

UNITED STATES PATENT OFFICE

2,050,865

COBALT-TUNGSTEN ALLOYS

Wesley P. Sykes, Cleveland Heights, Ohio, assignor to General Electric Company, a corporation of New York

No Drawing. Application March 24, 1931,
Serial No. 525,025

8 Claims. (Cl. 148—13)

The present invention relates to alloys and more particularly to a metal composition consisting mainly of cobalt but containing an appreciable amount of a hardening element, for example tungsten.

It is an object of the present invention to provide a hard, tough metal composition which may be cast or sintered and is particularly suitable for use as a swaging die although it may also be employed to advantage as a wear resisting surface or metal cutting tool.

The present application is a continuation-in-part of my copending application Serial No. 143,523, filed October 22, 1926, and entitled "Metal working alloy", now Patent No. 1,894,836. In my prior application, I have disclosed alloys consisting of iron with tungsten or molybdenum, or both. Such alloys contain little or no carbon but are very hard and particularly suitable for use as wire drawing dies. In the manufacture of such dies the materials comprising the alloy are mixed in powdered form, pressed into shape and heated in a hydrogen atmosphere at about 1400° C. for about one hour and then quenched in water. After reheating at a temperature of about 650° C. for several hours the hardness of the alloy is approximately 500 Brinell.

The alloy produced in accordance with the present invention is not only harder and tougher than the alloys disclosed in my prior application but shows no tendency to chip when subjected to peening tests. Dies made in accordance with my invention also exhibit a surprisingly long life when compared with high speed steel dies.

In carrying out the present invention, about 20 to 35% powdered tungsten is mixed with about 80 to 65% powdered cobalt. The mixed materials are preferably pressed into a desired shape and sintered at an elevated temperature in a hydrogen or inert atmosphere. In the sintering operation a certain minimum time is required for complete alloyage of the cobalt and tungsten or, in other words, for complete solution of the tungsten into cobalt. This can be determined by trial. Incomplete solution of the tungsten in the cobalt during sintering results in a non-uniform product having a lowered hardness.

The sintering may be carried out at temperatures above 1100° C., for example about 1400 to 1450° C. The sintering period will vary with different temperatures. With a temperature of 1425 to 1435° C. the sintering action may be completed in about one hour, whereas if a temperature between 1400 and 1425° C. is employed the sintering period will be lengthened to about two hours.

At temperatures below 1400° C. a longer sintering time will be required to allow the tungsten to dissolve in the cobalt.

The sintered alloy either may be quenched or cooled slowly from 1400° C. The final hardness appears to be the same whether the alloy is quenched or cooled at a moderate rate. When cooled in either way the alloy is relatively soft and may at that time be machined, or drilled if intended for use as a die.

After the cooling operation, the alloy is aged, either in air or in hydrogen, at a temperature between 600° C. to 700° C. for a period of time generally varying from about 50 to 100 hours during which time the alloy becomes very tough and attains a Brinell hardness of about 650. A cobalt tungsten alloy containing about 30% tungsten when quickly cooled from 1400° C. has a Rockwell C hardness of 30 to 33. After reheating at 600° C. for 10, 50, and 100 hours the Rockwell C hardness has increased respectively to 38, 50, and 65. The bending or transverse strength is about 180,000 to about 200,000 pounds per square inch in the age hardened condition.

Aging at temperatures above 600° C. results in more rapid hardening but the maximum values of hardness obtained under such conditions are less than those obtained by aging at about 600° C. An aging temperature of 650 to 675° C. produces in 50 hours a maximum Rockwell C hardness of 30 to 62 to 64 and is suitable for commercial purposes. At temperatures below 600° C. the increase in the hardness is quite slow.

Age hardening takes place in cobalt tungsten alloys containing as low as 10% tungsten. The maximum Rockwell C hardness in such a composition is about 38. In the case of a cobalt tungsten alloy containing 20% tungsten, a Rockwell C hardness of 55 can be obtained. If the tungsten content of the alloy exceeds 35% the toughness of the alloy is noticeably decreased. At the present time I prefer to employ a cobalt tungsten alloy containing from about 25% to about 35% tungsten. A small amount of carbon, for example .05%, may be present in the alloy. However, as little as .20% carbon noticeably lowers the secondary hardness of the alloy.

