

OR 2,051,972

Patented Aug. 25, 1936

2,051,972

UNITED STATES PATENT OFFICE

2,051,972

PROCESS OF PRODUCING SINTERED HARD METAL ALLOYS

Kjell Magnus Tigerschiöld, Stockholm, and
Karl Bonthron, Fagersta, SwedenNo Drawing. Application June 25, 1935, Serial
No. 28,372. In Sweden July 5, 1934

12 Claims. (Cl. 75-137)

In modern industry the sintered hard metals acquire a still increasing importance. In general, the said hard metal alloys are produced by mixing one or more hard compounds of elements, which belong to the third, fourth, fifth or sixth group of the periodical system, possibly together with one or more of these elements themselves, in a finely pulverized state with one or more auxiliary metals, such as cobalt, nickel and iron, which are also in a finely pulverized state, and pressing the intimate mixture obtained in this way to regular form pieces. From the said form pieces objects of desired shapes are produced after heating in a reducing or neutral atmosphere up to about 900° C., the said objects being then sintered at a higher temperature, over about 1300° C., by which they receive their final shape and hardness.

It is known, too, to add the auxiliary metal in the form of an organic compound such as acetate, oxalate or the like and also in the form of an oxide. The mixing operation is preferably carried out by grinding. After that the material is heated in a reducing atmosphere to such a temperature that a reduction of the above mentioned metal compound takes place, after which a pressing operation, a pre-sintering at 900° C. a treatment with material removing tools, and finally, sintering at a temperature over about 1300° C. are carried out. The adding of auxiliary metal in a non-metallic state has the following advantages, which appear most sharply when using an inorganic compound, such as an oxide or carbonate of the auxiliary metal, which compound may be decomposed by means of gas into metal and a gaseous product of reaction.

In the first place, as to the mixing, which in most cases is carried out by grinding, it has proved, that, when the auxiliary metal is added in the form of a metal, the individual grains will be forged together to larger tinsels or aggregations of grains during the grinding, by which the homogeneity of the mixture and thereby the quality of the produced hard metal will be reduced. If, however, the auxiliary metal is added in the form of an inorganic compound the said difficulties will be completely avoided, for the mixing (grinding) may be extended for very long periods without inconvenience because the auxiliary metal compound cannot be forged and is brittle.

In pressing the initial material to form pieces it has heretofore been difficult to avoid cracks due to the pressing even if special precautions have been taken to overcome the said difficulties, such as the addition of certain organic substances

acting as lubricants at the pressing. If, however, form pieces are pressed according to the invention from the initial material containing the auxiliary metal compound no cracks will form on account of the pressing, even if no special precautions are taken at the pressing. Consequently, the invention provides a very considerable reduction in the percentage of refused material in the production of sintered hard metal alloys.

The invention provides, however, also other economical advantages, for it has proved that the tear and wear of the tools used for working the pressed form pieces, becomes very considerable, in case said pieces are subjected to the heretofore ordinary heating up to about 900° C. to be brought in a workable form. The pressed form pieces produced according to the invention distinguish themselves by very good workability without being subjected to any special treatment, and the tear and wear of the tools used at the working will be very slight on account of the consistency of the pressed form pieces, which is suitable for the working.

In comparison with the processes used heretofore the invention provides further economical advantages, too, inasmuch as the decomposition of the auxiliary metal compound may be carried out simultaneously with the sintering operation, and the heating in a reducing atmosphere, which is required to convert the pressed form pieces into a workable state, may be completely dispensed with.

The process in question may be used for producing all kinds of sintered hard metal alloys. It has proved especially important in the manufacture of sintered hard metal alloys for working of tenacious materials of average hardness. The inventors have found that sintered hard metal alloys for this purpose do not become tenacious enough, if they are produced in the manner generally used heretofore, especially, if in addition to tungsten carbide the alloys contain one or more of the following carbides, viz. molybdenum, niobium, tantalum and titanium carbide, which for the treatment of tenacious materials have a crystal structure, which with regard to friction is more suitable than that of tungsten carbide.

If, however, the said alloys are produced according to the invention a hard metal is obtained, which in the first place is qualitatively superior as to tenacity and which is specially good for treating the above mentioned tenacious materials.

The inventors have found it suitable to convert the carbides into mixed crystals or double

carbides, before the auxiliary metal compound is added. Preferably 5 to 25% of titanium carbide are contained in the mixture, which carbide, however, may wholly or partly be replaced by carbides of other substances, which also belong to the fourth group of the periodical system, such as thorium, silicium and especially zirconium. In addition hereto up to 10% of the tungsten carbide without inconvenience may be replaced by molybdenum carbide. If tantalum and niobium carbide are used the ratio between the tantalum carbide and the niobium carbide should lie between the limits 10:1 and 1:4.

In producing the said carbides it is difficult to avoid the formation of nitrides. Therefore, as a rule, a product is obtained, which in addition to carbide contains also a small quantity of nitrides. The inventors, however, have found that in the invention in question a product of the kind mentioned containing nitrides may be used very well instead of the pure carbides.

