Patented May 19, 1925. 1,538,360

UNITED STATES PATENT OFFICE.

WILLIAM H. SMITH, OF CLEVELAND, OHIO, ASSIGNOR TO LUDLUM STEEL CO., OF WATERVLIET, NEW YORK, A CORPORATION OF NEW JERSEY.

MALLEABLE NONCORRODIBLE ALLOY.

No Drawing. Application filed February 27, 1919. Serial No. 279,649.

To all whom it may concern:

Be it known that I, WILLIAM H. SMITH, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Malleable Noncorrodible Alloys, of which the following is a full, clear, and exact description.

The present invention relates to an alloy which has certain properties both chemical and physical which render the alloy exceedingly important from a commercial standpoint, for the manufacture of all articles or parts of structures wherein the article or structure is subjected to repeated heatings to high temperatures, or where the article or structure is subjected to the action of corrosive liquids, solids or fumes, or to oxidizing gases.

Among the important properties of the alloy may be mentioned the fact that the alloy is exceedingly resistant to wear and also is resistant to warping, cracking and breaking. Furthermore, the alloy is resistant to corrosion by contact with corroding substances or fumes and is not subject to surface flaking which causes rapid deterioration of an article which exhibits this failing.

A still further desirable property is the fact that the melting point of the alloy is very high, so that an article or part of a structure may be subjected to considerable heat without in any way endangering the structure of the article due to melting or fusing.

The fact that articles and parts of structures made from this alloy do not warp and do not grow, or in other words, increase their dimensions by repeated heatings, makes the alloy exceedingly useful in a great many instances.

Among the important uses to which the alloy may be put we may mention containers or heat treating boxes, saggars, furnace parts, crucibles, glass molds, metal molds for foundry use, retorts, dies, die rings, and in fact, any structure in the use of which the important properties of this alloy may be utilized. The alloy is also a good material for the manufacture of electrical resistance elements, the alloy being non-oxidizing at high temperatures.

One very important use to which the alloy may be put is the making of heat treating boxes, or containers. Boxes made of the proposed alloy are non-warping and non-scaling even though subjected to repeated heating at high temperature and subsequent cooling, and are free from the fault of cracking. Furthermore, the walls of these boxes may be made comparatively thin, thereby lightening the weight of these boxes to a considerable degree over that necessary where the boxes are made of iron or steel.

The alloy does not materially oxidize when heated or subjected to fumes or gases. The aluminum and silicon at the surfaces of the alloy forms an oxidizing coating or skin which protects the metal from further oxidizing effects.

The alloy comprises as its essential elements, chromium, iron, nickel, and a small proportion of titanium. In addition it is found advantageous to use manganese, as well as silicon and aluminum may be present if desired, and also a small proportion of carbon.

The alloy may contain 15 to 40 per cent of chromium, 1 to 15 per cent of nickel, 3/100 of 1 per cent to 10 per cent of titanium, 3/10 of 1 per cent to 2½ per cent of silicon, ½ of 1 per cent to 2 per cent of manganese, and 4/100 of 1 per cent to 2 per cent of aluminum if the presence of aluminum is desired, the balance consisting mainly of iron and carbon. If sulphur and phosphorus be present in the alloy, the amount should be kept as low as possible, preferably less than 5/100 of 1 per cent.

As an example, a typical analysis of an alloy found to contain the desirable qualities, the following is given:

18 per cent chromium, 4 per cent nickel, 1½ per cent manganese, 8/100 per cent titanium, 1 per cent silicon, 3/100 per cent aluminum if aluminum is present at all, balance iron and carbon.

The chromium is the element which imparts the highly resistant qualities as to wear and corrosion to the alloy as well as the property of non-warping. The nickel renders the alloy more homogeneous and less likely to cracking when subjected to repeated heatings. The manganese gives a good grain to the alloy.

The silicon and aluminum, (if aluminum

is used,) are added just before the metal is poured. The silicon acts as a de-oxidizer of the metal bath and also imparts fluidity to the metal so that it is readily poured.

In the event that the source of ferro-chrome used is that of the thermite process, there is likely to be some aluminum in the ferro-chrome which appears in the final alloy.

The titanium performs two functions. While the alloy is in melted condition within the furnace, it acts as a de-oxidizer, part of the titanium combining with occluded gases, particularly nitrogen, and this combination with titanium is removed by the slag. Additionally, the titanium which is in excess of that required as a de-oxidizer, appears in the final alloy and imparts the properties of toughness, resiliency and resistance to cracking. The quantity of titanium will vary in accordance with the degree in which it is desired to produce the characteristics just mentioned, and may vary within the limits which have before been specified.

