Dec. 3, 1946. B. BRENNER 2,411,867

INDUSTRIAL DIAMOND TOOL AND METHOD OF PRODUCING SAME

Filed Dec. 19, 1942



Fig. 1.

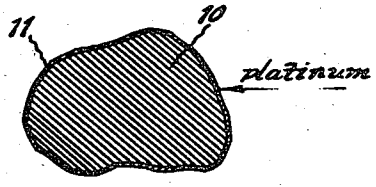


Fig. 2.

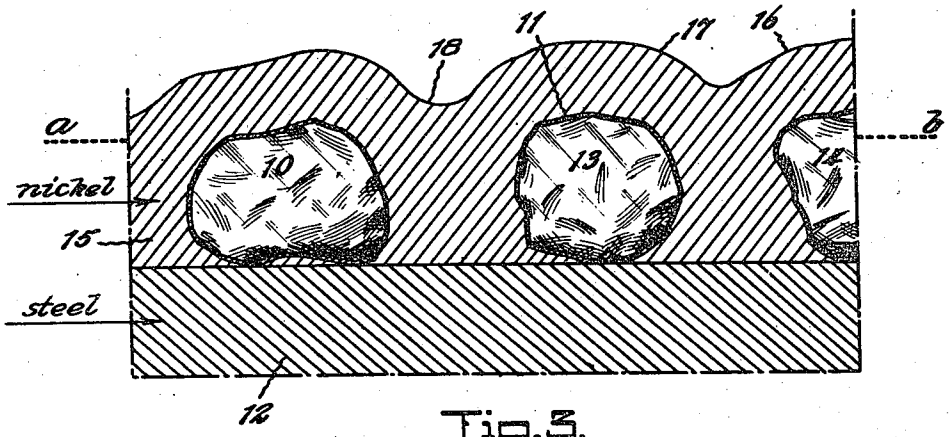


Fig. 3.

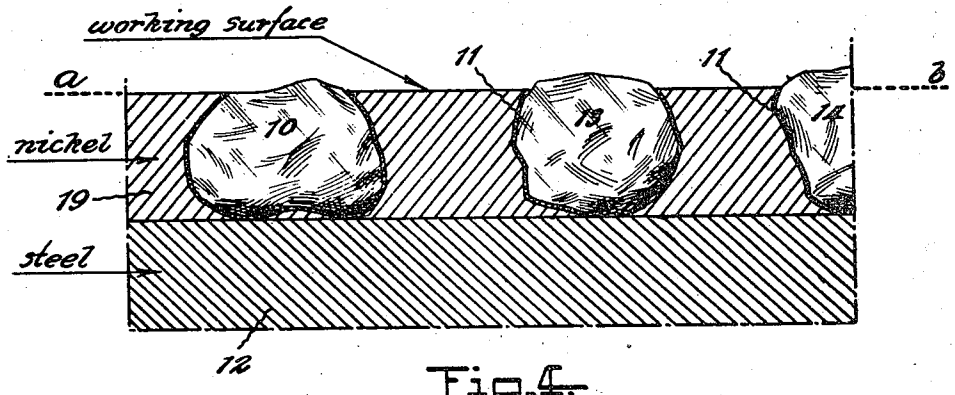


Fig. 4.

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2,411,867

INDUSTRIAL DIAMOND TOOL AND METHOD OF PRODUCING SAME

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Application December 19, 1942, Serial No. 469,754

20 Claims. (Cl. 51—309)

1

The invention relates to an improved form of work surface for cutting, grinding, lapping, polishing and other abrasive tools, known as industrial diamond tools, such as diamond dental instruments, diamond grinding or dressing wheels, diamond bits and the like. The invention also relates to a method of producing the diamond containing work surfaces of such tools.

While the invention is particularly concerned with the formation of diamond studded work tools, it is within the scope of the disclosure to practice the method hereinafter described in the mounting of diamonds for use other than as tools and it is suggested that the method may be used in mounting diamonds and, particularly, for mounting diamond bort in jewelry, and for ornamental, decorative and other purposes.

