UNITED STATES PATENT OFFICE.

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NOBLE ALLOY.

1,150,113. Specification of Letters Patent. Patented Aug. 17, 1915.

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To all whom it may concern:

Be it known that I, ELWOOD HAYNES, a citizen of the United States, residing at Kokomo, in the county of Howard and State of Indiana, have invented certain new and useful Improvements in Noble Alloys, of which the following is a specification.

This invention relates to noble alloys; and it comprises as a new and useful composition of matter an alloy of noble characteristics containing cobalt and chromium together with iron as a third or softening metal; such alloy containing no substantial amounts, say, not over 4 or 5 per cent. of other metals and containing little carbon; all as more fully hereinafter set forth and as claimed.

In composition with various other metals, chromium alloys can be obtained which are noble in their characteristics; that is they resemble the noble metals, such as gold and silver, in that they do not suffer alteration or change in their surfaces by exposure to acids, oxidizing influences, air, etc. In certain prior patents I have described and claimed a number of alloys of this character. In one such patent, No. 873,945, I have described and claimed an alloy consisting substantially of cobalt and chromium. These alloys of chromium with cobalt offer a high resistance against atmospheric influences. Such an alloy containing 10 per cent. or more of cobalt resists boiling with nitric acid and many other extreme oxidizing actions. It does not tarnish and can be given a pleasing and permanent polish. The alloy can be worked while hot and can be given a good and permanent edge; and in edge tools the metal is sufficiently hard to enable it to cut most other metals. As a rule the hardness increases with the amount of chromium present. These alloys however are somewhat difficult to work, the difficulty increasing with the amount of chromium present. They can however be cast into ingots or bars and these bars worked at high temperatures by special manipulation, but this working is somewhat costly because of the high temperatures required. Their hardness is also greater than is required in actual use in making knives, auger bits, gimlets, etc. It is sufficient for most of the purposes of edge tools if the metal used is sufficiently hard to cut wood, bone and materials of like nature, though for some purposes of course an even greater hardness is desirable. For these latter purposes I have described and claimed in various patents alloys of this character having the hardness enhanced by an addition of other metals of the chromium group. But as stated, for certain purposes so much hardness as is found in chromium-cobalt alloys is not necessary; and is even disadvantageous. For example, in a wood saw there is no use of more hardness than suffices for cutting wood and great hardness of metal not only makes the production of the saw more expensive and difficult but adds to the labor and trouble of renewing the sharpness of the tool after long use. The cobalt-chromium alloys are so hard as to make filing difficult and grinding tedious and laborious. I have found however that without sacrifice of their valuable properties as regards resistance to oxidizing influence these alloys can be somewhat softened by an addition of iron. This diminution of hardness may be to any degree desired. Nickel in a chromium-cobalt alloy has some of the softening influence of iron but not in so marked a degree and the iron-containing alloys are tougher, both hot and cold, and are therefore easier to work. These ternary cobalt-chromium-iron alloys are of sufficient hardness to serve efficiently for saws and similar tools; being as hard or harder than the ordinary tempered steel employed for such purposes, but not so hard as to prevent ready re-sharpening with a file or grindstone. A similar alloy containing nickel, replacing part or all of the iron in a cobalt-chromium-iron alloy has some of the same advantages. As noted however the softening influence of nickel in such alloys is not as great as that of iron. A series of alloys of cobalt, chromium and iron, with low carbon content, has been prepared containing a constant per cent. of chromium (about 20 per cent.) in which the iron content has been gradually increased from 10 per cent. to 75 per cent. of the entire mixture. Alloys so formed show little variation in either their chemical or physical properties so long as they contain 5 per cent. or more of cobalt and from 20 per cent. to 25 per cent. of chromium. They are all readily malleable at a bright red heat and can be worked into sheets or rods from cast ingots without difficulty. These alloys receive and retain a beautiful luster and are much less subject to oxidation or other changes in the atmosphere than the binary

alloys consisting of iron and chromium alloy. Such alloys containing a constant percentage of chromium (namely, 20 per cent.) and varying from 5 per cent. to 75 per cent. in iron (at intervals of 10 per cent.) and varying in the proportion of cobalt from 70 per cent. to 5 per cent., made in the form of bars were ground to a smooth surface and then covered with a strong solution of ammonium chlorid which was allowed to dry on. The bars were then subjected to moist air for several days, but failed to show the slightest stain or tarnish. While these ternary alloys are distinctly softer than the alloys of cobalt and chromium only, they have certain peculiar advantages which give them wide application, for example, such alloys may be manufactured into saws, boring tools, etc., which possess sufficient hardness for wood working tools of this description; and at the same time these tools can be worked almost as readily by the file as similar instruments made of steel. These ternary alloys also work very well under hammer at a moderate red heat. The softening influence of the iron is so great that the per cent. of chromium may be quite high. In an alloy containing a given amount of chromium, the cobalt and iron have opposite influences, the cobalt tending to harden and the iron to soften. An alloy containing, say, 40 per cent. chromium, 20 per cent. iron and 40 per cent. cobalt is much more workable than an alloy containing 40 per cent. chromium and 60 per cent. cobalt. In these alloys it is desirable not to have any material amount of carbon; say, not above 1 per cent. carbon; while a carbon content below 0.60 is better. Alloys containing as little as 0.2 to 0.4 are even better. Carbon makes the alloy more fusible but it detracts from its properties for the purposes here intended.

