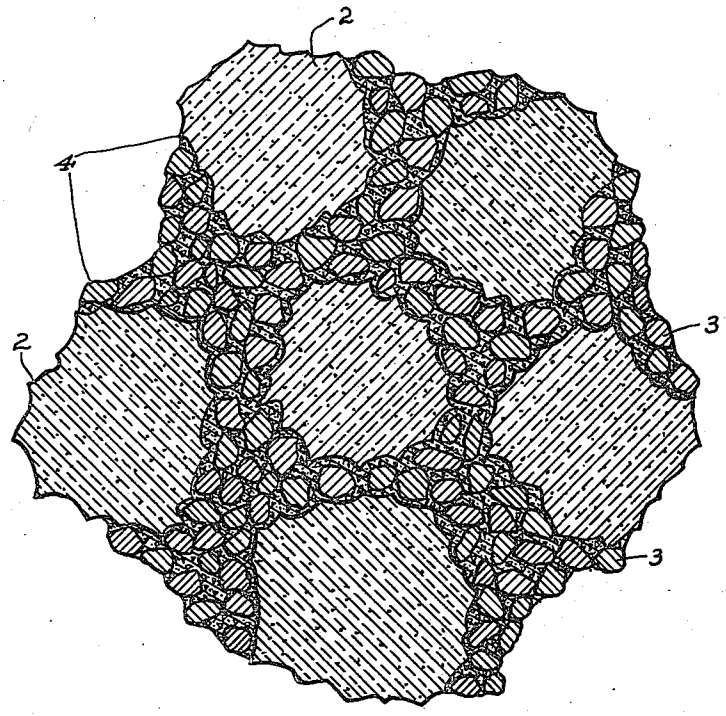
June 13, 1939. A. L. BALL 2,162,600

FILLER FOR ABRASIVE ARTICLES

Filed July 27, 1936



INVENTOR.
ALBERT L. BALL

BY R. C. Benner

ATTORNEY.

Patented June 13, 1939

2,162,600

UNITED STATES PATENT OFFICE

2,162,600

FILLER FOR ABRASIVE ARTICLES

Albert L. Ball, Lewiston, N. Y., assignor, by mesne assignments, to The Carborundum Company, Niagara Falls, N. Y., a corporation of Delaware

Application July 27, 1936, Serial No. 92,784

7 Claims. (Cl. 51—280)

This invention relates to abrasive articles containing costly abrasive material such as diamond particles for example, and relates more particularly to materials which are comparatively speaking, non-abrasive constituents of the abrasive article.

The non-abrasive constituents of an abrasive article may be subdivided into the bonding materials and the so-called inert fillers. The chief function of the bonding materials is to give a strong mechanical structure to such a body as an abrasive wheel which is subject to large centrifugal stresses resulting from high running speeds and from working stresses produced by the work of abrasion. The function of the fillers is more difficult to describe. In the case of diamond wheels (which are herein described for purposes of illustration), one of the most important functions of the fillers consists in the improvement of the grinding efficiency of the wheel whereby the life of the wheel is prolonged and the costly abrasive material is economically utilized.

The present invention may be considered therefore from two points of view, viz., the grinding efficiency and the cutting rate, both under specified working conditions.

The grinding efficiency under given working conditions may be defined as the number of grams of material removed from the work-piece divided by the number of grams of diamonds lost from the abrading tool as a result of such removal. Instead of defining the mass of diamonds in grams, it may be expressed in carats, the international carat being a fifth of a gram. The grinding efficiency is of importance in judging the probable life of a given type of diamond wheel.

The cutting rate of an abrasive wheel for a given running speed is measured by the number of grams of material removed from the work-piece per unit time. This datum is of importance from the point of view of economy of time in the performance of a given type of grinding job; that is, an increase in cutting rate means a direct saving of skilled and expensive labor.

