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PRODUCTION OF TRANSFORMER AND DYNAMO STEELS

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1 Claim. (Cl. 75—129)

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This invention relates to the production of transformer and dynamo steels; it is a continuation-in-part of our copending U. S. patent application Ser. No. 108,664, filed August 4, 1949, now abandoned.

To date, dynamo and transformer steels have been exclusively manufactured in open hearth and in electric furnaces.

In order to eliminate the high operational costs of these furnaces, attempts have been made to produce these steels in a converter. For this purpose, a high phosphorus steel was blasted in a basic converter at a low temperature and this steel was hereafter subjected to a combined oxidizing and silicon enriching treatment in a ladle. The reduction of the phosphorous was effected in the basic converter at a low temperature; the refining of the steel and the admixture of the silicon was carried out in the ladle.

It is an object of the invention to eliminate the disadvantages resulting from the maintenance of a low temperature in the basic converter.

It is another important object of the invention to avoid the grave difficulties arising from the simultaneous oxidation, dephosphorization and silicon introduction in the ladle.

With the above stated objects in view, a pig iron having a comparatively high content of phosphorous and manganese is charged into a Bessemer converter, blasted until the carbon is reduced to about 0.02 per cent, the manganese to less than 0.30 per cent, the sulfur to less than 0.05 per cent and the phosphorous to about 0.08 to 0.12 per cent.

The temperature during this treatment is maintained at about 1650° C.

The thus treated steel is, upon separation from the slag, transferred into a first ladle; here it is treated with a basic oxidizing slag, for instance slags containing, in addition to silica, alkali, earth alkali oxide, iron oxide, earth alkali carbonates and fluorspar.

A suitable composition of these slags is two-thirds of sodium carbonate and one-third of iron oxide or equal parts of sodium carbonate, calcium carbonate and iron oxide.

The slags used during the first ladle treatment may be applied in a presintered or premelted condition; they act to reduce the phosphorous of the melt substantially to the amount, which is desired in the final steel. The percentages of C, Mn, P and S of the steel after the first ladle treatment may preferably be 0.02 per cent C, less than 0.20 per cent Mn, less than 0.04 per cent P and

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less than 0.03 per cent S. The treating temperature in the first ladle is 1620–1650° C.

The final treatment of the steel being a separate process step is of particular importance.

5 In conformity therewith the steel which has been blasted in the Bessemer converter and has been oxidized and dephosphorized in a first ladle is transferred into a second ladle; here it is treated with ferro-silicon or calciumsilicon and aluminum and hereby enriched with silicon and deoxidized; the temperature is raised by the reaction to about 1670–1680° C. After standing for about thirty minutes, the steel is poured at a temperature of about 1600° C.

15 This second ladle treatment is performed at a comparatively high temperature produced by the action of the silicon and aluminum which renders it possible, to pour the final steel in spite of longer periods of standing at a temperature of about 1600° C.

20 As apparent from the above, the instant method for the production of dynamo and transformer steels having a high content of up to about 4 per cent Si is based on the successive treatment in a Bessemer converter, in a first and in a second ladle, each of these devices serving its particular purpose and thereby eliminating the above mentioned disadvantages of the prior art.

25 The steel is subjected in the Bessemer converter to an initial oxidation; the phosphorous content of the steel is reduced to about 0.08 per cent to 0.12 per cent. The main oxidation and particularly the main removal of the phosphorous practically up to the final limits is hereupon carried-out in the first ladle. In this manner, the phosphorous removal and the refining of the steel by oxidation is separated from its silicon enrichment and its deoxidation which is therefore carried-out in the second ladle.

30 By this subdivision of the refining treatment and the silicon introduction in two separate steps carried-out in two ladles the steel can be kept sufficiently fluid in the second ladle in spite of the admixture of the silicon and the aluminum; this preservation of the high fluidity of the bath is important, as it enables in the second ladle an easy and effective introduction of the silicon into and removal of the oxygen from, the molten steel; at the same time, the calcium of the calcium silicide evaporates and thoroughly penetrates the bath; it liquefies the alumina, the silicates and the sulfur, which latter in the strongly bubbling melt is converted into calcium sulfide.

35 The steel which becomes heated in the second ladle to a temperature of about 1670–1680° C. is

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left standing for about thirty minutes and is then poured at a temperature of about 1600° C.

It is apparent from the above that the subdivision of the final treatment into two ladle steps is of decisive importance for a successful execution of the invention.

The latter is more in detail described in the following example.

Example

17,000 kilograms of pig iron containing 3.3 per cent C, 0.7 per cent Mn, 1.5 per cent Si, 0.11 per cent P and 0.03 per cent S are charged into a Bessemer converter and blasted in the usual manner at a temperature of about 1670° C. A steel results having about 0.02 per cent C, about 0.15 per cent Mn, about 0.12 per cent P and about 0.03 per cent S.

The steel is separated from the slag and poured into a first ladle; 400 kilograms of an oxidizing slag containing 60 per cent CaO, 29 per cent Fe₂O₃, 3 per cent SiO₂ and 2 per cent Al₂O₃ and heated to about 1700° C. are added. After a treatment of about two minutes, a steel results of the following composition:

0.01 per cent carbon, 0.08 per cent Mn, 0.03 per cent P, 0.02 per cent S and having a temperature of about 1650° C.

Upon removal of the thinly fluid slag, the steel is transferred into a second ladle. The following alloying and slag forming agents are added:

200 kilograms CaSi, 590 kilograms FeSi, 45 kilograms, Al, 15 kilograms CaF₂.

The steel temperature then rises up to about 1680° C.

The composition of the steel is now:

0.02 per cent C, 0.08 per cent Mn, 0.02 per cent P, 0.004 per cent S, 4.3 per cent Si, 0.28 per cent Al, rest iron.

The composition of the slag is:

0.2 per cent Fe, 0.15 per cent Mn, 0.06 per cent P, 24 per cent Al₂O₃, 11 per cent SiO₂, 55 per cent CaO, 4 per cent F, 2 per cent MgO, 0.5 per cent S.

The steel is left standing for about thirty minutes, whereby the temperature drops to about 1600° C. The steel is cast at this temperature.

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Since certain changes in carrying out the above process could be made without departing from the scope thereof, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

Having thus described the invention, what we claim as new and desire to be secured by Letters Patent, is as follows:

A method for the production of high silicon transformer and dynamo steels, comprising charging a pig iron containing up to about 1.0 per cent Mn and up to about 0.12 per cent P into a Bessemer converter, blasting the metal at a temperature of about 1650-1680° C. to produce steel having about 0.02 per cent C, less than 0.3 per cent Mn, up to about 0.12 per cent P and less than 0.05 per cent S, tapping the steel into a first ladle, refining the same in said ladle by the admixture of a basic calcium and iron silicate slag to about 0.01 per cent C, to less than 0.20 per cent Mn, less than 0.04 per cent P, and less than 0.03 per cent S, transferring the steel into a second ladle, adding to the steel in said second ladle a mixture of Al, CaF₂ and of a substance selected from the group consisting of CaSi and FeSi, treating the steel with the said mixture until the desired silicon content and a temperature is reached of about 1680° C., keeping the steel at rest for about thirty minutes and pouring the same at a temperature of about 1600° C.

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