S. L. MERSHON.
PROCESS OF PURIFYING IRON.
APPLICATION FILED AUG. 8, 1900.
2 SHEETS—SHEET 2.

Inventor:
Stephen L. Mershon.

Witnesses:
A. B. Copper
Norman C. Metius.

by his Attorney:
Thorn & Thorn.

THE NOYES METER CO., INDIANAPOLIS, KT. I.
To all whom it may concern:

Be it known that I, STEPHEN L. MERSHON, a citizen of the United States, residing in Montclair, New Jersey, have invented an Improved Process of Purifying Iron, of which the following is a specification.

The object of my invention is to quickly and effectually remove the impurities from molten iron in order to convert the same into steel, an object which I attain in the manner hereinafter set forth, reference being had to the accompanying drawings, which represent, partly in section and partly in elevation, apparatus designed for carrying out my invention.

Iron greatly varies in the quantity of the respective impurities contained therein, the various foreign elements differing in relative proportions in every succeeding lot of raw material. These inequalities my process fully controls, either by modification or elimination, in the manufacture of steel.

In the accompanying drawings, Figure 1 is a view, partly in side elevation and partly in longitudinal section, of apparatus designed for carrying out my invention; and Fig. 2 is a transverse section of the furnace structure on the line $a \ldots$, Fig. 1.

The apparatus shown in the drawings may be briefly described, as follows:

A is a cupola for the melting in the ordinary manner of pig-iron or other material under treatment.

B is a spout from which the molten iron is permitted to pour into furnace $O$. C is a drain which is used to guide the iron into said furnace $O$ or into reservoir $D$.

D is a reservoir into which the iron is poured from the cupola $A$ when the furnace $O$ shall have received its full charge or be unable to treat the said molten metal as rapidly as it is discharged from cupola $A$. The excess metal is then retained in said reservoir $D$ for a time and then tapped or poured into the furnace $O$, as required.

E is a platform or track on which said reservoir $D$ rests, said reservoir being either stationary or movable and either with a tap-hole or spilling device. F is a boiler for the generation of steam. I is a pipe for conducting steam from the boiler to the furnace. J is a port connected with pipe $I$, by which a blast of steam may be directed into the furnace $O$ direct from the boiler at the boiler's initial heat. K is a port through which an air-blast is directed into the furnace $O$ from a proper fan or air-pump. L is a port through which fuel-gas at a normal temperature is introduced from a reservoir or pipe. M is a port by which fuel-oil is introduced, the same being so constructed that when desired a jet of steam may be combined with fuel-oil, the steam connection being indicated at $m$. O is the refining or purifying furnace, into which the molten metal is poured from the said cupola $A$ or reservoir $D$ and converted into steel.

P P are supply pipes or ports through which is introduced a powdered fluxing substance or material composed largely of a lime or other flux, between which and sulfur, special chemical affinity. A view, partly in side elevation and partly in longitudinal section of apparatus designed for carrying out my invention.

The furnace may have either an acid or basic lining and bottom, and the various pipes may have slip-joints $a$, so as to readily disconnect them from the furnace when the same is of the tipping or tilting type.

It is well known that in the practical operation of steel-making the variations in the chemical composition of the pig-iron or other ingredients commonly employed cause the composition of each charge to greatly vary, with the result that there are also very material variations in the density of successive charges. It is found that even when the iron ore used is apparently uniform and of uniform pig-iron poured out of the cupola varies greatly in chemical properties and closeness of grain, because of the fact that the softer particles of iron melt first in the cupola and the elements most easily affected by heat find their way out of the cupola into the first pourings of iron. So true is this that the pig-iron poured from a single charge of uniform metal is graded into distinct classes of iron known as "No. 1," "No. 2," "No. 3," "No. 4," and "No. 5" foundry iron and "Bessemer pig-iron." Upon analysis these grades of iron are all found to vary in the relative proportions of the different impurities or foreign elements they possess—that is, in the quantity of carbon, silicon, manganese, sulfur, and phosphorus. To reduce each or all of these elements to quick and positive control or to
eliminate some or all, as required, is the object obtained by my invention. I so unite the above-mentioned substances or compounds of the same as to enable me in one furnace to treat in rapid succession the varying qualities of iron, so as to secure substantially any grade of steel of uniform quality.

It is not necessary in all cases to use all of the features of my process; but in the ordinary refining and purifying of iron and in the manufacture of steel the varying nature of the raw materials used gives each feature its value.

