Patented Aug. 1, 1933

1,920,934

UNITED STATES PATENT OFFICE

1,920,934

CORROSION RESISTING STEEL

William Herbert Keen, Albany, N. Y., assignor to Chas. W. Guttzeit, New York, N. Y.

No Drawing. Application July 10, 1928 Serial No. 291,697

17 Claims. (Cl. 75—1)

This invention relates to alloy steels and has for an object to provide a corrosion resisting steel.

Corrosion resisting steels have been produced heretofore containing 12% to 18% chromium but the cost of the same prohibits their use commercially for structural beams and plates and in other applications where the tonnage is high. I have discovered that the amount of chromium and, therefore, the cost of the steel can be materially reduced if magnesium is present with the chromium. For example, in steels containing from 1.5% to 7.5% or more of chromium the presence of magnesium in amounts from 0.05% to 2% or more adds to the corrosion resisting properties more or less in proportion to the amount of magnesium present.

The present invention has been developed more particularly in connection with the production of corrosion resisting steel suitable for use in boiler tubes, rolled plates, sheets and the like, such as used for roofing and in the manufacture of freight cars, and for convenience of disclosure such an embodiment of the invention will be described. The description, however, is illustrative merely and it not intended as defining the limits of the invention.

An alloy steel suitable for rolling and having corrosion resisting properties may contain, for example—

Carbon	.01% to 1%
Chromium	1.5% to 20%
Magnesium	.15% to 5%
Aluminum	0% to 2%
Nickel	0% to 10%

Ordinarily the chromium may be kept between 4% and 7.5% to obtain desired quality without too great expense.

Manganese and silicon may be varied within the usual limits as in ordinary or stainless types of steel according to specification desired without any marked effect upon corrosion resistance. Deoxidants such as zirconium, aluminum, calcium, boron and titanium may be used but are not essential to the quality of the steel.

A steel of this character with chromium in the lower part of the range indicated while not necessarily having as effective corrosion resisting properties as the best corrosion resisting chromium steel, will nevertheless withstand the effects of corrosion perhaps three or four times as well as the steel now used for structural work and the like, and yet the cost will not be prohibitive.

An increase of chromium improves the corrosion resisting properties but adds to the expense. Such elements as vanadium, molybdenum, tungsten or tantalum may be advantageously added for the usual purposes and do not substantially change the corrosion resisting properties of this steel.

The addition of magnesium to corrosion resisting steels of higher chromium content is also beneficial and improves their stain resisting properties to a noticeable degree. This improvement is especially noticeable in improved resistance to attack of acetic acid, and is also apparent on the copper sulphate test which is now being employed by many users of steels of this type. Benefits are noted even with very small amounts such as are barely determinable by chemical analysis, but are more marked with increasing quantities on up to 1.5% and 2%.

In the manufacture of this steel the alloys should in general be added in the usual manner, but it is desirable that the magnesium be added shortly before pouring when the steel has been properly killed and the temperature is about right for tapping. A small area of the bath should be cleaned of slag by means of a scraper and the magnesium added directly to the metal. Tapping should follow as soon as practicable to avoid undue loss of magnesium. Ordinarily the addition of pure magnesium metal is impractical. The ideal alloy to be added would be a composition of magnesium and iron, but up to the present time no one has been able to produce a ferro-magnesium alloy. Nickel magnesium is perhaps the most easily obtained and generally the most desirable alloy to add in practice. However, some of the more common alloys such as aluminum-silicon-magnesium, aluminum-magnesium, or magnesium-manganese-silicon may effectively be added. The use of a compound containing aluminum has the advantage that the presence of aluminum also improves the corrosion resisting properties and permits a reduction of the percentage of magnesium to obtain the same degree of corrosion resistance. A mixture of several alloys may be added, if desired.

It is of interest to note that steel of the character described wi.. withstand exposure over long periods at elevated temperatures. At 1700° Fahrenheit, for instance, there is no appreciable oxidation.

