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METAL REFINING METHOD AND APPARATUS

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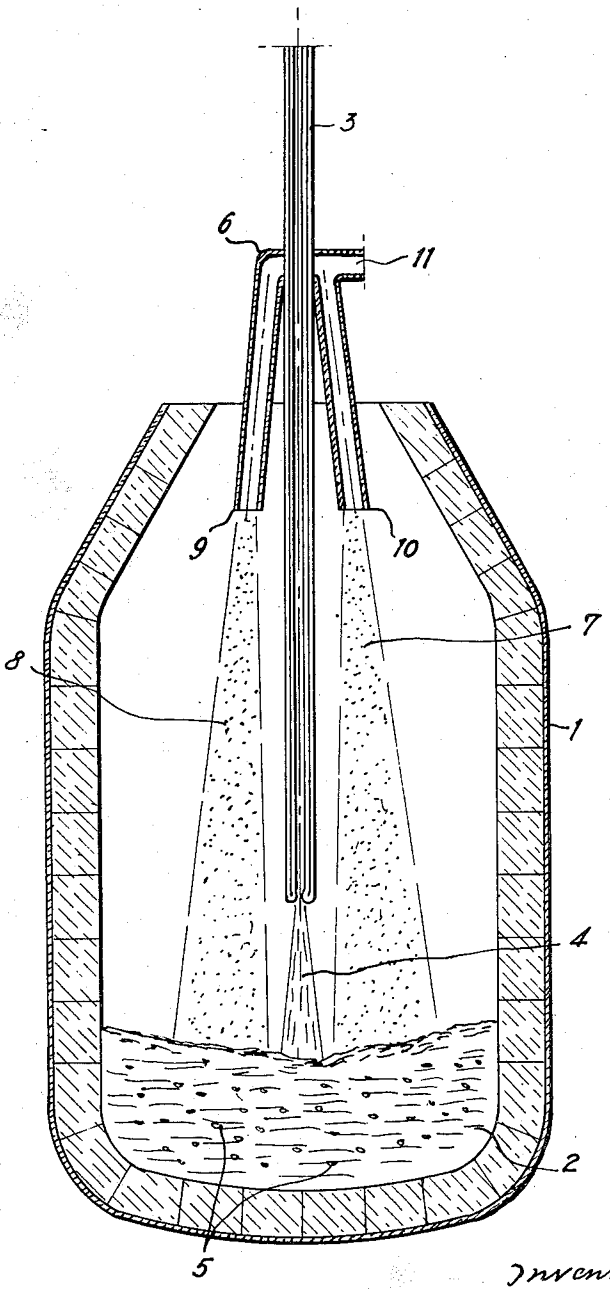

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METAL REFINING METHOD AND APPARATUS

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The present invention relates to a metal refining method and apparatus and more particularly, the present invention is concerned with the refining of pig iron.

It is well known to refine pig iron with the aid of an oxidizing fluid, preferably with technically pure oxygen, so as to oxidize carbon contained in the pig iron to carbon monoxide, and also to oxidize other components of the pig iron. The oxidation of these components is an exothermic process which will increase the temperature of the molten pig iron bath from the initial temperature of the bath to the higher temperature required for the pouring of the refined pig iron or steel.

Within limits, oxidizing of the carbon to carbon monoxide will yield sufficient heat to allow addition to the bath of cooling substances such as scrap iron, iron oxide and various iron ores. However, the foregoing notwithstanding, a considerable portion of the thermic potential of the oxidizing reaction is not materialized but is lost in the form of a combustible gas containing carbon monoxide which emanates from the molten metal bath at high temperature and which is released into the atmosphere.