It has been suggested heretofore to form the diamond work surfaces of industrial tools by coating diamond chips or particles, varying in size from 20 to 80 mesh, with a thin film of conductive material such as silver or gold, and then coating the conductive material with a magnetic metal such as nickel or cobalt, sometimes electro-deposited, after which the diamonds so coated are arranged in grooves or slots on the tool, which is usually of steel, in some desired order and held in place by electromagnetic force. The coated particles so located on the core of the tool are bonded thereto by electroplating with nickel and similar materials over the pre-coated diamond chips. This method is cumbersome and not practical for large tools.

In the known methods, the conductive silver coating has been formed on the cleaned diamond chips by flashing, as by placing the diamonds in an ammoniacal silver nitrate solution and adding a reducing agent such as cane sugar or formaldehyde. The conductive gold coating has been formed on the diamond particles by spattering the same with gold. However, these methods are not practical for bort less than one hundred microns in diameter.

In actual practice, these silver and gold coatings have not proven entirely satisfactory or workable particularly when attempts have been made to coat diamond bort in the form of fine particles because by these methods it is impossible to avoid air or gas films, that is, pockets forming between the coatings and the extremely large surface areas of small diamond particles. The present disclosure features a method not only capable of coating diamond particles of the size contemplated in the gold or silver coating methods above referred to, but capable of providing a thin

2

conductive coating or mirror on diamond bort as fine as 40–100 microns, or even finer texture.

With reference to the article aspect of the invention, it has for its primary object the providing of an inexpensive and improved form of work surface for an industrial diamond tool and, incidental to this general object, to provide such a surface that can be formed not only from relatively large chips but which can also be formed from a relatively fine form of diamond bort.

Among the other objects of the invention are the provision of an industrial diamond tool in which the diamond particles, or bort, are permanently set in position; in which the diamonds are uniformly distributed over the work face of the tool; in which each diamond particle, irrespective as to how small, will be securely anchored or bonded in place; in which the diamonds will not become loose or shift from their original positions when the tool is in operation; in which the diamonds are restrained from chipping, cracking or softening, and in which the diamonds retain to the end their hard cutting characteristics and year away uniformly and thus present substantially the same character of work face during the entire active life of the tool.

As above indicated it has been known to coat diamonds with a conducting layer or silver or gold and thereafter to deposit thereon another metal such as copper, preferably by an electroplating process. When diamonds so coated have been imbedded in an industrial diamond tool subjected to, or which in use generates high temperatures, the bond provided by the gold or silver becomes weakened and the tool quickly becomes useless. Temperatures even as low as 300° C. cause both the silver and gold to lose their initial bonding properties and the diamonds loosen in the tool.

Accordingly another object of the invention is to provide an industrial diamond tool such as a diamond drill in which the bonding coating on the diamonds can maintain its bonding capacity to unite the diamonds to the core, bond or matrix of the tool and which will maintain its bonding or adhesion capacity and thus fix the diamonds in place and maintain them fixed in place under high temperature conditions and even at temperatures at which the diamonds themselves begin to disintegrate.

The invention therefore features a form of diamond tool which is capable of maintaining its diamond particles fixedly in place under the usual heat conditions to which such tools are subjected when in use and which will maintain it-

self intact at temperatures above that at which silver or gold bonded diamonds become loose; (300° C.) and which will not be deleteriously affected at extremely high temperatures of the order of 600° C.

With reference to the method aspect of the disclosure, the primary object of the invention is to provide an improved technique for forming inexpensively an extremely thin, but dense, smooth and uniform coating or mirror on diamonds, especially on small diamond particles or bort, preparatory to securing the diamonds so coated as by electrolytic deposition of a bonding metal to a tool core or surface to form the work surface of an industrial diamond tool. The invention particularly features a thorough wetting of the entire exposed surface of the diamonds and thus avoids the formation of any small pockets or blisters beneath the coating layer of conductive material.

Basically, the invention contemplates the forming of a thin coating or mirror of metallic platinum by heat precipitation on each individual particle of a batch of diamond particles or bort to condition them before they are subjected to the bonding and electroplating action of an electrolytic bath. With reference to the bonding by electrolytic action, the invention contemplates the substantial uniform distribution of the diamonds over the work surface of the tool by pouring the coated and clean diamonds into the electrolyte of the bath so that the diamonds will fall gravitationally through the bath on to the tool surface intended to be covered by the diamonds.

