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NOBLE METALS ALLOY CONTAINING GALLIUM
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The present invention relates to alloys and more particularly to noble metal alloys for use in dentures, dental appliances, jewelry and analogous purposes.

Noble metal alloys for the purposes specified usually contain a high percentage of platinum, have the color and general appearance of platinum, have high tensile strength and are highly resistant to corrosion and oxidation. Because of the high cost of platinum, said metal has been alloyed with palladium and gold with good results. Where the alloys contained a substantial percentage of palladium, silver and nickel have been added to harden the alloy and lower further the cost thereof. It has also been proposed to eliminate entirely the platinum and form the alloy of palladium and nickel. Although palladium-nickel alloys possess many desirable properties, they are deficient in reflectivity when used for jewelry and particularly for settings for gems. To improve the color and reflectivity of such palladium-nickel alloys, ruthenium has been added to provide a palladium-nickel-ruthenium alloy which has more desirable characteristics.

Notwithstanding the advances made in noble metal alloys for use in dentures and dental appliances much was still desired in the physical properties of such alloys.

An object of the present invention is to provide an improved corrosion and tarnish resistant noble metal alloy which does not contain platinum but which nevertheless has all the desirable properties of a platinum alloy and which is useful and more practicable in making partial dentures, cast crowns, inlays and bridgework and articles of jewelry.

A further object of the invention is to provide a noble metal alloy which does not contain platinum and which can be bonded to porcelain to enhance the esthetic appearance of a denture formed of such alloy.

A still further object of the invention is to provide a novel noble metal alloy which has the desired hardness and which also has improved workability such as ease in machining, grinding and polishing and a lower temperature casting point which renders the alloy particularly suitable to dental applications.

The foregoing and other objects of the invention, not specifically set forth, I accomplish by providing a novel noble metal alloy comprising substantial percentages of palladium and gold, a lesser percentage of ruthenium and also gallium and optionally, silver or copper in percentages not in excess of the gold.

An alloy having the physical properties desired as set forth in the aforementioned objects of the invention is obtainable by alloying from 40 to 70% palladium, from 10 to 50% gold, from 2.0 to 5.0% ruthenium and from 2.0 to 15.0% gallium, and optionally from 10 to 25% of either silver or copper. Preferably the palladium, silver or copper when used, ruthenium and gallium are first melted together, the gallium having the property of lowering the temperature of the melt to which the gold in molten condition is then added.

The color of the alloy will vary from light gold to silvery white as the percentages of the gold, and copper when used, is lowered and the percentage of one or more of the silver, ruthenium and gallium are increased. Where especially high reflectivity is desired in the alloy when polished, such for example, when the alloy is to be used for jewelry and especially for setting precious stones therein, the higher limits of the ruthenium and gallium

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are used in the alloy. I have also found that the melting point of the alloy can be brought down to better workable limits and can be cast in plasterbound refractory material where the percentage of gallium is 10% or more.

Specific alloy formulations which I have made and tested are as follows:

Example 1

	Percent
Palladium	62
Gold	25
Gallium	10
Ruthenium	3

This alloy was easy to cast in plasterbound molds and possessed good adhesion to porcelain. In fact it has been observed that where porcelain is fused to this alloy, the bond between the alloy and the porcelain is so great that the porcelain cannot be easily separated by a chipping procedure. In fact the porcelain will chip within itself before it separates from the surface of the alloy.

Example 2

	Percent
Palladium	40
Gold	25
Silver or copper	20
Gallium	10
Ruthenium	5

This alloy was easy to cast in plasterbound molds, was good for partial dentures, but was not satisfactory for adhesion to porcelain.

Example 3

	Percent
Palladium	50
Gold	30
Silver or copper	10
Gallium	5
Ruthenium	5

This alloy may be cast at a temperature of about 2372° F. thereby rendering it castable in plasterbound refractory molds to great accuracy and workable at approximately 2192° F. at which the alloy softens but does not melt. This alloy is not satisfactory for adhesion to porcelain.

As the ruthenium in the foregoing formulations is introduced primarily for hardening purposes, it will be understood that it can be replaced by iridium. The selection of ruthenium in preference to iridium is a matter of economy.

An economy alloy could be formed by reducing the percentages of palladium and/or gold and introducing copper and/or silver up to 25% and still have a satisfactory alloy. Such alloys are set forth in Examples 2 and 3 but are not as high in quality as alloys without copper and/or silver.

It is also well known in the dental art that cast partials frequently require repair due to fracture of metal parts or additions to the pre-existing partial and that such repairs or additions are made by the use of solder or welding rods.

Where a welding rod is used, it should have a melting temperature substantially below the melting temperature of the cast partial in order to avoid damage to the latter during the welding operation. I have found that with the foregoing alloys I can produce a welding rod alloy of the same constituents having a suitable lower melting temperature by the addition of about 5% more gallium to the alloy composition. It will be understood that the precise amount of gallium to be added to form the welding rod is such as will lower the melting point of the welding rod alloy to approximately 200° to 400° F. below the melting point of the alloy forming the cast partial denture.

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Although I have described the invention broadly and have given but a few examples of specific alloys formulations possessing the desirable characteristics in an alloy particularly adaptable for use in making partial dentures, dental appliance applications and jewelry, it is to be understood that the invention is to be construed by the scope of the appended claims.

What I claim is:

1. An alloy consisting essentially of the following elements within the following percentages by weight:

	Percent
Palladium -----	40-62
Gold -----	40-10
Ruthenium -----	2.0-5.0
Gallium -----	2.0-15

2. An alloy consisting essentially of the following elements within the following percentages by weight:

	Percent
Palladium -----	40-62
Gold -----	40-10
Ruthenium -----	2.0-5.0
Gallium -----	2.0-15

and from 10%-25% of at least one of the elements selected from the group consisting of copper and silver.

3. An alloy consisting essentially of the following elements in percentages by weight:

	Percent
Palladium -----	62.0
Gold -----	25.0
Ruthenium -----	3.0
Gallium -----	10.0

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4. An alloy consisting essentially of the following elements in percentages by weight:

	Percent
5 Palladium -----	40.0
Gold -----	25.0
Ruthenium -----	5.0
Gallium -----	10.0
And at least one element selected from the group consisting of copper and silver -----	20.0

5. An alloy consisting essentially of the following elements in percentages by weight:

	Percent
15 Palladium -----	50.0
Gold -----	30.0
Ruthenium -----	5.0
Gallium -----	5.0
20 And at least one element selected from the group consisting of copper and silver -----	10.0

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