Patented Mar. 30, 1943

2,315,156

UNITED STATES PATENT OFFICE

2,315,156

LOW-ALLOY CORROSION-RESISTANT STEEL

Clifford P. Larrabee, Vandergrift, Pa.

No Drawing. Application October 10, 1941, Serial No. 414,523

2 Claims. (Cl. 75—125)

This invention relates to low-alloy corrosion-resistant steels, and it is particularly concerned with the production of a steel of this type which is characterized by having exceptionally increased resistance to both fresh water and atmospheric corrosion. Insofar as is known, prior art steels of this type, while resistant to atmospheric corrosion, are not appreciably more resistant to fresh water corrosion than ordinary steels.

It has been found that the steel presently disclosed, when in contact with fresh water, loses only about one-half the weight in a given period of time as do the plain carbon or copper-bearing steels. In addition, its loss in the atmosphere is only about one-third that of the plain carbon steel, or two-thirds that of the copper-bearing steel.

This new steel is characterized by the following composition:

Element	Preferred analysis based on open hearth economies	Permissible range
Carbon	0.05 to 0.10	0.01 to 0.1.
Manganese	0.30	0.20 to 0.40.
Phosphorus	0.07	0.05 to 0.10.
Sulphur	Less than 0.04	Less than 0.04.
Silicon	0.10 max	0.0 to 0.10.
Copper	0.20 min	0.20 to 0.40.
Nickel	Residual	Residual.
Chromium	1.75 min	1.75—up.
Titanium	4 times the carbon content.	4 times the carbon content.

It is to be noted that the above gives a rather exact analysis best suited to its economical manufacture by the open hearth, and one of broader range that represents the variations that are possible while still retaining the steel's unexpectedly high resistance to fresh water and atmospheric corrosion. It is to be noted that the steel has its resistance to both these types of corrosion. It might also be mentioned that the steel possesses its corrosion-resistant characteristics regardless of whether it is heat-treated.

In further explanation of the analysis of the steel, it is to be understood that it is very difficult, and sometimes undesirable, to provide an extremely low carbon content. The steel's carbon may go as high as .10% without detracting from its qualities. The manganese and silicon are included solely to permit the manufacture of the steel in accordance with good steel-making practices, but neither of these elements should exceed the stated amounts. The sulphur should be kept below .04%, as is customary in any good steel.

The components that actively contribute to the unexpected characteristics of the steel appear to be, in part, its phosphorus content, which increases the atmospheric corrosion resistance of the steel without appreciably lessening its corrosion resistance to water, providing the stated phosphorus limits are observed. The copper also functions to improve the atmospheric corrosion resistance without introducing trouble of its own and without making the steel expensive to manufacture, it being understood that, here again, the limit stated should be observed. As to chromium, the content advanced appears to be the minimum required if the steel is to have its extraordinary good resistance to fresh water corrosion. At the same time, it does not detract from the function of the phosphorus and the copper. The upper limit of the chromium is set by the type of the new steel, it being understood that it should not exceed that taking the steel out of its low-alloy classification and placing it among the high-alloy, and the more expensive, steels. It is commonly recognized that a low-alloy steel should not contain more than about 3% chromium, because of the expense attendant higher percentages.

The titanium content of the steel functions to eliminate the necessity for an expensive heat-treatment, the steel having practically the same resistance to corrosion whether it is heat-treated or not. A stated amount of titanium, that is to say, a titanium content proportioned to the carbon content as described, insures the steel having its maximum resistance to fresh water corrosion, regardless of the fact that it contains carbon either because of economical reasons or because the carbon is needed to add strength to the steel.

It is to be noted that the steel contains no nickel, this element being neither needed nor desired. This is of importance, since, in times of war, nickel is a metal of extreme strategic importance, it representing a material that must be imported to this country.

So far as is known, the inventors of other steels have paid little attention to the fact that a steel which may resist corrosion relatively satisfactorily from other media, is frequently subject to easy corrosion attack when exposed to fresh water. The atmospheric corrosion problem has been recognized, but it has remained uncoupled with the just-named type of corrosion. In the case of certain types of structures, such as steel barges which are exposed to both fresh water and atmosphere, a steel having the exceptionally high

resistance to both types of corrosion, such as is possessed by this new steel, represents a material of considerable value. Such a material has been heretofore unavailable.

In closing, it might be mentioned that the new steel has adequate strength. Thus, physical tests applied to a sample of steel having the described composition showed that it had an ultimate strength of 65,100 pounds per square inch, with an attendant elongation in two inches of 19.5%.

I claim:

1. A steel of the low-alloy type and which is characterized by increased resistance to both fresh water and atmospheric corrosion, said steel containing not more than .10% carbon, from .20 to .40% manganese, from .05 to .10% phosphorus, less than .04% sulphur, not more than .10% silicon, from .20 to .40% copper, from 1.75% to 3% chromium, about four times its carbon content of titanium, and with its balance substantially all iron.

2. A steel of the low-alloy type and which is characterized by increased resistance to both fresh water and atmospheric corrosion, said steel containing from .05 to .10% carbon, about .30% manganese, about .07% phosphorus, less than .04% sulphur, not more than .10% silicon, not less than .20% copper, from 1.75% to 3% chromium and titanium to the amount of about four times said carbon content, said steel being otherwise iron, and said copper and chromium not being in excess of what qualifies said steel as low-alloy.

CLIFFORD P. LARRABEE.