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PROCESS OF MAKING HARD SINTERED METALS

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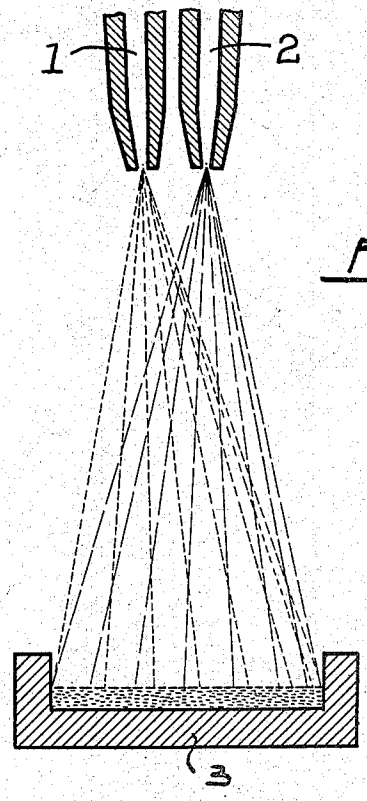


Fig. 1.

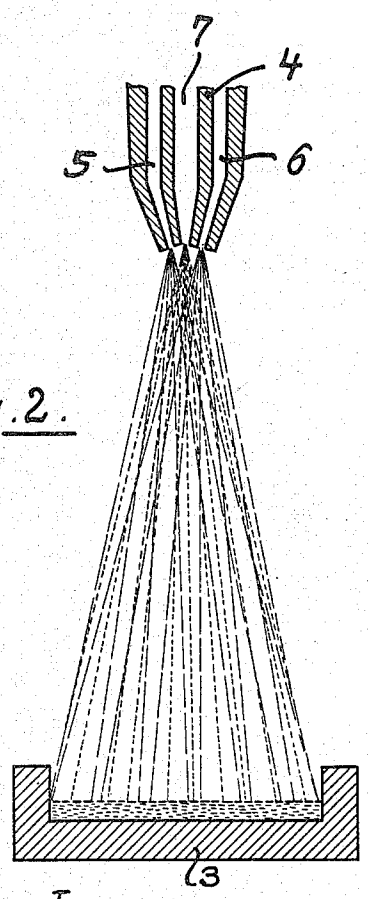


Fig. 2.

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PROCESS OF MAKING HARD SINTERED METALS

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4 Claims. (Cl. 75—1)

This invention relates to processes of making sintered hard metals and consists essentially in novel steps connected with the process and in the production of a new kind of hard metal.

As working material for high-grade cutting and drawing tools there are used so-called hard metals which consist either of an alloy or a sintered mixture of several component metals. In making the sintered metals frequently the difficultly fusible carbides of tungsten and molybdenum are used as the carrier of hardness and a more easily fusible bedding or auxiliary metal is sintered into said carbides. A very good success had also been obtained with a sintering metal in which silicides of titanium or boron and titanium or a mixture of both have been united by means of cobalt in the absence of carbon. In this case by further addition of magnesium, aluminum, vanadium or beryllium the hardness and, above all, the toughness of this metal may still be considerably increased.

These or similar sintered hard metals are generally produced by first most finely powdering and mixing the initial materials and thereupon wetting the same. As the completely sintered metal cannot subsequently be worked and shaped, the moist and plastic masses are filled into molds having the shape of the objects to be formed and carefully dried therein, while the whole mass is first sintered only until a formed piece of some firmness is obtained. Considering the degree of shrinkage, this formed piece may now be slightly worked into final shape and subsequently thereto the sintering is completed. A drawback of a process of this kind consists in that a considerable shrinkage of the mass is to be figured with during sintering and that even if high pressures are employed for the forming process, there will still be a shrinkage amounting to from 20 to 25%. This fact, among other things, serves to prove that the fine-grained metals or metal compounds after being formed and pressed are still of relatively loose structure with the result of diminishing the homogeneousness and therewith also the toughness of the completed material.

In order to make a dense and therewith tough hard metal a process had heretofore been used which consists in that the previously properly treated and moistened mixture of metal is pressed into shape by spraying with the aid of compressed air. In this manner formed pieces of extraordinary density may be made, which without employing previous sintering are of such firmness that they may be worked into final shape. Quite irrespective of the fact that a spraying process of this kind, in which process previous sintering is dispensed with, reduces considerably the cost of making the hard metals, this process will also furnish a final product of considerably greater toughness and homogeneousness. The shrinkage of the so treated mixture of metal of earth moisture, that is, with a moisture content such that the mixture will have about the consistency of ordinary damp earth or soil, according to experience amounts to only from 5 to 8%, this figure permitting further conclusions to be made as regards the quality of the completed sintered alloy.

The spraying process which has heretofore been employed for blowing the completed finely grained metal mixture which is made up by means of a liquid paste into forms with the aid of pressure air, still involves considerable drawbacks, in spite of the progress otherwise attained by such process. The compressed air which is used in connection with this process, even after most careful dehydrating and drying, always contains certain quantities of moisture, which when carried into the forms gives rise to the formation of pores during the sintering of the mass, therewith impairing the homogeneousness of the structure of the completed metal. A further drawback is found to reside in the difficulty of uniformly supplying the metal dust which is moistened by the paste, that is the plastic mass, from the spraying apparatus into the metal form. In present practice it frequently happens that the sticky mixture of metal is not sufficiently disintegrated so that it is sprayed into the form in droplets or lumps of greater or smaller size. By this there will be produced unlike formed pieces, which in addition, usually also possess different shrinkages.

