Patented May 11, 1954 2,678,270

UNITED STATES PATENT OFFICE

2,678,270

MOLYBDENUM-TANTALUM ALLOYS

John L. Ham, Dearborn, Frederick P. Bens and Alvin J. Herzig, Detroit, and George A. Timmons, Ferndale, Mich., assignors to Climax Molybdenum Company, New York, N. Y., a corporation of Delaware

No Drawing. Application October 6, 1951, Serial No. 250,205

13 Claims. (Cl. 75—176)

1

This invention relates to alloys of molybdenum and tantalum and more specifically to large, sound cast molybdenum-tantalum alloy ingots which are capable of being worked at elevated temperatures by forging, pressing, rolling, extrusion and other similar methods. This invention is also concerned with molybdenum-tantalum alloys containing minor quantities of other elements and to such alloys in which a part of the molybdenum has been replaced by tungsten. Such alloys are useful in applications which require metals of high strength or hardness at both room and elevated temperatures, and more specifically in such applications as piercing points for forming seamless steel tubing, electrodes for heating molten glass, die-casting dies for brass and other metals, etc. This application is a continuation-in-part of applicants' copending application, Serial No. 218,524, filed March 30, 1951, now abandoned.

The principal object of this invention is to provide improved cast molybdenum-base alloys which are capable of being worked at elevated temperatures.

A further object of this invention is to provide cast molybdenum-base alloys which can be worked at elevated temperatures and exhibit a tendency to retain work-hardening at elevated temperatures.

Another object of this invention is to provide improved cast molybdenum-base alloys which possess increased hardness at both room and elevated temperatures above that which is possessed by pure molybdenum.

The terms "cast" and "casting" as used in this specification are intended to designate the product resulting from the melting of metal and solidifying the same in a mold whether or not the metal has been subjected to subsequent working or machining. The term "casting" is also used to designate any process or method which involves melting metal and solidifying the same in a mold.

In accordance with this invention, cast molybdenum alloys having the above properties are produced when tantalum is employed as an alloying element. Cast alloys of molybdenum and tantalum are capable of being worked at elevated temperatures only if they contain limited amounts of tantalum and other elements.

It has previously been established that the presence of minute amounts of oxygen in a casting of molybdenum or a molybdenum-base alloy seriously impairs or destroys the capacity of the casting to be worked at elevated temperatures if

2

the oxygen is segregated at the grain boundaries in the form of certain metallic oxides. The detrimental oxide is visible on microscopic examination of intergranular fractures and is believed to consist largely of MoO_2. However, the oxides of certain other metals, if present, are also detrimental. In any event, when examined microscopically, castings which can be worked at elevated temperatures have no visible oxide segregations at the grain boundaries which are similar to the manifestations of MoO_2. Cast molybdenum containing less than about .001% oxygen can be worked at elevated temperatures but it is very difficult in the production of cast ingots of molybdenum and its alloys to reduce the oxygen content of the metal to such a low value.

As set forth in the patent to Frederick P. Bens et al., No. 2,580,273, the detrimental oxide segregation is not found in molybdenum castings containing not more than .005% oxygen if small amounts of carbon are present. Such castings can be worked at elevated temperatures.

It is now found that the detrimental oxides may also be eliminated by incorporating in the casting certain metals which have a stronger affinity for oxygen than does molybdenum and form oxides which either do not segregate at the grain boundaries or, if segregated at the boundaries, provide greater intergranular cohesion than does the oxide of molybdenum. Aluminum and beryllium have been found to fulfill these requirements, and forgeable castings of molybdenum and molybdenum-base alloys containing up to a maximum of .05% oxygen have been produced by incorporating small quantities of aluminum or beryllium or both in the casting. Carbon may also be present, if desired, and small quantities of carbon or aluminum are particularly beneficial in molybdenum-base alloys containing beryllium.

The effect of oxygen on the molybdenum-tantalum alloy castings of the present invention is similar to its effect in other molybdenum-base alloy castings, and consequently it is necessary to eliminate segregations of molybdenum oxide at the grain boundaries if the casting is to be worked at elevated temperatures. This is preferably done by incorporating carbon, aluminum or beryllium in the alloy, either singly or in combination. This critical effect of oxygen on the capacity of the alloy to be worked at elevated temperatures is peculiar to cast alloys as distinguished from those produced by sintering metal powders.

If carbon is present in amounts between .01% and .04% and no aluminum or beryllium is pres-