

(No Model.)

J. W. BOOKWALTER.  
PROCESS OF REFINING IRON.

No. 411,417.

Patented Sept. 24, 1889.

Fig. 1.

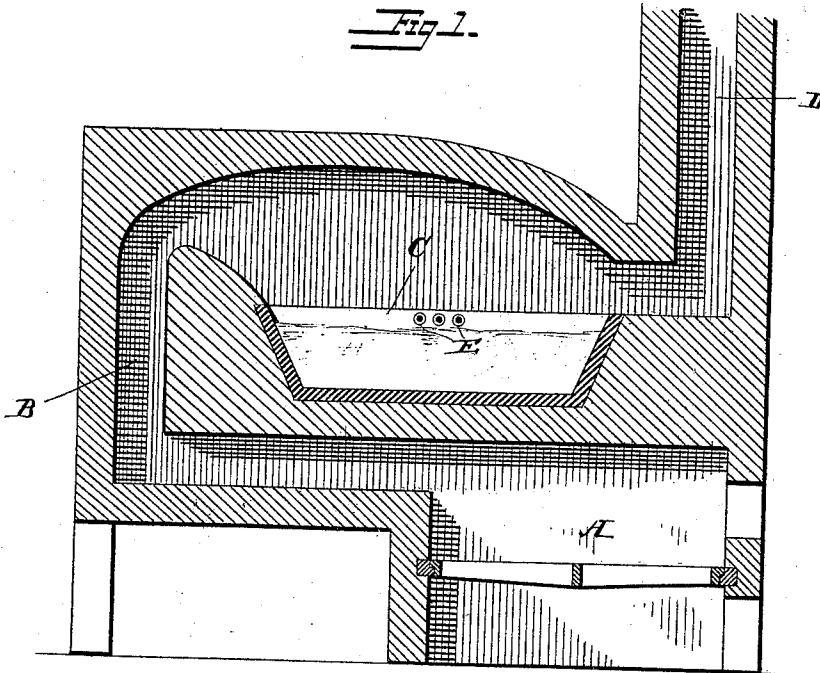
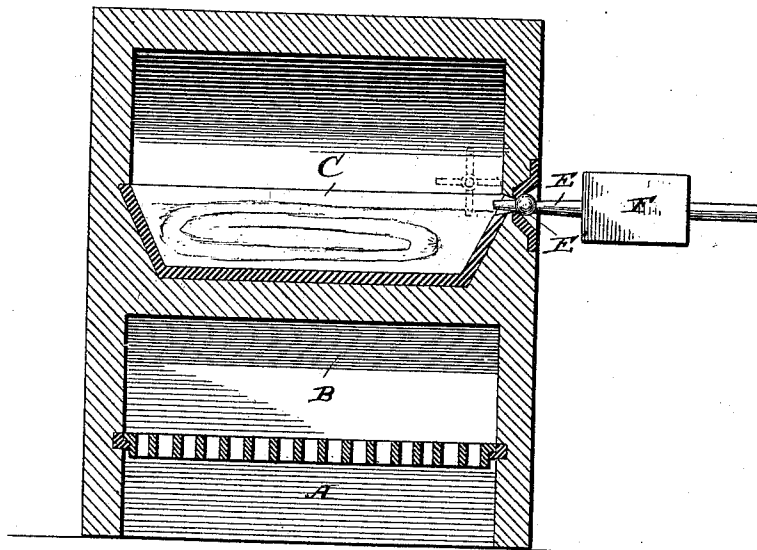


Fig. 2.



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# UNITED STATES PATENT OFFICE.

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## PROCESS OF REFINING IRON.

SPECIFICATION forming part of Letters Patent No. 411,417, dated September 24, 1889.

Application filed October 22, 1888. Serial No. 288,765. (No model.)

### *To all whom it may concern:*

Be it known that I, JOHN W. BOOKWALTER, a citizen of the United States, residing at Springfield, in the county of Clark and State of Ohio, have invented a new and useful Improvement in the Process of Refining Iron, of which the following is a specification.

