June 9, 1964 G. DECAMPS 3,136,626

METHOD OF REFINING CAST-IRON

Filed Aug. 2, 1961 2 Sheets-Sheet 1

FIG. 1

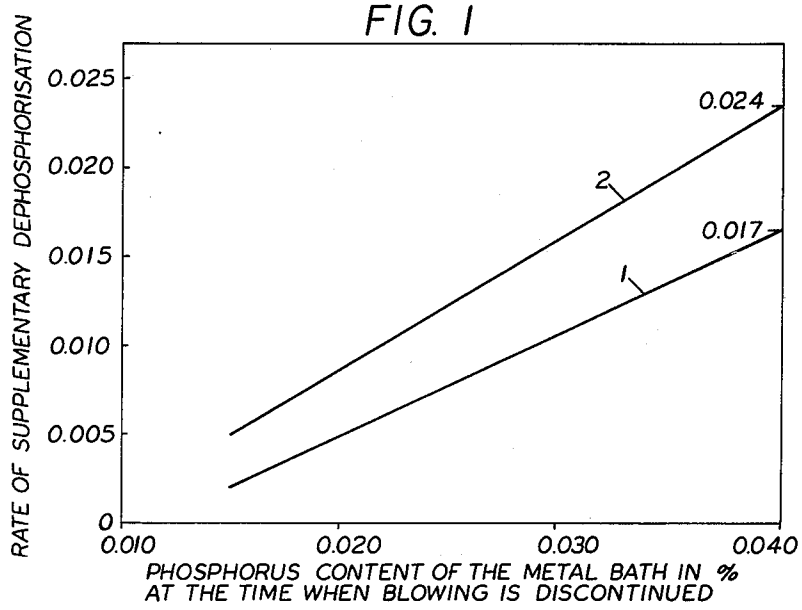
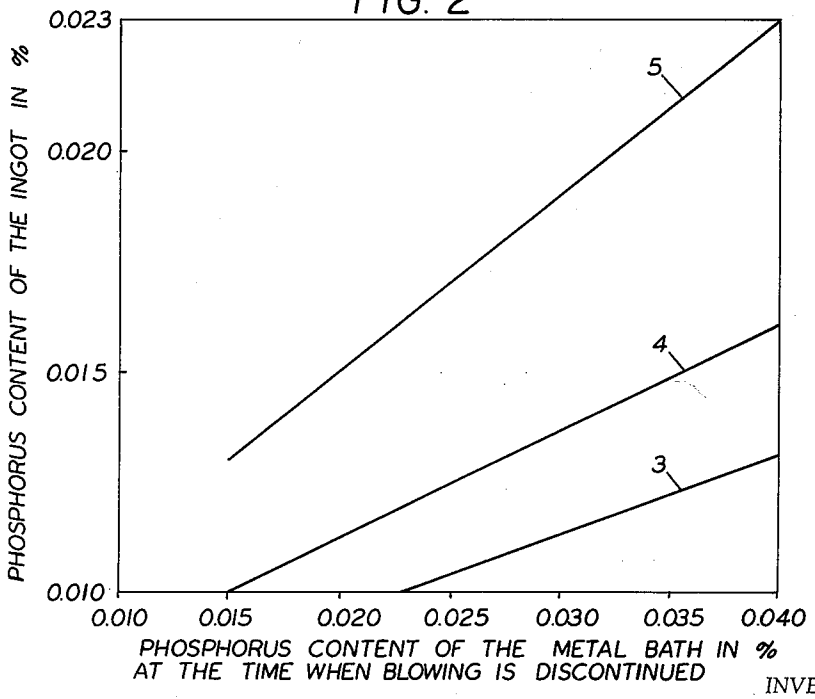


