

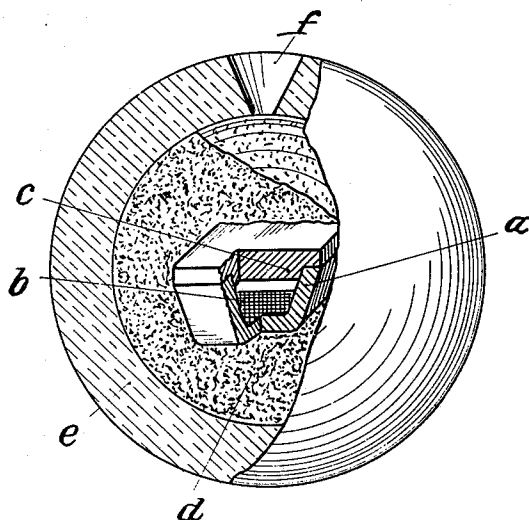
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PROCESS OF PRODUCING HARD METAL ALLOYS

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PROCESS OF PRODUCING HARD METAL ALLOYS

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The so-called hard metals used mainly, though not exclusively, for cutting and drilling tools are commonly mixtures or alloys of carbides of metals having high melting points, e. g. tungsten and molybdenum. In the process of manufacture the constituents may be melted down, or particles thereof may be fused together. In either case it has heretofore been generally accepted that the property of hardness was due to the use of carbides, and strict attention was given to having a more or less precisely defined proportion of carbon in the mixture or alloy. In one well known case of a fused product the proportion of carbon is given as from 3 to 7%, and in the case of a well known hard alloy it is given as from 3 to 4.5%. In the case of fused products particular attention has been paid, in view of the nonhomogeneous nature of the mixture, to include a comparatively easily melting metal. In the case of melting processes for producing alloys the melting has been performed in vacuo and in the presence of reducing agents with a view to increasing the density and hardness of the product.

Some of these processes have produced compositions having a very high degree of hardness, but they all involve what may be described as artificial interference or manipulation producing an artificial structure of the product rather than one arising from natural physical processes.

My invention produces alloys resulting from uniting highly refractory metals without non-metallic admixtures, or with only a small proportion of such admixtures, the distinctive features of the process being that the constituents are heated to a temperature substantially above the melting point of the alloy, and are, when melted, suddenly subjected to high pressure which is maintained during the cooling process.

The hardening of iron and carbon alloys by sudden cooling is well known, and alloys containing tungsten carbide or molybdenum carbide have also been suddenly cooled by placing the melting pot in ice-water, but the simultaneous application of pressure for increasing the density of the product was not included in the process.

The single figure of the accompanying drawing is a diagrammatic representation of a structure which may be used in practicing my invention.

In said drawing the crucible *a*, which may be made, for example, of carbon, contains the material *b* which is to be subjected to treatment. This crucible is closed by the cover *c*. The covered crucible is enclosed in a layer *d* consisting of thermite powder, this thermite being of a composition which is defined in greater detail here-

inafter. The thermite *d* is in turn enclosed in a layer *e* of plastic material, for example clay.

An opening *f* in the layer of clay provides access to the thermite mixture and makes it possible to introduce the customary ignition fuse for kindling the mixture upon lighting the said fuse.

It will be understood that although the crucible *b* has been shown here of a definite shape, this shape is arbitrary and the crucible may be of any customary shape or may be of a special shape serving to mold the article produced therein and shaped accordingly. Also the layer of thermite *d* and the surrounding shell of plastic material *e* need not be spherical, as shown, but may be given any other suitable or desirable configuration.

In my invention I may use any of the metals and auxiliary metals which have heretofore been used for making hard alloys. An important advantage of the invention is that it is not restricted to using the metals in the form of carbides. Pure metallic molybdenum, vanadium, titanium, tungsten and so on can be used, singly or mixed. A novel and distinctive feature of the invention, is that the production of the pure metals from their oxides or other compounds, hitherto separately performed, is accomplished in one operation, simultaneously with the melting or alloying. The fact that the same heat is used for melting and alloying renders the process particularly economical.

The heat for the melting process is obtained according to the invention by using thermite, that is, an intimate mixture of finely divided aluminium with oxides of the metals to be alloyed. The pot or crucible, generally a carbon crucible, is shaped to serve as a mould of the article to be produced, and has a tightly fitting cover. Filled with the metals to be alloyed the crucible is embedded in so much thermite as will provide the requisite heat, and the whole is enclosed in a refractory shell, generally produced from some suitable plastic material. Openings are provided for introducing an igniting composition and for discharge of slag and gases. The process then proceeds in three stages.

