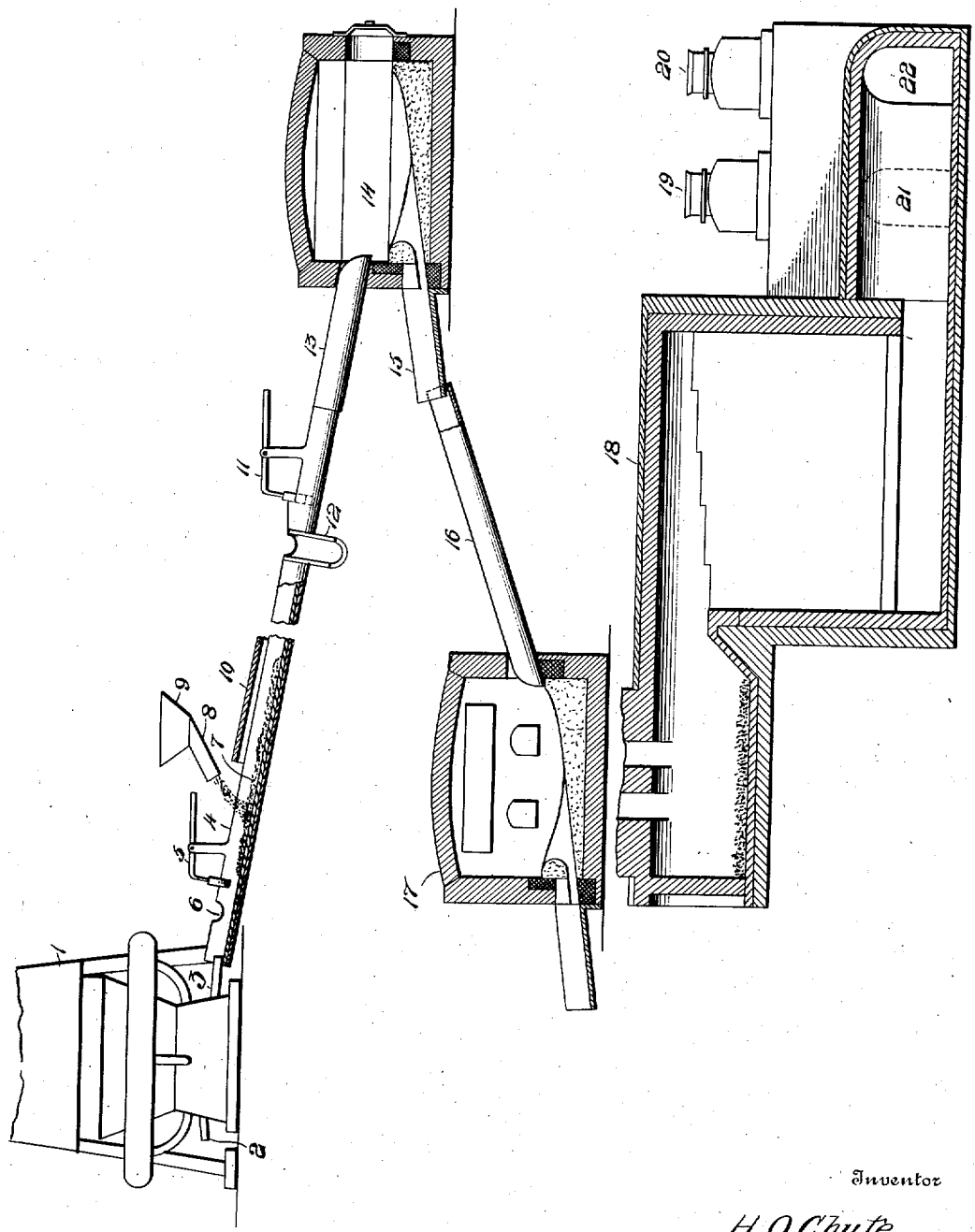
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H. O. CHUTE.

PROCESS OF MAKING STEEL.

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Inventor

H. O. Chute

Witnesses

B. M. Offutt.

Alfred W. Houghton.

By

W. P. McEbray.

Attorney

UNITED STATES PATENT OFFICE.

HARRY O. CHUTE, OF CLEVELAND, OHIO.

PROCESS OF MAKING STEEL.

No. 874,391. Specification of Letters Patent. Patented Dec. 24, 1907.

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To all whom it may concern.

Be it known that I, HARRY O. CHUTE, a citizen of the United States, residing in Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Processes of Making Steel; and I do hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to processes of making steel and consists in a method of smelting low-grade and impure ores to produce a special iron and in systematically refining such iron; all as more fully hereinafter set forth and as claimed.

