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METHOD FOR MAKING STAINLESS STEEL

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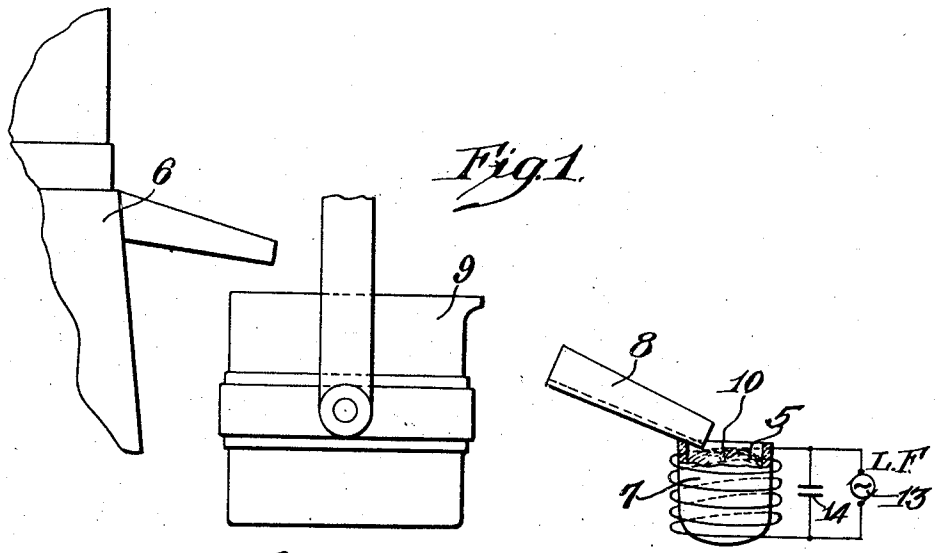


Fig. 1.

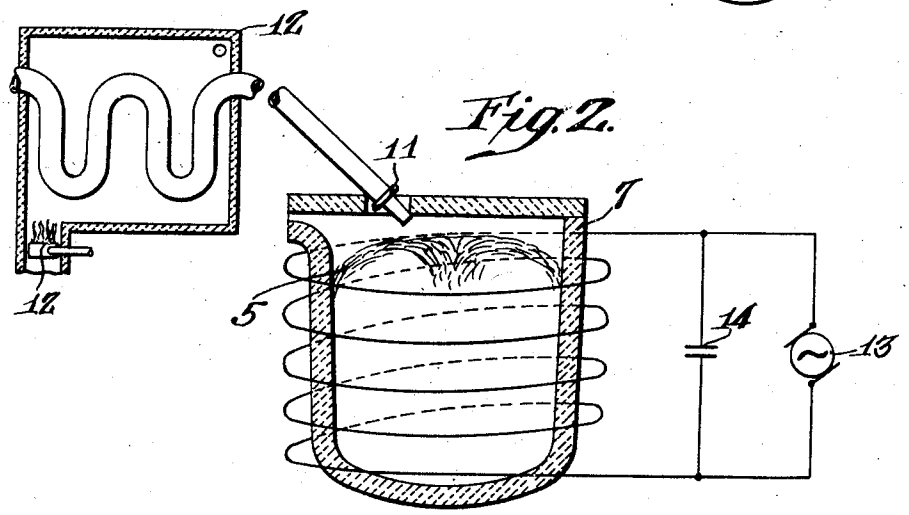


Fig. 2.

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METHOD FOR MAKING STAINLESS STEEL

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Continuation of application Serial No. 306,746, September 18, 1928. This application October 16, 1926. Serial No. 312,758

2 Claims. (Cl. 75—22.5)

My invention relates to the production of steel having a considerable chromium content, such, for example, as stainless steel.

The main purpose of my invention is to produce a cast iron having sufficient chromium to leave finally the requisite chromium content and to treat the iron to burn out the excess carbon of the cast iron without burning out the chromium or with but a small loss of chromium.

A further purpose is to make a cast iron having the necessary excess of chromium content over that finally required, preferably by mixing ores to proportion the chromium properly and subsequently to burn out substantially all of the carbon from the cast iron while superheating the molten metal and circulating it vigorously in vertical planes to change the metal at the surface as its carbon is burned out there so as to produce a steel of the requisite chromium content.

