(No Model.)

C. P. SHERK, J. L. RUTTER & S. GROH.

MANUFACTURE OF IRON.

No. 553,875. Patented Feb. 4, 1896.

Fig. 1.

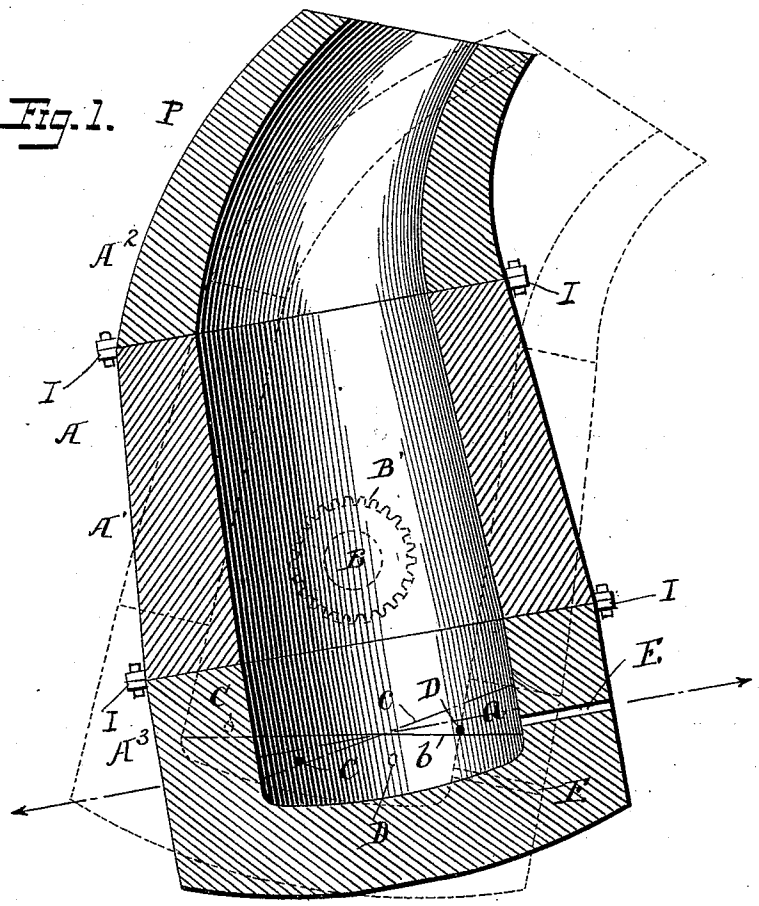
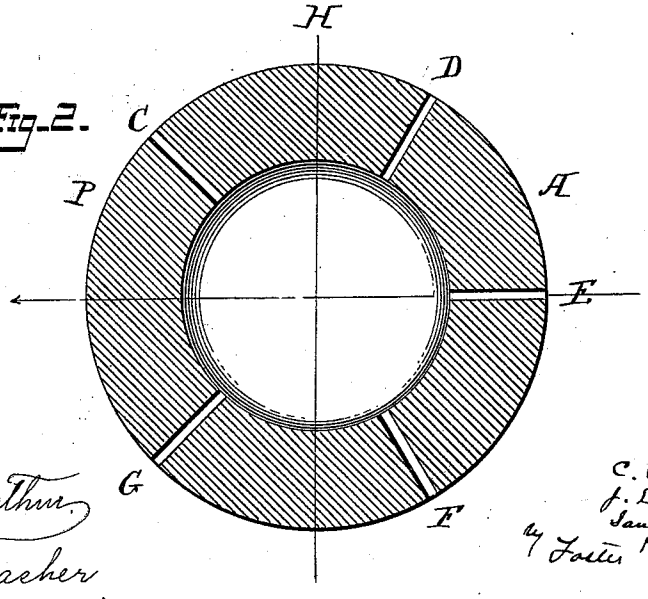


Fig. 2.



Witnesses
H. S. McArthur
E. L. Thrasher

Inventors
C. P. Sherk
J. L. Rutter
Saml. Groh
by Foster Freeman
Attorneys

UNITED STATES PATENT OFFICE.

CHARLES PENROSE SHERK AND JAMES L. RUTTER, OF LEBANON, AND SAMUEL GROH, OF LICKDALE, PENNSYLVANIA; SAID GROH ASSIGNOR TO SAID SHERK AND SAMUEL WEISS, OF LEBANON, PENNSYLVANIA.

MANUFACTURE OF IRON.

SPECIFICATION forming part of Letters Patent No. 553,875, dated February 4, 1896.

Application filed September 4, 1891. Serial No. 404,750. (No model.)

To all whom it may concern:

Be it known that we, CHARLES PENROSE SHERK and JAMES L. RUTTER, residing at Lebanon, and SAMUEL GROH, residing at Lickdale, Lebanon county, Pennsylvania, citizens of the United States, have invented certain new and useful Improvements in the Manufacture of Iron, of which the following is a specification.

