

G. CINILLE.
MANUFACTURE OF STEEL.

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1,352,580.

Patented Sept. 14, 1920.

Fig. 1

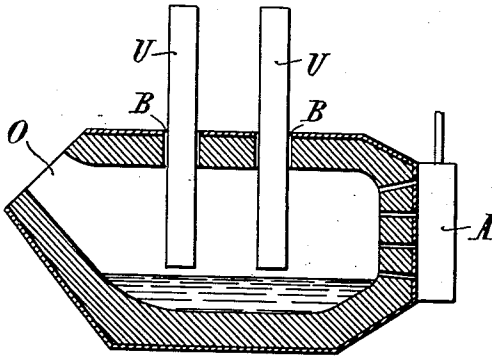


Fig. 2

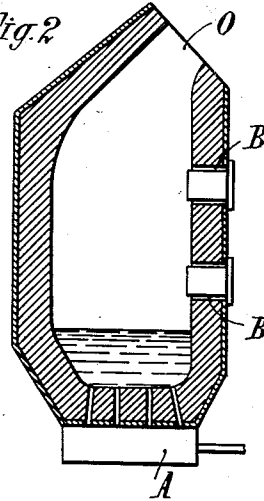


Fig. 3

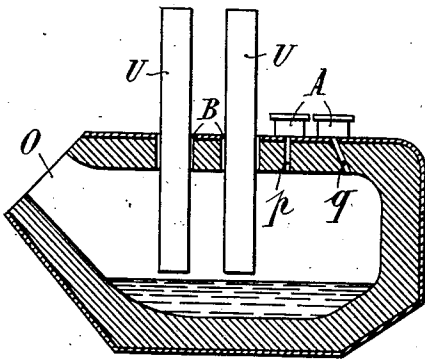


Fig. 4

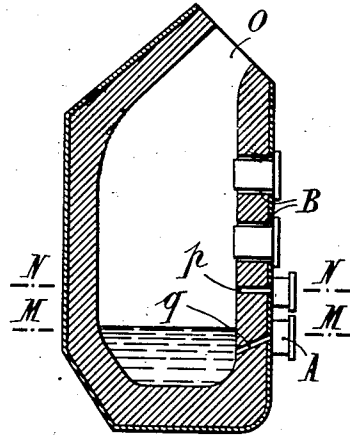


Fig. 5

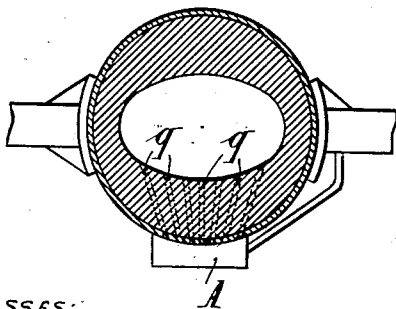
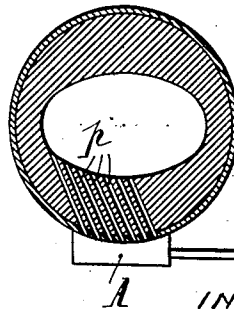


Fig. 6



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MANUFACTURE OF STEEL.

1,352,580.

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To all whom it may concern:

Be it known that I, GEORGES CINILLE, a citizen of the Republic of France, residing at Epierre, Savoie, France, have invented certain new and useful Improvements in the Manufacture of Steel, of which the following is a specification.

The purpose of this invention is to manufacture hard steel containing a substantial proportion of carbon and to obtain this result by means of one single operation, purifying the crude iron in a hot working converter, in the presence of basic slag; the mass of molten metal being constantly stirred by the blasts from twyers so that all parts of this mass will come in contact with the basic slag. In this manner phosphorus, sulfur and other impurities the crude iron might contain, are directly eliminated and yet the steel will keep the desired proportion of carbon. This process of direct manufacture of hard steel from the crude iron does not require a subsequent carburization of the metal as is the case with present processes.

This result is obtained by treating the crude iron in a converter by means of an electric current, which permits the use of basic slag (with lime as the base) and brings about the hot working.

