United States Patent Office

2,810,642
Patented Oct. 22, 1957

2,810,642

TITANIUM-ALUMINUM-SILVER ALLOYS

Robert I. Jaffee, Worthington, and Horace R. Ogden, Columbus, Ohio, assignors, by mesne assignments, to Rem-Cru Titanium, Inc., Midland, Pa., a corporation of Pennsylvania

No Drawing. Application January 15, 1953, Serial No. 331,504

9 Claims. (Cl. 75—175.5)

This invention pertains to ductile titanium-base alloys containing aluminum and silver as essential constituents.

Broad and preferred ranges for the aluminum and silver contents consistent with retention of adequate ductility for fabrication purposes are as follows:

	Range, Percent	
	Broad	Preferred
Aluminum	0.5–8	1–7.5
Silver	0.5–15	1–10

The alloys of the invention may be materially strengthened without undue loss of ductility by controlled additions of the interstitials carbon, oxygen and nitrogen in amounts ranging up to about 0.2% each, the aggregate content not to exceed about 0.6%.

These alloys may be made by melt-casting in a cold mold, employing an electric arc in an inert atmosphere, or may be produced in other ways in which the alloy is rendered molten before casting.

The titanium base metal employed may be the product of high purity obtained by the "iodide" process de- be the product of "commercial purity" produced by the scribed in U. S. Patent 1,671,213 to Van Arkel; or may magnesium reduction of titanium tetrachloride by the process described in U. S. Patent 2,205,854 to Kroll; or by other procedures producing titanium metal of equivalent purity.

The alloys of the invention possess a substantially all-alpha microstructure at room temperature. This results from the alpha microstructure of the titanium at room temperature, and the fact that aluminum together with the interstitials carbon, oxygen and nitrogen are all alpha promoters or stabilizers, while silver has so little effect on the beta transus temperature of titanium that its effect is practically neutral. Although formerly considered an alpha stabilizer it now appears more properly grouped as a borderline beta stabilizer.

These alloys are further characterized in possessing

an ultimate strength at least ten percent in excess of that of the unalloyed titanium base metal, consistent with retention of good ductility. For the broad range of analysis the minimum bend ductilities do not exceed 20 T or possess tensile elongations under about 2%. For the preferred range of analysis the minimum bend ductilities do not exceed about 7 T, with elongation ranging upwards of about 10%.

Owing to their substantially all-alpha microstructure the alloys may be welded without appreciable impairment of ductility in the welded as compared to the non-welded portions.

The following Table I gives mechanical properties of typical alloys according to the invention, as produced from titanium base metal of commercial purity. In the table "VHN" designates Vickers hardness, while "MBR" signifies "Minimum bend radius."

Table I

MECHANICAL PROPERTIES OF Ti-Al-Ag ALLOYS

[These alloys were 980° C. forged, 850° C. rolled to 0.040 inch, and annealed two hours at 850° C. and rapidly cooled.]

Composition, percent (Balance Titanium)	0.2% Offset Yield	Ultimate Strength	Percent Elongation in 1"	Percent Reduction in Area	VHN	MBR, T	
						L	T
0	51,000	76,000	21	51	201	0.8	0.8
2.5 Al-1 Ag	75,000	86,000	22	46	287	1.2	1.6
2.5 Al-2.5 Ag	79,000	91,000	22	49	289	1.5	1.5
2.5 Al-5 Ag	75,000	89,000	25	47	287	1.6	1.5
2.5 Al-10 Ag	81,000	88,000	9	28	317	1.8	1.8
5 Al-1 Ag	93,000	102,000	19	38	354	1.8	1.8
5 Al-2.5 Ag	93,000	102,000	22	47	342	1.5	1.5
5 Al-5 Ag	93,000	106,000	12	31	363	3.4	2.7

The following Table II gives test data on the weldability of the alloys of Table I as arc welded in an inert atmosphere, viz. argon.

Table II

Composition, Percent (Balance Titanium)	MBR, T	
	Welded	Not Welded
0	1.1	0.8
2.5 Al-1 Ag	1.2	1.2
2.5 Al-2.5 Ag	1.5	1.5
2.5 Al-5 Ag	5.5	1.6
2.5 Al-10 Ag	1.6	1.8
5 Al-1 Ag	2.8	1.8
5 Al-2.5 Ag	2.3	1.5
5 Al-5 Ag	1.9	3.4

It will be seen from the above data that the ductility of these alloys is substantially unaffected by welding.

We claim:

1. A titanium base alloy consisting essentially of about: 0.5 to 8% aluminum, 0.5 to 15% silver, and up to 0.2% each of carbon, oxygen and nitrogen, characterized in having an ultimate strength at least ten percent in excess of the unalloyed titanium base metal, and a minimum bend radius of not over 20 T.

2. A titanium base alloy consisting essentially of about: 1 to 7.5% aluminum, 1 to 10% silver, and up to 0.2% each of carbon, oxygen and nitrogen, characterized in having an ultimate strength at least ten percent in excess of the unalloyed titanium base metal, and a minimum bend ductility of not over 7 T.

3. An alloy consisting essentially of about: 0.5 to 8% aluminum, 0.5 to 15% silver, up to 0.2% each of carbon, oxygen and nitrogen, balance titanium, characterized in having an ultimate strength at least ten percent in excess of the unalloyed titanium base metal, and a minimum bend radius of not over 20 T.

4. An alloy consisting essentially of about: 1 to 7.5%

aluminum, about 1 to 10% silver, up to 0.2% each of carbon, oxygen and nitrogen, balance titanium, characterized in having an ultimate strength at least ten percent in excess of the unalloyed titanium base metal, and a minimum bend ductility of not over 7 T.

5. An alloy consisting of about: 0.5 to 8% aluminum, 0.5 to 15% silver, up to 0.2% each of carbon, oxygen and nitrogen, balance titanium, characterized in having an ultimate strength at least ten percent in excess of the unalloyed titanium base metal, and a minimum bend radius of not over 20 T.

6. An alloy consisting of about: 1 to 7.5% aluminum, about 1 to 10% silver, up to 0.2% each of carbon, oxygen and nitrogen, balance titanium, characterized in having an ultimate strength at least ten percent in excess of the unalloyed titanium base metal, and a minimum bend ductility of not over 7 T.

7. An alloy consisting of 1–4% aluminum, 2–8% silver, balance titanium.

8. An alloy consisting of 1–6% aluminum, 2–8% silver, balance titanium.

9. An alloy consisting of about: 0.5 to 8% aluminum, 0.5 to 15% silver, up to 0.2% each of carbon, oxygen and nitrogen, and the balance titanium.

No references cited.