

UNITED STATES PATENT OFFICE.

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PROCESS FOR PRODUCING STAINLESS STEEL.

No Drawing.

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To all whom it may concern:

Be it known that I, FRANK D. CARNEY, a citizen of the United States of America, and a resident of New York, county and State of New York, U. S. A., have invented certain new and useful Improvements in Processes for Producing Stainless Steel; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to the art of making stainless steel; and the object of my invention is to make such a steel more cheaply than by other processes, and also, if desired, so low in carbon that it can be readily rolled in rolling mills for subsequent forming processes, such as deep drawing, corrugating, stamping, &c., whereby wire, sheets, hardware, tubes, kitchen utensils and many other finished products may be made of stainless and rustless steel.

I can therefore make from such a steel finished products which it is not practicable to make by present methods by reason of the prohibitive costs.

In order to give to a steel stainless properties, it is customary to have from about seven to twenty per cent chromium in the steel, but the carbon content is too high for the usual manufacture of commercial steel articles such as mentioned above.

The chromium content of stainless steel is given to it by the addition to the melted steel of ferro-chromium, the cost of which increases with the decrease in the carbon content of the ferro-chromium, the cheaper grades of which carry from about seven to ten per cent carbon, and about sixty per cent chromium.

It is the effect of this undesirable high carbon content of the ferro-chrome addition in the finished metal that prohibits such stainless steel from being used for purposes where tonnage would be involved, as for roofing, hardware, &c., and the methods now used are not adapted to tonnage production.

Stainless and rustless steel for cutlery and similar articles where the elastic limit is required to be high contains around 0.50% carbon.

For the purposes outlined by me the stainless steel must contain less than 0.15% carbon, and preferably less than 0.10% to

readily adapt it to forming for the purposes specified.

Now, in order to show how the ferro-chrome addition to steel raises the carbon content in the finished metal I shall give a few examples.

In order to add twelve per cent chromium to the steel by means of ferro-chromium containing 60% chromium, it would require a 20% addition to the steel of ferro-chromium containing about 10% carbon. This would make a carbon addition to the steel of 2.00%.

If the carbon content of the ferro-chrome were low, say 7%, the carbon addition would be 1.40%, which is yet too high for the purposes intended.

The problem then is to get rid of the carbon without unduly sacrificing the chromium. Chromium is prone to oxidize under the usual steel making conditions.

Now, in accordance with my invention I eliminate the carbon after the ferro-chrome addition by bringing the metal to a very hot condition, and passing air through this unusually hot metal.

At the usual steel making temperatures chromium will oxidize when blown before the carbon, but when the temperature of the metal is high enough a reversal of the affinities of carbon and chromium for oxygen takes place, and the carbon will oxidize first.

A hot or high temperature metal, preparatory to oxidizing may be obtained in several ways, but I prefer to do this by an addition of ferro-silicon to the metal, as it appears to be the cheapest, needs no special apparatus, and may be practised in any Bessemer plant. Besides this, most furnace men have been accustomed to use ferro-silicon in other operations.

As illustrative of the specific manner in which my process may be carried out, I place in a melting furnace a charge of steel, preferably very low carbon steel having about 0.10% to 0.20% carbon, and add sufficient ferro-chrome to the charge to make the final analysis of the metal within the limits of chromium content required for the particular stainless steel to be made.

This addition will raise the carbon content of the bath in the neighborhood of 1.50%.

Ferro-silicon is then added to this bath in such quantity that the silicon content of the mixture is about 2.00% and the mixture is then transferred to a Bessemer converter,

electric twyer furnace, or equivalent furnace, and blown.

Silicon is the first metal oxidized in the Bessemer process and at the same time generates very rapidly sufficient heat to raise the temperature of the bath above the normal temperature at which metal is treated in converters. When the temperature reaches a certain point the affinities of silicon and carbon for oxygen reverse, and silicon will no longer be oxidized but the carbon will be. At this high temperature chromium is also not readily oxidized, so that the oxidation of the carbon will go on in preference to the oxidation of the chromium.

If the temperature should drop during the blowing, silicon again begins to oxidize in preference to carbon and thus heats the metal, the silicon thus acting as an element to control the temperature.

After the carbon has been reduced to the point desired, say below 0.15% or 0.10% the converter is lowered and the metal poured into a ladle; or if an electric furnace provided with twyers has been used, it is tapped in the usual way into the ladle, with the customary addition of ferro-manganese or any other finishing metal. Or the metal may be transferred to the usual electric furnace for more complete de-oxidation.

The silicon content of the mixture charged into the Bessemer converter acts therefore as a controller for the temperature, keeping the metal up to its high temperature by the oxidation thereof until the carbon has been reduced to the limits desired, say below 0.15%.

Naturally the quantity of carbon left in the blown metal will depend upon the quantity of silicon contained in the unblown metal, and this silicon content must be proportioned according to the carbon elimination desired and also in accordance with the customary conditions found in the particular plant, and which the furnace manager takes into consideration, such as the temperature of the converter or other furnace at the beginning of the blow, the temperature of the metal when charged into the furnace, the size of the converter, the depth of the bath, the air pressure, the air volume, &c., conditions which are well known and always taken into consideration when blowing metal.

I have found, however, that a silicon content of 2.00%, slightly more or less, will be sufficient under the usual furnace conditions to secure the low carbon content desired, at the same time preventing the oxidation, during blowing, of any prohibitive quantity of

chromium, thus protecting the metal from loss of chromium.

I claim—

1. The method of making stainless steel which comprises adding ferro-chrome to a steel and maintaining the melt sufficiently hot to cause a change of the relative affinities of oxygen for carbon and chromium and thereby cause the carbon to oxidize before the chromium.

2. The method of making stainless steel which comprises adding ferro-chrome and sufficient ferro-silicon to raise the temperature high enough to change the relative affinities of oxygen for carbon and chromium to a steel and blowing the melt so formed.

3. The method of making stainless steel which comprises adding to steel under oxidizing conditions ferro-chrome sufficient to give the desired chromium content to the finished metal, and an element which oxidizes more readily than carbon under furnace conditions and upon oxidation causes a reversal of the affinities of carbon and said element for oxygen.

4. The method of making stainless steel which comprises adding to low carbon steel ferro-chrome sufficient to give the chromium content desired for the finished metal and ferro-silicon, and blowing the metal until the carbon is reduced to the desired low limit, and finishing the metal.

5. The method of making low carbon stainless steel which comprises melting low carbon steel, adding thereto ferro-chrome in quantity sufficient to give the desired chromium content for the finished metal and ferro-silicon, and blowing the metal to reduce the carbon below 0.15%.

6. The method of making low carbon stainless steel which comprises melting a steel containing carbon below 0.20% and adding thereto ferro-chrome, in quantity sufficient to give the desired chromium content for the finished metal, and ferro-silicon sufficient to maintain a reversal of the affinities of carbon and silicon during the elimination of carbon to a low percentage.

7. The method of making low carbon stainless steel which comprises adding to steel below 0.20% carbon content, ferro-chrome in quantity to give the desired chromium content for the finished metal and ferro-silicon not exceeding two per cent, and blowing the metal to eliminate carbon below 0.15%.

In testimony that I claim the foregoing as my invention, I have signed my name hereto.

FRANK D. CARNEY.