Various other objects and advantages of the invention will be in part obvious from a consideration of the method features of the disclosure and from an inspection of the accompanying drawing and in part will be more fully set forth in the following particular description of one method of practicing the invention, and the invention also consists in certain new and novel modifications of the preferred method hereinafter set forth and claimed.

The invention will be described in connection with the accompanying drawing in which:

Fig. 1 is a view in side elevation of a particle of diamond bort, many times magnified, and of indefinite shape, such as are intended for use in practicing the invention herein disclosed;

Fig. 2 is a cross section of the particle shown in Fig. 1 coated with a layer of metallic platinum applied following the method herein featured and illustrating a preferred embodiment of one of the coated diamonds employed in forming the article feature of this disclosure;

Fig. 3 is a cross section of a very small portion of an industrial tool in the process of having its work surface formed, practicing the method aspect of this invention, and showing several coated particles like that shown in Fig. 2 enclosed in a bonding layer secured to a steel core of the finished tool; and

Fig. 4 corresponds to the showing in Fig. 1 showing the work surface of the finished tool in its finally formed condition ready for use and after the overlapping layer above the line *a*—*b* of Fig. 3 has been removed.

In forming the finished tool shown in Fig. 4, care is exercised to see that the diamond particles or bort 10 used are at least substantially of the same grain size, otherwise the exposed surfaces of the diamonds will project unevenly beyond the work face, indicated by the line *a*—*b*. For this reason, the diamond bort, usually crushed and screened, is graded as to size as by screening; but, for sizes below 100 micron in diameter, by levigrating, air floating or other usual methods. A batch of these particles of about the same size is deposited in a solution containing a halid of one of the platinum metals together with an easily evaporated or volatile solvent, and, if desired, with a wetting agency.

While an aqueous or acid solution of platinum halids may be also workable, it is a particular feature of this disclosure to mix the platinum containing solution into a body of readily evaporated solvents capable of extensively diluting the solution to be heated and thus effecting a thorough diffusing of the resulting particles of metallic platinum while maintaining an intense cohesive action between the particles and the coating; at the same time, forming the coating as an extremely fine layer or mirror.

The platinum containing agent is preferably chloroplatinic acid (H_2PtCl_6), or platinic chloride ($PtCl_4$). While others of the halids of platinum, such as platinic bromide ($PtBr_4$) or platinic iodide (PtI_4) may be used with some degree of success, the platinic chloride has worked best in actual practice. Rhodium and palladium have been used in place of the platinum herein featured and have given some satisfaction but the platinum is preferred.

The diamond bort and platinic chloride are placed in a bath containing ethyl alcohol and ethyl ether with or without an agent such as turpentine intended to increase the wetting effect. In one method which has operated with marked success, the bath is composed of:

	Per cent
Chloroplatinic acid	6
Ethyl alcohol (C_2H_5)OH	57
Ethyl ether (C_2H_5)$_2$O	32
Turpentine	5

each by weight. Where the particles are of relatively large size the inclusion of the turpentine or any other supplemental wetting agency is unnecessary.

The preferred formula above indicated may, of course, be varied materially, as for instance where the particles are extremely fine the percentage of chloroplatinic acid will be reduced even to as little as 1%.

The bath with its contents is heated to a temperature sufficiently high to break down the chloroplatinic acid or platinic chloride and evaporate the solvents, but not so high as will deleteriously affect the diamonds. The bath is agitated until the solvents, and the turpentine if used, have evaporated and there remains on the red hot diamond particles an extremely thin coating of platinum. A temperature of about 600° C. has been found to be entirely satisfactory.

When the diamonds are heated to a temperature of the order of 600° C. there results a better adhesion between the metallic platinum layer and the surface of the diamonds than is the case where a substantially lower tempertaure is used and, on the other hand, temperatures materially above 800° C. begin to damage the diamond structure and to reduce the effective life of the diamonds.

In order to give the desired wetting effect, it also appears to be necessary to use with the platinum containing agent some form of easily volatile and thin solvent such as the alcohol and ether mentioned above because when a solution

of chloroplatinic acid alone is heated, or even when platinic chloride suspended in oil of lavender is heated to decompose the chloride, the adhesion between the fine diamond particles and their platinum mirrors does not appear to be as effective as when following the method herein featured. Oil of lavender is too sticky and does not sufficiently diffuse the resulting platinum.