The best results are reached if the initial mixture contains 5 to 25% of titanium carbide (zirconium carbide), possibly together with 1 to 25% tantalum and niobium carbide, preferably, however, only 2 to 4%, and up to 30% of inorganic compounds of one or more auxiliary metals melting at a lower temperature, preferably, however, below 10%, the remainder being substantially tungsten carbide. In this case the carbides are preferably contained in the mixture in the form of mixed crystals or double carbides.

As examples of the mixtures in question the following may be mentioned:

	I	II	III	IV	V	VI	VII	VIII
Titanium carbide %	11	20	8	15	12	14	8	18
Tantalum carbide %				12	3	2	2,5	6
Niobium carbide %				3	1	2	1,5	13
Zirconium carbide %						6	4	1
Thorium carbide %			2			3	1	
Silicium carbide %							1	(if desired)
Tungsten carbide %	83	75	79	59	77	66	76	53
Cobalt oxide %	6	5	5	7	4	7	4	6
Nickel oxide %			2	4	3		2	3
	100	100	100	100	100	100	100	100

In all of these mixtures up to 2% iron oxide may be contained instead of part of the cobalt oxide and of the nickel oxide, and likewise up to 10% of the tungsten carbide may be replaced by molybdenum carbide, preferably in quantities from 1 to 7%.

Hard metal alloys, produced from the mixtures in question, distinguish themselves by great tenacity relatively to the great hardness and by a low coefficient of friction against metals, by which the resistance to wear and tear will be great. They are suitable for cutting tools for hard as well as for tenacious materials, such as cast iron, manganese steel, stainless steels and ordinary steels. They are specially suitable to working of the two last mentioned kinds of material, they may, however, be used also for other tools than cutting tools as for example, for drawing dies and cold or hot pressing tools.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. Process of producing sintered hard metal alloys from a mixture of at least one hard compound, of one of the metals W, Ti, Ta, Nb, and at least one inorganic compound of an auxiliary metal, melting at a lower temperature, which compound is decomposable by means of gas into

metal and gaseous product of reaction, by pressing from the mixture without preceding decomposition of the auxiliary metal compound, form pieces which, after working to desired shapes by means of material removing tools, are reduced to decompose the auxiliary metal compound, and finally, sintered at such a high temperature that the auxiliary metal melts.

2. In a process as claimed in claim 1, carrying out the decomposition of the auxiliary metal compound into metal in the same operation as the sintering.

3. A process for producing sintered hard metal alloys from a mixture of at least one hard compound of one of the metals W, Ti, Ta and Nb, and at least one inorganic compound of a lower melting auxiliary metal, which is decomposable by a gas into the metal and gaseous vapors, consisting in pressing form pieces from the mixture, reducing said form pieces so as to decompose the auxiliary metal compound, and finally sintering the reduced form pieces at a temperature above the melting point of the auxiliary metal.

4. In a process as claimed in claim 1, producing the sintered hard metal alloys from a mixture of at least one hard compound of one of the metals W, Ti, Ta, Nb, together with such elements themselves.

5. In a process as claimed in claim 1, producing the form pieces from a mixture, containing 5 to 25% of at least one carbide of elements, which belong to the fourth group of the periodic system, and up to 30% of at least one inorganic compound of an auxiliary metal, which melts at a lower temperature, the remainder being substantially tungsten carbide.

6. In a process as claimed in claim 1, producing the form pieces from a mixture containing 5 to 25% titanium carbide, and up to 30% of at least one inorganic compound of an auxiliary metal, which melts at a lower temperature, the remainder being substantially tungsten carbide.

7. In a process as claimed in claim 1, producing the form pieces from a mixture, containing 5 to 25% of at least one carbide of elements, which belong to the fourth group of the periodic system up to 30% of at least one inorganic compound of an auxiliary metal, which melts at a lower temperature, and 1 to 25% tantalum and niobium carbide, the remainder being substantially tungsten carbide.

8. In a process as claimed in claim 1, producing the form pieces from a mixture, containing 5 to 25% of at least one carbide of elements, which belong to the fourth group of the periodic system, up to 30% of at least one inorganic compound of an auxiliary metal, which melts at a lower temperature, and 1 to 25% tantalum and niobium carbide, the ratio between the quantity of tantalum carbide and niobium carbide in the mixture lying between the limits 10:1 and 1:4 the remainder being substantially tungsten carbide.

9. In a process as claimed in claim 1, producing the form pieces from a mixture, containing 5 to 25% of at least one carbide of elements, which belong to the fourth group of the periodic system, up to 30% of at least one inorganic compound of an auxiliary metal, which melts at a lower temperature, and 2 to 4% tantalum and niobium carbide, the remainder being substantially tungsten carbide.

10. In a process as claimed in claim 1, producing the form pieces from a mixture, containing 5 to 25% of at least one carbide of elements,

2,051,972

3

which belong to the fourth group of the periodic system, and up to 30% of at least one inorganic compound of an auxiliary metal, which melts at a lower temperature, up to 10% of the remainder being molybdenum carbide and the rest substantially tungsten carbide.

5

11. Process as claimed in claim 1, character-

ized by the fact that the carbides partly are replaced by the corresponding nitrides.

12. Process as claimed in claim 1, characterized by the fact that the mixture contains up to 10% cobalt oxide.

5

KJELL MAGNUS TIGERSCHIÖLD.

KARL BONTHRON.