

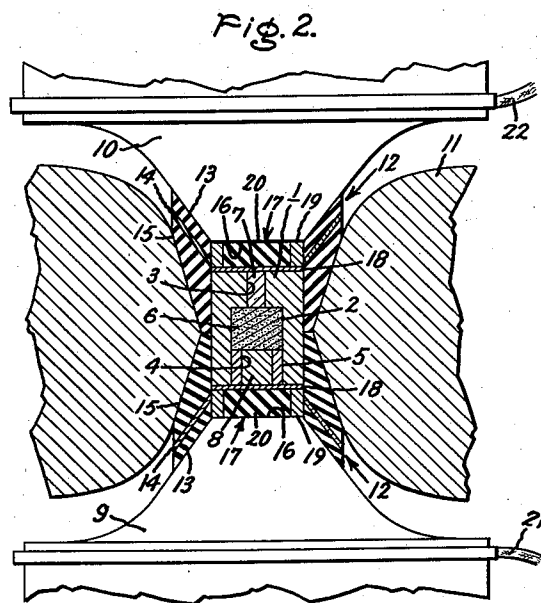
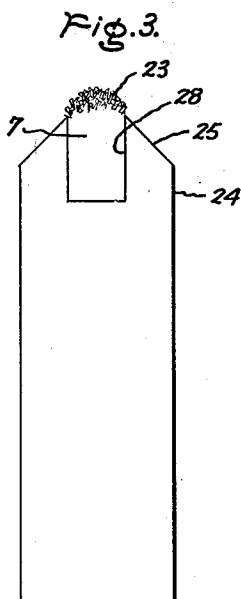
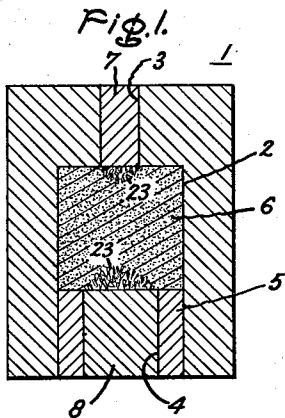
Aug. 20, 1963

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3,101,260

DIAMOND TOOL

Filed Aug. 9, 1957



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3,101,260

DIAMOND TOOL

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Filed Aug. 9, 1957, Ser. No. 677,403
2 Claims. (Cl. 51-293)

This invention relates to diamond tools, which may be briefly described as metal or other hard material cutting or grinding implements having a diamond as the cutting element, and more particularly, to the method and apparatus utilized in growing diamonds on a metal plug or support to be thereafter inserted in a suitable tool holder.

It is a presently cognizable feature of diamond tools that, not only are the diamonds relatively expensive compared to metal tools, but also, the mounting of the stones in the cutting tool is an exacting problem. This mounting problem is at best one quite dependent on a number of variables including, bonding agents, the shape of the diamond, the prospective use, and the tool material. Therefore, a method of growing or forming a diamond upon a support not only substantially eliminates the aforementioned mounting and bonding problem, but also produces such tools quickly and economically.

Accordingly, it is an object of this invention to provide a novel and efficient method of making diamond tools.

It is a further object of this invention to provide a diamond tool with an improved bond between the diamond and the tool.

It is yet another object of this invention to grow a diamond in a particular support for tool mounting purposes.

It is still another object of this invention to provide an abrasive diamond tool which eliminates separate bonding of the diamonds to the tool.

Briefly described, this invention in its preferred form includes growing diamond crystals upon a catalytic metallic support in suitable high pressure and high temperature apparatus to inherently bond the diamond to the support. The support, together with the diamond crystals formed thereon, may then be affixed to a conventional tool for the complete fixture.

This invention may be better understood when taken in connection with the following drawing, and its scope will be pointed out in the appended claims.

FIG. 1 discloses a cross-sectional view of the hollow cylinder or vessel wherein diamonds are formed on a metallic support;

FIG. 2 discloses a cross-sectional view of the hollow cylinder or vessel of FIG. 1 together with the apparatus utilized for diamond growth; and

FIG. 3 discloses the support and the diamonds grown thereon when mounted in a suitable tool.

