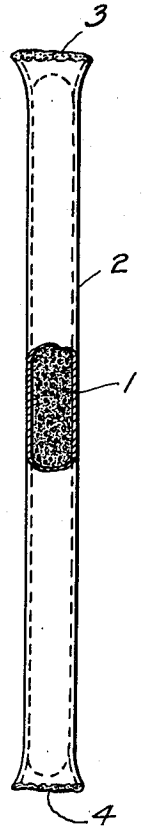
May 25, 1954 P. G. COTTER 2,679,452

ABRADING TOOL-DIAMOND LAP

Filed April 20, 1951



INVENTOR
PERRY G. COTTER
BY H. L. Godfrey
ATTORNEY

Patented May 25, 1954

2,679,452

UNITED STATES PATENT OFFICE

2,679,452

ABRADING TOOL-DIAMOND LAP

Perry G. Cotter, Norris, Tenn., assignor to the United States of America as represented by the Solicitor of the Department of the Interior

Application April 20, 1951, Serial No. 222,130

10 Claims. (Cl. 51—309)

(Granted under Title 35, U. S. Code (1952), sec. 266)

1

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to me of any royalty thereon in accordance with the provisions of the act of April 30, 1928 (Ch. 460, 45 Stat. L. 467).

This invention relates to grinding wheels and more particularly to grinding wheels utilizing a metal bond for diamond abrasive.

It has been known and is common to use a metallic binder for diamond abrasive wheels and also to use ceramic or resin-bonded laps. The wheels produced by using ceramic and resin bonds or bonding agents suffer from the defect of not having sufficiently high tensile strength and hardness. Metallic bonds of the past have had the undesirable quality of often contaminating the abraded article by particles of the metal used as the bonding material.

The object of this invention is to provide a lightweight, corrosion-resistant, non-magnetic diamond lap which is harder than the ordinary ceramic or metallic diamond laps and is less friable than resin-bonded laps.

An additional object of the invention is to provide a metallic binder for a diamond lap which will not contaminate the article to be abraded by the tool used.

A further object of the invention is to provide a binder for diamond particles or other abrasive materials, which binder consists of a metal of high tensile strength and hardness.

Other objects and advantages of this invention will be obvious from a consideration of the description of a preferred embodiment of the invention and of the drawing wherein the figure is a view, partially cut away, of the means used to obtain my abrasive tools.

My invention is a tool and the method of making said tool consisting of a fine abrasive such as diamond dust, bonded with titanium metal which tool may be used to produce a smooth and accurate surface upon other metals or materials. The metal titanium is used because of its hardness and its resistance to wear and because it holds the abrasive particles better than the metals ordinarily used prior to this invention. This greater grip of the metal binder upon abrasive particles, and the greater hardness of the metal allows the abrading tool to be used for a longer period of time before the diamonds fall out.

Because of its high melting point (1800° C.), its affinity for oxygen, nitrogen, hydrogen and carbon and its reaction with most refractories,

2

titanium is difficult to work and at elevated temperatures must be protected from the atmosphere. To prepare a diamond lap using titanium as a matrix by vacuum casting is not possible as the diamonds are lighter than the titanium and float to the top. A method has been found by which a diamond impregnated lap may be made using titanium as the metallic binder.

In a particular embodiment of the invention and referring now to the figure, a quantity of diamond powder is wet by a small amount of a volatile hydrocarbon and is then intimately mixed by stirring with titanium powder. It is preferable to use titanium powder which has been hydrogen reduced and also degassed. The mixture 1 of diamond and titanium powder is then placed in a metal tube 2, preferably formed of iron, and is then compacted under high pressure. The purpose of compacting the powder mixture in the tube is twofold. First, this compacting reduces the volume of the loose powder which is normally three to four times that of the metal, and secondly, it reduces the volume of air left in the tube to a negligible amount. The tube protects the mixture and particularly the titanium metal from harmful gases and other impurities during the entire processing to obtain the titanium bonded diamond lap. After packing the tube with the diamond particle-titanium particle mixture, the ends 3 and 4 of the containing tube are flattened by any suitable means such as a hydraulic press, and the ends are then closed to exclude atmospheric contaminants by any suitable means. It has been found preferable to weld these ends shut and an oxy-acetylene torch has been found suitable for this welding. During the welding process, most of the remaining hydrocarbon is expelled by the welding heat.

The thus closed tube is then heated in any suitable manner, such as in a furnace or by means of high frequency induction. When a temperature high enough to form the titanium bond around the diamond particles is reached, the tube is removed from the furnace. I have found that a temperature of 850° C. is sufficient to form the proper bond.

When the tube is removed from the furnace, it is repeatedly run through rollers to reduce the thickness of the tube and to form a flat-sided diamond lap. The outer sheet of iron is then removed by slitting it, and the diamond impregnated titanium bonded compact is removed.

An abrasive tool made in this manner is relatively light in weight. It has a specific gravity of approximately 4.5 as compared to the specific

gravity of 7.9 where steel is used as the binder. It has great tensile strength and hardness and is not malleable as are many common metallic bonded tools.

The tool also has a high resistance to corrosion; resisting nitrate acid, aqua regia, chlorine, sodium hydroxide, and dilute solutions of hydrochloric and sulfuric acids and can, therefore, be cleaned by an acid bath from the metals and alloys which normally load an abrasive wheel after it is used.

