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Weiss

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[54] **METAL BONDED GRINDING WHEELS**

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[52] **U.S. Cl.** **51/297,** 51/309

[51] **Int. Cl.** **B24d 3/06**

[58] **Field of Search** 51/293, 309, 308, 307, 204, 51/297

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[57] **ABSTRACT**

Grinding wheels having an electrodeposited metal matrix and abrasive grit forming a grinding surface, with an electrodeposited metal backing layer integrated with the composite matrix and grit layer; the matrix layer having an optimized distribution of grit therein.

11 Claims, 6 Drawing Figures

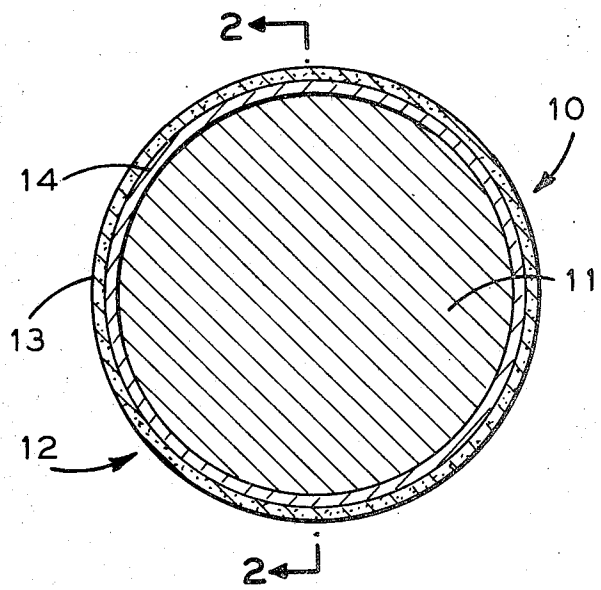


FIG. 1

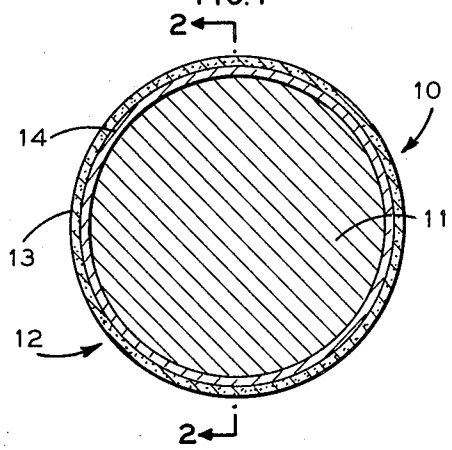


FIG. 2

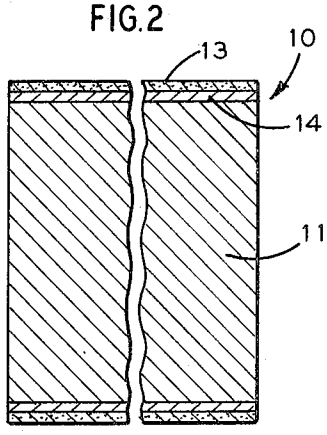


FIG. 3

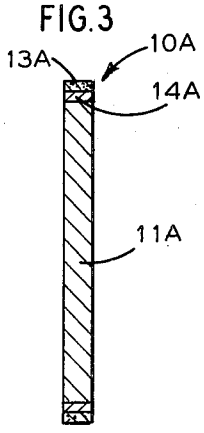


FIG. 5

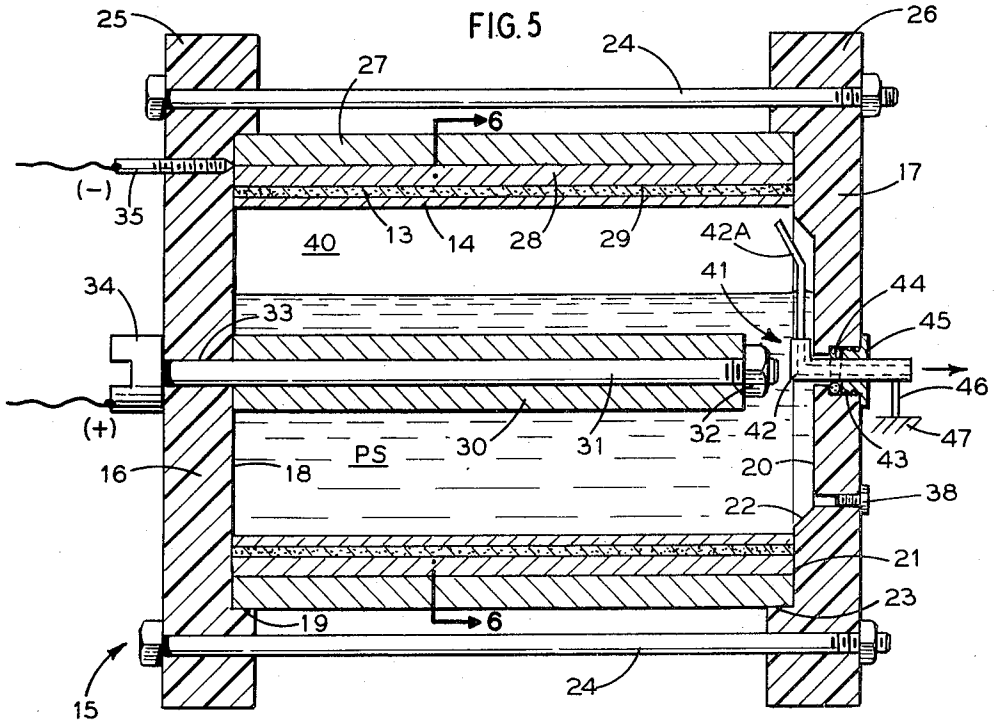
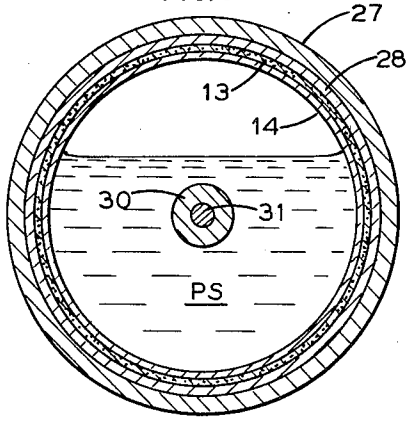


FIG. 6



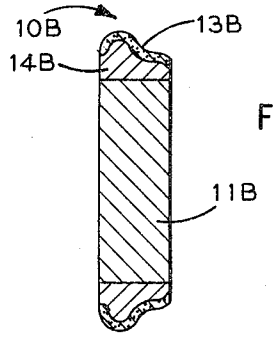


FIG. 4

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METAL BONDED GRINDING WHEELS

BACKGROUND OF THE INVENTION

Grinding wheels, cutoff wheels and forming wheels having a grit-matrix grinding surface, have heretofore shown rather limited useful life; being operable with a rather reduced load relative to the materials being cut or ground; a tendency to rapid wear at the edges of the device which necessitates repeated dressing of the device; and having a limited cutting efficiency.

In known grinding wheel constructions of the sintered metal or resinoid bonded types, the grit which is diamond particle or the like, is generally limited to approximately 25 percent by volume of the composite grit-matrix layer. Attempts to increase the grit proportion with a corresponding decrease in matrix proportion, has been directed to sintered metal bonded wheels. However, the reduced matrix proportion leads to inefficient grit bonding and a resultant reduction in the useful life of the wheel, as well as poor grinding qualities.

Accordingly, an object of this invention is to provide improved grinding wheels, cutoff wheels, forming wheels and the like; having a grinding surface made up of grit such as diamond particles held in an electroplated metal matrix; wherein the concentration of grit is increased substantially and may be of the order of 75 percent to 85 percent of the total volume of the composite grit-matrix.

