UNITED STATES PATENT OFFICE.

ELWOOD HAYNES, OF KOKOMO, INDIANA.

METAL ALLOY.

1,057,828. Specification of Letters Patent. Patented Apr. 1, 1913.

No Drawing. Original application filed July 20, 1912, Serial No. 710,598. Divided and this application filed August 16, 1912. Serial No. 715,326.

To all whom it may concern:

Be it known that I, ELWOOD HAYNES, a citizen of the United States, and a resident of Kokomo, in the county of Howard and State of Indiana, have invented certain new and useful Improvements in Metal Alloys; and I do hereby declare that the following is a full, clear, and exact description thereof.

This invention relates to a metal alloy more particularly designed for use in the manufacture of articles, such as tools or cutting implements, wherein are required the qualities of hardness, toughness and elasticity, together with the capacity of taking a high polish and receiving and retaining a sharp cutting edge.

Among the objects of my invention are to produce a metal capable of production on a commercial scale and at a moderate cost and having the properties above set forth, and which is particularly adapted for use as a substitute for steel for making cutting implements, machine tools and the like.

In my prior Patent No. 873,745, issued December 17, 1907, I have described a binary alloy, consisting of cobalt and chromium, or other metal of the chromium group allied with chromium, or having properties like those of chromium; such metals of the chromium group embracing, in addition to chromium, tungsten, molybdenum and uranium. The binary alloy described in said patent possesses a high degree of hardness and toughness adapting it for use in the manufacture of edged tools, cutlery and the like, has a high degree of resistance to oxidization and the corrosive action of the atmosphere and fumes occurring therein, and is capable of being forged, hammered, or otherwise worked into various forms of instruments and articles.

I have discovered that quaternary alloys, consisting of cobalt and three metals of the chromium group, possess particular value and qualities in many respects superior to those of the binary alloy set forth in said patent above mentioned. I have discovered, moreover, that such quaternary alloys possess very valuable properties when composed of cobalt, chromium, tungsten and molybdenum.

An alloy made in accordance with my invention is composed of cobalt, chromium and two of the other metals of the chromium group, combined in the proportions substantially as hereinafter specified. The metals included in the chromium group, to which reference has been made, embrace, in addition to chromium, tungsten, molybdenum and uranium. My experiments up to the present time have led me to prefer, of the metals of the chromium group, tungsten and molybdenum, as possessing the most desirable qualities as constituents of my alloy for the general purposes and uses intended, although it may be found that for different uses the other metal of the chromium group, to wit, uranium, may be employed to advantage, as one of the constituents of the alloy. An alloy of cobalt, chromium, tungsten and molybdenum, which I have found to possess the desired properties for many articles or uses, contains chromium in a percentage of fifteen per cent. (15%) or less, and tungsten and molybdenum together in a percentage of fifteen per cent. (15%) or less. Such quaternary alloys may be readily forged at a red heat. Moreover, by using a considerable amount of care an alloy containing sixty-five per cent. (65%) of cobalt, fifteen per cent. (15%) of chromium and twenty per cent. (20%) of tungsten and molybdenum can be forged to a considerable degree. All such quaternary alloys possess valuable properties in addition to those of the binary, or cobalt and chromium alloys, for many purposes, on account of the tungsten and molybdenum constitutents, which give to the alloy increased hardness and toughness, as well as a superior capacity to receive a sharp cutting edge and to retain the same under the most severe usage.

In a quaternary alloy of cobalt, chromium, tungsten and molybdenum, if the chromium constituent equal twenty-five per cent. (25%) and the tungsten and molybdenum together be present in the proportion of five per cent. (5%), the alloy is particularly suitable for wood-cutting tools, table knives and other cutlery. Such an alloy forges readily, shows a fine fracture, is very strong and elastic, and takes a fine cutting edge. Moreover, this alloy possesses the desirable qualities of the cobalt-chromium alloy described in my prior Patent No. 873,745 in being capable of taking a high and durable luster, and of resisting the oxidizing and corrosive fumes commonly occurring in the atmosphere.

If in a quaternary alloy of cobalt, chro-

mium, tungsten and molybdenum, the tungsten and molybdenum constituents together be increased from fifteen per cent. (15%) to say, fifty per cent. (50%), the alloy becomes harder with increasing percentage of tungsten and molybdenum, and the same cannot be successfully forged after the last named constituents exceed twenty-five per cent. (25%). A quaternary alloy containing from twenty-five per cent. (25%) to fifty per cent. (50%) of tungsten and molybdenum, and fifteen per cent. (15%) of chromium, the remainder being cobalt, makes excellent lathe tools, possessing to a high degree the qualities of hardness, toughness and capacity of receiving and retaining a very sharp cutting edge. I have found that such lathe tools possess hardness, toughness and cutting qualities to a degree making them much superior to any steel lathe tools now produced. Moreover, such alloy is found to be capable of resisting to a large degree the corrosive action of moisture and the atmosphere. When the tungsten and molybdenum constituents together exceed twenty-five per cent. (25%), the alloy becomes sufficiently hard to readily scratch glass, and will even mark or score rock crystal. When the tungsten and molybdenum constituents taken together, are present in percentages of twenty-five (25) to fifty (50) per cent. of the total, the quaternary alloy while not capable of being forged, may be readily fused, and lathe tools or other articles may be readily made by casting the same in the desired form and finishing by a suitable grinding operation. When the tungsten and molybdenum constituents in the quaternary alloy together exceed fifty per cent. (50%), the alloy becomes very difficult to fuse, or fuses under very high temperatures, such as are usually obtainable only by the use of the electric arc, but the alloy containing such higher percentages of these metals, while somewhat brittle, makes excellent lathe tools.

