Patented Apr. 5, 1938 2,113,171

UNITED STATES PATENT OFFICE

2,113,171

CARBIDE MATERIAL

Hugh S. Cooper, Cleveland Heights, Ohio, assignor to Cooper Products, Inc., Cleveland, Ohio, a corporation of Ohio

No Drawing. Application April 8, 1936, Serial No. 73,344

9 Claims. (Cl. 75—136)

The present invention relates to a hard carbide material, especially a hard tungsten carbide material, suitable for cutting tools, wire drawing dies, and the like, and to a method of producing the same.

Tungsten carbide is known to exist in two forms having the formulae, respectively, of WC and W_2C. Of these two the first, WC, which has a theoretical carbon content of 6.12%, has the greater hardness and suitability as a cutting tool and die material. This form of tungsten carbide requires a bonding agent as it will not sinter together into a sufficiently strong body when heated in pure form. Even when brought to fusion it produces a porous and rather weak and brittle mass. Heretofore the preferred bonding material has been cobalt added in sufficient quantity to form 8% to 12% of the final product by weight.

I have discovered that if the carbon content is reduced to about 5.5% the resulting material has novel and unpredictable self-bonding qualities, and in addition it has great hardness and strength suitable for die and cutting tool material. With a carbon content of 5.5%, the material must necessarily consist of a mixture or compound of WC and W, or WC and W_2C, or all three. So far I have not determined which of these three possible forms the material actually takes, although an examination of it by X-ray spectroscopy favors the theory that it consists of a mixture of WC and W and that the excess tungsten acts as the binder and sinters the material together. Irrespective of which of the possible forms the final product takes, I have found that it has the desirable properties of good bonding, great strength, and great hardness.

The preferred process of producing the material of the present invention comprises intimately mixing together very finely powdered tungsten, and very finely powdered carbon, usually as lamp-black, in such proportion that the carbon forms approximately 5.5% of the total by weight. To insure thorough blending, this mixture may be ball milled for about forty-eight hours. The resulting powder is then heated in a hydrogen atmosphere furnace for thirty to forty-five minutes at about 1200° C. to 1600° C., preferably 1400° C. For this purpose it is preferably packed in a graphite cylinder which is perforated or loosely stoppered to permit the ready diffusion of gas. When a graphite cylinder is used, as suggested, the powder picks up some carbon from the graphite during the heating, and to compensate for this, the amount of carbon actually put into the mixture in this case is less than that desired in the final product. This adjustment of carbon content varies with the particular dimensions of equipment employed and the exact relation between the original and the final carbon content has to be determined by trial.

After the powder has cooled it is rubbed in a mortar and is then ready to be pressed in a suitable die into the final form of die or tool required. A pressure of fifteen tons per square inch of pressing surface of the die used is usually satisfactory. After pressing, the shaped pieces are placed on a tungsten carbide slab in a graphite cylinder and heated in a carbon tube resistor furnace for about thirty minutes at about 2200° C. to 2400° C., preferably 2300° C. Pieces treated in this way are then ready for use after suitable grinding and polishing to the exact size required.

Material made in the manner just described has a fine silky fracture and great strength and hardness. The modulus of transverse rupture is about one hundred thousand pounds per square inch, and the hardness is from 1400 to 1800 Brinell, as determined with a diamond point impressor.

The carbon content is quite critical and may not vary more than .25% from the preferred content of 5.5%. In fact if it is reduced by as little as say .15% (to 5.35%) the strength may drop to one-half or less, and the hardness may drop below 1000. Increasing the carbon content by the same amount (to 5.65%) has a similar effect and, in addition, in the final heating the material may puff up and form blisters, and be entirely unsuitable for use. Although variations of the carbon content within the limits aforesaid produce material suitable for certain purposes, the most satisfactory tool and die material is obtained when the carbon content is not varied widely from the preferred content of 5.5%. To the best of my knowledge this cementing action of W_2C or pure W (as the case may be), has never before been observed or reported, nor the critical relation of the strength and hardness of the self-bonded product with its exact carbon content.

Having thus described my invention, I claim:

1. The process of making a hard sintered tungsten carbide material which comprises pressing a powdered substance containing from 5.35% to 5.65% carbon and the balance substantially tungsten into a desired shape, and subsequently sintering the same at approximately 2300° C.

2. The process of making a hard sintered tungsten carbide material which consists in heating

a powdered substance containing approximately 5.5% carbon and approximately 94.5% tungsten in a hydrogen atmosphere at approximately 1400° C., pressing the resulting material into a desired shape, and subsequently sintering the pressed material at approximately 2300° C.

3. The process of making a hard sintered tungsten carbide material which comprises forming a tungsten carbide material containing from 5.25% to 5.75% carbon and the remainder substantially tungsten, pressing the same to a desired shape, and subsequently sintering the pressed material at approximately 2200° C. to 2400° C.

4. The process of making a hard sintered tungsten carbide material which comprises forming a tungsten carbide material containing from 5.25% to 5.75% carbon and the remainder substantially tungsten, pressing the same to a desired shape, and subsequently sintering the pressed material out of contact with free carbon at a temperature of from 2200° C. to 2400° C.

5. The process of making a hard sintered tungsten carbide material which comprises forming a tungsten carbide material containing approximately 5.5% carbon and approximately 94.5% tungsten, pressing the same to a desired shape, and subsequently sintering the pressed material at approximately 2300° C.

6. The process of making a hard sintered tungsten carbide material which comprises forming a tungsten carbide material containing approximately 5.5% carbon and approximately 94.5% tungsten, pressing the same to a desired shape and subsequently sintering the pressed material out of contact with free carbon at approximately 2300° C.

7. The process of making a hard sintered tungsten carbide material which comprises forming a tungsten carbide material containing approximately 5.5% carbon and approximately 94.5% tungsten, pressing the same to a desired shape, and subsequently sintering the pressed material on a tungsten carbide slab at approximately 2300° C.

8. A self-bonded hard sintered tungsten carbide material containing from 5.35% to 5.65% carbon and the remainder substantially tungsten produced by pressing a simple tungsten carbide material comprising from 5.35% to 5.65% carbon and the remainder substantially tungsten into a desired shape, and subsequently sintering the same out of contact with free carbon at approximately 2200° C. to 2400° C.

9. A self-bonded hard sintered tungsten carbide material containing approximately 5.5% carbon and the remainder substantially tungsten produced by pressing a simple tungsten carbide material comprising 5.5% carbon into a desired shape, and subsequently sintering the same out of contact with free carbon at approximately 2300° C.

HUGH S. COOPER.