Referring now to FIG. 1, a vessel in one preferred form of a hollow cylinder 1 is shown which is utilized in a high pressure high temperature apparatus for the transformation of non diamond carbonaceous materials, such as for example graphite to diamond. A transformation method and apparatus employed to carry out the process of this invention is disclosed and claimed in copending applications, Serial No. 655,885, Strong, filed April 29, 1957, now abandoned, and continuation-in-part application thereof Serial No. 707,433, Strong, filed January 6, 1958, and now U.S. Patent No. 2,947,609, and Serial No. 633,505, Hall et al., filed January 10, 1957, now abandoned, and continuation-in-part application thereof Serial No. 707,435, filed January 6, 1958, now U.S. Patent No. 2,947,610, each assigned to the same assignee as the present invention. The material of cylinder 1 is pyrophyllite, catlinite, or other electrically non-

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conducting materials which have desirable compressibility properties such as the ability to transmit pressure in a rather uniform hydrostatic manner while also retaining thermal and electrical insulating characteristics. The material of cylinder 1 is descriptively referred to as electrical and thermal insulating high pressure transmitting material. Cylinder 1 contains an axial bore characterized by including a generally centrally located cylindrical chamber 2 having a pair of cylindrical openings 3 and 4 of different diameters leading to opposite faces of the cylinder 1. In order to assemble the required material within the particular bore formation of cylinder 1, one of the openings such as opening 3 is bored through cylinder 1. Thereafter, the chamber is counterbored to form the central chamber 2, and a sleeve 5 is employed to give a desired diameter to the remaining opening 4. While FIG. 1 discloses one preferred form of this invention, it should be readily understood that cylinder 1 may be made of one or more parts, such as halves, to facilitate the placing of the material within the bore. Cylinder 1 is not limited to a pair of bores of different diameter since it should be apparent that a plurality of bores may be employed of either the same or different diameters.

A nondiamond carbonaceous material 6 such as carbon or graphite is placed within the chamber 2, and diamond catalytic metallic cylindrical plugs or supports 7 and 8 are utilized in cylindrical openings 3 and 4 respectively to complete the assembly. It has been found that good results are obtained with this invention when carbon is placed in chamber 2 in the form of a cylindrical slug of a suitable high density high purity graphite. Various metals may be employed for a growth of diamonds thereon; however, such metals must display catalytic characteristics which contribute to the transformation of the carbonaceous material to diamond. Examples of diamond catalytic metals which have the desired characteristics include iron, tantalum, ruthenium, rhodium, palladium, osmium, iridium, cobalt, chromium, and nickel, as well as alloys containing one or more of the foregoing metals. In one form of this invention as disclosed, plugs 7 and 8 are made of nickel and of different diameters.

In FIG. 2, the cylinder 1 of FIG. 1 is mounted between a pair of punches or anvils 9 and 10 of a high pressure apparatus such as a hydraulic press and the like wherein one or both of the punches 9 and 10 may be movable toward each other. A hardened steel or carbide belt or ring 11 is positioned between and concentrically with punches 9 and 10 defining therewith an enclosure about cylinder 1.

In order to seal cylinder 1 within this enclosure, a pair of gasket assemblies 12 are provided, one assembly being between ring 11 and punch 9, and another assembly being between ring 11 and punch 10. Each gasket assembly 12 comprises a first frustoconical gasket 13, of the same material and characteristics as heretofore described for cylinder 1, which is mounted concentrically on one of the frustoconical punches 9 or 10. Positioned concentric with and adjacent each gasket 13 is a second frustoconical electrically conducting gasket 14, of metal and the like material, which is in turn concentrically fitted with a third frustoconical gasket 15 of similar material as gaskets 13. Gaskets 15, when mounted adjacent gaskets 14, project from the punches 9 and 10 to encircle cylinder 1 and meet in abutting relationship with each other. Between cylinder 1 and each face 16 of the punches 9 and 10 is a cap assembly 17. A cap assembly 17 includes an electrically conducting disc 18 adjacent the cylinder 1, a hard metal ring 19 adjacent the disc 18, and a disc 20, of the same material as gaskets 13 and 15, positioned within ring 19 and adjacent disc 18.

Pressure on the order of 50,000 to 110,000 atmos-

pheres is imposed upon the cylinder 1 by movement of one or both punches 9 and 10 toward each other which results in a reduction in size of the various parts of the assembly, particularly those parts heretofore described being electrically and thermally insulating high pressure transmitting material.

Together with high pressure, the material 6 and catalytic plugs 7 and 8 are subjected to a temperature on the order of 1200°-3000° C. for a period of a few seconds to several minutes. While various methods may be utilized to obtain high temperature conditions, in the preferred form of this invention, resistance heating is employed by conducting electric current from a suitable source (not shown) to one of the punches, for example, 9, by means of conductor 21. Current is then conducted through the punch 9 through ring 19 and disc 18 and into the catalytic plug 8 and material 6. Current continues to flow in the reverse order of parts to punch 10 and conductor 22.