The mechanism of hardening appears to be substantially as follows: At 1450° C. a cobalt tungsten alloy containing about 34% tungsten consists of a cobalt-rich solution of tungsten in cobalt, the single phase alpha. This may be formed either by melting the cobalt tungsten mixture or by sintering the pressed powdered materials for one or two hours at 1425 to 1450° C.

If the alloy is now cooled slowly say at 50° per hour a beta phase separates from the cobalt-rich solid solution. Little of the beta phase is formed during cooling to 1100° C. At about 1100° C. there is a reaction between the beta phase and the alpha phase resulting in the formation of a lambda phase consisting of a cobalt tungsten compound containing about 45 to about 50% tungsten. As the alloy is cooled below 1100° C. the beta phase is converted to the lambda phase, and as the temperature is still further reduced the lambda phase separates or is precipitated from the cobalt-rich solid solution. These changes are relatively sluggish and require slow cooling for their approximate completion.

If the alloy is cooled in a few minutes from 1400° C. to room temperature the cobalt-rich solid solution or alpha phase is preserved without appreciable change. By reheating to 600° C. or higher (theoretically up to 1050° C.) and aging, the lambda phase separates or is precipitated from the solid solution. The precipitated compound probably exists as particles of sub-microscopic size scattered through the cobalt-rich matrix. The latter, while relatively fine grained, is much coarser than the precipitated compound. The lambda phase which provides the hardness in the alloy, is stable only below about 1100° C.

Dies made in accordance with the present invention are very hard and tough and have an unusually long life. For example swaging dies made by my process and consisting of an alloy containing about 30% tungsten and 70% cobalt have a life approximately 8 to 10 times longer than that of similar high speed steel dies. By the expression "particles of sub-microscopic size" I mean particles not clearly distinguishable under usual microscopic examination.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of forming a hard, tough alloy consisting of about 90% to about 65% cobalt and about 10% to about 35% tungsten which comprises heating the cobalt and tungsten in close association to a temperature at which a solid solution of the tungsten and cobalt will take place, then cooling the alloy and finally aging it at a temperature below 1050° C. at which there will be a precipitation of a compound of cobalt and tungsten.

2. The method of forming a hard, tough alloy consisting of about 80% to about 65% cobalt and about 20% to about 35% tungsten which comprises heating said metals in close association to a temperature between about 1100° C. and about 1450° C. for an appreciable period of time, then cooling the alloy and aging it at a temperature between 600 and 700° C.

3. The method of forming a hard, tough alloy consisting of about 80% to about 65% cobalt and about 20% to about 35% tungsten which comprises heating said metals in close association to a temperature between about 1100° C. and about 1450° C. for an appreciable period of time, then cooling the alloy and heating between 600 and 700° C. for about 20 to about 100 hours.

4. The method of forming a hard, tough alloy containing about 80 to about 65% cobalt and about 20 to about 35% tungsten which comprises heating said metals in close association to a temperature between about 1100° C. and about 1450° C. for an appreciable period of time then cooling the alloy and aging it at a temperature between about 600° C. and 1050° C. at which there will be a precipitation of a cobalt-tungsten compound.

5. An age hardened, tough alloy consisting substantially of about 80 to about 65% cobalt and about 20 to about 35% tungsten.

6. An age hardened alloy consisting substantially of about 90% to about 65% cobalt and about 10% to about 35% tungsten, said alloy comprising sub-microscopic particles of a cobalt-tungsten compound containing about 45 to about 50% tungsten precipitated through a matrix of a solid solution of tungsten in cobalt.

7. An age hardened alloy consisting substantially of about 90% to about 65% cobalt and about 10% to about 35% tungsten, said alloy comprising sub-microscopic particles of a cobalt-tungsten compound precipitated through a matrix of a solid solution of tungsten in cobalt.

8. An age hardened alloy consisting substantially of 90% to 65% cobalt and about 10% to about 35% tungsten, said alloy comprising finely dispersed particles of a cobalt-tungsten compound precipitated through a matrix of a solid solution of tungsten in cobalt.

WESLEY P. SYKES. 50