

May 23, 1933.

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1,910,884

METHOD OF MAKING HARD METAL COMPOSITIONS

Filed Nov. 14, 1931

Fig. 1.

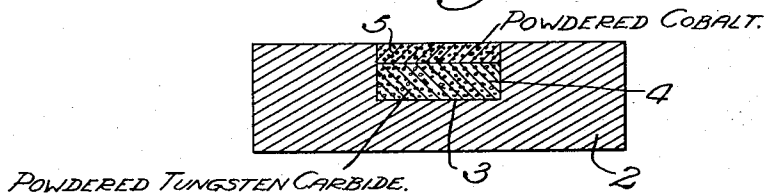


Fig. 2.

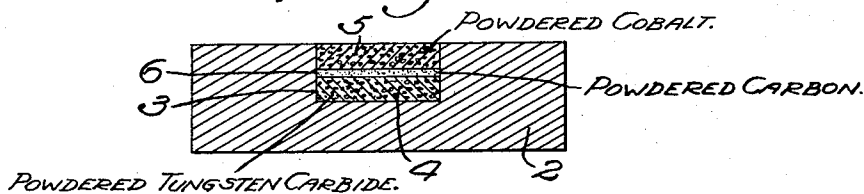


Fig. 3.

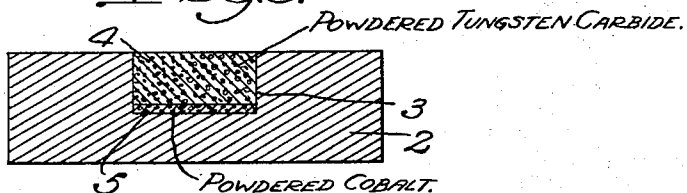
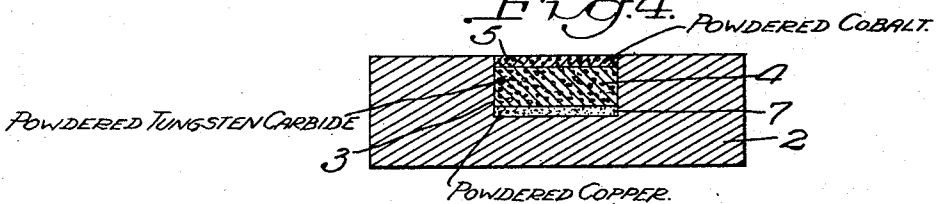


Fig. 4.



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METHOD OF MAKING HARD METAL COMPOSITIONS

Application filed November 14, 1931. Serial No. 574,991.

This invention relates to a method of making hard metal compositions of a type suitable for cutting and forming tools, dies and the like.

5 In the accompanying drawing, there is shown for purposes of illustration, and not by way of limiting the invention thereto, several ways in which the invention may be practiced. In the drawing, Figures 1, 2, 3 and 4 are cross-sectional views through a mold showing various arrangements of the layers of bonding metal and hard abrasive particles, the particles of materials constituting the different layers being shown on an enlarged scale. The drawing illustrates the layers before they have been heated to melt the bonding metal in order to form the hard metal composition.

20 Hard metal compositions of the general type contemplated by this invention are now made by a sintering process. In the sintering process, as now practiced, it is customary to grind a mixture of a hard abrasive material such as tungsten carbide with a bonding metal such as cobalt, in order to coat the individual particles of tungsten carbide with pellicles of cobalt. This mixture is then compressed into a billet or other desired shape and the billet composed of a mixture of tungsten carbide and cobalt is sintered, the sintering usually being carried out under reducing conditions. Although the mixture is compacted before sintering, there are interstices between the particles, some being of capillary size and others being larger. When the compressed mixture of tungsten carbide and cobalt is heated to a sintering temperature, the cobalt melts and forms pools of molten cobalt in the larger interstices. The cobalt is distributed throughout the mass by the capillary action drawing the cobalt through the capillary passages between the particles. In order to obtain a satisfactory bonding of the tungsten carbide particles in the usual sintering process as just described, it is necessary that the bonding metal be of a character such as to wet the capillary passages and thereby be distributed throughout the mass. If the bonding metal is not of such character that it wets the capillary passage between the par-

ticles of tungsten carbide, satisfactory bonding of the tungsten carbide particles is not accomplished.

It is an object of the present invention to provide a method whereby hard metal compositions may be made from a hard abrasive material in finely divided condition and a bonding metal also in finely divided condition without the necessity of grinding a mixture of the hard abrasive particles and bonding metal. It is also an object of the present invention to provide a process wherein the bonding action of the bonding metal is not dependent upon the wetting of the walls of the capillaries formed between the hard abrasive particles.

