Dec. 11, 1951 G. E. BJÖRKLUND ET AL 2,578,167

GRINDING WHEEL AND METHOD OF PRODUCING SAME

Filed Sept. 18, 1946

FIG. 1

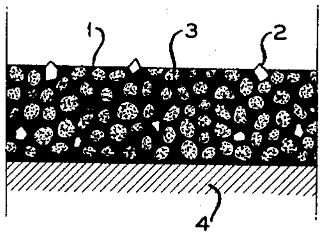


FIG. 2

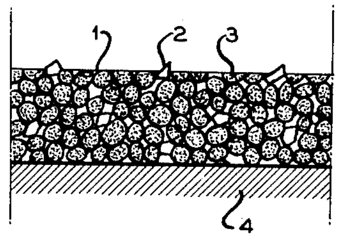


FIG. 3

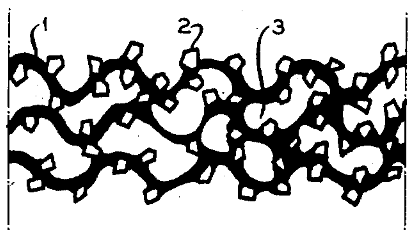


FIG. 4

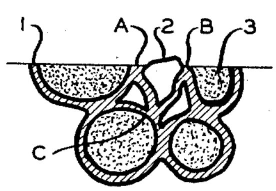


FIG. 5

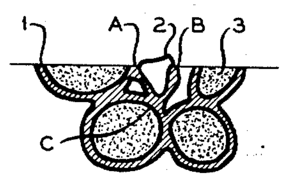


FIG. 6

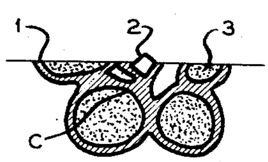
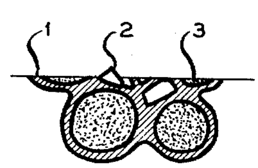


FIG. 7



INVENTORS
GUSTAF ERIK BJÖRKLUND
JOHAN ERIC HAYDEN WESTBERG
BY
Jarvis C. Marble
ATTORNEY

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2,578,167

GRINDING WHEEL AND METHOD OF PRODUCING SAME

Gustaf Erik Björklund, Stockholm, and Johan Eric Hayden Westberg, Malarhojden, Sweden, assignors to Aktiebolaget Dentatus, Jakobsdal, Aspudden, Sweden, a corporation of Sweden

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7 Claims. (Cl. 51—309)

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In the production of diamond grinding wheels problems arise that do not have the same importance in the manufacture of wheels with other kinds of abrasives. This is particularly the case in connection with grinding wheels for working on very hard materials.

On account of the costliness of the diamond material it is required that it shall be used up as completely as possible. It has been proven that very good utilization of the diamond is attained if this is set in solid metal of suitable strength. A grinding body based on such a construction however gives a poor grinding effect i. e. working up of material. As a matter of fact the solid fastening of the grinding grains renders their getting loose or displacement impossible after they have been worn smooth and thus lost their sharpness. Any new cutting edges will therefore not be presented but the cutting effect will be gradually transformed into a sort of wearing effect.

The present invention refers to such a construction of a diamond- or similar wheel that by varying certain factors influencing the functioning of the wheel one is able to vary the properties of the wheel in such a way that the diamond material is always used up as completely as possible, a satisfactory grinding effect at the same time being obtained. This is effected by the matrix of metallic binding material surrounding the grinding grains having celliform structure due to cavities occuring in the same. The cavities are suitably filled with a material which has little strength in comparison with the metallic binding material. The material may thus consist of small grains with relatively weak binding between the grains effected through pressure or partial sintering or a weak binding means by way of example.

The invention will be described more in detail in the following description with reference to the accompanying drawings in which:

Fig. 1 is a schematic section of a part of a grinding wheel according to the invention in enlarged scale;

Figs. 2 and 3 are similar sections of other embodiments according to the invention;

Figs. 4–7 show how the structure of the wheels according to the invention makes the maintenance of a high grinding effect and a good grinding economy possible.

