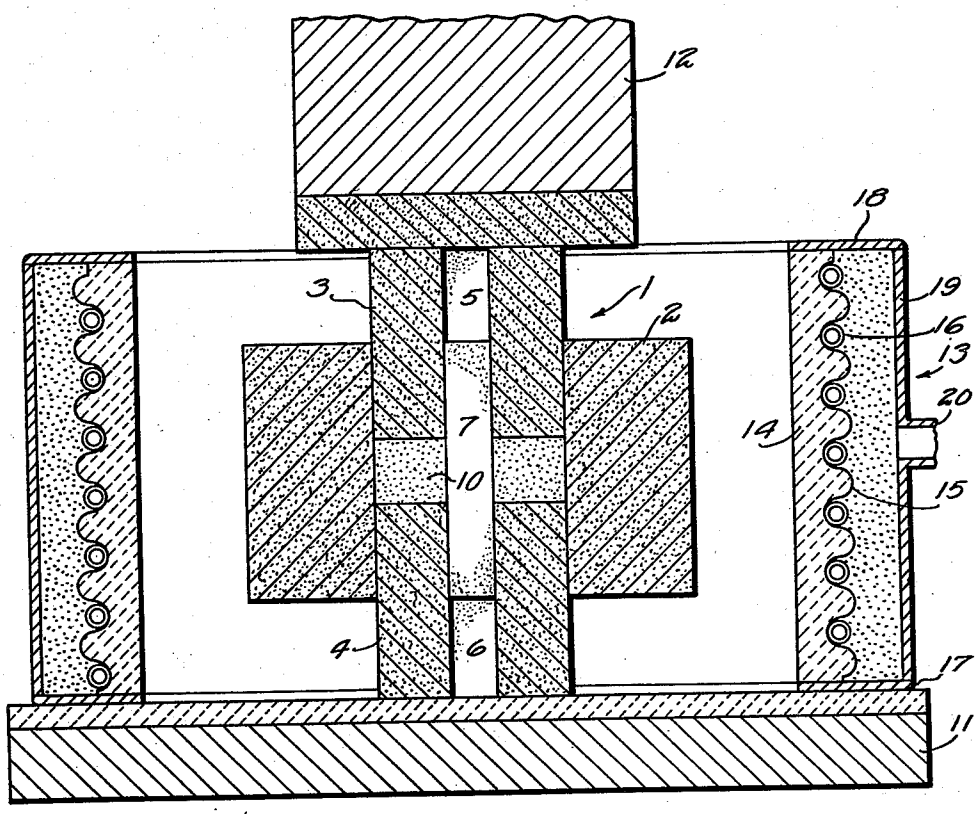
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ABRASIVE WHEEL

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ABRASIVE WHEEL

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The invention relates to abrasive wheels and a method of making the same.

One object of the invention is to provide a grinding wheel for grinding very hard substances. Another object of the invention is to provide a bond and a method of bonding particularly suitable for the manufacture of grinding or lapping wheels the abrasive part of which includes diamonds. Another object of the invention is to provide a bond for diamond abrasive from which the diamonds may be recovered at small expense and without destruction of the diamonds. Another object of the invention is to provide a bond which itself will break down but which nevertheless will hold the abrasive grain so long as free cutting edges are presented. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing in which is shown one of various possible embodiments of the mechanical features of this invention, the single view is a vertical axial cross section through an electric furnace and pressure apparatus together with a mold which may be used to carry out the method of the invention.

I provide aluminum in powdered form which may be in the neighborhood of 100 mesh grit size although other grit may be used. I provide also powdered silicon which may be of the same grit size. Taking in the neighborhood of 60%, by weight, of silicon, and 40%, by weight, aluminum, I mix the powders together thoroughly. This may be done in any convenient manner as by hand or in a ball mill. It should be understood that many different sizes of grain can be used but for the best results I prefer to use fairly fine grain. Instead of mixing grain or powders of aluminum and silicon I may form an alloy of the two metals in the usual manner and then powder them to the size of grain indicated.

This powder or mixture of powders I then mix with the required amount of diamond grit. Diamond grit which, because of its extreme hardness and its other qualities, constitutes probably the best abrasive substance known, exists in a form commercially known as "bort" which is commercially available in sufficient quantities and at such prices that it may be used for the manufacture of grinding wheels and other abrasive bodies. While bort is expensive, nevertheless on account of the great superiority of the diamond for abradant purposes, the wheel formed thereof has many practical uses and advantages. With the powdered bond of the type indicated I mix in the neighborhood of between 25 and 50% by volume of such bort, in a grit size of between 80 mesh and 500 mesh, for example. The mesh size of bort selected will depend upon the abrading operation that the wheel is to perform, and my invention has no limitations in this respect, in so much as grinding, polishing and lapping operations differ vastly among themselves. For the finer polishing or lapping operations a finer grit size of bort will be used.

