Jan. 13, 1970 R. L. BENNER ET AL 3,488,892

ABRASIVE SAW

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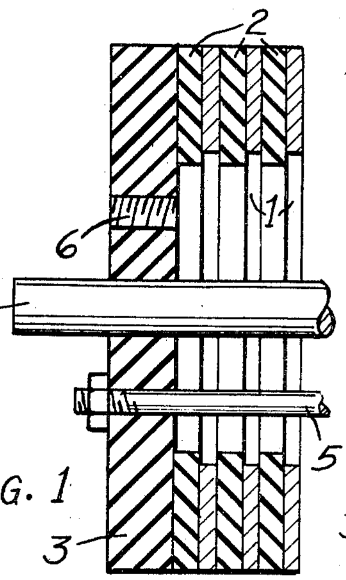


FIG. 1

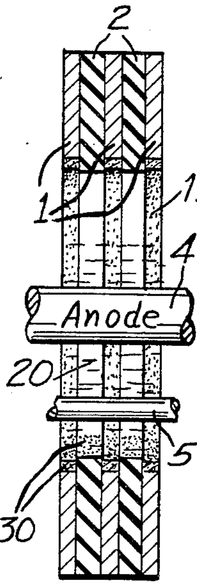


FIG. 2

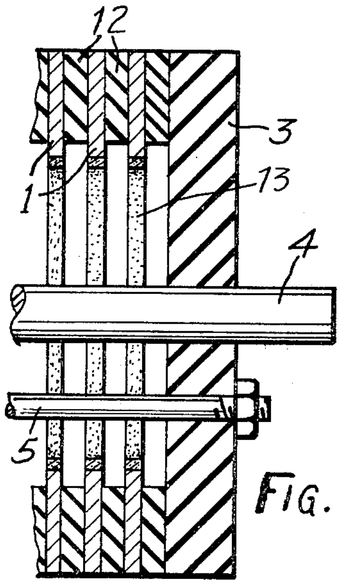


FIG. 3

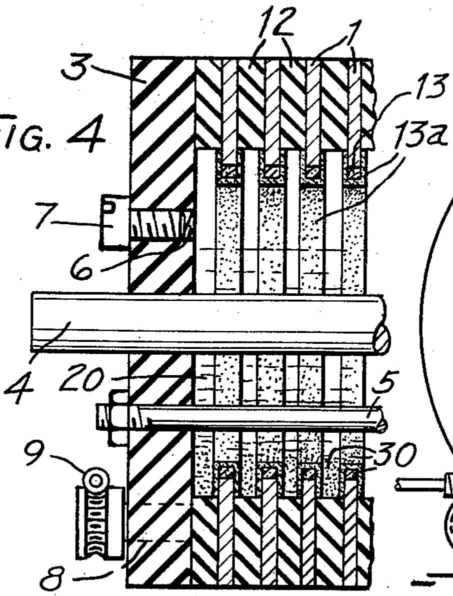
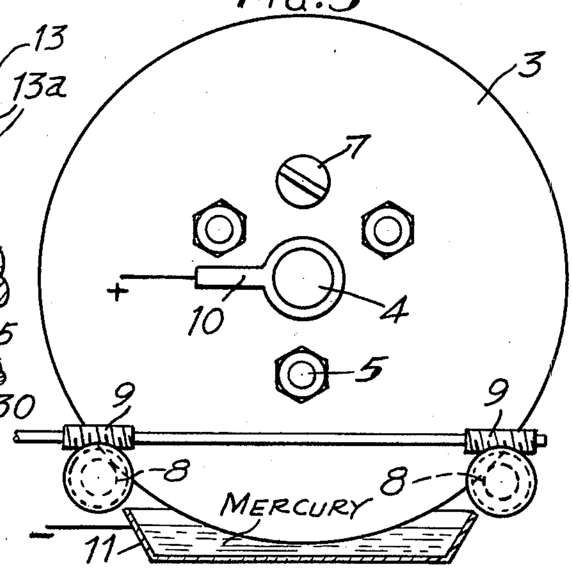


FIG. 4

FIG. 5



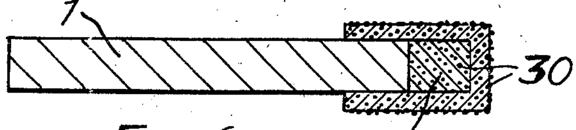


FIG. 6

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ABRASIVE SAW

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U.S. Cl. 51—204 14 Claims

ABSTRACT OF THE DISCLOSURE

A cutting tool with an abrasive saw edge comprising a first layer of electrodeposited metal bonded abrasive and a second layer of electrodeposited metal bonded abrasive encapsulating the first layer and extending over a portion of the sides of the tool.

BACKGROUND OF THE INVENTION

The field of the invention is abrading and the invention is particularly concerned with metal bonded abrasive saws and methods of making.

