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WELDING ROD AND PROCESS OF MAKING THE SAME

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This invention relates to processes wherein metal is fused by the electric arc or the blowpipe flame and flowed into contact with heated solid metal for the purpose of welding, filling, armoring, sheathing, or the like. More particularly, the invention relates to the use in such processes of welding rods formed from certain alloys consisting essentially of cobalt, chromium and tungsten.

Many of the cobalt-chromium-tungsten alloys are excellent for the high speed cutting of metals because they retain their hardness, which is an inherent property of the alloys, no heat-treatment being required to develop it, at relatively high temperatures. The alloys are also useful for a great many other purposes where a high degree of resistance to abrasion is required, and they have been used with marked success for the cutting edges of oilwell drills; the wearing parts of rock, ore, and other crushers; forging, upsetting and drawing dies; conveyor buckets; dredge teeth; locomotive bearings; and many other articles subject to extreme abrasive wear. Some of the softer and stronger alloys have given extraordinarily good results when used to build up the wearing surfaces of railway track frogs, crossovers, and guard rails, showing an excellent resistance to the pounding and wearing action of the rolling stock.

These cobalt-chromium-tungsten alloys are furthermore characterized by being extremely resistant to atmospheric and many forms of chemical corrosion so that they are exceptionally well suited for the manufacture of cutlery, surgical and dental instruments, and parts of machines, particularly where a combined resistance to abrasion and certain chemicals is of great importance such as, for instance, the molds for making dry battery cells, and the valves in refrigerating, homogenizing, or emulsifying machines. Some of the alloys, more particularly the extremely hard ones, are relatively brittle and cannot be machined, forged, rolled, or shaped in any way other than by casting and grinding. Others can be forged and some of them can even be machined to a slight degree, although with great difficulty.

The wide range of properties which it is possible to impart to these alloys is, in part, obtained by varying the proportions of the essential constituents, cobalt, chromium and tungsten, and in part by the addition of other metals or non-metals. Thus, carbon in relatively small amounts will decrease the melting point and make the alloys easier to cast, but if present in too large amounts, will make them brittle and decrease their resistance to corrosion. Boron may be added to alloys of this type which are to be used for high-speed cutting tools as it gives an alloy particularly suited for this purpose. Several other metals and non-metals, including some of those generally present in the commercial raw materials from which the alloys are made, may be present without exerting any detrimental effect and may even impart desirable properties when the alloys are designed to be used in certain specific applications. Among the more important of these are: iron, nickel and tantalum. When the alloys are to be used under conditions where red hardness, i. e. hardness at a red heat or above, is not essential, iron and/or nickel may replace a large portion of the cobalt; and alloys containing as much as 30% of nickel or 30% of iron, or a total of 40% of nickel and iron, are entirely satisfactory for a great many purposes, since they have a hardness, without heat treatment, of 250 to 450 Brinell units, and ample strength for many forms of service.

As cobalt-chromium-tungsten alloys are relatively expensive, there have been many attempts, with some degree of success, to make composite tools and other articles having a cobalt-chromium-tungsten alloy only at the place which receives the hardest wear, such as the cutting edge of a tool or the wearing surface of a grinding device, the remainder of the tool or article being composed of material which is cheaper and easier to work. The cobalt-chromium-tungsten alloys may be attached to the base metal of the body of the tool or article by a number of methods.

They may be cast and ground to the desired shape and then welded, brazed, keyed, wedged, bolted, or otherwise held in position. All of the methods have disadvantages, and many attempts have been made to apply the alloys by fusing them in an electric arc or blowpipe flame and flowing them against the solid metal to which they are to be attached, the latter having been heated to a suitable temperature. These attempts have heretofore been only partly successful as the cobalt-chromium-tungsten alloys heretofore available, for example those used for the production of cast tools cannot be successfully fused and deposited from a rod heated by the blowtorch flame or the electric arc. The difficulty encountered with these alloys is that the deposited metal is unsound and contains blowholes which render it unfit for the intended use. I have found that this difficulty may be largely avoided by modifying the alloys.