The present invention, not being dependent upon wetting of the walls of the capillaries, enables me to use other bonding metals which do not produce satisfactory bonding in the usual sintering processes.

In practicing the present invention, hard abrasive material is ground to a finely divided condition and without any addition of bonding metal, is placed in a graphite or other suitable mold and a separate layer of bonding metal is placed in the mold either on top of, below, or both on top of and below the layer of hard abrasive. The mold containing the layers of hard abrasive material and bonding metal is heated in a furnace, preferably having a reducing or neutral atmosphere, to a temperature sufficient to melt the bonding metal but not abrasive. The temperature may be between 2400 and 3000° F. depending upon the abrasive and bonding metal used. In case the bonding metal has been placed in a layer above the layer of hard abrasive particles, the bonding metal, upon melting, flows downward by gravity into the interstices between the particles of hard abrasive material. In case the bonding metal is placed in a layer below the layer of hard abrasive particles, the bonding metal, after melting, is drawn by capillary action into the interstices between the particles of hard abrasive material, and in either case, the bonding metal acts to bond the particles of hard abrasive material together when the composition is cooled. If the layer of bonding metal is placed below

the layer of hard abrasive material, only such bonding metal can be used as has the capacity for wetting the capillaries formed between the particles of hard abrasive material.

5 One particular manner of carrying out the process will be described in connection with Figure 1 of the accompanying drawing which shows a graphite mold 2 having a molding cavity 3 formed therein. The molding cavity is approximately the shape of the article to be formed, but is larger than the article to allow for shrinkage. Finely divided tungsten carbide, either in the form of loose powder or previously compacted is placed in the mold to form a layer 4. On top of this layer of tungsten carbide is placed a separate layer 5 of cobalt which may be either in powdered form or in the form of a compacted body of powdered cobalt, or in the form of metallic cobalt which has been cast and cut to the desired shape. The cobalt is preferably in the form of a compacted body of powdered cobalt, since the compacting lowers its melting point. The tungsten carbide also preferably is compacted as this increases the capillary action and thus facilitates dispersion of the cobalt throughout the mass. A pressure of about 10,000 pounds per square inch has been found suitable for compacting, although this may be varied somewhat to suit particular conditions. The mold containing the superimposed layers is placed in a furnace and heated to a temperature sufficient to melt the layer of cobalt, the heating preferably being carried out under reducing conditions. When the cobalt has melted, it flows by gravity into the interstices formed in the layer 4 of tungsten carbide, filling the interstices so that when the mold is cooled and the composition removed, the cobalt firmly binds the particles of tungsten carbide together.

In illustrating the manner in which the method may be carried out, I have selected tungsten carbide as the hard abrasive material and cobalt as the bonding metal. It will be understood that other hard abrasive material may be used in place of the tungsten carbide. Other examples of hard abrasive material which may be mentioned are the carbides of chromium, molybdenum, vanadium, titanium, tantalum, zirconium, thorium, and uranium. Silicides of these metals or of other metals which have hard abrasive characteristics might also be employed. The invention is applicable irrespective of the particular hard abrasive material which is used. As illustrative of other bonding metals which might be used, I may mention nickel, iron, and copper. More than one hard abrasive material and more than one bonding metal may be used, if desired. Any suitable hard abrasive material, or mixtures of such materials, and any suitable bonding metal, or mixture of bonding metals, may be used according to the method which has just

been described or according to the other methods hereinafter described.

In Figure 2, there is illustrated a modified method in which the layer 4 of hard abrasive material is separated from the layer 5 of bonding metal by a layer 6 of a melting point depressant such as powdered carbon, which lowers the melting point of the bonding metal. In any of the methods described herein, it is preferred to use the bonding metal in the form of a compressed body of finely divided particles, since the pressure imparted to the body enables it to be melted at a lower temperature than would be the case otherwise.

In the method illustrated in Figure 3, the layer 5 of bonding metal is placed below the layer 4 of hard abrasive material. When the layers are so arranged, it is necessary that the bonding material which is selected have the capacity to wet the capillaries formed in the compacted body 4 in order that the bonding metal may be dispersed throughout the mass.

In Figure 4, there is illustrated a method in which a layer 4 of hard abrasive particles has a layer 5 of bonding metal superimposed thereon and a layer 7 of a different bonding material placed in the bottom of the mold. It is sometimes desirable to use two different types of bonding metal. For example, in the formation of a cutting tip, it is desirable to provide a tip, the top portion of which has good cutting properties while the bottom portion is of such character that it may be welded or otherwise secured to the tool holder. The lower layer 7 of bonding metal might be composed of copper, while the upper layer 5 might be composed of cobalt. The hard abrasive particles bonded by cobalt have good cutting characteristics, whereas the lower portion of the cutting tip, which, due to the capillary action, would be bonded by copper, is of such composition that it can be satisfactorily welded to a tool holder.