One known method of bonding diamonds is to utilize a synthetic resin as a bond matrix. Inert fillers have also been used along with diamond particles and a bond in making abrasive articles in which diamond particles were the main abrasive constituents. Examples of some of the more common of such fillers are graphite, flint, clay, wood flour, mica dust, etc.; and in general the reason for their use is to cheapen the cost of the article by using a portion of quite inexpensive substance. Fillers of low priced artificial abrasives are also used when diamond is the major and expensive cutting agent. In accordance with the present invention, however, large proportions of powdered metals are utilized as fillers; and it is found that striking improvements in abrasive performance are brought about by the use of such powdered metal fillers. An example of constituents which can be used in making an abrasive wheel in accordance with the present invention is as follows:

Formula "A"

	Per cent
Diamond particles of grit size 80–200	3.9
Powdered metallic iron	82.8
Resinous bonding material	13.3

The grit size given above defines particles which will pass through a screen containing 80 meshes to the linear inch but which are retained on a screen containing 200 meshes to the linear inch. The sizes and proportions of particles mentioned are given for purposes of illustration and not by way of limitation.

In making up an abrasive wheel according to the above Formula "A", crushed diamonds are carefully screened to yield a fraction passing an 80 mesh screen and being retained on a 200 mesh screen. This diamond composition is mixed with a reactive resinous material and with finely divided iron in the proportions given above. If the reactive resin is in liquid form it may be used as a plasticizer for the other constituents by adding it at a rate to facilitate thorough mixing. The abrasive mix is transferred from any convenient mixing receptacle to a mold where it is subjected to heat and pressure to form a wheel or abrasive article of the desired shape. It may be desirable to advance the state of the resin (toward its final stage) by warming the abrasive mix prior to molding it by the application of heat and pressure. The molded article may then be further heated in the mold or removed to an oven where it is heated, the time-temperature schedule being adapted to cure the resin to the so-called C stage where it is infusible.

An abrasive wheel prepared in this manner from the constituents given in Formula "A" is adapted for sharpening hard cemented carbide tool tips, the latter being applied to the side of the wheel having diamond particles as the main abrasive constituent. This form of grinding is exceedingly difficult of accomplishment and it constitutes a good basis for comparing the relative efficiencies of various abrasive wheels con-

taining diamond constituents. By arranging test conditions to be standard in all respects except as to wheel composition, the amount of hard carbide removed from the object being ground becomes a measure of the efficiency of the diamond wheel having a given set of constituents.

Tests have shown that 11.3 grams of hard carbide can be removed per carat of diamond when the wheel is made in accordance with Formula "A" and the procedure described in general above for making such a wheel. This performance may be compared with the corresponding efficiencies obtained in the case of wheels made in a similar manner from the constituents given in Formula "B".

Formula "B"

	Per cent
Diamonds	8.7
Silicon carbide	78.3
Resin	13

A wheel made up with the constituents of Formula "B" showed an efficiency of only slightly over half the amount of carbide removed per carat of diamond as compared with a wheel made with the constituents of Formula "A".

The following table gives corresponding cutting rates in grams of material removed per minute under similar working conditions.

Wheel made according to formula	Cutting rate grams per minute
"A"	0.7
"B"	0.29

This indicates that the cutting rate of the improved metal powder filled wheel is over double that of a non-metal filled wheel which contains over twice as great a percentage of diamonds.

The general structure of the abrasive article which is the subject of this invention is illustrated by the accompanying drawing.

The drawing represents diagrammatically a cross-section of a fragment of an abrasive article in which there are distributed with reasonable uniformity diamond particles **2** in a matrix of metallic particles **3**. Most of these metallic particles **3** are closely surrounded by other metallic particles so that they tend to support each other and the diamond particles enclosed by them. The strength of the mechanical structure of the abrasive article is mainly dependent on the bond in the interstices between the metallic particles and in the spaces between the metallic particles and the diamond particles. This bond should be of such a character that it adheres strongly to both the metallic particles and to the diamond particles.

The bond may be for example, a phenolic condensation product resin which may be used in either or both of its reactive states, i. e. A or B resin stages during the mixing process. It may subsequently be cured to the infusible C stage. The A, B, and C resin stages have the significance which they have acquired in the art of making phenol condensation product resins.

