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SHOCK RESISTANT ALLOY STEEL

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This invention pertains to an improved alloy steel and particularly, to an improved shock alloy which can be hardened in water and is of very low hardenability.

Steels of low hardenability are of value for impact tools such as cold heading dies and similar applications. Previous to my present invention, steels containing sufficient alloy to be called alloy steel have had too great hardenability to withstand the impact loading of most striking applications. The commonly used steels for this purpose are the so-called sraight carbon or carbon vanadium tool steels which had the desired low hardenability ratings needed for many shock applications, but did not have sufficient impact wear resistance for use as tool steels and thus had a rather short period of life.

It has thus been an object of my invention to provide a steel of the desired hardenability that will at the same time also have an improved impact wear resistance and thus a greater period of life;

Another object has been to make possible the utilization of elements in an alloy steel that will help to impart wear resistance thereto without adversely increasing the hardenability of such steel;

These and many other objects of my invention will appear to those skilled in the art from the disclosure thereof.

I have been able to provide an alloy steel, or in other words, a ferrous-base alloy to which elements that normally increase hardenability can be included to increase wear resistance by properly proportioning such elements with the element cobalt.

I have found that cobalt can be used in this connection without adversely effecting either the toughness or the desired low hardenability of the alloy and in such a manner as to offset the positive hardenability effect of elements which help to impart wear resistance. In accordance with my invention, alloy steel has been made having a hardenability rating equivalent to many of the so-called straight carbon or vanadium tool steels, but which has a greatly increased life due to its increased toughness and wear resistance.

A typical analysis of a steel made in accordance with my invention is:

Table I

	Percent
Carbon	1.03
Manganese	.20
Silicon	.16

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Table I—Continued

	Percent
Chromium	.30
Tungsten	1.75
Vanadium	.10
Cobalt	1.74
Molybdenum	.12
Nickel	.15
Remainder iron and incidental impurities	

(Total of Mn, Cr, Mo and Ni equals substantially .75%; W and Co, each, equals substantially 1 plus .75%)

The alloy of Table I when hardened from 1450° F. in water showed as "an quenched" hardness of Rockwell C 65 or better. Its hardenability rating, using the well known Shepherd PF test was 5/32. Extremely long life was obtained when this alloy was used for cold heading dies.

The general alloy range within which the desired hardenability rating (shallow hardening) and wear resistance can be obtained in accordance with my invention is:

Table II

	Percent
Carbon	.50 to 1.50
Manganese	Nil to .50
Silicon	Nil to .50
Tungsten	.50 to 5.00
Chromium (optimum up to .50%)	Nil to 2.00
Vanadium	Nil to 2.00
Cobalt	.50 to 5.00
Nickel	Nil to 2.00
Molybdenum (optimum up to .50 %)	Nil to 2.00
Remainder iron and incidental impurities	

It is believed that I have been the first to discover that the negative-hardenability element cobalt can, particularly within the specified range, be successfully used for the above purpose and without adversely effecting the alloy and its resultant properties. Molybdenum, manganese and chromium are strong in their positive hardenability effects, tungsten is intermediate, and nickel is low. Tungsten is the major alloying element with cobalt, and not only imparts good wear resistance, but makes possible a minimum amount of cobalt to offset positive hardenability effect. I have found that these two elements in substantially equal ranges are essential and within the specified range of carbon content, make possible an improved alloy of low hardenability and permit additions of the other listed elements within maximums set forth without spoiling its improved characteristics and while making possible additional improved characteristics. For optimum results, the tungsten and

cobalt will be in substantially equal proportions, see for example, the alloy of Table I. Vanadium insures toughness without adversely effecting hardenability and although not essential, it appears to aid the cobalt in offsetting the strong positive hardenability effect of metals such as molybdenum, manganese, etc. In my alloy, for optimum results the amount of tungsten will be at least equal to the sum of the total amounts of the elements manganese, chromium, and molybdenum.

What I claim is:

1. A ferrous-base alloy which contains about .50 to 1.50% carbon, about .50 to 5.00% tungsten, about .50 to 5.00% cobalt, the remainder iron; the tungsten and cobalt being essential within equal ranges and the alloy being characterized by its low hardenability with its improved impact wear resistance, and by its extremely long life.

2. A ferrous-base alloy which contains tungsten and negative-hardenability-imparting cobalt, each in substantially equal proportions and each being essential within the same range of about .50 to 5.00%, about 0.50 to 1.50% carbon, the remainder iron; the alloy being characterized by its low hardenability with an improved impact wear resistance, and by its extremely long life.

3. A ferrous-base alloy which consists essentially of about .50 to 1.50% carbon, about .50 to 5.00% each of tungsten and cobalt and being essential within the same range, up to about .50% each of silicon and manganese, up to about 2.00% each of chromium, vanadium, nickel and molybdenum, and the remainder iron; the alloy being characterized by its low hardenability with an improved wear resistance, and by its extremely long life.

4. A ferrous-base alloy which consists essentially of about .50 to 1.50% carbon, about .50 to 5.00% each of tungsten and cobalt in substantially equal proportions and being essential within the same range, up to about .50% each of silicon and manganese, up to about 2.00% each of chromium, vanadium, nickel and molybdenum, and the remainder iron; the alloy being characterized by its low hardenability with an improved wear resistance, and by its extremely long life.

5. A ferrous-base alloy which consists essentially of about .50 to 1.50% carbon, about .50 to 5.00% each of tungsten and cobalt in substantially equal proportions and being essential within the same range, up to about .50% each of silicon and manganese, up to about 2.00% each of chromium, vanadium, nickel and molybdenum, the tungsten being in a minimum amount of the total amount of the manganese, chromium, and molybdenum, and the remainder iron; the alloy being characterized by its low hardenability with an improved impact wear resistance, and by its extremely long life.

6. A ferrous-base alloy which consists essentially of 1.00% carbon, about .20% manganese, about .16% silicon, about .30% chromium, about 1.75% tungsten, about .10% vanadium, about 1.74% cobalt, about .12% molybdenum, about .15% nickel, and the remainder iron; the alloy being characterized by its relative low hardenability with its improved impact wear resistance, and by its extremely long life; the alloy having a hardness of about Rockwell C 65 or better and a Shepherd PF hardenability of about 5/32.

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