

[54] **RHENIUM CONTAINING GOLD ALLOYS**

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[*] Notice: The portion of the term of this patent subsequent to May 30, 1989, has been disclaimed.

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 764,589, Oct. 2, 1968, abandoned, which is a continuation-in-part of Ser. No. 665,995, July 26, 1967, abandoned.

[52] U.S. Cl. **75/165, 75/134 V, 75/172**

[51] Int. Cl. **C22c 5/00**

[58] Field of Search. **75/165, 134 V, 172**

[56] **References Cited**

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[57] **ABSTRACT**

There is disclosed a novel and improved gold alloy containing at least about 5.5 per cent of palladium and about 0.03 to 1.0 per cent by weight of rhenium, and either or both of platinum and iron when the palladium content is less than 25.0 per cent.

8 Claims, No Drawings

RHENIUM CONTAINING GOLD ALLOYS

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation-in-part of copending application Ser. No. 764,589 filed Oct. 2, 1968, now abandoned, which in turn was a continuation-in-part of then copending application Ser. No. 665,995, filed July 26, 1967, now abandoned.

BACKGROUND OF THE INVENTION

It is generally known that the metals of Group VIII of the Periodic Table affect the morphology or grain structure of gold alloy castings. Use of ruthenium, rhodium, palladium, platinum and indium in gold alloys in amounts of up to about 3.0 percent total or the solubility thereof produces grain refinement with castings containing such elements evidencing a grain size several times smaller than the grain size of comparable alloys which do not contain such alloying elements.

However, as the content of the Group VIII metals increases to above about 3.0 percent by weight of the gold alloy, the grain structure thereof becomes progressively coarser. Initially, the increasing amounts produce irregular grains and then a dendritic structure. Coarse grain structure is generally undesirable because it tends to severely affect the quality of castings and the workability of the alloy. As is known, coarse grain dendritic alloys are significantly susceptible to increased porosity in the cast condition and tend to develop intergranular cracking during cold working.

Accordingly, it is an object of the present invention to provide novel equiaxed grain gold alloys containing palladium, with or without platinum and/or iron, in relatively large quantities and which may be cast without close control over the amount of superheat and rate of cooling.

It is also an object to provide such an alloy which evidences a fine grain structure upon casting and which is readily adapted to working.

A further object is to provide such an alloy for producing castings which exhibit low shrinkage porosity and highly desirable balanced properties.

SUMMARY OF THE INVENTION

It has now been found that the foregoing and related objects can be readily attained in a gold alloy consisting essentially of about 5.5 to 40.0 percent palladium, 0.0 to 10.0 percent platinum, 0.03 to 1.0 percent rhenium, 0.0 to 2.0 percent silver, 0.0 to 1.0 percent iron, 0.0 to 1.5 percent zinc, 0.0 to 2.0 percent tin, 0.0 to 1.0 percent indium, and the balance gold. The gold is present in an amount of about 59.0 to 94.47 percent and the total of palladium and platinum in the alloy does not exceed 40.0 percent by weight thereof with the platinum being less than the palladium, all based upon the total weight of said alloy.

When the palladium content is less than about 25.0 percent of the alloy, there is present at least one modifying metal selected from the group consisting of iron and platinum to produce an equiaxed grain structure; the platinum modifying metal is present in an amount of at least about 1.0 percent and the iron modifying metal being present in an amount of at least about 0.3 percent.

By the present invention, highly desirable gold alloys containing relatively large quantities of palladium and platinum may be prepared for use both as castings and in worked forms such as foil and wire. Although gold alloys containing more than about 3.0 percent by weight of the Group VIII metals tend to evidence a coarse grain structure, far larger quantities of palladium and platinum may now be employed while at the same time obtaining a fine equiaxed grain structure.

The palladium and platinum may be present in varying amounts, although the total thereof must not exceed 40.0 percent. Generally, the palladium may comprise from 5.5 to 40.0 percent by weight of the alloy. It may be used alone or in combination with platinum which may be used in amounts of up to 10.0 percent by weight of the alloy but less than the palladium content. Although rhodium may be used in small amounts in conjunction with palladium, it is generally less desirable because of its possible effect upon other properties of the alloy.