The steel described may be readily rolled into structural shapes, plates, sheets and the like, and it can be produced at a cost which is more than justified by the greater durability.

The following analyses of typical steels which have been found suitable for rolling into plates, sheets, and the like, are illustrative—

Iron	.93%	.93%	.90%
Carbon	.28	.2	.32
Silicon	.23	.28	.16
Manganese	.32	.37	.27
Sulphur	.014	.017	.029
Phosphorus	.021	.024	.032
Chromium	5.24	4.9	6.05
Magnesium	1.30	.95	.42
Aluminum		.6	
Nickel			1.83

It will be noted that in these typical steels, the chromium approximates 5% and is within the range of 3.5% to 5.5%, and the magnesium approximates 1% and is within the range of 0.5% to 1.5%. These analyses are illustrative merely of steels which would meet the physical requirements for tonnage applications.

A fairly good degree of hardness is obtainable if desired even in the lower range of carbon as illustrated by a steel of the following composition: carbon .44%, chromium 4.89%, magnesium .12% and nickel 1.41%. When hardened by quenching in oil, a Brinell hardness may be obtained as shown below:

Temperature	Brinell
1500 Fahr.	477
1600	555
1700	600
1800	627
1900	600

The addition of the magnesium apparently does not cause a depreciation in the hardening quality as does the addition of some other elements, as, for example, aluminum, but an effect similar to the effect of aluminum would be reasonable to expect if the magnesium content were further increased.

I claim:

1. A corrosion resisting steel containing 1.5% to 20% chromium, and 0.5% to 2% magnesium, the remainder being substantially iron.

2. A corrosion resisting steel containing 3.5% to 20% chromium, and 0.1% to 2.5% magnesium, the remainder being substantially iron.

3. A corrosion resisting steel comprising approximately 5% chromium and approximately 1% magnesium, the remainder being substantially iron.

4. A corrosion resisting steel comprising approximately 3.5% to 5.5% chromium and approximately 0.5% to 1.5% magnesium, the remainder being substantially iron.

5. A corrosion resisting steel comprising approximately 5% chromium and approximately 1% magnesium, together with approximately 1% aluminum, the remainder being substantially iron.

6. A corrosion resisting steel comprising approximately 3.5% to 5.5% chromium and approximately 0.5% to 1.5% magnesium, together with an appreciable amount, more than an impurity, aluminum ranging up to 2%, the remainder being substantially iron.

7. A corrosion resisting steel containing 1.5% to 20% chromium and 1% to 5% magnesium, the remainder being substantially iron.

8. A corrosion resisting steel comprising approximately 5% to 9% chromium and .10% to 5.0% magnesium, the remainder being substantially iron.

9. A corrosion resisting steel containing 3% to 20% chromium to cause a substantial resistance to corrosion and 0.15% to 5% magnesium to substantially increase the corrosion resistance, the remainder being substantially iron.

10. A corrosion resisting steel comprising approximately 3.5% to 5% chromium and approximately 0.5% to 5% magnesium, the remainder being substantially iron.

11. A corrosion resisting steel comprising approximately 3.5% to 7% chromium and approximately 0.15% to 5% magnesium, the remainder being substantially iron.

12. A corrosion resisting steel comprising approximately 5 to 9% chromium and 1 to 5% magnesium, the remainder being substantially iron.

13. A corrosion resisting steel comprising 3.5 to 20% chromium and 1 to 5% magnesium, the remainder being substantially iron.

14. A corrosion resisting steel comprising 3.5 to 5.5% chromium and 1 to 5% magnesium, the remainder being substantially iron.

15. A corrosion resisting steel comprising 3.5 to 5.5% chromium and 1 to 2.5% magnesium, the remainder being substantially iron.

16. A corrosion resisting steel comprising 3.5 to 7.5% chromium and 0.25 to 0.75% magnesium, the remainder being substantially iron.

17. A corrosion resisting steel comprising 5 to 7% chromium and 0.25 to 0.75% magnesium, the remainder being substantially iron.

WILLIAM HERBERT KEEN.