(No Model.)

G. L. ROBERT.

PROCESS OF CONVERTING CRUDE IRON INTO MALLEABLE IRON OR STEEL.

No. 407,117. Patented July 16, 1889.

Fig. 1.

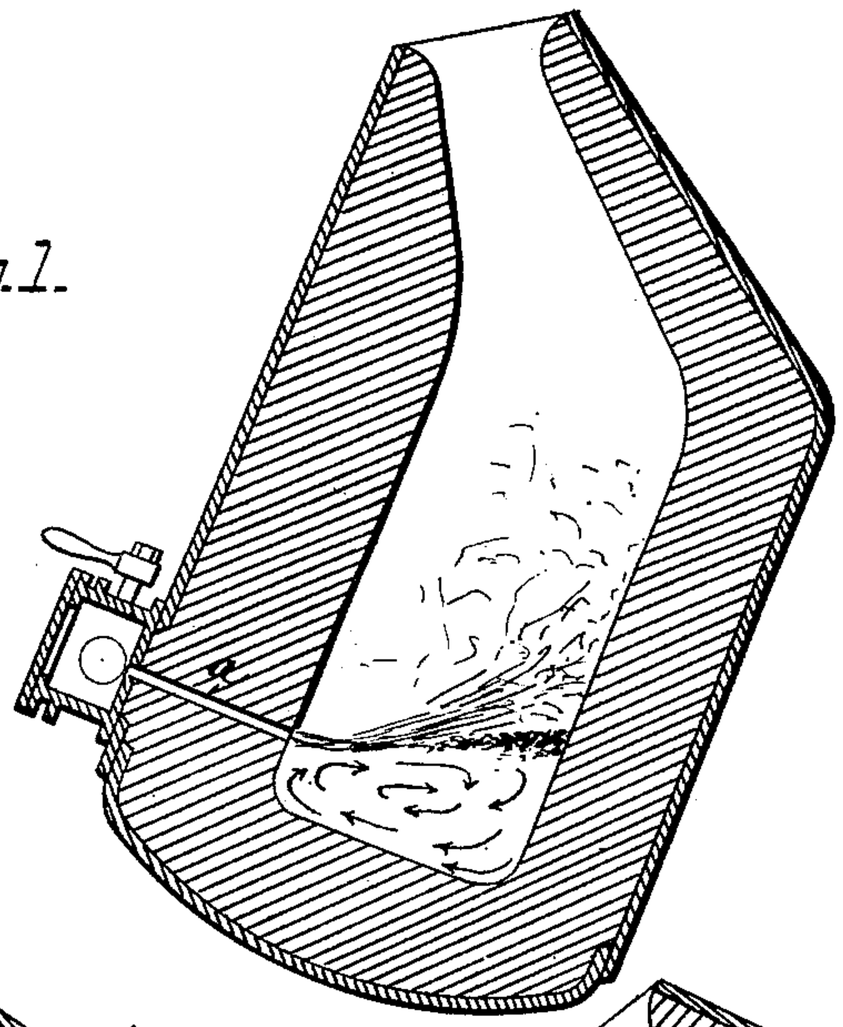


Fig. 2.

