United States Patent [19]

Webster et al.

[11] **3,839,022**

[45] **Oct. 1, 1974**

[54] **HOT WORK TOOLS AND ALLOYS THEREFOR**

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[22] Filed: **Jan. 27, 1972**

[21] Appl. No.: **221,398**

[30] **Foreign Application Priority Data**

Jan. 28, 1971 Great Britain 3428/71

[52] **U.S. Cl.** .... **75/126 B,** 75/128 A

[51] **Int. Cl.**.. **C22c 39/28,** C22c 39/34, C22c 41/02

[58] **Field of Search** .... 75/126 B, 128 A

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[57] **ABSTRACT**

Amethod for hot-working metals at temperatures in excess of 550° C wherein the hot-work tool is an austenitic manganese steel. A tool for use in the method is also disclosed, which tool is made from an alloy having the following essential constituents in the ranges specified by weight:

Carbon	0.3 – 0.9%
Silicon	0.1 – 2.0%
Manganese	6.0 –35.9%
Chromium	≯ 25%
Nickel	≯ 12%

and at least one carbide former, the remainder being iron and unavoidable impurities.

11 Claims, No Drawings

HOT WORK TOOLS AND ALLOYS THEREFOR

This invention relates to hot work tools and to alloy steels for the manufacture of such tools.

Available ferritic hot-work tool steels such as the AISI – H10 – H13 series, while generally satisfactory for the extrusion of aluminium and like alloys, tend to wear very rapidly when used with higher melting point materials, particularly at working rates exceeding 50 extrusions per hour. They also suffer the disadvantage of undergoing a phase change when heated above about 750°C which is the kind of temperature likely to be encountered for example by the liner of a heavy extrusion press, where the billet extruded is likely to be at 900° to 950°C.

Nickel or cobalt alloys and nickel based austenitic steels are sometimes used for hot work tools but whilst they are usually satisfactory for the extrusion of high melting point alloys the raw material, particularly nickel, used in their manufacture are very expensive, and further, expensive techniques are quite frequently required in their manufacture.

Hitherto austenitic manganese steels have not been recommended for hot-working applications in view of structural instability at temperatures in the range of 275 percent and upwards. It has now been discovered that an austenitic manganese steel including quite small amounts of nickel and chromium can be used in hot-working to advantage, the alloy having a high wear resistance and being not too expensive to manufacture. This characteristics is (we believe) due to the ability of the alloy to maintain its hardness at temperatures in excess of 550°C.

The present invention aims to provide hot work tools such as hot extrusion liners made from alloys which have a high wear resistance and which also are not too expensive to manufacture.

The invention provides a method for hot-working metal comprising providing an extrusion tool manufactured from an austenitic manganese steel alloy which has been precipitation hardened and extruding said metal at an alloy temperature in excess of 550 degrees C said alloy consisting essentially of:

Carbon	0.3 – 0.9%
Silicon	0.1 – 2.0%
Manganese	6.0 – 35.0%
Chromium	≯ 25%
Nickel	≯ 12%

in the ranges specified by weight, and at least one carbide former, the remainder being iron and unavoidable impurities.

The carbide former is preferably vanadium, tungsten, titanium or niobium and/or tantalum. Of these, vanadium is preferred.

While alloys used in processes according to the invention can be made without nickel when the manganese content is above the minimum specified above, nickel will always be present at the lower manganese levels. As a general guide the amount of manganese and/or nickel will always be such that the alloys retains its austenitic characteristics at the temperatures likely to be encountered in use.

The essential requirements for the alloys used are that they retain an austenitic matrix, as has been said above, and that they are susceptible to age or precipitation hardening. It is the latter connection that the carbide formers are important. Of the carbide formers vanadium is preferred and when employed will usually be present in a proportion of 0.5 to 4 percent. As an alternative or in addition the alloys may contain up to the indicated amounts of one or more of the following:

Molybdenum	5%
Tungsten	5%
Titanium	5%
Niobium and/or Tantalum	5%
Aluminum	2%
Zirconium	2%
Beryllium	2%

In general the total amount of such elements will not exceed 10 percent.

Further the alloy can contain up to the indicated amounts of the following:

Cobalt	5%
Nitrogen	0.2%
Boron	0.5%
Phosphorus	0.5%

While alloys can be made without chromium it would be more usual to incorporate 3–12 percent in order to impart scaling resistance and to assist in the hardening to which reference will be made below. It is thought desirable to add molybdenum when the chromium content is low.

