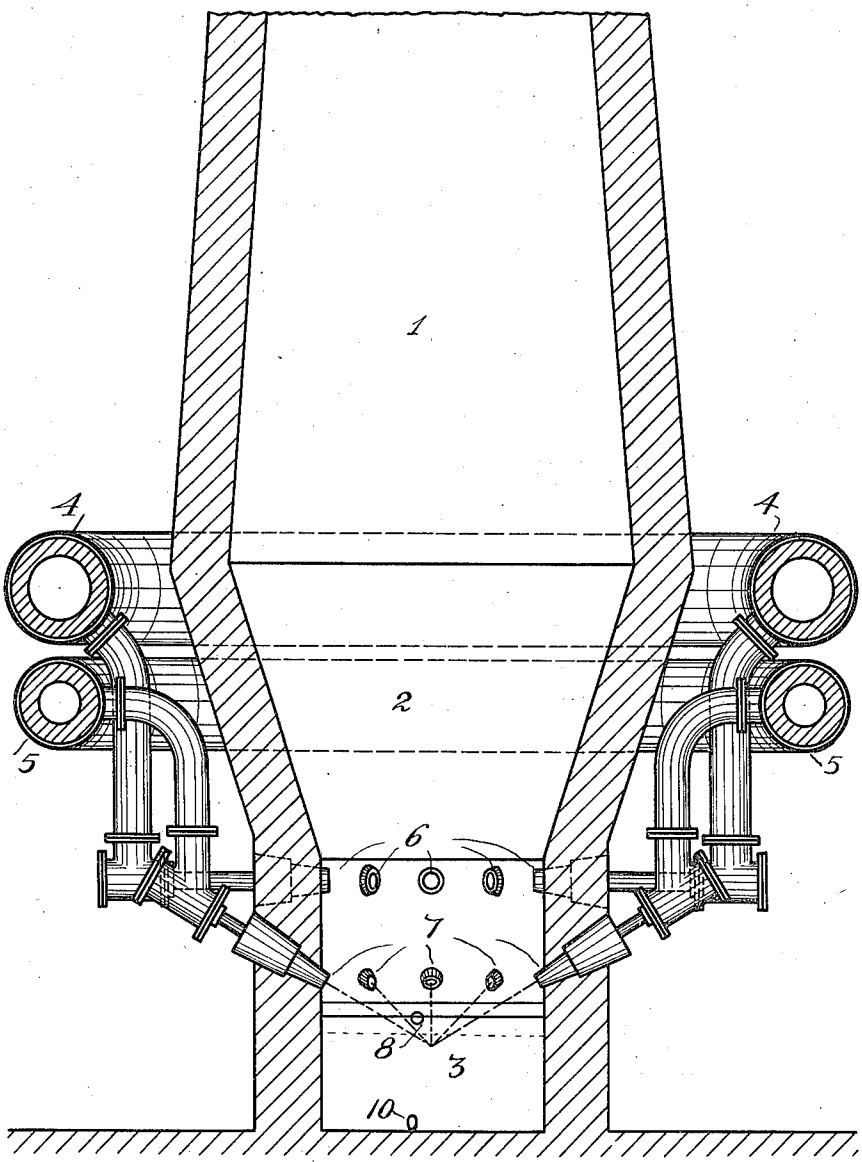
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PROCESS OF SMELTING AND PURIFYING IRON.

APPLICATION FILED SEPT. 24, 1914.

1,260,660. Patented Mar. 26, 1918.




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## PROCESS OF SMELTING AND PURIFYING IRON.

1,260,660. Specification of Letters Patent. Patented Mar. 26, 1918.

Application filed September 24, 1914. Serial No. 863,244.

*To all whom it may concern:*

Be it known that I, GUSTAV R. GEHRANDT, a subject of the Emperor of Germany, residing at Oak Park, Illinois, have invented certain new and useful Improvements in Processes of Smelting and Purifying Iron, of which the following is a specification.

The essential object of this invention is to produce a pig iron which is very much purer than any ordinary pig iron now obtained in commercial quantities; and the invention embodies certain improvements upon the process of smelting and purifying iron, described and shown in my prior United States Letters Patent issued September 15, 1914, No. 1,110,540. This invention (like the above-mentioned invention upon which this is an improvement) comprises both a process and an apparatus or a furnace adapted to perform the same, although the process itself can be performed by many furnaces other than the one herein shown and described.

