

[54] NICKEL ALLOYS

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[56] References Cited
UNITED STATES PATENTS

2,597,495 5/1952 Jackson et al. 75/171

2,743,176 4/1956 Thomas et al. 75/171

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[57] ABSTRACT

A corrosion resistant precision casting alloy particularly suitable for use as a dental alloy comprises essentially, by weight, 15.0 to 25.0 percent chromium, 3.0 to 6.0 percent molybdenum, 1.0 to 4.0 percent tin, 0.5 to 1.5 percent manganese, 0.5 to 5.0 percent copper, 1.0 to 4.0 percent silicon, up to 1.0 percent aluminum, up to 1.0 percent cobalt, up to 0.2 percent carbon and the balance nickel.

5 Claims, No Drawings

NICKEL ALLOYS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to corrosion resistant precision casting alloys particularly suitable for use as dental alloys.

2. Prior Art

Metals and metal alloys are used extensively in restorative and corrective dentistry for removable restorations, inlays, crowns and bridges, orthodontic appliances, and the like. Dental alloys must meet stringent physical and chemical requirements. First, the chemical nature of the alloy must be such that no harmful physiological effects are produced on the patient or the operator. The alloy must be stainless and resistant to attack by the various acid and alkaline substances naturally present in the mouth and in foods and beverages. It must be capable of being fabricated into the desired dental appliances by dentists and technicians and yet must be hard enough and strong enough to resist wear and deformation in use, and it must be capable of being cast to form precision castings free of inclusions, blow holes and other defects.

Gold alloys were originally the most widely used and useful of the dental alloys. However, the high cost and scarcity of gold led to the development of dental alloys comprising predominantly cobalt and chromium with minor amounts of tungsten, nickel and other metals. These cobalt-chromium base dental alloys are exemplified by those disclosed in U.S. Pat. Nos. 1,961,626 and 2,134,423 to Enrique G. Touceda. More recent work has led to the development of dental alloys comprising predominantly nickel and chromium with minor amounts of molybdenum, iron, copper and other metals. These newer nickel-chromium base dental alloys are exemplified by the alloy disclosed in U.S. Pat. No. 2,597,495 to Jackson and Simmons. All of these prior dental alloys possess to a greater or lesser extent the characteristics required of such alloys as previously discussed. However, none possesses all of the required characteristics to the optimum extent, and research and development of new dental alloys with improved characteristics is constantly taking place.

As a result of our investigation of the problems involved in the development of dental alloys with optimum physical and chemical characteristics, we have found that the addition of a minor but significant amount of tin to nickel-chromium base dental alloys results in a marked improvement in the desired properties of these alloys. The presence of tin in the dental alloy reduces the melting point of the alloy and results in improvement in castability, and the resulting casting is easy to finish and polish and possesses the desired strength and hardness.

SUMMARY OF THE INVENTION

The improved corrosion resistant alloy of the invention comprises essentially, by weight, 15.0 to 25 percent chromium, 3.0 to 6.0 percent molybdenum, 1.0 to 4.0 percent tin, 0.5 to 1.5 percent manganese, 0.5 to 5.0 percent copper, 1.0 to 4.0 percent silicon, up to 1.0 percent aluminum, up to 1.0 percent cobalt, up to 0.2 percent carbon and the balance (52.3 to 79.0 percent) nickel. The resulting alloy is capable of being cast to form precision castings that are free of inclusions, blow

holes and other defects, and the alloy is relatively easy to work while possessing adequate strength and hardness.

DESCRIPTION OF PREFERRED EMBODIMENT

The corrosion resistant alloy of our invention consists predominantly of nickel and chromium with minor but significant amounts of other metals that modify the physical properties (for example, its fusion point, hardness and workability) of the basic alloy composition. In general, the proportion of nickel to chromium in the basic alloy composition may range from about 2:1 to about 5:1, and in the preferred composition is about 3.5:1. Nickel is the major component of the alloy and is employed for its inherent resistance to corrosion. Chromium, the other predominant component of the basic alloy composition, enhances the corrosion resistance of the alloy and also is a solid solution/precipitation hardener. In addition, a small but significant amount of molybdenum is employed to enhance the corrosion resistance of the alloy and as a powerful solid solution/precipitation hardener. A small amount of manganese acts as a safeguard against possible sulfur contamination, a small amount of silicon acts as a deoxidizer and also lowers the fusion temperature of the alloy, and a small amount of copper is added to improve the surface finish of the cast alloy. Optionally, the alloy may contain small amounts of cobalt and aluminum, the latter as a deoxidizer and precipitation hardener, and a very small amount of carbon is usually present in the alloy. Lastly, the alloy of the invention contains a small but significant amount of tin which greatly improves the fluidity of the molten alloy and also contributes to the strength and hardness of the cast alloy without unduly reducing the elongation of the alloy.

