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METALLURGICAL ALLOY

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This invention relates to new and improved alloys suitable for addition to steels containing chromium, particularly stainless steel (18% chromium, 8% nickel) and 5% chromium steel.

In the production of 5% chromium steel and stainless steel, it is often desired to include in the steel a certain amount of titanium. This titanium, when present to at least four times the carbon content of the finished steel, combines with all the carbon to form titanim carbide. In addition to the combined titanium, it is usually desired to include in the finished steel a certain amount of excess titanium to insure complete combination with all the carbon. These results have hitherto been accomplished by adding to the steel at the ladle a small amount of a ferro-titanium alloy (called a metallurgical alloy) containing enough titanium so as to secure the required amount in the finished steel. Such alloys obviously contain as small an amount of carbon as is conveniently practicable, since such steels should have a very low carbon content. Furthermore, the titanium content should be as high as conveniently possible, in order to avoid adding too large an amount of cold metal to the molten steel just before pouring, giving too low a pouring temperature. In practice, an alloy containing about 40% titanium has been found to produce excellent results on an economical scale.

One of the difficulties occasionally encountered in the use of such ferro-titanium is the tendency for titanium to combine with nitrogen in the air and with carbon to form titanium cyanonitride, an undesirable compound to be incorporated in chromium steels, since it promotes hard spots, seams, and a rough appearance to the ingot, or alligator skin.

The present new and improved alloy overcomes this and other difficulties, and at the same time serves as a source of part of the chromium in the finished steel. In accordance with this invention, chromium is incorporated with the iron and titanium to form a metallurgical alloy containing iron, titanium, and chromium. By this means, nitrogen in the alloy apparently combines with chromium to form chromium nitride, a compound which is stable at high temperatures. The nitrogen is thus largely or completely made unavailable for combination with titanium, so that no titanium cyanonitride can exist to form hard spots, seams, or other defects.

In addition to titanium, iron and chromium, the present alloy contains appreciable amounts of silicon, aluminum and carbon. The carbon is present as an impurity, and is kept as low as possible. The aluminum is present because the alloy is prepared by the alumino-thermic process, or because it is present in the ore from which the alloy is produced. Silicon is also usually present in the ore from which the alloy is produced. However, it is important to insure that too much silicon is not present, since it tends to form a coarse-grained steel and to impair the impact resistance of the steel, and in the case of stainless steel to promote the formation of ferrite.

The percentages of the various ingredients in the present new and improved alloy are as follows:

	Per cent
Titanium	35 to 45
Chromium	2 to 14
Silicon	1 to 14
Aluminum	3 to 14
Carbon	Below 0.2
Iron plus impurities (phosphorus, sulfur, etc.)	Balance

More preferably, the ranges of these ingredients are as follows:

	Per cent
Titanium	38 to 42
Chromium	3 to 14
Silicon	2 to 5
Aluminum	6 to 9
Carbon	Below 0.1
Iron plus impurities (phosphorus, sulfur, etc.)	Balance

The alloy according to the present invention can be made by any convenient method. Preferably it is made by reducing the titanium ore such as ilmenite and rutile, together with a suitable quantity of a chromium containing ore such as chromite, with aluminum by the alumino-thermic process. Some sources of raw ilmenite contain appreciable quantities of chromium ore as an impurity, and most sources contain a certain amount of silicon. Accordingly, ilmenite often serves as the source of silicon and some of the chromium.

The invention having been described generally, the following specific example is now given:

Example

A charge consisting of 25 pounds of calcined chromium ore, 130 pounds of calcined ilmenite, 92 pounds of rutile, 132 pounds of a grained aluminum composition, 10 pounds of magnesium oxide, 2 pounds of calcium silicide, 11 pounds of cryolite, and 33 pounds of sodium chlorate was prepared. The chromium ore used in this charge contained 48.92% Cr_2O_3, 14.0% Fe_2O_3, 16.46% MgO, 15.06% Al_2O_3, 2.02% CaO, and 3.54% moisture plus impurities. The ilmenite contained 47.75% TiO_2, 27.94% FeO, 14.16% Fe_2O_3, 3.7% Al_2O_3, 2.63% Cr_2O_3, and 3.82% silica plus impurities. The rutile contained 98% TiO_2, 0.3% Fe_2O_3, 0.2% SiO_2, and 1.5% zircon plus impurities. The grained aluminum was prepared according to U. S. Patent No. 2,162,938 and con-

tained about 13% cryolite, 11% rutile, and 76% aluminum of ordinary commercial purity. The chromium ore and ilmenite were calcined to remove moisture and to convert FeO to Fe_2O_3 before they were mixed into the charge.

The charge was mixed in a ball mill, for about half an hour, and then placed in a crucible. The charge was ignited by means of small amounts of sodium, magnesium, and sodium chlorate placed on top. The reaction produced 75 pounds of an alloy of the following composition:

	Per cent
Titanium	41.1
Chromium	10.17
Aluminum	7.0
Silicon	2.99
Carbon	0.03
Iron plus impurities	Balance

The alloy of the present invention is added to the steel in any convenient way, particularly adding the alloy to molten steel in the ladle.

As many variations are possible within the scope of this invention, it is not intended to be limited except as defined by the appended claims.

What is claimed is:

1. A metallurgical alloy containing 35 to 45% titanium, 2 to 14% chromium, 1 to 14% silicon, 3 to 14% aluminum, less than 0.2% carbon, and the balance iron plus impurities.

2. A metallurgical alloy containing 38 to 42% titanium, 3 to 14% chromium, 2 to 5% silicon, 6 to 9% aluminum, less than 0.1% carbon, and the balance iron plus impurities.

3. A metallurgical alloy containing about 41% titanium, about 10% chromium, about 7% aluminum, about 3% silicon, about 0.03% carbon, and the balance iron plus impurities.

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