It has been attempted to carry out further combustion of the carbon monoxide gas inside the refining vessel in order to improve thermic yield, i.e. to utilize in the metal bath a larger proportion of the thermic potential of the carbon originally contained in the pig iron. For instance, it has been suggested in connection with converters in which the oxygen gas is introduced into the molten bath from the bottom portion thereof, to burn all or a part of the combustible gases emanating from the upper free surface of the metal bath by means of a stream of oxidizing gas which is introduced into the converter above the level of the metal bath. While it is possible in this manner at least partly to further oxidize the carbon monoxide to carbon dioxide and thus to generate additional heat, only a small fraction of the heat which is thus generated above the molten metal bath will in fact be absorbed by the metal bath. It is well known that the transmission to the metal bath of heat released even at a small distance only from the surface of the metal bath, is very unsatisfactory. It has been attempted to improve heat transmission from the gas base above the metal bath to the metal bath by using a rotating furnace, but considerable difficulties are involved in the operation of rotating furnaces and the heat transfer results still were not as good as desired.

It is therefore an object of the present invention to overcome the above described disadvantages in the refining of pig iron.

It is another object of the present invention to provide a method and apparatus by means of which a greater portion of the heat evolved by oxidation of carbon contained in pig iron will be absorbed by the molten metal bath.

It is another object of the present invention to provide a method and apparatus for the refining of molten metal and particularly of pig iron, which—due to the better utilization of the heat produced by complete oxidation of carbon contained in the molten metal—will permit the introduction of larger quantities of solid cooling materials

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such as iron containing materials or refining additives, so as to increase the efficiency and yield of the operation.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention comprises in a process for refining a bath of carbon-containing molten metal wherein carbon monoxide is formed and emanates from the bath into a region adjacent the upper surface of the bath, the steps of contacting the emanated carbon monoxide in the region with a combustion supporting oxidizing gas so as to oxidize the carbon monoxide to carbon dioxide, and simultaneously directing a stream of particulate solid material through the region into the bath so that the particles of the stream while passing through that region will absorb at least a portion of the heat developed by oxidation of the carbon monoxide and the thus absorbed heat will be introduced by the particulate material into the molten bath.

The present invention also contemplates in a process of refining a bath of molten pig iron, the steps of introducing from above a stream of technically pure oxygen into the bath so as to react at least a portion of the carbon of the molten metal with the oxygen under formation of carbon monoxide gas, the latter emanating from the bath into a region adjacent the upper surface thereof, contacting the emanated carbon monoxide in the region with a combustion supporting oxidizing gas so as to oxidize the carbon monoxide to carbon dioxide, and simultaneously directing a stream of particulate solid material selected from the group consisting of pulverulent lime and iron ores through the region into the bath so that the particles of the stream while passing through that region will absorb at least a portion of the heat developed by oxidation of the carbon monoxide and the thus absorbed heat will be introduced by the particulate material into the molten bath.

It is also within the scope of the present invention to provide in a device of the character described, in combination, a converter vessel having a lower portion adapted to contain molten metal and an upper portion defining a gas space; means for injecting oxygen into the lower portion of the converter vessel, and means for introducing a stream of particulate solid material distributed in an oxidizing gas into the upper portion of the converter vessel.

According to a preferred embodiment of the apparatus of the present invention, the same comprises in combination a tiltable converter vessel having an open top, a lower portion adapted to contain molten metal and an upper portion defining a gas space, injection means including a lance extending downwardly through the open top for a predetermined distance into the upper portion of the converter vessel for injecting oxygen into the lower portion of the converter vessel, and introduction means including a plurality of conduits substantially equally spaced from and surrounding the lance and extending through the open top into the upper portion of the converter vessel for a distance considerably less than the predetermined distance for introducing a stream of particulate solid material distributed in an oxidizing gas into the upper portion of the converter vessel.

Thus, according to the present invention, the thermic yield of the metal refining process, particularly the refining of pig iron, is improved by oxidizing the carbon monoxide emanating from the bath of pig iron during the decarburization thereof in the portion of the atmosphere which is situated within the region of the upper surface of the metal bath or immediately above such upper surface. Oxidation of the carbon monoxide is carried out by introducing a stream of oxidizing gas, preferably substantially pure oxygen into such region. This oxidizing gas does not take part in the refining of the pig iron, inasmuch as it does not penetrate into the metal bath.

