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FORMING DIES AND ALLOY THEREFOR

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This invention relates to dies for use in forming materials suitable for high temperature operation and to an alloy from which such dies can be made. More particularly, the invention relates to dies and alloys from which they can be made for use in both hot and cold forming operations such as forging, swaging and upsetting, and cold trimming and rolling.

In hot hammer forging operations a metal bar or billet which has been preheated to a relatively high temperature is shaped by its being impacted between a set of dies. The time it takes to wear out a die through repeated hammering of hot metal into the die shape depends on the metal being formed and the material from which the die has been cut. Similarly, the dies used in cold forming operations such as cold rolling and cold trimming are subject to wear. My use of the term "forming" includes forging, swaging, upsetting, trimming, rolling, pressing, extruding, hubbing and similar methods of shaping metals both hot and cold.

The period of usefulness of a die is called "die life" and is generally measured by the number of pieces formed by the die before it must be repaired or scrapped. The ultimate cost of a die shaped product depends a great deal upon the cost of such dies. Increased die life means lower operating costs and hence lower product cost.

It is an object of this invention to provide a die which has improved die life for not only hot but also cold forming operations and which is especially useful in forming high temperature alloys.

Another object is to provide a vanadium containing iron base alloy from which dies having improved die life can be made.

Briefly stated, in accordance with one aspect of my invention, I have found that materially increased die life can be achieved for dies used in forming when they are made from an alloy containing, by weight, from 0.5-0.6 percent carbon, 1.5-2.5 percent manganese, 1.25-2.5 percent silicon, 3-4 percent chromium, 0.75-1.5 percent tungsten, 1-2 percent nickel, 0.75-1.5 percent vanadium with the balance essentially iron.

The alloys of the present invention are particularly characterized by improved high impact strength, wear resistance and hot hardness in addition to excellent resistance to thermal checking. These alloys which are air hardening and have a minimum hardness of 25 Rockwell "C", can be cast into an ingot from about a 2800° F. melt of elements within my alloy range. In order to create material called die stock from which my improved dies can be made, the cast ingot may then itself be formed, as by forging, in a temperature range of about 2050-2100° F. After forming, I prefer to anneal my alloy by first holding it for one hour at about 1475° F. to form austenite in the alloy, then cool the die stock to about 1275° F. and hold it at that temperature for about four hours. It is then cooled to room temperature. I then reheat the die stock to about 1275° F. at which temperature I maintain it for about six hours before cooling it to room tem-

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perature. The die stock is then in a preferred condition for the making of forming dies.

My invention will be better understood from my examples which are given by of illustration only and not in any sense by way of limitations. Its scope will be pointed out in the appended claims.

Example 1

A comparison of the composition in percent by weight of a similar, commercially available alloy with that of the alloy I am disclosing in this application is as follows:

	Old Alloy	Improved Alloy
Carbon.....	0.3-0.4	0.5-0.6
Manganese.....	1.5-2.5	1.5-2.5
Silicon.....	1.25-2.5	1.25-2.5
Chromium.....	3-4	3-4
Tungsten.....	0.75-1.5	0.75-1.5
Nickel.....	1-2	1-2
Vanadium.....		0.75-1.5
Iron.....	Balance	Balance

My increasing the carbon content and adding vandium resulted in the formation of vanadium carbide which vastly improved wear properties of dies made from my alloy. An average increase of about 40 percent in die life has resulted.

Example 2

I prefer to use dies made from my alloy in the following composition range:

	Percent by weight
Carbon.....	0.5-0.6
Manganese.....	1.7-2.0
Silicon.....	1.5-2.0
Chromium.....	3.25-3.75
Tungsten.....	0.85-1.15
Nickel.....	1.25-1.75
Vanadium.....	0.90-1.10
Iron.....	Balance

Hot forging dies made from material within this preferred composition range have shown an average increase of 412 pieces worked per die or an average increase in die life of 42 percent over the best other available or disclosed die alloy.

Example 3

A specific example of the composition in percent by weight of an improved die I have used and which has shown about a 40 percent increase in die life is as follows:

	Percent by weight
Carbon.....	0.55
Manganese.....	1.8
Silicon.....	1.8
Chromium.....	3.4
Tungsten.....	1.0
Nickel.....	1.7
Vanadium.....	1.0
Iron.....	Balance

In the foregoing description I have disclosed an improved forming die and alloy therefor. Although I have described my invention in conjunction with specific examples of alloys, heat treatments and dies, these examples are to be construed as illustrative of rather than limitations on my broad idea for a forming die and alloy therefor which I cover in the appended claims. Those skilled in the art of metal forming will readily understand that my die and alloy therefor may be used in a variety of operations such as forging, swaging, upsetting, trimming, rolling, pressing, extruding, hubbing and similar methods

of shaping metals, both hot and cold and in a variety of compositions within my claimed range.

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

1. An air hardening alloy suitable for use as a forming die comprising by weight from about 0.5–0.6% carbon, 1.5–2.5% manganese, 1.25–2.5% silicon, 3–4% chromium, 0.75–1.5% tungsten, 1–2% nickel, 0.75–1.5% vanadium, balance essentially iron, said alloy being characterized by high impact strength, wear resistance, hot hardness and resistance to thermal checking.

2. An air hardening alloy suitable for use as a forming die comprising by weight from about 0.5–0.6% carbon, 1.7–2.0% manganese, 1.5–2.0% silicon, 3.25–3.75% chromium, 0.85–1.15% tungsten, 1.25–1.75% nickel, 0.90–1.10% vanadium, balance essentially iron, said alloy being characterized by high impact strength, wear resistance, hot hardness and resistance to thermal checking.

3. An air hardening alloy suitable for use as a forming die comprising by weight from about 0.55% carbon, 1.8% manganese, 1.8% silicon, 3.4% chromium, 1.0% tungsten, 1.7% nickel, 1.0% vanadium, balance essentially iron,

said alloy being characterized by high impact strength, wear resistance, hot hardness and resistance to thermal checking.

4. A forming die composed of the air hardening alloy of claim 1.

5. A forming die composed of the air hardening alloy of claim 2.

6. A forming die composed of the air hardening alloy of claim 3.

7. A forming die composed of the air hardening alloy of claim 1, the alloy before being made into a die having been first formed at a temperature of about 2050–2100° F. and then annealed by heating to about 1475° F., holding at 1475° F. for about one hour, cooling to about 1275° F., holding at about 1275° F. for about four hours, cooling to room temperature, reheating to about 1275° F., holding at about 1275° F. for about six hours, and then cooling from about 1275° F. to room temperature.

References Cited in the file of this patent

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