Another object of this invention is to provide improved grinding wheels having a grinding surface made up of an electroplated metal matrix holding a very large proportion of diamond particles; the useful life of such improved grinding wheels being extended by as much as 2 to 5 times that of known grinding wheels.

Yet another object of this invention is to provide grinding wheels of the character described, wherein the total amount of grit particles is distributed in an electroplated metal matrix of reduced radial dimension to thereby substantially increase the concentration of particles in the matrix, thereby allowing a reduced amount of particles to be of increased effectiveness in use and reducing the cost of the device.

Still another object of this invention is to provide improved grinding wheels of the character described, wherein the distribution and concentration of abrasive grit in an electroplated metal matrix is of a character to substantially reduce wear at the edges of the wheel and thereby reduce the need for dressing operations during the useful life of the wheel.

Yet another object of this invention is to provide improved grinding wheels of the character described, which are adapted to withstand increased grinding loads when grinding or cutting very hard materials, thus realizing relatively high rates of material removal.

Other objects of this invention will in part be obvious and in part hereinafter pointed out.

DESCRIPTION OF THE DRAWING

FIG. 1 is a transverse sectional view of a grinding wheel embodying the invention;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is a sectional view similar to that of FIG. 2, showing a cutoff wheel embodying the invention;

FIG. 4 is a sectional view similar to that of FIG. 3, showing a forming tool embodying the invention;

FIG. 5 is an elevational view in section showing apparatus for forming the devices of the instant invention; and

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIGS. 1, 2; 10 designates a grinding wheel embodying the invention. The same comprises a metal core 11 which may be formed of brass, aluminum, steel or the like. The core 11 has affixed to the outer cylindrical surface thereof a grinding assembly 12 which comprises an outer annular layer 13 and a backing layer 14 integrated therewith.