The relative proportions of the various elements comprising the new alloy composition have been determined as the result of an intensive investigation to obtain an alloy having optimum chemical and physical properties. Specifically, we have found that the alloy composition of the invention should contain 15 to 25 percent by weight chromium, 3.0 to 6.0 percent by weight molybdenum, 1.0 to 4.0 percent by weight tin, 0.5 to 1.5 percent by weight manganese, 0.5 to 5.0 percent by weight copper, 1.0 to 4.0 percent by weight silicon, up to 2.0 percent by weight aluminum, up to 1.0 percent by weight cobalt, up to 0.2 percent by weight carbon and the balance (about 52.3 to 79.0 percent by weight) nickel. It should be noted that aluminum, cobalt, and carbon are optional constituents of the alloy composition, and further that tin is an essential constituent thereof. A corrosion resistant alloy which contains the aforementioned components in the amounts specified may be readily cast to produce precision castings that may be easily finished and that have the necessary strength and hardness for the applications intended. In particular, the presence of tin in the alloy composition effects a significant improvement in these essential characteristics.

The following specific examples describe the preparation of preferred alloy compositions of the invention.

A base alloy composition comprising 68.25 parts by weight nickel, 20.0 parts by weight chromium, 4.5 parts by weight molybdenum and 1.25 parts by weight manganese was prepared by melting the substantially pure components in a crucible under an inert atmosphere,

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1.5 parts by weight copper, 2.5 parts by weight silicon and, most important, 2.0 parts by weight tin were then added to the alloy melt. After the molten ingredients were thoroughly mixed to form a homogenous melt, the molten alloy was poured into a mold or investment of refractory material to obtain a cast metal shape. Several such investment castings were made. In each case the resulting cast metal shape conformed precisely to the shape of the investment mold and was without blow holes, inclusions or other defects. The alloy shape that was allowed to air-cool in its investment mold had a Rockwell B hardness of 83, and 0.2 percent yield strength of 49,500 psi and a maximum elongation of 13 percent. When cooling was accelerated by the water quenching of the alloy shape — investment mold composite, the alloy had a Rockwell B hardness of 82, and 0.2 percent yield strength of 42,500 psi and a maximum elongation of 17 percent. Further reductions in the Rockwell B hardness and the 0.2 percent yield strength to values of 80 and 42,000 psi respectively accompanied by an increase in the maximum elongation to 25 percent were accomplished by annealing of the alloy shape at 2,000°F. for 30 minutes after which the alloy was quenched in water. The generally good working characteristics typical of the alloy when air cooled can therefore be improved by the two aforementioned techniques or similar treatments following casting. All of these physical characteristics reflect a substantial improvement over the properties of similar, but tin-free, corrosion resistant precision casting alloys known in the prior art.

The foregoing alloy composition was modified by the inclusion of 1.0 percent by weight aluminum therein, the aluminum serving as a deoxidizer and precipitation hardening agent. Other melts of the alloy were modified by the inclusion therein of up to 2.0 percent by

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weight aluminum and up to 1.0 percent by weight cobalt. Some alloy melts contained up to 0.2 percent by weight carbon. All possessed the improved physical properties characteristic of the alloy compositions of the invention.

We claim:

1. A corrosion resistant, hot workable and hardenable precision casting alloy consisting essentially, by weight,

Chromium	15.0 - 25.0	percent
Molybdenum	3.0 - 6.0	do.
Tin	1.0 - 4.0	do.
Manganese	0.5 - 1.5	do.
Copper	0.5 - 5.0	do.
Silicon	1.0 - 4.0	do.
Aluminum	0.0 - 1.0	do.
Cobalt	0.0 - 1.0	do.
Carbon	0.0 - 0.2	do.
Nickel	Balance	

2. The alloy according to claim 1 consisting essentially, by weight,

Chromium	20.0	percent
Molybdenum	4.5	do.
Tin	2.0	do.
Manganese	1.25	do.
Copper	1.5	do.
Silicon	2.5	do.
Nickel	Balance	

3. The alloy according to claim 2 in which the alloy also contains 1.0 percent by weight aluminum.

4. The alloy according to claim 2 in which the alloy also contains up to 1.0 percent by weight cobalt.

5. The alloy according to claim 2 in which the alloy also contains up to 0.2 percent by weight carbon.

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