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METHOD OF MAKING A COMPOSITION OF MATTER

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This invention relates generally to a method of making a composition of matter having cutting or abrading characteristics. Such compositions are suitable for making cutting or abrading tools, such as bits, milling cutters, shapers, drills and the like. They are also suitable for making dies, particularly dies for drawing wire.

The present application is a continuation in part of my copending application Serial No. 301,692, filed August 23, 1928.

It has been proposed heretofore to make compositions having cutting or abrading properties by mechanically mixing a finely divided cutting agent, such as tungsten carbide, with a finely divided binding agent, such as cobalt. These materials after being mixed are pressed into shape and are then heated, in order to sinter or fuse the binding agent without, however, melting the cutting agent. This forms a composition in which the particles of cutting agent are embedded in a matrix of binding metal.

It has been found that there is some difficulty in obtaining a homogeneous mixture of a finely divided cutting agent and binding agent when both the cutting agent and binding agent are in powdered form. This difficulty is increased when large percentages of cutting agent are mixed with small percentages of binding agent. For example, in cases where, say, 99.5% of cutting agent is to be used with about 0.5% of binding agent, it is very difficult to obtain an even distribution of the binding agent throughout the mass of cutting agent particles, by mechanically mixing the materials in powdered form. Another objection to mixing the cutting agent and binding agent while both materials are in powdered form is that a cutting agent, such as tungsten carbide, is much heavier than a binding agent, such as cobalt, which results, after mixing, in the tungsten carbide, settling to the bottom. If a homogeneous mixture of cutting agent and binding agent is not provided, the article resulting from sintering the mixture of cutting agent and binding agent is not homogeneous and does not perform its function as efficiently as an entirely homogeneous body.

In order to provide a homogeneous body of a mixture of cutting agent and binding agent, I coat the particles of cutting agent with a metallic binding agent, such as cobalt. The particles of cutting agent having a metallic coating of cobalt thereon are pressed into a mass which will retain its shape and the mass is then heated in a furnace so as to sinter the binding agent without, however, melting the cutting agent. This results in an article in which the particles of cutting agent are embedded in a matrix of binding agent, and in which the binding agent is evenly distributed throughout the mass, so as to provide a homogeneous product.

As cutting agents, I include hard materials, such as tungsten carbide, silicon carbide, chromium carbide or any material which has cutting or abrasive characteristics. The binding metals which are used to coat the particles of cutting agent include cobalt, copper, nickel, iron or other suitable metal or alloy. The binding agent may be composed of mixtures or alloys of any of these metals. The binding agent particles may be coated with two or more layers of the same or different binding agents. Although any of these cutting agents or binding agents may be used, depending upon the characteristics desired in the finished article, I have found that for most purposes I prefer to use tungsten carbide as the cutting agent and cobalt as the binding agent. The percentages of cutting agent and binding agent will vary according to the materials used as cutting agents and binding agents, and also according to the uses of the article.

I will describe in detail the method which I prefer to employ when tungsten carbide is used as the cutting agent and cobalt is used as the binding agent. It is to be understood that the percentages of materials and the steps of the process may be varied, particularly if other materials are used. Tungsten carbide is ground to a finely divided condition, preferably to a fineness such that it will pass through a screen having three hundred and twenty-five meshes per inch. The fineness to which the tungsten carbide is ground will depend upon the article to be made and is not limited to the degree of fineness above set forth.

The finely divided tungsten carbide particles are then coated with cobalt. I have found it advantageous to coat the particles by electro-depositing metallic cobalt thereon from a cobalt solution. I may use a solution of cobalt sulphate, cobalt ammonium sulphate or cobalt chloride, preferably cobalt ammonium sulphate. The tungsten carbide particles are placed on a nickel plate which forms the cathode, and metallic cobalt is used as the anode. The cobalt plating may be carried out to such an extent that the cobalt constitutes from an effective amount up to about 50% of the total weight of the tungsten carbide. The preferred proportions are from about 3½% to 13% of cobalt, and from 87% to about 96½% of tungsten carbide.

