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DENTAL CASTING ALLOY

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This invention relates to metallurgy and more particularly to an alloy suitable for use in the manufacture of cast dentures and the like.

In the manufacture of metallic dentures the alloy composition employed must be stainless and non-corrosive towards various acid and alkaline reagents present in the mouth or in various food or liquids. The alloy also must be wear-resistant and the alloy must be variable as to percentages of the several constituents to a sufficient extent to permit the obtainance of degrees of strength and flexibility permitting its use under a wide variety of service conditions. Moreover, the alloy composition must be adapted to being readily cast free from blow holes, voids and from slag and oxide inclusions, in a variety of irregular shapes and configurations common to dentures with a minimum of material less and with a minimum of material surplus, by the ordinary methods practiced in the art.

The present invention aims to provide an alloy adapted to meet these many conditions and further aims to provide a denture comprised of the said alloy.

The alloy composition of the present invention comprises a base consisting of nickel and cobalt in such relative proportions as to give the required strength, toughness and wear-resistant properties desired and chromium in sufficient amount to render the base stainless and corrosion resistant. Into this base I may incorporate manganese or silicon or both in such amounts as will be necessary to completely deoxidize the alloy and to completely neutralize the deleterious effect of any sulfur or carbon present in the base and I may also incorporate a percentage of molybdenum or tungsten or both in such an amount as will augment the normal strength or rigidity of the base. Into the base or into the base improved by additions of one or more of the metals manganese, silicon, molybdenum and tungsten, I incorporate a sufficient percentage of boron as will effectively protect the alloy constituents from oxidation during subsequent re-melting and casting to form dentures.

In the manufacture of dentures it is customary in the art to melt the alloy in an open crucible by impinging thereon to open flame of an oxy-acetylene or oxy-hydrogen blow torch. When fully molten the alloy is centrifugally cast into a mold wherein relatively rapid solidification occurs. Heretofore in the art it has been difficult to manufacture cast dentures of metals other than the noble metals in this manner due to the fact that it is impractical to employ a protective slag over the metal during the melting and casting operation as the slag, when used, also entered the mold and was entrapped by the rapidly solidifying metal, causing blow holes, voids and the like. When, however, a protective slag was not used during the melting operation excessive oxidation of the metal constituents occurred and voids caused by oxide and gas occlusions are obtained. This circumstance has greatly limited the use and adaptation of chromium-containing alloys, particularly in the forming of cast dentures, due to the fact that when molten or during melting the chromium content of such alloys rapidly oxidize to form difficultly fusible oxide compounds even though the alloy has been covered or protected by readily fusible slag materials.

I have found that the most effective way to prevent the oxidation of the chromium in chromium-containing alloys is to incorporate in the alloy an alloy constituent which is more readily oxidizable than the chromium and which on oxidation forms a relatively low melting slag operating to protect the alloy from direct contact with oxidizing agents. Boron is the only alloy constituent of which I am aware that will accomplish this desired result.

The amount of boron I may incorporate in the alloy composition of the present invention may vary widely without departure. I have successfully employed as low as 1.00% and as high as 10.00%. Under very expert manipulating conditions a boron content of less than 1.0% probably can be employed but under the ordinary manipulating conditions of melting and casting I prefer to have present in my alloy about 5.0% boron, as this amount permits of repeated remelting without detrimental results to the alloy. The excess boron does not appear to be deleterious in the alloy but to the contrary appears to increase the fluidity of the alloy when molten and the ease with which it may be cast, and cast dentures of my alloy containing 5% or more boron appear to be more sharply defined than those containing 1 or 2% boron. This amount of boron, moreover, appears to beneficially affect the physical properties of the alloy, making it of finer grain structure and improving its hardness and luster.

