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TITANIUM IRON ALLOY

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This invention relates to corrosion-resisting irons or steels and more particularly to such irons or steels having new and improved properties.

Irons and steels may be roughly divided into two classes on the basis of their resistance to corrosion. The first class includes those compositions which are highly resistant to corrosion, either because of the absence of impurities which cause corrosion or because of the presence of added elements which make them highly resistant to corrosion. An example of this class is stainless steel. The second class includes compositions which are only mildly resistant to corrosion, due to the presence of impurities, but which possess relatively long life under corroding influences by reason of a more or less uniform dispersion of the impurities in finely divided particles. Thus, while the metal corrodes it does so slowly and uniformly as compared with the same metal in which the impurities are present in segregated form and where the corrosion is localized with the formation of pits or holes which soon make the article of little or no value. An example of this class is the iron of the Charls Patent No. 1,355,589.

In our copending application Ser. No. 119,264 filed January 6, 1937, we have pointed out our discovery that nitrogen in proper form and amount is not an element to be avoided, but in fact can be used to confer desirable characteristics on corrosion-resisting irons or steels of certain compositions. In that application it was pointed out that the presence of nitrogen and phosphorous in certain specified amounts conferred certain desirable characteristics on such irons.

Our present invention is based on the discovery that titanium and nitrogen, in certain amounts, confer desirable characteristics on corrosion resisting irons or steels, particularly when certain other elements in certain amounts are present. Articles composed of such irons or steels have exhibited a marked improvement in resistance to atmospheric and water corroding influences and possess physical properties lacking in similar steels which do not contain nitrogen and titanium.

Articles to be exposed during use to corroding conditions and embodying the present invention are typified by the following analyses:—

	Percent
Carbon	.02 to .10
Manganese	.05 to .25
Aluminum	.005 to .2
Copper	.45 to .55
Nitrogen	.005 to .2
Titanium	.10 to .35

It will be understood that the remainder is iron with the usual amounts of impurities, including phosphorous, sulphur and the like, which are ordinarily present in low carbon steels of the foregoing range of analyses.

A preferred range of analyses within the foregoing limits is as follows:—

	Percent
Carbon	.02 to .08
Manganese	.05 to .15
Aluminum	.005 to .20
Copper	.45 to .55
Nitrogen	.005 to .05
Titanium	.10 to .25

A preferred specific composition is as follows:—

	Percent
Carbon	.06
Manganese	.10
Aluminum	.10
Copper	.50
Nitrogen	.03
Titanium	.20

We believe that when nitrogen within the foregoing limits is present, preferably in the form of more or less stable nitrides in compositions of the foregoing analyses, it increases the resistance of the articles composed of such compositions to mildly corroding influences and prolongs the life of such articles. We believe that these characteristics are traceable partly to the presence of nitrides of titanium, and possibly of other metals, which are in the composition in the form of minute more or less uniformly distributed needles or particles which in themselves are highly resistant to corrosion and which serve as anchors to which may adhere iron oxide which forms during corrosion. These nitrides apparently act to form a film which may be retained as a protective coating over the surface portions of the iron and which is more or less resistant to corrosion. Such a film protects the iron from continued contact with the corroding agent and hence improves the resistance and prolongs the life of articles made from such compositions.

The nitrogen is believed to exert a dispersing effect on the titanium compounds and thus to insure the subsequent formation of a protective film containing titanium compounds, which is more or less uniform on the surfaces exposed to corrosive action.

Nitrides of iron and certain other metals present in low carbon steels have a marked tendency to precipitate out of solution and segregate. When such action takes place, the steel may be adversely affected because of cracks or localized spots of greater hardness due to such nitrides. We believe that when titanium is present it first has a deoxidizing action on the steel and that the portion which does not combine with oxygen to form oxides and similar substances reacts with

the nitrogen and fixes it as titanium nitride which is dispersed more or less finely and uniformly thruout the composition and which has little or no tendency to precipitate out of solution or to segregate.