The method of consolidating the powdered titanium and diamond mixture by rolling the heated mixture while still in the tube protects the titanium during the heating and rolling from destructive gases, and at the same time, because the powder is confined, some working back and forth of the individual particles takes place which tends to produce better compacts and welding of the grains. The tool produced in this manner is dense and firm in contrast to the usual porous material obtained by the conventional methods of pressing and sintering and contains very few voids which lower the diamond holding ability.

If it is desired to make grinding or cut-off wheels of titanium bonded diamond dust, a process similar to that described above may be used. In this modification the homogeneously mixed combination of diamond dust and titanium is compacted in a short can having a flat bottom. A top is then welded on to the can and the can and contents heated as before. When the proper temperature is reached, the container is placed in a stamping press and pressure is applied from a vertical direction. If no dies are used, a discoid is produced which can be drilled to fit upon a spindle, or an arbor. By the use of suitable dies, wheels of V shape, saucer-shape, or cup-shape may be produced which can be drilled and mounted as usual.

Obviously the size and amount of diamond dust used in the processes of this invention may be varied to produce the cutting effect desired in the wheel.

It is also obvious from a consideration of the above description of a preferred embodiment of the invention that other abrasive materials may be substituted for the diamond powder and the combinations of other metals with titanium or alloys of titanium and other metals may be substituted for the plain titanium metal. It is to be emphasized, however, that the amount of titanium must be substantial in order to obtain the desired results and advantages of my invention. I have found that a satisfactory titanium bonded diamond lap may be obtained by a mixture of 98% titanium metal and 2% diamond particles but obviously these portions may be varied dependent upon the desired results.

The lap formed according to the processes of this invention may be heat treated in various ways to produce certain desired qualities, as is common in the art.

It will be appreciated from a reading of the foregoing specification that the invention herein described is susceptible of various changes and modifications without departing from the spirit and scope thereof. The invention is, therefore, to be limited only by the scope and spirit as set forth in the appended claims.

What is claimed is:

1. A metal-bonded abrasive article comprising diamond particles bonded in a metallic matrix of titanium metal, the proportion of titanium metal to diamond particles being about 49 to 1.

2. A metal-bonded abrasive article comprising diamond particles bonded in a metallic matrix consisting essentially of titanium metal, the percentage of titanium metal being greater than that of the diamond particles.

3. A metal-bonded abrasive article comprising diamond particles bonded in a metallic matrix containing a substantial portion of titanium metal as an essential ingredient.

4. A metal-bonded abrasive article comprising abrasive particles bonded in a metallic matrix containing a substantial portion of titanium metal as an essential ingredient.

5. The method of making an abrasive article comprising diamond particles bonded in a metallic matrix containing titanium metal which comprises compacting a mixture of two per cent diamond particles and ninety-eight per cent of reduced and degassed titanium metal particles in a ferrous metal container, sealing the open ends of said container thereby excluding atmospheric contaminants, heating said compacted particle mixture to 850° C., molding said heated compact to the desired shape while still excluding atmospheric contaminants, and then removing said container to obtain said abrasive article.

6. The method of making an abrasive article comprising diamond particles bonded in a metallic matrix containing titanium metal which comprises compacting in a ferrous metal container a mixture containing diamond particles and reduced and degassed titanium metal particles, the amount of titanium metal particles being greater than the amount of diamond particles, sealing the open ends of said container to thereby exclude atmospheric contaminants, heating said compacted particle mixture to a temperature sufficient to form the desired bond but below the melting point of the container and compact, molding said heated compact to the desired shape while still excluding atmospheric contaminants, and then removing said container to obtain said abrasive article.

7. The method of making an abrasive article comprising diamond particles bonded in a metallic matrix containing titanium metal which comprises compacting a mixture containing diamond particles and titanium metal particles in a ferrous metal container, sealing said container thereby excluding atmospheric contaminants, heating said compacted mixture to a temperature below the melting point of the container and compact to form the desired bond, molding the heated compact to the desired shape, and then removing said container to obtain said abrasive article.

8. The method of making an abrasive article comprising diamond particles bonded in a metallic matrix containing titanium metal which comprises compacting a mixture containing diamond particles and titanium metal particles in an iron container, welding said container to form a seal and exclude atmospheric contaminants and then heating and working said compacted mixture at a temperature below the melting point of the container and compact to form the desired bond.

9. The method of making an abrasive article comprising abrasive particles bonded in a metallic matrix containing titanium metal which comprises compacting a mixture containing abrasive particles and titanium metal particles in a ferrous metal container, sealing said container thereby excluding atmospheric contaminants, and then heating and working said compacted mixture at a temperature below the

melting point of the container and compact to form the desired bond thereby obtaining said abrasive article.

10. The method of making an abrasive article which comprises compacting a mixture of abrasive particles with a greater amount of titanium metal particles in a ferrous metal tube, sealing the ends of the tube to the atmosphere by a metal bond, heating the tube and compacted contents to a temperature of approximately 850° C., passing the heated tube and contents through compressing rolls to reduce the thickness of the tube and to form a flat-sided abrasive article, and

removing the tube from the abrasive article so formed.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,240,829	Bevillard	May 6, 1941
2,545,676	Small	Mar. 20, 1951

OTHER REFERENCES

J. Electro-Chem. Soc., vol. 9, of 1951, pages 465–473.