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ALLOY STEEL

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4 Claims. (Cl. 75—1)

This invention relates to alloy steels containing chromium and nickel, referring more especially to improvements in steels containing high percentages of both chromium and nickel, and the primary object of the invention is to provide chromium-nickel steels which are stronger and which can be machined more easily than the steels of this type heretofore known.

Alloy steels containing relatively large percentages of chromium and nickel find numerous and varied uses, primarily because of their peculiar excellence in resisting the attack of corrosives. It is found however that these steels have a comparatively low yield point, and are moreover difficult to machine, either in the wrought condition or as cast metal.

I have discovered that the addition of nitrogen in quantities appreciably greater than those commonly present in steels tends markedly to increase the strength and improve the machinability of cast and wrought alloy steels which contain relatively large amounts of chromium and nickel. These improvements are secured according to my invention without greatly impairing the resistance to corrosion and stain, the toughness, or the ductility of the steels. The strength of the steels is raised without greatly affecting the hardness.

In general, I prefer to have the maximum amount of nitrogen present in the steel that can be retained in stable combination at the temperatures which are required for casting the metal. The amount of nitrogen which can be retained in the final product seems to increase with increased chromium content and decrease with increased nickel content; thus, a steel containing 35% chromium and 5% nickel will retain at the casting temperature as much as about 0.6% nitrogen, while a steel containing 15% chromium and 35% nickel will retain at the casting temperature only about 0.1% nitrogen. I have found that where it is possible to add as much as about 0.2% of nitrogen, at least that amount should be present in order to obtain the marked improvements in properties of the steels which my invention affords, but where the nickel content is so high that less than 0.2% of nitrogen can be held stably by the metal, the smaller amount stably held is still sufficient to produce beneficial results.

I also prefer to introduce nitrogen into the steel by adding nitrides, such for example as chromium nitride and high-nitrogen ferro-chromium, to the molten metal, in substantially the manner disclosed in my application bearing the Serial Number 553,889, which was filed on July 29, 1931. Nitrogen which is present in the metal in substantially the form and distribution obtained by this method, is herein referred to as alloyed nitrogen.

Tests which I have made demonstrate the useful discovery which my invention involves. My tests show that the addition of nitrogen to chromium-nickel steels containing from about 15% to about 35% of chromium and from about 5% to about 35% of nickel, in such amounts that the steel contains a total of at least about 0.1% of nitrogen, results in a valuable improvement in these steels from the standpoint of their strength and of the ease with which they can be machined. Since the steels containing nickel in the higher percentages and chromium in the lower percentages of the above ranges are more readily machinable than the other possible combinations thereof, the improvement in strength for these high-nickel, low-chromium steels is of somewhat greater importance than the improvement in machinability. I have observed that additions of nitrogen to chromium-nickel steels do not affect the grain size of the metal to a degree comparable to the effect secured by adding nitrogen to the plain chromium steels as disclosed in my above-mentioned application.

The following table gives a series of numerical results obtained in tests of representative steels embodying my invention, in which they are compared to ordinary low-nitrogen chromium-nickel steels. The test samples had the approximate composition: 0.5% of silicon, 0.5% of manganese, 0.3% of carbon and the remainder iron except for chromium, nickel and nitrogen in the percentages indicated in the table.

Alloy			Metal condition	Tensile tests			Transverse tests		Hard. Brin.
% Cr	% Ni	% N		Y. P.	M. S.	% El.	T. B. L.	Defl.	
17	34	0.03	Cast	37	49	3.0	6.8	1.8	131
17	34	.12	Cast	50	56	3.0	7.5	1.0	126
23	12	.06	Cast	46	57	4.0	7.9	2.7	187
23	12	.30	Cast	59	74	3.0	8.4	2.4	187
18	8	.08	Cast				7.1	3.2	156
18	8	.30	Cast				8.0	3.1	163
*18	8	.03	Wrought	37	92	60			143
18	8	.30	Wrought	53	107	50			159

*Note. This metal contained about 0.10% carbon.

In the above table the following abbreviations are used: Alloy for the percentages of alloy ele-

ments present in the steel sample; Y. P. for yield point in thousands of pounds per square inch; M. S. for maximum stress in thousands of pounds per square inch; % El. for percentage elongation in two inches in a standard 0.505 inch tensile sample; Transverse tests to designate the results of tests on a standard arbitration bar; T. B. L. for transverse breaking load in thousands of pounds; Defl. for deflection in inches; and Hard. Brin. for the hardness number on the Brinell scale.

In all of the above tests, it was found that the sample containing the higher percentage of nitrogen, of the pair having the same metal composition, was the easier to machine. By extensive tests with acid and salt spray methods on these samples I have determined that the presence of the high percentages of nitrogen does not greatly affect the resistance of the steels to corrosion and stain.

It will be evident that the scope of my invention is not limited to the specific examples given, but is limited only by the broad principle which I have disclosed herein and defined by the appended claims.

I claim:

1. An alloy steel comprising about 15% to 35% chromium; about 5% to 35% nickel; at least about 0.1%, and not more than about 0.6%, nitrogen; the remainder chiefly iron; said steel having throughout substantially the same concentration of nitrogen.

2. An alloy steel comprising about 18% to 25% chromium; about 5% to 15% nickel; at least about 0.2%, and not more than about 0.4%, nitrogen; the remainder substantially all iron; said steel having throughout substantially the same concentration of nitrogen.

3. An alloy steel comprising about 15% to 35% chromium; about 5% to 15% nickel; at least about 0.2%, and not more than about 0.6%, nitrogen; the remainder substantially all iron; said steel having throughout substantially the same concentration of nitrogen.

4. An alloy steel comprising about 18% to 25% chromium; about 5% to 15% nickel; at least about 0.2%, and not more than about 0.6%, nitrogen; the remainder substantially all iron; said nitrogen being present in substantially the maximum amount that can be retained by the steel in stable combination at the casting temperature of the steel; and said steel having throughout substantially the same concentration of nitrogen.

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