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DIAMOND GRINDING WHEEL


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4 Claims. (Cl. 51—309)

The invention relates to diamond grinding wheels.

One object of the invention is to provide a free cutting diamond grinding wheel which is nevertheless durable that is to say has a low rate of wheel wear. Another object of the invention is to provide a metal bonded diamond wheel of characteristics similar to vitrified bonded diamond wheels but of superior resistance to wear. Still another object of the invention is to provide a grinding wheel of superior characteristics for the grinding of the hard metal carbides, particularly for fixed feed grinding and fixed pressure grinding. Another object of the invention is to provide a superhard diamond wheel for less grinding. Another object of the invention is to provide a metal bonded diamond wheel of superior characteristics and of extremely uniform quality such that thousands of wheels can be made to a given formula and will be for all practical purposes substantially alike and a given wheel will grind when it is near the end of its life practically the same as it did when it was first used. Another object of the invention is to provide a grinding wheel of the characteristics indicated infrequently requiring dressing. Another object of the invention is to provide a superhard metal bonded diamond wheel for offhand grinding of single point carbide tips and tools. Another object is to provide a superhard diamond wheel for the continuous bevelling of glass on semi-automatic or automatic machines.

Other objects will be in part obvious or in part pointed out hereinafter.

As conducive to a clearer understanding of the present invention, it is pointed out that one of the greatest uses for diamond grinding wheels is for the grinding of the hard metal carbides, that is to say tungsten carbide, tantalum carbide, titanium carbide and mixtures thereof bonded with cobalt or other metals or any other hard carbides useful for the manufacture of tool tips, bits and cutters. Since most lathes and screw machines nowadays are equipped with carbide tipped tools the annual production of such carbide tips must be enormous. Herefore it was found that resinoid bonded diamond grinding wheels when used for large scale production of such carbide tips suffered excessive wheel wear so as to make the grinding cost unreasonably high. Then vitrified bonded diamond wheels were used for the large scale production of these carbide tips, bits and cutters with improved results. Such vitrified bonded diamond wheels are quite free cutting and they do not wear away as fast as the resinoid bonded diamond wheels but still industry has complaints about the grinding cost is high. It has been known for years that, in general, metal bonded diamond wheels grind with lower wheel wear, other things being equal. There has long been a demand for a grinding wheel that would combine the long life of the metal bond with the fast free cutting action of the vitrified bond. According to my invention consists of from 5.50% by volume diamonds to 27% by volume diamonds bonded with a sintered bronze ranging from, by weight, 87Cu 13Sn to 95Cu 5Sn, said sintered bronze containing between, by weight, 3% and 7% of iron oxide FeO to the total bronze, said sintered bronze containing FeO being having a Rockwell hardness on the F scale of between 70 and 85 and a modulus of rupture in cross bending between 30,000 and 45,000 pounds per square inch.

The diamonds, are, of course, in the form of small particles of any grit size desired. The grit sizes commonly used for grinding the hard metal carbides are from 100 grit size to 320 grit size inclusive. The grit sizes commonly used for grinding class are from 60 grit size to 400 grit size inclusive. The concentration of diamonds mentioned covers substantially the range of concentrations used at present and found to be most practical for grinding operations such as those indicated. This range of concentrations is given in the above statement as from 5.50% by volume diamonds to 27% by volume diamonds. The concentration of abrasive is always best expressed in volume percentage because it is the percent by volume which is significant and the percentage by weight is of no consequence per se.

The symbols Cu and Sn in the above statement are the chemical symbols for copper and tin. Bronze ranging between 87Cu 13Sn and 95Cu 5Sn is a soft and ductile bronze. For example, a prominent manufacturer has for years used for the bonding of diamonds a bronze which is, as nearly as can be achieved, 81.4Cu 18.6Sn. This is a friable bronze which is considerably harder than the bronze which I use in my invention. When this 81.4Cu 18.6Sn bronze is fired in gas which is known only by the trademark Endo gas the hardness on the Rockwell B scale ranges from 68 to 78. When this same 81.4Cu 18.6Sn bronze is fired in nitrogen the hardness on the Rockwell B scale ranges from 60 to 80. It is well known that the Rockwell F scale is for materials much softer than those measured on the Rockwell B scale and of course Rockwell F 85 is far softer than Rockwell B 60.

To achieve the composition above defined the firing atmosphere is important. I have found I can obtain the results by firing the composition in an atmosphere of nitrogen. I can say about the nitrogen atmosphere is it is fairly pure and contains less than 0.2% of oxygen. By comparison a typical analysis of Endo gas is 29.7H₂, 19.4CO, 1.8CH₄, 45.2N₂, 3.9CO₂. I desire that the bronze component of my bond shall contain not more than 1% by weight oxygen and this I can achieve by firing in a nitrogen atmosphere. Other atmospheres could be used to keep the oxygen content at not more than 1% of the bronze but the use of a nitrogen atmosphere may give other desirable qualities; at least I have had the best results sintering in nitrogen.

The copper and tin which I have used were of course in powder form and of high purity. The copper was electrolytic copper and the tin was atomized tin. Any impurity other than oxygen was probably only a small fraction of a percent in either case. However other compatible metals in very minor amount could be tolerated. FeO₄ is the chemical designation for magnetic iron oxide which is the black variety of iron oxide. I have used the C. P. product which is quite pure but the exact purity I do not know. Obviously insignificant amounts of the other iron oxides Fe₃O₄ and Fe₂O₃ could be tolerated and also minute proportions of other impurities whose nature and effect are not known. I need not describe the various shapes and mechanical features of diamond grinding wheels since there are many varieties which are now well known. I need not describe how to secure a diamond abrasive composition to a back, using an intermediate layer or not, as such matters are well known. I need not describe typical mold parts and acceptable molding procedures since this is also
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Metal bonded diamond wheels in all kinds of shapes have now been made and used for many years and many patents have issued thereon.