An alloy of 55 parts iron, 25 parts cobalt and 20 parts chormium is highly resistant against atmospheric influence, works readily under the hammer at a red heat and is, considering ordinary steels, very hard; but it is nevertheless soft enough to permit slow filing with an ordinary file. Tools of this alloy are hard enough to permit easy working of wood, bone, ivory and soft metals, and are easily sharpened at ordinary temperatures.

The present alloys have inherent hardness; their hardness is not much affected by working or temperature changes. Tempering has little effect. The presence of carbon changes their properties in this respect. By adding carbon to these ternary alloys they may be hardened to a considerable degree without losing very much in malleability, and for certain purposes carbon may become a valuable constituent. Silicon, sulfur, etc., should be substantially absent.

For some purposes a slight addition of other metals of the chromium group may be made to the ternary alloys here described though these elements tend to harden the alloy and make it less workable. But the amount of such an addition should ordinarily not exceed, say, 4 or 5 per cent. For example, 2 or 3 per cent. of molybdenum may be added to an iron-cobalt-chromium alloy to give it a somewhat different surface appearance or color. For some purposes such an addition is advantageous.

The described alloys may be made by melting together the required amounts of the several metals. Alumina or magnesia crucibles are most suitable as being highly refractory and containing no carbon. Graphite crucibles should not be used without a lining of indifferent material since otherwise they tend to raise the carbon content. Any convenient manner of heating, such as the oxyhydrogen or oxyacetylene flame, electric heating, etc., may be used. With high amounts of chromium, electric heating is better. Ferro-chromium may be employed in making these alloys but on account of its high carbon content, it is necessary to remove the excess of carbon in some way. This may be done by adding to the melt a small amount of oxid of chromium, oxid of iron or oxid of cobalt, proper allowance being of course made in the composition for the amount of metal thus reduced. A little ferro-titanium may be added to the melt for the purposes of removing oxygen and nitrogen, etc. Or a little manganese may be used as a deoxidant. After fusion, the alloy may be cast into ingots or bars of any suitable size or shape,—$\frac{5}{16}$ square bars are convenient for many purposes. The bar so produced may be worked down to tools at a red heat, by hammering, rolling, swaging, etc. Knife blades, saws, etc., may be given their shape and edge during the working. The edge will be retained on cooling. Drilling, grinding and polishing are easily practicable in the manufacture of tools without need of using very hard abrasives, such as carborundum.

The relative ratios of the three metals may be as desired for the particular purposes desired. An increase in the amount of chromium raises the melting point, the hardness and the resistance to oxidation and the cobalt tends in the same direction while an increase in the amount of iron (or, in a less degree, or nickel) renders the alloy more fusible, more malleable and softer. In securing noble alloys having the characteristics desired in the present invention, there should always be a substantial amount, say, 10 per cent. or more, of chromium present; and the same is true of the other two metals. An alloy may be made of 10 per cent. chromium and 90 per cent. of cobalt

and iron together, which is excellent for some purposes, but it is much better to have between 20 and 30 per cent. of chromium. Alloys running as high as 80 per cent. chromium may be made but are hard to melt and work. Ten per cent. of iron will soften cobalt-chromium alloys considerably but 20 to 30 per cent. is better. To obtain the full value of these alloys, particularly as regards their resistance to atmospheric influences or corrosive agents, they should contain as high as 10 per cent. chromium. The chromium may be increased to 40 or 50 per cent. if desired for certain purposes, but these higher percentages render the alloy much less workable under the hammer. Alloys containing from 20 to 30 per cent. chromium are preferable for most purposes.

What I claim is:—

1. As a new material a noble alloy of cobalt, chromium and iron.

2. As a new material a noble alloy of cobalt, chromium and iron, said iron being present in amounts greater than 10 per cent.

3. As a new material a noble alloy of cobalt, chromium and iron, said cobalt being present in amount greater than 5 per cent.

4. As a new material, a noble alloy or cobalt and chromium containing a substantial amount of a third softening metal, said third metal being a metal of the iron group.

In testimony whereof, I affix my signature.

ELWOOD HAYNES.