

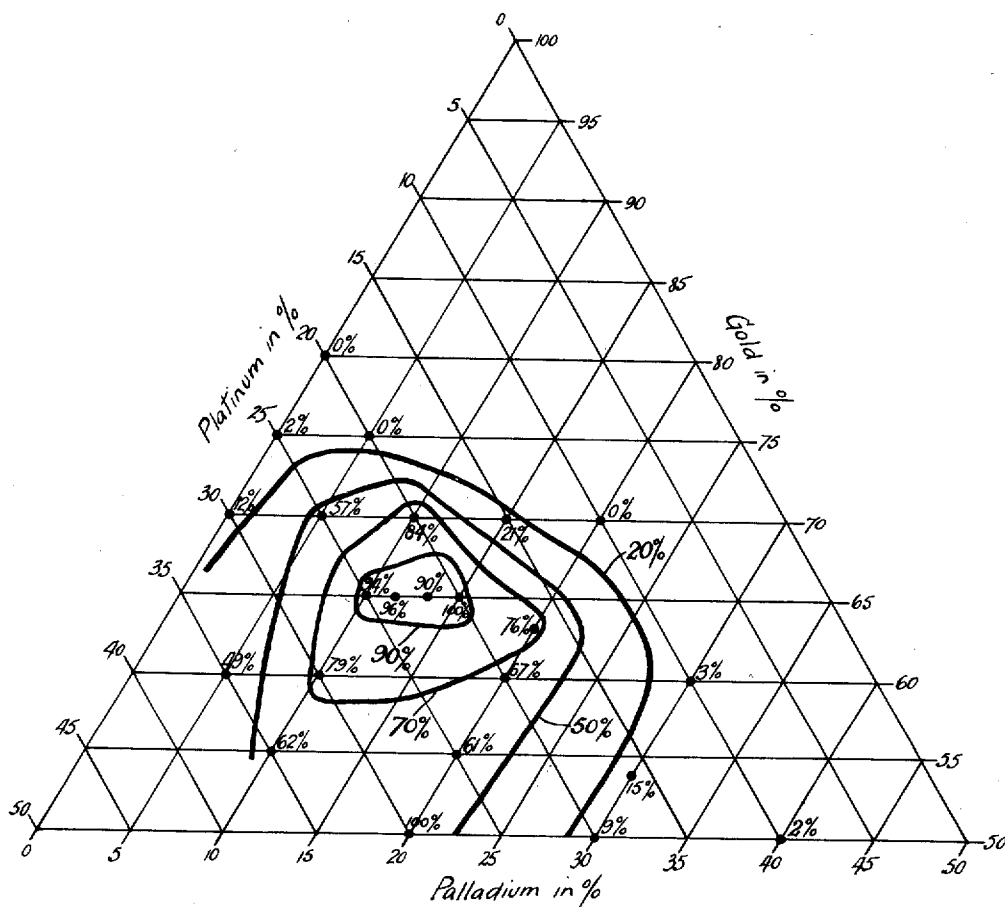
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PRECIOUS METAL ALLOYS

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PRECIOUS METAL ALLOYS

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This invention relates to the production and heat treatment of precious metal alloys containing more than 50% of gold and more particularly of such alloys the other components of which are platinum and palladium.

It is well known that platinum gold alloys containing more than about 20% of platinum can be hardened by heat treatment i. e. by quenching from a high temperature and annealing at an intermediate temperature. An alloy of 70% of gold and 30% of platinum has been used for making caps for spinning artificial silk but great difficulty is experienced in making it owing to the ease with which segregation occurs in casting and the slowness with which a homogeneous solid solution is obtained by high temperature annealing. Attempts have been made to overcome these difficulties by reducing the platinum content to from 10 to 20% and adding a base metal, as for example iron, zinc, nickel or copper to produce the desired hardening action on heat treatment. The presence of base metals in these alloys is undesirable for many purposes and introduces difficulties in working and annealing.

We have now found that all these difficulties may be overcome by utilizing platinum and palladium together as the alloying elements. Contrary to expectation, palladium which readily forms homogeneous solid solutions with both platinum and gold, does not reduce the hardening effect of the platinum but rather increases it within a certain range of composition.

The accompanying diagram shows the range of composition within which these so-called precipitation-hardening effects can be obtained, the lines representing equal percentage increases in hardness produced by annealing for 2 hours at 600° C. alloys which have been quenched from 1100° C.