When palladium is employed alone, it will preferably be present in the amount of about 5.5 to 15.0 percent by weight. When palladium and platinum are utilized in combination, the palladium is preferably in the range of about 5.5 to 12.0 percent by weight, and the platinum is preferably in the range of about 2.0 to 7.0 percent by weight but less than the palladium content. The weight ratio of the Group VIII metals to gold must be in the ratio of about 0.03 - 0.67:1.0 in order to obtain the desired equiaxed grain structure. Similarly, the ratio of rhenium to gold should be controlled so as to fall within the range of about 0.0005 - 0.017:1.0.

Other compatible alloying elements conventionally employed in gold alloys may be incorporated in the compositions of the present invention such as silver up to about 2.0 percent by weight, iron up to about 1.0 percent by weight, zinc up to about 1.5 percent by weight, tin up to about 2.0 percent by weight, and indium up to about 1.0 percent by weight. The total amount of these optional alloying elements should not exceed 10.0 percent by weight of the alloy. Hardeners, such as iron, have proven particularly advantageous in the alloys produced in accordance with the present invention. However, a relatively large amount of any element in which rhenium exhibits extensive solubility should be avoided since it would seriously impair the efficacy of the rhenium in accordance with the present invention.

The mechanism of the rhenium in this alloy is not fully understood, although its effect is most obvious. Although the rhenium may be employed to advantage over the relatively wide range of 0.03 to 1.0 percent by weight, it is preferably employed in the range of about 0.08 to 0.3 percent by weight for optimum balance of properties, but larger amounts may be desirable where the gold content is higher. The rhenium is preferably added after the remaining alloying elements have been melted together and thereafter the alloy may be remelted without any detriment to the benefits obtained thereby.

Moreover, when the palladium content is less than about 25.0 percent, it has been found that reliable results in obtaining an equiaxed structure require the presence of at least one or both of platinum and iron as modifying metals. The function of these metals in

promoting the equiaxed structures is not understood but the presence of as little as 1.0 percent platinum will greatly improve the reliability of the alloy. Iron in an amount of 0.3 – 1.0 percent also improves the reliability of the alloy in giving rise to an equiaxed grain structure in the cast product, and the preferred alloys with less than 25.0 percent palladium contain both platinum and iron.

It has been found that the alloys of the present invention do not require critical control of superheat or cooling rates. As a result, fine-grain castings have been obtained with superheats of as much as 500° C.

Castings of the alloys have been found to be uniformly sound and free from shrinkage porosity and to possess an equiaxed fine-grain structure. Working of these alloys into nugget and wire form has established the highly desirable workability thereof and freedom from intergranular cracking. Hardening mechanisms common to gold-platinum alloys are effective in the presence of the rhenium additive. Thus, the alloy of the present invention evidences significant utility and obvious advantages.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Illustrative of two specific alloy compositions are the following wherein one contains a hardening system and the other does not:

Alloy No. One

	Percent by Weight
Gold	91.4
Palladium	5.5
Platinum	3.0
Rhenium	0.1

Alloy No. Two

Gold	79.4
Palladium	10.8
Platinum	5.9
Rhenium	0.1
Iron	0.8
Tin	1.0
Silver	2.0

Exemplary of the efficacy of the present invention are the following specific examples wherein all parts and percentages are by weight unless otherwise indicated.

A series of gold-base alloys containing at least various of the elements palladium, platinum, iron and rhenium were prepared and cast into 700° C. phosphate-bound investment molds. As a measure of grain size in the solidified alloys, the number of grain boundaries observed to intercept a line was determined and expressed as grain boundaries per millimeter, the greater number of boundaries being indicative of the smaller-sized grains. Table One which follows indicates the grain size of cast alloys containing the various elements in the weight percentages specified.

Example	Au Pd	Pt	Fe Re	Grain Boundaries Other per Millimeter
One	60.040.0			11
Two	59.739.8		0.50	23
Three	59.439.6		1.0	30
Four	71.428.6			19
Five	71.028.5		0.5	46
Six	81.111.0	6.0	0.8	1.1 Sn 1.8
Seven	81.011.0	6.0	0.8 0.1	1.1 Sn 57
Eight	89.910.0		0.1	13
Nine	89.410.0		0.5 0.1	37

Ten	87.96.0	6.0	0.1		40
Eleven	79.410.8	5.9	0.77 0.09	1.08 Sn; 1.96 Ag	57
Twelve	80.210.9	5.9	0.8 0.1	1.1 Sn; 1.0 In	53
Thirteen	79.610.8	5.9	0.8 0.1	1.08 Sn; 0.98 Ag; 0.74 Zn	50
Fourteen	87.512.0		0.5		11
Fifteen	87.56.0	6.0	0.5 0.1		37