Abrasive tools for cutting thin wafers of hard materials such as silicon and germanium have been made by electroplating through a static layer of abrasive onto a metal base. This process and the products resulting therefrom is disclosed in U.S. Patent No. 3,281,996 of Harlan D. Cuklanz, filed Apr. 27, 1964 and issued Nov. 1, 1966. According to Cuklanz a metal base material is supported in a nonconductive holder having an elongated cavity around an edge of the base material. The cavity is then filled with loose abrasive material such as diamond grains and a metal is electrodeposited through the abrasive grains. The electrodeposition bonds the grains together and in turn bonds the agglomerated grains to the base material. These products of the prior art require siding operations such as grinding the surfaces to expose the abrasive material.

Although aluminum oxide and silicon carbide are useful, the abrasives which find the greatest utility in the present invention are diamond grains. The prior art uses, raw materials, standards, shapes and methods of making bonded abrasive and diamond products are disclosed in Kirk-Othmer, Encyclopedia of Chemical Technology, 2d ed., volume 1, particularly pages 25 to 28, 31 to 33, 37 and 38, and volume 4, particularly pages 293 and 301. The bonded abrasive and diamond sections of the abrasive tools are available in many grain sizes with 46 to 320 being the most common range. The grain and grit sizes available are determined, according to U.S. Standard Sieve Series.

Particular prior art methods for electroplating and compositions useful therefor are discolsed in Kirk-Othmer, Encyclopedia of Chemical Technology, 2d ed., volume 8, pages 36–74, particularly pages 58 and 62, wherein cobalt, copper and nickel plating baths are disclosed.

SUMMARY OF THE INVENTION

Having in mind the limitations of the prior art, it is an object of the present invention to provide an abrasive tocl which yields accurate free cutting side relief without siding operations.

Another object of the present invention is to strengthen the metal matrix supporting the abrasive particles.

According to the present invention, an abrasive saw is produced by a 2-stage electro-forming process in which the saw blade is first provided on its edge with a metal bonded increment of the order of 0.005 to 0.010 inch and then in the second stage is provided with an additional deposit of metal bonded abrasive particles surrounding

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the first deposit and covering both sides of the blade immediately behind the edge. The deposit of the second stage extends about 0.0625 to 0.125 inch. The abrasive deposits provide adequate side relief without requiring additional siding operations and provide a metal matrix of increased strength for supporting the abrasive particles.

BRIEF DESCRIPTION OF THE DRAWING

The invention is described in detail with reference to the drawing, wherein:

FIGURES 1 and 2 are fragmentary sectional views showing several saws mounted for processing in the first stage of a barrel electro-forming process;

FIGURES 3 and 4 show the saws of FIGURES 1 and 2 in the second stage of the process;

FIGURE 5 is an end view of a suitable barrel plating apparatus for carrying out the present invention; and

FIGURE 6 shows a cross-section of the cutting edge of a diamond saw made according to the present invention.

With particular reference to FIGURES 1 and 2, metal saw blanks **1** are shown mounted between non-conductive spacers **2** for carrying out the first step of electrodeposition. The metal blanks **1** are secured between end plates **3** and tie rods **5**. The assembly is mounted about anode **4** and opening **6** in end plate **3** facilitates the insertion of electroplating solution and abrasive particles. FIGURE 1 shows the metal blanks before the coating has been applied. FIGURE 2 shows the metal blanks with the first coating of electroplated metal bonded abrasive thereto.

In FIGURES 3 and 4 the metal blanks are shown mounted with insulating spacers **12** of less width than the spacers **2** and the metal blanks **1**. A threaded plug **7** is shown inserted in opening **6**.

An assembly of annular saw blanks is shown mounted for rotation and electroplating in FIGURE 5. On end plate **3** is shown anode **4** having a brush or slip ring **10** connected to a positive terminal of a D.C. source. The assembly is rotated by two parallel shafts **8** which are actuated by worm gearing **9**. The shafts **8** support the assembly so that the metal blanks **1** are in contact with mercury containing metal pan **11** which in turn is connected to a negative D.C. source.

The apparatus disclosed in the Cuklanz Patent 3,281,-996 may be utilized in conjunction with the 2-step electroplating process disclosed herein to produce saw blades of other types having an abrasive cutting portion as shown in FIGURE 6.

The produce of the 2-step electroplating process is shown in FIGURE 6 where the covering **13***a* of abrasive particles in the metal matrix is shown affixed to an edge of the saw blank.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The electroplating process can be carried out with a single saw blade but it is equally suitable for making a plurality of saw blades at one time. For example, in producing annular saw blades, a number of metal discs **1** having a thickness of about 0.002 to 0.006 inch are spaced from one another by spacers **2** of insulating material inserted between adjacent discs. The internal diameters of the metal discs **1** in the first stage of the process are slightly larger than the inside diameters of the spacers **2**. After the desired number of discs and spacers have been assembled, the two ends of the assembly are covered by end plates **3** and an anode bar **4** is positioned coaxially therein. Tie rods **5** keep the parts clamped tightly together and prevent leakage of the electroplating solution **20** and abrasives **30** which are introduced through an opening

6 in one of the end plates. The opening is securely closed by threaded plug 7.

