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PALLADIUM ALLOY

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7 Claims. (Cl. 148—32)

The present application is a division of an application filed in the United States Patent Office by the said Otto Feussner and Alfred Jedele on July 14, 1932 under Serial No. 622,568.

This invention relates to alloys which are suitable for special technical use, said alloys containing as main constituents palladium and silver, the percentage of palladium varying between 40% and 60%, while the percentage of silver varies between 20% and 48%.

Palladium-silver alloys have found some application, although to a limited extent, as a cheap substitute for platinum, for instance in connection with dental work and in the electrical industry for making contacts for small current strength, and so forth. As compared with fine silver, palladium-silver alloys are possessed of the advantage of offering a greater resistance in a chemical as well as in a mechanical respect. However, the hardness even of the hardest alloy composed of like parts of silver and palladium is increased to a value which is about twice the value of the hardness of the two initial metals which are very soft as known. These alloys are unfit for improvement by merely a heat treatment.

If gold is added to the palladium-silver alloys, there will result, as may be expected, an alloy of high chemical and mechanical resistance which, however, is not yet capable of being improved by merely a heat treatment.

According to the present invention, now, a fourth substance is added to the alloy, said fourth substance being used for hardening proper and termed herein the "hardener".

Systematic investigations carried out by the above-named inventors have demonstrated that a number of formerly proposed additional substances such as beryllium, do not effect an essential improvement in connection with palladium alloys. Such an improvement, however, may be accomplished according to the present invention by means of other additional substances.

The substances which according to the present invention are used as the fourth ingredient or main hardener are selected from the metals of the iron group, that is iron, cobalt, nickel. These hardeners may be used either individually or together, say in the form of alloys. Investigations have shown that the amount of the main hardener should not exceed 10%, and should be not less than 2%. The particular constituent, selected from the iron group, which is employed in each particular case should have the property of being dissolved by the base metal of the resulting alloy to a considerably greater degree at higher temperatures than at lower temperatures.

Of the metals of the iron group, cobalt and nickel are preferable to iron. Cobalt and iron are both effective as hardeners in the case of alloys which are composed of about equal parts of palladium and silver, while in the case of alloys which are richer in silver than in palladium, nickel will bring about a better improvement as to hardness, and in the case of alloys which contain a larger proportion of palladium than of silver, cobalt will have a better hardening effect.

In order to have some special desirable properties preponderate or in order to suppress certain undesirable properties of the alloy, it is preferable to add a further, that is to say, a fifth component, to the alloy in very small amounts to act as a supplementary hardener and as a refining agent.

The action of this supplementary hardener consists on the one hand in more or less absorbing the impurities including the gas contained in the alloy in the fused condition, or in converting said impurities into slag, and on the other hand in increasing the capability of the alloy of being improved.

It is known that, for instance, phosphorus has a strong deoxidizing action and lowers the fusing point of the alloys of heavy metals, at the same time increasing the liquidity of the fused alloy. Tantalum and similar substances have become known to the modern art of alloying as being suitable for various purposes on account of their ability of absorbing gas. These substances may therefore be used with advantage in the sense of the present invention for the purpose of changing the properties of the alloys in one way or another.

Increase in hardness with the aforementioned alloys is due to a process of improvement by separation, that is in such a way that the alloys which have been annealed at high temperatures and quenched or chilled are soft and that the hardness is considerably increased by subsequent annealing, the increase in hardness amounting in favorable cases to more than 100%. The most preferable temperatures for the first heating are about from 700 to 1000° C., and for the annealing subsequent to quenching or chilling about from 400 to 700° C.

The mode of operation in making the new and technically valuable alloys of heavy metals as well as the advantages of the new alloys may be illustrated by the following examples:

(*a*) The Brinell hardness of an alloy composed of about equal parts of silver and palladium amounts to 75 kg. per mm². With an addition of 16% of gold and 4% of nickel or of 18% of gold and 2% of cobalt, the Brinell hardness will be raised prior to the process of improvement to 100 kg. per mm² and after heat treatment to from 150 to 180 kg. per mm². Also by addition of 10% of gold and 10% of cobalt the hardness may be improved to attain a value of 160 kg. per mm².

