Patented May 13, 1952

2,596,454

UNITED STATES PATENT OFFICE

2,596,454

GOLD ALLOYS

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No Drawing. Application September 10, 1949, Serial No. 115,111

6 Claims. (Cl. 75—165)

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This invention relates to gold alloys.

Among the several objects of the invention may be noted the provision of a gold alloy which may be used to manufacture either solid gold objects or gold-plated objects, which gold alloy has a greater resistance to stress-corrosion than other gold alloys of similar color and karat; the provision of a gold alloy of the class described which is harder, work hardens less, and wears better when subjected to the wear normally encountered by articles of jewelry, than other gold alloys of similar karat and color; and the provision of a gold alloy which, while having the characteristics outlined above, is simple to make and whose manufacture lends itself to already existing techniques of gold alloy making. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the ingredients and combinations of ingredients, the proportions thereof, and features of composition, which will be exemplified in the products hereinafter described, and the scope of the application of which will be indicated in the following claims.

One of the serious problems existing in regard to gold alloys for the jewelry industry, is that of stress-corrosion. By stress-corrosion is meant, without going into great detail, the phenomenon that when the surface of a metal is under tensile stresses, cracking of the metal by corrosive elements in contact with it is enhanced and greatly speeded. During the course of making an article of jewelry from gold alloy stock material in many instances the gold alloy stock is subjected to cold-working, with the result that the finished article of jewelry will have many places where the surface of the gold alloy is in a highly stressed condition and subject to this type of corrosion. A simple example would be where a sheet of gold alloy, either solid or plated, is formed to make a watch case. The material forming the bent-over rim of the case will be in a stressed condition and subject to stress-corrosion.

This stressed condition is desirable in many instances because such stresses may tend to give a desired stiffness to the finished article. Therefore, in these instances, it will not do to anneal the finished article of jewelry to put it in an unstressed condition.

As an example of the effect of stress in hastening corrosion, the following simple experiment may be cited:

Two pieces of metal of the same alloy were used for the experiment, the alloy being a standard

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10 k. yellow gold having the composition (by weight):

	Per cent
Gold	41.66
Silver	7.67
Copper	41.97
Zinc	8.70

and each piece being approximately 2 inches long by ¼ inch wide by .015 inch thick. The material from which these pieces were cut had previously been subjected to a 50% reduction in thickness by passing it through a rolling mill. One of these pieces was then bent to bring its ends together, and these ends were fastened to maintain the piece in this bent condition. The purpose of the bending is to create a place of concentrated tensile stress in the material. Then both of these pieces (one unbent, and the other bent and thus put under tensile stress) were put in a 1% solution of ferric chloride, which is well known to be a corrosive reagent for gold alloys. The bent piece broke in two at the place of bend in 30 seconds, whereas the unbent piece was substantially unaffected after several hours in the test solution.

The above example is also cited to illustrate a standard procedure for testing for resistance to stress-corrosion. It is, of course, an accelerated test, and the time required for a specimen to break may be taken as a measure of the resistance to stress-corrosion.

This problem of stress-corrosion is particularly acute for the low-karat gold alloys, that is, the 8 to 12 karat alloys from which a large percentage of costume jewelry is made today, and especially where the gold alloy is used only as a thin plating over the base metal which goes to make up the bulk of the article of jewelry.

It is the general purpose of this invention, therefore, to provide a gold alloy, and in particular one suitable for use in the jewelry industry, having a high degree of resistance to stress-corrosion.

The stress-corrosion resistant gold alloy of this invention consists basically of gold, copper, and indium, the latter being present in the gold alloy in the percentages of 0.1% to 5.0% by weight. As supplementary ingredients, it may also contain one or more of the metals silver, zinc, and cadmium.

The quantity of gold present is determined by the desired karat of the gold. This invention is concerned chiefly with gold alloys of 8 to 12 karat, consequently the proportion by weight of the gold in the alloy may vary from approximately 33% to approximately 50%.

The copper content may vary from about 10.7% to about 67% by weight of the alloy, depending upon desired color, hardness, and other qualities of the finished alloy.

As stated above, the indium content of this invention is preferably within the range 0.1% to 5.0%, with 1.0% being a preferred quantity by weight. The indium seems to act as an inhibitor of stress-corrosion and tends to whiten the alloy. If a quantity of indium substantially higher than 5% is used, the resulting alloy tends to lack ductility and becomes difficult to cold work.

As to the supplementary metals, the silver and zinc (or cadmium) help to get the desired color in the alloy. The zinc (or cadmium) stiffens the alloy, acts as a deoxidizer, and helps in casting the alloy. The silver affects the ductility of the alloy. Each of the silver, zinc, and cadmium may be in the range of about 2–10% by weight.

While the stress corrosion resisting property of gold alloys is substantially increased in all cases by the presence of indium in the alloy, this increase is not uniform, as is indicated in Table I, wherein is shown the composition of the alloys tested (all being 10 k.) and the relative stress corrosion, the latter being indicated by the time required for breaking of the test strip in an $FeCl_3$ solution of 1% (as described above).