Precipitation hardening of the alloys used in the practice of the invention is usually carried out at temperatures between 300° and 950°C and for a period which, according to the chosen temperature, will give the strength required. It is best first to subject the alloy to a solution treatment at a temperature between 1000° and 1300°C.

The conditions under which the solution and hardening treatments are applied depend upon the properties which the final product is to have because the yield point, ultimate strength, ductility, corrosion resistance and creep resistance are all differently affected by variations in these treatments. A compromise must therefore be sought for each practical application.

Where for example high tensile strength is desired in combination with resistance to mildly corrosive conditions it is desirable to precipitation harden at a temperature between 300° and 750°C but for strongly corrosive conditions it may be advantageous to omit the precipitation hardening treatment. Where service at high temperature is required, it is desirable to "over-age" the alloys in which case the precipitation should be carried out between 600° and 950°C. A practical trial of a hot extrusion liner made for use in a method according to the invention has demonstrated clearly the advantages particularly in connection with resistance to wear. In normal use a liner of this composition set out below according to the invention was used in a direct extrusion process to extrude metals including E.109 Aluminum Bronze and C.S.C. 60/40 brass through a circular disc. Under the same conditions in the same workshop a conventional liner made from AISIH 13 steel became unusable after between 3000 and 5000 extrusions. The liner used in accordance with the present invention was still usable after between 12000 and 17000 extrusions. The temperatures to which the liners were subjected to were varied and difficult to define but were frequently in excess of 550°C. The composition of the alloy used in accordance with the invention was:

Silicon	0.95%
Carbon	0.62%
Sulphur	0.014%
Phosphorous	0.026%
Manganese	19.1%
Chromium	4.33%
Nickel	0.11%
Molybdenum	0.81%
Vanadium	1.8%

the remainder being iron and unavoidable impurities.

Although the alloys used in the invention may display rather low ductility at ambient temperature this property improves considerably when the metal is warm and it is therefore recommended that the tools be preheated before use.

We claim:

1. An extrusion tool comprising a stable austenitic manganese steel alloy which has been carbide precipitation hardened, said alloy consisting essentially of:

Carbon	0.3 – 0.9%
Silicon	0.1 – 2.0%
Manganese	6.0 – 35.0%
Chromium	≯ 25%
Nickel	≯ 12%

in the ranges specified by weight, and at least one carbide former, the remainder being iron and unavoidable impurities.

2. The tool of claim 1 wherein the carbide former in the alloy includes vanadium, tungsten, titanium or niobium and/or tantalum.

3. The tool of claim 2 wherein the carbide former in the alloy is vanadium and is present in an amount falling in the range of 0.5 to 4% by weight.

4. The tool of claim 1 wherein the alloy includes any of the following constituents in amounts by weight not exceeding those specified

Molybdenum	5%
Tungsten	5%
Titanium	5%
Niobium and/or Tantalum	5%
Aluminum	2%
Zirconium	2%
Beryllium	2%

5. The tool of claim 4 wherein the total amount of the constituents specified does not exceed 10% by weight of the alloy.

6. The tool of claim 1 wherein the alloy additionally includes any of the following elements in amounts by weight not exceeding those specified

Cobalt	5%
Nitrogen	0.2%
Boron	0.5%
Phosphorous	0.5%

7. The tool of claim 1 wherein the alloy includes chromium in the range 3.0 to 12%.

8. The tool of claim 1 wherein the alloy has a low chromium content and includes molybdenum.

9. The tool of claim 1 wherein the alloy has been age hardened.

10. The tool of claim 9 wherein the age hardening comprises solution treatment at a temperature in the range 1000 to 1200° C followed by precipitation hardening at a temperature in the range 350 to 950° C.

11. In combination, an extrusion liner lined with a stable austenitic manganese steel alloy which has been carbide precipitation hardened, said alloy consisting essentially of:

Carbon	0.62%
Silicon	0.95%
Sulphur	0.014%
Phosphorous	0.026%
Manganese	19.1%
Chromium	4.33%
Nickel	0.11%
Molybdenum	0.81%
Vanadium	1.8%

the balance being iron and unavoidable impurities.

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