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UNITED STATES PATENT OFFICE.

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ALLOY.

No Drawing. Original application filed January 8, 1925, Serial No. 1,305. Divided and this application filed March 5, 1926. Serial No. 92,584.

Our invention relates to alloys for use as high-speed cutting tools and the like which are similar in general physical properties and structural characteristics to those obtained by H. S. Cooper, U. S. Patents Nos. 1,221,769, 1,277,046, 1,278,304, 1,350,359 and 1,461,178.

Our new alloys contain as essential components nickel or cobalt in preponderating proportion, usually substantial amounts of tungsten, small amounts of boron up to about 1%, and substantial amounts of titanium. Minor amounts of silicon and aluminum are usually present and have more or less effect on the properties of the alloy. Molybdenum or uranium may be present, replacing part or all of the tungsten.

Heretofore in preparing alloys such as those disclosed by Cooper in the patents above mentioned, the desired hardness has been obtained by adding a considerable amount of aluminum over and above that contained in the alloys used as raw materials. A great deal of trouble was encountered through oxidation of this excess aluminum and in addition the tungsten segregated very rapidly as soon as the aluminum was added. We have now produced alloys of this type in which hardness and good cutting properties are secured by raising the titanium content and correspondingly decreasing the aluminum content, whereby oxidation of aluminum and the segregation of tungsten are largely avoided.

We have found that the hardness of the alloy is increased by the presence of boron therein, and that there is a marked refinement of grain. We have also found that the boron seems to act in conjunction with the titanium in producing a much better cutting tool than can be made from alloys of this type which do not contain boron.

Alloys made in accordance with our invention have a preferred composition range of 5 to 12% tungsten, 6 to 12% titanium, 3.5 to 6% silicon, 3 to 5% aluminum, up to 1% boron, with the balance principally nickel or cobalt. The boron may be added in the form of ferro-boron, chromium-boron, boron carbide or any other suitable alloy of boron. When ferro-boron or chromium-boron is used, small amounts of iron or chromium will be introduced into the final alloy, but these have no appreciable effect on its properties. The other raw materials frequently contain small amounts of iron so that the iron content of the final alloy may be as high as 2 or 3%.

These alloys may be conveniently made by melting the nickel-, tungsten-, silicon-, and boron-containing materials together in a graphite crucible in any suitable type of furnace, raising the temperature of the molten bath to 1600°–1800° C., and then stirring the titanium in the form of some suitable titanium alloy into the melt. The titanium alloy will dissolve quite readily if vigorous stirring is employed. The melt may be poured at once into sand, carbon, or graphite molds. A titanium alloy which has given good results in this work contains 64.8% titanium, 27.3% aluminum, 2.2% silicon, 2.1% iron and 1.0% carbon. It is friable and may be crushed to a powder. The best results have been obtained when it was crushed to approximately 40 mesh. No aluminum except that contained in the titanium alloy is added to the melt. One melt of this cutting tool alloy which has the proper hardness and good cutting quality had the following composition: tungsten 7.23%, titanium 7.20%, aluminum 3.90%, silicon 4.40%, iron 0.95%, carbon 0.52%, boron 0.55%, nickel remainder.

While in the examples above given nickel has been specified as the principal constituent of the alloy, it is to be understood that cobalt may be substituted for nickel or used with the same, and that "nickel" is used in the claims to mean either nickel or cobalt or both.

In our application, Serial No. 1,305, filed January 8, 1925, of which this application is a division, we have somewhat broadly claimed alloys of this class containing boron and either titanium or zirconium, and we have also claimed specifically such of said alloys as are characterized by the use of boron and zirconium.

All the alloys comprised within the invention are suitable for tools for the high-speed cutting of cast iron, steel and semi-steel, though they are also useful for other purposes. The term "high-speed" is here used in the same sense as in the common expression "high-speed steel," and imports conditions of such severity that ordinary carbon steels subjected to them would be

softened by the heat generated in the cutting and thus become useless.

We claim:—

1. An alloy containing from 3 to 5% aluminum, 3.5 to 6% silicon, 5 to 12% tungsten, 6 to 12% titanium, boron in substantial and effective amounts up to 1%, the balance being principally nickel.

2. A non-ferrous alloy suitable for tools for the high-speed cutting of cast iron which contains 3% to 5% of aluminum, 3.5% to 6% of silicon, 5 to 12% of tungsten, 6 to 12% or titanium, and approximately 0.5% of boron, with the balance principally nickel.

3. A cutting tool composed of an alloy containing from 3 to 5% aluminum, 3.5 to 6% silicon, 5 to 12% tungsten, 6 to 12% titanium, boron in substantial and effective amounts up to 1%, the balance being principally nickel.

In testimony whereof, we affix our signatures.

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