The mixing of the grain with the bond may be accomplished manually, for although machine methods might be used, the bort or diamond dust is so valuable as to dictate care in the mixing to avoid loss of diamond. Referring now to the drawing, I take a measured quantity of bond and bort and place it in an annular mold 1. This mold 1 may comprise a cylindrical annulus 2 of graphite. While other substances may be used with success, I prefer to use graphite because at the temperature which I prefer to employ in sintering the material, the graphite acts as a protector for the diamond and also the alloy involved by combining with oxygen before it has a chance to reach the materials being molded and sintered. The mold further comprises, in the preferred embodiment of the invention, a pair of annular cylindrical plungers 3 and 4, also preferably of graphite for the reason above given, and whose outside diameter is the inside diameter of the annulus 2, and each having a bore 5 and 6 respectively, coaxial and of the same diameter and in which is a graphite core 7 fitting with a sliding fit.

The annuluses 3 and 4 are in the nature of plungers and fit the annulus 2 with a sliding fit. I place the diamond and bond mixture 10 between the plungers 3 and 4, the core 7 and the annulus 2 as shown, thus filling a cylindrical annular space. I then introduce the mold 1 into a furnace capable of producing a temperature of 1400° C. and between pressure apparatus arranged to exert pressure against the plungers 3 and 4 in a true axial direction. Such furnace apparatus and pressure apparatus may take any desired form and my invention is in no wise limited to any particular one, but by way of example I have shown a rigid support or platen

11 having a horizontal plane surface above which is located a plunger 12 having a lower horizontal plane surface and which plunger 12 may be moved vertically downward with the required force. Upon the platen 11 is an annular electric furnace 13 being a molybdenum wound furnace of a type which is well known. Such a furnace may have a cylindrical refractory core 14 of aluminum oxide having a corrugated outer wall 15 whose convolutions extend helically and have in them helically wound molybdenum wire 16. The aluminum oxide core or shell may rest upon an annular steel disk 17, and at the top of the furnace there may be an annular steel disk 18, the disks 17 and 18 being connected by a hollow steel cylinder 19. Thus a space is left surrounding the molybdenum resistance wire 16 which space is filled with powdered insulating material, such as magnesium oxide.

Having introduced the material 10 into the mold 1, and placed the mold 1 upon the platen 11 as shown, I bring the plunger 12 down to the plunger 3 and energize the furnace 13. The furnace 13 is designed to heat the material being molded to a temperature of 1400° C. and to avoid oxidation of the molybdenum winding 16 there is provided a nipple 20 which may be connected to a hose for the introduction of an inert gas such as nitrogen or a reducing gas such as hydrogen which permeates the space in which is the magnesium oxide insulation and also escapes through the porous aluminum oxide refractory onto the mold 1, thus protecting the mold 1 from oxidation and further protecting the material 10. At or before the attainment of 1400° C. I cause the plunger 12 to exert a pressure on the material 10 in the neighborhood of 600 lbs. per sq. in. I may, however, employ more or less pressure and the amount of pressure used will depend upon the porosity which I desire to achieve in the bond and wheel. With more pressure I get a denser wheel and with less pressure I get a more porous wheel. For certain types of grinding, I may wish a porous wheel. The material may be sintered at the temperature specified by pressure as low as 50 lbs. per sq. in. On the other hand, I may use a lower temperature to produce a more porous bond or with higher pressure to produce the same porosity. Thus the pressure employed may vary between wide limits and in certain cases I may use a pressure as high as 3000 lbs. per sq. in. Merely by way of example I note that for the production of a fairly dense and strong wheel using diamond grit size of 100 mesh and bond grit size of 200 mesh and a temperature of 1400° C., a pressure of 600 lbs. per sq. in. was employed.

Although I prefer to apply pressure and heat simultaneously, in certain cases I may attain excellent results applying them seriatim, the mixture being pressed first and heated afterwards. This is because the intimate contact for fusion sintering persists after the mixture is compacted. The heating, however, substantially changes the characteristics of the ultimate product.