However, the oxidizing gas comes in contact with carbon monoxide emanating from the metal bath and will oxidize such carbon monoxide to carbon dioxide. Thereby heat is generated and this heat is taken up by a stream of finely divided solid particles which pass through the region in which combustion of carbon monoxide to carbon dioxide occurs and which then penetrates into the metal bath. In this manner, the solid particles will transfer a considerable portion of the carbon monoxide to carbon dioxide combustion heat into the metal bath. The carbon monoxide is formed in the metal bath by decarburization of the same, for instance by introduction of a stream of oxygen into the metal bath. In this case, two distinct streams of oxygen or at least two distinct streams of oxygen containing gas will be required, one stream to serve as a source of oxygen for the decarburization of the pig iron within the molten metal bath, and the other stream which will not penetrate the metal bath will serve for combustion of carbon monoxide to carbon dioxide.

The method of the present invention may also include one or more of the following features:

(*a*) The finely divided pulverulent material which will be heated in the region in which carbon monoxide is oxidized to carbon dioxide and which will then penetrate the molten metal bath, may consist of pulverulent iron oxides or iron ores.

(*b*) The finely divided solid material which is thus used for the transfer of heat may consist at least partly of powdered lime, which lime upon being incorporated in the molten metal bath will not only give up heat but also serve as an additive for the refining of the pig iron.

(*c*) The finely divided solid particles discussed in (*a*) and (*b*) may be suspended in a stream of oxidizing gas which is directed downwardly towards the surface of the molten metal bath, in such a manner that the oxidizing gas will not penetrate the molten metal bath and will serve for oxidizing the carbon monoxide, while the entrained solid particles will enter the molten metal bath.

(*d*) The oxidizing gas discussed in (*c*) above may be technically pure oxygen.

(*e*) The oxidizing gas may be air enriched with oxygen.

(*f*) The finely divided solid particles discussed in (*c*) above may be primarily distributed in the peripheral area of the stream of oxidizing gas.

(*g*) It appears that particularly good results are achieved by suspending a pulverulent iron oxide in technically pure oxygen and to introduce a stream thereof in such a manner that the technically pure oxygen will serve for combustion of the carbon monoxide while the thus heated pulverulent iron oxide will penetrate into the molten bath. It is particularly advantageous to proceed in this manner when it is desired to fluidize a solid or granulous slag layer which may have formed on the surface of the molten metal bath.

The present invention is also concerned with an apparatus particularly suitable for carrying out the above defined method which apparatus comprises an injection pipe or lance for producing a refining jet of commercially pure oxygen which may or may not contain suspended therein pulverulent refining additives and which will penetrate the molten metal bath, and at least one conduit or injector of a pulverulent solid material such as lime or iron ore suspended in an oxidizing gas, which oxidizing gas is intended for the combustion of at least a portion of the gases—particularly carbon monoxide—which are produced during the refining process and which emanate from the molten bath.

The pulverulent solid material which will be heated in the region where carbon monoxide is oxidized to carbon dioxide and which will then transfer heat to the interior of the molten metal bath, can be introduced independently of, or as a suspension in the stream of oxidizing gas.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which the figure is an elevational cross sectional view of a device according to the present invention.

Referring now to the drawing, the converter type vessel **1** contains liquid pig iron **2**. An injection pipe or lance **3** of a type known per se, introduces technically pure oxygen which will penetrate molten pig iron **2** and which will serve for refining the same. The jet of oxygen gas which may or may not contain suspended pulverulent refining additives and which will penetrate more or less deeply into the refining bath, is indicated by reference numeral **4**. Part of the thus introduced oxygen will oxidize carbon contained in the metallic bath and will form thereby gas bubbles **5** consisting essentially of carbon monoxide. The gas bubbles **5** will pass upwardly through the molten pig iron **2** and will emanate at the upper surface of molten pig iron **2**.

A conduit **6** introduces for instance powdered iron oxide suspended in a stream of technically pure oxygen into two introducing conduits **9** and **10** from which streams **7** and **8** will emanate. The streams **7** and **8** thus consist essentially of an oxidizing gas having distributed therethrough a powdered iron ore or lime or the like.