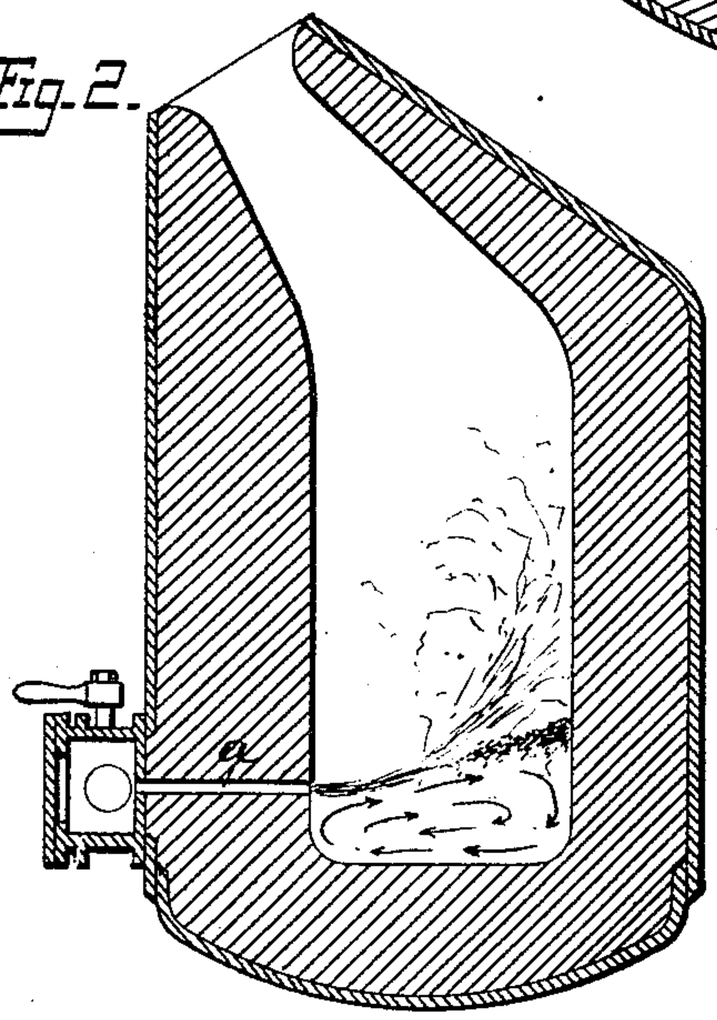
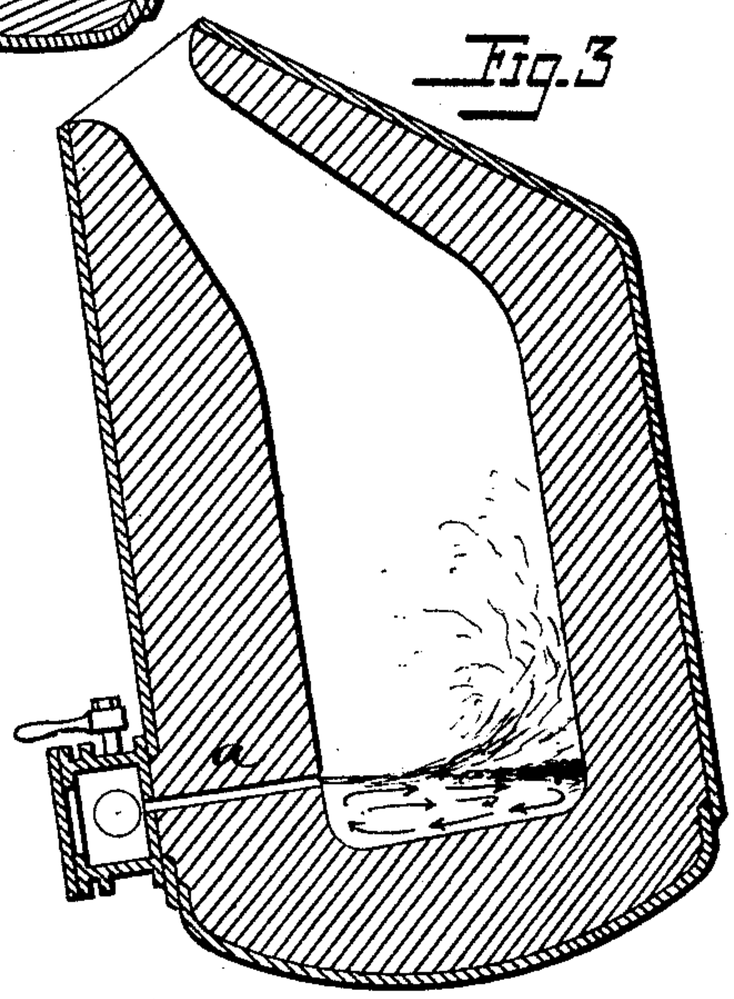


Fig. 3



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UNITED STATES PATENT OFFICE.

