United States Patent Office 3,256,085 Patented June 14, 1966

3,256,085

METHOD OF COATING ALUMINUM AND ADDING SAME TO MOLTEN STEEL

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No Drawing. Filed Sept. 29, 1961, Ser. No. 141,595
3 Claims. (Cl. 75—58)

This invention relates to addition agents for molten steel and, more particularly, to treating aluminum for addition to molten steel.

Steel is deoxidized by the addition of aluminum shot, slugs or bars to the molten steel either in the ladle or in the mold or both. The aluminum combines with the dissolved oxygen and reacts with iron oxide to control gas evolution. Although other deoxidizing agents are sometimes used, aluminum is the most widely used addition agent for deoxidizing steel.

It is well known that aluminum exposed to the atmosphere will quickly form an aluminum oxide coating and investigation has indicated that this coating often prevents the aluminum added to molten steel from diffusing through the steel. The aluminum oxide coating is a refractory material which is not fused at the melting temperature of steel, and when the aluminum is added to the molten steel the refractory aluminum oxide tends to form an impervious skin which retains the aluminum therein. Although the aluminum within this skin is sufficiently heated so that it is molten, the refractory skin is an impervious wall which encases the molten aluminum and prevents it from diffusing throughout the steel. This results in segregated areas rich in aluminum. Further, the aluminum so contained within the refractory skin is not available to perform its deoxidizing function.

When the steel is rolled the segregated areas of aluminum are elongated and form narrow bands or layers of aluminum rich alloy in the steel sheet. These bands are relatively hard material and are not recrystallized during box annealing. The bands are surrounded by softer ferrite grains which do recrystallize during annealing. When sheets having these bands are cold formed the softer ferrite deforms first and to a greater extent than do the harder bands and therefore, the bands appear as raised streaks commonly known as "ghost lines" or longitudinal ridges. Ghost lines on a sheet present an unsightly appearance which often means an unacceptable product. Even painting will not cover these ghost lines and in fact serves to high-light them. Inspection before cold forming will not reveal the presence of these bands and hence, they do not appear until the steel has been stamped into a finished product.

It is therefore a principal object of this invention to provide a method of treating aluminum to insure its diffusion through molten steel.

Yet another object of this invention is to provide a method of treating aluminum which eliminates the aluminum oxide coating thereon.

A more specialized object of this invention is to provide coated aluminum free of aluminum oxide.

Still another object of this invention is to provide a coating for aluminum which will prevent the formation of aluminum oxide and also act as a flux in molten steel.

Another more particular object of this invention is to provide a method of removing the oxide coating from aluminum and coating the aluminum to prevent any subsequent aluminum oxide formation.

Other objects and a fuller understanding of this invention may be had from the following description and claims.

We have found that by removing the aluminum oxide coating from aluminum and coating the aluminum with

a material that is adherent to the aluminum at ambient temperature, impervious to air, non-deliquescent, and non-adherent to the aluminum at the temperature of molten steel, a superior addition agent results. The aluminum oxide may be removed in any convenient manner such as by pickling in an acid. When the aluminum oxide coating has been removed the acid is washed off and the aluminum is immediately coated before an oxide coating has a chance to form.

Although various materials such as plastisols, varnishes, paints, metal stearates and the like are suitable as coating materials and have the above noted properties, we prefer to use sodium silicate. Sodium silicate has the advantage that at the temperature of molten steel it fuses and acts as a flux to clean impurities from the steel. The fusing of the sodium silicate releases the aluminum allowing it to diffuse through the steel to perform its deoxidizing function. The general formula for sodium silicate is $Na_2O \cdot xSiO_2$. We have found that the ratio of SiO_2 to Na_2O preferably should be at least 1.69 to 1. If the ratio is below this value the coating remains tacky and will not dry, thus leaving moisture in contact with the aluminum surface which may form an oxide coating. A specific example of the method of treating aluminum is given below.

Example

Aluminum shot, slugs and bars having an oxide coating were pickled in a 1 to 1 solution of hydrochloric acid and water. The shot, slugs and bars were allowed to remain in the acid until hydrogen gas was liberated indicating that the oxide layer had been completely removed. The aluminum was then withdrawn from the acid and rinsed in cold water to remove any acid residue. The shot, slugs and bars were then immediately immersed in a 31% solution of sodium silicate, the silicate having the general formula $Na_2O \cdot 3.9SiO_2$. The aluminum was then removed from the solution and the coating thus applied allowed to dry for about 7 hours. The sodium silicate set to an adherent, impervious, non-deliquescent coating which fused when the coated aluminum was added to the molten steel. Thus, an addition agent of an aluminum core with a shell of sodium silicate bonded thereto is provided and the sodium silicate will fuse to form a slag when the aluminum is added to molten steel.

Although it is preferred to completely remove aluminum oxide coating from all of the surface of the aluminum, all that is required is that the coating be removed from a portion of the aluminum surface and that portion be coated to prevent aluminum oxide from re-forming. If there is a break in the oxide coating a complete shell to retain the molten aluminum will not be formed when it is added to molten steel and when the aluminum melts it can escape through the break in the oxide shell.

While one embodiment of our invention has been described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

We claim:

1. A method of insuring diffusion of aluminum shot, slugs, bars and the like introduced as addition agents for molten steel comprising the steps of pickling the aluminum until the oxide coating is removed, thereafter rinsing off the pickling agent, and coating the aluminum with a material having the characteristics at ambient temperature of being adherent to the aluminum, impervious to air, non-deliquescent, and at the temperature of molten steel being non-adherent to the aluminum, and adding the prepared aluminum to the molten steel.

2. A method of insuring diffusion of aluminum shot, slugs, bars and the like introduced as addition agents for molten steel comprising the steps of pickling the aluminum

until the oxide coating is removed, thereafter rinsing off the pickling agent, and coating the aluminum with sodium silicate, and adding the prepared aluminum to the molten steel.

3. A method of insuring diffusion of aluminum shot, slugs, bars and the like introduced as addition agents for molten steel comprising the steps of pickling the aluminum until the oxide coating is removed, thereafter rinsing off the pickling agent, and coating the aluminum with sodium silicate, said sodium silicate having a ratio of SiO_2 to Na_2O of at least 1.69 to 1, and adding the prepared aluminum to the molten steel.

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