(*b*) An alloy composed of 60% of palladium, 20% of silver, 14% of gold, 6% of cobalt has an initial hardness of about 110 kg. per mm². The hardness is increased by heat treatment to 230 kg. per mm².

(*c*) An alloy composed of 40% of palladium, 48% of silver, 8% of gold, 4% of nickel after chilling from 1000° C. has a hardness of 115 kg. per mm² and after heat treatment at 450° C. a hardness of 180 kg. per mm². This alloy can be worked excellently.

(*d*) An alloy composed of 60% of palladium, 20% of silver, 16% of gold, 4% of nickel after treatment like that stated in the Example (*c*) has in soft condition a hardness of 130 kg. per mm² and in hard condition of 200 kg. per mm².

The addition of about 3 to 4% of phosphorus is particularly advisable in order to reduce the fusing point of the alloy without impairing its other properties, thus facilitating the casting of the alloys, which is of particular importance when it is desired to make castings of small dimensions, for instance, for dental purposes which castings after final fashioning and after proper heat treatment should attain greatest possible hardness.

If the improvement process by heat treatment is combined with the improvement process by case hardening which may be done in a single working step, a hardness may be obtained in the alloy surpassing in some cases the above mentioned values by 100% and more.

This is due especially to the case hardening which brings about a diffusion between the several constitutents of the alloy, this diffusion acting favorably upon the finely dispersed separation which is necessary for the hardening, a heavy diffusion taking place at the same time through the crystal grid. On account of the fact that the new alloys are composed of four or more substances considerable improvements may be attained by applying the new combination of different processes of hardening, these improvements consisting essentially therein that even in the form of relatively thick fashioned pieces the completed alloys are in every case homogeneous throughout and not merely treated to a smaller or greater extent on the surface.

An especial characteristic property of the new alloys has been found to reside in the fact that within a range of temperature between 600 to 650° C. the structure of the alloy undergoes a conversion, in the present case with the effect that the boundaries of the grain of the alloys will disappear more or less and by proper treatment even fully and that surfaces made on the alloy by grinding will assume a uniformly chamfered appearance. As the boundaries of the grain, as known, are always more or less mechanically weak so that fractures and the like are liable to arise at these places, a treatment of the alloy which results in the disappearance of these boundaries will be of especial value from a technological point of view. It is therefore advisable to bring about this condition by heat treatment at temperatures above about 600° C., as far as this can possibly be carried out.

Where in the appended claims the expression "substantially consisting of about" is used, this is to be interpreted as meaning that the alloys may also contain other metals of the platinum group, minor amounts of copper (which is similar to gold and does not change the tarnish-resisting properties of the alloys when used in amounts up to 5%) and such substances as phosphorus or tantalum which do not materially change the properties of the alloys to be hardened by heat treatment, but do improve the alloys as to their natural hardness, melting point, liquidity etc.

We claim as the invention of the said Otto Feussner and Alfred Jedele:

1. An age hardening alloy substantially consisting of about 60 to 40% of palladium, 20 to 48% of silver, 8 to 18% of gold, and not less than 2 nor more than 10% of a constituent selected from the metals of the iron group (iron, cobalt, nickel).

2. An age hardening alloy according to claim 1, containing an addition of about 3 to 4% of phosphorus.

3. An age hardening alloy substantially consisting of about 40% of palladium, 40% of silver, 16% of gold, and 4% of nickel.

4. An age hardening alloy substantially consisting of about 60% of palladium, 20% of silver, 14% of gold, and 6% of cobalt.

5. An age hardening alloy substantially consisting of about 60% of palladium, 20% of silver, 16% of gold, and 4% of nickel.

6. A dental element in the form of a member cast in the shape required for the dental work in the particular case, said cast member being made of the alloy set forth in claim 1.

7. A dental element in the form of a member cast in the shape required for the dental work in the particular case, said cast member being made of the alloy set forth in claim 1, in which the melting point of the liquid alloy is decreased, the liquidity is increased and the alloy is completely deoxidized by the addition of from 3 to 4% of phosphorus.

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