Our invention relates to the method of and apparatus for converting crude or pig iron into malleable iron or steel, and it has for its object to provide an improved method and apparatus whereby the usual conversion may be carried out at a minimum cost, with the least waste of material, and to the best advantage.

To these ends our invention consists in a method of operation, and a construction of apparatus, substantially such as is hereinafter pointed out.

In the accompanying drawings we have represented the preferred form of apparatus for carrying out our invention in a manner sufficient to enable those skilled in the art to understand its essential features of construction and arrangement.

Figure 1 is a diagram showing a vertical section of a converter in two positions. Fig. 2 is a horizontal transverse section of the converter on the line of the arrows, Fig. 1.

In carrying out our process we apply the blast of air used in the conversion of the metal so that a portion of the blast enters the metal below its surface, in one general direction from one side of the converter, and a portion of the blast enters the converter above the surface of the metal, in another or opposing general direction from the opposite side of the converter, and by varying the relative relations of the separate blasts with the surface of the metal by suitable means, as a tilting converter, we are enabled to vary the application of the blast so as to regulate the amount applied to the surface of the metal of the bath and the amount injected into the bath below its surface in accordance with the requirements of any particular case, so that the action of the different blasts upon the metal may be completely and perfectly regulated and the baths of varying qualities, conditions, and compositions may be converted into malleable iron or steel of the desired quality.

Referring to the accompanying drawings, A represents a converter which may be of any desired form or type, but preferably substantially like that indicated in the drawings. The converter is shown as made of three sections $A' A^2 A^3$, as we find this is the most convenient construction, and the converter is mounted on suitable trunnions B, provided with a gear-wheel B', which is adapted to be connected to a hydraulic or other motor by means of which the converter can readily and quickly be tilted, not only in the operation of filling and pouring, but in the operation of converting the metal. The sections $A' A^2 A^3$ may be joined together by any suitable means. As shown, each section is provided at its edges with a series of perforated lugs I, adapted to coincide with corresponding lugs on the adjacent section and to receive bolts or other desirable securing devices which pass through the perforations in the lugs and hold said lugs together.

Arranged at a suitable distance from the bottom of the converter are the tuyeres C, D, E, F, G, which are shown as passing through the walls of the converter in a horizontal position, and are, of course, to be connected in the usual way with the air-blast apparatus. In the drawings we have shown five tuyeres, and while this is found to be a practical number our invention is not limited to this precise number, as this number may be varied to suit the requirements of any particular case. It is, however, important that the tuyeres should be arranged substantially in the manner indicated, or in an equivalent manner which will produce substantially the same result. Thus it will be seen that on the pouring side P of the converter there are a less number of tuyeres than upon the other side and the arrangement is different. Thus on the pouring side P we have shown the tuyeres C G, and these are arranged at an equal distance from the central line H passing through the converter in the plane of the trunnions of the converter. Thus

in the drawings the tuyeres C and G are arranged at an angle of forty-five degrees to the line H. Of course it will be understood that these angles may vary somewhat, the angles given being examples of arrangements we have found most satisfactory, although we have found that similar results can be attained with a variation in the angles. On the other side of the converter we have shown three tuyeres, tuyere E being arranged at right angles with the line H and the other tuyeres disposed at equal angles thereto.

Such being the preferred construction and arrangement of the converter in use, we supply the converter with a suitable amount of molten metal, which, if the converter were in its normal or vertical position, would rise somewhat above the tuyeres—as, for instance, the line *a;* but as in practice the converter is usually tilted or swung downward to receive the charge on its pouring side, the metal does not in the beginning assume this level. When the charge has been supplied, the converter is turned up to occupy substantially the position shown in full lines in Fig. 1, and the metal will assume a level in the converter on the line *b*, in which it will be seen that the tuyeres C and G are below the surface of the metal and on one side of a plane passing through the trunnions of the converter, while the tuyeres D, E and F on the opposite side of the converter are above the line of metal. In this position the pressure of the air on all the tuyeres being the same, it will be seen that more air will be admitted above the line of metal from one side of the converter than below it from the opposite side of the converter, and, moreover, as the metal above the tuyeres offers an obstruction to the passage of the air from the tuyeres there will be a relatively greater amount of air passing through the tuyeres above the surface of the metal than below the surface. This is the position we find most favorable for eliminating the silicon. It will be seen that at this stage of the process a larger proportion of the air is flowing over the surface of the bath, while a lesser portion is flowing into the body of the bath, the two portions flowing from tuyeres in the opposite sides of the converters in opposing directions, and while the air coming from these last tuyeres will aid in eliminating the silicon it also performs another important function, and that is to agitate the mass of the metal and aid in exposing every atom to the air-blast, so that the whole mass is more rapidly and thoroughly desiliconized.

