article disposed proximate to said base.

4. A cutting tool in accordance with claim **1**, said base comprising steel which is cast to shape in situ about said cutting member.

5. A cutting tool in accordance with claim **1**, said cutting member having said first portion thereof shaped with a variable cross section so as to mechanically lock said member within the material of said base when said material is formed thereabout.

6. A cutting tool in accordance with claim **3**, said cutting members comprising a plurality of abrasive particles disposed so as to form a layer across a portion of the surface of said base, each of said particles being mechanically secured to the outer stratum of said base to form a hard, wear-resistant layer thereon.

7. A cutting tool in accordance with a claim **6**, said tool having a cutting edge, said abrasive particles being bonded as a layer to said tool along said cutting edge.

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U.S. Cl. X.R.

29—103; 125—15