GUSTAVE L. ROBERT, OF STENAY, FRANCE, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE BOOKWALTER STEEL AND IRON COMPANY, OF JERSEY CITY, NEW JERSEY.

PROCESS OF CONVERTING CRUDE IRON INTO MALLEABLE IRON OR STEEL.

SPECIFICATION forming part of Letters Patent No. 407,117, dated July 16, 1889.

Application filed November 20, 1888. Serial No. 291,319. (No specimens.) Patented in England May 9, 1888, No. 6,886.

To all whom it may concern:

Be it known that I, GUSTAVE LOUIS ROBERT, a citizen of the Republic of France, residing at Stenay, Department of the Meuse, Republic of France, have invented certain new and useful Improvements in the Process of Converting Crude Iron into Malleable Iron or Steel, (for which I have received a British patent, No. 6,886, May 9, 1888,) of which the following is a full, clear, and exact specification.

My invention relates to that mode of converting crude iron into malleable iron or steel in which limited portions of a body of molten metal are successively violently agitated in the presence of a converting agent, the impurities and the metal are separated, the metal returned to the bath and again brought to the area of violent agitation, and these operations are repeated until all the metal is acted on, converted, and purified, as set forth in my patent, No. 395,175, dated December 25, 1888.

The object of my present invention is to regulate the action in carrying out the aforesaid process at the will of the operator, so as to avoid uncertain or detrimental results, and this I effect by the means hereinafter fully described, and I may use the apparatus illustrated in the accompanying drawings, in which—

Figures 1, 2, and 3 represent in vertical section and in different positions a converter of a character to carry out my improvement.

One of the primary characteristics of the before-named process of conversion is that the body of the molten metal is divided during the operation of converting practically into two sections or portions in radically-different conditions. One section is small in volume and the particles thereof are stripped from the main body with a violent action that atomizes or finely divides the same, and as a result the impurities naturally separate themselves from the metal, while the other portion, comprising the greater body, is comparatively quiescent—that is, free from violent commotions.

The greater violence of the action that is practicable to impart to limited portions of the metal results in a twofold effect: First, it favors rapid conversion, because such violent action separates and finely divides the particles, exposing large areas of surface to the converting agent; second, it secures the separation of the impurities by the natural action before referred to, whether these impurities were in the crude metal or are formed in the bath during the process of conversion, and, third, it carries the particles of metal away from the area of violent agitation and conversion, so as to avoid continuous action of the oxidizing agent on the same particles, and brings in new metal to the agitating and converting area, thus preventing overoxidation.

As one means of securing the desired atomic disturbances of portion of the entire mass of molten metal, I make use of an oxidizing or converting blast, and I have found that this may be so directed upon the body of metal as to strip off and violently agitate portions only of the same at one time, leaving the greater mass undisturbed, except to the extent of imparting a desirable flow of gyration, that repeatedly brings every portion into position to be acted on directly by the blast. The converter, after being charged, is tilted, as shown in Fig. 1, and the blast is applied upon or so near to the normal surface of the metal in the bath and is so directed thereto that it will not enter or penetrate the body of the metal as in former processes, and so that practically no portion of the metal will be above the blast, and in such manner that but a small portion of the metal will be subjected to the action of the blast at any one time. Thus as the blast passes inward through the tuyere at a point adjacent to the surface of the metal its rapid forward motion, combined with the tendency to escape upward in the direction of least resistance, gives to the blast and to the portion of metal carried therewith a resultant diagonally-upward direction away from the main body of metal, so that small portions only of the metal are thus acted upon and stripped off at one time; but as such small portions are subjected to the impact of the entire blast a much more violent agitation is imparted thereto by a comparatively light blast than it would be possible to impart to the entire body by a blast of the most powerful character, and as a result of this agitation not only are the particles of impurities separated from the metal, but the latter is so atom-