The annular layer 13 is made up of an electroplated matrix of metal or metal alloy carrying abrasive grit such as diamond particles or the like. The grit content of the matrix is of the order of from about 40 percent to about 85 percent by volume. The backing layer 14 is an electrodeposited layer of metal or metal alloy, preferably similar to that of the matrix layer 13; the layers 13, 14 being in integrated relation to each other.

Thus, the metal of layers 13, 14 may be of nickel, copper, silver; nickel-cobalt; copper-nickel; copper-tin-nickel-cobalt, or other suitable metals and metal alloys which lend themselves to electrodeposition. The grit size can vary in accordance with the desired grinding, cutting or forming characteristics of the wheel, as related to the character and hardness of the material being ground or cut; and may be in the range of from 1 micron to 1,200 microns. The radial thickness of layer 13 may be of the order of from about 0.010 inch to about 0.250 inch, while the thickness of layer 14 may range from about 0.050 inch to about 0.500 inch.

Alternatively, the invention may be embodied in a cutoff wheel 10A, shown in FIG. 3, wherein a metal core 11A carries the grinding assembly 12A, made up of a composite metal matrix and grit layer 13A and a backing layer of electrodeposited metal 14A, as previously described.

Also, as shown in FIG. 4, the invention is embodied in a forming wheel or tool 10B, with a core 11B carrying the grinding assembly 12B made up of composit grit-matrix layer 13B and backing layer 14B. Here the grinding layer 13B is contoured to a selected cross section corresponding to the section of the work piece to be ground and formed.

The assembly 12, 12A or 12B is formed in apparatus shown in FIG. 5 and generally indicated at 15. Such apparatus comprises a pair of circular disc members 16, 17 formed of methyl methacrylate or other suitable synthetic resin. Disc 16 is formed on one surface thereof with an annular shallow recess 18, providing a shoulder 19. Disc 17 is formed on one surface thereof with a small diameter recess 20 and a concentric larger diameter recess 21; an annular juncture portion 22 of conical shape; and providing an annular shoulder 23.

The discs 16, 17 are held in axially opposed relation, with recesses 18, 20 thereof facing each other; by a series of circumferentially spaced bolts 24 passing through aligned openings in the peripheral portions 25, 26 respectively of said discs 16, 17.

A tubular member 27 of a diameter to fit the same snugly in shoulders 19, 23 of discs 16, 17, is disposed between said discs to form a rotatable plating chamber. Member 27 has an axial extent equal to the axial extent of grinding wheel 10 to be formed. An annular layer 28 of a low melting point alloy such as lead-tin or the like, is cast on the inner surface of member 27 and its annular inner surface 29 is precision machined to a given inner diamater.

A tubular anode 30 is axially mounted on disc 16 by way of a rod 31 and a nut 32 on its threaded inner end. The outer end portion of rod 31 passes through an axial opening 33 in disc 16 and terminates in a socketed coupling head portion 34. A cathode connector 35 having a threaded portion 36 is screwed into the outer portion of disc 16 to make electrical contact with member 27 and layer 28.

A filler opening 37 is formed in disc 17, being closed by a threaded plug 38, to allow the plating chamber 40 formed by assembled discs 16, 17 and member 27, to receive a plating solution PS to a level above the anode 30. The solution PS typically may be of a nickel salt such as nickel sulfamate or the like, in which case the anode 30 is also of nickel.

The solution PS also contains a calculated quantity of diamond or other abrasive grit of selected size. The apparatus 15 is arranged for rotation about its horizontal axis, by suitable motor means, not shown, through coupling head 34. Leads from a suitable plating current source are connected to cathode connector 35 and anode rod 31, in a manner known in the art. The current source has a voltage of from 2 to 6 volts and an amperage of the order of from 5 to 30 amperes per sq. ft.

The apparatus 15 is operated in two successive phases. Initially, the device is alternatively rotated at a given constant speed and stopped; with the rotational periods ranging from 2 to 30 seconds and the rest periods ranging from 2 to 30 seconds. The rotational speed is of the order of from about 0.25 to 5.0 rpm.

During such initial phase of operation, the composite layer 13 made up of metal or metal alloy and grit is electrodeposited on the inner surface 29 of annular layer 28. Upon exhausting the diamond grit content of solution PS, the layer 13 is completed to a selected radial dimension. Such layer 13 may have a grit content of up to 75 percent to 85 percent by volume. Reduced volumetric proportions of grit, to values of about 40 percent by volume may be attained by suitable adjustment of the rotational and rest periods of the initial phase of operation of apparatus 15.