Many non-bessemer ores are highly silicious and do not make good basic pig iron, and these ores are frequently high in sulfur, or, in some cases, the only fuels available for smelting them are high in sulfur. With such ores and such fuels, in ordinary practice if the furnace is run hot a silicious pig iron is produced which cannot be easily handled in a basic furnace. If the furnace is run cold, a sulfurous pig iron is produced which cannot be easily freed of impurities in the basic open hearth. This is especially true in the absence of manganese in the ores, a very frequent condition.

It is the purpose of the present invention to treat these ores by a simple, cheap and ready method, making available large deposits now considered unavailable; certain of these ores best adapted to the present process being generally considered fit for nothing because too impure or too deficient in manganese.

I have discovered that by using an excess of fuel as compared with the ordinary smelting operation to produce basic pig iron in the blast furnace and thereby running such furnace very hot, I can charge it with an ore mixture containing manganese and phosphorus, both preferably added as by-products resulting from a later operation, and with enough lime to make a basic slag, and thereby almost completely eliminate sulfur in the slag as manganese sulfid, producing a very hot and fluid pig iron, rich in silicon and phosphorus, all the phosphorus in the charge, substantially, appearing in the iron. About half the manganese in the charge also appears in the iron and such iron is practically saturated with carbon. The product of this operation is a highly silicious, very hot pig iron, which may be termed superheated as compared with the ordinary temperature at which iron is tapped from furnaces producing basic pig iron, while the sulfur is mostly eliminated in the basic slag as sulfid of calcium or manganese. While other pig iron containing much silicon and phosphorus, produced in other methods of operating the furnace, may be employed for my purposes, as hereinafter set forth, such other pig iron must be heated to a temperature analogous to that of the pig iron produced in the above operation; must be superheated as compared with the ordinary tapping temperature of basic pig. A superheated iron of this character, I have discovered, can be readily desiliconized by causing it to flow into contact with oxid of iron. The oxid may be dusted on the hot, very fluid iron by any suitable mechanism or the container may have the bottom lined with iron ore or mill scale. In pig iron of the described character made in the described manner there is enough sensible heat to inaugurate the reaction while its composition insures that the reaction with the iron oxid shall be sufficiently exothermic to maintain itself. The iron does not become chilled and is preserved in the melted condition while the larger part of the silicon is removed and the carbon begins to be attacked. The presence of the phosphorus is useful in maintaining the fluidity during the reaction. It remains in the iron while the silicon is being removed. The manganese in the iron is largely attacked and removed during the oxidation of the silicon, going into the slag which may be removed and reserved for reuse in the furnace. In this operation advantage is taken of the fact that with a high temperature and a silicious iron, the silicon and manganese are preferentially attacked.

It is important that the quantity of iron ore or other iron oxid brought into contact with the iron should be limited to that necessary to remove the silicon, without otherwise changing materially the composition or fluidity of the pig iron. This may be readily effected by control of the amount dusted in or lengthening or shortening the time of contact of the molten metal with iron oxid.

The product of the reaction on the molten metal, or slag, may be skimmed off by any suitable means. As stated, it is to be reserved for re-use in the blast furnace. One appropriate way of separating it is by the

use of an auxiliary furnace connected with the container in which the treatment with oxid is performed and serving at once as slag-separating means, re-heating means and means for forming a reservoir or dominant mass of molten metal, in which the reaction can be equalized, continued or regulated, to be drawn on for the later operations. The purified, skimmed iron is still essentially pig iron but is now largely freed from silicon, sulfur and manganese but contains large amounts of carbon and phosphorus, rendering it fusible, fluid and an ideal material for treatment in a basic open hearth furnace in which it may be treated in the usual way to eliminate the carbon and phosphorus, with formation of the well known phosphoric basic slag. This phosphoric slag, being highly basic and containing a considerable amount of iron as well as the phosphorus, is well suited as an ingredient of the charge in the blast furnace to produce the high-phosphorus pig iron. It may be used for this purpose, wholly or in part. Or it may be utilized for other purposes. There will always be an excess of phosphoric slags. A considerable economy in the process is effected by returning the slag from the desiliconizing, which is silicate of iron and manganese, to the furnace together with the slag from the basic hearth, whereby the iron may be recovered and the manganese and phosphorus re-utilized. If manganese be absent in the ore, some must be supplied from any convenient source. Running the furnace hot with sufficient fuel to produce the described pig iron, a rich gas is obtained which may be advantageously employed in the auxiliary furnace and in the basic open hearth furnace.