This initial coating or mirror will usually be too thin and this heating step is repeated with a fresh supply of the chloroplatinic acid, or platinic chloride, and solvents as above indicated, but usually without the turpentine. This second treatment provides an additional and likewise thin layer of platinum superposed on the initial layer.

This step of adding thin layers of platinum is repeated until the desired thickness of coating, indicated at 11 on Fig. 2 has been attained. In practice, a coating layer or platinum mirror of the order of less than 0.00001 of an inch thick has been found sufficient and, of course, no greater thickness is attempted than is necessary. The resulting red hot particles are permitted to cool and are washed in distilled water as they must be used chemically clean in the succeeding step in the method.

Let it be assumed that the mass of diamonds so coated is to be used to form the work surface of a steel grinding tool, a portion of the core of which is shown at 12 in Figs. 4 and 5. The core is treated as by masking with paraffine, or wax, plastics or glass, to define the surface to be coated with the prepared particles; and then mounted in an electrolytic bath containing a bonding metal of which nickel has been selected herein as preferable and is made the cathode of the electrolytic bath. As the nickel is deposited on the core by electroplating action, the mass of diamonds while still covered with the distilled wash water is slowly poured into the electrolyte. By retaining the coated bort in the final wash bath of distilled water, the coated surfaces are protected from air contamination and in keeping the nacently formed platinum chemically clean there is insured an improved form of bond between the platinum and the electro-deposited nickel, or other bonding agent. The coated diamond particles fall gravitationally through the electrolyte and fall on to the surface to be treated in substantially uniform distribution.

There is thus formed a layer of closely positioned but actually spaced apart platinum coated diamond particles or bort of which three, marked 10, 13 and 14, are shown in Figs. 3 and 4 each touching the exposed surface of the core 12. The diamond particles are bonded to the core by a layer of electrolytically deposited nickel 15 which also bonds the diamonds to each other in the arrangement in which they fell or, rather, were drawn, on to the surface of the core. The exposed surface will take the irregular shape indicated at 16 (Fig. 3) with crowns 17 arched over the particles and troughs 18 therebetween. The electroplating is continued following conventional practices in this respect until the coated diamonds have been fully and completely covered as shown in Fig. 3. It is within the scope of this invention that several layers thus can be formed superposed one on the other in order to increase the total useful life of the tool.

Finally, the excess amount of the bonding material overlapping the diamonds is removed and the article otherwise trimmed, as by grinding; or, preferably, by using the device thus formed as

the cathode of a nickel containing electrolytic bath. The original surface is worked down to the line *a*—*b* and, incidentally, there is removed the upper and thus exposed portions of the platinum coating. There is finally formed the finished tool with its diamond bonding layer of nickel at 19 and part of the work surface of the tool is defined by the line *a*—*b* of Fig. 4.

Industrial diamond tools of the type herein disclosed and featuring a thin mirror of metallic platinum as a coating material on the diamond particles have such particles securely anchored or bonded in place and this securing is maintained under temperature conditions much greater than 300° C. and even as high as 600° C.

In those cases where the tool is required to have its diamond work surface on a plurality of continuous faces, as on the cylindrical surface of a grinding wheel, or, on the head of a dental drill, the core is mounted in the electrolytic cell for slow rotary movement about a self-contained axis, so as to insure that the entire surface to be coated shall be presented to the falling particles of platinum coated bort. By rotating the core with a substantially uniform speed all of the surface to be coated will be at some time facing upwardly to receive the falling diamond particles.

In place of the nickel bonding material above suggested as preferable, it is within the scope of this disclosure to bond the diamond particles by electroplating with other metals such as cobalt, iron, copper, and alloys thereof.

I claim:

1. In the art of binding industrial diamond bort to form the work surfaces of abrasive and cutting tools, the method which consists in selecting a mass of the bort of substantially the same size, agitating the same while in a bath containing chloroplatinic acid approximately 6%, and solvents including ethyl alcohol approximately 57%, ether approximately 32% and turpentine approximately 5%, by weight, while heating the bath to approximately 600° C. until the solvents have evaporated and a thin coating of metallic platinum has formed on the diamond bort, causing the diamond bort so coated to fall gravitationally in the electrolyte of an electrolytic bath containing nickel while electrolytically bonding the coated bort to the work surface with electrolytically deposited nickel, thereby to cause the coated bort to be distributed in a substantially uniform layer over said surface and trimming off from the bonding nickel overlapping the bort an amount sufficient to expose portions of each diamond bort to provide a work surface formed in part of a layer of the exposed diamond bort.