These disadvantages are completely avoided by my new process of making sintered hard metals. My new process permits producing firm and homogeneous formed or molded pieces in a most simple and reliable way, the formed pieces after sintering representing a working material, which is free from fissures, cracks and pores and, above all, is of great toughness. This is accomplished in the first place by spraying the finely powdered dry mixture of metal and the liquid necessary for the shaping, at high pressure through two separate spraying nozzles which are so directed against each other that the sprays of metal powder and liquid adhesive will impinge upon each other on their way towards or within the molds. Without limiting the present process to any definite pressures, it

may be stated that in general very good results are obtained by using pressures of three to five atmospheres. The exact pressure most suitable in any given instance will, of course, vary with the conditions and it is, therefore, not possible to set down any definite pressure as being best for all purposes. Owing to the fact that both of these media are most finely divided or atomized when passing through the spraying nozzles, the several small grains of the metal during the impact between said media will be moistened quite uniformly. Moreover, said small grains of metal no longer find time to stick to each other and are thrown at high pressure most densely and uniformly into the mold. Furthermore, according to my invention, I make use, instead of moist, compressed air, of a gas, such as hydrogen or nitrogen, which is previously carefully dried, as a conveying medium and pressure agent for the metal dust. In this manner every injurious and uncontrollable supply of water-vapor or air-moisture is avoided, thereby rendering it possible to produce a hard metal free from cracks, fissures and pores.

In the drawing two exemplary ways of carrying out the new process are diagrammatically illustrated in Figs. 1 and 2.

In Fig. 1, two nozzles 1 and 2 serve for feeding the dry metallic mixture and the adhesive or adhesion promoting liquid. Through the nozzle 1 the liquid is fed under pressure, through the nozzle 2, likewise under pressure, is fed the finely divided metallic powder. High-pressure dry gases serve as the feeding agent for the latter. The nozzles 1 and 2 are so directed with respect to one another that the stream of metallic powder meets the stream of liquid on the way to the metal mold 3. Thereby both ingredients become most intimately mixed with one another and the metallic dust becomes uniformly moistened with the liquid. The metallic grains, which are discharged under high pressure, can thereby no longer form lumps or stick together, and are thrown in the most dense and uniform distribution into the mold 3.

In Fig. 2 the two nozzles 1 and 2 are combined into a single nozzle 4 having three bores. From the outer bores 5 and 6 of the nozzle the metallic dust is discharged under high pressure, through the central passage 7 the finely divided liquid. The nozzle points are directed toward one another in such way that in this case the meeting of the two substances takes place closely in front of the opening of the nozzle and then a long path to the metal mold 3 is provided wherein the uniform moistening of the metallic mixture ensues.

The formed pieces made according to the spraying process do not need to be previously sintered and, if it should be desired, may immediately be worked. For the final sintering the forms are embedded in metal powder; in this case the duration and the temperature of ignition depend upon the thickness of the walls of the formed pieces and upon the nature of the metal mixture. The ignition temperature is above 1300° C. With the new process hard metals of the following compositions have been made with special advantages:

1	Percent
Titanium	76
Silicon	14.5
Cobalt	9.5

2	Percent
Titanium	45
Boron	40
Cobalt	15

3	
Titanium	71
Silicon	17.5
Cobalt	11
Vanadium	0.5

4	
Titanium	41
Silicon	13.2
Boron	32.6
Cobalt	12.5
Vanadium	0.3
Magnesium	0.4

5	
Tungsten	70
Silicon	13
Titanium	10
Vanadium	0.5
Cobalt	6.5

6	
Tungsten	81
Carbon	10
Titanium	4
Vanadium	0.3
Cobalt	4.5

I claim:

1. Process for making sintered hard metals, in a mold, which comprises producing a spray of a dry, finely powdered mixture of difficultly fusible metals and a more readily fusible auxiliary metal, under high pressure, producing a spray of an adhesive agent customary for binding hard metals likewise under high pressure, so directing said sprays that the spray of metallic powder and the spray of adhesive liquid will meet on their way to the mold or within the latter, whereby the mold will become filled with a compact moist mass of the metallic powder, and finally completing the hard metal article thus molded by sintering.

2. Process for making sintered hard metals, in a mold, which comprises producing a spray of a dry, finely powdered mixture of difficultly fusible metals and a more readily fusible auxiliary metal, under high pressure, producing a spray of an adhesive agent customary for binding hard metals likewise under high pressure, so directing said sprays that the spray of metallic powder and the spray of adhesive liquid will meet on their way to the mold or within the latter, whereby the mold will become filled with a compact moist mass of the metallic powder, working said mass into its desired ultimate shape and finally completing the hard metal article thus shaped by sintering.

3. Process in accordance with claim 1, wherein the finely powdered mixture of metals is atomized and sprayed by means of a dried gas at proper pressure.

4. Process in accordance with claim 2, wherein the finely powdered mixture of metals is atomized and sprayed by means of a dried gas at proper pressure.

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