FIG. 2



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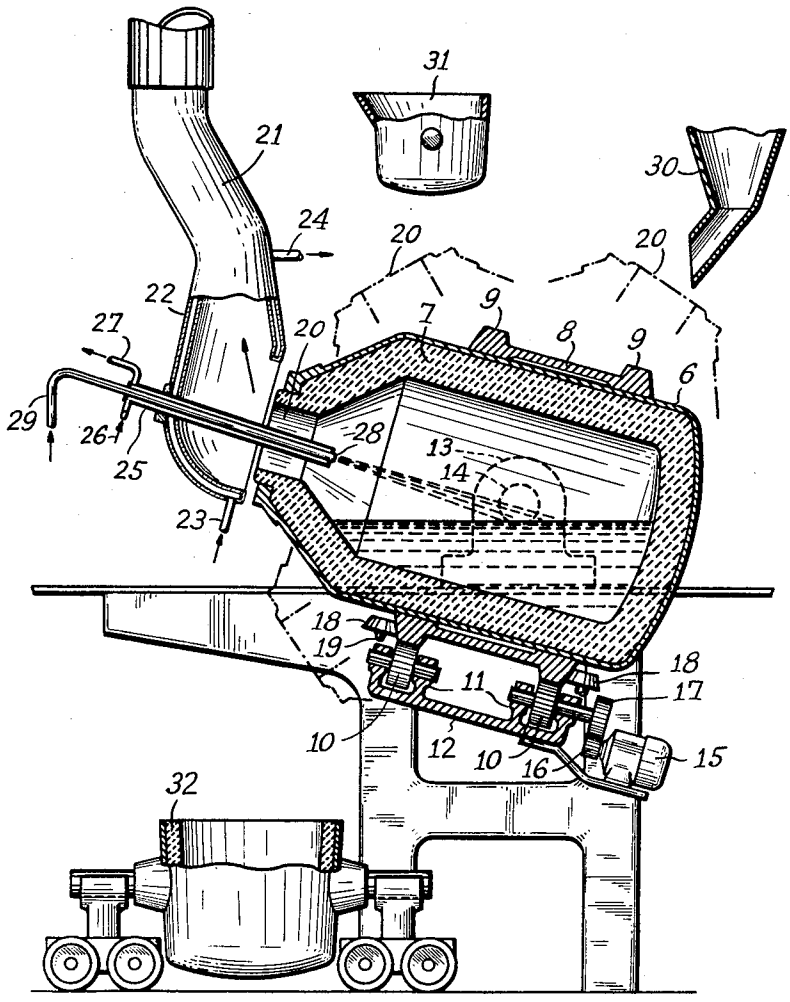
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June 9, 1964 G. DECAMPS 3,136,626

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Filed Aug. 2, 1961 2 Sheets-Sheet 2

Fig. 3



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3,136,626

METHOD OF REFINING CAST-IRON

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4 Claims. (Cl. 75—52)

It is known to refine cast-iron by blowing a molten bath of the cast-iron with oxygen, the latter effecting the combustion of the elements to be eliminated and especially of silicon, manganese, carbon, phosphorus and sulphur. The heat generated by these reactions keeps the bath in the molten state and permits the formation of a liquid slag.

The blowing of oxygen into the liquid bath produces some agitation of the bath, but it has already been proposed to further cause agitation by independent means, for example by effecting the refinement in a rotary furnace.

At the end of the treatment, the slag is not saturated with phosphoric anhydride, but the rate of dephosphorisation is practically limited since the continued dephosphorisation until a phosphorus content of the bath lower than 0.015% is obtained necessitates a high content of iron oxide in the slag.

For this reason, when it is desired to obtain a steel with a low phosphorus content, it has been necessary to use at least two slags with an intermediate skimming of slag, the second slag being of less volume than the first and therefore carrying with it a smaller quantity of iron. Attempts have also been made to retain this second, iron-rich slag in the furnace, in order to use it as first slag for the succeeding charge, for example, as in United States Letters Patent No. 2,804,385.