In the accompanying illustration, I have shown more or less diagrammatically, one assemblage of apparatus of the many combinations adapted to perform my process. In this showing, 1 is the usual type of blast furnace, shown fragmentarily, provided with cinder notch 2 and iron notch 3. The latter leads into trough 4, provided with the usual skimming apparatus 5 and slag outlet 6. The trough is lined, as usual, with firebrick or other refractory material, and as shown, it is also lined in use for a portion of its length with iron oxid or mill scale 7. As an alternative means of using the iron oxid, feeder spout 8 from the hopper 9 may be employed. It may also be used in conjunction with the stated lining. The amount of iron oxid used in either or both ways is of course adjusted to the tenor in silicon of the pig iron. A portion of the trough may be covered, as shown at 10. During transit through the trough in contact with the iron oxid, the iron is deprived of its silicon and partly of its manganese, forming a floating slag of silicates. This is skimmed off by an ordinary skimmer 11 and passes out through the side trough 12, where it cools and is broken up for return to the blast furnace. The desiliconized iron, still fluid because of its carbon and phosphorus content, passes under the skimmer and into and through a movable trough 13 into the auxiliary furnace and reservoir 14. From this it is tapped from time to time through the spout 15 and movable trough 16 into the basic open hearth furnace 17. This latter should be of the usual or standard basic open hearth construction, with the usual regenerative chambers 18, the gaseous fuel being admitted through the valve 20 and conduit 22 to the regenerative chambers and thence to the furnace in the usual manner. The air similarly reaches the furnace through valve 19. The hot rich gas produced by the blast furnace while working in this process is well adapted to heat the basic open hearth furnace.

1. The process of making steel which consists in smelting iron from a basic charge containing phosphorus and manganese under proper thermal conditions to produce a superheated pig iron rich in silicon and phosphorus and a sulfurous slag, contacting the superheated pig iron with sufficient oxid of iron to remove silicon and then treating the desiliconized iron to remove phosphorus and carbon.

2. The process of making steel which consists in smelting iron from a basic charge containing phosphoric and manganic slag from a later operation under proper thermal conditions to produce a superheated pig iron rich in silicon and phosphorus and a sulfurous slag, contacting the superheated pig iron with sufficient oxid of iron to remove silicon and removing and reserving the produced slag for subsequent use in the smelting, and then treating the desiliconized iron to remove phosphorus and carbon and produce a basic slag.

3. The process of making steel which consists in smelting silicious non-bessemer ores under proper thermal and fluxing conditions to produce a superheated pig iron rich in silicon and phosphorus and a sulfurous slag, contacting the superheated pig iron with sufficient oxid of iron to remove silicon, and then treating the desiliconized iron to remove phosphorus and carbon.

4. The process of making steel which consists in smelting iron from a basic charge containing phosphorus and manganese under proper thermal conditions to produce a superheated pig iron rich in silicon and phosphorus and a sulfurous slag, producing a flowing current of such molten superheated pig iron and contacting it in transit with sufficient oxid of iron to remove silicon, and then treating the desiliconized iron to remove phosphorus and carbon.

5. The process of making steel which consists in smelting silicious non-bessemer ores in the presence of basic slag containing phosphorus and a silicate slag containing manganese under proper thermal conditions to produce a superheated pig iron rich in silicon and phosphorus and a sulfurous slag, producing a flowing current of such molten superheated pig iron and contacting it in transit with sufficient oxid of iron to remove silicon and form a silicate slag containing manganese, and then treating the desiliconized iron to remove phosphorus and carbon and form a basic slag containing phosphorus.

6. The process of making steel which consists in smelting silicious non-bessemer ores under proper thermal and fluxing conditions to form a superheated pig iron rich in silicon and phosphorus and a sulfurous slag, producing a flowing current of such molten superheated pig iron and contacting it in transit with sufficient oxid of iron to remove silicon and then treating the desiliconized iron by the basic open hearth process to remove phosphorus and carbon.

7. The process of making steel which consists in producing molten pig iron containing silicon and phosphorus and in a superheated state, contacting it while in said superheated state with sufficient oxid of iron to remove silicon and form a silicate slag, and then treating the desiliconized iron by the basic open hearth process to remove phosphorus and carbon.

8. The process of making steel which consists in smelting silicious non-bessemer ores under proper thermal and fluxing conditions to produce a superheated pig iron rich in silicon and phosphorus, tapping such superheated pig iron into contact with a sufficient amount of oxid of iron to remove silicon as a silicated slag and removing such silicated slag, and thereafter treating the desiliconized iron by the basic open hearth process to remove phosphorus and carbon.

In testimony whereof, I affix my signature in the presence of two witnesses.

HARRY O. CHUTE.

Witnesses:
B. L. CHADWELL,
K. P. MCELROY.