W. SMITH.

MANUFACTURE OF PUDDLED IRON.

To all whom it may concern:

Be it known that I, WILLIAM SMITH, of Pittsburgh, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful Improvement in the Manufacture of Puddled Iron; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

Figure 1, Sheet 1, is a view in elevation of my improved combined Bessemer converter and puddler. Fig. 2 is horizontal sectional view, looking downward. Fig. 3, Sheet 2, shows a front elevation, Figs. 1, 2, and 3 showing the converter in horizontal position for puddling; and Fig. 4 is a view in side elevation, showing the converter in vertical position for treating the charge by the Bessemer process.

My invention relates to the manufacture of balled or puddled iron by means of the Bessemer and puddling processes, carried on in the same chamber, vessel, or converter.

In the drawings, A represents a converter-body formed with a well, a, in its lower end, a swell or belly, a', at or about its middle zone, and a mouth, a', of about the diameter of well a. This body is constructed with an outer metallic shell, d, having a lining or fettling, d', of fire-clay, ganister, or other suitable materials. The air-chest B is secured to the body by means of a flange, d', formed on the lower end of shell d, and a cap or ring, b, which is bolted or otherwise secured to the rim b' of the air-chest, and extends over the flange d; also, the periphery of flange d' projects into a groove, b', made in the inner face of rim b'. In order to secure the tightness of joint without excessive friction between the flange d', ring b, and groove b', the adjacent faces of these parts are ground or turned true and smooth. As thus connected, the body A of the converter is free to be rotated on its longitudinal axis while the air-chest B remains stationary. Tuyeres c, supported by transverse bars or in other suitable way, are arranged in the lower end of body A for admitting blast to the converter. These tuyeres fill the end which they occupy, and rotate with the converter-body independent of air-chest B. A chamber, C, is made in this air-chest under the tuyeres, which is supplied by an air-pipe, C', leading from the periphery of the air-chest to the hollow or pipe-like trunnion E, from which suitable pipe-connections may lead to any suitable blast apparatus. A valve, e', in pipe C' may be used to open or close the pipe-passage as required. A branch-pipe, C'', having valve e'', may also lead off from pipe C' or from chamber C, for purposes presently to be described.

The converter is mounted or supported as follows: A band, I, surrounds and is secured to the outer surface of body A, in or near the plane or zone of belly a'. On the periphery of this band is a circumferential tongue, i, which fits into or is received by a groove, e, made in the inner edge of a rim, F, which also surrounds the converter in the plane of band I. This rim F is by preference made in two parts or plates, F', which are securely bolted together. On the rim are cast or otherwise secured trunnions E E', which have journal-bearings on frames H of sufficient height to permit free rotation of the converter on its trunnions; also, the tongue-and-groove connection between band I and rim F permits free rotation of the converter-body on its longitudinal axis. Rotary movement on trunnions E E' is effected by means of a gear-wheel, K, secured on the extended end of trunnion E', and a rack, K', which gears with wheel K and receives reciprocating motion from any suitable hydraulic or steam motor, such as are commonly used for such purposes. This movement on trunnions E E' is designed for tipping the converter from vertical to horizontal positions, and reverse, and it may be locked in such position by means of pawl m', the former being secured on trunnion E and the latter being pivoted on frame H. (See Fig. 1.) In order, however, to provide more substantial support for the converter in its horizontal position, and also to remove pressure and friction from band I and rim F, I make use of tracks N N', which are run into and out of position on the tracks T T', laid for the purpose. Rollers a a are mounted on the frames of these trucks in proper position and relation to form bearings for the converter at or near its ends, (see Figs. 1 and 3,) and thereby facilitate axial
rotation of the converter-body. In tipping the converter to its horizontal position the mouth is depressed below the horizontal sufficiently to permit the truck N to be run into place, when the mouth is again raised and the truck \( N' \) is run into place.

Rotary motion on its axis or within the rim \( P \) is given to the converter-body as follows: A power-shaft, \( R \), mounted on bracket \( r \), gears by pinion \( r \) with bevel-wheel \( R' \), which latter wheel is mounted idle on trunnion \( E' \); also, a bevel-pinion, \( s \), mounted on counter-shaft \( s' \), gears with wheel \( R' \), and, through pinion \( S \) and gear \( S' \), gives the desired motion to the converter. This may be a continuous rotary motion; or by reversing at proper intervals it may be made an oscillating motion.

Instead of wheels \( S, S' \), band-wheels or sheave-pulleys \( w, w' \) may be used with a suitable cable or band for giving motion to the converter, as described.