As can be seen from Table One, the alloy of Example One contained only gold and a large amount of palladium; the grains of the alloy were relatively large. Inspection of the grains also indicates that they were irregularly shaped. For comparison, the alloys of Examples Two and Three, which contained essentially the same amount of gold and palladium as the alloy of Example One were prepared, but 0.50 and 1.0 percent rhenium were included respectively in the latter two alloys. As the table shows, adding 0.50 percent of rhenium decreased the size of the grains by about one-half. Adding 1.0 percent caused a further decrease so that the size of the grains was almost one-third of the size of the grains contained in the alloy of Example One. In addition, the grains in the alloys of Examples Two and Three were found to be much more equiaxed than those of the alloy of Example One.

The increased effectiveness of rhenium in alloys containing a greater gold:platinum ratio is demonstrated by the comparison of the alloys of Examples Four and Five. Here it found that the grains are refined by the inclusion of 0.48 percent rhenium to an average size which is about two-fifths the size of the comparable alloy containing no phenium.

The alloys of Examples Six and Seven demonstrate not only the effectiveness of the inclusion of rhenium in alloys containing even higher gold:palladium ratios, but also the effectiveness of rhenium alloys containing a combination of palladium and platinum. Small amounts of iron were also present in these alloys. It is seen that a dramatic decrease in grain size results from the inclusion of a very small amount of rhenium. Inspection of the alloys also showed that the alloy of Example Six had a dendritic morphology whereas the grains of the alloy of Example Seven, which contained the rhenium, were nondendritic. Thus, by comparing the alloys of Examples Six and Seven, the effect of rhenium on grain formation is clearly demonstrated.

In Examples Eight through Ten, the effect of iron or platinum in obtaining a high level of grain refining is demonstrated. In Examples Fourteen and Fifteen, the effect of iron with and without rhenium may be seen.

Other alloys were prepared which contained in addition to gold, platinum, and/or iron, palladium and rhenium small amounts of the elements tin, silver, zinc and indium as set forth in Examples Ten through Thirteen. All such alloys exhibited fine grain structure and none exhibited dendritic morphology.

Thus, it can be seen that the present invention provides novel gold alloys containing significant amounts of palladium (and platinum) while at the same time evidencing equiaxed fine-grain structure. The alloys produce castings free from shrinkage porosity and are readily workable to provide structures free from intergranular cracking. Hardening mechanisms are optionally employed in connection therewith so that alloys of a most desirable balance of properties may be obtained.

Having thus described the invention, I claim:

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1. A gold alloy consisting essentially of about 5.5 to 40.0 percent palladium, 0.0 to 10.0 percent platinum, 0.03 to 1.0 percent rhenium, 0.0 to 2.0 percent silver, 0.0 to 1.0 percent iron, 0.0 to 1.5 percent zinc, 0.0 to 2.0 percent tin, 0.0 to 1.0 percent indium, and the balance gold, said gold being present in an amount of about 59.0 to 94.47 percent, the total palladium and platinum in said alloy not exceeding 40.0 percent with said platinum being less than said palladium, all based upon the total weight of said alloy, provided that when said palladium is less than about 25.0 percent of said alloy there is present at least one modifying metal selected from the group consisting of iron and platinum to produce fine grain structure, said platinum modifying metal being present in an amount of at least about 1.0 percent, and said iron modifying metal being present in an amount of at least 0.3 percent.

2. The gold alloy of claim 1 wherein said rhenium is present in the amount of about 0.08 to 0.3 percent by weight.

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3. The gold alloy of claim 1 wherein said palladium is present in the amount of 5.5 to 15.0 percent by weight, platinum is not present and iron is present in the amount of 0.3 to 1.0 percent.

4. The gold alloy of claim 1 wherein said palladium is present in the amount of 5.5 to 12.0 percent by weight and said platinum is present in the amount of 2.0 to 7.0 percent by weight.

5. The gold alloy of claim 4 wherein iron is present in the amount of about 0.3 to 1.0 percent.

6. The gold alloy of claim 1 wherein there is present at least 1.0 percent by weight platinum.

7. The gold alloy of claim 1 wherein the ratio of rhenium to gold is within the range of 0.0005 to 0.017:1.0 and the ratio of Group VIII metals to gold is in the range of about 0.03 to 0.67:1.0.

8. The gold alloy of claim 1 wherein palladium is present in the amount of about 25 to 40 percent.

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