ized that it is spread or divided into small particles as to present the desired extended surfaces required to effect the speedy and thorough oxidation of all particles. The action of the blast in carrying a portion of the metal to the opposite side of the converter is to pile up the metal at that side, which, together with the impact of the blast on the exterior portion of the body of metal, results in the production of a circulatory or gyratory current in the direction of the arrows, which causes a flow of the metal downward and upward toward the area of violent action, while the metal is prevented from rising above the line of the blast by the impact of the latter, which strips or beats off the particles presented in its path, so that an inclined surface is imparted to the bath at one edge lower and at the other higher than the mouths of the tuyeres. As a result of the more perfect and rapid oxidation from the more thorough admixture of the atoms of air and metal, there is a higher temperature, inasmuch as there is a more complete and uniform conversion, and because, owing to the limited portion of metal acted upon at one time, every portion may be thoroughly oxidized. The temperature of the bath is therefore not only maintained as the result of the action of the blast, but is increased, so that the metal is rendered extremely fluid, thereby facilitating its movements under the action of the blast and preventing its rapid cooling when removed from the converter.

From the foregoing it clearly appears that the blast must not be too deep or it will enter into the body of the metal, while on the other hand it must be deep enough to come into sufficiently extensive and intimate contact with the metal to produce the necessary reactions and conversion, or it will escape without producing the desired results; but it must be remembered that the bulk of the metal diminishes during the conversion by reason of the elimination of the impurities. Consequently the level of the surface of the metal falls during the process, and therefore the blast must be varied to maintain its position relatively to the metal. This may be done in various ways, two of which naturally present themselves—first, by bringing the blast down to the metal, and, second, by bringing the metal up to the blast. The former proceeding may be most conveniently accomplished by using a tilting converter and turning it upon its trunnions during the progress of conversion to different positions, as indicated in Figs. 1, 2, and 3, to vary the ferrostacic pressure against the blast as the process continues, or, in a fixed converter, by having the tuyeres movable and dropping them as required. By thus adjusting the relative positions of the blast and metal a continuous supply of new or fresh metal can be brought into the area or zone of conversion in such exactly-regulated quantities as will maintain the proportion of the metal acted on relative to the volume of air as is necessary to the production of the best results. The raising of the level of the metal could be effected by adding more metal or by means of a false bottom, which would raise the whole of the metal, or otherwise, so as by occupying part of the space previously occupied by the metal to restore the surface-level.

By tilting the converter or otherwise varying the amount of metal presented to the action of the blast, the extent to which the metal is divided or atomized may be regulated at the will of the operator, and by thus throwing the iron by a regulated action into a sort of spray, or minutely subdividing or atomizing it, the largest possible surface is presented to the atmosphere, and the particles of carbon, silicon, and phosphorus, or other combustible matter, are exposed and commingled with the oxidizing agent, and there is a rapid and intense combustion of said combustible elements and such a high temperature is imparted to the metal as renders it extremely fluid and mobile. The extent of the spraying action will depend on the extent to which the metal is presented to the spraying means. As this is regulated at the will of the operator by the means described, the feeding of the metal, the rapidity of the conversion and degree of heat, and the degree of the fluidity of the metal may all be controlled.

I do not limit myself to the use of means described for securing the simultaneous conversion and violent local atomic agitation of the metal, nor to the specific construction of apparatus or arrangement of parts shown for carrying out said process, as this may be done with various means in different ways, as will be evident to those skilled in the art.

I claim—

1. In the conversion of molten cast or crude iron into malleable iron or steel, the mode substantially as hereinbefore described, consisting in subjecting the molten metal to the action of a converting blast on the surface portion only of the metal, and in lowering the level of the blast as the conversion proceeds, substantially as described.

2. In the conversion of crude iron into malleable iron or steel, subjecting the bath of molten metal to the action of an oxidizing-blast upon a limited portion of the metal at the surface only of the bath, and maintaining the relative positions of the metal surface and the blast during the process of conversion, substantially as described.

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

GUSTAVE L. ROBERT.

Witnesses:

F. L. FREEMAN,

J. S. BARKER.