2. In the art of binding diamond particles to form the abrasive surface of an industrial tool, the method which consists in agitating a bath containing platinic chloride and a solvent including alcohol, ether and turpentine and particles of diamonds while heating the bath to a temperature of approximately 600° C., continuing the heating until the solvent has evaporated and a thin coating of metallic platinum has formed on the diamond particles, repeating said coating step until the desired uniformity and density of coating has been obtained, permitting the resulting red hot coated particles to cool, immediately placing the particles in a medium capable of keeping the coating chemically clean, pouring the particles with said medium into the electrolyte of an electrolytic bath containing a solution of a metal capable of electrolytically bonding the platinum coated particles to a sur-

face of the material of which the tool is formed, and permitting the coated particles to fall gravitationally through the electrolyte and to cause the particles to cover the surface substantially in uniform distribution and so become bonded to said surface.

3. In the art of forming the abrasive surface to an industrial diamond tool, the method which consists in grading a mass of diamond bort to obtain therefrom a plurality of particles of the bort of substantially uniform size, mixing the particles so graded into a coating bath containing a solution of a halid of one of the platinum metals, together with readily evaporable solvents, heating the coating bath to a temperature of about 600° C. until its solvents have evaporated and a layer of the contained metal coats the bort particles, washing the resulting metal coated bort finally in a bath of distilled water, pouring the coated bort while covered by and thus protected by its wash water into the electrolyte of an electrolytic bath containing a solution of metal capable when electrolytically deposited of bonding the coated bort to the material of the tool while subjecting the tool to the action of such electrolytic bath.

4. In the art of forming a diamond abrasive surface to a tool, the method which consists in placing a mass of diamond particles of approximately the same size in a bath containing a solution of platinic chloride and an easily evaporable solvent, heating the bath to a temperature sufficiently high to evaporate the solvent and to cause a thin coating of metallic platinum to enclose each of the diamond particles, while regulating the temperature so as not to deleteriously affect the diamonds, pouring the coated diamond particles into an electrolytic bath containing a bonding metal and that portion of the tool which is to form the abrasive surface, and causing the particles to fall gravitationally on to said surface while subjecting the particles to the action of said electrolytic bath thereby to cause the coated diamond particles to be cathodically bonded by electrolytically deposited metal to the tool while the coated diamonds are being distributed in substantially uniform degree over said tool surface.

5. In the art of coating diamonds having a degree of fineness of the order of 40 to 100 microns with a layer of conductive material to condition them for subsequent electrolytic deposition of a binding metal thereon, the step which consists in subjecting the diamonds while in a bath containing platinic chloride and a solvent therefor containing ethyl alcohol and ethyl ether to a temperature materially less than that at which the diamonds may become injured and sufficiently high to cause the chlorine and the solvent to pass off and to cause a coating of metallic platinum to form on the surface of the diamonds entirely enclosing the same, and repeating the heating process with additional platinic chloride and the solvent until the requisite thickness of coating has been formed.

6. In the art of coating diamonds having a degree of fineness of the order of 40 to 100 microns with a layer of conductive material to condition them for subsequent electrolytic deposition of a binding metal thereon, the step which consists in subjecting the diamonds while in a bath containing platinic chloride and a solvent containing ethyl alcohol and ethyl ether to a temperature materially less than that at which the diamonds may become injured and sufficiently high to cause the chlorine and the solvent to pass off and to cause a coating of metallic platinum to form on the surface of the diamonds entirely enclosing the same.

7. In the art of coating particles of diamond of a size less than about twenty mesh when in a mass composed of a large number of such small particles with a conductive coating for subsequent cathodic treatment in an electrolytic process, the method which includes the step of heating a bath containing the bort and a solution of a halid of one of the platinum metals to a temperature sufficiently high to evaporate the solvent and to deposit metallic platinum on each individual particle but not so high as will deleteriously affect the diamonds, and continuing such heating until the halid has passed off and and has left a coating of its constituent platinum metal on each particle of the bort.