The treatment of the crude iron in the converter under these conditions can be carried out even though the mass of molten metal in same should be of great thickness, inasmuch as the direction of the twyers results in stirring up the molten material and in bringing all its parts in contact with the basic slag which is rich in lime. This stirring is made possible in a converter owing to the large space over the metal.

Through this invention special steels of given compositions can be produced in one single operation, without having to resort, as is the case with all other processes known, first to the treatment of the crude iron in a Bessemer converter and then to the treatment of the steel thus obtained in an electric furnace.

This process is worked in a converter which is used not only as a metallurgical, but also as a heating device, as the electric current furnishes the necessary heat to entirely produce the chemical and thermic reactions required for the treatment of the most impure pig iron. It is essential to point out that the very close contact exist-

ing between the stirred metal and the basic slag, together with the high temperature developed insures the elimination of such impurities as sulfur, phosphorus, silicon and manganese, before the carbon is entirely burnt out, a substantial proportion of it still remaining in the metal.

By means of this process a control of the temperature, the basicity and the nature of the scoria is obtained, and it is a very easy matter to secure a reducing atmosphere; consequently, all sulfur and phosphorus can be eliminated in a state of calcium sulfid and phosphate of lime before the carbon disappears entirely, a result that cannot be obtained with any of the Bessemer converters by the processes in use at the present time.

As a result of this process, a hard steel, absolutely pure, is directly obtained in the Bessemer converter from a pig iron more impure than those generally treated in converters. It is therefore possible to treat in the converter, a blast or cupola furnace cast iron that is not sufficiently silicious to be put through the Bessemer acid process or not sufficiently phosphorus to be put through the Thomas furnace.

Moreover, as there is but one single operation to perform for the direct production of hard steel, the pouring off of the metal from the Bessemer converter into an electric furnace is avoided and consequently the loss of metal and the chilling which invariably follows this pouring operation, are eliminated.

The changes which it is found convenient to make in the converter entail only a comparatively small expense, and yet the converter thus modified does away with the necessity of employing costly mixers or special furnaces, since the improved converter becomes in effect, an electrometallurgical furnace.

The attached drawing shows, by way of illustration, how the process is worked:—

Figure 1 is a cross section of a converter with bottom blowing which is shown lying horizontally for the electric heating.

Fig. 2 is a cross section showing the converter in the proper position for the blowing operation, so as to cause the stirring of the mass of molten metal.

Fig. 3 is a cross section of a converter with side blowing in the position for electric heating.

Fig. 4 is a cross section of converter

shown in Fig. 3 raised to a vertical position for the blowing operation.

Figs. 5 and 6 are horizontal cross sections through M M and N N, Fig. 4, showing the direction of the twyers which determine the stirring of the molten metal and the revolving motion of the blast of air.

The electric heating of the material in the converter takes place by means of electrodes U of opposite polarities, placed over the molten metal bath.

The converter should be placed in a horizontal position for the electric heating, so that the electric arc may flash between the electrodes of opposite polarities at the surface of the metal bath.

The electrodes U are placed behind the converter, on the side of nose "O." In the converters with side blowing (see Figs. 3 and 4), the openings B which are used for the passage of carbons U are placed over the blast-box A.

The electrodes U hang from brackets, independent of the converter. These brackets are provided with drums and ropes for handling these electrodes and for holding the junction boxes. They are lowered into the furnace through the openings B, when the converter is in a horizontal position. As the operation takes place at all times on a bath of molten metal, there is no fear that the arc may break, as is a frequent occurrence when the fusion of solid pieces of scrap iron is made in electric furnaces.

When the converter has bottom blowing twyers, (see Figs. 1 and 2) the blast from the twyers naturally determines the stirring of the molten metal and all parts of this molten metal come in contact with the basic slag used in the process.