The materials used in the commercial production of alloys of the kind discussed herein usually contain silicon as an impurity, and this silicon is incorporated in the finished alloy. When the alloy is to be cast in the form in which it is to be used, for example, a cutting tool, silicon is usually regarded as non-essential, and none is added intentionally. The patent Huff, 1,543,921, recommends, however, that the silicon content be brought up to at least one percent.

Manganese is also a common impurity in the materials from which commercial cobalt-chromium-tungsten alloys are made, and manganese is added intentionally when cast tools are being made, solely to make the alloy easier to cast. The Huff patent referred to above states that manganese produces a better alloy, and sets one percent as a minimum manganese content.

I have found that the welding properties of cobalt-chromium-tungsten alloys are unfavorably affected by the presence of manganese if the content of this element rises too high. I prefer to add no manganese at all, so that there will be present in the finished alloy only that quantity of manganese, usually not more than 0.5%, which is introduced as an impurity. Even this amount is unnecessary, but its effect may be counteracted by the measure presently to be described. In any event, the manganese content should not exceed 0.9%, and my researchers indicate that the welding properties suffer somewhat if the manganese exceeds 0.8%, even when an attempt is made to counteract its influence.

The measure to which I have referred in the preceding paragraph for neutralizing the effect of the manganese is to provide enough silicon so that the proportion of silicon to manganese is greater than 1 to 2.5 and preferably greater than 1 to 1.25; or in other words, the alloy should preferably have a silicon content which is at least four-fifths of the manganese content. Excellent results are obtained when the amount of silicon exceeds the manganese, for example when the silicon content is from 1.8 to 7 times the manganese content. In making cobalt-chromium-tungsten alloys for purposes other than welding, it is customary to add no silicon, and to increase the manganese until the proportion of manganese to silicon is 3 or more to 1, depending on the amount of silicon present in the raw materials. In making alloys for welding, suitable compositions according to my invention will ordinarily be arrived at by adding silicon, but no manganese.

Since it is impossible, on a commercial scale, to manufacture cobalt-chromium-tungsten alloys which are quite free from manganese, it will be clear that my invention is not concerned with a lower limit for the manganese range. I prefer to keep the manganese as low as possible. It follows that a lower limit for silicon cannot be set more definitely than by the condition that the proportion of silicon to manganese should be greater than 1 to 2.5. The silicon percentage may rise to 2.0%, and I prefer that it shall not fall below 0.3%.

Welding rods adapted to deposit sound metal having the hereindescribed characteristic properties of the cobalt-chromium-tungsten alloys can be made by regulating the silicon and manganese as described above, and by holding the proportions of the essential metals and of carbon within the following limits:

	Broad ranges	Preferred ranges
	Percent	*Percent*
Cobalt	20 to 65	40 to 65
Chromium	15 to 45	25 to 35
Tungsten	2 to 35	3 to 17
Carbon	0.25 to 3.5	0.9 to 2.75

The following are examples of typical alloys from which I have made excellent welding rods:

An alloy consisting of

	Percent
Chromium	32.82
Tungsten	3.80
Carbon	1.78
Manganese	0.64
Silicon	0.50
Iron+nickel	4.46

Balance essentially cobalt

was applied to the wearing surface of a railway track frog and showed practically no wear after five months of hard, continuous day and night service in a switching yard.

It had a Brinell hardness of 375 after welding, without heat treatment.

An alloy consisting of

	Percent
Chromium	31.82
Tungsten	14.95
Carbon	2.74
Boron	0.11
Manganese	0.80
Silicon	1.00
Iron+nickel	6

Balance essentially cobalt

had a Brinell hardness, without heat treatment, of 550 after being deposited on a steel base and is particularly suitable for use where a very high degree of resistance to abrasion is desired, as in oilwell drills, crusher parts, and similar articles.