Moreover, we have discovered that titanium has many other beneficial effects on low carbon compositions typified by the foregoing analyses. As above stated, titanium assists in deoxidizing and degasifying the composition because it forms titanium oxides in the molten metal which have comparatively low melting points, which are readily fluxed and which assist in eliminating undesired ingredients such as sulphides, aluminum oxides and the like. Titanium tends to reduce the hot or red shortness of the composition traceable to the presence of oxygen and sulphur, partly by eliminating such substances and partly by forming stable compounds thereof. Titanium reduces the ageing phenomenon which heretofore has characterized irons and steels containing certain nitrides by forming titanium nitrides which disperse thruout the composition and do not tend to precipitate out of solution or to segregate. Titanium does not leave in the composition inclusions which are as detrimental to the physical properties thereof as aluminum oxides.

In practicing the present invention an iron or steel may be made in the usual manner as in an electric furnace or in an acid or basic open hearth furnace, or in a Bessemer furnace, and/or converter. Such iron or steel should contain between about .02% and about .10% of carbon, between about .05% and about .25% of manganese, and the usual amounts of impurities such as phosphorous and the like which are ordinarily present in low carbon steel. Copper, aluminum and titanium are added to such an iron or steel to bring the contents thereof within the limits specified in the foregoing analyses. Such addition may be accomplished by using the proper amounts of suitable materials containing such metals. For example, manganese-titanium-ferro-alloys may be used as a source of titanium and aluminum as well as of manganese additional to that which normally is present in the steel as an impurity. The copper may be added as such. These metals may be added to the molten metal in the furnace, in the ladle or in the mold.

Nitrogen in the amounts specified in the foregoing analyses may be brought into the molten metal by throwing into the ingot molds, when the molten metal is being poured from the ladle into such molds, a quantity of a suitable nitrogen material sufficient to insure the presence of between about .005% and about .2% of nitrogen in the cold ingot. Alternatively, the nitrogen may be added either in the furnace or in the ladle together with or after the above mentioned metals have been added.

Nitrogen bearing materials which have been found to be suitable for the present purpose include metallic materials such as unstable nitrides of copper or iron, cyanides of the alkali metal and alkaline earth metals and urea or other organic compounds containing nitrogen. The alkali and alkaline earth cyanides and cyanamides are quite useful for this purpose. Titanium cyanonitride, which is a metallurgical product containing titanium, iron, nitrogen and carbon, may be conveniently used as a source of both titanium and nitrogen. The addition of about 5 lbs. of calcium cyanamid, or of about 1½ lbs. of titanium cyanonitride per ton of molten metal will carry a sufficient amount of nitrogen thereinto for present purposes.

It will be understood, from what has been previously stated, that the titanium serves partly as a means for fixing the nitrogen as stable nitrides in the iron composition. Other metals which possess the property of similarly retaining the nitrogen in the iron in the form of stable nitrides are molybdenum, vanadium, zirconium, columbium and tantalum. Additionally, silicon, aluminum, boron and beryllium serve as good nitrogen fixers. Small amounts of one or more of these several elements may be used instead of or together with titanium to retain nitrogen in the iron within the limits of between about .005% and about .2%.

Having thus described the present invention so that those skilled in the art may practice the same, we state that what we desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:—

1. An iron article to be exposed during use to corroding conditions containing between about .02% and about .10% of carbon, between about .05% and about .25% of manganese, between about .45% and about .55% of copper, between about .005% and about .2% of aluminum, between about .10% and about .35% of titanium, and between above .02% and about .2% of nitrogen, the remainder consisting of iron containing small amounts of ordinary impurities.

2. An iron article to be exposed during use to corroding conditions containing between about .02% and about .10% of carbon, between about .05% and about .25% of manganese, between about .45% and about .55% of copper, between about .005% and about .2% of aluminum, between about .10% and about .35% of titanium, and between above .02% and about .10% of nitrogen, the remainder consisting of iron containing small amounts of ordinary impurities.

3. An iron article to be exposed during use to corroding conditions containing between about .02% and about .08% of carbon, between about .05% and about .15% of manganese, between about .005% and about .20% of aluminum, between about .45% and about .55% of copper, between above .02% and about .05% of nitrogen, and between about .10% and about .25% of titanium, the remainder consisting of iron containing small amounts of ordinary impurities.

4. An iron article to be exposed during use to corroding conditions containing between about .05% and about .10% carbon, about .10% of manganese, about .10% of aluminum, about .50% of copper, about .03% of nitrogen, and between about .10% and about .35% of titanium, the remainder consisting of iron containing small amounts of ordinary impurities.

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