It is perhaps, however, important to point out that I have found good results can be achieved by pressing my diamond abrasive composition at a pressure of 35 tons per square inch. I do not believe it is necessary for me to give the permissible range of pressures as the important thing is to obtain the physical characteristics set forth and pressure at 35 tons per square inch will give the results indicated. Weighed amounts of the copper, tin and iron oxide powders are first screened as through a 14 mesh screen and then tumbled for approximately one hour. The mixture is again passed through the same screen to break up any agglomerates that may have formed and is finally tumbled for an additional two hours. Then the metal powder mixture is mixed with the required amount of diamonds and the mixing is done by hand with a spatula. After this the complete diamond abrasive mixture is pressed for example at 35 tons per square inch and later on the "green" article (pressed wheel) is fired for approximately five hours at 600°C in an atmosphere of dry oil pumped nitrogen which does not seriously change the ratio of oxide to metal phase. The rise during furnacing is preferably at a rate of about 35°C per hour. The foregoing directions are to be considered as purely illustrative since it is possible that my composition could be made in many other ways. However so far as certain features of the invention are concerned, the firing in nitrogen is important.

The resulting diamond abrasive composition is much freer cutting than the other diamond bronze compositions mentioned herein and will grind the hard carbides with greater economy of diamond than the vitrified bonded diamond abrasive compositions and with far greater economy of diamond than the resinoid bonded diamond abrasive compositions. My composition is weaker than the above mentioned diamond bronze compositions. For example the above mentioned 81.4Cu 18.6Sn bronze composition sintered in Endo gas has a modulus of rupture between 60,000 and 75,000 pounds per square inch while the same bronze composition sintered in nitrogen has a modulus of rupture between 41,000 and 57,000 pounds per square inch. However it will be seen that I have achieved a strength which overlaps that of the aforesaid old bronze composition fired in nitrogen. It will be remembered that both the aforesaid bronze compositions were brittle bronze compositions whereas mine is a soft bronze composition.

The best embodiment of the invention that I am aware of is where the percentage of copper is 90%, the percentage of tin is 10% (these percentages being by weight and defining the bronze per se without the diamonds or the iron oxide) and the percentage of iron oxide is 5% on the total bronze. With this preferred composition I get a Rockwell hardness on the F scale between 72 and 82 and a modulus of rupture between 34,000 and 44,000 pounds per square inch. In giving my formula I have first given the formula of the bronze and then given the amount of iron oxide as a percentage of the weight of the bronze as this is much more logical and calculations are easier to make in this manner. For example the ratio of copper to tin determines the characteristics of the bronze per se, other things being equal, and the percentage of iron oxide FeO on the total bronze determines how much the properties of the bronze are modified. The controlling factor about the diamonds is they should be present in volume percentage within commercial limits, however in the particular way I have stated my formula is the correct one for this art.

The reason for the alloy limits on the bronze is because within these limits the bronze is soft enough to be free cutting and to give the desired results in carbide and glass grinding. I have found that if more than 7% of iron oxide is added a weak and soft composition results which is not satisfactory for grinding carbides and glass. I have found that with less than 3% of iron oxide the abrasive composition is not sufficiently free cutting, that is to say an insufficient amount of material being ground would be removed in a given time. The limits 3% to 7% of iron oxide are therefore quite critical.

Diamond grinding wheels the abrasive portion of which has the composition according to this invention have now been found to be superior to many others for the types of grinding mentioned in the foregoing objects especially for grinding of the cemented carbides. In one type of grinding operation for making lenses, instead of there being a mere line contact between the grinding wheel and the work piece, the contact is over a considerable area, say several square inches. Thus the grinding wheel may have an abrasive surface which is a partial sphere and this abrasive surface may be pressed against a lens blank to cover the whole area of the lens blank and eventually the lens blank mates with the abrasive surface. Owing to lack of the usual clearance this is a very difficult grinding operation and few diamond abrasive compositions have given sufficiently satisfactory results. Lenses of course have been made but it was customary to separate wheel and work frequently to dress the surface of the wheel. Now, using lens grinding wheels having the abrasive composition according to the present invention, less dressing of the wheel is required, production has increased and my composition has been found to be superior to all others for this purpose.

It will thus be seen that there has been provided by this invention a diamond abrasive composition in which the various objects hereinbefore set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes may be made in the embodiment above set forth, it is to be understood that all matter heretofore set forth is to be interpreted as illustrative and not in a limiting sense.

I claim: 1. A diamond abrasive composition for a grinding wheel and the like which essentially consists of from 5.50% by volume diamonds to 27% by volume diamonds bonded with a sintered bronze ranging from copper, by weight, 87Cu 13Sn to 95Cu 5Sn, said sintered bronze containing between, by weight, 3% and 7% of iron oxide FeO on the total bronze, said sintered bronze containing FeO on the total bronze, having a Rockwell hardness on the F scale of between 70 and 85 and a modulus of rupture between 30,000 and 45,000 pounds per square inch.

2. A diamond abrasive composition as claimed in claim 1 in which the bronze component has not more than one percent by weight of oxygen.

3. A diamond abrasive composition as claimed in claim 1 in which the sintered bronze contains substantially 5% by weight of iron oxide FeO on the total bronze.

4. A diamond abrasive composition as claimed in claim 3 in which the bronze component has not more than one percent by weight of oxygen.

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