In ordinary use the process could be substantially as follows: The metal is first melted in cupola A, from which it pours into drain B and then down into furnace O in a thin sheet or is temporarily caught in the reservoir D and from that reservoir D is poured or run into furnace O. As the metal enters the furnace O a blast of steam is introduced at the initial boiler-temperature or at a lower temperature through the port J, and simultaneously therewith a blast of air is introduced through port K, both of which blast impinge on the sheet of pouring metal thereby bringing into conjunction with the molten iron a combined flame of oxygen and hydrogen produced by the decomposition of the steam and by the air supplied therewith. The steam upon its introduction into the furnace is decomposed on account of the action of its oxygen upon the carbon contained in the stream of molten iron, the hydrogen so freed combining with the oxygen furnished by the air-blast to form the very hot flame above referred to. An important element here is the action on the carbon, manganese, silicon, sulfur, and phosphorus of the oxygen and hydrogen gases and also the dynamic or explosive energy in the minute globules of moisture contained in the steam, the same being in the wet state as delivered by the boiler—that is to say, not superheated. I do not superheat the steam in order that I may maintain in the highest degree and with perfect safety the explosive energy in the globules of moisture, which upon sudden discharge into the extremely-high temperature in the furnace-chamber explode over an extended area in the proportion that the low temperature of the steam bears to the high temperature of the iron in the heated furnace. This so-called “explosive” effect is due partly to the sudden vaporization of the small particles of water carried by the wet steam and partly to the similarly sudden expansion of the comparatively cool steam upon its exposure to the very high temperature of the furnace. The effect of this incalculable number of minute explosions in the iron stream is to puddle, stir up, separate and dissociate the particles of iron one from another, exposing the foreign elements in the iron to the instantaneous action of the oxygen and hydrogen gases. This dynamic action is very important where the iron is hard, tenacious, and yields reluctantly to the disintegrating action of burning gases. If I desire to increase the active energy of hydrogen with oxygen, I open the port L and a blast of fuel-gas, composed of hydrogen and carbonic oxide with naphtha, petroleum, or other combustible gases, is hurled into the furnace with well-governed pressure and proper chemical results. As I avoid the highly-heated carbonaceous gases drawn from a furnace and used in other processes, I gain in the explosive energy and in the regularity of supply as well as in the economy of fuel.

In order to sustain the heat of the furnace so that the high temperature of the chamber may be maintained at all times regardless of the above-mentioned supply of the oxygen and hydrogen gases, I introduce at M a supply of oil or pulverized coal or coke, using either oil or said pulverized fuel alone or in combination with steam or gas, it being understood that the oxygen necessary for the combustion of this material is furnished by the blast employed to force said material into the furnace.

When the iron is in process of chemical change in the chamber O and when the sulfur or phosphorus is in proportions beyond those readily eliminated by the oxygen and hydrogen blasts, I inject into the furnace through ports P powdered lime or other substances, such as sulfur and phosphorus have a special chemical affinity. I find that as the silica is eliminated the sulfur will naturally combine with lime and other substances more readily than with iron. After such introduction of powdered material the metal precipitated to the bottom of the furnace is further heated by the continued combustion of the gas or other material employed in the operations above referred to. After such automatic puddling and after a short time the impurities separated from the iron by my process are found to have been released substantially as follows: The eliminated carbon has burned off as a gas. The eliminated sulfur has also burned off in gas or has been absorbed in the pulverized material. The phosphorus has been separated from the iron by the gases and fluxes and converted into slag.

By proper combination of the various treatments provided by the furnace all kinds of scrap or pig iron can be reduced to steel of high grade, the combinations being determined by the character of the metal flowing from time to time into the said furnace and the quality of the steel desired to be drawn therefrom.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The mode herein described of purifying molten iron, said mode consisting in subjecting the molten metal while in the form of a falling
sheet or stream and while in a furnace to the action of a blast of wet steam, substantially as specified.

2. The mode herein described of purifying iron, said mode consisting in subjecting the molten metal while in the form of a falling sheet or stream and while in a furnace, to the action of a blast of wet steam combined with a blast of oxygen, substantially as specified.

3. The mode herein described of purifying iron, said mode consisting in subjecting the molten metal while in the form of a falling sheet or stream and while in a furnace, to the action of heating-gases, a blast of wet steam, and a blast of oxygen, substantially as specified.

4. The mode herein described of purifying iron, said mode consisting in subjecting the molten metal while in the form of a falling sheet or stream, and while in a furnace, to the direct action of a blast of burning hydrocarbon oil and to a blast of wet steam, substantially as specified.

5. The mode herein described of purifying iron, said mode consisting in subjecting the molten metal while in the form of a falling sheet or stream, and while in a furnace, to the direct action of a blast of burning hydrocarbon oil, a blast of wet steam, and a blast of oxygen, substantially as specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

STEPHEN L. MERSHON.

Witnesses:

F. E. BECHTOLD,

JOS. H. KLEIN.