8. In the art of bonding diamonds in an industrial diamond tool, the method which consists in electrodepositing on the tool while the same is revolving about a self-contained axis a binding metal deposited from an electrolyte containing particles of the diamonds coated with a covering of a metal of the platinum group while causing the particles to fall gravitationally on to the tool to cover the same uniformly.

9. In the art of bonding recently coated diamond particles to a tool core, the method which consists in coating the diamond particles with a conductive metal, containing the coated particles in a wash bath to avoid air contamination and pouring the bath with its coated particles into the electrolyte of an electrolytic bath containing a bonding metal and the tool core and thus permitting the particles to fall by gravity on to the tool core as the cathode while the bath is bonding the particles electrolytically to the core.

10. The method which consists in mixing a platinum containing solution into a body of thin solvents including ethyl alcohol, ethyl ether and turpentine capable of extensively diffusing the resulting metallic platinum particles, agitating diamond bort particles into the mixture while subjecting the same to heat to cause the platinum solution to deposit the diffused platinum in an extremely thin mirror on to the particles of diamond bort to cover the same.

11. In a diamond industrial tool, a plurality of diamond particles having a degree of fineness of the order of 40 to 100 microns disposed at substantially regularly spaced locations on the working face of the tool, said particles being so located that a portion of the surface of each projects beyond the adjacent surface of said face, means individual to each of said particles initially covering its entire surface for completely coating each particle independently of all the other particles and comprising a plurality of superposed mirrors each formed of a dense, uniform and continuous metal of the platinum group and of the type of such metal as is formed when it is heat precipitated, and a one-piece bonding means common to all the particles for permanently attaching them to the tool, said last named means comprising an electrolytically deposited metal coacting with the deposited metal to form the work face and initially covering each of said individual coating means.

12. A metal bonded abrasive comprising fine diamond particles having a degree of fineness of the order of 40 to 100 microns and a bond consisting of metallic p[illegible]um and an electrolytical-

ly deposited metal in which the diamond particles are embedded.

13. A diamond industrial tool provided with a work surface comprising a layer of diamond particles of substantially the same size and approximately not materially more than 100 microns in diameter, said diamond particles being embedded in a layer of bonding material and the embedded portion of each particle being coated with a thin layer of platinum of the order of 0.000,005 of an inch.

14. A diamond industrial tool provided with a work surface including a diamond particle of the order of 100 microns in diameter coated with a thin, dense and uniform layer of platinum embedded in a bonding material.

15. In the art of preparing diamond particles of a size not greater than 20 mesh and as fine as 200 mesh, for the subsequent deposition electrolytically of a metal thereon, the method which includes the step of heating a bath containing the diamond particles and a solution of chloroplatinic acid present in a proportion of the order of one to six per cent, at a temperature less than that which might destroy the diamonds and continuing the heating until the solution has evaporated and a mirror of metallic platinum has formed on the diamond particles.

16. An article of manufacture comprising a plurality of distinct particles of diamonds of a degree of fineness of the order of 20–200 mesh, each of said particles enclosed in a mirror of

metallic platinum adhering thereto, said mirrors each providing a dense, smooth and uniform coating to its associated particle, and means for bonding the particles together.

17. An article of manufacture comprising a particle of diamond of the order of 20–40 mesh, a mirror of metallic platinum adhering thereto and a layer of electrolytically deposited metal adhering to the platinum mirror.

18. A new article of manufacture comprising a particle of diamond finer than 40 mesh with a mirror of metallic platinum adhering thereto and completely enclosing the same.

19. An industrial diamond tool having a work surface formed primarily of a bonding material in which are embedded fine metal coated diamond particles in spaced apart relation, the surfaces of the portions of the particles within the bonding material being coated with a mirror of metallic platinum acting even when the tool becomes heated at temperatures of the order of 300°–600° C. to fixedly secure the diamond particles in place and providing a degree of adhesion at such temperatures between the diamond particle and the bonding material greater than is provided by a similar coating of either silver or gold when heated to such temperatures.

20. The tool defined in claim 19 and in which the diamond particles are of a degree of fineness not greater than 20 mesh and as fine as 200 mesh.

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