In the Figures, **1** is the binding material and **2** the grinding grains embedded therein. In the binding material are also cavities **3** filled with air or other gas or a material with little strength. The binding material set with grinding grains forms an active layer which is fixed upon a supporting base **4** (not shown in Fig. 3).

In the embodiment according to Fig. 1, the binding material fills up the whole space between the grinding grains and the cavities. Through the cavities which lie close together the binding material is given a celliform structure. In the embodiment according to Fig. 2 each cavity is surrounded by a shell of binding material and the grinding grains are coated with a similar shell. The cells formed by the cavities and their shells and the grinding grains are connected at their adjacent points, for instance by means of soldering. In this way a coherent tissue of cavities is formed between the different cells and between these and the grinding grains such tissue aids in increasing the effect attained by the cells.

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In the embodiment according to Fig. 3, the binding material is formed by a number of corrugated foils lying close to each other and joined together by means of soldering or other means. On these foils grinding grains provided with metal shells, for example, are attached by means of soldering. On account of the corrugations of the foils cavities in the shape of lengthened channels are formed between the foils and around the grinding grains. Fig. 3 shows a section of the active layer at right angles to the active surface of the grinding wheel and at right angles to the longitudinal direction of the corrugations.

It is obvious that one is able to attain highly varying qualities of the active layer by changing the dimensions of the structure of the celliform binding material and by variation of the selection of the binding material and filing material in the cavities. By changing the thickness of the metal layer surrounding the grinding grains or by choosing a metal for this layer that is more or less firm one will thus be able to vary the fastening force at the grains. However the tenability of the setting of the diamond grains likewise depends on the velocity with which the active surface of the grinding wheel is worn out. This surface principally consists of celliform tissue of binding material. The filling material of the cavities has such poor strength that its resistance to the wear can be wholly overlooked, the wearing out of the active surface being principally dependent on the tenability of the tissue of binding material. This can be varied by changing the thickness of the layer of binding material surrounding the cavities and by choosing the binding material. Also by varying the relative size of the cavities the total supporting metal surface that is subjected to the grinding pressure i. e. the specific pressure on the active layer and therefore also the rate of wearing can be varied. One has thus the possibility of accommodating the rate of renewal of the grinding grains i. e. the supply of effective grinding grains to the active surface by varying the above mentioned factors so that the most economical grinding effect is obtained.

By means of the design of the active layer described above a certain mobility of the grinding grains is obtained which entails an increase of the grinding effect as well as a more complete wearing out of the grinding grains than in case of the grinding grains being set in solid metal. Figs. 4 to 7 illustrate how the grinding grains behave in different stages of the wearing process. As an example a structure of the grinding wheel of the kind shown in Fig. 2 has been chosen. In Fig. 4, 2 is a grinding grain which is in cutting position at the surface of the grinding wheel and which is but slightly worn. Its shell is firmly connected with the shells surrounding the adjacent cavities 3 at A, B and C and the grinding grain is thus firmly anchored in the binding material. The shells provide substantially arch-shaped walls surrounding the cavities to provide a strong body until the shell wall is worn through. In Fig. 5 the connection at A and B has been broken off in consequence of the wear of the metal shells. However the grinding grain is firmly held at C at the shell of the underlying cavity, the grinding grain under influence of the force acting on same having been turned so that a new cutting edge has come into action. In Fig. 6 the wear of the shells of binding material has proceeded so far that a further turning of the grinding grain about C has been possible by means of which a new part of the grinding grain has come into play. Finally in Fig. 7 the wear has proceeded so far that the grinding grain has got loose from its shell and has slipped off the same but has become fastened in the small groove in the surface of the grinding wheel that is formed by the shells of the adjacent cavities. By these means a last wearing out of the grinding grain is made possible, the grain having been successively worn out so that only a small part of the same remains.