In practicing the present invention, wherein the hard abrasive material and the bonding metal form separate layers, it is not necessary to grind a mixture of the abrasive material and bonding metal. This results in economy in the process of forming the hard metal composition. Furthermore, in the preferred method wherein the bonding metal is introduced into the hard abrasive body by placing a layer of bonding metal on top of the abrasive material in a mold and then melting the bonding metal, the introduction of the bonding material does not depend upon capillary action, and for this reason any suitable binding metal may be employed.

I have illustrated and described several methods of carrying out the process and have selected for purposes of illustration certain hard abrasive materials and certain bonding metals. It is to be understood, however, that other abrasive materials and other bonding

metals may be employed and that the invention may be otherwise practiced within the scope of the following claims.

I claim:

5 1. The method of making hard metal compositions, comprising forming separate layers of a compacted body of hard abrasive particles having interstices between the particles, and a compacted body of bonding metal particles, and heating the layers to a temperature sufficient to melt the bonding metal but not the abrasive and cause the bonding metal to flow into the interstices in order to bond the hard abrasive particles upon cooling the composition.

15 2. The method of making hard metal compositions, comprising superimposing a separate layer of powdered bonding metal on a compacted body of hard abrasive particles in a mold, said compacted body having interstices between the particles, and heating the mold and contents to a temperature sufficient to melt the bonding metal but not the abrasive and cause the bonding metal to flow into the interstices in order to bond the hard abrasive particles upon cooling the composition.

25 3. The method of making hard metal compositions, comprising superimposing a separate layer of powdered and compacted bonding metal on a compacted body of hard abrasive particles in a mold, said compacted body having interstices between the particles, and heating the mold and contents to a temperature sufficient to melt the bonding metal but not the abrasive and cause the bonding metal to flow into the interstices in order to bond the hard abrasive particles upon cooling the composition.

30 4. The method of making hard metal compositions, comprising forming a body containing a layer of hard abrasive particles having interstices between the particles, a layer of bonding metal, and carbon between the layers of hard abrasive particles and bonding metal, and heating the body to a temperature sufficient to melt the bonding metal but not the abrasive and cause the bonding metal to flow into the interstices in order to bond the hard abrasive particles upon cooling the composition.

40 5. The method of making hard metal compositions, comprising forming separate layers of a compacted body of finely divided tungsten carbide particles having interstices between the particles, and a bonding metal in powdered form, and heating the layers to a temperature sufficient to melt the bonding metal but not the tungsten carbide and cause the bonding metal to flow into the interstices in order to bond the tungsten carbide particles upon cooling the composition.

50 6. The method of making hard metal compositions, comprising forming separate layers of a compacted body of finely divided tungsten carbide particles having interstices be-

tween the particles, and a compacted body of bonding metal particles, and heating the layers to a temperature sufficient to melt the bonding metal but not the tungsten carbide and cause the bonding metal to flow into the interstices in order to bond the tungsten carbide particles upon cooling the composition.

70 7. The method of making hard metal compositions, comprising forming separate layers of a compacted body of finely divided tungsten carbide particles having interstices between the particles, and cobalt, and heating the layers to a temperature sufficient to melt the cobalt but not the tungsten carbide and cause the cobalt to flow into the interstices, in order to bond the tungsten carbide particles upon cooling the composition.

75 8. The method of making hard metal compositions, comprising forming separate layers of a compacted body of finely divided tungsten carbide particles having interstices between the particles, and finely divided cobalt, and heating the layers to a temperature sufficient to melt the cobalt but not the tungsten carbide and cause the cobalt to flow into the interstices, in order to bond the tungsten carbide particles upon cooling the composition.

80 9. The method of making hard metal compositions, comprising forming separate layers of a compacted body of finely divided tungsten carbide particles having interstices between the particles, and a compacted body of finely divided cobalt, and heating the layers to a temperature sufficient to melt the cobalt but not the tungsten carbide and cause the cobalt to flow into the interstices, in order to bond the tungsten carbide particles upon cooling the composition.

85 10. The method of making hard metal compositions, comprising forming a body containing a compacted layer of hard abrasive particles having interstices between the particles, a compacted layer of bonding metal, and a carbon layer between the layers of hard abrasive particles and bonding metal, and heating the body to a temperature sufficient to melt the bonding metal but not the abrasive and cause the bonding metal to flow into the interstices in order to bond the hard abrasive particles upon cooling the composition.

110 In testimony whereof I have hereunto set my hand.

GREGORY J. COMSTOCK.

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