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ALLOY AND CUTTING TOOL

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This invention relates to abrasion resistant alloys of the type composed principally of chromium and iron, and to new and useful cutting tools made therefrom.

Chromium-iron alloys, often modified by the addition of other elements, have been used to resist wear and abrasion. By varying the composition, and in some instances the heat treatment, it has been possible to vary the hardness, toughness, and strength of the alloys over wide ranges. But hardness of a very high degree such as is required of a metal-cutting tool has heretofore been accompanied by an undue degree of brittleness. Cutting tool "high speed" steels have been basically tungsten-iron compositions rather than chromium-iron, and have typically contained 18% tungsten, 4% chromium, and 1% vanadium (so-called "18-4-1") sometimes modified by the addition of one or more of the metals cobalt, nickel, and molybdenum.

It is a primary object of the invention to provide an abrasion resistant chromium iron alloy which, in the form of a cutting tool, will cut metals at high speeds at least as well as 18-4-1 high speed steel.

We have discovered that a hard chromium-iron alloy containing between 45% and 65% chromium is considerably toughened by the addition of carbon, preferably in a percentage between 1% and 3%. For some purposes the carbon content may be somewhat above or below that range. We have further found that the general suitability of such an alloy for use as a cutting tool and other abrasion-resisting articles is enhanced by the addition of one or more of the following elements: cobalt; nickel; boron; silicon; manganese; tungsten; molybdenum; columbium; tantalum; and vanadium.

According to this invention, a cutting tool alloy has a composition in the neighborhood of 53% chromium, 12% cobalt, 7% nickel, 2% carbon, remainder iron. These percentages may be varied somewhat, but should ordinarily be within the limits:

	Broad	Preferred
Percent chromium	45 to 65	50 to 56
Percent cobalt	5 to 20	7 to 15
Percent nickel	4 to 20	6 to 15
Percent carbon	1 to 3	1.5 to 2.25

the iron being usually more than 15% and preferably at least 20%. On occasion it will be desirable to add one or more of the elements silicon, tungsten, molybdenum, titanium, zirconium, columbium, tantalum, and vanadium, in individual percentages not exceeding 5% and in a total aggregate percentage under 10% and manganese up to about 10%; the iron however being maintained above 15%. It is sometimes desirable to add boron in a percentage not over about 5%: in a proportion between 0.2% and 1.5% this element considerably enhances the cutting qualities and toughness of the alloy. The normal impurities of steels, such as phosphorus, sulfur, and nitrogen, may be present in small fractional percentages without departing from the invention.

The alloys of this invention may be used in the as-cast condition (after casting in sand or carbon molds for instance) or when heat treated. A suitable heat treatment consists in holding the alloy at a temperature between about 550° C. and about 850° C. for a time between about five minutes at the higher temperatures to about twenty hours at the lower temperatures. The alloys are hot forgeable to a limited extent. If the alloys are to be forged, it is best to begin that operation before they have cooled from the casting step to below 900° C. Some cold deformation of the forged alloy can be effected, preferably after quenching from above 900° C.

Depending chiefly upon the composition and heat treatment, the hardness of the alloy of the invention varies between the approximate limits of 55 to 70 Rockwell "C." The best cutting tool quality is usually attained in tools having a hardness in the neighborhood of 60 Rockwell "C." The transverse strength of the as-cast alloys is upwards of 1000 pounds (loading applied centrally to a section 0.5 inch by 0.5 inch square, supported in a 4 inch span) and in the preferred range of compositions attains 3000 to 4000 pounds and sometimes more.

Cutting tests indicate that the alloy tool of the invention compares favorably with standard high speed steel tools of the 18-4-1 type. In accelerated life tests, cutting steel billets and semi-steel billets, and using surface speeds, feeds, and cuts considerably greater than normal, tools of this invention cut from two to eight times as far as standard "Rex AAA," a widely used high speed steel of high quality.

Although the use of the alloy of this invention as a cutting tool has been emphasized in the foregoing description, the alloy is capable of many other uses which are within the invention, for instance as a hard-facing material for tool and machinery wear-resisting parts.

We claim:

1. Alloy, resistant to wear and abrasion and suitable for use as a cutting tool, having substantially the composition: between 45% and 65% chromium, between 5% and 20% cobalt, between 4% and 20% nickel, carbon between 1% and 3% to impart toughness, remainder iron.

2. Alloy, resistant to wear and abrasion and suitable for use in the as-cast condition as a cutting tool, having substantially the composition: 50% to 56% chromium, 7% to 15% cobalt, 6% to 15% nickel, 1.5% to 2.25% carbon, remainder iron; the iron content being more than 15%.

3. A cutting tool having a composition approximating: 53% chromium, 12% cobalt, 7% nickel, 2% carbon, remainder iron.

4. An alloy as claimed in claim 1, which alloy has been improved by being heated at a temperature within the range 550° C. to 850° C. for a time between five minutes and twenty hours.

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