In the drawing, the single figure is a vertical section of a blast furnace adapted to practice the invention, and said furnace comprises the stack 1, bosh 2, and hearth 3. The bustle-pipe 4 carries an air-blast and to said pipe 4 there may be applied such of the appliances for controlling the pressure, temperature, and volume of the air as the judgment of the operator may determine. A second bustle-pipe 5 is provided, and the twyers 6 and 7 extend from pipes 4 and 5, respectively, to the hearth. Twyers 6 are horizontally disposed and twyers 7 are oblique, being arranged with their discharge ends lowermost, so as to direct the streams of air downwardly, and at an angle oblique to the level of the molten iron which collects in the hearth 3. The usual cinder-notch 8 is provided, and the iron notch 10 is located near the bottom of the hearth, all of those notches being adapted to be plugged by fire clay in the usual manner. Preferably the obliquely-disposed twyers 7 are so arranged that their axial lines produced all meet approximately at the axis of the furnace.

It is well known that in the operation of the ordinary blast-furnace, the stack is charged with a mix of ore, flux, coke (or other fuel), and such other articles as are required, and that an air-blast is forced into the furnace through the twyers, which are usually arranged above the highest level which the molten mass of metal and slag can attain. The resultant product is the commercial pig iron, pig being chemically an alloy of iron and sundry elements and compounds thereof, such as carbon, silicon, manganese, phosphorus, sulfur, etc., and in the arts it is frequently necessary to free the iron from some or all of its impurities, both metallic and non-metallic. Many ways of purifying iron or of converting same into steel have been employed, but heretofore all such processes have necessitated the removal of the pig iron from the blast-furnace to a different apparatus, such as a converter, where a separate and distinct step of the process of making the ultimate product, whatever it may be, is performed; whereas, in this invention the iron is purified, or partly so, in the same furnace in which the ore is smelted, and thus the operator dispenses with the necessity of one handling of the metal, and is enabled to produce a pig iron, the chemical composition of which can be regulated and determined within reasonable limits. Otherwise stated, the purifying process and the smelting process proceed simultaneously, and in the same furnace, and one apparatus produces a finished product for the production of which two apparatuses were formerly required. As will hereinafter more fully appear, this invention effects many of the same results as the invention described and shown in my said prior patent dated September 15, 1914, although this invention embodies sundry improvements over said prior process.

In the operation of the furnace the same is charged with the usual mix, and started like any ordinary blast-furnace. The blast from the upper or horizontal twyers 6 will not pierce the metal but will pass through the mix in the bosh 2 and stack 1 in the usual manner, and the air from said twyers 6 is intended solely to facilitate the combustion and smelting. The streams of air from the obliquely-disposed twyers 7, however, will be forced downwardly and into the mass of molten iron and slag which collects in the hearth, and the air-blast from pipe 5 will thus pierce the molten metal and will oxidize the impurities of the molten iron; and in this process, as well as the one over which this constitutes an improvement, it is possible to determine within reasonable limits the chemical constituency of the pig iron by regulating the quantity, temperature, and pressure of the blast.

The blast is so controlled that the pressure in pipe 4 is lower than the pressure in pipe 5. The air from pipe 5 must be under sufficient pressure to make sure that the streams of air will enter and pierce the molten metal, whereas the air from pipe 4 is provided solely to furnish oxygen and the draft for the combustion process, and hence need not be under a very high pressure.

Some of the oxygen of the air which enters the furnace through the oblique twyers 7 will be exhausted in passing through the molten iron and slag, but there will also be some of the oxygen which passes upwardly from the level of the molten mass. The downwardly-pointed twyers 7 will obviously create within the hearth what may conveniently be termed an inverted air umbrella, and nearly every particle of smelted iron dropping from the stack or bosh into the hearth will pass through this umbrella, and every such particle of smelted iron is accordingly partly purified before it even reaches the hearth.