The alloy is produced in the electric furnace by melting ferro-chrome together with the various other ingredients of the alloy which have been mentioned, and with a suitable flux such as is well known in the art. In making the alloy it is only necessary to bring the temperature of the furnace to a sufficient degree to insure a thorough melting and incorporation of the various elements of the alloy. The final alloy obtained is a metal which is very easily handled in the foundry and can be poured and cast in manner and by methods similar to those employed in foundry practice.

The alloy has a high tensile strength, and on fracture shows a fine compact grain. The alloy is tough and resistant to breakage. The melting point is high, being in the neighborhood of 2700° Fahrenheit.

It has been found that when the alloy contains a low percentage of carbon, say .11 per cent to .12 per cent, the alloy is fairly malleable and where the carbon is kept as low as 7/100 per cent to 8/100 per cent, the alloy is also easily machinable. Under many circumstances this quality of malleability is important and desirable.

Having described my invention, I claim:

1. A malleable alloyed soft steel resistant to corrosion and to oxidation containing iron in excess of 50%, chromium not less than 15% and not greater than 40%, together with nickel and titanium not greater than the chromium.

2. A malleable alloyed soft steel resistant to corrosion and to oxidation containing iron in excess of 50%, nickel not less than 1% and not greater than 15% together with chromium and titanium not greater than 50% nor less than 15%.

3. A malleable alloyed soft steel resistant to corrosion and to oxidation containing iron in excess of 50%, nickel about 15%, titanium not less than .08% nor greater than 10%, together with chromium.

4. A malleable alloyed soft steel resistant to corrosion and to oxidation containing iron in excess of 50%, chromium approximately 18%, nickel not less than 1% nor greater than 15% and a small quantity of titanium.

5. A malleable alloy resistant to corrosion and to oxidation containing as essential ingredients, substantially 15 to 40 per cent of chromium, substantially 1 to 15 per cent of nickel, substantially 3/100 of 1 per cent to 15 per cent of titanium, balance of iron and carbon.

6. A malleable alloy resistant to corrosion and to oxidation consisting of substantially 15% to 40% of chromium, 1% to 15% of nickel, ½% to 2% of manganese, substantially 3/100% to 2½% of a metal having the properties of silicon with respect to forming a non-flaking oxide, a small quantity of titanium in excess of 3/100%, the balance being iron and carbon.

7. A malleable alloy resistant to corrosion and to oxidation consisting of substantially 18 per cent of chromium, 4 per cent of nickel, 1½ per cent of manganese, 8/10% of titanium, balance iron and carbon.

8. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 15%, silicon 2.5%, manganese 2%, and titanium about .08%.

9. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 15%, material having the properties of silicon and aluminum .53% to 4.5%, and titanium about .08%.

10. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 1% to 15%, silicon 2.5%, manganese 2%, and titanium about .08%.

11. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 1% to 15%, material having the properties of silicon and aluminum .53% to 4.5%, and titanium about .08%.

12. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 15%, silicon 2.5%, manganese 2%, and titanium .03% to 10%.

13. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 15%, material having the properties of silicon and aluminum .53% to 4.5%, and titanium .03% to 10%.

14. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 1% to 15%, silicon 2.5%, manganese 2%, and titanium .03% to 10%.

15. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 1% to 15%, material having the properties of silicon and aluminum .53% to 4.5%, and titanium .03% to 10%.

In testimony whereof, I hereunto affix my signature.

WILLIAM H. SMITH.

14. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 1% to 15%, silicon 2.5%, manganese 2%, and titanium .03% to 10%.

15. Alloyed malleable soft steel resistant to corrosion and to oxidation containing substantially chromium 15% to 40%, nickel 1% to 15%, material having the properties of silicon and aluminum .53% to 4.5%, and titanium .03% to 10%.

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WILLIAM H. SMITH.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,538,360, granted May 19, 1925, upon the application of William H. Smith, of Cleveland, Ohio, for an improvement in "Malleable Noncorrodible Alloys," errors appear in the printed specification requiring correction as follows: Page 1, line 66, before the word "fumes" insert the word *oxidizing*, and line 68 for "oxidizing" read *coating;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of June, A. D. 1925.

[SEAL.]

KARL FENNING,
Acting Commissioner of Patents.

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KARL FENNING,
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