Due to their inertia, the powdered particles in streams **7** and **8** will preserve, to a large extent, their initial velocity and thus will be able to penetrate the surface of liquid pig iron bath **2**. On the other hand, the speed of the gas stream leaving introducing pipes **10** and **9** will be sufficiently slow and the distance between the orifices of conduits **9** and **10** and the surface of the bath **2** of molten pig iron will be sufficiently great, so that the gas streams **7** and **8** will not be capable to penetrate the surface of the molten pig iron bath **2**.

For instance, if the speed of the oxidizing gas leaving the orifices of conduits **9** and **10** is less than 50 meters per second, and the distance between these orifices and the bath is 3.8 meters, while the distance between the bath and the mouth of the converter is 4.4 meters, the oxidizing gas emanating from orifices **9** and **10** will not be capable of penetrating the pig iron bath, while the solid pulverulent material suspended in the oxidizing gas will penetrate into the interior of the molten pig iron bath.

Thus, for instance commercially pure oxygen, used as carrier for the suspended pulverulent ore in conduit **11** leading to distributor **6** and introduction conduits **9** and **10**, will form the combustion supporting gas which will oxidize carbon monoxide in the lower portion of streams **7** and **8** to carbon dioxide. It is important that gas streams **7** and **8** will be capable of oxidizing the carbon monoxide and thus to release the heat which will be transferred to the pulverulent material within gas streams **7** and **8** and by such pulverulent material into the bath of molten pig iron. It is therefore also desirable that the oxidizing gas of streams **7** and **8** will not penetrate into the bath of molten pig iron. In the region adjacent to the upper surface of the bath of molten pig iron **2**, the pulverulent ore or lime carried by streams **7** and **8** will reach a high temperature due to the great amount of heat generated in this region by the combustion of carbon monoxide and thus a considerable number of calories will be introduced into the molten pig iron by the pulverulent particles of streams **7** and **8** when these particles penetrate the surface of the bath of molten pig iron. It is of course also within the scope of the present invention to provide only one conduit such as conduits **9** and **10**, or a greater number thereof than the two conduits **9** and **10** illustrated in the drawing.

It will be clear from the foregoing, that it is essential, according to the present invention, to pass a finely divided, preferably solid material such as iron ore or lime in an oxidizing gas stream towards the bath of molten pig iron, in such a manner that the oxidizing gas stream will be used as combustion supporting gas for oxidizing carbon monoxide emanating from the bath of pig iron and so that only the pulverulent material but not the oxidizing gas stream will penetrate into the bath of molten pig iron. The oxygen required for the refining of the pig iron is introduced by separate means such as lance 3. Thus, the speed of the stream of oxidizing gas serving for oxidizing carbon monoxide should be kept relatively slow as compared with the velocity of the refining jet of oxygen emanating from lance 3. Furthermore, it is not absolutely required, according to the present invention that the stream of oxidizing gas emanating from conduits 9 and 10 is flowing during the entire refining process. It is also within the scope of the present invention to have streams 7 and 8 flow only intermittently whenever the quantity of carbon monoxide released from the molten bath of pig iron becomes sufficiently great, or when it is considered necessary to fluidize a solid or granulose slag.

The following example is given as illustrative only of the process of the present invention without limiting the present invention to the specific details of the example.

Example

A quantity of 35 tons of pig iron having a composition of 3.6% of carbon, 0.48% silicon, 0.6% manganese and 1.7% phosphorus is introduced into converter 1.

Lime in lump form is added to the molten bath in the converter in a ratio of 15 kg. of lime per ton of pig iron. Thereafter, the converter is raised to substantially vertical position such as illustrated in the drawing. Injection pipe 3 is now lowered into the mouth of the converter in such a manner that the orifice of pipe or lance 3 will be about 1 m. from the static level of the bath of pig iron.

Oxygen is injected through lance 3 in a quantity of 80 cubic meters per minute and at such speed that the stream of oxygen will penetrate into the molten pig iron bath, that is at about 330 m./s. During the first six minutes of oxygen injection, 25 kg. of sized lime for each ton of pig iron will be successively introduced by a chute in order to neutralize the oxide formed by oxidation of same constituents of the metallic bath.