The described displacements of the grinding grain do not take place continuously but by steps. When the force acting upon the grain overcomes the attaching forces the grain will move until the attaching and supporting forces again balance the forces arising from the grinding pressure. With the differences in the influencing factors depending upon the variation in the setting of the grains the displacements of the different grains will however greatly vary as to size and progress. The essential thing is however that each movement of the grains can bring new cutting edges into action which imports increase of the grinding effect of the individual grinding grain and an improved utilization of the same.

Grinding wheels according to the invention can be manufactured in different ways by laying in grinding grains and filling grains of a material with little strength into the binding material. However the manufacturing will be suitably done in the following manner:

The grinding grains, preferably diamond grains, are covered with metal, nickel by way of example. This is suitably done electrolytically after the grains have been made conductive by wet silvering by cathode sputtering, or in any other way.

In order to produce grains with small strength meant for the filling of the cavities the raw material which may consist of a suitable metal or metalloid or chemical compound is fine-pulverized. As examples of suitable materials ceramic materials and metallic oxides may be mentioned. Of metals such will in the first place be taken into consideration as can be distributed into very fine powder and as do not sinter together at the heat treatment during the following manufacturing process or as do not bake together into solid consistence at the grinding with the finished wheel. Preferably, such hard metals as chromium or tungsten are available. The pulverization is performed into a size of grains that is far below the crushing of the diamond.

The fine powder is mixed with a suitable binding agent and is pressed into bricks. The binding agent and the pressure is thereby chosen in such a way that the mechanical strength of the bricks will be small. Possibly powder of metal or metallic oxide for instance silver oxide or graphite or the like in colloidal or otherwise in very fine-grained state is mixed in, so that the brick material will be conductive for electricity. The bricks are crushed into grains of suitable size usually a little greater than but approximately the size of the diamond grains. It often will be advantageous to use a mixture of grains of varying size. The grains are thereafter coated with a shell of metal of suitable thickness. This may for instance be done in the electrolytic way the grains having first been made conductive.

Filling grains with cavities filled with air or other gas or a liquid may also be used. In manufacturing these, grains are first produced from a soluble or easily fusible substance, for instance aluminium or wax or the like, which is coated electrolytically by way of example with a very thin and not entirely tight layer of metal. The content of these grains is thereafter removed by means of heating or dissolving, so that only the shell remains. After that the shell is reinforced to desired thickness, suitably electrolytically. The filling grains may also be manufactured from a solid substance that is not granular for instance very soft metals such as lead or tin or other soft materials such as synthetic resins or thermoplastics or the like.

The filling grains produced in one or other of the ways mentioned above and the grinding grains are all covered with a suitable soldering metal for instance silver. This is preferably done electrolytically. Also heat soldering is however applicable. Filling grains and diamond grains are thereafter mixed in suitable proportions possibly with some flux added thereto and the mixture is pressed slightly in moulds made of a material neutral to the soldering metal and is finally heated to the soldering temperature. After cooling a coherent grinding body is obtained. Instead of coating the grains with soldering metal a paste containing the soldering metal in fine-pulverized state and the flux can be added. The quantity of metal in the paste can thereby be weighed out in such a way that the soldering metal does not cause any substantial filling of the spaces between the grains or in such a way that the soldering metal wholly or partly fills up these spaces.

A grinding wheel according to the invention may however also be manufactured wholly electrolytically. For this reason a matrix of the shape of the desired grinding body is placed in a suitable electrolyte and coupled as cathode in a current circuit in such a way that the binding metal begins to precipitate on the same. A mixture of filling grains and diamond grains in suitable proportions is thereafter allowed to fall through the electrolyte onto the surface of the matrix either continually or at short intervals of time. As the grains come in contact with the surface of the matrix the binding metal begins to precipitate on them. Current and supply of grains are regulated in such a way that the grains are coated with metal shells of suitable thickness before being wholly covered by other grains. However the precipitation of binding metal may be regulated in such a way that by this method the spaces wholly or partly are filled with binding metal. The matrix may be at rest or rotate or otherwise move in order to achieve the desired precipitation of the active layer. In this latter method the different grains do not need to be coated with metal shells beforehand but at the time when they are filled with gas or liquid. They only need to be made electrically conductive before their immersion in the electrolyte.

