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ALLOYING STEEL

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The present invention relates to alloying tungsten with ferrous metals and more particularly to a novel and improved process and composition for introducing tungsten into steel during the alloying process.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the steps, processes and instrumentalities pointed out in the appended claims.

The invention consists in the novel steps, processes, combinations and improvements herein shown and described.

Heretofore, tungsten-bearing ferrous alloys have been commercially produced by adding calcium tungstate, ferro-tungsten or some tungsten-bearing mineral such as wolframite, scheelite, ferberite or hubernite to the molten steel. However, due to the relatively great specific gravity of ferro-tungsten, it tends to sink in the molten steel and it is difficult to dissolve and thereby obtain a homogeneous alloy. Many of the alloying materials also have the disadvantage that they are absorbed only slowly into the steel bath, and at the same time introduce undesirable impurities.

In accordance with the present invention, the alloys are produced by adding to the bath of molten steel at least a substantial part of the desired amount of tungsten in the form of an oxide of tungsten, such as tungstic oxide (WO_3), tungsten dioxide (WO_2), of a suboxide (WO , W_2O_5 , W_2O_3 , W_4O_3 , W_5O_9 or W_4O_{11}). The tungsten oxide is rapidly reduced, and at the same time the molten metal is vigorously boiled so that a homogeneous mixture of the added tungsten as well as any previously added ingredients are insured.

Where the tungsten alloy steel is produced in an electric furnace, it is usual to cover the ferrous alloy with a reducing slag (carbide slag), and if that be the case, the reduction of the tungstic or other tungsten oxide not only renders the tungsten available for solution in the steel, but also tends to remove certain of the objectionable impurities from the steel.

However, when the process of the present invention is carried out with an acid slag on the molten steel, the formation of other oxides by reduction of tungstic oxide or other tungsten oxide tends to oxidize certain of the impurities in the molten alloy and to cause them to rise and go into the slag. Thus, the use of the tung-

sten oxide purifies the alloy and removes certain of the alloying ingredients such as chromium and vanadium, which can then be caused to go back into the alloy by the addition to the slag of ferro-silicon or some other reducing agent.

For convenience in handling, and in order to reduce the amount of oxidation caused by the tungsten oxide, it is preferably prepared for use by mixing it with some carbonaceous, reducing material, such as still-pitch, and by molding this mixture into briquettes each of which may contain a uniform amount of tungsten.

In case only a portion of the desired amount of tungsten is added in the form of tungstic oxide briquettes, the remainder is preferably added in the form of ferro-tungsten and this addition preferably takes place before the addition of the tungstic oxide, so that the vigorous mixing effect accompanying the reduction of the tungstic oxide insures a thorough mixing of the molten ingredients.

Instead of using ferro-tungsten for a portion of the tungsten addition, the lower oxides of tungsten may be employed alone or in combination with tungstic oxide, and where an alloy rich in tungsten is to be produced, this will be advantageous over using tungstic oxide as the boiling will be less vigorous and more easily controlled.

Referring now in detail to the present preferred manner of carrying out the invention, the powdered tungstic oxide is mixed with about one tenth its weight of still-pitch, and this mixture is formed into uniform briquettes each of which may conveniently contain five pounds of tungsten. Where lower oxides of tungsten are used, a lesser proportion of carbonaceous material may be employed, enough being used, however, to completely reduce the oxide.

The alloying ingredients for the desired alloy, excluding only the tungsten oxide briquettes, are charged in the electric furnace, and brought to the proper temperature in the usual manner. Thereafter, after sufficient time has been allowed for the absorption of whatever ferro-tungsten may be used, the remainder of the tungsten requirements is added in the form of the tungsten oxide briquettes. As these are added, the power supplied to the electric furnace may be controlled or reduced so as to control the heat of the mixture and to prevent too vigorous agitation or "boiling" as the tungsten oxide is reduced.

After the reduction of tungsten oxide has been completed, the heating of the alloy is continued and, if the process is being carried out with an