UNITED STATES PATENT OFFICE.

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ALLOY.

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No Drawing. Application filed October 30, 1916. Serial No. 128,404.

To all whom it may concern:

Be it known that I, HUGH S. COOPER, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Alloys, of which the following is a specification.

This invention consists of an alloy of zirconium and nickel or cobalt, with or without the addition of another metal, all substantially as herein shown and described and more particularly pointed out in the claims.

I have found by careful experimentation that ductile metals such as cobalt or nickel may be hardened or toughened to a variable degree by the addition of more or less of the metal zirconium, and that the alloy and a product made therefrom is also resistant to acids and alkalis, and possesses high electrical resistance, and when heated to about 1150 C. there is formed on the outside a thin adherent coating of oxid which prevents further oxidation of the metal.

Where a small percentage of zirconium is used, for example two to ten per cent., and the balance nickel, the alloy takes a fine and lasting cutting edge and is suitable for knives, razors and other cutlery. In an alloy of zirconium and nickel comprising eight per cent. to fifteen per cent. of zirconium and the remaining per cent. nickel or cobalt, the melting point of the alloy is decreased below that of nickel, or about 1400 C., and the electrical resistance increased compared with nickel, while an increase in hardness and resistance to oxidation and corrosion is also effected. Cutlery made of the alloy remains bright and clean even under the action of acids found in such fruits as lemons, oranges, etc., and cutting tools or implements made therefrom are far superior to steel tools. The alloy may be forged or worked at red heat, and is also applicable to electrical uses. That is, it may be used with advantage in thermo-electric junctions, and as a resistance element in heating appliances, such as electric toasters, irons, stoves, and furnace windings. In producing the alloy, the technical oxid of nickel is suitable for use without purification.

Where the zirconium content is increased to say sixteen to thirty per cent, the hardness of the alloy is greatly increased. For example, with twenty-five to thirty per cent. of zirconium and the balance of nickel, the alloy is of exceptional utility when formed into cutting tools. For example, a tool of this alloy easily cuts glass. The melting point and tensile strength is lowered by increased amounts of zirconium, and the alloy cannot be worked by ordinary methods involving forging, drawing and rolling, but may be cast to produce lathe or cutting tools for working alloy steels, cast iron, drill rod and bronze. Even high speed steel is easily cut at a higher speed than with the tools now in use, and without appreciable wear or loss in temper of the cutting tool.

The high speed steels now used in making cutting tools contain iron, tungsten, a small amount of chromium or vanadium, and more or less carbon. Care is necessary in grinding tools made of high speed steel to prevent burning of the tool, and loss in temper and dulling of the cutting edge also takes place when operating the cutting tool at high speed. My alloy is free from carbon and iron and I have found by exhaustive tests that it is impossible to burn a tool made of my alloy, either when cutting at a high speed or in grinding the tool, and that no special care need be taken in grinding operations. I have also found that the wear in grinding is only about one-tenth of that of the best high speed steel, which means a great saving in material, and that the tool remains white notwithstanding grinding or high speed operations. Moreover, my alloy can be manufactured at a lower cost than tungsten steels, as a zirconium ore with an oxid content of about 73% is obtainable in the market at a much lower price than tungsten ores.

With the zirconium content increased to sixteen to thirty per cent. the alloy is given a very low melting point, approximately 1150 C., and where it is necessary to operate

tools or dies of this alloyage at a red heat an additional metal may be incorporated to raise the melting point of the alloy to the proper degree necessary to insure hardness at higher temperatures. For this purpose a small amount of one or more of the metals of the chromium group may be advantageously added, and in my experiments and tests molybdenum appears to give the best results of any of the metals of the chromium group, and I have made alloys with various percentages of molybdenum up to thirty-five per cent. with as high as twenty-five per cent. of zirconium and the balance nickel or cobalt. For general use, however, only a sufficient amount of molybdenum or its equivalent need be added to establish the melting point of the alloy at about 1600 C. as I find this to be sufficiently high to impart the necessary heat resisting qualities for nearly every practical purpose, and at the same time low enough so that the worn or used tools may be easily remelted and cast into bars or tools for further use. This alloy possesses sufficient tensile strength so that it is possible to permit the tool to be used with a long overhang. An alloy of this type is preferably composed of about ten per cent. molybdenum, twenty-five per cent. zirconium, and sixty-five per cent. nickel or cobalt.