A precise explanation of the superiority of the metal filler, used for example in Formula "A", can not be given here with certainty. It is believed that by adjusting the ratios of the constituents in the abrasive composition in such a manner that metal particles are for the most part strongly held in comparatively close contact, a strong matrix for the diamond particles is produced. This result is attained where the relative amounts and particle sizes of abrasive grain and metal filler are proportioned so that the majority of the metallic particles are substantially in close contact, while the pore spaces between the metallic particles are filled for the most part with resinous bond. It may in some cases be desirable to use metal powder in a considerably finer state of subdivision than the abrasive particles. Abrasive particles disposed in such a matrix are retained in position with great firmness. Shocks which they receive in the process of grinding are resisted by substantially solid metal with the result that a good abrading action is obtained. Another possible reason for the durability of metal powder filled wheels may be the presence of a tough, closely knit metallic structure than can effectively resist the disintegrating action of particles that are torn from the work-piece and from the abrading article. This detritus or debris from the grinding process is not generally dissipated with sufficient rapidity to prevent injurious effects on the abrading article. The rolling action of the separated particles tends to wear down the working surface of the abrading article as indicated in locations between abrasive particles **2** by means of the reference numeral **4** and the connecting lines in the drawing, assuming that this portion of the fragmentary view is a part of the working surface.

Various metals or alloys possessing any desired properties of toughness, or friability, etc., in finely powdered condition may be used in combination with diamond particles or other abrasives approximating the diamond in hardness, such as fused alumina or carbides of various metals (such as boron, silicon, etc.) associated with a hardenable bond, in making abrasive articles according to the present invention which is defined within the compass of the following claims.

I claim:

1. An abrasive article comprising diamond particles distributed at substantial intervals in a mass of metallic particles which are closely packed against each other and against the diamond particles and which have an aggregate mass equal to several times that of the diamond particles, and a resinous bond interconnecting the diamond particles and the metallic particles.

2. An abrasive article comprising diamonds spaced apart from each other in a matrix consisting mainly of iron particles having an aggregate mass several times greater than that of the diamond particles, and a hardened resinous bond interconnecting the iron particles with each other and with the diamond particles.

3. An abrasive wheel comprised of diamond particles embedded in a matrix of irregularly shaped iron particles whose linear dimensions are much smaller than the corresponding dimensions of the diamond particles but whose total mass greatly exceeds the mass of the diamond particles, and a heat-hardened phenol condensation resin bond for the diamond particles and iron filler.

4. An abrasive wheel comprising less than ten per cent of diamond particles, more than seventy per cent of irregularly shaped iron particles dispersed around and between the diamond particles, and a resinoid bond cured to the C-stage in intimate contact with the diamond particles and iron particles and constituting more than ten per cent of the mass of the wheel.

5. An abrasive wheel containing diamond

particles in which each diamond particle is surrounded by a large number of iron particles, the diamond particles constituting less than ten per cent of the mass of the wheel and the iron particles constituting more than seventy per cent of the mass of the wheel, the diamond particles and the surrounding iron particles being bonded by means of a resinoid bond cured to the C-stage in intimate contact with the diamond particles and the iron particles and said bond constituting more than ten per cent of the mass of the wheel.

6. An abrasive article comprising 3 to 5 parts by weight of diamond particles whose average dimensions vary from about 1/80 inch to about 1/200 inch, 80 to 90 parts of powdered metallic iron, a plurality of iron particles being distributed on the average around each diamond particle, and 10 to 15 parts of resinous bonding material, in which article the bond was hardened to an infusible state in intimate contact with the diamond particles and with the iron particles that surround the diamond particles.

7. An abrasive article comprising abrasive particles distributed at substantial intervals in a mass of metallic particles which are closely packed against each other and against the abrasive particles and which have an aggregate mass equal to several times that of the abrasive particles, and a resinous bond interconnecting the abrasive particles and the metallic particles.

ALBERT L. BALL.