After washing free from salts and drying the tungsten carbide, having each of its particles coated with cobalt, is then pressed in a die and subjected to pressure while cold. The pressure may be from 1000 to 300,000 pounds per square inch. This compacting of the material enables the mass to be removed from the mold and transferred to a furnace. The mass is given a first sintering at a temperature of about 1800° F. During the sintering the furnace is maintained under neutral or reducing conditions by the introduction of a gas, such, for example, as hydrogen, in order to prevent oxidation of the material. After the material has been allowed to cool in the furnace, it is removed and in this condition it can be ground, sawed, filed or otherwise worked to the desired finished shape. This first sintering does not entirely melt the cobalt, but simply provides a mass which is sufficiently strong to be ground or sawed into the desired shaped article.

The article which has been ground to substantially finished shape is again placed in the furnace and subjected to a second sintering operation, again under non-oxidizing conditions, at a temperature of about 2650° F. The article is allowed to cool in the furnace and after removal therefrom, it may be used for the purposes hereinbefore described. The second sintering step results in an article which is very difficult to grind or otherwise shape. For this reason, it is preferred to carry out the sintering in two steps, rather than in a single operation.

Instead of first pressing the coated particles to shape and then sintering, the loose coated particles may be placed in a mold and sintered. Pressure may be used to compress the particles either before, during, or after sintering, or it may be used both before and either during or after the sintering step. I prefer, however, to press the coated particles to shape while cold, and then sinter without applying pressure.

I have described the use of tungsten carbide as the preferred cutting agent and cobalt as the preferred binding agent. However, other cutting agents or a mixture of cutting agents may be used with other metallic binding agents, or a mixture or alloy of other metallic binding agents.

In my process the metal which is used to coat the particles of cutting agent binds the particles of cutting agent together when the mixture is sintered. The sintering temperature is such that it fuses or melts the coating metal but does not melt the cutting agent. The fused or melted binding metal itself forms the matrix in which the particles of cutting agent are embedded.

My process is distinguished from a process in which particles of cutting agent are first coated with a metal and then the coated particles are mixed with molten metal having a low melting point, as compared with the melting point of the coating metal. In such cases, the binding agent is generally a metal, such as zinc, which has a very low melting point and which cannot be employed satisfactorily where the article gets very hot when in use. My invention contemplates the use of binding metals having relatively high melting points, so that even if the tool becomes highly heated when in use, the binding metal will not be melted but will firmly hold the particles of cutting agent. A composition in which cobalt is used as the binding agent is suitable for many uses where a composition containing zinc or other low melting point metal could not be used. This is true because cobalt has a relatively high melting point, about 2690° F.

Throughout the foregoing description where I have referred to tungsten carbide, I preferably utilize a carbide having approximately 6% of carbon combined with the tungsten. I have found that other carbides of tungsten produce compositions of materially different characteristics.

I have described the present preferred manner of practicing my process. It will be understood, however, that the invention may be otherwise practiced within the scope of the following claims.

I claim as my invention:

1. The method of making compositions of matter having cutting or abrading characteristics, comprising coating finely divided particles of tungsten carbide with metallic cobalt by electrodepositing the cobalt thereon, and sintering the coated particles under non-oxiding conditions at a temperature sufficient to melt the cobalt but not the tungsten carbide.

2. The method of making compositions of matter having cutting or abrading characteristics, comprising coating finely divided

particles of tungsten carbide with 3½ to 13% of cobalt by electrodepositing the cobalt thereon, and sintering the coated particles at a temperature sufficient to melt the cobalt but not the tungsten carbide.

3. The method of making compositions of matter having cutting or abrading characteristics, comprising coating finely divided particles of cutting agent with cobalt by electrodepositing metallic cobalt from a cobalt solution on the particles, and sintering the coated particles at a temperature sufficient to melt the cobalt but not the cutting agent.

4. The method of making compositions of matter having cutting or abrading characteristics, comprising coating finely divided particles of tungsten carbide with cobalt by electrodepositing metallic cobalt from a cobalt solution on the particles to provide a coating constituting from 3½ to 13% of the weight of the coated particles, and sintering the coated particles under non-oxidizing conditions at a temperature sufficient to melt the cobalt but not the tungsten carbide.

5. The method of making compositions of matter having cutting or abrading characteristics, comprising electrodepositing binding metal of the group including cobalt, copper, nickel or iron, on finely divided particles of tungsten carbide to coat the particles with binding metal, compressing the coated particles, and sintering at a temperature sufficient to melt the binding metal but not the tungsten carbide.

In testimony whereof I have hereunto set my hand.

ELMER B. WELCH.