Table I

Alloy No.	Composition in per cent by weight					Cracking Time in 1% $FeCl_3$ Solution
	Au	Cu	Ag	Zn	In	
1	41.66	41.75	8.34	8.0	.25	Cracked 2 min. 20 sec.
2	41.66	42.50	8.34	7.0	.50	No cracks after 22 hours.
3	41.66	43.0	8.34	6.0	1.0	Do.
4	41.66	43.0	8.34	5.0	2.0	Do.
5	41.66	41.17	7.17	4.70	5.0	41 min. 25 sec.

In Table II, for purposes of identification, there is given a series of 8, 10 and 12 karat gold alloys, by their compositions, one half of these alloys containing 1% indium, the other half not. Then in Table III there is shown the effect of the addition of the 1% indium on the stress corrosion properties of these alloys. It will be noted that in each case, the comparison is made between alloys of substantially the same composition, except for the addition of the indium. For example alloy A is an 8 karat red gold alloy, and A–1 is substantially the same 8 karat red gold alloy with 1% indium added. Similarly, alloy B is an 8 karat yellow gold alloy, and alloy B–1 is substantially the same 8 karat yellow gold alloy with 1% indium.

Table II

Alloy	Composition in Per Cent by Weight				
	Au	Cu	Ag	Zn	In
A	33.33	58.20	4.96	3.51	------
A–1	33.33	57.83	4.66	3.18	1.0
B	33.33	47.95	8.77	9.95	------
B–1	33.33	47.61	8.44	9.62	1.0
C	41.66	50.93	4.34	3.07	------
C–1	41.66	50.59	4.01	2.74	1.0
D	41.66	41.97	7.67	8.70	------
D–1	41.66	43.00	8.34	6.0	1.0
E	50.00	43.65	3.72	2.63	------
E–1	50.00	43.31	3.39	2.30	1.0
F	50.00	35.97	6.57	7.46	------
F–1	50.00	35.63	6.24	7.13	1.0

Table III

Alloy	Cracking Time, 1% $FeCl_3$
A	5 min. 15 sec.
A–1	12 min. 12 sec.
B	18 min. 23 sec.
B–1	50 min. 43 sec.
C	1 min. 20 sec.
C–1	1 min. 32 sec.
D	1 min. 48 sec.
D–1	24 hours O. K.
E	1 min. 15 sec.
E–1	24 hours O. K.
F	1 min. 10 sec.
F–1	5 min. 27 sec.

In each of these alloys, it will be observed that the presence of the indium deters or inhibits stress-corrosion, increasing the time required (in the accelerated test used) for the corrosion cracks to appear.

In addition to the above described corrosion-resisting effect of the indium, the use of indium has other advantages in gold alloys. Among these may be noted the fact that the indium gold alloys of this invention are readily cold worked, yet are harder alloys than the corresponding alloys without the indium. They also work harden less, during the manufacturing operations performed on the material in formation of articles of jewelry.

Table IV shows the increase in hardness given to the respective alloy in its cold worked state by addition of indium, the alloys of Table I being shown.

Table IV

HARDNESS-ROCKWELL 15T

Alloy	Annealed at .030 inch thick	50% Reduction at .015 inch thick
1	86	92½
2	85	93
3	85½	93
4	85	93
5	85	93

The fact that these alloys are harder means that the alloy will wear better and that a piece of jewelry made from it will retain its surface finish over a longer period of time. The factor of less work hardening means that it will be possible to make more economically a finished piece of jewelry with the hardness of all of its parts more uniform.

In the manufacture of the alloys of this invention, standard melting procedures may be used, care being taken to prevent loss of indium due to its relatively low boiling point. It may be found necessary, in some cases, to add a little more indium than called for in the formula, in order to take care of such loss. Such practice is well known to those skilled in the art and need not be detailed here.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above alloys without departing from the scope of this invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

I clam:

1. A stress-corrosion resistant gold alloy consisting essentially of gold, about 33–50%; indium, about 0.1 to 5%; at least one coloring

metal selected from the group consisting of silver, zinc, and cadmium each in an amount in the range of 2–10%; and balance, copper but not less than about 10.7%; all by weight

2. A stress-corrosion resistant gold alloy consisting essentially of gold, about 33 to 50%; indium, about 0.1 to 5%; silver, about 2 to 10%; zinc, about 2–10%; and balance, copper but not less than about 10.7%; all by weight.

3. A stress-corrosion resistant gold alloy consisting essentially of gold, about 33 to 50%; indium, about 0.1 to 5%; silver, about 2–10%; cadmium, about 2–10%; and balance, copper but not less than about 10.7%; all by weight.

4. A stress-corrosion resistant gold alloy consisting essentially of gold, about 33% to 50%; indium, about 0.1 to 5%; silver, about 2 to 10%; and balance, copper but not less than about 10.7%; all by weight.

5. A stress-corrosion resistant gold alloy consisting essentially of gold, about 33 to 50%; indium, about 0.1 to 5%; zinc, about 2–10%; and balance, copper but not less than about 10.7%; all by weight.

6. A stress-corrosion resistant gold alloy consisting essentially of gold, about 33 to 50%; indium, about 0.1 to 5%; cadmium, about 2–10%; and balance, copper but not less than about 10.7%; all by weight.

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