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TITANIUM BASE ALLOYS

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This invention pertains to titanium base alloys consisting essentially of about 0.5 to 9% and preferably about 0.5 to 8% aluminum and from more than 15% up to about 50% of one or more elements selected from the group consisting of vanadium, columbium and tantalum.

The alloys of the invention on solution treating and quenching from above the beta transus generally are characterized by a relatively low yield strength and by excellent bend ductility and by high uniform and total tensile elongations, and hence are ideally adapted for forming into sheet parts such as skins or wing and body coverings for airplanes and the like, where the ability to stretch uniformly is required. An exception to this behavior are the alloys containing over about 25% vanadium, which do not possess the low yield strength and high uniform elongated characteristic of the other alloys by virtue of the substantial amounts of transformation to martensite they undergo during cold working. However, the alloys with the higher vanadium contents have excellent strength and tensile and bend ductility and are eminently suitable for sheet forming operations, except where the ability to stretch uniformly is required. Thus, these alloys in the form of rolled sheet and in the solution treated and quenched condition are easily formed to shape. Thereafter they may be strengthened and hardened by aging at about 300 to 500° C. for about 1 to 16 hours.

As is known, pure titanium metal assumes at temperatures below about 885° C. or 1625° F., a close-packed, hexagonal microstructure known as the alpha phase, while at this temperature and above, it assumes a body-centered cubic structure known as the beta phase.

Aluminum is a promoter or stabilizer of alpha titanium, while each of vanadium, columbium and tantalum, is a promoter or stabilizer of beta titanium. Vanadium, columbium and tantalum are, moreover, beta isomorphous with titanium. Hence the alloys of the invention will

have at room temperature either a mixed alpha-beta or an all-beta microstructure depending on the heat treatment. As quenched from above the beta transus, they will have in general a substantially all-beta microstructure; whereas "as annealed" or after cold working, the structure will be mixed alpha-beta, when the total beta promoter content is at the low end of its range, i.e., from more than 15 to about 20%, while for total beta promoter contents above about 20%, the alloys will have a substantially all-beta structure.

The following Table I gives the room temperature tensile properties of representative alloys according to the invention after fabrication at 1600° F. to 40-mil sheet and ½ hour solution heat treatment at 1600° F. and water quenched.

Table I

Composition, Percent (Balance Titanium)	VHN (Surface)	Average MBR, T		Tensile Properties, p.s.i.X1,000		Elongation, Percent in 1 inch		Percent Reduction in Area
		(Long.)	(Trans.)	0.2% Offset Yield	Ult. Str.	Uniform	Total	
	187	0.8	0.8	48	71	----------	21	51
2Al-18V	227	0	0	66	96	18	24	32
2Al-24V	251	0	0	92	102	9	12	20
0.5Al-30V	234	1.0	1.0	102	107	----------	10	26
0.5Al-40V	255	0	0	107	111	----------	10	33
6.75Al-38.25V	291	0	0	114	115	----------	7	24
8.25Al-46.75V	317	0.4/1.50	>10	133	134	----------	10	27
2Al-18Ta	254	0	0.8	86	104	7	11	33
2Al-24Ta	247	0.5	1.0/7.8	78	106	10	12	28
0.5Al-30Ta	215	0.5	1.0	71	74	----------	15	31
2Al-16Cb	246	1.0	1.7	64	105	13	14	17
2Al-20Cb	285	0.7	1.1	73	110	14	16	22
2Al-24Cb	247	0.4	3.0/6/2	73	110	14	16	22
0.5Al-30Cb	222	0	0.8	71	98	----------	20	33

The above alloys were prepared by arc melting in a cold mold furnace in an inert or argon atmosphere. The titanium employed was of the commercial purity type as produced by the magnesium reduction of titanium tetrachloride according to the process of the Kroll U.S. Patent 2,205,854.

It will be noted from the data of Table I that these alloys have excellent bend ductilities in both the longitudinal and transverse directions, on the order of 0 to 1 or 2T for most analyses. They also possess high tensile elongations both uniform and total, thus to permit of deep drawing and stretch forming operations. For these operations, bend ductilities up to about 20T and total tensile elongation values down to about 9 or 10% are permissible.

These alloys, being generally of the beta type, will not tolerate excessive additions of the interstitials carbon, oxygen and nitrogen without embrittlement, ordinarily not more than about 0.2% each or in total amount.

This application is a continuation-in-part of application Serial No. 398,868, filed December 17, 1953.

What is claimed is:

1. A titanium base alloy consisting essentially of about 0.5 to 9% aluminum, from more than 15% to about 50% of at least one beta promoter selected from the group consisting of vanadium, columbium and tantalum, balance substantially titanium, characterized in having a minimum bend ductility of not over 20T and a minimum tensile elongation of about 10%.

2. A titanium base alloy consisting essentially of about 0.5 to 9% aluminum, from more than 15% to about 50% of at least one beta promoter selected from the group consisting of vanadium, columbium and tantalum, the aluminum content being on the low side of its range when the beta promoter content is on the high side of its range and vice versa, balance substantially ti-

tanium, said alloy being characterized in having a minimum bend ductility of not over 20T and a minimum tensile elongation of about 10%.

3. A titanium base alloy consisting essentially of about 0.5 to 9% aluminum, from more than 15% to about 50% of vanadium, balance substantially titanium, characterized in having a minimum bend ductility of not over 20T and a minimum tensile elongation of about 10%.

4. A titanium base alloy consisting essentially of about 0.5 to 8% aluminum, from more than 15% to about 40% of columbium, balance substantially titanium, characterized in having a minimum bend ductility of not over 20T and a minimum tensile elongation of about 10%.

5. A titanium base alloy consisting essentially of about 0.5 to 8% aluminum, from more than 15% to about 40% of tantalum, balance substantially titanium, characterized in having a minimum bend ductility of not over 20T and a minimum tensile elongation of about 10%.

References Cited in the file of this patent

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