In the conversion of crude iron into malleable iron or steel by the processes heretofore employed the impurities in the bath, partly those which were in the crude iron and partly the result of the action of the converting agent upon the iron, are in many instances intimately mixed with the body of the metal during the process of conversion; or where this does not result to so great an extent, as in what is called the "slow" process, where the impurities are thrown to the surface by the action of the rabbling or puddling tool, the process is so slow as to be accompanied by serious disadvantages.

My invention has for its object to secure the advantageous results ensuing in the slow process from the action of the rabbling-tool and from maintaining a comparatively quiescent surface upon the greater portion of the metal that will support the impurities eliminated without the delays which result ordinarily from such process; and to this end my invention consists in subjecting the molten metal to the action of the converting agent and also to the action of an independent rabble in the form of a bladed wheel, a non-connecting blast, or other agent, which is so applied, as herein after fully set forth, as to produce in regular succession upon small portions of the metal a rapid atomic action, and also to produce in the main body of the metal a gyratory motion, which regularly and quickly brings all portions of said body into position to be again subjected to the impact of the rabble. The two agents to which I have referred, the converting agent and the independent rabble, may be employed simultaneously or successively. For instance, in the "rapid" or Bessemer process of conversion, the conversion of the body of the metal may be effected by the converting-blast of air, as usual, after which the purifying of the metal may be effected by the rabble. In this case it is necessary, if a

blast is used, to employ a hot rabbling-blast of non-converting gas in order to maintain the desired temperature and fluidity of the metal after the converting agent has been cut off. In the process more analogous to slow process, wherein the converting agent is not passed through the body of the metal, but passes over the surface of the same, the rabbling-blast may be introduced simultaneously with the converting-agent, in which case it is not essential to heat the rabbling-blast.

In carrying out my improved process in connection with a converting agent which is applied simultaneously with but independently of the rabbling action, I make use of an apparatus which, for purposes of illustration, may be of the construction shown in the accompanying drawings, in which—

Figure 1 is a longitudinal section of the apparatus, and Fig. 2 a transverse section of the same.

The furnace I has a suitable grate A, and a passage B therefrom leads to and over a vat or basin C, containing the molten metal, so that the heated air or gases, products of combustion, or other aeriform converting agent pass from the grate over the surface of the metal in the basin and thence out at D.

Arranged preferably at right angles to the line of passage of the heated gases are one or more tuyeres E, having their discharge-outputs at the side of the basin and nearly on a level with the surface of the metal therein. The tuyere may be tilted or inclined so as to direct the blast onto the surface of the metal, and in this instance is shown as having a ball-and-socket joint E', and it will be seen that the direction of the blast can be easily regulated by inclining the tuyere. The tuyere is supplied with a blast which constitutes a rabbling-blast, and which is not an oxidizing agent, and which may be of air de-oxidized by being passed through a bed of charcoal placed in a receptacle F in the line of the pipe leading to the tuyere from the compressor. This rabbling-blast may be either hot or cold, according as to whether the same is depended upon to maintain the fluidity of the metal after the oxidizing or converting blast or other heating agent has

ceased to act upon the metal. Assuming that a body of molten metal is contained within the basin and that the converting-gases are flowing over the surface of the same from the passage B and that a blast of practically non-converting gas is passing from the tuyeres upon and over the surface of the metal in the bath, the action will be as follows: The rabbling-blast, entering under pressure and at a high velocity, will act upon the surface only of the metal in the bath, and will impart to the metal at part of said surface a violent atomic agitation. As is well known, when two substances of different specific gravities are intimately and minutely mixed together there is a tendency for them to adhere; but this tendency may be overcome by atomic agitation of the mixture, and I take advantage of this fact by causing the rapidly-moving blast of gas to strike forcibly against the particles of the metal at the surface of the blast, whereby the desired violent atomic agitation is locally produced and the impurities are separated from the pure metal and instead of being further carried thereby are carried separately and apart from the metal toward the opposite side of the converter and are deposited and rest upon the comparatively quiescent portion of the surface of the metal, owing to their less specific gravity, while the metal separated from such impurities flows back to the body of the metal. In addition to this atomic agitation of the metal at a portion of its surface, the main body of the metal, as a result of the rapid current flowing over the same, receives a gyratory motion, which causes a current to flow away from the tuyere, carrying the scoria with it to the portion of the surface upon which it is deposited and rests, and below such scoria downward and then back again to the locality where the surface receives the impact of the rabbling-blast. This motion, while it occurs with such rapidity as to quickly bring all portions of the body of the metal to the presence of the rabbling-blast and into a position to be exposed to and acted upon by the converting-agent above the surface of the bath, is not of such a character as to tend to draw down into the body of the metal any of the particles of impurities which rest upon the surface in the form of scoria, so that the metal, after being purified to any extent, is not again commingled with any impurities, but is brought in a purer condition to and again and again exposed to the action of the converting-gases until all the impurities are practically eliminated.