Iron cannot be used to replace the nickel or cobalt in the alloy as the alloys of zirconium iron which I have made are too soft for the purpose stated. Titanium (another member of the same group as zirconium) may be alloyed with nickel, but this substitute does not yield advantages comparable with zirconium, and nickel has proven superior to cobalt.

These alloys have the peculiar property of self-hardening and are ready for use when casted; that is, no treatment is necessary before use nor are they improved by any tempering process known to me. The alloy takes a beautiful polish which is not affected by gases of the atmosphere, nor corroded by alkalis or cold concentrated nitric, sulfuric, hydrochloric, or boiling sulfuric acids, or cold dilute acids.

Chromium, uranium, or tungsten may be added to zirconium and nickel or cobalt and in this way make ternary and quarternary alloys of perhaps greater hardness than the above, and I have made alloys containing zirconium-nickel and tungsten, with as high as twenty-five per cent. tungsten, and also uranium but so far the increased cost has not been overcome by a sufficiently better alloy to justify the use of these added elements.

I have found it is possible to produce these alloys by various methods, one being the alumino-thermic method, and a typical example for the reaction in an alloy containing about twenty-five per cent. zirconium may be expressed as follows:

$$7Ni_2O_3+3ZrO_2+18Al=Zr_3Ni_{14}9Al_2O_3.$$

If the ore is substituted for the oxid of zirconium a correspondingly larger amount must be used.

What I claim is:

1. An alloy comprising zirconium and a preponderating amount of nickel and cobalt, the zirconium content being not less than about two per cent. and not more than about forty per cent. of the composition.

2. A cutting tool composed of a self-hardening alloy containing two per cent. to forty per cent. of zirconium together with a preponderating amount of nickel.

3. An alloy comprising zinconium and a preponderating amount of a metal having the properties of nickel or cobalt, with the addition of a small amount of one or more of the metals of the chromium group not exceeding thirty five per cent. of the composition.

4. An alloy comprising zirconium and a preponderating amount of a metal having the properties of nickel or cobalt.

5. An alloy consisting of a metal having the properties of nickel or cobalt, and two to thirty per cent. of zirconium.

6. An alloy for cutting tools consisting of nickel and a metal having the properties of zirconium or titanium.

7. A cutting tool composed of an alloy containing two per cent. to thirty per cent. of zirconium and a metal having the properties of nickel or cobalt.

8. An alloy containing eight per cent. to fifteen per cent. of zirconium, with fifty or more per cent. of nickel.

9. A cutting tool or electrical resistance element composed of an alloy containing a preponderating amount of nickel and eight to fifteen per cent. of zirconium.

10. An alloy composed mainly of nickel not more than thirty-five per cent. of zirconium, and one or more of the metals of the chromium group.

11. A self-hardening cutting tool composed of an alloy containing a preponderating amount of nickel, and zirconium, and not more than thirty five per cent. of one or more of the metals of the chromium group.

12. An alloy composed of nickel, zirconium, and ten per cent. to thirty-five per cent. of one or more of the metals of the chromium group.

13. An alloy composed of two per cent. to thirty-five per cent. of zirconium, a metal having the properties of nickel or cobalt, and one or more metals of the chromium group.

14. An alloy composed of nickel and zirconium and one or more of the metals of the

chromium group, in which the proportion of nickel exceeds the zirconium and the proportion of zirconium exceeds the metal or metals of the chromium group.

15. An alloy composed of nickel and zirconium and molybdenum, in which the proportion of molybdenum is less than twenty-five per cent. and the zirconium sixteen to thirty per cent.

16. A cutting tool composed of an alloy containing nickel, sixteen to thirty per cent. of zirconium, and ten to twenty-five per cent. of molybdenum.

17. An alloy composed of approximately sixty-five per cent. of nickel, twenty-five per cent. of zirconium, and ten per cent. of molybdenum.

18. A cutting tool made of an alloy composed of sixty-five per cent. of nickel, twenty-five per cent. of zirconium, and ten per cent. of a metal having the property of molybdenum.

Signed at Cleveland, in the county of Cuyahoga, and State of Ohio, this 26th day of October, 1916.

HUGH S. COOPER.