The high iron oxide content of the slag renders the latter wild, so that it is difficult to retain it in the furnace when the liquid bath is poured into a casting ladle and there is danger that it may pass into this ladle. If the slag passes into the ladle, the result is:

An abnormal and irregular final manganese content, a part of the added ferro-manganese being oxidised by the slag and a part being enveloped with slag so that it only melts in the course of the casting into the ingot mould; and

A rephosphorisation of the steel as the additions of deoxidising agent in the ladle reduce the phosphoric anhydride content of the slag and cause return of the corresponding phosphorus into the metal.

In attempts to avoid these drawbacks, various means have been used. For example, it has been proposed to skim the slag thoroughly from the molten bath, but this involves a significant loss of iron. It has also been proposed to dry the slag by the addition of lime; however in fact the lime forms an island which floats on the bath and which only acts on the surface, solidifying only the upper layer of the slag.

It has also been proposed to provide the furnace with a casting hole; and this is the method which is most used at present. However, as this hole is necessarily of a limited diameter, the casting into the ladle is relatively slow, involving a significant loss of time and of temperature; furthermore the problem of the refractory materials around this casting hole is difficult to solve. At the end of the casting, entraining of the slag takes place inside the steel gate and a rephosphorisation is observed in the ladle.

The object of the present invention is to provide an improved method for the refining of cast-iron by blowing with oxygen and agitation of the bath by means independent of the blowing, which avoids rephosphorisation, while achieving significant dephosphorisation, appreciable gains in the yield of iron, and reduction in the time required for the operation and the wear of the casting ladles.

In accordance with the invention, when the steel has almost reached the desired composition or carbon content, an agent capable of dephosphorising the bath and also of drying the slag, such as, for example, lime, is added to the liquid bath, and supplementary agitation is effected while blowing with oxygen is discontinued.

It is then observed that a part of the lime is immediately scorified by reason of the high iron oxide content of the slag. The new slag, by reason of its stirring with the bath, oxidises the reducing element which the latter contains. The carbon and phosphorus contents of the bath diminish appreciably. When a Kaldo rotary furnace is used, at its normal rotation speed, this operation lasts less than one minute. Furthermore the reduction of the slag by the bath has the effect of rendering it less fluid and the excess lime completes drying of the slag, so as to permit rapid casting through the furnace nozzle (less than two minutes for 120 tons) without observing the passage of slag into the ladle.

In practice the addition of the lime or other drying and dephosphorising agent can be effected when the carbon content is about 0.04 or 0.05% higher than the final content desired. The quantity of lime to be added is determined easily by experience, but generally good results are obtained with a quantity between 1 and 3% of the weight of the metal, the variation depending upon the degree of oxidisation of the slag.

The curves of FIGURES 1 and 2 show the results obtained with the improved method according to the invention.

The curves of FIGURE 1 represent the rate of supplementary dephosphorisation after addition of the dephosphorising agent as a function of the phosphorus content of the bath when the blowing with oxygen is discontinued the curves **1** and **2** relate to slags having iron contents which are respectively lower and higher than 22%.

These curves show that the supplementary dephosphorisation is increased with increases in the iron oxide content of the slag, this being logical since a slag containing relatively large amounts of iron oxide can absorb more pure lime, while remaining liquid. This dephosphorisation is also much more intense if the phosphorus content is higher at the time when the blowing with oxygen is discontinued.

When the phosphorus content of the bath varies from 0.015 to 0.040% at the time when blowing is discontinued, the dephosphorisation rate varies:

For an iron content of the slag greater than 22%, from 7 to 24 points.

For an iron content less than 22%, from 2 to 17 points.

The curves **3**, **4** and **5** in FIGURE 2 relate to slags having an iron content higher than 28%, between 22 and 28%, and lower than 22%, respectively, and indicate the phosphorus content of the ingot as a function of the phosphorus content of the bath at the time when blowing is discontinued.

They show that the phosphorus content of the ingot is always less than 0.015% for an initial phosphorus content of 0.035%, if the slag comprises more than 22% of iron. Frequently, ingots are obtained having a phosphorus content below 0.010%.

