This invention relates to alloys of titanium and molybdenum and contemplates certain alloys having an extraordinary resistance to attack by acids.

Substantially pure titanium metal can be secured by the "iodide" process described in the patent to Van Arkel, et al., No. 1,671,213. However, commercial titanium is more commonly manufactured in other ways, such as by the magnesium process described in the patent to Kroll, No. 2,205,654, and modifications thereof. Such commercial titanium contains small fractions of oxygen and nitrogen, and sometimes carbon, which significantly alter its hardness and tensile properties as compared to those of pure titanium. Its Vickers hardness varies from about 140 to over 200 as compared with a Vickers hardness of about 100 for pure titanium under comparable conditions, and its tensile properties are augmented substantially in the same proportion as its hardness. Its nitrogen content may vary between about 0.01% and about 0.15%, its oxygen content from about 0.01% to about 0.25%, and its carbon content between 0% and about 0.5%. The term "titanium" as used in this specification and the claim appended thereto is to be taken to include both pure titanium and commercial titanium unless the context indicates otherwise.

The present invention comprises the discovery of certain alloys of titanium and molybdenum which show extraordinary resistance to attack by acids, particularly boiling hydrochloric and sulphuric acids. The resistance of the alloys to attack by these and other acids is comparable with that of gold, platinum, and tantalum, and far in excess of that of titanium and other known base metals or alloys. The acid resistant characteristics become distinctive in an alloy containing between 25% and 30% molybdenum, balance substantially all titanium, and are somewhat augmented as the molybdenum content is increased. Alloys containing more than about 40% molybdenum are very highly acid resistant but tend to be too brittle for fabrication by presently known processes. It will be understood, therefore, that the upper limit of the molybdenum content is established, not by the disappearance or decrease of the acid resistant characteristics, but by the limitations of presently known fabricating processes.

The alloys of this invention are all beta compositions of the "beta isomorphous" type, that is, the titanium present is chiefly, if not wholly, in the beta or body-centered cubic phase, rather than the alpha or close-packed hexagonal phase. In unalloyed titanium the beta phase is stable only above a temperature of about 885° C., whereas in the alloys of this invention and others it is stable at ordinary temperatures.

Among the most severe corrosion tests known to the chemical industry are exposures for a period of 48 hours to boiling 40% sulphuric acid and to boiling 20% hydrochloric acid. The results may be conveniently stated in terms of mils per year of corrosion as determined by weight loss of the specimen. Alloys of the present invention comprising 30%, 35%, and 40% of molybdenum, balance either commercial titanium or pure titanium, when subjected to these tests, showed a maximum average corrosion rate of about 10 mils per year; and many specimens showed a much lower rate. For example, an alloy comprising 60% pure titanium and 40% molybdenum gave an average corrosion rate of 2.2 mils per year in boiling 40% sulphuric acid and an average corrosion rate of 2.5 mils per year in boiling 20% hydrochloric acid. An alloy comprising 70% commercial titanium and 30% molybdenum showed an average corrosion rate of 6.3 mils per year in boiling 40% sulphuric acid and an average corrosion rate of 9.1 mils per year in 20% boiling hydrochloric acid. It will be seen that these figures are of the same order of magnitude as the corrosion rates for platinum, tantalum, and gold, the latter being from 0 to 3 mils per year, and are vastly superior to most, if not all, known base metals and base metal alloys. These alloys also possess the tensile and other properties desirable for commercial use. The 30% molybdenum, balance pure titanium alloy, for example, when annealed at 700° C. has a 0.2% offset yield strength of about 60,000 p. s. i., an ultimate strength of over 78,000 p. s. i., an elongation in ½” of 25%, and a Vickers hardness of about 180. The 40% molybdenum, balance pure titanium alloy, as warm rolled, has a yield strength of about 141,000 p. s. i., an ultimate strength of over 154,000 p. s. i., an elongation in ½” of 3%, and a Vickers hardness of about 335. The alloys can also be welded with comparative ease.

What is claimed is:

An alloy consisting essentially of between 30% and 40% molybdenum, balance titanium; said alloy having a corrosion rate in boiling hydrochloric acid of not over about 10 mils per year.

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REFERENCES CITED

The following references are of record in the file of this patent:

FOREIGN PATENTS

Number Country Date

718,822 Germany Mar. 24, 1942

OTHER REFERENCES