The cylindrical assembly is then mounted for slow rotation about a geometric axis, as for example by placing it upon two parallel shafts 8 rotated in the same direction by worm gearing 9. The assembly is rotated suitably at a speed of about 1/32 r.p.m.

Electric current is then passed through the electroplating solution and the system is slowly rotated. This is carried out conveniently by connecting the positive terminal of a D.C. source to the anode 4, as for example through a brush or slip ring 10, and a negative terminal is connected to metal pan 11 containing mercury or to any other suitable means such as a second brush or slip ring to make electric contact with the discs at their peripheries. The electroplating process is continued until a first coating 13 of electroplated metal bonded abrasive having a thickness of about 0.005 to 0.010 inch and a width defined by the spacers 2 is thereby applied to the internal surface of the metal discs 1.

After sufficient metal and diamond abrasive particles have been deposited on the inner peripheries of the discs 1, the electroplating solution 20 with the abrasive particles 30 is then emptied from the cylindrical assembly and the latter is disassembled. New insulating spacers 12 having slightly larger inside diameters are now interposed between the adjacent metal discs 1, as shown in FIGURE 3, and the parts again are assembled and replenished with electroplating solution and abrasive particles for the second stage of the process. The electroplating solution and the abrasive grains in the second stage are suitably the same or different from those used in the first stage. In the second stage of the process the entire periphery of the first stage deposit of the saw blade is completely encapsulated and the adjacent inner marginal portions of the saw blades are coated with a covering layer 13*a* of abrasive particles in a metal matrix, as shown in FIGURES 4 and 6. The covering layer 13*a* suitably has a thickness of about 0.002 inch and extends about 0.0625 to 0.125 inch in depth.

In a particular embodiment contemplated by the present invention, the electroplating solution of the first and second stages is an electrolyte comprising 60 ounces per gallon of nickel sulfamate, 10.2 ounces per gallon of nickel metal, 5 ounces per gallon of boric acid and 5 hundredths ounces per gallon of an anti-pitting agent. The abrasive particles used with the solution are natural diamonds having a grain size of 220.

Another embodiment which is illustrative of the invention incorporates a nickel plating solution and 220 grain size natural diamonds in the first stage and a cobalt plating solution with 500 grain size synthetic diamonds in the second stage.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

We claim:

1. An abrasive saw comprising:

a saw blank having an edge surface and adjacent side surfaces;

a first layer of electrodeposited metal bonded abrasive on said edge surface;

a second layer of electrodeposited metal bonded abrasive encapsulating said first layer and extending over a portion of the side surfaces.

2. The abrasive saw of claim 1, wherein the first layer on the edge surface extends to the side surfaces.

3. The abrasive saw of claim 1, wherein the first layer extends about 0.005 to 0.010 inch from the edge surface.

4. The abrasive saw of claim 1, wherein the second layer has a thickness of about 0.002 inch.

5. The abrasive saw of claim 1, wherein the second layer is about 0.0625 to 0.125 inch in depth.

6. An abrasive annular saw having an inner annular surface defining an internal diameter, an outer annular surface defining an outside diameter, side surfaces adjacent to said annular surfaces connecting said inner and outer annular surfaces, a first layer of electrodeposited metal bonded abrasive on said inner annular surface extending in the radial direction and a second layer of electrodeposited metal bonded abrasive encapsulating said first layer and extending over a portion of said side surfaces.

7. An abrasive annular saw of claim 6, wherein the first layer on the inner annular surface extends to the side surfaces.

8. The abrasive annular saw of claim 6, wherein said first layer extends about 0.005 to 0.010 inch from the inner annular surface.

9. The abrasive annular saw of claim 6, wherein said second layer has a thickness of about 0.002 inch.

10. The abrasive annular saw of claim 6, wherein said second layer extends about 0.0625 to 0.125 inch in depth.

11. A 2-stage process for electrodepositing a metal bonded abrasive cutting element on an edge and adjacent side surfaces of a metal blank to form an abrasive saw, comprising a first stage of depositing first abrasive particles with a first metal matrix on the edge surface, and a second stage of encapsulating the resulting new first deposit and the adjacent marginal portions of the side surfaces with an additional deposit of second abrasive particles in a second metal matrix.

12. The process of claim 11, wherein said first and second matrices have the same composition and said first and second abrasive particles are the same abrasive material and have the same grain sizes.

13. The process of claim 11, wherein said first and second matrices have different compositions and said first and second abrasive particles are different abrasive materials.

14. The process of claim 13, wherein said first and second abrasive particles have different grain sizes.

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OTHELL M. SIMPSON, Primary Examiner

U.S. Cl. X.R.

51—309; 125—15; 204—16