When the converter has side blowing (see Figs. 3 and 4), the twyers are at least partially directed from the blast box A toward the bottom of the converter. Two groups of twyers are seen on these figures, one of horizontal twyers which blow the air over the molten metal bath and another group of inclined twyers which inject the blast into the mass, producing a stirring of the metal and placing all of its parts in contact with the basic slag. It is understood that these twyers can blow either air or gas which will act as a reducing, oxidizing or neutral agent, as the case may require.

These twyers can be placed parallel with each other or else in fan-shape, more or less spread out, as is shown by Fig. 5; this figure, which is a cross section along line M M of Fig. 4, shows by dotted lines the twyers that are both fan shaped and plunging, which makes a powerful mixing of the molten metal with the peripheral slag at the center from top to bottom of the bath. The angle formed by each twyer with the vertical axis may vary according to the

capacity of the converter; and so also the angle formed by the twyers with the horizontal plane. The inclination of the side blast plunging twyers is such that all the molecules of the bath are in contact with the blast which produces a perfect mixing, as also with the slag. While the mixing of the metal with the slag, through the blast, is avoided in all side blowing converters in existence, the opposite result is obtained here, as the blast acts at the same time as oxidizer and as a mechanical means of getting a thorough mixing.

The horizontal twyers which inject the air or gas over the bath may be placed obliquely, as shown by cross section, Fig. 6, which is a cross section through N N, Fig. 4, so as to impart a revolving motion, in the inside of the converter, to the blown gas.

The operation is carried out in the following manner:—A supply of crude iron from a blast or a cupola furnace is poured into the converter, and either before or after pouring the crude iron, the necessary quantity of lime for transforming all the silicon, the sulfur and the phosphorus into lime silicate, calcium sulfid and lime phosphate, is placed in the converter. The solid lime remains in suspension in the bath, thus producing a pasty mixture, insufficiently fluid. The converter is then placed in a horizontal position, the electrodes U are lowered to the surface of the bath and the electric current is permitted to go through; in this manner a high temperature is obtained which results in giving the lime an extreme fluidity. The electric current is then shut off and the electrodes are raised in order to take them out of the converter. After this operation, the openings used for the passage of the electrodes are closed by means of plugs; the converter is then set up again and placed in position for the blowing which comes either from the side or from the bottom. The air or the gas under pressure brought in through the twyers stirs up the molten metal, mixes the metallic bath with the lime and puts the metal in contact with the slag. During the blowing, the flame projecting from the converter nozzle is not reddish as in the ordinary Bessemer operations. It is just at this period that the scorification of the silicon takes place.

As the silicon disappears, the flame burns whiter and whiter. The carbon burns with the air injected by the twyers and the bath being very hot and very fluid, carbon monoxid is produced, without a violent rise, as is frequently the case in converters.

In the new process the blowing is stopped as soon as the rise takes place, the converter is placed again in a horizontal position, the molten metal is left to decant and the clean-

ing is done in an extracalcareous, hot and reducing medium, the atmosphere of the converter being filled with carbon monoxid.

Owing to these three conditions, high temperature, thorough mixing of the blast oxidized bath with the extracalcareous slag, and reducing atmosphere, the sulfur, phosphorus, silicon and manganese are eliminated in the form of lime silicate, calcium and manganese sulfid and lime phosphate. These elements being eliminated before the carbon is entirely burned out, the metal may be cast just as it is, if the test bar should show the percentage of carbon desired.

When the cleaning is over, care is taken to connect the current to the electrodes, to make the necessary additions and to shut off the current when the bath is hot enough and no more gas escapes which might come out of the mass.

In order to avoid the contact of the atmosphere with the bath, a light calcareous slag is formed which protects the metal from cooling off. After a certain amount of time has elapsed, a hot steel flows, which is homogeneous and possesses all the properties of electric steel.

What I claim is:—

1. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying additional heat thereto to maintain an increased fluidity of the mass, and injecting gas into the mass below its surface in such manner as to intimately mix the metal with the basic slag whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

2. A process for producing hard steel containing a substantial proportion of carbon which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying additional heat thereto to maintain an increased fluidity of the mass, and injecting gas into the mass in such manner as to intimately mix the metal with the basic slag, whereby to eliminate the excess of carbon, and produce a steel of the desired carbon content without subsequent carburization.

3. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying by means of an electric current additional heat thereto to maintain an increased fluidity of the mass, and injecting gas into the mass below its surface in such manner as to intimately mix the metal with the basic slag whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

4. A process for producing hard steel containing a substantial proportion of carbon which consists in placing crude iron in a Bessemer converter in the presence of basic

slags, supplying by means of an electric current additional heat thereto to maintain an increased fluidity of the mass, and injecting gas into the mass in such manner as to intimately mix the metal with the basic slag, whereby to eliminate the excess of carbon, and produce a steel of the desired carbon content without subsequent carburization.

5. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, heating the mass by means of electrodes of opposite polarities arranged over the mass, withdrawing the electrodes, and injecting gas into the mass in such manner as to intimately mix the metal with the basic metal whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

6. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying additional heat thereto to maintain an increased fluidity of the mass, and injecting into the mass gas in jets which are inclined with relation to one another in such manner as to intimately mix the metal with the basic slag whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

7. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying additional heat thereto to maintain an increased fluidity of the mass, injecting gas into the mass below its surface in such manner as to intimately mix the metal with the basic slag, and injecting into the converter gas over the mass of metal whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

8. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying additional heat thereto to maintain an increased fluidity of the mass, and injecting into the mass divergent jets of gas to intimately mix the metal with the basic slag whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

9. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic slags, supplying additional heat thereto to maintain an increased fluidity of the mass, and injecting into the mass gas in divergent and downwardly inclined jets to intimately mix the metal with the basic slag whereby to completely eliminate the phosphorus, sulfur and other impurities from the mass.

10. A process for producing hard steel which consists in placing crude iron in a Bessemer converter in the presence of basic

- slags, supplying additional heat thereto to maintain an increased fluidity of the mass, injecting gas into the mass in such manner as to intimately mix the metal with the basic slag, and injecting gas into the converter over the mass of metal in a more or less tangential direction whereby to completely eliminates the phosphorus, sulfur and other impurities from the mass.
11. In the manufacture of steel in a Bessemer converter in the presence of basic slags, the process of intimately mixing the metal with the slags which consists in introducing into the charge below the surface thereof gas under pressure in such direction as to bring the metal and slags into close and thorough contact.
12. The process of producing hard steel containing a substantial proportion of carbon which consists in placing crude iron in a Bessemer converter having a basic lining, in the presence of basic slags, supplying additional heat to the mass by an electric current, injecting into the mass below its surface gas in such manner as to intimately mix the metal with the basic slag whereby to completely eliminate the phosphorus, sulfur and other impurities and excess of carbon in a single operation.
13. The method of producing hard steel containing a substantial proportion of carbon which consists in placing crude iron in a Bessemer converter having a basic lining, adding sufficient lime thereto to transform the silicon, sulfur and phosphorus into silicate of lime, sulfid of lime and phosphate

of lime in the presence of basic slags, supplying additional heat to the mass to increase its fluidity, and injecting gas into the mass below its surface in such manner as to produce an intimate mixing of the metal and slag whereby to eliminate the silicon, sulfur and phosphorus in the form of silicate of lime, sulfid of lime and phosphate of lime.

14. The method of producing hard steel containing a substantial proportion of carbon which consists in placing crude iron in a Bessemer converter having a basic lining, adding sufficient lime thereto to transform the silicon, sulfur and phosphorus into silicate of lime, sulfid of lime and phosphate of lime, placing an electrode in said converter, passing an electric current through said mass, thus supplying additional heat to increase the fluidity of the mass, removing the electrode, tilting the converter, introducing gas in such manner as to bring the metal and slag into intimate contact, whereby to eliminate the silicate of lime, sulfid of lime and phosphate of lime and any excess of carbon, and then casting the metal, whereby in one operation hard steel having the desired carbon content may be produced.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

GEORGES CINILLE.

Witnesses:

HENRI LALANDE,
ETIENNE GARRY.