In addition to varying the temperature and pressure, the diametrical difference in plugs 7 and 8 may also be utilized as a form of control since it is apparent that in resistance heating the smaller diameter plug gives rise to a higher temperature and thus the diamond transformation takes place sooner on the smaller diameter plug. In this manner, the individual diamond growth on the plugs may be controlled so that the growth on one of the plugs may be larger than on the other and/or the number of diamond crystals formed on either may be limited. Furthermore, the invention is readily adaptable to the growing of diamonds on a single support, if desired.

This process results, as shown in FIG. 1, in the forming or the growing of a cluster or crown 23 of diamond crystals in the material 6 adjacent the plugs 7 and 8, and essentially on the end surface thereof, thus providing clean side and end surfaces to facilitate joining to a tool holder. Various forms of control including the above-mentioned may be exercised over the diamond forming process, so that the number of crystals formed about the plugs 7 and 8 may be made to vary, for prospective particular future usage, from large clusters of crystals to 3 or less. This cluster or crown 23 of diamond crystals is firmly bonded, or surrounded and cemented together by the nickel plug in the growing process.

After the assembly is removed from the high pressure high temperature apparatus, the crushed cylinder 1 is removed, and the plugs 7 and 8 parted through the graphite. The diamond crown 23 on the plugs 7 and 8 is cleaned by removing excessive carbon and perhaps some nickel to expose a desired crown configuration. In this respect, it may be appreciated that the diamond crown 23 may also be reduced in size, or otherwise shaped to a particular form suitable as a metal or other material cutting or dressing tool.

In FIG. 3 there is shown a well known type of tool holder 24 whose working surface 25 contains a recess 28. Into the recess 28 there is placed one of the plugs 7 or 8 with its preformed diamond crown 23. The plug is maintained within the recess 28 by soldering, brazing, cementing, or other well known forms of joining. The attaching is facilitated since diamonds are grown on less than all surfaces of the plug or on portions only thus leaving clean geometric surfaces for the soldering, brazing, cementing, etc. Such a finished tool may then be employed for various cutting and grinding purposes, generally heretofore requiring particularly hard metals and materials, and furthermore for special uses where such metals and materials have been found not satisfactory as compared to the cutting and abrasive qualities of diamonds.

The following specific example is given as an illustration, and not as a limitation, of my invention. The cylinder 1 as herein described together with the graphite and plugs of nickel were inserted in a high pressure press apparatus and subjected to pressures on the order of 90,000

atmospheres while simultaneously heated to a temperature of approximately 1700°-1900° C. After a period of 2-3 minutes, the cylinder was taken from the high pressure high temperature apparatus, the nickel plugs were removed from the vessel and excess graphite cleaned therefrom. On each of the nickel plugs, diamond crystals were formed or grown with an average diametrical size of 100-200 microns in clusters firmly bonded or cemented together by the nickel plug. Thereafter, the plugs were mounted in a tool holder for satisfactory performance as a grinding tool, and in plural form on the surface of a disc as a grinding wheel.

While other modifications of this invention and variations of apparatus which may be employed within the scope of the invention have not been described, the invention is intended to include all such as may be embraced within the following claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of producing diamond tools which comprises, placing a quantity of graphite centrally in the bore of an electrical and thermal insulating high pressure transmitting material cylinder, inserting a catalytic metal plug in said bore on each side of and adjacent the said centrally located graphite with the side surface thereof contacting the bore of said cylinder, subjecting said plug, graphite, and cylinder to high pressures in the approximate range of 50,000-110,000 atmospheres and high temperatures in the range of 1200-3000° C., maintaining said pressures and temperatures for a period of two to three minutes to cause diamond crystal formation only on the portion of said plugs adjacent said graphite while maintaining the remaining portions of said plug free from diamond growth thereon, reducing the temperature and pressure, removing said plugs with the diamond formation thereon from said cylinder, shaping said diamond formation to a cutting configuration, and mounting said plugs in tool holders by means of portion of said plug maintained free of diamond growth.

2. A method of producing a diamond tool plug having diamond growth thereon which comprises, placing a quantity of non-diamond carbonaceous material in a bore of an electrically and thermally insulating high pressure transmitting material vessel, inserting a diamond catalytic metal plug in said bore at one end thereof on at least one side of said non-diamond carbonaceous material with a substantial side surface portion of said plug out of contact with said graphite, subjecting said metal plug and non-diamond carbonaceous material and vessel to a high temperature of at least about 1200° C. and high pressure of at least about 50,000 atmospheres to cause diamond crystal formation on said plug only where adjacent said non-diamond carbonaceous material, maintaining the remaining portions of said plug out of the range of diamond crystal formation so that a metal surface free of diamond growth is provided for joining said plug to a tool holder, reducing the temperature and pressure and recovering said plug with diamonds thereon.

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