It will be seen that alloys having the composition 50 to 75% of gold, 40 to 15% of platinum and 5 to 25% of palladium undergo an increase in hardness of more than 20%, those having the composition 50 to 70% of gold, 35 to 15% of platinum and 5 to 23% of palladium an increase of more than 50%, those having a composition 60 to 70% gold, 30 to 15% of platinum and 10 to 20% of palladium an increase of more than 70% and those having the composition 63 to 68% of gold, 25 to 20% of platinum and 10 to 15% of palladium an increase of more than 90%.

The following table shows the hardening effects obtained with a number of alloys after the pre-

ferred heat treatment described more fully below:—

	Composition in percent			Vickers pyramid hardness	
	Gold	Platinum	Palladium	Annealed at 1100° C. for 90 minutes and quenched	Re-annealed at 600° C. for 2 hours
1	80	20	—	78	77
2	75	25	—	98	100
3	75	20	5	90	89
4	70	30	—	117	132
5	70	25	5	90	89
6	70	20	10	104	192
7	70	15	15	93	113
8	70	10	20	75	75
9	65	25	10	128	249
10	65	20	15	104	210
11	65	23	12	119	234
12	60	35	5	177	265
13	60	20	20	115	193
14	60	10	30	89	92
15	55	25	20	138	223
16	50	30	20	107	216

We have found that the heat treatment necessary to produce the said hardening effects comprises a homogenizing anneal at a temperature above 1000° C. but below the melting point of the alloy and preferably about 1100° C., quenching and reheating at a temperature within the range of from 500° to 750° C. for a sufficient time to produce the desired hardness. The actual hardness obtained is a function of the reheating temperature and the time of reheating, maximum values being obtained at 600° C. in from about 1 to 1½ hours. Naturally, the higher the reheating temperature, the shorter the time required.

In the preparation of sheets by rolling from cast ingots of these alloys we have found that the prolonged high temperature annealing necessary for complete homogenization if given at the final of rolling induces a very coarse crystal growth in the sheet, which is objectionable when the alloy is to be used for deep drawing or stamping. We prefer therefore to give the alloy this prolonged high temperature anneal as for example 1 to 2 hours at 1100° C. at an early stage in the rolling process for example after 50% reduction in thickness and to carry out subsequent anneals for the purpose of removing work-hardness at the same high temperature but only for very short periods, for example from 1 to 5 minutes, it being understood that a quenching follows every anneal. In this way the sheets acquire a fine-grained crystal structure and can be very readily stamped or deep-drawn into caps

for spinnerets and the like having a very smooth surface suitable for drilling. The subsequent heat treatment at from 500° to 750° C. produces the desired hardening effect without in any way causing distortion.

We have also found that the final hardness of the alloy may be further increased by subjecting the soft metal resulting from the high temperature anneal and quenching operation to cold-work, such as rolling, stamping or drawing, prior to the reheating at intermediate temperature. The final hardness in this case appears to be the sum of the work-hardening effect and the precipitation hardening effect.

Thus a specimen of the 70:20:10 gold-platinum-palladium alloy after quenching from 1100° C. has a hardness of about 85 and after 1 hour at 600° C. a hardness of about 142. Another specimen of the same alloy after quenching was cold-rolled to a hardness of 165; after 1 hour at 600° C. the hardness had risen to 221.

We have also found that the said hardening effects may be obtained by slow cooling from the high temperature to the intermediate temperature and then quenching. Thus for example the alloy specified above after heating at 1050° C. for 1 hour and cooling during 40 minutes to 600° C. and then quenching gave a hardness of about 172. This result indicates that precipitation of the new phase which produces hardening takes place fairly rapidly in the range of from 600° to 800° C. and therefore that rapid quenching from above 1000° C. is essential to produce a soft alloy.

What we claim is:—

1. An alloy composed of 50 to 75% of gold, 40 to 15% of platinum and 5 to 25% of palladium hardened by heat treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

2. An alloy composed of 50 to 70% of gold, 35 to 15% of platinum and 15 to 25% of palladium hardened by heat treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

3. An alloy composed of 60 to 70% of gold, 30 to 15% of platinum and 10 to 20% of palladium hardened by heat treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

4. An alloy composed of 63 to 68% of gold, 25 to 20% of platinum and 10 to 15% of palladium hardened by heat treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

5. An alloy of 60% of gold, 20% of platinum and 20% of palladium hardened by heat treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

6. An alloy of 70% of gold, 20% of platinum and 10% of palladium hardened by heat treatment comprising annealing at 1100° C. to obtain homogeneity, quenching and reheating at 600° C. for from 1 to 1½ hours.