Because of the fact that the air-blast from the twyers 7 strikes the molten mass somewhere near the center of the furnace, the agitation of the mass of molten metal is confined to a circular or annular space, and the metal or slag near the outer wall of the hearth is not violently agitated at any time; hence, it is not a difficult matter to draw off the layer of slag because the surface of the metal or slag near the walls is relatively smooth, and the slag can be drawn off when it reaches the proper height in the manner common to blast-furnace practice.

In the former process, upon which this invention is an improvement, the mouths of the twyers through which the air-blast is forced into the molten metal must be at a lower level than the top level of the molten mass. When it is necessary to repair or replace any of the twyers, therefore, it is necessary to check the refining of the molten iron in the furnace to a certain extent and to permit the molten iron and slag to be withdrawn until the molten mass stands at a lower level than the mouths of the twyers. In this invention, however, a broken or defective twyer, whether of the horizontal or oblique series, can be replaced and repaired at will, and without stopping or checking the operation of the furnace.

In the operation of the furnace depicted in the drawings, as well as in the operation of practically all of the old-stye blast-furnaces in common use today, the mass of coke, ore, and flux will drop to the bottom of the bosh where the coke will be at a white heat. The space between the bottom of the mix and the top of the mass of molten iron and slag is filled with carbon dioxid, carbon monoxid, and other gases, including some of the air forced into the furnace through the twyers. It is well known that even though the air-blast be heated before entering the furnace, the air will be at a lower temperature than the temperature of the burning coke and molten iron and in the old-style furnaces part of the heat evolved from the coke is expended in raising the temperature of the air. In this invention, however, the fact that the oblique twyers 7 are forcing a certain amount of air into the molten metal, results in the emanating of a large volume of heated gases from the molten metal, which gases will from time to time include a certain amount of unconsumed and uncombined oxygen. These heated gases, the heat of which is derived from the heat of the molten iron, which heat would otherwise be entirely wasted and lost as the iron cools, passes upwardly where it mingles with the relatively cooler air entering through the horizontal twyers 6 and, as a result, raises the temperature of the blast which passes into the furnace through said horizontal twyers. In other words, the heat of the molten iron contributes to a certain extent toward heating the air-blast before the same reaches the burning fuel; hence, it follows that by the use of this process the operator decreases his coke consumption and decreases the volume of air which must be fed through the horizontal twyers. The increase in the temperature in the hearth, which is due to the fact just noted that gases which have been heated by contact with and passage through the molten iron will fill the upper part of the hearth, tends to decrease the number and the sizes of the heating stoves through which the blast must pass before reaching either of the bustle-pipes shown in the drawing, and the greater amount of heat production naturally will increase the iron output of any furnace per unit of time. This invention, moreover, like the one shown in my aforesaid prior Patent No. 1,110,540, dated September 15, 1914, results in the production of a refined iron suitable for various purposes for which ordinary pig iron is not available, and, in addition, reduces the expense of making steel by furnishing a partly refined iron, and an iron from which many of the impurities which cause difficulty to the steelmaker have already been extracted.

I claim as my invention:

1. The herein described process of producing a purified iron which consists in smelting the ore, collecting the smelted iron in the hearth of the smelting furnace, directing jets of air under relatively high pressure obliquely upon the molten iron, and simultaneously directing jets of air under a lower pressure, said last-mentioned jets being at a point higher than said first-mentioned jets.

2. The herein described process of producing a purified iron which consists in

smelting the ore, collecting the smelted iron in the hearth of the smelting furnace, directing jets of air obliquely upon the molten iron, said jets being under sufficiently high pressure to pierce the molten mass, and simultaneously directing a series of jets into the furnace at a point above said obliquely-disposed jets and at a lower pressure than said obliquely-disposed jets.

3. The herein described process of producing a purified iron which consists in smelting the ore, collecting the smelted iron in the hearth of the smelting furnace and in causing an air-blast to enter the smelted iron and to enter and pierce the same from a point above the level of the smelted iron and at an angle oblique to the level thereof, said air-blast being passed through the particles of iron while falling into the hearth and being under sufficiently high pressure to enable the same to reach and pierce the mass of molten iron, and causing another air-blast to enter intermediate the upper level of the reduced molten iron and the body of the ore.

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