Starting with about the fourth minute of oxygen injection through lance 3, projections of slag and of metal will appear at the surface of the metal bath. These projections indicate that the slag is only slightly reactive, being either solid or granulous, due to low temperature and unsatisfactory digestion of lime.

According to prior art methods, these projections are counteracted either by discontinuing the addition of lime or by adding fluxing materials, or by somewhat lifting lance 3, or by reducing the rate of inflow of oxygen from lance 3, or by a combination of the abovementioned steps. However, the results obtained are not satisfactory, particularly because it takes considerable time for the above methods to become effective and they also cause an increased wear and tear of the refractory lining of the converter.

According to the process of the present invention, starting with the fourth minute of oxygen injection, i.e. starting at the time when the above described projections tend to appear, the injection pipe 3 is lifted up to a height of 1.4 m. above the static level of the molten bath, and without reducing the inflow of oxygen through injection pipe 3, 370 kg. per minute of powdered iron ore suspended in an oxidizing stream of commercially pure oxygen flowing at a rate of flow of 25 cubic meters per minute, are introduced through conduits 11, 6, 9 and 10. This addition of ore is thus being made in a concentration of 15 kg. of ore per cubic meter (measured at normal pressure and temperature) of oxygen. The thus introduced powdered iron ore has a particle size of less than 200 microns and the velocity of the iron ore at the orifices of conduits 9 and 10 is about 40 m. per second.

The 25 cubic meters of oxygen thus introduced per minute, will be used up substantially for oxidizing carbon monoxide in the region adjacent to the upper level of the molten bath of pig iron and the stream of oxygen emanating from orifices 9 and 10 will not be capable of penetrating the bath of molten pig iron. However, during the oxidation of the carbon monoxide, the powdered iron ore will absorb and carry along into the bath of molten pig iron a considerable portion of the heat released by oxidation of the carbon monoxide. The addition of this important quantity of iron oxide at very high temperature will compensate for the loss of oxygen in the refining jet and will increase the quantity of metal to be refined and thus the yield of the individual charge. Furthermore, the addition of pulverulent and hot ore will fluidize the slag rapidly and will keep the tendency to create granulous slag projections under control. After proceeding as set forth above for four minutes, i.e. after 8 minutes from the start of injecting oxygen through lance 3, lance 3 is lowered to a distance of 0.8 m. from the static level of the pig iron bath and the introduction of oxygen and pulverulent material through conduits 9 and 10 may be discontinued.

During the first refining phase which will last about 17½ minutes, 40 cubic meters of oxygen have been introduced through injection pipe 3 for each ton of pig iron and 105 kg. of lime have been added per ton of pig iron. Furthermore, the introduction of ore and oxygen stream through conduits 9 and 10 was repeated three times and thus a total of 3900 kg. of ore, or 110 kg. per ton of initially introduced pig iron, have been additionally introduced. The ore employed in this case contained about 65% of iron.

At the end of the first phase, the temperature of the bath was 1630° C. as measured by an immersion pyrometer. A considerable portion of the slag was removed before the oxygen injection of the next phase started.

During the second phase of refining, 30 kg. of lime in pieces were added for each ton of pig iron and through lance 3, 12 cubic meters of oxygen were introduced per ton of pig iron. The second phase lasted 5½ minutes and was carried out with a flow of oxygen of 80 cubic meters per minute, while the injection pipe 3 was kept at a distance of 60 cm. from the bath. In accordance with the invention, 370 kg. of powdered ore per minute were introduced in a stream of oxygen flowing for 4 minutes at a rate of 25 cubic meters per minute from orifices 9 and 10. Thus, a total of 1500 kg. of ore were additionally introduced. This second phase of the refining was then terminated at a temperature of 1620° C.

In the above manner, it was possible to add to the molten pig iron 5400 kg. of powdered ore during the entire refining process, or more than 150 kg. of ore for each ton of pig iron. The amount of oxygen required to introduce the ore and, of course, also to oxidize carbon monoxide and thus to heat the ore particles prior to introduction of the same into the molten bath of pig iron, was 10 normal cubic meters of oxygen per ton of pig iron, the ore containing 65% of iron, and thus there were additionally obtained 3400 kg. of steel, or 10% of the total weight of the molten mass poured into the converter. With an ore addition made with ore in pieces according to the conventional method, it would have been possible to add about 110 kg. of ore per ton of pig iron.