When we find that the silicon has been practically eliminated, it is generally preferable to tilt the converter to substantially the position indicated in dotted lines in Fig. 1, in which the three tuyeres D, E, and F on one side of the converter will be below the surface, as indicated at the line *c*, while the tuyeres C and G on the opposite side will be above the surface, and then the operation of eliminating the carbon and perfecting the conversion is carried out. The degree of tilting and the time depend, of course, very much upon the character of the charge and the effect thereon of the air-blast.

It will be understood that by carefully watching the process the operator can tilt the converter more or less to immerse whichever tuyeres he desires, and, of course, he can do this at various times throughout the process, for while we have found the process first described as the most practicable in ordinary charges there are circumstances arising which require more or less tilting of the converter and at different periods of the process. For instance, if it is found that the metal of the bath is becoming heated too rapidly the converter can be tilted in such a manner as to retard this heating effect and avoid the oxidation of the metal.

When the process of conversion is practically completed, the converter is tilted in a position to pour the metal and the blast cut off.

While we have thus set forth the general characteristics of our process and the mode of carrying it out, it will be understood by those skilled in the art that the details can be varied to suit the requirements of any particular quality or condition of metal being treated, as it is well known that metals vary in relative proportions of silicon, carbon, &c., and of course in reducing such metals different amounts of oxygen from the air are required at different stages of the process. This can be thoroughly and practically regulated by the operator in noting the condition of the gases escaping from the mouth of the converter.

We have found that by the use of this apparatus in the manner set forth the silicon may be thoroughly and quickly eliminated from the metal without injuring the same, and then the manganese and carbon are eliminated and the metal thoroughly reduced, when it can be recarbonized to the desired degree. The metal thus produced is very uniform in character, every particle being brought equally and thoroughly under the influence of the blast, which will be mild and without producing excessive action or oxidation at one portion of the mass of metal over another, and the condition of the slag can be regulated, so as to make the process most economical and regular and so that there will not be an excessive absorption of the recarbonizer by the slag. Moreover, at no time need the metal become overheated or the slag become too fluid, as it is liable to do in the ordinary processes, as we find that the temperature of the metal may be perfectly controlled and the danger of oxidizing the metal and producing a too fluid slag is prevented.

While we have found under varying conditions more or less of the metal may be above the tuyeres at the starting, in the drawings we have indicated a converter adapted to re-

ceive a charge of two tons, and the tuyeres are arranged at such a distance from the bottom of the converter that when the metal is on the line *a* about two-thirds of the metal will be below the mouth of the tuyeres and one-third above, and when the converter is tilted to commence the operation the tuyeres C and G are about midway between the bottom and top surfaces of the metal, while the tuyeres D and F are substantially parallel to the surface and the tuyere E above the surface, and under these conditions we have found the most favorable results. It will be readily understood that as the lining becomes worn in the process of conversion these relations will vary somewhat initially, but they can be compensated for by tilting the converter more or less.

What we claim is—

1. In the conversion of crude or pig iron into malleable iron or steel, the method substantially as hereinbefore set forth which consists in simultaneously applying a portion of the blast across the bath above the surface of the metal, and a portion across the bath below, the portions of the blast being in opposing directions; thereby circulating the bath horizontally and effecting the conversion simultaneously.

2. In the conversion of crude or pig iron into malleable iron or steel, the method substantially as hereinbefore set forth which consists in simultaneously applying a larger portion of the air upon and across the surface of the bath, and a lesser portion of air beneath and across the surface of the bath the portions of the blast being in opposite directions.

3. In the conversion of crude or pig iron into malleable iron or steel, the method substantially as hereinbefore set forth which consists in first simultaneously applying a larger portion of the blast to the surface of the bath, and a lesser portion below the surface of the bath, and subsequently reversing the order and applying a lesser portion of the blast to the surface, and a greater portion below the surface the respective portions of the blast being in opposing directions in both conditions.

4. A tilting converter provided with a series of horizontal tuyeres arranged around the converter, there being a less number of tuyeres on the pouring side of the converter than upon the opposite side of the converter, substantially as described.

5. A tilting converter provided with a series of horizontal tuyeres, each being arranged on a radius from the center of the converter, the tuyeres on the pouring side being arranged at equal distances from the transverse central longitudinal plane of the converter, while the tuyeres on the opposite side are arranged at different angles to the same plane, substantially as described.

6. A tilting converter having two tuyeres on the pouring side, and having three tuyeres on the opposite side, one of which corresponds with the line passing through the center of the pouring side, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

C. PENROSE SHERK.
J. L. RUTTER.
SAMUEL GROH.

Witnesses:
J. S. BARKER,
F. L. FREEMAN.