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UNITED STATES PATENT OFFICE

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HARD ALLOY FOR TOOLS AND THE PROCESS FOR THEIR PRODUCTION

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It has not been possible hitherto to obtain alloys, by liquefying and melting metals with carbon, which would have the hardness required for tools that are to compete with diamond tools in hardness; that is to say, alloys whose hardness exceeds for instance that of the ruby. The carbides which are on the market are for instance far inferior to the ruby as regard hardness, since they can be attacked by ruby as well as by carborundum disks.

However, it has been determined, according to the invention, that it is possible to obtain suitable products of greater hardness than that of the ruby for tools, especially hones, provided a special combination of the alloy is observed; that is to say, the carbon content must not amount to more than 4.5% and must not be less than 3% with respect to the metal, for instance tungsten. Within these limits it is possible to obtain an alloy of remarkable hardness, especially when, by melting in the electric arc, at first coarse primary crystals are formed from the molten mass, which then by means of very rapid cooling, can be made to disintegrate and to form a very fine eutectoid. A microscopical observation will disclose the coarse primary crystals as well as the fine eutectoid structure of the alloy after etching.

The quantity of materials employed in the alloy may be expressed in atomic percentages rather than in percentages by weight. For example, the variation in tungsten expressed in atomic percentages may be from 58.1% to 68%, while the variation in carbon expressed in atomic percentages may be from 41.9% to 32%.

In order that the desired structure be obtained, it is necessary to see to it that the temperature range from the melting point to red heat be passed exceedingly rapidly.

If the cooling is slow, then a soft product is obtained, due to the coarse eutectoid, or crystallinic structure that forms itself. The same occurs when tempering is resorted to.

In order to arrive at the desired carbon content, it is necessary to use at the start a material with a high carbon content, and to melt it in an atmosphere that is free of carbon such as nitrogen, hydrogen, and the like, or in vacuum, till the right carbon content has been arrived at; or, one can start with material with lower carbon content, or without any carbon, and melt this material in a carboniferous atmosphere, till it has absorbed the desired carbon content.

It is also advantageous to substitute molybdenum or chromium partly or entirely for the tungsten, and on the other hand, to replace the carbon entirely or partly by means of boron, titanium or silicon, by the use of corresponding molecular proportions. In this case, it is advisable to have the melting process take place in a neutral gas atmosphere, or in vacuum.

After shutting off the electric arc, by means of which the material is heated to a molten mass, it is possible to suddenly harden by rapidly cooling this mass. Of course it is possible to arrive at the same results by removing the molten mass from the electric arc, for instance, by pouring it into a suitable form.

This new process permits also, if necessary, of using special means so that the substances which are to be manufactured can be non-porous. Such means are, for instance, the melting in a rarefied air atmosphere, as well as the use of a raw material which has been thoroughly freed from any gases by heating to a high temperature in vacuum, in an argon or in a hydrogen atmosphere.

It will be seen, therefore, that the alloy is made by combining a refractory metal with one of the elements of the 4th group of the Mendelejeff periodic table, such as carbon, titanium or silicon, or stating it otherwise, the alloy consists of elements of the 6th group of the Mendelejeff periodic table, such as tungsten, molybdenum or chromium with one of the elements in the 2nd horizontal group of the periodic table, such as carbon or boron.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An alloy containing from about 58.1 atomic per cent to about 67 atomic per cent of metal from a group consisting of tungsten, molybdenum and chromium and from about 41.9 atomic per cent to about 32 atomic

per cent of material from a group consisting of carbon, boron, titanium and silicon, said alloy having a fine-grained eutectoid structure.

2. A cast alloy consisting of from 58.1 to 67 atomic per cent tungsten and from 41.9 to 32 atomic per cent of one of the elements in a group consisting of carbon, boron, titanium and silicon, said alloy having a fine-grained eutectoid structure.

3. The method of making an alloy consisting mainly of refractory metal but containing an appreciable amount of material from a group consisting of carbon, boron, titanium and silicon, which comprises heating the refractory metal and said material to a molten condition and until the molten mass contains a desired proportion of constituents, and then suddenly chilling the molten mass.

4. A cast hard alloy consisting of from 95½% to 97% tungsten and 3 to 4½% carbon, said alloy having a fine-grained eutectoid structure.

5. A cast hard alloy consisting of from 95½% to 97% by weight of tungsten and 3% to 4½% by weight of carbon, said alloy consisting of a fine-grained crystal mixture produced by the eutectoid disintegration of coarse primary crystals.

6. The method of making a hard alloy which consists in heating to a molten state a refractory metal in the presence of an atmosphere and in the presence of carbon to cause the transfer of carbon between the metal and the atmosphere until the proportions of the metal and the carbon in the molten mass stand in the ratio of 95½% to 97% by weight of the metal to from 3% to 4½% by weight of carbon, and suddenly chilling the molten mass.

7. The method of making a hard alloy which consists of heating to a molten state a refractory metal in the presence of a comparatively high percentage of carbon in a reducing atmosphere to cause the removal of carbon from the metal until the proportion of the metal and the carbon in the molten mass stands in the ratio of from 95½% to 97% by weight of metal to from 3% to 4½% by weight of carbon, and thereafter chilling the molten mass.

8. The method of making a hard alloy which consists in heating to a molten state tungsten in the presence of an atmosphere and in the presence of carbon to cause the transfer of carbon between the metal and the atmosphere until the proportions of the metal and the carbon in the molten mass stand in the ratio of 95½% to 97% by weight of the metal to from 3% to 4½% by weight of carbon, and suddenly chilling the molten mass.

9. The method of making a hard alloy which consists of heating to a molten state tungsten in the presence of a comparatively high percentage of carbon in a reducing atmosphere to cause the removal of carbon from the metal until the proportion of the metal and the carbon in the molten mass stands in the ratio of from 95½% to 97% by weight of metal to from 3% to 4½% by weight of carbon, and thereafter chilling the molten mass.

10. The method of making an alloy which comprises heating to a molten condition a refractory metal in a gas and in the presence of carbon to cause transfer of the carbon between the metal and the gas until the proportions of metal and carbon in the molten mass stand in the ratio of 58.1 to 67 atomic percent of the metal to 41.9 to 33 atomic percent of carbon, and then suddenly chilling the molten mass.

In witness whereof, I have hereunto set my hand this 8th day of October, 1923.

KARL SCHRÖTER.