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CHROMIUM-MANGANESE-NICKEL STEEL

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4 Claims. (Cl. 75-128)

This invention relates to steels containing essentially iron, chromium, manganese, nickel, copper, and columbium or tantalum or both. An object of the invention is to provide a new stainless steel having excellent strength, toughness, ductility, and corrosion resistance at ordinary temperatures and at elevated temperatures up to 900° C.

By the present invention we propose to improve certain properties of the chromium-manganese-copper steel described in Patent 1,896,154, issued February 7, 1933, to Frederick M. Becket, by introducing nickel and columbium into the steel. We have found that the tendency of the chromium-manganese-copper steel to lose its resistance to intergranular corrosive attack after being heated at elevated temperatures can be markedly improved by the addition of columbium or tantalum, or both, especially when practically all the carbon present in the steel is in combination with columbium and tantalum, or both. This discovery is described in our copending application Serial No. 84,683, filed June 11, 1936. However, this columbium-bearing steel develops

though it has not been subjected to treatment at high temperatures.

We have also found that the toughness and ductility of these chromium-manganese-copper steels containing columbium can be markedly improved by the addition of relatively small percentages of nickel. This improvement is so pronounced that, if the nickel additions are in proper amount, the resulting product is inherently tough, and can even be heated to between about 300° C. and 900° C. without becoming seriously brittle. Although the introduction of nickel into these columbium-bearing chromium-manganese steels increases their cost somewhat, the resulting product is less expensive than the columbium-bearing austenitic chromium-nickel steels that are employed in many instances to serve the same purpose. In order to achieve the desired economy, the manganese content of the steel should in all instances exceed the nickel content.

An illustration of the marked improvement imparted to these columbium-bearing chromium-manganese steels by the addition of nickel is provided by the data given in the following table:

Composition (remainder iron)							Heat treatment*	Results of tests in boiling acidified copper sulphate solution
Percent Cr	Percent Mn	Percent Ni	Percent Cu	Percent C	Percent Cb	Percent Ta		
17.86	9.48	None	0.80	0.07	None	None	1	Disintegrated in 5 hr.
17.86	9.48	None	0.80	0.07	None	None	2	Disintegrated in 15 hr.
18.82	8.98	None	1.00	0.10	1.12	None	1	Unaffected in 100 hr., but metal brittle.
18.82	8.98	None	1.00	0.10	1.12	None	2	Unaffected in 100 hr., but metal brittle.
18.66	5.40	4.46	0.93	0.07	None	None	1	Disintegrated in 20 hr.
18.66	5.40	4.46	0.93	0.07	None	None	2	Disintegrated in 30 hr.
18.30	5.63	4.43	1.10	0.06	1.25	None	1	Unaffected in 100 hr. No signs of brittleness.
18.30	5.63	4.43	1.10	0.06	1.25	None	2	Unaffected in 100 hr. No signs of brittleness.
18.65	5.50	4.25	0.73	0.08	None	1.73	1	Unaffected in 100 hr. No signs of brittleness.
18.65	5.50	4.25	0.73	0.08	None	1.73	2	Unaffected in 100 hr. No signs of brittleness.

* 1. Samples quenched from 1150° C., held 3 days at 550° C. and air cooled.

2. Samples quenched from 1150° C., held 3 days at 650° C. and air cooled.

brittleness during prolonged holding at temperatures in excess of about 300° C. Also, when enough columbium is added to combine with all the carbon in the steel, there is a tendency for the metal to exhibit inherent brittleness even

That the chromium-manganese-copper steels are subject to loss of corrosion resistance upon prolonged holding at elevated temperatures and that this defect can be substantially eliminated by the addition of columbium is clearly evident

when a study is made of the data given in this table. It is further evident that the columbium-bearing steels, although not subject to intergranular attack, do develop brittleness on exposure for long periods at elevated temperatures, and that the addition of nickel to these chromium-manganese steels containing columbium imparts substantial freedom from brittleness on exposure to elevated temperatures and improved resistance to grain boundary attack.

To secure this relative freedom from brittleness and improved resistance to grain boundary deterioration at elevated temperatures, it is important to maintain a chromium content between about 16% and 22%, a manganese content between 5% and 14%, no less than 3% but no more than about 6% nickel, 0.25% to 2% copper, a carbon content in no instance exceeding 0.15%, and a columbium content at least four times the carbon content. The columbium content is preferably at least ten times the carbon content, but the total percentage of columbium should not exceed 1.50%. The tantalum content, when tantalum is used instead of columbium, should be at least six times the carbon content, but no more than 2% of the total alloy.

A typical steel of the invention is one that contains approximately 18% chromium, 6% manganese, 4% nickel, 0.70% copper, 0.08% carbon, 0.40% silicon and 0.60% columbium. Such a steel has been found to possess the valuable characteristics previously described. At the expense of some stability of the austenitic constituent of the steel, the copper content may be omitted.

We claim:

1. Alloy steel comprising 16% to 22% chromium, 5% to 14% manganese, copper in an amount not exceeding 2%, carbon in an amount not exceeding 0.15%, an amount at least four

times the carbon content but not exceeding about 1.5% of metal of the group columbium and tantalum which inhibits loss of corrosion resistance when the steel is held at elevated temperatures below 900° C., 3% to 6% nickel which inhibits the development of brittleness at temperatures below 900° C., and the remainder iron.

2. Alloy steel comprising 16% to 22% chromium, 5% to 14% manganese, 3% to 6% nickel, 0.25% to 2% copper, carbon in an amount not exceeding 0.15%, columbium in an amount at least ten times the carbon content but not exceeding 1.5%, the remainder iron.

3. Article used to withstand corrosive media during or after exposure to elevated temperatures below 900° C., which article is composed of an alloy steel comprising 16% to 22% chromium, 5% to 14% manganese, copper in an amount not exceeding 2%, carbon in an amount not exceeding 0.15%, an amount at least four times the carbon content but not exceeding about 1.5% of metal of the group columbium and tantalum which inhibits loss of corrosion resistance when the steel is held at elevated temperatures below 900° C., 3% to 6% nickel which inhibits the development of brittleness at temperatures below 900° C., and the remainder iron.

4. Article used to withstand corrosive media during or after prolonged exposure to elevated temperatures below 900° C., which article is composed of an alloy steel comprising 16% to 22% chromium, 5% to 14% manganese, 3% to 6% nickel, 0.25% to 2% copper, carbon in an amount not exceeding 0.15%, columbium in an amount at least ten times the carbon content but not exceeding 1.5%, the remainder iron.

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