In the manufacture of grinding wheels according to the invention one is however able to produce the celliform tissue of binding material around the grinding grains as shown in Fig. 3 without using filling grains as described above. A grinding wheel with the structure shown in Fig. 3 is manufactured of thin corrugated foils to which grinding grains provided with metal shells are attached by means of soldering or the like. The foils should be so positioned in the wheel that they in the main form right angles with the active surface of the grinding wheel. In all cases the different foils or the different parts of the foil strip, respectively, are attached to each other for instance by means of soldering. The cavities or channels formed by the corrugations are kept as open air spaces or filled with a material of little strength, for instance soft metal such as tin or lead. Of course other soft materials or materials with granular structure may be used as filling material. In the case of soft metals being used these may also serve as soldering materials at the soldering together of the foils.

The described methods of manufacturing grinding wheels according to the invention are only meant to constitute examples and may be varied in a multitude of different ways. The structure of binding material provided the cavities may also be provided by means of departing from other methods without the principles of the invention.

What we claim is:

1. A grinding body comprising a matrix of deformable metal having abrasive particles imbedded therein in spaced relation to one another, said abrasive particles being surounded by a metallic shell, said body being formed with cavities of approximately the same size as said particles, the walls of said cavities having concave substantially arch-shaped inner surfaces so as to provide a relatively strong supporting body for said particles, whereby during normal use the walls of said cavities are worn away resulting in deformation thereof under the pressure exerted by said particles due to the grinding operation to permit said particles to change their angular position and expose new cutting edges while retaining said particles firmly imbedded in said body.

2. A grinding body comprising a matrix of metal containing grinding particles coated with metal forming a shell therearound and relatively weak spacing particles of approximately the same size as said grinding particles coated with a deformable metal to provide other shells around said spacing particles, said coated grinding particles and coated spacing particles being interspersed and bonded together, the shells of said spacing particles being adapted to wear through in normal use so as to produce openings through the shells of said spacing particles whereby said grinding particles may automatically change their angular positions relative to the surface of said body as said body is worn away in normal use.

3. A grinding body comprising grinding grains, such as diamond grains, each coated with a metallic binding material, and a multiplicity of cells of approximately the same size and having substantially arch-shaped inner surfaces each formed with a shell of metallic binding material, said cells and grains being connected by metallic binding material to provide a matrix of metallic binding material of cellular form within the walls of which the grinding grains are firmly embedded.

4. A grinding body comprising metal coated abrasive particles, a plurality of concavo-convex metallic shells having cavities of approximately the same size as said particles interspersed with said coated abrasive particles, said shells and said coated abrasive particles being bonded together by integral connection of the metals thereof.

5. A body as set forth in claim 3 in which said shells and the metallic coatings of said grains are joined at spaced places to provide a multiplicity of cavities in the matrix between the grains and cells and between the cells.

6. A method of producing a grinding body having grinding grains such as diamond grains embedded in metallic binding material which comprises coating the grinding grains to provide a shell of homogeneous metal thereon, coating grains of relatively weak filling material with metal and thereafter joining the coated grains together by fusion of the metal coatings whereby to produce a metallic matrix within the walls of which the said grinding grains are firmly embedded.

7. The method of producing a grinding body having grinding grains such as diamond grains embedded in a metal binding material which comprises coating the grinding grains to provide a shell of homogeneous metal thereon, forming hollow fluid filled grains of metal and joining the grains together by metallic juncture of the metal surfaces of the grains to form a metal matrix within the walls of which the grinding grains are firmly embedded.

GUSTAF ERIK BJÖRKLUND.
JOHAN ERIC HAYDEN WESTBERG.

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Certificate of Correction

Patent No. 2,578,167 December 11, 1951

GUSTAF ERIK BJÖRKLUND ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 61, after "silvering" insert the word *or*; column 5, line 39, for "provided the" read *provided with*; line 40 and 41, strike out "departing from" and insert the same after "without" in line 41;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of March, A. D. 1952.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.