When in its horizontal position the mouth of the converter is closed by a door, \( P \), which is moved into and out of position by pulleys \( h, h' \) and track-rail \( P'. \) A bar, \( P', \) in front of the door serves to guide the door and hold it in position. These bars \( P', P'' \) may be supported from the bed of the plant in any convenient way. Flues \( p, p' \) are passed through the door \( P \), one of which, as \( p' \), has suitable pipe-connections with apparatus for supplying hydrogen gas or carbureted hydrogen to the converter, while the other, \( p' \), connects with a suitable escape-flue. The door may be made of any suitable materials adapted to withstand a high degree of heat. In its lower edge is a rabble-hole, \( s \), designed to admit the tools usually employed in hand-puddling; and thereby enable a workman to use such tools as assisting in the puddling and balling of the charge. The door is mounted independent of the converter-body, and permits of free rotary movement of the latter, the door \( P \) and air-chest \( B \) being stationary during such movement.

In operation a charge of molten metal is introduced into the converter and an air-blast turned on in the way usually practiced in carrying out the Bessemer operation. The refined metal and reduction of metal incident to such operation or treatment is continued until the converter is to the degree requisite for making into wrought-iron. To this point the use of the apparatus is substantially the same as in the beginning of the Bessemer process, the converter being in vertical position, as shown in Fig. 4. When the charge has in this way been refined and reduced to the desired degree for the purposes named the air-blast is shut off by valve \( e \), or otherwise, and the converter is turned upon its trunnions by rack and wheel \( K, K' \) into horizontal position, as represented in Figs. 1, 2, and 3, and is there supported by the trucks \( N, N' \), as before described. This being done, the door \( P \) is moved in front of it, so as to close, the mouth \( e' \) of the converter, as shown in Fig. 3, and the described connections are made with flues \( p' \) and \( p'' \), through which a supply of hydrogen or carbureted-hydrogen gas is admitted into the converter and onto and over the surface of the metal therein, which metal, upon the tipping of the converter, flows from the well \( z \) into the belly \( a' \). The presence of such hydrogen gas assists materially in refining the iron, and also in maintaining the requisite degree of heat within the converter to enable the puddling and balling to be performed with success. Instead, however, of admitting gas through flue \( p' \), as described, suitable pipe-connections may be made from branch pipe \( C' \) to the gas-supply, whereby such gas may be admitted through tuyeres \( e \) into the converter. In such construction the flues \( p' \) may be omitted or be used as escape-flues, though ordinarily the flue \( p'' \) will be found adequate for purposes of escape. While the heat is thus maintained by the inflowing gas the body \( A \) of the converter is rotated or oscillated on its axis, as before described, whereby the effects of mechanical puddling and balling are produced on the charge of metal. Such mechanical puddling may be and by preference is assisted by hand-puddling, as before described, and thereby a material advantage is secured over those furnaces which depend for puddling and balling upon mechanical means alone. When the charge of metal is thus balled in proper condition for rolling, the rotary motion of the converter is arrested, the door \( P \) is moved from in front of the converter-mouth, and the puddled ball is removed by depressing this end of the converter. The apparatus is then ready for another charge.

I am aware that it is not new with me to employ a converter in a vertical position for refining a charge of metal by an air-blast, and then, tipping such converter to a horizontal position, to give it rotary motion on its longitudinal axis to puddle the charge; and I make no claim herein to such features of construction alone considered, my invention relating more particularly to certain improvements in construction by which such double use of a converter is facilitated.

While I have described the use of the air-blast for decarburizing purposes I do not limit myself in this respect to any particular length of time during which this part of the operation may be continued, as, in fact, it may be continued only long enough to raise the temperature of the metal till it becomes highly fluid, say for only a few seconds. Carbon will of course be thus eliminated; but the most of the decarburizing work may best be done in the puddling operation referred to.

I claim as my invention:

1. The converter-body \( A \), in combination with band \( I \), rim \( F \), trunnions \( E, E' \), and supports \( H \), whereby the body has rotary movement on both its transverse and longitudinal axes, as described, and with an air-supply chest, \( C \), loosely secured to the body, as described, whereby such air-supply chest is mov-
able with the body on its transverse axis, but stationary with relation to rotary movement of the body on its longitudinal axis, and tuyeres c, substantially as set forth.

2. A converter-body, A, having a surrounding flange, c', at its bottom end, in combination with chambered bottom B, having rim b', cap or band b, tuyeres c, such bottom being adapted to permit axial rotation of the converter-body, the bottom being stationary, and blast-pipe C', substantially as set forth.

3. A converter, A, having a band, I, with tongue i, surrounding and secured to its middle zone, in combination with rim F, having groove e therein, adapted to receive tongue i, trunnions E E', and frames H for supporting the rim and converter, and mechanism for rotating the converter on its trunnions and also axially within the rim, substantially as and for the purposes set forth.

In testimony whereof I have hereunto set my hand.

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Witnesses:

R. H. WHITTLESEY,

C. L. PARKER.