The method according to the invention presents numerous advantages, apart from the possibility of obtaining a steel having a particularly low phosphorus content. More specifically, the method achieves:

A gain in the operation time, by reason of the possibility of rapid casting into the ladle;

A reduction in the consumption of oxygen of at least

115 kg. per each hundred tons of steel;

An increase in the yield of iron of at least 400 kg. for one hundred tons of steel;

An increase in temperature made possible by the rapid casting; and

An increase in the useful life of the casting ladles, as the slag covering the metal is relatively dry.

The drying and dephosphorising agent remaining in the furnace is economically used for forming the slag for the following charge. As it has solidified the whole of the slag and iron oxide, the pouring of the liquid melt into the furnace can be effected as soon as the casting of the steel is finished, without any danger and in less than one minute.

In FIGURE 3, a rotary furnace 6 of the type that can be conveniently used in practicing the method embodying this invention is illustrated.

The rotary furnace 6 comprises a metallic jacket having an internal ceramic lining 7 and being encircled by a support ring 8 having two spaced tracks 9. When the furnace rotates, the tracks 9 rotate on a series of rollers 10 mounted in bearings 11 fastened to the cradle 12 having journals 14 supported in the bearings 13, so that the whole furnace can be inclined in different positions for charging, casting and the treatment by heat, respectively. One of the rollers 10 is rotated by a motor 15 through gears 16, 17. Abutment rollers 18 rotatable on spindles 19 also engage the tracks 9 of the ring 8 and prevent the furnace from shifting axially when it is inclined. The furnace possesses a single opening 20 disposed in the center of one of the end walls. The gas evacuation chimney 21 is spaced by about 10 cm. from the opening 20 when the furnace is in the position for thermal treatment at an inclination of 15 to 20° for example. The chimney is provided with a cooling jacket 22 with a water inlet 23 and a water outlet 24. In the chimney there is mounted a jacketed nozzle 25 cooled by water arriving at the inlet 26 and issuing at the outlet 27. Inside the nozzle 25 there is disposed a conduit 28 which is connected through a flexible conduit 29 to a source of oxygen (not shown).

As indicated in broken lines on the drawings, the furnace can be inclined into a certain position for receiving the charge of the material forming the slag, and the iron ore, through a hopper 30, and into another position for receiving the charge of molten iron from a ladle 31, and

then into a third position for discharging the slag or the refined melt into a movable ladle 32.

The furnace 6 containing the slag from a previous refining operation is charged with molten iron. Then in known manner the oxygen is blown through the conduit 28 while the furnace is rotated.

After the first refining period, the slag is evacuated, material forming the second slag is added again and the blowing with oxygen is recommenced while the furnace is rotated.

When the steel has almost reached the desired composition, the slag drying agent, such as, lime, is added and the furnace is rotated for about one minute without blowing oxygen. The slag is thus dried and remains in the furnace when the furnace is inclined to pour the steel into the movable ladle 32.

What I claim is:

1. A method of refining cast-iron, comprising melting the cast-iron, introducing the molten cast-iron and slag into a furnace to produce a molten bath in the latter, blowing oxygen into the molten bath, adding lime to the molten bath when the molten metal has almost attained its desired carbon content while retaining the slag which is then in the furnace so that the added lime acts to dry the slag and further to effect dephosphorisation of the metal, agitating the molten bath while discontinuing the blowing of oxygen therein, and thereafter discharging the refined steel from the furnace while retaining the dried slag in the latter to act as the initial slag for a succeeding charge of metal to be refined.

2. A method as in claim 1; wherein the quantity of lime added to the molten bath is between approximately 1 and 3%, by weight, of the amount of metal in said bath.

3. A method as in claim 2; wherein the further agitation of the bath after addition of lime is effected for a maximum of approximately 1 minute.

4. A method as in claim 1; wherein the lime is added to the molten bath when the carbon content of the metal is approximately 0.04 to 0.05% higher than the desired final content.

References Cited in the file of this patent

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