A further purpose is to produce a cast iron having a necessary excess of chromium content over that finally required and to subject the cast iron to intense heat and a blast of air at the surface while separately stirring it vigorously in vertical planes to burn out the excess carbon and change the cast iron to steel having the required chromium content.

Further purposes will appear in the specification and in the claims.

Figure 1 is a diagrammatic view illustrating a blast furnace supplying metal to an electric furnace in which my process may be carried out.

Figure 2 is a vertical section of the electric furnace.

So called stainless steel is an alloy of steel with chromium. It is quite necessary that it have a low carbon content and the smaller this content the better.

Stainless steel is made at the present time by adding ferro-chrome to other steel of suitable carbon content.

Carney in U. S. Patent No. 1,444,062 proposes to burn out the carbon of a pig iron high in chromium, raising the temperature by adding ferro-silicon to reverse the affinities of carbon and chromium for the oxygen of the air and then blowing to burn out the carbon.

The decarbonizing process is a long process. Though Carney could get the temperature which he desires he could not maintain the temperature for the long time required; and any attempt to maintain it would be very costly.

Greene in U. S. Patent No. 1,034,786 purports also to burn out the carbon from an iron high in alloyed metals, including chromium without excessively burning out the alloy metal, but fails to teach the invention in that he fails to provide adequate circulation and fails to teach the importance of such circulation.

My invention is intended to greatly reduce the cost by operating upon a cast iron already containing the desired chromium content and changing it to steel by an operation no more expensive than the initial preparation of steel and which is conducted in an electric induction furnace having a rapid circulation in a generally upward direction as hereinafter described.

My invention requires no slag and even if excessive air supply cause reduction in temperature so as to form a slag the circulation carries it over towards the sides of the pool so as to secure a clean surface of molten metal upon which the blast is directed.

Where oxide is added, as later suggested, it is quite desirable that the amount of oxide be kept low enough so as not to cover the surface of the metal by any slag-like coating.

In the practice of my invention I initially make a special cast iron in the blast furnace, performing the usual blast furnace operations except that I select my ores with a view to having the desired preliminary chromium content in the cast iron produced. Though the final chromium content for chromium steel may not be more than 14% and by my process can be made any percentage which may be required, it is desirable to make the initial chromium content somewhat higher than that intended, to provide for some loss of chromium. A final chromium content of 14% may require an initially cast iron chromium content of 20% or higher. The exact amount of excess needed is so far dependent upon the character of the apparatus used and upon its size and efficiency that the exact amount of excess chromium must be left for experimental determination by operation of the individual plants.

To secure this initial chromium content of say 20% I mix chromite or other chromium bearing ores having a high chromium content either with ores lacking in chromium content or with ores having a lower chromium content, proportioning the ores so as to yield the desired proportion of chromium in the cast iron produced. This cast iron is then changed to steel of low carbon content as hereinafter described preferably without allowing the cast iron to solidify.

I prefer to run the molten cast iron 5 from blast furnace 6 into an electric furnace 7 through spout 8 from intermediate ladle 9. In the electric furnace I am able to secure a high temperature accompanied by rapid circulation, both of which facilitate burning out the carbon with a minimum of elimination of chromium.

I find that the use of an electric furnace having an inductor surrounding the furnace pool enables me to secure the desired higher temperature quickly and economically and at the same time gives a rapidity of stirring which makes it possible to burn out the carbon very rapidly by an air blast upon the surface and without the

necessity for passing the blast through the body of the molten metal or by an oxidizing agent such as iron oxide or chromium oxide. The burning out of the carbon can be effected more quickly, of course, with passage of the air through the body of the molten metal but this adds mechanical complication and is not ordinarily required.

With the pool-surrounding furnace coil of the coreless induction furnace type I am able to secure any desired ratio between the heating effect of the current and its stirring effect, since the heating effect is large at high frequency and the stirring effect is then relatively small, whereas at low frequency the heating effect is relatively low and the stirring effect large. An intermediate frequency could be selected having any desired ratio between heating to stirring effects within rather wide limits.