In addition to the effect produced by the atomic agitation of the metal, as above described, the gyratory motion of the metal acts centrifugally to throw out the particles of impurities to the surface in position to be skimmed or washed therefrom by the action of the rabbling-blast, so that the process of purifying or washing the body of metal is attained with great rapidity, and in case the

converting action is simultaneous with the purifying action the two are carried on together and the conversion and purification of the metal is effected within a small proportion of the time required in the ordinary slow process.

While by means of the apparatus and operations above described the conversion and purification of the iron are effected simultaneously by two independent agents, this simultaneous action is not essential in connection with my invention, because the converting-gases may be brought to act upon the body of metal in the first instance until the conversion is effected, as in the Bessemer process, or as in the slow process, and after this the rabble may act upon the metal to eliminate the impurities therefrom. In such case, however, it is either necessary to admit an additional blast or current of heated non-converting air to maintain the desired temperature and fluidity of the metal in the bath; or, if a rabbling-blast is used, to heat the rabbling-gas to secure the same result, inasmuch as there is during the washing and purifying action in such case no decompositions, and consequently no such heat as results from such decomposition while the metal is under the action of a converting-gas, and it is necessary to supply to the metal in some manner that amount of heat as will be sufficient to maintain the requisite fluidity of the metal in the charge.

Instead of using a rabbling-blast, the desired violent atomic action, as well as the gyratory movement of the molten metal, may be secured by any other effective agency—as, for instance, by a revolving bladed wheel Y, (shown in dotted lines, Fig. 2,) the rapid rotation of this wheel imparting the gyratory movement to the metal, and also acting locally upon the body of the metal at a part of the surface, so as to throw the portions fed successively thereto by the flow of the metal violently to the opposite side of the converter with the like effect as if a blast-rabble were used.

While I have described and illustrated my invention in connection with a stationary converter, it may be carried out by means of converters of different forms, stationary or tilting.

Without limiting myself to the precise details of treatment herein set forth, I claim—

1. The mode described of treating iron, the same consisting in subjecting a bath of the molten metal to the action of a converting agent and producing a local violent atomic action at the surface of the bath upon successive portions of the metal by means independent of the converting agent, substantially as set forth.

2. The within-described improvement in treating iron, consisting in subjecting a body of the molten metal to the action of an aeriform converting agent, and also in projecting upon a portion of the surface of the bath

a non-oxidizing blast to produce a local agitation, and also to impart to the body of the metal a gyrating motion to bring all portions thereof in succession in position to be acted on directly by the blast, substantially as set forth.

3. The mode described of treating iron, the same consisting in subjecting a bath of the molten metal to the action of a converting agent and producing a local violent atomic action at the surface of the bath upon successive portions of the metal by a non-oxidizing blast, substantially as set forth.

4. The within-described improvement in treating iron, consisting in subjecting a body of the molten metal to the action of an aeri-

form converting agent, and also in acting upon a portion of the surface of the bath by means independent of the converting agent to produce a local agitation, and also to impart to the body of the metal a gyrating motion to bring all portions thereof in succession in position to be acted on directly by the blast, substantially as set forth.

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

JOHN W. BOOKWALTER.

Witnesses:

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