In my alloy composition I prefer to limit any iron content to less than 1.00%. Iron in amounts greater than this, while being of advantage in some respects, such as giving added strength and ductility, detrimentally effect the corrosion resistance properties and require added chromium

to counteract the same. For this reason, I prefer to limit my invention to a nickel-cobalt-chromium base with iron less than 1.0%. In this base alloy the chromium content may vary in amounts from 5% to 30% and the cobalt content may vary from 10 to 50%, with the remainder of the alloy consisting of nickel except for boron in amounts up to 10% but preferably about 5% and manganese 1 to 2% or silicon up to 1% or both. I find it preferable to increase the cobalt with decrease in chromium within the ranges specified although this relation is not empirical but solely for the purpose of maintaining relatively constant corrosion resistance properties in the alloy. Where molybdenum or tungsten or both are added to the alloy as stiffening constituents, I prefer to add these elements as replacements for part of the cobalt and in this respect the cobalt, molybdenum and tungsten are to be considered to be substantial equivalents, although each in addition contribute to the corrosion resistant properties of the alloy. The molybdenum content may be as high as 8% but preferably should be in the range 2 to 4%. The tungsten content may be as high as 4% but preferably should be in the range 1 to 2%.

As an example of the present invention, alloys that I have found most suitable for general purpose use in the casting of dentures have the following analyses:

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	Percent	*Percent*	*Percent*
Chromium	25.0	30.0	15.00
Nickel	33.0	40.0	44.0
Cobalt	36.0	22.0	33.0
Iron	0	1.0 max.	1.0 max.
Manganese	1.0	1.0	1.0
Boron	5.0	5.0	5.0
Silicon	0	1.0	1.0 max.

Alloys suitable for the same purpose but stronger and more suitable for bridge work are similar to composition No. 1 but contain molybdenum 2–8% with the cobalt reduced a corresponding amount, or tungsten 1–4% with the cobalt reduced a corresponding amount.

Where a softer alloy is desired, as in the forming of pins, bars and the like which subsequently are to be best to shape, I increase the nickel to about 50% and lower the cobalt a corresponding amount. The boron content of this alloy operates to facilitate the subsequent weld attachment of these pins or bars to a cast denture and even permits the casting of the denture directly onto the pin or bar as heretofore practiced in the art with other metals.

In the manufacture of the alloy composition of the present invention I prefer to separately form a cobalt-nickel alloy, a chromium-nickel alloy, and a nickel-boron alloy or a nickel-chromium-boron alloy either of which alloys may contain manganese in such amounts as is necessary to effectively neutralize any sulfur present in the alloys. These alloys preferably should be substantially free from carbon and from iron. I then mix the various alloys together, preferably in small sized pieces, in such relative amounts as will give me the alloy composition desired, and melt the same down in an electric induction furnace under conditions protecting the metal from oxidation. When fully molten the alloy is cast in a mold adapted to form relatively small diameter rods which after solidification may be cut or broken into relatively small sized pieces. Where silicon, molybdenum or tungsten are to be added to the alloy, I preferably add them in the form of nickel alloys of these metals.

In the forming of a denture from this alloy, a sufficient amount of these small sized pieces of rod is placed in an open crucible and is melted by the direct application thereon of the oxy-acetylene or oxy-hydrogen flame and as soon as the metal becomes molten and fluid the molten metal is cast centrifugally into the denture mold as heretofore practiced in the art. The thus formed cast denture will be substantially free from blow holes, voids, or of oxide and slag inclusions. Any boron which is oxidized during the melting prior to casting forms such a fluid slag that on entering the mold during casting the same does not interfere with the entrance of the molten metal into the finest crevices of the mold, and a clearly defined sound casting will be obtained.

From the above description of the present invention, it will be apparent that the same may be widely varied as to alloy composition without departure from the invention and all such modification and variations are contemplated as may fall within the scope of the following claims:

What I claim is:

1. A dental casting alloy adapted to be repeatedly re-melted and cast into substantially sound cast dentures, said alloy comprising chromium 5–30%, cobalt 10–50%, manganese 1 to 2%, boron 1–10%, the balance of the alloy consisting of nickel.

2. A dental casting alloy adapted to be repeatedly re-melted and cast into substantially sound cast dentures, said alloy comprising chromium 25%, cobalt 36%, manganese 1%, boron 5%, the balance of the alloy consisting of nickel.

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