The high temperature however effected, causes a reversal of the affinities of chromium and carbon to the oxygen of the air so that the oxygen unites chiefly with the carbon instead of, as would normally be the case, uniting with the chromium.

My invention contemplates also the introduction into the chrome steel of any other ingredients, such as nickel, which are desirable in the chrome steel, by the selection of ores having these ingredients in them and used in such proportion as to secure the requisite final percentage of these other ingredients in the chrome steel.

This application is a continuation of my application for Method of smelting stainless steel, Ser. No. 306,746, filed Sept. 18, 1928.

For example, nickel is a very desirable ingredient for some chrome steels and the nickel can readily be inserted in the cast iron because of the fact that nickel and chromium occur together in some chrome ores. The nickel can be added also by using separate nickel ores in the mixture of ores used for the formation of the initial cast iron.

In the coreless induction type of furnace shown the stirring takes place by a combination of pinch effect and motor effect, forcing the metal up in the center and permitting it to flow back down the outer sides. This type of circulation takes place in this coreless induction type of furnace with any frequency. As the stirring effect is great as compared with the heating effect at low frequency and the heating effect increases with the frequency and is great as compared with stirring effect at high frequency, the frequency of the furnace can be selected for the heating effect, using as low a frequency as is sufficient for the superheating.

In Figure 1 I have shown an oxidizing agent 10 upon the surface of the pool. It may be, for example, an oxide of iron or an oxide of chromium.

In Figure 2 I have shown tuyère 11 intended to represent an air blast nozzle by which the air blast may be applied upon the surface of the melt. The air may be preheated by any heater 12. Any number or location of tuyères desired may be supplied to blow the air upon or through the metal. The surface blast is shown because the speed of metal circulation available makes it possible to get good results with the air blast upon the surface only and it is both simple and inexpensive. Where oxides are to be applied to the surface of the bath to burn out or to assist in burning out the carbon they may be carried into the furnace by the air blast. Current supply is shown at 13 corrected for power factor by condensers 14.

My invention is dependent for its success upon the vigor of circulation and somewhat upon the character of circulation in generally vertical planes obtained best by the so-called coreless type of electric furnace.

If the circulation were mild or local it would mean that the new metal would come to the surface too slowly to successfully burn out the carbon from the chromium iron bath without excessive burning of the chromium. The reversal of the affinities of the chromium and carbon for oxygen is effective to protect the chromium only so long as there is a rapid continuing substitution of a carbon-containing surface with disappearance of the metal from which the carbon has been burned, and if the surface be not rapidly changed so that a carbon-free surface remains, the chromium is immediately attacked and burned. For this reason arc furnaces and ring-type induction furnaces are unsuited to my purpose.

For the same reason furnaces with a localized circulation, as from submerged channels at points in the pool, as distinguished from generally distributed within the pool, are not well suited to my invention unless the pools be so small as compared with the lines of circulation from the channels as to keep in circulation substantially the entire surface of the pool.

The character of the circulation shown sweeps the metal surface constantly from the center toward the sides, carrying that metal from which the carbon has been burned over to the sides of the furnace and out of the zone upon which the blast is directed. Even where oxides are used an air blast can be used also, as indicated, and can be applied to the surface of the metal coming up.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain part or all of the benefits of my invention without copying the structure shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. The method of making stainless steel from a blast furnace iron having a high chromium content, which consists in electromagnetically superheating the molten metal, in electromagnetically stirring it in vertical planes rapidly to produce a rapid change of metal at the surface of the bath and coincidentally applying preheated air to the surface of the bath while keeping the surface treated free from slag covering, thereby oxidizing carbon without excessive loss of chromium.

2. The method of making stainless steel from a blast furnace iron having a high chromium content, which consists in electromagnetically superheating the molten metal and at the same time stirring it in vertical planes rapidly to produce a rapid change of metal at the surface of the bath, coincidentally applying preheated air to the surface of the bath while keeping the surface treated free from slag covering, and covering the bath to apply the heat from the products of combustion to assist in preventing cooling of the metal.

HEINRICH NEUHAUSS.