Thus, there are several advantages to the process according to the present invention, first of all a substantial amount of heat is recovered by the oxidation of the carbon monoxide and by transfer of the thus developed heat into the molten bath, so that much larger quantities of cooling substances, such as additional scrap or additional ore can be introduced into the molten bath without a too great increase in the oxygen consumption, a prereduction of iron ore is accomplished as well as protection of the lining of the converter against the radiation of the combustion flames from the oxidation of carbon monoxide, since most of the thus developed heat is absorbed by the ore or lime particles passing through the region in which the oxidation takes place. Furthermore, a gradual and quantitatively controlled addition of cooling substances is made possible, and a fluidization of the slag by using iron ore which is preheated while passing through the carbon monoxide combustion region. When it is desirable that one or the other of the above mentioned advantages should be particularly pronounced, it is obviously possible to modify certain of the specific features discussed above, such as the concentration of ore in the oxidizing gas, the number of ore or lime containing streams of oxidizing gas, the speed of flow of the powdered ore, the velocity of the oxygen gas in the streams emanating from conduits **9** and **10**, and the distance which is to be covered by the powdered ore from the orifices **9** and **10** until reaching the surface of the metal bath. Of course, if instead of powdered ore powdered lime is introduced into the metal bath from the stream of oxidizing gas, the thus introduced quantity of powdered lime is to be deducted from the total quantity of lime which otherwise would have been introduced in conventional manner.

The conduit system terminating in lance **3** on the one hand and in pipes **9** and **10**, on the other hand, may, of course, be permanently linked or movable relative to each other.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of the invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a process for refining a bath of carbon-containing molten metal wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

2. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

3. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with substantially pure oxygen so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material through said region into said bath so that the

particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

4. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate lime adapted to refine said pig iron through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate lime into said molten bath.

5. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with substantially pure oxygen so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate lime adapted to refine said pig iron through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate lime into said molten bath.

6. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate iron-containing material through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate iron-containing material into said molten bath.

7. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with substantially pure oxygen so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate iron-containing material through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate iron-containing material into said molten bath.

8. In a process for refining a bath of molten pig iron wherein carbon monoxide is formed and emanates from said bath into a region adjacent the upper surface of said bath, the steps of contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material selected from the group consisting of pulverulent lime and iron ores through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

9. In a process of refining a bath of carbon-containing molten metal, the steps of introducing oxygen into said

bath so as to react at least a portion of the carbon of said molten metal with said oxygen under formation of carbon monoxide gas, the latter emanating from said bath into a region adjacent the upper surface thereof; contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

10. In a process of refining a bath of molten pig iron, the steps of introducing oxygen into said bath so as to react at least a portion of the carbon of said molten metal with said oxygen under formation of carbon monoxide gas, the latter emanating from said bath into a region adjacent the upper surface thereof; contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material selected from the group consisting of pulverulent lime and iron ores through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

11. In a process of refining a bath of molten pig iron, the steps of introducing from above a stream of technically pure oxygen into said bath so as to react at least a portion of the carbon of said molten metal with said oxygen under formation of carbon monoxide gas, the latter emanating from said bath into a region adjacent the upper surface thereof; contacting the emanated carbon monoxide in said region with a combustion supporting oxidizing gas so as to oxidize said carbon monoxide to carbon dioxide; and simultaneously directing a stream of particulate solid material selected from the group consisting of pulverulent lime and iron ores through said region into said bath so that the particles of said stream while passing through that region will absorb at least a portion of the heat developed by oxidization of said carbon monoxide and the thus absorbed heat will be introduced by said particulate material into said molten bath.

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Notice of Adverse Decision in Interference

In Interference No. 93,857 involving Patent No. 2,991,173, B. Trentini and P. Vayssiere, Metal refining method and apparatus, final judgment adverse to the patentees was rendered June 9, 1964, as to claims 1, 2, 4, 6, 8 and 10.

[*Official Gazette August 25, 1964.*]