In the quaternary alloys containing both molybdenum and tungsten, the same general conditions and characteristics are found to exist with varying proportions of these constituents; excepting that the increase in the percentage of molybdenum has a greater effect than an increase in the tungsten constituent, in lessening the capacity of the alloy to undergo the operation of forging. If the molybdenum constituent in such alloy exceeds twenty-five per cent. (25%), the alloy is made very hard, and if the proportion of molybdenum does not exceed thirty per cent. (30%) and the proportion of tungsten is relatively small, the alloy is not only very hard but likewise very tough and strong, and may be used with great advantage for lathe tools. When the percentage of molybdenum is as high as forty per cent. (40%) or more, the alloy becomes exceedingly hard and quite brittle. It will cut persistently into glass, and a sharp corner of the metal, when drawn back and forth over the surface of a quartz crystal, will rapidly cut a deep groove in that material.

In the quaternary alloys of cobalt, chromium, tungsten and molybdenum, an increase in the percentage of the chromium constituent will give greater hardness and brittleness to these alloys, even when they contain the tungsten and molybdenum in the lower percentages. I have found, however, that the alloys described, possess considerable toughness when the chromium constituent is present to the extent of as much as forty per cent. (40%), and if the tungsten and molybdenum constituents be low, that alloys useful for practical purposes may contain even a higher percentage of chromium. In view of the fact, however, that an increase of the percentage, either of the chromium constituent, or of the tungsten and molybdenum constituents tends to render the alloy more brittle, a smaller proportionate quantity of chromium will desirably be used when the proportion of tungsten and molybdenum is relatively large and vice versa. This is indicated by the examples above given of quaternary alloys suitable in one instance for cutlery and the like, and the other instance, for lathe tools; to wit, in the first instance, twenty-five per cent. (25%) of chromium and five per cent. (5%) of tungsten and molybdenum with a corresponding percentage of the cobalt constituent, and, in the second instance, fifteen per cent. (15%) of chromium, and twenty-five per cent. (25%) of tungsten and molybdenum with a corresponding percentage of cobalt.

The quaternary alloy consisting of cobalt, chromium, and two of the other metals of the chromium group, namely, both tungsten and molybdenum, are particularly suitable for high speed lathe tools. For example, I have produced an alloy containing five per cent. (5%) of molybdenum, twenty-five per cent. (25%) of tungsten, fifteen per cent. (15%) of chromium and fifty-five per cent. (55%) of cobalt, which, after being cast into a bar and made into a lathe tool, affords a tool which will cut cast iron or steel, without overheating of or injury to the tool, from fifty (50) to one hundred (100) per cent. faster than a tool made from the best special or "high speed" steel now produced for such purposes. In the case of such quaternary alloys, the chromium constituent may be present in the proportion of from five (5) to sixty per cent. (60%), or the tungsten and molybdenum constitutents together may be present in the same proportions of from five (5) to sixty (60) per cent. with such relative propor-

tions of the chromium constituent, on the one hand, and the total quantity of the tungsten and molybdenum constituents, on the other hand, as to prevent an undesirable degree of brittleness in the alloy.

I have found, in general, that cobalt, in an alloy with three or more metals of the chromium group, produces a series of useful alloys, throughout a very wide range in the relative proportion of the constituents. In the case of admixtures of many other metals, the hardness rapidly increases with the increase in the proportion of one or more of the constituents, until the alloy becomes so brittle as to be unfit for practical use. As, for instance, if copper be alloyed with tin, an increase in the hardness of the alloy takes place, until, when the proportion of tin is materially over ten per cent. (10%), the alloy becomes so brittle as to be unfit for practical use. To the contrary, an increase in either the chromium constituent, or the tungsten and molybdenum constituents in the quaternary alloys referred to, even beyond the proportions hereinbefore generally stated, (but so far as my experiments have gone, not exactly determined), will not make the alloy too brittle for practical uses. In other words, my tests have shown that, when the constituents of the alloys described are present, within the wide range of relative proportions stated, a series of alloys may be produced having novel and very valuable properties, and capable of use in the arts with great advantage and benefit.

It is to be understood that small quantities of other metals, or non-metallic substances, may be combined with the quaternary alloys described, such as will not injuriously affect the nature of such alloys, and which may to some extent modify their properties and render them more suitable for special requirements.

From the above, it will be understood that I have discovered new and useful quaternary metal alloys, consisting of cobalt, chromium and two other metals of the chromium group, and that these combinations or alloys possess peculiar and novel characteristics. It is also to be understood that any other metal of the chromium group may be added to the alloy or substituted in the alloy for either one of the metals of the chromium group hereinbefore particularly specified.

In my application, Serial No. 710,598, filed July 20, 1912, of which this application is a division, I have described and broadly claimed an alloy obtained by combining cobalt and chromium with one or more metals of the chromium group, and I have also claimed specifically in such application the ternary alloy consisting of cobalt, chromium and one other metal of the chromium group; the subject-matter of the present application being limited to the quaternary alloy herein described.

I claim as my invention—

1. A metal alloy composed of cobalt, chromium and two other metals of the chromium group.

2. A metal alloy composed of cobalt, chromium, tungsten and molybdenum.

3. A metal alloy composed of cobalt, chromium and a plurality of the other metals of the chromium group, in the proportion of not more than sixty per cent. (60%) of such other metals of the chromium group, the remainder of the alloy being cobalt and chromium.

4. A metal alloy composed of cobalt, chromium and a plurality of other metals of the chromium group, in the proportions of from five per cent. (5%) to sixty per cent. (60%) of such other metals of the chromium group, the remainder of the alloy being cobalt and chromium.

In testimony, that I claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 12th day of August, A. D. 1912.

ELWOOD HAYNES.

Witnesses:
H. W. LANTERMAN,
BERTHA B. HAYNES.