7. An alloy composed of 50 to 75% of gold, 40 to 15% of platinum and 5 to 25% of palladium hardened by heat and mechanical treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching, cold-working and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

8. An alloy composed of 50 to 70% of gold, 35 to 15% of platinum and 15 to 25% of palladium hardened by heat and mechanical treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching, cold-working and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

9. An alloy composed of 60 to 70% of gold, 30 to 15% of platinum and 10 to 20% of palladium hardened by heat and mechanical treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching, cold-working and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

10. An alloy composed of 63 to 68% of gold, 25 to 20% of platinum and 10 to 15% of palladium hardened by heat and mechanical treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching, cold-working and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

11. An alloy of 60% of gold, 20% of platinum and 20% of palladium hardened by heat and mechanical treatment comprising annealing at a temperature above 1000° C. but below the melting point of the alloy to obtain homogeneity, quenching, cold-working and reheating at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

12. An alloy of 70% of gold, 20% of platinum and 10% of palladium hardened by heat and mechanical treatment comprising annealing at 1100° C. to obtain homogeneity, quenching, cold-working and reheating at 600° C. for 1 to 1½ hours.

13. A hardened sheet alloy composed of 50 to 75% of gold, 40 to 15% of platinum and 5 to 25% of palladium having a fine crystal structure prepared by rolling from an ingot, a prolonged homogenizing anneal at above 1000° C. but below the melting point of the alloy being given to the alloy at an early stage of the rolling process, short anneals at the same temperature being effected at intervals in the rolling process to remove work-hardness, each of the anneals being followed by a quenching, and a final reheating being then carried out at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

14. A hardened sheet alloy composed of 50 to 70% of gold, 35 to 15% of platinum and 15 to 25% of palladium having a fine crystal structure prepared by rolling from an ingot, a prolonged homogenizing anneal at above 1000° C. but below the melting point of the alloy being given to the

alloy at an early stage of the rolling process, short anneals at the same temperature being effected at intervals in the rolling to remove work-hardness, each of the anneals being followed by a quenching, and a final reheating being then carried out at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

15. A hardened sheet alloy composed of 60 to 70% of gold, 30 to 15% of platinum and 10 to 20% of palladium having a fine crystal structure prepared by rolling from an ingot, a prolonged homogenizing anneal at above 1000° C. but below the melting point of the alloy being given to the alloy at an early stage of the rolling process, short anneals at the same temperature being effected at intervals in the rolling process to remove work-hardness, each of the anneals being followed by a quenching, and a final reheating being then carried out at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

16. A hardened sheet alloy composed of 63 to 68% of gold, 25 to 20% of platinum and 10 to 15% of palladium having a fine crystal structure prepared by rolling from an ingot, a prolonged homogenizing anneal at above 1000° C. but below the melting point of the alloy being given to the alloy at an early stage of the rolling process, short anneals at the same temperature being effected at intervals in the rolling to remove work-hardness, each of the anneals being followed by a quenching, and a final reheating being then

carried out at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

17. A hardened sheet alloy of 60% of gold, 20% of platinum and 20% of palladium having a fine crystal structure prepared by rolling from an ingot, a prolonged homogenizing anneal at above 1000° C. but below the melting point of the alloy being given to the alloy at an early stage of the rolling process, short anneals at the same temperature being effected at intervals in the rolling process to remove work-hardness, each of the anneals being followed by a quenching, and a final reheating being then carried out at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

18. A hardened sheet alloy of 70% of gold, 20% of platinum and 10% of palladium having a fine crystal structure prepared by rolling from an ingot, a prolonged homogenizing anneal at above 1000° C. but below the melting point of the alloy being given to the alloy at an early stage of the rolling process, short anneals at the same temperature being effected at intervals in the rolling process to remove work-hardness, each of the anneals being followed by a quenching, and a final reheating being then carried out at a temperature within the range of from 500° to 750° C. for a time sufficient to produce the desired hardness.

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