The apparatus 15 is then operated in its second phase, by rotating the device continuously at a rate of from about 0.25 to about 5.0 rpm, to form the backing layer 14 of metal or metal alloy in integrated relation to layer 13. The radial thickness of layer 14 may vary from 0.050 inch to 0.500 inch; and may be suitably related to the radial thickness of layer 13.

The apparatus 15 is provided with a breather assembly 41 mounted on disc 17; the same comprising a nipple 42 with an upstanding breather tube 42A; the nipple 42 passing through an opening 43 in disc 17 with a packing 44 and gland nut 45 sealing the same. A stem 46 extending from an outer portion of nipple 42 anchoring the same as at 47 to maintain tube 42A in its upright position while the apparatus rotates. Thus, gases discharged in chamber 40 during the electrodeposition operation, may be evacuated by way of breather tube 42A and nipple 42.

When the electrodeposition operations have been completed, the remaining solution PS is drained by way of opening 37 and the discs 16, 17 are disassembled from the member 27. The member 27 is then subjected to a temperature sufficient to melt layer 28, permitting the assembly 12 to be separated from member 27.

The composite 13, 14 of assembly 12 is now ready to be mounted on core 11. To this end, the I.D. of assembly 12 is machined to a given value and the O.D. of core 11 is machined to a value slightly greater than that of the I.D. of assembly 12. The core 11 is then cooled by dry ice, liquid nitrogen, or the like to temporarily reduce the O.D. to a value slightly less then the I.D. of assembly 12, allowing insertion of core 11 in assembly 12. On regaining room temperature, the core 11 is in a gripping relation to assembly 12, to form the finished grinding wheel 10.

It will be apparent that assembly 12 may be secured in mounted relation to core 11, as by soldering or brazing; or by an interlayer of epoxy resin adhesive.

It is understood that member 27 is replaced by other members when forming the cutoff wheel 10A, in which case member 27 has a small axial extent of the order of the thickness of core 11A. Also, the member 27 may be profiled at its periphery to provide an appropriate transverse contour in deposited layer 28, which in turn produces the composite 13B, 14B, FIG. 4, of corresponding contour to form with core 11B, forming tool 10B.

It will be apparent that plating solution PS is made up in a known manner, to include salts corresponding to the metal or alloy to be deposited to form the matrix carrying the abrasive grit.

It has been found that the procedure hereinbefore disclosed, allows for the layer 13 of the grinding assembly 12 to be made up of superposed diamond or other abrasive particles with interposed metal matrix material. Thus, the radial dimension of layer 13 is dependent on the number of superposed particles, particle size and proportion of metal matrix.

I claim:

1. A grinding member comprising a core element and an abrasive layer on said core element, said abrasive layer comprising an electrodeposited outer stratum consisting of a metallic matrix and abrasive grit distributed through said matrix and an electrodeposited inner stratum of metal integrally bonded to said outer stratum, said matrix having a grit content of from about 40 percent to about 85 percent by volume, said abrasive layer being in annular form and being in shrink fit relation to said core element.

2. A grinding member as in claim 1 wherein said matrix has a grit content of from about 75 percent to about 85 percent by volume.

3. A grinding member as in claim 1 wherein said grit is diamond particles.

4. A grinding member as in claim 3 wherein the metal of said matrix is selected from the group consisting of nickel, copper, silver, nickel alloys and copper alloys.

5. A grinding member as in claim 1, wherein the grit in said outer stratum comprises at least three superposed particles extending through the thickness thereof.

6. A grinding member as in claim 1, wherein said abrasive layer is of profiled cross section.

7. A grinding member as in claim 1 wherein, said outer stratum has a radial thickness of from about 0.010 inch to about 0.250 inch, and said inner stratum has a radial thickness of from about 0.050 inch to about 0.500 inch.

8. A method of forming a grinding layer for a grinding member comprising providing a rotatable electrolytic cell including an annular forming member as the cathode element thereof and an anode element, with a metal plating solution containing a dispersion of abrasive grit in said cell, continuously applying plating current to said cathode and anode while rotating said cell during successive spaced time intervals with intervening time intervals of non-rotation to electrodeposit a metallic matrix carrying abrasive grit on said forming member, the metallic matrix having a grit content of from about 40 percent to about 85 percent by volume thereof.

9. A method as in claim 8, and thereafter continuously rotating said cell to electrodeposite a metal backing layer in integrated relation to said grit carrying matrix, and separating the backed grit-carrying matrix from said forming member.

10. A method as in claim 9, wherein said forming member is formed of a low melting point metallic material.

11. A method as in claim 8, wherein the alternating rotational and non-rotational time intervals are from 2 to 30 seconds and the rotational speed is from 0.25 to 5.0 rpm.

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