I may remove the mold 1 as soon as the pressure is relieved and quench it in water. This will tend to make the bond more brittle. In such event the mold 1 is generally destroyed, but the loss is not great and the value of the resulting product is such that this need not be considered a vital factor. However, I may use the mold parts over and over again in case they are allowed to cool without quenching. For certain types of wheels I may prefer a somewhat softer bond.

Due to the extreme hardness and resistance to wear of the diamond when used as an abrasive compared with the commonly used types such as silicon carbide and aluminum oxide, it is desired to provide a bond of a sufficient strength and hardness to hold the individual particle until it becomes too dull for efficient cutting or abrading action. When that point is reached, however, and by means of the additional force applied to the particle when dull, it is desired that the particle should be either pulled out or re-oriented to present respectively a new particle or a new cutting point.

I, therefore, desire a bond which although brittle will under the grinding action maintain or develop a limited degree of ductility. A wheel made according to the foregoing disclosure is bonded with a bond of such characteristics, as found in actual practice, and furthermore is found to be tough and strong considered as a whole, and is free cutting and has excellent abrading characteristics. I believe the excellent results achieved by so constructing a wheel to be due to the intrinsic properties of the alloy used and also to the fact that it does not completely alloy. The alloy itself has a brittle characteristic while one of its ingredients, aluminum, has a ductile characteristic. Thus, although it is apparently impossible to have in a single substance both ductility and brittleness, unless considered relatively, I have achieved ductility and brittleness in my bond which may be due to the fact that it is not entirely homogeneous; nevertheless it is homogeneous enough to form an integral mass.

Although certain advantages inhere from the use of aluminum and silicon, it will be understood that the method of the invention involving the use of heat and pressure and the sintering of a bond in grain form may be used in connection with any other metal or metals having a fusion point at or below 1400° C. or thereabouts. While I have noted 40% aluminum and 60% silicon by weights, other proportions of these metals may be used, but I prefer to use a fairly large proportion of silicon. However, in the preferred embodiment of my invention it may be between 50% and 70%.

One marked advantage of a wheel constructed according to the invention lies in the fact that, when produced in annular form, it may be readily united to a central disk. Diamond grinding wheels are, under present market conditions, expensive, whatever the bond used, owing simply to the high price of bort, and accordingly it is highly desirable to waste as little of the diamond as is possible. In the case of any grinding wheel which is thin relative to its diameter, the central part will generally not be used. Accordingly, in the case of diamond wheels, it is preferred to form the central part in the form of a non-grinding disk or annulus. While a small internal grinding wheel, having a length on the order of half its diameter, may comprise 100% grinding substance and be attached by mounting directly upon a spindle, in the case of a cutting-off wheel, or a large sized wheel for the grinding of the cemented tungsten carbides and other hard substances, it is generally found economical to secure what amounts to an annular band of diamond grinding material to a central disk, having a hole therein. Therefore, a distinct problem has arisen in attaching the inside of the annular band of grinding substance to the periphery of the central supporting disk. If the union between the parts is weak, fracture will result and this destroys a grinding wheel which may have a market value in the neighborhood of from $50 to $200.

Although I have mentioned throughout diamond as the abrasive grit, certain advantages inhere in the combination of the bond specified with boron carbide grit. Boron carbide is an expensive abrasive grit, although not as expensive as diamond bort. Furthermore, boron carbide as well as diamond should be exposed for as short a time as possible to high temperatures on account of danger of oxidation and other chemical changes. Furthermore, in actual practice, the preferred bond of this invention has been found excellent in combination with boron carbide grit of a grain size of 100 mesh. The bond of the invention is more in the nature of a matrix than the common vitrified bond, and it is harder and tougher than the artificial resinous bonds, and has properties different from those of a rubber bond, and the properties of the bond of this invention are highly desirable in combination with grain of extreme hardness such as diamond and boron carbide on Moh's scale greater than 9 and harder than silicon carbide.

It will thus be seen that there has been provided by this invention a method and an article of manufacture or composition of matter in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments might be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:—

1. An abrasive body comprising diamond grain united with a bond comprising aluminum in the neighborhood of 40 parts and silicon in the neighborhood of 60 parts, the aluminum and the silicon being sintered together and not completely alloyed.

2. An abrasive body comprising diamond grain in a bond comprising silicon and aluminum.

3. An abrasive body comprising diamond grain in a bond comprising sintered aluminum and silicon, the silicon and aluminum being sintered together and not completely alloyed.

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