After ignition of the thermite the oxides contained therein are rapidly and energetically reduced, and the metals melt, forming a dense jacket round the crucible. The high temperature generated (over 3000° C.) quickly melts the contents of the crucible and raises its temperature to substantially above the melting point, producing an intimate alloy. When the supply of thermite is exhausted the compact body of metal enclosing

the crucible is chilled, for which purpose water at normal temperature or ice-water may be used, or some other suitable bath, according to the degree of hardness required. This causes the metal jacket referred to, to shrink, and the crucible is subjected, while cooling, to extremely powerful compression, together with the alloy therein. This renders the product very homogeneous and dense.

After cooling, the metal shell is broken up, to expose the crucible, and the pieces can be pulverized and used for the next charge from which alloy is to be made. It will be clear that the melting of the thermite metals in the course of their reduction may effect a sort of preliminary alloying thereof, which is subsequently completed or perfected by the melting in the crucible. Whether or not this takes place, the product is uncommonly dense and homogeneous, and is produced by a simple and economical process. Particularly by reason of the high compression exerted during the cooling the process enables hard alloys of good quality to be produced from metals which cannot be combined for that purpose by any process previously known.

The following examples illustrate the improved process.

Oxides of titanium, boron and cobalt are mixed in such proportion that when reduced an alloy is produced containing 45% titanium, 40% boron and 15% cobalt. The oxides are mixed with so much powdered aluminium as is required for their reduction, with addition of an oxidizing agent such as a chlorate or perchlorate.

Another good mixture consists of the oxides of tungsten, silicon, titanium, vanadium and cobalt, in such proportions as to yield 70% tungsten, 13% silicon, 10% titanium, 0.5% vanadium and 6.5% cobalt.

The fragments of the shell of thermite metal produced in one heat are finely divided and used for charging the crucible, e. g. a carbon crucible such as is generally used for hard alloys; the crucible being of the shape which the finished article is to have. The crucible is tightly closed and embedded in fresh thermite, around which a refractory clay jacket is made. Then the thermite is ignited, and burns in a few seconds, whereupon the jacket and its contents are chilled by means of water or other suitable cooling agent. The duration of the chilling process varies according to the agent used. It may, for example, run to 100 seconds.

It will be understood that instead of using, for the thermite, oxides of the metals to be alloyed I may use a mixture containing any of the usual constituents, e. g. iron oxide.

What I claim is:

1. The process of producing hard metal alloys, which consists in placing the metals to be alloyed in a closable carbon crucible, closing the crucible, surrounding the crucible and its closure with thermite and surrounding the thermite with a refractory mass, melting the metal contained in the crucible by burning the thermite and then suddenly cooling the resulting metal and slag of the thermite surrounding the crucible to effect high compression of the contents of the crucible by internal pressure of the said products of com-

bustion of the thermite due to contraction by cooling.

2. The process according to claim 1, which consists in causing the crucible to be surrounded gas-tight by the molten products of combustion of the thermite, effecting sudden cooling of the latter in a hardening bath and compressing the hard metal charge by the shrinking of the said molten products.

3. The process according to claim 1, which consists in simultaneously employing oxides of several metals for producing the hard metal alloys as metal oxide constituents of the thermite and in burning of the thermite causing pre-alloying of said metals and breaking up and preparing the pre-alloyed metals after removal of the crucible for subsequent melting in the crucible to produce hard metal.

4. The process of producing hard metal alloys, which consists in placing the metals to be alloyed in a closable carbon crucible, closing the crucible, surrounding the crucible with thermite containing the oxides of the metals to be alloyed and surrounding the thermite with a refractory mass, burning and melting the thermite to form a metal mass tightly surrounding the crucible, melting the metals contained in the crucible by the burning of the thermite, suddenly cooling said metal mass in a hardening bath and thus compressing the molten metals to be alloyed to form hard metal due to the resulting shrinking of said metal mass.

5. The process according to claim 4, consisting in breaking up and preparing the reduced metals after cooling and removal of the crucible and employing them as alloying metal for producing hard metal.

6. The process according to claim 4, which consists in simultaneously employing oxides of several alloying metals as metal oxides for the thermite, melting them by burning the thermite to form a preparatory alloy and breaking up and preparing the preparatory alloy after removal of the crucible and employing it as alloying metal to be molten in the crucible for producing hard metal.

7. The process of producing a shaped article of hard metal, which consists in employing a carbon crucible shaped to serve as a mold of the article to be produced, placing the metals to be alloyed in the crucible mold, covering the latter, surrounding the crucible and its cover with thermite and surrounding the thermite with a refractory mass, burning and melting the thermite to form a metal mass surrounding the crucible gas-tight, melting the metals to be alloyed in the crucible by the burning of the thermite, suddenly cooling the metal mass surrounding the crucible in a hardening bath of suitable temperature and compressing the metals to be alloyed by the shrinking of the metal mass to form the shaped article.

8. The process according to claim 1, which consists in causing the crucible to be surrounded gas-tight by the molten products of combustion of the thermite, effecting sudden cooling of the latter in water and compressing the hard metal charge by the shrinking of the said molten products.

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