Where requirements are not too severe I have found that somewhat cheaper alloys outside of the preferred range of composition give entirely satisfactory welding rods. One such alloy contained approximately

	Percent
Chromium	30
Tungsten	11
Carbon	2
Manganese	0.5
Silicon	0.5
Iron	30

Balance essentially cobalt

and had a Brinell hardness of 450 with a fair degree of strength, while another contained approximately

	Percent
Chromium	30
Tungsten	11
Carbon	2
Manganese	0.5
Silicon	0.5
Nickel	30

Balance essentially cobalt

and had a Brinell hardness of 418. These alloys, however, do not retain their hardness at high temperatures as well as those in my preferred range of composition.

This application is a continuation-in-part of my copending application, Serial No. 193,728, filed May 23, 1927.

I claim:—

1. A welding rod adapted to give a deposit of sound metal highly resistant to abrasive wear, said welding rod containing cobalt 20% to 65%, chromium 15% to 45%, tungsten 2% to 35%, carbon 0.25% to 3.5%, manganese as an impurity not more than 0.9% and silicon in such quantity, not greater than 2%, that the proportion of the silicon to the manganese is at least 1 to 2.5.

2. A welding rod adapted to give a deposit of sound metal highly resistant to abrasive wear, said welding rod containing cobalt 20% to 65%, chromium 15% to 45%, tungsten 2% to 35%, carbon 0.25% to 3.5%, manganese as an impurity not more than 0.8%, and silicon in such quantity, not greater than 2%, that the proportion of the silicon to the manganese is at least 1 to 1.25.

3. A welding rod adapted to give a deposit of sound metal highly resistant to abrasive wear, said welding rod containing cobalt 20% to 65%, chromium 15% to 45%, tungsten 2% to 35%, carbon 0.25% to 3.5%, manganese as an impurity not more than 0.8%, and silicon in such quantity, between the limits of 0.3% and 2% that the proportion of the silicon to the manganese is at least 1 to 1.25.

4. A welding rod adapted to give a deposit of sound metal highly resistant to abrasive wear, said welding rod containing cobalt 40% to 65%, chromium 25% to 35%, tungsten 3% to 17%, carbon 0.9% to 2.75%, manganese as an impurity not more than 0.9% and silicon in such quantity, not greater than 2%, that the proportion of the silicon to the manganese is at least 1 to 2.5.

5. A welding rod adapted to give a deposit of sound metal highly resistant to abrasive wear, said welding rod containing cobalt 40% to 65%, chromium 25% to 35%, tungsten 3% to 17%, carbon 0.9% to 2.75%, manganese as an impurity not more than 0.8%, and silicon in such quantity, not greater than 2%, that the proportion of the silicon to the manganese is at least 1 to 1.25.

6. A welding rod adapted to give a deposit of sound metal highly resistant to abrasive wear, said welding rod containing cobalt 40% to 65%, chromium 25% to 35%, tungsten 3% to 17%, carbon 0.9% to 2.75%, manganese as an impurity not more than 0.8%, and silicon in such quantity, between the limits of 0.3% and 2% that the proportion of the silicon to the manganese is at least 1 to 1.25.

7. In the process of making a cobalt-chromium-tungsten alloy welding rod capable of giving a deposit of sound metal highly resistant to abrasive wear, said alloy containing the constituents: cobalt 20 to 65%, chromium 15 to 45%, tungsten 2 to 35%, carbon 0.25 to 3.5%, said constituents adventitiously carrying into the alloy a small amount not to exceed 0.9% of manganese, the step which consists in neutralizing the effect of manganese by adding to the alloy silicon in an amount equal to at least 4/5 of the manganese and not more than 2% of the alloy.

8. In the process of making cobalt-chromium-tungsten alloy welding rod capable of giving a deposit of sound metal highly resistant to abrasive wear, said alloy containing the constituents: cobalt 40 to 65%, chromium 25 to 35%, tungsten 2 to 17%, carbon .9 to 2.75%, said constituents adventitiously carrying into the alloy a small amount not to

exceed 0.8% of manganese, the step which consists in neutralizing the effect of manganese by adding to the alloy silicon in an amount equal to at least 4/5 of the manganese whereby a silicon content substantially between the limits 0.3% and 2% is provided.

In testimony whereof, I affix my signature.

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